Run 2b Silicon Detector

Performance

Cost

Schedule

Resources

Alice Bean Fermilab/Univ. of Kansas

Fermilab Director's Review 12/03/01

DØ Performance

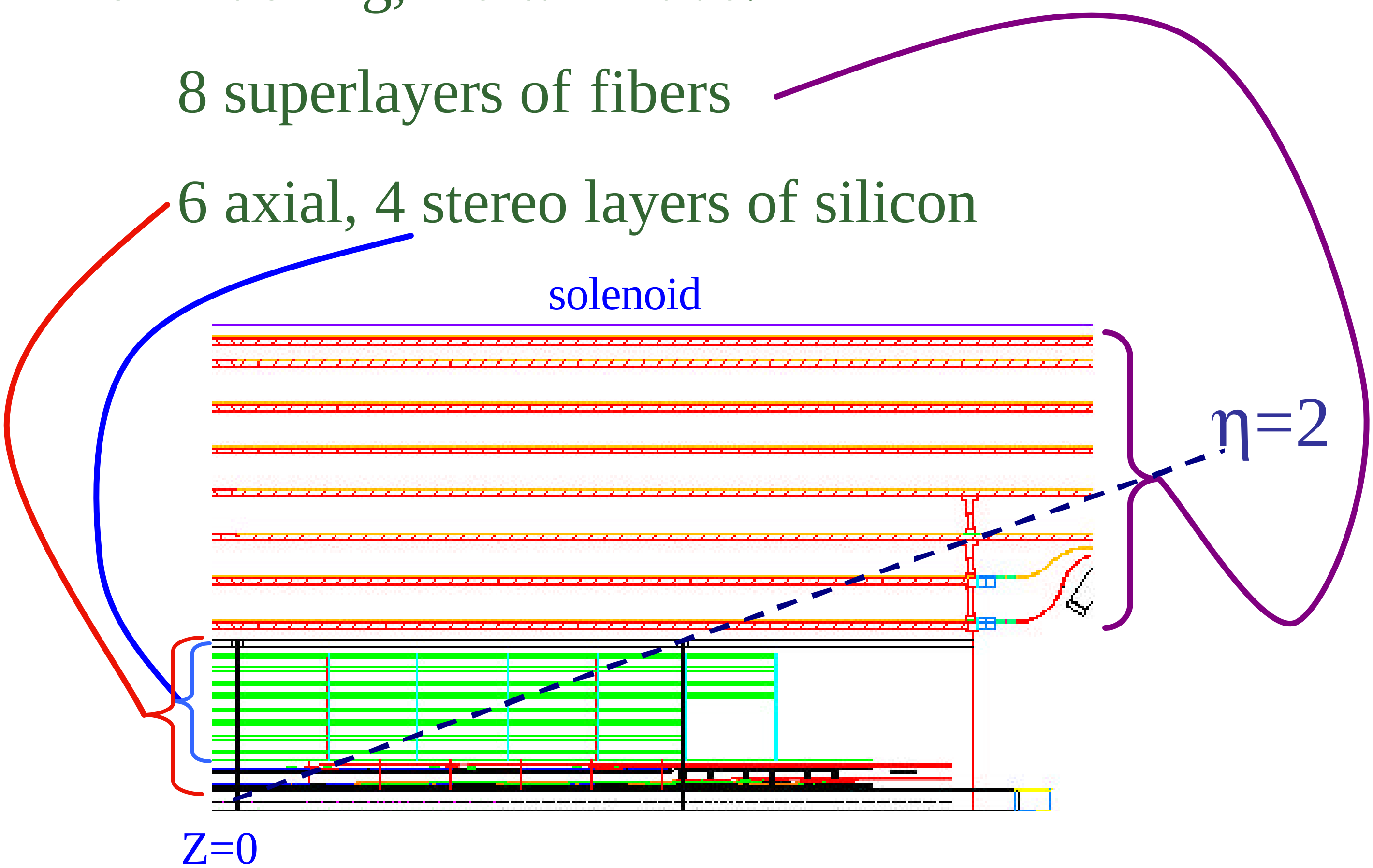
Goal is to have good b-tagging and tracking efficiencies for possible discovery of the Higgs.

Tracking will be more complicated for Run2b era with higher occupancies and more minimum bias tracks at higher luminosities. Pattern Recognition will play an important role.

For Tracking, D0 will have:

8 superlayers of fibers

6 axial, 4 stereo layers of silicon



Performance

We need:

good impact parameter resolution

⟹ L0 at r=18.6mm

good pattern recognition

⟹ 6 axial layers with

⟹ 4 stereo small angle layers to limit ghosts

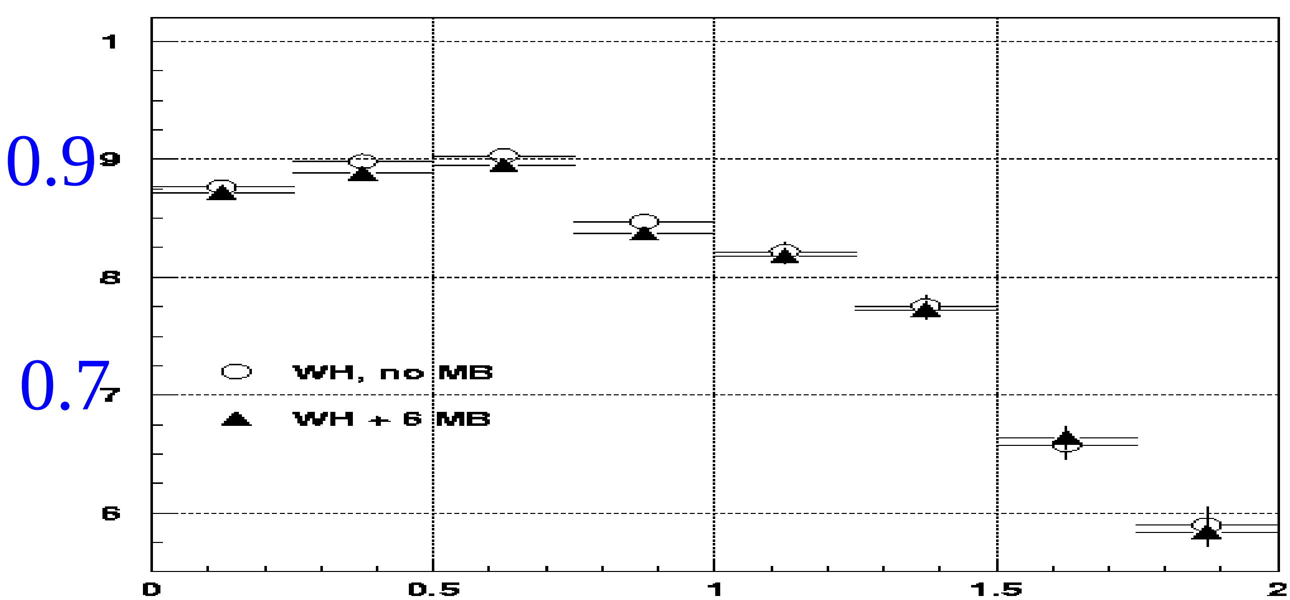
⟹ not too much ganging to limit track confusion

good tracking efficiency to η=2

⟹ 6 layers of silicon for stand-alone tracking

⟹ enough sensors in z for beam-spot size

We used Full GEANT simulations to study Performance



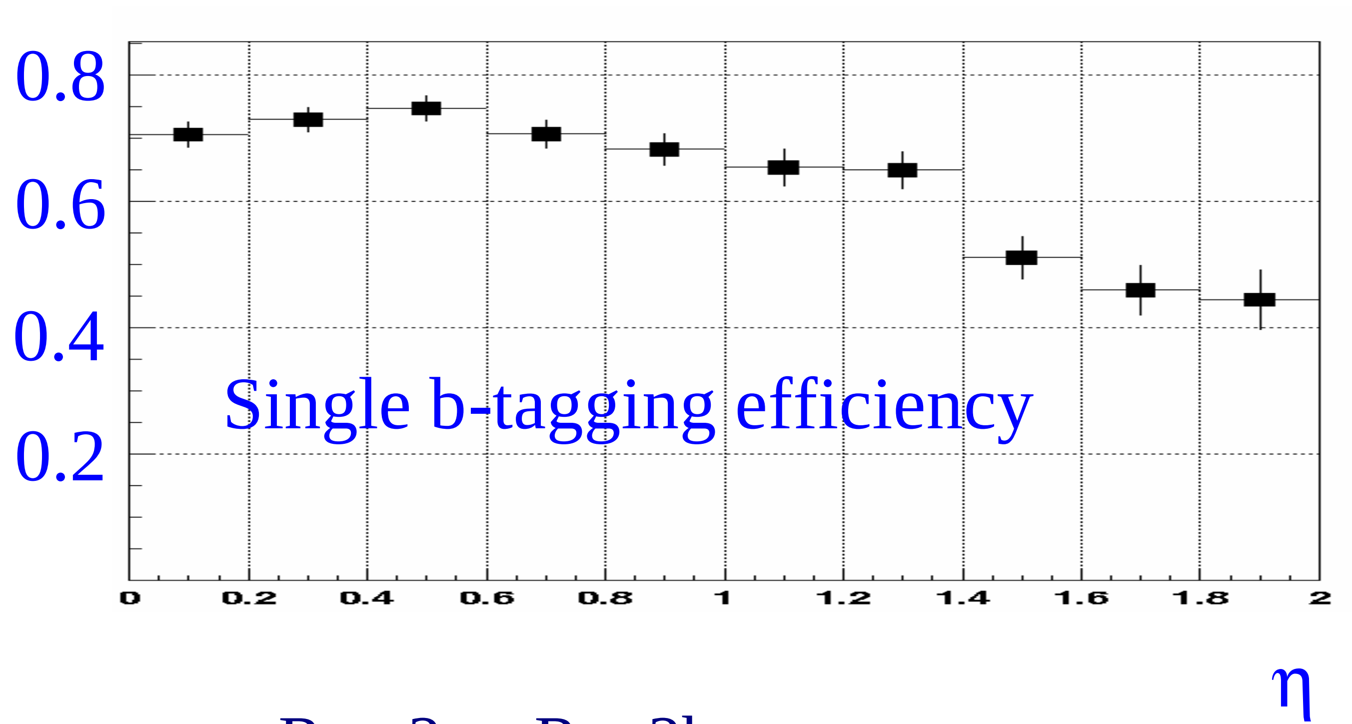
Tracking efficiency in jets as a function of η

b-tagging efficiencies

Guidance from Higgs studies:

Double b-tag efficiency in range 30-40% with mistag rates around or below 1%.

Our found mistag rates are at or below 1%



	Run 2a	Run2b
$P(n_b \geq 1)$	68%	80%
$P(n_b \geq 2)$	21%	35%

Event tag probabilities

Increase by factor of 1.6 in double b-tagging efficiency directly reduces amount of luminosity needed for Higgs discovery

Lessons from Run2a

- Prototyping
  - Do it early before ordering final parts
  - Do it for all assembly and production sequences
  - Order more than you think you need for prototyping
- Spares
  - Spares were used up prototyping
  - Number of types of parts increased #

Our Run2a experience allows us to arrive at what we believe are conservative estimates for cost, schedule, and labor for Run2b

Cost Estimate

- Prepared in September 2001
- Have a high confidence that eventua
  cost will be less than this estimate
- Use Run2a experience for number o
  spares and to verify amounts
- Subproject leaders went out for
  quotes on as many parts as possible
- M&S costs that do not include:
  - G&A (Indirect costs)
  - Fermilab Manpower
- Does include:
  - University costs charged to project
  - R&D cost

Cost Estimate

Run2b silicon detector cost estimate

MS#	Item	M&S (k$)	Cont. (%)	Total (k$)
1.1.1	Sensors	2,244	31	2,948
1.1.2	Readout	3,638	46	5,310
1.1.3	Mechanical	1,650	50	2,480
1.1.4	Assembly &Testing	429	32	567
1.1.5	Installation	90	47	133
1.1.6	Software	51	22	62
1.1	**TOTAL**	**8,101**	**42**	**11,499**

>Total M&S Project cost of $8.1 M, without contingency

> Cost estimate carried out down to "WBS" level 5

Cost drivers (including contingency)

Silicon production sensors	$2.0M
Production Cables:	
analog, jumper, and twisted pair	$1.2M
Hybrids	$1.1M

Cost Example

Layer 2-5 Hybrid costing

has 5 subcategories

for production include cost of:

beryllia substrates and printing	$375
components and connectors	$50
stuffing and SVX4 die attachment	$75

MS#	Item	Unit	#	Cost ($)	M&S Tot ($)
1.1.2.2.4	Layer 2-5 (sum.)				519,000
1.1.2.2.4.1	Layout	Lot	2	4,500	9,000
1.1.2.2.4.2	Prototypes	Ea	40	1,000	40,000
1.1.2.2.4.3	Production	Ea	880	500	440,000
1.1.2.2.4.4	Fixturing	Lot	1	15,000	15,000
1.1.2.2.4.5	Testing	Lot	1	15,000	15,000

672+30% spares

Cost Profile

Costs are in k$ unless noted

	FY02	FY03	FY04	TOT
R&D	1,129	3	0	1,132
M&S	1,899	4,284	788	6,970
Tot	3,028	4,287	788	8,102
Tot + Cont.	4,328	6,089	1,084	11,499
NSF MRI funds	1,062	1,035	305	2,402
Needed from Lab	3,266	5,053	779	9,098
Lab Guidance (TOTAL)	2.5M	2.8M	2.8M	+1M in FY05 =9.1M

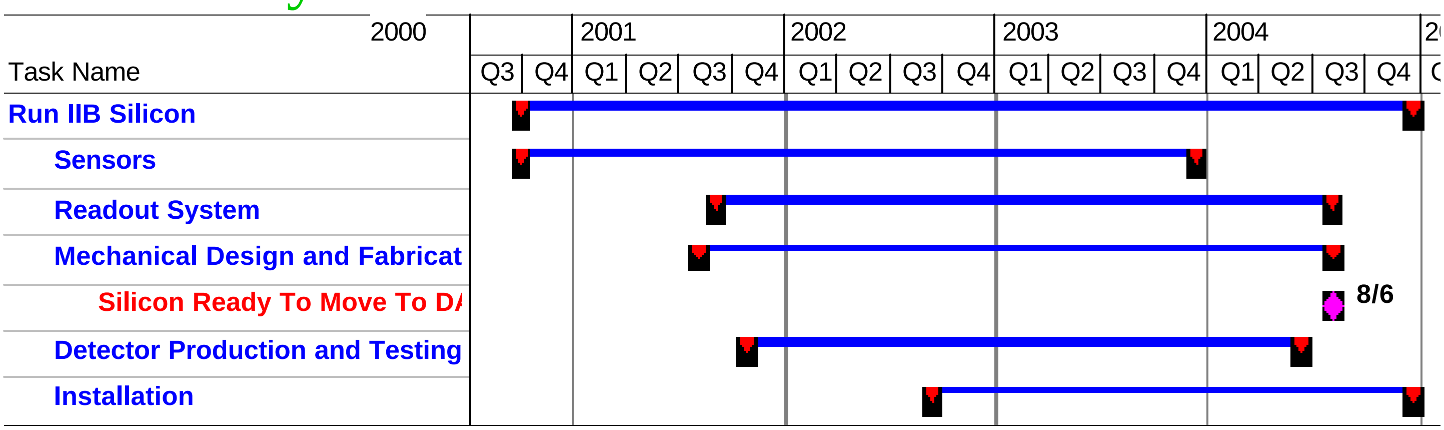
Total Lab Guidance is only enough to cover M&S costs for the silicon

The funding profile needs to be front-loaded

Schedule

- Using Microsoft Project, we've produced a resource loaded schedule
- The schedule associates to tasks equivalent to WBS level 5
- There are a total of 806 lines in the schedule

Summary Gantt Chart



Key tasks	dates
SVX4 production	7/02-10/02
Sensor production	10/02-12/03
Hybrid production and Testing	8/02- 7/03
Module Production and Testing	3/03 - 2/04
South L0 Complete	2/26/04
South L2-5 Complete	12/9/03
Silicon Ready to Move to DAB	8/06/04

DØ Schedule Example

South 10/10 Axial Modules for L2-L5

Total 84 Modules needed

Develop model of production based on CMMs and times for each module

we assume 1CMM with 2 fixtures and 2 gluing cycles/Day → 2 shifts

Add spares and some time contingency

For Predecessors make sure that you have enough sensors and hybrids

ID	Task Name	Duratio	Start	Finish	Predecesso	Resource Names
629	**10/10 Axial Modules**	**69.4**	**7/1/**	**11/1**		
630	Develop module prototype	12	7/1	9/24	85SS+2 w,1	PHYSF,MTF,MEF,DESF
631	Develop sensor module burn-in te	2	4/2	4/15	630,598	PHYSU,EEU[0.2],ModuleBurnIns
632	**South**	**12.4**	**3/4/**	**5/29**		
633	**10/10 South Axial Module Proc**	**0**	**3/4/**	**3/4/**	**634SS**	
634	Align and glue sensors to hybri	8	3/4	4/28	630,96SS+9	PHYSF,CMMS[2],CMMT[2],MTF
635	Wirebond sensors to hybrid	8	3/5	4/29	634SS+1 d	WBNDR[0.5],WBNDRT[0.5],PHY
636	**10/10 South Axial Module Proc**	**0**	**4/29**	**4/29**	**635**	
637	Debug sensor module	8	3/6	4/30	635SS+1 d	PHYSF[0.5],MTF[0.5],SASEQTes
638	Burn-in sensor modules	8	3/13	5/7	637SS+1 w	PHYSU,ModuleBurnInStand[0.5]
639	Evaluate and repair sensor mo	7	3/27	5/14	638SS+2 w	PHYSU[0.5],ETF[0.5],SASEQTes
640	Perform quality assurance tests	7	4/10	5/29	639SS+2 w	PHYSU[0.5],ETF[0.25],SASEQTe
641	**10/10 South Axial Module Test**	**0**	**5/29**	**5/29**	**640**	

Lines 629-641 of schedule

Line 634 - Align and glue sensors to hybrid

Duration of 8w at 4/day means that we could make 160 modules but this is the first module type so put extra time in!

Start date 3/4/03, End Date 4/28/03

Predecessors of module prototyping, silicon, hybrids

2 shifts with per shift:
0.5 physicist, 1 small CMM, 1 CMMT, 0.5 MTF

Some Key Milestones

ID	Task Name	Start	2002 Q1–Q4 / 2003 Q1–Q4 / 2004 Q1–Q4
106	SVX4 Released For Production	7/18/0	7/18
144	L1 Hybrids Released For Production	8/15/0	8/15
94	L2-L5 Sensors Released For Production	10/8/0	10/8
74	L1 Sensors Released For Production	11/13/0	11/13
188	L0 Flex Cable Production And Testing Complete	2/18/0	2/18
633	10/10 South Axial Module Production Begun	3/4/0	3/4
218	L2-L5 Digital Jumper Cables Produced And Tested	3/27/0	3/27
111	All SVX4 Chips Produced And Tested	4/10/0	4/10
48	L0 Sensors Released For Production	4/22/0	4/22
172	L2-L5 Hybrid Production Complete	5/22/0	5/22
347	Layer 0 South Mechanical Assemblies Complete	6/25/0	6/25
78	All L1 Sensors Delivered And Tested	7/10/0	7/10
377	Layer 1 South Mechanical Assemblies Complete	7/17/0	7/17
248	L2-5 Junction Cards Produced and Tested	7/24/0	7/24
618	L1 Module Production Complete	8/1/0	8/1
381	L1 South Complete	10/10/0	10/10
99	All L2-L5 Sensors Delivered And Tested	12/8/0	12/8
52	All L0 Sensors Delivered And Tested	12/9/0	12/9
459	Layer 2-5 South Complete	12/9/0	12/9
606	L0 Module Production Complete	2/4/0	2/4
743	10/20 North Module Testing Complete	2/23/0	2/23
351	L0 South Complete	2/26/0	2/26
384	L0-L1 South Complete	3/18/0	3/18
465	South Silicon Complete	5/12/0	5/12
488	L0-L1 North Complete	5/13/0	5/13
780	Shutdown for Installation Begins	5/19/0	5/19
526	Layer 2-5 North Complete	6/4/0	6/4
532	North Silicon Complete	7/30/0	7/30
309	Downstream Readout Ready	8/2/0	8/2
534	Silicon Ready To Move To DAB	8/6/0	8/6
801	Connect cabling and commission detector	10/12/0	

Near Term Tasks

Task	duration	start date	end date	Done?
Sensors:				
Produce ELMA L0 prototype sensors	10w	4/26/01	8/2/01	Ö
Order L1 prototype sensors	4w	11/26/01	12/21/01	we are ready
Order L2-L5 preproduction sensors	4w	12/12/01	1/17/02	
Readout:				
Test SVX4 prototype chips	12w	3/27/02	6/19/02	
Develop L1 hybrid specifications	12w	9/4/01	11/28/01	Ö
Procure L1 hybrid prototypes	12w	11/29/01	3/1/02	
Prepare L1 digital cable prototypes	16w	1/21/02	5/10/02	
Prepare L1 junction card prototypes	4w	1/7/02	2/1/02	
Prepare adaptor card prototypes	8w	2/4/02	3/29/02	
Mechanical:				
Design beam tube	12w	9/04/01	11/28/01	Ö
Design L0 sensor supports	13w	1/21/02	4/19/02	
Design L1 sensor supports	13w	10/16/01	1/25/02	
Design stave hybrid mounting	6w	1/7/02	2/15/02	
Prototype support cylinder	12w	2/4/02	4/26/02	

We have already started and have completed some tasks but need to continue to pursue tasks agressively to meet schedule.

DØ Labor Resources

A year ago, the Universities that collaborated on the NSF MRI proposal started to distribute tasks involved with designing and producing the detector:

SENSOR PROBING AND PROCUREMENT:

Kansas State University, Moscow State University, CINVESTAV, SUNY Stony Brook

READOUT ELECTRONICS:

Kansas State University, University of Kansas, Fresno State University, Brown

TESTING:

University of Illinois at Chicago

L0/L1 MECHANICAL DESIGN AND ASSEMBLY:

University of Washington

FIXTURING:

Michigan State University

We are currently trying to involve more University personnel

PersonPower Estimate

Done using Microsoft Project with the Resource Loaded Schedule

Sources of personnel include:

- F - Fermilab
- U- University person paid by University
- O- University person paid by project

Categories Used:

- PHYSF, PHYSU - Any Physicist

Techs:

- MTF, MTU,MTO - Mechanical Tech
- ETF, ETU,ETO - Electrical Tech
- CMMT, CMMP - CMM tech or programmer (Fermilab)
- WBNDRT - Wirebonder (Fermilab)

Engineers:

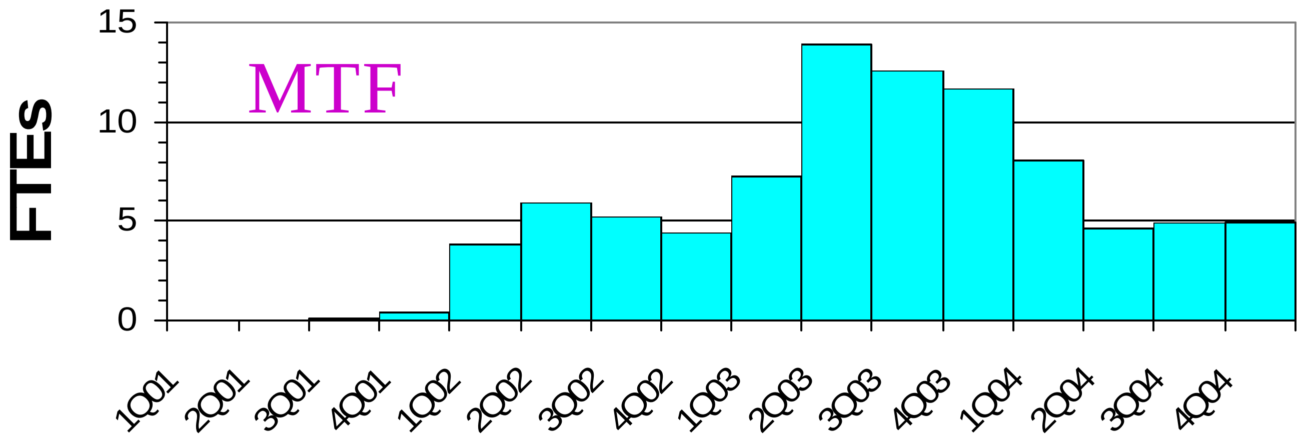
- EEF,EEU,EEO - Electrical Engineer
- MEF,MEU,MEO - Mechanical Engineer

Others at Fermilab:

- DESF - Designer
- COMPF - Computer professional

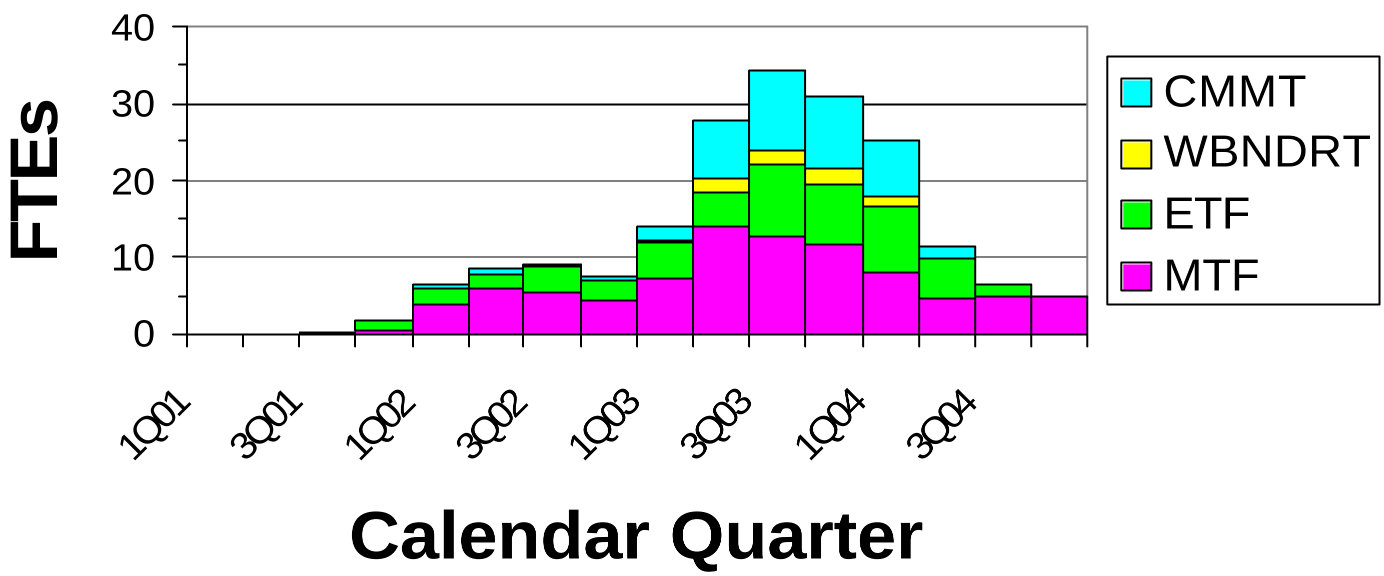
Fermilab Technicians

An Example of Mechanical Technicians at Fermilab (MTF) by Calendar Quarter



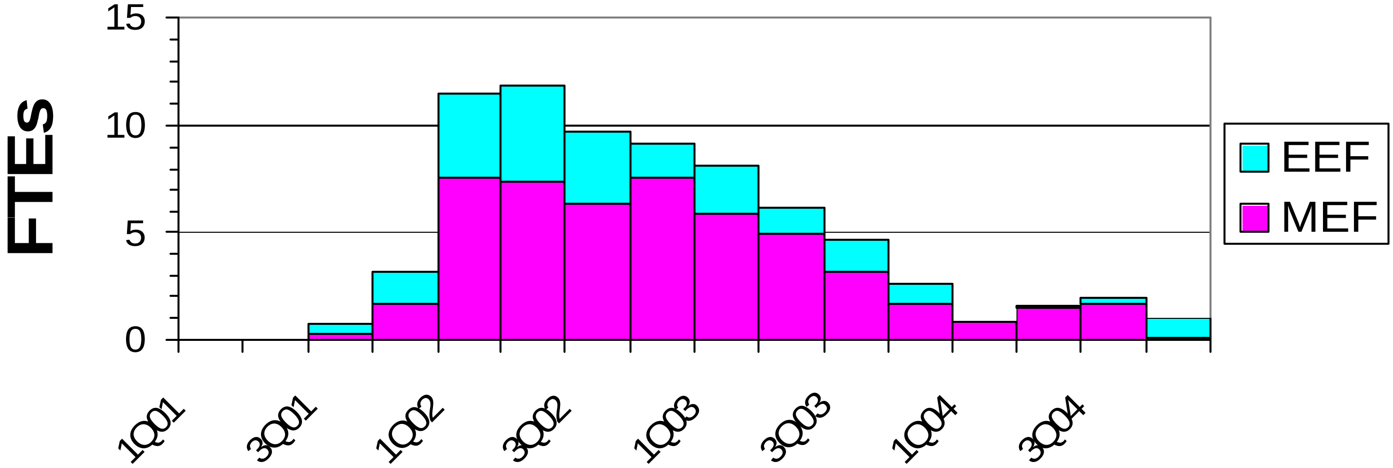
All Fermilab Techs

Lab Guidance at present: 13 FTEs



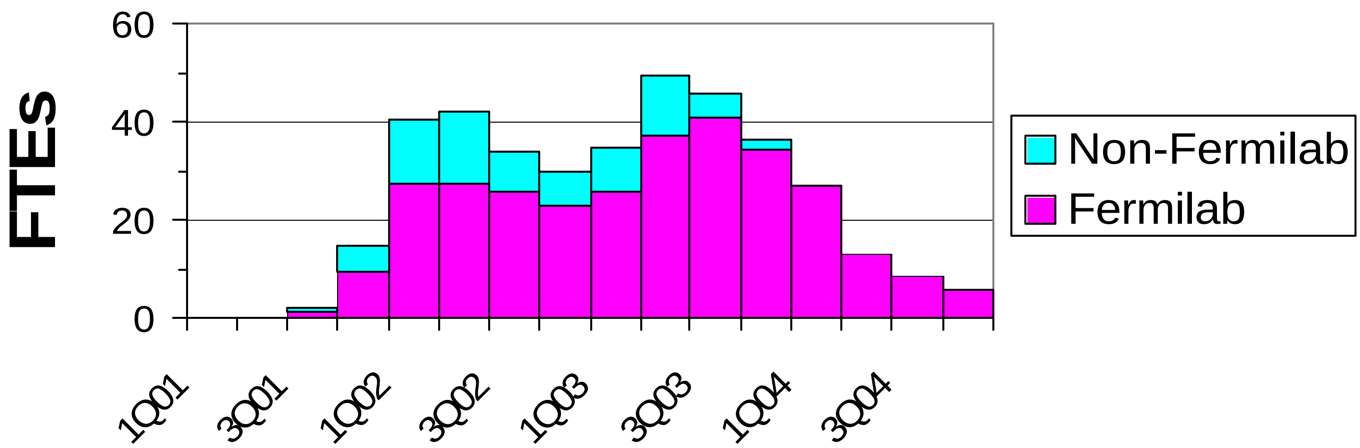
Technical Manpower

Fermilab Engineers



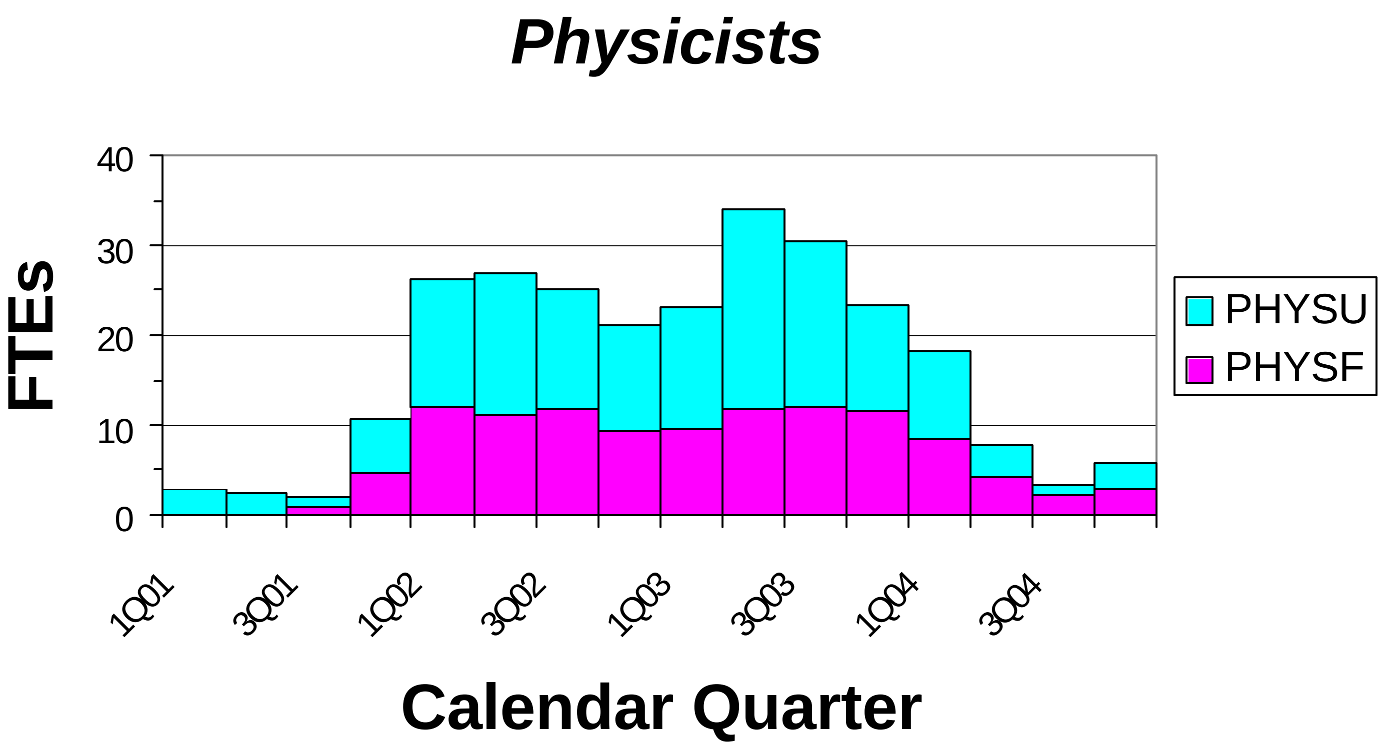
Fermilab Guidance: MEF - 3 FTEs

Technical Manpower



Calendar Quarter

DØ Physicists



We believe that we can find the people here.

Currently we have:

12 FTEs consisting of

1FTE - students (5 real people)

7 FTEs - University (15 real people)

4 FTEs - Fermilab (6 real people)

DØ Summary

- Simulations show our physics design goals are met
- Thought has gone into design to make it buildable on short time-scale
- Cost estimate is done using conservative assumptions
- Resource Loaded Schedule shows that we can complete the job in the right timescale if given the resources
- Not enough resources from Fermilab in either integral or profile