WBS Dictionary as of 9/21/02
Run IIb Silicon Schedule

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
1.1	**Run IIb Silicon**	**10/2/00**	**7/22/05**	**$7,146,747**	**$1,041,673**	**$3,909,020**	**$12,097,439**

Notes

WBS Definition-
This summary task covers the effort to develop, build, test, and install the silicon tracker for the D0 Run 2b upgrade project. The detector will replace the existing silicon microstrip tracker currently in use for Run 2a, and will enable operations up to integrated luminosities of 15 pb-1 or more.

Design Parameters

Layer	Nphi	R(mm) Axial	R(mm) Stereo	# Sensors in z	# Sensors Total	Sensor Width (mm)	Readout Pitch (μm)	# Readout in z	# Chips per Readout	Chips Total	# Hybrids Total
0A	12	17.95	--	12	72	15.50	50	12	2	144	72
0B	12	24.80	--	12	72	15.50	50	12	2	144	72
1A	12	34.75	--	12	72	24.97	58	12	3	216	36
1B	12	39.00	--	12	72	24.97	58	12	3	216	36
2A	12	54.57	57.43	12	144	40.34	60	8	5	480	48
2B	12	70.04	72.90	12	144	40.34	60	8	5	480	48
3A	18	89.45	86.59	12	216	40.34	60	8	5	720	72
3B	18	103.67	100.81	12	216	40.34	60	8	5	720	72
4A	24	116.52	119.38	12	288	40.34	60	8	5	960	96
4B	24	130.48	133.35	12	288	40.34	60	8	5	960	96
5A	30	148.83	145.97	12	360	40.34	60	8	5	1200	120
5B	30	162.75	159.75	12	360	40.34	60	8	5	1200	120
Total					**2304**					**7440**	**888**

1.1.1	**Sensors**	**10/2/00**	**7/28/04**	**$2,272,126**	**$233,777**	**$50,720**	**$2,556,623**

Notes

WBS Definition-
This summary element includes the development and procurement of commercial silicon sensors for all layers of the detector, as well as the setup of detector probing stations, sensor probing and acceptance testing, radiation testing, and vendor qualification and monitoring. There are 3 sensor types in D0 Run 2b silicon detector - L0, L1 and L2. L0 and L1 have the most stringent constraints in terms of the radiation hardness.

Risk Mitigation-
The technical and scope sensor risks are low because we are using single-sided sensors and prototypes have been built which satisfy our requirements. The sensor cost is a significant fraction of the budget so it has a large cost impact, but the probability of the cost going up is very small as we have a quote. The sensors have to be delivered on time or there will be a schedule slippage. Currently, the sensor delivery is not driving the schedule and there are a few months of slack. Schedules by Hamamatsu and their reputation allows us to assign a low probability of the schedule slippage.

1.1.1.1	**Probing Equipment Setup**	**10/2/00**	**7/28/04**	**$166,450**	**$76,490**	**$0**	**$242,940**

Notes

WBS Definition-
This summary element includes the the setup and maintenance of detector probing stations at the MRI institutions and Fermilab.

M&S BOE-
The contingency on this task is set to 0 as they are all fixed costs associated with the MRI grant.

Labor BOE-
The contingency for all tasks is 50% unless they are carried out by the MRI institute or are in the past. Physicist contingency is assigned 50%

1.1.1.1.1	**MRI Sites**	**10/2/00**	**7/28/04**	**$166,450**	**$76,490**	**$0**	**$242,940**

Notes

WBS Definition-
This summary element includes the the setup and maintenance of detector probing stations at three MRI institutions.

1.1.1.1.1.1	Kansas State Site	10/2/00	11/26/01	$0	$17,390	$0	$17,390

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
15	*ElecTechU*	*20%*	*464 h*	*0 w*	*10/2/00*	*11/26/01*	*$0*	*$0*	*$0*	*$0*	*0 h*	*0 h*	*464 h*	*0 h*
18	*PhysicistU*	*100%*	*2,320 h*	*0 w*	*10/2/00*	*11/26/01*	*$0*	*$0*	*$0*	*$0*	*0 h*	*0 h*	*2,320 h*	*0 h*
48	*MandS*	*17,390*	*17,390*	*0 w*	*10/2/00*	*11/26/01*	*$17,390*	*$0*	*$17,390*	*$0*		*0*	*17,390*	*0*

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost

"Kansas State Site" continued

Notes

WBS Definition-
The setup of detector probing stations at Kansas State Univ.

M&S BOE-
A technician at the 20% level for the duration is needed to setup the probestation and define the associated software. The labor cost, paid for from the MRI, is $42K*1.274(benefits)*1.455(IDC)=$77,854 per year. This gives a total cost of $17,390. The silicon sensor probing facility has been set up at Kansas State University at no cost to the project.

Labor BOE-
We assume 20% of one university technician to setup the probing equipment. The probing time setup is 47 weeks at SUNY at Stony Brook and the CINVESTAV probing sites; it is 58 weeks at KSU, since this is the first site and more time is needed for R&D and software setup. A physicist oversees the operation. The duration is based on our experience with Run2a silicon and CMS sensor probing.
We plan to perform IV and CV measurements and extensive strip-by-strip measurements, which will measure the strip leakage current, coupling capacitance and polysilicon resistor values. The software to perform these measurements is all LabView based. We estimate that it will take one month to adopt the software employed during previous sensor probing to the new sensor configurations. Setting up all equipment, which consists of about 15 components, will take 8 weeks.

1.1.1.1.1.2	CINVESTAV Site	10/2/01	12/13/02	$83,225	$0	$0	$83,225

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
15	ElecTechU	20%	480 h	0 w	10/2/01	12/13/02	$0	$0	$0	$0	0 h	0 h	377.6 h	102.4 h
18	PhysicistU	10%	240 h	0 w	10/2/01	12/13/02	$0	$0	$0	$0	0 h	0 h	188.8 h	51.2 h
48	MandS	83,225	83,225	0 w	10/2/01	12/13/02	$83,225	$0	$83,225	$0		0	75,036.7	8,188.3

Notes

WBS Definition-
The setup of detector probing stations at CINVESTAV in Mexico.

M&S BOE-
$83,225 is total cost for probe station setup. The cost is broken down as listed in the table.

Clean Room Equipment				
			price	
Keithley 237	Keithley Instrunents	Joanne Pamer	$ 7,195.00	
Rack Mounting kit	Keithley Instrunents		$ 134.10	
HP LCR 4284A	Agilent	Bruce Kempin	$ 9,944.00	
Cable option	Agilent	316-636-4934	included	
Test Leads	Agilent		$ 320.00	
Probe Station		Harry Vine <HVine@aol.com>		$65,952.77
REL-6100 8 in. Semi-Auto		$ 42,320.00		
Controller, probe type I	Celeron 450MHz, 64Mb,	6.4GB	$ 2,802.50	
Video adapter		$ 142.50		
Miscrocope 2x,10x,20x		$ 7,983.00		
Digitizer		$ 1,401.25		
positioner left		$ 1,181.50		
positioner right		$ 1,181.50		
positioner right		$ 1,181.50		
Probe FGI07		$ 175.50		
Probe FGI07		$ 175.50		
Probe FGI07		$ 175.50		
coax probe		$ 382.50		
coax probe		$ 382.50		
cables		$ 324.00		
probe points, box of 10		$ 495.00		
Adapter		$ 1,000.00		
Needle, box of 25		$ 133.00		
vacuum, kit		$ 675.00		
pump		$ 475.00		
Installation		$ 2,550.00		
s&h		$ 815.52		
Guard Box	self made			

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost

"CINVESTAV Site" continued

Notes

Storage			
refrigerator			
Misc.			
Filter 20x20x1 type dp 1-40	Airguard Industries		
Filter 12x24x1	Airguard Industries		
Gloves			
Coats (size M/L/xL)			
Hair cover			
Shoe Cover	VWR Critical Environment Solution		
Total equipment cost		$ 83,225.87	

A technician labor needed to setup the probestation and define the associated software is provided in-kind. (not on the MRI)

Labor BOE-
We assume 20% of one university technician to setup the probing equipment. The duration is based on our experience with Run2a silicon and CMS sensor probing. We plan to perform IV and CV measurements and extensive strip-by-strip measurements, which will measure the strip leakage current, coupling capacitance and polysilicon resistor values. The software to perform these measurements is all LabView based. We estimate that it will take two weeks to install the software for probing as developed by Kansas State University. Setting up all equipment, which consists of about 15 components, will take 8 weeks. A University physicist will oversee the setup. The technician time is provided as an inkind match and is not charged to the project.

1.1.1.1.1.3	Stony Brook Site	10/2/01	10/9/02	$83,225	$14,100	$0	$97,325

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
15	ElecTechU	20%	408 h	0 w	10/2/01	10/9/02	$0	$0	$0	$0	0 h	0 h	377.6 h	30.4 h
18	PhysicistU	10%	204 h	0 w	10/2/01	10/9/02	$0	$0	$0	$0	0 h	0 h	188.8 h	15.2 h
48	MandS	97,325	97,325	0 w	10/2/01	10/9/02	$97,325	$0	$97,325	$0		0	93,910.84	3,414.16

Notes

WBS Definition-
The setup of detector probing stations at SUNY StonyBrook

M&S BOE-
$83,225 is total cost for probe station setup. The breakdown of the cost is given in the setup of the CINVESTAV, Mexico City, probe station.
A technician at the 20% level for the duration is needed to setup the probestation and define the associated software. The labor cost, paid for from the MRI, is $42K*1.274(benefits)*1.455(IDC)=$77,854 per year. This gives a total cost of $14,100.

Labor BOE-
We assume 20% of one university technician to setup the probing equipment. The probing time setup is 51 weeks at SUNY at Stony Brook. The duration is based on our experience with Run2a silicon and CMS sensor probing. We plan to perform IV and CV measurements and extensive strip-by-strip measurements, which will measure the strip leakage current, coupling capacitance and polysilicon resistor values. The software to perform these measurements is all LabView based. We estimate that it will take two weeks to install the software for probing as developed by Kansas State University. Setting up all equipment, which consists of about 15 components, will take 8 weeks. A University physicist will oversee the setup.

1.1.1.1.1.4	Maintenance and Training Kansas State Site	10/2/01	7/28/04	$0	$22,500	$0	$22,500

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
15	ElecTechU	10%	560 h	0 w	10/2/01	7/28/04	$0	$0	$0	$0	0 h	0 h	188.8 h	371.2 h
48	MandS	22,500	22,500	0 w	10/2/01	7/28/04	$22,500	$0	$22,500	$0		0	6,649.86	15,850.14

Notes

WBS Definition-
Maintenance of the Probe Station Setup for the duration of the project.

M&S BOE-
We expect the maintenance of the probe station setup tp take 3 to 4 hours per week on average, or about 1 day per month. This corresponds to a technician at the 10% level. The labor cost for the technician is paid out of the MRI at a rate of $42,000*1.274(benefits)*1.455(IDC)=$77,854 per year. This gives a total cost of $22,500 for maintenance for the duration of the project. Regular maintenance of the probe stations is taken to start once sensors are being received and is expected to terminate once the last sensor has been received and probed.

Labor BOE-
The probe station setup consists of very few parts. Once the system is working we expect very little maintenance at the level of one day per month. This is a conservative estimate given our experience with the maintenance of the probe stations at Fermilab.

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
1.1.1.1.1.5	Maintenance and Training CINVESTAV Site	10/2/01	7/28/04	$0	$0	$0	$0

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
15	ElecTechU	10%	477.5 h	0 w	10/2/01	7/28/04	$0	$0	$0	$0	0 h	0 h	106.3 h	371.2 h

Notes

WBS Definition-
Maintenance of the Probe Station Setup for the duration of the project.

M&S BOE-
We expect the maintenance of the probe station setup tp take 3 to 4 hours per week on average, or about 1 day per month. This corresponds to a technician at the 10% level. The labor cost for the technician is an in-kind contribution.

Labor BOE-
The probe station setup consists of very few parts. Once the system is working we expect very little maintenance at the level of one day per month. This is a conservative estimate given our experience with the maintenance of the probe stations at Fermilab.

1.1.1.1.1.6	Maintenance and Training Stony Brook Site	10/2/01	7/28/04	$0	$22,500	$0	$22,500

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
15	ElecTechU	10%	560 h	0 w	10/2/01	7/28/04	$0	$0	$0	$0	0 h	0 h	188.8 h	371.2 h
48	MandS	22,500	22,500	0 w	10/2/01	7/28/04	$22,500	$0	$22,500	$0		0	6,649.86	15,850.14

Notes

WBS Definition-
Maintenance of the Probe Station Setup for the duration of the project.

M&S BOE-
We expect the maintenance of the probe station setup tp take 3 to 4 hours per week on average, or about 1 day per month. This corresponds to a technician at the 10% level. The labor cost for the technician is paid out of the MRI at a rate of $42,000*1.274(benefits)*1.455(IDC)=$77,854 per year. This gives a total cost of $22,500 for maintenance for the duration of the project. Regular maintenance of the probe stations is taken to start once sensors are being received and is expected to terminate once the last sensor has been received and probed.

Labor BOE-
The probe station setup consists of very few parts. Once the system is working we expect very little maintenance at the level of one day per month. This is a conservative estimate given our experience with the maintenance of the probe stations at Fermilab.

1.1.1.1.2	**Fermilab Probing Setup Tasks**	**10/1/01**	**11/6/02**	**$0**	**$0**	**$0**	**$0**

Notes

WBS Definition-
This summary element includes the the setup and maintenance of detector probing stations at Fermilab.

1.1.1.1.2.1	Fermilab Site Setup	10/1/01	3/28/02	$0	$0	$0	$0

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
17	PhysicistF	10%	96 h	0 w	10/1/01	3/28/02	$0	$0	$0	$0	0 h	0 h	96 h	0 h

Notes

WBS Definition-
The setup of detector probing stations at Fermilab

M&S BOE-
Over the course of the last years Fermilab has invested a lot of resources in setting up the Silicon Detector Center at the laboratory (SiDet). It is a worldclass facility for the design, testing, production and assembly of silicon detectors. The Run2a silicon detectors for CDF and Dzero were built at this facility. The silicon detectors for Run2b will also be built at this Center. SiDet has as part of its infrastructure a battery of Coordinate Measuring Machines (CMM's), three semi-automatic wirebonders, two automatic wirebonders and five probestations some of which are fully automatic. In addition there is a lot of additional equipment available to the projects for the design and construction of the projects. All equipment exists already and as such there is no M&S cost associated with the setup of probe stations at Fermilab.

Labor BOE-
We assume 10% of a physicist to setup the probing equipment. The setup time is taken to be half the time it needs to setup the site at Kansas State University, because all of the infrastructure exists already at Fermilab. The equipment only needs to be adapted to the new sensors. We plan to perform IV and CV measurements and extensive strip-by-strip measurements, which will measure the strip leakage current, coupling capacitance and polysilicon resistor values. The software to perform these measurements is all LabView based. We estimate that it will take one month to develop and adopt the software employed during previous sensor probing to the new sensor configurations.

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
1.1.1.1.2.2	Maintenance Fermilab Site	10/1/01	10/29/02	$0	$0	$0	$0

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
17	PhysicistF	5%	95.2 h	0 w	10/1/01	10/29/02	$0	$0	$0	$0	0 h	0 h	88.6 h	6.6 h

Notes

WBS Definition-
Maintenance of the Probe Station Setup for the duration of the R&D phase

M&S BOE-
We expect the maintenance of the probe station setup tp take 3 to 4 hours per week on average, or about 1 day per month. At Fermilab, a physicist is already performing this task.

Labor BOE-
The probe station setup consists of very few parts. Once the system is working we expect very little maintenance at the level of one day per month. This is a conservative estimate given our experience with the maintenance of the probe stations at Fermilab.

1.1.1.1.2.3	Certify probing stations/site	10/10/02	11/6/02	$0	$0	$0	$0

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
17	PhysicistF	100%	160 h	0 w	10/10/02	11/6/02	$0	$0	$0	$0	0 h	0 h	0 h	160 h
18	PhysicistU	100%	160 h	0 w	10/10/02	11/6/02	$0	$0	$0	$0	0 h	0 h	0 h	160 h

Notes

WBS Definition-
Verifying the calibrations of each probe station site with a set of common sensors which will be interchanged between the various sites and the results compared.

M&S BOE-
no costs associated with this line

Labor BOE-
Overseen by MRI Senior Physicist coordinated with the Fermilab physicist who has set up the probe stations. A similar certification procedure was performed for the CMS project and it took 4 weeks in coordination with all of the sites.

1.1.1.1.3	**Sensor Probing Equipment Setup And Certificatior**	**11/6/02**	**11/6/02**	**$0**	**$0**	**$0**	**$0**

Notes

WBS Definition-
Milestone: Completion of Setup of Sensor Probing Equipment

1.1.1.2	**L0 Sensors**	**10/1/01**	**12/3/03**	**$232,946**	**$36,795**	**$12,192**	**$281,933**

Notes

WBS Definition-
Summary task that describes the design, prototyping, production, and testing of all sensors for L0.
The decision on vendor is based on L1 prototypes ordered from two vendors - ELMA and HPK

M&S BOE-
The contingency follows the guidelines except for the following:
Elma tasks have 0% contingency as they are mostly in the past.
The production task has 75% contingency to account for both fluctuations in the Japanese Yen with respect to the dollar and also to allow for a batch problem with the sensors.

Labor BOE-
The contingency for all tasks is 50% unless they are carried out by the MRI institute or are in the past. Physicist contingency is assigned 50%

1.1.1.2.1	Development of L0 masks	10/29/01	11/27/01	$0	$0	$7,040	$7,040

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
21	DesignerF	100%	160 h	0 w	10/29/01	11/27/01	$7,040	$0	$7,040	$0	0 h	0 h	160 h	0 h

Notes

WBS Definition--
Develop drawings for the prototype sensors for Layer 0 for the silicon detector.

M&S BOE--
No M&S cost associated with this task.

Labor BOE-

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
"Development of L0 masks" continued							

Notes
Based on time spent.

1.1.1.2.2	**MRI Work on L0 Sensors**	**10/1/01**	**12/3/03**	**$69,380**	**$29,000**	**$0**	**$98,380**

Notes
WBS Definition-
This summary element includes all of the tasks for prototyping, production, and testing for the L0 sensors performed by the MRI institutions (KSU, StonyBrook, CINVESTAV, Moscow State Univ.)

1.1.1.2.2.1	Develop Specifications	10/1/01	10/26/01	$0	$0	$0	$0

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
18	PhysicistU	100%	160 h	0 w	10/1/01	10/26/01	$0	$0	$0	$0	0 h	0 h	160 h	0 h

Notes
WBS Definition-
Design and layout specifications for L0 sensors. This includes coordinating with the mechanical and electrical design teams to verify that the sensors meet those criteria as well as the physics operational criteria.

M&S BOE-
no costs on this line

Labor BOE-
In conjunction with the Run2b silicon group, the TDR specifications were written and the designs were verified for production with senior physicist experts. This time is the amount of time actually spent.

1.1.1.2.2.2	**ELMA**	**10/29/01**	**8/26/02**	**$69,380**	**$11,000**	**$0**	**$80,380**

Notes
WBS Definition-
Prototype sensors will be purchased from ELMA and probed. This summary task includes all work necessary for this. Two batches of L0 prototypes (20 sensors in each batch) were ordered from ELMA for two reasons - to qualify this fairly new to this market company and have sensors for prototyping studies early in the project. One set of prototypes was ordered prior to the start of this schedule and is not included in the project.

1.1.1.2.2.2.1	Order sensors (KSU)	10/29/01	11/27/01	$0	$0	$0	$0

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
18	PhysicistU	15%	24 h	0 w	10/29/01	11/27/01	$0	$0	$0	$0	0 h	0 h	24 h	0 h

Notes
WBS Definition--
Contacting the vendor and putting the paperwork through to place the order for prototype ELMA sensors.

M&S BOE--
No M&S cost associated with this task.

Labor BOE--
One University physicist at spending 3 days on this task. This is based on previous vendor contact time with this vendor from Run2a.

1.1.1.2.2.2.2	Develop prototype masks	11/28/01	1/3/02	$54,000	$0	$0	$54,000

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
18	PhysicistU	100%	160 h	0 w	11/28/01	1/3/02	$0	$0	$0	$0	0 h	0 h	160 h	0 h
48	MandS	54,000	54,000	0 w	11/28/01	1/3/02	$54,000	$0	$54,000	$0		0	54,000	0

Notes
WBS Definition--
Work done by senior physicist for drawing of all masks needed to produce prototype L0 sensors at ELMA. This work is done in conjunction with the vendor.

M&S BOE--
$54000 is based on a quote received through Moscow State University, consisting of $50,040 for the masks and an additional $3,960 in overhead at Moscow State University.

Labor BOE--
A collaborating physicist designs the masks. One University physicist at full time for a month is needed. Similar drawings were made for Run2a sensors by the same physicist. This is also based on work actually performed.

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
1.1.1.2.2.2.3	Produce prototype sensors (KSU)	1/4/02	6/28/02	$15,380	$0	$0	$15,380

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
48	MandS	15,380	15,380	0 w	1/4/02	6/28/02	$15,380	$0	$15,380	$0		0	15,380	0

Notes

WBS Definition--
Production and testing by vendor of L0 prototype sensors.

M&S BOE--
Based on quote from Moscow State Univ. 6/7/01
Masks: 1 set at $7000
5 wafers each at $400 Oxygenated with double side polish: total $2000
5 wafers each at $400 Oxygenated with single side polish: total $2000
5 wafers each at $400 non-oxygenated with double side polish: total $2000
5 wafers each at $400 non-oxygenated with single side polish: total $2000
S&H, insurance $380
Total $15,380

Labor BOE--
no project resources are needed on this task

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
1.1.1.2.2.2.4	Probe prototypes sensors (MRI)	7/1/02	8/26/02	$0	$11,000	$0	$11,000

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
15	ElecTechU	90%	288 h	0 w	7/1/02	8/26/02	$0	$0	$0	$0	0 h	0 h	288 h	0 h
18	PhysicistU	25%	71.6 h	0 w	7/1/02	8/26/02	$0	$0	$0	$0	0 h	0 h	71.6 h	0 h
48	MandS	11,000	11,000	0 w	7/1/02	8/26/02	$11,000	$0	$11,000	$0		0	11,000	0

Notes

WBS Definition--
We plan to perform two types of tests. Partial test consists of the visual inspection, IV and CV measurements. Full test adds extensive strip-by-strip measurement - strip leakage current, coupling capacitance, polysilicon resistor values. Our plan is to fully test all prototypes for L0

M&S BOE--
We estimate 1.5 hours needed for the partial test for each sensor while the full test requires 5 hours. These estimates are based on previous experience with prototype sensors for D0 Run 2b as well as CMS.

University technicians perform sensor-probing tests. We assume $42K of yearly salary. 27.4% is added for benefit cost and 45.5% for indirect cost. There will be a setup time of 4 days and then there will be 40 sensors to probe. This gives a total testing time of 40 days. Assume that 90% of an FTE is needed during this time at a total cost of $10,950 based on estimate from KSU.

Labor BOE--
See above for technician time which is charged as M&S. In addition, a senior physicist oversees the project assumed to take 2 weeks on their full time.

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
1.1.1.2.2.3	Develop sensor probing procedures	7/1/02	7/29/02	$0	$0	$0	$0

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
18	PhysicistU	25%	80 h	0 w	7/1/02	7/29/02	$0	$0	$0	$0	0 h	0 h	80 h	0 h

Notes

WBS Definition-
Development of QC procedures for sensors to be tested by D0 based on prototypes received.

M&S BOE-
no costs are included on this line

Labor BOE-
Done by senior physicist at university. It is expected that the physicist will review the testing being done on the ELMA sensor prototypes and modify the testing plan as needed. The procedures will be submitted to the Run2b group for approval. This process is foreseen to take 4 weeks, with only quarter of the time needed by the physicist to marshal the progress.

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
1.1.1.2.2.4	Develop final sensor specifications	2/6/03	2/19/03	$0	$0	$0	$0

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
18	PhysicistU	100%	80 h	0 w	2/6/03	2/19/03	$0	$0	$0	$0	0 h	0 h	0 h	80 h

Notes

WBS Definition-
Design and layout specifications for production sensors. Here it is verified that sensors meet: electrical, radiation, and mechanical specs by checking results on prototypes.

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
"Develop final sensor specifications" continued							

Notes

M&S BOE-
There are no costs associated with this line

Labor BOE-
A full time senior physicist oversees that all checks are made. The estimate of 2 weeks is based on the prototyping specifications which have already been done for Run2b.

1.1.1.2.2.5	Probe L0 sensors (MRI)	9/9/03	12/3/03	$0	$18,000	$0	$18,000

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
15	ElecTechU	100%	480 h	0 w	9/9/03	12/3/03	$0	$0	$0	$0	0 h	0 h	0 h	480 h
18	PhysicistU	15%	72 h	0 w	9/9/03	12/3/03	$0	$0	$0	$0	0 h	0 h	0 h	72 h
48	MandS	18,000	18,000	0 w	9/9/03	12/3/03	$18,000	$0	$0	$18,000		0	0	18,000

Notes

WBS Definition-
QC Testing done by D0 at MRI centers on a fraction of the production L0 sensors. We plan to perform two types of tests. Partial test consists of the visual inspection, IV and CV measurements. Full test adds extensive strip-by-strip measurement - strip leakage current, coupling capacitance, polysilicon resistor values.

M&S BOE-
University technicians perform sensor-probing tests. We assume $42K of yearly salary. 27.4% is added for benefit cost and 45.5% for indirect cost. There will be a setup time of 6 days for this test and then 216 sensors are produced. Each of these sensors will have the partial test done (1.5 hours per sensor) and 10% of the sensors will have the full test done (5 hours per sensor). The total time probing is estimated at 432 hours +6 day setup or 60 days and uses 100% of the technician's time. The total cost is then $18,000.

Labor BOE-
See above for technician time estimate. The operation is overseen by a senior physicist who is foreseen to take about 2 weeks of their time during this period. This estimate is based on the prototype testing as well as that from CMS.

1.1.1.2.3	**Irradiation Testing at KSU**	**7/16/02**	**10/6/03**	**$2,900**	**$7,795**	**$0**	**$10,695**

Notes

WBS Definition-
Prototype sensors and test structures from production sensors will be irradiated using protons to assure that the L0 sensors will meet the specifications. This summary task includes all work necessary for this.

1.1.1.2.3.1	**R&D Irradiation of L0**	**7/16/02**	**1/13/03**	**$2,900**	**$6,595**	**$0**	**$9,495**

Notes

WBS Definition-
Irradiate L0 sensors prototypes for R&D

1.1.1.2.3.1.1	Perform irradiation testing on prototypes	7/16/02	10/8/02	$2,900	$6,595	$0	$9,495

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
6	ElecEngU	10%	48 h	0 w	7/16/02	10/8/02	$0	$0	$0	$0	0 h	0 h	5.28 h	42.72 h
15	ElecTechU	20%	96 h	0 w	7/16/02	10/8/02	$0	$0	$0	$0	0 h	0 h	10.57 h	85.43 h
18	PhysicistU	50%	240 h	0 w	7/16/02	10/8/02	$0	$0	$0	$0	0 h	0 h	26.4 h	213.6 h
48	MandS	9,495	9,495	0 w	7/16/02	10/8/02	$9,495	$0	$9,495	$0		0	1,044.45	8,450.55

Notes

WBS Definition-
Tests to assure performance done at radiation facility

M&S BOE-
Different jigs are required to hold different sensor types and test structures. They are manufactured by a machine shop. Cost for jig material is $400 and 50 machine shop hours at $40/hour. Total for machining jigs of $2400.
A device is needed to control the beam. Beam is swept across the irradiated target by changing the electric field on a deflector. The electronics to control it is designed by the Electronics Design Lab of KSU. Estimated cost for the DAQ system components is $500 and 50 hours of electronics engineering time at EDL at $60/hour for a total of $3500.
Total irradiation time for these sensors is 12 weeks. Based on experience with pilot runs, irradiation work requires 20% of an FTE of a University technician, who gets paid at an annual rate of $42K*1.274 (benefits)*1.455(indirect cost) = $77,854. The cost for 12 weeks of a technician at 20% is thus: $77,854*0.2*12/52 = $3595.
Total cost: $9495.

Labor BOE-
See above for technician time. A senior physicist oversees the operation and from the prototyping tests will take approximately 6 weeks of their time on this task.

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
1.1.1.2.3.1.2	Analyze prototype test results	10/9/02	1/13/03	$0	$0	$0	$0

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
47	Student	30%	144 h	0 w	10/9/02	1/13/03	$0	$0	$0	$0	0 h	0 h	0 h	144 h

Notes

WBS Definition-
Analysis of all test results including radiation studies

M&S BOE-
No M&S costs associated with this task.

Labor BOE-
Based on prototyping work

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
1.1.1.2.3.2	Radiation Testing L0 Test Structures	9/9/03	10/6/03	$0	$1,200	$0	$1,200

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
15	ElecTechU	20%	32 h	0 w	9/9/03	10/6/03	$0	$0	$0	$0	0 h	0 h	0 h	32 h
18	PhysicistU	20%	32 h	0 w	9/9/03	10/6/03	$0	$0	$0	$0	0 h	0 h	0 h	32 h
48	MandS	1,200	1,200	0 w	9/9/03	10/6/03	$1,200	$0	$0	$1,200		0	0	1,200

Notes

WBS Definition-
Tests to assure performance done at radiation facility

M&S BOE-
Technician labor is paid for by an MOU. Total irradiation time for these sensors is 4 weeks. Based on experience with pilot runs, irradiation work requires 20% of an FTE of a University technician, who gets paid at an annual rate of $42K*1.274(benefits)*1.455(indirect cost) = $77,854. The cost for 4 weeks of a technician at 20% is thus: $77,854*0.2*4/52 = $1200.
Total cost: $1200.

Labor BOE-
See above.

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
1.1.1.2.4	**Choose L0 Silicon Sensor Technology**	**2/5/03**	**2/5/03**	**$0**	**$0**	**$0**	**$0**

Notes

WBS Definition-
Milestone: The choice of vendor and technology for the L0 sensors is made.

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
1.1.1.2.5	**Fermilab Production**	**2/20/03**	**12/3/03**	**$160,666**	**$0**	**$5,152**	**$165,818**

Notes

WBS Definition-
Summary task that describes all design, production, and testing of final sensors done at Fermilab.

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
1.1.1.2.5.1	Develop final masks and Production Readiness	3/20/03	4/16/03	$0	$0	$3,520	$3,520

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
17	PhysicistF	50%	80 h	0 w	3/20/03	4/16/03	$0	$0	$0	$0	0 h	0 h	0 h	80 h
21	DesignerF	50%	80 h	0 w	3/20/03	4/16/03	$3,520	$0	$0	$3,520	0 h	0 h	0 h	80 h

Notes

WBS Definition--
Develop final masks for the sensors for Layer 0 for the silicon detector.

M&S BOE--
No M&S cost associated with this task.

Labor BOE--
One Fermilab designer at 50% for the duration to make the sensor drawings. The time allocated is based on Run2a experience.
One physicist at 50% of his time to interact with the designer to ensure that the drawings are made according to the specifications.

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
1.1.1.2.5.2	Bid final sensor order	2/20/03	3/19/03	$0	$0	$0	$0

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
17	PhysicistF	10%	16 h	0 w	2/20/03	3/19/03	$0	$0	$0	$0	0 h	0 h	0 h	16 h

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost

"Bid final sensor order" continued

Notes

WBS Definition--
Submit the requisition to the Fermilab business office and interact with the vendor to obtain a final tender for the sensor production order

M&S BOE--
No M&S cost associated with this task

Labor BOE--
It is expected that a physicist will spend half a day per week on seeing the order through and interacting with the vendor.

1.1.1.2.5.3	Order production sensors	3/20/03	4/16/03	$0	$0	$0	$0

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
17	PhysicistF	10%	16 h	0 w	3/20/03	4/16/03	$0	$0	$0	$0	0 h	0 h	0 h	16 h

Notes

WBS Definition--
Place the actual purchase order for the layer 0 sensor production

M&S BOE--
No M&S cost associated with this task

Labor BOE--
It is expected that a physicist will spend half a day per week on seeing the order through and interacting with the vendor.

1.1.1.2.5.4	**L0 Silicon Sensors Released For Production**	**4/16/03**	**4/16/03**	**$0**	**$0**	**$0**	**$0**

Notes

WBS Definition-
Milestone: The designs and specifications have been reviewed and the L0 sensors are released for production

1.1.1.2.5.5	Produce L0 Sensors (Fermilab)	4/17/03	9/8/03	$160,666	$0	$0	$160,666

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
48	MandS	160,666	160,666	0 w	4/17/03	9/8/03	$160,666	$0	$0	$160,666		0	0	160,666

Notes

WBS Definition-
Vendor production of Layer 0 silicon sensors with their testing.

M&S BOE-
It is anticipated that these sensors will be procured from Hamamatsu. The sensors are very similar to the Layer 1 sensors and to the Layer 00 sensors used by CDF in Run2a. Based on a budgetary quote from Hamamatsu, the M&S cost for the layer 0 sensors is:
NRE cost: $54,810
preproduction sensor: $1156;
production sensor: $276
40 prototypes are ordered: $46,240
216 production sensors (144 needed and 72 spares): $59,616
Total cost: $160,666
The contingency has been set to 75% because we don't have an official quote yet and because of possible currency fluctuations.

Labor BOE-
No project labor associated with the production of the sensors.

1.1.1.2.5.6	Probe L0 sensors (Fermilab)	9/9/03	12/3/03	$0	$0	$1,632	$1,632

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
9	MechTechSF	10%	48 h	0 w	9/9/03	12/3/03	$1,632	$0	$0	$1,632	0 h	0 h	0 h	48 h
17	PhysicistF	25%	120 h	0 w	9/9/03	12/3/03	$0	$0	$0	$0	0 h	0 h	0 h	120 h

Notes

WBS Definition-
QC Testing done by D0 on a fraction of the production L0 sensors. We plan to perform two types of tests. Partial test consists of the visual inspection, IV and CV measurements. Full test adds extensive strip-by-strip measurement - strip leakage current, coupling capacitance, polysilicon resistor values.

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost

"Probe L0 sensors (Fermilab)" continued

Notes

M&S BOE-
No project cost associated with this task.

Labor BOE-
The probing of the Layer 0 sensors is described already above under the ELMA task, even if the sensors are received from Hamamatsu. Probing will also be done at Fermilab on a subset of sensors. We assume that 10% of the sensors will be probed at Fermilab. There will be a setup time of 6 days for this test and then 22 sensors are probed. Each of these sensors will have the full test done. The total time probing is estimated at 110 hours or 14 days by a physicist. The physicist is supported at the 10% level by a mechanical technician.

1.1.1.2.5.7	**1st L0 Silicon Sensor Delivered**	**9/8/03**	**9/8/03**	**$0**	**$0**	**$0**	**$0**

Notes

WBS Definition-
Milestone: The first batch of L0 sensors are deliverd after production at the vendor.

1.1.1.2.6	**All L0 Silicon Sensors Delivered And Tested**	**12/3/03**	**12/3/03**	**$0**	**$0**	**$0**	**$0**

Notes

WBS Definition-
Milestone: All L0 sensors have been delivered and tested.

1.1.1.3	**L1 Sensors**	**10/1/01**	**12/3/03**	**$290,930**	**$33,800**	**$8,672**	**$333,402**

Notes

WBS Definition-
Summary task that describes the design, prototyping, production, and testing of all sensors for L1

M&S BOE-
The contingency on these items is determined from the specified guidelines except for the following:
Elma sensor tasks have no contingency because they have been completed.
The prototype sensors have been ordered, but have 30% contingency on them to account for fluctuations in the Japanese Yen compared to the dollar.
The production sensors have a 75% contingency on them because they have not been ordered and we need to account for fluctuations in the Japanese Yen compared to the Dollar. Also, we believe that there might be some risk that we would need another batch of detectors.
All MRI probing tasks have 0% contingency on them because they are fixed from the grant and the contingency appears in the labor which is an in kind contribution.

Labor BOE-
The contingency on the labor is assigned to the 50% guideline except for:
MRI tasks have 0% technical worker contingency because they are fixed costs
The Fermilab probing task has 100% contingency to account for risks with lost probing.

1.1.1.3.1	**Fermilab Tasks With L1 Sensors**	**10/1/01**	**12/3/03**	**$0**	**$0**	**$8,672**	**$8,672**

Notes

WBS Definition-
Summary task that includes the efforts at Fermilab for design, production assitance, and testing of the L1 sensors.

1.1.1.3.1.1	Develop specifications	10/1/01	10/26/01	$0	$0	$0	$0

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
18	PhysicistU	100%	160 h	0 w	10/1/01	10/26/01	$0	$0	$0	$0	0 h	0 h	160 h	0 h

Notes

WBS Definition-
Design and layout specifications for L1 sensors. This includes coordinating with the mechanical and electrical design teams to verify that the sensors meet those criteria as well as the physics operational criteria.

M&S BOE-
no costs on this line

Labor BOE-
In conjunction with the Run2b silicon group, the TDR specifications were written and the designs were verified for production with senior physicist experts. This time is the amount of time actually spent.

1.1.1.3.1.2	Develop prototype masks	1/3/02	1/30/02	$0	$0	$7,040	$7,040

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
17	PhysicistF	30%	48 h	0 w	1/3/02	1/30/02	$0	$0	$0	$0	0 h	0 h	48 h	0 h

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
"Develop prototype masks" continued							

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
21	DesignerF	100%	160 h	0 w	1/3/02	1/30/02	$7,040	$0	$7,040	$0	0 h	0 h	160 h	0 h

Notes

WBS Definition--
Develop masks for the prototype sensors for Layer 1for the silicon detector.

M&S BOE--
No M&S cost associated with this task.

Labor BOE--
One Fermilab designer full time for the duration to make the sensor drawings. The time allocated is based on Run2a experience.
One physicist at 30% of his time to interact with the designer to ensure that the drawings are made according to the specifications.

1.1.1.3.1.3	Probe L1 sensors (Fermilab)	9/9/03	12/3/03	$0	$0	$1,632	$1,632

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
9	MechTechSF	10%	48 h	0 w	9/9/03	12/3/03	$1,632	$0	$0	$1,632	0 h	0 h	0 h	48 h
17	PhysicistF	25%	120 h	0 w	9/9/03	12/3/03	$0	$0	$0	$0	0 h	0 h	0 h	120 h

Notes

WBS Definition-
QC Testing done by D0 at Fermilab on a fraction of the production L1 sensors. We plan to perform two types of tests. Partial test consists of the visual inspection, IV and CV measurements. Full test adds extensive strip-by-strip measurement - strip leakage current, coupling capacitance, polysilicon resistor values.

M&S BOE-
No project cost associated with this task.

Labor BOE-
The probing of the Layer 1 sensors is described below under the MRI task. Probing will also be done at Fermilab on a subset of sensors. We assume that 10% of the sensors will be probed at Fermilab. There will be a setup time of 6 days for this test and then 22 sensors are probed. Each of these sensors will have the full test done. The total time probing is estimated at 110 hours or 14 days by a physicist. The physicist is supported at the 10% level by a mechanical technician.

1.1.1.3.2	**MRI Tasks Associated With L1 Sensors**	**10/29/01**	**12/3/03**	**$289,930**	**$30,200**	**$0**	**$320,130**

Notes

WBS Definition-
Summary task that includes the efforts at MRI institutes for design, prototyping, production assistance, and testing of the L1 sensors.

1.1.1.3.2.1	**ELMA**	**10/29/01**	**8/26/02**	**$69,380**	**$6,100**	**$0**	**$75,480**

Notes

WBS Definition-
Summary task that includes the design and prototyping for L1 sensors made by ELMA

1.1.1.3.2.1.1	Order sensors (KSU)	10/29/01	11/27/01	$0	$0	$0	$0

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
18	PhysicistU	25%	40 h	0 w	10/29/01	11/27/01	$0	$0	$0	$0	0 h	0 h	40 h	0 h

Notes

WBS Definition--
Place the actual purchase order for the prototype layer 1 sensor production at ELMA. This order goes through KSU.

M&S BOE--
No M&S cost associated with this task

Labor BOE--
It is expected that a physicist will spend half a day per week on seeing the order through and interacting with the vendor.

1.1.1.3.2.1.2	Develop prototype masks	11/28/01	1/3/02	$54,000	$0	$0	$54,000

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
18	PhysicistU	100%	160 h	0 w	11/28/01	1/3/02	$0	$0	$0	$0	0 h	0 h	160 h	0 h
48	MandS	54,000	54,000	0 w	11/28/01	1/3/02	$54,000	$0	$54,000	$0		0	54,000	0

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
"Develop prototype masks" continued							

Notes

WBS Definition--
Develop masks for the prototype sensors for Layer 1 for the silicon detector at ELMA.

M&S BOE--
$54000 is based on a quote received through Moscow State University, consisting of $50,040 for the masks and an additional $3,960 in overhead at Moscow State University.

Labor BOE--
These masks are designed by a collaborating physicist from Moscow State University.

1.1.1.3.2.1.3	Produce prototype sensors (KSU)	1/4/02	6/28/02	$15,380	$0	$0	$15,380

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
48	MandS	15,380	15,380	0 w	1/4/02	6/28/02	$15,380	$0	$15,380	$0		0	15,380	0

Notes

WBS Definition--
Production and testing by vendor of L1 prototype sensors.

M&S BOE--
Based on quote from Moscow State Univ. 10/10/01
Mask design and engineering: 1 set at $3000
Mask production: 1 set at $4,000
20 wafers of L1 sensors each at $400 totalling $8,000
S&H, insurance $380
Total $15,400

Labor BOE--
No labor associated with the production.

1.1.1.3.2.1.4	Probe prototypes sensors (MRI)	7/1/02	8/26/02	$0	$6,100	$0	$6,100

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
15	ElecTechU	50%	160 h	0 w	7/1/02	8/26/02	$0	$0	$0	$0	0 h	0 h	160 h	0 h
18	PhysicistU	25%	71.6 h	0 w	7/1/02	8/26/02	$0	$0	$0	$0	0 h	0 h	71.6 h	0 h
48	MandS	6,100	6,100	0 w	7/1/02	8/26/02	$6,100	$0	$6,100	$0		0	6,100	0

Notes

WBS Definition--
We plan to perform two types of tests. Partial test consists of the visual inspection, IV and CV measurements. Full test adds extensive strip-by-strip measurement - strip leakage current, coupling capacitance, polysilicon resistor values. Our plan is to fully test all prototypes.

M&S BOE--
We estimate 1.5 hours needed for the partial test for each sensor while the full test requires 5 hours. These estimates are based on previous experience with prototype sensors for D0 Run 2b as well as CMS.

University technicians perform sensor-probing tests. We assume $42K of yearly salary. 27.4% is added for benefit cost and 45.5% for indirect cost. There will be a setup time of 4 days and then there will be 20 sensors to probe. This gives a total testing time of 130 hours and a total of 20 probing days (130 hours +32 hrs setup). Assume that 50% of an FTE is needed during this time (full test takes 40 days) at a total cost of $6,070 based on estimate from KSU.

Labor BOE--
See above for technician time which is charged as M&S. In addition, a senior physicist oversees the project assumed to take 2 weeks on their full time.

1.1.1.3.2.2	**Hamamatsu**	**1/2/02**	**11/27/02**	**$66,050**	**$6,100**	**$0**	**$72,150**

Notes

WBS Definition-
Summary task that describes design, prototype sensors, and testing of HPK sensors

1.1.1.3.2.2.1	Order sensors (KSU)	1/2/02	4/23/02	$0	$0	$0	$0

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
18	PhysicistU	15%	96 h	0 w	1/2/02	4/23/02	$0	$0	$0	$0	0 h	0 h	96 h	0 h

Notes

WBS Definition--
Place the actual purchase order for the prototype layer 1 sensor production at HPK. This order goes through KSU.

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
"Order sensors (KSU)" continued							

Notes

M&S BOE--
No M&S cost associated with this task

Labor BOE--
It is expected that a physicist will spend half a day per week on seeing the order through and interacting with the vendor.

1.1.1.3.2.2.2	Produce prototype sensors (KSU)	4/25/02	9/30/02	$66,050	$0	$0	$66,050

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
48	MandS	66,050	66,050	0 w	4/25/02	9/30/02	$66,050	$0	$66,050	$0		0	58,844.55	7,205.45

Notes

WBS Definition--
Production and testing by vendor of L1 prototype sensors.

M&S BOE--
Based on quote from Hamamatsu, 04/23/02
NRE: $60,465
Prototype sensor: $558.45
10 prototype sensors ordered.
Total: $66,050.

Labor BOE--
No labor associated with the production.

1.1.1.3.2.2.3	Probe prototypes sensors (MRI)	10/3/02	11/27/02	$0	$6,100	$0	$6,100

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
15	ElecTechU	50%	160 h	0 w	10/3/02	11/27/02	$0	$0	$0	$0	0 h	0 h	0 h	160 h
18	PhysicistU	25%	80 h	0 w	10/3/02	11/27/02	$0	$0	$0	$0	0 h	0 h	0 h	80 h
48	MandS	6,100	6,100	0 w	10/3/02	11/27/02	$6,100	$0	$0	$6,100		0	0	6,100

Notes

WBS Definition--
We plan to perform two types of tests. Partial test consists of the visual inspection, IV and CV measurements. Full test adds extensive strip-by-strip measurement - strip leakage current, coupling capacitance, polysilicon resistor values. Our plan is to fully test all prototypes.

M&S BOE--
We estimate 1.5 hours needed for the partial test for each sensor while the full test normally requires 5 hours. For these sensors we expect the testing to take twice as long. These sensors are the only inner layer prototype sensors we order from Hamamatsu and will have to be mapped out extensively. These estimates are based on previous experience with prototype sensors for D0 Run 2b as well as CMS. University technicians perform sensor-probing tests. We assume $42K of yearly salary. 27.4% is added for benefit cost and 45.5% for indirect cost. There will be a setup time of 4 days and then there will be 10 sensors to probe. This gives a total testing time of 130 hours. This a total of 20 probing days (130 hrs + 32 hrs setup). Assume that 50% of an FTE is needed during this time (full test takes 40 days) at a total cost of $6,070 based on estimate from KSU.

Labor BOE--
See above for technician time which is charged as M&S. In addition, a senior physicist oversees the project assumed to take 2 weeks on their full time.

1.1.1.3.2.3	Develop final sensor specifications and production rea	2/6/03	2/19/03	$0	$0	$0	$0

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
18	PhysicistU	100%	80 h	0 w	2/6/03	2/19/03	$0	$0	$0	$0	0 h	0 h	0 h	80 h

Notes

WBS Definition-
Design and layout specifications for production sensors. Here it is verified that sensors meet: electrical, radiation, and mechanical specs by checking results on prototypes.

M&S BOE-
There are no costs associated with this line

Labor BOE-
A full time senior physicist oversees that all checks are made. The estimate of 2 weeks is based on the prototyping specifications which have already been done for Run2b.

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
1.1.1.3.2.4	Develop sensor probing procedures	2/6/03	2/19/03	$0	$0	$0	$0

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
18	PhysicistU	50%	40 h	0 w	2/6/03	2/19/03	$0	$0	$0	$0	0 h	0 h	0 h	40 h

Notes

WBS Definition-
Update and modify the QC procedures for sensors to be tested by D0.

M&S BOE-
No project cost associated with this task.

Labor BOE-
It is anticipated that a physicist will take one week to update all the QC probing procedures for the production sensors.

1.1.1.3.2.5	Bid final sensor order	2/20/03	3/19/03	$0	$0	$0	$0

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
18	PhysicistU	10%	16 h	0 w	2/20/03	3/19/03	$0	$0	$0	$0	0 h	0 h	0 h	16 h

Notes

WBS Definition--
Submit the requisition to the Fermilab business office and interact with the vendor to obtain a final tender for the sensor production order

M&S BOE--
No M&S cost associated with this task

Labor BOE--
It is expected that a physicist will spend half a day per week on seeing the order through and interacting with the vendor.

1.1.1.3.2.6	Order production sensors (KSU)	3/20/03	4/16/03	$0	$0	$0	$0

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
18	PhysicistU	10%	16 h	0 w	3/20/03	4/16/03	$0	$0	$0	$0	0 h	0 h	0 h	16 h

Notes

WBS Definition--
Place the actual purchase order for the layer 1 sensor production

M&S BOE--
No M&S cost associated with this task

Labor BOE--
It is expected that a physicist will spend half a day per week on seeing the order through and interacting with the vendor.

1.1.1.3.2.7	Produce L1 (KSU)	4/17/03	9/8/03	$154,500	$0	$0	$154,500

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
48	MandS	154,500	154,500	0 w	4/17/03	9/8/03	$154,500	$0	$0	$154,500		0	0	154,500

Notes

WBS Definition-
Vendor production of Layer 1 silicon sensors with their testing.

M&S BOE-
It is anticipated that these sensors will be procured from Hamamatsu and that a new set of masks will have to be made. Based on a quote from Hamamatsu, the M&S cost for the layer 1 sensors is:
NRE cost: $60,465
production sensor: $435.35
216 production sensors (144 needed and 72 spares): $94,036
Total cost: $154,500.
The contingency has been set to 30% because we have a quote in hand.

Labor BOE-
No project labor associated with the production of the sensors.

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
1.1.1.3.2.8	Probe L1 sensors (MRI)	9/9/03	12/3/03	$0	$18,000	$0	$18,000

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
15	ElecTechU	100%	480 h	0 w	9/9/03	12/3/03	$0	$0	$0	$0	0 h	0 h	0 h	480 h
18	PhysicistU	15%	72 h	0 w	9/9/03	12/3/03	$0	$0	$0	$0	0 h	0 h	0 h	72 h
48	MandS	18,000	18,000	0 w	9/9/03	12/3/03	$18,000	$0	$0	$18,000		0	0	18,000

Notes

WBS Definition-
QC Testing done by D0 at MRI centers on a fraction of the production L1 sensors. We plan to perform two types of tests. Partial test consists of the visual inspection, IV and CV measurements. Full test adds extensive strip-by-strip measurement - strip leakage current, coupling capacitance, polysilicon resistor values.

M&S BOE-
University technicians perform sensor-probing tests. We assume $42K of yearly salary. 27.4% is added for benefit cost and 45.5% for indirect cost. There will be a setup time of 6 days for this test and then 216 sensors are produced. Each of these sensors will have the partial test done (1.5 hours per sensor) and 10% of the sensors will have the full test done (5 hours per sensor). The total time probing is estimated at 432 hours or 60 days and uses 100% of the technician's time. The total cost is then $18,000.

Labor BOE-
See above for technician time estimate. The operation is overseen by a senior physicist who is foreseen to take about 2 weeks of their time during this period. This estimate is based on the prototype testing as well as that from CMS.

1.1.1.3.3	**Radiation Testing at KSU**	**10/31/02**	**10/6/03**	**$1,000**	**$3,600**	**$0**	**$4,600**

Notes

WBS Definition-
Summary task that includes the irradiation testing on L1 sensors and test structures done at KSU.

1.1.1.3.3.1	**R&D Irradiation Testing at KSU**	**10/31/02**	**2/5/03**	**$1,000**	**$2,400**	**$0**	**$3,400**
1.1.1.3.3.1.1	Perform irradiation testing on prototypes	10/31/02	1/7/03	$1,000	$2,400	$0	$3,400

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
15	ElecTechU	20%	64 h	0 w	10/31/02	1/7/03	$0	$0	$0	$0	0 h	0 h	0 h	64 h
18	PhysicistU	25%	80 h	0 w	10/31/02	1/7/03	$0	$0	$0	$0	0 h	0 h	0 h	80 h
48	MandS	3,400	3,400	0 w	10/31/02	1/7/03	$3,400	$0	$0	$3,400		0	0	3,400

Notes

WBS Definition-
Tests to assure performance done at radiation facility

M&S BOE-
Different jigs are required to hold different sensor types and test structures. They are manufactured by a machine shop. Cost for jig material is accounted for already in estimate for layer 0 jigs. Needed are 25 machine shop hours at $40/hour. Total for machining jigs of $1000.
Total irradiation time for these sensors is 8 weeks. Based on experience with pilot runs, irradiation work requires 20% of an FTE of a University technician, who gets paid at an annual rate of $42K*1.274(benefits)* 1.455(indirect cost) = $77,854. The cost for 8 weeks of a technician at 20% is thus: $77,854*0.2*8/52 = $2400.
Total cost: $3400.

Labor BOE-
See above. A physicist oversees the operation for 2 weeks.

1.1.1.3.3.1.2	Analyze prototype test results (KSU)	12/2/02	2/5/03	$0	$0	$0	$0

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
47	Student	30%	96 h	0 w	12/2/02	2/5/03	$0	$0	$0	$0	0 h	0 h	0 h	96 h

Notes

WBS Definition-
Analysis of all test results including radiation studies

M&S BOE-
No M&S costs associated with this task.

Labor BOE-
Based on prototyping work

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
1.1.1.3.3.2	Radiation Testing L1 Test Structures	9/9/03	10/6/03	$0	$1,200	$0	$1,200

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
15	ElecTechU	20%	32 h	0 w	9/9/03	10/6/03	$0	$0	$0	$0	0 h	0 h	0 h	32 h
18	PhysicistU	20%	32 h	0 w	9/9/03	10/6/03	$0	$0	$0	$0	0 h	0 h	0 h	32 h
48	MandS	1,200	1,200	0 w	9/9/03	10/6/03	$1,200	$0	$0	$1,200		0	0	1,200

Notes

WBS Definition-
Tests to assure performance done at radiation facility

M&S BOE-
Technician labor is paid for by an MOU. Total irradiation time for these sensors is 4 weeks. Based on experience with pilot runs, irradiation work requires 20% of an FTE of a University technician, who gets paid at an annual rate of $42K*1.274(benefits)*1.455(indirect cost) = $77,854. The cost for 4 weeks of a technician at 20% is thus: $77,854*0.2*4/52 = $1200.
Total cost: $1200.

Labor BOE-
See above. A physicist oversees the effort.

1.1.1.3.4	**Choose L1 Silicon Sensor Technology**	**2/5/03**	**2/5/03**	**$0**	**$0**	**$0**	**$0**

Notes

WBS Definition-
Milestone: The design and testing of prototypes is finished and a choice of vendor and technology can be made on L1 sensors.

1.1.1.3.5	**L1 Silicon Sensors Released For Production**	**4/16/03**	**4/16/03**	**$0**	**$0**	**$0**	**$0**

Notes

WBS Definition-
Milestone: The specifications have been reviewed and the L1 sensors are ready for production.

1.1.1.3.6	**1st L1 Silicon Sensor Delivered**	**9/8/03**	**9/8/03**	**$0**	**$0**	**$0**	**$0**

Notes

WBS Definition-
Milestone: The first L1 sensors are received back from the producer.

1.1.1.3.7	**All L1 Silicon Sensors Delivered And Tested**	**12/3/03**	**12/3/03**	**$0**	**$0**	**$0**	**$0**

Notes

WBS Definition-
Milestone: All L1 sensors are delivered and tested.

1.1.1.4	**L2-L5 Sensors**	**9/17/01**	**7/20/04**	**$1,581,800**	**$86,692**	**$29,856**	**$1,698,348**

Notes

WBS Definition-
Summary task that describes the design, prototyping, production, and testing of all sensors for L2-5

M&S BOE-
The contingency on these items is determined from the specified guidelines except for the following:
The preproduction sensor order has a 50% contingency to account for possible losses in the order and fluctuations in the japanese yen compared to the dollar
The production sensors have a 75% contingency on them because they have not been ordered and we need to account for fluctuations in the Japanese Yen compared to the Dollar. Also, we believe that there might be some risk that we would need another batch of detectors.
All MRI probing tasks have 0% contingency on them because they are fixed from the grant and the contingency appears in the labor which is an in kind contribution.

Labor BOE-
The contingency on the labor is assigned to the 50% guideline except for:
MRI tasks have 0% technical worker contingency because they are fixed costs
The Fermilab probing task has 100% contingency to account for risks with lost probing.

1.1.1.4.1	**MRI L2-L5 Sensor Tasks**	**9/17/01**	**7/20/04**	**$204,450**	**$79,492**	**$0**	**$283,942**

Notes

WBS Definition-
Summary task that includes the efforts at MRI institutions for design, production assitance, and testing of the L2-L5 sensors.

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
1.1.1.4.1.1	Develop preproduction specifications	9/17/01	4/25/02	$0	$0	$0	$0

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
18	PhysicistU	10%	240 h	0 w	9/17/01	4/25/02	$0	$0	$0	$0	0 h	0 h	240 h	0 h

Notes

WBS Definition--
Develop specifications for sensors employed in Layers 2 - 5 for the silicon detector.

M&S BOE--
No M&S cost associated with this task.

Labor BOE--
One University physicist at half a day per week of his time to develop the specifications for the sensors

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
1.1.1.4.1.2	Order preproduction sensors	4/26/02	8/5/02	$0	$0	$0	$0

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
18	PhysicistU	5%	28 h	0 w	4/26/02	8/5/02	$0	$0	$0	$0	0 h	0 h	26.4 h	1.6 h

Notes

WBS Definition--
Order preproduction sensors for Layers 2 - 5 for the silicon detector.

M&S BOE--
No M&S cost associated with this task.

Labor BOE--
One University physicist at 5% of his time to interact with Fermilab and coordinate the order with the MRI institution and see the order through the procurement chains and interact with the vendor regarding the specifications.

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
1.1.1.4.1.3	Produce preproduction sensors (Stony Brook)	8/6/02	11/26/02	$127,500	$0	$0	$127,500

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
48	MandS	127,500	127,500	0 w	8/6/02	11/26/02	$127,500	$0	$0	$127,500		0	0	127,500

Notes

WBS Definition--
Production at the vendor of the preproduction sensors for Layers 2 - 5 for the silicon detector.

M&S BOE--
Based on a quote from Hamamatsu:
NRE Setup Charges: 7,500,000 Yen
Prototype sensors, 100 at 78,000 Yen each
Total: $127,500 at an exchange rate of $1=120Yen

Labor BOE--
No Labor associated with this task.

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
1.1.1.4.1.4	Probe preproduction sensors (MRI)	11/27/02	4/29/03	$0	$30,000	$0	$30,000

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
15	ElecTechU	150%	1,200 h	0 w	11/27/02	4/29/03	$0	$0	$0	$0	0 h	0 h	0 h	1,200 h
18	PhysicistU	10%	80 h	0 w	11/27/02	4/29/03	$0	$0	$0	$0	0 h	0 h	0 h	80 h
48	MandS	30,000	30,000	0 w	11/27/02	4/29/03	$30,000	$0	$0	$30,000		0	0	30,000

Notes

WBS Definition--
We plan to perform two types of tests. Partial test consists of the visual inspection, IV and CV measurements. Full test adds extensive strip-by-strip measurement - strip leakage current, coupling capacitance, polysilicon resistor values. Our plan is to fully test all prototypes.

M&S BOE--
We estimate 1.5 hours needed for the partial test for each sensor while the full test for the outer layer sensors requires 8 hours. These estimates are based on previous experience with prototype sensors for D0 Run 2b as well as CMS. University technicians at 3 sites perform sensor-probing tests. The technicians need to be paid at two of these sites and the third, the labor is an in-kind contribution. We assume $42K of yearly salary. 27.4% is added for benefit cost and 45.5% for indirect cost. There will be a setup time of 6 days and then there will be 100 sensors to probe. 75% of the sensors will undergo a full probe test. This gives a total testing time of 750 hours and a total of 100 probing days. Assume that 50% of an FTE at each of three institutions is needed during this time at a total cost of $30,000 based on estimate from KSU.

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
"Probe preproduction sensors (MRI)" continued							

Notes

Labor BOE--
See above for technician time which is charged as M&S. In addition, a senior physicist oversees the project assumed to take 1 week on the task duration.

1.1.1.4.1.5	Develop final sensor specifications	12/13/02	1/6/03	$0	$0	$0	$0

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
18	PhysicistU	50%	40 h	0 w	12/13/02	1/6/03	$0	$0	$0	$0	0 h	0 h	0 h	40 h

Notes

WBS Definition-
Design and layout specifications for production sensors. Here it is verified that sensors meet: electrical, radiation, and mechanical specs by checking results on prototypes.

M&S BOE-
There are no costs associated with this line

Labor BOE-
A half time senior physicist oversees that all checks are made. The estimate of 2 weeks is based on the prototyping specifications which have already been done for Run2b.

1.1.1.4.1.6	Develop sensor probing procedures	11/27/02	1/6/03	$0	$0	$0	$0

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
18	PhysicistU	25%	40 h	0 w	11/27/02	1/6/03	$0	$0	$0	$0	0 h	0 h	0 h	40 h

Notes

WBS Definition-
Update and modify the QC procedures for sensors to be tested by D0.

M&S BOE-
No project cost associated with this task.

Labor BOE-
It is anticipated that a physicist will take one week to update all the QC probing procedures for the production sensors.

1.1.1.4.1.7	Produce 1st lot of L2-L5 sensors (Stony Brook)	2/12/03	5/21/04	$76,950	$0	$0	$76,950

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
48	MandS	76,950	76,950	0 w	2/12/03	5/21/04	$76,950	$0	$0	$76,950		0	0	76,950

Notes

WBS Definition--
Production at the vendor of the production sensors for Layers 2 - 5 for the silicon detector.

M&S BOE--
The detector calls for a total of 2016 sensors. We assume 5% spares for each module and that building the various modules has an 85% yield. There are a total of 168 of each of the: 10-10A, 20-20A, 10-10S, and 20-20S modules needed. Putting in the yields and 8 spares for each, we need to build 207 of each type of module. The 10-10A and 10-10S each use 2 sensors apiece. The 20-20A and 20-20S modules each need 4 sensors apiece. The total number of sensors needed is 2484 sensors. We assume we can build all the mechanical prototypes with the prototype sensors. To build electrical prototype modules we need 36 sensors for 3 prototypes of each flavor.

We assume stave production will have a yield of 95%, which implies an additional 120 sensors. Moreover, we want 8 staves as spares, which gives another 96 sensors needed. This gives a total of 2736 sensors needed for the project.

Based on a quote from Hamamatsu:
NRE Setup Charges: 7,500,000 Yen
Production sensors, 2736 at 61,000 Yen each
Total: $1,453,300 at an exchange rate of $1=120Yen
Payment spread out over 4 intervals, with $363,325 per payment
Partial payment for 1st lot by Stony Brook MRI is $76950.

The duration of the task is taken to be 64 weeks. It is assumed that no new masks will need to be produced for the production sensors and that the preproduction sensors satisfy our criteria. When the go ahead is given for production it will take 4 weeks for Hamamatsu to setup the production line and start producing sensors. The production of sensors is assumed to take 4 weeks of processing. At a production rate of 200 sensors per month, 14 months are needed to fill the order, or 56 weeks. An additional 4 weeks is added for Hamamatsu to test the sensors, fill in the paperwork and shipping.

The contingency is taken to be 55%. This includes 30% according to the contingency guidelines as we have a quote. There is also a 25% contingency part added to account for the fluctuations in the US$ to Japanese Yen.

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost

"Produce 1st lot of L2-L5 sensors (Stony Brook)" continued

Notes

Labor BOE--
No Labor associated with this task.

1.1.1.4.1.8	Probe L2-L5 sensors (MRI)	6/5/03	7/20/04	$0	$49,492	$0	$49,492

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
15	ElecTechU	50%	1,120 h	0 w	6/5/03	7/20/04	$0	$0	$0	$0	0 h	0 h	0 h	1,120 h
18	PhysicistU	4%	89.6 h	0 w	6/5/03	7/20/04	$0	$0	$0	$0	0 h	0 h	0 h	89.6 h
48	MandS	49,492	49,492	0 w	6/5/03	7/20/04	$49,492	$0	$0	$49,492		0	0	49,492

Notes

WBS Definition--
We plan to perform two types of tests. Partial test consists of the visual inspection, IV and CV measurements. Full test adds extensive strip-by-strip measurement - strip leakage current, coupling capacitance, polysilicon resistor values. Our plan is to fully test all prototypes.

M&S BOE--
We estimate 1.5 hours needed for the partial test for each sensor while the full test for the outer layer sensors requires 8 hours. These estimates are based on previous experience with prototype sensors for D0 Run 2b as well as CMS. University technicians perform sensor-probing tests. We assume $42K of yearly salary. 27.4% is added for benefit cost and 45.5% for indirect cost. There will be a total of 16 days spent in setting up the equipment. About 5% of the total number of sensors ordered (2736) will undergo the partial and full test. Two sensors can be tested at each facility per day. Assume that 50% of an FTE is needed during this time at a total cost of $50,000 based on estimate from KSU.

Labor BOE--
See above for technician time which is charged as M&S. In addition, a senior physicist oversees the project assumed to take 2 weeks on the task duration.

1.1.1.4.2	**Fermilab L2-L5 Sensor Tasks**	**4/26/02**	**7/20/04**	**$1,376,350**	**$0**	**$29,856**	**$1,406,206**

Notes

WBS Definition-
Summary task that includes the efforts at Fermilab for design, production assitance, and testing of the L2-L5 sensors.

1.1.1.4.2.1	Develop masks (Fermilab)	4/26/02	5/31/02	$0	$0	$8,800	$8,800

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
17	PhysicistF	30%	60 h	0 w	4/26/02	5/31/02	$0	$0	$0	$0	0 h	0 h	60 h	0 h
21	DesignerF	100%	200 h	0 w	4/26/02	5/31/02	$8,800	$0	$8,800	$0	0 h	0 h	200 h	0 h

Notes

WBS Definition--
Develop masks for the prototype sensors for Layers 2 - 5 for the silicon detector.

M&S BOE--
No M&S cost associated with this task.

Labor BOE--
One Fermilab designer full time for the duration to make the sensor drawings. The time allocated is based on Run2a experience.
One physicist at 30% of his time to interact with the designer to ensure that the drawings are made according to the specifications.

1.1.1.4.2.2	**Fermilab Production L2-L5 Sensor Tasks**	**11/27/02**	**7/20/04**	**$1,376,350**	**$0**	**$21,056**	**$1,397,406**

Notes

WBS Definition-
Summary task that includes the specification, production, and testing of L2-L5 sensors done by Fermilab.

1.1.1.4.2.2.1	Probe preproduction sensors (Fermilab)	11/27/02	2/4/03	$0	$0	$544	$544

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
9	MechTechSF	5%	16 h	0 w	11/27/02	2/4/03	$544	$0	$0	$544	0 h	0 h	0 h	16 h
17	PhysicistF	15%	48 h	0 w	11/27/02	2/4/03	$0	$0	$0	$0	0 h	0 h	0 h	48 h

Notes

WBS Definition-
QC Testing done by D0 at Fermilab on a fraction of the preproduction L2-5 sensors. We plan to perform two types of tests. Partial test consists of the visual inspection, IV and CV measurements. Full test adds extensive strip-by-strip measurement - strip leakage current, coupling capacitance, polysilicon resistor values.

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost

"Probe preproduction sensors (Fermilab)" continued

Notes

M&S BOE-
No project cost associated with this task.

Labor BOE-
The probing of the Layer 2-5 sensors is described above under the MRI task. Probing will also be done at Fermilab on a subset of sensors. We assume that 10% of the sensors will be probed at Fermilab. There will be a setup time of 6 days for this test and then 10 sensors are probed. Each of these sensors will have the full test done (8 hours per sensor). The total time probing is estimated at 80 hours or two weeks by a physicist. The physicist is supported at the 5% level by a mechanical technician.

1.1.1.4.2.2.2	Develop final masks and Production Readiness Revie	1/7/03	2/4/03	$0	$0	$5,280	$5,280

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
17	PhysicistF	50%	80 h	0 w	1/7/03	2/4/03	$0	$0	$0	$0	0 h	0 h	0 h	80 h
21	DesignerF	75%	120 h	0 w	1/7/03	2/4/03	$5,280	$0	$0	$5,280	0 h	0 h	0 h	120 h

Notes

WBS Definition--
Develop final masks for the prototype sensors for Layers 2 - 5 for the silicon detector.

M&S BOE--
No M&S cost associated with this task.

Labor BOE--
One Fermilab designer at 75% for the duration to make the sensor drawings. The time allocated is based on Run2a experience.
One physicist at 50% of his time to interact with the designer to ensure that the drawings are made according to the specifications.

1.1.1.4.2.2.3	Bid final sensor order	1/7/03	1/13/03	$0	$0	$0	$0

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
17	PhysicistF	10%	4 h	0 w	1/7/03	1/13/03	$0	$0	$0	$0	0 h	0 h	0 h	4 h

Notes

WBS Definition--
Submit the requisition to the Fermilab business office and interact with the vendor to obtain a final tender for the sensor production order

M&S BOE--
No M&S cost associated with this task

Labor BOE--
It is expected that a physicist will spend half a day per week on seeing the order through and interacting with the vendor.

1.1.1.4.2.2.4	Order production sensors	2/5/03	2/11/03	$0	$0	$0	$0

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
17	PhysicistF	10%	4 h	0 w	2/5/03	2/11/03	$0	$0	$0	$0	0 h	0 h	0 h	4 h

Notes

WBS Definition--
Place the actual purchase order for the layer 2-5 sensor production

M&S BOE--
No M&S cost associated with this task

Labor BOE--
It is expected that a physicist will spend half a day per week on seeing the order through and interacting with the vendor.

1.1.1.4.2.2.5	**L2-L5 Silicon Sensors Released For Production**	**2/11/03**	**2/11/03**	**$0**	**$0**	**$0**	**$0**

Notes

WBS Definition--
Milestone: The design and mask layout have been reviewed and the L2-L5 sensors are released for production.

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
1.1.1.4.2.2.6	Produce 25% of L2-L5 sensors (Fermilab)	2/12/03	5/21/04	$286,375	$0	$0	$286,375

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
17	PhysicistF	10%	256 h	0 w	2/12/03	5/21/04	$0	$0	$0	$0	0 h	0 h	0 h	256 h
48	MandS	286,375	286,375	0 w	2/12/03	5/21/04	$286,375	$0	$0	$286,375		0	0	286,375

Notes

WBS Definition--
Production at the vendor of the production sensors for Layers 2 - 5 for the silicon detector.

M&S BOE--
The detector calls for a total of 2016 sensors. We assume 5% spares for each module and that building the various modules has an 85% yield. There are a total of 168 of each of the: 10-10A, 20-20A, 10-10S, and 20-20S modules needed. Putting in the yields and 8 spares for each, we need to build 207 of each type of module. The 10-10A and 10-10S each use 2 sensors apiece. The 20-20A and 20-20S modules each need 4 sensors apiece. The total number of sensors needed is 2484 sensors. We assume we can build all the mechanical prototypes with the prototype sensors. To build electrical prototype modules we need 36 sensors for 3 prototypes of each flavor.

We assume stave production will have a yield of 95%, which implies an additional 120 sensors. Moreover, we want 8 staves as spares, which gives another 96 sensors needed. This gives a total of 2736 sensors needed for the project.

Based on a quote from Hamamatsu:
NRE Setup Charges: 7,500,000 Yen
Production sensors, 2736 at 61,000 Yen each
Total: $1,453,300 at an exchange rate of $1=120Yen
Payment spread out over 4 intervals, with $363,325 per payment
First payment is reduced by Stony Brook MRI contribution ($76,950) for a first payment total of $286,375 needed by Fermilab.

The duration of the task is taken to be 64 weeks. It is assumed that no new masks will need to be produced for the production sensors and that the preproduction sensors satisfy our criteria. When the go ahead is given for production it will take 4 weeks for Hamamatsu to setup the production line and start producing sensors. The production of sensors is assumed to take 4 weeks of processing. At a production rate of 200 sensors per month, 14 months are needed to fill the order, or 56 weeks. An additional 4 weeks is added for Hamamatsu to test the sensors, fill in the paperwork and shipping.

The contingency is taken to be 55%. This includes 30% according to the contingency guidelines as we have a quote. There is also a 25% contingency part added to account for the fluctuations in the US$ to Japanese Yen.

Labor BOE--
No Labor associated with this task.

1.1.1.4.2.2.7	Produce 25% of L2-L5 sensors (Fermilab)	6/5/03	9/26/03	$363,325	$0	$0	$363,325

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
48	MandS	363,325	363,325	0 w	6/5/03	9/26/03	$363,325	$0	$0	$363,325		0	0	363,325

Notes

WBS Definition--
Production at the vendor of the production sensors for Layers 2 - 5 for the silicon detector.

M&S BOE--
The detector calls for a total of 2016 sensors. We assume 5% spares for each module and that building the various modules has an 85% yield. There are a total of 168 of each of the: 10-10A, 20-20A, 10-10S, and 20-20S modules needed. Putting in the yields and 8 spares for each, we need to build 207 of each type of module. The 10-10A and 10-10S each use 2 sensors apiece. The 20-20A and 20-20S modules each need 4 sensors apiece. The total number of sensors needed is 2484 sensors. We assume we can build all the mechanical prototypes with the prototype sensors. To build electrical prototype modules we need 36 sensors for 3 prototypes of each flavor.

We assume stave production will have a yield of 95%, which implies an additional 120 sensors. Moreover, we want 8 staves as spares, which gives another 96 sensors needed. This gives a total of 2736 sensors needed for the project.

Based on a quote from Hamamatsu:
NRE Setup Charges: 7,500,000 Yen
Production sensors, 2736 at 61,000 Yen each
Total: $1,453,300 at an exchange rate of $1=120Yen
Payment spread out over 4 intervals, with $363,325 per payment

The duration of the task is taken to be 64 weeks. It is assumed that no new masks will need to be produced for the production sensors and that the preproduction sensors satisfy our criteria. When the go ahead is given for production it will take 4 weeks for Hamamatsu to setup the production line and start producing sensors. The production of sensors is assumed to take 4 weeks of processing. At a production rate of 200 sensors per month, 14 months are needed to fill the order, or 56 weeks. An additional 4 weeks is added for Hamamatsu to test the sensors, fill in the paperwork and shipping.

The contingency is taken to be 55%. This includes 30% according to the contingency guidelines as we have a quote. There is also a 25% contingency part added to account for the fluctuations in the US$ to Japanese Yen.

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost

"Produce 25% of L2-L5 sensors (Fermilab)" continued

Notes

Labor BOE--
No Labor associated with this task.

1.1.1.4.2.2.8	Produce 25% of L2-L5 sensors (Fermilab)	9/29/03	1/30/04	$363,325	$0	$0	$363,325

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
48	MandS	363,325	363,325	0 w	9/29/03	1/30/04	$363,325	$0	$0	$363,325		0	0	363,325

Notes

WBS Definition--
Production at the vendor of the production sensors for Layers 2 - 5 for the silicon detector.

M&S BOE--
The detector calls for a total of 2016 sensors. We assume 5% spares for each module and that building the various modules has an 85% yield. There are a total of 168 of each of the: 10-10A, 20-20A, 10-10S, and 20-20S modules needed. Putting in the yields and 8 spares for each, we need to build 207 of each type of module. The 10-10A and 10-10S each use 2 sensors apiece. The 20-20A and 20-20S modules each need 4 sensors apiece. The total number of sensors needed is 2484 sensors. We assume we can build all the mechanical prototypes with the prototype sensors. To build electrical prototype modules we need 36 sensors for 3 prototypes of each flavor.

We assume stave production will have a yield of 95%, which implies an additional 120 sensors. Moreover, we want 8 staves as spares, which gives another 96 sensors needed. This gives a total of 2736 sensors needed for the project.

Based on a quote from Hamamatsu:
NRE Setup Charges: 7,500,000 Yen
Production sensors, 2736 at 61,000 Yen each
Total: $1,453,300 at an exchange rate of $1=120Yen
Payment spread out over 4 intervals, with $363,325 per payment

The duration of the task is taken to be 64 weeks. It is assumed that no new masks will need to be produced for the production sensors and that the preproduction sensors satisfy our criteria. When the go ahead is given for production it will take 4 weeks for Hamamatsu to setup the production line and start producing sensors. The production of sensors is assumed to take 4 weeks of processing. At a production rate of 200 sensors per month, 14 months are needed to fill the order, or 56 weeks. An additional 4 weeks is added for Hamamatsu to test the sensors, fill in the paperwork and shipping.

The contingency is taken to be 55%. This includes 30% according to the contingency guidelines as we have a quote. There is also a 25% contingency part added to account for the fluctuations in the US$ to Japanese Yen.

Labor BOE--
No Labor associated with this task.

1.1.1.4.2.2.9	Produce 25% of L2-L5 sensors (Fermilab)	2/2/04	5/21/04	$363,325	$0	$0	$363,325

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
48	MandS	363,325	363,325	0 w	2/2/04	5/21/04	$363,325	$0	$0	$363,325		0	0	363,325

Notes

WBS Definition--
Production at the vendor of the production sensors for Layers 2 - 5 for the silicon detector.

M&S BOE--
The detector calls for a total of 2016 sensors. We assume 5% spares for each module and that building the various modules has an 85% yield. There are a total of 168 of each of the: 10-10A, 20-20A, 10-10S, and 20-20S modules needed. Putting in the yields and 8 spares for each, we need to build 207 of each type of module. The 10-10A and 10-10S each use 2 sensors apiece. The 20-20A and 20-20S modules each need 4 sensors apiece. The total number of sensors needed is 2484 sensors. We assume we can build all the mechanical prototypes with the prototype sensors. To build electrical prototype modules we need 36 sensors for 3 prototypes of each flavor.

We assume stave production will have a yield of 95%, which implies an additional 120 sensors. Moreover, we want 8 staves as spares, which gives another 96 sensors needed. This gives a total of 2736 sensors needed for the project.

Based on a quote from Hamamatsu:
NRE Setup Charges: 7,500,000 Yen
Production sensors, 2736 at 61,000 Yen each
Total: $1,453,300 at an exchange rate of $1=120Yen
Payment spread out over 4 intervals, with $363,325 per payment

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost

"Produce 25% of L2-L5 sensors (Fermilab)" continued

Notes

The duration of the task is taken to be 64 weeks. It is assumed that no new masks will need to be produced for the production sensors and that the preproduction sensors satisfy our criteria. When the go ahead is given for production it will take 4 weeks for Hamamatsu to setup the production line and start producing sensors. The production of sensors is assumed to take 4 weeks of processing. At a production rate of 200 sensors per month, 14 months are needed to fill the order, or 56 weeks. An additional 4 weeks is added for Hamamatsu to test the sensors, fill in the paperwork and shipping.

The contingency is taken to be 55%. This includes 30% according to the contingency guidelines as we have a quote. There is also a 25% contingency part added to account for the fluctuations in the US$ to Japanese Yen.

Labor BOE--
No Labor associated with this task.

1.1.1.4.2.2.10	Probe L2-L5 sensors (Fermilab)	6/5/03	7/20/04	$0	$0	$15,232	$15,232

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
9	MechTechSF	20%	448 h	0 w	6/5/03	7/20/04	$15,232	$0	$0	$15,232	0 h	0 h	0 h	448 h
17	PhysicistF	25%	560 h	0 w	6/5/03	7/20/04	$0	$0	$0	$0	0 h	0 h	0 h	560 h

Notes

WBS Definition-
QC Testing done by D0 at Fermilab on a fraction of the production L2-L5 sensors. We plan to perform two types of tests. Partial test consists of the visual inspection, IV and CV measurements. Full test adds extensive strip-by-strip measurement - strip leakage current, coupling capacitance, polysilicon resistor values.

M&S BOE-
no costs associated with this item

Labor BOE-
We estimate 1.5 hours needed for the partial test for each sensor while the full test for the outer layer sensors requires 8 hours. These estimates are based on previous experience with prototype sensors for D0 Run 2b as well as CMS. There will be a total of 16 days spent in setting up the equipment. About 5% of the total number of sensors ordered (2736) will undergo the partial and full test. Two sensors can be tested at each facility per day. Assume that 25% of a physicist is needed during this time. The probing is all done by a physicist. 20% of a mechtechSF is assumed (1 day/week) to help in cataloguing the sensors and database entry.

1.1.1.4.3	**25% L2-L5 Silicon Sensors Delivered And Tested**	**9/12/03**	**9/12/03**	**$0**	**$0**	**$0**	**$0**

Notes

WBS Definition--
Milestone: 25% of the total number of L2-L5 sensors ordered have been delivered and tested.

1.1.1.4.4	**50% L2-L5 Silicon Sensors Delivered And Tested**	**12/23/03**	**12/23/03**	**$0**	**$0**	**$0**	**$0**

Notes

WBS Definition-
Milestone: 50% of the total number of L2-L5 sensors ordered have been delivered and tested.

1.1.1.4.5	**75% L2-L5 Silicon Sensors Delivered And Tested**	**4/9/04**	**4/9/04**	**$0**	**$0**	**$0**	**$0**

Notes

WBS Definition--
Milestone: 75% of the total number of sensors ordered have been delivered and tested.

1.1.1.4.6	**All L2-L5 Silicon Sensors Delivered And Tested**	**7/20/04**	**7/20/04**	**$0**	**$0**	**$0**	**$0**

Notes

WBS Definition--
Milestone: All L2-L5 sensors have been delivered and tested.

1.1.1.4.7	**Radiation Testing at KSU**	**12/13/02**	**6/7/04**	**$1,000**	**$7,200**	**$0**	**$8,200**

Notes

WBS Definition-
Summary task that includes all radiation testing of L2-L5 sensors and test structures done at KSU.

1.1.1.4.7.1	Perform preproduction irradiation testing	12/13/02	1/21/03	$1,000	$2,400	$0	$3,400

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
15	ElecTechU	50%	80 h	0 w	12/13/02	1/21/03	$0	$0	$0	$0	0 h	0 h	0 h	80 h
18	PhysicistU	100%	160 h	0 w	12/13/02	1/21/03	$0	$0	$0	$0	0 h	0 h	0 h	160 h

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost

"Perform preproduction irradiation testing" continued

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
48	MandS	3,400	3,400	0 w	12/13/02	1/21/03	$3,400	$0	$0	$3,400		0	0	3,400

Notes

WBS Definition-
Tests to assure performance done at radiation facility

M&S BOE-
Different jigs are required to hold different sensor types and test structures. They are manufactured by a machine shop. Cost for jig material is accounted for already in estimate for layer 0 jigs. Needed are 25 machine shop hours at $40/hour. Total for machining jigs of $1000. Technician labor is paid for by an MOU. Total irradiation time for these sensors is 8 weeks. Based on experience with pilot runs, irradiation work requires 20% of an FTE of a University technician, who gets paid at an annual rate of $42K*1.274(benefits)*1.455(indirect cost) = $77,854. The cost for 8 weeks of a technician at 20% is thus: $77,854*0.2* 8/52 = $2400.
Total cost: $3400.

Labor BOE-
See above.

1.1.1.4.7.2	Analyze preproduction test results	1/22/03	2/4/03	$0	$0	$0	$0

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
18	PhysicistU	100%	80 h	0 w	1/22/03	2/4/03	$0	$0	$0	$0	0 h	0 h	0 h	80 h

Notes

WBS Definition-
Analysis of all test results including radiation studies

M&S BOE-
no costs associated with this item

Labor BOE-
Based on Prototyping work a full time physicist is needed.

1.1.1.4.7.3	Radiation Testing L2-5 Test Structures	6/5/03	6/7/04	$0	$4,800	$0	$4,800

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
15	ElecTechU	5%	100 h	0 w	6/5/03	6/7/04	$0	$0	$0	$0	0 h	0 h	0 h	100 h
18	PhysicistU	5%	100 h	0 w	6/5/03	6/7/04	$0	$0	$0	$0	0 h	0 h	0 h	100 h
48	MandS	4,800	4,800	0 w	6/5/03	6/7/04	$4,800	$0	$0	$4,800		0	0	4,800

Notes

WBS Definition-
Tests to assure performance done at radiation facility

M&S BOE-
Technician labor is paid for by an MOU. Total irradiation time for these sensors is 16 weeks. Based on experience with pilot runs, irradiation work requires 20% of an FTE of a University technician, who gets paid at an annual rate of $42K*1.274(benefits)*1.455(indirect cost) = $77,854. The cost for 16 weeks of a technician at 20% is thus: $77,854*0.2*16/52 = $4800.
Total cost: $4800.

Labor BOE-
The total duration of the task is 50 weeks. However, the radiation tests only take 2 weeks every two months for a total of 16 weeks, which was used in the M&S BOE.

1.1.1.5	**All Silicon Sensors Delivered And Tested**	**7/28/04**	**7/28/04**	**$0**	**$0**	**$0**	**$0**

Notes

WBS Definition-
Milestone: All L0, L1, and L2-L5 sensors have been delivered and tested.

1.1.2	**Readout System**	**10/1/01**	**5/18/05**	**$3,754,068**	**$474,447**	**$1,190,659**	**$5,419,174**

Notes

WBS Definition-
This summary element includes the development, procurement, and testing of SVX4 readout chips, readout hybrids, cabling, junction cards, test cards, adaptor cards, interface boards, and power supplies, as well as improvements to selected elements of the front-end DAQ system.

Risk Mitigation-

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
"Readout System" continued							

Notes

Items with significant risk included in the readout electronics are:
SVX4 chips and the Analog Flex Cables. The project crucially depends on the timely operation of the SVX4 chip. Please see the appropriate summary task for a more detailed description of these two items.

1.1.2.1	**SVX4 Chips**	**12/3/01**	**4/2/04**	**$799,350**	**$214,640**	**$125,840**	**$1,139,830**

Notes

WBS Definition-
This is a summary task that includes the development, procurement, and testing of SVX4 readout chips.

Risk Mitigation-
The SVX4 chips are the highest risk item for the Run2b silicon detector. CDF and D0 are joint on the project and the chip must work for both projects to succeed. A 1st round chip has been produced and has been successfully read out by D0. A prototype hybrid stuffed with these chips has also been successfully read out by a stand alone teststand. Worries are:
- reworks of the existing chip in the next iteration may destroy or change the ability to readout the chip
- there are features of the chip that haven't been explored fully that would change the operation of the detector.

Cost:
The cost of the wafers is fixed, it is just a question of the yield of the chips. We've assumed there is a 50% yield in the wafers to obtain this cost. For the production contingency, we've put 75% to be conservative. The costs from LBL for engineering has a 100% contingency placed on it in case large redesigns of the chip are needed.

Schedule:
We've assumed a 2nd run of the chip before the production run. The risk here is that we don't test thoroughly enough to catch all of the problems in the chip before the preproduction run. 3 sets of testing are occuring:
- tests at LBL on single chips to verify functionality
- tests at Fermilab on single chips to explore the whole timing space for functionality
- system tests allowing readout on hybrids.

If we find a problem at some point that we think is significant enough to rework the chip, it will cause a schedule delay if it is not found before the production run. Any problems can be corrected however, by submitting more runs at a risk to the schedule.

Scope/Technical:
As described in the worries section. We are trying to mitigate these risks by testing the prototype chips more thoroughly in system tests as well as in a setup that allows us to explore several timing diagrams.

1.1.2.1.1	**SVX4 Chips (at Fermilab)**	**12/3/01**	**4/2/04**	**$537,212**	**$0**	**$125,840**	**$663,052**

Notes

WBS Definition-
This is a summary task that includes the development, procurement, and testing of SVX4 readout chips done at Fermilab.

1.1.2.1.1.1	**Fermilab R&D Tasks**	**12/3/01**	**10/18/02**	**$78,000**	**$0**	**$32,560**	**$110,560**

Notes

WBS Definition-
This is a summary task that includes the development, procurement, and testing of SVX4 readout chips done at Fermilab during R&D phase.

1.1.2.1.1.1.1	Develop prototype	12/3/01	6/26/02	$63,000	$0	$6,160	$69,160

ID	*Resource Name*	*Units*	*Work*	*Delay*	*Start*	*Finish*	*Cost*	*Baseline Cost*	*Act. Cost*	*Rem. Cost*	*Ovt. Work*	*Baseline Work*	*Act. Work*	*Rem. Work*
4	*ElecEngF*	*10%*	*112 h*	*0 w*	*12/3/01*	*6/26/02*	*$6,160*	*$0*	*$6,160*	*$0*	*0 h*	*0 h*	*112 h*	*0 h*
17	*PhysicistF*	*20%*	*224 h*	*0 w*	*12/3/01*	*6/26/02*	*$0*	*$0*	*$0*	*$0*	*0 h*	*0 h*	*224 h*	*0 h*
48	*MandS*	*63,000*	*63,000*	*0 w*	*12/3/01*	*6/26/02*	*$63,000*	*$0*	*$63,000*	*$0*		*0*	*63,000*	*0*

Notes

WBS Definition-
This work includes the D0 Fermilab effort that is collaborating with the design team at LBL and Fermilab. In particular, the design, layout, documentation for the first chip prototype and consultation on production and postprocessing of first prototype chip is included.

M&S BOE-
Cost for production at TSMC is 200K$ for 10 wafers, minimum order.
Order split between CDF, D0 and BTeV. CDF and Dzero will both obtain equal number of chips.
Cost for Dzero SVX4 is 50K$ for masks + 8K$ for chips.
Postprocessing cost for D0 (grinding, backplating and dicing) 5k$
Total cost $63,000.

Labor BOE-
Almost 3 weeks of time by the D0 electrical engineer is included in order to train the engineer on the functionality of the chip and consult with the design team. This includes a 2 hour weekly meeting for 1 week

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost

"Develop prototype" continued

Notes

and a half of his time. For a senior physicist, almost 6 weeks of full time work is included. It is expected that the physicist will spend three weeks on documentation alone in addition to the 1.5 weeks of standard meetings and another 1.5 weeks in other contact time with the designers.

1.1.2.1.1.1.2	Test SVX4 prototypes by design group	7/17/02	8/13/02	$0	$0	$8,800	$8,800

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
4	ElecEngF	100%	160 h	0 w	7/17/02	8/13/02	$8,800	$0	$4,400	$4,400	0 h	0 h	80 h	80 h

Notes

WBS Definition-
Verification of design parameters and functionality of prototype SVX4 chip by Fermilab design group.

M&S BOE-
no costs associated with this item

Labor BOE-
We assume the full time use of the preamp designer. This estimate comes from Ray Yarema's list of how much time is needed. He estimates 40 days of an electrical engineer to test and redesign the chip at Fermilab. This time and cost is shared between 1.1.2.1.1.1.2 and 1.1.2.1.1.2.1 and 1.1.2.1.1.2.4.

1.1.2.1.1.1.3	Test SVX4 prototype chips by D0 group	6/27/02	10/18/02	$15,000	$0	$17,600	$32,600

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
4	ElecEngF	50%	320 h	0 w	6/27/02	10/18/02	$17,600	$0	$11,880	$5,720	0 h	0 h	216 h	104 h
17	PhysicistF	25%	160 h	0 w	6/27/02	10/18/02	$0	$0	$0	$0	0 h	0 h	108 h	52 h
44	PostDoc	100%	640 h	0 w	6/27/02	10/18/02	$0	$0	$0	$0	0 h	0 h	432 h	208 h
48	MandS	15,000	15,000	0 w	6/27/02	10/18/02	$15,000	$0	$15,000	$0		0	10,125	4,875

Notes

WBS Definition-
This element includes probing, stimulus and any other tests D0 performs on chips to verify the operation of the chip both alone and mounted on prototype hybrids by Fermilab personnel. There are two parallel tasks that account for the university personnel.

M&S BOE-
We assume that there will be a new stimulus board setup. For four stimulus boards, we expect to spend $2000. There is also an SVX3 adapter board that allows us to test the SVX3 chip with the SVX4 stimulus setup: $500. Miscellaneous cables and software licenses are expected to cost $2500. There are also probe cards to buy to assist with the wafer test setup assumed to cost $10000.
Total: $15000

Labor BOE-
The effort for testing the chip assumes 2 full time students, a full time university postdoc, a full time fermilab postdoc, a quarter-time senior physicist, and a half time electrical engineer. Based on our Run2a experience with the SVX2 chips and the existing test stands, we have listed the tests we expect to perform which we expect to take 8 weeks. We have doubled the time in the schedule to take care of unexpected features found with the SVX4.

1.1.2.1.1.2	**Fermilab Production Tasks**	**10/21/02**	**4/2/04**	**$459,212**	**$0**	**$93,280**	**$552,492**

Notes

WBS Definition-
This is a summary task that includes the development, procurement, and testing of SVX4 readout chips done at Fermilab during production phase.

1.1.2.1.1.2.1	Develop preproduction chip	10/21/02	11/15/02	$0	$0	$4,400	$4,400

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
4	ElecEngF	50%	80 h	0 w	10/21/02	11/15/02	$4,400	$0	$0	$4,400	0 h	0 h	0 h	80 h
17	PhysicistF	20%	32 h	0 w	10/21/02	11/15/02	$0	$0	$0	$0	0 h	0 h	0 h	32 h

Notes

WBS Definition-
This includes the design and layout for the second run of the chip

M&S BOE-
no costs associated with this item.

Labor BOE-
We assume the full time use of the preamp designer. This estimate comes from Ray Yarema's list of how much time is needed. He estimates 40 days of an electrical engineer to test and redesign the chip at Fermilab. This time and cost is shared between 1.1.2.1.1.1.2 and 1.1.2.1.1.2.1 and 1.1.2.1.1.2.4.

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
1.1.2.1.1.2.2	Produce preproduction chip	11/18/02	2/25/03	$157,500	$0	$2,728	$160,228

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
4	ElecEngF	10%	49.6 h	0 w	11/18/02	2/25/03	$2,728	$0	$0	$2,728	0 h	0 h	0 h	49.6 h
17	PhysicistF	10%	49.6 h	0 w	11/18/02	2/25/03	$0	$0	$0	$0	0 h	0 h	0 h	49.6 h
48	MandS	157,500	157,500	0 w	11/18/02	2/25/03	$157,500	$0	$0	$157,500		0	0	157,500

Notes

WBS Definition-
The production, and backplating and dicing of the second prototype chip

M&S BOE-
One run at TSMC costs $200K. It is assumed that D0 will pay half of the cost of this run for
10 wafers, minimum order : $100K
D0 orders an additional lot at $50K
Backplating, grinding and other postprocessing costs $15K of which D0 pays half: $7500.
Total: $157,500
Agreed upon contingency of 0% with CDF and Ray Yarema based on the fact that there will be a production run and we know the costs of the preproduction run.

Labor BOE-
Based on Ray Yarema estimate and using time from prototype run. A Physicist and ElecEng have to keep in touch with the vendor for 10% of this time.

1.1.2.1.1.2.3	Test preproduction by D0 group	2/26/03	4/22/03	$5,000	$0	$8,800	$13,800

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
4	ElecEngF	50%	160 h	0 w	2/26/03	4/22/03	$8,800	$0	$0	$8,800	0 h	0 h	0 h	160 h
17	PhysicistF	25%	80 h	0 w	2/26/03	4/22/03	$0	$0	$0	$0	0 h	0 h	0 h	80 h
44	PostDoc	100%	320 h	0 w	2/26/03	4/22/03	$0	$0	$0	$0	0 h	0 h	0 h	320 h
48	MandS	5,000	5,000	0 w	2/26/03	4/22/03	$5,000	$0	$0	$5,000		0	0	5,000

Notes

WBS Definition-
This element includes probing, stimulus and any other tests D0 performs on the second prototype run of chips

M&S BOE-
$5000 is assumed here in case a probe card or other card has to be made to assist in testing.

Labor BOE-
The effort for testing the chip assumes a full time student, a full time university postdoc, a full time fermilab postdoc, a quarter-time senior physicist, and a half time electrical engineer. Based on our Run2a experience with the SVX2 chips and the existing test stands, we have listed the tests we expect to perform which we expect to take 4 weeks. We have doubled the time in the schedule to take care of unexpected features found with the SVX4.

1.1.2.1.1.2.4	Test preproduction by design group	2/26/03	3/25/03	$0	$0	$4,400	$4,400

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
4	ElecEngF	50%	80 h	0 w	2/26/03	3/25/03	$4,400	$0	$0	$4,400	0 h	0 h	0 h	80 h

Notes

WBS Definition-
Verification of design parameters and functionality of preproduction SVX4 chip by Fermilab design group.

M&S BOE-
no costs associated with this item

Labor BOE-
We assume the full time use of the preamp designer. This estimate comes from Ray Yarema's list of how much time is needed. He estimates 40 days of an electrical engineer to test and redesign the chip at Fermilab. This time and cost is shared between 1.1.2.1.1.1.2 and 1.1.2.1.1.2.1 and 1.1.2.1.1.2.4.

1.1.2.1.1.2.5	(retired)	10/21/02	10/21/02	$0	$0	$0	$0

Notes

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
1.1.2.1.1.2.6	Produce final wafers(Fermilab)	5/21/03	7/31/03	$275,712	$0	$0	$275,712

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
17	PhysicistF	5%	20 h	0 w	5/21/03	7/31/03	$0	$0	$0	$0	0 h	0 h	0 h	20 h
48	MandS	275,712	275,712	0 w	5/21/03	7/31/03	$275,712	$0	$0	$275,712		0	0	275,712

Notes

WBS Definition-
This includes the procurement and production of the wafers, Fermilab's part

M&S BOE-
Estimate based on Ray Yarema's numbers.
The production mask cost is $150,000 which D0 and CDF split. We assume a 50% yield on the number of wafers/lot and a lot cost of $50,000. D0 then needs 8 lots (12000 chips).
=$75,000+8*$50,000=$475,000. This cost is split between Fermilab and the MRI.
Fermilab portion: $275,712
Contingency of 75% is assumed according to guidelines.

Labor BOE-
Physicist at 5% is included to interface with vendor.

1.1.2.1.1.2.7	Wafer backgrinding/plating	8/1/03	8/28/03	$16,000	$0	$0	$16,000

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
48	MandS	16,000	16,000	0 w	8/1/03	8/28/03	$16,000	$0	$0	$16,000		0	0	16,000

Notes

WBS Definition-
This includes all backgrinding, plating, and dicing of the chip

M&S BOE-
We assume 80 wafers (8 lots x 10 wafers/lot) each needing $200/wafer cost based on estimates from LBL : Total $16000

Labor BOE-
Based on Ray Yarema estimate, an ElecEngF needs to be in contact with whole operation for a total of one week.

1.1.2.1.1.2.8	Test chips on wafers	8/29/03	4/2/04	$5,000	$0	$41,052	$46,052

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
4	ElecEngF	53%	614.8 h	0 w	8/29/03	4/2/04	$33,814	$0	$0	$33,814	0 h	0 h	0 h	614.8 h
13	ElecTechF	16%	185.6 h	0 w	8/29/03	4/2/04	$7,238	$0	$0	$7,238	0 h	0 h	0 h	185.6 h
17	PhysicistF	35%	406 h	0 w	8/29/03	4/2/04	$0	$0	$0	$0	0 h	0 h	0 h	406 h
48	MandS	5,000	5,000	0 w	8/29/03	4/2/04	$5,000	$0	$0	$5,000		0	0	5,000

Notes

WBS Definition-
All testing done at Fermilab including documentation, packaging and shipping to hybrid vendor

M&S BOE-
$5000 is assumed here in case a probe card or other card has to be made to assist in testing.

Labor BOE-
Testing includes:
1. automated probing of wafers before dicing where a physicist oversees the operation and an electrical technician tests the chips. The estimate here is based on William Wester's estimate.
2. Testing in systems tests: Here we assume one full time engineer and another for 25% of the time. A full time Fermilab postdoc is also needed for the duration. This is also overseen by a physicist at 25% and there are other resources listed on parallel tasks for this effort.

1.1.2.1.1.2.9	Test chips in D0 system	8/29/03	4/2/04	$0	$0	$31,900	$31,900

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
4	ElecEngF	50%	580 h	0 w	8/29/03	4/2/04	$31,900	$0	$0	$31,900	0 h	0 h	0 h	580 h
44	PostDoc	50%	580 h	0 w	8/29/03	4/2/04	$0	$0	$0	$0	0 h	0 h	0 h	580 h

Notes

WBS Definition-
All testing done at Fermilab- running the chip in SVX2 mode, including documentation, packaging and shipping to hybrid vendor.

M&S BOE-

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost

"Test chips in D0 system" continued

Notes
n/a

Labor BOE-
Testing includes:
1. automated probing of wafers before dicing where a physicist oversees the operation and an electrical technician tests the chips. The estimate here is based on William Wester's estimate.
2. Testing in systems tests: Here we assume one full time engineer and another for 25% of the time. A full time Fermilab postdoc is also needed for the duration. This is also overseen by a physicist at 25% and there are other resources listed on parallel tasks for this effort.

1.1.2.1.2	**SVX4 Chip Development and Testing at LBL**	**12/3/01**	**5/20/03**	**$0**	**$194,640**	**$0**	**$194,640**

Notes
WBS Definition-
This is a summary task that includes the development, procurement, testing, and documentation of SVX4 readout chips done at LBL

M&S BOE-
Except for tasks already charged contingency is set to 100% to account for the risk and importance associated with this chip' development.

1.1.2.1.2.1	**SVX4 Chip Development for R&D**	**12/3/01**	**9/20/02**	**$0**	**$101,812**	**$0**	**$101,812**

Notes
WBS Definition-
This is a summary task that includes the development, procurement, testing, and documentation of SVX4 readout chips done at LBL in R&D phase.

1.1.2.1.2.1.1	Develop prototype(LBL)	12/3/01	6/26/02	$0	$80,500	$0	$80,500

ID	*Resource Name*	*Units*	*Work*	*Delay*	*Start*	*Finish*	*Cost*	*Baseline Cost*	*Act. Cost*	*Rem. Cost*	*Ovt. Work*	*Baseline Work*	*Act. Work*	*Rem. Work*
48	*MandS*	*80,500*	*80,500*	*0 w*	*12/3/01*	*6/26/02*	*$80,500*	*$0*	*$80,500*	*$0*		*0*	*80,500*	*0*

Notes
WBS Definition--
The design, layout and simulation of the SVX4 chip 1st run.

M&S BOE--
The labor at LBL associated with engineering and design of the SVX4 in the amount of $80,500.
This is half of the initial cost for chip design, which is shared between Dzero and CDF. (money spent). 0% contingency!

Labor BOE--
The labor associated with this is charged to M&S and is associated with the chip design team at LBL.

1.1.2.1.2.1.2	Test SVX4 prototype chips and documentation	6/27/02	9/20/02	$0	$21,312	$0	$21,312

ID	*Resource Name*	*Units*	*Work*	*Delay*	*Start*	*Finish*	*Cost*	*Baseline Cost*	*Act. Cost*	*Rem. Cost*	*Ovt. Work*	*Baseline Work*	*Act. Work*	*Rem. Work*
48	*MandS*	*21,312*	*21,312*	*0 w*	*6/27/02*	*9/20/02*	*$21,312*	*$0*	*$21,312*	*$0*		*0*	*10,656*	*10,656*

Notes
WBS Definition--
For the first run of the chip, there will be functionality testing and documentation in preparation for the next run of the chip.

M&S BOE--
The labor at LBL associated with producing the necessary documentation for the chip is estimated to be $15,000, we split this with CDF so D0 cost is $7,500.
Labor cost at LBL, as per Henrik Van Der Lippe and Ray Yarema (3/19/02), for tests performed at LBL including radiation damage assesment amount to $27,624.00 of which D0 pays half $13,812, as documented in Ray Yarema's spreadsheet.
Total cost: $21,312.
A 100% contingency is added on to this item because of it's high risk and experience in the past of LBL estimations.

Labor BOE--
The labor associated with this is charged to M&S and is associated with the chip design team at LBL.

1.1.2.1.2.2	**SVX4 Chip Production Tasks**	**10/21/02**	**5/20/03**	**$0**	**$92,828**	**$0**	**$92,828**

Notes
WBS Definition-
This is a summary task that includes the development, procurement, testing, and documentation of SVX4 readout chips done at LBL during production phase

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
"SVX4 Chip Production Tasks" continued							

Notes

1.1.2.1.2.2.1	Preproduction chip layout and design(LBL)	10/21/02	11/15/02	$0	$54,036	$0	$54,036

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
48	MandS	54,036	54,036	0 w	10/21/02	11/15/02	$54,036	$0	$0	$54,036		0	0	54,036

Notes

WBS Definition--
The design, simulation, layout, and documentation associated with the 2nd run of the SVX4 chip done by personnel at LBL.

M&S BOE--
Labor cost at LBL, as per Henrik Van Der Lippe and Ray Yarema (3/19/02), for 2nd chip design at LBL totals $108,072 of which D0 pays half - $54,036 (see Ray Yarema's spreadsheet). A 100% contingency is added on to this item because of it's high risk and experience in the past of LBL estimations.

Labor BOE--
The labor associated with this is charged to M&S and is associated with the chip design team at LBL.

1.1.2.1.2.2.2	Preproduction chip testing(LBL)	2/26/03	4/15/03	$0	$6,000	$0	$6,000

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
48	MandS	6,000	6,000	0 w	2/26/03	4/15/03	$6,000	$0	$0	$6,000		0	0	6,000

Notes

WBS Definition--
Functionality testing and verification of the 2nd run of SVX4 chips done by the LBL design team.

M&S BOE--
Labor cost at LBL, as per Henrik Van Der Lippe and Ray Yarema (3/19/02), for 2nd chip testing at LBL totals $12,000 of which D0 pays half - $6,000 (see Ray Yarema's spreadsheet). A 100% contingency is added on to this item because of it's high risk and experience in the past of LBL estimations.

Labor BOE--
The labor associated with this is charged to M&S and is associated with the chip design team at LBL.

1.1.2.1.2.2.3	Production chip layout and design (LBL)	4/23/03	5/20/03	$0	$32,792	$0	$32,792

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
48	MandS	32,792	32,792	0 w	4/23/03	5/20/03	$32,792	$0	$0	$32,792		0	0	32,792

Notes

WBS Definition--
Functionality testing and verification of the 2nd run of SVX4 chips done by the LBL design team.

M&S BOE--
Labor cost at LBL, as per Henrik Van Der Lippe and Ray Yarema (3/19/02), for production chip submission at LBL for a total of $65,584, of which D0 pays half - $32,792 (see Ray Yarema's spreadsheet). A 100% contingency is added on to this item because of it's high risk and experience in the past of LBL estimations.

Labor BOE--
The labor associated with this is charged to M&S and is associated with the chip design team at LBL.

1.1.2.1.3	**SVX4 Chip Testing and Production MRI Grant**	**2/13/02**	**4/2/04**	**$262,138**	**$20,000**	**$0**	**$282,138**

Notes

WBS Definition-
This is a summary task that includes the development, procurement, testing, and documentation of SVX4 readout chips done with MRI resources.

1.1.2.1.3.1	Develop SVX chip probing procedures	2/13/02	6/26/02	$10,000	$20,000	$0	$30,000

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
6	ElecEngU	20%	152 h	0 w	2/13/02	6/26/02	$0	$0	$0	$0	0 h	0 h	152 h	0 h
44	PostDoc	100%	760 h	0 w	2/13/02	6/26/02	$0	$0	$0	$0	0 h	0 h	760 h	0 h
48	MandS	30,000	30,000	0 w	2/13/02	6/26/02	$30,000	$0	$30,000	$0		0	30,000	0

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost

"Develop SVX chip probing procedures" continued

Notes

WBS Definition-
Includes setting up all D0 manned testing systems for chips including stimulus teststands.

M&S BOE-
Assumes $8000 for cost share on logic analyzer at KU (money spent)
$2000 for testing boards that make up stimulus system (money spent)
$20,000 match for electrical engineering time spent on the project for the last year.
Total $30,000.

Labor BOE-
Based on resources spent.

1.1.2.1.3.2	Test SVX4 prototype chips MRI	6/27/02	10/18/02	$22,850	$0	$0	$22,850

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
44	PostDoc	100%	640 h	0 w	6/27/02	10/18/02	$0	$0	$0	$0	0 h	0 h	435.2 h	204.8 h
47	Student	100%	640 h	0 w	6/27/02	10/18/02	$0	$0	$0	$0	0 h	0 h	435.2 h	204.8 h
48	MandS	22,850	22,850	0 w	6/27/02	10/18/02	$22,850	$0	$22,850	$0		0	15,538	7,312

Notes

WBS Definition-
This element includes probing, stimulus and any other tests D0 performs on chips to verify the operation of the chip both alone and mounted on prototype hybrids by Fermilab personnel. There are three parallel tasks that account for Fermilab and LBL testing as well.

M&S BOE-
A network analyzer is bought at $22,850 (money spent)

Labor BOE-
The effort for testing the chip assumes a full time student, a full time university postdoc for the MRI portion. Based on our Run2a experience with the SVX2 chips and the existing test stands, we have listed the tests we expect to perform which we expect to take 8 weeks. We have doubled the time in the schedule to take care of unexpected features found with the SVX4.

1.1.2.1.3.3	Test preproduction chips MRI	2/26/03	4/22/03	$20,000	$0	$0	$20,000

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
18	PhysicistU	10%	32 h	0 w	2/26/03	4/22/03	$0	$0	$0	$0	0 h	0 h	0 h	32 h
44	PostDoc	100%	320 h	0 w	2/26/03	4/22/03	$0	$0	$0	$0	0 h	0 h	0 h	320 h
47	Student	100%	320 h	0 w	2/26/03	4/22/03	$0	$0	$0	$0	0 h	0 h	0 h	320 h
48	MandS	20,000	20,000	0 w	2/26/03	4/22/03	$20,000	$0	$0	$20,000		0	0	20,000

Notes

WBS Definition-
This element includes probing, stimulus and any other tests D0 performs on chips to verify the operation of the chip both alone and mounted on prototype hybrids by MRI personnel. There are two parallel tasks that account for the LBL and Fermilab personnel.

M&S BOE-
Budgeted costs from Brown University on MRI to buy oscilloscopes or other testing equipment.
A 0% contingency is assumed as it is already alotted.

Labor BOE-
The effort for testing the chip assumes a full time student, a full time university postdoc. Based on our Run2a experience with the SVX2 chips and the existing test stands, we have listed the tests we expect to perform which we expect to take 4 weeks. We have doubled the time in the schedule to take care of unexpected features found with the SVX4. Another physicist oversees the efforts from the university at the 10% level.

1.1.2.1.3.4	Produce final wafers MRI	5/21/03	7/31/03	$199,288	$0	$0	$199,288

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
48	MandS	199,288	199,288	0 w	5/21/03	7/31/03	$199,288	$0	$0	$199,288		0	0	199,288

Notes

WBS Definition-
This includes the procurement and production of the wafers, MRI part

M&S BOE-
Estimate based on Ray Yarema's numbers.

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
"Produce final wafers MRI" continued							

Notes

The production mask cost is $150,000 which D0 and CDF split. We assume a 50% yield on the number of wafers/lot and a lot cost of $50,000. D0 then needs 8 lots (12000 chips).
=$75,000+8*$50,000=$475,000. This cost is split between Fermilab and the MRI.
Brown's (MRI) portion: $199,288. Contingency is placed on the Fermilab line.

Labor BOE-
no labor on this line

1.1.2.1.3.5	Test final chips MRI	8/29/03	4/2/04	$10,000	$0	$0	$10,000

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
44	PostDoc	100%	1,160 h	0 w	8/29/03	4/2/04	$0	$0	$0	$0	0 h	0 h	0 h	1,160 h
47	Student	100%	1,160 h	0 w	8/29/03	4/2/04	$0	$0	$0	$0	0 h	0 h	0 h	1,160 h
48	MandS	10,000	10,000	0 w	8/29/03	4/2/04	$10,000	$0	$0	$10,000		0	0	10,000

Notes

WBS Definition-
This element includes probing, stimulus and any other tests D0 performs on chips to verify the operation of the chip both alone and mounted on prototype hybrids by MRI personnel. There are two parallel tasks that account for the LBL and Fermilab personnel.

M&S BOE-
Budgeted costs from Brown University on MRI to buy oscilloscopes or other testing equipment. A 0% contingency is assumed as it is already alotted.

Labor BOE-
The effort for testing the chip assume a full time students, a full time university postdoc. Based on our Run2a experience with the SVX2 chips and the existing test stands, we expect to continue tests that verify operation on stimulus teststands in addition to the wafer testing done by Fermilab group.

1.1.2.1.4	First chip ready for hybrid	7/8/02	7/8/02	$0	$0	$0	$0

Notes

WBS Definition-
Milestone: 1st run prototype chip has been verified to readout and it is ready for mounting on hybrid.

1.1.2.1.5	SVX4 Wafers Delivered	7/31/03	7/31/03	$0	$0	$0	$0

Notes

WBS Definition-
Milestone: The production run of the SVX4 chip has been completed and the wafers have been delivered for postprocessing.

1.1.2.1.6	SVX4 Released For Production	5/20/03	5/20/03	$0	$0	$0	$0

Notes

WBS Definition-
Milestone: D0 and the chip designers have verified and accepted that the SVX4 chip is ready for the production run.

1.1.2.1.7	All SVX4 Chips Produced And Tested	4/2/04	4/2/04	$0	$0	$0	$0

Notes

WBS Definition-
Milestone: All production chips are in hand and have been tested so that they are ready for placement on hybrids.

1.1.2.2	L0 Hybrids	7/24/02	4/30/04	$80,570	$0	$44,549	$125,119

Notes

WBS Definition-
This is a summary task that includes the development, procurement, stuffing, wirebonding, and testing of all Layer 0 hybrid assemblies

1.1.2.2.1	Prototypes with Fermilab	7/24/02	3/5/03	$23,750	$0	$29,981	$53,731

Notes

WBS Definition-
This is a summary task that includes the development, procurement, stuffing, wirebonding, and testing of all Layer 0 hybrid prototype assemblies by Fermilab.

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
1.1.2.2.1.1	Develop prototype specifications	7/24/02	10/2/02	$4,500	$0	$14,080	$18,580

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
4	ElecEngF	50%	192 h	0 w	7/24/02	10/2/02	$10,560	$0	$7,920	$2,640	0 h	0 h	144 h	48 h
17	PhysicistF	25%	96 h	0 w	7/24/02	10/2/02	$0	$0	$0	$0	0 h	0 h	72 h	24 h
21	DesignerF	20%	80 h	0 w	7/24/02	10/2/02	$3,520	$0	$2,534	$986	0 h	0 h	57.6 h	22.4 h
48	MandS	4,500	4,500	0 w	7/24/02	10/2/02	$4,500	$0	$4,500	$0		0	3,240	1,260

Notes

WBS Definition-
The design and layout of Layer 0 hybrids
L0 hybrid will interface 2 SVX4 chips to the ouside electronics. The hybrid will provide power and control signals to the chips and will read out data. L0 hybrid has 2 SVX4 chips, 50-pin AVX connector and 28 SMT components. The hybrid design is based on thick film screen printing on beryllia substrate. Routing is performed via 3 layers of traces, one ground layer and one power layer. Schematics and layout of the hybrid is provided. The total number of dielectric and metal layers is 11. Several back side prints are necessary to compensate for possible warping.

M&S BOE
L0 hybrid layout and routing is performed by Wolf Electronics in Elgin IL. Typical charge is $1500 per iteration of the design. We assume 3 iterations which was required for L1 prototype hybrids now produced. total cost is $4500.

Labor BOE-
Similar technology was used by CDF in Run2A so the estimates are supported by Run2a experience. Estimate of 10 weeks total
1 month of ElecEngF and 2 weeks of Physicist is based on the design of L1 prototype accomplished in 2001. L1 estimate was 18 weeks which will be reduced for L0 to 10 weeks because of similarity of L1 and L0 hybrid designs. 10 days of DesF is required to produce three drawings of the L0 hybrid and L0 module. L0 module composed of the sensor, analog cable and the hybrid.

1.1.2.2.1.2	Procure prototypes	10/3/02	1/7/03	$16,250	$0	$2,256	$18,506

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
4	ElecEngF	5%	24 h	0 w	10/3/02	1/7/03	$1,320	$0	$0	$1,320	0 h	0 h	0 h	24 h
13	ElecTechF	5%	24 h	0 w	10/3/02	1/7/03	$936	$0	$0	$936	0 h	0 h	0 h	24 h
48	MandS	16,250	16,250	0 w	10/3/02	1/7/03	$16,250	$0	$0	$16,250		0	0	16,250

Notes

WBS Definition-
The vendor selection and procurement of bare prototype hybrids

M&S BOE
$16250 cost assumes 25 prototypes at $441 per bare hybrid and NRE of $3750 (CPT budget quote of 3/1/2002) and $60 per hybrid for the hybrid components and assembly. This includes costs for stuffing and wirebonding of the hybrids.

Labor BOE-
Manufacturing includes interactions with CPT/Amitron engineers especially at the initial stage to nail down details of the design and adjust it to the concrete technological process used by the vendor. 5% ElecEngF and 5% of ElecTech is requested for the whole duration of the manufacturing (12 weeks). Some involvement in the Fermilab procurement chain is assumed as well.

1.1.2.2.1.3	Design, procure, and qualify hybrid prototype fixtures	10/3/02	11/27/02	$3,000	$0	$5,152	$8,152

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
1	MechEngF	10%	32 h	0 w	10/3/02	11/27/02	$1,632	$0	$0	$1,632	0 h	0 h	0 h	32 h
21	DesignerF	25%	80 h	0 w	10/3/02	11/27/02	$3,520	$0	$0	$3,520	0 h	0 h	0 h	80 h
48	MandS	3,000	3,000	0 w	10/3/02	11/27/02	$3,000	$0	$0	$3,000		0	0	3,000

Notes

WBS Definition-
Fixtures needed for stuffing and wirebonding as well as testing of hybrids are designed and produced

M&S BOE-
Assumes 5 fixtures at $600 needed for stuffing, glueing SVX4 chips, bonding and storing the prototype hybrids. based on run2a experience.
Total $3,000.

Labor BOE-
Duration of the task is 8 weeks.
20% of PhysicistU is needed to design and qualify the fixtures
10% of MechEngF is needed to design and procure the fixtures
25% of DesignerF is needed to prepare 5 drawings of fixtures. Two iterations are assumed for 3 drawings.

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
1.1.2.2.1.4	Test prototypes	1/8/03	3/5/03	$0	$0	$5,773	$5,773

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
4	ElecEngF	25%	80 h	0 w	1/8/03	3/5/03	$4,400	$0	$0	$4,400	0 h	0 h	0 h	80 h
12	ElecTechSF	13%	41.6 h	0 w	1/8/03	3/5/03	$1,373	$0	$0	$1,373	0 h	0 h	0 h	41.6 h
17	PhysicistF	50%	160 h	0 w	1/8/03	3/5/03	$0	$0	$0	$0	0 h	0 h	0 h	160 h
34	SASEQTestStandF	100%	320 h	0 w	1/8/03	3/5/03	$0	$0	$0	$0	0 h	0 h	0 h	320 h

Notes

WBS Definition-
Probing, stuffing, wirebonding, and all testing of prototype L0 hybrids

M&S BOE-
no M&S coist associated with this task

Labor BOE
Test includes electrical debugging of hybrids and associated cabling and electronics. Hybrids will be characterized in terms of performance of SVX4 chips. Measurements will include full scan of possible SVX4 parameters. Some repairs and replacement of chips are assumed. Signal terminations need to be optimized. This will take a total of 8 weeks with the PhysicistF having 4 weeks, ElecEngF (2 weeks) and 1 week of an ElecTechSF. The request is based on Run2a experience of HDI prototyping with SVX2 chips which were similar in complexity.

1.1.2.2.1.5	Perform mechanical tests	1/8/03	2/5/03	$0	$0	$2,720	$2,720

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
9	MechTechSF	50%	80 h	0 w	1/8/03	2/5/03	$2,720	$0	$0	$2,720	0 h	0 h	0 h	80 h

Notes

WBS Definition-
Studies of the mechanical properties of bare hybrids including flatness and sizes

M&S BOE-
no M&S cost is associated with this task

Labor BOE-
Flatness and dimensions of hybrids need to be measured. Alignment and gluing procedures need to be developed. 80 hours of MechTechSF is requested. Assume 30 hours for the development of procedures, 25 hours for the measurements setup and then 1 hour per hybrid times 25 hybrids.

1.1.2.2.2	**Silicon L0 Hybrids Released For Production**	**5/6/03**	**5/6/03**	**$0**	**$0**	**$0**	**$0**

Notes

WBS Definition-
Milestone: The design of the L0 hybrids has been verified for both mechanical and electrical properties and is ready for a production run.

1.1.2.2.3	**MRI Tasks With L0 Hybrids**	**10/31/02**	**3/26/04**	**$55,320**	**$0**	**$0**	**$55,320**

Notes

WBS Definition-
This is a summary task that includes the development, procurement, stuffing, wirebonding, and testing of all Layer 0 hybrid assemblies both prototypes and production done by MRI institutions.

1.1.2.2.3.1	Develop bare hybrid probing procedures	10/31/02	1/7/03	$500	$0	$0	$500

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
15	ElecTechU	50%	160 h	0 w	10/31/02	1/7/03	$0	$0	$0	$0	0 h	0 h	0 h	160 h
47	Student	50%	160 h	0 w	10/31/02	1/7/03	$0	$0	$0	$0	0 h	0 h	0 h	160 h
48	MandS	500	500	0 w	10/31/02	1/7/03	$500	$0	$0	$500		0	0	500

Notes

WBS Definition-
The testing procedures are designed for: visual inspection and bare hybrid probing for the L0 hybrids

M&S BOE-
$500 is included for fixturing that will allow this hybrid to be aligned on the probe station

Labor BOE-
A Univ. of Kansas technician will setup and verify operation of the probe stand assumed to take 4 weeks. A student will adapt the Run2a Labview code for the L0 hybrid design which is expected to take a total of 4 weeks with the verification.

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
1.1.2.2.3.2	Test prototypes	1/8/03	3/5/03	$0	$0	$0	$0

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
47	Student	63%	201.6 h	0 w	1/8/03	3/5/03	$0	$0	$0	$0	0 h	0 h	0 h	201.6 h

Notes

WBS Definition-
Probing and all testing of prototype L0 hybrids including visual inspection and continuity and short testiing, as well as tests on stuffed hybrids with standalone teststands.

M&S BOE-
no M&S cost associated with this task

Labor BOE
Each bare hybrid if probed totally manually takes 3 hours. This includes the visual inspection. There are expected to be 25 hybrids tested. In addition, the standalone sequencer test takes about 1 hour per hybrid. Therefore a total of 100 hours of testing is assumed.

1.1.2.2.3.3	Bid hybrid production	4/9/03	5/6/03	$0	$0	$0	$0

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
18	PhysicistU	10%	16 h	0 w	4/9/03	5/6/03	$0	$0	$0	$0	0 h	0 h	0 h	16 h

Notes

WBS Definition-
Vendor qualification and selection for final L0 hybrids

M&S BOE-
no costs associated with this item

Labor BOE-
Physicist just needs to verify funding and contact vendors and purchasers; Run2a experience

1.1.2.2.3.4	Produce hybrids (KU)	5/7/03	7/31/03	$40,420	$0	$0	$40,420

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
18	PhysicistU	10%	48 h	0 w	5/7/03	7/31/03	$0	$0	$0	$0	0 h	0 h	0 h	48 h
48	MandS	40,420	40,420	0 w	5/7/03	7/31/03	$40,420	$0	$0	$40,420		0	0	40,420

Notes

WBS Definition-
The production of the bare hybrid at vendor

M&S BOE
$40420 cost assumes 190 hybrids (144 + 30% spares) at $193 per bare hybrid and NRE of $3750 (CPT budgetary quote 3/1/2002).

Labor BOE-
A senior physicist is needed to oversee operation. Assume that 1 week of a full time physicist is enough for the needed contact with the vendor as well as the engineers associated with the project at Fermilab.

1.1.2.2.3.5	Probe bare hybrids	8/1/03	9/12/03	$600	$0	$0	$600

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
15	ElecTechU	40%	96 h	0 w	8/1/03	9/12/03	$0	$0	$0	$0	0 h	0 h	0 h	96 h
47	Student	40%	96 h	0 w	8/1/03	9/12/03	$0	$0	$0	$0	0 h	0 h	0 h	96 h
48	MandS	600	600	0 w	8/1/03	9/12/03	$600	$0	$0	$600		0	0	600

Notes

WBS Definition-
Testing of bare hybrid at MRI institute including a visual inspection and verification by probing of the electrical continuity of the hybrid and all needed documentation.

M&S BOE-
$100 is included for shipping costs
$500 for supplies for a total of $600

Labor BOE-
Visual inspection on every one of 190 hybrids each at 0.25 hours. Each hybrid will be probed using automatic prober which takes 2 hours. Half of the hybrids will be checked at this stage. The work is split between an electrical tech and a student.

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
1.1.2.2.3.6	Stuff and wirebond hybrids (Fresno)	11/24/03	2/27/04	$13,800	$0	$0	$13,800

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
18	PhysicistU	20%	96 h	0 w	11/24/03	2/27/04	$0	$0	$0	$0	0 h	0 h	0 h	96 h
48	MandS	13,800	13,800	0 w	11/24/03	2/27/04	$13,800	$0	$0	$13,800		0	0	13,800

Notes

WBS Definition-
At vendor, components are placed and attached including SVX4 die and then all wirebonding is done

M&S BOE - 190 hybrids will be stuffed, die attached and wirebonded.
$70/hybrid including $20 components and $50 stuffing, bonding and testing. Budgetary quotes from Silitronics for $23/hybrid and Meltronics for $70 per 10-chip hybrid. We scale those numbers to account for fewer chips to $50/hybrid. Assume travel costs of $500 for one trip of two days within California.
Total $13,800.

Labor BOE-
Physicist needed for overseeing the process with vendor visits; based on Run2a experience.

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
1.1.2.2.3.7	Develop functionality test	1/30/03	2/26/03	$0	$0	$0	$0

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
47	Student	100%	160 h	0 w	1/30/03	2/26/03	$0	$0	$0	$0	0 h	0 h	0 h	160 h

Notes

WBS Definition-
Design of testing for stuffed hybrids and run through with equipment

M&S BOE-
Setups are planned at 2 institutions. The costs for the setups are included in the SASEQ teststand setup task.

Labor BOE-
At each of the 2 institutions, a student will work for 2 weeks to verify the operation of the teststands with sample parts and the existing software developed elsewhere.

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
1.1.2.2.3.8	Perform initial functionality test	3/1/04	3/26/04	$0	$0	$0	$0

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
15	ElecTechU	40%	64 h	0 w	3/1/04	3/26/04	$0	$0	$0	$0	0 h	0 h	0 h	64 h
35	SASEQTestStandU	100%	160 h	0 w	3/1/04	3/26/04	$0	$0	$0	$0	0 h	0 h	0 h	160 h
47	Student	60%	96 h	0 w	3/1/04	3/26/04	$0	$0	$0	$0	0 h	0 h	0 h	96 h

Notes

WBS Definition-
Tests of basic readout and noise functions done at either of 2 MRI institutes. This test uses the stand-alone test stand.

M&S BOE-
No costs associated with this item

Labor BOE-
Each hybrid is assumed to take 1/2 hour to test based on Run2a experience for the 190 tested hybrids, it will take 100 hours (by student). In addition, 10% of the hybrids are assumed to take an extra 3 hours to debug and fix for a total 60 hours (by electrical tech).

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
1.1.2.2.3.9	Develop hybrid burn-in test	6/19/03	7/17/03	$0	$0	$0	$0

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
15	ElecTechU	50%	80 h	0 w	6/19/03	7/17/03	$0	$0	$0	$0	0 h	0 h	0 h	80 h
47	Student	25%	40 h	0 w	6/19/03	7/17/03	$0	$0	$0	$0	0 h	0 h	0 h	40 h

Notes

WBS Definition-
Designing and testing of the burn-in stands that will power cycle and readout hybrids continuously for a few day period including analysis software

M&S BOE-
no costs associated with this item.

Labor BOE-
Burn-in stands developed in another task need to be verified for use with L0 hybrids. An electrical technician verifies the power consumption and setups (2 weeks), while a student runs some sample tests (1week of time)

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
1.1.2.2.4	**Production at Fermilab**	**3/12/03**	**4/30/04**	**$1,500**	**$0**	**$14,568**	**$16,068**

Notes

WBS Definition-
This is a summary task that includes the design procurement, stuffing, wirebonding, and testing of all Layer 0 production hybrid assemblies done by Fermilab.

1.1.2.2.4.1	Develop final specifications	3/12/03	4/8/03	$1,500	$0	$5,808	$7,308

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
4	ElecEngF	50%	80 h	0 w	3/12/03	4/8/03	$4,400	$0	$0	$4,400	0 h	0 h	0 h	80 h
17	PhysicistF	50%	80 h	0 w	3/12/03	4/8/03	$0	$0	$0	$0	0 h	0 h	0 h	80 h
21	DesignerF	20%	32 h	0 w	3/12/03	4/8/03	$1,408	$0	$0	$1,408	0 h	0 h	0 h	32 h
48	MandS	1,500	1,500	0 w	3/12/03	4/8/03	$1,500	$0	$0	$1,500		0	0	1,500

Notes

WBS Definition-
Design and layout for final L0 hybrids

M&S BOE
L0 hybrid layout and routing is performed by Wolf Electronics in Elgin IL. Typical charge is $1500 per iteration of the design. We assume one iteration.

Labor BOE
Duration of task is 4 weeks. 2 weeks each of ElecEngF and Physicist are needed to implement changes in the hybrid layout. The ElecEng supervises the designer as well. The physicist also interfaces with the rest of the Run2b silicon group. 20% DesignerF is required to produce 3 final drawings of the hybrid and L0 module.

1.1.2.2.4.2	Procure and qualify hybrid burn-in fixtures	5/7/03	6/18/03	$0	$0	$4,392	$4,392

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
1	MechEngF	10%	24 h	0 w	5/7/03	6/18/03	$1,224	$0	$0	$1,224	0 h	0 h	0 h	24 h
21	DesignerF	30%	72 h	0 w	5/7/03	6/18/03	$3,168	$0	$0	$3,168	0 h	0 h	0 h	72 h

Notes

WBS Definition-
Fixtures needed for the hybrid burn-in stands and repair work

M&S BOE-
no M&S cost is assciated with this item, the costs appear in parallel MRI task.

Labor BOE-
duration of task is 6 weeks. 30% DesignerF is needed to produce 5 drawings of fixtures for burn-in stand. 10% MechEngF is needed to update the design and qualify the fixtures. based on Run2a experience, prototyping work.

1.1.2.2.4.3	Produce hybrids (Fermilab)	5/7/03	7/31/03	$0	$0	$2,256	$2,256

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
4	ElecEngF	5%	24 h	0 w	5/7/03	7/31/03	$1,320	$0	$0	$1,320	0 h	0 h	0 h	24 h
13	ElecTechF	5%	24 h	0 w	5/7/03	7/31/03	$936	$0	$0	$936	0 h	0 h	0 h	24 h

Notes

WBS Definition-
The production of the bare hybrid at the vendor (Fermilab part)

M&S BOE
see MRI line

Labor BOE-
Manufacturing includes interactions with CPT/Amitron engineers especially at the initial stage to nail down details of the design and adjust it to the concrete technological process used by the vendor. 5% ElecEngF and 5% of ElecTechF is requested for the whole duration of the manufacturing (12 weeks). Their involvement in the procurement chain is assumed as well.

1.1.2.2.4.4	Perform hybrid burn-in test	3/8/04	4/30/04	$0	$0	$2,112	$2,112

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
12	ElecTechSF	20%	64 h	0 w	3/8/04	4/30/04	$2,112	$0	$0	$2,112	0 h	0 h	0 h	64 h
39	HybridBurnInStand	100%	320 h	0 w	3/8/04	4/30/04	$0	$0	$0	$0	0 h	0 h	0 h	320 h
44	PostDoc	5%	16 h	0 w	3/8/04	4/30/04	$0	$0	$0	$0	0 h	0 h	0 h	16 h
47	Student	40%	128 h	0 w	3/8/04	4/30/04	$0	$0	$0	$0	0 h	0 h	0 h	128 h

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost

"Perform hybrid burn-in test" continued

Notes

WBS Definition-
Power cycling and reading out L0 hybrids for a few days and analysyzing noise and other performance characteristics of hybrids

M&S BOE-
There are no costs associated with this item.

Labor BOE-
Based on Run2a experience.
Assume that 190 hybrids need to be burned in and that some need to be burned in twice so assume there are a total of 210 burn-in cycles that happen over 8 weeks. Thus 21 hybrids need to be burned-in per week. There are a total of 32 hybrids (2 stations each with 16 slots) that can be run at one time. Each burn-in takes 3 days or there are two cycles per week so a capacity of 64 per week is allowed. We thus assume full use of one burn-in stand for the entire 8 weeks= 21/32 or an efficiency of 66% for that stand. The total labor needed assumes 0.5 hours of physicist shifter (probably students) per hybrid burned-in = 0.5*210=105 hours or a total of 14 shifts for 8 hours. A technician is also needed to help with maintenance of the stand and perform repairs on the hybrids. Assume that 10% of the 190 hybrids which are needed require some sort of repair (as assumed above to get a total of 210 burn-in cycles). If each repair takes 2 hours then a total time of 5 days is spent on repairs. Assume that another 5 days is spent in helping to maintain the system for a total of 2 weeks spent. A physicist also will be overseeing the operation to make sure it is running smoothly. This can be a postdoctoral researcher at 5% of their time for the duration.

1.1.2.2.5	**Silicon L0 Hybrid Production Complete**	**2/27/04**	**2/27/04**	**$0**	**$0**	**$0**	**$0**

Notes

WBS Definition-
Milestone: All L0 hybrids have been produced, stuffed, SVX4 dies attached and wirebonded.

1.1.2.2.6	**Silicon L0 Hybrid Production And Testing Complet**	**4/30/04**	**4/30/04**	**$0**	**$0**	**$0**	**$0**

Notes

WBS Definition-
Milestone: All produced L0 hybrids have been tested and burned-in and are ready for assembly onto modules.

1.1.2.3	**L1 Hybrids**	**10/1/01**	**2/11/04**	**$100,512**	**$0**	**$94,920**	**$195,432**

Notes

WBS Definition-
This is a summary task that includes the development, procurement, stuffing, wirebonding, and testing of all Layer 1 hybrid assemblies

1.1.2.3.1	**Prototypes**	**10/1/01**	**11/15/02**	**$6,300**	**$0**	**$56,254**	**$62,554**

Notes

WBS Definition-
This is a summary task that includes all prototyping and preproduction work for the Layer 1 hybrid assemblies done by Fermilab

1.1.2.3.1.1	Develop prototype specifications	10/1/01	1/18/02	$4,500	$0	$36,238	$40,738

ID	*Resource Name*	*Units*	*Work*	*Delay*	*Start*	*Finish*	*Cost*	*Baseline Cost*	*Act. Cost*	*Rem. Cost*	*Ovt. Work*	*Baseline Work*	*Act. Work*	*Rem. Work*
4	*ElecEngF*	*100%*	*568 h*	*0 w*	*10/1/01*	*1/18/02*	*$31,240*	*$0*	*$31,240*	*$0*	*0 h*	*0 h*	*568 h*	*0 h*
17	*PhysicistF*	*50%*	*284 h*	*0 w*	*10/1/01*	*1/18/02*	*$0*	*$0*	*$0*	*$0*	*0 h*	*0 h*	*284 h*	*0 h*
21	*DesignerF*	*20%*	*113.6 h*	*0 w*	*10/1/01*	*1/18/02*	*$4,998*	*$0*	*$4,998*	*$0*	*0 h*	*0 h*	*113.6 h*	*0 h*
48	*MandS*	*4,500*	*4,500*	*0 w*	*10/1/01*	*1/18/02*	*$4,500*	*$0*	*$4,500*	*$0*		*0*	*4,500*	*0*

Notes

WBS Definition-
The design and layout of Layer 1 hybrids

M&S BOE
L1 hybrid layout and routing is performed by Wolf Electronics in Elgin IL. Typical charge is $1500 per iteration of the design. We assume 3 iterations which was required for L1 prototype hybrids now produced. total cost is $4500.

Labor BOE-
L0 hybrid will interface 2 SVX4 chips to the ouside electronics. The hybrid will provide power and control signals to the chips and will read out data. L0 hybrid has 2 SVX4 chips, 50-pin AVX connector and 28 SMT components. The hybrid design is based on thick film screen printing on beryllia substrate. Routing is performed via 3 layers of traces, one ground layer and one power layer. Schematics and layout of the hybrid is provided. The total number of dielectric and metal layers is 11. Several back side prints are necessary to compensate for possible warping. Similar technology was used by CDF in Run2A so the below estimates are supported by Run2a experience.

Estimate of 18 weeks total
5 weeks each of Physicist and ElecEngF is based on the design of L1 prototype accomplished in 2001. L1 estimate was 18 weeks which will be reduced for L0 to 10 weeks because of similarity of L1 and L0 hybrid designs. 10 days of DesF is required to produce three drawings of the L0 hybrid and L0 module. L0 module composed of the sensor, analog cable and the hybrid.

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
1.1.2.3.1.2	Procure prototypes (Fermilab)	1/21/02	4/12/02	$0	$0	$2,640	$2,640

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
4	ElecEngF	10%	48 h	0 w	1/21/02	4/12/02	$2,640	$0	$2,640	$0	0 h	0 h	48 h	0 h

Notes

WBS Definition-
The vendor selection and procurement of bare prototype hybrids

M&S BOE-
no Fermilab M&S cost associated with this item.

Labor BOE-
Manufacturing includes interactions with CPT/Amitron engineers especially at the initial stage to nail down details of the design and adjust it to the concrete technological process used by the vendor. 10% ElecEngF is requested for the whole duration of the manufacturing (12 weeks). Some involvement of ElecEngF in the procurement chain is assumed as well.

1.1.2.3.1.3	Perform mechanical tests	8/23/02	9/20/02	$0	$0	$2,720	$2,720

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
9	MechTechSF	50%	80 h	0 w	8/23/02	9/20/02	$2,720	$0	$1,904	$816	0 h	0 h	56 h	24 h

Notes

WBS Definition-
Studies of the mechanical properties of bare hybrids including flatness and sizes

M&S BOE-
no M&S cost is associated with this task

Labor BOE-
Flatness and dimensions of hybrids need to be measured. Alignment and gluing procedures need to be developed. 80 hours of MechTechSF is requested. Assume 30 hours for the development of procedures, 25 hours for the measurements setup and then 1 hour per hybrid times 25 hybrids.

1.1.2.3.1.4	Test prototypes	7/26/02	9/20/02	$0	$0	$8,800	$8,800

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
4	ElecEngF	50%	160 h	0 w	7/26/02	9/20/02	$8,800	$0	$7,480	$1,320	0 h	0 h	136 h	24 h
17	PhysicistF	50%	160 h	0 w	7/26/02	9/20/02	$0	$0	$0	$0	0 h	0 h	136 h	24 h
34	SASEQTestStandF	100%	320 h	0 w	7/26/02	9/20/02	$0	$0	$0	$0	0 h	0 h	272 h	48 h

Notes

WBS Definition-
Probing, stuffing, wirebonding, and all testing of prototype L1 hybrids

M&S BOE-
no M&S coist associated with this task

Labor BOE
Test includes electrical debugging of hybrids and associated cabling and electronics. Hybrids will be characterized in terms of performance of SVX4 chips. Measurements will include full scan of possible SVX4 parameters. Some repairs and replacement of chips are assumed. Signal terminations need to be optimized. 8 weeks of PhysicistF at 50%, ElecEngF at 50% are requested. The request is based on Run2a experience of HDI prototyping with SVX2 chips which were similar in complexity.

1.1.2.3.1.5	Design, procure, and qualify hybrid fixtures	9/23/02	11/15/02	$1,800	$0	$5,856	$7,656

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
1	MechEngF	10%	32 h	0 w	9/23/02	11/15/02	$1,632	$0	$0	$1,632	0 h	0 h	0 h	32 h
18	PhysicistU	20%	64 h	0 w	9/23/02	11/15/02	$0	$0	$0	$0	0 h	0 h	0 h	64 h
21	DesignerF	30%	96 h	0 w	9/23/02	11/15/02	$4,224	$0	$0	$4,224	0 h	0 h	0 h	96 h
48	MandS	1,800	1,800	0 w	9/23/02	11/15/02	$1,800	$0	$0	$1,800		0	0	1,800

Notes

WBS Definition-
Fixtures needed for stuffing and wirebonding as well as testing of hybrids are designed and produced

M&S BOE-
Assumes fixtures needed for holding, stuffing, glueing SVX4 chips, bonding and storing for prototype hybrids.

Labor BOE-
Duration of the task is 8 weeks.

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
"Design, procure, and qualify hybrid fixtures" continued							

Notes
20% of PhysicistU is needed to design and qualify the fixtures. also talks to vendor, possibly visits the vendor.
10% of MechEngF is needed to design and procure the fixtures. supervises designer.
30% of DesignerF is needed to prepare 5 drawings of the fixtures. Two iterations are assumed for 3 drawings.

1.1.2.3.2	**MRI Production and Testing**	**1/21/02**	**2/11/04**	**$89,712**	**$0**	**$0**	**$89,712**

Notes
WBS Definition-
This is a summary task that includes the procurement, stuffing, wirebonding, and testing of all Layer 1 hybrid assemblies both prototypes and production done by MRI institutions.

1.1.2.3.2.1	Procure prototypes (KU)	1/21/02	4/12/02	$18,531	$0	$0	$18,531

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
48	MandS	18,531	18,531	0 w	1/21/02	4/12/02	$18,531	$0	$18,531	$0		0	18,531	0

Notes
WBS Definition-
The vendor selection and procurement of bare prototype hybrids

M&S BOE
$16131 cost assumes 25 prototypes at $495 per bare hybrid and NRE of $3750 (KU PO), $900 for prototype finger and $60 per hybrid for the hybrid components and assembly. total cost is $18531.

Labor BOE
see Fermilab's part of procurement, no labor here.

1.1.2.3.2.2	Develop hybrid testing procedures	7/26/02	9/20/02	$0	$0	$0	$0

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
15	ElecTechU	50%	160 h	0 w	7/26/02	9/20/02	$0	$0	$0	$0	0 h	0 h	136 h	24 h
47	Student	50%	160 h	0 w	7/26/02	9/20/02	$0	$0	$0	$0	0 h	0 h	136 h	24 h

Notes
WBS Definition-
The testing procedures are designed for: visual inspection and bare hybrid probing for the L1 hybrids.

M&S BOE-
no costs associated with this item

Labor BOE-
Technician sets up and verifies functionality of probe station - 4 weeks
A student will adapt the Run2a Labview code for the L1 hybrid design which is expected to take a total of 4 weeks with the verification.

1.1.2.3.2.3	Test prototype L1 hybrids	7/26/02	9/20/02	$0	$0	$0	$0

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
47	Student	63%	201.6 h	0 w	7/26/02	9/20/02	$0	$0	$0	$0	0 h	0 h	171.37 h	30.23 h

Notes
WBS Definition-
Probing and all testing of prototype L1 hybrids including visual inspection and continuity and short testiing, as well as tests on stuffed hybrids with standalone teststands.

M&S BOE-
no M&S cost associated with this task

Labor BOE
Each bare hybrid if probed totally manually takes 3 hours. This includes the visual inspection. There are expected to be 25 hybrids tested. In addition, the standalone sequencer test takes about 1 hour per hybrid. Therefore a total of 100 hours of testing is assumed. With a 50% efficiency factor of the students, this takes 200 hours or 5 weeks.

1.1.2.3.2.4	Procurement and production of all hybrid boxes	11/18/02	3/21/03	$20,000	$0	$0	$20,000

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
48	MandS	20,000	20,000	0 w	11/18/02	3/21/03	$20,000	$0	$0	$20,000		0	0	20,000

Notes
WBS Definition-

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost

"Procurement and production of all hybrid boxes" continued

Notes
The boxes needed for shipping, functional testing, and burn-in of all 4 types of hybrids are designed and produced

M&S BOE-
$20000 are needed to procure 400 boxes for 4 types of hybrids (all boxes the same). Each box costs $50 based on assembly of prototype boxes.

Labor BOE
see Fermilab's part of this task, no labor here.

1.1.2.3.2.5	Procure preproduction parts (KU)	1/10/03	4/4/03	$17,631	$0	$0	$17,631

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
48	MandS	17,631	17,631	0 w	1/10/03	4/4/03	$17,631	$0	$0	$17,631		0	0	17,631

Notes
WBS Definition-
Procurement of second bare prototype hybrid and stuffing and wirebonding

M&S BOE
$16131 cost assumes 25 preproduction at $495 per bare hybrid and NRE of $3750 (prototype cost - KU PO), and $60 per hybrid for the hybrid components and assembly. total cost is $17631.

Labor BOE
see Fermilab's part of procurement, no labor here.

1.1.2.3.2.6	Produce L1 hybrids (KU)	7/1/03	9/24/03	$23,050	$0	$0	$23,050

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
48	MandS	23,050	23,050	0 w	7/1/03	9/24/03	$23,050	$0	$0	$23,050		0	0	23,050

Notes
WBS Definition-
The production of the bare hybrid at vendor for L1

M&S BOE
total cost $23050 assumes 100 hybrids (72 needed and 28 spares) at $193 per bare hybrid and NRE of $3750 (CPT budget quote of 3/1/2002).

Labor BOE
see Fermilab's part of procurement for labor assigned to this task.

1.1.2.3.2.7	Test bare L1 hybrids	9/25/03	10/22/03	$0	$0	$0	$0

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
15	ElecTechU	100%	160 h	0 w	9/25/03	10/22/03	$0	$0	$0	$0	0 h	0 h	0 h	160 h
47	Student	100%	160 h	0 w	9/25/03	10/22/03	$0	$0	$0	$0	0 h	0 h	0 h	160 h

Notes
WBS Definition-
Testing of bare hybrid at MRI institute including a visual inspection and verification by probing of the electrical continuity of the hybrid and all needed documentation.

M&S BOE-
no costs associated with this item.

Labor BOE-
Visual inspection on every one of 100 hybrids each at 0.5 hours total 50-60 hours
Each hybrid will be probed using automatic prober which takes 2 hours. Half of the hybrids will be checked at this stage. The work is split between an electrical tech and a student.

1.1.2.3.2.8	Develop functionality test for L1 hybrids	11/18/02	1/24/03	$0	$0	$0	$0

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
47	Student	100%	320 h	0 w	11/18/02	1/24/03	$0	$0	$0	$0	0 h	0 h	0 h	320 h

Notes
WBS Definition-
Design of testing for stuffed hybrids and run through with equipment

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost

"Develop functionality test for L1 hybrids" continued

Notes

M&S BOE-
Setups are planned at 2 institutions. The costs for the setups are included in the SASEQ teststand setup task.

Labor BOE-
At each of the 2 institutions, a student will work for 4 weeks to verify the operation of the teststands with sample parts and the existing software developed elsewhere. This is the first hybrid tested.

1.1.2.3.2.9	Perform functionality test on L1 hybrids	1/14/04	2/11/04	$0	$0	$0	$0

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
15	ElecTechU	50%	80 h	0 w	1/14/04	2/11/04	$0	$0	$0	$0	0 h	0 h	0 h	80 h
35	SASEQTestStandU	100%	160 h	0 w	1/14/04	2/11/04	$0	$0	$0	$0	0 h	0 h	0 h	160 h
47	Student	50%	80 h	0 w	1/14/04	2/11/04	$0	$0	$0	$0	0 h	0 h	0 h	80 h

Notes

WBS Definition-
Tests of basic readout and noise functions done at either of 2 MRI institutes. This test uses the stand-alone test stand.

M&S BOE-
No costs associated with this item

Labor BOE-
Each hybrid is assumed to take 1/2 hour to test based on Run2a experience for the 100 tested hybrids, it will take 50 hours (by student). In addition, 20% of the hybrids are assumed to take an extra 3 hours to debug and fix for a total 60 hours (by electrical tech). An extra 20 hours of electrical tech time is included as cushion.

1.1.2.3.2.10	Stuff and wire-bond L1 hybrids (Fresno)	10/23/03	1/13/04	$10,500	$0	$0	$10,500

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
18	PhysicistU	25%	100 h	0 w	10/23/03	1/13/04	$0	$0	$0	$0	0 h	0 h	0 h	100 h
48	MandS	10,500	10,500	0 w	10/23/03	1/13/04	$10,500	$0	$0	$10,500		0	0	10,500

Notes

WBS Definition-
At vendor, components are placed and attached including SVX4 die and then all wirebonding is done

M&S BOE - $100/hybrid including $30 components and $70 stuffing, bonding and testing. Budgetary quotes from Silitronics and Meltronics (10-chip hybrid) are provided. One trip costing $500 is assumed within California for a total of $10,500

Labor BOE-
10 weeks 25% of PhysicistU is needed for overseeing the process possibly with vendor visits. based of Run2a experience.

1.1.2.3.2.11	Develop hybrid burn-in test	8/13/03	11/5/03	$0	$0	$0	$0

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
15	ElecTechU	33%	158.4 h	0 w	8/13/03	11/5/03	$0	$0	$0	$0	0 h	0 h	0 h	158.4 h
47	Student	50%	240 h	0 w	8/13/03	11/5/03	$0	$0	$0	$0	0 h	0 h	0 h	240 h

Notes

WBS Definition-
Designing and testing of the burn-in stands that will power cycle and readout hybrids continuously for a few day period including analysis software

M&S BOE-
no costs associated with this item.

Labor BOE-
Burn-in stands developed in another task need to be verified for use with L1 hybrids. This is the first hybrid that needs verification An electrical technician verifies the power consumption and setups (4 weeks), while a student runs some sample tests (6 weeks of time). The student has to verify all of the software works for this hybrid testing.

1.1.2.3.3	**Production at Fermilab**	**11/18/02**	**2/11/04**	**$4,500**	**$0**	**$38,666**	**$43,166**

Notes

WBS Definition-
This is a summary task that includes all production and testing work for the Layer 1 hybrid assemblies done by Fermilab

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
1.1.2.3.3.1	Design and procurement of all hybrid boxes	11/18/02	3/21/03	$0	$0	$1,088	$1,088

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
9	MechTechSF	5%	32 h	0 w	11/18/02	3/21/03	$1,088	$0	$0	$1,088	0 h	0 h	0 h	32 h
17	PhysicistF	15%	96 h	0 w	11/18/02	3/21/03	$0	$0	$0	$0	0 h	0 h	0 h	96 h

Notes

WBS Definition-
The boxes needed for shipping, functional testing, and burn-in of all 4 types of hybrids are designed and produced (Fermilab part)

M&S BOE-
The costs for this item are listed under the MRI institution similar task.

Labor BOE-
A mechanical engineer designs the boxes and a mechanical tech helps to assemble some prototype boxes before procurement. The estimates assume 400 hybrid boxes needed all of the same type.

1.1.2.3.3.2	Develop preproduction specifications	12/4/02	1/9/03	$3,000	$0	$5,808	$8,808

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
4	ElecEngF	50%	80 h	0 w	12/4/02	1/9/03	$4,400	$0	$0	$4,400	0 h	0 h	0 h	80 h
17	PhysicistF	50%	80 h	0 w	12/4/02	1/9/03	$0	$0	$0	$0	0 h	0 h	0 h	80 h
21	DesignerF	20%	32 h	0 w	12/4/02	1/9/03	$1,408	$0	$0	$1,408	0 h	0 h	0 h	32 h
48	MandS	3,000	3,000	0 w	12/4/02	1/9/03	$3,000	$0	$0	$3,000		0	0	3,000

Notes

WBS Definition-
The design and layout of Layer 1 second prototype hybrids

Labor BOE-
Estimate of 4 weeks of 50% Physicist and 50% EEF is based on the design of L1 prototype accomplished in 2001. 4 days of DesF is required to produce two drawings of L! hybrid and L1 module.

M&S BOE
L1 hybrid layout and routing is performed by Wolf Electronics in Elgin IL. Typical charge is $1500 per iteration of the design. We assume 2 iterations. total cost is $3000.

1.1.2.3.3.3	Procure preproduction parts(Fermilab)	1/10/03	4/4/03	$0	$0	$2,256	$2,256

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
4	ElecEngF	5%	24 h	0 w	1/10/03	4/4/03	$1,320	$0	$0	$1,320	0 h	0 h	0 h	24 h
13	ElecTechF	5%	24 h	0 w	1/10/03	4/4/03	$936	$0	$0	$936	0 h	0 h	0 h	24 h

Notes

WBS Definition-
The vendor selection and procurement of bare prototype hybrids

M&S BOE-
no Fermilab M&S cost associated with this item.

Labor BOE-
Manufacturing includes interactions with CPT/Amitron engineers especially at the initial stage to nail down details of the design and adjust it to the concrete technological process used by the vendor. 5% EEF and 5% of ElecTechF is requested for the whole duration of the manufacturing (12 weeks). Their involvement in the procurement chain is assumed as well.

1.1.2.3.3.4	Test preproduction	4/7/03	6/2/03	$0	$0	$2,640	$2,640

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
12	ElecTechSF	25%	80 h	0 w	4/7/03	6/2/03	$2,640	$0	$0	$2,640	0 h	0 h	0 h	80 h
17	PhysicistF	40%	128 h	0 w	4/7/03	6/2/03	$0	$0	$0	$0	0 h	0 h	0 h	128 h
18	PhysicistU	40%	128 h	0 w	4/7/03	6/2/03	$0	$0	$0	$0	0 h	0 h	0 h	128 h

Notes

WBS Definition-
All electrical tests needed to verify performance of second prototype

M&S BOE-
no M&S cost associated with this task

Labor BOE
Test includes electrical debugging of hybrids and associated cabling and electronics. Hybrids will be characterized in terms of performance of SVX4 chips. Measurements will include full scan of possible SVX4 parameters. Some repairs and replacement of chips are assumed. Signal terminations need to be optimized. 8 weeks of PhysicistU at 40%, PhysicistF at 40%, ElecTechSF at 25% are requested. The request is

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost

"Test preproduction" continued

Notes
based on Run2a experience of HDI prototyping with SVX2 chips which were similar in complexity.

1.1.2.3.3.5	Procure and qualify hybrid burn-in fixtures	7/1/03	8/12/03	$0	$0	$8,722	$8,722

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
1	MechEngF	10%	24 h	0 w	7/1/03	8/12/03	$1,224	$0	$0	$1,224	0 h	0 h	0 h	24 h
9	MechTechSF	66%	158.4 h	0 w	7/1/03	8/12/03	$5,386	$0	$0	$5,386	0 h	0 h	0 h	158.4 h
18	PhysicistU	20%	48 h	0 w	7/1/03	8/12/03	$0	$0	$0	$0	0 h	0 h	0 h	48 h
21	DesignerF	20%	48 h	0 w	7/1/03	8/12/03	$2,112	$0	$0	$2,112	0 h	0 h	0 h	48 h

Notes
WBS Definition-
Fixtures needed for the hybrid burn-in stands and repair work

M&S BOE-
no M&S cost is assciated with this item.

Labor BOE-
Duration of task is 6 weeks. 20% DesignerF is needed to produce 3 drawings of fixtures for burn-in stand. 10% MechEngF is needed to design and qualify the fixtures. 20% PhysicistU is required for qualification and supervision. 66% MechTechSF is requested for burn-in stand assembly. based on Run2a experience, prototyping work.

1.1.2.3.3.6	Develop final specifications	6/3/03	6/30/03	$1,500	$0	$12,320	$13,820

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
4	ElecEngF	100%	160 h	0 w	6/3/03	6/30/03	$8,800	$0	$0	$8,800	0 h	0 h	0 h	160 h
17	PhysicistF	50%	80 h	0 w	6/3/03	6/30/03	$0	$0	$0	$0	0 h	0 h	0 h	80 h
21	DesignerF	50%	80 h	0 w	6/3/03	6/30/03	$3,520	$0	$0	$3,520	0 h	0 h	0 h	80 h
48	MandS	1,500	1,500	0 w	6/3/03	6/30/03	$1,500	$0	$0	$1,500		0	0	1,500

Notes
WBS Definition-
Design and layout for final L1 hybrids

M&S BOE
L1 hybrid layout and routing is performed by Wolf Electronics in Elgin IL. Typical charge is $1500 per iteration of the design. We assume one iteration.

Labor BOE
Duration of task is 4 weeks. A full time ElecEngF is needed to implement changes in the hybrid layout based on Run2a experience. 50% DesignerF is required to produce 3 final drawings of the hybrid and L1 module.

1.1.2.3.3.7	Bid hybrid production	6/3/03	6/30/03	$0	$0	$0	$0

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
18	PhysicistU	20%	32 h	0 w	6/3/03	6/30/03	$0	$0	$0	$0	0 h	0 h	0 h	32 h

Notes
WBS Definition-
Vendor qualification and selection for final L1 hybrids

M&S BOE-
no costs associated with this item

Labor BOE-
Duration of the task is 4 weeks. 20% of PhysicistU is assumed for communications with vendors including possible vendor visits. based on Run2a experience.

1.1.2.3.3.8	Produce hybrids (Fermilab)	7/1/03	9/24/03	$0	$0	$4,512	$4,512

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
4	ElecEngF	10%	48 h	0 w	7/1/03	9/24/03	$2,640	$0	$0	$2,640	0 h	0 h	0 h	48 h
13	ElecTechF	10%	48 h	0 w	7/1/03	9/24/03	$1,872	$0	$0	$1,872	0 h	0 h	0 h	48 h

Notes
WBS Definition-
The production of the bare hybrid at the vendor (Fermilab part)

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
"Produce hybrids (Fermilab)" continued							

Notes
M&S BOE
see MRI line

Labor BOE-
Manufacturing includes interactions with CPT/Amitron engineers especially at the initial stage to nail down details of the design and adjust it to the concrete technological process used by the vendor. 10% ElecEngF and 10% of ElecTechF is requested for the whole duration of the manufacturing (12 weeks). Their involvement in the procurement chain is assumed as well.

1.1.2.3.3.9	Perform hybrid burn-in test	1/14/04	2/11/04	$0	$0	$1,320	$1,320

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
12	ElecTechSF	25%	40 h	0 w	1/14/04	2/11/04	$1,320	$0	$0	$1,320	0 h	0 h	0 h	40 h
39	HybridBurnInStand	100%	160 h	0 w	1/14/04	2/11/04	$0	$0	$0	$0	0 h	0 h	0 h	160 h
44	PostDoc	5%	8 h	0 w	1/14/04	2/11/04	$0	$0	$0	$0	0 h	0 h	0 h	8 h
47	Student	35%	56 h	0 w	1/14/04	2/11/04	$0	$0	$0	$0	0 h	0 h	0 h	56 h

Notes
WBS Definition-
Power cycling and reading out L1 hybrids for a few days and analysyzing noise and other performance characteristics of hybrids

M&S BOE-
There are no costs associated with this item.

Labor BOE-
Based on Run2a experience.
Assume that 100 hybrids need to be burned in and that some need to be burned in twice so assume there are a total of 110 burn-in cycles that happen over 4 weeks. Thus 28 hybrids need to be burned-in per week. There are a total of 32 hybrids (2 stations each with 16 slots) that can be run at one time. Each burn-in takes 3 days or there are two cycles per week so a capacity of 64 per week is allowed. We thus assume full use of one burn-in stand for the entire 4 weeks= 28/32 or an efficiency of 88% for that stand. The total labor needed assumes 0.5 hours of physicist shifter (probably students) per hybrid burned-in = 0.5*110=55 hours or a total of 7 shifts for 8 hours. A technician is also needed to help with maintenance of the stand and perform repairs on the hybrids. Assume that 10% of the 100 hybrids which are needed require some sort of repair (as assumed above to get a total of 110 burn-in cycles). If each repair takes 2 hours then a total time of 3 days is spent on repairs. Assume that another 5 days is spent in helping to maintain the system. A physicist also will be overseeing the operation to make sure it is running smoothly. This can be a postdoctoral researcher at 5% of their time for the duration.

1.1.2.3.4	**Silicon L1 Hybrids Released For Production**	**6/30/03**	**6/30/03**	**$0**	**$0**	**$0**	**$0**

Notes
WBS Definition-
Milestone: The design of the L1 hybrids have been verified for both mechanical and electrical properties and is ready for a production run.

1.1.2.3.5	**Silicon L1 Hybrid Production Complete**	**1/13/04**	**1/13/04**	**$0**	**$0**	**$0**	**$0**

Notes
WBS Definition-
Milestone: All L1 hybrids have been produced, stuffed, SVX4 dies attached and wirebonded.

1.1.2.3.6	**Silicon L1 Hybrid Production And Testing Complet**	**2/11/04**	**2/11/04**	**$0**	**$0**	**$0**	**$0**

Notes
WBS Definition-
Milestone: All produced L1 hybrids have been tested and burned-in and are ready for assembly onto modules.

1.1.2.4	**L2-L5 Hybrids**	**10/9/01**	**7/12/04**	**$651,012**	**$0**	**$112,676**	**$763,688**

Notes
WBS Definition-
This is a summary task that includes the development, procurement, stuffing, wirebonding, and testing of all Layer 2-5 hybrid assemblies

1.1.2.4.1	**Prototypes (Fermilab)**	**10/9/01**	**10/23/02**	**$6,000**	**$0**	**$27,988**	**$49,988**

Notes
WBS Definition-
This is a summary task that includes all prototyping work for the Layer 2-5 hybrid assemblies done by Fermilab

1.1.2.4.1.1	Develop prototype specifications	10/9/01	3/1/02	$6,000	$0	$27,588	$33,588

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
4	ElecEngF	50%	380 h	0 w	10/9/01	3/1/02	$20,900	$0	$20,900	$0	0 h	0 h	380 h	0 h

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost

"Develop prototype specifications" continued

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
17	PhysicistF	25%	190 h	0 w	10/9/01	3/1/02	$0	$0	$0	$0	0 h	0 h	190 h	0 h
21	DesignerF	20%	152 h	0 w	10/9/01	3/1/02	$6,688	$0	$6,688	$0	0 h	0 h	152 h	0 h
48	MandS	6,000	6,000	0 w	10/9/01	3/1/02	$6,000	$0	$6,000	$0		0	6,000	0

Notes

WBS Definition-
The design and layout of Layer 2-5 hybrids
L2-5 hybrids will interface 10 SVX4 chips to the ouside electronics. The hybrid will provide power and control signals to the chips and will read out data. there two types of the hybrid - axial L2A and stereo L2S. L2-5 hybrid has 10 SVX4 chips, 50-pin AVX connector and 20 SMT components. The hybrid design is based on thick film screen printing on beryllia substrate. Routing is performed via 3 layers of traces, one ground layer and one power layer. Schematics and layout of the hybrid is provided. The total number of dielectric and metal layers is 11. Several back side prints are necessary to compensate for possible warping. Similar technology was used by CDF in Run2A so the below estimates are supported by Run2a experience.

M&S BOE
Hybrid layout and routing is performed by Wolf Electronics in Elgin IL. Typical charge is $1500 per iteration of the design. 2 iterations were required for each type (L2A and L2S). total cost is $6000.

Labor BOE-
19 weeks of 25% Physicist and 50% ElecEngF is based on the work already accomplished in 2002. 20% of DesignerF is required to produce five drawings of L2A and L2S hybrids, L2A and L2S modules and to understand bonding angles. L2-5 module is composed of two sensors and one hybrid.

1.1.2.4.1.2	Procure prototypes (Fermilab)	3/4/02	6/24/02	$0	$0	$3,520	$3,520

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
4	ElecEngF	10%	64 h	0 w	3/4/02	6/24/02	$3,520	$0	$3,520	$0	0 h	0 h	64 h	0 h

Notes

WBS Definition-
The vendor selection and procurement of bare prototype hybrids

M&S BOE : see MRI part

Labor BOE-
Manufacturing includes interactions with CPT/Amitron engineers especially at the initial stage to nail down details of the design and adjust it to the concrete technological process used by the vendor. 10% ElecEngF is requested for the whole duration of the manufacturing (16 weeks).

1.1.2.4.1.3	Perform mechanical tests	8/28/02	9/25/02	$0	$0	$2,720	$2,720

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
9	MechTechSF	50%	80 h	0 w	8/28/02	9/25/02	$2,720	$0	$1,496	$1,224	0 h	0 h	44 h	36 h

Notes

WBS Definition-
Studies of the mechanical properties of bare hybrids including flatness and sizes

M&S BOE-
no M&S cost is associated with this task

Labor BOE-
Flatness and dimensions of hybrids need to be measured. Alignment and gluing procedures need to be developed. 80 hours of MechTechSF is requested. Assume 30 hours for the development of procedures, 25 hours for the measurements setup and then 0.5 hour per hybrid times 50 hybrids.

1.1.2.4.1.4	Perform Temperature cycles	9/26/02	10/9/02	$0	$0	$1,360	$1,360

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
9	MechTechSF	50%	40 h	0 w	9/26/02	10/9/02	$1,360	$0	$0	$1,360	0 h	0 h	0 h	40 h

Notes

WBS Definition-
Testing the bare and stuffed hybrids at temperatures of -10C

M&S BOE-
no costs associated with this item

Labor BOE-
0.5 of each day for 2 weeks of mechanical tech

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
1.1.2.4.1.5	Test prototypes(fermilab)	8/28/02	10/23/02	$0	$0	$8,800	$8,800

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
4	ElecEngF	50%	160 h	0 w	8/28/02	10/23/02	$8,800	$0	$2,420	$6,380	0 h	0 h	44 h	116 h
17	PhysicistF	25%	80 h	0 w	8/28/02	10/23/02	$0	$0	$0	$0	0 h	0 h	22 h	58 h
34	SASEQTestStandF	100%	320 h	0 w	8/28/02	10/23/02	$0	$0	$0	$0	0 h	0 h	88 h	232 h

Notes

WBS Definition-
Probing, stuffing, wirebonding, and all testing of prototype L2-5 hybrids at Fermilab

M&S BOE-
no M&S coist associated with this task

Labor BOE
Test includes electrical debugging of hybrids and associated cabling and electronics. Hybrids will be characterized in terms of performance of SVX4 chips. Measurements will include full scan of possible SVX4 parameters. Some repairs and replacement of chips are assumed. Signal terminations need to be optimized. 8 weeks of PhysicistU at 50%, PhysicistF at 50%, ElecEngF at 100% are requested. The request is based on Run2a experience of HDI prototyping with SVX2 chips which were similar in complexity.

1.1.2.4.2	**MRI Production and Testing of Hybrids**	**6/4/02**	**7/5/04**	**$379,741**	**$0**	**$0**	**$379,741**

Notes

WBS Definition-
This is a summary task that includes the procurement, stuffing, wirebonding, and testing of all Layer 2-5 hybrid assemblies both prototypes and production done by MRI institutions.

1.1.2.4.2.1	Procure prototypes	6/4/02	9/25/02	$90,069	$0	$0	$90,069

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
48	MandS	90,069	90,069	0 w	6/4/02	9/25/02	$90,069	$0	$90,069	$0		0	79,936.24	10,132.76

Notes

WBS Definition-
The vendor selection and procurement of bare prototype hybrids

M&S BOE :
25 L2A hybrids were ordered from Amitron. Cost is $720 per bare hybrid plus NRE $4900 - total $22900. Quote and PO are provided
50 L2A and 50 L2S hybrids were ordered from CPT. Cost is $447.39 per bare hybrid plus NRE $2590 x 2. Total is $49919.
assume $30 per hybrid for components and $100 for stuffing and wirebonding. Based on Meltronics quote for 10-chip hybrids. Total for stuffing of 125 hybrids is $16250.
Also, expect two trips at $500/trip for a total of $1000.

Total cost of 125 assembled hybrids is $89069+$1000 travel.

Labor BOE-
See Fermilab's part, no labor here.

1.1.2.4.2.2	Develop bare hybrid probing procedures	7/31/02	9/25/02	$23,023	$0	$0	$23,023

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
15	ElecTechU	36%	115.2 h	0 w	7/31/02	9/25/02	$0	$0	$0	$0	0 h	0 h	89.28 h	25.92 h
47	Student	150%	480 h	0 w	7/31/02	9/25/02	$0	$0	$0	$0	0 h	0 h	372 h	108 h
48	MandS	23,023	23,023	0 w	7/31/02	9/25/02	$23,023	$0	$23,023	$0		0	17,842.83	5,180.18

Notes

WBS Definition-
The testing procedures are designed for the bare Layer 2-5 hybrids

M&S BOE-
Costs at CSUF associated with setting up probe station as budgeted in MRI. Some student support is assumed as well as videoconferencing equipment to allow contact with Run2b group. A total of $23,023

Labor BOE-
Technician sets up and verifies functionality of probe station at KU- 3 weeks
A student will adapt the Run2a Labview code for the L1 hybrid design which is expected to take a total of 2 weeks with the verification at each institution (total 4 weeks). At CSUF, two students are expected to take half time to setup and verify the probe station.

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
1.1.2.4.2.3	Test prototypes(MRI)	8/28/02	10/23/02	$0	$0	$0	$0

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
18	PhysicistU	10%	32 h	0 w	8/28/02	10/23/02	$0	$0	$0	$0	0 h	0 h	8.8 h	23.2 h
47	Student	200%	640 h	0 w	8/28/02	10/23/02	$0	$0	$0	$0	0 h	0 h	176 h	464 h

Notes

WBS Definition-
Probing and all testing of prototype L2-5 hybrids including visual inspection and continuity and short testiing, as well as tests on stuffed hybrids with stand-alone test stands.

M&S BOE-
no M&S cost associated with this task

Labor BOE
Each bare hybrid if probed will be assumed to take 2 hours done automatically with a fraction of them probed manually. This includes the visual inspection. There are expected to be 125 hybrids tested. In addition, the standalone sequencer test takes about 1 hour per hybrid. Therefore a total of 375 hours of testing is assumed. This testing is done at 2 institutions so we double the resources. 5% of a senior physicist is assumed at each institution to oversee the operation.

1.1.2.4.2.4	Produce hybrids (KU)	7/16/03	11/5/03	$0	$0	$0	$0

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
18	PhysicistU	5%	32 h	0 w	7/16/03	11/5/03	$0	$0	$0	$0	0 h	0 h	0 h	32 h

Notes

WBS Definition-
The production of the bare hybrid at vendor(KU-MRI part)

M&S BOE--
No M&S costs associated with this task. The costs are obligated in the following task, after the hybrids have been received, to push the obligation of the funds into the next fiscal year.

Labor BOE-
The time scheduled is based on prototype runs obtained.
5% of a physicist to oversee purchase along with Fermilab personnel on other task.

1.1.2.4.2.5	Obligate Funds for Hybrid Production (KU)	10/31/03	11/6/03	$176,649	$0	$0	$176,649

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
48	MandS	176,649	176,649	0 w	10/31/03	11/6/03	$176,649	$0	$0	$176,649		0	0	176,649

Notes

WBS Definition--
Obligation of funds for procurement of L2-5 hybrids

M&S BOE--
Total number of hybrids is 880 (672 + 30% spares). cost per bare hybrid is $434 on the highest quote (Amitron 5/24/2002). CPT quote is $268/hybrid. Total cost is $381920 which is split between MRI funds and Fermilab.

Labor BOE-
none on this task, it is in the procurement task

1.1.2.4.2.6	Probe bare hybrids (MRI)	10/9/03	1/28/04	$0	$0	$0	$0

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
15	ElecTechU	40%	224 h	0 w	10/9/03	1/28/04	$0	$0	$0	$0	0 h	0 h	0 h	224 h
47	Student	50%	280 h	0 w	10/9/03	1/28/04	$0	$0	$0	$0	0 h	0 h	0 h	280 h

Notes

WBS Definition-
Testing of bare hybrid at MRI institute including a visual inspection and verification by probing of the electrical continuity of the hybrid and all needed documentation.

M&S BOE-
no costs associated with this item.

Labor BOE-
There are a total of 880 hybrids.
Visual inspection on every one hybrids each at 0.25 hours total 220 hours
5% of hybrids will be probed using automatic prober which takes 2 hours*44=88hours.

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
"Probe bare hybrids (MRI)" continued							

Notes
The work is split between an electrical tech and students.

1.1.2.4.2.7	(retired)	10/9/03	10/9/03	$0	$0	$0	$0

Notes

1.1.2.4.2.8	Stuff and wire-bond hybrids	11/7/03	5/6/04	$90,000	$0	$0	$90,000

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
18	PhysicistU	20%	192 h	0 w	11/7/03	5/6/04	$0	$0	$0	$0	0 h	0 h	0 h	192 h
48	MandS	90,000	90,000	0 w	11/7/03	5/6/04	$90,000	$0	$0	$90,000		0	0	90,000

Notes
WBS Definition-
At vendor, components are placed and attached including SVX4 die and then all wirebonding is done

M&S BOE :
Total number of hybrids is 880 (672 + 30% spares). cost to stuff, wirebond and test is $70/hy based on Meltronix quote of 6/20/2002. cost of components is $30/hy including AVX connectors and SMT components. assumes also $2000 for travel to vendors by MRI personnel.

Labor BOE
Run2a experience of communication with vendors, possible visits to vendors a total of 20% of Physicist is assigned during the production run. The time for this process is assume to take 6 months. For each batch sent to the vendor, we assume that the parts will be done 2 months later. The production is also paced by the availability of tested SVX4 chips. Assume that the first batch is for 220 hybrids.

1.1.2.4.2.9	Perform initial functionality test (MRI)	1/15/04	7/5/04	$0	$0	$0	$0

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
15	ElecTechU	36%	345.6 h	0 w	1/15/04	7/5/04	$0	$0	$0	$0	0 h	0 h	0 h	345.6 h
18	PhysicistU	10%	96 h	0 w	1/15/04	7/5/04	$0	$0	$0	$0	0 h	0 h	0 h	96 h
47	Student	50%	480 h	0 w	1/15/04	7/5/04	$0	$0	$0	$0	0 h	0 h	0 h	480 h

Notes
WBS Definition-
Tests of basic readout and noise functions done at either of 2 MRI institutes. This test uses the stand alone teststand.

M&S BOE-
No costs associated with this item

Labor BOE-
The time paces the stuffing and wirebonding at the vendor. Each hybrid is assumed to take 1/2 hour to test based on Run2a experience for the 880 tested hybrids, it will take 440 hours (by student). In addition, 10% of the hybrids are assumed to take an extra 3 hours to debug and fix for a total 330 hours (by electrical tech). Extra hours of electrical tech time is included as cushion. A physicist oversees the operation at the 10% level for the duration.

1.1.2.4.2.10	Develop hybrid burn-in test(MRI)	6/17/03	7/15/03	$0	$0	$0	$0

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
15	ElecTechU	100%	160 h	0 w	6/17/03	7/15/03	$0	$0	$0	$0	0 h	0 h	0 h	160 h
47	Student	50%	80 h	0 w	6/17/03	7/15/03	$0	$0	$0	$0	0 h	0 h	0 h	80 h

Notes
WBS Definition-
Testing using the burn-in stands with the L2-L5 hybrids that will power cycle and readout hybrids continuously for a few day period including analysis software

M&S BOE-
no costs associated with this item.

Labor BOE-
Burn-in stands developed in another task. An electrical technician verifies the power consumption and setups, while a student runs some sample tests (2 weeks of time).

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
1.1.2.4.3	**Production (Fermilab)**	**10/18/02**	**7/12/04**	**$265,271**	**$0**	**$68,688**	**$333,959**

Notes

WBS Definition-
This is a summary task that includes all production and testing work for the Layer 2-5 hybrid assemblies done by Fermilab

1.1.2.4.3.1	Develop preproduction specifications	11/18/02	1/24/03	$4,500	$0	$12,320	$16,820

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
4	ElecEngF	50%	160 h	0 w	11/18/02	1/24/03	$8,800	$0	$0	$8,800	0 h	0 h	0 h	160 h
17	PhysicistF	40%	128 h	0 w	11/18/02	1/24/03	$0	$0	$0	$0	0 h	0 h	0 h	128 h
21	DesignerF	25%	80 h	0 w	11/18/02	1/24/03	$3,520	$0	$0	$3,520	0 h	0 h	0 h	80 h
48	MandS	4,500	4,500	0 w	11/18/02	1/24/03	$4,500	$0	$0	$4,500		0	0	4,500

Notes

WBS Definition-
The design and layout of Layer 2-5 second prototype hybrids

Labor BOE-
Estimate of 8 weeks of 40% Physicist and 50% EEF is based on the design of L2A and L2S prototypes accomplished in 2002. 10 days of DesF is required to produce 5 drawings of the hybrids, modules and stave.

M&S BOE
L1 hybrid layout and routing is performed by Wolf Electronics in Elgin IL. Typical charge is $1500 per iteration of the design. We assume 3 iterations in total. total cost is $4500.

1.1.2.4.3.2	Procure preproduction	1/27/03	4/18/03	$31,500	$0	$2,256	$33,756

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
4	ElecEngF	5%	24 h	0 w	1/27/03	4/18/03	$1,320	$0	$0	$1,320	0 h	0 h	0 h	24 h
13	ElecTechF	5%	24 h	0 w	1/27/03	4/18/03	$936	$0	$0	$936	0 h	0 h	0 h	24 h
48	MandS	31,500	31,500	0 w	1/27/03	4/18/03	$31,500	$0	$0	$31,500		0	0	31,500

Notes

WBS Definition-
Procurement of second bare prototype hybrid and stuffing and wirebonding

M&S BOE-
25 L2A and 25 L2S hybrids are ordered assuming $500 per bare hybrid plus a total of $6000 in NRE costs. (similar cost to CPT quote)
Assume $30 per hybrid for components and $100 for stuffing and wirebonding. Based on Meltronics quote for 10-chip hybrids. Total for stuffing of 50 hybrids is $6500.
Total: $31,500

Labor BOE-
Manufacturing includes interactions with CPT/Amitron engineers especially at the initial stage to nail down details of the design and adjust it to the concrete technological process used by the vendor. 5% EEF is requested for the whole duration of the manufacturing (12 weeks). His involvement in the procurement chain is assumed as well. An electrical technician is also helping with the procurement at the 5% level.

1.1.2.4.3.3	Test preproduction	4/21/03	6/16/03	$16,000	$0	$8,800	$24,800

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
4	ElecEngF	50%	160 h	0 w	4/21/03	6/16/03	$8,800	$0	$0	$8,800	0 h	0 h	0 h	160 h
17	PhysicistF	40%	128 h	0 w	4/21/03	6/16/03	$0	$0	$0	$0	0 h	0 h	0 h	128 h
34	SASEQTestStandF	100%	320 h	0 w	4/21/03	6/16/03	$0	$0	$0	$0	0 h	0 h	0 h	320 h
48	MandS	16,000	16,000	0 w	4/21/03	6/16/03	$16,000	$0	$0	$16,000		0	0	16,000

Notes

WBS Definition-
All electrical tests needed to verify performance of preproduction parts

M&S BOE-
two 500 MHz 4-ch oscilloscopes and probes at total $16000

Labor BOE-
Test includes electrical debugging of hybrids and associated cabling and electronics. Hybrids will be characterized in terms of performance of SVX4 chips. Measurements will include full scan of possible SVX4 parameters. Some repairs and replacement of chips are assumed. Signal terminations need to be optimized. 8 weeks of PhysicistF at 40%, ElecEngF at 50% are requested. The request is based on Run2a experience of HDI prototyping with SVX2 chips which were similar in complexity.

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
1.1.2.4.3.4	Design, procure, and qualify hybrid fixtures	10/24/02	12/20/02	$5,000	$0	$13,152	$18,152

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
1	MechEngF	30%	96 h	0 w	10/24/02	12/20/02	$4,896	$0	$0	$4,896	0 h	0 h	0 h	96 h
9	MechTechSF	50%	160 h	0 w	10/24/02	12/20/02	$5,440	$0	$0	$5,440	0 h	0 h	0 h	160 h
18	PhysicistU	10%	32 h	0 w	10/24/02	12/20/02	$0	$0	$0	$0	0 h	0 h	0 h	32 h
21	DesignerF	20%	64 h	0 w	10/24/02	12/20/02	$2,816	$0	$0	$2,816	0 h	0 h	0 h	64 h
48	MandS	5,000	5,000	0 w	10/24/02	12/20/02	$5,000	$0	$0	$5,000		0	0	5,000

Notes

WBS Definition-
Fixtures needed for the hybrid burn-in stands and repair work, and stuffing and wirebonding at the vendors

M&S BOE-
$5000 is included for 10 fixtures each at $500

Labor BOE-
duration of task is 8 weeks. 20% DesignerF is needed to produce 3 drawings of fixtures for burn-in stand. Another 2 drawings are needed for the stuffing and wirebonding fixtures. 30% MechEngF is needed to design and qualify the fixtures. 10% PhysicistU is required for qualification and supervision. 50% MechTechSF is requested for burn-in stand assembly. based on Run2a experience, prototyping work.

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
1.1.2.4.3.5	Develop final specifications	6/17/03	7/15/03	$3,000	$0	$12,320	$15,320

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
4	ElecEngF	100%	160 h	0 w	6/17/03	7/15/03	$8,800	$0	$0	$8,800	0 h	0 h	0 h	160 h
17	PhysicistF	50%	80 h	0 w	6/17/03	7/15/03	$0	$0	$0	$0	0 h	0 h	0 h	80 h
21	DesignerF	50%	80 h	0 w	6/17/03	7/15/03	$3,520	$0	$0	$3,520	0 h	0 h	0 h	80 h
48	MandS	3,000	3,000	0 w	6/17/03	7/15/03	$3,000	$0	$0	$3,000		0	0	3,000

Notes

WBS Definition-
Design and layout for final L2A and L2S hybrids

M&S BOE
Hybrid layout and routing is performed by Wolf Electronics in Elgin IL. Typical charge is $1500 per iteration of the design. We assume two iterations, one for each hybrid type.

Labor BOE
Duration of task is 4 weeks. A full time ElecEngF is needed to implement changes in the hybrid layout based on Run2a experience. 50% DesignerF is required to produce 6 final drawings of the hybrid. A physicist oversees the operation at the 50% level.

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
1.1.2.4.3.6	Bid hybrid production	6/17/03	7/15/03	$0	$0	$624	$624

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
13	ElecTechF	10%	16 h	0 w	6/17/03	7/15/03	$624	$0	$0	$624	0 h	0 h	0 h	16 h
18	PhysicistU	20%	32 h	0 w	6/17/03	7/15/03	$0	$0	$0	$0	0 h	0 h	0 h	32 h

Notes

WBS Definition-
Vendor qualification and selection for final L2-5 hybrids

M&S BOE-
no costs associated with this item

Labor BOE-
Time is assumed to take 6 weeks and we assume that over 1 week time by physicist will be needed to interface with the purchasing department. We also need 10% of the Electrical Technicians time specifying and contacting vendors.

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
1.1.2.4.3.7	Produce hybrids (Fermilab)	7/16/03	11/5/03	$205,271	$0	$6,016	$211,287

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
4	ElecEngF	10%	64 h	0 w	7/16/03	11/5/03	$3,520	$0	$0	$3,520	0 h	0 h	0 h	64 h
13	ElecTechF	10%	64 h	0 w	7/16/03	11/5/03	$2,496	$0	$0	$2,496	0 h	0 h	0 h	64 h
48	MandS	205,271	205,271	0 w	7/16/03	11/5/03	$205,271	$0	$0	$205,271		0	0	205,271

Notes

WBS Definition-
The production of the bare hybrid at vendor(Fermilab part)

M&S BOE--

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost

"Produce hybrids (Fermilab)" continued

Notes

Total number of hybrids is 880 (672 + 30% spares). cost per bare hybrid is $434 on the highest quote (Amitron 5/24/2002). CPT quote is $268/hybrid. Total cost is $381920 which is split between MRI funds and Fermilab.

Labor BOE-
Manufacturing includes interactions with CPT/Amitron engineers especially at the initial stage to nail down details of the design and adjust it to the concrete technological process used by the vendor. 10% EEF and 10% of ElecTechF is requested for the whole duration of the manufacturing (12 weeks). Their involvement in the procurement chain is assumed as well.

1.1.2.4.3.8	Develop functionality test	10/18/02	11/14/02	$0	$0	$5,280	$5,280

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
12	ElecTechSF	100%	160 h	0 w	10/18/02	11/14/02	$5,280	$0	$0	$5,280	0 h	0 h	0 h	160 h
44	PostDoc	100%	160 h	0 w	10/18/02	11/14/02	$0	$0	$0	$0	0 h	0 h	0 h	160 h

Notes

WBS Definition-
Design of testing for stuffed hybrids and run through with equipment done in conjunction with university test stand people.

M&S BOE-
The costs for the setups are included in the SASEQ teststand setup task.

Labor BOE-
An electrical tech working in conjunction with a physicist need to verify the operation of the teststands with sample parts and the existing software developed elsewhere for the 10 SASEQ teststands located at Fermilab.

1.1.2.4.3.9	Perform hybrid burn-in test	1/23/04	7/12/04	$0	$0	$7,920	$7,920

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
12	ElecTechSF	25%	240 h	0 w	1/23/04	7/12/04	$7,920	$0	$0	$7,920	0 h	0 h	0 h	240 h
39	HybridBurnInStand	200%	1,920 h	0 w	1/23/04	7/12/04	$0	$0	$0	$0	0 h	0 h	0 h	1,920 h
44	PostDoc	5%	48 h	0 w	1/23/04	7/12/04	$0	$0	$0	$0	0 h	0 h	0 h	48 h
47	Student	50%	480 h	0 w	1/23/04	7/12/04	$0	$0	$0	$0	0 h	0 h	0 h	480 h

Notes

WBS Definition-
Power cycling and reading out L2A and L2S hybrids for a few days and analysyzing noise and other performance characteristics of hybrids

M&S BOE-
There are no costs associated with this item.

Labor BOE-
Based on Run2a experience.
Assume that 880 hybrids need to be burned in and that some need to be burned in twice so assume there are a total of 960 burn-in cycles that happen over 24 weeks. Thus 40 hybrids need to be burned-in per week. There are a total of 32 hybrids (2 stations each with 16 slots) that can be run at one time. Each burn-in takes 3 days or there are two cycles per week so a capacity of 64 per week is allowed. We thus assume an efficiency factor of 40/64=0.625 to account for the need to burn-in other hybrids and also allow for failures in the burn-in stand. The total labor needed assumes 0.5 hours of physicist shifter (probably students) per hybrid burned-in =0.5*960=480 hours or a total of 60 shifts for 8 hours. A technician is also needed to help with maintenance of the stand and perform repairs on the hybrids. Assume that 10% of the 880 hybrids need some sort of repair (as assumed above to get a total of 960 burn-in cycles). If each repair takes 2 hours then a total time of 22 days is spent on repairs. Assume that another 8 days is spent in helping to maintain the system for a total of 6 weeks spent. A physicist also will be overseeing the operation to make sure it is running smoothly. This can be a postdoctoral researcher at 5% of their time for the duration.

1.1.2.4.4	Silicon L2-L5 Hybrids Released For Production	7/15/03	7/15/03	$0	$0	$0	$0

Notes

WBS Definition-
Milestone: The design of both L2A and L2S hybrids have been verified for both mechanical and electrical properties and are ready for a production run.

1.1.2.4.5	Silicon L2-L5 Hybrid Production Complete	5/6/04	5/6/04	$0	$0	$0	$0

Notes

WBS Definition-
Milestone: All L2A and L2S hybrids have been produced, stuffed, SVX4 chips placed on them and had wirebonding finished.

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
1.1.2.4.6	**Silicon L2-L5 Hybrid Production And Testing Com**	**7/12/04**	**7/12/04**	**$0**	**$0**	**$0**	**$0**

Notes
WBS Definition-
Milestone: All produced L2A and L2S hybrids have been tested and burned in and are ready for mounting onto modules.

1.1.2.4.7	**All Silicon Hybrids Produced And Tested**	**7/12/04**	**7/12/04**	**$0**	**$0**	**$0**	**$0**

Notes
WBS Definition-
Milestone: All hybrids produced and tested.

1.1.2.5	**L0 Analog Flex Cables**	**1/2/02**	**1/15/04**	**$182,880**	**$0**	**$49,656**	**$232,536**

Notes
WBS Definition-
Summary task that includes design, prototyping, production, and testing of L0 analog flex cables

M&S BOE-
Costs are described on the line where they appear. Contingency is assigned by the guidelines except that the risk for the production run is very high so 100% contingency is assumed due to the crucialness of this part.

Risk Mitigation-
The analog cables connect the sensors to the readout for L0. L0 is the most crucial element for providing the impact parameter resolution needed for the physics.

Worries are:
1. Finding a vendor who can produce cables to our specs
2. The ability to wirebond to the cables,
3. The capacitance of the cables which contributes to the noise and the ability to shield the cables effectively to obtain good signal/noise.

Cost:
There is 100% contingency put in for the cost for these items although the cost is not a significant risk
Schedule:
There is not a significant schedule risk unless our current vendor goes out of business. There are 2 months after the cables are tested before module production begins
Technical/Scope:
We have obtained several prototypes from Dyconex. We have determine that they can manufacture the cables and that they satisfy our criteria and we have addressed all but a grounding issue problem of the worries with sample prototypes. A full mock-up L0 prototype is presently being built to address any other assembly and grounding issues. Therefore, the risk mainly lies in having only one vendor. CDF is exploring these same cables with another vendor and we believe our vendor issue is mitigated by their work.

1.1.2.5.1	**L0 Analog Cable Prototyping**	**1/2/02**	**3/5/03**	**$16,000**	**$0**	**$17,664**	**$33,664**

Notes
WBS Definition-
Summary task that includes design and prototyping of L0 analog flex cables

1.1.2.5.1.1	Design cables	1/2/02	3/26/02	$0	$0	$8,304	$8,304

ID	*Resource Name*	*Units*	*Work*	*Delay*	*Start*	*Finish*	*Cost*	*Baseline Cost*	*Act. Cost*	*Rem. Cost*	*Ovt. Work*	*Baseline Work*	*Act. Work*	*Rem. Work*
1	*MechEngF*	*10%*	*48 h*	*0 w*	*1/2/02*	*3/26/02*	*$2,448*	*$0*	*$2,448*	*$0*	*0 h*	*0 h*	*48 h*	*0 h*
13	*ElecTechF*	*20%*	*96 h*	*0 w*	*1/2/02*	*3/26/02*	*$3,744*	*$0*	*$3,744*	*$0*	*0 h*	*0 h*	*96 h*	*0 h*
18	*PhysicistU*	*50%*	*240 h*	*0 w*	*1/2/02*	*3/26/02*	*$0*	*$0*	*$0*	*$0*	*0 h*	*0 h*	*240 h*	*0 h*
21	*DesignerF*	*10%*	*48 h*	*0 w*	*1/2/02*	*3/26/02*	*$2,112*	*$0*	*$2,112*	*$0*	*0 h*	*0 h*	*48 h*	*0 h*

Notes
WBS Definition-
Design and layout for Analog flex cables for L0. Analog cable connects L0 sensor and L0 hybrid. Two cables with 90 micron trace pitch are required for one L0 module. Cable specs are provided.

M&US BOE
no cost associated with this item

Labor BOE-
12 weeks of 50% Physicist, 20% ElecTechF, 10% MechEngF and 10% DesignerF are based on the accomplished prototype layout. ElecTechF was working on layout of two types of cables and the layout of the HV filtering board. MechEngF was needed to understand constraints of L0 support structure. DesignerF was needed to produce 3 drawings of the cable.

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
1.1.2.5.1.2	Produce prototype cables	3/27/02	6/19/02	$6,000	$0	$0	$6,000

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
18	PhysicistU	20%	96 h	0 w	3/27/02	6/19/02	$0	$0	$0	$0	0 h	0 h	96 h	0 h
48	MandS	6,000	6,000	0 w	3/27/02	6/19/02	$6,000	$0	$6,000	$0		0	6,000	0

Notes

WBS Definition-
Vendor production of analog flex cable prototypes

M&S BOE
$6000 spent on 20 prototype cables at Dyconex from PO.

Labor BOE
20% of PhysicistU is required for the full duration of 12 weeks for communications with vendor and possible vendor visits.

1.1.2.5.1.3	Test prototype cables	12/2/02	3/5/03	$10,000	$0	$9,360	$19,360

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
9	MechTechSF	30%	144 h	0 w	12/2/02	3/5/03	$4,896	$0	$0	$4,896	0 h	0 h	0 h	144 h
12	ElecTechSF	20%	96 h	0 w	12/2/02	3/5/03	$3,168	$0	$0	$3,168	0 h	0 h	0 h	96 h
18	PhysicistU	50%	240 h	0 w	12/2/02	3/5/03	$0	$0	$0	$0	0 h	0 h	0 h	240 h
23	WirebonderSF	10%	48 h	0 w	12/2/02	3/5/03	$1,296	$0	$0	$1,296	0 h	0 h	0 h	48 h
44	PostDoc	100%	480 h	0 w	12/2/02	3/5/03	$0	$0	$0	$0	0 h	0 h	0 h	480 h
48	MandS	10,000	10,000	0 w	12/2/02	3/5/03	$10,000	$0	$0	$10,000		0	0	10,000

Notes

WBS Definition-
Electrical and mechanical testing of prototype cables

M&S BOE
$10000 assumes cost of 5 fixtures $1000/fixture to prepare L0 module prototypes, $2000 for HV filtering board prototype and $3000 for associated material cost. Separate fixtures for cutting the cables, laminating two cables together, gluing the substrates and bonding are assumed with two iterations for two of them.

Labor BOE-
8 weeks of 100% Postdoc and 50% PhysicistU : measurements of capacitance, resistance, noise performance, shielding performance, required thickness for spacer between cables.
ElecTechSF[20%] : electrical characterization of cables, soldering of HV filter components, repairs of the prototypes
MechTechSF[30%] : preparation of 5 prototype setups with analog cable. Each prototype includes cutting the cables, laminating two cables together, gluing the substrates and setting up jigs for bonding. two iterations for two of them are assumed.
WirebonderSF[10%] : cable bondability tests, bonding of 5 protype modules

1.1.2.5.2	**L0 Analog Cable Production and Testing**	**3/12/03**	**1/15/04**	**$166,880**	**$0**	**$31,992**	**$198,872**

Notes

WBS Definition-
Summary task that includes design, production, and testing of L0 analog flex cables

1.1.2.5.2.1	Develop final specifications	3/12/03	6/4/03	$0	$0	$25,392	$25,392

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
1	MechEngF	30%	144 h	0 w	3/12/03	6/4/03	$7,344	$0	$0	$7,344	0 h	0 h	0 h	144 h
13	ElecTechF	40%	192 h	0 w	3/12/03	6/4/03	$7,488	$0	$0	$7,488	0 h	0 h	0 h	192 h
17	PhysicistF	30%	144 h	0 w	3/12/03	6/4/03	$0	$0	$0	$0	0 h	0 h	0 h	144 h
18	PhysicistU	20%	96 h	0 w	3/12/03	6/4/03	$0	$0	$0	$0	0 h	0 h	0 h	96 h
21	DesignerF	50%	240 h	0 w	3/12/03	6/4/03	$10,560	$0	$0	$10,560	0 h	0 h	0 h	240 h

Notes

WBS Definition-
Design and layout of final analog flex cables

M&S BOE-
no costs associated with this item

Labor BOE-
PhysicistU[20%],MechEngF[30%],DesignerF[50%],PhysicistF[30%] are needed to settle all mechanical and assembly constraints for the L0 analog cable. 5 drawings of the L0 region and of the cable-to-sensor and cable-to-hybrid are required. two iterations on two of them are assumed.

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
"Develop final specifications" continued							

Notes
ElecTechF[40%] required to do the layout of 12 types of cables and prepare files for vendor. Based on prototype layout time.

1.1.2.5.2.2	Bid cable production	6/5/03	7/2/03	$0	$0	$0	$0

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
18	PhysicistU	25%	40 h	0 w	6/5/03	7/2/03	$0	$0	$0	$0	0 h	0 h	0 h	40 h

Notes
WBS Definition-
The vendor selection and bidding for final analog cables

M&S BOE-
no M&S cost associated

Labor BOE-
One week of physicist for communications with two vendoirs, Run2a experience

1.1.2.5.2.3	**Silicon L0 Flex Cables Released For Production**	**7/2/03**	**7/2/03**	**$0**	**$0**	**$0**	**$0**

Notes
WBS Definition-
Milestone: Design and specifications have been verified so that production run of analog cables can be started.

1.1.2.5.2.4	Produce cables	7/3/03	11/21/03	$166,880	$0	$0	$166,880

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
18	PhysicistU	10%	80 h	0 w	7/3/03	11/21/03	$0	$0	$0	$0	0 h	0 h	0 h	80 h
48	MandS	166,880	166,880	0 w	7/3/03	11/21/03	$166,880	$0	$0	$166,880		0	0	166,880

Notes
WBS Definition-
Vendor production of analog flex cables. For each sensor, there are two cables needed and there are a total of 144 sensors so we need 288 cables. We assume 30% spares so we need 380 cables. for L0 sector prototyping we need 50 extra cables. there are cables of 12 different lengths. the total number of cables is 430.

M&S BOE
430 analog cables at $350 per cable equals to $150500. Based on Dyconex budget quote of 4/9/2002. assumed 1 SF=0.7 US$. Quote for longest length is taken. NRE cost is 1950 SF per cable type (total for NRE equals to $16380). total cost is $166880.

Labor BOE-
10% PhysicistU for communications with vendor and possibly vendor visits. Based on prototype procurements

1.1.2.5.2.5	Test cables	8/15/03	1/15/04	$0	$0	$6,600	$6,600

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
12	ElecTechSF	25%	200 h	0 w	8/15/03	1/15/04	$6,600	$0	$0	$6,600	0 h	0 h	0 h	200 h
18	PhysicistU	10%	80 h	0 w	8/15/03	1/15/04	$0	$0	$0	$0	0 h	0 h	0 h	80 h
47	Student	100%	800 h	0 w	8/15/03	1/15/04	$0	$0	$0	$0	0 h	0 h	0 h	800 h

Notes
WBS Definition-
Electrical and mechanical testing of cables. Includes visual inspection of the cables and sample measurement of capacitance and resistance.

M&S BOE-
no costs associated with this item

Labor BOE-
12 weeks total assumes 40 cables are tested per week or the student spends 1 hour per cable. A senior physicist supervises this procedure at the 10% level. Assume ElecTechSF has to fix every 4th cable (total of 108 cables) and each cable takes one hour to fix.

1.1.2.5.3	**Silicon L0 Flex Cable Production And Testing Com**	**1/15/04**	**1/15/04**	**$0**	**$0**	**$0**	**$0**

Notes
WBS Definition-
Milestone: production and testing of all L0 analog cables needed is complete

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
1.1.2.6	**L0-L1 Digital Jumper Cables (KSU)**	**1/21/02**	**11/5/03**	**$117,950**	**$2,290**	**$0**	**$120,240**

Notes

WBS Definition-
Summary task that includes design, prototyping, production, and testing of L0/L1 digital jumper cables done by KSU

1.1.2.6.1	**L0/L1 Digital Jumper Cable Prototyping**	**1/21/02**	**12/17/02**	**$18,010**	**$1,190**	**$0**	**$19,200**

Notes

WBS Definition-
Summary task that includes design and prototyping of L0/L1 digital jumper cables done by KSU.

1.1.2.6.1.1	Design cables	1/21/02	2/15/02	$0	$0	$0	$0

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
18	PhysicistU	25%	40 h	0 w	1/21/02	2/15/02	$0	$0	$0	$0	0 h	0 h	40 h	0 h

Notes

WBS Definition-
Design and layout of the digital jumper cables needed for layers 0 and 1. These are the cables that attach from the hybrid to the junction card.

M&S BOE-
There are no costs associated with this item as physicist time is used.

Labor BOE-
The physicist labor for the layout is what was spent on the task (1 week)

1.1.2.6.1.2	Prepare prototypes	2/18/02	11/27/02	$18,010	$0	$0	$18,010

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
18	PhysicistU	10%	109.2 h	0 w	2/18/02	11/27/02	$0	$0	$0	$0	0 h	0 h	75.6 h	33.6 h
48	MandS	18,010	18,010	0 w	2/18/02	11/27/02	$18,010	$0	$18,010	$0		0	10,445.8	7,564.2

Notes

WBS Definition-
Construct the bare flex circuits to qualify two vendors with two cable lengths. The connection pads are then cleaned (ablation) and connectors are bought.

M&S BOE-
Materials bought on FNAL PO 544790 5/8/02: $3805 for 1/2 oz copper on kapton base. This is a 500 ft minimum order.
Vendor 1 bare flex (Honeywell) through money transfer by Fermilab.10, 50cm cables
Vendor 2 bare flex (Basic): 10, 50cm cables at $2025 from quote #13396 6/27/02,
20, 100cm cables at $9,200 from quote #13143 12/5/01
Ablation costs by Applied Laser Technology (ALT)
mask $400, 3 setup and minimum lot charges of $800 totalling $2,800
from quote #201381 of 2/22/02
AVX connectors 2/cable at $4.50 per pair totalling $180 from actual purchase price in
lots of 1000
Total $18,010

Labor BOE-
The physicist needs to contact the vendors. Assume 4 weeks total contact time based on Run2a experience with low mass cables

1.1.2.6.1.3	Test prototypes from vendor 1	6/27/02	7/11/02	$0	$670	$0	$670

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
6	ElecEngU	3%	2.4 h	0 w	6/27/02	7/11/02	$0	$0	$0	$0	0 h	0 h	2.4 h	0 h
15	ElecTechU	31%	24.8 h	0 w	6/27/02	7/11/02	$0	$0	$0	$0	0 h	0 h	24.8 h	0 h
18	PhysicistU	50%	40 h	0 w	6/27/02	7/11/02	$0	$0	$0	$0	0 h	0 h	40 h	0 h
48	MandS	670	670	0 w	6/27/02	7/11/02	$670	$0	$670	$0		0	670	0

Notes

WBS Definition-
Electrical and mechanical testing of cables done in conjunction with LaTech as well as measurements on the cables to test impedance, etc.

M&S BOE-
$90 for parts for breakout and daisy chain cards.
Labor at KSU costs for EDL:
Electrical Engineer $60/hour for 2.5 hours = $150

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
"Test prototypes from vendor 1" continued							

Notes

ElecTech $30/hour for 3 hours = $90
Elec Tech assistant (student) at $20/hour for 21.5 hours = $430
Total $670

Labor BOE-
In addition to the engineering hours listed in the M&S costs, a physicist spent 40 hours making measurements on these cables (time spent).

1.1.2.6.1.4	Test prototypes from vendor 2	12/4/02	12/17/02	$0	$520	$0	$520

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
15	ElecTechU	31%	24.8 h	0 w	12/4/02	12/17/02	$0	$0	$0	$0	0 h	0 h	0 h	24.8 h
18	PhysicistU	50%	40 h	0 w	12/4/02	12/17/02	$0	$0	$0	$0	0 h	0 h	0 h	40 h
48	MandS	520	520	0 w	12/4/02	12/17/02	$520	$0	$0	$520		0	0	520

Notes

WBS Definition-
Electrical and mechanical testing of cables done in conjunction with LaTech as well as measurements on the cables to test impedance, etc.

M&S BOE-
Labor at KSU costs for EDL:
ElecTech $30/hour for 3 hours = $90
Elec Tech assistant (student) at $20/hour for 21.5 hours = $430
Total $520

Labor BOE-
In addition to the engineering hours listed in the M&S costs, a physicist will spend 40 hours making measurements on these cables. Estimated from other prototype testing done.

1.1.2.6.2	**L0/L1 Cable Production and Testing**	**4/9/03**	**9/26/03**	**$99,940**	**$1,100**	**$0**	**$101,040**

Notes

WBS Definition-
Summary task that includes design, production, and testing of L0/L1 digital jumper cables done by KSU.

1.1.2.6.2.1	Develop final specifications	4/9/03	5/6/03	$0	$0	$0	$0

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
18	PhysicistU	50%	80 h	0 w	4/9/03	5/6/03	$0	$0	$0	$0	0 h	0 h	0 h	80 h

Notes

WBS Definition-
Design and layout of final Digital jumper cable to verify mechanical and electrical specifications.

M&S BOE-
no costs associated with this item

Labor BOE-
A physicist spends 2 weeks in contact with Run2b group and verifies the specifications. There are also a few drawings assumed to take 1 week of that time.

1.1.2.6.2.2	Bid cable production	5/7/03	6/4/03	$0	$0	$0	$0

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
18	PhysicistU	10%	16 h	0 w	5/7/03	6/4/03	$0	$0	$0	$0	0 h	0 h	0 h	16 h

Notes

WBS Definition-
Vendor selection and bidding for procurement of cables

M&S BOE-
no costs associated with this line

Labor BOE-
Based on actual time taken for procurement of Run2a low mass cables, which are quite similar to the present digital jumper cables. There are 20 hours of physicist time alotted.

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
1.1.2.6.2.3	**Silicon L0-L1 Digital Jumper Cables Released For**	**6/4/03**	**6/4/03**	**$0**	**$0**	**$0**	**$0**

Notes

WBS Definition-
Milestone: Digital jumper cable design and layout is verified so it is released for production.

1.1.2.6.2.4	Produce cables	6/5/03	8/28/03	$98,740	$0	$0	$98,740

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
18	PhysicistU	9%	43.2 h	0 w	6/5/03	8/28/03	$0	$0	$0	$0	0 h	0 h	0 h	43.2 h
48	MandS	98,740	98,740	0 w	6/5/03	8/28/03	$98,740	$0	$0	$98,740		0	0	98,740

Notes

WBS Definition-
Production of Digital jumper cables for layers 0 and 1. A total of 216 cables are needed with 15% spares and 5% breakage for a total of 260 cables. This includes fabricating the bare flex, ablation (cleaning off the connection pads), and attaching connectors.

M&S BOE-
Fabricate bare flex $353 x 260 = $91,780 (Nonbinding quote from Honeywell, 1 Aug 02)
Ablation costs in batches of 56 from ALT quote #201381 of 2/22/2
5 setups of $300 + ablation cost/piece $16.50*260 totalling $5,790
AVX connectors 2/cable @ $4.50 per pair from purchase cost = $1,170
Total $98,740

Labor BOE-
Physicist time of 1 week assumed to keep in contact with vendor also based on Run2a experience with low mass cables.

1.1.2.6.2.5	Test cables	8/29/03	9/26/03	$1,200	$1,100	$0	$2,300

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
6	ElecEngU	4%	6.4 h	0 w	8/29/03	9/26/03	$0	$0	$0	$0	0 h	0 h	0 h	6.4 h
15	ElecTechU	31%	49.6 h	0 w	8/29/03	9/26/03	$0	$0	$0	$0	0 h	0 h	0 h	49.6 h
18	PhysicistU	50%	80 h	0 w	8/29/03	9/26/03	$0	$0	$0	$0	0 h	0 h	0 h	80 h
48	MandS	2,300	2,300	0 w	8/29/03	9/26/03	$2,300	$0	$0	$2,300		0	0	2,300

Notes

WBS Definition-
Procedures established at KSU and LaTech for verification of specifications as well as testing a fraction of the cables at KSU.

M&S BOE-
$600 for breakout cards and test fixtures
$600 dollars for physicist from KSU to travel to La Tech for a couple of day trip.
To establish the procedures at KSU with their EDL lab:
Electrical Engineer 6 hours at $60/hour = $360
Electrical Tech: 10 hours at $30/hour = $300
Electrical assistant (Student) 10 hours at $20/hour = $200 Totals: $860
Testing 20% of the cables for checking:
30 hours of (physics student) at 8/hour = $240
Total M&S cost: $2,300

Labor BOE-
Electrical Techs(including students) and Electrical Engineer costs are listed above in M&S. A physicist spends 1 week verifying the test procedures and testing some cables and contacts; La Tech for 1 trip for a total of 2 weeks time.

1.1.2.6.3	**Silicon L0-L1 Digital Jumper Cables Produced And**	**11/5/03**	**11/5/03**	**$0**	**$0**	**$0**	**$0**

Notes

WBS Definition-
Milestone: All Layer 0 and Layer 1 digital cables needed are produced and tested.

1.1.2.7	**L2-L5 Digital Jumper Cables (KSU)**	**10/30/01**	**12/17/03**	**$271,388**	**$1,850**	**$0**	**$273,238**

Notes

WBS Definition-
Summary task that includes design, prototyping, production, and testing of L2-5 Digital jumper cables done by KSU

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
1.1.2.7.1	**Protyping of Digital Jumper Cables**	**10/30/01**	**3/5/03**	**$7,282**	**$670**	**$0**	**$7,952**

Notes

WBS Definition-
Summary task that includes design and prototyping, of L2-5 Digital jumper cables done by KSU.

1.1.2.7.1.1	Design cables	10/30/01	2/1/02	$0	$0	$0	$0

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
18	PhysicistU	8%	38.4 h	0 w	10/30/01	2/1/02	$0	$0	$0	$0	0 h	0 h	38.4 h	0 h

Notes

WBS Definition-
Design and layout of the digital jumper cables needed for layers 2-5. These are the cables that attach from the hybrid to the junction card.

M&S BOE-
There are no costs associated with this item as physicist time is used.

Labor BOE-
The physicist labor for the layout is what was spent on the task (1 week)

1.1.2.7.1.2	Prepare prototypes	2/4/02	8/6/02	$7,282	$0	$0	$7,282

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
18	PhysicistU	12%	124.8 h	0 w	2/4/02	8/6/02	$0	$0	$0	$0	0 h	0 h	124.8 h	0 h
48	MandS	7,282	7,282	0 w	2/4/02	8/6/02	$7,282	$0	$7,282	$0		0	7,282	0

Notes

WBS Definition-
Construct the bare flex circuits to qualify two vendors with two cable lengths. The connection pads are then cleaned (ablation) and connectors are bought.

M&S BOE-
Materials bought $840 for 1 oz copper on kapton base 120 ft at $7/ft.
Vendor 1 bare flex (Honeywell) through money transfer by Fermilab.10, 50cm cables
and 20, 100cm cables
Vendor 2 bare flex (Basic): 10, 50cm cables at $3,862 from KSU APO #02319 2/14/02
Ablation costs by Applied Laser Technology (ALT)
3 setup and minimum lot charges of $800 totalling $2,400
from quote #201381 of 2/22/02
AVX connectors 2/cable at $4.50 per pair totalling $180 from actual purchase price in
lots of 1000
Total $7282

Labor BOE-
The physicist needs to contact the vendors. Assume 3 week total contact time based on previous low mass cable experience with Run2a.

1.1.2.7.1.3	Test prototypes	8/13/02	8/26/02	$0	$670	$0	$670

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
6	ElecEngU	3%	2.4 h	0 w	8/13/02	8/26/02	$0	$0	$0	$0	0 h	0 h	2.4 h	0 h
15	ElecTechU	31%	24.8 h	0 w	8/13/02	8/26/02	$0	$0	$0	$0	0 h	0 h	24.8 h	0 h
18	PhysicistU	50%	40 h	0 w	8/13/02	8/26/02	$0	$0	$0	$0	0 h	0 h	40 h	0 h
48	MandS	670	670	0 w	8/13/02	8/26/02	$670	$0	$670	$0		0	670	0

Notes

WBS Definition-
Electrical and mechanical testing of cables done in conjunction with LaTech as well as measurements on the cables to test impedance, etc.

M&S BOE-
$90 for parts for breakout and daisy chain cards.
Labor at KSU costs for EDL:
Electrical Engineer $60/hour for 2.5 hours = $150
ElecTech $30/hour for 3 hours = $90
Elec Tech assistant (student) at $20/hour for 21.5 hours = $430
Total $670

Labor BOE-

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
"Test prototypes" continued							

Notes
In addition to the engineering hours listed in the M&S costs, a physicist spends 40 hours making measurements on these cables.

1.1.2.7.1.4	Develop final specifications	1/23/03	3/5/03	$0	$0	$0	$0

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
18	PhysicistU	33%	79.2 h	0 w	1/23/03	3/5/03	$0	$0	$0	$0	0 h	0 h	0 h	79.2 h

Notes
WBS Definition-
Design and layout of final Digital jumper cable to verify mechanical and electrical specifications.

M&S BOE-
no costs associated with this item

Labor BOE-
A physicist spends 2 weeks in contact with Run2b group and verifies the specifications. There are also a few drawings assumed to take 1 week of that time.

1.1.2.7.2	**Production of L2-L5 Digital Jumper Cables**	**3/6/03**	**12/17/03**	**$264,106**	**$1,180**	**$0**	**$265,286**

Notes
WBS Definition-
Summary task that includes production and testing of L2-5 Digital jumper cables done by KSU.

1.1.2.7.2.1	Bid cable production	3/6/03	4/2/03	$0	$0	$0	$0

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
18	PhysicistU	12%	19.2 h	0 w	3/6/03	4/2/03	$0	$0	$0	$0	0 h	0 h	0 h	19.2 h

Notes
WBS Definition-
Vendor selection and bidding for procurement of cables

M&S BOE-
no costs associated with this line

Labor BOE-
Based on actual time taken for procurement of Run2a low mass cables, which are quite similar to the present digital jumper cables. There are 20 hours of physicist time alotted.

1.1.2.7.2.2	**Silicon L2-L5 Digital Jumper Cables Released For**	**4/2/03**	**4/2/03**	**$0**	**$0**	**$0**	**$0**

Notes
WBS Definition-
Milestone: The design and specifications of L2-L5 digital jumper cables is ready for the production order to be placed.

1.1.2.7.2.3	Produce cables	4/3/03	11/17/03	$262,906	$0	$0	$262,906

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
18	PhysicistU	7%	89.6 h	0 w	4/3/03	11/17/03	$0	$0	$0	$0	0 h	0 h	0 h	89.6 h
48	MandS	262,906	262,906	0 w	4/3/03	11/17/03	$262,906	$0	$0	$262,906		0	0	262,906

Notes
WBS Definition-
Production of Digital jumper cables for layers 2-5. A total of 672 cables are needed with 15% spares and 5% breakage for a total of 807 cables. This includes fabricating the bare flex, ablation (cleaning off the connection pads), and attaching connectors. Assume 5 weeks setup and then 30 cables/week (27 weeks), total 32 weeks.

M&S BOE-
Material, Rogers Kapton 1 oz copper 600 ft at $7/ft =$4200 from Roger's phone quote Jan 02.
Fabricate bare flex $294 x 807 = $237,258 (Nonbinding quote from Honeywell, 1 Aug 02)
Ablation costs in batches of 56 from ALT quote #201381 of 2/22/2
15 setups of $300 + ablation cost/piece $16.50*807 totalling $17,816
AVX connectors 2/cable @ $4.50 per pair from purchase cost = $3,632
Total $262,906

Labor BOE-
Physicist time of around 2 weeks assumed to keep in contact with vendor also based on Run2a experience with low mass cables.

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
1.1.2.7.2.4	Test cables	6/27/03	12/17/03	$1,200	$1,180	$0	$2,380

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
6	ElecEngU	1%	9.6 h	0 w	6/27/03	12/17/03	$0	$0	$0	$0	0 h	0 h	0 h	9.6 h
15	ElecTechU	6%	57.6 h	0 w	6/27/03	12/17/03	$0	$0	$0	$0	0 h	0 h	0 h	57.6 h
18	PhysicistU	12%	115.2 h	0 w	6/27/03	12/17/03	$0	$0	$0	$0	0 h	0 h	0 h	115.2 h
48	MandS	2,380	2,380	0 w	6/27/03	12/17/03	$2,380	$0	$0	$2,380		0	0	2,380

Notes

WBS Definition-
Procedures established at KSU and LaTech for verification of specifications as well as testing a fraction of the cables at KSU.

M&S BOE-
$600 for breakout cards and test fixtures
$600 dollars for physicist from KSU to travel to La Tech for a couple of day trip.
To establish the procedures at KSU with their EDL lab:
Electrical Engineer 6 hours at $60/hour = $360
Electrical Tech: 10 hours at $30/hour = $300
Electrical assistant (Student) 10 hours at $20/hour = $200 Totals: $860
Testing 10% of the cables for checking:
80 cables @ 0.5 hour per cable 40 hours of (physics student) at $8/hour = $320
Total M&S cost: $2380

Labor BOE-
The estimates are based on Run2a experience with low mass cable. Electrical Techs(including students) and Electrical Engineer costs are listed above in M&S. A physicist spends 1 week verifying the test procedures and testing some cables and contacts; La Tech for 1 trip for a total of 3 weeks time.

1.1.2.7.2.5	**Silicon L2-L5 Digital Jumper Cables Produced And**	**12/17/03**	**12/17/03**	**$0**	**$0**	**$0**	**$0**

Notes

WBS Definition-
Milestone: All Layer 2-5 digital cables needed are produced and tested.

1.1.2.8	**All Silicon Digital Jumper Cables Produced And Te**	**12/17/03**	**12/17/03**	**$0**	**$0**	**$0**	**$0**

Notes

WBS Definition-
Milestone: All digital jumper cables have been produced and tested and are ready for attachment to hybrids.

1.1.2.9	**Testing of Cables (LA Tech)**	**8/7/02**	**12/17/03**	**$7,400**	**$5,000**	**$0**	**$12,400**

Notes

WBS Definition-
Summary task that includes design, prototyping, production, and testing of Digital jumper cables done by Louisiana Tech.

1.1.2.9.1	**Prototype Testing at LaTech**	**8/7/02**	**4/18/03**	**$6,200**	**$5,000**	**$0**	**$11,200**
1.1.2.9.1.1	Prototype testing of L2-L5 Digital jumper cables	8/7/02	9/4/02	$5,400	$2,500	$0	$7,900

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
18	PhysicistU	10%	16 h	0 w	8/7/02	9/4/02	$0	$0	$0	$0	0 h	0 h	16 h	0 h
47	Student	200%	320 h	0 w	8/7/02	9/4/02	$0	$0	$0	$0	0 h	0 h	320 h	0 h
48	MandS	7,900	7,900	0 w	8/7/02	9/4/02	$7,900	$0	$7,900	$0		0	7,900	0

Notes

WBS Definition-
Procedures established at KSU and LaTech for verification of specifications as well as testing all cables at La Tech

M&S BOE-
$5000 for digital ohmmeter with computer interface
salary for 2 students each at one month for $2500.
Shipping and insurance at $400 for 2 sets of shipping.
Total: $7900

Labor BOE-
See M&S for costs. 2 students will set up electrical teststand and interface with KSU group to qualify the teststand setup. A physicist will oversee at the 10% level.

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
1.1.2.9.1.2	Prototype testing of L0/L1 Digital jumper cables	12/2/02	1/7/03	$400	$1,250	$0	$1,650

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
18	PhysicistU	10%	16 h	0 w	12/2/02	1/7/03	$0	$0	$0	$0	0 h	0 h	0 h	16 h
47	Student	200%	320 h	0 w	12/2/02	1/7/03	$0	$0	$0	$0	0 h	0 h	0 h	320 h
48	MandS	1,650	1,650	0 w	12/2/02	1/7/03	$1,650	$0	$0	$1,650		0	0	1,650

Notes

WBS Definition-
Procedures established at KSU and LaTech for verification of specifications as well as testing all cables at La Tech

M&S BOE-
salary for 1 student for one month for $1250.
Shipping and insurance at $400 for 2 sets of shipping.
Total $1650

Labor BOE-
Student will verify electrical teststand setup and interface with KSU group to qualify the teststand setup. Another student will help test cables paid from another grant. A physicist will oversee at the 10% level.

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
1.1.2.9.1.3	Testing of teststand jumper cables	3/24/03	4/18/03	$400	$1,250	$0	$1,650

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
18	PhysicistU	10%	16 h	0 w	3/24/03	4/18/03	$0	$0	$0	$0	0 h	0 h	0 h	16 h
47	Student	200%	320 h	0 w	3/24/03	4/18/03	$0	$0	$0	$0	0 h	0 h	0 h	320 h
48	MandS	1,650	1,650	0 w	3/24/03	4/18/03	$1,650	$0	$0	$1,650		0	0	1,650

Notes

WBS Definition-
Procedures established at KSU and LaTech for verification of specifications as well as testing all cables at La Tech

M&S BOE-
salary for 1 student for one month for $1250.
Shipping and insurance at $400 for 2 sets of shipping.
Total $1650

Labor BOE-
See M&S for costs. Students will interface with KSU group and test all cables A physicist will oversee at the 10% level.

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
1.1.2.9.2	**Testing During Project Phase of Cables**	**6/27/03**	**12/17/03**	**$1,200**	**$0**	**$0**	**$1,200**

Notes

WBS Definition-
Summary task that testing of Digital jumper cables done by Louisiana Tech.

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
1.1.2.9.2.1	Testing of L0/L1 Digitial jumper production cables	9/17/03	11/5/03	$400	$0	$0	$400

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
18	PhysicistU	10%	28 h	0 w	9/17/03	11/5/03	$0	$0	$0	$0	0 h	0 h	0 h	28 h
47	Student	200%	560 h	0 w	9/17/03	11/5/03	$0	$0	$0	$0	0 h	0 h	0 h	560 h
48	MandS	400	400	0 w	9/17/03	11/5/03	$400	$0	$0	$400		0	0	400

Notes

WBS Definition-
Procedures established at KSU and LaTech for verification of specifications as well as testing all cables at La Tech

M&S BOE-
Shipping and insurance at $400 for 2 sets of shipping.
Total $400

Labor BOE-
See M&S for costs. Students will interface with KSU group and test all cables A physicist will oversee at the 10% level. Students are paid from another grant. A total of 260 cables will be tested assuming 1 hour/cable this gives 7 weeks of time.

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
1.1.2.9.2.2	Testing of L2-L5 Digitial jumper cable production cable	6/27/03	12/17/03	$800	$0	$0	$800

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
18	PhysicistU	10%	96 h	0 w	6/27/03	12/17/03	$0	$0	$0	$0	0 h	0 h	0 h	96 h
47	Student	200%	1,920 h	0 w	6/27/03	12/17/03	$0	$0	$0	$0	0 h	0 h	0 h	1,920 h

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost

"Testing of L2-L5 Digitial jumper cable production cables" continued

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
48	MandS	800	800	0 w	6/27/03	12/17/03	$800	$0	$0	$800		0	0	800

Notes

WBS Definition-
Procedures established at KSU and LaTech for verification of specifications as well as testing all cables at La Tech

M&S BOE-
Shipping and insurance at $800 for 4 sets of shipping.
Total $400

Labor BOE-
Students will interface with KSU group and test all cables A physicist will oversee at the 10% level. Students are paid from another grant. A total of 800 cables will be tested assuming 1 hour/cable this gives 20 weeks of time. An extra 4 weeks is assumed in case there are problems and also to match with the production schedule.

1.1.2.10	**L0-L1 Junction Cards**	**11/5/01**	**7/27/04**	**$7,085**	**$22,606**	**$0**	**$29,691**

Notes

WBS Definition-
The summary task that describes the design, prototyping, production and testing of the L0 junction cards which are fit at the end of the active region at KSU.

1.1.2.10.1	**L0/L1 Prototypes**	**11/5/01**	**5/23/02**	**$2,056**	**$15,576**	**$0**	**$17,632**

Notes

WBS Definition-
The summary task that describes the design and prototyping of the L0 junction cards which are fit at the end of the active region at KSU.

1.1.2.10.1.1	Design cards	11/5/01	4/4/02	$0	$14,776	$0	$14,776

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
6	ElecEngU	25%	200 h	0 w	11/5/01	4/4/02	$0	$0	$0	$0	0 h	0 h	200 h	0 h
15	ElecTechU	15%	120 h	0 w	11/5/01	4/4/02	$0	$0	$0	$0	0 h	0 h	120 h	0 h
18	PhysicistU	5%	40 h	0 w	11/5/01	4/4/02	$0	$0	$0	$0	0 h	0 h	40 h	0 h
48	MandS	14,776	14,776	0 w	11/5/01	4/4/02	$14,776	$0	$14,776	$0		0	14,776	0

Notes

WBS Definition-
Design and layout of junction cards for L0/L1. These cards have a connection for the digital jumper cable coming from the hybrid and then will have the twisted pair cables soldered on.
The L0/L1 junction cards attach 3 hybrids per card and the card itself is 8 layers to route signals. Only passive components are included on the cards.

M&S BOE-
Design layout by Electrical Engineer at KSU EDL: 204.5 hours at $60/hour = $12,270
layout: ElecTechU 125.3 hours at $20/hour = $2506.
Based on actual spent.
Total: $14776.

Labor BOE-
See M&S costs. Physicist is specifying and reporting at 40 hours (actual time spent).

1.1.2.10.1.2	Prepare and test prototypes	4/5/02	5/23/02	$2,056	$800	$0	$2,856

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
15	ElecTechU	17%	47.6 h	0 w	4/5/02	5/23/02	$0	$0	$0	$0	0 h	0 h	47.6 h	0 h
48	MandS	2,856	2,856	0 w	4/5/02	5/23/02	$2,856	$0	$2,856	$0		0	2,856	0

Notes

WBS Definition-
Vendor production and stuffing of prototype L0/L1 cards and testing by KSU for continuity and shorts.

M&S BOE-
parts cost: $206 actual cost spent on 10 cards.
fab: $1850 invoice from Dynamic and Proto Circuits #68508
Assembly: KSU 40 hours of ElecTech at $20/hour = $800
Total: $2856

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost

"Prepare and test prototypes" continued

Notes
Labor BOE-
See M&S costs.

1.1.2.10.2	**Production of L0/L1 Junction Cards**	**3/29/04**	**7/27/04**	**$5,029**	**$7,030**	**$0**	**$12,059**

Notes
WBS Definition-
The summary task that describes the design, production and testing of the L0/L1 junction cards which are fit at the end of the active region at KSU.

1.1.2.10.2.1	Develop final specifications	3/29/04	4/23/04	$0	$4,160	$0	$4,160

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
6	ElecEngU	25%	40 h	0 w	3/29/04	4/23/04	$0	$0	$0	$0	0 h	0 h	0 h	40 h
18	PhysicistU	25%	40 h	0 w	3/29/04	4/23/04	$0	$0	$0	$0	0 h	0 h	0 h	40 h
48	MandS	4,160	4,160	0 w	3/29/04	4/23/04	$4,160	$0	$0	$4,160		0	0	4,160

Notes
WBS Definition-
Design and layout of final L0/L1 junction cards with verification of electrical and mechanical specifications.

M&S BOE-
ElecEng 64 hours at $65/hour based on prototype layout and assuming one-third of the layout is changed.
Total: $4160

Labor BOE-
See M&S costs. Assume 1 week of physicist time for reporting and communication with engineers.

1.1.2.10.2.2	**Silicon L0-L1 Junction Cards Released For Produc**	**4/23/04**	**4/23/04**	**$0**	**$0**	**$0**	**$0**

Notes
WBS Definition-
Milestone: L0/L1 junction card design and specifications are released for production.

1.1.2.10.2.3	Produce cards	4/26/04	6/28/04	$4,429	$0	$0	$4,429

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
48	MandS	4,429	4,429	0 w	4/26/04	6/28/04	$4,429	$0	$0	$4,429		0	0	4,429

Notes
WBS Definition-
Vendor production and stuffing of final cards

M&S BOE-
87 cards produced (72 cards needed and 15 spares)
parts: $10.27/card includes 15% for minimum orders and spares. (Vendor quotes)
PC board fab: $9.85 per board, setup and nettest $1200 (Dynamic and Proto circuits
quote #9234)
Assembly: $10.10 per board (Altron quote #Q20306 (hep038))
Solder and paste stencil $600 (")
Total: $4429

Labor BOE-
none required

1.1.2.10.2.4	Test cards	6/29/04	7/27/04	$600	$2,870	$0	$3,470

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
6	ElecEngU	8%	12.8 h	0 w	6/29/04	7/27/04	$0	$0	$0	$0	0 h	0 h	0 h	12.8 h
15	ElecTechU	62%	99.2 h	0 w	6/29/04	7/27/04	$0	$0	$0	$0	0 h	0 h	0 h	99.2 h
18	PhysicistU	13%	20.8 h	0 w	6/29/04	7/27/04	$0	$0	$0	$0	0 h	0 h	0 h	20.8 h
48	MandS	3,470	3,470	0 w	6/29/04	7/27/04	$3,470	$0	$0	$3,470		0	0	3,470

Notes
WBS Definition-
Electrical and mechanical testing of cards

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
"Test cards" continued							

Notes

M&S BOE-
Assume 1 hour check out per board and 2% failure rate per AVX connector
Test fixtures: breakout cards $600
87 hours at $20/hour by ElecTech =$1740
Repair 5 boards at 2 hours each with ElecTech at $35/hour = $350
ElecEng supervision 12 hours at $65/hour = $780
Total: $3470

Labor BOE-
See M&S BOE; Physicist supervision and reporting 20 hours

1.1.2.10.3	**Silicon L0-L1 Junction Cards Produced And Teste**	**7/27/04**	**7/27/04**	**$0**	**$0**	**$0**	**$0**

Notes

WBS Definition-
Milestone: All L0-L1 junction cards have been produced and tested and are ready for twisted pair cable attachment.

1.1.2.11	**L2-5 Junction Cards**	**6/25/02**	**8/17/04**	**$13,454**	**$23,590**	**$0**	**$37,044**

Notes

WBS Definition-
The summary task that describes the design, prototyping, production and testing of the L2-5 junction cards which are fit at the end of the active region at KSU.

1.1.2.11.1	**L2-L5 Junction Card Prototyping**	**6/25/02**	**11/13/02**	**$1,850**	**$12,500**	**$0**	**$14,350**
1.1.2.11.1.1	Design cards	6/25/02	9/18/02	$0	$12,000	$0	$12,000

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
6	ElecEngU	40%	192 h	0 w	6/25/02	9/18/02	$0	$0	$0	$0	0 h	0 h	179.2 h	12.8 h
18	PhysicistU	8%	38.4 h	0 w	6/25/02	9/18/02	$0	$0	$0	$0	0 h	0 h	35.83 h	2.57 h
48	MandS	12,000	12,000	0 w	6/25/02	9/18/02	$12,000	$0	$12,000	$0		0	11,200	800

Notes

WBS Definition-
Design and layout of junction cards for L2-L5. These cards have a connection for the digital jumper cable coming from the hybrid and then will have the twisted pair cables soldered on.
The L2-L5 junction cards attach 2 hybrids per card and the card itself is 8 layers to route signals. Only passive components are included on the cards.

M&S BOE-
Design layout by Electrical Engineer at KSU EDL: 200 hours at $60/hour = $12,000
80% of time taken for actual L0/L1 design layout cost assumed

Labor BOE-
See M&S costs. Physicist is specifying and reporting at 40 hours (L0/L1 time).

1.1.2.11.1.2	Prepare and test prototypes	9/19/02	11/13/02	$1,850	$500	$0	$2,350

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
15	ElecTechU	8%	25.6 h	0 w	9/19/02	11/13/02	$0	$0	$0	$0	0 h	0 h	0 h	25.6 h
48	MandS	2,350	2,350	0 w	9/19/02	11/13/02	$2,350	$0	$0	$2,350		0	0	2,350

Notes

WBS Definition-
Vendor production and stuffing of prototype L2-L5 cards and testing by KSU for continuity and shorts.

M&S BOE-
10 cards
parts cost included L0/L1 prototype
fab: $1850 invoice from Dynamic and Proto Circuits #68508
Assembly: KSU 25 hours of ElecTech at $20/hour = $500
Total: $2350

Labor BOE-
See M&S costs.

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
1.1.2.11.2	**L2-L5 Junction Card Testing and Production**	**3/29/04**	**8/17/04**	**$11,604**	**$11,090**	**$0**	**$22,694**

Notes

WBS Definition-
The summary task that describes the design,production and testing of the L2-5 junction cards which are fit at the end of the active region at KSU.

1.1.2.11.2.1	Develop final specifications	3/29/04	4/23/04	$0	$4,160	$0	$4,160

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
6	ElecEngU	25%	40 h	0 w	3/29/04	4/23/04	$0	$0	$0	$0	0 h	0 h	0 h	40 h
18	PhysicistU	25%	40 h	0 w	3/29/04	4/23/04	$0	$0	$0	$0	0 h	0 h	0 h	40 h
48	MandS	4,160	4,160	0 w	3/29/04	4/23/04	$4,160	$0	$0	$4,160		0	0	4,160

Notes

WBS Definition-
Design and layout of final L2-L5 junction cards with verification of electrical and mechanical specifications.

M&S BOE-
ElecEng 64 hours at $65/hour based on prototype layout and assuming one-third of the layout is changed.
Total: $4160

Labor BOE-
See M&S costs. Assume 1 week of physicist time for reporting and communication with engineers.

1.1.2.11.2.2	**Silicon L2-5 Junction Cards Released For Producti**	**4/23/04**	**4/23/04**	**$0**	**$0**	**$0**	**$0**

Notes

WBS Definition-
Milestone: L2-L5 junction card design and specifications are released for production

1.1.2.11.2.3	Produce cards	4/26/04	8/17/04	$11,104	$0	$0	$11,104

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
18	PhysicistU	6%	38.4 h	0 w	4/26/04	8/17/04	$0	$0	$0	$0	0 h	0 h	0 h	38.4 h
48	MandS	11,104	11,104	0 w	4/26/04	8/17/04	$11,104	$0	$0	$11,104		0	0	11,104

Notes

WBS Definition-
Vendor production and stuffing of final L2-L5 junction cards

M&S BOE-
437 cards produced (336 cards needed and 101 spares. These are also needed for teststands)
parts: $6.84/card includes 15% for minimum orders and spares. (Vendor quotes)
PC board fab: $8.95 per board, setup and nettest $1200 (Dynamic and Proto circuits
quote #9242)
Assembly: $5.50 per board (Altron quote #Q20306 (hep041))
Solder and paste stencil $600 (")
Total: $11104

Labor BOE-
Physicist needed to check on vendor at 1 week's time

1.1.2.11.2.4	Test cards	5/24/04	7/20/04	$500	$6,930	$0	$7,430

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
6	ElecEngU	6%	19.2 h	0 w	5/24/04	7/20/04	$0	$0	$0	$0	0 h	0 h	0 h	19.2 h
15	ElecTechU	80%	256 h	0 w	5/24/04	7/20/04	$0	$0	$0	$0	0 h	0 h	0 h	256 h
18	PhysicistU	12%	38.4 h	0 w	5/24/04	7/20/04	$0	$0	$0	$0	0 h	0 h	0 h	38.4 h
48	MandS	7,430	7,430	0 w	5/24/04	7/20/04	$7,430	$0	$0	$7,430		0	0	7,430

Notes

WBS Definition-
Electrical and mechanical testing of cards

M&S BOE-
Assume 1/2 hour check out per board and 2% failure rate per AVX connector
Test fixtures: breakout cards $500
218.5 hours at $20/hour by ElecTech =$4370

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
"Test cards" continued							

Notes

Repair 18 boards at 2 hours each with ElecTech at $35/hour = $1260
ElecEng supervision 20 hours at $65/hour = $1300
Total: $7430

Labor BOE-
See M&S BOE; Physicist supervision and reporting 20 hours

1.1.2.11.3	**Silicon L2-5 Junction Cards Produced And Tested**	**7/20/04**	**7/20/04**	**$0**	**$0**	**$0**	**$0**

Notes

WBS Definition-
Milestone: All L2-L5 junction cards have been produced and tested and are ready for twisted pair cable attachment.

1.1.2.12	**Twisted-pair Cables**	**3/4/02**	**1/19/05**	**$327,427**	**$0**	**$53,136**	**$380,563**

Notes

WBS Definition-
The summary task that describes the design, layout, procurement, testing of the Twisted pair cables and also includes the connection of the twisted pair cables to the junction cards.

1.1.2.12.1	**Twisted-pair Prototyping**	**3/4/02**	**12/13/02**	**$4,557**	**$0**	**$15,072**	**$19,629**

Notes

WBS Definition-
The summary task that describes the design, layout, procurement, testing of the Twisted-pair cables and also includes the connection of the twisted pair cables to the junction cards for the prototypes.

1.1.2.12.1.1	Design cables	3/4/02	4/26/02	$0	$0	$7,040	$7,040

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
4	ElecEngF	40%	128 h	0 w	3/4/02	4/26/02	$7,040	$0	$7,040	$0	0 h	0 h	128 h	0 h
17	PhysicistF	40%	128 h	0 w	3/4/02	4/26/02	$0	$0	$0	$0	0 h	0 h	128 h	0 h

Notes

WBS Definition-
Design and layout of twisted pair cables and connectors. The cable connects junction card and adapter cards. it consists of three parts : signal twisted pairs terminated with 44-pin Omnetics connector from the adapter card side, power twisted pair terminated with 6-pin Omnetics connector and two minicoax clock cables terminated with subminiature connectors. all the above parts are soldered on the junction card side.

M&s BOE
no cost associated with this item

Labor BOE-
8 weeks of ElecEngF[40%] is required to measure the properties of sample cables, determine correct termination scheme on both ends of the cable, estimate required number of twisted pair and gauge of the wire. Based on work already done.

1.1.2.12.1.2	Procure prototype parts	4/29/02	8/20/02	$3,057	$0	$1,760	$4,817

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
4	ElecEngF	5%	32 h	0 w	4/29/02	8/20/02	$1,760	$0	$1,760	$0	0 h	0 h	32 h	0 h
17	PhysicistF	5%	29 h	0 w	4/29/02	8/20/02	$0	$0	$0	$0	0 h	0 h	29 h	0 h
48	MandS	3,057	3,057	0 w	4/29/02	8/20/02	$3,057	$0	$3,057	$0		0	3,057	0

Notes

WBS Definition-
Procurement of twisted pair, cables, connectors and termination of the cables

M&S BOE
$577 for AWG34 twisted pair from NewEngland Wire (quote 3/6/2002). $1010 for 6 protype signal twisted pairs terminated with Omnetics 44-pin connector (quote 4/17/2002). $1470 for 50 power cables (quote 4/8/2002). total cost $3057.

Labor BOE-
Investigation of the market, communications with several vendors, procurement paperwork based on time spent.

1.1.2.12.1.3	Assemble prototypes	8/21/02	10/16/02	$1,500	$0	$1,872	$3,372

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
13	ElecTechF	15%	48 h	0 w	8/21/02	10/16/02	$1,872	$0	$749	$1,123	0 h	0 h	19.2 h	28.8 h

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
"Assemble prototypes" continued							

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
48	MandS	1,500	1,500	0 w	8/21/02	10/16/02	$1,500	$0	$1,500	$0		0	600	900

Notes

WBS definition: assemble prototype cables. assume three cables assembled at Fermilab and 3 cables assembled at BINP, Novosibirsk to qualify this vendor.

M&S BOE
$1500 for cable assembly at BINP (Novosibirsk), including $1000 NRE for test and assembly fixtures. based on a mail quotation.

Labor BOE
8 weeks of ElecTechF[15%] reqired to assemble three cables. assumes 2 days of setup and one day per cable.

1.1.2.12.1.4	Test prototypes	10/17/02	12/13/02	$0	$0	$4,400	$4,400

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
4	ElecEngF	25%	80 h	0 w	10/17/02	12/13/02	$4,400	$0	$0	$4,400	0 h	0 h	0 h	80 h
17	PhysicistF	10%	32 h	0 w	10/17/02	12/13/02	$0	$0	$0	$0	0 h	0 h	0 h	32 h
18	PhysicistU	25%	80 h	0 w	10/17/02	12/13/02	$0	$0	$0	$0	0 h	0 h	0 h	80 h

Notes

WBS Definition-
Electrical and mechanical testing of cables including characterization in readout chain.

M&S BOE
no cost associated with this item

Labor BOE-
8 weeks of ElecEngF[25%], PhysicistF[10%], PhysicistU[25%] needed to measure characteristics and understand performance of the cable in readout chain. based on Run2A experience.

1.1.2.12.2	**Twisted-pair Production Tasks**	**12/16/02**	**1/19/05**	**$322,870**	**$0**	**$38,064**	**$360,934**

Notes

WBS Definition-
The summary task that describes the design, layout, procurement, testing of the Twisted-pair cables and also includes the connection of the twisted-pair cables to the junction cards.

1.1.2.12.2.1	Design preproduction cables	12/16/02	1/22/03	$0	$0	$8,800	$8,800

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
4	ElecEngF	100%	160 h	0 w	12/16/02	1/22/03	$8,800	$0	$0	$8,800	0 h	0 h	0 h	160 h
17	PhysicistF	25%	40 h	0 w	12/16/02	1/22/03	$0	$0	$0	$0	0 h	0 h	0 h	40 h

Notes

WBS Definition-
Design and layout of twisted pair cables and connectors. The cable connects junction card and adapter cards. it consists of three parts : signal twisted pairs terminated with 44-pin Omnetics connector from the adapter card side, power twisted pair terminated with 6-pin Omnetics connector and two minicoax clock cables terminated with subminiature connectors. all the above parts are soldered on the junction card side.

M&s BOE
no cost associated with this item

Labor BOE-
4 weeks of ElecEngF and PhysicistF[25%] is required to implement R&D finding from prototype work to the design, design three types of twisted pair cable (signal, power, HV), design soldering connections to two types of junction cards, design connections to adapter cards, document the design for assembly vendors.

1.1.2.12.2.2	Procure preproduction parts	1/23/03	6/12/03	$15,180	$0	$1,560	$16,740

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
13	ElecTechF	5%	40 h	0 w	1/23/03	6/12/03	$1,560	$0	$0	$1,560	0 h	0 h	0 h	40 h
48	MandS	15,180	15,180	0 w	1/23/03	6/12/03	$15,180	$0	$0	$15,180		0	0	15,180

Notes

WBS Definition-
Procurement of twisted pair, cables, connectors. assume 60 12-feet cable assemblies.

M&S BOE
per cable :
signal cable with 26 twisted pairs 12 feet x $10.65 = $127.8, AXON quote 10/15/2001

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost

"Procure preproduction parts" continued

Notes

termination with 44-pin connector $75.10, Omnetics quote 4/17/2002
power 6-pin connector with 12 feet twisted pairs $29.37, Omnetics quote 4/8/2002
clock minicoaxial cable 12 feet x $0.44 x 2 = $10.56, NE Electric Wire quote 7/20/1999
termination of the coaxes $10, Run2a experience
total per cable : $253
total for 60 cables $15180

Labor BOE-
ElecTechF[5%] for the full duration of 20 weeks to coordinate procurement.

1.1.2.12.2.3	Assemble preproduction cables	6/13/03	8/8/03	$4,300	$0	$0	$4,300

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
17	PhysicistF	25%	80 h	0 w	6/13/03	8/8/03	$0	$0	$0	$0	0 h	0 h	0 h	80 h
48	MandS	4,300	4,300	0 w	6/13/03	8/8/03	$4,300	$0	$0	$4,300		0	0	4,300

Notes

WBS definition--
Assemble prototype cables, test cables for shorts and continuity. assume 60 cables assembled at BINP, Novosibirsk

M&S BOE-
$1000 NRE for test and assembly fixtures, $55 per cable assembly. based on a mail quotation.
total $4300.

Labor BOE-
PhysicistF[25%] for the duration of the task to coordinate the assembly and for initial quality checking.

1.1.2.12.2.4	Test preproduction cables	8/11/03	10/6/03	$0	$0	$8,800	$8,800

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
4	ElecEngF	50%	160 h	0 w	8/11/03	10/6/03	$8,800	$0	$0	$8,800	0 h	0 h	0 h	160 h
17	PhysicistF	25%	80 h	0 w	8/11/03	10/6/03	$0	$0	$0	$0	0 h	0 h	0 h	80 h

Notes

WBS Definition-
Electrical and mechanical testing of cables including characterization in readout chain.

M&S BOE
no cost associated with this item

Labor BOE-
8 weeks of ElecEngF[50%], PhysicistF[25%] needed to measure characteristics and understand performance of the cable in readout chain. based on Run2A experience.

1.1.2.12.2.5	Develop final specifications	2/2/04	3/26/04	$0	$0	$17,344	$17,344

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
1	MechEngF	20%	64 h	0 w	2/2/04	3/26/04	$3,264	$0	$0	$3,264	0 h	0 h	0 h	64 h
4	ElecEngF	40%	128 h	0 w	2/2/04	3/26/04	$7,040	$0	$0	$7,040	0 h	0 h	0 h	128 h
17	PhysicistF	40%	128 h	0 w	2/2/04	3/26/04	$0	$0	$0	$0	0 h	0 h	0 h	128 h
21	DesignerF	50%	160 h	0 w	2/2/04	3/26/04	$7,040	$0	$0	$7,040	0 h	0 h	0 h	160 h

Notes

WBS Definition-
Design and layout of twisted pair cables and connectors. Final design will require input from mechanical group to define cable paths and lengths.

M&S BOE
no cost associated with this item

Labor BOE-
8 weeks of ElecEngF[40%] and PhysicistF[40%] is required to implement findings from preproduction run to the design of three types of twisted pair cable (signal, power, HV) and other components of the cable. DesignerF[50%] and MechEngF[20%] are needed to define cable paths from junction cards to the Horseshoe. 5 drawings are required to determine cable lengths.

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
1.1.2.12.2.6	Bid cable production	3/29/04	4/23/04	$0	$0	$0	$0

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
17	PhysicistF	10%	16 h	0 w	3/29/04	4/23/04	$0	$0	$0	$0	0 h	0 h	0 h	16 h

Notes

WBS Definition-
Vendor selection and bidding for procurement of cables

M&S BOE-
no costs associated with this item

Labor BOE-
Communications with vendors. Run2a experience says you need some physicist time.

1.1.2.12.2.7	**Silicon Twisted-pair Cables Released For Producti**	**4/23/04**	**4/23/04**	**$0**	**$0**	**$0**	**$0**

Notes

WBS Definition-
Milestone: The design, and specifications for the twisted pair cable layout have been reviewed and the cables are ready for production.

1.1.2.12.2.8	Procure parts for production	4/26/04	9/15/04	$256,490	$0	$1,560	$258,050

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
13	ElecTechF	5%	40 h	0 w	4/26/04	9/15/04	$1,560	$0	$0	$1,560	0 h	0 h	0 h	40 h
48	MandS	256,490	256,490	0 w	4/26/04	9/15/04	$256,490	$0	$0	$256,490		0	0	256,490

Notes

WBS Definition-
Procurement of twisted pair, cables, connectors. assume 1160 12-feet cable assemblies.

M&S BOE
assume 1160 12-feet cable assemblies. There are 912 cables needed for the detector
per cable :
signal cable with 26 twisted pairs 12 feet x $10.65 = $127.8, AXON quote 10/15/2001
termination with 44-pin connector $52.3, Omnetics quote 4/17/2002
power 6-pin connector with 12 feet twisted pairs $20.45, Omnetics quote 4/8/2002
clock minicoaxial cable 12 feet x $0.44 x 2 = $10.56, NE Electric Wire quote 7/20/1999
termination of the coaxes $10, Run2a experience
total per cable : $221.11

total for 1160 cables $256490

Labor BOE-
ElecTechF[5%] for the full duration of 20 weeks to coordinate procurement.

1.1.2.12.2.9	Assemble cables	9/16/04	1/19/05	$46,900	$0	$0	$46,900

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
17	PhysicistF	10%	64 h	0 w	9/16/04	1/19/05	$0	$0	$0	$0	0 h	0 h	0 h	64 h
48	MandS	46,900	46,900	0 w	9/16/04	1/19/05	$46,900	$0	$0	$46,900		0	0	46,900

Notes

WBS definition: assemble prototype cables, test cables for shorts and continuity. assume 1160 cables assembled at BINP, Novosibirsk

M&S BOE
$1000 NRE for test and assembly fixtures, two set of two types of fixtures assume with total $4000 for the fixtures. $37 per cable assembly based on a KSU MRI estimate. there is a lower estimate from BINP, Novosibirsk but conservatively we used the highest one.
total for 1160 cable assemblies $46900.

Labor BOE
PhysicistF[10%] for the duration of the task to coordinate the assembly and for initial quality checking, possibly a vendor visit.

1.1.2.12.2.10	Test cables	10/14/04	1/19/05	$0	$0	$0	$0

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
47	Student	100%	480 h	0 w	10/14/04	1/19/05	$0	$0	$0	$0	0 h	0 h	0 h	480 h

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost

"Test cables" continued

Notes

WBS Definition-
Functionality test in the full chain setup with junction card attached.

M&S BOE
no cost associated with this item

Labor BOE-
Assume 20 cables tested per day by student and there are a total of 1160 cables.

1.1.2.12.3	**Silicon Twisted-pair Cables Produced And Tested**	**1/19/05**	**1/19/05**	**$0**	**$0**	**$0**	**$0**

Notes

WBS Definition-
Milestone: All cables tested and ready for assembly onto junction cards.

1.1.2.13	**Adapter Cards**	**10/1/01**	**11/10/04**	**$191,324**	**$99,032**	**$0**	**$290,356**

Notes

WBS Definition-
This summary task includes all design, prototyping, production, and testing of adapter cards which regulate the power and pass the signals to the SVX4 chips on the hybrid done by KSU.

M&S BOE-
The contingency assigned is 100% for the design and preproduction work as the risk is high except for tasks completed. The production boards are assigned 75% contingency according to guidelines.

1.1.2.13.1	**Adapter Card R&D Phase**	**10/1/01**	**10/30/02**	**$6,586**	**$36,261**	**$0**	**$42,847**

Notes

WBS Definition-
This summary task includes all design, prototyping, production, and testing of adapter cards which regulate the power and pass the signals to the SVX4 chips on the hybrid done by KSU during prototyping phase.

1.1.2.13.1.1	Design cards	10/1/01	6/24/02	$0	$34,401	$0	$34,401

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
6	ElecEngU	29%	419.92 h	0 w	10/1/01	6/24/02	$0	$0	$0	$0	0 h	0 h	419.92 h	0 h
15	ElecTechU	18%	260.63 h	0 w	10/1/01	6/24/02	$0	$0	$0	$0	0 h	0 h	260.63 h	0 h
18	PhysicistU	13%	188.23 h	0 w	10/1/01	6/24/02	$0	$0	$0	$0	0 h	0 h	188.23 h	0 h
48	MandS	34,401	34,401	0 w	10/1/01	6/24/02	$34,401	$0	$34,401	$0		0	34,401	0

Notes

WBS Definition-
Design and layout of adapter card. The adapter card is a 6 layer card that services 4 hybrids. It provides the voltage regulation and monitoring for the SVX4 chip. It translates differential signals to TTL and has connectors for HV pass through on L0/L1 hybrids and connectors CAL/SR.

M&S BOE-
Based on money spent by KSU:
Electrical Engineer 456 hours at $60/hour =$27360
Senior Elec Tech 146.7 hours at $15/hour (subsidized from another grant)= $2201
Junior electrical tech 242 hours at $20/hour =$4840
Total: $34,401

Labor BOE-
See M&S above. Also physicist with 200 hours.

1.1.2.13.1.2	Prepare prototypes	6/25/02	9/18/02	$6,586	$900	$0	$7,486

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
15	ElecTechU	13%	62.4 h	0 w	6/25/02	9/18/02	$0	$0	$0	$0	0 h	0 h	58.23 h	4.17 h
48	MandS	7,486	7,486	0 w	6/25/02	9/18/02	$7,486	$0	$7,486	$0		0	6,986.93	499.07

Notes

WBS Definition-
Production including stuffing of first prototype cards

M&S BOE-
12 cards produced.

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost

"Prepare prototypes" continued

Notes

parts cost $404/card = $4848
fab of 16 bare boards: $1738 from Dynamic and Protocircuits quote #9054
assembly: 5 hours per card 60 hours of electech at $15/hour = $900
Total: $7486

Labor BOE-
see M&S above for technician.

1.1.2.13.1.3	Test adapter card prototypes at KSU	9/19/02	10/30/02	$0	$960	$0	$960

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
15	ElecTechU	20%	48 h	0 w	9/19/02	10/30/02	$0	$0	$0	$0	0 h	0 h	0 h	48 h
18	PhysicistU	6%	14.4 h	0 w	9/19/02	10/30/02	$0	$0	$0	$0	0 h	0 h	0 h	14.4 h
48	MandS	960	960	0 w	9/19/02	10/30/02	$960	$0	$0	$960		0	0	960

Notes

WBS Definition-
All electrical and mechanical tests with pulse generator to verify operation of boards.

M&S BOE-
test 12 cards at 4 hours per card of ElecTech at $20/hour = $960

Labor BOE-
see M&S costs and add another 2 days of physicist time for communications with group.

1.1.2.13.2	**Adapter Card Production Phase**	**12/9/02**	**11/10/04**	**$184,738**	**$62,771**	**$0**	**$247,509**

Notes

WBS Definition-
This summary task includes all design, prototyping, production, and testing of adapter cards which regulate the power and pass the signals to the SVX4 chips on the hybrid done by KSU during production phase.

1.1.2.13.2.1	Design preproduction cards	12/9/02	3/12/03	$0	$29,241	$0	$29,241

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
6	ElecEngU	80%	384 h	0 w	12/9/02	3/12/03	$0	$0	$0	$0	0 h	0 h	0 h	384 h
15	ElecTechU	25%	120 h	0 w	12/9/02	3/12/03	$0	$0	$0	$0	0 h	0 h	0 h	120 h
18	PhysicistU	33%	158.4 h	0 w	12/9/02	3/12/03	$0	$0	$0	$0	0 h	0 h	0 h	158.4 h
48	MandS	29,241	29,241	0 w	12/9/02	3/12/03	$29,241	$0	$0	$29,241		0	0	29,241

Notes

WBS Definition-
Design and layout of 2nd run of adapter card. This run is to address heat seeking and heat flow measurements and incorporate changes found from SVX4 prototype chip tests.

M&S BOE-
Based on estimate by KSU which is based on prototype run.
Electrical Engineer 379.5 hours at $60/hour
Senior Elec Tech 122 hours at $15/hour (subsidized from another grant)
Junior electri tech 232 hours at $20/hour
Total: $29241

Labor BOE-
See M&S above. Also physicist with 160 hours.

1.1.2.13.2.2	Prepare preproduction cards	3/13/03	6/5/03	$8,686	$0	$0	$8,686

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
48	MandS	8,686	8,686	0 w	3/13/03	6/5/03	$8,686	$0	$0	$8,686		0	0	8,686

Notes

WBS Definition-
Production including stuffing of second round cards

M&S BOE-
12 cards produced. 1st Prototypes cost $624/card. Add $100 per card for heat sink parts.
Total: $8686

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost

"Prepare preproduction cards" continued

Notes

Labor BOE-
no labor here.

1.1.2.13.2.3	Test preproduction cards	6/6/03	7/18/03	$0	$960	$0	$960

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
15	ElecTechU	20%	48 h	0 w	6/6/03	7/18/03	$0	$0	$0	$0	0 h	0 h	0 h	48 h
18	PhysicistU	6%	14.4 h	0 w	6/6/03	7/18/03	$0	$0	$0	$0	0 h	0 h	0 h	14.4 h
48	MandS	960	960	0 w	6/6/03	7/18/03	$960	$0	$0	$960		0	0	960

Notes

WBS Definition-
All electrical and mechanical tests with pulse generator to verify operation of boards.

M&S BOE-
Test 12 cards at 4 hours per card of ElecTech at $20/hour = $960

Labor BOE-
See M&S costs and add another 2 days of physicist time for communications with group.

1.1.2.13.2.4	Develop final specifications	11/24/03	1/30/04	$0	$11,300	$0	$11,300

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
6	ElecEngU	38%	121.6 h	0 w	11/24/03	1/30/04	$0	$0	$0	$0	0 h	0 h	0 h	121.6 h
15	ElecTechU	31%	99.2 h	0 w	11/24/03	1/30/04	$0	$0	$0	$0	0 h	0 h	0 h	99.2 h
18	PhysicistU	25%	80 h	0 w	11/24/03	1/30/04	$0	$0	$0	$0	0 h	0 h	0 h	80 h
48	MandS	11,300	11,300	0 w	11/24/03	1/30/04	$11,300	$0	$0	$11,300		0	0	11,300

Notes

WBS Definition-
Design and layout of production adapter card. Verification of all electronic and mechanical specifications.

M&S BOE-
Based on estimate by KSU which is based on prototype run.
Electrical Engineer 120 hours at $65/hour =$7800
Senior Elec Tech 100 hours at $35/hour $3500
Total: $11300

Labor BOE-
See M&S above. Also physicist with 80 hours for reporting and communications.

1.1.2.13.2.5	Bid card production	2/2/04	3/26/04	$0	$0	$0	$0

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
18	PhysicistU	10%	32 h	0 w	2/2/04	3/26/04	$0	$0	$0	$0	0 h	0 h	0 h	32 h

Notes

WBS Definition-
Vendor selection and bidding for procurement of production adapter cards

M&S BOE-
no costs associated with this item

Labor BOE-
Physicist at the 10% level to oversee process in conjunction with Fermilab.

1.1.2.13.2.6	**Silicon Adapter Cards Released For Production**	**3/26/04**	**3/26/04**	**$0**	**$0**	**$0**	**$0**

Notes

WBS Definition-
Milestone: Design and Layout has been verified so that adapter cards can be released for production.

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
1.1.2.13.2.7	Produce cards	3/29/04	7/20/04	$174,852	$0	$0	$174,852

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
18	PhysicistU	5%	32 h	0 w	3/29/04	7/20/04	$0	$0	$0	$0	0 h	0 h	0 h	32 h
48	MandS	174,852	174,852	0 w	3/29/04	7/20/04	$174,852	$0	$0	$174,852		0	0	174,852

Notes

WBS Definition-
Production including stuffing of production round of adapter cards

M&S BOE-
290 cards produced of which 222 are used in the detector. Extra cards are spares and used for teststands. Based on budgetary quote.
Parts: $504/card including heat sink parts = $146,000
Fab: bare boards $14.95/board = $4336 (Quote Dynamic and Proto Circuits #9232)
Fab setup/nettest $1000 (typical)
Assembly: $71.40/board = $20,706 (Altron quote #Q20306 (hep039))
Assembly setup $450 (")
Solder paste/stencil $1200 (")
Shipping and insurance $1000 (1/2 % of insured value)
Total: $174852 ($603/card)

Labor BOE-
Physicist oversees run at 5% of the time.

1.1.2.13.2.8	Test cards	7/21/04	11/10/04	$1,200	$21,270	$0	$22,470

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
6	ElecEngU	15%	96 h	0 w	7/21/04	11/10/04	$0	$0	$0	$0	0 h	0 h	0 h	96 h
15	ElecTechU	110%	704 h	0 w	7/21/04	11/10/04	$0	$0	$0	$0	0 h	0 h	0 h	704 h
18	PhysicistU	31%	198.4 h	0 w	7/21/04	11/10/04	$0	$0	$0	$0	0 h	0 h	0 h	198.4 h
48	MandS	22,470	22,470	0 w	7/21/04	11/10/04	$22,470	$0	$0	$22,470		0	0	22,470

Notes

WBS Definition-
All electrical and mechanical tests. Uses SASEQ teststands to verify operation.

M&S BOE-
Based on KSU estimate derived from Run2a Interface board testing
Test setup and Training: 40 hours of ElecTech at $35/hour = $1400
Test 290 cards at 2 hours/card: 580 hours of ElecTech At $20/hour = $11600
Test Fixtures: 2sets at $600 each actual cost = $1200
Electrical Engineer oversight 96 hours at $65/hour = $6240
Repair: assume 10% failure rate per card and 2 hour repair per card = 58 hours of
Electrical Tech at $35/hour = $2030
Total $22470

Labor BOE-
See M&S costs and add another 200 hours of physicist for overseeing and reporting.

1.1.2.13.3	**Silicon Adapter Cards Produced And Tested**	**11/10/04**	**11/10/04**	**$0**	**$0**	**$0**	**$0**

Notes

WBS Definition-
Milestone: All of the adapter cards have been produced and tested.

1.1.2.14	**SASEQ Test Stands**	**2/4/02**	**6/18/03**	**$417,543**	**$64,254**	**$70,560**	**$552,357**

Notes

WBS Definition-
Summary task that describes design and building of the test stands for production testing using stand alone sequencers (SASEQs)

M&S BOE-
The cost basis are explained on each line. For the contingency, items in the past are 0%. All of the other items are costed according to the guidelines.

Labor BOE-
Contingency according to the nominal 50% except for tasks in the past (0%)

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
1.1.2.14.1	**MRI Procurements**	**4/26/02**	**3/21/03**	**$154,600**	**$27,761**	**$0**	**$182,361**

Notes

WBS Definition-
Summary task that describes procurements for the test stands for production testing using stand alone sequencers (SASEQs) done by MRI institutions.

1.1.2.14.1.1	Procure parts through MRI grant	4/26/02	1/21/03	$68,200	$10,000	$0	$78,200

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
18	PhysicistU	3%	43.2 h	0 w	4/26/02	1/21/03	$0	$0	$0	$0	0 h	0 h	23.28 h	19.92 h
48	MandS	78,200	78,200	0 w	4/26/02	1/21/03	$78,200	$0	$78,200	$0		0	42,141.11	36,058.89

Notes

WBS Definition-
Procurement of Stand-Alone Sequencers and cables for the hybrid and module testing test stands.

M&S BOE-
Total of 61 SASEQs and 60, 50conductor cables
The cost is shared with Fermilab for the SASEQs.
UIC saseq order ($60,000) + UIC cables order ($8,200)
Stand Alone Sequencer-D 6U x 160 x 0.093 VME SVX Readout Controller Module:
2 prototype modules at $2,106.51 each
Testing NRE for Flying Probe Test: $240
Stand Alone Sequencer-D 6Ux160x0.093 Vme SVX Readout Controller Module:
50 prototypes at $906.15 each
Testing NRE for Flying Probe Test: $5,900.00
Bare Board Tooling: $600.00
Bare Board Level 1 Test:$500.00
Flying Probe Programming: $2,000.00
Assembly SMT Solder Stencil: $1100
Assembly SMT Solder Program: $300

60 50-conductor cables for connection of Saseq to purple card, for a total of $8,200.

Additionally, there is $10,000 matching money for 20% of the KU electrical engineer's time.
TOTAL M&S - $78,200

Labor BOE-
Assume 1 week of physicist time to put through the POs for the order.

1.1.2.14.1.2	Procure mechanical parts through MRI grant	9/23/02	2/21/03	$9,500	$0	$0	$9,500

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
48	MandS	9,500	9,500	0 w	9/23/02	2/21/03	$9,500	$0	$0	$9,500		0	0	9,500

Notes

WBS Definition--
Procurement of mechanical and cooling parts for burn-in stations.

M&S BOE--
Parts for 2 module burn-in teststands, each with: 2 dew point meters$750, rail, plates, and tubing at $2000, box and support for $1000, and interlock system for $1000.
Total per stand of $4750; total this item $9500 These costs are based on Run2a experience.

Labor BOE-- labor for this is included in the infrastructure setup task.

1.1.2.14.1.3	Procure electrical components	9/23/02	12/17/02	$31,900	$0	$0	$31,900

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
18	PhysicistU	8%	38.4 h	0 w	9/23/02	12/17/02	$0	$0	$0	$0	0 h	0 h	0 h	38.4 h
48	MandS	31,900	31,900	0 w	9/23/02	12/17/02	$31,900	$0	$0	$31,900		0	0	31,900

Notes

WBS Definition--
Procurement of VME crates and low voltage power supplies for Fermilab based SASEQ teststands including burn-in stations.

M&S BOE--

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost

"Procure electrical components" continued

Notes

3 low voltage power supplies needed per test stand station (2 set per module burn-in station) at $1,200 per set, for a total of 12 at $14,400; Seven crate/power supply combination at $2,500 each, for a total of $17,500.
Total cost: $31,900

Labor BOE--
1 week of Physicist time for procurements from prototyping and other experience.

1.1.2.14.1.4	Procure commercial products	9/23/02	10/18/02	$45,000	$0	$0	$45,000

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
18	PhysicistU	10%	16 h	0 w	9/23/02	10/18/02	$0	$0	$0	$0	0 h	0 h	0 h	16 h
48	MandS	45,000	45,000	0 w	9/23/02	10/18/02	$45,000	$0	$0	$45,000		0	0	45,000

Notes

WBS Definition-
Procurement of PCs and software for all SASEQ teststands. We need 15 SASEQ PCs total. There are 10 located at Fermilab and 5 at other universities.

M&S BOE-
Assume $3000 per PC including software based on general market costs. Software needed includes MSOffice Professional ($75), Fortran, C++, Visual Basic. The compilers are all bought using MS Studio for $300.

Labor BOE --
Physicist oversees the procurement for a total of 2 days: interact with vendors, decide on the system and place the order for the test stand PCs.

1.1.2.14.1.5	Infrastructure Setup	9/23/02	3/21/03	$0	$17,761	$0	$17,761

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
6	ElecEngU	100%	960 h	0 w	9/23/02	3/21/03	$0	$0	$0	$0	0 h	0 h	0 h	960 h
48	MandS	17,761	17,761	0 w	9/23/02	3/21/03	$17,761	$0	$0	$17,761		0	0	17,761

Notes

WBS Definition--
Setup of infrastructure related to the test stands

M&S BOE--
Expenses for Moscow State electrical engineer to stay at Fermilab at $17761 based on previous trips and Fermilab charges. We assume $2500 per month costs for 6 months plus the overhead costs of 18.4%.

Labor BOE--
See M&S costs. Setup time is based on Run2a teststand setup. The teststands were similar in complexity to those used here.

1.1.2.14.2	**SASEQ Stand R&D by Fermilab**	**4/26/02**	**6/18/03**	**$97,000**	**$0**	**$70,560**	**$167,560**

Notes

WBS Definition-
Summary task that describes the procurement, assembly and testing of all new stand alone sequencers

1.1.2.14.2.1	Procure parts for SASEQs	4/26/02	1/21/03	$10,000	$0	$11,232	$21,232

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
13	ElecTechF	20%	288 h	0 w	4/26/02	1/21/03	$11,232	$0	$6,053	$5,179	0 h	0 h	155.2 h	132.8 h
18	PhysicistU	10%	144 h	0 w	4/26/02	1/21/03	$0	$0	$0	$0	0 h	0 h	77.6 h	66.4 h
48	MandS	10,000	10,000	0 w	4/26/02	1/21/03	$10,000	$0	$10,000	$0		0	5,388.89	4,611.11

Notes

WBS Definition--
Procurement of Stand-Alone Sequencers and parts for the hybrid and module testing test stands.

M&S BOE--
Stand Alone Sequencer-D 6Ux160x0.093 Vme SVX Readout Controller Module: 11 prototypes at $906.15 each This order is split with MRI parallel task.

Labor BOE-- ElecTechF at 20%: work on the bid process, evaluate potential vendors, place the order. Assumed to take 7 weeks, 20% of task duration. physicist at 10%: verify the final board schematics, oversee the bit process, manage the funding. Assumed to take 3 weeks, 10% of task duration.

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
1.1.2.14.2.2	Assemble and test SASEQs	1/22/03	3/18/03	$0	$0	$29,920	$29,920

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
4	ElecEngF	50%	160 h	0 w	1/22/03	3/18/03	$8,800	$0	$0	$8,800	0 h	0 h	0 h	160 h
12	ElecTechSF	200%	640 h	0 w	1/22/03	3/18/03	$21,120	$0	$0	$21,120	0 h	0 h	0 h	640 h

Notes

WBS Definition--
Reprogramming of Stand-Alone Sequencers for the hybrid and module testing test stands.

M&S BOE-
no costs associated with this item

Labor BOE--
There are 59 new Stand-Alone Sequencers purchased for Run2b. These new boards will be assembled and tested by a vendor. When they are received they are subjected to additional testing and programming.
The following labor is estimated for this work:
- two electrical technicians for the duration for official inspection, looking for shorts and opens, misplaced components, bad soldering, etc. and repair when necessary.
- An electrical engineer to program the boards and assist in the debugging of the boards, at 50%

1.1.2.14.2.3	Refurbish Run 2a SASEQs	5/21/03	6/18/03	$0	$0	$9,680	$9,680

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
4	ElecEngF	50%	80 h	0 w	5/21/03	6/18/03	$4,400	$0	$0	$4,400	0 h	0 h	0 h	80 h
12	ElecTechSF	100%	160 h	0 w	5/21/03	6/18/03	$5,280	$0	$0	$5,280	0 h	0 h	0 h	160 h
18	PhysicistU	10%	16 h	0 w	5/21/03	6/18/03	$0	$0	$0	$0	0 h	0 h	0 h	16 h

Notes

WBS Definition--
Reprogramming of Stand-Alone Sequencers for the hybrid and module testing test stands.

M&S BOE-
no costs associated with this item

Labor BOE--
There are 50 Stand-Alone Sequencers from Run2a that will be re-utilized for Run2b. These boards will have to be adapted to work with the new SVX4 chip. The work consists mainly of reprogramming the FPGA's and is expected to take 4 weeks.
The manpower needed is:
-One electrical technician for the duration to repair damaged boards
-An electrical engineer to reprograms the boards, at 50%
-10% of the time of a physicist from a University to test the functionality of the boards

1.1.2.14.2.4	Procure bit3	9/23/02	12/17/02	$24,500	$0	$1,872	$26,372

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
13	ElecTechF	10%	48 h	0 w	9/23/02	12/17/02	$1,872	$0	$0	$1,872	0 h	0 h	0 h	48 h
18	PhysicistU	10%	48 h	0 w	9/23/02	12/17/02	$0	$0	$0	$0	0 h	0 h	0 h	48 h
48	MandS	24,500	24,500	0 w	9/23/02	12/17/02	$24,500	$0	$0	$24,500		0	0	24,500

Notes

WBS Definition-
Procurement of the VME Bit3 interface cards for all SASEQ teststands

M&S BOE-
7 bit 3 boards at $3,500 each. QUOTE IN BOOK FOR $3,407, BUT WE MIGHT NEED A LONGER CABLE.
Total $24,500

Labor BOE-
Electrical Technician and Physicist oversee the purchases at the 10% level.

1.1.2.14.2.5	Procure low voltage power supplies	10/1/02	1/3/03	$22,500	$0	$1,872	$24,372

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
13	ElecTechF	10%	48 h	0 w	10/1/02	1/3/03	$1,872	$0	$0	$1,872	0 h	0 h	0 h	48 h
18	PhysicistU	10%	48 h	0 w	10/1/02	1/3/03	$0	$0	$0	$0	0 h	0 h	0 h	48 h
48	MandS	22,500	22,500	0 w	10/1/02	1/3/03	$22,500	$0	$0	$22,500		0	0	22,500

Notes

WBS Definition-

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost

"Procure low voltage power supplies" continued

Notes

Procurement and testing of all low voltage power supplies used in SASEQ teststands

M&S BOE-
Assume 15 low voltage supplies purchased for Fermilab teststands at $1500 per supply. Market costs.

Labor BOE-
Electrical Technician and Physicist oversee the purchase at the 10% level

1.1.2.14.2.6	Infrastructure Setup	9/23/02	3/21/03	$40,000	$0	$6,528	$46,528

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
9	MechTechSF	20%	192 h	0 w	9/23/02	3/21/03	$6,528	$0	$0	$6,528	0 h	0 h	0 h	192 h
44	PostDoc	50%	480 h	0 w	9/23/02	3/21/03	$0	$0	$0	$0	0 h	0 h	0 h	480 h
48	MandS	40,000	40,000	0 w	9/23/02	3/21/03	$40,000	$0	$0	$40,000		0	0	40,000

Notes

WBS Definition--
Setup of infrastructure related to the test stands

M&S BOE--
Three chillers at $10,000 each
Materials at $10,000
Total $40,000

Labor BOE--
One physicist for the duration anticipated. There are 2 hybrid burn-in test stands equipped with 8 Stand-Alone Sequencers each and 2 module burn-in stations, equipped with 16 Stand-Alone Sequencers each. It is expected that the setup will take approximately one week per Stand-Alone Sequencer. MechTechSF at 20%; obtain IP addresses and set the PCs up as part of the cluster when they are delivered.

1.1.2.14.2.7	Attach connectors for digital jumper cables	3/10/03	3/21/03	$0	$0	$3,120	$3,120

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
13	ElecTechF	100%	80 h	0 w	3/10/03	3/21/03	$3,120	$0	$0	$3,120	0 h	0 h	0 h	80 h

Notes

WBS Definition-
Attaching AVX connectors to bare digital jumper cables for teststands.

M&S BOE-
no costs associated with this item

Labor BOE-
Assumes 230 cables at 4 cables an hour of an electrical tech. This was time spent for placing connectors on 30 prototype cables. A total of 57.5 hours. An additional 3 days is assumed for repair and rework.

1.1.2.14.2.8	Assemble test stands and verify operation	11/14/02	5/14/03	$0	$0	$6,336	$6,336

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
12	ElecTechSF	20%	192 h	0 w	11/14/02	5/14/03	$6,336	$0	$0	$6,336	0 h	0 h	0 h	192 h
44	PostDoc	100%	960 h	0 w	11/14/02	5/14/03	$0	$0	$0	$0	0 h	0 h	0 h	960 h

Notes

WBS Definition--
Assembly of 10 Fermilab-based SASEQ test stands (4 burn-in stands and 6 two-channel stands) and verification of operation using hybrids to read out.

M&S BOE--
No costs associated with this item

Labor BOE--
One physicist for the duration anticipated. There are 2 hybrid burn-in test stations equipped with 8 Stand-Alone Sequencers each and 2 module burn-in stations, equipped with 16 Stand-Alone Sequencers each. It is expected that the setup will take 4 weeks each for the burn-in stations and 1 week for the 2 channel teststands for a total of 4x 4weeks + 6x1 week=22 wks. There are two weeks added to the task duration for repairs and rework. An electrical technician is assigned at the 20% level to help in adjusting the settings on the stands.

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
1.1.2.14.3	**Digital Jumper Cables for Test Stations (KSU)**	**7/12/02**	**4/4/03**	**$112,431**	**$0**	**$0**	**$112,431**

Notes

WBS Definition-
Summary task that includes the design, production and testing of the digital jumper cables needed for the teststations done at KSU.

1.1.2.14.3.1	Design cables for test stations	7/12/02	9/6/02	$0	$0	$0	$0

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
18	PhysicistU	5%	16 h	0 w	7/12/02	9/6/02	$0	$0	$0	$0	0 h	0 h	16 h	0 h

Notes

WBS Definition-
Design and layout of the digital jumper cables needed for teststands. These are assumed to be similar cables to those used for the L2-L5 cables.

M&S BOE-
There are no costs associated with this item. The cables are assumed to be identical to 50cm prototypes already constructed.

Labor BOE-
The physicist labor for the layout is mostly in the design task for the L2-L5 digital jumper cables. A small amount of time is assumed to verify the design in terms of the test station needs.

1.1.2.14.3.2	Prepare cables for test stations	10/7/02	3/7/03	$111,831	$0	$0	$111,831

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
18	PhysicistU	10%	80 h	0 w	10/7/02	3/7/03	$0	$0	$0	$0	0 h	0 h	0 h	80 h
48	MandS	111,831	111,831	0 w	10/7/02	3/7/03	$111,831	$0	$0	$111,831		0	0	111,831

Notes

WBS Definition-
Production of Digital jumper cables for teststations. A total of 300 cables are needed with 15% spares for a total of 345 cables. This includes fabricating the bare flex, ablation (cleaning off the connection pads), and attaching connectors.

M&S BOE-
Material, Rogers Kapton
1 oz copper, 200' at $7.00/ft = $1,400 (Rogers Corp phone quote Jan. 02)
Fab bare flex $293 x 345 = $101,085 (Nonbinding quote from Honeywell, 1 Aug 02)
Ablation, batches of approx 56 $300 x 7 + $16.5 x 345 = 7,793
AVX connectors, $4.50 x 345 = 1,553
Total $111,831

Labor BOE-
Physicist time of 2 weeks assumed to keep in contact with vendor.

1.1.2.14.3.3	Test cables for test stations	3/24/03	4/4/03	$600	$0	$0	$600

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
18	PhysicistU	100%	80 h	0 w	3/24/03	4/4/03	$0	$0	$0	$0	0 h	0 h	0 h	80 h
48	MandS	600	600	0 w	3/24/03	4/4/03	$600	$0	$0	$600		0	0	600

Notes

WBS Definition-
Procedures established at KSU and LaTech for verification of specifications as well as testing a fraction of the cables at KSU.

M&S BOE-
$600 dollars for physicist from KSU to travel to La Tech for a couple of day trip.

Labor BOE-
A physicist spends 1 week verifying the test procedures and testing some cables and contacts; La Tech for 1 trip for a total of 2 weeks time.

1.1.2.14.4	**Purple Card (KSU)**	**2/4/02**	**3/19/03**	**$53,512**	**$36,493**	**$0**	**$90,005**

Notes

WBS Definition-
Summary task that describes the design, procurement, and testing of cards to be used to process signals and power to the SVX4 chip in the SASEQ test stands. These tasks are to be done by KSU.

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
1.1.2.14.4.1	Design prototype purple card	2/4/02	5/10/02	$0	$22,163	$0	$22,163

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
6	ElecEngU	50%	280 h	0 w	2/4/02	5/10/02	$0	$0	$0	$0	0 h	0 h	280 h	0 h
15	ElecTechU	75%	420 h	0 w	2/4/02	5/10/02	$0	$0	$0	$0	0 h	0 h	420 h	0 h
18	PhysicistU	10%	112 h	0 w	2/4/02	5/10/02	$0	$0	$0	$0	0 h	0 h	112 h	0 h
48	MandS	22,163	22,163	0 w	2/4/02	5/10/02	$22,163	$0	$22,163	$0		0	22,163	0

Notes

WBS Definition-
Design and layout of prototype purple card. The purple card is the interface card used in the SASEQs. Via cables it connects the Sequencer to the hybrid. There are two hybrids read out with every purple card. The card provides the voltage regulation for the SVX4 chips.

M&S BOE-
Estimates from the KSU Engineering Design Lab, but based on actual costs through 6/7/02
Electrical Engineer for 260 hours at $60/hour
Electrical Tech at 171.5 hours @ $15/hour (subsidized)
Elec. Eng. Student 200 hours at $20/hour
Total: $22163

Labor BOE-
See M&S costs. These are based on actual time spent. A physicist used 50 hours for this task. KSU estimate

1.1.2.14.4.2	Produce prototype purple card	5/13/02	7/16/02	$8,766	$0	$0	$8,766

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
18	PhysicistU	7%	25.2 h	0 w	5/13/02	7/16/02	$0	$0	$0	$0	0 h	0 h	25.2 h	0 h
48	MandS	8,766	8,766	0 w	5/13/02	7/16/02	$8,766	$0	$8,766	$0		0	8,766	0

Notes

WBS Definition-
Procurement including stuffing of prototype purple cards used for SASEQ teststands

M&S BOE-
12 cards produced, 6 assembled
Based on KSU actual spent: $8766

Labor BOE-
Vendor contact at a few days for Physicist.

1.1.2.14.4.3	Test prototype purple card by KSU	5/28/02	7/29/02	$0	$240	$0	$240

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
15	ElecTechU	3%	10.57 h	0 w	5/28/02	7/29/02	$0	$0	$0	$0	0 h	0 h	10.57 h	0 h
48	MandS	240	240	0 w	5/28/02	7/29/02	$240	$0	$240	$0		0	240	0

Notes

WBS Definition-
Testing of prototype cards at KSU. Verification of electrical functionality, but does not include testing with SVX4 chips.

M&S BOE-
$240 based on actual spent at KSU 12 hours by a electronics tech at $20/hour

Labor BOE-
See M&S costs for electrical tech time. 2 hours/board.

1.1.2.14.4.4	Design and layout of 2nd prototype purple card	6/11/02	9/18/02	$0	$3,600	$0	$3,600

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
6	ElecEngU	4%	22.4 h	0 w	6/11/02	9/18/02	$0	$0	$0	$0	0 h	0 h	21.12 h	1.28 h
15	ElecTechU	8%	44.8 h	0 w	6/11/02	9/18/02	$0	$0	$0	$0	0 h	0 h	42.23 h	2.57 h
18	PhysicistU	3%	16.8 h	0 w	6/11/02	9/18/02	$0	$0	$0	$0	0 h	0 h	15.83 h	0.97 h
48	MandS	3,600	3,600	0 w	6/11/02	9/18/02	$3,600	$0	$3,600	$0		0	3,348.57	251.43

Notes

WBS Definition-
Design and layout of second prototype purple card. The purple card is the interface card used in the SASEQs. Via cables it connects the Sequencer to the hybrid. There are two hybrids read out with every purple card. The card provides the voltage regulation for the SVX4 chips.

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
"Design and layout of 2nd prototype purple card" continued							

Notes

M&S BOE-
Estimates from the KSU Engineering Design Lab
Electrical Engineer for 40 hours at $60/hour
Electrical Tech at 40 hours @ $30/hour
Total: $3600

Labor BOE-
See M&S costs. A physicist used 16 hours for this task. KSU time spent.

1.1.2.14.4.5	Produce 2nd prototype purple card	9/19/02	10/23/02	$6,658	$0	$0	$6,658

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
18	PhysicistU	10%	20 h	0 w	9/19/02	10/23/02	$0	$0	$0	$0	0 h	0 h	0 h	20 h
48	MandS	6,658	6,658	0 w	9/19/02	10/23/02	$6,658	$0	$0	$6,658		0	0	6,658

Notes

WBS Definition-
Procurement including stuffing of second prototype purple cards used for SASEQ teststands

M&S BOE-
12 cards produced.
Based on KSU estimate: $6658
Recycle leftover parts from 1st prototype.

Labor BOE-
Vendor contact at a few days for Physicist.

1.1.2.14.4.6	Test 2nd prototype purple card by KSU	10/17/02	11/13/02	$0	$960	$0	$960

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
15	ElecTechU	15%	24 h	0 w	10/17/02	11/13/02	$0	$0	$0	$0	0 h	0 h	0 h	24 h
48	MandS	960	960	0 w	10/17/02	11/13/02	$960	$0	$0	$960		0	0	960

Notes

WBS Definition-
Testing of prototype cards at KSU. Verification of electrical functions. Does not use SVX4 chip.

M&S BOE-
$960 based on actual spent at KSU 48 hours by a electronics tech at $20/hour

Labor BOE-
See M&S costs for electrical tech time. 2 hours/board based on first prototype board test.

1.1.2.14.4.7	Develop final specification of purple card	10/24/02	11/27/02	$0	$3,600	$0	$3,600

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
6	ElecEngU	31%	62 h	0 w	10/24/02	11/27/02	$0	$0	$0	$0	0 h	0 h	0 h	62 h
18	PhysicistU	25%	50 h	0 w	10/24/02	11/27/02	$0	$0	$0	$0	0 h	0 h	0 h	50 h
48	MandS	3,600	3,600	0 w	10/24/02	11/27/02	$3,600	$0	$0	$3,600		0	0	3,600

Notes

WBS Definition-
Design and layout of final cards with verification of SVX4 chip functionality using prototype chips. includes readines review prior to procurement.

M&S BOE-
Based on KSU estimate of EDL time:
Electrical Engineer: layout and design modifications 60 hours at $60/hour = $3600

Labor BOE-
See M&S costs above. Also assumes Physicist oversight for communications with Run2b group at 25% (1 week)

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
1.1.2.14.4.8	Procure purple cards	12/2/02	2/19/03	$37,488	$800	$0	$38,288

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
15	ElecTechU	8%	32 h	0 w	12/2/02	2/19/03	$0	$0	$0	$0	0 h	0 h	0 h	32 h
18	PhysicistU	5%	20 h	0 w	12/2/02	2/19/03	$0	$0	$0	$0	0 h	0 h	0 h	20 h
48	MandS	38,288	38,288	0 w	12/2/02	2/19/03	$38,288	$0	$0	$38,288		0	0	38,288

Notes

WBS Definition-
Procurement including stuffing of final purple cards for a total of 75 cards which includes spares.

M&S BOE-
Based on KSU estimates which is based on prototype work.
Order and track parts: ElecTech 40 hours @$20/hour =$800
parts for 75 boards at $318/board = $23850
fabrication: setup of $750 with 75 boards at $57/board $4258 (quote Q76-00 rev A Network Electronics)
Assembly: setup of $750 and per board cost of $102 (tape and reel) (quote Q76-00rev A Network Electronics)
Shipping and insurance: $250
Total: $38288

Labor BOE-
See M&S cost above for Elec Tech. In addition, a physicist is listed at the 5% level to communicate with vendors.

1.1.2.14.4.9	Test cards	2/20/03	3/19/03	$600	$5,130	$0	$5,730

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
6	ElecEngU	25%	40 h	0 w	2/20/03	3/19/03	$0	$0	$0	$0	0 h	0 h	0 h	40 h
15	ElecTechU	80%	128 h	0 w	2/20/03	3/19/03	$0	$0	$0	$0	0 h	0 h	0 h	128 h
18	PhysicistU	40%	64 h	0 w	2/20/03	3/19/03	$0	$0	$0	$0	0 h	0 h	0 h	64 h
48	MandS	5,730	5,730	0 w	2/20/03	3/19/03	$5,730	$0	$0	$5,730		0	0	5,730

Notes

WBS Definition-
Testing of prototype cards at KSU. Verification of electrical functions. Testing with SVX4 hybrids on SASEQ teststand.

M&S BOE-
Test setup and training: 40 hours of ElecEng at $60/hour = $2400
Test fixtures: $600 for breakout cards based on prototype actual cost
Assume 1.5 hours for each of 75 cards by
112.5 hours at $20/hour by ElecTech
Repair: Assume 10%, need 16hours at $30/hour for Senior Elec Tech = $480.
Total $5730

Labor BOE-
See M&S costs. A physicist spends 64 hours supervising the operation based on Run2a experience in setting up the teststands for interface card testing.

1.1.2.15	**Silicon SASEQ Test Stands Ready**	**6/18/03**	**6/18/03**	**$0**	**$0**	**$0**	**$0**

Notes

WBS Definition-
Milestone: All of the Fermilab SASEQ teststands including burn-in stations are ready for production testing.

1.1.2.16	**Interface Boards and Backplanes**	**11/18/02**	**10/27/04**	**$85,951**	**$41,185**	**$0**	**$127,136**

Notes

WBS Definition-
Summary task that describes all rework to existing interface boards and the power distribution system as well as the procurement and testing of new interface boards. This task also includes design, production, and testing of J1 backplanes done by KSU.

M&S BOE-
The costs are based on the KSU estimate. As the design can be changed substantially, we've assigned 100% contingency to all items except the testing items where we've assigned 50% contingency per the guidelines.

1.1.2.16.1	Develop specifications for re-worked boards	2/2/04	3/12/04	$0	$10,400	$0	$10,400

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
6	ElecEngU	67%	160.8 h	0 w	2/2/04	3/12/04	$0	$0	$0	$0	0 h	0 h	0 h	160.8 h

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost

"Develop specifications for re-worked boards" continued

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
18	PhysicistU	50%	120 h	0 w	2/2/04	3/12/04	$0	$0	$0	$0	0 h	0 h	0 h	120 h
48	MandS	10,400	10,400	0 w	2/2/04	3/12/04	$10,400	$0	$0	$10,400		0	0	10,400

Notes

WBS Definition-
Obtain new design for the power supply distribution system and figure out design changes to existing Run2a interface boards.

M&S BOE-
Based on KSU estimates
Electrical Engineer 160 hours at $65/hour = $10,400 (10% of parts must be replaced) Estimate is 10% of the original design effort

Labor BOE-
See M&S for engineering time. Physicist is needed for communication with group and engineering staff at 50% level.

1.1.2.16.2	Rework existing boards	3/15/04	6/7/04	$6,880	$3,920	$0	$10,800

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
15	ElecTechU	23%	110.4 h	0 w	3/15/04	6/7/04	$0	$0	$0	$0	0 h	0 h	0 h	110.4 h
48	MandS	10,800	10,800	0 w	3/15/04	6/7/04	$10,800	$0	$0	$10,800		0	0	10,800

Notes

WBS Definition-
Use existing spare Run2a interface boards, procure parts, and reassemble the boards

M&S BOE-
Buy parts for all existing 162 Run2a interface boards
Parts procurement: 40 hours at $35/hour = $1400 of Elec Tech
Cost of parts based on guess of 5% of original parts cost makes $40/board = $6480
Insert new parts: 4 hours/board of ElecTech $35/hour for 18 cards (spares not being used in experiment). The rest of the card parts are replaced during installation and commissioning.
= $2520
Shipping and Insurance $400
Total: $10800

Labor BOE-
See M&S cost above

1.1.2.16.3	Test reworked boards	6/8/04	7/6/04	$1,200	$6,260	$0	$7,460

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
6	ElecEngU	45%	72 h	0 w	6/8/04	7/6/04	$0	$0	$0	$0	0 h	0 h	0 h	72 h
15	ElecTechU	48%	76.8 h	0 w	6/8/04	7/6/04	$0	$0	$0	$0	0 h	0 h	0 h	76.8 h
48	MandS	7,460	7,460	0 w	6/8/04	7/6/04	$7,460	$0	$0	$7,460		0	0	7,460

Notes

WBS Definition-
Test reworked Run2a Interface boards using a SASEQ teststand with the SVX4 chip.

M&S BOE-
Based on KSU estimate from Run2a interface board testing
Teststand setup and training: 60 hours of Elec Eng at $65/hour = $3900
Testing: 4 hours/board = 72 hours of ELec Tech at $20/hour = $1440
Test fixtures: $1200
ElecEng oversight and debugging 12 hours at $65/hour = $780
Repairs: 2 hours each for 2 boards a total of 4 hours at Elec Tech $35/hour
Total: $7460

Labor BOE-
See M&S costs.

1.1.2.16.4	Procure new boards	7/7/04	9/29/04	$40,396	$6,500	$0	$46,896

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
6	ElecEngU	21%	100.8 h	0 w	7/7/04	9/29/04	$0	$0	$0	$0	0 h	0 h	0 h	100.8 h
18	PhysicistU	5%	24 h	0 w	7/7/04	9/29/04	$0	$0	$0	$0	0 h	0 h	0 h	24 h

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
"Procure new boards" continued							

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
48	MandS	46,896	46,896	0 w	7/7/04	9/29/04	$46,896	$0	$0	$46,896		0	0	46,896

Notes

WBS Definition-
Procure and stuff new IB boards needed. 10 layer, 9U by 280mm board. Handles 8 hybrids/board.

M&S BOE-
Make 12 boards.
KSU estimate based Run2a interface board costs.
EE: oversight, layout, parts procurement, bidding 100 hours at $65/hour = $6500
parts: $971/board *12 boards = $11,661
fab and assembly: (add 10% for inflation) $28,435 (Manutech quote 10/99 Run2a prototypes)
shipping and insurance $300
Total $46896

Labor BOE-
See M&S for engineer. Physicist at 5% to oversee the process and communication with Run2b project.

1.1.2.16.5	Test new boards	9/30/04	10/27/04	$0	$4,200	$0	$4,200

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
15	ElecTechU	75%	120 h	0 w	9/30/04	10/27/04	$0	$0	$0	$0	0 h	0 h	0 h	120 h
18	PhysicistU	25%	40 h	0 w	9/30/04	10/27/04	$0	$0	$0	$0	0 h	0 h	0 h	40 h
48	MandS	4,200	4,200	0 w	9/30/04	10/27/04	$4,200	$0	$0	$4,200		0	0	4,200

Notes

WBS Definition-
Test new Interface boards using a SASEQ teststand with the SVX4 chip.

M&S BOE-
Based on KSU estimate from Run2a interface board testing
Testing: 8 hours/board = 96 hours of ELec Tech at $35/hour = $3360
Repairs: Assume 50% need repair 4 hours each =24 hours at Elec Tech $35/hour = $840
Total: $4200

Labor BOE-
See M&S costs. Physicist oversight at 25%.

1.1.2.16.6	**Silicon Interface Boards Ready**	**10/27/04**	**10/27/04**	**$0**	**$0**	**$0**	**$0**

Notes

WBS Definition-
Milestone: additional boards and spare reworked Run2a interface boards are ready for use in Run2b.

1.1.2.16.7	Design backplane preproduction	11/18/02	3/7/03	$0	$5,400	$0	$5,400

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
6	ElecEngU	9%	50.4 h	0 w	11/18/02	3/7/03	$0	$0	$0	$0	0 h	0 h	0 h	50.4 h
15	ElecTechU	14%	78.4 h	0 w	11/18/02	3/7/03	$0	$0	$0	$0	0 h	0 h	0 h	78.4 h
18	PhysicistU	10%	56 h	0 w	11/18/02	3/7/03	$0	$0	$0	$0	0 h	0 h	0 h	56 h
48	MandS	5,400	5,400	0 w	11/18/02	3/7/03	$5,400	$0	$0	$5,400		0	0	5,400

Notes

WBS Definition-
Design the J1 backplane on the interface board crate. This is 3Ux20inches multilayer passive PCB.

M&S BOE-
Based on KSU estimates for Run2a backplane actual cost.
Electrical Engineer 50 hours at $60/hour = $3000
ElecTech 80 hours at $30/hour = $2400
Total $5400

Labor BOE-
See M&S for engineering time. Physicist is needed for communication with group and engineering staff at the 10% level.

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
1.1.2.16.8	Procure and testing backplane preproduction	3/10/03	5/2/03	$5,300	$160	$0	$5,460

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
15	ElecTechU	3%	9.6 h	0 w	3/10/03	5/2/03	$0	$0	$0	$0	0 h	0 h	0 h	9.6 h
18	PhysicistU	5%	16 h	0 w	3/10/03	5/2/03	$0	$0	$0	$0	0 h	0 h	0 h	16 h
48	MandS	5,460	5,460	0 w	3/10/03	5/2/03	$5,460	$0	$0	$5,460		0	0	5,460

Notes

WBS Definition-
Procure and stuff preproduction backplanes.

M&S BOE-
Make 2 backplane preproduction
KSU estimate based Run2a backplane costs.
parts: $250/board *2 boards = $500
fab and assembly: (add 10% for inflation) $2400/board = $4800
Test backplanes 4 hours each with ElecTech at $20/hour = $160
Total $5460

Labor BOE-
See M&S for technician. Physicist at 5% to oversee the process and communication with Run2b project.

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
1.1.2.16.9	Develop final specifications on backplanes	8/13/03	10/8/03	$0	$3,025	$0	$3,025

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
6	ElecEngU	8%	25.6 h	0 w	8/13/03	10/8/03	$0	$0	$0	$0	0 h	0 h	0 h	25.6 h
15	ElecTechU	13%	41.6 h	0 w	8/13/03	10/8/03	$0	$0	$0	$0	0 h	0 h	0 h	41.6 h
48	MandS	3,025	3,025	0 w	8/13/03	10/8/03	$3,025	$0	$0	$3,025		0	0	3,025

Notes

WBS Definition-
Design the J1 backplane on the interface board crate and verify the final specifications.

M&S BOE-
Based on KSU estimates for Run2a backplane actual cost.
Electrical Engineer 25 hours at $65/hour = $1625 (50% of prototype effort assumed in redesign)
ElecTech 40 hours at $35/hour = $1400
Total $3025

Labor BOE-
See M&S for engineering time.

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
1.1.2.16.10	Bid backplanes	10/9/03	11/19/03	$0	$0	$0	$0

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
18	PhysicistU	7%	16.8 h	0 w	10/9/03	11/19/03	$0	$0	$0	$0	0 h	0 h	0 h	16.8 h

Notes

WBS Definition-
Vendor contact and pricing for the backplane production run

M&S BOE-
no costs associated with this item

Labor BOE-
Physicist time to communicate with procurement for 16 hours total from previous Run2a experience.

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
1.1.2.16.11	Produce backplanes	11/20/03	1/28/04	$32,175	$0	$0	$32,175

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
48	MandS	32,175	32,175	0 w	11/20/03	1/28/04	$32,175	$0	$0	$32,175		0	0	32,175

Notes

WBS Definition-
Procure and stuff production J1 backplanes.

M&S BOE-

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost

"Produce backplanes" continued

Notes

Make 11 backplanes. 8 are needed for the experiment, 2 for teststands and 1 spare
KSU estimate based Run2a backplane costs.
parts: $500/board *11 boards = $5500
fab and assembly: (add 10% for inflation) $2400/board = $26400
Shipping and insurance $275
Total $32,175

Labor BOE-
None needed, covered in other tasks.

1.1.2.16.12	Test backplanes	1/29/04	2/18/04	$0	$1,320	$0	$1,320

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
48	MandS	1,320	1,320	0 w	1/29/04	2/18/04	$1,320	$0	$0	$1,320		0	0	1,320

Notes

WBS Definition-
Test new J1 backplanes with power supplies, HV supplies and pulsers. Measurement of ohmic resistance of all contacts.

M&S BOE-
Based on KSU estimate from Run2a backplane testing
Testing: 6 hours/board = 66 hours of Elec Tech at $20/hour = $1320

Labor BOE-
See M&S costs.

1.1.2.16.13	**All Silicon Interface Crate Backplanes Produced A**	**2/18/04**	**2/18/04**	**$0**	**$0**	**$0**	**$0**

Notes

WBS Definition-
Milestone: All J1 backplanes produced and tested.

1.1.2.17	**Low Voltage System**	**10/21/02**	**12/1/04**	**$110,440**	**$0**	**$223,568**	**$334,008**

Notes

WBS Definition-
The Low Voltage Power Supply system includes the power for the Interface Boards, Adapter Cards, and SVX4 chips. The current Run2a LV supply system needs revision for the SVX4 voltage requirement and the addition of the adapter card voltage requirements. The supplies are also being made assessible during short accesses.

M&S BOE-
The costs are estimated on each line where they apply. However, a detailed design does not exist so a 100% contingency factor is applied.

1.1.2.17.1	Design system	10/21/02	2/21/03	$0	$0	$33,440	$33,440

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
4	ElecEngF	75%	480 h	0 w	10/21/02	2/21/03	$26,400	$0	$0	$26,400	0 h	0 h	0 h	480 h
17	PhysicistF	25%	160 h	0 w	10/21/02	2/21/03	$0	$0	$0	$0	0 h	0 h	0 h	160 h
21	DesignerF	25%	160 h	0 w	10/21/02	2/21/03	$7,040	$0	$0	$7,040	0 h	0 h	0 h	160 h

Notes

WBS Definition-
This includes the design of power supplies required for the Interface Board, Adapter Card, and SVX4 readout chip.

M&S BOE-
no costs associated with this item

Labor BOE-
A 3/4 time electrical engineer in conjunction with physicist (at the 25% level) to design the system based on Run2a experience. A designer is needed for approximately 4 weeks to produce about 8 drawings of the hardware configuration in the cathedral.

1.1.2.17.2	Procure preproduction power supplies	2/24/03	5/16/03	$15,440	$0	$9,024	$24,464

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
4	ElecEngF	20%	96 h	0 w	2/24/03	5/16/03	$5,280	$0	$0	$5,280	0 h	0 h	0 h	96 h

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
"Procure preproduction power supplies" continued							

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
13	ElecTechF	20%	96 h	0 w	2/24/03	5/16/03	$3,744	$0	$0	$3,744	0 h	0 h	0 h	96 h
48	MandS	15,440	15,440	0 w	2/24/03	5/16/03	$15,440	$0	$0	$15,440		0	0	15,440

Notes

WBS Definition-
Writing requisitions and obtaining quotes for a preproduction power supply system

M&S BOE-
The system requires 2 low voltage power supply units and 2 adapter card power supply units at $3507 each for a total of $15440. See quote.

Labor BOE-
ElecEng provides the BOM to the ElecTech based on the design (2 weeks) The electrical tech generates, and submits the requisitions to the purchasing system with vendor selection.

1.1.2.17.3	Assemble preproduction power supplies	5/19/03	6/16/03	$0	$0	$6,240	$6,240

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
13	ElecTechF	100%	160 h	0 w	5/19/03	6/16/03	$6,240	$0	$0	$6,240	0 h	0 h	0 h	160 h

Notes

WBS Definition-
Assemble the preproduction system (1/8 of the final system)

M&S BOE-
no costs associated with this item.

Labor BOE-
An electrical tech builds the system full time. 4 weeks time is derived from Run2a experience in building supplies.

1.1.2.17.4	Refurbish LV PS test stand	2/24/03	3/21/03	$5,000	$0	$10,640	$15,640

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
4	ElecEngF	50%	80 h	0 w	2/24/03	3/21/03	$4,400	$0	$0	$4,400	0 h	0 h	0 h	80 h
13	ElecTechF	100%	160 h	0 w	2/24/03	3/21/03	$6,240	$0	$0	$6,240	0 h	0 h	0 h	160 h
48	MandS	5,000	5,000	0 w	2/24/03	3/21/03	$5,000	$0	$0	$5,000		0	0	5,000

Notes

WBS Definition-
The Low Voltage Power supply test stand

M&S BOE-
$5000 is alotted for LV supplies to refurbish current test stand.

Labor BOE-
ElecEng designs the new stand (2 weeks time) while the Electrical tech builds the stand and procures the materials (full time).

1.1.2.17.5	Test preproduction power supplies	6/17/03	8/12/03	$0	$0	$15,040	$15,040

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
4	ElecEngF	50%	160 h	0 w	6/17/03	8/12/03	$8,800	$0	$0	$8,800	0 h	0 h	0 h	160 h
13	ElecTechF	50%	160 h	0 w	6/17/03	8/12/03	$6,240	$0	$0	$6,240	0 h	0 h	0 h	160 h

Notes

WBS Definition-
Test conducted to ensure the designed system meets all technical and safety requirements.

M&S BOE-
no costs associated with this item.

Labor BOE-
ElecEng develops the criteria for proper operation by generating testing procedures (4 weeks).
Electrical Tech assists the electrical eng. by conducting tests and recording measurements based on the test procedures. (4 weeks)

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
1.1.2.17.6	Develop final specifications	8/13/03	10/8/03	$0	$0	$12,320	$12,320

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
4	ElecEngF	50%	160 h	0 w	8/13/03	10/8/03	$8,800	$0	$0	$8,800	0 h	0 h	0 h	160 h
17	PhysicistF	50%	160 h	0 w	8/13/03	10/8/03	$0	$0	$0	$0	0 h	0 h	0 h	160 h
21	DesignerF	25%	80 h	0 w	8/13/03	10/8/03	$3,520	$0	$0	$3,520	0 h	0 h	0 h	80 h

Notes

WBS Definition-
Based on preproduction test results, final specifications for production of the low voltage power supply system will be determined.

M&S BOE-
no costs associated with this item.

Labor BOE-
ElecEng: Updates design to meet any criterion not met by preproduction (4 weeks)
Physicist: Confirms that all paramters of the system comply with required specifications (4 weeks)
Designer: Updates the drawings (2 weeks).

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
1.1.2.17.7	Procure power supplies	10/9/03	3/10/04	$40,000	$0	$1,560	$41,560

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
13	ElecTechF	5%	40 h	0 w	10/9/03	3/10/04	$1,560	$0	$0	$1,560	0 h	0 h	0 h	40 h
48	MandS	40,000	40,000	0 w	10/9/03	3/10/04	$40,000	$0	$0	$40,000		0	0	40,000

Notes

WBS Definition-
Write purchase requisitions and obtain quotes for the production power supply units

M&S BOE-
There are 8 power supplies (+2 spares) required for the system. The cost of 10 supplies is $35,070 (based on quote). An additional $4930 has been allotted for possible design changes based on preproduction results.

Labor BOE-
An Electrical Tech generates and submits the requisitions into the purchasing system. Based on Run2a experience, this takes 1 week of his time.

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
1.1.2.17.8	Assemble power supplies	3/11/04	7/1/04	$0	$0	$27,200	$27,200

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
8	MechTechF	10%	64 h	0 w	3/11/04	7/1/04	$2,240	$0	$0	$2,240	0 h	0 h	0 h	64 h
13	ElecTechF	100%	640 h	0 w	3/11/04	7/1/04	$24,960	$0	$0	$24,960	0 h	0 h	0 h	640 h

Notes

WBS Definition-
Assemble power supplies with external control electronics and cooling

M&S BOE-
no costs associated with this item.

Labor BOE-
10 supplies are assembled.
Electronics tech required to assemble electronic control boards at the full time level for 16 weeks. This is based on Run2a assembly experience. A MechTech is required to assemble the cooling portion of the power supply assumed to take less than 1 day per supply.

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
1.1.2.17.9	Test power supplies	7/5/04	8/27/04	$0	$0	$15,040	$15,040

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
4	ElecEngF	50%	160 h	0 w	7/5/04	8/27/04	$8,800	$0	$0	$8,800	0 h	0 h	0 h	160 h
13	ElecTechF	50%	160 h	0 w	7/5/04	8/27/04	$6,240	$0	$0	$6,240	0 h	0 h	0 h	160 h

Notes

WBS Definition-
Testing the power supplies with the refurbished test fixture based on test procedures provided by Engineer.

M&S BOE-
no costs associated with this item.

Labor BOE-

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost

"Test power supplies" continued

Notes
ElecEng provides the test procedures assumed to take 4 weeks. The electrical tech can test 3 power supply assemblies per week.

1.1.2.17.10	Procure adapter card power supplies	10/9/03	3/10/04	$10,000	$0	$1,560	$11,560

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
13	ElecTechF	5%	40 h	0 w	10/9/03	3/10/04	$1,560	$0	$0	$1,560	0 h	0 h	0 h	40 h
48	MandS	10,000	10,000	0 w	10/9/03	3/10/04	$10,000	$0	$0	$10,000		0	0	10,000

Notes
WBS Definition-
Write Requisitions and obtain quotes for adapter card power supplies

M&S BOE-
There are 2 power supply units required for the system at a cost of $7720 total. See quote.
$2280 has been added to cover spare pods.

Labor BOE-
The electrical tech obtains quotes and submits the requisition assumed to take 1 week.

1.1.2.17.11	Assemble adapter card power supplies	3/11/04	5/5/04	$0	$0	$13,600	$13,600

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
8	MechTechF	10%	32 h	0 w	3/11/04	5/5/04	$1,120	$0	$0	$1,120	0 h	0 h	0 h	32 h
13	ElecTechF	100%	320 h	0 w	3/11/04	5/5/04	$12,480	$0	$0	$12,480	0 h	0 h	0 h	320 h

Notes
WBS Definition-
Assemble Adapter card power supplies with external control electronics.

M&S BOE-
no costs associated with this item.

Labor BOE-
Electronics tech required for the assembly of electronic control boards full time. A mechanical tech is required to assemble the cooling portion of the power supply. Each of the 2 power supply units takes 4 weeks to assemble.

1.1.2.17.12	Test adapter card power supplies	5/6/04	7/1/04	$0	$0	$15,040	$15,040

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
4	ElecEngF	50%	160 h	0 w	5/6/04	7/1/04	$8,800	$0	$0	$8,800	0 h	0 h	0 h	160 h
13	ElecTechF	50%	160 h	0 w	5/6/04	7/1/04	$6,240	$0	$0	$6,240	0 h	0 h	0 h	160 h

Notes
WBS Definition-
Testing conducted to ensure the designed system meets all technical and safety requirements.

M&S BOE-
no costs associated with this item.

Labor BOE-
ElecEng develops criteria for proper operation by generating testing procedures (assumed to take 4 weeks)
Electrical Tech carries out the tests and records measurements (4 weeks - 2 weeks per supply)

1.1.2.17.13	Procure fuse panel	10/9/03	3/10/04	$20,000	$0	$1,560	$21,560

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
13	ElecTechF	5%	40 h	0 w	10/9/03	3/10/04	$1,560	$0	$0	$1,560	0 h	0 h	0 h	40 h
48	MandS	20,000	20,000	0 w	10/9/03	3/10/04	$20,000	$0	$0	$20,000		0	0	20,000

Notes
WBS Definition-
Write Requisitions and obtain quotes for power supply system fuse panel

M&S BOE-
$20,000 is assigned based on Run2a experience. Eight panels at $2500 each. Approx 350 fuses and holders per panel.

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost

"Procure fuse panel" continued

Notes

Labor BOE-
An electrical tech is needed at the 5% level to obtain quotes and write the purchase requisition.

1.1.2.17.14	Assemble fuse panel	3/11/04	7/1/04	$0	$0	$30,560	$30,560

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
8	MechTechF	25%	160 h	0 w	3/11/04	7/1/04	$5,600	$0	$0	$5,600	0 h	0 h	0 h	160 h
13	ElecTechF	100%	640 h	0 w	3/11/04	7/1/04	$24,960	$0	$0	$24,960	0 h	0 h	0 h	640 h

Notes

WBS Definition-
Assemble the production fuse panel for the power supply system.

M&S BOE-
no costs associated with this item.

Labor BOE-
Electronics Technician is required full time to wire the panel based on Run2a experience with similar panel (hopefully not too similar). The Mechanical Tech needs 4 weeks to machine and construct the mounting hardware for the panel.

1.1.2.17.15	Test fuse panel	7/5/04	8/27/04	$0	$0	$15,040	$15,040

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
4	ElecEngF	50%	160 h	0 w	7/5/04	8/27/04	$8,800	$0	$0	$8,800	0 h	0 h	0 h	160 h
13	ElecTechF	50%	160 h	0 w	7/5/04	8/27/04	$6,240	$0	$0	$6,240	0 h	0 h	0 h	160 h

Notes

WBS Definition-
Tests conducted to ensure the fuse panel system meets all technical and safety requirements

M&S BOE-
no costs associated with this item.

Labor BOE-
Electrical Engineer develops criteria for proper operation by generating testing procedures (4 weeks). The electrical tech carries out the tests and records the measurements (4 weeks).

1.1.2.17.16	Procure LV cables	10/9/03	5/19/04	$20,000	$0	$1,404	$21,404

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
13	ElecTechF	3%	36 h	0 w	10/9/03	5/19/04	$1,404	$0	$0	$1,404	0 h	0 h	0 h	36 h
48	MandS	20,000	20,000	0 w	10/9/03	5/19/04	$20,000	$0	$0	$20,000		0	0	20,000

Notes

WBS Definition-
Procurement of all cables to run from power supplies to interface boards.

M&S BOE-
Guess based on Run2a experience

Labor BOE-
Assume 3% of an electrical tech is needed to interface with vendors.

1.1.2.17.17	Low-voltage system test	8/30/04	12/1/04	$0	$0	$14,300	$14,300

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
4	ElecEngF	50%	260 h	0 w	8/30/04	12/1/04	$14,300	$0	$0	$14,300	0 h	0 h	0 h	260 h
17	PhysicistF	25%	130 h	0 w	8/30/04	12/1/04	$0	$0	$0	$0	0 h	0 h	0 h	130 h

Notes

WBS Definition-
Tests of the low voltage distribution system to ensure it is ready to be installed into the collision hall

M&S BOE-

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
"Low-voltage system test" continued							

Notes
no costs associated with this item.

Labor BOE-
Electrical engineer needed for 4 weeks to provide test procedures based on specifications of the design and conducts some tests (3 weeks) The Physicist confirms that the system conforms to established safety and operational specifications. (4 weeks).

1.1.2.17.18	**Silicon Low-voltage System Ready**	**12/1/04**	**12/1/04**	**$0**	**$0**	**$0**	**$0**

Notes
WBS Definition-
Milestone: the low voltage distribution system has been assembled and tested and is ready to be installed into the collision hall.

1.1.2.18	**High-mass Cables**	**1/2/03**	**5/8/03**	**$27,000**	**$0**	**$8,112**	**$35,112**

Notes
WBS Definition-
Summary task to describe the production and testing of new high mass cables which go between the adapter cards and the interface boards.

1.1.2.18.1	Produce new cables	1/2/03	4/24/03	$27,000	$0	$4,992	$31,992

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
13	ElecTechF	20%	128 h	0 w	1/2/03	4/24/03	$4,992	$0	$0	$4,992	0 h	0 h	0 h	128 h
48	MandS	27,000	27,000	0 w	1/2/03	4/24/03	$27,000	$0	$0	$27,000		0	0	27,000

Notes
WBS Definition-
Production including connectors of new high mass cables possibly required for the replacement of some old cables.

M&S BOE-
100 high mass cables $270 per cable. Run2a experience; 50% contingency is assigned per guidelines.

Labor BOE-
An electrical Tech is required for 3 weeks to place connectors. (1 hour/cable); Run2a experience

1.1.2.18.2	Test new cables	4/25/03	5/8/03	$0	$0	$3,120	$3,120

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
13	ElecTechF	100%	80 h	0 w	4/25/03	5/8/03	$3,120	$0	$0	$3,120	0 h	0 h	0 h	80 h
17	PhysicistF	20%	16 h	0 w	4/25/03	5/8/03	$0	$0	$0	$0	0 h	0 h	0 h	16 h

Notes
WBS Definition-
Electrical and mechanical testing of cables

M&S BOE-
no costs associated with this item

Labor BOE-
10 cables per day by ElecTechF. Includes time required for the setup; Run2a experience; A physicist supervises estimated at 2 days time.

1.1.2.18.3	**Silicon High-mass Cables Ready**	**5/8/03**	**5/8/03**	**$0**	**$0**	**$0**	**$0**

Notes
WBS Definition-
Milestone: The new procured high mass cables are tested and ready for installation into the detector.

1.1.2.19	**High Voltage System**	**3/4/02**	**3/15/04**	**$288,300**	**$0**	**$67,152**	**$355,452**

Notes
WBS Definition-
Summary task to describe the design, procurement, and testing of the new system for L0/L1 as well as verifying the current system use for L2-L5

M&S BOE-
The costs BOEs are described on each line. The contingency is set to 100% as detailed designs are not yet available. For the CINVESTAV order, it has been placed, but there may need to be some additional modules ordered so a 50% contingency is put on this.

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
1.1.2.19.1	Decision on HV PS type	3/4/02	3/15/02	$0	$0	$4,400	$4,400

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
4	ElecEngF	100%	80 h	0 w	3/4/02	3/15/02	$4,400	$0	$4,400	$0	0 h	0 h	80 h	0 h
17	PhysicistF	100%	80 h	0 w	3/4/02	3/15/02	$0	$0	$0	$0	0 h	0 h	80 h	0 h

Notes

WBS Definition-
Decision on type of high voltage system power supplies to be used for Run2a.

M&S BOE-
no costs associated with this item

Labor BOE-
Time spent

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
1.1.2.19.2	Procure new modules (Cinvestav)	3/18/02	10/9/02	$201,300	$0	$0	$201,300

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
18	PhysicistU	10%	116 h	0 w	3/18/02	10/9/02	$0	$0	$0	$0	0 h	0 h	100.8 h	15.2 h
48	MandS	201,300	201,300	0 w	3/18/02	10/9/02	$201,300	$0	$201,300	$0		0	174,922.76	26,377.24

Notes

WBS Definition-
Procurement of VME crates, backplanes, harnesses, motherboards and new pods for HV system at Cinvestav

M&S BOE-
Based on BiRa Systems quote of 6/11/2002 and money being spent

Labor BOE-
Physicist needed at the 10% level for communications with vendor and funding agencies

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
1.1.2.19.3	**Production of HV System During Project Phase**	**10/10/02**	**3/15/04**	**$87,000**	**$0**	**$62,752**	**$149,752**

Notes

WBS Definition-
Summary task to describe the design, procurement, and testing of the new system for L0/L1 as well as verifying the current system use for L2-L5.

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
1.1.2.19.3.1	Procure new modules (Fermilab)	10/10/02	3/26/03	$11,000	$0	$0	$11,000

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
17	PhysicistF	10%	88 h	0 w	10/10/02	3/26/03	$0	$0	$0	$0	0 h	0 h	0 h	88 h
48	MandS	11,000	11,000	0 w	10/10/02	3/26/03	$11,000	$0	$0	$11,000		0	0	11,000

Notes

WBS Definition-
Procurement of VME crates, backplanes, harnesses, motherboards and new pods for HV system at Cinvestav

M&S BOE-
Based on BiRa Systems quote of 6/11/2002. assumes purchase of 4 additional motherboards at $2750 each. Total $11000.

Labor BOE-
Physicist needed to communicate with vendor and place order.

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
1.1.2.19.3.2	Design HV distribution system	3/27/03	7/18/03	$0	$0	$14,080	$14,080

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
4	ElecEngF	40%	256 h	0 w	3/27/03	7/18/03	$14,080	$0	$0	$14,080	0 h	0 h	0 h	256 h
17	PhysicistF	40%	256 h	0 w	3/27/03	7/18/03	$0	$0	$0	$0	0 h	0 h	0 h	256 h

Notes

WBS Definition-
The design and specification of the high voltage distribution system for L0/L1 (capable of supplying 1000V) and the integration of L2-L5 high voltage and routing for the entire detector.

M&S BOE-
no costs associated with this item

Labor BOE-

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
"Design HV distribution system" continued							

Notes
Assume that a physicist and an electrical engineer work in tandem to design and specify the system for a total of 16 weeks each at 40%. This is a guess based on Run2a experience.

1.1.2.19.3.3	Test new modules	3/27/03	5/21/03	$0	$0	$12,480	$12,480

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
13	ElecTechF	100%	320 h	0 w	3/27/03	5/21/03	$12,480	$0	$0	$12,480	0 h	0 h	0 h	320 h

Notes
WBS Definition-
Basic functionality testing.

M&S BOE-
no costs associated with this item

Labor BOE-
Assume full time work based on Run2a experience of electrical technician for verification of functionality.

1.1.2.19.3.4	Procure new fanout boxes	7/21/03	11/10/03	$20,000	$0	$2,496	$22,496

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
13	ElecTechF	10%	64 h	0 w	7/21/03	11/10/03	$2,496	$0	$0	$2,496	0 h	0 h	0 h	64 h
48	MandS	20,000	20,000	0 w	7/21/03	11/10/03	$20,000	$0	$0	$20,000		0	0	20,000

Notes
WBS Definition-
Procurement of Hv fanout boxes

M&S BOE
Fanout boxes for RunIIb will be similar in functionality to Run2A fanout boxes. assumed the same cost as for RunIIa. Twenty-five boxes at $800 per box are needed.

Labor BOE
Electrical Technician needed for communications with vendors.

1.1.2.19.3.5	Assemble and test fanout boxes	11/11/03	1/16/04	$0	$0	$6,240	$6,240

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
13	ElecTechF	50%	160 h	0 w	11/11/03	1/16/04	$6,240	$0	$0	$6,240	0 h	0 h	0 h	160 h
47	Student	50%	160 h	0 w	11/11/03	1/16/04	$0	$0	$0	$0	0 h	0 h	0 h	160 h

Notes
WBS Definition-
assembly and testing of HV fanout boxes

M&S BOE
no cost associated with this item

Labor BOE
8 weeks of ElecTechF[50%] and Student[50%] to assemble and test 12 boxes.

1.1.2.19.3.6	Procure new breakout boxes	7/21/03	11/10/03	$20,000	$0	$2,496	$22,496

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
13	ElecTechF	10%	64 h	0 w	7/21/03	11/10/03	$2,496	$0	$0	$2,496	0 h	0 h	0 h	64 h
48	MandS	20,000	20,000	0 w	7/21/03	11/10/03	$20,000	$0	$0	$20,000		0	0	20,000

Notes
WBS Definition-
Procurement of HV breakout boxes

M&S BOE
Breakout boxes for RunIIb will be similar in functionality to RunIIa breakout boxes. Twenty-five new boxes are required at approx $800 per box. Assumed the same cost as for RunIIa.

Labor BOE
Electrical Tech needed for communications with vendors.

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
1.1.2.19.3.7	Assemble and test breakout boxes	11/11/03	1/16/04	$0	$0	$6,240	$6,240

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
13	ElecTechF	50%	160 h	0 w	11/11/03	1/16/04	$6,240	$0	$0	$6,240	0 h	0 h	0 h	160 h
47	Student	50%	160 h	0 w	11/11/03	1/16/04	$0	$0	$0	$0	0 h	0 h	0 h	160 h

Notes

WBS Definition-
Assembly and testing of HV breakout boxes

M&S BOE-
no cost associated with this item

Labor BOE-
8 weeks of ElecTechF[50%] and Student[50%] to assemble and test 12 boxes.

1.1.2.19.3.8	Procure HV cables	7/21/03	12/10/03	$36,000	$0	$3,120	$39,120

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
13	ElecTechF	10%	80 h	0 w	7/21/03	12/10/03	$3,120	$0	$0	$3,120	0 h	0 h	0 h	80 h
48	MandS	36,000	36,000	0 w	7/21/03	12/10/03	$36,000	$0	$0	$36,000		0	0	36,000

Notes

WBS Definition-
Procurement of HV cables

M&S BOE-
400 HV cables at cost of $90/cable where we ssumed the same cost as for Run2A.
Total cost $36000

Labor BOE-
Electrical technician needed for communications with vendors.

1.1.2.19.3.9	Test HV cables	12/11/03	1/16/04	$0	$0	$3,120	$3,120

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
13	ElecTechF	50%	80 h	0 w	12/11/03	1/16/04	$3,120	$0	$0	$3,120	0 h	0 h	0 h	80 h
47	Student	50%	80 h	0 w	12/11/03	1/16/04	$0	$0	$0	$0	0 h	0 h	0 h	80 h

Notes

WBS Definition-
Electrical testing of HV cables

M&S BOE
no cost associated with this item

Labor BOE
4 weeks of ElecTechF[50%] and Student[50%] to test 400 cables.

1.1.2.19.3.10	**Silicon HV System Components Ready**	**1/16/04**	**1/16/04**	**$0**	**$0**	**$0**	**$0**

Notes

WBS Definition-
Milestone: The HV system is assembled and tested and ready for installation into the collision hall.

1.1.2.19.3.11	Test system	1/20/04	3/15/04	$0	$0	$12,480	$12,480

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
13	ElecTechF	100%	320 h	0 w	1/20/04	3/15/04	$12,480	$0	$0	$12,480	0 h	0 h	0 h	320 h
44	PostDoc	100%	320 h	0 w	1/20/04	3/15/04	$0	$0	$0	$0	0 h	0 h	0 h	320 h

Notes

WBS Definition-
Testing of the HV system for viability with all readout elements using the vertical slice integration test.

M&S BOE-
no costs associated with this item

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
"Test system" continued							

Notes
Labor BOE-
Assume full time work based on Run2a experience of both an electrical tech and a postdoc.

1.1.2.20	**Downstream Silicon Readout Ready for Installatior**	**1/19/05**	**1/19/05**	**$0**	**$0**	**$0**	**$0**

Notes
WBS Definition-
Milestone: All downstream readout components have been produced and tested: Junction cards, twisted pair cables, high mass cables, adapter cards, HV system, LV system, and Interface boards and backplanes.

1.1.2.21	**Support of Downstream Electronics at Fermilab**	**10/30/01**	**5/18/05**	**$21,557**	**$0**	**$125,171**	**$146,728**

Notes
WBS Definition-
Summary task that includes all support by Fermilab for the downstream electronics: Digital jumper cables, junction cards, adapter cards, interface boards and backplanes.

1.1.2.21.1	**Support of Electronics for R&D**	**10/30/01**	**12/6/02**	**$21,557**	**$0**	**$31,484**	**$53,041**

Notes
WBS Definition-
Summary task that includes all support by Fermilab during the R&D phase for the digital jumper cable design and production, as well as design support for junction cards and adapter cards.

1.1.2.21.1.1	Design and integration of digital jumper cables	10/30/01	2/1/02	$0	$0	$2,112	$2,112

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
17	PhysicistF	10%	120 h	0 w	10/30/01	2/1/02	$0	$0	$0	$0	0 h	0 h	120 h	0 h
21	DesignerF	10%	48 h	0 w	10/30/01	2/1/02	$2,112	$0	$2,112	$0	0 h	0 h	48 h	0 h

Notes
WBS Definition-
Layout and verification of specifications to help KSU group produce prototype digital jumper cables.

M&S BOE-
no costs associated with this item

Labor BOE-
The time for this task paces the design effort at KSU. A physicist is needed to verify the specifications. A few drawings for mechanical layout purposes of the rest of the system are drawn by the designer.

1.1.2.21.1.2	Money transfer for prototype digital jumper cables	2/4/02	2/22/02	$21,557	$0	$0	$21,557

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
17	PhysicistF	33%	39.6 h	0 w	2/4/02	2/22/02	$0	$0	$0	$0	0 h	0 h	39.6 h	0 h
48	MandS	21,557	21,557	0 w	2/4/02	2/22/02	$21,557	$0	$21,557	$0		0	21,557	0

Notes
WBS Definition-
The funding for the Honeywell Kansas City plant to manufacture prototype digital jumper cables. This is done through a DOE interlaboratory transfer. See parallel task in KSU jumper cable section.

M&S BOE-
Based on quote from 1/8/02, money transferred, no contingency
It includes artwork, fixtures, and construction for:
10, Layer 0/1 50cm cable prototypes
10, Layer 2-5 50cm cable prototypes
20 Layer 2-5 100cm cable prototypes

Labor BOE-
One week of senior physicist to facilitate paperwork with purchasing. This is based on actual work done.

1.1.2.21.1.3	Integration of digital jumper cables	2/25/02	10/30/02	$0	$0	$3,080	$3,080

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
17	PhysicistF	5%	70 h	0 w	2/25/02	10/30/02	$0	$0	$0	$0	0 h	0 h	56.4 h	13.6 h
21	DesignerF	5%	70 h	0 w	2/25/02	10/30/02	$3,080	$0	$2,482	$598	0 h	0 h	56.4 h	13.6 h

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost

"Integration of digital jumper cables" continued

Notes

WBS Definition-
Verification of the consistency of the part design with the rest of the Run2b silicon detector design for the digital jumper cables

M&S BOE-
no costs associated with this item

Labor BOE-
A physicist and designer are assigned to this effort at a nominal level to make drawings that are stored as part of the system setup and to communicate with KSU to verify the specifications.

1.1.2.21.1.4	Attachment of connectors for L0/L1 prototype digital ju	6/25/02	6/26/02	$0	$0	$624	$624

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
13	ElecTechF	100%	16 h	0 w	6/25/02	6/26/02	$624	$0	$624	$0	0 h	0 h	16 h	0 h

Notes

WBS Definition-
Attaching AVX connectors to bare digital jumper cables for all prototype cables. A total of 20 cables are assumed to have connectors attached

M&S BOE-
no costs associated with this item

Labor BOE-
Assumes 20 cables at 4 cables an hour of an electrical tech. This is based on time spent.

1.1.2.21.1.5	Attachment of connectors for L2-L5 prototype digital ju	8/7/02	8/12/02	$0	$0	$1,248	$1,248

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
13	ElecTechF	100%	32 h	0 w	8/7/02	8/12/02	$1,248	$0	$1,248	$0	0 h	0 h	32 h	0 h

Notes

WBS Definition-
Attaching AVX connectors to bare digital jumper cables for L2-L5 prototype cables. A total of
40 cables are assumed to have connectors attached

M&S BOE-
no costs associated with this item

Labor BOE-
Assumes 40 cables at 4 cables an hour of an electrical tech. This was time spent for placing connectors on 40 prototype cables. Also includes one day of setup.

1.1.2.21.1.6	Attachment of connectors for L0/L1 prototype digital ju	12/2/02	12/3/02	$0	$0	$624	$624

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
13	ElecTechF	100%	16 h	0 w	12/2/02	12/3/02	$624	$0	$0	$624	0 h	0 h	0 h	16 h

Notes

WBS Definition-
Attaching AVX connectors to bare digital jumper cables for all prototype cables. A total of 20 cables are assumed to have connectors attached

M&S BOE-
no costs associated with this item

Labor BOE-
Assumes 20 cables at 4 cables an hour of an electrical tech. This is based on time spent for placing connectors on other prototype cables. Assume two days is spent to count for efficiency factors.

1.1.2.21.1.8	Testing of prototype adapter cards	10/31/02	12/6/02	$0	$0	$3,520	$3,520

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
4	ElecEngF	20%	40 h	0 w	10/31/02	12/6/02	$2,200	$0	$0	$2,200	0 h	0 h	0 h	40 h
12	ElecTechSF	20%	40 h	0 w	10/31/02	12/6/02	$1,320	$0	$0	$1,320	0 h	0 h	0 h	40 h
17	PhysicistF	20%	40 h	0 w	10/31/02	12/6/02	$0	$0	$0	$0	0 h	0 h	0 h	40 h

Notes

WBS Definition-

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost

"Testing of prototype adapter cards" continued

Notes

The testing of the prototype adapter cards done at Fermilab after initial debugging of cards at KSU. These tests are to verify that the cards work within the system.

M&S BOE-
No costs associated with this item

Labor BOE-
Each of a physicist, engineer, and electronics technician will need to spend 1 week's time in the testing phase. The engineer verifies the full system operation while the tech performs the needed measurements.

1.1.2.21.1.7	Support of all other downstream readout R&D	10/30/01	10/30/02	$0	$0	$20,276	$20,276

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
1	MechEngF	8%	151.68 h	0 w	10/30/01	10/30/02	$7,736	$0	$6,848	$888	0 h	0 h	134.27 h	17.4 h
4	ElecEngF	5%	100 h	0 w	10/30/01	10/30/02	$5,500	$0	$4,752	$748	0 h	0 h	86.4 h	13.6 h
17	PhysicistF	10%	174 h	0 w	10/30/01	10/30/02	$0	$0	$0	$0	0 h	0 h	160.4 h	13.6 h
21	DesignerF	8%	160 h	0 w	10/30/01	10/30/02	$7,040	$0	$6,083	$957	0 h	0 h	138.23 h	21.77 h

Notes

WBS Definition-
Task that encompasses all efforts by Fermilab team in support of the KSU effort on junction card design and prototyping and adapter card design and prototyping.

M&S BOE-
no costs associated with this item

Labor BOE-
An electrical engineer is assigned time for reviewing drawings submitted by KSU. A designer is assigned time to make system drawings in particular for the mounting of the adapter cards onto the horseshoe (4 weeks), a mechanical engineer is assigned time to study the cooling issues and mounting of the adapter cards, and a physicist is assigned for communications and supervision of the effort.

1.1.2.21.2	**Support of Electronics During Project Phase**	**10/3/02**	**5/18/05**	**$0**	**$0**	**$93,687**	**$93,687**

Notes

WBS Definition-
Summary task that includes integration of the digital jumper cables, junction cards, adapter cards, and interface boards and backplanes into the overall Run2b silicon design and testing of the system by Fermilab personnel.

1.1.2.21.2.1	Integration of Digital jumper cables	10/31/02	4/2/03	$0	$0	$3,520	$3,520

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
17	PhysicistF	10%	80 h	0 w	10/31/02	4/2/03	$0	$0	$0	$0	0 h	0 h	0 h	80 h
21	DesignerF	10%	80 h	0 w	10/31/02	4/2/03	$3,520	$0	$0	$3,520	0 h	0 h	0 h	80 h

Notes

WBS Definition-
Verification of the consistency of the part design with the rest of the Run2b silicon detector design for the digital jumper cables

M&S BOE-
no costs associated with this item

Labor BOE-
A physicist and designer are assigned to this effort at a nominal level to make drawings that are stored as part of the system setup and to communicate with KSU to verify the specifications.

1.1.2.21.2.2	Attachment of connectors for L0/L1 digital jumper cabl	8/29/03	9/17/03	$0	$0	$3,900	$3,900

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
13	ElecTechF	100%	100 h	0 w	8/29/03	9/17/03	$3,900	$0	$0	$3,900	0 h	0 h	0 h	100 h

Notes

WBS Definition-
Attaching AVX connectors to bare digital jumper cables for Layer 0/1 cables. A total of 260 cables are assumed to have connectors attached

M&S BOE-
no costs associated with this item

Labor BOE-
Assumes 260 cables at 4 cables an hour of an electrical tech. This was time spent for placing connectors on 30 prototype cables. A total of 65 hours is assumed.

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
1.1.2.21.2.3	Attachment of connectors for L2-L5 digital jumper cabl	6/13/03	12/3/03	$0	$0	$12,355	$12,355

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
13	ElecTechF	33%	316.8 h	0 w	6/13/03	12/3/03	$12,355	$0	$0	$12,355	0 h	0 h	0 h	316.8 h

Notes

WBS Definition-
Attaching AVX connectors to bare digital jumper cables for Layer 2-5 cables. A total of 807 cables are assumed to have connectors attached

M&S BOE-
no costs associated with this item

Labor BOE-
Assumes 808 cables at 4 cables an hour of an electrical tech. This was the time spent for placing connectors on 30 prototype cables. A total of 202 hours is assumed. The task lasts a total of 24 weeks to pace the production.

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
1.1.2.21.2.4	Integration of junction cards	10/3/02	1/9/04	$0	$0	$18,104	$18,104

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
1	MechEngF	10%	248 h	0 w	10/3/02	1/9/04	$12,648	$0	$0	$12,648	0 h	0 h	0 h	248 h
17	PhysicistF	5%	124 h	0 w	10/3/02	1/9/04	$0	$0	$0	$0	0 h	0 h	0 h	124 h
21	DesignerF	5%	124 h	0 w	10/3/02	1/9/04	$5,456	$0	$0	$5,456	0 h	0 h	0 h	124 h

Notes

WBS Definition-
Verification of the consistency of the part design with the rest of the Run2b silicon detector design for the junction cards. The location and mounting structure of the junction cards is determined.

M&S BOE-
no costs associated with this item

Labor BOE-
A physicist is assigned to oversee the project with the designers and mechanical engineers and to communicate with KSU on the electrical specifications. A mechanical engineer is assigned for 6 weeks to design the mounting system and supervise the designer in making the several drawings needed for this effort (assumed to take 3 weeks).

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
1.1.2.21.2.5	Integration of adapter cards	10/31/02	11/17/03	$0	$0	$23,400	$23,400

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
1	MechEngF	10%	208 h	0 w	10/31/02	11/17/03	$10,608	$0	$0	$10,608	0 h	0 h	0 h	208 h
8	MechTechF	5%	104 h	0 w	10/31/02	11/17/03	$3,640	$0	$0	$3,640	0 h	0 h	0 h	104 h
17	PhysicistF	10%	208 h	0 w	10/31/02	11/17/03	$0	$0	$0	$0	0 h	0 h	0 h	208 h
21	DesignerF	10%	208 h	0 w	10/31/02	11/17/03	$9,152	$0	$0	$9,152	0 h	0 h	0 h	208 h

Notes

WBS Definition-
Verification of the consistency of the part design with the rest of the Run2b silicon detector design for the adapter cards. The location, mounting structure, and cooling of the adapter cards is determined.

M&S BOE-
no costs associated with this item

Labor BOE-
A physicist is assigned to oversee the project with the designers and mechanical engineers and to communicate with KSU on the electrical specifications. A mechanical engineer is assigned for ~5 weeks to design the mounting and cooling systems and supervise the designer in making the several drawings needed for this effort (assumed to take ~5 weeks). The mecahnical tech is needed for ~ 3 weeks for prototyping.

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
1.1.2.21.2.6	Develop cable routing plan	12/9/02	3/12/03	$0	$0	$14,904	$14,904

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
1	MechEngF	33%	158.4 h	0 w	12/9/02	3/12/03	$8,078	$0	$0	$8,078	0 h	0 h	0 h	158.4 h
8	MechTechF	18%	86.4 h	0 w	12/9/02	3/12/03	$3,024	$0	$0	$3,024	0 h	0 h	0 h	86.4 h
17	PhysicistF	33%	158.4 h	0 w	12/9/02	3/12/03	$0	$0	$0	$0	0 h	0 h	0 h	158.4 h
18	PhysicistU	50%	240 h	0 w	12/9/02	3/12/03	$0	$0	$0	$0	0 h	0 h	0 h	240 h
21	DesignerF	18%	86.4 h	0 w	12/9/02	3/12/03	$3,802	$0	$0	$3,802	0 h	0 h	0 h	86.4 h

Notes

WBS Definition-
Determine the paths of cables and services from the inner surface of CFT barrel 3 to locations on the face of the central calorimeter

M&S BOE-

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost

"Develop cable routing plan" continued

Notes
not applicable

Labor BOE-
A mechanical tech is needed to verify the current Run2a cable path (2 weeks). A designer is needed for 2 weeks to update the drawings for the Run2a cable path (2 weeks). The University physicist has the primary responsibility for the work done here. A physicist and Mechanical engineer are assigned for consultations at the 4 week level.

1.1.2.21.2.7	Integration of interface boards	2/2/04	5/18/05	$0	$0	$6,864	$6,864

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
12	ElecTechSF	8%	208 h	0 w	2/2/04	5/18/05	$6,864	$0	$0	$6,864	0 h	0 h	0 h	208 h
17	PhysicistF	10%	260 h	0 w	2/2/04	5/18/05	$0	$0	$0	$0	0 h	0 h	0 h	260 h

Notes
WBS Definition-
Verification of the consistency of the part design with the rest of the Run2b silicon detector design for the interface boards and backplane.

M&S BOE-
no costs associated with this item

Labor BOE-
A physicist is assigned to this effort at a nominal level to communicate with KSU to verify the specifications. An electrical technician is assigned for 5 weeks to help make changes on the existing interface boards.

1.1.2.21.2.8	System test of interface boards and backplanes	10/28/04	1/4/05	$0	$0	$10,640	$10,640

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
4	ElecEngF	25%	80 h	0 w	10/28/04	1/4/05	$4,400	$0	$0	$4,400	0 h	0 h	0 h	80 h
13	ElecTechF	50%	160 h	0 w	10/28/04	1/4/05	$6,240	$0	$0	$6,240	0 h	0 h	0 h	160 h
44	PostDoc	100%	320 h	0 w	10/28/04	1/4/05	$0	$0	$0	$0	0 h	0 h	0 h	320 h

Notes
WBS Definition-
Verification of operation of the interface boards in the D0 data acquisition and power supply system.

M&S BOE-
no costs associated with this item

Labor BOE-
A full time physicist tests the interface boards both the Sidet system and a test stand at DAB. An electrical technician and electrical engineer are assigned for consultation and fixes.

1.1.2.22	**Stand-alone System Integration Test**	**10/1/02**	**10/10/03**	**$0**	**$0**	**$38,680**	**$38,680**

Notes
WBS Definition-
This is a summary task describing system integration testing using the Stand alone Sequencers with the downstream electronics.

1.1.2.22.1	Readout multiple hybrids	10/1/02	11/25/02	$0	$0	$11,440	$11,440

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
4	ElecEngF	50%	160 h	0 w	10/1/02	11/25/02	$8,800	$0	$0	$8,800	0 h	0 h	0 h	160 h
12	ElecTechSF	25%	80 h	0 w	10/1/02	11/25/02	$2,640	$0	$0	$2,640	0 h	0 h	0 h	80 h
44	PostDoc	100%	320 h	0 w	10/1/02	11/25/02	$0	$0	$0	$0	0 h	0 h	0 h	320 h

Notes
WBS Definition-
Test to read out many L2 hybrids with the purple card in SASEQ teststand

M&S BOE-
no costs associated with this item

Labor BOE-
based on Run2a experience; A full time postdoc conducts the tests. An electrical engineer is needed to help debug the SVX4 chip with the power supplies for 4 weeks. An electrical tech is assigned at 2 weeks to help make the necessary fixes and assist the postdoc.

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
1.1.2.22.2	**Successful Readout Of More Than 1 Silicon Hybrid**	**11/25/02**	**11/25/02**	**$0**	**$0**	**$0**	**$0**

Notes

WBS Definition-
Milestone: Multiple hybrids are successfully being readout for many events using the stand alone sequencer teststands.

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
1.1.2.22.3	Readout full stave with Purple Card	7/18/03	10/10/03	$0	$0	$27,240	$27,240

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
1	MechEngF	15%	72 h	0 w	7/18/03	10/10/03	$3,672	$0	$0	$3,672	0 h	0 h	0 h	72 h
4	ElecEngF	50%	240 h	0 w	7/18/03	10/10/03	$13,200	$0	$0	$13,200	0 h	0 h	0 h	240 h
9	MechTechSF	15%	72 h	0 w	7/18/03	10/10/03	$2,448	$0	$0	$2,448	0 h	0 h	0 h	72 h
12	ElecTechSF	50%	240 h	0 w	7/18/03	10/10/03	$7,920	$0	$0	$7,920	0 h	0 h	0 h	240 h
17	PhysicistF	10%	48 h	0 w	7/18/03	10/10/03	$0	$0	$0	$0	0 h	0 h	0 h	48 h
44	PostDoc	100%	480 h	0 w	7/18/03	10/10/03	$0	$0	$0	$0	0 h	0 h	0 h	480 h

Notes

WBS Definition-
Full stave (4 modules) testing with SASEQ test stand

M&S BOE-
no costs associated with this item

Labor BOE-
based on Run2a experience
A physicistF supervises the operation at 10% level, while a full time postdoc conducts the tests. An electrical engineer is needed to help debug the SVX4 chip with the power supplies for 4 weeks. An electrical tech is assigned at 4 weeks to help make the necessary fixes and assist the postdoc. A mechanical engineer and mechanical technician are assigned for 2 weeks each to help develop the mechanical structure to hold and cool the stave.

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
1.1.2.22.4	**Successful Readout Of Full Silicon Stave**	**10/10/03**	**10/10/03**	**$0**	**$0**	**$0**	**$0**

Notes

WBS Definition-
Milestone: Successful readout of a full stave simultaneously for many events using the stand alone sequencer teststands.

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
1.1.2.23	**Vertical Slice Integration Tests**	**6/13/02**	**7/28/04**	**$52,925**	**$0**	**$176,639**	**$229,564**

Notes

WBS Definition-
Summary task that includes the setup and the tests done that allow a large set of hybrids to be readout using the real readout chain components

M&S BOE-
The costs are described per item.
The contingency is set to 100% to account for lack of detailed plans except for on the order of the single unit full chain test. The order which is being placed presently has a 50% contingency on it.

Labor BOE-
The contingency is assigned by the guidelines

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
1.1.2.23.1	**Single-unit Full Chain Test (NU)**	**6/13/02**	**5/14/03**	**$0**	**$0**	**$0**	**$0**

Notes

WBS Definition-
Summary task that includes efforts by Northwestern to setup and test a single hybrid in the full data acquisition path teststand.

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
1.1.2.23.1.1	Single Unit Full Chain Test Setup (NU)	6/13/02	11/1/02	$0	$0	$0	$0

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
6	ElecEngU	10%	80 h	0 w	6/13/02	11/1/02	$0	$0	$0	$0	0 h	0 h	51.2 h	28.8 h
18	PhysicistU	10%	80 h	0 w	6/13/02	11/1/02	$0	$0	$0	$0	0 h	0 h	51.2 h	28.8 h
47	Student	20%	160 h	0 w	6/13/02	11/1/02	$0	$0	$0	$0	0 h	0 h	102.4 h	57.6 h

Notes

WBS Definition-
Setup of electronics of the readout chain for full chain test at SiDet done by NorthWestern collaborators. All components of the full chain test will be the same as used in the Dzero data acquisition system in the coliision hall. The setup will consist of Adapter Card, Interface Board, Sequencer, VRB, VRB Controller and Single Board Computer with interface to Data Acquisition System, and all associated cables and power supplies. A single readout unit will be read out.

M&S BOE-

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost

"Single Unit Full Chain Test Setup (NU)" continued

Notes

No costs associated with this item. All costs are absorbed by Fermilab in the associated Fermilab task under this heading.

Labor BOE-
Based on Run2a experience.
Physicist: verify purchase criteria and funding and specifications of test. Assumed to take 2 weeks
Electrical Engineer (Univ): check and setup actual system and verify its functionality. Setup consists of about 20 components. Setup of each component is expected to take on average half a day with assistance from a StudentU
StudentU: spends twice the amount of time the engineer spends in actual setup of system.

1.1.2.23.1.2	Single Unit Full Chain Test (NU)						12/16/02		5/14/03	$0		$0		$0	$0
ID	*Resource Name*	*Units*	*Work*	*Delay*	*Start*	*Finish*	*Cost*	*Baseline Cost*	*Act. Cost*	*Rem. Cost*	*Ovt. Work*	*Baseline Work*		*Act. Work*	*Rem. Work*
18	*PhysicistU*	*10%*	*80 h*	*0 w*	*12/16/02*	*5/14/03*	*$0*	*$0*	*$0*	*$0*	*0 h*	*0 h*		*0 h*	*80 h*
47	*Student*	*20%*	*160 h*	*0 w*	*12/16/02*	*5/14/03*	*$0*	*$0*	*$0*	*$0*	*0 h*	*0 h*		*0 h*	*160 h*

Notes

WBS Definition-
The readout of a hybrid using the electronics used in the Dzero data acquisition system in the coliision hall.

M&S BOE-
no costs associated with this item

Labor BOE-
Based on Run2a experience.
PhysU: Supervises the test at the 2 week level. A student assists in the testing for one month's time.

1.1.2.23.2	**R&D Testing With Single and Multi-unit Full-chain**	**6/13/02**	**11/15/02**	**$42,925**	**$0**	**$54,221**	**$97,146**

Notes

WBS Definition-
Summary tast that includes the setup and testing during the R&D phase of both SASEQ readout full chain tests and real D0 DAQ full chain tests.

1.1.2.23.2.1	SASEQ Readout Layer 1 hybrid with Purple Card						7/26/02		9/20/02	$0		$0		$11,456	$11,456
ID	*Resource Name*	*Units*	*Work*	*Delay*	*Start*	*Finish*	*Cost*	*Baseline Cost*	*Act. Cost*	*Rem. Cost*	*Ovt. Work*	*Baseline Work*		*Act. Work*	*Rem. Work*
4	*ElecEngF*	*50%*	*160 h*	*0 w*	*7/26/02*	*9/20/02*	*$8,800*	*$0*	*$7,480*	*$1,320*	*0 h*	*0 h*		*136 h*	*24 h*
9	*MechTechSF*	*5%*	*16 h*	*0 w*	*7/26/02*	*9/20/02*	*$544*	*$0*	*$462*	*$82*	*0 h*	*0 h*		*13.6 h*	*2.4 h*
12	*ElecTechSF*	*20%*	*64 h*	*0 w*	*7/26/02*	*9/20/02*	*$2,112*	*$0*	*$1,795*	*$317*	*0 h*	*0 h*		*54.4 h*	*9.6 h*
44	*PostDoc*	*100%*	*320 h*	*0 w*	*7/26/02*	*9/20/02*	*$0*	*$0*	*$0*	*$0*	*0 h*	*0 h*		*272 h*	*48 h*

Notes

WBS Definition-
Test to readout 1 Layer 1 hybrid with Purple card through the SASEQ teststand

M&S BOE-
Costs for teststand are covered in another task so no costs are associated with this item.

Labor BOE-
Based on Run2a teststand experience 8 weeks are needed.
ElecEng spends 4w helping to debug the readout of the SVX4 system and the hybrid design on the teststand, a full time physicist is conducting the test. Electrical technician and mechanical technician time is included to help setup the infrasture in the teststand for use.

1.1.2.23.2.2	**Successful Readout of Hybrid With SASEQ Test St**	**8/1/02**	**8/1/02**	**$0**	**$0**	**$0**	**$0**

Notes

WBS Definition-
Milestone: Successful readout of a single hybrid using the SASEQ teststand with a purple card.

1.1.2.23.2.3	Single Unit Full Chain Test Setup (Fermilab)						6/13/02		11/1/02	$17,925		$0		$9,976	$27,901
ID	*Resource Name*	*Units*	*Work*	*Delay*	*Start*	*Finish*	*Cost*	*Baseline Cost*	*Act. Cost*	*Rem. Cost*	*Ovt. Work*	*Baseline Work*		*Act. Work*	*Rem. Work*
12	*ElecTechSF*	*20%*	*138.57 h*	*0 w*	*6/13/02*	*11/1/02*	*$4,573*	*$0*	*$3,052*	*$1,521*	*0 h*	*0 h*		*92.48 h*	*46.08 h*
13	*ElecTechF*	*20%*	*138.57 h*	*0 w*	*6/13/02*	*11/1/02*	*$5,404*	*$0*	*$3,607*	*$1,797*	*0 h*	*0 h*		*92.48 h*	*46.08 h*
44	*PostDoc*	*50%*	*400 h*	*0 w*	*6/13/02*	*11/1/02*	*$0*	*$0*	*$0*	*$0*	*0 h*	*0 h*		*256 h*	*144 h*
48	*MandS*	*17,925*	*17,925*	*0 w*	*6/13/02*	*11/1/02*	*$17,925*	*$0*	*$17,925*	*$0*		*0*		*11,472*	*6,453*

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost

"Single Unit Full Chain Test Setup (Fermilab)" continued

Notes

WBS Definition-
Setup of electronics of the readout chain for full chain test at SiDet. All components of the full chain test will be the same as used in the Dzero data acquisition system in the coliision hall. The setup will consist of Adapter Card, Interface Board, Sequencer, VRB, VRB Controller and Single Board Computer with interface to Data Acquisition System, and all associated cables and power supplies. One single readout unit will be read out.

M&S BOE-
Total cost: $17,925

Description of component		unit cost	# units	total price
MVME2304 with 128MB		4100	1	4100
VxWorks license		225	1	225
extender for VME64	250	1	250	
VMIC SBC		3000	1	3000
extender for VME64	350	1	350	
Bit3 PCI interface, Model 620		4000	1	4000
PC-Windows 2000		3000	1	3000
Linux computer with 3 ethernet ports		3000	1	3000

Labor BOE-
Based on Run2a experience.
A postdoc supervises the setup at the 50% level. There is an electrical tech needed for 4 weeks to help with the infrastructure setup. Another electrical tech helps to contact the vendors and with purchasing.

1.1.2.23.2.4 Multi Hybrid Full Chain Test Setup

Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
6/13/02	11/15/02	$25,000	$0	$32,789	$57,789

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
1	MechEngF	20%	176 h	0 w	6/13/02	11/15/02	$8,976	$0	$5,222	$3,754	0 h	0 h	102.4 h	73.6 h
9	MechTechSF	10%	88 h	0 w	6/13/02	11/15/02	$2,992	$0	$1,741	$1,251	0 h	0 h	51.2 h	36.8 h
12	ElecTechSF	10%	88 h	0 w	6/13/02	11/15/02	$2,904	$0	$1,690	$1,214	0 h	0 h	51.2 h	36.8 h
13	ElecTechF	4%	35.2 h	0 w	6/13/02	11/15/02	$1,373	$0	$799	$574	0 h	0 h	20.48 h	14.72 h
19	CompProfF	40%	352 h	0 w	6/13/02	11/15/02	$16,544	$0	$9,626	$6,918	0 h	0 h	204.8 h	147.2 h
44	PostDoc	75%	660 h	0 w	6/13/02	11/15/02	$0	$0	$0	$0	0 h	0 h	384 h	276 h
48	MandS	25,000	25,000	0 w	6/13/02	11/15/02	$25,000	$0	$25,000	$0		0	14,545.45	10,454.55

Notes

WBS Definition-
Setup of electronics of the readout chain for full chain test at SiDet. All components of the full chain test will be the same as used in the Dzero data acquisition system in the coliision hall. The setup will consist of Adapter Card, Interface Board, Sequencer, VRB, VRB Controller and Single Board Computer with interface to Data Acquisition System, and all associated cables and power supplies. One interface board crate, one sequencer crate, and one VRB crate will be filled up so that we can read out 5 staves.

M&S BOE-
Total cost of around $25,000 made up of the following:

Description of component		unit cost	# units	total price
MVME2304 with 128MB		4100	1	4100
VxWorks license		225	1	225
extender for VME64	250	3	750	
VMIC SBC		3000	1	3000
Bit3 PCI interface, Model 620		4000	1	4000
PC-Windows 2000		3000	1	3000
Linux computer with 3 ethernet ports		3000	1	3000
Rack Monitor unit		1500	3	4500
VRBC		600	1	600
fan pack		300	3	900
backplane		1000	1	1000

Labor BOE-
Based on Run2a experience.
ElecTechF: assistance in purchasing and vendor contact
ElecEngF: 4 weeks to specify the system and help setup the tests
ElecTechSF: 2 weeks to help setup the system electrically
MechTechSF: Assistance in infrastructure setup with racks.
Postdoc 8 weeks spent helping to setup and debug the system, 4 weeks support by D0 online controls group for EPICS support, 4 weeks support of database for calibration
CompProf: support by D0 online controls group for EPICS support (includes 1553), the support for the Trigger Frame work emulator, and support for the VRBC assumed to take 8 weeks.

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
1.1.2.23.3	**Full-chain Tests**	**1/23/03**	**7/28/04**	**$10,000**	**$0**	**$122,418**	**$132,418**

Notes

WBS Definition-
Summary tast that includes the testing done using a single chain and multiple chains with the real D0 DAQ system.

1.1.2.23.3.1	Single Unit Full Chain Test(Fermilab)	1/23/03	6/12/03	$0	$0	$13,880	$13,880

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
4	ElecEngF	20%	160 h	0 w	1/23/03	6/12/03	$8,800	$0	$0	$8,800	0 h	0 h	0 h	160 h
12	ElecTechSF	5%	40 h	0 w	1/23/03	6/12/03	$1,320	$0	$0	$1,320	0 h	0 h	0 h	40 h
19	CompProfF	10%	80 h	0 w	1/23/03	6/12/03	$3,760	$0	$0	$3,760	0 h	0 h	0 h	80 h
44	PostDoc	100%	800 h	0 w	1/23/03	6/12/03	$0	$0	$0	$0	0 h	0 h	0 h	800 h

Notes

WBS Definition-
The readout of a hybrid using the electronics used in the Dzero data acquisition system in the coliision hall. (Done in conjunction with NU)

M&S BOE-
no costs associated with this item.

Labor BOE-
ElecEng: helps to debug readout chains using the SVX4 chip (assume 4 weeks)
ElecTech: as needed for rework on boards and cables (assume 1 week)
Postdoc: Full time to conduct the tests
CompProfF: assistance with the 1553, database, and VRBC (2weeks)

1.1.2.23.3.2	**Successful Readout Of Silicon Single-unit Full-cha**	**6/12/03**	**6/12/03**	**$0**	**$0**	**$0**	**$0**

Notes

WBS Definition-
Milestone: Successful readout of a hybrid using the full chain real D0 DAQ for multiple events

1.1.2.23.3.3	Multi Hybrid Full Chain Test	8/11/03	11/3/03	$0	$0	$18,005	$18,005

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
4	ElecEngF	25%	120 h	0 w	8/11/03	11/3/03	$6,600	$0	$0	$6,600	0 h	0 h	0 h	120 h
12	ElecTechSF	25%	120 h	0 w	8/11/03	11/3/03	$3,960	$0	$0	$3,960	0 h	0 h	0 h	120 h
19	CompProfF	33%	158.4 h	0 w	8/11/03	11/3/03	$7,445	$0	$0	$7,445	0 h	0 h	0 h	158.4 h
44	PostDoc	100%	480 h	0 w	8/11/03	11/3/03	$0	$0	$0	$0	0 h	0 h	0 h	480 h

Notes

WBS Definition-
Testing of all components of as used in the Dzero data acquisition system in the coliision hall with multiple staves. The setup will consist of Adapter Card, Interface Board, Sequencer, VRB, VRB Controller and Single Board Computer with interface to Data Acquisition System, and all associated cables and power supplies. One interface board crate, one sequencer crate, and one VRB crate will be filled up so that we can read out 5 staves.

M&S BOE-
no costs associated with this item

Labor BOE-
Based on Run2a experience.
Postdoc full time runs the test
ElecEngF: 3 weeks for debugging multiple hybrid mode including timing issues.
ElecTechSF: 3 weeks for repairs and reworks as needed
CompProf: support for 1553, the support for the Trigger Frame work emulator, and support for the VRBC assumed to take 4 weeks.

1.1.2.23.3.4	Single Stave Full Chain Test	11/4/03	2/9/04	$0	$0	$10,560	$10,560

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
4	ElecEngF	25%	120 h	0 w	11/4/03	2/9/04	$6,600	$0	$0	$6,600	0 h	0 h	0 h	120 h
12	ElecTechSF	25%	120 h	0 w	11/4/03	2/9/04	$3,960	$0	$0	$3,960	0 h	0 h	0 h	120 h
44	PostDoc	100%	480 h	0 w	11/4/03	2/9/04	$0	$0	$0	$0	0 h	0 h	0 h	480 h

Notes

WBS Definition-
Testing of all components of as used in the Dzero data acquisition system in the coliision hall with a single stave. The setup will consist of Adapter Card, Interface Board, Sequencer, VRB, VRB Controller and Single Board Computer with interface to Data Acquisition System, and all associated cables and power supplies.

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost

"Single Stave Full Chain Test" continued

Notes

M&S BOE-
no costs associated with this item

Labor BOE-
Based on Run2a experience.
Postdoc full time runs the test
ElecEngF: 3 weeks for debugging multiple IBs
ElecTechSF: 3 weeks for repairs and reworks as needed

1.1.2.23.3.5	Multi Stave Full Chain Test	2/10/04	5/3/04	$0	$0	$10,560	$10,560

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
4	ElecEngF	25%	120 h	0 w	2/10/04	5/3/04	$6,600	$0	$0	$6,600	0 h	0 h	0 h	120 h
12	ElecTechSF	25%	120 h	0 w	2/10/04	5/3/04	$3,960	$0	$0	$3,960	0 h	0 h	0 h	120 h
44	PostDoc	100%	480 h	0 w	2/10/04	5/3/04	$0	$0	$0	$0	0 h	0 h	0 h	480 h

Notes

WBS Definition-
Testing of all components of as used in the Dzero data acquisition system in the coliision hall with a multiple staves. The setup will consist of Adapter Card, Interface Board, Sequencer, VRB, VRB Controller and Single Board Computer with interface to Data Acquisition System, and all associated cables and power supplies. We expect to readout 5 staves.

M&S BOE-
no costs associated with this item

Labor BOE-
Based on Run2a experience.
Postdoc full time runs the test
ElecEngF: 3 weeks for debugging multiple IBs
ElecTechSF: 3 weeks for repairs and reworks as needed.

1.1.2.23.3.6	**Successful Readout Of Multiple Silicon Staves witl**	**5/3/04**	**5/3/04**	**$0**	**$0**	**$0**	**$0**

Notes

WBS Definition-
Milestone: Successful readout of multiple staves using the full chain real D0 DAQ for multiple events

1.1.2.23.3.7	Layer 0 Sector Full Chain Test	11/4/03	2/9/04	$10,000	$0	$19,618	$29,618

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
1	MechEngF	15%	72 h	0 w	11/4/03	2/9/04	$3,672	$0	$0	$3,672	0 h	0 h	0 h	72 h
4	ElecEngF	25%	120 h	0 w	11/4/03	2/9/04	$6,600	$0	$0	$6,600	0 h	0 h	0 h	120 h
9	MechTechSF	33%	158.4 h	0 w	11/4/03	2/9/04	$5,386	$0	$0	$5,386	0 h	0 h	0 h	158.4 h
12	ElecTechSF	25%	120 h	0 w	11/4/03	2/9/04	$3,960	$0	$0	$3,960	0 h	0 h	0 h	120 h
17	PhysicistF	100%	480 h	0 w	11/4/03	2/9/04	$0	$0	$0	$0	0 h	0 h	0 h	480 h
44	PostDoc	100%	480 h	0 w	11/4/03	2/9/04	$0	$0	$0	$0	0 h	0 h	0 h	480 h
48	MandS	10,000	10,000	0 w	11/4/03	2/9/04	$10,000	$0	$0	$10,000		0	0	10,000

Notes

WBS Definition-
Testing of all components of as used in the Dzero data acquisition system in the coliision hall with a layer 0 sector (18 hybrids). The setup will consist of Adapter Card, Interface Board, Sequencer, VRB, VRB Controller and Single Board Computer with interface to Data Acquisition System, and all associated cables and power supplies.

M&S BOE-
Assume that cooling infrastructure and dark boxes are needed for mechanical infrastructure. Guess that we need $10000 for these items.

Labor BOE-
Based on Run2a experience.
Postdoc and Physicist full time run the test
ElecEngF: 3 weeks for debugging multiple IBs
ElecTechSF: 3 weeks for repairs and reworks as needed
MechEng: assists in cooling setup designfor 2 weeks
MechTech: helps to build cooling setup (4weeks)

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
1.1.2.23.3.8	Layer 1 Sector Full Chain Test	2/10/04	5/3/04	$0	$0	$19,618	$19,618

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
1	MechEngF	15%	72 h	0 w	2/10/04	5/3/04	$3,672	$0	$0	$3,672	0 h	0 h	0 h	72 h
4	ElecEngF	25%	120 h	0 w	2/10/04	5/3/04	$6,600	$0	$0	$6,600	0 h	0 h	0 h	120 h
9	MechTechSF	33%	158.4 h	0 w	2/10/04	5/3/04	$5,386	$0	$0	$5,386	0 h	0 h	0 h	158.4 h
12	ElecTechSF	25%	120 h	0 w	2/10/04	5/3/04	$3,960	$0	$0	$3,960	0 h	0 h	0 h	120 h
17	PhysicistF	100%	480 h	0 w	2/10/04	5/3/04	$0	$0	$0	$0	0 h	0 h	0 h	480 h
44	PostDoc	100%	480 h	0 w	2/10/04	5/3/04	$0	$0	$0	$0	0 h	0 h	0 h	480 h

Notes

WBS Definition-
Testing of all components of as used in the Dzero data acquisition system in the coliision hall with a layer 1 sector (18 hybrids). The setup will consist of Adapter Card, Interface Board, Sequencer, VRB, VRB Controller and Single Board Computer with interface to Data Acquisition System, and all associated cables and power supplies.

M&S BOE-
no costs associated with this item

Labor BOE-
Based on Run2a experience.
Postdoc and Physicist full time run the test
ElecEngF: 3 weeks for debugging multiple IBs
ElecTechSF: 3 weeks for repairs and reworks as needed
MechEng: assists in cooling setup designfor 2 weeks
MechTech: helps to build cooling setup (4weeks)

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
1.1.2.23.3.9	Full Sector Full Chain Test	5/4/04	7/28/04	$0	$0	$30,178	$30,178

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
1	MechEngF	33%	158.4 h	0 w	5/4/04	7/28/04	$8,078	$0	$0	$8,078	0 h	0 h	0 h	158.4 h
4	ElecEngF	33%	158.4 h	0 w	5/4/04	7/28/04	$8,712	$0	$0	$8,712	0 h	0 h	0 h	158.4 h
9	MechTechSF	50%	240 h	0 w	5/4/04	7/28/04	$8,160	$0	$0	$8,160	0 h	0 h	0 h	240 h
12	ElecTechSF	33%	158.4 h	0 w	5/4/04	7/28/04	$5,227	$0	$0	$5,227	0 h	0 h	0 h	158.4 h
17	PhysicistF	100%	480 h	0 w	5/4/04	7/28/04	$0	$0	$0	$0	0 h	0 h	0 h	480 h
44	PostDoc	100%	480 h	0 w	5/4/04	7/28/04	$0	$0	$0	$0	0 h	0 h	0 h	480 h

Notes

WBS Definition-
Testing of all components of as used in the Dzero data acquisition system in the coliision hall with 6 L0 hybrids, 6 Layer 1 hybrids and 2 staves (total 20 hybrids). The setup will consist of Adapter Card, Interface Board, Sequencer, VRB, VRB Controller and Single Board Computer with interface to Data Acquisition System, and all associated cables and power supplies.

M&S BOE-
no costs associated with this item

Labor BOE-
Based on Run2a experience.
Postdoc and Physicist full time run the test
ElecEngF: 4 weeks to assist with power consumption questions
ElecTechSF: 4 weeks for repairs and reworks as needed
MechEng: assists in cooling setup and infrastructure design for 4 weeks
MechTech: assists in setup of infrastructure and connections (6 weeks)

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
1.1.2.24	**Successful Readout of Silicon Full-sector Full-chai**	**7/28/04**	**7/28/04**	**$0**	**$0**	**$0**	**$0**

Notes

WBS Definition-
Milestone: Successful readout of a full sector using the real D0 DAQ teststand for multiple events.

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
1.1.3	**Mechanical Design and Fabrication**	**10/1/01**	**12/22/04**	**$349,224**	**$299,949**	**$524,012**	**$1,173,185**

Notes

WBS Definition-
This summary element includes the development and fabrication of assembly fixtures, tooling, and support structures for sensors, readout components, and the fully assembled detector. Also included are mechanical and electrical infrastructure items such as mounting hardware, a detector cooling system, a dry-gas purge system, and equipment protection interlocks and detector status monitoring equipment.

M&S BOE-
Costs are broken down in detail on each line's task.

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost

"Mechanical Design and Fabrication" continued

Notes

For the contingency:
L0/L1 structures have specific contingency assumptions included in the cost book. The rest of these tasks have 100% contingency assumed because it is for parts production and fixturing. There is enough risk involved in not having finalized designs and having to make special orders that we've included this 100% contingency.

Labor BOE-
The labor contingency is set nominally to 50% for the carbon tasks done at Fermilab. For the L0/L1 integration by Fermilab, it is set to 100% to account for the lack of D0 experience in making these structures. The University of Washington contingency is described in detail in the cost book.

1.1.3.1	Machining through MRI grant	10/2/01	10/7/04	$32,662	$0	$0	$32,662

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
18	PhysicistU	2%	120 h	0 w	10/2/01	10/7/04	$0	$0	$0	$0	0 h	0 h	37.77 h	82.23 h
48	MandS	32,662	32,662	0 w	10/2/01	10/7/04	$32,662	$0	$32,662	$0		0	10,277.64	22,384.36

Notes

WBS Definition-
The machining tasks which are produced by University shops associated with the MRI institutions and grants for the Mechanical Design and Fabrication portion of the schedule.

M&S BOE-
The funding for each task is costed in more detail on the line in the schedule where it appears.
Here is a summary of the lines that are costed.
$5000 for the L0 holding fixture
$8400 for the L0 module installation fixture.
$5000 for the L1 holding fixture
$2800 for the L1 module installation fixture.
$6000 for L0/L1 mating fixture
$2000 for the L0/L1 insertion fixture into L2-5
$3462 for other machining costs assigned to Michigan State Univ.
Total: $32662
A 100% contingency is assigned in case the designated shop cannot fabricate the part and it has to go elsewhere.

Labor BOE-
A physicist oversees the distribution of tasks at the 2% level.

1.1.3.2	L0 Structures Design	10/1/01	3/17/03	$43,944	$70,516	$0	$114,460

Notes

WBS Definition-
Summary task for the design of the layer 0 support structure.

M&S BOE-
The contingency fractions for these tasks are described in detail in the cost book.

Labor BOE-
The labor contingency fractions for these tasks are described in detail in the cost book.

Risk Mitigation-
L0 is important for obtaining the b vertex impact parameter resolution.
Worries are:
Ability to provide the necessary cooling without leaks,
Grounding and space issues that limit signal to noise performance,
The ability to produce an object that conforms to the specifications.
Cost doesn't appear to be an issue.
Schedule:
These tasks are started early in the project and have many prototypes associated with them. There is a total of 40 weeks of extra time if needed to help work on these structures.
Technical/Scope
There are also parallel tasks done at Fermilab that include testing prototype structures to verify that the grounding scheme can be implemented and works, and long term cooling tests. Currently, prototypes have been made that show fabrication of an acceptable structure is possible.

1.1.3.2.1	Mechanical Structures	2/21/02	3/10/03	$3,000	$13,756	$0	$16,756

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
18	PhysicistU	8%	156 h	0 w	2/21/02	3/10/03	$0	$0	$0	$0	0 h	0 h	85.8 h	70.2 h

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
"Mechanical Structures" continued							

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
45	SeniorMechEngU	8%	156 h	0 w	2/21/02	3/10/03	$0	$0	$0	$0	0 h	0 h	85.8 h	70.2 h
46	MechEngU	3%	58.23 h	0 w	2/21/02	3/10/03	$0	$0	$0	$0	0 h	0 h	32.03 h	26.2 h
47	Student	4%	83.2 h	0 w	2/21/02	3/10/03	$0	$0	$0	$0	0 h	0 h	45.77 h	37.43 h
48	MandS	16,756	16,756	0 w	2/21/02	3/10/03	$16,756	$0	$16,756	$0		0	9,215.8	7,540.2

Notes

WBS Definition-
Design of support structures for L0. Creation and maintenance of detailed 3-d CAD solid model of these structures and all components mounted on them. This includes the silicon sensors, the hybrid chips, all cables and the cooling system.

M&S BOE-
Material estimate based on cost of K13C Carbon-fibre pre-preg and associated fabrication materials needed to produce design prototypes and test samples for $3000. See cost book parts list and the details of basis of estimate. Four drawings need to be produced at 160 hours of a senior engineer, 60 hours of a junior engineer and 80 hours of a student. Total labor cost, paid for by the project, is $13,756 for a total M&S cost of $16,756.

Labor BOE-
Engineering estimate based on experience of the Senior Engineers on design of similar structures. Junior Engineer estimate based on number of drawings and includes solid model, checking and sign-off time, and assembly drawings.

1.1.3.2.2	Mechanical Analysis (FEA)	7/1/02	3/11/03	$0	$3,534	$0	$3,534

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
18	PhysicistU	4%	29.43 h	0 w	7/1/02	3/11/03	$0	$0	$0	$0	0 h	0 h	14.33 h	15.1 h
45	SeniorMechEngU	4%	29.43 h	0 w	7/1/02	3/11/03	$0	$0	$0	$0	0 h	0 h	14.33 h	15.1 h
48	MandS	3,534	3,534	0 w	7/1/02	3/11/03	$3,534	$0	$3,534	$0		0	1,039.06	2,494.94

Notes

WBS Definition-
Mechanical FEA analysis of the L0 structures for both stress and deflection considerations.

M&S BOE-
Fifty hours of a senior engineer to do the FEA analysis for a total cost of $3,534 to the project.

Labor BOE-
Estimate based on time that was needed to complete and run pilot structural FEA studies during initial design work on the L0/L1 structure. This estimate includes development of parametric FEA models of the L0 structure, the connection between L0 and L1 and the necessary interfacing with design personnel at FNAL.

1.1.3.2.3	Connections to L1	11/7/02	2/12/03	$1,826	$4,538	$0	$6,364

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
18	PhysicistU	10%	48 h	0 w	11/7/02	2/12/03	$0	$0	$0	$0	0 h	0 h	0 h	48 h
45	SeniorMechEngU	10%	48 h	0 w	11/7/02	2/12/03	$0	$0	$0	$0	0 h	0 h	0 h	48 h
46	MechEngU	6%	28.8 h	0 w	11/7/02	2/12/03	$0	$0	$0	$0	0 h	0 h	0 h	28.8 h
47	Student	4%	19.2 h	0 w	11/7/02	2/12/03	$0	$0	$0	$0	0 h	0 h	0 h	19.2 h
48	MandS	6,364	6,364	0 w	11/7/02	2/12/03	$6,364	$0	$0	$6,364		0	0	6,364

Notes

WBS Definition-
Design connection mechanism needed to attach and precisely hold the L0 structure within the L1 structure.

M&S BOE-
Machine shop estimates and cost of fabrication materials needed to produce design prototypes for a material cost of $500 and 20 hours of shop time for a total shop time charge of $1326. Four drawings need to be made at 50 hours of a senior engineer, 30 hours of a junior engineer and 20 hours of a student for a total labor cost of $4,538. See cost book for parts list and details of estimate. Total M&S cost of $6,364.

Labor BOE-
Engineering estimate based on experience of the Senior Engineers on design of similar structures. Junior Engineer estimate based on number of drawings and includes solid model, checking and sign-off time, and assembly drawings. See cost book for the list of drawings and details of basis of estimate.

1.1.3.2.4	L0 Silicon Sensor Cooling Components/Assembly	6/12/02	3/13/03	$3,152	$4,977	$0	$8,129

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
18	PhysicistU	4%	47.12 h	0 w	6/12/02	3/13/03	$0	$0	$0	$0	0 h	0 h	18.32 h	28.8 h
45	SeniorMechEngU	4%	47.12 h	0 w	6/12/02	3/13/03	$0	$0	$0	$0	0 h	0 h	18.32 h	28.8 h
46	MechEngU	3%	32.32 h	0 w	6/12/02	3/13/03	$0	$0	$0	$0	0 h	0 h	13.12 h	19.2 h
47	Student	4%	59.2 h	0 w	6/12/02	3/13/03	$0	$0	$0	$0	0 h	0 h	20.8 h	38.4 h

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost

"L0 Silicon Sensor Cooling Components/Assembly" continued

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
48	MandS	8,129	8,129	0 w	6/12/02	3/13/03	$8,129	$0	$8,129	$0		0	3,133.16	4,995.84

Notes

WBS Definition-
Design the cooling tubes for the silicon sensors in L0. This includes mechanical integration with the support structure.

M&S BOE-
Machine shop estimates and cost of fabrication materials needed to produce design prototypes. Cost in materials is $500 and 40 hours of shop time for a charge of $2,652. Four drawings need to be made with 50 hours of senior engineering time, 30 hours of junior engineering time and 60 hours of a student for a total labor cost of $4,977 to the project. Total cost to the project of $8,129. See cost book for parts list and details of estimate.

Labor BOE-
Engineering estimate based on experience of the Senior Engineers on design of similar structures. This includes the necessary interfacing with design personnel at FNAL. Junior Engineer estimate based on number of drawings and includes solid model, checking and sign-off time, and assembly drawings. See cost book for the list of drawings and details of basis of estimate.

1.1.3.2.5	L0 Hybrid Support and Cooling Components/Assembly	6/12/02	3/13/03	$5,000	$6,067	$0	$11,067

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
18	PhysicistU	4%	47.12 h	0 w	6/12/02	3/13/03	$0	$0	$0	$0	0 h	0 h	18.32 h	28.8 h
45	SeniorMechEngU	4%	47.12 h	0 w	6/12/02	3/13/03	$0	$0	$0	$0	0 h	0 h	18.32 h	28.8 h
46	MechEngU	7%	79.43 h	0 w	6/12/02	3/13/03	$0	$0	$0	$0	0 h	0 h	31.43 h	48 h
47	Student	3%	44.4 h	0 w	6/12/02	3/13/03	$0	$0	$0	$0	0 h	0 h	15.6 h	28.8 h
48	MandS	11,067	11,067	0 w	6/12/02	3/13/03	$11,067	$0	$11,067	$0		0	4,265.56	6,801.44

Notes

WBS Definition-
Design the mechanical support, cooling tubes and cooling manifolds for the L0 hybrids.

M&S BOE-
Machine shop estimates and cost of fabrication materials needed to produce design prototypes. Cost in materials is $5000. Twenty drawings need to be made with 50 hours of senior engineering time, 80 hours of junior engineering time and 40 hours of a student for a total labor cost of $6,067 to the project. Total cost to the project of $11,067. See cost book for parts list and details of estimate.

Labor BOE-
Engineering estimate based on experience of the Senior Engineers on design of similar structures. This includes the necessary interfacing with design personnel at FNAL. Junior Engineer estimate based on number of drawings and includes solid model, checking and sign-off time, and assembly drawings. See cost book for the list of drawings and details of basis of estimate.

1.1.3.2.6	FEA Thermal	7/1/02	3/11/03	$0	$9,894	$0	$9,894

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
18	PhysicistU	10%	136 h	0 w	7/1/02	3/11/03	$0	$0	$0	$0	0 h	0 h	41.6 h	94.4 h
45	SeniorMechEngU	10%	136 h	0 w	7/1/02	3/11/03	$0	$0	$0	$0	0 h	0 h	41.6 h	94.4 h
48	MandS	9,894	9,894	0 w	7/1/02	3/11/03	$9,894	$0	$9,894	$0		0	3,026.4	6,867.6

Notes

WBS Definition-
Thermal FEA analysis of the cooling systems in L0.

M&S BOE-
140 hours of a senior engineer to perform the FEA analysis at a cost of $9,894 to the project.

Labor BOE-
Estimate based on time that was needed to complete and run pilot thermal FEA studies during initial design work on the L0/L1 structure. This estimate includes development of a parametric FEA model of the L0 thermal structure and the necessary interfacing with design personnel at FNAL.

1.1.3.2.7	Engineering Prototypes	11/5/02	3/10/03	$11,803	$11,306	$0	$23,109

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
18	PhysicistU	16%	102.4 h	0 w	11/5/02	3/10/03	$0	$0	$0	$0	0 h	0 h	0 h	102.4 h
45	SeniorMechEngU	16%	102.4 h	0 w	11/5/02	3/10/03	$0	$0	$0	$0	0 h	0 h	0 h	102.4 h
46	MechEngU	19%	121.6 h	0 w	11/5/02	3/10/03	$0	$0	$0	$0	0 h	0 h	0 h	121.6 h
47	Student	16%	102.4 h	0 w	11/5/02	3/10/03	$0	$0	$0	$0	0 h	0 h	0 h	102.4 h
48	MandS	23,109	23,109	0 w	11/5/02	3/10/03	$23,109	$0	$0	$23,109		0	0	23,109

Notes

WBS Definition-

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost

"Engineering Prototypes" continued

Notes

Fabricate and test complete engineering prototype of the L0 support structure and its cooling system. This includes verification of both the mechanical and thermal FEA.

M&S BOE-
Machine shop estimates and cost of K13C Carbon-fibre pre-preg and associated fabrication materials needed to produce complete engineering prototypes. Cost in materials is $6500 and 80 hours of shop time for a charge of $5,303. 100 hours of senior engineering time, 120 hours of junior engineering time and 100 hours of a student for a total labor cost of $11,306 to the project. Total cost to the project of $23,109. See cost book for parts list and details of estimate.

Labor BOE-
Estimate based on experience resident in the U. Washington Mechanical Engineering department in fabricating Carbon-fiber pre-preg structures and confirmed by work done to date with K13C pre-preg.

1.1.3.2.8	Integration of Design (sensors, grounding, cooling) UV	11/12/02	3/17/03	$0	$3,455	$0	$3,455

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
18	PhysicistU	7%	44.8 h	0 w	11/12/02	3/17/03	$0	$0	$0	$0	0 h	0 h	0 h	44.8 h
45	SeniorMechEngU	7%	44.8 h	0 w	11/12/02	3/17/03	$0	$0	$0	$0	0 h	0 h	0 h	44.8 h
46	MechEngU	5%	32 h	0 w	11/12/02	3/17/03	$0	$0	$0	$0	0 h	0 h	0 h	32 h
48	MandS	3,455	3,455	0 w	11/12/02	3/17/03	$3,455	$0	$0	$3,455		0	0	3,455

Notes

WBS Definition-
Ensure complete collaboration and interchange of information with FNAL staff to ensure that the L0 structure design meets all design requirements. Ensure compatibility with all required assembly and installation procedures.

M&S BOE-
Five drawings need to be made with 40 hours of senior engineering time, 24 hours of junior engineering time and 0 hours of a student for a total labor cost of $3,455 to the project. Total cost to the project of $3,455.

Labor BOE-
Total system complexity and engineering experience. This includes the necessary interfacing with design personnel at Fermilab on the detailed interface of the cooling system, grounding, etc.

1.1.3.2.9	Material R&D and Fab. Technique Evaluation	10/1/01	8/14/02	$19,163	$12,989	$0	$32,152

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
18	PhysicistU	2%	34.72 h	0 w	10/1/01	8/14/02	$0	$0	$0	$0	0 h	0 h	34.72 h	0 h
45	SeniorMechEngU	2%	34.72 h	0 w	10/1/01	8/14/02	$0	$0	$0	$0	0 h	0 h	34.72 h	0 h
46	MechEngU	13%	225.68 h	0 w	10/1/01	8/14/02	$0	$0	$0	$0	0 h	0 h	225.68 h	0 h
47	Student	10%	173.6 h	0 w	10/1/01	8/14/02	$0	$0	$0	$0	0 h	0 h	173.6 h	0 h
48	MandS	32,152	32,152	0 w	10/1/01	8/14/02	$32,152	$0	$32,152	$0		0	32,152	0

Notes

WBS Dictionary-
Survey of available material for fabrication of sensor supports, contact vendors, obtain samples, order pre-prototype material for evaluation and selection of base line material for TDR. Material evaluated by making pre-prototypes and performing structural and thermal conductivity tests.Survey of available material for fabrication of sensor supports, contact vendors, obtain samples, order pre-prototype material for evaluation and selection of base line material for TDR. Material evaluated by making pre-prototypes and performing structural and thermal conductivity tests.

M&S BOE-
Cost for materials was $4462 and 86 hours of machine shop time were needed at a charge of $5701. In addition 39 hours of senior engineering time, 297 hours of junior engineering time and 224 hours of student work were required to do the material R&D for a total labor cost of $12,989. No contingency is applied because this work has been performed already. In addition 9 trips to Fermilab by UW physicists and engineers were taken to discuss material properties with the physicists and engineers at Fermilab at a cost per trip of $1000, for a total of $9000. Total cost of $32,152. All numbers are based on actual invoices. See cost book.

Labor BOE-
Based on actual work performed.

1.1.3.3	**L1 Structures Design**	**10/1/01**	**3/27/03**	**$28,293**	**$70,840**	**$0**	**$99,133**

Notes

WBS Definition-
Summary task for the design of the layer 1 support structure at the Univ. of Washington.

M&S BOE-
The contingency fractions for these tasks are described in detail in the cost book.

Labor BOE-

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost

"L1 Structures Design" continued

Notes

The labor contingency fractions for these tasks are described in detail in the cost book.

1.1.3.3.1	Mechanical Structures	5/9/02	3/10/03	$3,500	$11,819	$0	$15,319

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
18	PhysicistU	10%	152.17 h	0 w	5/9/02	3/10/03	$0	$0	$0	$0	0 h	0 h	67.92 h	84.23 h
45	SeniorMechEngU	10%	152.17 h	0 w	5/9/02	3/10/03	$0	$0	$0	$0	0 h	0 h	67.92 h	84.23 h
46	MechEngU	3%	37.37 h	0 w	5/9/02	3/10/03	$0	$0	$0	$0	0 h	0 h	18.63 h	18.72 h
47	Student	5%	82 h	0 w	5/9/02	3/10/03	$0	$0	$0	$0	0 h	0 h	35.2 h	46.8 h
48	MandS	15,319	15,319	0 w	5/9/02	3/10/03	$15,319	$0	$15,319	$0		0	7,043.63	8,275.37

Notes

WBS Definition-
Design of support structures for L1. Creation and maintenance of detailed 3-d CAD solid model of these structures and all components mounted on them. This includes the silicon sensors, the hybrid chips, all cables and the cooling system.

M&S BOE-
Material estimate based on cost of K13C Carbon-fibre pre-preg and associated fabrication materials needed to produce design prototypes and test samples. Cost in materials is $3500. Three drawings need to be made with 140 hours of senior engineering time, 40 hours of junior engineering time and 80 hours of a student for a total labor cost of $11,819 to the project. Total cost to the project of $15,319. See cost book parts list and the details of basis of estimate.

Labor BOE-
Engineering estimate based on experience of the Senior Engineers on design of similar structures. Junior Engineer estimate based on number of drawings and includes solid model, checking and sign-off time, and assembly drawings. See cost book for the list of drawings and details of basis of estimate.

1.1.3.3.2	Mechanical Analysis (FEA)	7/9/02	3/11/03	$0	$7,067	$0	$7,067

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
18	PhysicistU	8%	105.6 h	0 w	7/9/02	3/11/03	$0	$0	$0	$0	0 h	0 h	30.08 h	75.52 h
45	SeniorMechEngU	8%	105.6 h	0 w	7/9/02	3/11/03	$0	$0	$0	$0	0 h	0 h	30.08 h	75.52 h
48	MandS	7,067	7,067	0 w	7/9/02	3/11/03	$7,067	$0	$7,067	$0		0	2,013.02	5,053.98

Notes

WBS Definition-
Mechanical FEA analysis of the L1 structures for both stress and deflection considerations.

M&S BOE-
One hundred hours of a senior engineer needed to do the FEA analysis at a cost to the project of $7,067.

Labor BOE-
Estimate based on time that was needed to complete and run pilot structural FEA studies during initial design work on the L0/L1 structure. This estimate includes development of parametric FEA models of the L1 structure and the connection between L1 and L2 and the necessary interfacing with design personnel at FNAL.

1.1.3.3.3	Connections to L2	11/1/02	3/6/03	$2,326	$5,726	$0	$8,052

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
18	PhysicistU	9%	57.6 h	0 w	11/1/02	3/6/03	$0	$0	$0	$0	0 h	0 h	0 h	57.6 h
45	SeniorMechEngU	9%	57.6 h	0 w	11/1/02	3/6/03	$0	$0	$0	$0	0 h	0 h	0 h	57.6 h
46	MechEngU	6%	38.4 h	0 w	11/1/02	3/6/03	$0	$0	$0	$0	0 h	0 h	0 h	38.4 h
47	Student	6%	38.4 h	0 w	11/1/02	3/6/03	$0	$0	$0	$0	0 h	0 h	0 h	38.4 h
48	MandS	8,052	8,052	0 w	11/1/02	3/6/03	$8,052	$0	$0	$8,052		0	0	8,052

Notes

WBS Definition-
Design connection mechanism needed to attach and precisely hold the L1 structure within the L2 structure.

M&S BOE-
Machine shop estimates and cost of fabrication materials needed to produce design prototypes. Cost in materials is $1000 and 20 hours of shop time for a charge of $1,326. Six drawings need to be made with 60 hours of senior engineering time, 40 hours of junior engineering time and 40 hours of a student for a total labor cost of $5,726 to the project. Total cost to the project of $8,052. See cost book for parts list and details of estimate.

Labor BOE-
Engineering estimate based on experience of the Senior Engineers on design of similar structures. This includes the necessary interfacing with design personnel at FNAL. Junior Engineer estimate based on number of drawings and includes solid model, checking and sign-off time, and assembly drawings. See cost book for the list of drawings and details of basis of estimate.

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
1.1.3.3.4	Cooling Components/Assembly	9/19/02	3/27/03	$4,652	$5,726	$0	$10,378

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
18	PhysicistU	6%	60 h	0 w	9/19/02	3/27/03	$0	$0	$0	$0	0 h	0 h	0 h	60 h
45	SeniorMechEngU	6%	60 h	0 w	9/19/02	3/27/03	$0	$0	$0	$0	0 h	0 h	0 h	60 h
46	MechEngU	4%	40 h	0 w	9/19/02	3/27/03	$0	$0	$0	$0	0 h	0 h	0 h	40 h
47	Student	4%	40 h	0 w	9/19/02	3/27/03	$0	$0	$0	$0	0 h	0 h	0 h	40 h
48	MandS	10,378	10,378	0 w	9/19/02	3/27/03	$10,378	$0	$0	$10,378		0	0	10,378

Notes

WBS Definition-
Design the cooling components/assembly for both the silicon sensors and the hybrid chips in L1.

M&S BOE-
Machine shop estimates and cost of fabrication materials needed to produce design prototypes. Cost in materials is $2000 and 40 hours of shop time for a charge of $2,652. Seven drawings need to be made with 60 hours of senior engineering time, 40 hours of junior engineering time and 50 hours of a student for a total labor cost of $5,726 to the project. Total cost to the project of $10,378. See cost book for parts list and details of estimate.

Labor BOE-
Engineering estimate based on experience of the Senior Engineers on design of similar structures. This includes the necessary interfacing with design personnel at FNAL. Junior Engineer estimate based on number of drawings and includes solid model, checking and sign-off time, and assembly drawings. See cost book for the list of drawings and details of basis of estimate.

1.1.3.3.5	FEA Thermal	7/9/02	3/11/03	$0	$11,307	$0	$11,307

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
18	PhysicistU	12%	158.4 h	0 w	7/9/02	3/11/03	$0	$0	$0	$0	0 h	0 h	45.12 h	113.28 h
45	SeniorMechEngU	12%	158.4 h	0 w	7/9/02	3/11/03	$0	$0	$0	$0	0 h	0 h	45.12 h	113.28 h
48	MandS	11,307	11,307	0 w	7/9/02	3/11/03	$11,307	$0	$11,307	$0		0	3,220.78	8,086.22

Notes

WBS Definition-
Thermal FEA analysis of the cooling systems in L1.

M&S BOE-
160 hours of senior engineering time required to do the FEA analyses at a cost of $11,307 to the project.

Labor BOE-
Estimate based on time that was needed to complete and run pilot thermal FEA studies during initial design work on the L0/L1 structure. This estimate includes development of a parametric FEA model of the L1 thermal structure and the necessary interfacing with design personnel at FNAL.

1.1.3.3.6	Engineering Prototypes	11/1/02	3/14/03	$7,652	$12,646	$0	$20,298

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
18	PhysicistU	20%	136 h	0 w	11/1/02	3/14/03	$0	$0	$0	$0	0 h	0 h	0 h	136 h
45	SeniorMechEngU	20%	136 h	0 w	11/1/02	3/14/03	$0	$0	$0	$0	0 h	0 h	0 h	136 h
46	MechEngU	12%	81.6 h	0 w	11/1/02	3/14/03	$0	$0	$0	$0	0 h	0 h	0 h	81.6 h
47	Student	9%	61.2 h	0 w	11/1/02	3/14/03	$0	$0	$0	$0	0 h	0 h	0 h	61.2 h
48	MandS	20,298	20,298	0 w	11/1/02	3/14/03	$20,298	$0	$0	$20,298		0	0	20,298

Notes

WBS Definition-
Fabricate and test complete engineering prototype of the L1 support structure and its cooling system. This includes verification of both the mechanical and thermal FEA.

M&S BOE-
Shop estimates and cost of K13C Carbon-fibre pre-preg and associated fabrication materials needed to produce complete engineering prototypes. Cost in materials is $5000 and 40 hours of shop time for a charge of $2,652. 140 hours of senior engineering time, 80 hours of junior engineering time and 60 hours of a student for a total labor cost of $12,646 to the project. Total cost to the project of $20,298. See cost book for parts list and details of estimate.

Labor BOE-
Estimate based on experience resident in the U. Washington Mechanical Engineering department in fabricating Carbon-fiber pre-preg structures and confirmed by work done to date with K13C pre-preg.

1.1.3.3.7	Integration of Design (sensors, grounding, cooling) UV	11/8/02	3/21/03	$0	$3,560	$0	$3,560

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
18	PhysicistU	6%	40.8 h	0 w	11/8/02	3/21/03	$0	$0	$0	$0	0 h	0 h	0 h	40.8 h
45	SeniorMechEngU	6%	40.8 h	0 w	11/8/02	3/21/03	$0	$0	$0	$0	0 h	0 h	0 h	40.8 h
46	MechEngU	4%	27.2 h	0 w	11/8/02	3/21/03	$0	$0	$0	$0	0 h	0 h	0 h	27.2 h
48	MandS	3,560	3,560	0 w	11/8/02	3/21/03	$3,560	$0	$0	$3,560		0	0	3,560

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost

"Integration of Design (sensors, grounding, cooling) UW" continued

Notes

WBS Definition-
Ensure complete collaboration and interchange of information with FNAL staff to ensure that the L1 structure design meets all design requirements. Ensure compatibility with all required assembly and installation procedures.

M&S BOE-
Five drawings need to be made with 40 hours of senior engineering time, 28 hours of junior engineering time and 0 hours of a student for a total labor cost of $3,560 to the project.

Labor BOE-
Total system complexity and engineering experience. This includes the necessary interfacing with design personnel at Fermilab on the detailed interface of the cooling system, grounding, etc.

1.1.3.3.8	Material R&D and Fab. Technique Evaluation	10/1/01	8/14/02	$10,163	$12,989	$0	$23,152

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
18	PhysicistU	2%	34.72 h	0 w	10/1/01	8/14/02	$0	$0	$0	$0	0 h	0 h	34.72 h	0 h
45	SeniorMechEngU	2%	34.72 h	0 w	10/1/01	8/14/02	$0	$0	$0	$0	0 h	0 h	34.72 h	0 h
46	MechEngU	14%	243.03 h	0 w	10/1/01	8/14/02	$0	$0	$0	$0	0 h	0 h	243.03 h	0 h
47	Student	10%	173.6 h	0 w	10/1/01	8/14/02	$0	$0	$0	$0	0 h	0 h	173.6 h	0 h
48	MandS	23,152	23,152	0 w	10/1/01	8/14/02	$23,152	$0	$23,152	$0		0	23,152	0

Notes

WBS Dictionary-
Survey of available material for fabrication of sensor supports, contact vendors, obtain samples, order pre-prototype material for evaluation and selection of base line material for TDR. Material evaluated by making pre-prototypes and performing structural and thermal conductivity tests.Survey of available material for fabrication of sensor supports, contact vendors, obtain samples, order pre-prototype material for evaluation and selection of base line material for TDR. Material evaluated by making pre-prototypes and performing structural and thermal conductivity tests.

M&S BOE-
Cost for materials was $4462 and 86 hours of machine shop time were needed at a charge of $5701. In addition 39 hours of senior engineering time, 297 hours of junior engineering time and 224 hours of student work were required to do the material R&D for a total labor cost of $12,989. No contingency is applied because this work has been performed already. Total cost of $23,152. All numbers are based on actual invoices. See cost book.

Labor BOE-
Based on actual work performed.

1.1.3.4	**L0 Fabrication Tooling**	**8/29/02**	**6/23/03**	**$17,147**	**$14,470**	**$0**	**$31,617**

Notes

WBS Definition-
Summary task that includes the design, fabrication of all tooling needed at UW for the fabrication of the L0 structures.

M&S BOE-
The contingency fractions for these tasks are described in detail in the cost book.

Labor BOE-
The labor contingency fractions for these tasks are described in detail in the cost book.

1.1.3.4.1	Design Tooling	8/29/02	12/3/02	$0	$5,811	$0	$5,811

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
18	PhysicistU	13%	67.6 h	0 w	8/29/02	12/3/02	$0	$0	$0	$0	0 h	0 h	9.88 h	57.72 h
45	SeniorMechEngU	13%	67.6 h	0 w	8/29/02	12/3/02	$0	$0	$0	$0	0 h	0 h	9.88 h	57.72 h
46	MechEngU	13%	67.6 h	0 w	8/29/02	12/3/02	$0	$0	$0	$0	0 h	0 h	9.88 h	57.72 h
48	MandS	5,811	5,811	0 w	8/29/02	12/3/02	$5,811	$0	$5,811	$0		0	849.3	4,961.7

Notes

WBS Definition-
Design of tooling needed for carbon/epoxy part fabrication and assembly of the complete L0 structure and cooling system. This includes tooling for prototype parts and the production structures.

M&S BOE-
Thirteen drawings need to be made at 60 hours of senior engineering time, 60 hours of junior engineering time and 0 hours of a student for a total labor cost of $5,811 to the project.

Labor BOE-
Engineering estimate based on experience of the Senior Engineer on design of similar structures. Junior Engineer estimate based on number of drawings. See cost book for the list of drawings and details of basis of estimate.

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
1.1.3.4.2	Engineering Prototype Tooling	8/29/02	12/3/02	$6,803	$1,571	$0	$8,374

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
46	MechEngU	13%	67.6 h	0 w	8/29/02	12/3/02	$0	$0	$0	$0	0 h	0 h	9.88 h	57.72 h
48	MandS	8,374	8,374	0 w	8/29/02	12/3/02	$8,374	$0	$8,374	$0		0	1,223.89	7,150.11

Notes

WBS Definition-
Fabricate tooling needed for the L0 engineering prototypes.

M&S BOE-
Shop estimates and materials needed to produce tooling for design and engineering prototypes. Cost in materials is $1500 and 80 hours of shop time for a charge of $5,303. 60 hours of junior engineering time for a total labor cost of $1,571 to the project. Total cost to the project of $8,374. See cost book for tooling list and details of estimate.

Labor BOE-
Engineering estimate based on experience of the Senior Engineer on design of similar structures. Junior Engineer estimate based on number of tools and confirmed by work done to date. See cost book for the list tooling list and details of basis of estimate.

1.1.3.4.3	Design Final Tooling/Production Drawings	12/3/02	3/14/03	$0	$5,811	$0	$5,811

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
18	PhysicistU	12%	62.4 h	0 w	12/3/02	3/14/03	$0	$0	$0	$0	0 h	0 h	0 h	62.4 h
45	SeniorMechEngU	12%	62.4 h	0 w	12/3/02	3/14/03	$0	$0	$0	$0	0 h	0 h	0 h	62.4 h
46	MechEngU	12%	62.4 h	0 w	12/3/02	3/14/03	$0	$0	$0	$0	0 h	0 h	0 h	62.4 h
48	MandS	5,811	5,811	0 w	12/3/02	3/14/03	$5,811	$0	$0	$5,811		0	0	5,811

Notes

WBS Definition-
Revise tooling design and produce production drawings for the L0 production tooling.

M&S BOE-
Thirteen drawings need to be made with 60 hours of senior engineering time and 60 hours of junior engineering time for a total labor cost of $5,811 to the project. Total cost to the project of $5,811.

Labor BOE-
Number of drawings. See cost book for the list of drawings and details of basis of estimate.

1.1.3.4.4	Fabricate Tooling	3/14/03	6/23/03	$10,344	$1,277	$0	$11,621

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
46	MechEngU	6%	33.6 h	0 w	3/14/03	6/23/03	$0	$0	$0	$0	0 h	0 h	0 h	33.6 h
47	Student	7%	39.2 h	0 w	3/14/03	6/23/03	$0	$0	$0	$0	0 h	0 h	0 h	39.2 h
48	MandS	11,621	11,621	0 w	3/14/03	6/23/03	$11,621	$0	$0	$11,621		0	0	11,621

Notes

WBS Definition-
Fabricate L0 production tooling.

M&S BOE-
Machine shop estimates and materials needed to produce final production tooling. Cost in materials is $400 and 150 hours of shop time for a charge of $9,944. 32 hours of junior engineering time and 40 hours of a student for a total labor cost of $1,277 to the project. Total cost to the project of $11,620. See cost book for tooling list and details of estimate.

Labor BOE-
Engineering estimate based on experience of the Senior Engineer on design of similar structures. Junior Engineer estimate based on number of tools and confirmed by work done to date. See cost book for the tooling list and details of basis of estimate.

1.1.3.5	**L1 Fabrication Tooling**	**10/10/02**	**10/10/03**	**$16,947**	**$16,250**	**$0**	**$33,197**

Notes

WBS Definition-
Summary task that includes the design, fabrication of all tooling needed at UW for the fabrication of the L1 structures.

M&S BOE-
The contingency fractions for these tasks are described in detail in the cost book.

Labor BOE-
The labor contingency fractions for these tasks are described in detail in the cost book.

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
1.1.3.5.1	Design Tooling	10/10/02	2/19/03	$0	$6,701	$0	$6,701

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
18	PhysicistU	12%	81.6 h	0 w	10/10/02	2/19/03	$0	$0	$0	$0	0 h	0 h	0 h	81.6 h
45	SeniorMechEngU	12%	81.6 h	0 w	10/10/02	2/19/03	$0	$0	$0	$0	0 h	0 h	0 h	81.6 h
46	MechEngU	6%	40.8 h	0 w	10/10/02	2/19/03	$0	$0	$0	$0	0 h	0 h	0 h	40.8 h
48	MandS	6,701	6,701	0 w	10/10/02	2/19/03	$6,701	$0	$0	$6,701		0	0	6,701

Notes

WBS Definition-
Design tooling necessary to make engineering prototypes for the Layer 1 support structure.

M&S BOE-
Nine drawings need to be made with 80 hours of senior engineering time and 40 hours of junior engineering time for a total labor cost of $6,701 to the project. Total cost to the project of $6,701.

Labor BOE-
Engineering estimate based on experience of the Senior Engineers on design of similar structures. Junior Engineer estimate based on number of drawings and includes solid model, checking and sign-off time, and assembly drawings. See cost book for the list of drawings and details of basis of estimate.

1.1.3.5.2	Engineering Preproduction Tooling	10/10/02	2/19/03	$6,703	$1,571	$0	$8,274

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
46	MechEngU	9%	61.2 h	0 w	10/10/02	2/19/03	$0	$0	$0	$0	0 h	0 h	0 h	61.2 h
48	MandS	8,274	8,274	0 w	10/10/02	2/19/03	$8,274	$0	$0	$8,274		0	0	8,274

Notes

WBS Definition-
Fabricate, evaluate and test support structure and redesign based on information obtained

M&S BOE-
Shop estimates and materials needed to produce tooling for design and engineering prototypes. Cost in materials is $1400 and 80 hours of shop time for a charge of $5,303. 60 hours of junior engineering time for a total labor cost of $1,571 to the project. Total cost to the project of $8,274. See cost book for tooling list and details of estimate.

Labor BOE-
Engineering estimate based on experience of the Senior Engineer on design of similar structures. Junior Engineer estimate based on number of tools and confirmed by work done to date. See cost book for the tooling list and details of basis of estimate.

1.1.3.5.3	Design Final Tooling/Production Drawings	3/12/03	7/2/03	$0	$6,701	$0	$6,701

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
18	PhysicistU	13%	83.2 h	0 w	3/12/03	7/2/03	$0	$0	$0	$0	0 h	0 h	0 h	83.2 h
45	SeniorMechEngU	13%	83.2 h	0 w	3/12/03	7/2/03	$0	$0	$0	$0	0 h	0 h	0 h	83.2 h
46	MechEngU	6%	38.4 h	0 w	3/12/03	7/2/03	$0	$0	$0	$0	0 h	0 h	0 h	38.4 h
48	MandS	6,701	6,701	0 w	3/12/03	7/2/03	$6,701	$0	$0	$6,701		0	0	6,701

Notes

WBS Definition-
Fabricate, evaluate and test cooling tubes and connections and redesign based on information obtained

M&S BOE-
Nine drawings need to be made with 80 hours of senior engineering time and 40 hours of junior engineering time for a total labor cost of $6,701. Total cost to the project of $6,701.

Labor BOE-
Number of drawings. See cost book for the list of drawings and details of basis of estimate.

1.1.3.5.4	Fabricate Tooling	7/3/03	10/10/03	$10,244	$1,277	$0	$11,521

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
46	MechEngU	6%	33.6 h	0 w	7/3/03	10/10/03	$0	$0	$0	$0	0 h	0 h	0 h	33.6 h
47	Student	7%	39.2 h	0 w	7/3/03	10/10/03	$0	$0	$0	$0	0 h	0 h	0 h	39.2 h
48	MandS	11,521	11,521	0 w	7/3/03	10/10/03	$11,521	$0	$0	$11,521		0	0	11,521

Notes

WBS Definition-
Fabricate, evaluate and test cooling tubes and connections and redesign based on information obtained

M&S BOE-
Cost in materials is $300 and 150 hours of shop time for a charge of $9,944. 32 hours of junior engineering time and 40 hours of a student for a total labor cost of $1,277 to the project. Total cost to the project of

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
"Fabricate Tooling" continued							

Notes

$11,520.

Labor BOE-
Shop estimates and materials needed to produce final production tooling. See cost book for tooling list and details of estimate.

1.1.3.6	Quality Assurance Tooling	3/14/03	5/9/03	$19,561	$9,831	$0	$29,392

Notes

WBS Definition-
Summary task that includes the design, fabrication of all tooling needed at UW for the quality assurance of the L0/L1 structures

M&S BOE-
The contingency fractions for these tasks are described in detail in the cost book.

Labor BOE-
The labor contingency fractions for these tasks are described in detail in the cost book.

1.1.3.6.1	Design L0/L1 QA Tooling	3/14/03	4/4/03	$0	$5,811	$0	$5,811

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
18	PhysicistU	50%	60 h	0 w	3/14/03	4/4/03	$0	$0	$0	$0	0 h	0 h	0 h	60 h
45	SeniorMechEngU	50%	60 h	0 w	3/14/03	4/4/03	$0	$0	$0	$0	0 h	0 h	0 h	60 h
46	MechEngU	50%	60 h	0 w	3/14/03	4/4/03	$0	$0	$0	$0	0 h	0 h	0 h	60 h
48	MandS	5,811	5,811	0 w	3/14/03	4/4/03	$5,811	$0	$0	$5,811		0	0	5,811

Notes

WBD Definition-
Design the tooling for the Quality Assurance of the layer 0/1 support structures.

M&S BOE-
Four drawings need to be made with 60 hours of senior engineering time and 60 hours of junior engineering time for a total labor cost of $5,811 to the project.

Labor BOE-
Engineering estimate based on experience of the Senior Engineers on design of similar structures. Junior Engineer estimate based on number of drawings and includes solid model, checking and sign-off time, and assembly drawings. See cost book for the list of drawings and details of basis of estimate.

1.1.3.6.2	Fabricate Initial QA Tooling	4/4/03	4/18/03	$5,603	$2,010	$0	$7,613

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
46	MechEngU	75%	60 h	0 w	4/4/03	4/18/03	$0	$0	$0	$0	0 h	0 h	0 h	60 h
47	Student	50%	40 h	0 w	4/4/03	4/18/03	$0	$0	$0	$0	0 h	0 h	0 h	40 h
48	MandS	7,613	7,613	0 w	4/4/03	4/18/03	$7,613	$0	$0	$7,613		0	0	7,613

Notes

WBS Definition-
Fabricate prototype tooling to perform the QA of the layer 0/1 structures.

M&S BOE-
Machine shop estimates for time and materials needed to fabricate prototype QA fixtures and tooling. Cost in materials is $300 and 80 hours of shop time for a charge of $5,303. 60 hours of junior engineering time and 40 hours of a student for a total labor cost of $2,010 to the project. Total cost to the project of $7,613. See cost book for tooling list and details of estimate.

Labor BOE-
Engineering estimate based on experience of the Senior Engineers on design of similar structures. Jr. Engineering estimate based on expected effort level to commision all inspection and testing apparatus. See cost book for tooling list and details of estimate..

1.1.3.6.3	Fabricate Final QA Tooling	4/18/03	5/9/03	$13,958	$2,010	$0	$15,968

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
46	MechEngU	50%	60 h	0 w	4/18/03	5/9/03	$0	$0	$0	$0	0 h	0 h	0 h	60 h
47	Student	33%	39.6 h	0 w	4/18/03	5/9/03	$0	$0	$0	$0	0 h	0 h	0 h	39.6 h
48	MandS	15,968	15,968	0 w	4/18/03	5/9/03	$15,968	$0	$0	$15,968		0	0	15,968

Notes

WBS Definition-
Fabrication of the final QA tooling

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost

"Fabricate Final QA Tooling" continued

Notes

M&S BOE-
Machine shop estimates for time and materials needed to fabricate final QA fixtures and tooling. Cost in materials is $700 and 200 hours of shop time for a charge of $13,258. 60 hours of junior engineering time and 40 hours of a student for a total labor cost of $2,010 to the project.

Labor BOE-
Jr. Engineering estimate based on expected effort level to commision all inspection and testing apparatus. Confirmed by work to date. See cost book for tooling list and details of estimate.

1.1.3.7	Production Readiness Review	5/23/03	6/2/03	$0	$6,052	$816	$6,868

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
1	MechEngF	40%	16 h	0 w	5/23/03	6/2/03	$816	$0	$0	$816	0 h	0 h	0 h	16 h
17	PhysicistF	40%	16 h	0 w	5/23/03	6/2/03	$0	$0	$0	$0	0 h	0 h	0 h	16 h
18	PhysicistU	40%	16 h	0 w	5/23/03	6/2/03	$0	$0	$0	$0	0 h	0 h	0 h	16 h
45	SeniorMechEngU	140%	56 h	0 w	5/23/03	6/2/03	$0	$0	$0	$0	0 h	0 h	0 h	56 h
46	MechEngU	200%	80 h	0 w	5/23/03	6/2/03	$0	$0	$0	$0	0 h	0 h	0 h	80 h
48	MandS	6,052	6,052	0 w	5/23/03	6/2/03	$6,052	$0	$0	$6,052		0	0	6,052

Notes

WBS Definition-
Fabrication of the final QA tooling

M&S BOE-
2 days of review plus 3 days of preparation requires a total of 56 senior engineering hours, and 80 jr. engineering hours for a total labor cost, paid for by the project, of $6052.

Labor BOE-
2 days of review plus 3 days of preparation requires a total of 56 senior engineering hours, and 80 jr. engineering hours.

1.1.3.8	**L0 Structures Production**	**6/23/03**	**2/19/04**	**$29,428**	**$58,902**	**$0**	**$88,330**

Notes

WBS Definition-
The summary task that includes production and assembly of the L0 structures.

M&S BOE-
The contingency fractions for these tasks are described in detail in the cost book.

Labor BOE-
The labor contingency fractions for these tasks are described in detail in the cost book.

1.1.3.8.1	Production/Assembly Drawings South	6/23/03	9/3/03	$0	$4,314	$0	$4,314

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
18	PhysicistU	6%	24 h	0 w	6/23/03	9/3/03	$0	$0	$0	$0	0 h	0 h	0 h	24 h
45	SeniorMechEngU	6%	24 h	0 w	6/23/03	9/3/03	$0	$0	$0	$0	0 h	0 h	0 h	24 h
46	MechEngU	25%	100 h	0 w	6/23/03	9/3/03	$0	$0	$0	$0	0 h	0 h	0 h	100 h
48	MandS	4,314	4,314	0 w	6/23/03	9/3/03	$4,314	$0	$0	$4,314		0	0	4,314

Notes

WBS Definition-
Make the final production and assembly drawings for the South layer 0 support structure.

M&S BOE-
Thirtyseven drawings need to be made with 24 hours of senior engineering time, 100 hours of junior engineering time and 0 hours of a student for a total labor cost of $4,314 to the project. Total cost to the project of $4,314.

Labor BOE-
Engineer estimate based on number of drawings and includes solid model, checking and sign-off time, and assembly drawings. See cost book for the list of drawings and details of basis of estimate.

1.1.3.8.2	Produce/Procure Parts for South	6/23/03	10/15/03	$14,714	$11,452	$0	$26,166

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
18	PhysicistU	19%	121.6 h	0 w	6/23/03	10/15/03	$0	$0	$0	$0	0 h	0 h	0 h	121.6 h
45	SeniorMechEngU	19%	121.6 h	0 w	6/23/03	10/15/03	$0	$0	$0	$0	0 h	0 h	0 h	121.6 h
46	MechEngU	13%	83.2 h	0 w	6/23/03	10/15/03	$0	$0	$0	$0	0 h	0 h	0 h	83.2 h

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
"Produce/Procure Parts for South" continued							

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
47	Student	13%	83.2 h	0 w	6/23/03	10/15/03	$0	$0	$0	$0	0 h	0 h	0 h	83.2 h
48	MandS	26,166	26,166	0 w	6/23/03	10/15/03	$26,166	$0	$0	$26,166		0	0	26,166

Notes

WBS Definition-
Produce the final layer 0 support stucture for the south half and procure final parts as applicable.

M&S BOE-
Machine shop estimate based on hours to fabricate all machine parts. Material estimate based on cost of K13C Carbon-fibre pre-preg and associated fabrication materials needed to produce complete support structure and cooling system. Cost in materials is $8085 and 100 hours of shop time for a charge of $6,629. 120 hours of senior engineering time, 80 hours of junior engineering time and 80 hours of a student for a total labor cost of $11,452 to the project. Total cost to the project of $26,166. See cost book for details of estimate..

Labor BOE-
Sr. and Jr. Engineer estimate based on number of Carbon-fibre layups. Confirmed by work done to date. See cost book for parts list and details of basis of estimate.

1.1.3.8.3	Assemble Parts for South	10/15/03	11/19/03	$0	$6,689	$0	$6,689

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
18	PhysicistU	30%	60 h	0 w	10/15/03	11/19/03	$0	$0	$0	$0	0 h	0 h	0 h	60 h
45	SeniorMechEngU	30%	60 h	0 w	10/15/03	11/19/03	$0	$0	$0	$0	0 h	0 h	0 h	60 h
46	MechEngU	30%	60 h	0 w	10/15/03	11/19/03	$0	$0	$0	$0	0 h	0 h	0 h	60 h
47	Student	40%	80 h	0 w	10/15/03	11/19/03	$0	$0	$0	$0	0 h	0 h	0 h	80 h
48	MandS	6,689	6,689	0 w	10/15/03	11/19/03	$6,689	$0	$0	$6,689		0	0	6,689

Notes

WBS Definition-
The layer 0 support structure consists of an inner tube and a castellated outer tube. This tasks refers to the assembly of both components and its connection with the layer 0 support structure for the hybrids.

M&S BOE-
60 hours of senior engineering time, 60 hours of junior engineering time and 80 hours of a student for a total labor cost of $6,689 to the project. Total cost to the project of $6,689.

Labor BOE-
Sr. and Jr. Engineer estimate based on number of components to be assembled. Confirmed by work done to date. See cost book for parts list and details of basis of estimate.

1.1.3.8.4	Quality Assurance of South	11/26/03	12/19/03	$0	$8,283	$0	$8,283

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
18	PhysicistU	45%	54 h	0 w	11/26/03	12/19/03	$0	$0	$0	$0	0 h	0 h	0 h	54 h
45	SeniorMechEngU	45%	54 h	0 w	11/26/03	12/19/03	$0	$0	$0	$0	0 h	0 h	0 h	54 h
46	MechEngU	103%	123.6 h	0 w	11/26/03	12/19/03	$0	$0	$0	$0	0 h	0 h	0 h	123.6 h
47	Student	64%	76.8 h	0 w	11/26/03	12/19/03	$0	$0	$0	$0	0 h	0 h	0 h	76.8 h
48	MandS	8,283	8,283	0 w	11/26/03	12/19/03	$8,283	$0	$0	$8,283		0	0	8,283

Notes

WBS Definition-
Quality assurance of the final product, including deflection tests.

M&S BOE-
57 hours of senior engineering time, 129 hours of junior engineering time and 80 hours of a student for a total labor cost of $8,283 to the project.

Labor BOE-
Sr. and Jr. Engineer estimate based on number of components and assemblies to be inspected and tested. See cost book for parts list and details of basis of estimate.

1.1.3.8.5	**Silicon Layer 0 South Mechanical Assemblies Com**	**12/19/03**	**12/19/03**	**$0**	**$0**	**$0**	**$0**

Notes

WBS Definition-
Milestone: L0 Structural assemblies for the south have been produced and QCed.

1.1.3.8.6	Production/Assembly Drawings North	6/23/03	8/5/03	$0	$2,984	$0	$2,984

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
18	PhysicistU	8%	19.2 h	0 w	6/23/03	8/5/03	$0	$0	$0	$0	0 h	0 h	0 h	19.2 h
45	SeniorMechEngU	8%	19.2 h	0 w	6/23/03	8/5/03	$0	$0	$0	$0	0 h	0 h	0 h	19.2 h
46	MechEngU	25%	60 h	0 w	6/23/03	8/5/03	$0	$0	$0	$0	0 h	0 h	0 h	60 h

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
"Production/Assembly Drawings North" continued							

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
48	MandS	2,984	2,984	0 w	6/23/03	8/5/03	$2,984	$0	$0	$2,984		0	0	2,984

Notes

WBS Definition-
Make the final production and assembly drawings for the North Layer 0 support structure.

M&S BOE-
Thirtyseven drawings need to be made with 20 hours of senior engineering time, 60 hours of junior engineering time and 0 hours of a student for a total labor cost of $2,984 to the project. Total cost to the project of $2,984.

Labor BOE-
Engineer estimate based on number of drawings and includes solid model, checking and sign-off time, and assembly drawings. See cost book for the list of drawings and details of basis of estimate.

1.1.3.8.7	Produce/Procure Parts for North	6/23/03	7/22/03	$14,714	$10,929	$0	$25,643

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
18	PhysicistU	75%	120 h	0 w	6/23/03	7/22/03	$0	$0	$0	$0	0 h	0 h	0 h	120 h
45	SeniorMechEngU	75%	120 h	0 w	6/23/03	7/22/03	$0	$0	$0	$0	0 h	0 h	0 h	120 h
46	MechEngU	38%	60.8 h	0 w	6/23/03	7/22/03	$0	$0	$0	$0	0 h	0 h	0 h	60.8 h
47	Student	50%	80 h	0 w	6/23/03	7/22/03	$0	$0	$0	$0	0 h	0 h	0 h	80 h
48	MandS	25,643	25,643	0 w	6/23/03	7/22/03	$25,643	$0	$0	$25,643		0	0	25,643

Notes

WBS Definition-
Produce the final layer 0 support stucture for the North half and procure final parts as applicable.

M&S BOE-
Machine shop estimate based on hours to fabricate all machine parts. Material estimate based on cost of K13C Carbon-fibre pre-preg and associated fabrication materials needed to produce complete support structure and cooling system. Cost in materials is $8085 and 100 hours of shop time for a charge of $6,629. 120 hours of senior engineering time, 60 hours of junior engineering time and 80 hours of a student for a total labor cost of $10,929 to the project. Total cost to the project of $25,643. See cost book for details of estimate..

Labor BOE-
Sr. and Jr. Engineer estimate based on number of Carbon-fibre layups. Confirmed by work done to date. See cost book for parts list and details of basis of estimate.

1.1.3.8.8	Assemble Parts for North	12/19/03	1/21/04	$0	$6,689	$0	$6,689

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
18	PhysicistU	34%	40.8 h	0 w	12/19/03	1/21/04	$0	$0	$0	$0	0 h	0 h	0 h	40.8 h
45	SeniorMechEngU	34%	40.8 h	0 w	12/19/03	1/21/04	$0	$0	$0	$0	0 h	0 h	0 h	40.8 h
46	MechEngU	34%	40.8 h	0 w	12/19/03	1/21/04	$0	$0	$0	$0	0 h	0 h	0 h	40.8 h
47	Student	45%	54 h	0 w	12/19/03	1/21/04	$0	$0	$0	$0	0 h	0 h	0 h	54 h
48	MandS	6,689	6,689	0 w	12/19/03	1/21/04	$6,689	$0	$0	$6,689		0	0	6,689

Notes

WBS Definition-
The layer 0 support structure consists of an inner tube and a castellated outer tube. This tasks refers to the assembly of both components and its connection with the layer 0 support structure for the hybrids.

M&S BOE-
60 hours of senior engineering time, 60 hours of junior engineering time and 80 hours of a student for a total labor cost of $6,689 to the project.

Labor BOE-
Sr. and Jr. Engineer estimate based on number of components to be assembled. Confirmed by work done to date. See cost book for parts list and details of basis of estimate.

1.1.3.8.9	Quality Assurance of North	1/28/04	2/18/04	$0	$7,562	$0	$7,562

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
18	PhysicistU	49%	58.8 h	0 w	1/28/04	2/18/04	$0	$0	$0	$0	0 h	0 h	0 h	58.8 h
45	SeniorMechEngU	49%	58.8 h	0 w	1/28/04	2/18/04	$0	$0	$0	$0	0 h	0 h	0 h	58.8 h
46	MechEngU	119%	142.8 h	0 w	1/28/04	2/18/04	$0	$0	$0	$0	0 h	0 h	0 h	142.8 h
47	Student	37%	44.4 h	0 w	1/28/04	2/18/04	$0	$0	$0	$0	0 h	0 h	0 h	44.4 h
48	MandS	7,562	7,562	0 w	1/28/04	2/18/04	$7,562	$0	$0	$7,562		0	0	7,562

Notes

WBS Definition-
Quality assurance of the final product, including deflection tests.

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
"Quality Assurance of North" continued							

Notes

M&S BOE-
53 hours of senior engineering time, 129 hours of junior engineering time and 40 hours of a student for a total labor cost of $7,562 to the project.

Labor BOE-
Sr. and Jr. Engineer estimate based on number of components and assemblies to be inspected and tested. See cost book for parts list and details of basis of estimate.

1.1.3.8.10	**Silicon Layer 0 North Mechanical Assemblies Com**	**2/18/04**	**2/18/04**	**$0**	**$0**	**$0**	**$0**

Notes

WBS Definition-
Milestone: L0 Structural assemblies for the North have been produced and QCed.

1.1.3.8.11	(retired)	2/18/04	2/19/04	$0	$0	$0	$0

Notes

WBS Definition-
This is explicit slack (time contingency) on the Layer 0 support structures.

1.1.3.9	**L1 Structures Production**	**10/13/03**	**6/22/04**	**$20,424**	**$53,088**	**$0**	**$73,512**

Notes

WBS Definition-
The production, assembly, and Quality assurance testing done for the L1 support structures by the UW

M&S BOE-
The contingency assigned to these tasks is described in detail in the cost book

Labor BOE-
The labor contingency fractions for these tasks are described in detail in the cost book.

1.1.3.9.1	Production/Assembly Drawings South	10/13/03	1/15/04	$0	$2,984	$0	$2,984

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
18	PhysicistU	4%	19.2 h	0 w	10/13/03	1/15/04	$0	$0	$0	$0	0 h	0 h	0 h	19.2 h
45	SeniorMechEngU	4%	19.2 h	0 w	10/13/03	1/15/04	$0	$0	$0	$0	0 h	0 h	0 h	19.2 h
46	MechEngU	13%	62.4 h	0 w	10/13/03	1/15/04	$0	$0	$0	$0	0 h	0 h	0 h	62.4 h
48	MandS	2,984	2,984	0 w	10/13/03	1/15/04	$2,984	$0	$0	$2,984		0	0	2,984

Notes

WBS Definition-
Make the final production and assembly drawings for the South Layer 1 support structure.

M&S BOE-
Twenty-one drawings need to be made with 20 hours of senior engineering time, 60 hours of junior engineering time and 0 hours of a student for a total labor cost of $2,984 to the project.

Labor BOE-
Engineer estimate based on number of drawings and includes solid model, checking and sign-off time, and assembly drawings. See cost book for the list of drawings and details of basis of estimate.

1.1.3.9.2	Produce/Procure Parts for South	10/13/03	2/13/04	$10,212	$9,515	$0	$19,727

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
18	PhysicistU	11%	70.4 h	0 w	10/13/03	2/13/04	$0	$0	$0	$0	0 h	0 h	0 h	70.4 h
45	SeniorMechEngU	11%	70.4 h	0 w	10/13/03	2/13/04	$0	$0	$0	$0	0 h	0 h	0 h	70.4 h
46	MechEngU	7%	44.8 h	0 w	10/13/03	2/13/04	$0	$0	$0	$0	0 h	0 h	0 h	44.8 h
47	Student	9%	57.6 h	0 w	10/13/03	2/13/04	$0	$0	$0	$0	0 h	0 h	0 h	57.6 h
48	MandS	19,727	19,727	0 w	10/13/03	2/13/04	$19,727	$0	$0	$19,727		0	0	19,727

Notes

WBS Definition-
Procure materials needed for fabrication and assembly of cooling and mechanical support structure and fabrication of structure.

M&S BOE-
Machine shop estimate based on hours to produce all machine parts. Material estimate based on cost of K13C Carbon-fibre pre-preg and associated fabrication materials needed to produce complete support structure and cooling system. Cost in materials is $7560 and 40 hours of shop time for a charge of $2,652. 100 hours of senior engineering time, 60 hours of junior engineering time and 80 hours of a student for a

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost

"Produce/Procure Parts for South" continued

Notes

total labor cost of $9,515 to the project. Total cost to the project of $19,727. See cost book.

Labor BOE-
Sr. and Jr. Engineer estimate based on number of Carbon-fibre layups. Confirmed by work done to date. See cost book for parts list and details of basis of estimate.

1.1.3.9.3	Assemble Parts for South	2/16/04	3/19/04	$0	$6,165	$0	$6,165

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
18	PhysicistU	18%	36 h	0 w	2/16/04	3/19/04	$0	$0	$0	$0	0 h	0 h	0 h	36 h
45	SeniorMechEngU	18%	36 h	0 w	2/16/04	3/19/04	$0	$0	$0	$0	0 h	0 h	0 h	36 h
46	MechEngU	12%	24 h	0 w	2/16/04	3/19/04	$0	$0	$0	$0	0 h	0 h	0 h	24 h
47	Student	23%	46 h	0 w	2/16/04	3/19/04	$0	$0	$0	$0	0 h	0 h	0 h	46 h
48	MandS	6,165	6,165	0 w	2/16/04	3/19/04	$6,165	$0	$0	$6,165		0	0	6,165

Notes

WBS Definition-
Assemble all parts for the South Layer 1 structure

M&S BOE-
60 hours of senior engineering time, 40 hours of junior engineering time and 80 hours of a student for a total labor cost of $6,165 to the project.

Labor BOE-
Sr. and Jr. Engineer estimate based on number of components to be assembled. Confirmed by work done to date. See cost book for parts list and details of basis of estimate.

1.1.3.9.4	Quality Assurance of South	3/29/04	4/16/04	$0	$7,759	$0	$7,759

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
18	PhysicistU	55%	66 h	0 w	3/29/04	4/16/04	$0	$0	$0	$0	0 h	0 h	0 h	66 h
45	SeniorMechEngU	55%	66 h	0 w	3/29/04	4/16/04	$0	$0	$0	$0	0 h	0 h	0 h	66 h
46	MechEngU	106%	127.2 h	0 w	3/29/04	4/16/04	$0	$0	$0	$0	0 h	0 h	0 h	127.2 h
47	Student	78%	93.6 h	0 w	3/29/04	4/16/04	$0	$0	$0	$0	0 h	0 h	0 h	93.6 h
48	MandS	7,759	7,759	0 w	3/29/04	4/16/04	$7,759	$0	$0	$7,759		0	0	7,759

Notes

WBS Definition-
Make detailed measurements and analyze measurements to certify mechanical precision

M&S BOE-
57 hours of senior engineering time, 109 hours of junior engineering time and 80 hours of a student for a total labor cost of $7,759 to the project.

Labor BOE-
Sr. and Jr. Engineer estimate based on number of components and assemblies to be inspected. See cost book for parts list and details of basis of estimate.

1.1.3.9.5	**Silicon Layer 1 South Mechanical Assemblies Com**	**4/16/04**	**4/16/04**	**$0**	**$0**	**$0**	**$0**

Notes

WBS Definition-
Milestone: L1 Structural assemblies for the south have been produced and QCed.

1.1.3.9.6	Production/Assembly Drawings North	3/29/04	4/30/04	$0	$2,743	$0	$2,743

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
18	PhysicistU	12%	24 h	0 w	3/29/04	4/30/04	$0	$0	$0	$0	0 h	0 h	0 h	24 h
45	SeniorMechEngU	12%	24 h	0 w	3/29/04	4/30/04	$0	$0	$0	$0	0 h	0 h	0 h	24 h
46	MechEngU	20%	40 h	0 w	3/29/04	4/30/04	$0	$0	$0	$0	0 h	0 h	0 h	40 h
48	MandS	2,743	2,743	0 w	3/29/04	4/30/04	$2,743	$0	$0	$2,743		0	0	2,743

Notes

WBS Definition-
Make the final production and assembly drawings for the North Layer 1 support structure.

M&S BOE-
Twenty-one drawings need to be made with 24 hours of senior engineering time, 40 hours of junior engineering time and 0 hours of a student for a total labor cost of $2,743 to the project.

Labor BOE-

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost

"Production/Assembly Drawings North" continued

Notes
Engineer estimate based on number of drawings and includes solid model, checking and sign-off time, and assembly drawings. See cost book for the list of drawings and details of basis of estimate.

1.1.3.9.7	Produce/Procure Parts for North	3/29/04	4/30/04	$10,212	$9,515	$0	$19,727

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
18	PhysicistU	55%	110 h	0 w	3/29/04	4/30/04	$0	$0	$0	$0	0 h	0 h	0 h	110 h
45	SeniorMechEngU	55%	110 h	0 w	3/29/04	4/30/04	$0	$0	$0	$0	0 h	0 h	0 h	110 h
46	MechEngU	33%	66 h	0 w	3/29/04	4/30/04	$0	$0	$0	$0	0 h	0 h	0 h	66 h
47	Student	44%	88 h	0 w	3/29/04	4/30/04	$0	$0	$0	$0	0 h	0 h	0 h	88 h
48	MandS	19,727	19,727	0 w	3/29/04	4/30/04	$19,727	$0	$0	$19,727		0	0	19,727

Notes
WBS Definition-
Procure materials needed for fabrication and assembly of cooling and mechanical support structure and fabrication of structure.

M&S BOE-
Machine shop estimate based on hours to produce all machine parts. Material estimate based on cost of K13C Carbon-fibre pre-preg and associated fabrication materials needed to produce complete support structure and cooling system. Cost in materials is $7560 and 40 hours of shop time for a charge of $2,652. 100 hours of senior engineering time, 60 hours of junior engineering time and 80 hours of a student for a total labor cost of $9,515 to the project. Total cost to the project of $19,727. See cost book.

Labor BOE-
Sr. and Jr. Engineer estimate based on number of Carbon-fibre layups. Confirmed by work done to date. See cost book for parts list and details of basis of estimate.

1.1.3.9.8	Assemble Parts for North	5/3/04	5/21/04	$0	$6,689	$0	$6,689

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
18	PhysicistU	50%	60 h	0 w	5/3/04	5/21/04	$0	$0	$0	$0	0 h	0 h	0 h	60 h
45	SeniorMechEngU	50%	60 h	0 w	5/3/04	5/21/04	$0	$0	$0	$0	0 h	0 h	0 h	60 h
46	MechEngU	50%	60 h	0 w	5/3/04	5/21/04	$0	$0	$0	$0	0 h	0 h	0 h	60 h
47	Student	67%	80.4 h	0 w	5/3/04	5/21/04	$0	$0	$0	$0	0 h	0 h	0 h	80.4 h
48	MandS	6,689	6,689	0 w	5/3/04	5/21/04	$6,689	$0	$0	$6,689		0	0	6,689

Notes
WBS Definition-
Assemble all parts for the North Layer 1 structure

M&S BOE-
60 hours of senior engineering time, 60 hours of junior engineering time and 80 hours of a student for a total labor cost of $6,689 to the project.

Labor BOE-
Sr. and Jr. Engineer estimate based on number of components to be assembled. Confirmed by work done to date. See cost book for parts list and details of basis of estimate.ence

1.1.3.9.9	Quality Assurance of North	6/1/04	6/21/04	$0	$7,718	$0	$7,718

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
18	PhysicistU	43%	51.6 h	0 w	6/1/04	6/21/04	$0	$0	$0	$0	0 h	0 h	0 h	51.6 h
45	SeniorMechEngU	43%	51.6 h	0 w	6/1/04	6/21/04	$0	$0	$0	$0	0 h	0 h	0 h	51.6 h
46	MechEngU	113%	135.6 h	0 w	6/1/04	6/21/04	$0	$0	$0	$0	0 h	0 h	0 h	135.6 h
47	Student	70%	84 h	0 w	6/1/04	6/21/04	$0	$0	$0	$0	0 h	0 h	0 h	84 h
48	MandS	7,718	7,718	0 w	6/1/04	6/21/04	$7,718	$0	$0	$7,718		0	0	7,718

Notes
WBS Definition-
Make detailed measurements and analyze measurements to certify mechanical precision

M&S BOE-
49 hours of senior engineering time, 129 hours of junior engineering time and 80 hours of a student for a total labor cost of $7,718 to the project.

Labor BOE-
Sr. and Jr. Engineer estimate based on number of components and assemblies to be inspected. See cost book for parts list and details of basis of estimate.

1.1.3.9.10	**Silicon Layer 1 North Mechanical Assemblies Com**	**6/21/04**	**6/21/04**	**$0**	**$0**	**$0**	**$0**

Notes
WBS Definition-

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
"Silicon Layer 1 North Mechanical Assemblies Complete" continued							

Notes
Milestone: L1 Structural assemblies for the North have been produced and QCed.

1.1.3.9.11	(retired)	6/22/04	6/22/04	$0	$0	$0	$0

Notes
WBS Definition-

1.1.3.10	**Integration Layer 0 and Layer 1 (Fermilab)**	**2/21/02**	**12/22/04**	**$0**	**$0**	**$254,196**	**$254,196**

Notes
WBS Definition-
Summary task that describes work done by Fermilab personnel in the integration of the design, and layout of the L0/L1 structures in coordination with UW.

M&S BOE-
No M&S Costs associated with these items.

Labor BOE-
All the tasks that fall under this category are tasks that the project has never undertaken before. Based on the experience from other experiments, we know that these tasks are very involved and very risky. Therefore, we have assigned 100% labor contingency to both the technical staff and the physicists for these tasks

Risk Mitigation-
L0 is important for obtaining the b vertex impact parameter resolution. L1 is also important for obtaining the needed efficiency to reconstruct the vertex. These summary tasks are included to assist Univ. of Washington in the design and construction because these layers are so important.
Worries are:
Ability to provide the necessary cooling without leaks,
Grounding and space issues that limit signal to noise performance,
The ability to produce an object that conforms to the specifications.
Cost doesn't appear to be an issue.
Schedule:
These tasks are started early in the project and have many prototypes associated with them. There is a total of 40 weeks of extra time if needed to help work on the L0 structure. L1 has at least 20 weeks of contingency time in the schedule.
Technical/Scope
The tasks here are trying to reduce the impact of these risks. They include testing prototype structures to verify that the grounding scheme can be implemented and works, and long term cooling tests. Currently, prototypes have been made that show fabrication of an acceptable structure is possible and grounding tests have shown a scheme that is acceptable and is being implemented into a prototype. Continuation of projects that also involve prototyping the assembly process will follow.

1.1.3.10.1	**R&D Integration tasks for L0/L1 (Fermilab)**	**2/21/02**	**6/23/03**	**$0**	**$0**	**$68,928**	**$68,928**

Notes
WBS Definition-

1.1.3.10.1.1	Integration of Design for Layer 0 and 1 R&D phase	2/21/02	11/4/02	$0	$0	$13,680	$13,680

ID	*Resource Name*	*Units*	*Work*	*Delay*	*Start*	*Finish*	*Cost*	*Baseline Cost*	*Act. Cost*	*Rem. Cost*	*Ovt. Work*	*Baseline Work*	*Act. Work*	*Rem. Work*
1	*MechEngF*	*10%*	*144 h*	*0 w*	*2/21/02*	*11/4/02*	*$7,344*	*$0*	*$5,834*	*$1,510*	*0 h*	*0 h*	*114.4 h*	*29.6 h*
17	*PhysicistF*	*30%*	*323.2 h*	*0 w*	*2/21/02*	*11/4/02*	*$0*	*$0*	*$0*	*$0*	*0 h*	*0 h*	*293.6 h*	*29.6 h*
21	*DesignerF*	*10%*	*144 h*	*0 w*	*2/21/02*	*11/4/02*	*$6,336*	*$0*	*$5,034*	*$1,302*	*0 h*	*0 h*	*114.4 h*	*29.6 h*

Notes
WBS Definition--
Coordination and documentation of UW and Fermilab efforts on Layer 0 and Layer 1 taking into account the external cooling system and connections to it, dry gas systems, beam pipe installation and support, thermal, deflection, accuracy, cabling, monitoring, and electronics requirements, geometrical constraints, and assembly and installation requirements

M&S BOE-
no costs associated with this item,
travel costs are assumed in the administration section

Labor BOE-
Several trips to University of Washington for discussions of design, prototyping, testing, and fabrication, 4 weeks per person for exchange of drawings, review of drawings, and revisions to drawings. Additional time for the physicist to verify the drawing and communicate with Run2b group.

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
1.1.3.10.1.2	QA of L1 prototype components and assemblies	3/28/03	6/23/03	$0	$0	$27,624	$27,624

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
1	MechEngF	35%	168 h	0 w	3/28/03	6/23/03	$8,568	$0	$0	$8,568	0 h	0 h	0 h	168 h
4	ElecEngF	20%	96 h	0 w	3/28/03	6/23/03	$5,280	$0	$0	$5,280	0 h	0 h	0 h	96 h
8	MechTechF	35%	168 h	0 w	3/28/03	6/23/03	$5,880	$0	$0	$5,880	0 h	0 h	0 h	168 h
17	PhysicistF	35%	168 h	0 w	3/28/03	6/23/03	$0	$0	$0	$0	0 h	0 h	0 h	168 h
28	CMMProgrammerSF	35%	168 h	0 w	3/28/03	6/23/03	$7,896	$0	$0	$7,896	0 h	0 h	0 h	168 h

Notes

WBS Definition--
CMM measurements and load testing at Fermilab of the L1 support structure components and completed assemblies, leak checking of cooling tubes, electrical measurements of components and assemblies, and analysis of the QA results

M&S BOE-
no costs associated with this item

Labor BOE-
Run2a bulkhead inspections, Run 2a readout testing, Run2b grounding studies. MechTech sets up fixturing and assists with measurements and leak checks, CMM programmer prepares measurement programs and assists with measurements, Mech Eng and physicist analyze dimensional information, Elec Eng and physicist perform and analyze electrical measurements.

1.1.3.10.1.3	QA of L0 prototype components and assemblies	3/25/03	6/17/03	$0	$0	$27,624	$27,624

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
1	MechEngF	35%	168 h	0 w	3/25/03	6/17/03	$8,568	$0	$0	$8,568	0 h	0 h	0 h	168 h
4	ElecEngF	20%	96 h	0 w	3/25/03	6/17/03	$5,280	$0	$0	$5,280	0 h	0 h	0 h	96 h
8	MechTechF	35%	168 h	0 w	3/25/03	6/17/03	$5,880	$0	$0	$5,880	0 h	0 h	0 h	168 h
17	PhysicistF	35%	168 h	0 w	3/25/03	6/17/03	$0	$0	$0	$0	0 h	0 h	0 h	168 h
28	CMMProgrammerSF	35%	168 h	0 w	3/25/03	6/17/03	$7,896	$0	$0	$7,896	0 h	0 h	0 h	168 h

Notes

WBS Definition--
CMM measurements and load testing at Fermilab of the L0 support structure components and completed assemblies, leak checking of cooling tubes, electrical measurements of components and assemblies, and analysis of the QA results

M&S BOE-
no costs associated with this item

Labor BOE-
Run2a bulkhead inspections, Run 2a readout testing, Run2b grounding studies. MechTech sets up fixturing and assists with measurements and leak checks, CMM programmer prepares measurement programs and assists with measurements, Mech Eng and physicist analyze dimensional information, Elec Eng and physicist perform and analyze electrical measurements.

1.1.3.10.2	**Intergration of Design Layer 0 and Layer 1**	**11/4/02**	**12/22/04**	**$0**	**$0**	**$23,028**	**$23,028**

Notes

WBS Definition-

1.1.3.10.2.1	Integration of Design Layer 0	11/4/02	10/11/04	$0	$0	$10,944	$10,944

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
1	MechEngF	3%	115.2 h	0 w	11/4/02	10/11/04	$5,875	$0	$0	$5,875	0 h	0 h	0 h	115.2 h
17	PhysicistF	5%	192 h	0 w	11/4/02	10/11/04	$0	$0	$0	$0	0 h	0 h	0 h	192 h
21	DesignerF	3%	115.2 h	0 w	11/4/02	10/11/04	$5,069	$0	$0	$5,069	0 h	0 h	0 h	115.2 h

Notes

WBS Definition--
Coordination and documentation of UW and Fermilab efforts on Layer 0 taking into account the external cooling system and connections to it, dry gas systems, beam pipe installation and support, thermal, deflection, accuracy, cabling, monitoring, and electronics requirements, geometrical constraints, and assembly and installation requirements

M&S BOE-
no costs associated with this item,
travel costs are assumed in the administration section

Labor BOE-
Several trips to University of Washington for discussions of design, prototyping, testing, and fabrication, 3 weeks per person for exchange of drawings, review of drawings, and revisions to drawings. Additional time for the physicist to verify the drawing and communicate with Run2b group.

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
1.1.3.10.2.2	Integration of Design Layer 1	11/4/02	12/22/04	$0	$0	$12,084	$12,084

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
1	MechEngF	3%	127.2 h	0 w	11/4/02	12/22/04	$6,487	$0	$0	$6,487	0 h	0 h	0 h	127.2 h
17	PhysicistF	5%	212 h	0 w	11/4/02	12/22/04	$0	$0	$0	$0	0 h	0 h	0 h	212 h
21	DesignerF	3%	127.2 h	0 w	11/4/02	12/22/04	$5,597	$0	$0	$5,597	0 h	0 h	0 h	127.2 h

Notes

WBS Definition--
Coordination and documentation of UW and Fermilab efforts on Layer 1 taking into account the external cooling system and connections to it, dry gas systems, beam pipe installation and support, thermal, deflection, accuracy, cabling, monitoring, and electronics requirements, geometrical constraints, and assembly and installation requirements

M&S BOE-
no costs associated with this item,
travel costs are assumed in the administration section

Labor BOE-
Several trips to University of Washington for discussions of design, prototyping, testing, and fabrication, 3 weeks per person for exchange of drawings, review of drawings, and revisions to drawings. Additional time for the physicist to verify the drawing and communicate with Run2b group.

1.1.3.10.3	**QA Layer 0**	**1/13/04**	**4/14/04**	**$0**	**$0**	**$14,592**	**$14,592**

Notes

WBS Definition--
CMM measurements and load testing at Fermilab of the L0 south support structure components and completed assemblies including prototypes and final articles, leak checking of cooling tubes, electrical measurements of components and assemblies, and analysis of the QA results.

1.1.3.10.3.1	QA Layer 0 South final article components and assem	1/13/04	2/25/04	$0	$0	$7,296	$7,296

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
1	MechEngF	15%	36 h	0 w	1/13/04	2/25/04	$1,836	$0	$0	$1,836	0 h	0 h	0 h	36 h
9	MechTechSF	35%	84 h	0 w	1/13/04	2/25/04	$2,856	$0	$0	$2,856	0 h	0 h	0 h	84 h
17	PhysicistF	35%	84 h	0 w	1/13/04	2/25/04	$0	$0	$0	$0	0 h	0 h	0 h	84 h
27	CMMOperatorSF	35%	84 h	0 w	1/13/04	2/25/04	$2,604	$0	$0	$2,604	0 h	0 h	0 h	84 h

Notes

WBS Definition--
QA measurements of the L0 south support structure, leak checking of cooling tubes, and the analysis of the QA results.

M&S BOE-
no costs associated with this item

Labor BOE-
Run2a bulkhead inspections, Run 2a readout testing, Run2b grounding studies. MechTech sets up fixturing, assists with measurements and does the leak checking. CMM operator makes the measurements, Mech Eng and physicist analyze dimensional information.

1.1.3.10.3.2	QA Layer 0 North final article components and assemt	3/3/04	4/14/04	$0	$0	$7,296	$7,296

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
1	MechEngF	15%	36 h	0 w	3/3/04	4/14/04	$1,836	$0	$0	$1,836	0 h	0 h	0 h	36 h
9	MechTechSF	35%	84 h	0 w	3/3/04	4/14/04	$2,856	$0	$0	$2,856	0 h	0 h	0 h	84 h
17	PhysicistF	35%	84 h	0 w	3/3/04	4/14/04	$0	$0	$0	$0	0 h	0 h	0 h	84 h
27	CMMOperatorSF	35%	84 h	0 w	3/3/04	4/14/04	$2,604	$0	$0	$2,604	0 h	0 h	0 h	84 h

Notes

WBS Definition--
QA measurements of the L0 north support structure, leak checking of cooling tubes, and the analysis of the QA results.

M&S BOE-
no costs associated with this item

Labor BOE-
Run2a bulkhead inspections, Run 2a readout testing, Run2b grounding studies. MechTech sets up fixturing, assists with measurements and does the leak checking. CMM operator makes the measurements, Mech Eng and physicist analyze dimensional information.

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
1.1.3.10.4	**QA Layer 1**	**5/3/04**	**8/17/04**	**$0**	**$0**	**$14,760**	**$14,760**

Notes

WBS Definition--
CMM measurements and load testing at Fermilab of the L1 south support structure components and completed assemblies (including prototypes and final articles), leak checking of cooling tubes, electrical measurements of components and assemblies, and analysis of the QA results.

1.1.3.10.4.1	QA Layer 1 South final article components and assem	5/3/04	6/14/04	$0	$0	$7,380	$7,380

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
1	MechEngF	15%	36 h	0 w	5/3/04	6/14/04	$1,836	$0	$0	$1,836	0 h	0 h	0 h	36 h
8	MechTechF	35%	84 h	0 w	5/3/04	6/14/04	$2,940	$0	$0	$2,940	0 h	0 h	0 h	84 h
17	PhysicistF	35%	84 h	0 w	5/3/04	6/14/04	$0	$0	$0	$0	0 h	0 h	0 h	84 h
27	CMMOperatorSF	35%	84 h	0 w	5/3/04	6/14/04	$2,604	$0	$0	$2,604	0 h	0 h	0 h	84 h

Notes

WBS Definition--
QA measurements of the L1 south support structure, leak checking of cooling tubes, and the analysis of the QA results.

M&S BOE-
no costs associated with this item

Labor BOE-
Run2a bulkhead inspections, Run 2a readout testing, Run2b grounding studies. MechTech sets up fixturing, assists with measurements and does the leak checking. CMM operator makes the measurements, Mech Eng and physicist analyze dimensional information.

1.1.3.10.4.2	QA Layer 1 North final article components and assemb	7/7/04	8/17/04	$0	$0	$7,380	$7,380

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
1	MechEngF	15%	36 h	0 w	7/7/04	8/17/04	$1,836	$0	$0	$1,836	0 h	0 h	0 h	36 h
8	MechTechF	35%	84 h	0 w	7/7/04	8/17/04	$2,940	$0	$0	$2,940	0 h	0 h	0 h	84 h
17	PhysicistF	35%	84 h	0 w	7/7/04	8/17/04	$0	$0	$0	$0	0 h	0 h	0 h	84 h
27	CMMOperatorSF	35%	84 h	0 w	7/7/04	8/17/04	$2,604	$0	$0	$2,604	0 h	0 h	0 h	84 h

Notes

WBS Definition--
QA measurements of the L1 north support structure, leak checking of cooling tubes, and the analysis of the QA results.

M&S BOE-
no costs associated with this item

Labor BOE-
Run2a bulkhead inspections, Run 2a readout testing, Run2b grounding studies. MechTech sets up fixturing, assists with measurements and does the leak checking. CMM operator makes the measurements, Mech Eng and physicist analyze dimensional information.

1.1.3.10.5	**Design, Fabrication, and Testing of Assembly and**	**3/11/03**	**1/6/04**	**$0**	**$0**	**$132,888**	**$132,888**

Notes

WBS Definition--
All design, engineering, fabrication, testing, QC, and documentation (including drawings) necessary to obtain fully operational fixtures.

1.1.3.10.5.1	L0 structure holding fixtures	3/11/03	7/1/03	$0	$0	$17,216	$17,216

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
1	MechEngF	20%	128 h	0 w	3/11/03	7/1/03	$6,528	$0	$0	$6,528	0 h	0 h	0 h	128 h
8	MechTechF	10%	64 h	0 w	3/11/03	7/1/03	$2,240	$0	$0	$2,240	0 h	0 h	0 h	64 h
17	PhysicistF	10%	64 h	0 w	3/11/03	7/1/03	$0	$0	$0	$0	0 h	0 h	0 h	64 h
21	DesignerF	30%	192 h	0 w	3/11/03	7/1/03	$8,448	$0	$0	$8,448	0 h	0 h	0 h	192 h

Notes

WBS Definition--
Fixtures to hold and position L0 support structures during sensor / hybrid installation. These fixtures are also used in QA items listed under Integration of Layer 0 and Layer 1 (Fermilab)

M&S BOE-
Separate fixtures for north and south silicon to allow the fixtures to be used for storage of assemblies. Cost per fixture is that of a Run 2a fixture to hold and position barrels during ladder installation. Cost is $5000 which is listed under the MRI machining task.

Labor BOE-

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost

"L0 structure holding fixtures " continued

Notes
Run2a experience with cylinder support and module installation fixtures.

1.1.3.10.5.2	L0 module installation fixtures	3/11/03	8/27/03	$0	$0	$32,496	$32,496

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
1	MechEngF	25%	240 h	0 w	3/11/03	8/27/03	$12,240	$0	$0	$12,240	0 h	0 h	0 h	240 h
8	MechTechF	10%	96 h	0 w	3/11/03	8/27/03	$3,360	$0	$0	$3,360	0 h	0 h	0 h	96 h
17	PhysicistF	15%	144 h	0 w	3/11/03	8/27/03	$0	$0	$0	$0	0 h	0 h	0 h	144 h
21	DesignerF	40%	384 h	0 w	3/11/03	8/27/03	$16,896	$0	$0	$16,896	0 h	0 h	0 h	384 h

Notes
WBS Definition--
Fixtures to lift, position, align, and hold L0 modules as they are attached to a L0 support structure.

M&S BOE-
Separate fixtures for north and south silicon to allow work to progress at separate locations without moving and realigning fixturing. The fixturing remains to be designed but requires precision 5-axis positioning capability for sensors plus the ability to hold and position hybrids independently. Total cost is $8400 which is included in the MRI Machining task costs.

Labor BOE-
Run2a experience with ladder and wedge installation fixtures.

1.1.3.10.5.3	L1 structure holding fixtures	3/14/03	7/8/03	$0	$0	$17,216	$17,216

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
1	MechEngF	20%	128 h	0 w	3/14/03	7/8/03	$6,528	$0	$0	$6,528	0 h	0 h	0 h	128 h
8	MechTechF	10%	64 h	0 w	3/14/03	7/8/03	$2,240	$0	$0	$2,240	0 h	0 h	0 h	64 h
17	PhysicistF	10%	64 h	0 w	3/14/03	7/8/03	$0	$0	$0	$0	0 h	0 h	0 h	64 h
21	DesignerF	30%	192 h	0 w	3/14/03	7/8/03	$8,448	$0	$0	$8,448	0 h	0 h	0 h	192 h

Notes
WBS Definition--
Fixtures to hold and position L1 structure during readout module installation. These fixtures are also used in QA items listed under Integration of Layer 0 and Layer 1 (Fermilab).

M&S BOE-
Separate fixtures for north and south silicon to allow the fixtures to be used for storage of assemblies. Cost per fixture is that of a Run 2a fixture to hold and position barrels during ladder installation. Cost is $5000 which is listed under the MRI machining task.

Labor BOE-
Run2a experience with cylinder support and module installation fixtures.

1.1.3.10.5.4	L1 module installation fixtures	3/14/03	6/9/03	$0	$0	$16,248	$16,248

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
1	MechEngF	25%	120 h	0 w	3/14/03	6/9/03	$6,120	$0	$0	$6,120	0 h	0 h	0 h	120 h
8	MechTechF	10%	48 h	0 w	3/14/03	6/9/03	$1,680	$0	$0	$1,680	0 h	0 h	0 h	48 h
17	PhysicistF	15%	72 h	0 w	3/14/03	6/9/03	$0	$0	$0	$0	0 h	0 h	0 h	72 h
21	DesignerF	40%	192 h	0 w	3/14/03	6/9/03	$8,448	$0	$0	$8,448	0 h	0 h	0 h	192 h

Notes
WBS Definition--
Fixtures to lift, position, align, and hold L1 readout modules as they are attached to a L1 support structure

M&S BOE-
Separate fixtures for north and south silicon to allow work to progress at separate locations without moving and realigning fixturing. The fixturing consists of adapters to allow the L0 module installation fixtures to be used for L1 modules. The fixturing remains to be designed. The cost estimate is based on Run2a experience and the $2800 cost appears under the MRI machining task.

Labor BOE-
Run2a experience with ladder and wedge installation fixtures.

1.1.3.10.5.5	L0/L1 mating fixture	3/14/03	9/3/03	$0	$0	$32,496	$32,496

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
1	MechEngF	25%	240 h	0 w	3/14/03	9/3/03	$12,240	$0	$0	$12,240	0 h	0 h	0 h	240 h
8	MechTechF	10%	96 h	0 w	3/14/03	9/3/03	$3,360	$0	$0	$3,360	0 h	0 h	0 h	96 h
17	PhysicistF	15%	144 h	0 w	3/14/03	9/3/03	$0	$0	$0	$0	0 h	0 h	0 h	144 h

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
"L0/L1 mating fixture " continued							

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
21	DesignerF	40%	384 h	0 w	3/14/03	9/3/03	$16,896	$0	$0	$16,896	0 h	0 h	0 h	384 h

Notes

WBS Definition--
A fixture to hold a completed L0 assembly and insert it into a completed L1 assembly

M&S BOE-
Adapters to allow a L0 structure holding fixture to be used to insert L0 into L1. Five axis motion is needed. The fixtures remain to be designed. Estimates are based on Run2a experience for a total cost of $6000 which appears under the MRI machining task.

Labor BOE-
Run2a experience with beam tube and H-disk installation fixtures.

1.1.3.10.5.6	L0/L1 into L2-L5 insertion fixture	9/3/03	1/6/04	$0	$0	$17,216	$17,216

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
1	MechEngF	20%	128 h	0 w	9/3/03	1/6/04	$6,528	$0	$0	$6,528	0 h	0 h	0 h	128 h
8	MechTechF	10%	64 h	0 w	9/3/03	1/6/04	$2,240	$0	$0	$2,240	0 h	0 h	0 h	64 h
17	PhysicistF	10%	64 h	0 w	9/3/03	1/6/04	$0	$0	$0	$0	0 h	0 h	0 h	64 h
21	DesignerF	30%	192 h	0 w	9/3/03	1/6/04	$8,448	$0	$0	$8,448	0 h	0 h	0 h	192 h

Notes

WBS Definition--
A fixture to hold a completed L0/L1 assembly and insert it into a completed L2 through L5 assembly.

M&S BOE-
L0 is supported from an inner cylinder within L1 during mating. The fixture provides protection and safe motion to L0 and support for its digital cables as it is moved into position for mating. Cost is expected to be somewhat lower than that of other fixtures because this fixture need not provide precision positioning. The fixture remains to be designed by the cost is estimated at $2000 and is assigned to the MRI machining task.

Labor BOE-
Run2a experience with fixtures to install silicon within the fiber tracker.

1.1.3.11	**Stave Design**	**3/25/02**	**1/22/03**	**$25,500**	**$0**	**$144,900**	**$170,400**

Notes

WBS Definition-
Summary task that includes the design and prototyping of the staves for Layers 2-5.

1.1.3.11.1	**Design & Prototyping of Stave Cores**	**4/16/02**	**1/22/03**	**$21,900**	**$0**	**$87,984**	**$109,884**

Notes

WBS Definition-
Summary task that includes all design and prototyping of stave cores

1.1.3.11.1.1	Design cooling tubes	4/16/02	8/7/02	$0	$0	$21,952	$21,952

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
1	MechEngF	50%	320 h	0 w	4/16/02	8/7/02	$16,320	$0	$16,320	$0	0 h	0 h	320 h	0 h
17	PhysicistF	50%	320 h	0 w	4/16/02	8/7/02	$0	$0	$0	$0	0 h	0 h	320 h	0 h
21	DesignerF	20%	128 h	0 w	4/16/02	8/7/02	$5,632	$0	$5,632	$0	0 h	0 h	128 h	0 h

Notes

WBS Definition-
Develop cooling tube mechanical designs sufficiently to begin fabrication of cooling tube prototypes. Calculations of pressure drop versus flow and heat transfer are based upon spreadsheet models developed for Run 2a and verified by finite element models. Ply layup for cooling tubes is based upon standard laminate theory and fabrication of R&D tubes.

M&S BOE-
no costs associated with this item

Labor BOE-
Based on other design projects and Run 2b R&D experience. The physicist, and mechanical engineer each work 1/2 time, the designer works 20% to complete the task.

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
1.1.3.11.1.2	(retired)	8/8/02	8/8/02	$0	$0	$0	$0

Notes
WBS Definition-

1.1.3.11.1.3	Conduct cooling analyses and tests	8/8/02	10/3/02	$2,200	$0	$10,880	$13,080

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
1	MechEngF	50%	160 h	0 w	8/8/02	10/3/02	$8,160	$0	$5,100	$3,060	0 h	0 h	100 h	60 h
9	MechTechSF	25%	80 h	0 w	8/8/02	10/3/02	$2,720	$0	$1,700	$1,020	0 h	0 h	50 h	30 h
17	PhysicistF	25%	80 h	0 w	8/8/02	10/3/02	$0	$0	$0	$0	0 h	0 h	50 h	30 h
48	MandS	2,200	2,200	0 w	8/8/02	10/3/02	$2,200	$0	$2,200	$0		0	1,375	825

Notes
WBS Definition-
Perform finite element and hand calculations to understand heat removal by the cooling structures, perform testing to verify the calculations.

M&S BOE-
Miscellaneous pump and instrumentation costs associated with SiDet flow testing system

Labor BOE-
Mechnical engineer specifies and conducts tests, mechanical tech assists, physicist and mechanical engineer analyze data.

1.1.3.11.1.4	Design stave hybrid mounting	12/9/02	1/22/03	$0	$0	$5,780	$5,780

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
1	MechEngF	20%	40 h	0 w	12/9/02	1/22/03	$2,040	$0	$0	$2,040	0 h	0 h	0 h	40 h
4	ElecEngF	20%	40 h	0 w	12/9/02	1/22/03	$2,200	$0	$0	$2,200	0 h	0 h	0 h	40 h
12	ElecTechSF	10%	20 h	0 w	12/9/02	1/22/03	$660	$0	$0	$660	0 h	0 h	0 h	20 h
17	PhysicistF	40%	80 h	0 w	12/9/02	1/22/03	$0	$0	$0	$0	0 h	0 h	0 h	80 h
21	DesignerF	10%	20 h	0 w	12/9/02	1/22/03	$880	$0	$0	$880	0 h	0 h	0 h	20 h

Notes
WBS Definition-
Design the attachment of hybrids to the remainder of the stave structure, including insulators and ground connections

M&S BOE-
no costs associated with this item

Labor BOE-
Based on number of drawings and Run2a design experiences and time spent

1.1.3.11.1.5	Design stave core and fiducial and locating features	7/2/02	9/25/02	$0	$0	$15,072	$15,072

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
1	MechEngF	40%	192 h	0 w	7/2/02	9/25/02	$9,792	$0	$8,323	$1,469	0 h	0 h	163.2 h	28.8 h
17	PhysicistF	50%	240 h	0 w	7/2/02	9/25/02	$0	$0	$0	$0	0 h	0 h	204 h	36 h
21	DesignerF	25%	120 h	0 w	7/2/02	9/25/02	$5,280	$0	$4,488	$792	0 h	0 h	102 h	18 h

Notes
WBS Definition-
Design fiducials to be used in placing silicon onto the stave cores and to be used in measuring stave positions within the completed silicon support structure; design the mechanical connections between the stave and its support stuctures.

M&S BOE-
no costs associated with this item

Labor BOE-
Based on other design projects. The physicist works 50%, the mechanical engineer 40%, and the designer 25% to complete the task.

1.1.3.11.1.6	Procure stave core prototype fixtures	9/26/02	11/6/02	$7,200	$0	$2,280	$9,480

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
1	MechEngF	10%	24 h	0 w	9/26/02	11/6/02	$1,224	$0	$0	$1,224	0 h	0 h	0 h	24 h
21	DesignerF	10%	24 h	0 w	9/26/02	11/6/02	$1,056	$0	$0	$1,056	0 h	0 h	0 h	24 h
48	MandS	7,200	7,200	0 w	9/26/02	11/6/02	$7,200	$0	$0	$7,200		0	0	7,200

Notes
WBS Definition-

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost

"Procure stave core prototype fixtures" continued

Notes

Complete fixture drawings for prototypes, submit fixtures for fabrication, and complete fabrication of fixtures for prototypes, QC fixtures

M&S BOE-
2 fixtures @ $3600/fixture, each fixture includes at least three pieces, pieces must be flat and dimensionally accurate. $300 for materials, 66 hours machining at $50/hr.

Labor BOE-
Time is allocated for consultation both with the designer and the mechanical engineer.

1.1.3.11.1.7	Procure carbon fiber prepreg and other materials for c	8/28/02	11/6/02	$7,500	$0	$1,020	$8,520

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
1	MechEngF	5%	20 h	0 w	8/28/02	11/6/02	$1,020	$0	$224	$796	0 h	0 h	4.4 h	15.6 h
48	MandS	7,500	7,500	0 w	8/28/02	11/6/02	$7,500	$0	$7,500	$0		0	1,650	5,850

Notes

WBS Definition-
Procure carbon fiber, epoxy, insulating materials, and other materials needed for fabrication of stave core prototypes.

M&S BOE-
Based upon 62 MSI fiber at $500/lb and typical minimum order requirements. Past purchases indicate minimum order is 14-16 lb.

Labor BOE-
Based on other carbon fiber procurements.

1.1.3.11.1.8	Fabricate prototype stave cores	11/7/02	12/6/02	$0	$0	$11,560	$11,560

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
1	MechEngF	75%	120 h	0 w	11/7/02	12/6/02	$6,120	$0	$0	$6,120	0 h	0 h	0 h	120 h
9	MechTechSF	100%	160 h	0 w	11/7/02	12/6/02	$5,440	$0	$0	$5,440	0 h	0 h	0 h	160 h
17	PhysicistF	25%	40 h	0 w	11/7/02	12/6/02	$0	$0	$0	$0	0 h	0 h	0 h	40 h

Notes

WBS Definition-
Fabricate sufficient core prototypes to ensure that the fabrication process works well.

M&S BOE-
no costs associated with this item

Labor BOE-
Full time prototyping work based on other design projects.

1.1.3.11.1.9	Design and procure stave core QC fixtures	9/26/02	11/6/02	$5,000	$0	$11,400	$16,400

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
1	MechEngF	50%	120 h	0 w	9/26/02	11/6/02	$6,120	$0	$0	$6,120	0 h	0 h	0 h	120 h
17	PhysicistF	50%	120 h	0 w	9/26/02	11/6/02	$0	$0	$0	$0	0 h	0 h	0 h	120 h
21	DesignerF	50%	120 h	0 w	9/26/02	11/6/02	$5,280	$0	$0	$5,280	0 h	0 h	0 h	120 h
48	MandS	5,000	5,000	0 w	9/26/02	11/6/02	$5,000	$0	$0	$5,000		0	0	5,000

Notes

WBS Definition-
Design and procure sufficient fixturing to allow QC of prototype cores to be carried out. Fixturing is to be suitable to verify flatness, straightness, and dimensional accuracy of core structures.

M&S BOE-
2 fixtures @ $2500/fixture.

Labor BOE-
Based on other design experience.

1.1.3.11.1.10	QC prototype stave cores	11/14/02	11/27/02	$0	$0	$4,640	$4,640

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
1	MechEngF	50%	40 h	0 w	11/14/02	11/27/02	$2,040	$0	$0	$2,040	0 h	0 h	0 h	40 h
9	MechTechSF	50%	40 h	0 w	11/14/02	11/27/02	$1,360	$0	$0	$1,360	0 h	0 h	0 h	40 h
27	CMMOperatorSF	50%	40 h	0 w	11/14/02	11/27/02	$1,240	$0	$0	$1,240	0 h	0 h	0 h	40 h

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
"QC prototype stave cores" continued							

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
30	CMMSmall	50%	40 h	0 w	11/14/02	11/27/02	$0	$0	$0	$0	0 h	0 h	0 h	40 h

Notes

WBS Definition-
Perform and analyze measurements sufficient to ensure that stave core prototypes are dimensionally acceptable.

M&S BOE-
no costs associated with this item

Labor BOE-
Based on Run2a experience with measurements and fixtures.

1.1.3.11.1.11	Conduct cooling tests	12/2/02	12/13/02	$0	$0	$3,400	$3,400

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
1	MechEngF	50%	40 h	0 w	12/2/02	12/13/02	$2,040	$0	$0	$2,040	0 h	0 h	0 h	40 h
9	MechTechSF	50%	40 h	0 w	12/2/02	12/13/02	$1,360	$0	$0	$1,360	0 h	0 h	0 h	40 h

Notes

WBS Definition-
Measure and analyze the thermal performance of completed stave cores.

M&S BOE-
Assumes the use of existing SiDet instrumentation so no cost is assumed here

Labor BOE-
Based on Run2a experience.

1.1.3.11.2	**Design & Prototyping of Stave Shells**	**3/25/02**	**10/23/02**	**$3,600**	**$0**	**$46,692**	**$50,292**

Notes

WBS Definition-
Summary task that includes all design and prototyping of stave shells (C-channels).

1.1.3.11.2.1	Design stave shells	3/25/02	9/11/02	$0	$0	$28,704	$28,704

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
1	MechEngF	50%	480 h	0 w	3/25/02	9/11/02	$24,480	$0	$24,480	$0	0 h	0 h	480 h	0 h
17	PhysicistF	50%	480 h	0 w	3/25/02	9/11/02	$0	$0	$0	$0	0 h	0 h	480 h	0 h
21	DesignerF	10%	96 h	0 w	3/25/02	9/11/02	$4,224	$0	$4,224	$0	0 h	0 h	96 h	0 h

Notes

WBS Definition-
Design the shells which provide mechanical stiffness to the staves, complete shell drawings.

M&S BOE-
no costs associated with this item

Labor BOE-
Run2a design experience and Run 2b R&D.

1.1.3.11.2.2	Fabricate and test prototype stave shells	4/22/02	10/9/02	$0	$0	$13,872	$13,872

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
1	MechEngF	15%	144 h	0 w	4/22/02	10/9/02	$7,344	$0	$6,181	$1,163	0 h	0 h	121.2 h	22.8 h
9	MechTechSF	20%	192 h	0 w	4/22/02	10/9/02	$6,528	$0	$5,494	$1,034	0 h	0 h	161.6 h	30.4 h
17	PhysicistF	15%	144 h	0 w	4/22/02	10/9/02	$0	$0	$0	$0	0 h	0 h	121.2 h	22.8 h

Notes

WBS Definition-
Fabricate and test a sufficient number of shells to verify that shells are dimensionally accurate and reproducible and that their deflections under load are acceptable.

M&S BOE-
carbon fiber and fixtures are procured on other tasks.

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost

"Fabricate and test prototype stave shells" continued

Notes

Labor BOE-
Assumes that physicist and mechanical engineer participate in the evaluation of results and that shells are fabricated and measurements are performed by mechanical tech.

1.1.3.11.2.3	Design and procure shell QC fixtures	9/12/02	10/23/02	$3,600	$0	$4,116	$7,716

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
1	MechEngF	25%	60 h	0 w	9/12/02	10/23/02	$3,060	$0	$0	$3,060	0 h	0 h	0 h	60 h
17	PhysicistF	25%	60 h	0 w	9/12/02	10/23/02	$0	$0	$0	$0	0 h	0 h	0 h	60 h
21	DesignerF	10%	24 h	0 w	9/12/02	10/23/02	$1,056	$0	$0	$1,056	0 h	0 h	0 h	24 h
48	MandS	3,600	3,600	0 w	9/12/02	10/23/02	$3,600	$0	$0	$3,600		0	0	3,600

Notes

WBS Definition-
Design, document via drawings, and procure any fixtures needed to verify mechanical precision of stave shells, QC fixtures.

M&S BOE-
2 fixtures @ $1800/fixture. The fixture precision is essentially the same as that of the shell fabrication fixture, so the same fixture cost has been assigned based upon a machine shop estimate.

Labor BOE-
Run2a design and procurement experience.

1.1.3.11.3	Prototype Mechanical Stave	11/15/02	12/16/02	$0	$0	$10,224	$10,224

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
1	MechEngF	50%	80 h	0 w	11/15/02	12/16/02	$4,080	$0	$0	$4,080	0 h	0 h	0 h	80 h
9	MechTechSF	100%	160 h	0 w	11/15/02	12/16/02	$5,440	$0	$0	$5,440	0 h	0 h	0 h	160 h
17	PhysicistF	50%	80 h	0 w	11/15/02	12/16/02	$0	$0	$0	$0	0 h	0 h	0 h	80 h
21	DesignerF	10%	16 h	0 w	11/15/02	12/16/02	$704	$0	$0	$704	0 h	0 h	0 h	16 h
31	CMMMedium	100%	160 h	0 w	11/15/02	12/16/02	$0	$0	$0	$0	0 h	0 h	0 h	160 h

Notes

WBS Definition-
Building using mechanical parts (not able to read out) full stave using all suggested assembly procedures

M&S BOE-
no costs associated with this item

Labor BOE-
Full time MechTech with 1/2 time phyicist and MechEngF, small DesignerF in case drawings need to be modified.

1.1.3.11.4	**Silicon Prototype Mechanical Stave Built**	**12/16/02**	**12/16/02**	**$0**	**$0**	**$0**	**$0**

Notes

WBS Definition-
Milestone: A completed mechanical stave prototype has been built

1.1.3.12	Finalize stave design and Readiness Review	8/1/03	8/14/03	$0	$0	$11,400	$11,400

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
1	MechEngF	150%	120 h	0 w	8/1/03	8/14/03	$6,120	$0	$0	$6,120	0 h	0 h	0 h	120 h
17	PhysicistF	200%	160 h	0 w	8/1/03	8/14/03	$0	$0	$0	$0	0 h	0 h	0 h	160 h
21	DesignerF	150%	120 h	0 w	8/1/03	8/14/03	$5,280	$0	$0	$5,280	0 h	0 h	0 h	120 h

Notes

WBS Definition-
Establish the design of staves and fixtures for stave fabrication, approve stave and fixture fabrication drawings

M&S BOE-
no costs associated with this item

Labor BOE-
Drawings to be completed using 1.5 designers and mechanical engineers. Two are physicists needed to verify all parts and make sure measurements are OK.

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
1.1.3.13	**Stave Core Production**	**7/18/03**	**3/26/04**	**$52,646**	**$0**	**$68,772**	**$121,418**

Notes
WBS Definition-
Summary task that includes all production and assembly of L2-L5 stave cores

1.1.3.13.1	**Stave Core Fabrication-South**	**7/18/03**	**1/23/04**	**$52,646**	**$0**	**$40,578**	**$93,224**

Notes
WBS Definition-
Summary task that includes all assembly of the stave cores for the South barrel

1.1.3.13.1.1	Procure stave core fixtures	8/15/03	11/7/03	$14,400	$0	$9,120	$23,520

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
1	MechEngF	20%	96 h	0 w	8/15/03	11/7/03	$4,896	$0	$0	$4,896	0 h	0 h	0 h	96 h
21	DesignerF	20%	96 h	0 w	8/15/03	11/7/03	$4,224	$0	$0	$4,224	0 h	0 h	0 h	96 h
48	MandS	14,400	14,400	0 w	8/15/03	11/7/03	$14,400	$0	$0	$14,400		0	0	14,400

Notes
WBS Definition-
Make any revisions to core fixture fabrication drawings taking into account knowledge gained from prototypes and procure the final core fabrication fixtures, QC fixtures.

M&S BOE-
4 fixtures @ $3600/fixture.

Labor BOE-
Time is allocated for consultation both with the designer and the mechancial engineer.

1.1.3.13.1.2	Procure stave core materials	7/18/03	11/7/03	$38,246	$0	$3,264	$41,510

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
1	MechEngF	10%	64 h	0 w	7/18/03	11/7/03	$3,264	$0	$0	$3,264	0 h	0 h	0 h	64 h
48	MandS	38,246	38,246	0 w	7/18/03	11/7/03	$38,246	$0	$0	$38,246		0	0	38,246

Notes
WBS Definition-
Procure carbon fiber, epoxy, insulating materials, and other materials needed for fabrication of all outer layer stave cores.

M&S BOE-
A total of 130 Stave cores will be fabricated for layers 3 and 4 with a cost breakdown of:
18 lb carbon fiber @ $800/lb
200 sq. ft. aluminum foil @ $0.05/sq. ft.
400 sq. ft. kapton @ $3/sq. ft.
264 nozzles @ $25 ea.
2 gal epoxy @ $300/gal
528 pins @ $3/pin
Total cost of $24,394.

There are a total of 72 Stave cores to be fabricated for layers 2 and 3 with a cost breakdown of:
10 lb carbon fiber @ $800/lb
120 sq. ft. aluminum foil @ $0.05/sq. ft.
240 sq. ft. kapton @ $3/sq. ft.
146 nozzles @ $25 ea.
2 gal epoxy @ $300/gal
292 pins @ $3/pin
Total cost of $13,852.
Overall cost for stave cores is $38,246.

Labor BOE-
Prototype procurements have needed some MechEng time to communicate with vendor.

1.1.3.13.1.3	Fabricate stave cores	11/10/03	12/23/03	$0	$0	$21,624	$21,624

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
1	MechEngF	10%	24 h	0 w	11/10/03	12/23/03	$1,224	$0	$0	$1,224	0 h	0 h	0 h	24 h
9	MechTechSF	250%	600 h	0 w	11/10/03	12/23/03	$20,400	$0	$0	$20,400	0 h	0 h	0 h	600 h

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost

"Fabricate stave cores" continued

Notes

WBS Definition-
Fabricate the cores for the outer layer south staves. The cores include a Carbon Fiber cooling tube, mounting hardware, and Rohacel core.

M&S BOE-
no costs associated with this item

Labor BOE-
There are 54 stave cores needed for the south layers 4 and 5. We assume 20% spares for a total of 65 stave cores to be built for layers 4 and 5. There are 30 stave cores needed for the south layers 2 and 3. We assume 20% spares for a total of 36 stave cores to be built. Overall, 101 stave cores will have to be built. We assume that 5 cooling tubes can be built per day out of carbon fiber with a yield of 50% and it takes one hour to build one cooling tube by a mechanical tech. Testing of the cooling tubes will also take 1 hour per tube by a mechanical tech. The construction of 200 cooling tubes and leak checking them will thus take 400 hours. Construction of the bulkhead ball mounts will take 1 hour for the 2 mounts per stave core by a mechanical tech. Assembly of the stave core will take 1 hour per stave core and be done using a fixture by a mechanical tech. This gives a total of 600 hours for 100 stave cores. A mechanical engineer will supervise this work at the 10% level.

1.1.3.13.1.4	QC stave cores	1/2/04	1/23/04	$0	$0	$6,570	$6,570

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
1	MechEngF	50%	60 h	0 w	1/2/04	1/23/04	$3,060	$0	$0	$3,060	0 h	0 h	0 h	60 h
9	MechTechSF	45%	54 h	0 w	1/2/04	1/23/04	$1,836	$0	$0	$1,836	0 h	0 h	0 h	54 h
27	CMMOperatorSF	45%	54 h	0 w	1/2/04	1/23/04	$1,674	$0	$0	$1,674	0 h	0 h	0 h	54 h
30	CMMSmall	100%	120 h	0 w	1/2/04	1/23/04	$0	$0	$0	$0	0 h	0 h	0 h	120 h

Notes

WBS Definition-
Measure stave cores and verify that they meet dimensional requirements, verify that insulating materials are intact, verify that cooling passages are leak free and not plugged

M&S BOE-
No costs associated with this item

Labor BOE-
Based on Run2a experience with measurement times. There will be 101 stave cores to be measured. We assume that the CMM operator and Mechanical tech will measure 30 per week working 4 hours per day. There is 1.5w of MechEng time to verify the measurements and supervise the operation.

1.1.3.13.2	Stave Cores For South Silicon Complete	1/23/04	1/23/04	$0	$0	$0	$0

Notes

WBS Definition-
Milestone: All stave cores have been produced and tested and are ready for modules to be mounted on them (for the south).

1.1.3.13.5	Stave Core Fabrication-North	1/26/04	3/26/04	$0	$0	$28,194	$28,194

Notes

WBS Definition-
Summary task that includes all assembly of the L4-L5 stave cores for the North barrel.

1.1.3.13.5.1	Fabricate stave cores	1/26/04	3/5/04	$0	$0	$21,624	$21,624

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
1	MechEngF	10%	24 h	0 w	1/26/04	3/5/04	$1,224	$0	$0	$1,224	0 h	0 h	0 h	24 h
9	MechTechSF	250%	600 h	0 w	1/26/04	3/5/04	$20,400	$0	$0	$20,400	0 h	0 h	0 h	600 h

Notes

WBS Definition-
Fabricate the cores for the outer layer south staves. The cores include a Carbon Fiber cooling tube, mounting hardware, and Rohacel core.

M&S BOE-
no costs associated with this item

Labor BOE-
There are 54 stave cores needed for the south layers 4 and 5. We assume 20% spares for a total of 65 stave cores to be built for layers 4 and 5. There are 30 stave cores needed for the south layers 2 and 3. We assume 20% spares for a total of 36 stave cores to be built. Overall, 101 stave cores will have to be built. We assume that 5 cooling tubes can be built per day out of carbon fiber with a yield of 50% and it takes one hour to build one cooling tube by a mechanical tech. Testing of the cooling tubes will also take 1 hour per tube by a mechanical tech. The construction of 200 cooling tubes and leak checking them will thus take 400 hours. Construction of the bulkhead ball mounts will take 1 hour for the 2 mounts per stave core by a mechanical tech. Assembly of the stave core will take 1 hour per stave core and be done using a fixture by a mechanical tech. This gives a total of 600 hours for 100 stave cores. A mechanical engineer will supervise this work at the 10% level.

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
1.1.3.13.5.2	QC stave cores	3/8/04	3/26/04	$0	$0	$6,570	$6,570

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
1	MechEngF	50%	60 h	0 w	3/8/04	3/26/04	$3,060	$0	$0	$3,060	0 h	0 h	0 h	60 h
9	MechTechSF	45%	54 h	0 w	3/8/04	3/26/04	$1,836	$0	$0	$1,836	0 h	0 h	0 h	54 h
27	CMMOperatorSF	45%	54 h	0 w	3/8/04	3/26/04	$1,674	$0	$0	$1,674	0 h	0 h	0 h	54 h
30	CMMSmall	100%	120 h	0 w	3/8/04	3/26/04	$0	$0	$0	$0	0 h	0 h	0 h	120 h

Notes

WBS Definition-
Measure stave cores and verify that they meet dimensional requirements, verify that insulating materials are intact, verify that cooling passages are leak free and not plugged.

M&S BOE-
No costs associated with this item

Labor BOE-
Based on Run2a experience with measurement times. There will be 101 stave cores to be measured. We assume that the CMM operator and Mechanical tech will measure 30 per week working 4 hours per day. There is 1.5w of MechEng time to verify the measurements and supervise the operation.

1.1.3.13.6	**Stave Cores For North Silicon Complete**	**3/26/04**	**3/26/04**	**$0**	**$0**	**$0**	**$0**

Notes

WBS Definition-
Milestone: All L4-L5 stave cores have been produced and tested and are ready for modules to be mounted on them for the north.

1.1.3.14	**Stave Shell Production**	**10/3/02**	**12/9/03**	**$62,672**	**$0**	**$43,928**	**$106,600**

Notes

WBS Definition-
Summary task that includes the fabrication and QC of the stave shells which are the carbon fiber supports along the edges of the staves (C-channels) and the cross bars between them.

M&S BOE-
For contingency:
On procurements, a 50% contingency is taken based on the guidelines. All fixturing has a 100% contingency on it to take into account non-finalized designs.

1.1.3.14.1	Procure shell fabrication fixtures	10/10/02	2/12/03	$14,672	$0	$0	$14,672

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
18	PhysicistU	20%	128 h	0 w	10/10/02	2/12/03	$0	$0	$0	$0	0 h	0 h	0 h	128 h
48	MandS	14,672	14,672	0 w	10/10/02	2/12/03	$14,672	$0	$0	$14,672		0	0	14,672

Notes

WBS Definition-
Design, document via drawings, and procure fixtures needed to fabricate stave shells, QC fixtures

M&S BOE-
8 fixtures @ $1834 ea. based upon estimate from U. Washington shop.

Labor BOE-
Time is allocated for consultation both with DesignerF and MechEngF.

1.1.3.14.2	Procure carbon fiber prepreg for shell preproduction	10/3/02	2/5/03	$7,500	$0	$3,264	$10,764

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
1	MechEngF	10%	64 h	0 w	10/3/02	2/5/03	$3,264	$0	$0	$3,264	0 h	0 h	0 h	64 h
48	MandS	7,500	7,500	0 w	10/3/02	2/5/03	$7,500	$0	$0	$7,500		0	0	7,500

Notes

WBS Definition-
Procure carbon fiber prepreg for shell prototypes.

M&S BOE-
5 lb 105 MSI fiber @ $1500/lb

Labor BOE-
Based on other carbon fiber procurements.

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
1.1.3.14.3	Fabricate preproduction stave shells	2/13/03	3/12/03	$0	$0	$13,600	$13,600

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
1	MechEngF	100%	160 h	0 w	2/13/03	3/12/03	$8,160	$0	$0	$8,160	0 h	0 h	0 h	160 h
9	MechTechSF	100%	160 h	0 w	2/13/03	3/12/03	$5,440	$0	$0	$5,440	0 h	0 h	0 h	160 h
17	PhysicistF	50%	80 h	0 w	2/13/03	3/12/03	$0	$0	$0	$0	0 h	0 h	0 h	80 h

Notes

WBS Definition-
Fabricate preproduction stave shells, verify that fixturing works, verify that mechanical precision and structural stiffness of shells are acceptable

M&S BOE-
no costs associated with this item.

Labor BOE-
Assume shells for up to 10 staves are built. Task takes 4 weeks of full time MechEng and MechTech for fabrication. Physicist supervises effort.

1.1.3.14.4	Procure carbon fiber prepreg for shells	3/13/03	7/3/03	$40,500	$0	$3,264	$43,764

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
1	MechEngF	10%	64 h	0 w	3/13/03	7/3/03	$3,264	$0	$0	$3,264	0 h	0 h	0 h	64 h
48	MandS	40,500	40,500	0 w	3/13/03	7/3/03	$40,500	$0	$0	$40,500		0	0	40,500

Notes

WBS Definition-
Procure carbon fiber prepreg for shells.

M&S BOE-
27 lb 105 MSI carbon fiber @ $1500/lb

Labor BOE-
Based on other carbon fiber procurements.

1.1.3.14.5	Fabricate stave shells South	8/15/03	9/19/03	$0	$0	$7,820	$7,820

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
1	MechEngF	10%	20 h	0 w	8/15/03	9/19/03	$1,020	$0	$0	$1,020	0 h	0 h	0 h	20 h
9	MechTechSF	100%	200 h	0 w	8/15/03	9/19/03	$6,800	$0	$0	$6,800	0 h	0 h	0 h	200 h

Notes

WBS Definition-
Fabricate stave shells including the C-Channel and cross bars.

M&S BOE-
no costs associated with this item

Labor BOE-
There will be 84 staves built for the south. Each stave has 2 stave shells. Assume 20% spares and a total of 200 C-Channels need to be fabricated. Assume that 40 channels can be fabricated per week by a mechanical tech working 6 hours per day. A mechanical engineer supervises the effort at the 10% level.

1.1.3.14.6	QC stave shells South	9/22/03	10/10/03	$0	$0	$4,080	$4,080

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
9	MechTechSF	100%	120 h	0 w	9/22/03	10/10/03	$4,080	$0	$0	$4,080	0 h	0 h	0 h	120 h
17	PhysicistF	25%	30 h	0 w	9/22/03	10/10/03	$0	$0	$0	$0	0 h	0 h	0 h	30 h

Notes

WBS Definition-
Perform and analyze CMM measurements to verify mechanical precision of stave shells.

M&S BOE-
no costs associated with this item

Labor BOE-
A fixture is available to test the stave shell components. There are 200 components to test and the mechanical technician can test 100 parts per week. An extra week is assigned to understand the results and retest if needed. The physicist analyses the results at the 25% level of effort.

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
1.1.3.14.7	**Stave Shells For South Silicon Complete**	**10/10/03**	**10/10/03**	**$0**	**$0**	**$0**	**$0**

Notes
WBS Definition-
Milestone: All stave shells have been produced at tested for the south barrel

1.1.3.14.8	Fabricate stave shells North	10/13/03	11/14/03	$0	$0	$7,820	$7,820

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
1	MechEngF	10%	20 h	0 w	10/13/03	11/14/03	$1,020	$0	$0	$1,020	0 h	0 h	0 h	20 h
9	MechTechSF	100%	200 h	0 w	10/13/03	11/14/03	$6,800	$0	$0	$6,800	0 h	0 h	0 h	200 h

Notes
WBS Definition-
Fabricate stave shells including the C-Channel and cross bars.

M&S BOE-
no costs associated with this item

Labor BOE-
There will be 84 staves built for the North. Each stave has 2 stave shells. Assume 20% spares and a total of 200 C-Channels need to be fabricated. Assume that 40 channels can be fabricated per week by a mechanical tech working 6 hours per day. A mechanical engineer supervises the effort at the 10% level.

1.1.3.14.9	QC stave shells North	11/17/03	12/9/03	$0	$0	$4,080	$4,080

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
9	MechTechSF	100%	120 h	0 w	11/17/03	12/9/03	$4,080	$0	$0	$4,080	0 h	0 h	0 h	120 h
17	PhysicistF	25%	30 h	0 w	11/17/03	12/9/03	$0	$0	$0	$0	0 h	0 h	0 h	30 h

Notes
WBS Definition-
Perform and analyze CMM measurements to verify mechanical precision of stave shells.

M&S BOE-
no costs associated with this item

Labor BOE-
A fixture is available to test the stave shell components. There are 200 components to test and the mechanical technician can test 100 parts per week. An extra week is assigned to understand the results and retest if needed. The physicist analyses the results at the 25% level of effort.

1.1.3.14.10	**Stave Shells For North Silicon Complete**	**12/9/03**	**12/9/03**	**$0**	**$0**	**$0**	**$0**

Notes
WBS Definition-
Milestone: All stave shells have been produced at tested for the North barrel.

1.1.4	**Detector Production and Testing**	**10/2/00**	**3/25/05**	**$184,452**	**$0**	**$851,639**	**$1,036,090**

Notes
WBS Definition-
This summary element includes the hardware and software used in testing and quality assurance activities associated with silicon sensor, hybrid, and detector module production. It includes test stands/stations, storage boxes, commercial diagnostic and database software for recording test results.

M&S BOE-
Costs are listed per line. There are:
1. module boxes costs with contingency of 50% based on guidelines
2. Fixture costs with contingency of 100% because there are not detailed designs existing
3. Epoxy costs with contingency of 100% because we are still looking towards a vendor to provide the necessary glues

Labor BOE-
There is a flat contingency of 50% put on all labor except for the L2-L5 module and stave production tasks. Here there is a 100% contingency placed. This is based on experience from Run2a module and stave assembly where we ended up using another 0.5 shift of the technicians. They receive time and a half pay so that we need at least 75% contingency for this. We've also assumed another 25% on top of that for safety.

1.1.4.1	**Develop Module**	**9/4/02**	**8/3/04**	**$79,200**	**$0**	**$0**	**$79,200**

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
1.1.4.1.1	Develop module burn-in stands (MRI)	6/19/03	8/14/03	$0	$0	$0	$0

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
44	PostDoc	100%	320 h	0 w	6/19/03	8/14/03	$0	$0	$0	$0	0 h	0 h	0 h	320 h

Notes

WBS Definition-
Development of the module burn-in stands. There will be 2 stations which use the stand-alone sequencers (SASEQs)each with a capability to burn in 16 modules. Therefore, there are 8 SASEQs, etc and HV supplies for 16 modules.

M&S BOE-
no costs associated with this item. The burn-in station parts are procured through the SASEQ test station tasks.

Labor BOE-
This is a task done in conjunction with the parallel Fermilab task. A full-time post-doc is needed to verify the operation, setup and software for the test-stands, based on Run2a experience.

1.1.4.1.2	Fixturing through MRI grant	9/4/02	8/3/04	$21,200	$0	$0	$21,200

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
18	PhysicistU	5%	190 h	0 w	9/4/02	8/3/04	$0	$0	$0	$0	0 h	0 h	2.8 h	187.2 h
48	MandS	21,200	21,200	0 w	9/4/02	8/3/04	$21,200	$0	$21,200	$0		0	312.42	20,887.58

Notes

WBS Definition-
Fixturing funded by MRI institutions.

M&S BOE-
All Layer 0 readout module fixtures and all wirebonding fixtures. See the M&S BOE on the appropriate lines:
WBS 1.1.4.3.4 $2100 for L2-L5 initial wirebonding fixture
WBS 1.1.4.4.2 $2900 for initial Layer 0 readout module fixtures
WBS 1.1.4.4.5 $5800 for final layer 0 module
WBS 1.1.4.4.8 $1900 for initial Layer 0 wirebonding fixture
WBS 1.1.4.4.11 $1900 for production Layer 0 wirebonding fixture
WBS 1.1.4.5.8 $1200 for initital layer 1 wirebonding fixture
WBS 1.1.4.5.11 $1200 for production Layer 1 wirebonding fixture
WBS 1.1.4.6.10 $4200 for L2-L5 production wirebonding fixtures
Total $21,200

Labor BOE-
Assume physicist oversight to help put the jobs through the shops.

1.1.4.1.3	Module boxes	12/5/02	5/5/03	$58,000	$0	$0	$58,000

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
18	PhysicistU	20%	160 h	0 w	12/5/02	5/5/03	$0	$0	$0	$0	0 h	0 h	0 h	160 h
48	MandS	58,000	58,000	0 w	12/5/02	5/5/03	$58,000	$0	$0	$58,000		0	0	58,000

Notes

WBS Definition-
Production of module boxes for storage and testing and burn-in of assembled silicon modules.

M&S BOE-
Each box costs $100. The total number of boxes needed is 580 with the following breakdown:
150 Layer 0 boxes
80 Layer 1 boxes
175 10-10 boxes
175 20-20 boxes.
Initial cost estimate by J. Fast. Independent detailed estimate based on preliminary design
is included in BOE book.

Labor BOE-
A university physicist oversees the production at the 20% level
The boxes are assembled in the university shops and assembly manpower is included in the M&S cost.

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
1.1.4.2	Develop module burn-in stands (Fermilab)	6/19/03	8/14/03	$0	$0	$46,080	$46,080

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
4	ElecEngF	100%	320 h	0 w	6/19/03	8/14/03	$17,600	$0	$0	$17,600	0 h	0 h	0 h	320 h
9	MechTechSF	100%	320 h	0 w	6/19/03	8/14/03	$10,880	$0	$0	$10,880	0 h	0 h	0 h	320 h
12	ElecTechSF	100%	320 h	0 w	6/19/03	8/14/03	$10,560	$0	$0	$10,560	0 h	0 h	0 h	320 h
17	PhysicistF	100%	320 h	0 w	6/19/03	8/14/03	$0	$0	$0	$0	0 h	0 h	0 h	320 h
21	DesignerF	50%	160 h	0 w	6/19/03	8/14/03	$7,040	$0	$0	$7,040	0 h	0 h	0 h	160 h

Notes

WBS Definition-
Development of the module burn-in stands. There will be 2 stations which use the stand-alone sequencers (SASEQs) each with a capability to burn in 16 modules. Therefore, there are 8 SASEQs, etc and HV supplies for 16 modules.

M&S BOE-
no costs associated with this item. The burn-in station parts are procured through the SASEQ test station tasks.

Labor BOE-
This is a task done in conjunction with the parallel MRI task.
Based on Run2a experience:
PhysicistF full time
Electrical Engineer consultant full time
Mechanical Tech to set up cooling systems full time
and Electrical Tech for to help assemble parts.
Designer is needed to draw up plate assembly parts for 4 weeks.

1.1.4.3	**Module R&D Tasks**	**6/24/02**	**1/27/03**	**$8,856**	**$0**	**$66,200**	**$75,056**

Notes

WBS Definition-
Summary task that includes all design and prototyping work associated with the different modules during the R&D phase of the project.

1.1.4.3.1	Design module gang and readout fixtures for L2-5	6/24/02	9/3/02	$0	$0	$36,600	$36,600

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
1	MechEngF	50%	200 h	0 w	6/24/02	9/3/02	$10,200	$0	$10,200	$0	0 h	0 h	200 h	0 h
17	PhysicistF	50%	200 h	0 w	6/24/02	9/3/02	$0	$0	$0	$0	0 h	0 h	200 h	0 h
18	PhysicistU	10%	40 h	0 w	6/24/02	9/3/02	$0	$0	$0	$0	0 h	0 h	40 h	0 h
21	DesignerF	150%	600 h	0 w	6/24/02	9/3/02	$26,400	$0	$26,400	$0	0 h	0 h	600 h	0 h

Notes

WBS Definition-
L2-5 modules consist of two or four sensors and a hybrid mounted spanning a pair of sensors. There are 4 module types: 10-10 and 20-20 axial and 10-10 and 20-20 stereo, where the numbers indicate the readout lengths at each end of the module. The module fabrication includes installation of a HV connection between the hybrid and the back plane of the sensors, lamination of an insulating Kapton foil over the back side (HV plane) of the sensors and provisions for grounding/shielding of the module from the carbon fiber support structure. There are two fixtures required, one for alignment and hybrid attachment and a second one to do all of the required work on the back side of the module. This task involves the development of fixture designs and drawings for production of prototype fixtures for each of these assembly steps for each module type.

Labor BOE-
Two fixtures are required for each of the 4 module types. Designing fixtures for the first module type is 60% of the effort. Adapting this design to the other 3 module types accounts for the remaining 40% of the effort. Approximately 30-35 detailed part and assembly drawings required. Requires review and approval of drawings by ME and PHYS prior to fabrication of initial fixtures.

1.1.4.3.2	Procure initial layer 2-5 gang and readout module fixtu	9/4/02	10/15/02	$7,475	$0	$1,752	$9,227

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
1	MechEngF	10%	24 h	0 w	9/4/02	10/15/02	$1,224	$0	$286	$938	0 h	0 h	5.6 h	18.4 h
21	DesignerF	5%	12 h	0 w	9/4/02	10/15/02	$528	$0	$123	$405	0 h	0 h	2.8 h	9.2 h
48	MandS	7,475	7,475	0 w	9/4/02	10/15/02	$7,475	$0	$7,475	$0		0	1,744.17	5,730.83

Notes

WBS Definition-
Machining and parts procurement for initial fixtures

M&S BOE-
In order to have equipment to prototype each of the five module types we will need the following parts machined: Four vacuum chucks (2x10cm, 2x20cm) at 7 hrs each, four bearing pucks at 1.5 hrs each, four center vacuum chucks (two each axial and stereo) at 7 hrs each, riser block, riser post and adjustment screw set at 8.5 hrs, one each short and long base plates at 6 hrs each, eight adjustment screw and spring plunger holding plates at 1 hr each, 4 flipping fixtures at 6 hrs. each, plus 5 hrs for miscellaneous parts and modifications. This comes to a total of 119.5 hrs. Materials costs and purchase parts are estimated at

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost

"Procure initial layer 2-5 gang and readout module fixtures" continued

Notes

$1500 for the lot. Total estimated cost is $7475.

Labor BOE-
Typical procurement time via local shop, engineer spends 6 days interfacing with purchasing and vendor, designer spends 3 days preparing drawings and interfacing on issues regarding drawing details.

1.1.4.3.3	Design L2-L5 wire bonding fixtures	9/4/02	10/8/02	$0	$0	$6,580	$6,580

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
1	MechEngF	30%	60 h	0 w	9/4/02	10/8/02	$3,060	$0	$857	$2,203	0 h	0 h	16.8 h	43.2 h
17	PhysicistF	30%	60 h	0 w	9/4/02	10/8/02	$0	$0	$0	$0	0 h	0 h	16.8 h	43.2 h
21	DesignerF	40%	80 h	0 w	9/4/02	10/8/02	$3,520	$0	$986	$2,534	0 h	0 h	22.4 h	57.6 h

Notes

WBS Definition-
Design of a fixture to hold L2-L5 modules for wire bonding. There are 4 module types but we anticipate only needing two unique fixtures. Production of associated drawings for fabrication of a prototype fixture.

Labor BOE-
The expectation is that a Fermilab physicist and mechanical engineer will spend two weeks on the initial designs. The designer will spend 2 weeks making initial drawings. A final week, involving the Fermilab physicist, mechanical engineer and designer, will be spent reviewing drawings for approval and making any required changes. All of the above occurs at 50% effort over the indicated durations.

1.1.4.3.4	Procure initial L2-L5 wire bonding fixtures	10/9/02	11/19/02	$0	$0	$1,752	$1,752

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
1	MechEngF	10%	24 h	0 w	10/9/02	11/19/02	$1,224	$0	$0	$1,224	0 h	0 h	0 h	24 h
21	DesignerF	5%	12 h	0 w	10/9/02	11/19/02	$528	$0	$0	$528	0 h	0 h	0 h	12 h

Notes

WBS Definition-
Machining and parts procurement for initial fixtures

M&S BOE-
There are three components to this tooling. The first two are similar fixtures to hold the 10-10 modules and 20-20 modules during bonding. These are precision vacuum chucks. The 20-20 fixture is longer with similar flatness required and hence higher cost than the 10-10 module fixture. The third component is adapter hardware to allow for mounting of the vacuum chucks on the existing hardware of the 8090 bonding machine. The two vacuum chacks and module clamp bars are estimated at 26 hours of machining and the mounting adapter hardware at 7 hours, for a total of 33 hours, or $1650. Parts and materials are estimated at $450. Total cost $2100. Cost is assumed under MRI fixturing task.

Labor BOE-
Typical procurement interaction with University shop. Fermilab engineer spends about 3 days getting drawings to university and discussing the job with the shop. A university physicist is allocated at 5% for 95 weeks under wbs 1.1.4.1.2 (Fixturing through MRI grant) to oversee jobs at the university shop and to manage the accounting for the work.

1.1.4.3.5	Develop L1 module prototype	12/5/02	1/27/03	$376	$0	$9,396	$9,772

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
1	MechEngF	15%	36 h	0 w	12/5/02	1/27/03	$1,836	$0	$0	$1,836	0 h	0 h	0 h	36 h
9	MechTechSF	30%	72 h	0 w	12/5/02	1/27/03	$2,448	$0	$0	$2,448	0 h	0 h	0 h	72 h
12	ElecTechSF	5%	12 h	0 w	12/5/02	1/27/03	$396	$0	$0	$396	0 h	0 h	0 h	12 h
17	PhysicistF	100%	240 h	0 w	12/5/02	1/27/03	$0	$0	$0	$0	0 h	0 h	0 h	240 h
21	DesignerF	15%	36 h	0 w	12/5/02	1/27/03	$1,584	$0	$0	$1,584	0 h	0 h	0 h	36 h
23	WirebonderSF	5%	12 h	0 w	12/5/02	1/27/03	$324	$0	$0	$324	0 h	0 h	0 h	12 h
27	CMMOperatorSF	15%	36 h	0 w	12/5/02	1/27/03	$1,116	$0	$0	$1,116	0 h	0 h	0 h	36 h
28	CMMProgrammerSF	15%	36 h	0 w	12/5/02	1/27/03	$1,692	$0	$0	$1,692	0 h	0 h	0 h	36 h
29	WirebondingMachineF	5%	12 h	0 w	12/5/02	1/27/03	$0	$0	$0	$0	0 h	0 h	0 h	12 h
30	CMMSmall	65%	156 h	0 w	12/5/02	1/27/03	$0	$0	$0	$0	0 h	0 h	0 h	156 h
48	MandS	376	376	0 w	12/5/02	1/27/03	$376	$0	$0	$376		0	0	376

Notes

WBS Definition-
Design and prototyping of a L1 module. Includes mechanical design and integration of HV isolation and any required electrical shielding to eliminate noise pickup from the conductive support structure.

M&S BOE-
Ceramic precision cut to hybrid dimensions with al lot cost of $236. Sensor blanks require cutting of four 6" wafers at $12.25 each. Epoxy cost based on 12 10cc mixed batches with an anticipated cost of $1500 for 20 liters of epoxy ($0.75 per 10cc), including purity testing. In addition there will be 2 packets of silver epoxy, at $11 each. Additional miscellaneous parts and materials included at $60 total. Total cost is $376.

Labor BOE-

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost

"Develop L1 module prototype" continued

Notes

Assembly and inspection of prototype modules, including refinement of assembly sequence and tooling. The physicist and engineer will develop the assembly procedures with the mechanical technician utilizing the initial L1 module fixtures. This is expected to require 2 weeks. The following 2 weeks will be spent assembling mechanical parts and debugging the process with the designer revising drawings as needed. The final 2 weeks will be spent making prototypes using sensors produced at ELMA and prototype hybrids produced by CPT. These will have fiducials on the sensors so that CMM programming for module production can begin, as well as wire bonding programming and bonding of the prototypes. A small allocation of an electrical technician is included to provide support in this final stage.

1.1.4.3.6	Fabricate mechanical module prototypes	10/16/02	11/12/02	$1,005	$0	$10,120	$11,125

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
1	MechEngF	25%	40 h	0 w	10/16/02	11/12/02	$2,040	$0	$0	$2,040	0 h	0 h	0 h	40 h
9	MechTechSF	25%	40 h	0 w	10/16/02	11/12/02	$1,360	$0	$0	$1,360	0 h	0 h	0 h	40 h
17	PhysicistF	100%	160 h	0 w	10/16/02	11/12/02	$0	$0	$0	$0	0 h	0 h	0 h	160 h
21	DesignerF	25%	40 h	0 w	10/16/02	11/12/02	$1,760	$0	$0	$1,760	0 h	0 h	0 h	40 h
27	CMMOperatorSF	100%	160 h	0 w	10/16/02	11/12/02	$4,960	$0	$0	$4,960	0 h	0 h	0 h	160 h
30	CMMSmall	100%	160 h	0 w	10/16/02	11/12/02	$0	$0	$0	$0	0 h	0 h	0 h	160 h
48	MandS	1,005	1,005	0 w	10/16/02	11/12/02	$1,005	$0	$0	$1,005		0	0	1,005

Notes

WBS Definition-
Use CMMs and fixtures to glue mechanical parts together and test tolerances for all module types

M&S BOE-
Ceramic precision cut for each of 2 hybrid types. Typical lot cost of $230 for each hybrid type. Three of each module type for L2-L5 requires a total of 36 sensor blanks. Two sensor blanks per wafer with 10% loss during cutting means roughly 20 silicon wafers will be needed. Blank 6" diameter, 300-320 micron thick silicon wafers at $12.25 each. Epoxy cost based on two 10cc mix per day with an anticipated cost of $1500 for 20 liters of epoxy ($0.75 per 10cc), including purity testing. In addition there will be 1 packet of silver epoxy used every other day, at $11 each. Additional miscellaneous parts and materials included at $160 total. Total cost estimate is $1005.

Labor BOE-
Mechanical tech operating dicing saw can cut 5 silicon wafers per day. Attachment of fiducials to blank sensors at a rate of 10 sensors per day. Assembly of three of each of 4 module types, 2 days each. It is anticipated that this will fully occupy a small CMM, CMM technician and Physicist for the entire period, 50% for assembly and 50% for inspection. A mechanical technician, mechanical engineer and designer are allocated at 25% to provide support with assembly operations, fixture questions, drawing revisions and fixture modifications.

1.1.4.4	**L0 Readout Module Fixtures**	**10/3/02**	**1/26/04**	**$0**	**$0**	**$50,336**	**$50,336**

Notes

WBS Definition-
The summary task that includes all of the L0 readout module fixture design, production, and QC

1.1.4.4.1	Design initial L0 fixtures (Fermilab)	10/3/02	11/27/02	$0	$0	$15,200	$15,200

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
1	MechEngF	50%	160 h	0 w	10/3/02	11/27/02	$8,160	$0	$0	$8,160	0 h	0 h	0 h	160 h
17	PhysicistF	50%	160 h	0 w	10/3/02	11/27/02	$0	$0	$0	$0	0 h	0 h	0 h	160 h
18	PhysicistU	10%	32 h	0 w	10/3/02	11/27/02	$0	$0	$0	$0	0 h	0 h	0 h	32 h
21	DesignerF	50%	160 h	0 w	10/3/02	11/27/02	$7,040	$0	$0	$7,040	0 h	0 h	0 h	160 h

Notes

WBS Definition-
L0 modules consist of a sensor, a pair of analogue cables and hybrid. Fixtures are required for each assembly step. The first step is to glue ceramic spacers to the ends of the cables and to glue the cables to each other. The second step is to glue this cable pair to the sensor. The third step involves gluing the other end of the cable to the hybrid. The final step is to wire bond the cable to the sensor and hybrid. This task involves the development of fixture designs and drawings for production of prototype fixtures for each of these assembly steps.

Labor BOE-
The expectation is that a Fermilab physicist and mechanical engineer will spend one week per fixture on the initial designs for the three required fixtures. The designer will spend 3 weeks making initial drawings. The Fermilab physicist and university physicist will review the drawings and confirm that the finished product will integrate properly with the support structure (1 week). A final week, involving the Fermilab physicist, mechanical engineer and designer, is spent reviewing drawings for approval and making any required changes.

1.1.4.4.2	Procure initial layer 0 readout module fixtures	12/2/02	3/5/03	$0	$0	$1,224	$1,224

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
1	MechEngF	5%	24 h	0 w	12/2/02	3/5/03	$1,224	$0	$0	$1,224	0 h	0 h	0 h	24 h

Notes

WBS Definition-
Machining and parts procurement for initial fixtures

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost

"Procure initial layer 0 readout module fixtures" continued

Notes

M&S BOE-
Three fixtures are needed. Material and part costs of $100 per fixture. Machining time of 10 hrs for the cable gluing fixture and 20 hours each for the cable to sensor and cable to hybrid gluing fixtures. Total of 50 hrs @$50/hr plus $400 parts and materials for a total of $2900.
Costs are assumed under MRI machining task.

Labor BOE-
University physicist is expected to spend 30 hrs to initiate and closeout fabrication during the first and last week of the fabrication cycle. An additional 4 hrs per week of oversight is added for the remainder of the production time.

1.1.4.4.3	QC readout module fixtures(Fermilab)	3/6/03	3/19/03	$0	$0	$5,880	$5,880

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
1	MechEngF	50%	40 h	0 w	3/6/03	3/19/03	$2,040	$0	$0	$2,040	0 h	0 h	0 h	40 h
9	MechTechSF	50%	40 h	0 w	3/6/03	3/19/03	$1,360	$0	$0	$1,360	0 h	0 h	0 h	40 h
17	PhysicistF	30%	24 h	0 w	3/6/03	3/19/03	$0	$0	$0	$0	0 h	0 h	0 h	24 h
27	CMMOperatorSF	100%	80 h	0 w	3/6/03	3/19/03	$2,480	$0	$0	$2,480	0 h	0 h	0 h	80 h
30	CMMSmall	100%	80 h	0 w	3/6/03	3/19/03	$0	$0	$0	$0	0 h	0 h	0 h	80 h

Notes

WBS Definition-
Verify that the initial set of fixtures meet specifications and perform as designed

Labor BOE-
CMM and operator used throughout period. Roughly one half of the time is for inspection of fixtures with consultation of ME to understand measurement results. The other half of the time is spent with the mechanical technician excercising the fixtures for functionality.

1.1.4.4.4	Finalize readout module fabrication fixtures	8/11/03	9/8/03	$0	$0	$8,656	$8,656

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
1	MechEngF	50%	80 h	0 w	8/11/03	9/8/03	$4,080	$0	$0	$4,080	0 h	0 h	0 h	80 h
17	PhysicistF	50%	80 h	0 w	8/11/03	9/8/03	$0	$0	$0	$0	0 h	0 h	0 h	80 h
21	DesignerF	65%	104 h	0 w	8/11/03	9/8/03	$4,576	$0	$0	$4,576	0 h	0 h	0 h	104 h

Notes

WBS Definition-
Revise fixture drawings and specifications to take into account information learned from the first fixture set

Labor BOE-
Two physicists and engineer working 50% for 1 week to complete design changes. Two weeks drafting by designer full time with 25% of physicist and engineer to complete drawing revisions. One week of 2 physicists, engineer and designer each at 50% to review and approve drawings for fabrication of production parts.

1.1.4.4.5	Procure remaining layer 0 module fixtures	9/9/03	1/9/04	$0	$0	$1,632	$1,632

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
1	MechEngF	5%	32 h	0 w	9/9/03	1/9/04	$1,632	$0	$0	$1,632	0 h	0 h	0 h	32 h

Notes

WBS Definition-
Machining and parts procurement for final fixtures

M&S BOE-
Two sets of three fixtures. Material and part costs of $100 per fixture. Machining time of 10 hrs for the cable gluing fixture and 20 hours each for the cable to sensor and cable to hybrid gluing fixtures. Total of 100 hrs @$50/hr plus $800 parts and materials for a total of $5800. Cost is assumed under MRI fixturing task.

Labor BOE-
University physicist is expected to spend 30 hrs to initiate and closeout fabrication during the first and last week of the fabrication cycle. An additional 4 hrs per week of oversight is added for the remainder of the production time. Fermilab physicist responds to any fabrication questions from University shops

1.1.4.4.6	QC readout module fixtures	1/12/04	1/26/04	$0	$0	$4,520	$4,520

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
1	MechEngF	50%	40 h	0 w	1/12/04	1/26/04	$2,040	$0	$0	$2,040	0 h	0 h	0 h	40 h
17	PhysicistF	30%	24 h	0 w	1/12/04	1/26/04	$0	$0	$0	$0	0 h	0 h	0 h	24 h
27	CMMOperatorSF	100%	80 h	0 w	1/12/04	1/26/04	$2,480	$0	$0	$2,480	0 h	0 h	0 h	80 h
30	CMMSmall	100%	80 h	0 w	1/12/04	1/26/04	$0	$0	$0	$0	0 h	0 h	0 h	80 h

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost

"QC readout module fixtures" continued

Notes

WBS Definition-
Verify that the remaining fixtures meet specifications and perform as designed

Labor BOE-
Assume full time measurements at CMM and consulting with an MEF to understand results based on Run2a measurement times

1.1.4.4.7	Design Layer 0 wirebonding fixture	1/8/03	2/5/03	$0	$0	$4,856	$4,856

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
1	MechEngF	25%	40 h	0 w	1/8/03	2/5/03	$2,040	$0	$0	$2,040	0 h	0 h	0 h	40 h
17	PhysicistF	25%	40 h	0 w	1/8/03	2/5/03	$0	$0	$0	$0	0 h	0 h	0 h	40 h
21	DesignerF	40%	64 h	0 w	1/8/03	2/5/03	$2,816	$0	$0	$2,816	0 h	0 h	0 h	64 h

Notes

WBS Definition-
Design of fixtures to hold L0 module (sensor end and hybrid end) for wire bonding. Production of associated drawings for fabrication of a prototype fixture.

Labor BOE-
The expectation is that a Fermilab physicist and mechanical engineer will spend one week on the initial design. The designer will spend 2 weeks making initial drawings. A final week, involving the Fermilab physicist, mechanical engineer and designer, is spent reviewing drawings for approval and making any required changes. All of the above occurs at 50% effort over the indicated durations.

1.1.4.4.8	Procure initial L0 wire bonding fixtures	2/6/03	4/30/03	$0	$0	$1,224	$1,224

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
1	MechEngF	5%	24 h	0 w	2/6/03	4/30/03	$1,224	$0	$0	$1,224	0 h	0 h	0 h	24 h

Notes

WBS Definition-
Machining and parts procurement for initial fixtures

M&S BOE-
Two fixtures (sensor end and hybrid end). Material and part costs of $200 per fixture. Machining time of 15 hrs each. Total cost $1900. Cost is assumed under the MRI fixturing task.

Labor BOE-
Typical procurement interaction with University shop. Fermilab engineer spends about 3 days getting drawings to university and discussing the job with the shop. A university physicist is allocated at 5% for 95 weeks under wbs 1.1.4.1.2 (Fixturing through MRI grant) to oversee jobs at the university shop and to manage the accounting for the work.

1.1.4.4.9	QC initial L0 wire bonding fixtures	5/1/03	5/14/03	$0	$0	$2,320	$2,320

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
17	PhysicistF	30%	24 h	0 w	5/1/03	5/14/03	$0	$0	$0	$0	0 h	0 h	0 h	24 h
23	WirebonderSF	50%	40 h	0 w	5/1/03	5/14/03	$1,080	$0	$0	$1,080	0 h	0 h	0 h	40 h
27	CMMOperatorSF	50%	40 h	0 w	5/1/03	5/14/03	$1,240	$0	$0	$1,240	0 h	0 h	0 h	40 h
29	WirebondingMachineF	50%	40 h	0 w	5/1/03	5/14/03	$0	$0	$0	$0	0 h	0 h	0 h	40 h
30	CMMSmall	50%	40 h	0 w	5/1/03	5/14/03	$0	$0	$0	$0	0 h	0 h	0 h	40 h

Notes

WBS Definition-
Verify that the initial set of fixtures meet specifications and perform as designed

Labor BOE-
CMM and operator used throughout period. Roughly one half of the time is for inspection of fixtures with consultation of ME to understand measurement results. The other half of the time is spent with the wirebonding technician excercising the fixtures for functionality.

1.1.4.4.10	Finalize L0 wire bonding fixtures	9/9/03	9/22/03	$0	$0	$2,780	$2,780

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
1	MechEngF	25%	20 h	0 w	9/9/03	9/22/03	$1,020	$0	$0	$1,020	0 h	0 h	0 h	20 h
17	PhysicistF	50%	40 h	0 w	9/9/03	9/22/03	$0	$0	$0	$0	0 h	0 h	0 h	40 h
21	DesignerF	50%	40 h	0 w	9/9/03	9/22/03	$1,760	$0	$0	$1,760	0 h	0 h	0 h	40 h

Notes

WBS Definition-
Revise fixture drawings and specifications to take into account information learned from the first fixture set

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost

"Finalize L0 wire bonding fixtures" continued

Notes

Labor BOE-
Physicist and engineer working part time for 1 week to complete design changes and second week to review and approve drawings for fabrication of production parts. Designer at 50% throughout period to revise drawings as required.

1.1.4.4.11	Procure production L0 wire bonding fixtures	9/23/03	12/17/03	$0	$0	$1,224	$1,224

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
1	MechEngF	5%	24 h	0 w	9/23/03	12/17/03	$1,224	$0	$0	$1,224	0 h	0 h	0 h	24 h

Notes

WBS Definition-
Machining and parts procurement for final fixtures

M&S BOE-
Two fixtures (sensor end and hybrid end). Material and part costs of $200 per fixture. Machining time of 15 hrs each. Total cost $1900. Cost is assumed under MRI fixturing task.

Labor BOE-
Typical procurement interaction with University shop. Fermilab engineer spends about 3 days getting drawings to university and discussing the job with the shop. A university physicist is allocated at 5% for 95 weeks under wbs 1.1.4.1.2 (Fixturing through MRI grant) to oversee jobs at the university shop and to manage the accounting for the work.

1.1.4.4.12	QC production L0 wire bonding fixtures	12/18/03	1/2/04	$0	$0	$820	$820

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
1	MechEngF	25%	10 h	0 w	12/18/03	1/2/04	$510	$0	$0	$510	0 h	0 h	0 h	10 h
17	PhysicistF	30%	12 h	0 w	12/18/03	1/2/04	$0	$0	$0	$0	0 h	0 h	0 h	12 h
27	CMMOperatorSF	25%	10 h	0 w	12/18/03	1/2/04	$310	$0	$0	$310	0 h	0 h	0 h	10 h
30	CMMSmall	25%	10 h	0 w	12/18/03	1/2/04	$0	$0	$0	$0	0 h	0 h	0 h	10 h

Notes

WBS Definition-
Verify that the remaining fixtures meet specifications and perform as designed

Labor BOE-
Inspection of fixture on the CMM with consultation Physicist to understand measurement results.

1.1.4.5	**L1 Readout Module Fixtures**	**10/1/02**	**12/5/03**	**$9,450**	**$0**	**$50,780**	**$60,230**

Notes

WBS Definition-
The summary task that includes all of the L1 readout module fixture design, production, and QC

1.1.4.5.1	Design fixtures(Fermilab)	10/1/02	11/18/02	$0	$0	$13,300	$13,300

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
1	MechEngF	50%	140 h	0 w	10/1/02	11/18/02	$7,140	$0	$0	$7,140	0 h	0 h	0 h	140 h
17	PhysicistF	50%	140 h	0 w	10/1/02	11/18/02	$0	$0	$0	$0	0 h	0 h	0 h	140 h
18	PhysicistU	10%	28 h	0 w	10/1/02	11/18/02	$0	$0	$0	$0	0 h	0 h	0 h	28 h
21	DesignerF	50%	140 h	0 w	10/1/02	11/18/02	$6,160	$0	$0	$6,160	0 h	0 h	0 h	140 h

Notes

WBS Definition-
L1 modules consist of two sensors and a hybrid mounted spanning the sensors. The module fabrication includes installation of a HV connection between the hybrid and the back plane of the sensors, lamination of an insulating Kapton foil over the back side (HV plane) of the sensors and provisions for grounding/shielding of the module from the carbon fiber support structure. There are two fixtures required, one for alignment and hybrid attachment and a second one to do all of the required work on the back side of the module. This task involves the development of fixture designs and drawings for production of prototype fixtures for each of these assembly steps.

Labor BOE-
The expectation is that a Fermilab physicist and mechanical engineer will spend two weeks per fixture on the initial designs for the two required fixtures. The designer will spend 2 weeks making initial drawings. The Fermilab physicist and university physicist will review the drawings and confirm that the finished product will integrate properly with the support structure (1 week). A final week, involving the Fermilab physicist, mechanical engineer and designer, is spent reviewing drawings for approval and making any required changes.

1.1.4.5.2	Procure initial layer 1 readout module fixtures	10/22/02	11/18/02	$3,350	$0	$1,216	$4,566

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
1	MechEngF	8%	12.8 h	0 w	10/22/02	11/18/02	$653	$0	$0	$653	0 h	0 h	0 h	12.8 h

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
"Procure initial layer 1 readout module fixtures" continued							

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
21	DesignerF	8%	12.8 h	0 w	10/22/02	11/18/02	$563	$0	$0	$563	0 h	0 h	0 h	12.8 h
48	MandS	3,350	3,350	0 w	10/22/02	11/18/02	$3,350	$0	$0	$3,350		0	0	3,350

Notes

WBS Definition-
Machining and parts procurement for initial fixtures

M&S BOE-
Prototyping of L1 modules requires one module assembly fixture with an estimated machining time of 51 hours: 2 vacuum chucks at 7 hrs each, 2 bearing pucks at 1.5 hr each, 1 center vacuum chuck at 7 hrs, 1 riser block, riser post and adjustment screw set at 8.5 hrs per set, 1 base plate at 6 hrs, 4 adjustment screw and spring plunger plates at 1 hr each, 1 flipping fixture at 6 hrs plus 2.5 hrs for miscellaneous parts and modifications. Materials and purchase parts are estimated at $800, giving a total cost of $3350.

Labor BOE-
A typical procurement through Fermilab with an outside vendor takes 2 days for an ME and a designer each.

1.1.4.5.3	QC initial readout module fixtures	11/19/02	12/4/02	$0	$0	$6,760	$6,760

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
1	MechEngF	50%	40 h	0 w	11/19/02	12/4/02	$2,040	$0	$0	$2,040	0 h	0 h	0 h	40 h
9	MechTechSF	50%	40 h	0 w	11/19/02	12/4/02	$1,360	$0	$0	$1,360	0 h	0 h	0 h	40 h
17	PhysicistF	30%	24 h	0 w	11/19/02	12/4/02	$0	$0	$0	$0	0 h	0 h	0 h	24 h
21	DesignerF	25%	20 h	0 w	11/19/02	12/4/02	$880	$0	$0	$880	0 h	0 h	0 h	20 h
27	CMMOperatorSF	100%	80 h	0 w	11/19/02	12/4/02	$2,480	$0	$0	$2,480	0 h	0 h	0 h	80 h
30	CMMSmall	100%	80 h	0 w	11/19/02	12/4/02	$0	$0	$0	$0	0 h	0 h	0 h	80 h

Notes

WBS Definition-
Verify that the initial set of fixtures meet specifications and perform as designed

Labor BOE-
CMM and operator used throughout period. Roughly one half of the time is for inspection of fixtures with consultation of ME and designer to understand measurement results. The other half of the time is spent with the mechanical technician excercising the fixtures for functionality.

1.1.4.5.4	Finalize readout module fabrication fixtures	7/1/03	7/29/03	$0	$0	$7,840	$7,840

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
1	MechEngF	40%	64 h	0 w	7/1/03	7/29/03	$3,264	$0	$0	$3,264	0 h	0 h	0 h	64 h
17	PhysicistF	65%	104 h	0 w	7/1/03	7/29/03	$0	$0	$0	$0	0 h	0 h	0 h	104 h
21	DesignerF	65%	104 h	0 w	7/1/03	7/29/03	$4,576	$0	$0	$4,576	0 h	0 h	0 h	104 h

Notes

WBS Definition-
Revise fixture drawings and specifications to take into account information learned from the first fixture set

Labor BOE-
Two physicists and engineer working 50% for 1 week to complete design changes. Two weeks drafting by designer full time with 25% of physicist and engineer to complete drawing revisions. One week of 2 physicists, engineer and designer each at 50% to review and approve drawings for fabrication of production parts.

1.1.4.5.5	Procure remaining layer 1 module fixtures	7/30/03	11/19/03	$6,100	$0	$3,040	$9,140

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
1	MechEngF	5%	32 h	0 w	7/30/03	11/19/03	$1,632	$0	$0	$1,632	0 h	0 h	0 h	32 h
21	DesignerF	5%	32 h	0 w	7/30/03	11/19/03	$1,408	$0	$0	$1,408	0 h	0 h	0 h	32 h
48	MandS	6,100	6,100	0 w	7/30/03	11/19/03	$6,100	$0	$0	$6,100		0	0	6,100

Notes

WBS Definition-
Machining and parts procurement for final fixtures

M&S BOE-
For a production capacity of 2 modules per day we anticipate producing a set of 2 fixtures on one small CMM. The total machining time estimate is 90 hours: 4 vacuum chucks at 5 hrs each, 4 bearing pucks at 1 hr each, 4 center vacuum chucks at 5 hrs each, 2 riser block, riser post and adjustment screw sets at 6.5 hrs per set, 2 base plates at 5 hrs, 8 adjustment screw and spring plunger plates at 1 hr each, 2 flipping fixtures at 5 hrs each and 5 hours miscellaneous machining. Additional production capacity requires only the manufacture of more center vacuum pucks and flipping fixtures. Materials and purchase parts are estimated at $800 per fixture, giving a total cost of $6100.

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost

"Procure remaining layer 1 module fixtures" continued

Notes

Labor BOE-
A typical procurement through Fermilab with an outside vendor takes 2 days for an mechanical engineer and a designer each. Given the size of the order and its duration, interaction with the outside vendor will have to occur on a weekly basis at the level of 1.5 hours per week

1.1.4.5.6	QC readout module fixtures	11/20/03	12/5/03	$0	$0	$5,400	$5,400

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
1	MechEngF	50%	40 h	0 w	11/20/03	12/5/03	$2,040	$0	$0	$2,040	0 h	0 h	0 h	40 h
17	PhysicistF	30%	24 h	0 w	11/20/03	12/5/03	$0	$0	$0	$0	0 h	0 h	0 h	24 h
21	DesignerF	25%	20 h	0 w	11/20/03	12/5/03	$880	$0	$0	$880	0 h	0 h	0 h	20 h
27	CMMOperatorSF	100%	80 h	0 w	11/20/03	12/5/03	$2,480	$0	$0	$2,480	0 h	0 h	0 h	80 h
30	CMMSmall	100%	80 h	0 w	11/20/03	12/5/03	$0	$0	$0	$0	0 h	0 h	0 h	80 h
32	CMMLarge	100%	80 h	0 w	11/20/03	12/5/03	$0	$0	$0	$0	0 h	0 h	0 h	80 h

Notes

WBS Definition-
Verify that the remaining fixtures meet specifications and perform as designed

Labor BOE-
Assume full time measurements at CMM and consulting with DESF and MEF to understand results based on Run2a measurement times

1.1.4.5.7	Design layer 1 wire bonding fixtures	2/20/03	3/19/03	$0	$0	$4,856	$4,856

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
1	MechEngF	25%	40 h	0 w	2/20/03	3/19/03	$2,040	$0	$0	$2,040	0 h	0 h	0 h	40 h
17	PhysicistF	25%	40 h	0 w	2/20/03	3/19/03	$0	$0	$0	$0	0 h	0 h	0 h	40 h
21	DesignerF	40%	64 h	0 w	2/20/03	3/19/03	$2,816	$0	$0	$2,816	0 h	0 h	0 h	64 h

Notes

WBS Definition-
Design of a fixture to hold L1 modules for wire bonding. Production of associated drawings for fabrication of a prototype fixture.

Labor BOE-
The expectation is that a Fermilab physicist and mechanical engineer will spend one week on the initial design. The designer will spend 2 weeks making initial drawings. A final week, involving the Fermilab physicist, mechanical engineer and designer, is spent reviewing drawings for approval and making any required changes. All of the above occurs at 50% effort over the indicated durations.

1.1.4.5.8	Procure initial layer 1 wire bonding fixtures	3/20/03	6/12/03	$0	$0	$1,224	$1,224

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
1	MechEngF	5%	24 h	0 w	3/20/03	6/12/03	$1,224	$0	$0	$1,224	0 h	0 h	0 h	24 h

Notes

WBS Definition-
Machining and parts procurement for initial fixtures

M&S BOE-
One fixture plus adapter hardware to mount on 8090 bonder. Material and part costs of $225. Machining time of 19.5 hrs. Total cost $1200. Cost is assumed under MRI fixturing task

Labor BOE-
Typical procurement interaction with University shop. Fermilab engineer spends about 3 days getting drawings to university and discussing the job with the shop. A university physicist is allocated at 5% for 95 weeks under wbs 1.1.4.1.2 (Fixturing through MRI grant) to oversee jobs at the university shop and to manage the accounting for the work.

1.1.4.5.9	QC initial layer 1 wire bonding fixtures	6/13/03	6/26/03	$0	$0	$2,320	$2,320

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
17	PhysicistF	30%	24 h	0 w	6/13/03	6/26/03	$0	$0	$0	$0	0 h	0 h	0 h	24 h
23	WirebonderSF	50%	40 h	0 w	6/13/03	6/26/03	$1,080	$0	$0	$1,080	0 h	0 h	0 h	40 h
27	CMMOperatorSF	50%	40 h	0 w	6/13/03	6/26/03	$1,240	$0	$0	$1,240	0 h	0 h	0 h	40 h
29	WirebondingMachineF	50%	40 h	0 w	6/13/03	6/26/03	$0	$0	$0	$0	0 h	0 h	0 h	40 h
30	CMMSmall	50%	40 h	0 w	6/13/03	6/26/03	$0	$0	$0	$0	0 h	0 h	0 h	40 h

Notes

WBS Definition-
Verify that the initial set of fixtures meet specifications and perform as designed

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost

"QC initial layer 1 wire bonding fixtures" continued

Notes

Labor BOE-
CMM and operator used throughout period. Roughly one half of the time is for inspection of fixtures with consultation of ME and designer to understand measurement results. The other half of the time is spent with the wirebonder technician excercising the fixtures for functionality.

1.1.4.5.10	Finalize layer 1 wire bonding fixtures	7/30/03	8/12/03	$0	$0	$2,780	$2,780

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
1	MechEngF	25%	20 h	0 w	7/30/03	8/12/03	$1,020	$0	$0	$1,020	0 h	0 h	0 h	20 h
17	PhysicistF	50%	40 h	0 w	7/30/03	8/12/03	$0	$0	$0	$0	0 h	0 h	0 h	40 h
21	DesignerF	50%	40 h	0 w	7/30/03	8/12/03	$1,760	$0	$0	$1,760	0 h	0 h	0 h	40 h

Notes

WBS Definition-
Revise fixture drawings and specifications to take into account information learned from the first fixture set

Labor BOE-
Physicist and engineer working part time for 1 week to complete design changes and second week to review and approve drawings for fabrication of production parts. Designer at 50% throughout period to revise drawings as required.

1.1.4.5.11	Procure production layer 1 wire bonding fixtures	8/13/03	11/5/03	$0	$0	$1,224	$1,224

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
1	MechEngF	5%	24 h	0 w	8/13/03	11/5/03	$1,224	$0	$0	$1,224	0 h	0 h	0 h	24 h

Notes

WBS Definition-
Machining and parts procurement for final fixtures

M&S BOE-
One fixture plus adapter hardware to mount on 8090 bonder. Material and part costs of $225. Machining time of 19.5 hrs. Total cost $1200. Cost is assumed under MRI fixturing task

Labor BOE-
Typical procurement interaction with University shop. Fermilab engineer spends about 3 days getting drawings to university and discussing the job with the shop. A university physicist is allocated at 5% for 95 weeks under wbs 1.1.4.1.2 (Fixturing through MRI grant) to oversee jobs at the university shop and to manage the accounting for the work.

1.1.4.5.12	QC production layer 1 wire bonding fixtures	11/6/03	11/12/03	$0	$0	$820	$820

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
1	MechEngF	25%	10 h	0 w	11/6/03	11/12/03	$510	$0	$0	$510	0 h	0 h	0 h	10 h
17	PhysicistF	30%	12 h	0 w	11/6/03	11/12/03	$0	$0	$0	$0	0 h	0 h	0 h	12 h
27	CMMOperatorSF	25%	10 h	0 w	11/6/03	11/12/03	$310	$0	$0	$310	0 h	0 h	0 h	10 h
30	CMMSmall	25%	10 h	0 w	11/6/03	11/12/03	$0	$0	$0	$0	0 h	0 h	0 h	10 h

Notes

WBS Definition-
Verify that the remaining fixtures meet specifications and perform as designed

Labor BOE-
Inspection of fixture on the CMM with consultation Physicist to understand measurement results.

1.1.4.6	**L2-L5 Readout Module Fixtures**	**10/16/02**	**2/18/04**	**$33,600**	**$0**	**$62,624**	**$96,224**

Notes

WBS Definition-
The summary task that includes all of the L2-L5 readout module fixture design, production, and QC

1.1.4.6.1	QC initial readout module fixtures	10/16/02	10/29/02	$300	$0	$5,400	$5,700

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
1	MechEngF	50%	40 h	0 w	10/16/02	10/29/02	$2,040	$0	$0	$2,040	0 h	0 h	0 h	40 h
17	PhysicistF	30%	24 h	0 w	10/16/02	10/29/02	$0	$0	$0	$0	0 h	0 h	0 h	24 h
21	DesignerF	25%	20 h	0 w	10/16/02	10/29/02	$880	$0	$0	$880	0 h	0 h	0 h	20 h
27	CMMOperatorSF	100%	80 h	0 w	10/16/02	10/29/02	$2,480	$0	$0	$2,480	0 h	0 h	0 h	80 h
30	CMMSmall	100%	80 h	0 w	10/16/02	10/29/02	$0	$0	$0	$0	0 h	0 h	0 h	80 h
48	MandS	300	300	0 w	10/16/02	10/29/02	$300	$0	$0	$300		0	0	300

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost

"QC initial readout module fixtures" continued

Notes

WBS Definition-
Verify that the initial set of fixtures meet specifications and perform as designed

M&S BOE-
Time and materials for miscellaneous tooling to hold parts for inspection on CMM.

Labor BOE-
Requires inspection of roughly 20 parts (~1hr each), 8 subassemblies (~2hr each) and 5 assemblies (~3 hr each). ME/PHYS oversee work and analyze results. Any required modifications and re-inspection of parts/assemblies included. CMM programming included. Mechanical tech will do assembly of parts with ME/PHYS. Assemblies will be exercised by CMMT under direction of ME/PHYS with dummy sensors and hybrids (~6 hr per assembly) to provide input for revisions before final fixtures are fabricated. Listing of number parts detailed in M&S BOE.

1.1.4.6.2	Finalize readout module fabrication fixtures	7/16/03	9/10/03	$0	$0	$15,200	$15,200

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
1	MechEngF	50%	160 h	0 w	7/16/03	9/10/03	$8,160	$0	$0	$8,160	0 h	0 h	0 h	160 h
17	PhysicistF	50%	160 h	0 w	7/16/03	9/10/03	$0	$0	$0	$0	0 h	0 h	0 h	160 h
21	DesignerF	50%	160 h	0 w	7/16/03	9/10/03	$7,040	$0	$0	$7,040	0 h	0 h	0 h	160 h

Notes

WBS Definition-
Revise fixture drawings and specifications to take into account information learned from the first fixture set. Requires ME/PHYS to develop revisions to address problems encountered in prototype fixture testing, followed by incorporation of changes into drawings and review and release of completed drawings.

Labor BOE-
There are 6 assembly drawings and about 10 parts per assembly, with about a 50% overlap in the various parts for the different assemblies. We anticipate that it will take on average about 1 day to revise and finalize each part. Resources are allocated at the 50% level because there is so much similarity between the various parts.

1.1.4.6.3	Procure production layer 2-5 module fixtures	9/11/03	12/5/03	$14,550	$0	$2,102	$16,652

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
1	MechEngF	6%	28.8 h	0 w	9/11/03	12/5/03	$1,469	$0	$0	$1,469	0 h	0 h	0 h	28.8 h
21	DesignerF	3%	14.4 h	0 w	9/11/03	12/5/03	$634	$0	$0	$634	0 h	0 h	0 h	14.4 h
48	MandS	14,550	14,550	0 w	9/11/03	12/5/03	$14,550	$0	$0	$14,550		0	0	14,550

Notes

WBS Definition-
Procure the remaining fixtures to be used for L2-L5 modules

M&S BOE-
For a production capacity of 2 staves per day we anticipate producing a set of 8 fixtures to be used on 5 CMMs with sufficient interchangeable components to match module production to available part flow while maintaining a production rate of two modules per fixture per day. To achieve this we require: 16 vacuum chucks (8x10cm, 8x20 cm) at 5 hrs each, 16 bearing pucks at 1 hr each, 16 center vacuum chucks (8 each axial and stereo) at 5 hrs each, 8 riser block, riser post and adjustment screw sets at 6.5 hrs per set, 8 base plates (4 long and 4 short) at 5 hrs and 40 adjustment screw and spring plunger plates at 1 hr each, 12 flipping fixtures (four per module type) at 5 hrs each plus 15 hrs for miscellaneous parts and modifications. Total machining time estimate is 411 hrs. Of this, parts corresponding to 160 hours of machining are already available from the L2-L5 ganging fixtures, so the additional machining required is only 251 hours. Machining times are expected to be reduced relative to initial fixtures due to larger part quantities being fabricated. Additional production capacity requires only the manufacture of more center vacuum pucks and flipping fixtures. Materials costs and purchase parts are estimated at $2000 for the lot ($500 per fixture for 4 additional fixtures, roughly). Total estimated cost is $14,550.

Labor BOE-
Typical procurement time via local shop, engineer spends 6 days interfacing with purchasing and vendor, designer spends 3 days preparing drawings and interfacing on issues regarding drawing details.

1.1.4.6.4	QC readout module fixtures	12/8/03	1/13/04	$450	$0	$10,800	$11,250

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
1	MechEngF	50%	80 h	0 w	12/8/03	1/13/04	$4,080	$0	$0	$4,080	0 h	0 h	0 h	80 h
17	PhysicistF	30%	48 h	0 w	12/8/03	1/13/04	$0	$0	$0	$0	0 h	0 h	0 h	48 h
21	DesignerF	25%	40 h	0 w	12/8/03	1/13/04	$1,760	$0	$0	$1,760	0 h	0 h	0 h	40 h
27	CMMOperatorSF	100%	160 h	0 w	12/8/03	1/13/04	$4,960	$0	$0	$4,960	0 h	0 h	0 h	160 h
30	CMMSmall	100%	160 h	0 w	12/8/03	1/13/04	$0	$0	$0	$0	0 h	0 h	0 h	160 h
48	MandS	450	450	0 w	12/8/03	1/13/04	$450	$0	$0	$450		0	0	450

Notes

WBS Definition-
Verify that the remaining fixtures meet specifications and perform as designed

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost

"QC readout module fixtures" continued

Notes

M&S BOE-
Time and materials for miscellaneous tooling to hold parts for inspection on CMM.

Labor BOE-
Requires inspection of parts for 8 module fixtures. CMM programming done previously on prototype parts/assemblies, therefore inspection rate will be roughly 30 minutes per part. MechEng/Physicist oversee work and analyze results. Mechanical tech will do assembly of parts into assemblies with MechEng/Physicist oversight.

1.1.4.6.5	Finalize 20cm gang fixture	10/30/02	11/26/02	$0	$0	$9,120	$9,120

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
1	MechEngF	60%	96 h	0 w	10/30/02	11/26/02	$4,896	$0	$0	$4,896	0 h	0 h	0 h	96 h
17	PhysicistF	60%	96 h	0 w	10/30/02	11/26/02	$0	$0	$0	$0	0 h	0 h	0 h	96 h
21	DesignerF	60%	96 h	0 w	10/30/02	11/26/02	$4,224	$0	$0	$4,224	0 h	0 h	0 h	96 h

Notes

WBS Definition-
Revise fixture drawings and specifications for producing the 20cm sensor gangs to take into account information learned from the first fixture set. Requires ME/PHYS to develop revisions to address problems encountered in prototype fixture testing, followed by incorporation of changes into drawings and review and release of completed drawings.

Labor BOE-
There is one assembly drawing with about 12 parts. We anticipate that it will take on average about 1 day of a Physicist, Mechanical Engineer and Designer to revise and finalize each part. So 12 days would suffice. A task duration of 4 weeks was assigned to allow appropriate feedback and interaction.

1.1.4.6.6	Procure final 20cm gang fixtures	11/27/02	3/4/03	$17,600	$0	$3,504	$21,104

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
1	MechEngF	10%	48 h	0 w	11/27/02	3/4/03	$2,448	$0	$0	$2,448	0 h	0 h	0 h	48 h
21	DesignerF	5%	24 h	0 w	11/27/02	3/4/03	$1,056	$0	$0	$1,056	0 h	0 h	0 h	24 h
48	MandS	17,600	17,600	0 w	11/27/02	3/4/03	$17,600	$0	$0	$17,600		0	0	17,600

Notes

WBS Definition-
Procurement of final fixture to produce 20 cm sensor gangs.

M&S BOE-
For a production capacity of 8 gangs per day we anticipate producing a set of 8 fixtures to be used on 4 CMMs. Each fixture consists of two vacuum chucks at 5 hrs each, two bearing pucks at 1 hr each, 1 center vacuum chuck at 5 hrs, one riser block and adjustment screw at 6.5 hrs, one short base plate at 5 hrs, 4 adjustment screw holding plates at 1 hr each plus 1.5 hrs for miscellaneous parts and modifications. This comes to a total of 34 hrs per fixture, 272 hours total. Machining times are expected to be reduced relative to initial fixtures due to larger part quantities being fabricated. Additional production capacity requires only the manufacture of more center vacuum pucks and flipping fixtures. Materials costs and purchase parts are estimated at $500 per fixture, $4000 total. Total estimated cost is $17,600 for eight fixtures.

Labor BOE-
Typical procurement time via local shop, engineer spends 6 days interfacing with purchasing and vendor, designer spends 3 days preparing drawings and interfacing on issues regarding drawing details.

1.1.4.6.7	QC final 20cm gang fixtures	3/5/03	4/1/03	$700	$0	$5,576	$6,276

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
1	MechEngF	25%	40 h	0 w	3/5/03	4/1/03	$2,040	$0	$0	$2,040	0 h	0 h	0 h	40 h
17	PhysicistF	15%	24 h	0 w	3/5/03	4/1/03	$0	$0	$0	$0	0 h	0 h	0 h	24 h
21	DesignerF	15%	24 h	0 w	3/5/03	4/1/03	$1,056	$0	$0	$1,056	0 h	0 h	0 h	24 h
27	CMMOperatorSF	50%	80 h	0 w	3/5/03	4/1/03	$2,480	$0	$0	$2,480	0 h	0 h	0 h	80 h
30	CMMSmall	50%	80 h	0 w	3/5/03	4/1/03	$0	$0	$0	$0	0 h	0 h	0 h	80 h
48	MandS	700	700	0 w	3/5/03	4/1/03	$700	$0	$0	$700		0	0	700

Notes

WBS Definition-
Verify that the remaining fixtures meet specifications and perform as designed

M&S BOE-
12 hrs. machine shop time for miscellaneous tooling to hold parts for inspection on CMM at a total of $600 and $100 in raw material.

Labor BOE-
Requires inspection of parts for 4 module fixtures. CMM programming done previously on prototype parts/assemblies, therefore inspection rate will be roughly 30 minutes per part. MechEng/Physicist oversee work and analyze results. Mechanical tech will do assembly of parts into assemblies with MechEng/Physicist oversight.

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
1.1.4.6.8	QC initial L2-L5 wire bonding fixtures	11/20/02	12/12/02	$0	$0	$3,480	$3,480

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
17	PhysicistF	30%	36 h	0 w	11/20/02	12/12/02	$0	$0	$0	$0	0 h	0 h	0 h	36 h
23	WirebonderSF	50%	60 h	0 w	11/20/02	12/12/02	$1,620	$0	$0	$1,620	0 h	0 h	0 h	60 h
27	CMMOperatorSF	50%	60 h	0 w	11/20/02	12/12/02	$1,860	$0	$0	$1,860	0 h	0 h	0 h	60 h
29	WirebondingMachineF	50%	60 h	0 w	11/20/02	12/12/02	$0	$0	$0	$0	0 h	0 h	0 h	60 h
30	CMMSmall	50%	60 h	0 w	11/20/02	12/12/02	$0	$0	$0	$0	0 h	0 h	0 h	60 h

Notes

WBS Definition-
Verify that the initial set of fixtures meet specifications and perform as designed.

Labor BOE-
One half of the time is for inspection of fixtures on the CMM with consultation Physicist to understand measurement results. The other half of the time is spent with the bonding technician excercising the fixture.

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
1.1.4.6.9	Finalize L2-L5 wire bonding fixtures	9/11/03	10/1/03	$0	$0	$4,170	$4,170

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
1	MechEngF	25%	30 h	0 w	9/11/03	10/1/03	$1,530	$0	$0	$1,530	0 h	0 h	0 h	30 h
17	PhysicistF	50%	60 h	0 w	9/11/03	10/1/03	$0	$0	$0	$0	0 h	0 h	0 h	60 h
21	DesignerF	50%	60 h	0 w	9/11/03	10/1/03	$2,640	$0	$0	$2,640	0 h	0 h	0 h	60 h

Notes

WBS Definition-
Revise fixture drawings and specifications to take into account information learned from the first fixture set

Labor BOE-
Physicist and engineer working part time for 2 weeks to complete design changes and last week to review and approve drawings for fabrication of production parts. Designer at 50% throughout period to revise drawings as required.

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
1.1.4.6.10	Procure production L2-L5 wire bonding fixtures	10/2/03	2/4/04	$0	$0	$1,632	$1,632

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
1	MechEngF	5%	32 h	0 w	10/2/03	2/4/04	$1,632	$0	$0	$1,632	0 h	0 h	0 h	32 h

Notes

WBS Definition-
Machining and parts procurement for final fixtures

M&S BOE-
Two sets of bonding fixtures, plus associated mounting hardware. Precision flat vacuum chucks for 10-10 and 20-20 modules are estimated at 26 hours per set. Mounting hardware to interface between these chucks and the 8090 bonders is estimated at 7 hours. Total is 33 hours per set of fixtures, or 66 hours total. $900 is allocated for materials and purchased parts. Total cost estimate is $4200. Cost is assumed under MRI fixturing task

Labor BOE-
Typical procurement interaction with University shop. Fermilab engineer spends about 4 days getting drawings to university and discussing the job with the shop. A university physicist is allocated at 5% for 95 weeks under wbs 1.1.4.1.2 (Fixturing through MRI grant) to oversee jobs at the university shop and to manage the accounting for the work.

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
1.1.4.6.11	QC production L2-L5 wire bonding fixtures	2/5/04	2/18/04	$0	$0	$1,640	$1,640

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
1	MechEngF	25%	20 h	0 w	2/5/04	2/18/04	$1,020	$0	$0	$1,020	0 h	0 h	0 h	20 h
17	PhysicistF	30%	24 h	0 w	2/5/04	2/18/04	$0	$0	$0	$0	0 h	0 h	0 h	24 h
27	CMMOperatorSF	25%	20 h	0 w	2/5/04	2/18/04	$620	$0	$0	$620	0 h	0 h	0 h	20 h
30	CMMSmall	25%	20 h	0 w	2/5/04	2/18/04	$0	$0	$0	$0	0 h	0 h	0 h	20 h

Notes

WBS Definition-
Verify that the remaining fixtures meet specifications and perform as designed

Labor BOE-
Inspection of fixture on the CMM with consultation Physicist to understand measurement results.

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
1.1.4.7	**L0 Modules**	**5/15/03**	**9/7/04**	**$1,710**	**$0**	**$54,672**	**$56,382**

Notes

WBS Definition-

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
"L0 Modules" continued							

Notes

The summary task that includes the prototyping and construction of all L0 modules

Risk Mitigation-
Assembly of L0 modules is important for obtaining the b vertex impact parameter resolution.
Worries are:
Grounding and space issues that limit signal to noise performance,
Attaching wirebonds to flex cables
Cost doesn't appear to be an issue.
Schedule:
These tasks are started early in the project and have many prototypes associated with them. There is a total of 40 weeks of extra time if needed.
Technical/Scope
There are parallel tasks that help to define the mounting and grounding of these modules as well as the wirebonding issues with the flex cables. Prototypes have already been built to demonstrate these connections. Further prototyping is planned.

1.1.4.7.1	Develop module preproduction	5/15/03	8/8/03	$517	$0	$13,176	$13,693

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
1	MechEngF	15%	72 h	0 w	5/15/03	8/8/03	$3,672	$0	$0	$3,672	0 h	0 h	0 h	72 h
9	MechTechSF	30%	144 h	0 w	5/15/03	8/8/03	$4,896	$0	$0	$4,896	0 h	0 h	0 h	144 h
12	ElecTechSF	5%	24 h	0 w	5/15/03	8/8/03	$792	$0	$0	$792	0 h	0 h	0 h	24 h
17	PhysicistF	100%	480 h	0 w	5/15/03	8/8/03	$0	$0	$0	$0	0 h	0 h	0 h	480 h
21	DesignerF	15%	72 h	0 w	5/15/03	8/8/03	$3,168	$0	$0	$3,168	0 h	0 h	0 h	72 h
23	WirebonderSF	5%	24 h	0 w	5/15/03	8/8/03	$648	$0	$0	$648	0 h	0 h	0 h	24 h
29	WirebondingMachineF	5%	24 h	0 w	5/15/03	8/8/03	$0	$0	$0	$0	0 h	0 h	0 h	24 h
48	MandS	517	517	0 w	5/15/03	8/8/03	$517	$0	$0	$517		0	0	517

Notes

WBS Definition-
Design and prototyping of a L0 module. Includes mechanical design and integration of HV isolation and any required electrical shielding to eliminate noise pickup from the conductive support structure.

M&S BOE-
Ceramic precision cut to hybrid dimensions with typical lot cost of $250. Sensor blanks require cutting of two 6" wafers at $12.25 each. Epoxy cost based on 20 10cc mixed batches with an anticipated cost of $1500 for 20 liters of epoxy ($0.75 per 10cc), including purity testing. In addition there will be 1 packet of silver epoxy for each electrical prototype and 2 for mechanical prototypes, at $11 each. Additional miscellaneous parts and materials included at $140 total. Total cost estimate is $517.

Labor BOE-
Assembly and inspection of prototype modules, including refinement of assembly sequence and tooling. We anticipate fabrication of 6 electrical grade prototypes, which will require fabrication of several mechanical grade prototypes as well to debug the assembly process. The Physicist and Engineer will develop the assembly procedures utilizing the initial L0 module fixtures, with particular attention to electrical issues such as HV connections and shielding. This is expected to require 2 weeks at 50% effort each with 25% of designer time to prepare drawings to aid the technicians in assembly and bonding. The following 4 weeks will be spent assembling mechanical parts and debugging the process with the Physicist and mechanical technician working at 25% effort on this task and the designer at 15% to revise drawings as needed. The last 6 weeks will involve production of electrical grade prototypes, each requiring roughly 2 days of mechanical tech effort, interspersed with electrical evaluation and process feedback.

1.1.4.7.2	**L0 Module Production Readiness**	**1/5/04**	**1/27/04**	**$0**	**$0**	**$1,644**	**$1,644**

Notes

WBS Definition-
Summary task that establishes the production readiness for Layer 0 module production.

1.1.4.7.2.1	L0 Module Production Training	1/5/04	1/20/04	$0	$0	$1,304	$1,304

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
9	MechTechSF	40%	32 h	0 w	1/5/04	1/16/04	$1,088	$0	$0	$1,088	0 h	0 h	0 h	32 h
17	PhysicistF	50%	40 h	0 w	1/5/04	1/16/04	$0	$0	$0	$0	0 h	0 h	0 h	40 h
23	WirebonderSF	10%	8 h	0 w	1/5/04	1/16/04	$216	$0	$0	$216	0 h	0 h	0 h	8 h
29	WirebondingMachineF	5%	4 h	0 w	1/5/04	1/16/04	$0	$0	$0	$0	0 h	0 h	0 h	4 h

Notes

WBS Definition-
Training of technical personnel for layer 0 module production.

M&S BOE-
None.

Labor BOE-

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost

"L0 Module Production Training" continued

Notes

Two mechanical technicians and one wirebonder need to be trained for L0 module production. A physicist oversees and organizes the training. Two full assemblies will be fabricated by each technician for training. There are three mechanical steps in the assembly: align and glue a pair of flex cables, align and glue sensor to cable, and align and glue the cable to the hybrid. Each of these is expected to take 2 hours in training plus two hours of evaluation. This implies two technicians involved at the 20% level, each. Wirebonding is expected to take one hour per asssembly plus one hour of evaluation and adjusting wirebonding settings.

1.1.4.7.2.2	L0 Module Production Readiness Review	1/20/04	1/27/04	$0	$0	$340	$340

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
1	MechEngF	10%	4 h	0 w	1/20/04	1/26/04	$204	$0	$0	$204	0 h	0 h	0 h	4 h
9	MechTechSF	10%	4 h	0 w	1/20/04	1/26/04	$136	$0	$0	$136	0 h	0 h	0 h	4 h
17	PhysicistF	100%	40 h	0 w	1/20/04	1/26/04	$0	$0	$0	$0	0 h	0 h	0 h	40 h

Notes

WBS Definition-
Review of readiness for L0 module production.

M&S BOE-
None.

Labor BOE-
The physicist production line floor manager spends a couple of days preparing all the paperwork and establishing the procedures after the review. The review itself is expected to take half a day with participation of the lead mechanical technician, a mechanical engineer and several physicists.

1.1.4.7.2.4	**Silicon Module Production Begun**	**1/27/04**	**1/27/04**	**$0**	**$0**	**$0**	**$0**

Notes

WBS Definition-
Start of silicon module production.

1.1.4.7.2.3	**Silicon L0 Module Production Begun**	**1/27/04**	**1/27/04**	**$0**	**$0**	**$0**	**$0**

Notes

WBS Definition-
Milestone: Module production for L0 has begun.

1.1.4.7.3	Align and glue pair of flex cables	1/27/04	6/1/04	$68	$0	$4,896	$4,964

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
9	MechTechSF	20%	144 h	0 w	1/27/04	6/1/04	$4,896	$0	$0	$4,896	0 h	0 h	0 h	144 h
17	PhysicistF	15%	108 h	0 w	1/27/04	6/1/04	$0	$0	$0	$0	0 h	0 h	0 h	108 h
48	MandS	67.5	67.5	0 w	1/27/04	6/1/04	$68	$0	$0	$68		0	0	67.5

Notes

WBS Definition-
An analogue cable consists of a set of two laminated cables. This task refers to the lamination of these two cables.

M&S BOE-
Epoxy cost based on one 10cc mix per day with an anticipated cost of $1500 for 20 liters of epoxy, including purity testing ($0.75 per 10cc). The total of $67.50 is 90 days times $0.75 per day.

Labor BOE-
There are 24 each of 6 types of modules differing only in the analogue cable lengths, plus 4 spares of each module type for a total of 168 modules to be built with one cable pair per module. A production rate of 2 modules per day leads to a 17 week production cycle. One week has been added to account for lower production rate at startup. Assembly time of 1/2 hour per cable pair plus 1/4 hour slack, for a mechanical tech effort of 20%. The physicist is responsible to tracking part flow and ensuring quality control with an anticipated effort of 1 hour per day.

1.1.4.7.4	Align and glue sensor to flex cable	1/29/04	6/3/04	$1,058	$0	$4,896	$5,954

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
9	MechTechSF	20%	144 h	0 w	1/29/04	6/3/04	$4,896	$0	$0	$4,896	0 h	0 h	0 h	144 h
17	PhysicistF	15%	108 h	0 w	1/29/04	6/3/04	$0	$0	$0	$0	0 h	0 h	0 h	108 h
48	MandS	1,057.5	1,057.5	0 w	1/29/04	6/3/04	$1,058	$0	$0	$1,058		0	0	1,057.5

Notes

WBS Definition-
Aligning sensor to flex cable and gluing it

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost

"Align and glue sensor to flex cable" continued

Notes

M&S BOE-
One package of silver epoxy per day for all required connections on all L0 modules in production at $11 each ($990 total). Additional $67.50 for high purity epoxy (see previous line).

Labor BOE-
There are 24 each of 6 types of modules differing only in the analogue cable lengths, plus 4 spares of each module type for a total of 168 modules to be built. A production rate of 2 modules per day leads to a 17 week production cycle. One week has been added to account for lower production rate at startup. Assembly time of 1/2 hour per pair plus 1/4 hour slack, for a mechanical tech effort of 20%. The physicist is responsible to tracking part flow and ensuring quality control with an anticipated effort of 1 hour per day.

1.1.4.7.5	Perform sensor-to-flex cable wirebonds	2/2/04	6/7/04	$0	$0	$9,720	$9,720

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
17	PhysicistF	25%	180 h	0 w	2/2/04	6/7/04	$0	$0	$0	$0	0 h	0 h	0 h	180 h
23	WirebonderSF	50%	360 h	0 w	2/2/04	6/7/04	$9,720	$0	$0	$9,720	0 h	0 h	0 h	360 h
29	WirebondingMachineF	50%	360 h	0 w	2/2/04	6/7/04	$0	$0	$0	$0	0 h	0 h	0 h	360 h

Notes

WBS Definition-
Wirebonding sensor to flex cable

Labor BOE-
There are 24 each of 6 types of modules differing only in the analogue cable lengths, plus 4 spares of each module type for a total of 168 modules to be built. A production rate of 2 modules per day leads to a 17 week production cycle. One week has been added to account for lower production rate at startup. Bonding time is 1 hour/unit. Estimated time is then doubled to account for problem parts and/or equipment, based on prior experience.

1.1.4.7.6	Attach end hybrids to flex cable	3/22/04	7/27/04	$68	$0	$4,896	$4,964

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
9	MechTechSF	20%	144 h	0 w	3/22/04	7/27/04	$4,896	$0	$0	$4,896	0 h	0 h	0 h	144 h
17	PhysicistF	15%	108 h	0 w	3/22/04	7/27/04	$0	$0	$0	$0	0 h	0 h	0 h	108 h
48	MandS	67.5	67.5	0 w	3/22/04	7/27/04	$68	$0	$0	$68		0	0	67.5

Notes

WBS Definition-
Gluing the hybrid to the flex cable

M&S BOE-
Epoxy cost based on one 10cc mix per day with an anticipated cost of $1500 for 20 liters of epoxy, including purity testing. The total of $67.50 is 90 days times $0.75 per day.

Labor BOE-
There are 24 each of 6 types of modules differing only in the analogue cable lengths, plus 4 spares of each module type for a total of 168 modules to be built. A production rate of 2 modules per day leads to a 17 week production cycle. One week has been added to account for lower production rate at startup. Assembly time of 1/2 hour per pair plus 1/4 hour slack, for a mechanical tech effort of 20%. The physicist is responsible to tracking part flow and ensuring quality control with an anticipated effort of 1 hour per day.

1.1.4.7.7	Wirebond end hybrid to flex cable	3/24/04	7/29/04	$0	$0	$9,720	$9,720

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
17	PhysicistF	25%	180 h	0 w	3/24/04	7/29/04	$0	$0	$0	$0	0 h	0 h	0 h	180 h
23	WirebonderSF	50%	360 h	0 w	3/24/04	7/29/04	$9,720	$0	$0	$9,720	0 h	0 h	0 h	360 h
29	WirebondingMachineF	50%	360 h	0 w	3/24/04	7/29/04	$0	$0	$0	$0	0 h	0 h	0 h	360 h

Notes

WBS Definition-
wirebonding hybrid to flex cable

Labor BOE-
There are 24 each of 6 types of modules differing only in the analogue cable lengths, plus 4 spares of each module type for a total of 168 modules to be built. A production rate of 2 modules per day leads to a 17 week production cycle. One week has been added to account for lower production rate at startup. Bonding time is 1 hour/unit. Estimated time is then doubled to account for problem parts and/or equipment, based on prior experience.

1.1.4.7.8	**Silicon L0 Module Production Complete**	**7/29/04**	**7/29/04**	**$0**	**$0**	**$0**	**$0**

Notes

WBS Definition-
Milestone: All modules for L0 have been produced.

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
1.1.4.7.9	Debug sensor modules	3/26/04	8/2/04	$0	$0	$2,376	$2,376

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
12	ElecTechSF	10%	72 h	0 w	3/26/04	8/2/04	$2,376	$0	$0	$2,376	0 h	0 h	0 h	72 h
34	SASEQTestStandF	100%	720 h	0 w	3/26/04	8/2/04	$0	$0	$0	$0	0 h	0 h	0 h	720 h
44	PostDoc	50%	360 h	0 w	3/26/04	8/2/04	$0	$0	$0	$0	0 h	0 h	0 h	360 h

Notes

WBS Definition-
First functionality test of module after construction, consisting of visual inspection, functionality test without biasing the detector, biasing of the detector and characterization of the module by determining IV and V-noise curves. Noisy channels are removed by pulling wirebonds.

Labor BOE-
Testing of 168 modules, 10 modules/week, 4 hour/module of test stand usage, of which two hours per module is physicist's time. ElecTech (at 10%) pulls bonds on bad channels in preparation for burn-in. Physicist debugs module and sends modules that fail to the "evaluate and repair" task (50% of physicist needed). We assume that 10% of the modules fail. Estimate based on Run IIa experience.

1.1.4.7.10	Burn-in sensor modules	4/2/04	8/9/04	$0	$0	$0	$0

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
40	ModuleBurnInStand	20%	144 h	0 w	4/2/04	8/9/04	$0	$0	$0	$0	0 h	0 h	0 h	144 h
47	Student	20%	144 h	0 w	4/2/04	8/9/04	$0	$0	$0	$0	0 h	0 h	0 h	144 h

Notes

WBS Definition-
The QC procedure where modules are readout out under bias voltage for a few days and evaluated for bad channels

Labor BOE-
Burn-in of 168 modules for 3 day cycle each. The burn-in stand accomodates up to 32 modules per cycle with 2 cycles per week. We anticipate needing to reprocess 10% of the modules. The L0 module production rate of 10/week, with 10% reprocessing means that 11 modules need to be burned-in per week. The stand has a total capacity of 64 modules per week. Thus, on average, 20% of a module burn-in resource is used over the task duration. Each module requires 0.5 hr documentation by physicist plus 0.3 hr to mount and remove module from test stand. Estimates based on Run IIa experience. The personnel involved is at the same level the burn-in stand is utilized. It is expected that batches of modules to be burned-in are staggered between the two burn-in stands. A physicist will load and document one stand one day, full time, and move to the next burn-in stand the next day. The following two days will be spent unloading and evaluating the burn-in test results and updating the documentation.

1.1.4.7.11	Evaluate and repair sensor modules	4/16/04	8/23/04	$0	$0	$3,348	$3,348

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
12	ElecTechSF	10%	72 h	0 w	4/16/04	8/23/04	$2,376	$0	$0	$2,376	0 h	0 h	0 h	72 h
23	WirebonderSF	5%	36 h	0 w	4/16/04	8/23/04	$972	$0	$0	$972	0 h	0 h	0 h	36 h
29	WirebondingMachineF	5%	36 h	0 w	4/16/04	8/23/04	$0	$0	$0	$0	0 h	0 h	0 h	36 h
34	SASEQTestStandF	100%	720 h	0 w	4/16/04	8/23/04	$0	$0	$0	$0	0 h	0 h	0 h	720 h
44	PostDoc	50%	360 h	0 w	4/16/04	8/23/04	$0	$0	$0	$0	0 h	0 h	0 h	360 h

Notes

WBS Definition-
Determining what repairs are necessary and repairing broken wirebonds, bad hybrids, or bad bias connections

Labor BOE-
We assume that 10% of the modules fail the debugging task. It takes twice as long to diagnose and repair problematic modules, so it takes 8hrs/module to repair. After the module has been repaired it needs to be debugged again, which also falls under the purview of this task. To debug these failed modules again takes 1 day. For layer 0, one module fails per week, corresponding to a half time physicist. The physicist needs the support of an ElecTechSF at 10% to replace chips and pull wirebonds, improve grounding, a SASEQTestStandF full time at his disposition, a WirebonderSF at the 5% level.

1.1.4.7.12	Perform quality assurance tests	4/30/04	9/7/04	$0	$0	$0	$0

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
34	SASEQTestStandF	100%	720 h	0 w	4/30/04	9/7/04	$0	$0	$0	$0	0 h	0 h	0 h	720 h
44	PostDoc	50%	360 h	0 w	4/30/04	9/7/04	$0	$0	$0	$0	0 h	0 h	0 h	360 h

Notes

WBS Definition-
Quality assurance of a subset of modules to fully characterize its performance.

Labor BOE-
For Layer 0 and Layer 1 we assume that 10% of the modules are submitted to extensive tests, including laser test, temperature cycling, probe and pull testing and possibly irradiation tests. A physicist will be occupied half time for one week for one module. He needs the support of a SASEQ test stand.

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
1.1.4.7.13	**Silicon L0 Module Production and Testing Comple**	**9/7/04**	**9/7/04**	**$0**	**$0**	**$0**	**$0**

Notes

WBS Definition-
Milestone: All modules for L0 have been produced and tested.

1.1.4.8	**L1 Modules**	**1/28/03**	**5/20/04**	**$760**	**$0**	**$31,926**	**$32,686**

Notes

WBS Definition-
The summary task that includes the prototyping and construction of all L1 modules

1.1.4.8.1	Develop L1 Module Preproduction	1/28/03	3/24/03	$135	$0	$9,446	$9,581

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
1	MechEngF	13%	41.6 h	0 w	1/28/03	3/24/03	$2,122	$0	$0	$2,122	0 h	0 h	0 h	41.6 h
9	MechTechSF	30%	96 h	0 w	1/28/03	3/24/03	$3,264	$0	$0	$3,264	0 h	0 h	0 h	96 h
12	ElecTechSF	5%	16 h	0 w	1/28/03	3/24/03	$528	$0	$0	$528	0 h	0 h	0 h	16 h
17	PhysicistF	100%	320 h	0 w	1/28/03	3/24/03	$0	$0	$0	$0	0 h	0 h	0 h	320 h
21	DesignerF	6%	19.2 h	0 w	1/28/03	3/24/03	$845	$0	$0	$845	0 h	0 h	0 h	19.2 h
23	WirebonderSF	5%	16 h	0 w	1/28/03	3/24/03	$432	$0	$0	$432	0 h	0 h	0 h	16 h
28	CMMProgrammerSF	15%	48 h	0 w	1/28/03	3/24/03	$2,256	$0	$0	$2,256	0 h	0 h	0 h	48 h
29	WirebondingMachineF	5%	16 h	0 w	1/28/03	3/24/03	$0	$0	$0	$0	0 h	0 h	0 h	16 h
30	CMMSmall	75%	240 h	0 w	1/28/03	3/24/03	$0	$0	$0	$0	0 h	0 h	0 h	240 h
48	MandS	135	135	0 w	1/28/03	3/24/03	$135	$0	$0	$135		0	0	135

Notes

WBS Definition-
Design and prototyping of a L1 module. Includes mechanical design and integration of HV isolation and any required electrical shielding to eliminate noise pickup from the conductive support structure.

M&S BOE-
Epoxy cost based on 12 10cc mixed batches with an anticipated cost of $1500 for 20 liters of epoxy, including purity testing ($0.75 per 10cc). In addition there will be 1 packet of silver epoxy for each of six electrical prototypes, at $11 each. Additional miscellaneous parts and materials included at $60 total. Total cost is $135.

Labor BOE-
Assembly and inspection of prototype modules, including refinement of assembly sequence and tooling. We anticipate fabrication of 6 electrical grade prototypes, which will require fabrication of several mechanical grade prototypes as well to debug the assembly process. The physicist and engineer will develop the assembly procedures utilizing the initial L1 module fixtures, with particular attention to electrical issues such as HV connections and shielding. This is expected to require 2 weeks at 50% effort each with 25% of designer time to prepare drawings to aid the technicians in assembly and bonding. The last 6 weeks will involve production of electrical grade prototypes, each requiring roughly 2 days of mechanical technician effort, interspersed with electrical evaluation and process feedback.

1.1.4.8.2	**L1 Module Production Readiness**	**1/7/04**	**1/29/04**	**$0**	**$0**	**$2,140**	**$2,140**

Notes

WBS Definition-
Summary task covering training and production readiness for L1 modules.

1.1.4.8.2.1	L1 Module Production Training	1/7/04	1/22/04	$0	$0	$1,800	$1,800

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
9	MechTechSF	40%	32 h	0 w	1/7/04	1/21/04	$1,088	$0	$0	$1,088	0 h	0 h	0 h	32 h
17	PhysicistF	50%	40 h	0 w	1/7/04	1/21/04	$0	$0	$0	$0	0 h	0 h	0 h	40 h
23	WirebonderSF	10%	8 h	0 w	1/7/04	1/21/04	$216	$0	$0	$216	0 h	0 h	0 h	8 h
27	CMMOperatorSF	20%	16 h	0 w	1/7/04	1/21/04	$496	$0	$0	$496	0 h	0 h	0 h	16 h
29	WirebondingMachineF	5%	4 h	0 w	1/7/04	1/21/04	$0	$0	$0	$0	0 h	0 h	0 h	4 h
30	CMMSmall	100%	80 h	0 w	1/7/04	1/21/04	$0	$0	$0	$0	0 h	0 h	0 h	80 h

Notes

WBS Definition-
Training of technical personnel for layer 1 module production.

M&S BOE-
None.

Labor BOE-
Two mechanical technicians, one CMM operator, and one wirebonder need to be trained for L1 module production. A physicist oversees and organizes the training. Two full assemblies will be fabricated by each technician for training on a small CMM. There are two mechanical steps in the assembly: align and glue the sensor and the hybrid and the work on the backside of the sensor, including HV and grounding. Each of these is expected to take 2 hours in training plus two hours of evaluation. The CMM operator is required for only the first of the two steps. This implies two technicians plus a CMM operator involved at the 20% level each. Wirebonding is expected to take one hour per asssembly plus one hour of evaluation and adjusting wirebonding settings.

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
1.1.4.8.2.2	L1 Module Production Readiness Review	1/22/04	1/29/04	$0	$0	$340	$340

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
1	MechEngF	10%	4 h	0 w	1/22/04	1/28/04	$204	$0	$0	$204	0 h	0 h	0 h	4 h
9	MechTechSF	10%	4 h	0 w	1/22/04	1/28/04	$136	$0	$0	$136	0 h	0 h	0 h	4 h
17	PhysicistF	100%	40 h	0 w	1/22/04	1/28/04	$0	$0	$0	$0	0 h	0 h	0 h	40 h

Notes

WBS Definition-
Review of readiness for L1 module production.

M&S BOE-
None.

Labor BOE-
The physicist production line floor manager spends a couple of days preparing all the paperwork and establishing the procedures after the review. The review itself is expected to take half a day with participation of the lead mechanical technician, a mechanical engineer and several physicists.

1.1.4.8.2.3	**Silicon L1 Module Production Begun**	**1/29/04**	**1/29/04**	**$0**	**$0**	**$0**	**$0**

Notes

WBS Definition-
Milestone: Module production for L1 has begun.

1.1.4.8.3	Align and glue sensors to hybrid	1/29/04	4/7/04	$625	$0	$9,900	$10,525

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
9	MechTechSF	50%	200 h	0 w	1/29/04	4/7/04	$6,800	$0	$0	$6,800	0 h	0 h	0 h	200 h
17	PhysicistF	25%	100 h	0 w	1/29/04	4/7/04	$0	$0	$0	$0	0 h	0 h	0 h	100 h
27	CMMOperatorSF	25%	100 h	0 w	1/29/04	4/7/04	$3,100	$0	$0	$3,100	0 h	0 h	0 h	100 h
30	CMMSmall	100%	400 h	0 w	1/29/04	4/7/04	$0	$0	$0	$0	0 h	0 h	0 h	400 h
48	MandS	625	625	0 w	1/29/04	4/7/04	$625	$0	$0	$625		0	0	625

Notes

WBS Definition-
On CMM, using fixtures align sensors and hybrid and glue all together

M&S BOE-
Epoxy cost based on two 10cc mix per day with an anticipated cost of $1500 for 20 liters of epoxy, including purity testing. In addition there will be 1 packet of silver epoxy used per day throughout this production, at $11 each. Total cost is $12.50 per day for a total of $625.

Labor BOE-
There are 72 L1 modules required for installation plus 20% spares for a total of 86 modules. Using one small CMM's, 2 modules can be produced per day, or 90 modules in 9 weeks. The initial production rate is anticipated to be lower so an additional week has been added. A mechanical technician will prepare the glue, parts and documentation. The CMM technician will operate the CMM and align the sensors. Preparation, setup and cleanup by the mechanical technician is expected to take about half an hour per module. Aligning the sensors and gluing the hybrid in place is also expected to take half an hour per module. The mechanical technician helps setting up and does the documentation and database entry. The following day a mechanical technician flips the module and makes the HV and ground connections and installs HV insulation and updates documentation. The latter operation will take 1 hour per module. A mechanical technician is thus assigned at the 50% level and a CMM operator at the 25% level. A senior Fermilab physicist oversees the production at 25%.

1.1.4.8.4	Wirebond sensors to hybrid	2/4/04	4/13/04	$0	$0	$5,400	$5,400

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
17	PhysicistF	25%	100 h	0 w	2/4/04	4/13/04	$0	$0	$0	$0	0 h	0 h	0 h	100 h
23	WirebonderSF	50%	200 h	0 w	2/4/04	4/13/04	$5,400	$0	$0	$5,400	0 h	0 h	0 h	200 h
29	WirebondingMachineF	50%	200 h	0 w	2/4/04	4/13/04	$0	$0	$0	$0	0 h	0 h	0 h	200 h

Notes

WBS Definition-
wirebond all necessary connections.

Labor BOE-
There are 72 L1 modules required for installation plus 20% spares for a total of 86 modules. A production rate of 2 modules per day leads to a 9 week production cycle. One week has been added to account for lower production rate at startup. Bonding time is 1 hour/unit. Estimated time is then doubled to account for problem parts and/or equipment, based on prior experience.
A physicist will oversee the process and update the documentation.

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
1.1.4.8.5	**Silicon L1 Module Production Complete**	**4/13/04**	**4/13/04**	**$0**	**$0**	**$0**	**$0**

Notes

WBS Definition-
Milestone: All modules for L1 have been produced.

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
1.1.4.8.6	Debug sensor modules	2/6/04	4/15/04	$0	$0	$1,320	$1,320

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
12	ElecTechSF	10%	40 h	0 w	2/6/04	4/15/04	$1,320	$0	$0	$1,320	0 h	0 h	0 h	40 h
34	SASEQTestStandF	100%	400 h	0 w	2/6/04	4/15/04	$0	$0	$0	$0	0 h	0 h	0 h	400 h
44	PostDoc	50%	200 h	0 w	2/6/04	4/15/04	$0	$0	$0	$0	0 h	0 h	0 h	200 h

Notes

WBS Definition-
First functionality test of module after construction, consisting of visual inspection, functionality test without biasing the detector, biasing of the detector and characterization of the module by determining IV and V-noise curves. Noisy channels are removed by pulling wirebonds.

Labor BOE-
Testing of 86 modules, 10 modules/week, 4 hour/module of test stand usage, of which two hours per module is physicist's time. ElecTech (at 10%) pulls bonds on bad channels in preparation for burn-in. Physicist debugs module and sends modules that fail to the "evaluate and repair" task (50% of physicist needed). We assume that 10% of the modules fail. Estimate based on Run IIa experience.

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
1.1.4.8.7	Burn-in sensor modules	2/13/04	4/22/04	$0	$0	$0	$0

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
40	ModuleBurnInStand	20%	80 h	0 w	2/13/04	4/22/04	$0	$0	$0	$0	0 h	0 h	0 h	80 h
47	Student	20%	80 h	0 w	2/13/04	4/22/04	$0	$0	$0	$0	0 h	0 h	0 h	80 h

Notes

WBS Definition-
The QC procedure where modules are readout out under bias voltage for a few days and evaluated for bad channels

Labor BOE-
Burn-in of 86 modules for 3 day cycle each. The burn-in stand accomodates up to 32 modules per cycle with 2 cycles per week. We anticipate needing to reprocess 10% of the modules. The L1 module production rate of 10/week, with 10% reprocessing means that 11 modules need to be burned-in per week. The stand has a total capacity of 64 modules per week. Thus, on average, 20% of a module burn-in resource is used over the task duration. Each module requires 0.5 hr documentation by physicist plus 0.3 hr to mount and remove module from test stand. Estimates based on Run IIa experience. The personnel involved is at the same level the burn-in stand is utilized. It is expected that batches of modules to be burned-in are staggered between the two burn-in stands. A physicist will load and document one stand one day, and move to the next burn-in stand the next day. The following two days will be spent unloading and evaluating the burn-in test results and updating the documentation.

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
1.1.4.8.8	Evaluate and repair sensor modules	2/27/04	5/6/04	$0	$0	$3,720	$3,720

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
12	ElecTechSF	20%	80 h	0 w	2/27/04	5/6/04	$2,640	$0	$0	$2,640	0 h	0 h	0 h	80 h
23	WirebonderSF	10%	40 h	0 w	2/27/04	5/6/04	$1,080	$0	$0	$1,080	0 h	0 h	0 h	40 h
29	WirebondingMachineF	10%	40 h	0 w	2/27/04	5/6/04	$0	$0	$0	$0	0 h	0 h	0 h	40 h
34	SASEQTestStandF	100%	400 h	0 w	2/27/04	5/6/04	$0	$0	$0	$0	0 h	0 h	0 h	400 h
44	PostDoc	50%	200 h	0 w	2/27/04	5/6/04	$0	$0	$0	$0	0 h	0 h	0 h	200 h

Notes

WBS Definition-
Determining what repairs are necessary and repairing broken wirebonds, bad hybrids, or bad bias connections

Labor BOE-
We assume that 10% of the modules fail the debugging task. It takes twice as long to diagnose and repair problematic modules, so it takes 8hrs/module to repair. After the module has been repaired it needs to be debugged again, which also falls under the purview of this task. To debug these failed modules again takes 1 day.
For layer 1, one module fails per week, corresponding to a half time physicist.
The physicist needs the support of an ElecTechSF at 20% to replace chips and pull wirebonds, improve grounding, a SASEQTestStandF full time at his disposition, a WirebonderSF at the 10% level.

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
1.1.4.8.9	Perform quality assurance tests	3/12/04	5/20/04	$0	$0	$0	$0

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
34	SASEQTestStandF	100%	400 h	0 w	3/12/04	5/20/04	$0	$0	$0	$0	0 h	0 h	0 h	400 h
44	PostDoc	50%	200 h	0 w	3/12/04	5/20/04	$0	$0	$0	$0	0 h	0 h	0 h	200 h

Notes

WBS Definition-
Quality assurance of a subset of modules to fully characterize its performance.

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
"Perform quality assurance tests" continued							

Notes

Labor BOE-
For Layer 0 and Layer 1 we assume that 10% of the modules are submitted to extensive tests, including laser test, temperature cycling, probe and pull testing and possibly irradiation tests. A physicist will be occupied half time for one week for one module. He needs the support of a SASEQ test stand.

1.1.4.8.10	**Silicon L1 Module Production and Testing Comple**	**5/20/04**	**5/20/04**	**$0**	**$0**	**$0**	**$0**

Notes

WBS Definition-
Milestone: All modules for L1 have been produced and tested.

1.1.4.9	**Fabricate 20cm Gangs**	**7/3/03**	**1/30/04**	**$2,820**	**$0**	**$38,968**	**$41,788**

Notes

WBS Definition-
Summary task that includes the gluing and alignment of all of the 20cm gangs used to fabricate modules.

1.1.4.9.1	20cm gang Production Training	7/3/03	7/17/03	$0	$0	$1,188	$1,188

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
9	MechTechSF	30%	24 h	0 w	7/3/03	7/17/03	$816	$0	$0	$816	0 h	0 h	0 h	24 h
17	PhysicistF	30%	24 h	0 w	7/3/03	7/17/03	$0	$0	$0	$0	0 h	0 h	0 h	24 h
27	CMMOperatorSF	15%	12 h	0 w	7/3/03	7/17/03	$372	$0	$0	$372	0 h	0 h	0 h	12 h
30	CMMSmall	100%	80 h	0 w	7/3/03	7/17/03	$0	$0	$0	$0	0 h	0 h	0 h	80 h

Notes

WBS Definition-
Training of technical personnel for 20cm gang production.

M&S BOE-
None.

Labor BOE-
Two mechanical technicians and one CMM operator need to be trained for the fabrication of the 20cm gangs. A physicist oversees and organizes the training. Four full assemblies will be fabricated by each technician for training on a small CMM. There is just one mechanical step iin the assembly: align and glue the sensors. This is expected to take 2 hours in training plus one hour of evaluation. This implies two technicians plus a CMM operator involved at the 15% level each.

1.1.4.9.2	20cm gang Production Readiness Review	7/18/03	7/24/03	$0	$0	$340	$340

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
1	MechEngF	10%	4 h	0 w	7/18/03	7/24/03	$204	$0	$0	$204	0 h	0 h	0 h	4 h
9	MechTechSF	10%	4 h	0 w	7/18/03	7/24/03	$136	$0	$0	$136	0 h	0 h	0 h	4 h
17	PhysicistF	100%	40 h	0 w	7/18/03	7/24/03	$0	$0	$0	$0	0 h	0 h	0 h	40 h

Notes

WBS Definition-
Review of readiness for 20cm gang production.

M&S BOE-
None.

Labor BOE-
The physicist production line floor manager spends a couple of days preparing all the paperwork and establishing the procedures after the review. The review itself is expected to take half a day with participation of the lead mechanical technician, a mechanical engineer and several physicists.

1.1.4.9.3	**Begin 20cm Gang Production**	**7/25/03**	**7/25/03**	**$0**	**$0**	**$0**	**$0**
1.1.4.9.4	Fabricate south axial 20 cm sensor gangs	7/25/03	10/17/03	$705	$0	$9,360	$10,065

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
9	MechTechSF	30%	144 h	0 w	7/25/03	10/17/03	$4,896	$0	$0	$4,896	0 h	0 h	0 h	144 h
17	PhysicistF	25%	120 h	0 w	7/25/03	10/17/03	$0	$0	$0	$0	0 h	0 h	0 h	120 h
27	CMMOperatorSF	30%	144 h	0 w	7/25/03	10/17/03	$4,464	$0	$0	$4,464	0 h	0 h	0 h	144 h
30	CMMSmall	200%	960 h	0 w	7/25/03	10/17/03	$0	$0	$0	$0	0 h	0 h	0 h	960 h
48	MandS	705	705	0 w	7/25/03	10/17/03	$705	$0	$0	$705		0	0	705

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost

"Fabricate south axial 20 cm sensor gangs" continued

Notes

WBS Definition-
Align 2 sensors and glue on CMM for 20 cm gangs

M&S BOE-
Epoxy cost based on one 10cc mix per day with an anticipated cost of $1500 for 20 liters of epoxy, including purity testing ($0.75 per 10cc). In addition there will be one packet of silver epoxy used per day throughout this production, at $11 each. Total cost is $705 with $45 in high purity epoxy and $660 in silver epoxy.

Labor BOE-
There are 672 sensor gangs for the whole detector. This task involves assembly of 1/4 of these, or 168 gangs. We assume there are 20% spares, that is, an additional 32 gangs. This gives a total of 200 gangs to be made. Using 2 small CMMs, 2 sets of gangs per CMM per day, we can produce 200 gangs in 10 weeks. We anticipate some inefficiency in production, particularly at startup, so we have allocated an additional 2 weeks.
The ganging of 2 sensors will be performed by a mechanical technician who will prepare the glue, parts and documentation. The CMM technician will operate the CMM and align the sensors to be ganged. Two CMMs are operated in parallel. On each CMM two sensor gangs will be produced per day. Preparation, setup and cleanup by the mechanical technician is expected to take about half an hour per gang. Glueing the sensors and operating the CMM is also expected to take half an hour per gang. Both technicians are thus occupied for 2 hours per day making sensor gangs. An overhead of half an hour per person is added to take into account breaks. Thus both technicians are assigned at the 30% level. A senior physicist from Fermilab oversees the production at 25%.

1.1.4.9.5	Fabricate south stereo 20 cm sensor gangs	7/25/03	10/17/03	$705	$0	$9,360	$10,065

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
9	MechTechSF	30%	144 h	0 w	7/25/03	10/17/03	$4,896	$0	$0	$4,896	0 h	0 h	0 h	144 h
17	PhysicistF	25%	120 h	0 w	7/25/03	10/17/03	$0	$0	$0	$0	0 h	0 h	0 h	120 h
27	CMMOperatorSF	30%	144 h	0 w	7/25/03	10/17/03	$4,464	$0	$0	$4,464	0 h	0 h	0 h	144 h
30	CMMSmall	200%	960 h	0 w	7/25/03	10/17/03	$0	$0	$0	$0	0 h	0 h	0 h	960 h
48	MandS	705	705	0 w	7/25/03	10/17/03	$705	$0	$0	$705		0	0	705

Notes

WBS Definition-
Align 2 sensors and glue on CMM for 20 cm gangs

M&S BOE-
Epoxy cost based on one 10cc mix per day with an anticipated cost of $1500 for 20 liters of epoxy, including purity testing ($0.75 per 10cc). In addition there will be one packet of silver epoxy used per day throughout this production, at $11 each. Total cost is $705 with $45 in high purity epoxy and $660 in silver epoxy.

Labor BOE-
There are 672 sensor gangs for the whole detector. This task involves assembly of 1/4 of these, or 168 gangs. We assume there are 20% spares, that is, an additional 32 gangs. This gives a total of 200 gangs to be made. Using 2 small CMMs, 2 sets of gangs per CMM per day, we can produce 200 gangs in 10 weeks. We anticipate some inefficiency in production, particularly at startup, so we have allocated an additional 2 weeks.
The ganging of 2 sensors will be performed by a mechanical technician who will prepare the glue, parts and documentation. The CMM technician will operate the CMM and align the sensors to be ganged. Two CMMs are operated in parallel. On each CMM two sensor gangs will be produced per day. Preparation, setup and cleanup by the mechanical technician is expected to take about half an hour per gang. Glueing the sensors and operating the CMM is also expected to take half an hour per gang. Both technicians are thus occupied for 2 hours per day making sensor gangs. An overhead of half an hour per person is added to take into account breaks. Thus both technicians are assigned at the 30% level. A senior physicist from Fermilab oversees the production at 25%.

1.1.4.9.6	Fabricate north axial 20 cm sensor gangs	10/27/03	1/30/04	$705	$0	$9,360	$10,065

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
9	MechTechSF	30%	144 h	0 w	10/27/03	1/30/04	$4,896	$0	$0	$4,896	0 h	0 h	0 h	144 h
17	PhysicistF	25%	120 h	0 w	10/27/03	1/30/04	$0	$0	$0	$0	0 h	0 h	0 h	120 h
27	CMMOperatorSF	30%	144 h	0 w	10/27/03	1/30/04	$4,464	$0	$0	$4,464	0 h	0 h	0 h	144 h
30	CMMSmall	200%	960 h	0 w	10/27/03	1/30/04	$0	$0	$0	$0	0 h	0 h	0 h	960 h
48	MandS	705	705	0 w	10/27/03	1/30/04	$705	$0	$0	$705		0	0	705

Notes

WBS Definition-
Align 2 sensors and glue on CMM for 20 cm gangs

M&S BOE-
Epoxy cost based on one 10cc mix per day with an anticipated cost of $1500 for 20 liters of epoxy, including purity testing ($0.75 per 10cc). In addition there will be one packet of silver epoxy used per day throughout this production, at $11 each. Total cost is $705 with $45 in high purity epoxy and $660 in silver epoxy.

Labor BOE-
There are 672 sensor gangs for the whole detector. This task involves assembly of 1/4 of these, or 168 gangs. We assume there are 20% spares, that is, an additional 32 gangs. This gives a total of 200 gangs to be made. Using 2 small CMMs, 2 sets of gangs per CMM per day, we can produce 200 gangs in 10 weeks. We anticipate some inefficiency in production, particularly at startup, so we have allocated an additional 2 weeks.
The ganging of 2 sensors will be performed by a mechanical technician who will prepare the glue, parts and documentation. The CMM technician will operate the CMM and align the sensors to be ganged. Two

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost

"Fabricate north axial 20 cm sensor gangs" continued

Notes

CMMs are operated in parallel. On each CMM two sensor gangs will be produced per day. Preparation, setup and cleanup by the mechanical technician is expected to take about half an hour per gang. Glueing the sensors and operating the CMM is also expected to take half an hour per gang. Both technicians are thus occupied for 2 hours per day making sensor gangs. An overhead of half an hour per person is added to take into account breaks. Thus both technicians are assigned at the 30% level. A senior physicist from Fermilab oversees the production at 25%.

1.1.4.9.7	Fabricate north stereo 20 cm sensor gangs	10/27/03	1/30/04	$705	$0	$9,360	$10,065

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
9	MechTechSF	30%	144 h	0 w	10/27/03	1/30/04	$4,896	$0	$0	$4,896	0 h	0 h	0 h	144 h
17	PhysicistF	25%	120 h	0 w	10/27/03	1/30/04	$0	$0	$0	$0	0 h	0 h	0 h	120 h
27	CMMOperatorSF	30%	144 h	0 w	10/27/03	1/30/04	$4,464	$0	$0	$4,464	0 h	0 h	0 h	144 h
30	CMMSmall	200%	960 h	0 w	10/27/03	1/30/04	$0	$0	$0	$0	0 h	0 h	0 h	960 h
48	MandS	705	705	0 w	10/27/03	1/30/04	$705	$0	$0	$705		0	0	705

Notes

WBS Definition-
Align 2 sensors and glue on CMM for 20 cm gangs

M&S BOE-
Epoxy cost based on one 10cc mix per day with an anticipated cost of $1500 for 20 liters of epoxy, including purity testing ($0.75 per 10cc). In addition there will be one packet of silver epoxy used per day throughout this production, at $11 each. Total cost is $705 with $45 in high purity epoxy and $660 in silver epoxy.

Labor BOE-
There are 672 sensor gangs for the whole detector. This task involves assembly of 1/4 of these, or 168 gangs. We assume there are 20% spares, that is, an additional 32 gangs. This gives a total of 200 gangs to be made. Using 2 small CMMs, 2 sets of gangs per CMM per day, we can produce 200 gangs in 10 weeks. We anticipate some inefficiency in production, particularly at startup, so we have allocated an additional 2 weeks.
The ganging of 2 sensors will be performed by a mechanical technician who will prepare the glue, parts and documentation. The CMM technician will operate the CMM and align the sensors to be ganged. Two CMMs are operated in parallel. On each CMM two sensor gangs will be produced per day. Preparation, setup and cleanup by the mechanical technician is expected to take about half an hour per gang. Glueing the sensors and operating the CMM is also expected to take half an hour per gang. Both technicians are thus occupied for 2 hours per day making sensor gangs. An overhead of half an hour per person is added to take into account breaks. Thus both technicians are assigned at the 30% level. A senior physicist from Fermilab oversees the production at 25%.

1.1.4.10	**Layer 2-5 Module Production Readiness**	**2/12/04**	**3/16/04**	**$0**	**$0**	**$4,280**	**$4,280**

Notes

WBS Definition-
Summary task covering training and production readiness review for L2-L5 module produiction.

1.1.4.10.1	L2-5 Axial Module Production Training	2/12/04	2/25/04	$0	$0	$1,800	$1,800

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
9	MechTechSF	40%	32 h	0 w	2/12/04	2/25/04	$1,088	$0	$0	$1,088	0 h	0 h	0 h	32 h
17	PhysicistF	50%	40 h	0 w	2/12/04	2/25/04	$0	$0	$0	$0	0 h	0 h	0 h	40 h
23	WirebonderSF	10%	8 h	0 w	2/12/04	2/25/04	$216	$0	$0	$216	0 h	0 h	0 h	8 h
27	CMMOperatorSF	20%	16 h	0 w	2/12/04	2/25/04	$496	$0	$0	$496	0 h	0 h	0 h	16 h
29	WirebondingMachineF	5%	4 h	0 w	2/12/04	2/25/04	$0	$0	$0	$0	0 h	0 h	0 h	4 h
30	CMMSmall	100%	80 h	0 w	2/12/04	2/25/04	$0	$0	$0	$0	0 h	0 h	0 h	80 h

Notes

WBS Definition-
Training of technical personnel for layer 2-5 axial module production.

M&S BOE-
None.

Labor BOE-
Two mechanical technicians, one CMM operator, and one wirebonder need to be trained for L2-5 axial module production. A physicist oversees and organizes the training. Two full assemblies will be fabricated by each technician for training on a small CMM. There are two mechanical steps in the assembly: align and glue the sensor and the hybrid and the work on the backside of the sensor, including HV and grounding. Each of these is expected to take 2 hours in training plus two hours of evaluation. The CMM operator is required for only the first of the two steps. This implies two technicians plus a CMM operator involved at the 20% level each. Wirebonding is expected to take one hour per asssembly plus one hour of evaluation and adjusting wirebonding settings.

1.1.4.10.2	L2-5 Axial Module Production Readiness Review	2/26/04	3/3/04	$0	$0	$340	$340

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
1	MechEngF	10%	4 h	0 w	2/26/04	3/3/04	$204	$0	$0	$204	0 h	0 h	0 h	4 h
9	MechTechSF	10%	4 h	0 w	2/26/04	3/3/04	$136	$0	$0	$136	0 h	0 h	0 h	4 h
17	PhysicistF	100%	40 h	0 w	2/26/04	3/3/04	$0	$0	$0	$0	0 h	0 h	0 h	40 h

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost

"L2-5 Axial Module Production Readiness Review" continued

Notes

WBS Definition-
Review of readiness for L2-5 axial module production.

M&S BOE-
None.

Labor BOE-
The physicist production line floor manager spends a couple of days preparing all the paperwork and establishing the procedures after the review. The review itself is expected to take half a day with participation of the lead mechanical technician, a mechanical engineer and several physicists.

1.1.4.10.3	L2-5 Stereo Module Production Training	2/12/04	2/25/04	$0	$0	$1,800	$1,800

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
9	MechTechSF	40%	32 h	0 w	2/12/04	2/25/04	$1,088	$0	$0	$1,088	0 h	0 h	0 h	32 h
17	PhysicistF	50%	40 h	0 w	2/12/04	2/25/04	$0	$0	$0	$0	0 h	0 h	0 h	40 h
23	WirebonderSF	10%	8 h	0 w	2/12/04	2/25/04	$216	$0	$0	$216	0 h	0 h	0 h	8 h
27	CMMOperatorSF	20%	16 h	0 w	2/12/04	2/25/04	$496	$0	$0	$496	0 h	0 h	0 h	16 h
29	WirebondingMachineF	5%	4 h	0 w	2/12/04	2/25/04	$0	$0	$0	$0	0 h	0 h	0 h	4 h
30	CMMSmall	100%	80 h	0 w	2/12/04	2/25/04	$0	$0	$0	$0	0 h	0 h	0 h	80 h

Notes

WBS Definition-
Training of technical personnel for layer 2-5 stereo module production.

M&S BOE-
None.

Labor BOE-
Two mechanical technicians, one CMM operator, and one wirebonder need to be trained for L2-5 stereo module production. A physicist oversees and organizes the training. Two full assemblies will be fabricated by each technician for training on a small CMM. There are two mechanical steps in the assembly: align and glue the sensor and the hybrid and the work on the backside of the sensor, including HV and grounding. Each of these is expected to take 2 hours in training plus two hours of evaluation. The CMM operator is required for only the first of the two steps. This implies two technicians plus a CMM operator involved at the 20% level each. Wirebonding is expected to take one hour per asssembly plus one hour of evaluation and adjusting wirebonding settings.

1.1.4.10.4	L2-5 Stereo Module Production Readiness Review	2/26/04	3/3/04	$0	$0	$340	$340

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
1	MechEngF	10%	4 h	0 w	2/26/04	3/3/04	$204	$0	$0	$204	0 h	0 h	0 h	4 h
9	MechTechSF	10%	4 h	0 w	2/26/04	3/3/04	$136	$0	$0	$136	0 h	0 h	0 h	4 h
17	PhysicistF	100%	40 h	0 w	2/26/04	3/3/04	$0	$0	$0	$0	0 h	0 h	0 h	40 h

Notes

WBS Definition-
Review of readiness for L2-5 stereo module production.

M&S BOE-
None.

Labor BOE-
The physicist production line floor manager spends a couple of days preparing all the paperwork and establishing the procedures after the review. The review itself is expected to take half a day with participation of the lead mechanical technician, a mechanical engineer and several physicists.

1.1.4.10.5	Module Production for L2-L5 South Silicon Begun	3/16/04	3/16/04	$0	$0	$0	$0

Notes

WBS Definition-
Milestone: Module production for L2-L5 modules for the South barrel begun.

1.1.4.11	Module Production and Testing for L2-L5 South Si	7/23/04	7/23/04	$0	$0	$0	$0

Notes

WBS Definition-
Milestone: Module production and testing for L2-L5 modules for the South barrel complete.

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
1.1.4.12	Module Production for L2-L5 North Silicon Begun	7/28/04	7/28/04	$0	$0	$0	$0

Notes
WBS Definition-
Milestone: Module production for L2-L5 modules for the North barrel begun.

1.1.4.13	Module Production and Testing for L2-L5 North Sil	11/9/04	11/9/04	$0	$0	$0	$0

Notes
WBS Definition-
Milestone: Module production and testing for L2-L5 modules for the North barrel complete.

1.1.4.24	Silicon Module Production And Testing Complete	11/9/04	11/9/04	$0	$0	$0	$0

Notes
WBS Definition-
All silicon detector module production and testing is complete.

1.1.4.14	10/10 Axial Modules	12/13/02	10/27/04	$1,540	$0	$63,632	$65,172

Notes
WBS Definition-
The summary task that includes the prototyping and construction of all 10/10 Axial modules

1.1.4.14.1	Develop electrical module preproduction	12/13/02	2/18/03	$130	$0	$22,832	$22,962

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
1	MechEngF	25%	80 h	0 w	12/13/02	2/18/03	$4,080	$0	$0	$4,080	0 h	0 h	0 h	80 h
9	MechTechSF	100%	320 h	0 w	12/13/02	2/18/03	$10,880	$0	$0	$10,880	0 h	0 h	0 h	320 h
12	ElecTechSF	5%	16 h	0 w	12/13/02	2/18/03	$528	$0	$0	$528	0 h	0 h	0 h	16 h
17	PhysicistF	100%	320 h	0 w	12/13/02	2/18/03	$0	$0	$0	$0	0 h	0 h	0 h	320 h
21	DesignerF	15%	48 h	0 w	12/13/02	2/18/03	$2,112	$0	$0	$2,112	0 h	0 h	0 h	48 h
27	CMMOperatorSF	30%	96 h	0 w	12/13/02	2/18/03	$2,976	$0	$0	$2,976	0 h	0 h	0 h	96 h
28	CMMProgrammerSF	15%	48 h	0 w	12/13/02	2/18/03	$2,256	$0	$0	$2,256	0 h	0 h	0 h	48 h
30	CMMSmall	45%	144 h	0 w	12/13/02	2/18/03	$0	$0	$0	$0	0 h	0 h	0 h	144 h
48	MandS	130	130	0 w	12/13/02	2/18/03	$130	$0	$0	$130		0	0	130

Notes
WBS Definition-
Design and preproduction of 10/10 Axial modules including how to build it

M&S BOE-
Epoxy cost based on 4 10cc mixed batches with an anticipated cost of $1500 for 20 liters of epoxy, including purity testing. In addition there will be 1 packet of silver epoxy for each electrical prototype, at $11 each. Additional miscellaneous parts and materials included at $80 total. Total cost is $130.

Labor BOE-
Assembly and inspection of electrical preproduction modules, including refinement of assembly sequence and tooling. We anticipate fabrication of 4 electrical grade modules. These are the first electrical grade preproduction axial modules to be built. The physicist and engineer will develop the assembly procedures utilizing the initial L2-L5 module fixtures, with particular attention to electrical issues such as HV connections and shielding. This is expected to require 4 weeks at 50% effort each with 25% of designer time to prepare drawings to aid the technicians in assembly and bonding. The CMM programmer will develop the required CMM programs for the module assembly procedure during this period and the CMM operator and mechanical technician will exercise the program and assembly procedures with mechanical parts. The last 4 weeks will involve production of the electrical grade modules, each requiring roughly 2 days of mechanical technician effort, interspersed with electrical evaluation and process feedback by a physicist before the next module is made. The designer and mechanical engineer are expected to contribute 15% effort over this period to address modifications to tooling and drawings. Wirebonding prototypes is expected to take roughly 4 hours in total which is a negligible impact on that resource over this period. The CMM operator mirrors the mechanical technician to provide the required support during fabrication of the electrical preproduction modules.

1.1.4.14.2	South	3/16/04	7/23/04	$705	$0	$20,400	$21,105

Notes
WBS Definition-
Summary task including all South 10/10 Axial module production

1.1.4.14.2.1	L2-5 (10/10 South Axial) Silicon Module Productior	3/16/04	3/16/04	$0	$0	$0	$0

Notes
WBS Definition-
Milestone: Production for L2-L5 10/10 South axial modules has begun.

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
1.1.4.14.2.2	Align and glue sensors to hybrid	3/16/04	6/9/04	$705	$0	$11,880	$12,585

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
9	MechTechSF	50%	240 h	0 w	3/16/04	6/9/04	$8,160	$0	$0	$8,160	0 h	0 h	0 h	240 h
17	PhysicistF	25%	120 h	0 w	3/16/04	6/9/04	$0	$0	$0	$0	0 h	0 h	0 h	120 h
27	CMMOperatorSF	25%	120 h	0 w	3/16/04	6/9/04	$3,720	$0	$0	$3,720	0 h	0 h	0 h	120 h
30	CMMSmall	100%	480 h	0 w	3/16/04	6/9/04	$0	$0	$0	$0	0 h	0 h	0 h	480 h
48	MandS	705	705	0 w	3/16/04	6/9/04	$705	$0	$0	$705		0	0	705

Notes

WBS Definition-
On CMM, using fixtures align sensors and hybrid and glue all together

M&S BOE-
Epoxy cost based on one 10cc mix per day with an anticipated cost of $1500 for 20 liters of epoxy, including purity testing. In addition there will be 1 packet of silver epoxy used per day throughout this production, at $11 each. Total epoxy cost is $11.75/day.

Labor BOE-
There are 168 staves and thus 168 10-10 axial modules in the detector, which means 84 modules per north and south barrel. Including 20% spares, a total of 100 modules will have to be produced.
We foresee building 2 modules per day on one CMM. All modules can be produced in 10 weeks. To adequately train people and setup the procedures we expect that only one module will be built per day in the first week. One week is added to accommodate possible delays in part arrivals, equipment downtime or mishaps during production. Production of a module, based on 2a experience, should take 1 hour of time for each of a mechanical technician and a CMM technician. The mechanical technician helps setting up and does the documentation and database entry. The following day a mechanical technician flips the module and makes the HV and ground connections and installs HV insulation and updates documentation. The latter operation will take 1 hour per module. A mechanical technician is thus assigned at the 50% level and a CMM operator at the 25% level. A senior Fermilab physicist oversees the production at 25%.

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
1.1.4.14.2.3	Wirebond sensors to hybrid	3/22/04	6/15/04	$0	$0	$4,056	$4,056

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
9	MechTechSF	5%	24 h	0 w	3/22/04	6/15/04	$816	$0	$0	$816	0 h	0 h	0 h	24 h
17	PhysicistF	10%	48 h	0 w	3/22/04	6/15/04	$0	$0	$0	$0	0 h	0 h	0 h	48 h
23	WirebonderSF	25%	120 h	0 w	3/22/04	6/15/04	$3,240	$0	$0	$3,240	0 h	0 h	0 h	120 h
29	WirebondingMachineF	25%	120 h	0 w	3/22/04	6/15/04	$0	$0	$0	$0	0 h	0 h	0 h	120 h

Notes

WBS Definition-
Wirebond all necessary connections.

Labor BOE-
The 100 modules from the previous task are wirebonded from the sensor to the SVX4 chips. Each hybrid holds 10 SVX4 chips, so 1280 wirebonds plus some additional ones for the bias voltage will have to be made. Wirebonding will be performed on the fully automatic K&S 8090 wirebonders, which can wirebond at a rate of 5 bonds per second. Setup time of the module on the wirebonder will be the most time consuming part. Based on our extensive experience with wirebonding we expect each module to take about 30 minutes for wirebonding. Additional time is required for inspection, repairs, documentation and feeding the production line. A total of 1 hour per module is allocated giving a utilization of a wirebonder at 25%. The same startup and production problems as in the previous task are assumed and thus the task duration is the same as the task duration for the module production.
A mechanical technician is allocated at the 5% level because we assume that 25% of the modules will have to be retrofitted. A physicist oversees the operation at half the level of the wirebonder.

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
1.1.4.14.2.4	**10/10 South Axial Silicon Module Production Comp**	**6/15/04**	**6/15/04**	**$0**	**$0**	**$0**	**$0**

Notes

WBS Definition-
Milestone: All 10/10 South Axial Modules needed are produced.

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
1.1.4.14.2.5	Debug sensor module	3/24/04	6/17/04	$0	$0	$1,584	$1,584

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
12	ElecTechSF	10%	48 h	0 w	3/24/04	6/17/04	$1,584	$0	$0	$1,584	0 h	0 h	0 h	48 h
34	SASEQTestStandF	100%	480 h	0 w	3/24/04	6/17/04	$0	$0	$0	$0	0 h	0 h	0 h	480 h
44	PostDoc	50%	240 h	0 w	3/24/04	6/17/04	$0	$0	$0	$0	0 h	0 h	0 h	240 h

Notes

WBS Definition-
First functionality test of module after construction, consisting of visual inspection, functionality test without biasing the detector, biasing of the detector and characterization of the module by determining IV and V-noise curves. Noisy channels are removed by pulling wirebonds.

Labor BOE-
Testing of 100 modules, 10 modules/week, 4 hour/module of test stand usage, of which two hours per module is physicist's time. ElecTech (at 10%) pulls bonds on bad channels in preparation for burn-in. Physicist debugs module and sends modules that fail to the "evaluate and repair" task (50% of physicist needed). We assume that 10% of the modules fail. Estimate based on Run IIa experience.

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
1.1.4.14.2.6	Burn-in sensor modules	3/31/04	6/24/04	$0	$0	$0	$0

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
40	ModuleBurnInStand	20%	96 h	0 w	3/31/04	6/24/04	$0	$0	$0	$0	0 h	0 h	0 h	96 h
47	Student	20%	96 h	0 w	3/31/04	6/24/04	$0	$0	$0	$0	0 h	0 h	0 h	96 h

Notes

WBS Definition-
The QC procedure where modules are readout out under bias voltage for a few days and evaluated for bad channels

Labor BOE-
Burn-in of 100 modules for 3 day cycle each. The burn-in stand accomodates up to 32 modules per cycle with 2 cycles per week. We anticipate needing to reprocess 10% of the modules. The L1 module production rate of 10/week, with 10% reprocessing means that 11 modules need to be burned-in per week. The stand has a total capacity of 64 modules per week. Thus, on average, 20% of a module burn-in resource is used over the task duration. Each module requires 0.5 hr documentation by physicist plus 0.3 hr to mount and remove module from test stand. Estimates based on Run IIa experience. The personnel involved is at the same level the burn-in stand is utilized. It is expected that batches of modules to be burned-in are staggered between the two burn-in stands. A physicist will load and document one stand one day, and move to the next burn-in stand the next day. The following two days will be spent unloading and evaluating the burn-in test results and updating the documentation.

1.1.4.14.2.7	Evaluate and repair sensor modules	4/14/04	7/9/04	$0	$0	$2,880	$2,880

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
12	ElecTechSF	10%	48 h	0 w	4/14/04	7/9/04	$1,584	$0	$0	$1,584	0 h	0 h	0 h	48 h
23	WirebonderSF	10%	48 h	0 w	4/14/04	7/9/04	$1,296	$0	$0	$1,296	0 h	0 h	0 h	48 h
29	WirebondingMachineF	10%	48 h	0 w	4/14/04	7/9/04	$0	$0	$0	$0	0 h	0 h	0 h	48 h
34	SASEQTestStandF	100%	480 h	0 w	4/14/04	7/9/04	$0	$0	$0	$0	0 h	0 h	0 h	480 h
44	PostDoc	50%	240 h	0 w	4/14/04	7/9/04	$0	$0	$0	$0	0 h	0 h	0 h	240 h

Notes

WBS Definition-
Determining what repairs are necessary and repairing broken wirebonds, bad hybrids, or bad bias connections

Labor BOE-
We assume that 10% of the modules fail the debugging task or 10 modules need to be debugged. It takes twice as long to diagnose and repair problematic modules, so it takes 8hrs/module to repair. After the module has been repaired it needs to be debugged again, which also falls under the purview of this task. To debug these failed modules again takes 1 day. The physicist needs the support of an ElecTechSF at 10% to replace chips and pull wirebonds, improve grounding, a SASEQTestStandF full time at his disposition, a WirebonderSF at the 10% level.

1.1.4.14.2.8	Perform quality assurance tests	4/28/04	7/23/04	$0	$0	$0	$0

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
34	SASEQTestStandF	100%	480 h	0 w	4/28/04	7/23/04	$0	$0	$0	$0	0 h	0 h	0 h	480 h
44	PostDoc	50%	240 h	0 w	4/28/04	7/23/04	$0	$0	$0	$0	0 h	0 h	0 h	240 h

Notes

WBS Definition-
Quality assurance of a subset of modules to fully characterize its performance.

Labor BOE-
For the outer layers a very small set of modules will be submitted to extensive tests, including laser test, temperature cycling, probe and pull testing and possibly irradiation tests. It is foreseen that these tests will be done on each batch of silicon sensors, with 24 batches in total. This corresponds to a full test for two module of each type for each detector half. A physicist will be occupied half time for one week for one module. He needs the support of a SASEQ test stand.

1.1.4.14.2.9	**10/10 South Axial Silicon Module Testing Complete**	**7/23/04**	**7/23/04**	**$0**	**$0**	**$0**	**$0**

Notes

WBS Definition-
Milestone: All 10/10 South Axial Modules are produced and tested.

1.1.4.14.3	**North**	**6/15/04**	**10/27/04**	**$705**	**$0**	**$20,400**	**$21,105**

Notes

WBS Definition-
Summary task including all North 10/10 Axial module production.

1.1.4.14.3.1	Raccoons shut down SiDet	6/15/04	6/18/04	$0	$0	$0	$0

Notes

WBS Definition-
Over the course of the years many raccoons were born inside the walls of SiDet. The raccoons view SiDet as their birthplace. The female raccoons return each year to give birth to their offspring in the comfort of the walls of SiDet. Given the problems raccoons have caused SiDet over the years (six raccoons were caught inside the SiDet complex in 2002, and one raccoon was sleeping during the day in the rafters of the

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost

"Raccoons shut down SiDet" continued

Notes

AB-Bridge, an office area for the SiDet engineers and designers) it is anticipated that raccoons will cause a three day disruption of work at SiDet during the breeding season in the year 2004. This assumes that the building manager will not have left the laboratory because of raccoon problems that occurred in 2003.

1.1.4.14.3.2	**10/10 North Axial Silicon Module Production Begu**	**6/18/04**	**6/18/04**	**$0**	**$0**	**$0**	**$0**

Notes

WBS Definition-
Milestone: Production for L2-L5 10/10 North axial modules has begun.

1.1.4.14.3.3	Align and glue sensors to hybrid	6/18/04	9/14/04	$705	$0	$11,880	$12,585

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
9	MechTechSF	50%	240 h	0 w	6/18/04	9/14/04	$8,160	$0	$0	$8,160	0 h	0 h	0 h	240 h
17	PhysicistF	25%	120 h	0 w	6/18/04	9/14/04	$0	$0	$0	$0	0 h	0 h	0 h	120 h
27	CMMOperatorSF	25%	120 h	0 w	6/18/04	9/14/04	$3,720	$0	$0	$3,720	0 h	0 h	0 h	120 h
30	CMMSmall	100%	480 h	0 w	6/18/04	9/14/04	$0	$0	$0	$0	0 h	0 h	0 h	480 h
48	MandS	705	705	0 w	6/18/04	9/14/04	$705	$0	$0	$705		0	0	705

Notes

WBS Definition-
On CMM, using fixtures align sensors and hybrid and glue all together

M&S BOE-
Epoxy cost based on one 10cc mix per day with an anticipated cost of $1500 for 20 liters of epoxy, including purity testing. In addition there will be 1 packet of silver epoxy used per day throughout this production, at $11 each. Total epoxy cost is $11.75/day.

Labor BOE-
There are 168 staves and thus 168 10-10 axial modules in the detector, which means 84 modules per north and south barrel. Including 20% spares, a total of 100 modules will have to be produced.
We foresee building 2 modules per day on one CMM. All modules can be produced in 10 weeks. To adequately train people and setup the procedures we expect that only one module will be built per day in the first week. One week is added to accommodate possible delays in part arrivals, equipment downtime or mishaps during production. Production of a module, based on 2a experience, should take 1 hour of time for each of a mechanical technician and a CMM technician. The mechanical technician helps setting up and does the documentation and database entry. The following day a mechanical technician flips the module and makes the HV and ground connections and installs HV insulation and updates documentation. The latter operation will take 1 hour per module. A mechanical technician is thus assigned at the 50% level and a CMM operator at the 25% level. A senior Fermilab physicist oversees the production at 25%.

1.1.4.14.3.4	Wirebond sensors to hybrid	6/24/04	9/20/04	$0	$0	$4,056	$4,056

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
9	MechTechSF	5%	24 h	0 w	6/24/04	9/20/04	$816	$0	$0	$816	0 h	0 h	0 h	24 h
17	PhysicistF	10%	48 h	0 w	6/24/04	9/20/04	$0	$0	$0	$0	0 h	0 h	0 h	48 h
23	WirebonderSF	25%	120 h	0 w	6/24/04	9/20/04	$3,240	$0	$0	$3,240	0 h	0 h	0 h	120 h
29	WirebondingMachineF	25%	120 h	0 w	6/24/04	9/20/04	$0	$0	$0	$0	0 h	0 h	0 h	120 h

Notes

WBS Definition-
Wirebond all necessary connections

Labor BOE-
The 100 modules from the previous task are wirebonded from the sensor to the SVX4 chips. Each hybrid holds 10 SVX4 chips, so 1280 wirebonds plus some additional ones for the bias voltage will have to be made. Wirebonding will be performed on the fully automatic K&S 8090 wirebonders, which can wirebond at a rate of 5 bonds per second. Setup time of the module on the wirebonder will be the most time consuming part. Based on our extensive experience with wirebonding we expect each module to take about 30 minutes for wirebonding. Additional time is required for inspection, repairs, documentation and feeding the production line. A total of 1 hour per module is allocated giving a utilization of a wirebonder at 25%. The same startup and production problems as in the previous task are assumed and thus the task duration is the same as the task duration for the module production.
A mechanical technician is allocated at the 5% level because we assume that 25% of the modules will have to be retrofitted. A physicist oversees the operation at half the level of the wirebonder.

1.1.4.14.3.5	**10/10 North Axial Silicon Module Production Comp**	**9/20/04**	**9/20/04**	**$0**	**$0**	**$0**	**$0**

Notes

WBS Definition-
Milestone: All 10/10 North Axial Modules needed are produced.

1.1.4.14.3.6	Debug sensor modules	6/28/04	9/22/04	$0	$0	$1,584	$1,584

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
12	ElecTechSF	10%	48 h	0 w	6/28/04	9/22/04	$1,584	$0	$0	$1,584	0 h	0 h	0 h	48 h
34	SASEQTestStandF	100%	480 h	0 w	6/28/04	9/22/04	$0	$0	$0	$0	0 h	0 h	0 h	480 h

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
"Debug sensor modules" continued							

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
44	PostDoc	50%	240 h	0 w	6/28/04	9/22/04	$0	$0	$0	$0	0 h	0 h	0 h	240 h

Notes

WBS Definition-
First functionality test of module after construction, consisting of visual inspection, functionality test without biasing the detector, biasing of the detector and characterization of the module by determining IV and V-noise curves. Noisy channels are removed by pulling wirebonds.

Labor BOE-
Testing of 100 modules, 10 modules/week, 4 hour/module of test stand usage, of which two hours per module is physicist's time. ElecTech (at 10%) pulls bonds on bad channels in preparation for burn-in. Physicist debugs module and sends modules that fail to the "evaluate and repair" task (50% of physicist needed). We assume that 10% of the modules fail. Estimate based on Run IIa experience.

1.1.4.14.3.7	Burn-in sensor modules	7/6/04	9/29/04	$0	$0	$0	$0

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
40	ModuleBurnInStand	20%	96 h	0 w	7/6/04	9/29/04	$0	$0	$0	$0	0 h	0 h	0 h	96 h
47	Student	20%	96 h	0 w	7/6/04	9/29/04	$0	$0	$0	$0	0 h	0 h	0 h	96 h

Notes

WBS Definition-
The QC procedure where modules are readout out under bias voltage for a few days and evaluated for bad channels

Labor BOE-
Burn-in of 100 modules for 3 day cycle each. The burn-in stand accomodates up to 32 modules per cycle with 2 cycles per week. We anticipate needing to reprocess 10% of the modules. The L1 module production rate of 10/week, with 10% reprocessing means that 11 modules need to be burned-in per week. The stand has a total capacity of 64 modules per week. Thus, on average, 20% of a module burn-in resource is used over the task duration. Each module requires 0.5 hr documentation by physicist plus 0.3 hr to mount and remove module from test stand. Estimates based on Run IIa experience. The personnel involved is at the same level the burn-in stand is utilized. It is expected that batches of modules to be burned-in are staggered between the two burn-in stands. A physicist will load and document one stand one day, and move to the next burn-in stand the next day. The following two days will be spent unloading and evaluating the burn-in test results and updating the documentation.

1.1.4.14.3.8	Evaluate and repair sensor modules	7/20/04	10/13/04	$0	$0	$2,880	$2,880

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
12	ElecTechSF	10%	48 h	0 w	7/20/04	10/13/04	$1,584	$0	$0	$1,584	0 h	0 h	0 h	48 h
23	WirebonderSF	10%	48 h	0 w	7/20/04	10/13/04	$1,296	$0	$0	$1,296	0 h	0 h	0 h	48 h
29	WirebondingMachineF	10%	48 h	0 w	7/20/04	10/13/04	$0	$0	$0	$0	0 h	0 h	0 h	48 h
34	SASEQTestStandF	100%	480 h	0 w	7/20/04	10/13/04	$0	$0	$0	$0	0 h	0 h	0 h	480 h
44	PostDoc	50%	240 h	0 w	7/20/04	10/13/04	$0	$0	$0	$0	0 h	0 h	0 h	240 h

Notes

WBS Definition-
Determining what repairs are necessary and repairing broken wirebonds, bad hybrids, or bad bias connections

Labor BOE-
We assume that 10% of the modules fail the debugging task. It takes twice as long to diagnose and repair problematic modules, so it takes 8hrs/module to repair. After the module has been repaired it needs to be debugged again, which also falls under the purview of this task. To debug these failed modules again takes 1 day. One modules fail per week, corresponding to a half time physicist. The physicist needs the support of an ElecTechSF at 10% to replace chips and pull wirebonds, improve grounding, a SASEQTestStandF full time at his disposition, a WirebonderSF at the 10% level.

1.1.4.14.3.9	Perform quality assurance tests	8/3/04	10/27/04	$0	$0	$0	$0

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
34	SASEQTestStandF	100%	480 h	0 w	8/3/04	10/27/04	$0	$0	$0	$0	0 h	0 h	0 h	480 h
44	PostDoc	50%	240 h	0 w	8/3/04	10/27/04	$0	$0	$0	$0	0 h	0 h	0 h	240 h

Notes

WBS Definition-
Quality assurance of a subset of modules to fully characterize its performance.

Labor BOE-
For the outer layers a very small set of modules will be submitted to extensive tests, including laser test, temperature cycling, probe and pull testing and possibly irradiation tests. It is foreseen that these tests will be done on each batch of silicon sensors, with 24 batches in total. This corresponds to a full test for two module of each type for each detector half. A physicist will be occupied half time for one week for one module. He needs the support of a SASEQ test stand.

1.1.4.14.3.10	**10/10 North Axial Silicon Module Testing Complete**	**10/27/04**	**10/27/04**	**$0**	**$0**	**$0**	**$0**

Notes

WBS Definition-

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
"10/10 North Axial Silicon Module Testing Complete" continued							

Notes
Milestone: All 10/10 North Axial Modules are produced and tested.

1.1.4.15	10/20 Axial Modules (RETIRED)	10/2/00	10/2/00	$0	$0	$0	$0

Notes
WBS Definition-
The summary task that includes the prototyping and construction of all 10/20 Axial modules. It was retired when the detector was redesigned to eliminate 10/20 modules.

1.1.4.16	**20/20 Axial Modules**	**1/7/03**	**10/27/04**	**$1,475**	**$0**	**$52,560**	**$54,035**

Notes
WBS Definition-
The summary task that includes the prototyping and construction of all 20/20 Axial modules

1.1.4.16.1	Develop electrical module preproduction	1/7/03	2/18/03	$65	$0	$14,640	$14,705

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
1	MechEngF	30%	72 h	0 w	1/7/03	2/18/03	$3,672	$0	$0	$3,672	0 h	0 h	0 h	72 h
9	MechTechSF	30%	72 h	0 w	1/7/03	2/18/03	$2,448	$0	$0	$2,448	0 h	0 h	0 h	72 h
12	ElecTechSF	5%	12 h	0 w	1/7/03	2/18/03	$396	$0	$0	$396	0 h	0 h	0 h	12 h
17	PhysicistF	50%	120 h	0 w	1/7/03	2/18/03	$0	$0	$0	$0	0 h	0 h	0 h	120 h
21	DesignerF	15%	36 h	0 w	1/7/03	2/18/03	$1,584	$0	$0	$1,584	0 h	0 h	0 h	36 h
27	CMMOperatorSF	50%	120 h	0 w	1/7/03	2/18/03	$3,720	$0	$0	$3,720	0 h	0 h	0 h	120 h
28	CMMProgrammerSF	25%	60 h	0 w	1/7/03	2/18/03	$2,820	$0	$0	$2,820	0 h	0 h	0 h	60 h
30	CMMSmall	75%	180 h	0 w	1/7/03	2/18/03	$0	$0	$0	$0	0 h	0 h	0 h	180 h
48	MandS	65	65	0 w	1/7/03	2/18/03	$65	$0	$0	$65		0	0	65

Notes
WBS Definition-
Design and preproduction of 20/20 Axial module including how to build it

M&S BOE-
Epoxy cost based on 2 10cc mixed batches with an anticipated cost of $1500 for 20 liters of epoxy, including purity testing. In addition there will be 1 packet of silver epoxy for each electrical prototype, at $11 each. Additional miscellaneous parts and materials included at $40 total. Total cost is $65.

Labor BOE-
Assembly and inspection of electrical preproduction modules, including refinement of assembly sequence and tooling. We anticipate fabrication of 2 electrical grade modules. This are quite similar to the 10-10 axial modules which will be started a few weeks earlier. The physicist, engineer, designer, mechanical technician and CMM programmer will spend 3 weeks developing the required written procedures and CMM programs and exercising them with mechanical parts. The last 2 weeks will involve production of the electrical grade modules, each requiring roughly 2 days of mechanical technician effort, interspersed with electrical evaluation and process feedback by a physicist before the next module is made. The designer and mechanical engineer are expected to contribute 15% effort over this period to address modifications to tooling and drawings. Wirebonding prototypes is expected to take roughly 4 hours in total which is a negligible impact on that resource over this period. The CMM operator mirrors the mechanical technician to provide the required support during fabrication of the electrical preproduction modules.

1.1.4.16.2	**South**	**3/16/04**	**7/23/04**	**$705**	**$0**	**$18,960**	**$19,665**

Notes
WBS Definition-
Summary task including all South 20/20 Axial module production

1.1.4.16.2.1	**20/20 South Axial Silicon Module Production Begu**	**3/16/04**	**3/16/04**	**$0**	**$0**	**$0**	**$0**

Notes
WBS Definition-
Milestone: Production for L2-L5 20/20 South axial modules has begun.

1.1.4.16.2.2	Align and glue sensors to hybrid	3/16/04	6/9/04	$705	$0	$11,880	$12,585

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
9	MechTechSF	50%	240 h	0 w	3/16/04	6/9/04	$8,160	$0	$0	$8,160	0 h	0 h	0 h	240 h
17	PhysicistF	25%	120 h	0 w	3/16/04	6/9/04	$0	$0	$0	$0	0 h	0 h	0 h	120 h
27	CMMOperatorSF	25%	120 h	0 w	3/16/04	6/9/04	$3,720	$0	$0	$3,720	0 h	0 h	0 h	120 h
30	CMMSmall	200%	960 h	0 w	3/16/04	6/9/04	$0	$0	$0	$0	0 h	0 h	0 h	960 h
48	MandS	705	705	0 w	3/16/04	6/9/04	$705	$0	$0	$705		0	0	705

Notes
WBS Definition-

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
"Align and glue sensors to hybrid" continued							

Notes

On CMM, using fixtures align sensors and hybrid and glue all together

M&S BOE-
Epoxy cost based on one 10cc mix per day with an anticipated cost of $1500 for 20 liters of epoxy, including purity testing. In addition there will be 1 packet of silver epoxy used per day throughout this production, at $11 each. Total epoxy cost is $11.75/day.

Labor BOE-
There are 168 staves and thus 168 20-20 axial modules in the detector, which means 84 modules per north and south barrel. Including 20% spares, a total of 100 modules will have to be produced.
We foresee building 2 modules per day on two small CMMs. All modules can be produced in 10 weeks. To adequately train people and setup the procedures we expect that only one module will be built per day in the first week. One week is added to accommodate possible delays in part arrivals, equipment downtime or mishaps during production. Production of a module, based on 2a experience, should take 1 hour of time for each of a mechanical technician and a CMM technician. The mechanical technician helps setting up and does the documentation and database entry. The following day a mechanical technician flips the module and makes the HV and ground connections and installs HV insulation and updates documentation. The latter operation will take 1 hour per module. A mechanical technician is thus assigned at the 50% level and a CMM operator at the 25% level. A senior Fermilab physicist oversees the production at 25%.

1.1.4.16.2.3	Wirebond sensors to hybrid	3/22/04	6/15/04	$0	$0	$4,056	$4,056

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
9	MechTechSF	5%	24 h	0 w	3/22/04	6/15/04	$816	$0	$0	$816	0 h	0 h	0 h	24 h
17	PhysicistF	10%	48 h	0 w	3/22/04	6/15/04	$0	$0	$0	$0	0 h	0 h	0 h	48 h
23	WirebonderSF	25%	120 h	0 w	3/22/04	6/15/04	$3,240	$0	$0	$3,240	0 h	0 h	0 h	120 h
29	WirebondingMachineF	25%	120 h	0 w	3/22/04	6/15/04	$0	$0	$0	$0	0 h	0 h	0 h	120 h

Notes

WBS Definition-
Wirebond all necessary connections

The 65 modules from the previous task are wirebonded from the sensor to the SVX4 chips. Each hybrid holds 10 SVX4 chips, so 1280 wirebonds plus some additional ones for the bias voltage will have to be made. In addition there are the 2*5*128 sensor to sensor wirebonds. Wirebonding will be performed on the fully automatic K&S 8090 wirebonders, which can wirebond at a rate of 5 bonds per second. Setup time of the module on the wirebonder will be the most time consuming part. Based on our extensive experience with wirebonding we expect each module to take about 30 minutes for wirebonding. Additional time is required for inspection, repairs, documentation and feeding the production line. A total of 1 hour per module is allocated giving a utilization of a wirebonder at 25%. The same startup and production problems as in the previous task are assumed and thus the task duration is the same as the task duration for the module production.
A mechanical technician is allocated at the 5% level because we assume that 25% of the modules will have to be retrofitted. A physicist oversees the operation at half the level of the wirebonder.

1.1.4.16.2.4	20/20 South Axial Silicon Module Production Comp	6/15/04	6/15/04	$0	$0	$0	$0

Notes

WBS Definition-
Milestone: All 20/20 South Axial Modules needed are produced.

1.1.4.16.2.5	Debug sensor modules	3/24/04	6/17/04	$0	$0	$1,584	$1,584

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
12	ElecTechSF	10%	48 h	0 w	3/24/04	6/17/04	$1,584	$0	$0	$1,584	0 h	0 h	0 h	48 h
34	SASEQTestStandF	100%	480 h	0 w	3/24/04	6/17/04	$0	$0	$0	$0	0 h	0 h	0 h	480 h
44	PostDoc	50%	240 h	0 w	3/24/04	6/17/04	$0	$0	$0	$0	0 h	0 h	0 h	240 h

Notes

WBS Definition-
Pull wirebonds on all bad channels so that module will take bias voltage

Labor BOE-
Testing of 100 modules, 10 modules/week, 4 hour/module of test stand usage, of which two hours per module is physicist's time. ElecTech (at 10%) pulls bonds on bad channels in preparation for burn-in. Physicist debugs module and sends modules that fail to the "evaluate and repair" task (50% of physicist needed). We assume that 10% of the modules fail. Estimate based on Run IIa experience.

1.1.4.16.2.6	Burn-in sensor modules	3/31/04	6/24/04	$0	$0	$0	$0

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
40	ModuleBurnInStand	20%	96 h	0 w	3/31/04	6/24/04	$0	$0	$0	$0	0 h	0 h	0 h	96 h
47	Student	20%	96 h	0 w	3/31/04	6/24/04	$0	$0	$0	$0	0 h	0 h	0 h	96 h

Notes

WBS Definition-
The QC procedure where modules are readout out under bias voltage for a few days and evaluated for bad channels

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
"Burn-in sensor modules" continued							

Notes

Labor BOE-
Burn-in of 100 modules for 3 day cycle each. The burn-in stand accomodates up to 32 modules per cycle with 2 cycles per week. The 20-20A module production rate of 10/week, with 10% reprocessing means that 11 modules need to be burned-in per week. The stand has a total capacity of 64 modules per week. On average, 20% of this resource is taken over the task duration. Each module requires 0.5 hr documentation by physicist plus 0.3 hr to mount and remove module from test stand. Estimates based on Run IIa experience.

1.1.4.16.2.7	Evaluate and repair sensor modules	4/14/04	7/9/04	$0	$0	$1,440	$1,440

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
12	ElecTechSF	5%	24 h	0 w	4/14/04	7/9/04	$792	$0	$0	$792	0 h	0 h	0 h	24 h
23	WirebonderSF	5%	24 h	0 w	4/14/04	7/9/04	$648	$0	$0	$648	0 h	0 h	0 h	24 h
29	WirebondingMachineF	5%	24 h	0 w	4/14/04	7/9/04	$0	$0	$0	$0	0 h	0 h	0 h	24 h
34	SASEQTestStandF	50%	240 h	0 w	4/14/04	7/9/04	$0	$0	$0	$0	0 h	0 h	0 h	240 h
44	PostDoc	25%	120 h	0 w	4/14/04	7/9/04	$0	$0	$0	$0	0 h	0 h	0 h	120 h

Notes

WBS Definition-
Determining what repairs are necessary and repairing broken wirebonds, bad hybrids, or bad bias connections

Labor BOE-
We assume that 10% of the modules fail the debugging task. It takes twice as long to diagnose and repair problematic modules, so it takes 8hrs/module to repair.
One modules fail per week, corresponding to a quarter time physicist.
The physicist needs the support of an ElecTechSF at 5% to replace chips and pull wirebonds, improve grounding, a SASEQTestStandF full time at his disposition, a WirebonderSF at the 5% level.

1.1.4.16.2.8	Perform quality assurance tests	4/28/04	7/23/04	$0	$0	$0	$0

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
34	SASEQTestStandF	100%	480 h	0 w	4/28/04	7/23/04	$0	$0	$0	$0	0 h	0 h	0 h	480 h
44	PostDoc	50%	240 h	0 w	4/28/04	7/23/04	$0	$0	$0	$0	0 h	0 h	0 h	240 h

Notes

WBS Definition-
Quality assurance of a subset of modules to fully characterize its performance.

Labor BOE-
For the outer layers a very small set of modules will be submitted to extensive tests, including laser test, temperature cycling, probe and pull testing and possibly irradiation tests. It is foreseen that these tests will be done on each batch of silicon sensors, with 24 batches in total. This corresponds to a full test for two module of each type for each detector half. A physicist will be occupied half time for one week for one module. He needs the support of a SASEQ test stand.

1.1.4.16.2.9	**20/20 South Axial Silicon Module Testing Complete**	**7/23/04**	**7/23/04**	**$0**	**$0**	**$0**	**$0**

Notes

WBS Definition-
Milestone: All 20/20 South Axial Modules are produced and tested.

1.1.4.16.3	**North**	**6/18/04**	**10/27/04**	**$705**	**$0**	**$18,960**	**$19,665**

Notes

WBS Definition-
Summary task including all North 20/20 Axial module production

1.1.4.16.3.1	**20/20 North Axial Silicon Module Production Begun**	**6/18/04**	**6/18/04**	**$0**	**$0**	**$0**	**$0**

Notes

WBS Definition-
Milestone: Production for L2-L5 20/20 North axial modules has begun.

1.1.4.16.3.2	Align and glue sensors to hybrid	6/18/04	9/14/04	$705	$0	$11,880	$12,585

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
9	MechTechSF	50%	240 h	0 w	6/18/04	9/14/04	$8,160	$0	$0	$8,160	0 h	0 h	0 h	240 h
17	PhysicistF	25%	120 h	0 w	6/18/04	9/14/04	$0	$0	$0	$0	0 h	0 h	0 h	120 h
27	CMMOperatorSF	25%	120 h	0 w	6/18/04	9/14/04	$3,720	$0	$0	$3,720	0 h	0 h	0 h	120 h
30	CMMSmall	200%	960 h	0 w	6/18/04	9/14/04	$0	$0	$0	$0	0 h	0 h	0 h	960 h
48	MandS	705	705	0 w	6/18/04	9/14/04	$705	$0	$0	$705		0	0	705

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
"Align and glue sensors to hybrid" continued							

Notes

WBS Definition-
On CMM, using fixtures align sensors and hybrid and glue all together

M&S BOE-
Epoxy cost based on one 10cc mix per day with an anticipated cost of $1500 for 20 liters of epoxy, including purity testing. In addition there will be 1 packet of silver epoxy used per day throughout this production, at $11 each. Total epoxy cost is $11.75/day.

Labor BOE-
There are 168 staves and thus 168 20-20 axial modules in the detector, which means 84 modules per north and south barrel. Including 20% spares, a total of 100 modules will have to be produced.
We foresee building 2 modules per day on two small CMMs. All modules can be produced in 10 weeks. To adequately train people and setup the procedures we expect that only one module will be built per day in the first week. One week is added to accommodate possible delays in part arrivals, equipment downtime or mishaps during production. Production of a module, based on 2a experience, should take 1 hour of time for each of a mechanical technician and a CMM technician. The mechanical technician helps setting up and does the documentation and database entry. The following day a mechanical technician flips the module and makes the HV and ground connections and installs HV insulation and updates documentation. The latter operation will take 1 hour per module. A mechanical technician is thus assigned at the 50% level and a CMM operator at the 25% level. A senior Fermilab physicist oversees the production at 25%.

1.1.4.16.3.3	Wirebond sensors to hybrid	6/24/04	9/20/04	$0	$0	$4,056	$4,056

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
9	MechTechSF	5%	24 h	0 w	6/24/04	9/20/04	$816	$0	$0	$816	0 h	0 h	0 h	24 h
17	PhysicistF	10%	48 h	0 w	6/24/04	9/20/04	$0	$0	$0	$0	0 h	0 h	0 h	48 h
23	WirebonderSF	25%	120 h	0 w	6/24/04	9/20/04	$3,240	$0	$0	$3,240	0 h	0 h	0 h	120 h
29	WirebondingMachineF	25%	120 h	0 w	6/24/04	9/20/04	$0	$0	$0	$0	0 h	0 h	0 h	120 h

Notes

WBS Definition-
wirebond all necessary connections

The 65 modules from the previous task are wirebonded from the sensor to the SVX4 chips. Each hybrid holds 10 SVX4 chips, so 1280 wirebonds plus some additional ones for the bias voltage will have to be made. In addition there are the 2*5*128 sensor to sensor wirebonds. Wirebonding will be performed on the fully automatic K&S 8090 wirebonders, which can wirebond at a rate of 5 bonds per second. Setup time of the module on the wirebonder will be the most time consuming part. Based on our extensive experience with wirebonding we expect each module to take about 30 minutes for wirebonding. Additional time is required for inspection, repairs, documentation and feeding the production line. A total of 1 hour per module is allocated giving a utilization of a wirebonder at 25%. The same startup and production problems as in the previous task are assumed and thus the task duration is the same as the task duration for the module production.
A mechanical technician is allocated at the 5% level because we assume that 25% of the modules will have to be retrofitted. A physicist oversees the operation at half the level of the wirebonder.

1.1.4.16.3.4	**20/20 North Axial Silicon Module Production Comp**	**9/20/04**	**9/20/04**	**$0**	**$0**	**$0**	**$0**

Notes

WBS Definition-
Milestone: All 20/20 North Axial Modules needed are produced.

1.1.4.16.3.5	Debug sensor modules	6/28/04	9/22/04	$0	$0	$1,584	$1,584

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
12	ElecTechSF	10%	48 h	0 w	6/28/04	9/22/04	$1,584	$0	$0	$1,584	0 h	0 h	0 h	48 h
34	SASEQTestStandF	100%	480 h	0 w	6/28/04	9/22/04	$0	$0	$0	$0	0 h	0 h	0 h	480 h
44	PostDoc	50%	240 h	0 w	6/28/04	9/22/04	$0	$0	$0	$0	0 h	0 h	0 h	240 h

Notes

WBS Definition-
Pull wirebonds on all bad channels so that module will take bias voltage

Labor BOE-
Testing of 100 modules, 10 modules/week, 4 hour/module of test stand usage, of which two hours per module is physicist's time. ElecTech (at 10%) pulls bonds on bad channels in preparation for burn-in. Physicist debugs module and sends modules that fail to the "evaluate and repair" task (50% of physicist needed). We assume that 10% of the modules fail. Estimate based on Run IIa experience.

1.1.4.16.3.6	Burn-in sensor modules	7/6/04	9/29/04	$0	$0	$0	$0

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
40	ModuleBurnInStand	20%	96 h	0 w	7/6/04	9/29/04	$0	$0	$0	$0	0 h	0 h	0 h	96 h
47	Student	20%	96 h	0 w	7/6/04	9/29/04	$0	$0	$0	$0	0 h	0 h	0 h	96 h

Notes

WBS Definition-
The QC procedure where modules are readout out under bias voltage for a few days and evaluated for bad channels

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
"Burn-in sensor modules" continued							

Notes

Labor BOE-
Burn-in of 100 modules for 3 day cycle each. The burn-in stand accomodates up to 32 modules per cycle with 2 cycles per week. The 20-20A module production rate of 10/week, with 10% reprocessing means that 11 modules need to be burned-in per week. The stand has a total capacity of 64 modules per week. On average, 20% of this resource is taken over the task duration. Each module requires 0.5 hr documentation by physicist plus 0.3 hr to mount and remove module from test stand. Estimates based on Run IIa experience.

1.1.4.16.3.7	Evaluate and repair sensor modules	7/20/04	10/13/04	$0	$0	$1,440	$1,440

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
12	ElecTechSF	5%	24 h	0 w	7/20/04	10/13/04	$792	$0	$0	$792	0 h	0 h	0 h	24 h
23	WirebonderSF	5%	24 h	0 w	7/20/04	10/13/04	$648	$0	$0	$648	0 h	0 h	0 h	24 h
29	WirebondingMachineF	5%	24 h	0 w	7/20/04	10/13/04	$0	$0	$0	$0	0 h	0 h	0 h	24 h
34	SASEQTestStandF	50%	240 h	0 w	7/20/04	10/13/04	$0	$0	$0	$0	0 h	0 h	0 h	240 h
44	PostDoc	25%	120 h	0 w	7/20/04	10/13/04	$0	$0	$0	$0	0 h	0 h	0 h	120 h

Notes

WBS Definition-
Determining what repairs are necessary and repairing broken wirebonds, bad hybrids, or bad bias connections

Labor BOE-
We assume that 10% of the modules fail the debugging task. It takes twice as long to diagnose and repair problematic modules, so it takes 8hrs/module to repair.
One module fail per week, corresponding to a uarter- time physicist.
The physicist needs the support of an ElecTechSF at 5% to replace chips and pull wirebonds, improve grounding, a SASEQTestStandF full time at his disposition, a WirebonderSF at the 5% level.

1.1.4.16.3.8	Perform quality assurance tests	8/3/04	10/27/04	$0	$0	$0	$0

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
34	SASEQTestStandF	100%	480 h	0 w	8/3/04	10/27/04	$0	$0	$0	$0	0 h	0 h	0 h	480 h
44	PostDoc	50%	240 h	0 w	8/3/04	10/27/04	$0	$0	$0	$0	0 h	0 h	0 h	240 h

Notes

WBS Definition-
Quality assurance of a subset of modules to fully characterize its performance.

Labor BOE-
For the outer layers a very small set of modules will be submitted to extensive tests, including laser test, temperature cycling, probe and pull testing and possibly irradiation tests. It is foreseen that these tests will be done on each batch of silicon sensors, with 24 batches in total. This corresponds to a full test for two module of each type for each detector half. A physicist will be occupied half time for one week for one module. He needs the support of a SASEQ test stand.

1.1.4.16.3.9	**20/20 North Axial Silicon Module Testing Complete**	**10/27/04**	**10/27/04**	**$0**	**$0**	**$0**	**$0**

Notes

WBS Definition-
Milestone: All 20/20 North Axial Modules are produced and tested.

1.1.4.17	**10/10 Stereo Modules**	**2/19/03**	**10/27/04**	**$1,540**	**$0**	**$63,632**	**$65,172**

Notes

WBS Definition-
The summary task that includes the prototyping and construction of all 10/10 Stereo modules

1.1.4.17.1	Develop electrical module preproduction	2/19/03	4/15/03	$130	$0	$22,832	$22,962

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
1	MechEngF	25%	80 h	0 w	2/19/03	4/15/03	$4,080	$0	$0	$4,080	0 h	0 h	0 h	80 h
9	MechTechSF	100%	320 h	0 w	2/19/03	4/15/03	$10,880	$0	$0	$10,880	0 h	0 h	0 h	320 h
12	ElecTechSF	5%	16 h	0 w	2/19/03	4/15/03	$528	$0	$0	$528	0 h	0 h	0 h	16 h
17	PhysicistF	100%	320 h	0 w	2/19/03	4/15/03	$0	$0	$0	$0	0 h	0 h	0 h	320 h
21	DesignerF	15%	48 h	0 w	2/19/03	4/15/03	$2,112	$0	$0	$2,112	0 h	0 h	0 h	48 h
27	CMMOperatorSF	30%	96 h	0 w	2/19/03	4/15/03	$2,976	$0	$0	$2,976	0 h	0 h	0 h	96 h
28	CMMProgrammerSF	15%	48 h	0 w	2/19/03	4/15/03	$2,256	$0	$0	$2,256	0 h	0 h	0 h	48 h
30	CMMSmall	45%	144 h	0 w	2/19/03	4/15/03	$0	$0	$0	$0	0 h	0 h	0 h	144 h
48	MandS	130	130	0 w	2/19/03	4/15/03	$130	$0	$0	$130		0	0	130

Notes

WBS Definition-
Design and preproduction of the 10/10 stereo module including how to build it.

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost

"Develop electrical module preproduction" continued

Notes

M&S BOE-
Epoxy cost based on 8 10cc mixed batches with an anticipated cost of $1500 for 20 liters of epoxy, including purity testing. In addition there will be 1 packet of silver epoxy for each electrical prototype, at $11 each. Additional miscellaneous parts and materials included at $80 total.

Labor BOE-
Assembly and inspection of electrical preproduction modules, including refinement of assembly sequence and tooling. We anticipate fabrication of 4 electrical grade modules. These are the first electrical grade preproduction stereo modules to be built. The physicist and engineer will develop the assembly procedures utilizing the initial L2-L5 module fixtures, with particular attention to electrical issues such as HV connections and shielding. This is expected to require 4 weeks at 50% effort each with 25% of designer time to prepare drawings to aid the technicians in assembly and bonding. The CMM programmer will develop the required CMM programs for the module assembly procedure during this period and the CMM operator and mechanical technician will exercise the program and assembly procedures with mechanical parts. The last 4 weeks will involve production of the electrical grade modules, each requiring roughly 2 days of mechanical technician effort, interspersed with electrical evaluation and process feedback by a physicist before the next module is made. The designer and mechanical engineer are expected to contribute 15% effort over this period to address modifications to tooling and drawings. Wirebonding modules is expected to take roughly 4 hours in total which is a negligible impact on that resource over this period. The CMM operator mirrors the mechanical technician to provide the required support during fabrication of the electrical preproduction modules.

1.1.4.17.2	**South**	**3/16/04**	**7/23/04**	**$705**	**$0**	**$20,400**	**$21,105**

Notes

WBS Definition-
Summary task including all South 10/10 Stereo module production

1.1.4.17.2.1	**10/10 South Stereo Silicon Module Production Beg**	**3/16/04**	**3/16/04**	**$0**	**$0**	**$0**	**$0**

Notes

WBS Definition-
Milestone: Production for L2-L5 10/10 South stereo modules has begun.

1.1.4.17.2.2	Align and glue sensors to hybrid	3/16/04	6/9/04	$705	$0	$11,880	$12,585

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
9	MechTechSF	50%	240 h	0 w	3/16/04	6/9/04	$8,160	$0	$0	$8,160	0 h	0 h	0 h	240 h
17	PhysicistF	25%	120 h	0 w	3/16/04	6/9/04	$0	$0	$0	$0	0 h	0 h	0 h	120 h
27	CMMOperatorSF	25%	120 h	0 w	3/16/04	6/9/04	$3,720	$0	$0	$3,720	0 h	0 h	0 h	120 h
30	CMMSmall	100%	480 h	0 w	3/16/04	6/9/04	$0	$0	$0	$0	0 h	0 h	0 h	480 h
48	MandS	705	705	0 w	3/16/04	6/9/04	$705	$0	$0	$705		0	0	705

Notes

WBS Definition-
On CMM, using fixtures align sensors and hybrid and glue all together

M&S BOE-
Epoxy cost based on one 10cc mix per day with an anticipated cost of $1500 for 20 liters of epoxy, including purity testing. In addition there will be 1 packet of silver epoxy used per day throughout this production, at $11 each. Total epoxy cost is $11.75/day.

Labor BOE-
There are 168 staves and thus 168 10-10 stereo modules in the detector, which means 84 modules per north and south barrel. Including 20% spares, a total of 100 modules will have to be produced.
We foresee building 2 modules per day on one CMM. All modules can be produced in 10 weeks. To adequately train people and setup the procedures we expect that only one module will be built per day in the first week. One week is added to accommodate possible delays in part arrivals, equipment downtime or mishaps during production. Production of a module, based on 2a experience, should take 1 hour of time for each of a mechanical technician and a CMM technician. The mechanical technician helps setting up and does the documentation and database entry. The following day a mechanical technician flips the module and makes the HV and ground connections and installs HV insulation and updates documentation. The latter operation will take 1 hour per module. A mechanical technician is thus assigned at the 50% level and a CMM operator at the 25% level. A senior Fermilab physicist oversees the production at 25%.

1.1.4.17.2.3	Wirebond sensors to hybrid	3/22/04	6/15/04	$0	$0	$4,056	$4,056

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
9	MechTechSF	5%	24 h	0 w	3/22/04	6/15/04	$816	$0	$0	$816	0 h	0 h	0 h	24 h
17	PhysicistF	10%	48 h	0 w	3/22/04	6/15/04	$0	$0	$0	$0	0 h	0 h	0 h	48 h
23	WirebonderSF	25%	120 h	0 w	3/22/04	6/15/04	$3,240	$0	$0	$3,240	0 h	0 h	0 h	120 h
29	WirebondingMachineF	25%	120 h	0 w	3/22/04	6/15/04	$0	$0	$0	$0	0 h	0 h	0 h	120 h

Notes

WBS Definition-
wirebond all necessary connections

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
"Wirebond sensors to hybrid" continued							

Notes

Labor BOE-
The 100 modules from the previous task are wirebonded from the sensor to the SVX4 chips. Each hybrid holds 10 SVX4 chips, so 1280 wirebonds plus some additional ones for the bias voltage will have to be made. Wirebonding will be performed on the fully automatic K&S 8090 wirebonders, which can wirebond at a rate of 5 bonds per second. Setup time of the module on the wirebonder will be the most time consuming part. Based on our extensive experience with wirebonding we expect each module to take about 30 minutes for wirebonding. Additional time is required for inspection, repairs, documentation and feeding the production line. A total of 1 hour per module is allocated giving a utilization of a wirebonder at 25%. The same startup and production problems as in the previous task are assumed and thus the task duration is the same as the task duration for the module production.
A mechanical technician is allocated at the 5% level because we assume that 25% of the modules will have to be retrofitted. A physicist oversees the operation at half the level of the wirebonder.

1.1.4.17.2.4	**10/10 South Stereo Silicon Module Production Con**	**6/15/04**	**6/15/04**	**$0**	**$0**	**$0**	**$0**

Notes

WBS Definition-
Milestone: All 10/10 South Stereo Modules needed are produced.

1.1.4.17.2.5	Debug sensor modules	3/24/04	6/17/04	$0	$0	$1,584	$1,584

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
12	ElecTechSF	10%	48 h	0 w	3/24/04	6/17/04	$1,584	$0	$0	$1,584	0 h	0 h	0 h	48 h
34	SASEQTestStandF	100%	480 h	0 w	3/24/04	6/17/04	$0	$0	$0	$0	0 h	0 h	0 h	480 h
44	PostDoc	50%	240 h	0 w	3/24/04	6/17/04	$0	$0	$0	$0	0 h	0 h	0 h	240 h

Notes

WBS Definition-
First functionality test of module after construction, consisting of visual inspection, functionality test without biasing the detector, biasing of the detector and characterization of the module by determining IV and V-noise curves. Noisy channels are removed by pulling wirebonds.

Labor BOE-
Testing of 100 modules, 10 modules/week, 4 hour/module of test stand usage, of which two hours per module is physicist's time. ElecTech (at 10%) pulls bonds on bad channels in preparation for burn-in. Physicist debugs module and sends modules that fail to the "evaluate and repair" task (50% of physicist needed). We assume that 10% of the modules fail. Estimate based on Run IIa experience.

1.1.4.17.2.6	Burn-in sensor modules	3/31/04	6/24/04	$0	$0	$0	$0

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
40	ModuleBurnInStand	20%	96 h	0 w	3/31/04	6/24/04	$0	$0	$0	$0	0 h	0 h	0 h	96 h
47	Student	20%	96 h	0 w	3/31/04	6/24/04	$0	$0	$0	$0	0 h	0 h	0 h	96 h

Notes

WBS Definition-
The QC procedure where modules are readout out under bias voltage for a few days and evaluated for bad channels

Labor BOE-
Burn-in of 100 modules for 3 day cycle each. The burn-in stand accomodates up to 32 modules per cycle with 2 cycles per week. We anticipate needing to reprocess 10% of the modules. The L1 module production rate of 10/week, with 10% reprocessing means that 11 modules need to be burned-in per week. The stand has a total capacity of 64 modules per week. Thus, on average, 20% of a module burn-in resource is used over the task duration. Each module requires 0.5 hr documentation by physicist plus 0.3 hr to mount and remove module from test stand. Estimates based on Run IIa experience.

1.1.4.17.2.7	Evaluate and repair sensor modules	4/14/04	7/9/04	$0	$0	$2,880	$2,880

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
12	ElecTechSF	10%	48 h	0 w	4/14/04	7/9/04	$1,584	$0	$0	$1,584	0 h	0 h	0 h	48 h
23	WirebonderSF	10%	48 h	0 w	4/14/04	7/9/04	$1,296	$0	$0	$1,296	0 h	0 h	0 h	48 h
29	WirebondingMachineF	10%	48 h	0 w	4/14/04	7/9/04	$0	$0	$0	$0	0 h	0 h	0 h	48 h
34	SASEQTestStandF	100%	480 h	0 w	4/14/04	7/9/04	$0	$0	$0	$0	0 h	0 h	0 h	480 h
44	PostDoc	50%	240 h	0 w	4/14/04	7/9/04	$0	$0	$0	$0	0 h	0 h	0 h	240 h

Notes

WBS Definition-
Determining what repairs are necessary and repairing broken wirebonds, bad hybrids, or bad bias connections

Labor BOE-
We assume that 10% of the modules fail the debugging task. It takes twice as long to diagnose and repair problematic modules, so it takes 8hrs/module to repair.
A half time physicist is required.
The physicist needs the support of an ElecTechSF at 10% to replace chips and pull wirebonds, improve grounding, a SASEQTestStandF full time at his disposition, a WirebonderSF at the 10% level.

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
1.1.4.17.2.8	Perform quality assurance tests	4/28/04	7/23/04	$0	$0	$0	$0

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
34	SASEQTestStandF	100%	480 h	0 w	4/28/04	7/23/04	$0	$0	$0	$0	0 h	0 h	0 h	480 h
44	PostDoc	50%	240 h	0 w	4/28/04	7/23/04	$0	$0	$0	$0	0 h	0 h	0 h	240 h

Notes

WBS Definition-
Quality assurance of a subset of modules to fully characterize its performance.

Labor BOE-
For the outer layers a very small set of modules will be submitted to extensive tests, including laser test, temperature cycling, probe and pull testing and possibly irradiation tests. It is foreseen that these tests will be done on each batch of silicon sensors, with 24 batches in total. This corresponds to a full test for two module of each type for each detector half. A physicist will be occupied half time for one week for one module. He needs the support of a SASEQ test stand.

1.1.4.17.2.9	**10/10 South Stereo Silicon Module Testing Comple**	**7/23/04**	**7/23/04**	**$0**	**$0**	**$0**	**$0**

Notes

WBS Definition-
Milestone: All 10/10 South Stereo Modules are produced and tested.

1.1.4.17.3	**North**	**6/18/04**	**10/27/04**	**$705**	**$0**	**$20,400**	**$21,105**

Notes

WBS Definition-
Summary task including all North 10/10 Stereo module production

1.1.4.17.3.1	**10/10 North Stereo Silicon Module Production Beg**	**6/18/04**	**6/18/04**	**$0**	**$0**	**$0**	**$0**

Notes

WBS Definition-
Milestone: Production for L2-L5 10/10 North stereo modules has begun.

1.1.4.17.3.2	Align and glue sensors to hybrid	6/18/04	9/14/04	$705	$0	$11,880	$12,585

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
9	MechTechSF	50%	240 h	0 w	6/18/04	9/14/04	$8,160	$0	$0	$8,160	0 h	0 h	0 h	240 h
17	PhysicistF	25%	120 h	0 w	6/18/04	9/14/04	$0	$0	$0	$0	0 h	0 h	0 h	120 h
27	CMMOperatorSF	25%	120 h	0 w	6/18/04	9/14/04	$3,720	$0	$0	$3,720	0 h	0 h	0 h	120 h
30	CMMSmall	100%	480 h	0 w	6/18/04	9/14/04	$0	$0	$0	$0	0 h	0 h	0 h	480 h
48	MandS	705	705	0 w	6/18/04	9/14/04	$705	$0	$0	$705		0	0	705

Notes

WBS Definition-
On CMM, using fixtures align sensors and hybrid and glue all together

M&S BOE-
Epoxy cost based on one 10cc mix per day with an anticipated cost of $1500 for 20 liters of epoxy, including purity testing. In addition there will be 1 packet of silver epoxy used per day throughout this production, at $11 each. Total epoxy cost is $11.75/day.

Labor BOE-
There are 168 staves and thus 168 10-10 stereo modules in the detector, which means 84 modules per north and south barrel. Including 20% spares, a total of 100 modules will have to be produced.
We foresee building 2 modules per day on one CMM. All modules can be produced in 10 weeks. To adequately train people and setup the procedures we expect that only one module will be built per day in the first week. One week is added to accommodate possible delays in part arrivals, equipment downtime or mishaps during production. Production of a module, based on 2a experience, should take 1 hour of time for each of a mechanical technician and a CMM technician. The mechanical technician helps setting up and does the documentation and database entry. The following day a mechanical technician flips the module and makes the HV and ground connections and installs HV insulation and updates documentation. The latter operation will take 1 hour per module. A mechanical technician is thus assigned at the 50% level and a CMM operator at the 25% level. A senior Fermilab physicist oversees the production at 25%.

1.1.4.17.3.3	Wirebond sensors to hybrid	6/24/04	9/20/04	$0	$0	$4,056	$4,056

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
9	MechTechSF	5%	24 h	0 w	6/24/04	9/20/04	$816	$0	$0	$816	0 h	0 h	0 h	24 h
17	PhysicistF	10%	48 h	0 w	6/24/04	9/20/04	$0	$0	$0	$0	0 h	0 h	0 h	48 h
23	WirebonderSF	25%	120 h	0 w	6/24/04	9/20/04	$3,240	$0	$0	$3,240	0 h	0 h	0 h	120 h
29	WirebondingMachineF	25%	120 h	0 w	6/24/04	9/20/04	$0	$0	$0	$0	0 h	0 h	0 h	120 h

Notes

WBS Definition-

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost

"Wirebond sensors to hybrid" continued

Notes
Wirebond all necessary connections

Labor BOE-
The 100 modules from the previous task are wirebonded from the sensor to the SVX4 chips. Each hybrid holds 10 SVX4 chips, so 1280 wirebonds plus some additional ones for the bias voltage will have to be made. Wirebonding will be performed on the fully automatic K&S 8090 wirebonders, which can wirebond at a rate of 5 bonds per second. Setup time of the module on the wirebonder will be the most time consuming part. Based on our extensive experience with wirebonding we expect each module to take about 30 minutes for wirebonding. Additional time is required for inspection, repairs, documentation and feeding the production line. A total of 1 hour per module is allocated giving a utilization of a wirebonder at 25%. The same startup and production problems as in the previous task are assumed and thus the task duration is the same as the task duration for the module production.
A mechanical technician is allocated at the 5% level because we assume that 25% of the modules will have to be retrofitted. A physicist oversees the operation at half the level of the wirebonder.

1.1.4.17.3.4	**L2-5 (10/10 North Stereo) Silicon Module Productio**	**9/20/04**	**9/20/04**	**$0**	**$0**	**$0**	**$0**

Notes
WBS Definition-
Milestone: All 10/10 North Stereo Modules needed are produced.

1.1.4.17.3.5	Debug sensor modules	6/28/04	9/22/04	$0	$0	$1,584	$1,584

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
12	ElecTechSF	10%	48 h	0 w	6/28/04	9/22/04	$1,584	$0	$0	$1,584	0 h	0 h	0 h	48 h
34	SASEQTestStandF	100%	480 h	0 w	6/28/04	9/22/04	$0	$0	$0	$0	0 h	0 h	0 h	480 h
44	PostDoc	50%	240 h	0 w	6/28/04	9/22/04	$0	$0	$0	$0	0 h	0 h	0 h	240 h

Notes
WBS Definition-
First functionality test of module after construction, consisting of visual inspection, functionality test without biasing the detector, biasing of the detector and characterization of the module by determining IV and V-noise curves. Noisy channels are removed by pulling wirebonds.

Labor BOE-
Testing of 100 modules, 10 modules/week, 4 hour/module of test stand usage, of which two hours per module is physicist's time. ElecTech (at 10%) pulls bonds on bad channels in preparation for burn-in. Physicist debugs module and sends modules that fail to the "evaluate and repair" task (50% of physicist needed). We assume that 10% of the modules fail. Estimate based on Run IIa experience.

1.1.4.17.3.6	Burn-in sensor modules	7/6/04	9/29/04	$0	$0	$0	$0

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
40	ModuleBurnInStand	20%	96 h	0 w	7/6/04	9/29/04	$0	$0	$0	$0	0 h	0 h	0 h	96 h
47	Student	20%	96 h	0 w	7/6/04	9/29/04	$0	$0	$0	$0	0 h	0 h	0 h	96 h

Notes
WBS Definition-
The QC procedure where modules are readout out under bias voltage for a few days and evaluated for bad channels

Labor BOE-
Burn-in of 100 modules for 3 day cycle each. The burn-in stand accomodates up to 32 modules per cycle with 2 cycles per week. We anticipate needing to reprocess 10% of the modules. The production rate of 10/week, with 10% reprocessing means that 11 modules need to be burned-in per week. The stand has a total capacity of 64 modules per week. Thus, on average, 20% of a module burn-in resource is used over the task duration. Each module requires 0.5 hr documentation by physicist plus 0.3 hr to mount and remove module from test stand. Estimates based on Run IIa experience.

1.1.4.17.3.7	Evaluate and repair sensor modules	7/20/04	10/13/04	$0	$0	$2,880	$2,880

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
12	ElecTechSF	10%	48 h	0 w	7/20/04	10/13/04	$1,584	$0	$0	$1,584	0 h	0 h	0 h	48 h
23	WirebonderSF	10%	48 h	0 w	7/20/04	10/13/04	$1,296	$0	$0	$1,296	0 h	0 h	0 h	48 h
29	WirebondingMachineF	10%	48 h	0 w	7/20/04	10/13/04	$0	$0	$0	$0	0 h	0 h	0 h	48 h
34	SASEQTestStandF	100%	480 h	0 w	7/20/04	10/13/04	$0	$0	$0	$0	0 h	0 h	0 h	480 h
44	PostDoc	50%	240 h	0 w	7/20/04	10/13/04	$0	$0	$0	$0	0 h	0 h	0 h	240 h

Notes
WBS Definition-
Determining what repairs are necessary and repairing broken wirebonds, bad hybrids, or bad bias connections

Labor BOE-
We assume that 10% of the modules fail the debugging task. It takes twice as long to diagnose and repair problematic modules, so it takes 8hrs/module to repair. A half-time physicist is required. The physicist needs the support of an ElecTechSF at 10% to replace chips and pull wirebonds, improve grounding, a SASEQTestStandF full time at his disposition, a WirebonderSF at the 10% level.

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
1.1.4.17.3.8	Perform quality assurance tests	8/3/04	10/27/04	$0	$0	$0	$0

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
34	SASEQTestStandF	100%	480 h	0 w	8/3/04	10/27/04	$0	$0	$0	$0	0 h	0 h	0 h	480 h
44	PostDoc	50%	240 h	0 w	8/3/04	10/27/04	$0	$0	$0	$0	0 h	0 h	0 h	240 h

Notes

WBS Definition-
Quality assurance of a subset of modules to fully characterize its performance.

Labor BOE-
For the outer layers a very small set of modules will be submitted to extensive tests, including laser test, temperature cycling, probe and pull testing and possibly irradiation tests. It is foreseen that these tests will be done on each batch of silicon sensors, with 24 batches in total. This corresponds to a full test for two module of each type for each detector half. A physicist will be occupied half time for one week for one module. He needs the support of a SASEQ test stand.

1.1.4.17.3.9	**L2-5 (10/10 North Stereo) Silicon Module Testing C**	**10/27/04**	**10/27/04**	**$0**	**$0**	**$0**	**$0**

Notes

WBS Definition-
Milestone: All 10/10 North Stereo Modules are produced and tested.

1.1.4.18	10/20 Stereo Modules (RETIRED)	10/2/00	10/2/00	$0	$0	$0	$0

Notes

WBS Definition-
The summary task that includes the prototyping and construction of all 10/20 Stereo modules. It was retired when the detector was redesigned to eliminate 10/20 modules.

1.1.4.19	**20/20 Stereo Modules**	**3/5/03**	**11/9/04**	**$1,475**	**$0**	**$47,680**	**$49,155**

Notes

WBS Definition-
The summary task that includes the prototyping and construction of all 20/20 Stereo modules

1.1.4.19.1	Develop electrical module preproduction	3/5/03	4/1/03	$65	$0	$9,760	$9,825

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
1	MechEngF	30%	48 h	0 w	3/5/03	4/1/03	$2,448	$0	$0	$2,448	0 h	0 h	0 h	48 h
9	MechTechSF	30%	48 h	0 w	3/5/03	4/1/03	$1,632	$0	$0	$1,632	0 h	0 h	0 h	48 h
12	ElecTechSF	5%	8 h	0 w	3/5/03	4/1/03	$264	$0	$0	$264	0 h	0 h	0 h	8 h
17	PhysicistF	50%	80 h	0 w	3/5/03	4/1/03	$0	$0	$0	$0	0 h	0 h	0 h	80 h
21	DesignerF	15%	24 h	0 w	3/5/03	4/1/03	$1,056	$0	$0	$1,056	0 h	0 h	0 h	24 h
27	CMMOperatorSF	50%	80 h	0 w	3/5/03	4/1/03	$2,480	$0	$0	$2,480	0 h	0 h	0 h	80 h
28	CMMProgrammerSF	25%	40 h	0 w	3/5/03	4/1/03	$1,880	$0	$0	$1,880	0 h	0 h	0 h	40 h
30	CMMSmall	75%	120 h	0 w	3/5/03	4/1/03	$0	$0	$0	$0	0 h	0 h	0 h	120 h
48	MandS	65	65	0 w	3/5/03	4/1/03	$65	$0	$0	$65		0	0	65

Notes

WBS Definition-
Design and preproduction of 20/20 stereo module including how to build it

M&S BOE-
Epoxy cost based on 4 10cc mixed batches with an anticipated cost of $1500 for 20 liters of epoxy, including purity testing. In addition there will be 1 packet of silver epoxy for each electrical prototype, at $11 each. Additional miscellaneous parts and materials included at $40 total.

Labor BOE-
Assembly and inspection of electrical preproduction modules, including refinement of assembly sequence and tooling. We anticipate fabrication of 2 electrical grade preproduction modules. This are quite similar to the 10-10 stereo modules which will be started a few weeks earlier and is the last of the 4 module types to be developed, hence the shortest development time. The physicist, engineer, designer, mechanical technician and CMM programmer will spend 2 weeks developing the required written procedures and CMM programs and exercising them with mechanical parts. The last 2 weeks will involve production of the electrical grade modules, each requiring roughly 2 days of mechanical technician effort, interspersed with electrical evaluation and process feedback by a physicist before the next module is made. The designer and mechanical engineer are expected to contribute 15% effort over this period to address modifications to tooling and drawings. Wirebonding modules is expected to take roughly 4 hours in total which is a negligible impact on that resource over this period. The CMM operator mirrors the mechanical technician to provide the required support during fabrication of the electrical preproduction modules.

1.1.4.19.2	**South**	**3/16/04**	**7/21/04**	**$705**	**$0**	**$18,960**	**$19,665**

Notes

WBS Definition-
Summary task including all South 20/20 Stereo module production

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
1.1.4.19.2.1	**20/20 South Stereo Silicon Module Production Beg**	**3/16/04**	**3/16/04**	**$0**	**$0**	**$0**	**$0**

Notes

WBS Definition-
Milestone: Production for L2-L5 20/20 South stereo modules has begun.

1.1.4.19.2.2	Align and glue sensors to hybrid	3/16/04	6/9/04	$705	$0	$11,880	$12,585

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
9	MechTechSF	50%	240 h	0 w	3/16/04	6/9/04	$8,160	$0	$0	$8,160	0 h	0 h	0 h	240 h
17	PhysicistF	25%	120 h	0 w	3/16/04	6/9/04	$0	$0	$0	$0	0 h	0 h	0 h	120 h
27	CMMOperatorSF	25%	120 h	0 w	3/16/04	6/9/04	$3,720	$0	$0	$3,720	0 h	0 h	0 h	120 h
31	CMMMedium	100%	480 h	0 w	3/16/04	6/9/04	$0	$0	$0	$0	0 h	0 h	0 h	480 h
48	MandS	705	705	0 w	3/16/04	6/9/04	$705	$0	$0	$705		0	0	705

Notes

WBS Definition-
On CMM, using fixtures align sensors and hybrid and glue all together

M&S BOE-
Epoxy cost based on one 10cc mix per day with an anticipated cost of $1500 for 20 liters of epoxy, including purity testing. In addition there will be 1 packet of silver epoxy used per day throughout this production, at $11 each. Total epoxy cost is $11.75/day.

Labor BOE-
There are 168 staves and thus 168 20-20 stereo modules in the detector, which means 84 modules per north and south barrel. Including 20% spares, a total of 100 modules will have to be produced.
We foresee building 2 modules per day on one medium CMM. All modules can be produced in 10 weeks. To adequately train people and setup the procedures we expect that only one module will be built per day in the first week. One week is added to accommodate possible delays in part arrivals, equipment downtime or mishaps during production. Production of a module, based on 2a experience, should take 1 hour of time for each of a mechanical technician and a CMM technician. The mechanical technician helps setting up and does the documentation and database entry. The following day a mechanical technician flips the module and makes the HV and ground connections and installs HV insulation and updates documentation. The latter operation will take 1 hour per module. A mechanical technician is thus assigned at the 50% level and a CMM operator at the 25% level. A senior Fermilab physicist oversees the production at 25%.

1.1.4.19.2.3	Wirebond sensors to hybrid	3/22/04	6/15/04	$0	$0	$4,056	$4,056

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
9	MechTechSF	5%	24 h	0 w	3/22/04	6/15/04	$816	$0	$0	$816	0 h	0 h	0 h	24 h
17	PhysicistF	10%	48 h	0 w	3/22/04	6/15/04	$0	$0	$0	$0	0 h	0 h	0 h	48 h
23	WirebonderSF	25%	120 h	0 w	3/22/04	6/15/04	$3,240	$0	$0	$3,240	0 h	0 h	0 h	120 h
29	WirebondingMachineF	25%	120 h	0 w	3/22/04	6/15/04	$0	$0	$0	$0	0 h	0 h	0 h	120 h

Notes

WBS Definition-
wirebond all necessary connections

The 65 modules from the previous task are wirebonded from the sensor to the SVX4 chips. Each hybrid holds 10 SVX4 chips, so 1280 wirebonds plus some additional ones for the bias voltage will have to be made. In addition there are the 2*5*128 sensor to sensor wirebonds. Wirebonding will be performed on the fully automatic K&S 8090 wirebonders, which can wirebond at a rate of 5 bonds per second. Setup time of the module on the wirebonder will be the most time consuming part. Based on our extensive experience with wirebonding we expect each module to take about 30 minutes for wirebonding. Additional time is required for inspection, repairs, documentation and feeding the production line. A total of 1 hour per module is allocated giving a utilization of a wirebonder at 25%. The same startup and production problems as in the previous task are assumed and thus the task duration is the same as the task duration for the module production.
A mechanical technician is allocated at the 5% level because we assume that 25% of the modules will have to be retrofitted. A physicist oversees the operation at half the level of the wirebonder.

1.1.4.19.2.4	**20/20 South Stereo Silicon Module Production Con**	**6/15/04**	**6/15/04**	**$0**	**$0**	**$0**	**$0**

Notes

WBS Definition-
Milestone: All 20/20 South Stereo Modules needed are produced.

1.1.4.19.2.5	Debug sensor modules	3/23/04	6/16/04	$0	$0	$1,584	$1,584

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
12	ElecTechSF	10%	48 h	0 w	3/23/04	6/16/04	$1,584	$0	$0	$1,584	0 h	0 h	0 h	48 h
34	SASEQTestStandF	100%	480 h	0 w	3/23/04	6/16/04	$0	$0	$0	$0	0 h	0 h	0 h	480 h
44	PostDoc	50%	240 h	0 w	3/23/04	6/16/04	$0	$0	$0	$0	0 h	0 h	0 h	240 h

Notes

WBS Definition-
Pull wirebonds on all bad channels so that module will take bias voltage

Labor BOE-

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost

"Debug sensor modules" continued

Notes
Testing of 100 modules, 10 modules/week, 4 hour/module of test stand usage, of which two hours per module is physicist's time. ElecTech (at 10%) pulls bonds on bad channels in preparation for burn-in. Physicist debugs module and sends modules that fail to the "evaluate and repair" task (50% of physicist needed). We assume that 10% of the modules fail. Estimate based on Run IIa experience.

1.1.4.19.2.6	Burn-in sensor modules	3/29/04	6/22/04	$0	$0	$0	$0

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
40	ModuleBurnInStand	20%	96 h	0 w	3/29/04	6/22/04	$0	$0	$0	$0	0 h	0 h	0 h	96 h
47	Student	20%	96 h	0 w	3/29/04	6/22/04	$0	$0	$0	$0	0 h	0 h	0 h	96 h

Notes
WBS Definition-
The QC procedure where modules are readout out under bias voltage for a few days and evaluated for bad channels

Labor BOE-
Burn-in of 100 modules for 3 day cycle each. The burn-in stand accomodates up to 32 modules per cycle with 2 cycles per week. The 20-20A module production rate of 10/week, with 10% reprocessing means that 11 modules need to be burned-in per week. The stand has a total capacity of 64 modules per week. On average, 20% of this resource is taken over the task duration. Each module requires 0.5 hr documentation by physicist plus 0.3 hr to mount and remove module from test stand. Estimates based on Run IIa experience.

1.1.4.19.2.7	Evaluate and repair sensor modules	4/12/04	7/7/04	$0	$0	$1,440	$1,440

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
12	ElecTechSF	5%	24 h	0 w	4/12/04	7/7/04	$792	$0	$0	$792	0 h	0 h	0 h	24 h
23	WirebonderSF	5%	24 h	0 w	4/12/04	7/7/04	$648	$0	$0	$648	0 h	0 h	0 h	24 h
29	WirebondingMachineF	5%	24 h	0 w	4/12/04	7/7/04	$0	$0	$0	$0	0 h	0 h	0 h	24 h
34	SASEQTestStandF	50%	240 h	0 w	4/12/04	7/7/04	$0	$0	$0	$0	0 h	0 h	0 h	240 h
44	PostDoc	25%	120 h	0 w	4/12/04	7/7/04	$0	$0	$0	$0	0 h	0 h	0 h	120 h

Notes
WBS Definition-
Determining what repairs are necessary and repairing broken wirebonds, bad hybrids, or bad bias connections

Labor BOE-
We assume that 10% of the modules fail the debugging task. It takes twice as long to diagnose and repair problematic modules, so it takes 8hrs/module to repair. One module fail per week, corresponding to a quarter- time physicist. The physicist needs the support of an ElecTechSF at 5% to replace chips and pull wirebonds, improve grounding, a SASEQTestStandF full time at his disposition, a WirebonderSF at the 5% level.

1.1.4.19.2.8	Perform quality assurance tests	4/26/04	7/21/04	$0	$0	$0	$0

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
34	SASEQTestStandF	100%	480 h	0 w	4/26/04	7/21/04	$0	$0	$0	$0	0 h	0 h	0 h	480 h
44	PostDoc	50%	240 h	0 w	4/26/04	7/21/04	$0	$0	$0	$0	0 h	0 h	0 h	240 h

Notes
WBS Definition-
Quality assurance of a subset of modules to fully characterize its performance.

Labor BOE-
For the outer layers a very small set of modules will be submitted to extensive tests, including laser test, temperature cycling, probe and pull testing and possibly irradiation tests. It is foreseen that these tests will be done on each batch of silicon sensors, with 24 batches in total. This corresponds to a full test for two module of each type for each detector half. A physicist will be occupied half time for one week for one module. He needs the support of a SASEQ test stand.

1.1.4.19.2.9	**20/20 South Stereo Silicon Module Testing Comple**	**7/21/04**	**7/21/04**	**$0**	**$0**	**$0**	**$0**

Notes
WBS Definition-
Milestone: All 20/20 South Stereo Modules are produced and tested.

1.1.4.19.3	**North**	**7/5/04**	**11/9/04**	**$705**	**$0**	**$18,960**	**$19,665**

Notes
WBS Definition-
Summary task including all North 20/20 Stereo module production

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
1.1.4.19.3.1	**20/20 North Stereo Silicon Module Production Beg**	**7/5/04**	**7/5/04**	**$0**	**$0**	**$0**	**$0**

Notes

WBS Definition-
Milestone: Production for L2-L5 20/20 North stereo modules has begun.

1.1.4.19.3.2	Align and glue sensors to hybrid	7/5/04	9/27/04	$705	$0	$11,880	$12,585

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
9	MechTechSF	50%	240 h	0 w	7/5/04	9/27/04	$8,160	$0	$0	$8,160	0 h	0 h	0 h	240 h
17	PhysicistF	25%	120 h	0 w	7/5/04	9/27/04	$0	$0	$0	$0	0 h	0 h	0 h	120 h
27	CMMOperatorSF	25%	120 h	0 w	7/5/04	9/27/04	$3,720	$0	$0	$3,720	0 h	0 h	0 h	120 h
31	CMMMedium	100%	480 h	0 w	7/5/04	9/27/04	$0	$0	$0	$0	0 h	0 h	0 h	480 h
48	MandS	705	705	0 w	7/5/04	9/27/04	$705	$0	$0	$705		0	0	705

Notes

WBS Definition-
On CMM, using fixtures align sensors and hybrid and glue all together

M&S BOE-
Epoxy cost based on one 10cc mix per day with an anticipated cost of $1500 for 20 liters of epoxy, including purity testing. In addition there will be 1 packet of silver epoxy used per day throughout this production, at $11 each. Total epoxy cost is $11.75/day.

Labor BOE-
There are 168 staves and thus 168 20-20 stereo modules in the detector, which means 84 modules per north and south barrel. Including 20% spares, a total of 100 modules will have to be produced.
We foresee building 2 modules per day on one medium CMM. All modules can be produced in 10 weeks. To adequately train people and setup the procedures we expect that only one module will be built per day in the first week. One week is added to accommodate possible delays in part arrivals, equipment downtime or mishaps during production. Production of a module, based on 2a experience, should take 1 hour of time for each of a mechanical technician and a CMM technician. The mechanical technician helps setting up and does the documentation and database entry. The following day a mechanical technician flips the module and makes the HV and ground connections and installs HV insulation and updates documentation. The latter operation will take 1 hour per module. A mechanical technician is thus assigned at the 50% level and a CMM operator at the 25% level. A senior Fermilab physicist oversees the production at 25%.

1.1.4.19.3.3	Wirebond sensors to hybrid	7/9/04	10/1/04	$0	$0	$4,056	$4,056

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
9	MechTechSF	5%	24 h	0 w	7/9/04	10/1/04	$816	$0	$0	$816	0 h	0 h	0 h	24 h
17	PhysicistF	10%	48 h	0 w	7/9/04	10/1/04	$0	$0	$0	$0	0 h	0 h	0 h	48 h
23	WirebonderSF	25%	120 h	0 w	7/9/04	10/1/04	$3,240	$0	$0	$3,240	0 h	0 h	0 h	120 h
29	WirebondingMachineF	25%	120 h	0 w	7/9/04	10/1/04	$0	$0	$0	$0	0 h	0 h	0 h	120 h

Notes

WBS Definition-
Wirebond all necessary connections

Labor BOE-
The 65 modules from the previous task are wirebonded from the sensor to the SVX4 chips. Each hybrid holds 10 SVX4 chips, so 1280 wirebonds plus some additional ones for the bias voltage will have to be made. In addition there are the 2*5*128 sensor to sensor wirebonds. Wirebonding will be performed on the fully automatic K&S 8090 wirebonders, which can wirebond at a rate of 5 bonds per second. Setup time of the module on the wirebonder will be the most time consuming part. Based on our extensive experience with wirebonding we expect each module to take about 30 minutes for wirebonding. Additional time is required for inspection, repairs, documentation and feeding the production line. A total of 1 hour per module is allocated giving a utilization of a wirebonder at 25%. The same startup and production problems as in the previous task are assumed and thus the task duration is the same as the task duration for the module production. A mechanical technician is allocated at the 5% level because we assume that 25% of the modules will have to be retrofitted. A physicist oversees the operation at half the level of the wirebonder.

1.1.4.19.3.4	**20/20 North Stereo Silicon Module Production Con**	**10/1/04**	**10/1/04**	**$0**	**$0**	**$0**	**$0**

Notes

WBS Definition-
Milestone: All 20/20 North Stereo Modules needed are produced.

1.1.4.19.3.5	Debug sensor modules	7/13/04	10/5/04	$0	$0	$1,584	$1,584

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
12	ElecTechSF	10%	48 h	0 w	7/13/04	10/5/04	$1,584	$0	$0	$1,584	0 h	0 h	0 h	48 h
34	SASEQTestStandF	100%	480 h	0 w	7/13/04	10/5/04	$0	$0	$0	$0	0 h	0 h	0 h	480 h
44	PostDoc	50%	240 h	0 w	7/13/04	10/5/04	$0	$0	$0	$0	0 h	0 h	0 h	240 h

Notes

WBS Definition-
Pull wirebonds on all bad channels so that module will take bias voltage

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost

"Debug sensor modules" continued

Notes

Labor BOE-
Testing of 100 modules, 10 modules/week, 4 hour/module of test stand usage, of which two hours per module is physicist's time. ElecTech (at 10%) pulls bonds on bad channels in preparation for burn-in. Physicist debugs module and sends modules that fail to the "evaluate and repair" task (50% of physicist needed). We assume that 10% of the modules fail. Estimate based on Run IIa experience.

1.1.4.19.3.6	Burn-in sensor modules	7/20/04	10/12/04	$0	$0	$0	$0

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
40	ModuleBurnInStand	20%	96 h	0 w	7/20/04	10/12/04	$0	$0	$0	$0	0 h	0 h	0 h	96 h
47	Student	20%	96 h	0 w	7/20/04	10/12/04	$0	$0	$0	$0	0 h	0 h	0 h	96 h

Notes

WBS Definition-
The QC procedure where modules are readout out under bias voltage for a few days and evaluated for bad channels

Labor BOE-
Burn-in of 100 modules for 3 day cycle each. The burn-in stand accomodates up to 32 modules per cycle with 2 cycles per week. The 20-20A module production rate of 10/week, with 10% reprocessing means that 11 modules need to be burned-in per week. The stand has a total capacity of 64 modules per week. On average, 20% of this resource is taken over the task duration. Each module requires 0.5 hr documentation by physicist plus 0.3 hr to mount and remove module from test stand. Estimates based on Run IIa experience.

1.1.4.19.3.7	Evaluate and repair sensor modules	8/3/04	10/26/04	$0	$0	$1,440	$1,440

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
12	ElecTechSF	5%	24 h	0 w	8/3/04	10/26/04	$792	$0	$0	$792	0 h	0 h	0 h	24 h
23	WirebonderSF	5%	24 h	0 w	8/3/04	10/26/04	$648	$0	$0	$648	0 h	0 h	0 h	24 h
29	WirebondingMachineF	5%	24 h	0 w	8/3/04	10/26/04	$0	$0	$0	$0	0 h	0 h	0 h	24 h
34	SASEQTestStandF	50%	240 h	0 w	8/3/04	10/26/04	$0	$0	$0	$0	0 h	0 h	0 h	240 h
44	PostDoc	25%	120 h	0 w	8/3/04	10/26/04	$0	$0	$0	$0	0 h	0 h	0 h	120 h

Notes

WBS Definition-
Determining what repairs are necessary and repairing broken wirebonds, bad hybrids, or bad bias connections

Labor BOE-
We assume that 10% of the modules fail the debugging task. It takes twice as long to diagnose and repair problematic modules, so it takes 8hrs/module to repair. One module fail per week, corresponding to a quarter time physicist. The physicist needs the support of an ElecTechSF at 5% to replace chips and pull wirebonds, improve grounding, a SASEQTestStandF full time at his disposition, a WirebonderSF at the 5% level.

1.1.4.19.3.8	Perform quality assurance tests	8/17/04	11/9/04	$0	$0	$0	$0

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
34	SASEQTestStandF	100%	480 h	0 w	8/17/04	11/9/04	$0	$0	$0	$0	0 h	0 h	0 h	480 h
44	PostDoc	50%	240 h	0 w	8/17/04	11/9/04	$0	$0	$0	$0	0 h	0 h	0 h	240 h

Notes

WBS Definition-
Quality assurance of a subset of modules to fully characterize its performance.

Labor BOE-
For the outer layers a very small set of modules will be submitted to extensive tests, including laser test, temperature cycling, probe and pull testing and possibly irradiation tests. It is foreseen that these tests will be done on each batch of silicon sensors, with 24 batches in total. This corresponds to a full test for two module of each type for each detector half. A physicist will be occupied half time for one week for one module. He needs the support of a SASEQ test stand.

1.1.4.19.3.9	**20/20 North Stereo Silicon Module Testing Comple**	**11/9/04**	**11/9/04**	**$0**	**$0**	**$0**	**$0**

Notes

WBS Definition-
Milestone: All 20/20 North Stereo Modules are produced and tested.

1.1.4.20	**Stave Assembly Prototyping**	**8/7/02**	**3/5/03**	**$6,000**	**$0**	**$56,758**	**$62,758**

Notes

WBS Definition-
Summary task related to design, fabrication and QA of prototype stave fabrication fixtures.

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
1.1.4.20.1	Design initial module installation fixtures	8/7/02	10/2/02	$0	$0	$23,328	$23,328

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
1	MechEngF	50%	160 h	0 w	8/7/02	10/2/02	$8,160	$0	$5,304	$2,856	0 h	0 h	104 h	56 h
9	MechTechSF	10%	32 h	0 w	8/7/02	10/2/02	$1,088	$0	$707	$381	0 h	0 h	20.8 h	11.2 h
17	PhysicistF	50%	160 h	0 w	8/7/02	10/2/02	$0	$0	$0	$0	0 h	0 h	104 h	56 h
21	DesignerF	100%	320 h	0 w	8/7/02	10/2/02	$14,080	$0	$9,152	$4,928	0 h	0 h	208 h	112 h

Notes

WBS Definition-
Design the fixtures to mount and align hybrid / sensor modules on the stave cores, complete drawings of the fixtures

Labor BOE-
Consists of fixtures for mounting modules on staves. Requires 2 base fixtures and 2 module holder/alignment chucks, plus hardware for precision adjustment of modules. Requires generation of about 10 part/assembly detail drawings. The expectation is that a Fermilab physicist and mechanical engineer will spend 4 weeks at 50% effort on the initial designs of the required fixtures. Two designers will spend 3 weeks making initial drawings in consultation with the physicist and mechanical engineer. A final week, involving the Fermilab physicist, mechanical engineer and designer, is spent reviewing drawings for approval and making any required changes.

1.1.4.20.2	Procure initial module installation fixtures	10/3/02	1/7/03	$3,500	$0	$3,504	$7,004

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
1	MechEngF	10%	48 h	0 w	10/3/02	1/7/03	$2,448	$0	$0	$2,448	0 h	0 h	0 h	48 h
21	DesignerF	5%	24 h	0 w	10/3/02	1/7/03	$1,056	$0	$0	$1,056	0 h	0 h	0 h	24 h
48	MandS	3,500	3,500	0 w	10/3/02	1/7/03	$3,500	$0	$0	$3,500		0	0	3,500

Notes

WBS Definition-
Procure initial module installation fixtures.

M&S BOE-
This set of fixtures consists of a two base plates (14-16 hrs each), two module vacuum chucks (6-8 hrs each), one pair precision pin holders (8 hrs per set) for a total of 60 hours. We have included an additional 4 hours for micsellaneous machining and modifications. We estimate $300 for raw materials and purchase parts. Total cost estimate $3500 assuming shop rate of $50/hr.

Labor BOE-
Typical procurement time via local shop, engineer spends 6 days interfacing with purchasing and vendor, designer spends 3 days preparing drawings and interfacing on issues regarding drawing details.

1.1.4.20.3	Design initial C-channel attachment fixtures	9/12/02	11/6/02	$0	$0	$22,240	$22,240

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
1	MechEngF	50%	160 h	0 w	9/12/02	11/6/02	$8,160	$0	$0	$8,160	0 h	0 h	0 h	160 h
17	PhysicistF	50%	160 h	0 w	9/12/02	11/6/02	$0	$0	$0	$0	0 h	0 h	0 h	160 h
21	DesignerF	100%	320 h	0 w	9/12/02	11/6/02	$14,080	$0	$0	$14,080	0 h	0 h	0 h	320 h

Notes

WBS Definition-
Design fixtures to attach C-channels to populated stave cores.

Labor BOE-
Consists of fixtures for mounting C-channels on staves. Labor estimate based on previous experience designing fixtures of similar complexity and precision. The conceptual design is as follows. A long precision flat fixture will hold the module/core sub-assemblies flat with vacuum during gluing. The C-channels will need to be held from carts on reasonably accurate rails to guide them into place. Locating tolerances are a few mils and glue control is critical to ensure that structural adhesive does not migrate onto the silicon sensors.

1.1.4.20.4	Procure initial C-channel attachment fixtures	11/7/02	2/12/03	$2,500	$0	$3,504	$6,004

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
1	MechEngF	10%	48 h	0 w	11/7/02	2/12/03	$2,448	$0	$0	$2,448	0 h	0 h	0 h	48 h
21	DesignerF	5%	24 h	0 w	11/7/02	2/12/03	$1,056	$0	$0	$1,056	0 h	0 h	0 h	24 h
48	MandS	2,500	2,500	0 w	11/7/02	2/12/03	$2,500	$0	$0	$2,500		0	0	2,500

Notes

WBS Definition-
Procure initial C-channel attachment fixtures.

M&S BOE-
To be designed. Conceptually these are likely to require reasonably accurate rails to guide shells into place ($250 each, 2 per fixture). Module/core sub-assembly must be held flat with vacuum during gluing, requiring a long precision flat fixture (16 hrs). C-channels will need to be held from carts on rails (6 hrs per side). Additional alignment features and machined parts (8 hrs). Raw materials for fabricated parts $200/fixture. Total cost estimate $2500 with shop rate of $50/hr.

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
"Procure initial C-channel attachment fixtures" continued							

Notes

Labor BOE-
Typical procurement time via local shop, engineer spends 6 days interfacing with purchasing and vendor, designer spends 3 days preparing drawings and interfacing on issues regarding drawing details.

1.1.4.20.5	QC and test initial stave assembly fixtures	2/13/03	3/5/03	$0	$0	$4,182	$4,182

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
1	MechEngF	25%	30 h	0 w	2/13/03	3/5/03	$1,530	$0	$0	$1,530	0 h	0 h	0 h	30 h
17	PhysicistF	25%	30 h	0 w	2/13/03	3/5/03	$0	$0	$0	$0	0 h	0 h	0 h	30 h
21	DesignerF	15%	18 h	0 w	2/13/03	3/5/03	$792	$0	$0	$792	0 h	0 h	0 h	18 h
27	CMMOperatorSF	50%	60 h	0 w	2/13/03	3/5/03	$1,860	$0	$0	$1,860	0 h	0 h	0 h	60 h
32	CMMLarge	100%	120 h	0 w	2/13/03	3/5/03	$0	$0	$0	$0	0 h	0 h	0 h	120 h

Notes

WBS Definition-
Inspection and functional evaluation of initial stave fixtures, both module installation and C-channel attachment.

Labor BOE-
Requires inspection of roughly 12 parts (~1hr each) and 3 assemblies (~4 hr each). Mechanical engineer and physicist oversee work and analyze results. Any required modifications and re-inspection of parts/assemblies included. CMM programming included. Mechanical tech will do assembly of parts with mechanical engineer and physicist. Assemblies will be exercised by CMM technician under direction of mechanical engineer and physicist with dummy sensors and hybrids (~6 hr per assembly) to provide input for revisions before final fixtures are fabricated.

1.1.4.21	**Stave Assembly Fixtures**	**8/15/03**	**2/27/04**	**$28,500**	**$0**	**$10,824**	**$39,324**

Notes

WBS Definition-
Summary task related to design, fabrication and QA of stave fabrication fixtures.

1.1.4.21.1	Finalize stave assembly fixtures	8/15/03	9/5/03	$0	$0	$4,170	$4,170

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
1	MechEngF	25%	30 h	0 w	8/15/03	9/5/03	$1,530	$0	$0	$1,530	0 h	0 h	0 h	30 h
17	PhysicistF	50%	60 h	0 w	8/15/03	9/5/03	$0	$0	$0	$0	0 h	0 h	0 h	60 h
21	DesignerF	50%	60 h	0 w	8/15/03	9/5/03	$2,640	$0	$0	$2,640	0 h	0 h	0 h	60 h

Notes

WBS Definition-
Revise fixture drawings and specifications to take into account information learned from the initial set of fixtures.

Labor BOE-
Physicist and engineer working part time for 2 weeks to complete design changes, with final week for review and approval drawings for fabrication of production parts. Designer at 50% throughout period to revise drawings as required.

1.1.4.21.2	Procure remaining stave assembly fixtures	9/8/03	2/6/04	$28,500	$0	$3,504	$32,004

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
1	MechEngF	6%	48 h	0 w	9/8/03	2/6/04	$2,448	$0	$0	$2,448	0 h	0 h	0 h	48 h
21	DesignerF	3%	24 h	0 w	9/8/03	2/6/04	$1,056	$0	$0	$1,056	0 h	0 h	0 h	24 h
48	MandS	28,500	28,500	0 w	9/8/03	2/6/04	$28,500	$0	$0	$28,500		0	0	28,500

Notes

WBS Definition-
Procure remaining stave assembly fixtures.

M&S BOE-
Four module installation fixtures and two C-channel attachment fixtures are required for a throughput of 2 staves per day. To accommodate a production capacity of 3 staves per day, we will buy six module installation fixtures and three C-channel attachment fixtures. The module installation fixtures are estimated at $3500 each and the C-channel attachment fixtures at $2500 each. Details of these estimates appear above under procurement of initial fixtures and are summarized in the BOE books.

Labor BOE-
Typical procurement time via local shop, engineer spends 6 days interfacing with purchasing and vendor, designer spends 3 days preparing drawings and interfacing on issues regarding drawing details.

1.1.4.21.3	QC final stave assembly fixtures	2/9/04	2/27/04	$0	$0	$3,150	$3,150

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
1	MechEngF	15%	18 h	0 w	2/9/04	2/27/04	$918	$0	$0	$918	0 h	0 h	0 h	18 h

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost

"QC final stave assembly fixtures" continued

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
17	PhysicistF	30%	36 h	0 w	2/9/04	2/27/04	$0	$0	$0	$0	0 h	0 h	0 h	36 h
27	CMMOperatorSF	60%	72 h	0 w	2/9/04	2/27/04	$2,232	$0	$0	$2,232	0 h	0 h	0 h	72 h
32	CMMLarge	100%	120 h	0 w	2/9/04	2/27/04	$0	$0	$0	$0	0 h	0 h	0 h	120 h

Notes

WBS Definition-
Inspection of remaining stave assembly fixtures.

Labor BOE-
Requires inspection of roughly 50 parts (~1hr each) and 9 assemblies (~3 hr each). MechEng/Physicist oversees work and analyzes results.

1.1.4.22	**Assemble Modules Onto Staves**	**4/30/03**	**3/25/05**	**$7,526**	**$0**	**$150,686**	**$158,212**

Notes

WBS Definition-
Summary task that includes all steps necessary to take the modules and place them accurately on the staves and then test the staves.

Risk Mitigationk-
The assembly of the modules onto the staves is risky for two reasons:
1. There is a lot of earned value in the objects by this time
2. This is a double sided structure that has to be aligned well to obtain the accuracy needed for tracking.

Cost: While the cost associated with this item is very low, the cost associated from lost parts is very high. Extensive prototyping with the fixtures is needed to assure that the process is safe for the parts.
Schedule: This is a critical path item, but we've decoupled the module assembly from this assembly onto staves so that they run in series. In reality, the assembly can go on in parallel so there are a few months to be gained.
Technical/Scope: It is crucial that these tasks be prototyped well to understand the process. We have included these tasks one year before needed in hopes of understanding the staves well.

1.1.4.22.1	Fabricate preproduction stave	4/30/03	6/4/03	$273	$0	$7,330	$7,603

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
1	MechEngF	25%	50 h	0 w	4/30/03	6/4/03	$2,550	$0	$0	$2,550	0 h	0 h	0 h	50 h
17	PhysicistF	50%	100 h	0 w	4/30/03	6/4/03	$0	$0	$0	$0	0 h	0 h	0 h	100 h
21	DesignerF	5%	10 h	0 w	4/30/03	6/4/03	$440	$0	$0	$440	0 h	0 h	0 h	10 h
27	CMMOperatorSF	70%	140 h	0 w	4/30/03	6/4/03	$4,340	$0	$0	$4,340	0 h	0 h	0 h	140 h
30	CMMSmall	40%	80 h	0 w	4/30/03	6/4/03	$0	$0	$0	$0	0 h	0 h	0 h	80 h
32	CMMLarge	60%	120 h	0 w	4/30/03	6/4/03	$0	$0	$0	$0	0 h	0 h	0 h	120 h
48	MandS	272.5	272.5	0 w	4/30/03	6/4/03	$273	$0	$0	$273		0	0	272.5

Notes

WBS Definition-
First time to assemble a prototype stave using initial stave assembly fixtures for all parts, a prototype core structure, prototype modules and prototype C-channels. This task is a follow-up task of the mechanical prototype stave and is in preparation of the electrical grade preproduction stave.

M&S BOE-
Epoxy cost based on 10 10cc mix with an anticipated cost of $1500 for 20 liters of epoxy, including purity testing ($0.75 per 10cc). In addition there will be 15 packets of silver epoxy used, at $11 each. An additional $100 is included for miscellaneous parts and/or minor machining modifications to the fixtures or prototype parts. Total cost $272.50.

Labor BOE-
We anticipate assembling a minimum of 2 mechanical prototype staves. Procedures for stave assembly will be developed by the physicist and engineer. Under their guidance the CMM technician will assemble a full prototype (mechanical) stave. The first two weeks of this process will utilize a small CMM to construct the required sensor/hybrid modules. Eight modules are required. To fabricate these modules twelve 20cm gangs will need to be produced at 2 hours each, followed by the eight modules at 2 hours each, for a total effort of 40 hours. This has been doubled to a 100% effort to allow for ancillory tasks. The following week is spent, at 50% effort, assembling the tooling and running through the procedures "dry", i.e. without gluing any parts together. The physicist and engineer will update procedures as required and the designer will update any drawings required for the assembly procedures. The final 2 weeks are allocated for the final assembly of the two staves. In principle this is a 4-5 day process per stave requiring about 2 hours per day to complete. We have doubled this estimate to 50% of the CMM operator, plus a physicist and mechanical engineer at the 25% level to allow for any problems that might arise.

1.1.4.22.2	**Fabricate And Test Electrical Grade Preproduction**	**6/5/03**	**7/31/03**	**$174**	**$0**	**$9,732**	**$9,906**
1.1.4.22.2.1	Assemble and electrically test electrical grade preprod	6/5/03	7/17/03	$174	$0	$4,092	$4,266

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
1	MechEngF	15%	36 h	0 w	6/5/03	7/17/03	$1,836	$0	$0	$1,836	0 h	0 h	0 h	36 h
12	ElecTechSF	5%	12 h	0 w	6/5/03	7/17/03	$396	$0	$0	$396	0 h	0 h	0 h	12 h
17	PhysicistF	75%	180 h	0 w	6/5/03	7/17/03	$0	$0	$0	$0	0 h	0 h	0 h	180 h
27	CMMOperatorSF	25%	60 h	0 w	6/5/03	7/17/03	$1,860	$0	$0	$1,860	0 h	0 h	0 h	60 h

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost

"Assemble and electrically test electrical grade preproduction staves" continued

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
32	CMMLarge	50%	120 h	0 w	6/5/03	7/17/03	$0	$0	$0	$0	0 h	0 h	0 h	120 h
48	MandS	173.5	173.5	0 w	6/5/03	7/17/03	$174	$0	$0	$174		0	0	173.5

Notes

WBS Definition-
Fabricate prototype staves by combining cores carrying hybrid / sensor modules with stave shells. This prototype uses preproduction electrical grade modules.

M&S BOE-
Epoxy cost based on 10 10cc mix with an anticipated cost of $1500 for 20 liters of epoxy, including purity testing. In addition there will be 6 packets of silver epoxy used, at $11 each. An additional $100 is included for miscellaneous parts and/or minor machining modifications to the fixtures or prototype parts.

Labor BOE-
We anticipate assembling two electrical prototype staves. The electrical grade modules are already assembled, so this task involves only installation of the modules on the stave core and attachment of the C-channels. In principle this is a 4-5 day process per stave requiring about 2 hours per day to complete. We have doubled this estimate to allow for any problems that might arise. The duration has been extended by two weeks to allow for electrical evaluation of the first prototype prior to assembly of the second. This will allow us to study grounding issues, for instance, and incorporate any improvements into the subsequent prototype. These two weeks have a physicist allocated 100% with an electrical technician at 10% for implementing any modifications to the first prototype. The first and last week, during which the two staves are fabricated, require a large CMM and 50% of a CMM operator, as well as a physicist at 50% and mechanical engineer at 25% to oversee the work.

1.1.4.22.2.2	Perform deflection tests on preproduction staves	7/18/03	7/31/03	$0	$0	$5,640	$5,640

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
1	MechEngF	100%	80 h	0 w	7/18/03	7/31/03	$4,080	$0	$0	$4,080	0 h	0 h	0 h	80 h
17	PhysicistF	100%	80 h	0 w	7/18/03	7/31/03	$0	$0	$0	$0	0 h	0 h	0 h	80 h
27	CMMOperatorSF	25%	20 h	0 w	7/18/03	7/31/03	$620	$0	$0	$620	0 h	0 h	0 h	20 h
28	CMMProgrammerSF	25%	20 h	0 w	7/18/03	7/31/03	$940	$0	$0	$940	0 h	0 h	0 h	20 h
32	CMMLarge	50%	40 h	0 w	7/18/03	7/31/03	$0	$0	$0	$0	0 h	0 h	0 h	40 h

Notes

WBS Definition-
Verify that deflections of preproduction staves under load are acceptable and feed the results into the final design of the stave assembly fixtures and procedures.

M&S BOE-
None

Labor BOE-
Run2a experience with mechanical testing

1.1.4.22.2.3	**Successful Fabrication of an Electrical-grade Pre-p**	**7/17/03**	**7/17/03**	**$0**	**$0**	**$0**	**$0**

Notes

WBS Definition-
Milestone: Succesful production of an electrical grade stave (real sensors and hybrids).

1.1.4.22.3	**Stave Production Readiness**	**7/1/04**	**7/23/04**	**$0**	**$0**	**$2,680**	**$2,680**
1.1.4.22.3.1	Stave Assembly Production Training	7/1/04	7/16/04	$0	$0	$2,340	$2,340

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
9	MechTechSF	45%	36 h	0 w	7/1/04	7/16/04	$1,224	$0	$0	$1,224	0 h	0 h	0 h	36 h
17	PhysicistF	45%	36 h	0 w	7/1/04	7/16/04	$0	$0	$0	$0	0 h	0 h	0 h	36 h
27	CMMOperatorSF	45%	36 h	0 w	7/1/04	7/16/04	$1,116	$0	$0	$1,116	0 h	0 h	0 h	36 h
32	CMMLarge	100%	80 h	0 w	7/1/04	7/16/04	$0	$0	$0	$0	0 h	0 h	0 h	80 h

Notes

WBS Definition-
Training of technical personnel for stave assembly.

M&S BOE-
None.

Labor BOE-
Three mechanical technicians and one CMM operator need to be trained for stave production. A physicist oversees and organizes the training. One full assembly will be fabricated by each technician for training on a large CMM. There are three mechanical steps in the assembly: install axial modules, install stereo modules and install C-channels. Each of these is expected to take 3 hours in training plus one hour of evaluation. The CMM operator is required for all three steps at half the level of the mechanical technician. This implies three technicians involved at the 15% level each. The CMM operator works with all three

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
"Stave Assembly Production Training" continued							

Notes
technicians and is thus allocated at the 45% level.

1.1.4.22.3.2	Stave Assembly Production Readiness Review	7/16/04	7/23/04	$0	$0	$340	$340

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
1	MechEngF	10%	4 h	0 w	7/16/04	7/23/04	$204	$0	$0	$204	0 h	0 h	0 h	4 h
9	MechTechSF	10%	4 h	0 w	7/16/04	7/23/04	$136	$0	$0	$136	0 h	0 h	0 h	4 h
17	PhysicistF	100%	40 h	0 w	7/16/04	7/23/04	$0	$0	$0	$0	0 h	0 h	0 h	40 h

Notes
WBS Definition-
Review of readiness for stave assembly.

M&S BOE-
None.

Labor BOE-
The physicist production line floor manager spends a couple of days preparing all the paperwork and establishing the procedures after the review. The review itself is expected to take half a day with participation of the lead mechanical technician, a mechanical engineer and several physicists.

1.1.4.22.4	**Silicon Stave Production Begun**	**7/23/04**	**7/23/04**	**$0**	**$0**	**$0**	**$0**

Notes
WBS Definition-
Start of silicon detector stave production.

1.1.4.22.5	**South**	**7/23/04**	**12/10/04**	**$3,540**	**$0**	**$65,472**	**$69,012**

Notes
WBS Definition-
The summary task that includes all prototyping work, design, production, testing, and assembly of: stave cores, modules onto the stave, and stave shells for Layers 2-5 South

1.1.4.22.5.1	(retired)	7/23/04	7/26/04	$0	$0	$0	$0

1.1.4.22.5.2	Install axial sensor modules on cores	7/23/04	10/18/04	$1,410	$0	$15,600	$17,010

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
9	MechTechSF	50%	240 h	0 w	7/23/04	10/18/04	$8,160	$0	$0	$8,160	0 h	0 h	0 h	240 h
17	PhysicistF	50%	240 h	0 w	7/23/04	10/18/04	$0	$0	$0	$0	0 h	0 h	0 h	240 h
27	CMMOperatorSF	50%	240 h	0 w	7/23/04	10/18/04	$7,440	$0	$0	$7,440	0 h	0 h	0 h	240 h
32	CMMLarge	100%	480 h	0 w	7/23/04	10/18/04	$0	$0	$0	$0	0 h	0 h	0 h	480 h
48	MandS	1,410	1,410	0 w	7/23/04	10/18/04	$1,410	$0	$0	$1,410		0	0	1,410

Notes
WBS Definition-
Install axial hybrid / sensor modules on stave cores

M&S BOE-
Epoxy cost based on 10cc mix with an anticipated cost of $1500 for 20 liters of epoxy, including purity testing, 2 mixes per day. In addition there will be 2 packets of silver epoxy used per day, at $11 each. Total cost is $23.50/day.

Labor BOE-
We plan on installing axial modules on two stave cores per day. Each core can have modules installed in 2 hours, leading to a 50% allocation of the personnel involved. This work requires a large CMM with one fixture at each end, so the CMM is fully occupied while the glue cures. There are 84 staves required for the south cylinder. We can assemble 90 in 9 weeks. An additional 3 weeks has been added to account for slower startup, certified module availability and equipment down time. In addition to the CMM operator and mechanical technician, a physicist is required to oversee the production.

1.1.4.22.5.3	Verify alignment of axial sensor modules	7/26/04	10/19/04	$0	$0	$3,720	$3,720

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
17	PhysicistF	25%	120 h	0 w	7/26/04	10/19/04	$0	$0	$0	$0	0 h	0 h	0 h	120 h
27	CMMOperatorSF	25%	120 h	0 w	7/26/04	10/19/04	$3,720	$0	$0	$3,720	0 h	0 h	0 h	120 h

Notes
WBS Definition-
Perform and analyze CMM measurements to verify proper positioning of sensors on cores

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost

"Verify alignment of axial sensor modules" continued

Notes

Labor BOE-
We plan on installing axial modules on two stave cores per day. The following morning the module alignment will be checked. This will require a CMM operator for 30 minutes per stave. An additional hour is allocated to transfer the parts off the CMM and to complete documentation. The CMM is the same machine that the modules are installed on so no additional resource is required for this task. A physicist will review the inspection results and certify the part for further processing.

1.1.4.22.5.4	Install stereo sensor modules on cores	7/26/04	10/19/04	$1,410	$0	$15,600	$17,010

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
9	MechTechSF	50%	240 h	0 w	7/26/04	10/19/04	$8,160	$0	$0	$8,160	0 h	0 h	0 h	240 h
17	PhysicistF	50%	240 h	0 w	7/26/04	10/19/04	$0	$0	$0	$0	0 h	0 h	0 h	240 h
27	CMMOperatorSF	50%	240 h	0 w	7/26/04	10/19/04	$7,440	$0	$0	$7,440	0 h	0 h	0 h	240 h
32	CMMLarge	100%	480 h	0 w	7/26/04	10/19/04	$0	$0	$0	$0	0 h	0 h	0 h	480 h
48	MandS	1,410	1,410	0 w	7/26/04	10/19/04	$1,410	$0	$0	$1,410		0	0	1,410

Notes

WBS Definition-
Install stereo hybrid / sensor modules on stave cores

M&S BOE-
Epoxy cost based on 10cc mix with an anticipated cost of $1500 for 20 liters of epoxy, including purity testing, 2 mixes per day. In addition there will be 2 packets of silver epoxy used per day, at $11 each. Total cost is $23.50/day.

Labor BOE-
We plan on installing stereo modules on two stave cores per day. Each core can have modules installed in 2 hours, leading to a 50% allocation of the personnel involved. This work requires a large CMM with one fixture at each end, so the CMM is fully occupied while the glue cures. There are 84 staves required for the south cylinder. We can assemble 90 in 9 weeks. An additional 3 weeks has been added to account for slower startup, certified module availability and equipment down time. In addition to the CMM operator and mechanical technician, a physicist is required to oversee the production.

1.1.4.22.5.5	Verify alignment of stereo sensor modules	7/27/04	10/20/04	$0	$0	$3,720	$3,720

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
17	PhysicistF	25%	120 h	0 w	7/27/04	10/20/04	$0	$0	$0	$0	0 h	0 h	0 h	120 h
27	CMMOperatorSF	25%	120 h	0 w	7/27/04	10/20/04	$3,720	$0	$0	$3,720	0 h	0 h	0 h	120 h

Notes

WBS Definition-
Perform and analyze CMM measurements to verify proper positioning of sensors on cores

Labor BOE-
We plan on installing stereo modules on two stave cores per day. The following morning the module alignment will be checked before the modules are electrically tested. This will require a CMM operator for 30 minutes per stave. An additional hour is allocated to transfer the parts off the CMM and to complete documentation. The CMM is the same machine that the modules are installed on so no additional resource is required for this task. A physicist will review the inspection results and certify the part for further processing.

1.1.4.22.5.6	Electrical test of modules on stave core	7/27/04	10/20/04	$0	$0	$3,168	$3,168

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
12	ElecTechSF	20%	96 h	0 w	7/27/04	10/20/04	$3,168	$0	$0	$3,168	0 h	0 h	0 h	96 h
17	PhysicistF	100%	480 h	0 w	7/27/04	10/20/04	$0	$0	$0	$0	0 h	0 h	0 h	480 h
34	SASEQTestStandF	100%	480 h	0 w	7/27/04	10/20/04	$0	$0	$0	$0	0 h	0 h	0 h	480 h

Notes

WBS Definition-
Electrical testing of modules installed on stave cores.

Labor BOE-
Testing of 90 staves, 2 stereo and 2 axial modules per stave for a total of 360 modules. The stave production rate corresponds to 8 modules per day. Testing is done at a rate of 1 hour/module. We anticipate 5% problem modules requiring 2 days to debug, repair and retest. An electrical technician is available to assist the physicist with repair work.

1.1.4.22.5.7	Attach C-channels to L2-L5 staves	8/3/04	10/27/04	$720	$0	$11,880	$12,600

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
9	MechTechSF	50%	240 h	0 w	8/3/04	10/27/04	$8,160	$0	$0	$8,160	0 h	0 h	0 h	240 h
17	PhysicistF	25%	120 h	0 w	8/3/04	10/27/04	$0	$0	$0	$0	0 h	0 h	0 h	120 h
27	CMMOperatorSF	25%	120 h	0 w	8/3/04	10/27/04	$3,720	$0	$0	$3,720	0 h	0 h	0 h	120 h
48	MandS	720	720	0 w	8/3/04	10/27/04	$720	$0	$0	$720		0	0	720

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost

"Attach C-channels to L2-L5 staves" continued

Notes

WBS Definition-
Attach C-channels to L4-L5 staves

M&S BOE-
Structural epoxy cost of $1 per day. Silver epoxy cost for grounding C-channels is $11/day (1 package per day). Total cost is $12/day.

Labor BOE-
We plan on attaching C-channels to two populated stave cores per day. There are 84 staves required for the south cylinder. We can assemble 90 in 9 weeks. An additional 3 weeks has been added to account for slower startup, certified module availability and equipment down time. In addition to the CMM operator and mechanical technician, a physicist is required to oversee the production. Assembly time is 2 hours per stave, for 50% effort, using a CMM operator, mechanical technician and physicist. This includes documentation and transfer of parts to and from fixtures.

1.1.4.22.5.8	**L2-L5 Silicon Stave Production For South Complet**	**10/27/04**	**10/27/04**	**$0**	**$0**	**$0**	**$0**

Notes

WBS Definition-
Milestone: All staves needed for the South L2-L5 section of the detector have been produced.

1.1.4.22.5.9	Test L2-L5 staves	10/27/04	12/10/04	$0	$0	$11,784	$11,784

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
1	MechEngF	50%	120 h	0 w	10/27/04	12/10/04	$6,120	$0	$0	$6,120	0 h	0 h	0 h	120 h
9	MechTechSF	50%	120 h	0 w	10/27/04	12/10/04	$4,080	$0	$0	$4,080	0 h	0 h	0 h	120 h
12	ElecTechSF	20%	48 h	0 w	10/27/04	12/10/04	$1,584	$0	$0	$1,584	0 h	0 h	0 h	48 h
34	SASEQTestStandF	100%	240 h	0 w	10/27/04	12/10/04	$0	$0	$0	$0	0 h	0 h	0 h	240 h
47	Student	100%	240 h	0 w	10/27/04	12/10/04	$0	$0	$0	$0	0 h	0 h	0 h	240 h

Notes

WBS Definition-
Electrical test of all staves (temporary cooling connections may be required), mechanical tests of a subset of staves

Labor BOE-
Electrical testing of staves at a rate of 4 staves per day (2 hours per stave, 0.5 hours per module). For 90 staves this takes 4.5 weeks. An additional 3 days is allocated to allow for equipment problems. We anticipate <10% problems and that these parts are shelved until the end of production. Mechanical testing of a small subset of the staves occurs in parallel with the electrical testing. This effort requires a mechanical engineer and mechanical technician working 50% to perform e.g. deflection tests or thermal cycling and to analyze and document the results.

1.1.4.22.5.10	**L2-5 Silicon Stave Testing for South Complete**	**12/10/04**	**12/10/04**	**$0**	**$0**	**$0**	**$0**

Notes

WBS Definition-
Milestone: All staves needed for the South L2-L5 section of the detector have been produced and tested

1.1.4.22.6	**South Silicon Staves Complete**	**12/10/04**	**12/10/04**	**$0**	**$0**	**$0**	**$0**

Notes

WBS Definition-
Milestone: All staves needed for the South barrel of the detector have been produced and tested.

1.1.4.22.7	**North**	**10/27/04**	**3/25/05**	**$3,540**	**$0**	**$65,472**	**$69,012**

Notes

WBS Definition-
The summary task that includes all prototyping work, design, production, testing, and assembly of: stave cores, modules onto the stave, and stave shells for Layers 2-5 North

1.1.4.22.7.1	(retired)	10/27/04	10/28/04	$0	$0	$0	$0
1.1.4.22.7.2	Install axial sensor modules on cores	10/27/04	2/2/05	$1,410	$0	$15,600	$17,010

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
9	MechTechSF	50%	240 h	0 w	10/27/04	2/2/05	$8,160	$0	$0	$8,160	0 h	0 h	0 h	240 h
17	PhysicistF	50%	240 h	0 w	10/27/04	2/2/05	$0	$0	$0	$0	0 h	0 h	0 h	240 h
27	CMMOperatorSF	50%	240 h	0 w	10/27/04	2/2/05	$7,440	$0	$0	$7,440	0 h	0 h	0 h	240 h
32	CMMLarge	100%	480 h	0 w	10/27/04	2/2/05	$0	$0	$0	$0	0 h	0 h	0 h	480 h
48	MandS	1,410	1,410	0 w	10/27/04	2/2/05	$1,410	$0	$0	$1,410		0	0	1,410

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost

"Install axial sensor modules on cores" continued

Notes

WBS Definition-
Install axial hybrid / sensor modules on stave cores

M&S BOE-
Epoxy cost based on 10cc mix with an anticipated cost of $1500 for 20 liters of epoxy, including purity testing, 2 mixes per day. In addition there will be 2 packets of silver epoxy used per day, at $11 each. Total cost is $23.50/day.

Labor BOE-
We plan on installing axial modules on two stave cores per day. Each core can have modules installed in 2 hours, leading to a 50% allocation of the personnel involved. This work requires a large CMM with one fixture at each end, so the CMM is fully occupied while the glue cures. There are 84 staves required for the south cylinder. We can assemble 90 in 9 weeks. An additional 3 weeks has been added to account for slower startup, certified module availability and equipment down time. In addition to the CMM operator and mechanical technician, a physicist is required to oversee the production.

1.1.4.22.7.3	Verify alignment of axial sensor modules	10/28/04	2/3/05	$0	$0	$3,720	$3,720

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
17	PhysicistF	25%	120 h	0 w	10/28/04	2/3/05	$0	$0	$0	$0	0 h	0 h	0 h	120 h
27	CMMOperatorSF	25%	120 h	0 w	10/28/04	2/3/05	$3,720	$0	$0	$3,720	0 h	0 h	0 h	120 h

Notes

WBS Definition-
Perform and analyze CMM measurements to verify proper positioning of sensors on cores

Labor BOE-
We plan on installing axial modules on two stave cores per day. The following morning the module alignment will be checked. This will require a CMM operator for 30 minutes per stave. An additional hour is allocated to transfer the parts off the CMM and to complete documentation. The CMM is the same machine that the modules are installed on so no additional resource is required for this task. A physicist will review the inspection results and certify the part for further processi

1.1.4.22.7.4	Install stereo sensor modules on cores	10/28/04	2/3/05	$1,410	$0	$15,600	$17,010

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
9	MechTechSF	50%	240 h	0 w	10/28/04	2/3/05	$8,160	$0	$0	$8,160	0 h	0 h	0 h	240 h
17	PhysicistF	50%	240 h	0 w	10/28/04	2/3/05	$0	$0	$0	$0	0 h	0 h	0 h	240 h
27	CMMOperatorSF	50%	240 h	0 w	10/28/04	2/3/05	$7,440	$0	$0	$7,440	0 h	0 h	0 h	240 h
32	CMMLarge	100%	480 h	0 w	10/28/04	2/3/05	$0	$0	$0	$0	0 h	0 h	0 h	480 h
48	MandS	1,410	1,410	0 w	10/28/04	2/3/05	$1,410	$0	$0	$1,410		0	0	1,410

Notes

WBS Definition-
Install stereo hybrid / sensor modules on stave cores

M&S BOE-
Epoxy cost based on 10cc mix with an anticipated cost of $1500 for 20 liters of epoxy, including purity testing, 2 mixes per day. In addition there will be 2 packets of silver epoxy used per day, at $11 each. Total cost is $23.50/day.

Labor BOE-
We plan on installing stereo modules on two stave cores per day. Each core can have modules installed in 2 hours, leading to a 50% allocation of the personnel involved. This work requires a large CMM with one fixture at each end, so the CMM is fully occupied while the glue cures. There are 84 staves required for the south cylinder. We can assemble 90 in 9 weeks. An additional 3 weeks has been added to account for slower startup, certified module availability and equipment down time. In addition to the CMM operator and mechanical technician, a physicist is required to oversee the production.

1.1.4.22.7.5	Verify alignment of stereo sensor modules	10/29/04	2/4/05	$0	$0	$3,720	$3,720

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
17	PhysicistF	25%	120 h	0 w	10/29/04	2/4/05	$0	$0	$0	$0	0 h	0 h	0 h	120 h
27	CMMOperatorSF	25%	120 h	0 w	10/29/04	2/4/05	$3,720	$0	$0	$3,720	0 h	0 h	0 h	120 h

Notes

WBS Definition-
Perform and analyze CMM measurements to verify proper positioning of sensors on cores

Labor BOE-
We plan on installing stereo modules on two stave cores per day. The following morning the module alignment will be checked before the modules are electrically tested. This will require a CMM operator for 30 minutes per stave. An additional hour is allocated to transfer the parts off the CMM and to complete documentation. The CMM is the same machine that the modules are installed on so no additional resource is required for this task. A physicist will review the inspection results and certify the part for further processing.

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
1.1.4.22.7.6	Electrical test of modules on stave core	10/29/04	2/4/05	$0	$0	$3,168	$3,168

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
12	ElecTechSF	20%	96 h	0 w	10/29/04	2/4/05	$3,168	$0	$0	$3,168	0 h	0 h	0 h	96 h
17	PhysicistF	100%	480 h	0 w	10/29/04	2/4/05	$0	$0	$0	$0	0 h	0 h	0 h	480 h
34	SASEQTestStandF	100%	480 h	0 w	10/29/04	2/4/05	$0	$0	$0	$0	0 h	0 h	0 h	480 h

Notes

WBS Definition-
Electrical testing of modules installed on stave cores.

Labor BOE-
Testing of 90 staves, 2 stereo and 2 axial modules per stave for a total of 360 modules. The stave production rate corrosponds to 8 modules per day. Testing is done at a rate of 1 hour/module. We anticipate 5% problem modules requiring 2 days to debug, repair and retest. An electrical technician is available to assist the physicist with repair work.

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
1.1.4.22.7.7	Attach C-channels to L2-L5 staves	11/5/04	2/11/05	$720	$0	$11,880	$12,600

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
9	MechTechSF	50%	240 h	0 w	11/5/04	2/11/05	$8,160	$0	$0	$8,160	0 h	0 h	0 h	240 h
17	PhysicistF	25%	120 h	0 w	11/5/04	2/11/05	$0	$0	$0	$0	0 h	0 h	0 h	120 h
27	CMMOperatorSF	25%	120 h	0 w	11/5/04	2/11/05	$3,720	$0	$0	$3,720	0 h	0 h	0 h	120 h
48	MandS	720	720	0 w	11/5/04	2/11/05	$720	$0	$0	$720		0	0	720

Notes

WBS Definition-
Attach C-channels to L4-L5 staves

M&S BOE-
Structural epoxy cost of $1 per day. Silver epoxy cost for grounding C-channels is $11/day (1 package per day). Total cost is $12/day.

Labor BOE-
We plan on attaching C-channels to two populated stave cores per day. There are 84 staves required for the south cylinder. We can assemble 90 in 9 weeks. An additional 3 weeks has been added to account for slower startup, certified module availability and equipment down time. In addition to the CMM operator and mechanical technician, a physicist is required to oversee the production. Assembly time is 2 hours per stave, for 50% effort, using a CMM operator, mechanical technician and physicist. This includes documentation and transfer of parts to and from fixtures.

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
1.1.4.22.7.8	**L2-L5 Silicon Stave Production For North Complet**	**2/11/05**	**2/11/05**	**$0**	**$0**	**$0**	**$0**

Notes

WBS Definition-
Milestone All staves needed for the North L2-L5 section of the detector have been produced.

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
1.1.4.22.7.9	Test L2-L5 staves	2/11/05	3/25/05	$0	$0	$11,784	$11,784

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
1	MechEngF	50%	120 h	0 w	2/11/05	3/25/05	$6,120	$0	$0	$6,120	0 h	0 h	0 h	120 h
9	MechTechSF	50%	120 h	0 w	2/11/05	3/25/05	$4,080	$0	$0	$4,080	0 h	0 h	0 h	120 h
12	ElecTechSF	20%	48 h	0 w	2/11/05	3/25/05	$1,584	$0	$0	$1,584	0 h	0 h	0 h	48 h
34	SASEQTestStandF	100%	240 h	0 w	2/11/05	3/25/05	$0	$0	$0	$0	0 h	0 h	0 h	240 h
47	Student	100%	240 h	0 w	2/11/05	3/25/05	$0	$0	$0	$0	0 h	0 h	0 h	240 h

Notes

WBS Definition-
Electrical test of all staves (temporary cooling connections may be required), mechanical tests of a subset of staves

Labor BOE-
Electrical testing of staves at a rate of 4 staves per day (2 hours per stave, 0.5 hours per module). For 90 staves this takes 4.5 weeks. An additional 3 days is allocated to allow for equipment problems. We anticipate <10% problems and that these parts are shelved until the end of production. Mechanical testing of a small subset of the staves occurs in parallel with the electrical testing. This effort requires a mechanical engineer and mechanical technician working 50% to perform e.g. deflection tests or thermal cycling and to analyze and document the results.

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
1.1.4.22.7.10	**L2-L5 Silicon Stave Testing For North Complete**	**3/25/05**	**3/25/05**	**$0**	**$0**	**$0**	**$0**

Notes

WBS Definition-
Milestone: All staves needed for the North L2-L5 section of the detector have been produced and tested.

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
1.1.4.22.8	**North Silicon Staves Complete**	**3/25/05**	**3/25/05**	**$0**	**$0**	**$0**	**$0**

Notes
WBS Definition-
Milestone: All North barrel stave are produced and tested.

1.1.4.23	**Silicon Stave Production Complete**	**3/25/05**	**3/25/05**	**$0**	**$0**	**$0**	**$0**

Notes
WBS Definition-
Milestone: All staves have been produced and tested.

1.1.5	**Silicon Barrel Assembly**	**9/3/02**	**7/22/05**	**$383,662**	**$0**	**$1,100,022**	**$1,483,684**

Notes
WBS Definition-
The summary task that includes designing, prototyping, and production of all cylinders and support structures, the cooling and dry gas systems, as well as the assembly of the L0/L1 modules onto their support structures and testing, and the assembly and testing of staves into the structure.

Risk Mitigation-
The tasks in this group include the final assembly of the North and South Barrels. This is done at the end of the project and has significant schedule and technical risks which are described in the summary tasks for those operations.

1.1.5.1	Machining through MRI grant funding	9/3/02	6/29/05	$18,000	$0	$0	$18,000

ID	*Resource Name*	*Units*	*Work*	*Delay*	*Start*	*Finish*	*Cost*	*Baseline Cost*	*Act. Cost*	*Rem. Cost*	*Ovt. Work*	*Baseline Work*	*Act. Work*	*Rem. Work*
18	*PhysicistU*	*2%*	*112 h*	*0 w*	*9/3/02*	*6/29/05*	*$0*	*$0*	*$0*	*$0*	*0 h*	*0 h*	*0 h*	*112 h*
48	*MandS*	*18,000*	*18,000*	*0 w*	*9/3/02*	*6/29/05*	*$18,000*	*$0*	*$0*	*$18,000*		*0*	*0*	*18,000*

Notes
WBS Definition-
The machining tasks which are produced by University shops associated with the MRI institutions and grants for the Silicon Barrel Assembly portion of the schedule.

M&S BOE-
The funding for each task is costed in more detail on the line in the schedule where it appears.
Here is a summary of the lines that are costed.
wbs 1.1.5.2.1.4. $2000 for cylinder prototype machine ring
wbs 1.1.5.2.1.10 $2000 for extension cylinder prototype machine ring
wbs 1.1.5.2.3.4 $2000 for machining south ring
wbs 1.1.5.2.4.4 $2000 for south extension ring
wbs 1.1.5.2.5.4 $2000 for machining north ring
wbs 1.1.5.2.6.4 $2000 for north extension ring
wbs 1.1.5.10.2 $6000 for fabrication of the support structure within CFT Barrel 3
Total $18000
There is 100% contingency placed on this item in case the particular machine shop cannot make the part and we have to go to another shop.

Labor BOE-
A physicist oversees the distribution of tasks at the 2% level

1.1.5.2	**Cylinders**	**9/3/02**	**2/24/05**	**$70,962**	**$0**	**$671,428**	**$742,390**

Notes
WBS Definition-
Summary task that includes both the south and north support cylinders and extension cylinder design, assembly, and testing

M&S BOE-
For each individual line, there is a BOE. The contingency on all these is set to 50% based on the guidelines.

Labor BOE-
There is a flat 50% contingency placed on all labor based on silicon guideline.

1.1.5.2.1	**Prototypes**	**9/3/02**	**6/10/03**	**$24,354**	**$0**	**$203,710**	**$228,064**

Notes
WBS Definition-
Summary task that includes cylinders and extension cylinder design and prototyping.

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
1.1.5.2.1.1	Prototype shells	9/3/02	10/14/02	$11,700	$0	$11,256	$22,956

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
1	MechEngF	50%	120 h	0 w	9/3/02	10/14/02	$6,120	$0	$1,632	$4,488	0 h	0 h	32 h	88 h
9	MechTechSF	50%	120 h	0 w	9/3/02	10/14/02	$4,080	$0	$1,088	$2,992	0 h	0 h	32 h	88 h
17	PhysicistF	25%	60 h	0 w	9/3/02	10/14/02	$0	$0	$0	$0	0 h	0 h	16 h	44 h
21	DesignerF	10%	24 h	0 w	9/3/02	10/14/02	$1,056	$0	$282	$774	0 h	0 h	6.4 h	17.6 h
48	MandS	11,700	11,700	0 w	9/3/02	10/14/02	$11,700	$0	$11,700	$0		0	3,120	8,580

Notes

WBS Definition-
Design and fabricate prototype outer cylindrical portions of the silicon support cylinder assembly

M&S BOE-
The support cylinders are double walled cylinders. Therefore two support cylinders are needed, one for the inner cylinder and one for the outer cylinder. Note that the experiment has extensive experience for producing carbon fiber cylinders gained from building the cylinders for the fiber tracker for Run2a.

Item	Quantity	Cost	Total
Mandrels	2	2500	5000
Mandrel Stand	1	1000	1000
Carbon Fiber	8	700	5600
Vacuum Bagging/Mold Release Supplies	1	100	100
Grand Total			11700

Labor BOE-
hours needed by part of task

Item	MTech SF	CMM Op	CMM P	Desi	MechE	Physi
Design Mandrels	4				24	24
Design Mandrel Stand	4				24	24
Mandrel Drawings				24	4	4
Mandrel Stand Drawing				24	4	4
Order Carbon Fiber					8	4
Order Mandrels					8	4
Order Mandrel Stand Materials	8				4	4
Order Supplies	8				4	4
QC Mandrels	24				16	24
Fabricate Mandrel Stand	40				8	8
Prepare Mandrels/Mold Release/Va	40				8	8
Prepare Carbon Fiber	40				4	4
Layup Shells	32				4	4
Vacuum Bag and setup Temperatu	16				4	4
Cure Shells	16				1	1
Remove Shells/bagging materials fl	32				4	4
Cut Shells to length	32				4	4
QC Shells	24				16	24
Cleanup Mandrels/store	32					
Totals	352	0	0	48	149	157

1.1.5.2.1.2	Prototype Z=600 bulkhead	9/3/02	10/14/02	$3,440	$0	$19,596	$23,036

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
1	MechEngF	50%	120 h	0 w	9/3/02	10/14/02	$6,120	$0	$1,632	$4,488	0 h	0 h	32 h	88 h
9	MechTechSF	50%	120 h	0 w	9/3/02	10/14/02	$4,080	$0	$1,088	$2,992	0 h	0 h	32 h	88 h
17	PhysicistF	50%	120 h	0 w	9/3/02	10/14/02	$0	$0	$0	$0	0 h	0 h	32 h	88 h
21	DesignerF	50%	120 h	0 w	9/3/02	10/14/02	$5,280	$0	$1,408	$3,872	0 h	0 h	32 h	88 h
27	CMMOperatorSF	25%	60 h	0 w	9/3/02	10/14/02	$1,860	$0	$496	$1,364	0 h	0 h	16 h	44 h
28	CMMProgrammerSF	20%	48 h	0 w	9/3/02	10/14/02	$2,256	$0	$602	$1,654	0 h	0 h	12.8 h	35.2 h
37	OGP	25%	60 h	0 w	9/3/02	10/14/02	$0	$0	$0	$0	0 h	0 h	16 h	44 h
48	MandS	3,440	3,440	0 w	9/3/02	10/14/02	$3,440	$0	$3,440	$0		0	917.33	2,522.67

Notes

WBS Definition-
Design and fabricate prototype outer stave positioning bulkheads

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost

"Prototype Z=600 bulkhead" continued

Notes

M&S BOE-

Item	Quantity	Cost	Total
Plates	2	500	1000
Carbon Fiber	1	700	700
Vacuum Bagging/Mold Release Supplies	1	100	100
Bearings	200	1.2	240
Bearing Holders	200	2	400
Assembly Fixture	1	1000	1000
Grand Total			3440

Labor BOE-
hours needed per task

Item	MT SF	CMM Op	CMM P	Desi	MechE	Phys
Design Bulkhead					40	80
Bulkhead Drawings				40	4	4
Design Assembly Fixture					32	8
Assembly Fixture Drawing				24	4	4
Order Carbon Fiber					8	4
Order Plates					8	4
Order Supplies	8				4	4
Order Bearings					8	4
Order Bearing Holders					8	4
Order Foam					8	4
Order Assembly Fixture					8	4
QC Plates	8				4	4
QC Assembly Fixture		32	32		2	2
Prepare Plates/Mold Release/Vacu	16				2	2
Prepare Carbon Fiber	16				2	2
Layup Plates	16				2	2
Vacuum Bag and setup Temperatur	8				1	1
Cure Plates	16				1	1
Remove bagging materials	8				1	1
Machine Bulkheads	40			40	4	4
Machine Foam	24			8	4	4
QC Bulkheads	8				8	4
QC Foam	2				1	1
Glue Bearings into Bearing holders	40				8	8
QC Beariing Assembly		40	16		8	8
Setup Initial Bearing position	16	16	16		4	4
Glue Bearing assembly in place	40				1	1
Glue Foam in place	8				1	1
Glue top carbon plate in place	8				1	1
QC Bulkhead assembly		40	40			
Cleanup/store	40					
Totals	322	128	104	112	187	175

1.1.5.2.1.3	Prototype z = 0 membrane	10/15/02	11/11/02	$1,350	$0	$25,528	$26,878

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
1	MechEngF	75%	120 h	0 w	10/15/02	11/11/02	$6,120	$0	$0	$6,120	0 h	0 h	0 h	120 h
9	MechTechSF	125%	200 h	0 w	10/15/02	11/11/02	$6,800	$0	$0	$6,800	0 h	0 h	0 h	200 h
17	PhysicistF	50%	80 h	0 w	10/15/02	11/11/02	$0	$0	$0	$0	0 h	0 h	0 h	80 h
21	DesignerF	80%	128 h	0 w	10/15/02	11/11/02	$5,632	$0	$0	$5,632	0 h	0 h	0 h	128 h
27	CMMOperatorSF	80%	128 h	0 w	10/15/02	11/11/02	$3,968	$0	$0	$3,968	0 h	0 h	0 h	128 h
28	CMMProgrammerSF	40%	64 h	0 w	10/15/02	11/11/02	$3,008	$0	$0	$3,008	0 h	0 h	0 h	64 h
37	OGP	80%	128 h	0 w	10/15/02	11/11/02	$0	$0	$0	$0	0 h	0 h	0 h	128 h
48	MandS	1,350	1,350	0 w	10/15/02	11/11/02	$1,350	$0	$0	$1,350		0	0	1,350

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost

"Prototype z = 0 membrane" continued

Notes

WBS Definition-
Design and fabricate prototype z = 0 membranes

M&S BOE-

M&S			
Item	Quantity	Cost	Total
Plates	2	0	0
Carbon Fiber	0.5	700	350
Vacuum Bagging/Mold Release Supplies	1	100	100
Bearings	200	2.5	500
Bearing Holders	200	2	400
Assembly Fixture	1	0	0
Grand Total			1350

Assembly fixture from another task is used.

Labor BOE-
hours spent on each task

Item	MT SF	CMM Op	CMM P	Des	MechE	Phys
Design Bulkhead					40	80
Bulkhead Drawings				40	4	4
Design Assembly Fixture					32	8
Assembly Fixture Drawing				24	4	4
Order Carbon Fiber					8	4
Order Plates					8	4
Order Supplies	8				4	4
Order Bearings					8	4
Order Bearing Holders					8	4
Order Foam					8	4
Order Assembly Fixture					8	4
QC Plates	8				4	4
QC Assembly Fixture		32	32		2	2
Prepare Plates/Mold Release/Vacu	16				2	2
Prepare Carbon Fiber	16				2	2
Layup Plates	16				2	2
Vacuum Bag and setup Temperatur	8				1	1
Cure Plates	16				1	1
Remove bagging materials	8				1	1
Machine Bulkheads	40			40	4	4
Machine Foam	24			8	4	4
QC Bulkheads	8				8	4
QC Foam	2				1	1
Glue Bearings into Bearing holders	40				8	8
QC Beariing Assembly		40	16		8	8
Setup Initial Bearing position	16	16	16		4	4
Glue Bearing assembly in place	40				1	1
Glue Foam in place	8				1	1
Glue top carbon plate in place	8				1	1
QC Bulkhead assembly		40	40			
Cleanup/store	40					
Totals	322	128	104	112	187	175

1.1.5.2.1.4	Prototype rings/reproducible ball connections	9/3/02	10/14/02	$638	$0	$19,567	$20,205

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
1	MechEngF	33%	79.2 h	0 w	9/3/02	10/14/02	$4,039	$0	$1,077	$2,962	0 h	0 h	21.12 h	58.08 h
9	MechTechSF	110%	264 h	0 w	9/3/02	10/14/02	$8,976	$0	$2,394	$6,582	0 h	0 h	70.4 h	193.6 h
17	PhysicistF	33%	79.2 h	0 w	9/3/02	10/14/02	$0	$0	$0	$0	0 h	0 h	21.12 h	58.08 h
27	CMMOperatorSF	35%	84 h	0 w	9/3/02	10/14/02	$2,604	$0	$694	$1,910	0 h	0 h	22.4 h	61.6 h
28	CMMProgrammerSF	35%	84 h	0 w	9/3/02	10/14/02	$3,948	$0	$1,053	$2,895	0 h	0 h	22.4 h	61.6 h
31	CMMMedium	25%	60 h	0 w	9/3/02	10/14/02	$0	$0	$0	$0	0 h	0 h	16 h	44 h
48	MandS	638	638	0 w	9/3/02	10/14/02	$638	$0	$638	$0		0	170.13	467.87

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost

"Prototype rings/reproducible ball connections" continued

Notes

WBS Definition-
Design and fabricate prototype reproducible ball connections

M&S BOE-

Item	Quantity	Cost	Total
Flat Plates	2	0	0
Carbon Fiber	0.5	700	350
Machine Ring	2	1000	2000
Ruby Balls	15	5	75
Ti Alloy Screws	15	7.5	112.5
Vacuum Bagging/Mold Release Supplies	1	100	100
Grand Total			2637.5

Cost for the Machine Ring is assigned to the MRI machining task
Total this task: $638

Labor BOE-
hours by task and resource type

Item	MT SF	CMM Op	CMM P	Des	MechE	Phys
Order Carbon Fiber					8	4
Order Supplies	2				1	1
Prepare Plates/Mold Release/Vac	24				4	4
Prepare Carbon Fiber	40				4	4
Layup Ring	32				4	4
Vacuum Bag and setup Temperatur	16				4	4
Cure Rings	16				1	1
Remove Rings/bagging materials fr	32				4	4
Rough cut ring for machine shop	32				4	4
QC rings	24				16	24
Join Rings together using Ruby Bal	8				4	4
Measuring rings joined together		32	32		8	8
Measured for reproducibiltiy		32	32		8	8
Cleanup Mandrels/store	32					
Totals	258	64	64	0	70	74

1.1.5.2.1.5	Fabricate prototype south support cylinder assembly	11/12/02	1/3/03	$700	$0	$25,356	$26,056

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
1	MechEngF	50%	120 h	0 w	11/12/02	1/3/03	$6,120	$0	$0	$6,120	0 h	0 h	0 h	120 h
9	MechTechSF	125%	300 h	0 w	11/12/02	1/3/03	$10,200	$0	$0	$10,200	0 h	0 h	0 h	300 h
17	PhysicistF	60%	144 h	0 w	11/12/02	1/3/03	$0	$0	$0	$0	0 h	0 h	0 h	144 h
21	DesignerF	20%	48 h	0 w	11/12/02	1/3/03	$2,112	$0	$0	$2,112	0 h	0 h	0 h	48 h
27	CMMOperatorSF	40%	96 h	0 w	11/12/02	1/3/03	$2,976	$0	$0	$2,976	0 h	0 h	0 h	96 h
28	CMMProgrammerSF	35%	84 h	0 w	11/12/02	1/3/03	$3,948	$0	$0	$3,948	0 h	0 h	0 h	84 h
31	CMMMedium	40%	96 h	0 w	11/12/02	1/3/03	$0	$0	$0	$0	0 h	0 h	0 h	96 h
48	MandS	700	700	0 w	11/12/02	1/3/03	$700	$0	$0	$700		0	0	700

Notes

WBS Definition-
Mate prototype outer cylindrical portion, outer stave positioning bulkhead, z = 0 membrane, and reproducible ball mounts

M&S BOE-

Item	Quantity	Cost	Total
Plates	2	0	0
Carbon Fiber	1	700	700
Vacuum Bagging/Mold Release Supplies	1	100	100
Grand Total			700

Plates from previous task are used in this operation.

Labor BOE-
hours spent by task by resource type. Add in efficiency factors.

Item	MT SF	CMM Op	CMM P	Des	MechE	Phys

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost

"Fabricate prototype south support cylinder assembly" continued

Notes

Order Carbon Fiber					8	4
Order Supplies	8				4	4
Prepare Plates/Mold Release/Vacu	16				2	2
Prepare Carbon Fiber	16				2	2
Layup Plates	16				2	2
Vacuum Bag and setup Temperatu	8				1	1
Cure Plates	16				1	1
Remove bagging materials	8				1	1
Machine ribs	40			40	4	4
QC Ribs	8				1	1
Glue Ribs into Cylinder	40				8	8
Glue reproducible ball connections	8	24	8		8	8
Setup Bulkhead positions	16	16	16		16	16
Glue bulkheads in place	24				1	1
QC cylinder assembly	8	40	40		24	24
Cleanup/store	40					
Totals	272	80	64	40	83	79

1.1.5.2.1.6 Measure prototype cylinder deflections under load

1/6/03 | 2/3/03 | $250 | $0 | $13,640 | $13,890

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
1	MechEngF	50%	80 h	0 w	1/6/03	2/3/03	$4,080	$0	$0	$4,080	0 h	0 h	0 h	80 h
9	MechTechSF	50%	80 h	0 w	1/6/03	2/3/03	$2,720	$0	$0	$2,720	0 h	0 h	0 h	80 h
17	PhysicistF	25%	40 h	0 w	1/6/03	2/3/03	$0	$0	$0	$0	0 h	0 h	0 h	40 h
27	CMMOperatorSF	100%	160 h	0 w	1/6/03	2/3/03	$4,960	$0	$0	$4,960	0 h	0 h	0 h	160 h
28	CMMProgrammerSF	25%	40 h	0 w	1/6/03	2/3/03	$1,880	$0	$0	$1,880	0 h	0 h	0 h	40 h
32	CMMLarge	100%	160 h	0 w	1/6/03	2/3/03	$0	$0	$0	$0	0 h	0 h	0 h	160 h
48	MandS	250	250	0 w	1/6/03	2/3/03	$250	$0	$0	$250		0	0	250

Notes

WBS Definition-
Perform and analyze CMM or other measurements of deflections of the support cylinder assembly under load

M&S BOE-

Item	Quantity	Cost	Total
Loading Fixture	1	250	250

Labor BOE-
labor hours by type and resource, in the estimate an addition efficiency is added in

Item	MT SF	CMM Op	CMM P	Des	MechE	Phys
Fabricate Loading Fixture	16				8	1
Setup cylinder on CMM	16	40	8		4	1
Measure cylinder under different	48	120	32		8	4
Analysis Data					60	34
Totals	80	160	40	0	80	40

1.1.5.2.1.7 Fabricate preproduction extension shells

2/4/03 | 3/3/03 | $1,500 | $0 | $13,872 | $15,372

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
1	MechEngF	50%	80 h	0 w	2/4/03	3/3/03	$4,080	$0	$0	$4,080	0 h	0 h	0 h	80 h
9	MechTechSF	180%	288 h	0 w	2/4/03	3/3/03	$9,792	$0	$0	$9,792	0 h	0 h	0 h	288 h
17	PhysicistF	50%	80 h	0 w	2/4/03	3/3/03	$0	$0	$0	$0	0 h	0 h	0 h	80 h
48	MandS	1,500	1,500	0 w	2/4/03	3/3/03	$1,500	$0	$0	$1,500		0	0	1,500

Notes

WBS Definiition-
Design and fabrication of carbon fiber extension shell prototype

M&S BOE-

Item	Quantity	Cost	Total

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost

"Fabricate preproduction extension shells" continued

Notes

Mandrels	2	0	0
Mandrel Stand	1	0	0
Carbon Fiber	2	700	1400
Vacuum Bagging/Mold Release Supplies	1	100	100
Grand Total			1500

mandrels and stand are contained in another task

Labor BOE-
hours by type including efficiency factor

Item	MT SF	CMM Op	CMM P	Des	MechE	Phys
Design Mandrels	0				0	0
Design Mandrel Stand	0				0	0
Mandrel Drawings				0	0	0
Mandrel Stand Drawing				0	0	0
Order Carbon Fiber					8	4
Order Mandrels					0	0
Order Mandrel Stand Materials	0				0	0
Order Supplies	8				8	4
QC Mandrels	0				0	0
Fabricate Mandrel Stand	0				0	0
Prepare Mandrels/Mold Release/Va	40				8	8
Prepare Carbon Fiber	40				4	4
Layup Cylinders	32				4	4
Vacuum Bag and setup Temperatu	16				4	4
Cure Cylinders	16				1	1
Remove Cylinders/bagging material	32				4	4
Cut Cylinders to length	32				4	4
QC Cylinders	24				16	24
Cleanup Mandrels/store	32					
Totals	272	0	0	0	61	61

1.1.5.2.1.8	Preproduction z = 830 membrane	1/6/03	2/3/03	$800	$0	$9,520	$10,320

ID	*Resource Name*	*Units*	*Work*	*Delay*	*Start*	*Finish*	*Cost*	*Baseline Cost*	*Act. Cost*	*Rem. Cost*	*Ovt. Work*	*Baseline Work*	*Act. Work*	*Rem. Work*
1	*MechEngF*	*25%*	*40 h*	*0 w*	*1/6/03*	*2/3/03*	*$2,040*	*$0*	*$0*	*$2,040*	*0 h*	*0 h*	*0 h*	*40 h*
9	*MechTechSF*	*50%*	*80 h*	*0 w*	*1/6/03*	*2/3/03*	*$2,720*	*$0*	*$0*	*$2,720*	*0 h*	*0 h*	*0 h*	*80 h*
17	*PhysicistF*	*25%*	*40 h*	*0 w*	*1/6/03*	*2/3/03*	*$0*	*$0*	*$0*	*$0*	*0 h*	*0 h*	*0 h*	*40 h*
21	*DesignerF*	*50%*	*80 h*	*0 w*	*1/6/03*	*2/3/03*	*$3,520*	*$0*	*$0*	*$3,520*	*0 h*	*0 h*	*0 h*	*80 h*
27	*CMMOperatorSF*	*25%*	*40 h*	*0 w*	*1/6/03*	*2/3/03*	*$1,240*	*$0*	*$0*	*$1,240*	*0 h*	*0 h*	*0 h*	*40 h*
31	*CMMMedium*	*25%*	*40 h*	*0 w*	*1/6/03*	*2/3/03*	*$0*	*$0*	*$0*	*$0*	*0 h*	*0 h*	*0 h*	*40 h*
48	*MandS*	*800*	*800*	*0 w*	*1/6/03*	*2/3/03*	*$800*	*$0*	*$0*	*$800*		*0*	*0*	*800*

Notes

WBS Definition-
Design, fabricate, and QC prototype z = 830 membranes

M&S BOE-

Item	Quantity	Cost	Total
Plates	2	0	0
Carbon Fiber	1	700	700
Vacuum Bagging/Mold Release Su	1	100	100
Grand Total			800

Plates are used from another task

Labor BOE-
labor hours by type and resource.

Item	MT SF	CMM Op	CMM P	Des	MechE	Phys
Design Membrane					10	20
Membrane Drawings				24	4	4

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost

"Preproduction z = 830 membrane" continued

Notes

Design Assembly Fixture					0	0
Assembly Fixture Drawing				24	4	4
Order Carbon Fiber					8	4
Order Plates					0	0
Order Supplies	8				4	4
Order Bearings					0	0
Order Bearing Holders					0	0
Order Foam					8	4
Order Assembly Fixture					0	0
QC Plates	0				0	0
QC Assembly Fixture		0	0		0	0
Prepare Plates/Mold Release/Vacu	8				2	2
Prepare Carbon Fiber	8				2	2
Layup Plates	8				2	2
Vacuum Bag and setup Temperatu	4				1	1
Cure Plates	8				1	1
Remove bagging materials	4				1	1
Machine Membrane	10			10	4	4
Machine Foam	10			2	2	2
QC Bulkheads	8				8	4
QC Foam	2				1	1
Glue Bearings into Bearing holders	0				0	0
QC Beariing Assembly		0	0		0	0
Setup Initial Bearing position	0	0	0		0	0
Glue Bearing assembly in place	0				0	0
Glue Foam in place	8				1	1
Glue top carbon plate in place	0				0	0
QC Bulkhead assembly	8	0	0			
Cleanup/store	40					
Totals	134	0	0	60	63	61

1.1.5.2.1.9	Prototype mounts to CFT barrel 1	2/4/03	3/17/03	$2,638	$0	$20,352	$22,990

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
1	MechEngF	25%	60 h	0 w	2/4/03	3/17/03	$3,060	$0	$0	$3,060	0 h	0 h	0 h	60 h
9	MechTechSF	120%	288 h	0 w	2/4/03	3/17/03	$9,792	$0	$0	$9,792	0 h	0 h	0 h	288 h
17	PhysicistF	25%	60 h	0 w	2/4/03	3/17/03	$0	$0	$0	$0	0 h	0 h	0 h	60 h
27	CMMOperatorSF	25%	60 h	0 w	2/4/03	3/17/03	$1,860	$0	$0	$1,860	0 h	0 h	0 h	60 h
28	CMMProgrammerSF	50%	120 h	0 w	2/4/03	3/17/03	$5,640	$0	$0	$5,640	0 h	0 h	0 h	120 h
31	CMMMedium	25%	60 h	0 w	2/4/03	3/17/03	$0	$0	$0	$0	0 h	0 h	0 h	60 h
48	MandS	2,638	2,638	0 w	2/4/03	3/17/03	$2,638	$0	$0	$2,638		0	0	2,638

Notes

WBS Definition-
Design, fabricate, and QC prototype mechanical connections from the silicon extension cylinder to the outer end of CFT barrel 1

M&S BOE-

Item	Quantity	Cost	Total
Mandrel	1	0	0
Mandrel Stand	1	0	0
Carbon Fiber	0.5	700	350
Machine Ring	2	1000	2000
Ruby Balls	15	5	75
Ti Alloy Screws	15	7.5	112.5
Vacuum Bagging/Mold Release Sup	1	100	100
Grand Total			2638

Labor BOE-
Labor hours by type

Item	MT SF	CMM Op	CMM P	Des	MechE	Phys

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost

"Prototype mounts to CFT barrel 1" continued

Notes

Design Mandrel					0	0
Mandrel Drawing				0	0	0
Order Carbon Fiber					8	4
Order Mandrel					0	0
Order Supplies	2				1	1
QC Mandrels	0				0	0
Prepare Mandrels/Mold Release/Va	24				4	4
Prepare Carbon Fiber	40				4	4
Layup Ring	32				4	4
Vacuum Bag and setup Temperatur	16				4	4
Cure Rings	16				1	1
Remove Rings/bagging materials fr	32				4	4
Rough cut ring for machine shop	32				4	4
QC rings	24				16	24
Join Rings together using Ruby Ball	8				4	4
Measuring rings joined together		32	32		8	8
Measured for reproducibiltiy		32	32		8	8
Cleanup Mandrels/store	32					
Totals	258	64	64	0	70	74

1.1.5.2.1.10	Prototype extension rings/reproducible ball connection	3/18/03	4/28/03	$638	$0	$16,286	$16,924

ID	*Resource Name*	*Units*	*Work*	*Delay*	*Start*	*Finish*	*Cost*	*Baseline Cost*	*Act. Cost*	*Rem. Cost*	*Ovt. Work*	*Baseline Work*	*Act. Work*	*Rem. Work*
1	*MechEngF*	*33%*	*79.2 h*	*0 w*	*3/18/03*	*4/28/03*	*$4,039*	*$0*	*$0*	*$4,039*	*0 h*	*0 h*	*0 h*	*79.2 h*
9	*MechTechSF*	*120%*	*288 h*	*0 w*	*3/18/03*	*4/28/03*	*$9,792*	*$0*	*$0*	*$9,792*	*0 h*	*0 h*	*0 h*	*288 h*
17	*PhysicistF*	*33%*	*79.2 h*	*0 w*	*3/18/03*	*4/28/03*	*$0*	*$0*	*$0*	*$0*	*0 h*	*0 h*	*0 h*	*79.2 h*
27	*CMMOperatorSF*	*33%*	*79.2 h*	*0 w*	*3/18/03*	*4/28/03*	*$2,455*	*$0*	*$0*	*$2,455*	*0 h*	*0 h*	*0 h*	*79.2 h*
31	*CMMMedium*	*33%*	*79.2 h*	*0 w*	*3/18/03*	*4/28/03*	*$0*	*$0*	*$0*	*$0*	*0 h*	*0 h*	*0 h*	*79.2 h*
48	*MandS*	*638*	*638*	*0 w*	*3/18/03*	*4/28/03*	*$638*	*$0*	*$0*	*$638*		*0*	*0*	*638*

Notes

WBS Definition-
Design, fabricate, and QC prototype reproducible ball connections from the silicon extension cylinder to the outer end of CFT barrel 2

M&S BOE-

Item	Quantity	Cost	Total
Mandrel	1	0	0
Mandrel Stand	1	0	0
Carbon Fiber	0.5	700	350
Machine Ring	2	1000	2000
Ruby Balls	15	5	75
Ti Alloy Screws	15	7.5	112.5
Vacuum Bagging/Mold Release Su	1	100	100
Grand Total			2638

Cost for the machine ring is covered under the MRI machining task
Total this task: $638

Labor BOE-
hours by type and resource

Item	MT SF	CMM Op	CMM P	Des	MechE	Phys
Design Mandrel					0	0
Mandrel Drawing				0	0	0
Order Carbon Fiber					8	4
Order Mandrel					0	0
Order Supplies	2				1	1
QC Mandrels	0				0	0
Prepare Mandrels/Mold Release/Va	24				4	4
Prepare Carbon Fiber	40				4	4
Layup Ring	32				4	4
Vacuum Bag and setup Temperatur	16				4	4
Cure Rings	16				1	1

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost

"Prototype extension rings/reproducible ball connections" continued

Notes

Remove Rings/bagging materials fr	32				4	4
Rough cut ring for machine shop	32				4	4
QC rings	24				16	24
Join Rings together using Ruby Ball	8				4	4
Measuring rings joined together		32	32		8	8
Measured for reproducibiltiy		32	32		8	8
Cleanup Mandrels/store	32					
Totals	258	64	64	0	70	74

1.1.5.2.1.11	Assemble and evaluate prototype extension cylinder	4/29/03	5/27/03	$700	$0	$17,336	$18,036

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
1	MechEngF	60%	96 h	0 w	4/29/03	5/27/03	$4,896	$0	$0	$4,896	0 h	0 h	0 h	96 h
9	MechTechSF	180%	288 h	0 w	4/29/03	5/27/03	$9,792	$0	$0	$9,792	0 h	0 h	0 h	288 h
17	PhysicistF	60%	96 h	0 w	4/29/03	5/27/03	$0	$0	$0	$0	0 h	0 h	0 h	96 h
21	DesignerF	20%	32 h	0 w	4/29/03	5/27/03	$1,408	$0	$0	$1,408	0 h	0 h	0 h	32 h
27	CMMOperatorSF	25%	40 h	0 w	4/29/03	5/27/03	$1,240	$0	$0	$1,240	0 h	0 h	0 h	40 h
31	CMMMedium	25%	40 h	0 w	4/29/03	5/27/03	$0	$0	$0	$0	0 h	0 h	0 h	40 h
48	MandS	700	700	0 w	4/29/03	5/27/03	$700	$0	$0	$700		0	0	700

Notes

WBS Definition-
Mate prototype extension cylinder, z = 830 membrane, mounts to CFT, and reproducible ball mounts to CFT

M&S BOE-

Item	Quantity	Cost	Total
Plates	2	0	0
Carbon Fiber	1	700	700
Vacuum Bagging/Mold Release Sup	1	100	100
Grand Total			700

Plates used from previous task

Labor BOE-
hours by resource type

Item	MT SF	CMM Op	CMM P	Des	MechE	Phys
Order Carbon Fiber					8	4
Order Supplies	8				4	4
Prepare Plates/Mold Release/Vacu	16				2	2
Prepare Carbon Fiber	16				2	2
Layup Plates	16				2	2
Vacuum Bag and setup Temperatur	8				1	1
Cure Plates	16				1	1
Remove bagging materials	8				1	1
Machine ribs	40			40	4	4
QC Ribs	8				1	1
Glue Ribs into Cylinder	40				8	8
Glue reproducible ball connections	8	24	8		8	8
Setup Bulkhead positions	16	16	16		16	16
Glue bulkheads in place	24				1	1
QC cylinder assembly	8	40	40		24	24
Cleanup/store	40					
Totals	272	80	64	40	83	79

1.1.5.2.1.12	Finalize design of support cylinders	5/28/03	6/10/03	$0	$0	$11,400	$11,400

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
1	MechEngF	150%	120 h	0 w	5/28/03	6/10/03	$6,120	$0	$0	$6,120	0 h	0 h	0 h	120 h
17	PhysicistF	200%	160 h	0 w	5/28/03	6/10/03	$0	$0	$0	$0	0 h	0 h	0 h	160 h
21	DesignerF	150%	120 h	0 w	5/28/03	6/10/03	$5,280	$0	$0	$5,280	0 h	0 h	0 h	120 h

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost

"Finalize design of support cylinders" continued

Notes

WBS Definition-
Evaluate prototype results, modify designs and procedures if needed, complete drawings of support cylinder components, the support cylinder assembly, and fabrication and assembly fixturing

M&S BOE--
no costs associated with this item.

Labor BOE-
hours by type

Item	MT SF	CMM Op	CMM P	Des	MechE	Phys
Discuss prototype results					40	80
Verfiy/modifiy analysis					64	72
Modify Drawing				120	16	8
Totals	0	0	0	120	120	160

1.1.5.2.2	**Silicon Cylinders Released for Production**	**6/10/03**	**6/10/03**	**$0**	**$0**	**$0**	**$0**

Notes

WBS Definition--
Milestone: Designs and prototyping is finished and all the cylinders are released for production.

1.1.5.2.3	**South Support Cylinder Assembly**	**6/11/03**	**3/25/04**	**$16,828**	**$0**	**$153,717**	**$170,545**

Notes

WBS Definition-
Summary task that includes the south support cylinder assembly of parts, and testing of parts

1.1.5.2.3.1	Fabricate south shells	6/11/03	9/4/03	$10,700	$0	$21,456	$32,156

ID	*Resource Name*	*Units*	*Work*	*Delay*	*Start*	*Finish*	*Cost*	*Baseline Cost*	*Act. Cost*	*Rem. Cost*	*Ovt. Work*	*Baseline Work*	*Act. Work*	*Rem. Work*
1	*MechEngF*	*30%*	*144 h*	*0 w*	*6/11/03*	*9/4/03*	*$7,344*	*$0*	*$0*	*$7,344*	*0 h*	*0 h*	*0 h*	*144 h*
9	*MechTechSF*	*80%*	*384 h*	*0 w*	*6/11/03*	*9/4/03*	*$13,056*	*$0*	*$0*	*$13,056*	*0 h*	*0 h*	*0 h*	*384 h*
17	*PhysicistF*	*30%*	*144 h*	*0 w*	*6/11/03*	*9/4/03*	*$0*	*$0*	*$0*	*$0*	*0 h*	*0 h*	*0 h*	*144 h*
21	*DesignerF*	*5%*	*24 h*	*0 w*	*6/11/03*	*9/4/03*	*$1,056*	*$0*	*$0*	*$1,056*	*0 h*	*0 h*	*0 h*	*24 h*
48	*MandS*	*10,700*	*10,700*	*0 w*	*6/11/03*	*9/4/03*	*$10,700*	*$0*	*$0*	*$10,700*		*0*	*0*	*10,700*

Notes

WBS Definition-
Fabricate the outer cylindrical portions of the silicon support cylinder assembly, QC the cylinder

M&S BOE-

Item	Quantity	Cost	Total
Mandrels	2	2500	5000
Mandrel Stand	1	0	0
Carbon Fiber	8	700	5600
Vacuum Bagging/Mold Release S	1	100	100
Grand Total			10700

Mandrel Stand obtained in another task

Labor BOE-
labor hours listed by type

Item	MT SF	CMM Op	CMM P	Des	MechE	Phys
Design Mandrels	4				24	24
Design Mandrel Stand	0				0	0
Mandrel Drawings				24	4	4
Mandrel Stand Drawing				0	0	0
Order Carbon Fiber					8	4
Order Mandrels					8	4
Order Mandrel Stand Materials	0				0	0
Order Supplies	8				4	4
QC Mandrels	24				16	24
Fabricate Mandrel Stand	0				0	0
Prepare Mandrels/Mold Release/V	40				8	8

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost

"Fabricate south shells" continued

Notes

Prepare Carbon Fiber	40				4	4
Layup Cylinders	32				4	4
Vacuum Bag and setup Temperatu	16				4	4
Cure Cylinders	16				1	1
Remove Cylinders/bagging material	32				4	4
Cut Cylinders to length	32				4	4
QC Cylinders	24				16	24
Cleanup Mandrels/store	32					
Totals	300	0	0	24	109	117

1.1.5.2.3.2	Fabricate South Z=600 bulkhead	9/5/03	10/16/03	$2,440	$0	$34,224	$36,664

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
1	MechEngF	100%	240 h	0 w	9/5/03	10/16/03	$12,240	$0	$0	$12,240	0 h	0 h	0 h	240 h
9	MechTechSF	150%	360 h	0 w	9/5/03	10/16/03	$12,240	$0	$0	$12,240	0 h	0 h	0 h	360 h
17	PhysicistF	80%	192 h	0 w	9/5/03	10/16/03	$0	$0	$0	$0	0 h	0 h	0 h	192 h
21	DesignerF	50%	120 h	0 w	9/5/03	10/16/03	$5,280	$0	$0	$5,280	0 h	0 h	0 h	120 h
27	CMMOperatorSF	60%	144 h	0 w	9/5/03	10/16/03	$4,464	$0	$0	$4,464	0 h	0 h	0 h	144 h
31	CMMMedium	60%	144 h	0 w	9/5/03	10/16/03	$0	$0	$0	$0	0 h	0 h	0 h	144 h
48	MandS	2,440	2,440	0 w	9/5/03	10/16/03	$2,440	$0	$0	$2,440		0	0	2,440

Notes

WBS Definition-
Fabricate the outer stave positioning bulkhead at z=600

M&S BOE-

Item	Quantity	Cost	Total
Plates	2	0	0
Carbon Fiber	1	700	700
Vacuum Bagging/Mold Release Sup	1	100	100
Bearings	200	1.2	240
Bearing Holders	200	2	400
Assembly Fixture	1	1000	1000
Grand Total			2440

Plates used obtained from other task

Labor BOE-
labor hours by type and task

Item	MT SF	CMM Op	CMM P	Des	MechE	Phys
Design Bulkhead					40	80
Bulkhead Drawings				40	4	4
Design Assembly Fixture					32	8
Assembly Fixture Drawing				24	4	4
Order Carbon Fiber					8	4
Order Plates					8	4
Order Supplies	8				4	4
Order Bearings					8	4
Order Bearing Holders					8	4
Order Foam					8	4
Order Assembly Fixture					8	4
QC Plates	0				0	0
QC Assembly Fixture		32	32		2	2
Prepare Plates/Mold Release/Vacu	16				2	2
Prepare Carbon Fiber	16				2	2
Layup Plates	16				2	2
Vacuum Bag and setup Temperatu	8				1	1
Cure Plates	16				1	1
Remove bagging materials	8				1	1
Machine Bulkheads	40			40	4	4
Machine Foam	24			8	4	4
QC Bulkheads	8				8	4

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost

"Fabricate South Z=600 bulkhead" continued

Notes

QC Foam	2				1	1
Glue Bearings into Bearing holders	40				8	8
QC Bearing Assembly		40	16		8	8
Setup Initial Bearing position	16	16	16		4	4
Glue Bearing assembly in place	40				1	1
Glue Foam in place	8				1	1
Glue top carbon plate in place	8				1	1
QC Bulkhead assembly		40	40			
Cleanup/store	40					
Totals	314	128	104	112	183	171

1.1.5.2.3.3 Fabricate z = 0 membrane

							10/17/03	11/20/03	$1,350		$0	$39,080		$40,430
ID	*Resource Name*	*Units*	*Work*	*Delay*	*Start*	*Finish*	*Cost*	*Baseline Cost*	*Act. Cost*	*Rem. Cost*	*Ovt. Work*	*Baseline Work*	*Act. Work*	*Rem. Work*
1	*MechEngF*	*100%*	*200 h*	*0 w*	*10/17/03*	*11/20/03*	*$10,200*	*$0*	*$0*	*$10,200*	*0 h*	*0 h*	*0 h*	*200 h*
9	*MechTechSF*	*175%*	*350 h*	*0 w*	*10/17/03*	*11/20/03*	*$11,900*	*$0*	*$0*	*$11,900*	*0 h*	*0 h*	*0 h*	*350 h*
17	*PhysicistF*	*100%*	*200 h*	*0 w*	*10/17/03*	*11/20/03*	*$0*	*$0*	*$0*	*$0*	*0 h*	*0 h*	*0 h*	*200 h*
21	*DesignerF*	*60%*	*120 h*	*0 w*	*10/17/03*	*11/20/03*	*$5,280*	*$0*	*$0*	*$5,280*	*0 h*	*0 h*	*0 h*	*120 h*
27	*CMMOperatorSF*	*75%*	*150 h*	*0 w*	*10/17/03*	*11/20/03*	*$4,650*	*$0*	*$0*	*$4,650*	*0 h*	*0 h*	*0 h*	*150 h*
28	*CMMProgrammerSF*	*75%*	*150 h*	*0 w*	*10/17/03*	*11/20/03*	*$7,050*	*$0*	*$0*	*$7,050*	*0 h*	*0 h*	*0 h*	*150 h*
37	*OGP*	*75%*	*150 h*	*0 w*	*10/17/03*	*11/20/03*	*$0*	*$0*	*$0*	*$0*	*0 h*	*0 h*	*0 h*	*150 h*
48	*MandS*	*1,350*	*1,350*	*0 w*	*10/17/03*	*11/20/03*	*$1,350*	*$0*	*$0*	*$1,350*		*0*	*0*	*1,350*

Notes

WBS Definition-
Fabricate z = 0 membrane, QC the membrane

M&S BOE-

Item	Quantity	Cost	Total
Plates	2	0	0
Carbon Fiber	0.5	700	350
Vacuum Bagging/Mold Release Su	1	100	100
Bearings	200	2.5	500
Bearing Holders	200	2	400
Assembly Fixture	1	0	0
Grand Total			1350

Plates are obtained from other task

Labor BOE-
labor hours by type and task

Item	MT SF	CMM Op	CMM P	Des	MechE	Phys
Design Bulkhead					40	80
Bulkhead Drawings				40	4	4
Design Assembly Fixture					32	8
Assembly Fixture Drawing				24	4	4
Order Carbon Fiber					8	4
Order Plates					8	4
Order Supplies	8				4	4
Order Bearings					8	4
Order Bearing Holders					8	4
Order Foam					8	4
Order Assembly Fixture					8	4
QC Plates	8				4	4
QC Assembly Fixture		32	32		2	2
Prepare Plates/Mold Release/Vacu	16				2	2
Prepare Carbon Fiber	16				2	2
Layup Plates	16				2	2
Vacuum Bag and setup Temperatu	8				1	1
Cure Plates	16				1	1
Remove bagging materials	8				1	1
Machine Bulkheads	40			40	4	4

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost

"Fabricate z = 0 membrane" continued

Notes

Machine Foam	24			8	4	4
QC Bulkheads	8				8	4
QC Foam	2				1	1
Glue Bearings into Bearing holders	40				8	8
QC Beariing Assembly		40	16		8	8
Setup Initial Bearing position	16	16	16		4	4
Glue Bearing assembly in place	40				1	1
Glue Foam in place	8				1	1
Glue top carbon plate in place	8				1	1
QC Bulkhead assembly		40	40			
Cleanup/store	40					
Totals	322	128	104	112	187	175

1.1.5.2.3.4	Fabricate South Rings/reproducible ball connectors	11/21/03	12/22/03	$1,638	$0	$22,040	$23,678

ID	*Resource Name*	*Units*	*Work*	*Delay*	*Start*	*Finish*	*Cost*	*Baseline Cost*	*Act. Cost*	*Rem. Cost*	*Ovt. Work*	*Baseline Work*	*Act. Work*	*Rem. Work*
1	*MechEngF*	*75%*	*120 h*	*0 w*	*11/21/03*	*12/22/03*	*$6,120*	*$0*	*$0*	*$6,120*	*0 h*	*0 h*	*0 h*	*120 h*
9	*MechTechSF*	*175%*	*280 h*	*0 w*	*11/21/03*	*12/22/03*	*$9,520*	*$0*	*$0*	*$9,520*	*0 h*	*0 h*	*0 h*	*280 h*
17	*PhysicistF*	*75%*	*120 h*	*0 w*	*11/21/03*	*12/22/03*	*$0*	*$0*	*$0*	*$0*	*0 h*	*0 h*	*0 h*	*120 h*
21	*DesignerF*	*20%*	*32 h*	*0 w*	*11/21/03*	*12/22/03*	*$1,408*	*$0*	*$0*	*$1,408*	*0 h*	*0 h*	*0 h*	*32 h*
27	*CMMOperatorSF*	*40%*	*64 h*	*0 w*	*11/21/03*	*12/22/03*	*$1,984*	*$0*	*$0*	*$1,984*	*0 h*	*0 h*	*0 h*	*64 h*
28	*CMMProgrammerSF*	*40%*	*64 h*	*0 w*	*11/21/03*	*12/22/03*	*$3,008*	*$0*	*$0*	*$3,008*	*0 h*	*0 h*	*0 h*	*64 h*
31	*CMMMedium*	*40%*	*64 h*	*0 w*	*11/21/03*	*12/22/03*	*$0*	*$0*	*$0*	*$0*	*0 h*	*0 h*	*0 h*	*64 h*
48	*MandS*	*1,638*	*1,638*	*0 w*	*11/21/03*	*12/22/03*	*$1,638*	*$0*	*$0*	*$1,638*		*0*	*0*	*1,638*

Notes

WBS Definition-
Fabricate and QC reproducible ball connections

M&S BOE-

Item	Quantity	Cost	Total
Mandrel	1	1000	1000
Mandrel Stand	1	0	0
Carbon Fiber	0.5	700	350
Machine Ring	2	1000	2000
Ruby Balls	15	5	75
Ti Alloy Screws	15	7.5	112.5
Vacuum Bagging/Mold Release Su	1	100	100
Grand Total			3638

The cost for the machine ring is covered under the MRI cost task
Total this task: $1638

Labor BOE-
labor hours by type and task

Item	MT SF	CMM Op	CMM P	Des	MechE	Phys
Design Mandrel					24	24
Mandrel Drawing				24	4	4
Order Carbon Fiber					8	4
Order Mandrel					8	4
Order Supplies	2				1	1
QC Mandrels	2				8	16
Prepare Mandrels/Mold Release/Va	24				4	4
Prepare Carbon Fiber	40				4	4
Layup Ring	32				4	4
Vacuum Bag and setup Temperatur	16				4	4
Cure Rings	16				1	1
Remove Rings/bagging materials fr	32				4	4
Rough cut ring for machine shop	32				4	4
QC rings	24				16	24
Join Rings together using Ruby Ball	8				4	4
Measuring rings joined together		32	32		8	8

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost

"Fabricate South Rings/reproducible ball connectors" continued

Notes

Measured for reproducibiltiy		32	32		8	8
Cleanup Mandrels/store	32					
Totals	260	64	64	24	114	122

1.1.5.2.3.5 Fabricate south support assembly

Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
12/23/03	2/12/04	$700	$0	$21,888	$22,588

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
1	MechEngF	40%	96 h	0 w	12/23/03	2/12/04	$4,896	$0	$0	$4,896	0 h	0 h	0 h	96 h
9	MechTechSF	125%	300 h	0 w	12/23/03	2/12/04	$10,200	$0	$0	$10,200	0 h	0 h	0 h	300 h
17	PhysicistF	40%	96 h	0 w	12/23/03	2/12/04	$0	$0	$0	$0	0 h	0 h	0 h	96 h
21	DesignerF	20%	48 h	0 w	12/23/03	2/12/04	$2,112	$0	$0	$2,112	0 h	0 h	0 h	48 h
27	CMMOperatorSF	25%	60 h	0 w	12/23/03	2/12/04	$1,860	$0	$0	$1,860	0 h	0 h	0 h	60 h
28	CMMProgrammerSF	25%	60 h	0 w	12/23/03	2/12/04	$2,820	$0	$0	$2,820	0 h	0 h	0 h	60 h
32	CMMLarge	25%	60 h	0 w	12/23/03	2/12/04	$0	$0	$0	$0	0 h	0 h	0 h	60 h
48	MandS	700	700	0 w	12/23/03	2/12/04	$700	$0	$0	$700		0	0	700

Notes

WBS Definition-
Install the z = 0 ball mount ring within the outer cylinder

M&S BOE-

Item	Quantity	Cost	Total
Plates	2	0	0
Carbon Fiber	1	700	700
Vacuum Bagging/Mold Release Sup	1	100	100
Grand Total			700

Plates from another task are used for this operation

Labor BOE-
Labor hours by type and task

Item	MT SF	CMM Op	CMM P	Des	MechE	Phys
Order Carbon Fiber					8	4
Order Supplies	8				4	4
Prepare Plates/Mold Release/Vacu	16				2	2
Prepare Carbon Fiber	16				2	2
Layup Plates	16				2	2
Vacuum Bag and setup Temperatu	8				1	1
Cure Plates	16				1	1
Remove bagging materials	8				1	1
Machine ribs	40			40	4	4
QC Ribs	8				1	1
Glue Ribs into Cylinder	40				8	8
Glue reproducible ball connections	8	24	8		8	8
Setup Bulkhead positions	16	16	16		16	16
Glue bulkheads in place	24				1	1
QC cylinder assembly	8	40	40		24	24
Cleanup/store	40					
Totals	272	80	64	40	83	79

1.1.5.2.3.6 Measure cylinder deflections under load

Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
2/13/04	3/25/04	$0	$0	$15,029	$15,029

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
1	MechEngF	40%	96 h	0 w	2/13/04	3/25/04	$4,896	$0	$0	$4,896	0 h	0 h	0 h	96 h
9	MechTechSF	33%	79.2 h	0 w	2/13/04	3/25/04	$2,693	$0	$0	$2,693	0 h	0 h	0 h	79.2 h
17	PhysicistF	20%	48 h	0 w	2/13/04	3/25/04	$0	$0	$0	$0	0 h	0 h	0 h	48 h
27	CMMOperatorSF	100%	240 h	0 w	2/13/04	3/25/04	$7,440	$0	$0	$7,440	0 h	0 h	0 h	240 h
32	CMMLarge	100%	240 h	0 w	2/13/04	3/25/04	$0	$0	$0	$0	0 h	0 h	0 h	240 h

Notes

WBS Definition-
Measure cylinder deflections under load and verify that they are consistent with results from the prototype

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost

"Measure cylinder deflections under load" continued

Notes

M&S BOE-
no costs associated with this item

Labor BOE-
Labor hours by type

Item	MT SF	CMM Op	CMM P	Des	MechE	Phys
Fabricate Loading Fixture	0				0	0
Setup cylinder on CMM	16	40	8		4	1
Measure cylinder under different l	48	120	32		8	4
Analysis Data					60	34
Totals	64	160	40	0	72	39

1.1.5.2.4	**South Extension Cylinder**	**6/11/03**	**4/12/04**	**$6,476**	**$0**	**$86,667**	**$93,143**

Notes
WBS Definition-
Summary task that includes the south extension cylinder design, assembly, and testing

1.1.5.2.4.1	Fabricate south extension shells	6/11/03	7/9/03	$1,500	$0	$13,600	$15,100

ID	*Resource Name*	*Units*	*Work*	*Delay*	*Start*	*Finish*	*Cost*	*Baseline Cost*	*Act. Cost*	*Rem. Cost*	*Ovt. Work*	*Baseline Work*	*Act. Work*	*Rem. Work*
1	*MechEngF*	*50%*	*80 h*	*0 w*	*6/11/03*	*7/9/03*	*$4,080*	*$0*	*$0*	*$4,080*	*0 h*	*0 h*	*0 h*	*80 h*
9	*MechTechSF*	*175%*	*280 h*	*0 w*	*6/11/03*	*7/9/03*	*$9,520*	*$0*	*$0*	*$9,520*	*0 h*	*0 h*	*0 h*	*280 h*
17	*PhysicistF*	*50%*	*80 h*	*0 w*	*6/11/03*	*7/9/03*	*$0*	*$0*	*$0*	*$0*	*0 h*	*0 h*	*0 h*	*80 h*
48	*MandS*	*1,500*	*1,500*	*0 w*	*6/11/03*	*7/9/03*	*$1,500*	*$0*	*$0*	*$1,500*		*0*	*0*	*1,500*

Notes
WBS Definition-
Fabricate and QC the Carbon Fiber extension cylinders for the south

M&S BOE-

Item	Quantity	Cost	Total
Mandrels	2	0	0
Mandrel Stand	1	0	0
Carbon Fiber	2	700	1400
Vacuum Bagging/Mold Release Sup	1	100	100
Grand Total			1500

The mandrels are obtained from the prototyping work

Labor BOE-
Hours by type and task

Item	MT SF	CMM Op	CMM P	Des	MechE	Phys
Design Mandrels	0				0	0
Design Mandrel Stand	0				0	0
Mandrel Drawings				0	0	0
Mandrel Stand Drawing				0	0	0
Order Carbon Fiber					8	4
Order Mandrels					0	0
Order Mandrel Stand Materials	0				0	0
Order Supplies	8				8	4
QC Mandrels	0				0	0
Fabricate Mandrel Stand	0				0	0
Prepare Mandrels/Mold Release/Va	40				8	8
Prepare Carbon Fiber	40				4	4
Layup Cylinders	32				4	4
Vacuum Bag and setup Temperatu	16				4	4
Cure Cylinders	16				1	1
Remove Cylinders/bagging material	32				4	4
Cut Cylinders to length	32				4	4
QC Cylinders	24				16	24

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost

"Fabricate south extension shells" continued

Notes

Cleanup Mandrels/store	32					
Totals	272	0	0	0	61	61

1.1.5.2.4.2	Fabricate z = 830 membrane	7/10/03	8/6/03	$800	$0	$12,336	$13,136

ID	*Resource Name*	*Units*	*Work*	*Delay*	*Start*	*Finish*	*Cost*	*Baseline Cost*	*Act. Cost*	*Rem. Cost*	*Ovt. Work*	*Baseline Work*	*Act. Work*	*Rem. Work*
1	*MechEngF*	*50%*	*80 h*	*0 w*	*7/10/03*	*8/6/03*	*$4,080*	*$0*	*$0*	*$4,080*	*0 h*	*0 h*	*0 h*	*80 h*
9	*MechTechSF*	*100%*	*160 h*	*0 w*	*7/10/03*	*8/6/03*	*$5,440*	*$0*	*$0*	*$5,440*	*0 h*	*0 h*	*0 h*	*160 h*
17	*PhysicistF*	*50%*	*80 h*	*0 w*	*7/10/03*	*8/6/03*	*$0*	*$0*	*$0*	*$0*	*0 h*	*0 h*	*0 h*	*80 h*
21	*DesignerF*	*40%*	*64 h*	*0 w*	*7/10/03*	*8/6/03*	*$2,816*	*$0*	*$0*	*$2,816*	*0 h*	*0 h*	*0 h*	*64 h*
48	*MandS*	*800*	*800*	*0 w*	*7/10/03*	*8/6/03*	*$800*	*$0*	*$0*	*$800*		*0*	*0*	*800*

Notes

WBS Definition-
Design, fabricate, and QC z = 830 membrane

M&S BOE-

Item	Quantity	Cost	Total
Plates	2	0	0
Carbon Fiber	1	700	700
Vacuum Bagging/Mold Release S	1	100	100
Grand Total			800

Plates are obtained from another task

Labor BOE-
labor hours by type and task

Item	MT SF	CMM Op	CMM P	Des	MechE	Phys
Design Membrane					10	20
Membrane Drawings				24	4	4
Design Assembly Fixture					0	0
Assembly Fixture Drawing				24	4	4
Order Carbon Fiber					8	4
Order Plates					0	0
Order Supplies	8				4	4
Order Bearings					0	0
Order Bearing Holders					0	0
Order Foam					8	4
Order Assembly Fixture					0	0
QC Plates	0				0	0
QC Assembly Fixture		0	0		0	0
Prepare Plates/Mold Release/Vacu	8				2	2
Prepare Carbon Fiber	8				2	2
Layup Plates	8				2	2
Vacuum Bag and setup Temperatu	4				1	1
Cure Plates	8				1	1
Remove bagging materials	4				1	1
Machine Membrane	10			10	4	4
Machine Foam	10			2	2	2
QC Bulkheads	8				8	4
QC Foam	2				1	1
Glue Bearings into Bearing holders	0				0	0
QC Beariing Assembly		0	0		0	0
Setup Initial Bearing position	0	0	0		0	0
Glue Bearing assembly in place	0				0	0
Glue Foam in place	8				1	1
Glue top carbon plate in place	0				0	0
QC Bulkhead assembly	8	0	0			
Cleanup/store	40					
Totals	134	0	0	60	63	61

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
1.1.5.2.4.3	Fabricate mounts to CFT barrel 1	8/7/03	9/4/03	$2,638	$0	$15,237	$17,875

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
1	MechEngF	50%	80 h	0 w	8/7/03	9/4/03	$4,080	$0	$0	$4,080	0 h	0 h	0 h	80 h
9	MechTechSF	175%	280 h	0 w	8/7/03	9/4/03	$9,520	$0	$0	$9,520	0 h	0 h	0 h	280 h
17	PhysicistF	50%	80 h	0 w	8/7/03	9/4/03	$0	$0	$0	$0	0 h	0 h	0 h	80 h
27	CMMOperatorSF	33%	52.8 h	0 w	8/7/03	9/4/03	$1,637	$0	$0	$1,637	0 h	0 h	0 h	52.8 h
31	CMMMedium	33%	52.8 h	0 w	8/7/03	9/4/03	$0	$0	$0	$0	0 h	0 h	0 h	52.8 h
48	MandS	2,638	2,638	0 w	8/7/03	9/4/03	$2,638	$0	$0	$2,638		0	0	2,638

Notes

WBS Definition-
Design, fabricate, and QC mechanical connections from the silicon extension cylinder to the outer end of CFT barrel 1

M&S BOE-

Item	Quantity	Cost	Total
Mandrel	1	0	0
Mandrel Stand	1	0	0
Carbon Fiber	0.5	700	350
Machine Ring	2	1000	2000
Ruby Balls	15	5	75
Ti Alloy Screws	15	7.5	112.5
Vacuum Bagging/Mold Release Su	1	100	100
Grand Total			2638

Mandrel and stand are costs are covered in another task

Labor BOE-
labor hours by type and task

Item	MT SF	CMM Op	CMM P	Des	MechE	Phys
Design Mandrel					0	0
Mandrel Drawing				0	0	0
Order Carbon Fiber					8	4
Order Mandrel					0	0
Order Supplies	2				1	1
QC Mandrels	0				0	0
Prepare Mandrels/Mold Release/Va	24				4	4
Prepare Carbon Fiber	40				4	4
Layup Ring	32				4	4
Vacuum Bag and setup Temperatu	16				4	4
Cure Rings	16				1	1
Remove Rings/bagging materials fr	32				4	4
Rough cut ring for machine shop	32				4	4
QC rings	24				16	24
Join Rings together using Ruby Bal	8				4	4
Measuring rings joined together		32	32		8	8
Measured for reproducibiltiy		32	32		8	8
Cleanup Mandrels/store	32					
Totals	258	64	64	0	70	74

1.1.5.2.4.4	Fabricate south extension rings/reproducible ball conn	9/5/03	10/2/03	$638	$0	$18,592	$19,230

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
1	MechEngF	50%	80 h	0 w	9/5/03	10/2/03	$4,080	$0	$0	$4,080	0 h	0 h	0 h	80 h
9	MechTechSF	175%	280 h	0 w	9/5/03	10/2/03	$9,520	$0	$0	$9,520	0 h	0 h	0 h	280 h
17	PhysicistF	50%	80 h	0 w	9/5/03	10/2/03	$0	$0	$0	$0	0 h	0 h	0 h	80 h
27	CMMOperatorSF	40%	64 h	0 w	9/5/03	10/2/03	$1,984	$0	$0	$1,984	0 h	0 h	0 h	64 h
28	CMMProgrammerSF	40%	64 h	0 w	9/5/03	10/2/03	$3,008	$0	$0	$3,008	0 h	0 h	0 h	64 h
31	CMMMedium	80%	128 h	0 w	9/5/03	10/2/03	$0	$0	$0	$0	0 h	0 h	0 h	128 h
48	MandS	638	638	0 w	9/5/03	10/2/03	$638	$0	$0	$638		0	0	638

Notes

WBS Definition-
Design, fabricate, and QC reproducible ball connections from the silicon extension cylinder to the outer end of CFT barrel 2

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost

"Fabricate south extension rings/reproducible ball connectors" continued

Notes

M&S BOE-

Item	Quantity	Cost	Total
Mandrel	1	0	0
Mandrel Stand	1	0	0
Carbon Fiber	0.5	700	350
Machine Ring	2	1000	2000
Ruby Balls	15	5	75
Ti Alloy Screws	15	7.5	112.5
Vacuum Bagging/Mold Release Su	1	100	100
Grand Total			2638

Mandrel and stand costs are covered under another task
Machine Ring is covered in the MRI machining task
Total this item: $638

Labor BOE-
labor hours by type and task

Item	MT SF	CMM Op	CMM P	Des	MechE	Phys
Design Mandrel					0	0
Mandrel Drawing				0	0	0
Order Carbon Fiber					8	4
Order Mandrel					0	0
Order Supplies	2				1	1
QC Mandrels	0				0	0
Prepare Mandrels/Mold Release/Va	24				4	4
Prepare Carbon Fiber	40				4	4
Layup Ring	32				4	4
Vacuum Bag and setup Temperatur	16				4	4
Cure Rings	16				1	1
Remove Rings/bagging materials fr	32				4	4
Rough cut ring for machine shop	32				4	4
QC rings	24				16	24
Join Rings together using Ruby Bal	8				4	4
Measuring rings joined together		32	32		8	8
Measured for reproducibiltiy		32	32		8	8
Cleanup Mandrels/store	32					
Totals	258	64	64	0	70	74

1.1.5.2.4.5	Assemble and evaluate south extension cylinder	10/3/03	10/23/03	$700	$0	$17,126	$17,826

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
1	MechEngF	33%	39.6 h	0 w	10/3/03	10/23/03	$2,020	$0	$0	$2,020	0 h	0 h	0 h	39.6 h
9	MechTechSF	225%	270 h	0 w	10/3/03	10/23/03	$9,180	$0	$0	$9,180	0 h	0 h	0 h	270 h
17	PhysicistF	33%	39.6 h	0 w	10/3/03	10/23/03	$0	$0	$0	$0	0 h	0 h	0 h	39.6 h
21	DesignerF	33%	39.6 h	0 w	10/3/03	10/23/03	$1,742	$0	$0	$1,742	0 h	0 h	0 h	39.6 h
27	CMMOperatorSF	67%	80.4 h	0 w	10/3/03	10/23/03	$2,492	$0	$0	$2,492	0 h	0 h	0 h	80.4 h
28	CMMProgrammerSF	30%	36 h	0 w	10/3/03	10/23/03	$1,692	$0	$0	$1,692	0 h	0 h	0 h	36 h
31	CMMMedium	100%	120 h	0 w	10/3/03	10/23/03	$0	$0	$0	$0	0 h	0 h	0 h	120 h
48	MandS	700	700	0 w	10/3/03	10/23/03	$700	$0	$0	$700		0	0	700

Notes

WBS Definition-
Install and align the z = 600 ball mount ring within the south extension cylinder

M&S BOE-

Item	Quantity	Cost	Total
Plates	2	0	0
Carbon Fiber	1	700	700
Vacuum Bagging/Mold Release Su	1	100	100
Grand Total			700

The plate costs are covered under another task

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost

"Assemble and evaluate south extension cylinder" continued

Notes

Labor BOE-

Labor hours by type and task

Item	MT SF	CMM Op	CMM P	Des	MechE	Phys
Order Carbon Fiber					8	4
Order Supplies	8				4	4
Prepare Plates/Mold Release/Vacu	16				2	2
Prepare Carbon Fiber	16				2	2
Layup Plates	16				2	2
Vacuum Bag and setup Temperatur	8				1	1
Cure Plates	16				1	1
Remove bagging materials	8				1	1
Machine ribs	40			40	4	4
QC Ribs	8				1	1
Glue Ribs into Cylinder	40				8	8
Glue reproducible ball connections	8	24	8		8	8
Setup Bulkhead positions	16	16	16		16	16
Glue bulkheads in place	24				1	1
QC cylinder assembly	8	40	40		24	24
Cleanup/store	40					
Totals	272	80	64	40	83	79

1.1.5.2.4.6 Mate with south support cylinder assembly

Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
3/26/04	3/29/04	$100	$0	$1,856	$1,956

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
1	MechEngF	100%	16 h	0 w	3/26/04	3/29/04	$816	$0	$0	$816	0 h	0 h	0 h	16 h
9	MechTechSF	100%	16 h	0 w	3/26/04	3/29/04	$544	$0	$0	$544	0 h	0 h	0 h	16 h
17	PhysicistF	100%	16 h	0 w	3/26/04	3/29/04	$0	$0	$0	$0	0 h	0 h	0 h	16 h
27	CMMOperatorSF	100%	16 h	0 w	3/26/04	3/29/04	$496	$0	$0	$496	0 h	0 h	0 h	16 h
32	CMMLarge	100%	16 h	0 w	3/26/04	3/29/04	$0	$0	$0	$0	0 h	0 h	0 h	16 h
48	MandS	100	100	0 w	3/26/04	3/29/04	$100	$0	$0	$100		0	0	100

Notes

WBS Definition-

Mate the south support cylinder assembly with the south extension cylinder

M&S BOE-

	Quan	cost	total
Vacuum Bagging/Mold Release Sup	1	100	100

Labor BOE-

Assumes 8 hours each of a mechanical tech, CMM operator, Mechanical Engineer, and Physicist to join them. One day extra is assumed in the schedule.

1.1.5.2.4.7 Install and align mounts for CFT barrel 1

Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
3/30/04	4/12/04	$100	$0	$7,920	$8,020

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
1	MechEngF	100%	80 h	0 w	3/30/04	4/12/04	$4,080	$0	$0	$4,080	0 h	0 h	0 h	80 h
9	MechTechSF	50%	40 h	0 w	3/30/04	4/12/04	$1,360	$0	$0	$1,360	0 h	0 h	0 h	40 h
17	PhysicistF	100%	80 h	0 w	3/30/04	4/12/04	$0	$0	$0	$0	0 h	0 h	0 h	80 h
27	CMMOperatorSF	100%	80 h	0 w	3/30/04	4/12/04	$2,480	$0	$0	$2,480	0 h	0 h	0 h	80 h
32	CMMLarge	100%	80 h	0 w	3/30/04	4/12/04	$0	$0	$0	$0	0 h	0 h	0 h	80 h
48	MandS	100	100	0 w	3/30/04	4/12/04	$100	$0	$0	$100		0	0	100

Notes

WBS Definition-

Install and align the mounts to connect silicon to CFT barrel 1 within the south extension cylinder, verify alignment

M&S BOE-

$100 is included for Vacuum bagging and mold release supplies

Labor BOE-

labor hours by type and task

Item	MT SF	CMM Op	CMM P	Des	MechE	Phys

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost

"Install and align mounts for CFT barrel 1" continued

Notes

Align CFT mounts	8	8			8	8
Glue CFT mounts	24	24	24		24	24
Verify alignment		24			24	24
Totals	32	56	24	0	56	56

1.1.5.2.5	**North Support Cylinder Assembly**	**3/26/04**	**1/10/05**	**$16,828**	**$0**	**$154,037**	**$170,865**

Notes

WBS Definition-
Summary task that includes the north support cylinder assembly, and testing

1.1.5.2.5.1	Fabricate north shells	3/26/04	6/18/04	$10,700	$0	$19,416	$30,116

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
1	MechEngF	25%	120 h	0 w	3/26/04	6/18/04	$6,120	$0	$0	$6,120	0 h	0 h	0 h	120 h
9	MechTechSF	75%	360 h	0 w	3/26/04	6/18/04	$12,240	$0	$0	$12,240	0 h	0 h	0 h	360 h
17	PhysicistF	25%	120 h	0 w	3/26/04	6/18/04	$0	$0	$0	$0	0 h	0 h	0 h	120 h
21	DesignerF	5%	24 h	0 w	3/26/04	6/18/04	$1,056	$0	$0	$1,056	0 h	0 h	0 h	24 h
48	MandS	10,700	10,700	0 w	3/26/04	6/18/04	$10,700	$0	$0	$10,700		0	0	10,700

Notes

WBS Definition-
Fabricate the outer cylindrical portions of the silicon support cylinder assembly, QC the cylinder

M&S BOE-

Item	Quantity	Cost	Total
Mandrels	2	2500	5000
Mandrel Stand	1	0	0
Carbon Fiber	8	700	5600
Vacuum Bagging/Mold Release Su	1	100	100
Grand Total			10700

Labor BOE-
labor hours by type and task

Item	MT SF	CMM Op	CMM P	Des	MechE	Phys
Design Mandrels	4				24	24
Design Mandrel Stand	0				0	0
Mandrel Drawings				24	4	4
Mandrel Stand Drawing				0	0	0
Order Carbon Fiber					8	4
Order Mandrels					8	4
Order Mandrel Stand Materials	0				0	0
Order Supplies	8				4	4
QC Mandrels	24				16	24
Fabricate Mandrel Stand	0				0	0
Prepare Mandrels/Mold Release/Va	40				8	8
Prepare Carbon Fiber	40				4	4
Layup Cylinders	32				4	4
Vacuum Bag and setup Temperatu	16				4	4
Cure Cylinders	16				1	1
Remove Cylinders/bagging material	32				4	4
Cut Cylinders to length	32				4	4
QC Cylinders	24				16	24
Cleanup Mandrels/store	32					
Totals	300	0	0	24	109	117

1.1.5.2.5.2	Fabricate North Z=600 bulkhead	6/21/04	8/2/04	$2,440	$0	$39,864	$42,304

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
1	MechEngF	100%	240 h	0 w	6/21/04	8/2/04	$12,240	$0	$0	$12,240	0 h	0 h	0 h	240 h

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost

"Fabricate North Z=600 bulkhead" continued

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
9	MechTechSF	150%	360 h	0 w	6/21/04	8/2/04	$12,240	$0	$0	$12,240	0 h	0 h	0 h	360 h
17	PhysicistF	85%	204 h	0 w	6/21/04	8/2/04	$0	$0	$0	$0	0 h	0 h	0 h	204 h
21	DesignerF	50%	120 h	0 w	6/21/04	8/2/04	$5,280	$0	$0	$5,280	0 h	0 h	0 h	120 h
27	CMMOperatorSF	60%	144 h	0 w	6/21/04	8/2/04	$4,464	$0	$0	$4,464	0 h	0 h	0 h	144 h
28	CMMProgrammerSF	50%	120 h	0 w	6/21/04	8/2/04	$5,640	$0	$0	$5,640	0 h	0 h	0 h	120 h
31	CMMMedium	100%	240 h	0 w	6/21/04	8/2/04	$0	$0	$0	$0	0 h	0 h	0 h	240 h
48	MandS	2,440	2,440	0 w	6/21/04	8/2/04	$2,440	$0	$0	$2,440		0	0	2,440

Notes

WBS Definition-
Fabricate the outer stave positioning bulkhead

M&S BOE-

Item	Quantity	Cost	Total
Plates	2	0	0
Carbon Fiber	1	700	700
Vacuum Bagging/Mold Release Sup	1	100	100
Bearings	200	1.2	240
Bearing Holders	200	2	400
Assembly Fixture	1	1000	1000
Grand Total			2440

Plates are costed on another task

Labor BOE-
labor hours by type and task

Item	MT SF	CMM Op	CMM P	Des	MechE	Phys
Design Bulkhead					40	80
Bulkhead Drawings				40	4	4
Design Assembly Fixture					32	8
Assembly Fixture Drawing				24	4	4
Order Carbon Fiber					8	4
Order Plates					8	4
Order Supplies	8				4	4
Order Bearings					8	4
Order Bearing Holders					8	4
Order Foam					8	4
Order Assembly Fixture					8	4
QC Plates	0				0	0
QC Assembly Fixture		32	32		2	2
Prepare Plates/Mold Release/Vacu	16				2	2
Prepare Carbon Fiber	16				2	2
Layup Plates	16				2	2
Vacuum Bag and setup Temperatur	8				1	1
Cure Plates	16				1	1
Remove bagging materials	8				1	1
Machine Bulkheads	40			40	4	4
Machine Foam	24			8	4	4
QC Bulkheads	8				8	4
QC Foam	2				1	1
Glue Bearings into Bearing holders	40				8	8
QC Beariing Assembly		40	16		8	8
Setup Initial Bearing position	16	16	16		4	4
Glue Bearing assembly in place	40				1	1
Glue Foam in place	8				1	1
Glue top carbon plate in place	8				1	1
QC Bulkhead assembly		40	40			
Cleanup/store	40					
Totals	314	128	104	112	183	171

WBS Dictionary as of 9/21/02
Run IIb Silicon Schedule

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
1.1.5.2.5.3	Fabricate z = 0 membrane	8/3/04	9/7/04	$1,350	$0	$35,800	$37,150

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
1	MechEngF	100%	200 h	0 w	8/3/04	9/7/04	$10,200	$0	$0	$10,200	0 h	0 h	0 h	200 h
9	MechTechSF	175%	350 h	0 w	8/3/04	9/7/04	$11,900	$0	$0	$11,900	0 h	0 h	0 h	350 h
17	PhysicistF	100%	200 h	0 w	8/3/04	9/7/04	$0	$0	$0	$0	0 h	0 h	0 h	200 h
21	DesignerF	60%	120 h	0 w	8/3/04	9/7/04	$5,280	$0	$0	$5,280	0 h	0 h	0 h	120 h
27	CMMOperatorSF	60%	120 h	0 w	8/3/04	9/7/04	$3,720	$0	$0	$3,720	0 h	0 h	0 h	120 h
28	CMMProgrammerSF	50%	100 h	0 w	8/3/04	9/7/04	$4,700	$0	$0	$4,700	0 h	0 h	0 h	100 h
37	OGP	100%	200 h	0 w	8/3/04	9/7/04	$0	$0	$0	$0	0 h	0 h	0 h	200 h
48	MandS	1,350	1,350	0 w	8/3/04	9/7/04	$1,350	$0	$0	$1,350		0	0	1,350

Notes

WBS Definition-
Fabricate z = 0 membrane, QC the membrane

M&S BOE-

Item	Quantity	Cost	Total
Plates	2	0	0
Carbon Fiber	0.5	700	350
Vacuum Bagging/Mold Release Su	1	100	100
Bearings	200	2.5	500
Bearing Holders	200	2	400
Assembly Fixture	1	0	0
Grand Total			1350

Labor BOE-
labor hours by type and task

Item	MT SF	CMM Op	CMM P	Des	MechE	Phys
Design Bulkhead					40	80
Bulkhead Drawings				40	4	4
Design Assembly Fixture					32	8
Assembly Fixture Drawing				24	4	4
Order Carbon Fiber					8	4
Order Plates					8	4
Order Supplies	8				4	4
Order Bearings					8	4
Order Bearing Holders					8	4
Order Foam					8	4
Order Assembly Fixture					8	4
QC Plates	8				4	4
QC Assembly Fixture		32	32		2	2
Prepare Plates/Mold Release/Vac	16				2	2
Prepare Carbon Fiber	16				2	2
Layup Plates	16				2	2
Vacuum Bag and setup Temperatu	8				1	1
Cure Plates	16				1	1
Remove bagging materials	8				1	1
Machine Bulkheads	40			40	4	4
Machine Foam	24			8	4	4
QC Bulkheads	8				8	4
QC Foam	2				1	1
Glue Bearings into Bearing holders	40				8	8
QC Beariing Assembly		40	16		8	8
Setup Initial Bearing position	16	16	16		4	4
Glue Bearing assembly in place	40				1	1
Glue Foam in place	8				1	1
Glue top carbon plate in place	8				1	1
QC Bulkhead assembly		40	40			
Cleanup/store	40					
Totals	322	128	104	112	187	175

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
1.1.5.2.5.4	Fabricate North Rings/reproducible ball connectors	9/8/04	10/5/04	$1,638	$0	$22,040	$23,678

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
1	MechEngF	75%	120 h	0 w	9/8/04	10/5/04	$6,120	$0	$0	$6,120	0 h	0 h	0 h	120 h
9	MechTechSF	175%	280 h	0 w	9/8/04	10/5/04	$9,520	$0	$0	$9,520	0 h	0 h	0 h	280 h
17	PhysicistF	75%	120 h	0 w	9/8/04	10/5/04	$0	$0	$0	$0	0 h	0 h	0 h	120 h
21	DesignerF	20%	32 h	0 w	9/8/04	10/5/04	$1,408	$0	$0	$1,408	0 h	0 h	0 h	32 h
27	CMMOperatorSF	40%	64 h	0 w	9/8/04	10/5/04	$1,984	$0	$0	$1,984	0 h	0 h	0 h	64 h
28	CMMProgrammerSF	40%	64 h	0 w	9/8/04	10/5/04	$3,008	$0	$0	$3,008	0 h	0 h	0 h	64 h
31	CMMMedium	100%	160 h	0 w	9/8/04	10/5/04	$0	$0	$0	$0	0 h	0 h	0 h	160 h
48	MandS	1,638	1,638	0 w	9/8/04	10/5/04	$1,638	$0	$0	$1,638		0	0	1,638

Notes

WBS Definition-
Fabricate north rings and QC reproducible ball connectors

M&S BOE-

Item	Quantity	Cost	Total
Mandrel	1	1000	1000
Mandrel Stand	1	0	0
Carbon Fiber	0.5	700	350
Machine Ring	2	1000	2000
Ruby Balls	15	5	75
Ti Alloy Screws	15	7.5	112.5
Vacuum Bagging/Mold Release Sup	1	100	100
Grand Total			3638

Mandrel stand cost comes on another item
Machine Ring cost is covered under MRI machining task
Total this task: $ 1638

Labor BOE-
labor hours by type and task

Item	MT SF	CMM Op	CMM P	Des	MechE	Phys
Design Mandrel					24	24
Mandrel Drawing				24	4	4
Order Carbon Fiber					8	4
Order Mandrel					8	4
Order Supplies	2				1	1
QC Mandrels	2				8	16
Prepare Mandrels/Mold Release/V	24				4	4
Prepare Carbon Fiber	40				4	4
Layup Ring	32				4	4
Vacuum Bag and setup Temperatur	16				4	4
Cure Rings	16				1	1
Remove Rings/bagging materials fr	32				4	4
Rough cut ring for machine shop	32				4	4
QC rings	24				16	24
Join Rings together using Ruby Ba	8				4	4
Measuring rings joined together		32	32		8	8
Measured for reproducibiltiy		32	32		8	8
Cleanup Mandrels/store	32					
Totals	260	64	64	24	114	122

1.1.5.2.5.5	Fabricate north support cylinder assembly	10/6/04	11/16/04	$700	$0	$21,888	$22,588

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
1	MechEngF	40%	96 h	0 w	10/6/04	11/16/04	$4,896	$0	$0	$4,896	0 h	0 h	0 h	96 h
9	MechTechSF	125%	300 h	0 w	10/6/04	11/16/04	$10,200	$0	$0	$10,200	0 h	0 h	0 h	300 h
17	PhysicistF	40%	96 h	0 w	10/6/04	11/16/04	$0	$0	$0	$0	0 h	0 h	0 h	96 h
21	DesignerF	20%	48 h	0 w	10/6/04	11/16/04	$2,112	$0	$0	$2,112	0 h	0 h	0 h	48 h
27	CMMOperatorSF	25%	60 h	0 w	10/6/04	11/16/04	$1,860	$0	$0	$1,860	0 h	0 h	0 h	60 h
28	CMMProgrammerSF	25%	60 h	0 w	10/6/04	11/16/04	$2,820	$0	$0	$2,820	0 h	0 h	0 h	60 h
32	CMMLarge	25%	60 h	0 w	10/6/04	11/16/04	$0	$0	$0	$0	0 h	0 h	0 h	60 h
48	MandS	700	700	0 w	10/6/04	11/16/04	$700	$0	$0	$700		0	0	700

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost

"Fabricate north support cylinder assembly" continued

Notes

WBS Definition-
Install the z = 0 ball mount ring within the outer cylinder

M&S BOE-

Item	Quantity	Cost	Total
Plates	2	0	0
Carbon Fiber	1	700	700
Vacuum Bagging/Mold Release Sup	1	100	100
Grand Total			700

Plates are costed in another task

Labor BOE-
labor hours by type and task

Item	MT SF	CMM Op	CMM P	Des	MechE	Phys
Order Carbon Fiber					8	4
Order Supplies	8				4	4
Prepare Plates/Mold Release/Vacu	16				2	2
Prepare Carbon Fiber	16				2	2
Layup Plates	16				2	2
Vacuum Bag and setup Temperatu	8				1	1
Cure Plates	16				1	1
Remove bagging materials	8				1	1
Machine ribs	40			40	4	4
QC Ribs	8				1	1
Glue Ribs into Cylinder	40				8	8
Glue reproducible ball connections	8	24	8		8	8
Setup Bulkhead positions	16	16	16		16	16
Glue bulkheads in place	24				1	1
QC cylinder assembly	8	40	40		24	24
Cleanup/store	40					
Totals	272	80	64	40	83	79

1.1.5.2.5.6	Measure cylinder deflections under load	11/17/04	1/10/05	$0	$0	$15,029	$15,029

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
1	MechEngF	40%	96 h	0 w	11/17/04	1/10/05	$4,896	$0	$0	$4,896	0 h	0 h	0 h	96 h
9	MechTechSF	33%	79.2 h	0 w	11/17/04	1/10/05	$2,693	$0	$0	$2,693	0 h	0 h	0 h	79.2 h
17	PhysicistF	20%	48 h	0 w	11/17/04	1/10/05	$0	$0	$0	$0	0 h	0 h	0 h	48 h
27	CMMOperatorSF	100%	240 h	0 w	11/17/04	1/10/05	$7,440	$0	$0	$7,440	0 h	0 h	0 h	240 h
32	CMMLarge	100%	240 h	0 w	11/17/04	1/10/05	$0	$0	$0	$0	0 h	0 h	0 h	240 h

Notes

WBS Definition-
Measure cylinder deflections under load and verify that they are consistent with results from the prototype

M&S BOE-
no costs associated with this item

Labor BOE-
labor hours by type and task

Item	MT SF	CMM Op	CMM P	Des	MechE	Phys
Fabricate Loading Fixture	0				0	0
Setup cylinder on CMM	16	40	8		4	1
Measure cylinder under different lo	48	120	32		8	4
Analysis Data					60	34
Totals	64	160	40	0	72	39

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
1.1.5.2.6	**North Extension Cylinder**	**6/21/04**	**2/24/05**	**$6,476**	**$0**	**$73,298**	**$79,774**

Notes

WBS Definition-
Summary task that includes the north extension cylinder assembly, and testing

1.1.5.2.6.1	Fabricate north extension cylinders	6/21/04	7/19/04	$1,500	$0	$13,600	$15,100

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
1	MechEngF	50%	80 h	0 w	6/21/04	7/19/04	$4,080	$0	$0	$4,080	0 h	0 h	0 h	80 h
9	MechTechSF	175%	280 h	0 w	6/21/04	7/19/04	$9,520	$0	$0	$9,520	0 h	0 h	0 h	280 h
17	PhysicistF	50%	80 h	0 w	6/21/04	7/19/04	$0	$0	$0	$0	0 h	0 h	0 h	80 h
48	MandS	1,500	1,500	0 w	6/21/04	7/19/04	$1,500	$0	$0	$1,500		0	0	1,500

Notes

WBS Definition-
Fabricate and QC the Carbon Fiber extension cylinders for the south

M&S BOE-

Item	Quantity	Cost	Total
Mandrels	2	0	0
Mandrel Stand	1	0	0
Carbon Fiber	2	700	1400
Vacuum Bagging/Mold Release Sup	1	100	100
Grand Total			1500

The mandrels are obtained from the prototyping work

Labor BOE-
Hours by type and task

Item	MT SF	CMM Op	CMM P	Des	MechE	Phys
Design Mandrels	0				0	0
Design Mandrel Stand	0				0	0
Mandrel Drawings				0	0	0
Mandrel Stand Drawing				0	0	0
Order Carbon Fiber					8	4
Order Mandrels					0	0
Order Mandrel Stand Materials	0				0	0
Order Supplies	8				8	4
QC Mandrels	0				0	0
Fabricate Mandrel Stand	0				0	0
Prepare Mandrels/Mold Release/Va	40				8	8
Prepare Carbon Fiber	40				4	4
Layup Cylinders	32				4	4
Vacuum Bag and setup Temperatu	16				4	4
Cure Cylinders	16				1	1
Remove Cylinders/bagging material	32				4	4
Cut Cylinders to length	32				4	4
QC Cylinders	24				16	24
Cleanup Mandrels/store	32					
Totals	272	0	0	0	61	61

1.1.5.2.6.2	Fabricate z = 830 membrane	7/20/04	8/16/04	$800	$0	$12,336	$13,136

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
1	MechEngF	50%	80 h	0 w	7/20/04	8/16/04	$4,080	$0	$0	$4,080	0 h	0 h	0 h	80 h
9	MechTechSF	100%	160 h	0 w	7/20/04	8/16/04	$5,440	$0	$0	$5,440	0 h	0 h	0 h	160 h
17	PhysicistF	50%	80 h	0 w	7/20/04	8/16/04	$0	$0	$0	$0	0 h	0 h	0 h	80 h
21	DesignerF	40%	64 h	0 w	7/20/04	8/16/04	$2,816	$0	$0	$2,816	0 h	0 h	0 h	64 h
48	MandS	800	800	0 w	7/20/04	8/16/04	$800	$0	$0	$800		0	0	800

Notes

WBS Definition-
Design, fabricate, and QC z = 830 membrane

M&S BOE-

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost

"Fabricate z = 830 membrane" continued

Notes

Item	Quantity	Cost	Total
Plates	2	0	0
Carbon Fiber	1	700	700
Vacuum Bagging/Mold Release S	1	100	100
Grand Total			800

Plates are obtained from another task

Labor BOE-
labor hours by type and task

Item	MT SF	CMM Op	CMM P	Des	MechE	Phys
Design Membrane					10	20
Membrane Drawings				24	4	4
Design Assembly Fixture					0	0
Assembly Fixture Drawing				24	4	4
Order Carbon Fiber					8	4
Order Plates					0	0
Order Supplies	8				4	4
Order Bearings					0	0
Order Bearing Holders					0	0
Order Foam					8	4
Order Assembly Fixture					0	0
QC Plates	0				0	0
QC Assembly Fixture		0	0		0	0
Prepare Plates/Mold Release/Vacu	8				2	2
Prepare Carbon Fiber	8				2	2
Layup Plates	8				2	2
Vacuum Bag and setup Temperatu	4				1	1
Cure Plates	8				1	1
Remove bagging materials	4				1	1
Machine Membrane	10			10	4	4
Machine Foam	10			2	2	2
QC Bulkheads	8				8	4
QC Foam	2				1	1
Glue Bearings into Bearing holders	0				0	0
QC Beariing Assembly		0	0		0	0
Setup Initial Bearing position	0	0	0		0	0
Glue Bearing assembly in place	0				0	0
Glue Foam in place	8				1	1
Glue top carbon plate in place	0				0	0
QC Bulkhead assembly	8	0	0			
Cleanup/store	40					
Totals	134	0	0	60	63	61

1.1.5.2.6.3	Fabricate mounts to CFT barrel 1	8/17/04	9/14/04	$2,638	$0	$15,237	$17,875

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
1	MechEngF	50%	80 h	0 w	8/17/04	9/14/04	$4,080	$0	$0	$4,080	0 h	0 h	0 h	80 h
9	MechTechSF	175%	280 h	0 w	8/17/04	9/14/04	$9,520	$0	$0	$9,520	0 h	0 h	0 h	280 h
17	PhysicistF	50%	80 h	0 w	8/17/04	9/14/04	$0	$0	$0	$0	0 h	0 h	0 h	80 h
27	CMMOperatorSF	33%	52.8 h	0 w	8/17/04	9/14/04	$1,637	$0	$0	$1,637	0 h	0 h	0 h	52.8 h
31	CMMMedium	33%	52.8 h	0 w	8/17/04	9/14/04	$0	$0	$0	$0	0 h	0 h	0 h	52.8 h
48	MandS	2,638	2,638	0 w	8/17/04	9/14/04	$2,638	$0	$0	$2,638		0	0	2,638

Notes

WBS Definition-
Design, fabricate, and QC mechanical connections from the silicon extension cylinder to the outer end of CFT barrel 1

M&S BOE-

Item	Quantity	Cost	Total
Mandrel	1	0	0
Mandrel Stand	1	0	0

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost

"Fabricate mounts to CFT barrel 1" continued

Notes

Carbon Fiber	0.5	700	350
Machine Ring	2	1000	2000
Ruby Balls	15	5	75
Ti Alloy Screws	15	7.5	112.5
Vacuum Bagging/Mold Release Su	1	100	100
Grand Total			2638

Mandrel and stand are costs are covered in another task

Labor BOE-
labor hours by type and task

Item	MT SF	CMM Op	CMM P	Des	MechE	Phys
Design Mandrel					0	0
Mandrel Drawing				0	0	0
Order Carbon Fiber					8	4
Order Mandrel					0	0
Order Supplies	2				1	1
QC Mandrels	0				0	0
Prepare Mandrels/Mold Release/Va	24				4	4
Prepare Carbon Fiber	40				4	4
Layup Ring	32				4	4
Vacuum Bag and setup Temperatu	16				4	4
Cure Rings	16				1	1
Remove Rings/bagging materials fr	32				4	4
Rough cut ring for machine shop	32				4	4
QC rings	24				16	24
Join Rings together using Ruby Bal	8				4	4
Measuring rings joined together		32	32		8	8
Measured for reproducibiltiy		32	32		8	8
Cleanup Mandrels/store	32					
Totals	258	64	64	0	70	74

1.1.5.2.6.4	Fabricate north extension rings/reproducible ball conn	9/15/04	9/28/04	$638	$0	$3,000	$3,638

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
1	MechEngF	25%	20 h	0 w	9/15/04	9/28/04	$1,020	$0	$0	$1,020	0 h	0 h	0 h	20 h
9	MechTechSF	50%	40 h	0 w	9/15/04	9/28/04	$1,360	$0	$0	$1,360	0 h	0 h	0 h	40 h
17	PhysicistF	50%	40 h	0 w	9/15/04	9/28/04	$0	$0	$0	$0	0 h	0 h	0 h	40 h
27	CMMOperatorSF	25%	20 h	0 w	9/15/04	9/28/04	$620	$0	$0	$620	0 h	0 h	0 h	20 h
31	CMMMedium	25%	20 h	0 w	9/15/04	9/28/04	$0	$0	$0	$0	0 h	0 h	0 h	20 h
48	MandS	638	638	0 w	9/15/04	9/28/04	$638	$0	$0	$638		0	0	638

Notes

WBS Definition-
Design, fabricate, and QC reproducible ball connections from the silicon extension cylinder to the outer end of CFT barrel 2

M&S BOE-

Item	Quantity	Cost	Total
Mandrel	1	0	0
Mandrel Stand	1	0	0
Carbon Fiber	0.5	700	350
Machine Ring	2	1000	2000
Ruby Balls	15	5	75
Ti Alloy Screws	15	7.5	112.5
Vacuum Bagging/Mold Release Su	1	100	100
Grand Total			2638

Mandrel and stand costs are covered under another task
Machine Ring is covered in the MRI machining task
Total this item: $638

Labor BOE-
labor hours by type and task

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost

"Fabricate north extension rings/reproducible ball connector" continued

Notes

Item	MT SF	CMM Op	CMM P	Des	MechE	Phys
Design Mandrel					0	0
Mandrel Drawing				0	0	0
Order Carbon Fiber					8	4
Order Mandrel					0	0
Order Supplies	2				1	1
QC Mandrels	0				0	0
Prepare Mandrels/Mold Release/Va	24				4	4
Prepare Carbon Fiber	40				4	4
Layup Ring	32				4	4
Vacuum Bag and setup Temperatur	16				4	4
Cure Rings	16				1	1
Remove Rings/bagging materials fr	32				4	4
Rough cut ring for machine shop	32				4	4
QC rings	24				16	24
Join Rings together using Ruby Bal	8				4	4
Measuring rings joined together		32	32		8	8
Measured for reproducibiltiy		32	32		8	8
Cleanup Mandrels/store	32					
Totals	258	64	64	0	70	74

1.1.5.2.6.5	Assemble and evaluate north extension cylinder asser	9/29/04	10/5/04	$700	$0	$5,709	$6,409

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
1	MechEngF	33%	13.2 h	0 w	9/29/04	10/5/04	$673	$0	$0	$673	0 h	0 h	0 h	13.2 h
9	MechTechSF	225%	90 h	0 w	9/29/04	10/5/04	$3,060	$0	$0	$3,060	0 h	0 h	0 h	90 h
17	PhysicistF	33%	13.2 h	0 w	9/29/04	10/5/04	$0	$0	$0	$0	0 h	0 h	0 h	13.2 h
21	DesignerF	33%	13.2 h	0 w	9/29/04	10/5/04	$581	$0	$0	$581	0 h	0 h	0 h	13.2 h
27	CMMOperatorSF	67%	26.8 h	0 w	9/29/04	10/5/04	$831	$0	$0	$831	0 h	0 h	0 h	26.8 h
28	CMMProgrammerSF	30%	12 h	0 w	9/29/04	10/5/04	$564	$0	$0	$564	0 h	0 h	0 h	12 h
31	CMMMedium	100%	40 h	0 w	9/29/04	10/5/04	$0	$0	$0	$0	0 h	0 h	0 h	40 h
48	MandS	700	700	0 w	9/29/04	10/5/04	$700	$0	$0	$700		0	0	700

Notes

WBS Definition-
Install and align the z = 600 ball mount ring within the south extension cylinder

M&S BOE-

Item	Quantity	Cost	Total
Plates	2	0	0
Carbon Fiber	1	700	700
Vacuum Bagging/Mold Release Su	1	100	100
Grand Total			700

The plate costs are covered under another task

Labor BOE-
Labor hours by type and task

Item	MT SF	CMM Op	CMM P	Des	MechE	Phys
Order Carbon Fiber					8	4
Order Supplies	8				4	4
Prepare Plates/Mold Release/Vacu	16				2	2
Prepare Carbon Fiber	16				2	2
Layup Plates	16				2	2
Vacuum Bag and setup Temperatur	8				1	1
Cure Plates	16				1	1
Remove bagging materials	8				1	1
Machine ribs	40			40	4	4
QC Ribs	8				1	1
Glue Ribs into Cylinder	40				8	8
Glue reproducible ball connections	8	24	8		8	8
Setup Bulkhead positions	16	16	16		16	16

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost

"Assemble and evaluate north extension cylinder assembly" continued

Notes

Glue bulkheads in place	24				1	1
QC cylinder assembly	8	40	40		24	24
Cleanup/store	40					
Totals	272	80	64	40	83	79

1.1.5.2.6.6 Mate all support and extension cylinders

Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
1/11/05	1/12/05	$100	$0	$1,856	$1,956

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
1	MechEngF	100%	16 h	0 w	1/11/05	1/12/05	$816	$0	$0	$816	0 h	0 h	0 h	16 h
9	MechTechSF	100%	16 h	0 w	1/11/05	1/12/05	$544	$0	$0	$544	0 h	0 h	0 h	16 h
17	PhysicistF	100%	16 h	0 w	1/11/05	1/12/05	$0	$0	$0	$0	0 h	0 h	0 h	16 h
27	CMMOperatorSF	100%	16 h	0 w	1/11/05	1/12/05	$496	$0	$0	$496	0 h	0 h	0 h	16 h
32	CMMLarge	100%	16 h	0 w	1/11/05	1/12/05	$0	$0	$0	$0	0 h	0 h	0 h	16 h
48	MandS	100	100	0 w	1/11/05	1/12/05	$100	$0	$0	$100		0	0	100

Notes

WBS Definition-
Mate the north support cylinder assembly with the north extension cylinder

M&S BOE-

	Quan	cost	total
Vacuum Bagging/Mold Release Sup	1	100	100

Labor BOE-
Assumes 8 hours each of a mechanical tech, CMM operator, Mechanical Engineer, and Physicist to join them. One day extra is assumed.

1.1.5.2.6.7 Install and align mounts to CFT barrel 1 in north exten

Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
1/13/05	1/27/05	$100	$0	$7,920	$8,020

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
1	MechEngF	100%	80 h	0 w	1/13/05	1/27/05	$4,080	$0	$0	$4,080	0 h	0 h	0 h	80 h
9	MechTechSF	50%	40 h	0 w	1/13/05	1/27/05	$1,360	$0	$0	$1,360	0 h	0 h	0 h	40 h
17	PhysicistF	100%	80 h	0 w	1/13/05	1/27/05	$0	$0	$0	$0	0 h	0 h	0 h	80 h
27	CMMOperatorSF	100%	80 h	0 w	1/13/05	1/27/05	$2,480	$0	$0	$2,480	0 h	0 h	0 h	80 h
32	CMMLarge	100%	80 h	0 w	1/13/05	1/27/05	$0	$0	$0	$0	0 h	0 h	0 h	80 h
48	MandS	100	100	0 w	1/13/05	1/27/05	$100	$0	$0	$100		0	0	100

Notes

WBS Definition-
Install and align the mounts to connect silicon to CFT barrel 1 within the south extension cylinder, verify alignment

M&S BOE-
$100 is included for Vacuum bagging and mold release supplies

Labor BOE-
labor hours by type and task

Item	MT SF	CMM Op	CMM P	Des	MechE	Phys
Align CFT mounts	8	8			8	8
Glue CFT mounts	24	24	24		24	24
Verify alignment		24			24	24
Totals	32	56	24	0	56	56

1.1.5.2.6.8 Measure cylinder deflections under load

Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
1/28/05	2/24/05	$0	$0	$13,640	$13,640

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
1	MechEngF	50%	80 h	0 w	1/28/05	2/24/05	$4,080	$0	$0	$4,080	0 h	0 h	0 h	80 h
9	MechTechSF	50%	80 h	0 w	1/28/05	2/24/05	$2,720	$0	$0	$2,720	0 h	0 h	0 h	80 h
17	PhysicistF	25%	40 h	0 w	1/28/05	2/24/05	$0	$0	$0	$0	0 h	0 h	0 h	40 h
27	CMMOperatorSF	100%	160 h	0 w	1/28/05	2/24/05	$4,960	$0	$0	$4,960	0 h	0 h	0 h	160 h
28	CMMProgrammerSF	25%	40 h	0 w	1/28/05	2/24/05	$1,880	$0	$0	$1,880	0 h	0 h	0 h	40 h
32	CMMLarge	100%	160 h	0 w	1/28/05	2/24/05	$0	$0	$0	$0	0 h	0 h	0 h	160 h

Notes

WBS Definition-

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost

"Measure cylinder deflections under load" continued

Notes

Perform and analyze deflection measurements of the complete, mated assembly under load

M&S BOE-
no costs associated with this item

Labor BOE-
labor hours by type and task

Item	MT SF	CMM Op	CMM P	Des	MechE	Phys
Fabricate Loading Fixture	0				0	0
Setup cylinder on CMM	16	40	8		4	1
Measure cylinder under different lo	48	120	32		8	4
Analysis Data					60	34
Totals	64	160	40	0	72	39

1.1.5.2.7	**Silicon Cylinders Ready for Barrel Assembly**	**2/24/05**	**2/24/05**	**$0**	**$0**	**$0**	**$0**

Notes

WBS Definition-
Milestone: All of the cylinders have been produced, tested, and assembled in preparation for module and stave assembly into them.

1.1.5.3	**South Silicon Barrel Assembly**	**4/19/04**	**6/17/05**	**$0**	**$0**	**$67,606**	**$67,606**

Notes

WBS Definition-
Summary task that includes all mechanical parts and assembly for the L0/L1 as well as L2-5 South silicon barrel, the cooling and gas systems as well as testing for all of it

M&S BOE-
No costs associated with this item, they are covered elsewhere.

Labor BOE-
The contingency on these items is fixed to 50% for both physicists and technical staff based on Run2a experience.

Risk Mitigation-
Assembly of L0/L1 is important for obtaining the b vertex impact parameter resolution. Assembly of the staves into the barrels is essential for alignment considerations. This is at the end of the production line and is by definition a critical path item.
Worries are:
Schedule slippages
Cooling hookup and testing
L0/L1 assembly because of tight space issues
Cost doesn't appear to be an issue.
Schedule:
For L0/L1, these tasks can slip by over 5 months without affecting the end date. Prototype mounting and cooling setup is planned with the cylinders as they will be available. We will have dry runs using prototype staves. The assembly of the South Barrel can slip by 4 months in the schedule without affecting the end date.
Technical/Scope:
It is clear, that we will do as much prototyping of the procedures as possible before the real barrel is available but we will also have 4 months to examine the south barrel once it is built.

1.1.5.3.1	**L0 Barrel**	**5/7/04**	**8/16/04**	**$0**	**$0**	**$19,304**	**$19,304**

Notes

WBS Definition-
The summary task that includes the mounting, assembly, and testing of the L0 readout modules onto the south support structure

1.1.5.3.1.1	Mount sensor modules for layer 0, south(Fermilab)	5/7/04	7/19/04	$0	$0	$16,420	$16,420

ID	*Resource Name*	*Units*	*Work*	*Delay*	*Start*	*Finish*	*Cost*	*Baseline Cost*	*Act. Cost*	*Rem. Cost*	*Ovt. Work*	*Baseline Work*	*Act. Work*	*Rem. Work*
9	*MechTechSF*	*50%*	*200 h*	*0 w*	*5/7/04*	*7/19/04*	*$6,800*	*$0*	*$0*	*$6,800*	*0 h*	*0 h*	*0 h*	*200 h*
17	*PhysicistF*	*30%*	*120 h*	*0 w*	*5/7/04*	*7/19/04*	*$0*	*$0*	*$0*	*$0*	*0 h*	*0 h*	*0 h*	*120 h*
18	*PhysicistU*	*30%*	*120 h*	*0 w*	*5/7/04*	*7/19/04*	*$0*	*$0*	*$0*	*$0*	*0 h*	*0 h*	*0 h*	*120 h*
21	*DesignerF*	*5%*	*20 h*	*0 w*	*5/7/04*	*7/19/04*	*$880*	*$0*	*$0*	*$880*	*0 h*	*0 h*	*0 h*	*20 h*
27	*CMMOperatorSF*	*25%*	*100 h*	*0 w*	*5/7/04*	*7/19/04*	*$3,100*	*$0*	*$0*	*$3,100*	*0 h*	*0 h*	*0 h*	*100 h*
28	*CMMProgrammerSF*	*30%*	*120 h*	*0 w*	*5/7/04*	*7/19/04*	*$5,640*	*$0*	*$0*	*$5,640*	*0 h*	*0 h*	*0 h*	*120 h*
32	*CMMLarge*	*100%*	*400 h*	*0 w*	*5/7/04*	*7/19/04*	*$0*	*$0*	*$0*	*$0*	*0 h*	*0 h*	*0 h*	*400 h*

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost

"Mount sensor modules for layer 0, south(Fermilab)" continued

Notes

WBS Definition-
Mount sensor modules on Layer 0 support structure

M&S BOE-
no costs associated with this item

Labor BOE-
Based on CDF experience in Run2a, assume 2 physicists and one CMMT working full time will mount 2 modules per day and include some slack time; put 1 week on consultation by DES to update drawings

1.1.5.3.1.2	Verify sensor alignment(Fermilab)	7/20/04	7/26/04	$0	$0	$1,388	$1,388

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
9	MechTechSF	50%	20 h	0 w	7/20/04	7/26/04	$680	$0	$0	$680	0 h	0 h	0 h	20 h
17	PhysicistF	50%	20 h	0 w	7/20/04	7/26/04	$0	$0	$0	$0	0 h	0 h	0 h	20 h
21	DesignerF	5%	2 h	0 w	7/20/04	7/26/04	$88	$0	$0	$88	0 h	0 h	0 h	2 h
27	CMMOperatorSF	50%	20 h	0 w	7/20/04	7/26/04	$620	$0	$0	$620	0 h	0 h	0 h	20 h
32	CMMLarge	100%	40 h	0 w	7/20/04	7/26/04	$0	$0	$0	$0	0 h	0 h	0 h	40 h
44	PostDoc	50%	20 h	0 w	7/20/04	7/26/04	$0	$0	$0	$0	0 h	0 h	0 h	20 h

Notes

WBS Definition-
Make detailed QC measurements on CMM and analyze measurements to certify mechanical precision

M&S BOE-
no costs associated with this item

Labor BOE-
Based on Run2a experience, full time measurements will be done 6 hours/day for 1 week

1.1.5.3.1.3	Install Temperature Sensors	7/27/04	8/2/04	$0	$0	$1,360	$1,360

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
9	MechTechSF	100%	40 h	0 w	7/27/04	8/2/04	$1,360	$0	$0	$1,360	0 h	0 h	0 h	40 h
17	PhysicistF	50%	20 h	0 w	7/27/04	8/2/04	$0	$0	$0	$0	0 h	0 h	0 h	20 h
18	PhysicistU	100%	40 h	0 w	7/27/04	8/2/04	$0	$0	$0	$0	0 h	0 h	0 h	40 h

Notes

WBS Definition-
The placement of the RTD temperature monitors on the L0 support structure and silicon.

M&S BOE-
no costs associated with this item

Labor BOE-
There are a total of 20 sensors to install. Assume that task takes one full week with full time MechTech. The installation physicist supervisor is there 50% of the time and the supervising physicist who designed and made sensors is there all the time.

1.1.5.3.1.4	Final electrical test of readout(Fermilab)	8/3/04	8/16/04	$0	$0	$136	$136

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
9	MechTechSF	5%	4 h	0 w	8/3/04	8/16/04	$136	$0	$0	$136	0 h	0 h	0 h	4 h
34	SASEQTestStandF	100%	80 h	0 w	8/3/04	8/16/04	$0	$0	$0	$0	0 h	0 h	0 h	80 h
44	PostDoc	150%	120 h	0 w	8/3/04	8/16/04	$0	$0	$0	$0	0 h	0 h	0 h	120 h

Notes

WBS Definition-
Perform electrical tests of L0 south readout and certify

M&S BOE-
no costs associated with this item

Labor BOE-
Each module will be plugged in to check (1 hour/module), groups of modules will be checked together for 3 days and final tests will be run for 1 week. Need 150% of physicist.
A mechanical tech is included to help make fine connections at the part time level.

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
1.1.5.3.1.5	L0 South Silicon Complete	8/16/04	8/16/04	$0	$0	$0	$0

Notes
WBS Definition-
Milestone: All modules for the L0 south barrel have been mounted and tested.

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
1.1.5.3.2	L1 Barrel	4/19/04	7/13/04	$0	$0	$13,768	$13,768

Notes
WBS Definition-
The summary task that includes all of the mounting L1 readout modules onto the L1 support structure and testing and survey of the south L1 assembly.

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
1.1.5.3.2.1	Mount sensor modules for layer 1, south(Fermilab)	4/19/04	6/28/04	$0	$0	$12,460	$12,460

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
9	MechTechSF	30%	120 h	0 w	4/19/04	6/28/04	$4,080	$0	$0	$4,080	0 h	0 h	0 h	120 h
17	PhysicistF	30%	120 h	0 w	4/19/04	6/28/04	$0	$0	$0	$0	0 h	0 h	0 h	120 h
18	PhysicistU	30%	120 h	0 w	4/19/04	6/28/04	$0	$0	$0	$0	0 h	0 h	0 h	120 h
21	DesignerF	5%	20 h	0 w	4/19/04	6/28/04	$880	$0	$0	$880	0 h	0 h	0 h	20 h
27	CMMOperatorSF	15%	60 h	0 w	4/19/04	6/28/04	$1,860	$0	$0	$1,860	0 h	0 h	0 h	60 h
28	CMMProgrammerSF	30%	120 h	0 w	4/19/04	6/28/04	$5,640	$0	$0	$5,640	0 h	0 h	0 h	120 h
32	CMMLarge	100%	400 h	0 w	4/19/04	6/28/04	$0	$0	$0	$0	0 h	0 h	0 h	400 h

Notes
WBS Definition-
Mount sensor modules onto Layer 1 support structure. As each module is mounted, it is tested using the SASEQ teststand to know that it reads out.

M&S BOE-
no costs associated with this item

Labor BOE-
Based experience in Run2a, assume 2 physicists and one CMMT working full time will mount 1 module per day and include some slack time put 1 week on consultation by DES to update drawings

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
1.1.5.3.2.2	Verify sensor alignment(Fermilab)	6/29/04	7/6/04	$0	$0	$1,240	$1,240

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
17	PhysicistF	50%	20 h	0 w	6/29/04	7/6/04	$0	$0	$0	$0	0 h	0 h	0 h	20 h
27	CMMOperatorSF	100%	40 h	0 w	6/29/04	7/6/04	$1,240	$0	$0	$1,240	0 h	0 h	0 h	40 h
32	CMMLarge	100%	40 h	0 w	6/29/04	7/6/04	$0	$0	$0	$0	0 h	0 h	0 h	40 h
44	PostDoc	50%	20 h	0 w	6/29/04	7/6/04	$0	$0	$0	$0	0 h	0 h	0 h	20 h

Notes
WBS Definition-
Make detailed QC measurements on CMM and analyze measurements to certify mechanical precision

M&S BOE-
no costs associated with this item

Labor BOE-
Based on Run2a experience, full time measurements will be done 6 hours/day for 1 week

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
1.1.5.3.2.3	Final electrical test of readout(Fermilab)	7/7/04	7/13/04	$0	$0	$68	$68

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
9	MechTechSF	5%	2 h	0 w	7/7/04	7/13/04	$68	$0	$0	$68	0 h	0 h	0 h	2 h
34	SASEQTestStandF	100%	40 h	0 w	7/7/04	7/13/04	$0	$0	$0	$0	0 h	0 h	0 h	40 h
44	PostDoc	150%	60 h	0 w	7/7/04	7/13/04	$0	$0	$0	$0	0 h	0 h	0 h	60 h

Notes
WBS Definition-
Perform electrical tests of south L1 readout and certify using SASEQ teststand

M&S BOE-
no costs associated with this item

Labor BOE-
Each module will be plugged in to check (1 hour/module), groups of modules will be checked together for 2 days and final tests will be run for 1 day. Need 150% of a physicist.
A mechanical tech at the 25% level is included to help make fine connections.

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
1.1.5.3.2.4	**L1 South Silicon Complete**	**7/13/04**	**7/13/04**	**$0**	**$0**	**$0**	**$0**

Notes

WBS Definition-
Milestone: All L1 south modules have been mounted and tested and L1 is ready for mating with L0

1.1.5.3.3	Mate layer 0 with layer 1, south(Fermilab)	8/17/04	8/23/04	$0	$0	$10,718	$10,718

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
1	MechEngF	25%	10 h	0 w	8/17/04	8/23/04	$510	$0	$0	$510	0 h	0 h	0 h	10 h
9	MechTechSF	100%	40 h	0 w	8/17/04	8/23/04	$1,360	$0	$0	$1,360	0 h	0 h	0 h	40 h
17	PhysicistF	100%	40 h	0 w	8/17/04	8/23/04	$0	$0	$0	$0	0 h	0 h	0 h	40 h
18	PhysicistU	100%	40 h	0 w	8/17/04	8/23/04	$0	$0	$0	$0	0 h	0 h	0 h	40 h
21	DesignerF	5%	2 h	0 w	8/17/04	8/23/04	$88	$0	$0	$88	0 h	0 h	0 h	2 h
27	CMMOperatorSF	100%	40 h	0 w	8/17/04	8/23/04	$1,240	$0	$0	$1,240	0 h	0 h	0 h	40 h
28	CMMProgrammerSF	400%	160 h	0 w	8/17/04	8/23/04	$7,520	$0	$0	$7,520	0 h	0 h	0 h	160 h
32	CMMLarge	100%	40 h	0 w	8/17/04	8/23/04	$0	$0	$0	$0	0 h	0 h	0 h	40 h

Notes

WBS Definition-
Install Layer 0 inside of Layer 1, make mechanical connections and verify relative positioning

M&S BOE-
no costs associated with this item

Labor BOE-
1 CMM full time with tech and physicist based on mating procedures in Run2a. A CMM programmer is needed for 4 weeks to ready the programs needed for this operation.

1.1.5.3.4	Final electrical test of layers 0-1 south(Fermilab)	8/24/04	9/7/04	$0	$0	$136	$136

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
9	MechTechSF	5%	4 h	0 w	8/24/04	9/7/04	$136	$0	$0	$136	0 h	0 h	0 h	4 h
34	SASEQTestStandF	100%	80 h	0 w	8/24/04	9/7/04	$0	$0	$0	$0	0 h	0 h	0 h	80 h
44	PostDoc	200%	160 h	0 w	8/24/04	9/7/04	$0	$0	$0	$0	0 h	0 h	0 h	160 h

Notes

WBS Definition-
Make final electrical tests of Layers 0-1 south

M&S BOE-
no costs associated with this item

Labor BOE-
There are 72 layer 0 modules and 36 layer 1 modules. 4 modules can be plugged in and read out per hour. Assume 2 full time physicists. A mechanical technician is included at the 5% level to help make fine connections. The modules have been read out previously after installation onto each layer so this is just a final check.

1.1.5.3.5	**L0-L1 South Silicon Complete**	**9/7/04**	**9/7/04**	**$0**	**$0**	**$0**	**$0**

Notes

WBS Definition-
Milestone: South layers 0 and 1 have been produced, tested, and mated together.

1.1.5.3.6	**L2-L5 Barrel Assembly**	**2/25/05**	**4/28/05**	**$0**	**$0**	**$10,484**	**$10,484**

Notes

WBS Definition-
Summary task that includes assembly and testing of the staves into the south barrel support cylinder

1.1.5.3.6.1	Align south support cylinder in fixture on CMM	2/25/05	3/3/05	$0	$0	$1,796	$1,796

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
9	MechTechSF	50%	20 h	0 w	2/25/05	3/3/05	$680	$0	$0	$680	0 h	0 h	0 h	20 h
17	PhysicistF	100%	40 h	0 w	2/25/05	3/3/05	$0	$0	$0	$0	0 h	0 h	0 h	40 h
21	DesignerF	10%	4 h	0 w	2/25/05	3/3/05	$176	$0	$0	$176	0 h	0 h	0 h	4 h
28	CMMProgrammerSF	50%	20 h	0 w	2/25/05	3/3/05	$940	$0	$0	$940	0 h	0 h	0 h	20 h
32	CMMLarge	100%	40 h	0 w	2/25/05	3/3/05	$0	$0	$0	$0	0 h	0 h	0 h	40 h

Notes

WBS Definition-

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost

"Align south support cylinder in fixture on CMM" continued

Notes

Align the cylinder in its fixture on CMM, set up coordinate system for measuring stave positions

M&S BOE-
No costs associated with this item.

Labor BOE-
Based on the Run2a experience the alignment is expected to take one week. Full time resources of a physicist, 50% of a mechtech, and 50% of a CMM programmer were needed for Run2a. The physicist has to verify the measurements made by the CMM operator. Some drawings will need to be checked so 10% of designer time is included.

1.1.5.3.6.2	Install staves in south support cylinder	3/4/05	3/31/05	$0	$0	$6,368	$6,368

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
1	MechEngF	10%	16 h	0 w	3/4/05	3/31/05	$816	$0	$0	$816	0 h	0 h	0 h	16 h
9	MechTechSF	50%	80 h	0 w	3/4/05	3/31/05	$2,720	$0	$0	$2,720	0 h	0 h	0 h	80 h
17	PhysicistF	100%	160 h	0 w	3/4/05	3/31/05	$0	$0	$0	$0	0 h	0 h	0 h	160 h
21	DesignerF	5%	8 h	0 w	3/4/05	3/31/05	$352	$0	$0	$352	0 h	0 h	0 h	8 h
27	CMMOperatorSF	50%	80 h	0 w	3/4/05	3/31/05	$2,480	$0	$0	$2,480	0 h	0 h	0 h	80 h
32	CMMLarge	100%	160 h	0 w	3/4/05	3/31/05	$0	$0	$0	$0	0 h	0 h	0 h	160 h

Notes

WBS Definition-
Install staves and attach to outer stave positioning bulkhead, connect staves to coolant distribution manifolds, strain relieve cables

M&S BOE-
no costs associated with this item

Labor BOE-
There are a total of 84 staves to be installed. We assume 5 staves per day and have alotted 4 weeks for this task. The installation of the 5 staves takes 4 hours of CMM operator and Mechanical Tech. In addition, there needs to be consultation time with the mechanical engineer and designers. A full time physicist oversees the operations.

1.1.5.3.6.3	Verify stave alignment	4/1/05	4/7/05	$0	$0	$1,300	$1,300

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
9	MechTechSF	50%	20 h	0 w	4/1/05	4/7/05	$680	$0	$0	$680	0 h	0 h	0 h	20 h
27	CMMOperatorSF	50%	20 h	0 w	4/1/05	4/7/05	$620	$0	$0	$620	0 h	0 h	0 h	20 h
32	CMMLarge	100%	40 h	0 w	4/1/05	4/7/05	$0	$0	$0	$0	0 h	0 h	0 h	40 h
44	PostDoc	50%	20 h	0 w	4/1/05	4/7/05	$0	$0	$0	$0	0 h	0 h	0 h	20 h

Notes

WBS Definition-
Perform and analyze CMM measurements of stave positions in cylinder

M&S BOE-
no costs associated with this item

Labor BOE-
Run2a experience assumes 4 hours of 2 techs time and the rest is supervisory

1.1.5.3.6.4	Final electrical test of south layers 2-5	4/8/05	4/28/05	$0	$0	$1,020	$1,020

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
9	MechTechSF	25%	30 h	0 w	4/8/05	4/28/05	$1,020	$0	$0	$1,020	0 h	0 h	0 h	30 h
34	SASEQTestStandF	100%	120 h	0 w	4/8/05	4/28/05	$0	$0	$0	$0	0 h	0 h	0 h	120 h
44	PostDoc	200%	240 h	0 w	4/8/05	4/28/05	$0	$0	$0	$0	0 h	0 h	0 h	240 h

Notes

WBS Definition-
Perform electrical tests of layer 2-5 staves (temporary cooling connections may be required). Each of the staves is connected and readout through the SASEQ test stands.

M&S BOE-
no costs associated with this item

Labor BOE-
There are 84 staves to test. 2 full time phys testing 6 staves per day. In addition some mechanical technician time is included for hooking up cooling.

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
1.1.5.3.7	**Layer 2-5 South Silicon Complete**	**4/28/05**	**4/28/05**	**$0**	**$0**	**$0**	**$0**

Notes

WBS Definition-
Milestone: The South cylinder with Layers 2-5 has been produced and tested and is ready for mating with Layers 0 and 1.

1.1.5.3.8	Mate L0-L1 with L2-L5, south	4/29/05	5/12/05	$0	$0	$9,456	$9,456

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
1	MechEngF	100%	80 h	0 w	4/29/05	5/12/05	$4,080	$0	$0	$4,080	0 h	0 h	0 h	80 h
9	MechTechSF	100%	80 h	0 w	4/29/05	5/12/05	$2,720	$0	$0	$2,720	0 h	0 h	0 h	80 h
17	PhysicistF	100%	80 h	0 w	4/29/05	5/12/05	$0	$0	$0	$0	0 h	0 h	0 h	80 h
21	DesignerF	5%	4 h	0 w	4/29/05	5/12/05	$176	$0	$0	$176	0 h	0 h	0 h	4 h
27	CMMOperatorSF	100%	80 h	0 w	4/29/05	5/12/05	$2,480	$0	$0	$2,480	0 h	0 h	0 h	80 h
32	CMMLarge	100%	80 h	0 w	4/29/05	5/12/05	$0	$0	$0	$0	0 h	0 h	0 h	80 h

Notes

WBS Definition-
Install layer 0-1 assembly into layer 2-5 assembly, complete mechanical connections at outer end, verify alignment, connect layers 0-1 to coolant distribution manifolds

M&S BOE-
no costs associated with this item

Labor BOE-
Run2a experience, with 2 full time techs, 2 full time supervisors on large CMM. We alot 2 weeks for this operation. The mating is done in short time and then the verifications take a few days.

1.1.5.3.9	Install Radiation monitors	5/13/05	5/26/05	$0	$0	$2,720	$2,720

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
9	MechTechSF	100%	80 h	0 w	5/13/05	5/26/05	$2,720	$0	$0	$2,720	0 h	0 h	0 h	80 h
17	PhysicistF	50%	40 h	0 w	5/13/05	5/26/05	$0	$0	$0	$0	0 h	0 h	0 h	40 h
18	PhysicistU	50%	40 h	0 w	5/13/05	5/26/05	$0	$0	$0	$0	0 h	0 h	0 h	40 h
44	PostDoc	100%	80 h	0 w	5/13/05	5/26/05	$0	$0	$0	$0	0 h	0 h	0 h	80 h

Notes

WBS Definition-
Install the radiation monitor sensors onto their mounts as part of the south barrel assembly and verifying that they read out.

M&S BOE-
no costs associated with this item

Labor BOE-
This is based on the Run2a installation of the radiation monitors onto the F-disks which took one week. We've alotted 2 weeks and assume that there is full use of a mechanical technician and that there is full time the postdoc who tested the radiation monitors available and part time of two other physicist supervisors.

1.1.5.3.10	Final electrical test of south silicon	5/27/05	6/17/05	$0	$0	$1,020	$1,020

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
9	MechTechSF	25%	30 h	0 w	5/27/05	6/17/05	$1,020	$0	$0	$1,020	0 h	0 h	0 h	30 h
34	SASEQTestStandF	100%	120 h	0 w	5/27/05	6/17/05	$0	$0	$0	$0	0 h	0 h	0 h	120 h
44	PostDoc	200%	240 h	0 w	5/27/05	6/17/05	$0	$0	$0	$0	0 h	0 h	0 h	240 h

Notes

WBS Definition-
Perform electrical tests of south silicon, temporary local cooling system amy be required. Staves are readout individually with SASEQ teststand.

M&S BOE-
no costs associated with this item

Labor BOE-
There are 84 staves, 72 layer 0 modules and 36 layer 1 modules to test. We assume that 6 full staves can be tested per day (2 weeks). For Layer 0 and Layer 1, at least 4 modules will be connected up and read out. Layer 0 takes 3 days and Layer 1 takes 2 days. This needs two full time postdocs and the assistance of a mechanical technician to help with the cooling setup.

1.1.5.4	**South Silicon Complete**	**6/17/05**	**6/17/05**	**$0**	**$0**	**$0**	**$0**

Notes

WBS Definition-
Milestone: Layers 0-5 of the south silicon barrel detector have been produced and tested and the barrel can be prepared for shipping to DAB

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
1.1.5.5	**North Silicon Barrel Assembly**	**8/24/04**	**7/5/05**	**$0**	**$0**	**$57,636**	**$57,636**

Notes

WBS Definition-
Summary task that includes all mechanical parts and assembly for the L0/L1 as well as L2-5 North silicon barrel, the cooling and gas systems as well as testing for all of it

M&S BOE-
There are no M&S costs associated with these tasks.

Labor BOE-
The contingency follows a straight 50% for both technical and physicist help based on previous Run2a experience.

Risk Mitigation-
Assembly of L0/L1 is important for obtaining the b vertex impact parameter resolution. Assembly of the staves into the barrels is essential for alignment considerations. This is at the end of the production line and is by definition a critical path item.
Worries are:
- Schedule slippages
- Cooling hookup and testing
- L0/L1 assembly because of tight space issues

Cost doesn't appear to be an issue.
Schedule:
For L0/L1, these tasks can slip by over 5 months without affecting the end date. Prototype mounting and cooling setup is planned with the cylinders as they will be available. We will have dry runs using prototype staves. The assembly of the South Barrel can slip by 4 months in the schedule without affecting the end date. We expect to have people well trained by the North barrel assembly which is on the critical path.
Technical/Scope:
It is clear, that we will do as much prototyping of the procedures as possible before the real barrel is available but we will also have 4 months to examine the south barrel once it is built.

1.1.5.5.1	**L0 Barrel**	**8/24/04**	**12/2/04**	**$0**	**$0**	**$20,516**	**$20,516**

Notes

WBS Definition-
The summary task that includes mounting and testing modules and temperature monitors on the north L0 support structure.

1.1.5.5.1.1	Mount sensor modules for layer 0, north(Fermilab)	8/24/04	11/2/04	$0	$0	$16,420	$16,420

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
9	MechTechSF	50%	200 h	0 w	8/24/04	11/2/04	$6,800	$0	$0	$6,800	0 h	0 h	0 h	200 h
17	PhysicistF	30%	120 h	0 w	8/24/04	11/2/04	$0	$0	$0	$0	0 h	0 h	0 h	120 h
18	PhysicistU	30%	120 h	0 w	8/24/04	11/2/04	$0	$0	$0	$0	0 h	0 h	0 h	120 h
21	DesignerF	5%	20 h	0 w	8/24/04	11/2/04	$880	$0	$0	$880	0 h	0 h	0 h	20 h
27	CMMOperatorSF	25%	100 h	0 w	8/24/04	11/2/04	$3,100	$0	$0	$3,100	0 h	0 h	0 h	100 h
28	CMMProgrammerSF	30%	120 h	0 w	8/24/04	11/2/04	$5,640	$0	$0	$5,640	0 h	0 h	0 h	120 h
32	CMMLarge	100%	400 h	0 w	8/24/04	11/2/04	$0	$0	$0	$0	0 h	0 h	0 h	400 h

Notes

WBS Definition-
Mount sensor modules on Layer 0 support structure

M&S BOE-
no costs associated with this item

Labor BOE-
Based on CDF experience in Run2a, assume 2 physicists and one CMMT working full time will mount 2 modules per day and include some slack time put 1 week on consultation by DES to update drawings

1.1.5.5.1.2	Verify sensor alignment	11/3/04	11/9/04	$0	$0	$2,600	$2,600

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
9	MechTechSF	100%	40 h	0 w	11/3/04	11/9/04	$1,360	$0	$0	$1,360	0 h	0 h	0 h	40 h
17	PhysicistF	50%	20 h	0 w	11/3/04	11/9/04	$0	$0	$0	$0	0 h	0 h	0 h	20 h
18	PhysicistU	50%	20 h	0 w	11/3/04	11/9/04	$0	$0	$0	$0	0 h	0 h	0 h	20 h
27	CMMOperatorSF	100%	40 h	0 w	11/3/04	11/9/04	$1,240	$0	$0	$1,240	0 h	0 h	0 h	40 h
32	CMMLarge	100%	40 h	0 w	11/3/04	11/9/04	$0	$0	$0	$0	0 h	0 h	0 h	40 h

Notes

WBS Definition-
Make detailed QC measurements on CMM and analyze measurements to certify mechanical precision

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
"Verify sensor alignment" continued							

Notes

M&S BOE-
no costs associated with this item

Labor BOE-
Based on Run2a experience, full time measurements will be done 6 hours/day for 1 week

1.1.5.5.1.3	Install Temperature monitors	11/10/04	11/16/04	$0	$0	$1,360	$1,360

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
9	MechTechSF	100%	40 h	0 w	11/10/04	11/16/04	$1,360	$0	$0	$1,360	0 h	0 h	0 h	40 h
17	PhysicistF	50%	20 h	0 w	11/10/04	11/16/04	$0	$0	$0	$0	0 h	0 h	0 h	20 h
18	PhysicistU	100%	40 h	0 w	11/10/04	11/16/04	$0	$0	$0	$0	0 h	0 h	0 h	40 h

Notes

WBS Definition-
The placement of the RTD temperature monitors on the L0 support structure and silicon.

M&S BOE-
no costs associated with this item

Labor BOE-
There are a total of 20 sensors to install. Assume that task takes one full week with full time MechTech. The installation physicist supervisor is there 50% of the time and the supervising physicist who designed and made sensors is there all the time.

1.1.5.5.1.4	Final electrical test of readout	11/17/04	12/2/04	$0	$0	$136	$136

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
9	MechTechSF	5%	4 h	0 w	11/17/04	12/2/04	$136	$0	$0	$136	0 h	0 h	0 h	4 h
34	SASEQTestStandF	100%	80 h	0 w	11/17/04	12/2/04	$0	$0	$0	$0	0 h	0 h	0 h	80 h
44	PostDoc	150%	120 h	0 w	11/17/04	12/2/04	$0	$0	$0	$0	0 h	0 h	0 h	120 h

Notes

WBS Definition-
Perform electrical tests of L0 south readout and certify

M&S BOE-
no costs associated with this item

Labor BOE-
There are 72 modules. Each module will be plugged in to check (1 hour/module), groups of modules will be checked together for 3 days and final tests will be run for 1 day. Need 1.5 physicists full time. A mechanical tech is included at the 5% level to help make fine connections.

1.1.5.5.2	**L0 North Silicon Complete**	**12/2/04**	**12/2/04**	**$0**	**$0**	**$0**	**$0**

Notes

WBS Definition-
Milestone: All modules for the L0 north barrel have been mounted and tested.

1.1.5.5.3	**L1 Barrel**	**8/24/04**	**11/16/04**	**$0**	**$0**	**$13,768**	**$13,768**

Notes

WBS Definition-
The summary task that includes mounting, testing, and assembly of the L1 modules onto the north support structure.

1.1.5.5.3.1	Mount sensor modules for layer 1, north	8/24/04	11/2/04	$0	$0	$12,460	$12,460

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
9	MechTechSF	30%	120 h	0 w	8/24/04	11/2/04	$4,080	$0	$0	$4,080	0 h	0 h	0 h	120 h
17	PhysicistF	30%	120 h	0 w	8/24/04	11/2/04	$0	$0	$0	$0	0 h	0 h	0 h	120 h
18	PhysicistU	30%	120 h	0 w	8/24/04	11/2/04	$0	$0	$0	$0	0 h	0 h	0 h	120 h
21	DesignerF	5%	20 h	0 w	8/24/04	11/2/04	$880	$0	$0	$880	0 h	0 h	0 h	20 h
27	CMMOperatorSF	15%	60 h	0 w	8/24/04	11/2/04	$1,860	$0	$0	$1,860	0 h	0 h	0 h	60 h
28	CMMProgrammerSF	30%	120 h	0 w	8/24/04	11/2/04	$5,640	$0	$0	$5,640	0 h	0 h	0 h	120 h
32	CMMLarge	100%	400 h	0 w	8/24/04	11/2/04	$0	$0	$0	$0	0 h	0 h	0 h	400 h

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
"Mount sensor modules for layer 1, north" continued							

Notes

WBS Definition-
Mount sensor modules onto layer 1 support structure

M&S BOE-
no costs associated with this item

Labor BOE-
Based experience in Run2a, assume 2 physicists and one CMM Tech working full time will mount 1 module per day and include some slack time put 1 week on consultation by Designer to update drawings.

1.1.5.5.3.2	Verify sensor alignment	11/3/04	11/9/04	$0	$0	$1,240	$1,240

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
17	PhysicistF	50%	20 h	0 w	11/3/04	11/9/04	$0	$0	$0	$0	0 h	0 h	0 h	20 h
27	CMMOperatorSF	100%	40 h	0 w	11/3/04	11/9/04	$1,240	$0	$0	$1,240	0 h	0 h	0 h	40 h
32	CMMLarge	100%	40 h	0 w	11/3/04	11/9/04	$0	$0	$0	$0	0 h	0 h	0 h	40 h
44	PostDoc	50%	20 h	0 w	11/3/04	11/9/04	$0	$0	$0	$0	0 h	0 h	0 h	20 h

Notes

WBS Definition-
Make detailed QC measurements on CMM and analyze measurements to certify mechanical precision

M&S BOE-
no costs associated with this item

Labor BOE-
Based on Run2a experience, full time measurements will be done 6 hours/day for 1 week

1.1.5.5.3.3	Final electrical test of readout	11/10/04	11/16/04	$0	$0	$68	$68

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
9	MechTechSF	5%	2 h	0 w	11/10/04	11/16/04	$68	$0	$0	$68	0 h	0 h	0 h	2 h
34	SASEQTestStandF	100%	40 h	0 w	11/10/04	11/16/04	$0	$0	$0	$0	0 h	0 h	0 h	40 h
44	PostDoc	150%	60 h	0 w	11/10/04	11/16/04	$0	$0	$0	$0	0 h	0 h	0 h	60 h

Notes

WBS Definition-
Perform electrical tests of south L1 readout and certify using SASEQ teststand

M&S BOE-
no costs associated with this item

Labor BOE-
There are 36 modules
Each module will be plugged in to check (1 hour/module), groups of modules will be checked together for 2 days and final tests will be run for 1 day. Need 1.5 full time physicists. A mechanical technician is included at the 5% level to help make fine connections.

1.1.5.5.4	**L1 North Silicon Complete**	**11/16/04**	**11/16/04**	**$0**	**$0**	**$0**	**$0**

Notes

WBS Definition-
Milestone: All L1 north modules have been mounted and tested and L1 is ready for mating with L0

1.1.5.5.5	Mate layer 0 with layer 1, north	12/3/04	12/9/04	$0	$0	$2,600	$2,600

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
9	MechTechSF	100%	40 h	0 w	12/3/04	12/9/04	$1,360	$0	$0	$1,360	0 h	0 h	0 h	40 h
17	PhysicistF	100%	40 h	0 w	12/3/04	12/9/04	$0	$0	$0	$0	0 h	0 h	0 h	40 h
18	PhysicistU	100%	40 h	0 w	12/3/04	12/9/04	$0	$0	$0	$0	0 h	0 h	0 h	40 h
27	CMMOperatorSF	100%	40 h	0 w	12/3/04	12/9/04	$1,240	$0	$0	$1,240	0 h	0 h	0 h	40 h
32	CMMLarge	100%	40 h	0 w	12/3/04	12/9/04	$0	$0	$0	$0	0 h	0 h	0 h	40 h

Notes

WBS Definition-
Install Layer 0 inside of Layer 1, make mechanical connections and verify relative positioning

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
"Mate layer 0 with layer 1, north" continued							

Notes

M&S BOE-
no costs associated with this item

Labor BOE-
1 CMM full time with tech and physicist based on mating procedures in Run2a

1.1.5.5.6	Final electrical test of layers 0-1 north	12/10/04	12/23/04	$0	$0	$136	$136

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
9	MechTechSF	5%	4 h	0 w	12/10/04	12/23/04	$136	$0	$0	$136	0 h	0 h	0 h	4 h
34	SASEQTestStandF	100%	80 h	0 w	12/10/04	12/23/04	$0	$0	$0	$0	0 h	0 h	0 h	80 h
44	PostDoc	200%	160 h	0 w	12/10/04	12/23/04	$0	$0	$0	$0	0 h	0 h	0 h	160 h

Notes

WBS Definition-
Make final electrical tests of Layers 0-1 north. Each module is plugged in and read out using the SASEQ teststand.

M&S BOE-
no costs associated with this item

Labor BOE-
There are 72 layer 0 modules and 36 layer 1 modules. 4 modules can be plugged in and read out per hour. Assume 2 full time physicists. A mechanical technician is included at the 5% level to help make fine connections. The modules have been read out previously after installation onto each layer so this is just a final check.

1.1.5.5.7	**L0-L1 North Silicon Complete**	**12/23/04**	**12/23/04**	**$0**	**$0**	**$0**	**$0**

Notes

WBS Definition-
Milestone: Layers 0 and 1 have been produced and tested and mated together and are ready to be assembled into the North barrel with L2-5

1.1.5.5.8	**L2-L5 Barrel Assembly**	**2/11/05**	**5/20/05**	**$0**	**$0**	**$8,956**	**$8,956**

Notes

WBS Definition-
Summary task that includes assembly and testing of the staves into the south barrel support cylinder

M&S BOE-
No costs associated with these items

Labor BOE-
Contingency of 150% is assigned to all labor as these tasks are on the critical path and are the last ones we need to do. If a second shift is required then they will receive time and a half pay.

1.1.5.5.8.1	Align north support cylinder in fixture on CMM	2/11/05	2/18/05	$0	$0	$620	$620

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
17	PhysicistF	100%	40 h	0 w	2/11/05	2/18/05	$0	$0	$0	$0	0 h	0 h	0 h	40 h
27	CMMOperatorSF	50%	20 h	0 w	2/11/05	2/18/05	$620	$0	$0	$620	0 h	0 h	0 h	20 h
32	CMMLarge	100%	40 h	0 w	2/11/05	2/18/05	$0	$0	$0	$0	0 h	0 h	0 h	40 h

Notes

WBS Definition-
Align the cylinder in its fixture on CMM, set up coordinate system for measuring stave positions

M&S BOE-
no costs associated with this item.

Labor BOE-
Based on the Run2a experience the alignment is expected to take one week. Full time resources of a physicist, mechanical tech, and CMM operator were needed for Run2a. The physicist has to verify the measurements made by the CMM operator.

1.1.5.5.8.2	Install staves in north support cylinder	3/25/05	4/22/05	$0	$0	$6,016	$6,016

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
1	MechEngF	10%	16 h	0 w	3/25/05	4/22/05	$816	$0	$0	$816	0 h	0 h	0 h	16 h
9	MechTechSF	50%	80 h	0 w	3/25/05	4/22/05	$2,720	$0	$0	$2,720	0 h	0 h	0 h	80 h

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
"Install staves in north support cylinder" continued							

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
17	PhysicistF	100%	160 h	0 w	3/25/05	4/22/05	$0	$0	$0	$0	0 h	0 h	0 h	160 h
27	CMMOperatorSF	50%	80 h	0 w	3/25/05	4/22/05	$2,480	$0	$0	$2,480	0 h	0 h	0 h	80 h
32	CMMLarge	100%	160 h	0 w	3/25/05	4/22/05	$0	$0	$0	$0	0 h	0 h	0 h	160 h

Notes

WBS Definition-
Install staves and attach to outer stave positioning bulkhead, connect staves to coolant distribution manifolds, strain relieve cables

M&S BOE-
no costs associated with this item

Labor BOE-
There are a total of 84 staves to be installed. We assume 5 staves per day and have alotted 4 weeks for this task. The installation of the 5 staves takes 4 hours of CMM operator and Mechanical Tech. In addition, there needs to be consultation time with the mechanical engineer. A full time physicist oversees the operations.

1.1.5.5.8.3	Verify stave alignment	4/22/05	4/29/05	$0	$0	$1,300	$1,300

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
9	MechTechSF	50%	20 h	0 w	4/22/05	4/29/05	$680	$0	$0	$680	0 h	0 h	0 h	20 h
27	CMMOperatorSF	50%	20 h	0 w	4/22/05	4/29/05	$620	$0	$0	$620	0 h	0 h	0 h	20 h
32	CMMLarge	100%	40 h	0 w	4/22/05	4/29/05	$0	$0	$0	$0	0 h	0 h	0 h	40 h
44	PostDoc	50%	20 h	0 w	4/22/05	4/29/05	$0	$0	$0	$0	0 h	0 h	0 h	20 h

Notes

WBS Definition-
Perform and analyze CMM measurements of stave positions

M&S BOE-
no costs associated with this item.

Labor BOE-
Run2a experience assumes 4 hours of 2 techs time and the rest is supervisory

1.1.5.5.8.4	Final electrical test of north layers 2-5	4/29/05	5/20/05	$0	$0	$1,020	$1,020

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
9	MechTechSF	25%	30 h	0 w	4/29/05	5/20/05	$1,020	$0	$0	$1,020	0 h	0 h	0 h	30 h
34	SASEQTestStandF	100%	120 h	0 w	4/29/05	5/20/05	$0	$0	$0	$0	0 h	0 h	0 h	120 h
44	PostDoc	200%	240 h	0 w	4/29/05	5/20/05	$0	$0	$0	$0	0 h	0 h	0 h	240 h

Notes

WBS Definition-
Perform electrical tests of layer 2-5 staves (temporary cooling connections may be required). Each of the staves is connected and readout through the SASEQ test stands.

M&S BOE-
no costs associated with this item

Labor BOE-
There are 84 staves to test. Two full time physicists testing 6 staves per day. In addition some mechanical technician time is included for hooking up cooling.

1.1.5.5.9	**Layer 2-5 North Silicon Complete**	**5/20/05**	**5/20/05**	**$0**	**$0**	**$0**	**$0**

Notes

WBS Definition-
Milestone: The North cylinder with Layers 2-5 has been produced and tested and is ready for mating with Layers 0 and 1.

1.1.5.5.10	Mate L0-L1 with L2-L5, north	5/20/05	6/6/05	$0	$0	$9,280	$9,280

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
1	MechEngF	100%	80 h	0 w	5/20/05	6/6/05	$4,080	$0	$0	$4,080	0 h	0 h	0 h	80 h
9	MechTechSF	100%	80 h	0 w	5/20/05	6/6/05	$2,720	$0	$0	$2,720	0 h	0 h	0 h	80 h
17	PhysicistF	100%	80 h	0 w	5/20/05	6/6/05	$0	$0	$0	$0	0 h	0 h	0 h	80 h
27	CMMOperatorSF	100%	80 h	0 w	5/20/05	6/6/05	$2,480	$0	$0	$2,480	0 h	0 h	0 h	80 h
32	CMMLarge	100%	80 h	0 w	5/20/05	6/6/05	$0	$0	$0	$0	0 h	0 h	0 h	80 h

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
"Mate L0-L1 with L2-L5, north" continued							

Notes

WBS Definition-
Install layer 0-1 assembly into layer 2-5 assembly, complete mechanical connections at outer end, verify alignment, connect layers 0-1 to coolant distribution manifolds

M&S BOE-
no costs associated with this item

Labor BOE-
Run2a experience, with 2 full time techs, 2 full time supervisors on large CMM. We alot 2 weeks for this operation. The mating is done in short time and then the verifications take a few days.
Contingency of 150% is assigned to all labor as these tasks are on the critical path and are the last ones we need to do. If a second shift is required then they will receive time and a half pay.

1.1.5.5.11	Install Radiation monitors	6/6/05	6/13/05	$0	$0	$1,360	$1,360

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
9	MechTechSF	100%	40 h	0 w	6/6/05	6/13/05	$1,360	$0	$0	$1,360	0 h	0 h	0 h	40 h
17	PhysicistF	50%	20 h	0 w	6/6/05	6/13/05	$0	$0	$0	$0	0 h	0 h	0 h	20 h
18	PhysicistU	50%	20 h	0 w	6/6/05	6/13/05	$0	$0	$0	$0	0 h	0 h	0 h	20 h
44	PostDoc	100%	40 h	0 w	6/6/05	6/13/05	$0	$0	$0	$0	0 h	0 h	0 h	40 h

Notes

WBS Definition-
Install the radiation monitor sensors onto their mounts as part of the north barrel assembly and verifying that they read out.

M&S BOE-
no costs associated with this item

Labor BOE-
This is based on the Run2a installation of the radiation monitors onto the F-disks which took one week. We've alotted 2 weeks and assume that there is full use of a mechanical technician and that there is full time the postdoc who tested the radiation monitors available and part time of two other physicist supervisors.
Contingency of 150% is assigned to all labor as these tasks are on the critical path and are the last ones we need to do. If a second shift is required then they will receive time and a half pay.

1.1.5.5.12	Final electrical test of north silicon	6/13/05	7/5/05	$0	$0	$1,020	$1,020

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
9	MechTechSF	25%	30 h	0 w	6/13/05	7/5/05	$1,020	$0	$0	$1,020	0 h	0 h	0 h	30 h
34	SASEQTestStandF	100%	120 h	0 w	6/13/05	7/5/05	$0	$0	$0	$0	0 h	0 h	0 h	120 h
44	PostDoc	200%	240 h	0 w	6/13/05	7/5/05	$0	$0	$0	$0	0 h	0 h	0 h	240 h

Notes

WBS Definition-
Perform electrical tests of north silicon, temporary local cooling system amy be required. Staves are readout individually with SASEQ teststand.

M&S BOE-
no costs associated with this item

Labor BOE-
There are 84 staves, 72 layer 0 modules and 36 layer 1 modules to test. We assume that 6 full staves can be tested per day (2 weeks). For Layer 0 and Layer 1, at least 4 modules will be connected up and read out. Layer 0 takes 3 days and Layer 1 takes 2 days. This needs two full time postdocs and the assistance of a mechanical technician to help with the cooling setup.
Contingency of 150% is assigned to all labor as these tasks are on the critical path and are the last ones we need to do. If a second shift is required then they will receive time and a half pay.

1.1.5.6	**North Silicon Complete**	**7/5/05**	**7/5/05**	**$0**	**$0**	**$0**	**$0**

Notes

WBS Definition-
Milestone: The north half of the silicon detector is complete with layers 0-5 and tested and ready for packaging for shipment to DAB.

1.1.5.7	(retired)	7/5/05	7/6/05	$0	$0	$0	$0

Notes

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
1.1.5.8	Prepare for shipment	7/5/05	7/22/05	$0	$0	$12,376	$12,376

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
1	MechEngF	100%	104 h	0 w	7/5/05	7/22/05	$5,304	$0	$0	$5,304	0 h	0 h	0 h	104 h
9	MechTechSF	200%	208 h	0 w	7/5/05	7/22/05	$7,072	$0	$0	$7,072	0 h	0 h	0 h	208 h
17	PhysicistF	100%	104 h	0 w	7/5/05	7/22/05	$0	$0	$0	$0	0 h	0 h	0 h	104 h

Notes

WBS Definition-
Move silicon to its shipping fixture, enclose with protective covers, provide any necessary purge gas connections and supplies

M&S BOE-
no costs associated with this item

Labor BOE-
Run2a experience:
Need 2 mechanical techs in order to move the detector at any one time. The mechanical engineer assures the procedures will ensure the safety of the detector. The physicist oversees the entire process and checks the engineer's calculations. Contingency of 150% is assigned to all labor as these tasks are on the critical path and are the last ones we need to do. If a second shift is required then they will receive time and a half pay.

Risk Mitigation-
If the detector is not prepared properly for shipment, then the entire project goes down the drain. However, it is technically straightforward and has been done before so the entire project team will scrutinize it carefully.

1.1.5.9	**Silicon Ready To Move To DAB**	**7/22/05**	**7/22/05**	**$0**	**$0**	**$0**	**$0**

Notes

WBS Definition-
Milestone: Run2b silicon detector is produced and tested and packaged and ready for shipping to the D0 assembly building for installation into D0

1.1.5.10	**Support Structures Within CFT Barrel 3**	**4/26/04**	**8/17/04**	**$0**	**$0**	**$10,416**	**$10,416**

Notes

WBS Definition-
This summary task includes design and fabrication of support structures within the fiber tracker

1.1.5.10.1	Design support structures	4/26/04	6/21/04	$0	$0	$7,600	$7,600

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
1	MechEngF	25%	80 h	0 w	4/26/04	6/21/04	$4,080	$0	$0	$4,080	0 h	0 h	0 h	80 h
17	PhysicistF	25%	80 h	0 w	4/26/04	6/21/04	$0	$0	$0	$0	0 h	0 h	0 h	80 h
18	PhysicistU	25%	80 h	0 w	4/26/04	6/21/04	$0	$0	$0	$0	0 h	0 h	0 h	80 h
21	DesignerF	25%	80 h	0 w	4/26/04	6/21/04	$3,520	$0	$0	$3,520	0 h	0 h	0 h	80 h

Notes

WBS Definition-
Design structures to support junction cards, cabling, and services within CFT barrel 3

M&S BOE-
no costs associated with this item

Labor BOE-
Task is 8 weeks in duration and each party contributes 2weeks of work at various times.
PhysicistU is working on the cable routing and junction card design,
PhysicistF is coordinating the effort and reviewing it,
Mechanical engineer is designing the support structures.
A few drawings are needed by the designer.
Run2a experience in designing cable and coolant manifold supports within CFT barrel 3.

1.1.5.10.2	Fabricate support structures	6/22/04	8/17/04	$0	$0	$2,816	$2,816

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
17	PhysicistF	20%	64 h	0 w	6/22/04	8/17/04	$0	$0	$0	$0	0 h	0 h	0 h	64 h
21	DesignerF	20%	64 h	0 w	6/22/04	8/17/04	$2,816	$0	$0	$2,816	0 h	0 h	0 h	64 h

Notes

WBS Definition-
Fabricate the structures support junction cards, cabling, and services within CFT barrel 3.

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost

"Fabricate support structures" continued

Notes

M&S BOE-
Run2a experience with cable and cooling line supports within CFT barrel 3. Fabrication of fixtures needed as done before. The cost total is $6000, but the cost appears in the MRI fixturing line.

Labor BOE-
Run2a experience in fabricating support structures for use within CFT barrel 3. We need a physicist and a designer at the 20% level.

1.1.5.11	**Coolant Distribution System**	**9/3/03**	**10/1/04**	**$144,700**	**$0**	**$228,720**	**$373,420**

Notes

WBS Definition-
This summary task includes design and fabrication of a coolant distribution system

1.1.5.11.1	Design and fabricate additional system to provide -20	9/3/03	2/3/04	$88,600	$0	$83,600	$172,200

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
1	MechEngF	50%	400 h	0 w	9/3/03	2/3/04	$20,400	$0	$0	$20,400	0 h	0 h	0 h	400 h
8	MechTechF	100%	800 h	0 w	9/3/03	2/3/04	$28,000	$0	$0	$28,000	0 h	0 h	0 h	800 h
17	PhysicistF	50%	400 h	0 w	9/3/03	2/3/04	$0	$0	$0	$0	0 h	0 h	0 h	400 h
21	DesignerF	100%	800 h	0 w	9/3/03	2/3/04	$35,200	$0	$0	$35,200	0 h	0 h	0 h	800 h
48	MandS	88,600	88,600	0 w	9/3/03	2/3/04	$88,600	$0	$0	$88,600		0	0	88,600

Notes

WBS Definition-
Design and fabricate an additional chiller, heat exchangers, storage vessels, gas purge and removal systems, and piping to provide -20 C cooling

M&S BOE-
Two chillers @ $15000 each, scaled upward from Run2a chiller cost to take into account lower temperature
$5100 for vacuum insulated piping based upon Run2a cost
$12000 for two vacuum pumps plus vacuum valves
$6000 for three additional vessels
$400 for filters
$500 for deionization equipment
$9600 for instrumentation at 48 locations
$20000 for a cooling system for a sector test at SiDet
$5000 for welding services during system fabrication
Contingency set by guidelines

Labor BOE-
Full time tech with 0.5 time of Physicist and MechEng based on Run2a experience, need lots of drawings so full time designer is needed.

1.1.5.11.2	Verify flow and delivery capabilities	2/4/04	3/16/04	$0	$0	$20,640	$20,640

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
1	MechEngF	100%	240 h	0 w	2/4/04	3/16/04	$12,240	$0	$0	$12,240	0 h	0 h	0 h	240 h
8	MechTechF	100%	240 h	0 w	2/4/04	3/16/04	$8,400	$0	$0	$8,400	0 h	0 h	0 h	240 h
17	PhysicistF	100%	240 h	0 w	2/4/04	3/16/04	$0	$0	$0	$0	0 h	0 h	0 h	240 h

Notes

WBS Definition-
Verify the flow and delivery capabilities of the -20 C system at operating temperature

M&S BOE-
no costs associated with this item

Labor BOE-
Full time testing with PHYS, ME, MT based on the similar distribution system used in Run2a.

1.1.5.11.3	Design and fabricate coolant distribution bulkheads	3/17/04	7/8/04	$56,100	$0	$83,200	$139,300

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
1	MechEngF	100%	640 h	0 w	3/17/04	7/8/04	$32,640	$0	$0	$32,640	0 h	0 h	0 h	640 h
8	MechTechF	100%	640 h	0 w	3/17/04	7/8/04	$22,400	$0	$0	$22,400	0 h	0 h	0 h	640 h
17	PhysicistF	100%	640 h	0 w	3/17/04	7/8/04	$0	$0	$0	$0	0 h	0 h	0 h	640 h

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
"Design and fabricate coolant distribution bulkheads" continued							

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
21	DesignerF	100%	640 h	0 w	3/17/04	7/8/04	$28,160	$0	$0	$28,160	0 h	0 h	0 h	640 h
48	MandS	56,100	56,100	0 w	3/17/04	7/8/04	$56,100	$0	$0	$56,100		0	0	56,100

Notes

WBS Definition-
Design and fabricate the bulkheads to distribute coolant to the ends of silicon layers 0-5

M&S BOE-
Based upon purchased beryllium distribution manifolds and Run 2a costs for barrel bulkheads and F-disk and H-disk cooling / support tubes. Contingency set by guidelines.

Labor BOE-
Full time work based on Run2a experience and Run 2b R&D need: physicist to help design system with mechanical engineer, mechanical tech fabricated the bulkheads, there are lots of drawings so the designer is also full time.

1.1.5.11.4	Measure pressure drops versus flows of flow elements	7/9/04	8/5/04	$0	$0	$13,760	$13,760

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
1	MechEngF	100%	160 h	0 w	7/9/04	8/5/04	$8,160	$0	$0	$8,160	0 h	0 h	0 h	160 h
8	MechTechF	100%	160 h	0 w	7/9/04	8/5/04	$5,600	$0	$0	$5,600	0 h	0 h	0 h	160 h
17	PhysicistF	100%	160 h	0 w	7/9/04	8/5/04	$0	$0	$0	$0	0 h	0 h	0 h	160 h

Notes

WBS Definition-
Measure pressure drop versus flow for each stave type, each layer 0-1 structure, coolant distribution bulkheads, piping elements, heat exchangers, and other individual cooling system components

Labor BOE-
Full time work based on Run2a experience and University of Washington Run 2b R&D on L0/L1 cooling tubes. Need physicist, mechanical engineer and mechanical tech.

1.1.5.11.5	Balance flows	8/6/04	10/1/04	$0	$0	$27,520	$27,520

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
1	MechEngF	100%	320 h	0 w	8/6/04	10/1/04	$16,320	$0	$0	$16,320	0 h	0 h	0 h	320 h
8	MechTechF	100%	320 h	0 w	8/6/04	10/1/04	$11,200	$0	$0	$11,200	0 h	0 h	0 h	320 h
17	PhysicistF	100%	320 h	0 w	8/6/04	10/1/04	$0	$0	$0	$0	0 h	0 h	0 h	320 h

Notes

WBS Definition-
Select and custom machine any flow control devices needed to provide the required flow rate to each parallel path of the cooling system

M&S BOE-
no costs associated with this item.

Labor BOE-
Full time work based on Run2a experience and Run 2b R&D for each of Mechanical Engineer, mechanical technician to assemble the devices needed. The physicist oversees the operation in daily contact with both the engineer and technician.

1.1.5.12	**Dry-gas Distribution System**	**10/4/04**	**1/6/05**	**$150,000**	**$0**	**$51,840**	**$201,840**

Notes

WBS Definition-
This summary task includes the design and fabrication of the dry gas distribution system

1.1.5.12.1	Design and fabricate dry gas system	10/4/04	11/12/04	$50,000	$0	$31,200	$81,200

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
1	MechEngF	100%	240 h	0 w	10/4/04	11/12/04	$12,240	$0	$0	$12,240	0 h	0 h	0 h	240 h
8	MechTechF	100%	240 h	0 w	10/4/04	11/12/04	$8,400	$0	$0	$8,400	0 h	0 h	0 h	240 h
17	PhysicistF	100%	240 h	0 w	10/4/04	11/12/04	$0	$0	$0	$0	0 h	0 h	0 h	240 h
21	DesignerF	100%	240 h	0 w	10/4/04	11/12/04	$10,560	$0	$0	$10,560	0 h	0 h	0 h	240 h
48	MandS	50,000	50,000	0 w	10/4/04	11/12/04	$50,000	$0	$0	$50,000		0	0	50,000

Notes

WBS Definition-
Design and fabricate all components, lines, instrumentation, controls, and equipment needed to provide high-reliability purge gas flow to the silicon region and to nearby detector regions

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost

"Design and fabricate dry gas system" continued

Notes

M&S BOE-
Based upon Run2a costs for a dry gas system including storage and distribution.
Contingency set to 30% as the cost is based on what we've built before

Labor BOE-
Based on Run2a experience and number of drawings needed

1.1.5.12.2	Prepare controls, monitoring, and interlocks	11/15/04	1/6/05	$100,000	$0	$20,640	$120,640

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
1	MechEngF	100%	240 h	0 w	11/15/04	1/6/05	$12,240	$0	$0	$12,240	0 h	0 h	0 h	240 h
8	MechTechF	100%	240 h	0 w	11/15/04	1/6/05	$8,400	$0	$0	$8,400	0 h	0 h	0 h	240 h
17	PhysicistF	100%	240 h	0 w	11/15/04	1/6/05	$0	$0	$0	$0	0 h	0 h	0 h	240 h
48	MandS	100,000	100,000	0 w	11/15/04	1/6/05	$100,000	$0	$0	$100,000		0	0	100,000

Notes

WBS Definition-
Prepare and test those controls, monitoring, and interlocks specific to silicon purge operation

M&S BOE-
Includes upgrade of PLC system to currently supported equipment and modules. Estimate from the engineer responsible for installation and maintenance of the Run 2a system. Contingency is set to 30% as cost is based on what we've built before.

Labor BOE-
Run2a experience

1.1.5.12.3	Silicon Cooling And Dry Gas Systems Ready For Ir	1/6/05	1/6/05	$0	$0	$0	$0

Notes

WBS Definition-
Milestone: Systems are specified with monitoring and controls for the cooling and dry gas system.

1.1.5.12.4	Review mechanical systems for pORC	12/15/04	1/6/05	$0	$0	$0	$0

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
17	PhysicistF	100%	80 h	0 w	12/15/04	1/6/05	$0	$0	$0	$0	0 h	0 h	0 h	80 h

Notes

WBS Definition-
Prepare, review, and submit documentation to demonstrate that silicon mechanical infrastructure is sufficient to safely install and operate silicon

M&S BOE-
no costs associated with this item

Labor BOE-
Run2a experience. Full time physicist reviews the documentation.

1.1.6	Monitoring	10/1/02	7/12/04	$34,225	$21,000	$31,712	$86,937

Notes

WBS Definition-
This summary element includes design, production and testing of radiation and temperature monitoring systems independent of DAQ readout chain

M&S BOE-
Costs are described in detail on the lines they appear. The contingency for this entire task is set to 50% based on previous experience building these devices.

Labor BOE-
The contingency is set to a flat 50% both for physicists and technical staff for all tasks.

Risk Mitigation-
The risks with having these systems not work are minimal.

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
1.1.6.1	Modify monitoring and control system	5/1/03	6/26/03	$0	$0	$30,080	$30,080

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
4	ElecEngF	100%	320 h	0 w	5/1/03	6/26/03	$17,600	$0	$0	$17,600	0 h	0 h	0 h	320 h
13	ElecTechF	100%	320 h	0 w	5/1/03	6/26/03	$12,480	$0	$0	$12,480	0 h	0 h	0 h	320 h

Notes

WBS Definition-
Make sure that the software and control system is setup to handle all of the high voltage modules in the system

Labor BOE-
Run2a experience

1.1.6.2	**Radiation Monitors**	**10/1/02**	**7/12/04**	**$14,000**	**$0**	**$1,632**	**$15,632**

Notes

WBS Definition-
This summary element includes hardware and detectors for radiation monitors that measure the dose and dose rate delivered to the silicon detector. It includes silicon diodes, hybrids, cabling, and readout electronics.

1.1.6.2.1	Design system (Fermilab)	10/1/02	11/25/02	$0	$0	$1,632	$1,632

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
1	MechEngF	10%	32 h	0 w	10/1/02	11/25/02	$1,632	$0	$0	$1,632	0 h	0 h	0 h	32 h
17	PhysicistF	10%	32 h	0 w	10/1/02	11/25/02	$0	$0	$0	$0	0 h	0 h	0 h	32 h

Notes

WBS Definition-
Integration of design and location of radiation monitor sensors sensors in collaboration with NIKHEF.

Labor BOE-
The critical issue is the location of the radiation monitors. It is expected that it takes the better part of a week of a physicist and a mechanical engineer to discuss the implications of the various possibilities for location of radiation monitors.

1.1.6.2.2	**Radiation Monitors (NIKHEF)**	**10/1/02**	**7/12/04**	**$14,000**	**$0**	**$0**	**$14,000**

Notes

WBS Definition-
Summary task that includes the design, prototyping, and production of the radiation monitor system by NIKHEF

1.1.6.2.2.1	Design system (NIKHEF)	10/1/02	11/25/02	$0	$0	$0	$0

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
6	ElecEngU	100%	320 h	0 w	10/1/02	11/25/02	$0	$0	$0	$0	0 h	0 h	0 h	320 h
18	PhysicistU	25%	80 h	0 w	10/1/02	11/25/02	$0	$0	$0	$0	0 h	0 h	0 h	80 h

Notes

WBS Definition-
Design system to monitor the radiation dose the silicon detector is exposed to.

M&S BOE-
No M&S cost associated with this task.

Labor BOE-
Since the system is a duplicate of the system build for the RunIIa detector, it is expected that it will take an electronics engineer 8 weeks to go review the system and adapt it to the new geometry. A physicist oversees and also interacts with the sensor people to ensure that the diodes on the test structures are adequate. He's involved at the 25% level.

1.1.6.2.2.2	Produce diodes	11/26/02	4/28/03	$0	$0	$0	$0

Notes

WBS Definition-
Production of silicon diodes by vendor. About 50 silicon diodes are needed for the radiation monitoring system.

M&S BOE-
No M&S cost associated with this task. The design of the silicon sensors submitted to the sensor producers include test structures. There are 0.8cm*0.8cm silicon diodes on the test structure which will be used as radiation monitors.

Labor BOE-

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost

"Produce diodes" continued

Notes
No labor associated with the production.

1.1.6.2.2.3 Test diodes

Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
4/29/03	7/23/03	$0	$0	$0	$0

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
15	ElecTechU	100%	480 h	0 w	4/29/03	7/23/03	$0	$0	$0	$0	0 h	0 h	0 h	480 h
18	PhysicistU	50%	240 h	0 w	4/29/03	7/23/03	$0	$0	$0	$0	0 h	0 h	0 h	240 h

Notes
WBS Definition-
Testing of the silicon diodes to ensure that they function as expected

M&S BOE-
No M&S cost associated with this task. The infrastructure to test the diodes is already in place from RunIIa.

Labor BOE-
Testing the diodes does not differ much from probing the sensors. The diodes will be tested for stability and leakage current behavior and their depletion voltage will be determined from the CV characteristic. The stability test needs at least 24 hours per diode. Up to four diodes can be measured simultaneously. For Run2a we had a yield of best diodes of about 25%. This means that about 200 diodes have to be tested, which will take 10 weeks. A week is added at the beginning to setup the test stands again. A week of contingency is added at the end. The diodes are glued to the PCB structure at the end of the production line, only holding the final testing of the fully assembled sensor cards.

1.1.6.2.2.4 Design sensor boards

Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
7/24/03	9/18/03	$0	$0	$0	$0

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
6	ElecEngU	50%	160 h	0 w	7/24/03	9/18/03	$0	$0	$0	$0	0 h	0 h	0 h	160 h
22	DesignerU	50%	160 h	0 w	7/24/03	9/18/03	$0	$0	$0	$0	0 h	0 h	0 h	160 h

Notes
WBS Definition-
Design the boards holding the diodes.

M&S BOE-
No M&S cost.

Labor BOE-
The design of the boards holding the diodes with the associated FE readout electronics only depends on the choice of the location of the sensor cards and on thus on the shape of the sensor cards. A minimum surface area of about 8 cm^2 is needed and the card should not be narrower than 1.2 cm. On both south and north side of the detector more than 12 sensor boards can be accommodated. Given the similarity between these cards and those designed for the RunIIa detector, an electronics engineer and a designer work on this task at the 50% level for the duration.

1.1.6.2.2.5 Procure prototype parts

Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
9/19/03	10/16/03	$0	$0	$0	$0

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
6	ElecEngU	10%	16 h	0 w	9/19/03	10/16/03	$0	$0	$0	$0	0 h	0 h	0 h	16 h

Notes
WBS Definition-
Procure preproduction parts for the sensor boards and downstream readout

M&S BOE-
The Sensor board is produced at a cost of $1000, the price paid for a sensor board for RunIIa.

Labor BOE-
The EE places the order and follows up on the procurement at half a day per week.

1.1.6.2.2.6 Fabricate prototypes

Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
10/17/03	12/15/03	$4,000	$0	$0	$4,000

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
48	MandS	4,000	4,000	0 w	10/17/03	12/15/03	$4,000	$0	$0	$4,000		0	0	4,000

Notes
WBS Definition-
Fabricate prototype sensor boards as well as downstream readout

M&S BOE-
Prototype boards are expected to cost $1000 per board for a total of $4000 for four boards. Production boards are expected to cost $200 per board.

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
"Fabricate prototypes" continued							

Notes

Labor BOE-
No labor associated with fabrication.

1.1.6.2.2.7	Test prototypes	12/16/03	1/22/04	$0	$0	$0	$0

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
6	ElecEngU	100%	160 h	0 w	12/16/03	1/22/04	$0	$0	$0	$0	0 h	0 h	0 h	160 h

Notes

WBS Definition-
Verify operation of prototype system

M&S BOE-
No M&S cost.

Labor BOE-
To fully verify and map the functionality of the boards is expected to take one week per board full time of an electronics engineer.

1.1.6.2.2.8	**Decide On Final Radiation Monitoring System**	**1/22/04**	**1/22/04**	**$0**	**$0**	**$0**	**$0**

Notes

WBS Definition-
Milestone: Verification of the specifications and design of system in conjunction with RUn2b silicon group so that it is released for production.

1.1.6.2.2.9	Procure final system	1/23/04	2/19/04	$0	$0	$0	$0

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
6	ElecEngU	10%	16 h	0 w	1/23/04	2/19/04	$0	$0	$0	$0	0 h	0 h	0 h	16 h

Notes

WBS Definition-
Procure parts including sensor boards, diodes, and components

M&S BOE-
No M&S cost.

Labor BOE-
The Electrical Engineer places the order and follows up on the procurement at half a day per week.

1.1.6.2.2.10	Fabricate final system	2/20/04	5/13/04	$10,000	$0	$0	$10,000

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
18	PhysicistU	10%	48 h	0 w	2/20/04	5/13/04	$0	$0	$0	$0	0 h	0 h	0 h	48 h
48	MandS	10,000	10,000	0 w	2/20/04	5/13/04	$10,000	$0	$0	$10,000		0	0	10,000

Notes

WBS Definition-
Make all of the sensor boards and all other readout components

M&S BOE-
Cost for a total of 25 sensor boards at $200 per board and the low mass readout cables at $200 per cable for a total M&S cost of $10,000.

Labor BOE-
No labor associated with fabrication.

1.1.6.2.2.11	Test radiation monitoring system	5/14/04	7/12/04	$0	$0	$0	$0

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
6	ElecEngU	100%	320 h	0 w	5/14/04	7/12/04	$0	$0	$0	$0	0 h	0 h	0 h	320 h
18	PhysicistU	10%	32 h	0 w	5/14/04	7/12/04	$0	$0	$0	$0	0 h	0 h	0 h	32 h

Notes

WBS Definition-
Finalize system and test full readout chain on the bench

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
"Test radiation monitoring system" continued							

Notes

M&S BOE-
No M&S cost.

Labor BOE-
The diodes are glued to the PCB structure at the end of the production line, only leaving the final testing of the fully assembled sensor cards. Final testing of the sensor cards takes about 1 day per card. There are 50 cards in the system.

1.1.6.2.2.12	**Radiation Monitoring System Ready For Installatio**	**7/12/04**	**7/12/04**	**$0**	**$0**	**$0**	**$0**

Notes
WBS Definition-
Milestone: The production and testing of the radiation monitoring system is complete and it is ready for mounting in the detector.

1.1.6.3	**Temperature Monitors**	**10/21/02**	**2/4/04**	**$20,225**	**$21,000**	**$0**	**$41,225**

Notes
WBS Definition-
The summary task includes the design, prototyping, production, and testing for an independent system to read the silicon temperatures on L0/L1

1.1.6.3.1	Design system (Fermilab)	10/21/02	6/9/03	$0	$0	$0	$0

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
17	PhysicistF	5%	62 h	0 w	10/21/02	6/9/03	$0	$0	$0	$0	0 h	0 h	0 h	62 h

Notes
WBS Definition-
Design, draw, and assist in placement of the RTD detectors on L0/L1.

M&S BOE-
no costs associated with this item

Labor BOE-
Overseen by a physicist who helps to verify the overall design including locations and functionality of the sensors.

1.1.6.3.2	**Temperature Monitors (Rice)**	**10/21/02**	**2/4/04**	**$20,225**	**$21,000**	**$0**	**$41,225**

Notes
WBS Definition-
Summary task that includes the design, production, and testing of the independent temperature monitoring system for the L0/L1 sensors done by Rice University.

1.1.6.3.2.1	Design system (Rice)	10/21/02	3/21/03	$0	$12,000	$0	$12,000

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
6	ElecEngU	30%	240 h	0 w	10/21/02	3/21/03	$0	$0	$0	$0	0 h	0 h	0 h	240 h
18	PhysicistU	10%	80 h	0 w	10/21/02	3/21/03	$0	$0	$0	$0	0 h	0 h	0 h	80 h
48	MandS	12,000	12,000	0 w	10/21/02	3/21/03	$12,000	$0	$0	$12,000		0	0	12,000

Notes
WBS Definition-
The development and design of the temperature monitoring system to reside on L0/L1. This includes testing of thermally conducting epoxies to attach RTDs and the readout system associated with the RTD.

M&S BOE-
Engineer to run tests and specify the system. Assume 30% for a period of 20 weeks at a total cost osf $12000. This estimate is from Rice University and is based on 40 hours/week at $50/hour including fringe and overhead.

Labor BOE-
See M&S costs. In addition a physicist oversees the design effort at the 10% level and communicates back to Run2b group.

1.1.6.3.2.2	Build and test preproduction	3/24/03	9/10/03	$2,600	$0	$0	$2,600

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
18	PhysicistU	10%	96 h	0 w	3/24/03	9/10/03	$0	$0	$0	$0	0 h	0 h	0 h	96 h
48	MandS	2,600	2,600	0 w	3/24/03	9/10/03	$2,600	$0	$0	$2,600		0	0	2,600

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost

"Build and test preproduction" continued

Notes

WBS Definition-
Procuring the necessary parts to assemble and then test preproduction modules for the temperature monitoring system

M&S BOE-
We need a CTI 2257 16-channel RTD Input Module at $2200. We also buy 20 RTD devices at $10 each $200 and 20 low mass cables at $10/cable
Total: $2600

Labor BOE-
Physicist to oversee procurements at the 10% level. The engineer who builds the system is covered in previous task.

1.1.6.3.2.3	Procure parts and build final system	9/11/03	1/6/04	$17,625	$9,000	$0	$26,625

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
6	ElecEngU	30%	180 h	0 w	9/11/03	1/6/04	$0	$0	$0	$0	0 h	0 h	0 h	180 h
18	PhysicistU	10%	60 h	0 w	9/11/03	1/6/04	$0	$0	$0	$0	0 h	0 h	0 h	60 h
48	MandS	26,625	26,625	0 w	9/11/03	1/6/04	$26,625	$0	$0	$26,625		0	0	26,625

Notes

WBS Definition-
Procuring the necessary parts to assemble and then production modules for the temperature monitoring system

M&S BOE-
We need a CTI 2257 16-channel RTD Input Module at $2500/16 channels = $156.25/channel. The CTI 505 RTD module, model 2557-SPQ334, supplies current to and reads back the voltage for Resistive Temperature Devices (RTDs) for temperature monitoring. These modules have been used often at Fermilab. The BoE is a recent PO by Dan Markley for use in the D0 magnet cryogenic system. The date of the PO is July 31, 2002, and the price per module is $2500. We estimate 100 channels for a cost of $15,625 for the modules which both provide current and readout the temperatures. RTD devices and low-mass cables. The RTD devices at $10 each x 100 devices =$1000. The cost of the low-mass cables is approximately $10/cable. For 100 cables, cost is $1000. Total $17,625.
Construction of final RTD/cable assemblies: 30% time of engineer for a period of 15 weeks for $9000. based on Rice estimate.

Labor BOE-
See M&S for electrical engineer. Physicist to oversee procurements at the 10% level.

1.1.6.3.2.4	Test temperature monitoring system	1/7/04	2/4/04	$0	$0	$0	$0

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
18	PhysicistU	10%	16 h	0 w	1/7/04	2/4/04	$0	$0	$0	$0	0 h	0 h	0 h	16 h
47	Student	100%	160 h	0 w	1/7/04	2/4/04	$0	$0	$0	$0	0 h	0 h	0 h	160 h

Notes

WBS Definition-
Full readout chain test on the bench and verification of functionality of all parts

M&S BOE-
no costs associated with this item

Labor BOE-
A full time student helps to test the system supervised by a physicist at the 10% level. Each of the 100 cables takes 1 hour to test for a total of 100 hours.

1.1.6.3.3	**Temperature Monitoring System Ready To Be Insta**	**2/4/04**	**2/4/04**	**$0**	**$0**	**$0**	**$0**

Notes

WBS Definition-
Milestone: RTD system of temperature monitors for the L0/L1 sensors is produced and tested and ready to be installed on modules.

1.1.7	**Software and Simulation**	**4/16/01**	**5/5/05**	**$2,500**	**$12,500**	**$0**	**$15,000**

Notes

WBS Definition-
This summary element refers to the software development needed for the design and commissioning of the Run IIb silicon tracker. It includes the simulation studies to justify our design, the development of codes required for silicon data analysis, calibration and monitoring and the associated design of a new hardware database.

M&S BOE-
There are costs associated with the production database that are described in that task. There is no contingency taken on this cost as it is fixed by an MRI grant.

Labor BOE-

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
"Software and Simulation" continued							

Notes

All tasks are handled by physicists in this summary task except for the production database task that is costed as M&S. The detailed description resides on each line on how the physicist cost was determined. The contingency for physicists is placed at 100% for all of these tasks to account for the vagaries of predicting how much work it will take to get the codes running.

Risk Mitigation-
No items appear above the cutoff, but this summary task is crucial to running of the detector during the commissioning stage and that is why these items appear in our schedule early.

1.1.7.1	**Simulation of Run 2b SMT Response**	**5/1/01**	**8/1/01**	**$0**	**$0**	**$0**	**$0**

Notes

WBS Definition-
Summary task referring to the simulation of the new RunIIb silicon tracker. Run 2A geometry simulation in the framework consists of two packages, d0gstar and simpp, and geometry description file used as inputfile for the geometry building interpretator.

1.1.7.1.1	Geometry Description	5/1/01	5/29/01	$0	$0	$0	$0

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
44	PostDoc	200%	320 h	0 w	5/1/01	5/29/01	$0	$0	$0	$0	0 h	0 h	320 h	0 h

Notes

WBS Definition-
Description of the geometry of the new detector

M&S BOE-
Not applicable

Labor BOE-
Estimate of required manpower and time is based on Run 2A experience. The Run 2A geometry simulation in the framework consists of two packages, d0gstar and simpp, and geometry description file used as inputfile for the geometry building interpretator. Geometry has to be written from scratch since it has nothing in common with Run 2A geometry; d0gstar and simpp packages should be modified moderately (about 30% of source codes should be modified); the core source of digitization package should be modified also.

1.1.7.1.2	**Implementation into GEANT**	**5/30/01**	**8/1/01**	**$0**	**$0**	**$0**	**$0**

Notes

WBS Definition-
Summary task that involves modification of d0gstar,SMT digitization and implementation of interface for storage information.

1.1.7.1.2.1	Modification of D0gstar D0 Run2a Package	5/30/01	6/12/01	$0	$0	$0	$0

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
44	PostDoc	200%	160 h	0 w	5/30/01	6/12/01	$0	$0	$0	$0	0 h	0 h	160 h	0 h

Notes

WBS Definition-
D0gstar package provides the GEANT hits: coordinates of entry and exit from the sensitive volume, energy and type of particle and energy loss. As geometry has been changed the way to get the hit coordinates as well as sensitive volume will also change and should be modified.

M&S BOE-
Not applicable

Labor BOE-
Based on time spent.

1.1.7.1.2.2	Implementation of Interface for Storage of Simulation I	6/13/01	7/3/01	$0	$0	$0	$0

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
44	PostDoc	200%	240 h	0 w	6/13/01	7/3/01	$0	$0	$0	$0	0 h	0 h	240 h	0 h

Notes

WBS Definition-
This step means that simpp RunIIa package should be modified. Simpp package creates chunks with information about hits according to detector type in the format appropriate for further usage.

M&S BOE-
Not applicable

Labor BOE-

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost

"Implementation of Interface for Storage of Simulation Information" continued

Notes
Estimate of required manpower and time is based on Run 2A experience and time spent.

1.1.7.1.2.3	Modification of Run2a SMT Digitization Package	7/5/01	8/1/01	$0	$0	$0	$0

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
44	PostDoc	200%	320 h	0 w	7/5/01	8/1/01	$0	$0	$0	$0	0 h	0 h	320 h	0 h

Notes
WBS Definition-
Modification of existing package means the introduction of the changes to work in the Run IIB model. For the D0Sim package the necessary change is digitization of detectors with intermediate strips.

M&S BOE-
Not applicable

Labor BOE-
Estimate of required manpower and time is based on Run 2A experience and time spent.

1.1.7.2	**Cluster Reconstruction**	**5/30/01**	**7/25/01**	**$0**	**$0**	**$0**	**$0**

Notes
WBS Definition-
Summary task that includes modification of the Run2a clustering packages and simulation and debugging of the cluster simulation.

1.1.7.2.1	Modification Run2a clustering packages	5/30/01	6/12/01	$0	$0	$0	$0

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
44	PostDoc	100%	80 h	0 w	5/30/01	6/12/01	$0	$0	$0	$0	0 h	0 h	80 h	0 h

Notes
WBS Definition-
Modification assumes that the Run IIA code can be used after making changes corresponding the the features of the Run IIB geometry. For the clusterization package this means that three-dimensional clusters cannot be done at that step in Run IIB geometry and corresponding part of software should be removed.

M&S BOE-
Not applicable

Labor BOE-
Based on time spent.

1.1.7.2.2	Testing of Cluster Simulation and Reconstruction	6/13/01	6/26/01	$0	$0	$0	$0

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
44	PostDoc	100%	80 h	0 w	6/13/01	6/26/01	$0	$0	$0	$0	0 h	0 h	80 h	0 h

Notes
WBS Definition-
Run on the known input and analyze output (compare GEANT hit positions to the reconstructed cluster positions)

M&S BOE-
not applicable

Labor BOE-
based on time spent

1.1.7.2.3	Simulation of Single Particles and Physics Processes	6/27/01	7/25/01	$0	$0	$0	$0

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
44	PostDoc	50%	80 h	0 w	6/27/01	7/25/01	$0	$0	$0	$0	0 h	0 h	80 h	0 h

Notes
WBS Definition-
Run the whole chain of RunIIB software starting from hit simulation and ending with reconstructed clusters for several sets of single particles and some physics processes (like Higgs production, minimum bias events)

M&S BOE-

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost

"Simulation of Single Particles and Physics Processes" continued

Notes
not applicable

Labor BOE-
based on time spent.

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
1.1.7.3	**Standalone Track Reconstruction**	**4/16/01**	**9/12/01**	**$0**	**$0**	**$0**	**$0**

Notes
WBS Definition-
Summary task that takes care of set of packages needed for the pattern recognition and track reconstruction out of recosntructed clusters.

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
1.1.7.3.1	Initial Design of Standalone Track Reconstruction Pac	4/16/01	6/11/01	$0	$0	$0	$0

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
44	PostDoc	50%	160 h	0 w	4/16/01	6/11/01	$0	$0	$0	$0	0 h	0 h	160 h	0 h
47	Student	100%	320 h	0 w	4/16/01	6/11/01	$0	$0	$0	$0	0 h	0 h	320 h	0 h

Notes
WBS Definition-
Creating the initial version of reconstruction code for the Run IIB SMT only

M&S BOE-
not applicable

Labor BOE-
Based on time spent.

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
1.1.7.3.2	Testing of Reconstruction Code	6/12/01	7/17/01	$0	$0	$0	$0

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
47	Student	100%	200 h	0 w	6/12/01	7/17/01	$0	$0	$0	$0	0 h	0 h	200 h	0 h

Notes
WBS Definition-
Check the code with the Run IIB datasets (track finding efficiency, fake track rate)

M&S BOE-
not applicable

Labor BOE-
Based on time spent.

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
1.1.7.3.3	Combining of SMT standalone tracking with the CFT r	7/18/01	7/31/01	$0	$0	$0	$0

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
44	PostDoc	50%	40 h	0 w	7/18/01	7/31/01	$0	$0	$0	$0	0 h	0 h	40 h	0 h
47	Student	100%	80 h	0 w	7/18/01	7/31/01	$0	$0	$0	$0	0 h	0 h	80 h	0 h

Notes
WBS Definition-
This step means integration of two different track finding codes into one global track finding package which will allow to reconstruct tracks in the both tracking systems, SMT and CFT.

M&S BOE-
not applicable

Labor BOE-
Based on time spent.

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
1.1.7.3.4	Testing of the Full Fimulation and Reconstruction Chai	8/1/01	9/12/01	$0	$0	$0	$0

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
44	PostDoc	50%	120 h	0 w	8/1/01	9/12/01	$0	$0	$0	$0	0 h	0 h	120 h	0 h
47	Student	50%	120 h	0 w	8/1/01	9/12/01	$0	$0	$0	$0	0 h	0 h	120 h	0 h

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost

"Testing of the Full Fimulation and Reconstruction Chain" continued

Notes

WBS Definition-
Run the track finding package on the simulated data and check the track finding efficiency and fake track rate

M&S BOE-
not applicable

Labor BOE-
Based on time spent.

1.1.7.3.5	**Release Of Silicon Reconstruction Code**	**9/12/01**	**9/12/01**	**$0**	**$0**	**$0**	**$0**

Notes

WBS Definition-
Milestone: The reconstruction code has been written and tested and is ready to be released into D0 library system.

1.1.7.4	**Software Development for Run2b Commissioning**	**10/3/02**	**8/25/03**	**$0**	**$0**	**$0**	**$0**

Notes

WBS Definition-
Summary task that includes development of the packages required to download, monitor, read out and analyze data from 1% of the silicon tracker

Labor BOE-
Offline software required for the commissioning of Run IIb silicon tracker includes the following packages:

unpack_reco	1540 lines
smtraw	3000 lines
smtutil	3000 lines
smt_examine	5500 lines
smt_event_display	1700 lines

As the number and configuration of silicon tracker elements will change these packages will require significant changes or complete re-design.

1.1.7.4.1	**Data Unpacking**	**10/3/02**	**4/30/03**	**$0**	**$0**	**$0**	**$0**

Notes

WBS Definition-
Summary task that includes the design, writing, and testing of the data unpacking and translation code.

Labor BOE-

Unpacking of the raw data is provided by three packages in Run 2a:
the following packages:

unpack_reco	1540 lines
smtraw	3000 lines
smtutil	3000 lines

As the format of the packed data, the mapping and configuration of silicon tracker will change these packages will require minor (unpack_reco) or significant changes (smtraw and smtutil). Based on Run2a experience we estimate that 30 weeks will be sufficient for 1 post-doc and 1 grad student @50% to complete this task.

1.1.7.4.1.1	Modification of Run2a Code for Data Unpacking	10/3/02	10/30/02	$0	$0	$0	$0

ID	*Resource Name*	*Units*	*Work*	*Delay*	*Start*	*Finish*	*Cost*	*Baseline Cost*	*Act. Cost*	*Rem. Cost*	*Ovt. Work*	*Baseline Work*	*Act. Work*	*Rem. Work*
44	*PostDoc*	*50%*	*80 h*	*0 w*	*10/3/02*	*10/30/02*	*$0*	*$0*	*$0*	*$0*	*0 h*	*0 h*	*0 h*	*80 h*
47	*Student*	*50%*	*80 h*	*0 w*	*10/3/02*	*10/30/02*	*$0*	*$0*	*$0*	*$0*	*0 h*	*0 h*	*0 h*	*80 h*

Notes

WBS Definition-
Data unpacking is a set of software packages providing conversion from the packed data format into the format accepted by the offline packages.

M&S BOE-
not applicable

Labor BOE-
The estimate of the required time and manpower is based on Run2a experience. Run2a data unpacking package (unpack_reco) source code contains 1540 lines. Design of this package for Run 2a required about 6 months of 1 postdoc at 100%. We estimate that the modification of the existing package (which is expected to be not very significant since we keep the most of the Run2a DAQ chain) will take 4 weeks for a grad student @50% and a post-doc @50%.

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
1.1.7.4.1.2	Testing of Code	10/31/02	11/13/02	$0	$0	$0	$0

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
44	PostDoc	50%	40 h	0 w	10/31/02	11/13/02	$0	$0	$0	$0	0 h	0 h	0 h	40 h
47	Student	50%	40 h	0 w	10/31/02	11/13/02	$0	$0	$0	$0	0 h	0 h	0 h	40 h

Notes

WBS Definition-
Package testing assumes running the package on the known input and analyze output

M&S BOE-
not applicable

Labor BOE-
Testing of the package containing 1500 lines after minor modifications will take two weeks for grad student @50% and post-doc @ 50%

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
1.1.7.4.1.3	Design Code for Address Translation	11/14/02	2/19/03	$0	$0	$0	$0

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
44	PostDoc	50%	240 h	0 w	11/14/02	2/19/03	$0	$0	$0	$0	0 h	0 h	0 h	240 h
47	Student	50%	240 h	0 w	11/14/02	2/19/03	$0	$0	$0	$0	0 h	0 h	0 h	240 h

Notes

WBS Definition-
Provide new classes for electronic to physics addresses conversion

M&S BOE-
not applicable

Labor BOE-
The second step of the data unpacking (electronic to physics address translation) involves complete or partial redesign of two packages (smtraw and smtutil). Their source codes are more than 3000 lines each. Therefore we assign 14 weeks to redesign these packages for 1 post-doc @ 50% and 1 grad student @50%

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
1.1.7.4.1.4	Testing Translation Code on Monte Carlo	2/20/03	3/19/03	$0	$0	$0	$0

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
44	PostDoc	50%	80 h	0 w	2/20/03	3/19/03	$0	$0	$0	$0	0 h	0 h	0 h	80 h
47	Student	50%	80 h	0 w	2/20/03	3/19/03	$0	$0	$0	$0	0 h	0 h	0 h	80 h

Notes

WBS Definition-
Run the package on the known input and analyze output

M&S BOE-
not applicable

Labor BOE-
Unpacking has to be tested and debugged on Monte Carlo first. Based on Run2a experience this work will require 4 weeks for 1 post-doc @50% and 1 grad student @50%

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
1.1.7.4.1.5	Integration Unpacking and Translation Code in Frame\	3/20/03	4/2/03	$0	$0	$0	$0

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
44	PostDoc	50%	40 h	0 w	3/20/03	4/2/03	$0	$0	$0	$0	0 h	0 h	0 h	40 h
47	Student	50%	40 h	0 w	3/20/03	4/2/03	$0	$0	$0	$0	0 h	0 h	0 h	40 h

Notes

WBS Definition-
Integration assumes running the package together with the other software packages within D0 framework

M&S BOE-
not applicable

Labor BOE-
Integration of any package into D0 framework typically takes 2 weeks for 1 post-doc @ 50% and 1 grad student @50%

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
1.1.7.4.1.6	Testing of Unpacking/Translation Chain	4/3/03	4/30/03	$0	$0	$0	$0

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
44	PostDoc	50%	80 h	0 w	4/3/03	4/30/03	$0	$0	$0	$0	0 h	0 h	0 h	80 h
47	Student	50%	80 h	0 w	4/3/03	4/30/03	$0	$0	$0	$0	0 h	0 h	0 h	80 h

Notes

WBS Definition-
Package testing assumes running the package on the known input and analyze output

M&S BOE-
not applicable

Labor BOE-
Testing and debugging of the full unpacking/translation chain starting from raw data is the critical task. Therefore we assign 4 weeks for it.

1.1.7.4.1.7	**Release Silicon Unpacking And Translation Packa**	**4/30/03**	**4/30/03**	**$0**	**$0**	**$0**	**$0**

Notes

WBS Definition-
Milestone: Unpacking and translation code are ready to have request to include new package into the official D0 software release.

1.1.7.4.2	**Data Analysis Package**	**1/23/03**	**6/12/03**	**$0**	**$0**	**$0**	**$0**

Notes

WBS Definition-
Summary task that includes the package for filling histograms related to the silicon tracker performance.

1.1.7.4.2.1	Design Data Analysis Package for Examine	1/23/03	4/30/03	$0	$0	$0	$0

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
44	PostDoc	100%	560 h	0 w	1/23/03	4/30/03	$0	$0	$0	$0	0 h	0 h	0 h	560 h
47	Student	50%	280 h	0 w	1/23/03	4/30/03	$0	$0	$0	$0	0 h	0 h	0 h	280 h

Notes

WBS Definition-
Create classes for booking and filling different types of histograms

M&S BOE-
not applicable

Labor BOE-
The estimate of time and requesred manpower is based on Run 2a experience. SMT Examine online and offline analysis package for Run 2a contains 5500 lines of source codes. The design of the classes for histogram booking and filling will take approximately the same time as for Run2a (14 weeks).

1.1.7.4.2.2	Test Package on Monte Carlo Digitization Output	5/1/03	5/14/03	$0	$0	$0	$0

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
44	PostDoc	100%	80 h	0 w	5/1/03	5/14/03	$0	$0	$0	$0	0 h	0 h	0 h	80 h
47	Student	50%	40 h	0 w	5/1/03	5/14/03	$0	$0	$0	$0	0 h	0 h	0 h	40 h

Notes

WBS Definition-
run package on the known Monte Carlo generated input file and check the histograms

M&S BOE-
not applicable

Labor BOE-
The estimate of time and required manpower is based on Run 2a experience. The functionality of SMT Examine analysis package needs to be first checked using the output of the digitization package which provides the data in the offline format. The assigned time includes input files generation (1 week) and running examine (1 week)

1.1.7.4.2.3	Test Package with Raw Data unpacking	5/15/03	6/12/03	$0	$0	$0	$0

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
44	PostDoc	100%	160 h	0 w	5/15/03	6/12/03	$0	$0	$0	$0	0 h	0 h	0 h	160 h
47	Student	50%	80 h	0 w	5/15/03	6/12/03	$0	$0	$0	$0	0 h	0 h	0 h	80 h

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost

"Test Package with Raw Data unpacking" continued

Notes

WBS Definition-
Input real data using the unpacking chain and check the histograms

M&S BOE-
not applicable

Labor BOE-
The estimate of time and requesred manpower is based on Run 2a experience. The functionality of SMT Examine analysis package needs to be demonstrated using the raw data input. In this case full offline data analysis chain is involved and testing requires more time (4 weeks).

1.1.7.4.2.4	**Release Silicon Examine Package**	**6/12/03**	**6/12/03**	**$0**	**$0**	**$0**	**$0**

Notes

WBS Definition-
Milestone: The Examine software package is ready for use with the run2b detector and is released into the D0 libraries

1.1.7.4.3	Analysis Tools	6/13/03	8/8/03	$0	$0	$0	$0

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
47	Student	50%	160 h	0 w	6/13/03	8/8/03	$0	$0	$0	$0	0 h	0 h	0 h	160 h

Notes

WBS Definition-
a set of standard root macros for producing a set of plots to characterize detector performance

M&S BOE-
not applicable

Labor BOE-
The estimate is based in the Run2a experience. Analysis macros were written by 1 GS@50% during the 2 months period of SMT 10% test. Similar time and manpower will be required to put together a new set of macros reflecting the new SMT design.

1.1.7.4.4	**Event Display**	**5/2/03**	**8/25/03**	**$0**	**$0**	**$0**	**$0**

Notes

WBS Definition-
Summary task that involves designing and implementing an event visualization for the new detector.

1.1.7.4.4.1	Design Visualisation Package for Event Display	5/2/03	7/28/03	$0	$0	$0	$0

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
47	Student	50%	240 h	0 w	5/2/03	7/28/03	$0	$0	$0	$0	0 h	0 h	0 h	240 h

Notes

WBS Definition-
Write classes for graphical presentation of the silicon tracker geometry and hits in silicon

M&S BOE-
not applicable

Labor BOE-
The estimate of time and requesred manpower is based on Run 2a experience. SMT event display package for Run 2a contains 1700 lines of source codes. This package needs to be completely redesigned since it is heavily dependent on the SMT geometry and electronic channel mapping. Therefore the time and manpower has to be similar to the ones in Run 2a.

1.1.7.4.4.2	Test Package on Monte Carlo and Raw Data	7/29/03	8/25/03	$0	$0	$0	$0

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
47	Student	50%	80 h	0 w	7/29/03	8/25/03	$0	$0	$0	$0	0 h	0 h	0 h	80 h

Notes

WBS Definition-
Run the event display package on the known input (MC) and analyze output

M&S BOE-

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost

"Test Package on Monte Carlo and Raw Data" continued

Notes
not applicable

Labor BOE-
The estimate of time and required manpower is based on Run 2a experience. SMT event display package needs to be tested on Monte Carlo and raw data input. The time and manpower will be similar to the ones in Run 2a.

1.1.7.4.4.3	**Release Silicon Event Display Package**	**8/25/03**	**8/25/03**	**$0**	**$0**	**$0**	**$0**

Notes
WBS Definition-
Milestone: The Event Display package is ready for release into the D0 library system and ready for use in Run2b.

1.1.7.5	Support for Packages	5/1/03	5/5/05	$0	$0	$0	$0

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
44	PostDoc	40%	1,600 h	0 w	5/1/03	5/5/05	$0	$0	$0	$0	0 h	0 h	0 h	1,600 h
47	Student	20%	800 h	0 w	5/1/03	5/5/05	$0	$0	$0	$0	0 h	0 h	0 h	800 h

Notes
WBS Definition-
Running tests and fixing possible problems due to change of compiler versions, other packages, etc

M&S BOE-
not applicable

Labor BOE-
Based on Run2a experience we know that all released packages require permanent support due to changes of compiler versions, other packages etc. After the first release each developer spends about 20% of time to support and install new versions of his/her package.

1.1.7.6	**Calibration**	**11/14/02**	**11/3/03**	**$0**	**$0**	**$0**	**$0**

Notes
WBS Definition-
Implement changes to calibration code to support svx4 chip and D0 electronics or SMT

M&S BOE-
Not applicable

Labor BOE-
The code is comprised of two basis parts: 1) downloading parameters to the svx4 chips and electronics and 2) code to collect data and analyze it. Currently the GUI/download part of the program sdaq_gui consists of about 13,000 lines of code which form the GUI, hardware modeling, hardware interface, and EPICS interface. The source code for calibration is maintained in cvs onl_smtcalib libraries and supports both calibration and monitoring. The approximate size of this code is 50,000 lines.

1.1.7.6.1	Design modification to database for Run 2B configurat	11/14/02	12/13/02	$0	$0	$0	$0

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
44	PostDoc	30%	48 h	0 w	11/14/02	12/13/02	$0	$0	$0	$0	0 h	0 h	0 h	48 h
47	Student	30%	48 h	0 w	11/14/02	12/13/02	$0	$0	$0	$0	0 h	0 h	0 h	48 h

Notes
WBS Definition-
This task includes designing: database schema smt_calib, add table smt_daq_adaptercard, modify tables smt_daq_interface, smt_daq_hv_pod, smt_daq_hdi to integrate the new table

M&S BOE-
not applicable

Labor BOE-
Based on Run IIa experience.

1.1.7.6.2	Implementation of the new mapping into the database	12/16/02	2/19/03	$0	$0	$0	$0

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
44	PostDoc	30%	96 h	0 w	12/16/02	2/19/03	$0	$0	$0	$0	0 h	0 h	0 h	96 h
47	Student	30%	96 h	0 w	12/16/02	2/19/03	$0	$0	$0	$0	0 h	0 h	0 h	96 h

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost

"Implementation of the new mapping into the database" continued

Notes

WBS Definition-
Enter the new mapping into a spreadsheet. VRB, SEQ, IB, HV, AC, HDI columns need to be modified. 900 rows each. Update the visual basic code that translates the spreadsheet into an oracle readable format (~200 lines). Run the code and check the resulting oracle table.

M&S BOE-
not applicable

Labor BOE-
This is based on Run IIa experience.

1.1.7.6.3	Modification to database to support SVX4	2/20/03	3/19/03	$0	$0	$0	$0

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
44	PostDoc	30%	48 h	0 w	2/20/03	3/19/03	$0	$0	$0	$0	0 h	0 h	0 h	48 h
47	Student	30%	48 h	0 w	2/20/03	3/19/03	$0	$0	$0	$0	0 h	0 h	0 h	48 h

Notes

WBS Definition-
Modifications of schema smt_calib, table smt_daq_svx, and a few columns with change of parameters.

M&S BOE-
not applicable

Labor BOE-
This is based on Run IIa experience.

1.1.7.6.4	Modifications of decoder routines for new data format	3/20/03	4/16/03	$0	$0	$0	$0

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
44	PostDoc	30%	48 h	0 w	3/20/03	4/16/03	$0	$0	$0	$0	0 h	0 h	0 h	48 h
47	Student	30%	48 h	0 w	3/20/03	4/16/03	$0	$0	$0	$0	0 h	0 h	0 h	48 h

Notes

WBS Definition-
onl_smtcalib code needs modifications to the following programs: smt_gui, classes RawData, SeqData, and SvxData which comprise about 300 lines of code and expect 10% will require modifications; Also will need to modify the program ssdaq, the file dataProcessing.c, and functions svxFill and hdiFill with about 500 lines total of which about 10% will require modifications.

M&S BOE-
not applicable

Labor BOE-
This is based on Run IIa experience.

1.1.7.6.5	Modification to GUI to support SVX4 downloads	4/17/03	5/14/03	$0	$0	$0	$0

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
44	PostDoc	30%	48 h	0 w	4/17/03	5/14/03	$0	$0	$0	$0	0 h	0 h	0 h	48 h
47	Student	30%	48 h	0 w	4/17/03	5/14/03	$0	$0	$0	$0	0 h	0 h	0 h	48 h

Notes

WBS Definition-
Contained within the onl_smtcalib package about 20lines of code in the program smt_gui and the class SmtDaqHdiItem will require modification to fine tune the timing during the download. Also in the same package, the program smt_gui and classes VRBCrate, SEQ, and HDI will be reviewed for changes.

M&S BOE-
not applicable

Labor BOE-
This is based on Run IIa experience.

1.1.7.6.6	Modification to GUI to support SVX4 calibrations	5/15/03	6/12/03	$0	$0	$0	$0

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
44	PostDoc	30%	48 h	0 w	5/15/03	6/12/03	$0	$0	$0	$0	0 h	0 h	0 h	48 h

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
"Modification to GUI to support SVX4 calibrations" continued							

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
47	Student	30%	48 h	0 w	5/15/03	6/12/03	$0	$0	$0	$0	0 h	0 h	0 h	48 h

Notes

WBS Definition-
Modification of frontend program to support SVX4 downloads will require about 50 lines of code to be modified in the onl_smtcalib package for program smt_gui and classes HDI and SVX.

M&S BOE-
not applicable

Labor BOE-
This is based on Run IIA experience.

1.1.7.6.7	Modification of front end program to support SVX4 dov	6/13/03	8/8/03	$0	$0	$0	$0

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
44	PostDoc	30%	96 h	0 w	6/13/03	8/8/03	$0	$0	$0	$0	0 h	0 h	0 h	96 h
47	Student	30%	96 h	0 w	6/13/03	8/8/03	$0	$0	$0	$0	0 h	0 h	0 h	96 h

Notes

WBS Definition-
Modification of frontend program to support the proper timing of SVX4 downloads will require about 20 lines of code to be modified in the onl_smtcalib package for program ssdaq and the file seq.c.

M&S BOE-
not applicable

Labor BOE-
This is based on Run IIA experience.

1.1.7.6.8	Testing of new code	8/11/03	11/3/03	$0	$0	$0	$0

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
44	PostDoc	30%	144 h	0 w	8/11/03	11/3/03	$0	$0	$0	$0	0 h	0 h	0 h	144 h
47	Student	30%	144 h	0 w	8/11/03	11/3/03	$0	$0	$0	$0	0 h	0 h	0 h	144 h

Notes

WBS Definition-
Testing of all of the calibration software packages to verify that they meet design criteria.

M&S BOE-
not applicable

Labor BOE-
Same labor is assumed for the designers and implementers to test their code. Based on Run IIa experience.

1.1.7.6.9	**Release Silicon Calibration Code Package With Do**	**11/3/03**	**11/3/03**	**$0**	**$0**	**$0**	**$0**

Notes

WBS Definition-
Milestone: All calibration software packages are produced and debugged and ready for use in Run2b and can be released to the D0 library system.

1.1.7.7	**Monitoring**	**4/3/03**	**1/26/04**	**$0**	**$0**	**$0**	**$0**

Notes

WBS Definition-
Summary task that includes the modifications and testing needed for monitoring the performance of the front end readout electronics and SMT SVX4 based detector.

M&S BOE-
no costs associated with this summary task

Labor BOE-
The monitoring code and calibration code share a majority of their code. The approximate size of this code is 65,000 lines. The current code needs to be modified for the changes related to using svx4 chips instead of svx2 chips. Based on Run IIa experience we estimate that 13 months of work of 1 postdoc @40% of time and 1 graduate student @30% of time is adequate for this task.

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
1.1.7.7.1	Modifications of software for changes in database	4/3/03	4/30/03	$0	$0	$0	$0

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
44	PostDoc	40%	64 h	0 w	4/3/03	4/30/03	$0	$0	$0	$0	0 h	0 h	0 h	64 h
47	Student	30%	48 h	0 w	4/3/03	4/30/03	$0	$0	$0	$0	0 h	0 h	0 h	48 h

Notes

WBS Definition-
The code that reads information from the database has to be modified for any changes implemented in the calibration portion of 1.1.7.6. This involves reading information about dead hardware (HDIs, chips,strips), reading current pedestal values, and transferring that information to the code on the frontent processors.

M&S BOE-
not applicable

Labor BOE-
This is based on Run IIa experience.

1.1.7.7.2	Develop pattern recognition for alarm conditions	5/1/03	6/26/03	$0	$0	$0	$0

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
44	PostDoc	40%	128 h	0 w	5/1/03	6/26/03	$0	$0	$0	$0	0 h	0 h	0 h	128 h
47	Student	30%	96 h	0 w	5/1/03	6/26/03	$0	$0	$0	$0	0 h	0 h	0 h	96 h

Notes

WBS Definition-

Development of the algorithms used to check the data quality is based on actual experience in Run IIa and initial experience with svx4 chips.

M&S BOE-
not applicable

Labor BOE-
This is based on Run IIa experience.

1.1.7.7.3	Implementation of alarms and significant event system	6/27/03	9/22/03	$0	$0	$0	$0

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
44	PostDoc	40%	192 h	0 w	6/27/03	9/22/03	$0	$0	$0	$0	0 h	0 h	0 h	192 h
47	Student	30%	144 h	0 w	6/27/03	9/22/03	$0	$0	$0	$0	0 h	0 h	0 h	144 h

Notes

WBS Definition-
The alarm generation is based on data quality checks. When an alarm is generated it makes a connection to the significant event system. The alarm code needs to be tuned for the new experience with svx4 chips to promptly notify the shift takers when action must to taken to improve the detector performance.

M&S BOE-
not applicable

Labor BOE-
This is based on Run IIa experience.

1.1.7.7.4	Testing of new code	9/23/03	1/26/04	$0	$0	$0	$0

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
44	PostDoc	40%	256 h	0 w	9/23/03	1/26/04	$0	$0	$0	$0	0 h	0 h	0 h	256 h
47	Student	30%	192 h	0 w	9/23/03	1/26/04	$0	$0	$0	$0	0 h	0 h	0 h	192 h

Notes

WBS Definition-
This is verification that monitoring code and its database conform to specifications.

M&S BOE-
not applicable

Labor BOE-
This is based on Run IIa experience.

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
1.1.7.7.5	**Release Silicon Monitoring Code Package With Do**	**1/26/04**	**1/26/04**	**$0**	**$0**	**$0**	**$0**

Notes

WBS Definition-
Milestone: Monitoring code and database are ready for RunIIb commissioning.

1.1.7.8	**Production Database Work**	**3/4/02**	**4/11/05**	**$2,500**	**$12,500**	**$0**	**$15,000**

Notes

WBS Definition-
Summary task that includes the design, construction and, maintenance of the production database for parts control as well as the travelers for the production.

1.1.7.8.1	MRI database work	3/4/02	3/8/04	$2,500	$12,500	$0	$15,000

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
20	CompProfU	25%	1,000 h	0 w	3/4/02	3/8/04	$0	$0	$0	$0	0 h	0 h	272 h	728 h
48	MandS	15,000	15,000	0 w	3/4/02	3/8/04	$15,000	$0	$15,000	$0		0	4,080	10,920

Notes

WBS Definition-
The design of the implementation for the production database to track parts.

M&S BOE-
2 years of an undergraduate computer science student hired at 10 hours per week. Assume$10/hour for 50 weeks/year - Total salary = $10,000 ID=25% so total is $12,500.
Database server computer: $2500 based on money spent.
Total = $15,000
No contingency is assigned as this is a fixed cost from the MRI grant.

Labor BOE-
See M&S above for costs.

1.1.7.8.2	**Fermilab-based Database Work**	**3/4/02**	**10/16/02**	**$0**	**$0**	**$0**	**$0**

Notes

WBS Definition-
Summary task that includes all work done on production database by personnel located at Fermilab.

1.1.7.8.2.1	Design database	3/4/02	6/24/02	$0	$0	$0	$0

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
18	PhysicistU	25%	160 h	0 w	3/4/02	6/24/02	$0	$0	$0	$0	0 h	0 h	160 h	0 h
44	PostDoc	50%	320 h	0 w	3/4/02	6/24/02	$0	$0	$0	$0	0 h	0 h	320 h	0 h

Notes

WBS Definition-
Finding platform and designing datastructures needed in database

M&S BOE-
not applicable

Labor BOE-
A postdoc and a university physicist do this each at the 50% level. Estimates of time are based on the Run2a database setup.

1.1.7.8.2.2	Design travelers	6/25/02	10/16/02	$0	$0	$0	$0

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
44	PostDoc	50%	320 h	0 w	6/25/02	10/16/02	$0	$0	$0	$0	0 h	0 h	224 h	96 h

Notes

WBS Definition-
Design system for individual travelers for each module type and hybrid. The travelers are hardcopy documents which go with each individual piece throughout production.

M&S BOE-
not applicable

Labor BOE-
A postdoc at the 50% level. Estimates of time are based on the Run2a travellers

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
1.1.7.8.2.3	Construct database	6/25/02	10/2/02	$0	$0	$0	$0

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
44	PostDoc	25%	140 h	0 w	6/25/02	10/2/02	$0	$0	$0	$0	0 h	0 h	112 h	28 h

Notes

WBS Definition-
Implement the database design on chosen platform

M&S BOE-
no costs associated with this item.

Labor BOE-
The Postdoc assists the UIC computing professional in setting up the database. Assume one month of time is needed.

1.1.7.8.3	Maintain database	11/4/02	4/11/05	$0	$0	$0	$0

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
47	Student	10%	480 h	0 w	11/4/02	4/11/05	$0	$0	$0	$0	0 h	0 h	0 h	480 h

Notes

WBS Definition-
Day-to-day maintenance of database as well as implementation of new features as necessary

M&S BOE-
no costs associated with this item

Labor BOE-
Run2a experience of time needed to help implement analysis procedures.

1.1.8	**Administration**	**10/1/01**	**6/2/05**	**$166,490**	**$0**	**$160,256**	**$326,746**

Notes

WBS Definition-
The summary task associated with administration of the silicon project including management, travel, shipping, purchasing support, technical support, and software licenses including both the R&D and project phases.

M&S BOE-
The cost BOEs are listed per item. The contingency is 50% for all project related items and 30% on the R&D phase which is nearing completion.

Labor BOE-
The contingency for all tasks is 50%. Physicist contingency is assigned 50%

1.1.8.1	**Administration for the R&D Phase**	**10/1/01**	**10/29/02**	**$39,745**	**$0**	**$0**	**$39,745**

Notes

WBS Definition-
The summary task associated with administration of the silicon project including management, travel, shipping, purchasing support, technical support, and software licenses during the R&D phase of the project.

1.1.8.1.1	Project management RD phase	10/1/01	10/29/02	$0	$0	$0	$0

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
17	PhysicistF	100%	2,160 h	0 w	10/1/01	10/29/02	$0	$0	$0	$0	0 h	0 h	1,896 h	264 h
18	PhysicistU	100%	2,160 h	0 w	10/1/01	10/29/02	$0	$0	$0	$0	0 h	0 h	1,896 h	264 h

Notes

WBS Definition-
The management carried out by the Run2b silicon L2 project managers and their helpers during the R&D phase. This task accounts for maintenance of the schedule, contacts with the Fermilab directorate, and other administrative time taken.

M&S BOE-
no costs associated with this item

Labor BOE-
There are two L2 managers of the silicon project that are physicists that are full time on this task.

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
1.1.8.1.2	Travel SVX4 (RD)	10/1/01	10/29/02	$20,000	$0	$0	$20,000

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
48	MandS	20,000	20,000	0 w	10/1/01	10/29/02	$20,000	$0	$20,000	$0		0	17,555.56	2,444.44

Notes

WBS Definition-
The SVX4 chip is designed by Fermilab, LBL and Pisa, with the responsibility for the chip integration with LBL. Travel to LBL to study the performance of the chip, and to interact with the design engineers is needed in the R&D phase.

M&S BOE--
Costs incurred for travel to LBL and housing at LBL.
Rent of an apartment in Berkeley for three months at $2500/month.
Miscellaneous costs (utilities) at $1000.
One postdoc resident at LBL for the duration; per diem cost at $3500
Travel to LBL, 4 trips at $2000 per trip
Total $20,000

Labor BOE-
Not applicable

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
1.1.8.1.3	Travel Vendor Visits and Collaborator Visits (RD)	10/1/01	10/29/02	$14,000	$0	$0	$14,000

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
48	MandS	14,000	14,000	0 w	10/1/01	10/29/02	$14,000	$0	$14,000	$0		0	12,288.89	1,711.11

Notes

WBS Definition-
Vendor visists are necessary to check out their facilities, to qualify vendors and to keep in contact with those vendors that have been awarded purchase orders. In addition visits from engineers from the University of Washington, responsible for the Layer 0/1 support structures, will be needed during the R&D phase.

M&S BOE-
Vendor Visits:
Hamamatsu: 1 trip to Japan to visit HPK at $5000 per trip for a total of $5,000
Hybrids: four domestic trips for hybrid vendor visits at $1000 per trip for a total of $4,000.

Collaborator Visits:
Washington: five trips for layer 0 and 1 structures to University of Washington at $1000
per trip for a total of $5,000.
TOTAL: $14000

Labor BOE-
no costs associated with this item

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
1.1.8.1.4	Shipping Costs (RD)	10/1/01	10/29/02	$2,000	$0	$0	$2,000

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
48	MandS	2,000	2,000	0 w	10/1/01	10/29/02	$2,000	$0	$2,000	$0		0	1,755.56	244.44

Notes

WBS Definition-
Costs for shipping various parts of the silicon detector to collaborating institutions and back to Fermilab.

M&S BOE--
Shipping costs for:
SVX4 chips
Hybrid production and testing
Sensor probing
Digital Cable testing
Twisted Pair Cable testing
TOTAL $2000

Labor BOE-
Not applicable

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost
1.1.8.1.5	Software licenses (RD)	10/1/01	10/29/02	$3,745	$0	$0	$3,745

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
48	MandS	3,745	3,745	0 w	10/1/01	10/29/02	$3,745	$0	$3,745	$0		0	3,287.28	457.72

Notes

WBS Definition-
Commercial licenses for software support.

M&S BOE-
Microsoft Office licences (1) for administrative personnel ($579/license); Microsoft Project Software license (3) for project management ($999/license) and Microsoft Frontpage license (1) for web page maintenance ($169/license). Total anticipated cost: $3745.

Labor BOE-
not applicable

1.1.8.2	**Administration for the Project Phase**	**10/30/02**	**6/2/05**	**$126,745**	**$0**	**$160,256**	**$287,001**

Notes

WBS Definition-
The summary task associated with administration of the silicon project including management, travel, shipping, purchasing support, technical support, and software licenses during the project.

1.1.8.2.1	Project Management, project phase	10/30/02	6/2/05	$0	$0	$0	$0

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
17	PhysicistF	100%	5,120 h	0 w	10/30/02	6/2/05	$0	$0	$0	$0	0 h	0 h	0 h	5,120 h
18	PhysicistU	100%	5,120 h	0 w	10/30/02	6/2/05	$0	$0	$0	$0	0 h	0 h	0 h	5,120 h

Notes

WBS Definition-
The management carried out by the Run2b silicon L2 project managers and their helpers during the R&D phase. This task accounts for maintenance of the schedule, contacts with the Fermilab directorate, and other administrative time taken.

M&S BOE-
no costs associated with this item

Labor BOE-
There are two L2 managers of the silicon project that are physicists that are full time on this task. This is based on the Run2a experiences and the additional responsibilities incurred with maintaining the schedule.

1.1.8.2.2	Travel SVX4 (project)	10/30/02	6/2/05	$8,000	$0	$0	$8,000

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
48	MandS	8,000	8,000	0 w	10/30/02	6/2/05	$8,000	$0	$0	$8,000		0	0	8,000

Notes

WBS Definition-
The SVX4 chips is designed by Fermilab, LBL and Pisa, with the responsibility for the chip integration with LBL. Travel to LBL to study the performance of the chip, and to interact with the design engineers is needed.

M&S BOE--
Costs incurred for travel to LBL 4 trips at $2000 per trip
Total $8,000

Labor BOE-
Not applicable

1.1.8.2.3	Travel vendor and collaborator visits (project)	10/30/02	6/2/05	$89,000	$0	$0	$89,000

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
48	MandS	89,000	89,000	0 w	10/30/02	6/2/05	$89,000	$0	$0	$89,000		0	0	89,000

Notes

WBS Definition-
Vendor visits are necessary to check out their facilities, to qualify vendors and to keep in contact with those vendors that have been awarded purchase orders. In addition visits from engineers from the University of Washington, responsible for the Layer 0/1 support structures, will be needed.

M&S BOE-

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost

"Travel vendor and collaborator visits (project)" continued

Notes

Vendor Visits:
Hamamatsu: four trips to Japan to visit HPK at $5000 per trip for a total of $20,000.
ELMA: two trips to Russia at $5000 per trip for a total of $10,000.
Dyconex: two trips to Switzerland at $4000 per trip for a total of $8000.
Hybrids: eight domestic trips for hybrid vendor visits at $1000 per trip for a total of $8,000.
Hybrid Assembly: eight domestic trips for hybrid surface mount component company visits at $1000 per trip for a total of $8,000.
Cables: six domestic trips at $1000 for a total of $6000.
two trips to Russia at $5000 per trip for a total of $10,000
Collaborator Visits:
Washington: six trips for layer 0 and 1 structures to University of Washington at $1000 per trip for a total of $6,000.
Washington: trip for three people for the production readiness review at Washington at $1000 per trip.
Others: ten trips to other collaborating institutions at $1000 per trip for a total of $10,000.
Total: $89000

Labor BOE-
not applicable

1.1.8.2.4	Shipping costs (EQ)	10/30/02	6/2/05	$10,000	$0	$0	$10,000

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
48	MandS	10,000	10,000	0 w	10/30/02	6/2/05	$10,000	$0	$0	$10,000		0	0	10,000

Notes

WBS Definition-
Costs for shipping various parts of the silicon detector to collaborating institutions and back to Fermilab.

M&S BOE--
Shipping costs for:
SVX4 chips
Hybrid production and testing
Sensor probing
Digital Cable testing
Twisted Pair Cable testing
TOTAL $10000

Labor BOE-
Not applicable

1.1.8.2.5	Purchasing Support	10/30/02	6/2/05	$0	$0	$35,840	$35,840

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
26	AdminAsstF	20%	1,024 h	0 w	10/30/02	6/2/05	$35,840	$0	$0	$35,840	0 h	0 h	0 h	1,024 h

Notes

WBS Definition-
Entering and processing purchasing requisitions including vendor contact time for help with purchasing.

M&S BOE-
no costs associated with this item

Labor BOE-
Administrative assistant one day per week for the project. This is based on Run2a silicon experience.

1.1.8.2.6	Administrative and Technical Support	10/30/02	6/2/05	$16,000	$0	$124,416	$140,416

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
9	MechTechSF	20%	1,024 h	0 w	10/30/02	6/2/05	$34,816	$0	$0	$34,816	0 h	0 h	0 h	1,024 h
26	AdminAsstF	50%	2,560 h	0 w	10/30/02	6/2/05	$89,600	$0	$0	$89,600	0 h	0 h	0 h	2,560 h
48	MandS	16,000	16,000	0 w	10/30/02	6/2/05	$16,000	$0	$0	$16,000		0	0	16,000

WBS	Name	Start	Finish	M&S EQ	M&S Labor	FNAL Labor	Total Cost

"Administrative and Technical Support" continued

Notes

WBS Definition-
Administrative and Technical Support for database entry of components, maintaining travelers, cataloguing, computing and networking support, shipping assistance, maintenance of web based documentation, maintenance of silicon web pages, and the like.

M&S BOE-
Two personal computers with 21" monitors are foreseen at $3000 per setup. Desks and office supplies at $10,000. Total estimated $16,000.

Labor BOE-
Administrative assistant is needed for database entry, shipping assistance, and maintenance of the web based documentation at 4 hours per day. A mechanical technician is needed for computing and networking support and cataloging of items, database entry, and other infrastructure needs at 1 day per week. These estimates are based on the Run2a silicon experience.

1.1.8.2.7	Software Licenses (project)	10/30/02	6/2/05	$3,745	$0	$0	$3,745

ID	Resource Name	Units	Work	Delay	Start	Finish	Cost	Baseline Cost	Act. Cost	Rem. Cost	Ovt. Work	Baseline Work	Act. Work	Rem. Work
48	MandS	3,745	3,745	0 w	10/30/02	6/2/05	$3,745	$0	$0	$3,745		0	0	3,745

Notes

WBS Definition-
Commercial licenses for software support.

M&S BOE-
Microsoft Office licences (1) for administrative personnel ($579/license); Microsoft Project Software license (3) for project management ($999/license) and Microsoft Frontpage license (1) for web page maintenance ($169/license). Total anticipated cost: $3745.

Labor BOE-
not applicable