H.Weerts

Fallback Options for the DØ Upgrade

(walk through the existing document)
PMG presentation on February 3, 2000

Introduction

- September 1999, DØ a new and realistic schedule
- Embrace schedule and make it our schedule; detailed understanding (already contingency created; last PMG)
- Confident we deliver the complete detector in time for the start of Run II on March 1, 2001.
- But make sure that at that date we indeed have a detector
- Develop fallback options for time between now and February 2001
- Identify risk areas
- December 1999 FNAL requested that we develop such fallback options.
- Started with some reluctance, DØ has now fully embraced this concept.

Our Strategy

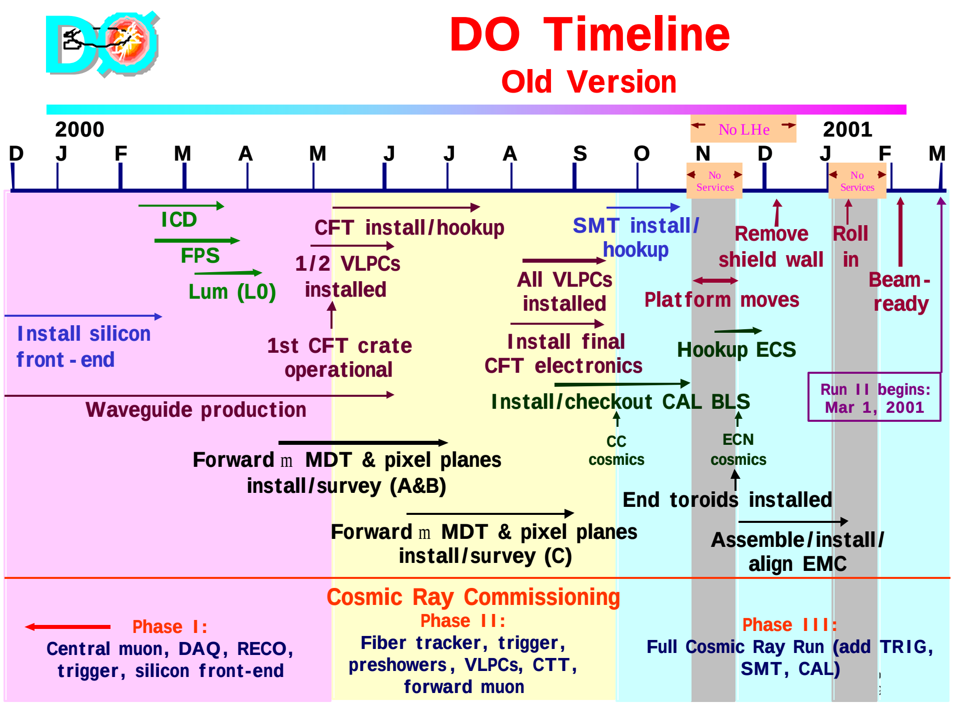
Following types of fallback position, descending order of desirability:

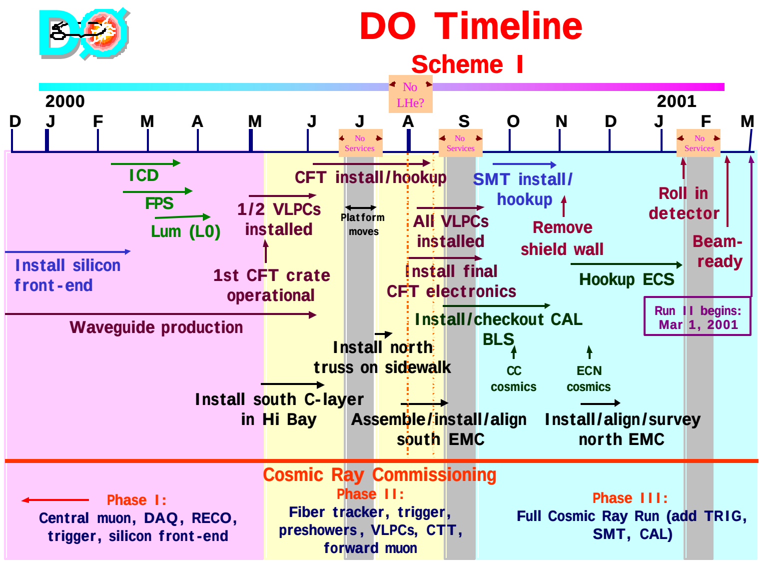
1. Gain schedule contingency by re-optimization of the installation and commissioning process
2. Prioritize the order in which detector construction work is carried out.
3. Understand which parts of the detector could be deferred, and installed after roll-in (staging).
4. Understand the physics impact of actually reducing the scope of the detector.

The collaboration is and has been involved in this process throughout.

Installation and Commissioning

The DØ baseline schedule (labeled as "Old Version") as it existed at the beginning of December 1999:





Current default schedule: “Scheme I”

Features:

1. During shutdown of Tevatron (August 1-15) install the south muon EMC truss, with the C layer MDT and pixel detectors mounted, in the Collision Hall. Time estimate: 3 weeks from the time the Tevatron shuts down to when it can start up again. Add one week of contingency
2. The north truss is moved down to the assembly pit sidewalk in early July ; the north C layer MDTs and pixels are mounted while this truss is in the pit.
3. Three platform moves.
4. Total of 4+ months of full detector commissioning time during the end game.

Implications of the Scheme I schedule:

I. Ties the DØ schedule to the Tevatron schedule

II. A final decision on timing of Tevatron shutdown has to be taken by June 1, 2000 in order not to effect the DØ schedule. No problem for BD.

III. rely on the Tevatron commissioning run ending at the end of October 2000.

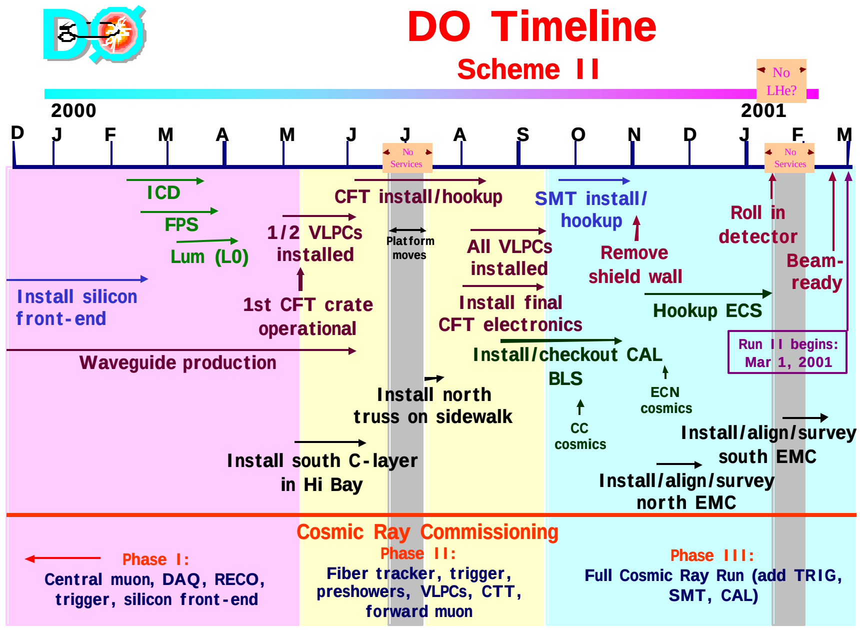
IV. The CFT installation window closes on June 26, 2000 and opens up on September 8, 2000.

V. Liquid helium engines disconnected once during the early July/beginning of August time frame. Working on a scheme to avoid this.

===→ have created about two months of contingency for the delivery of the silicon tracker,

===→ current completion date, moving it to February 13, 2001.

===→ to take advantage of this contingency, must hookup the ECS in the Collision Hall.



Fallback option "Scheme II"

If not possible to install the south truss in the collision hall during the shutdown ➔ fallback to "Scheme II".

Differences:

1. The south truss rolled into the Collision Hall last – after the north truss and the platform – allowing for disconnection of the helium engines, if it is needed, after the full detector is commissioned as fully as possible prior to roll-in.
2. There are a total of two platform moves.
3. A total of 6+ months of full detector commissioning time during the end game.

Implications of the Scheme II schedule:

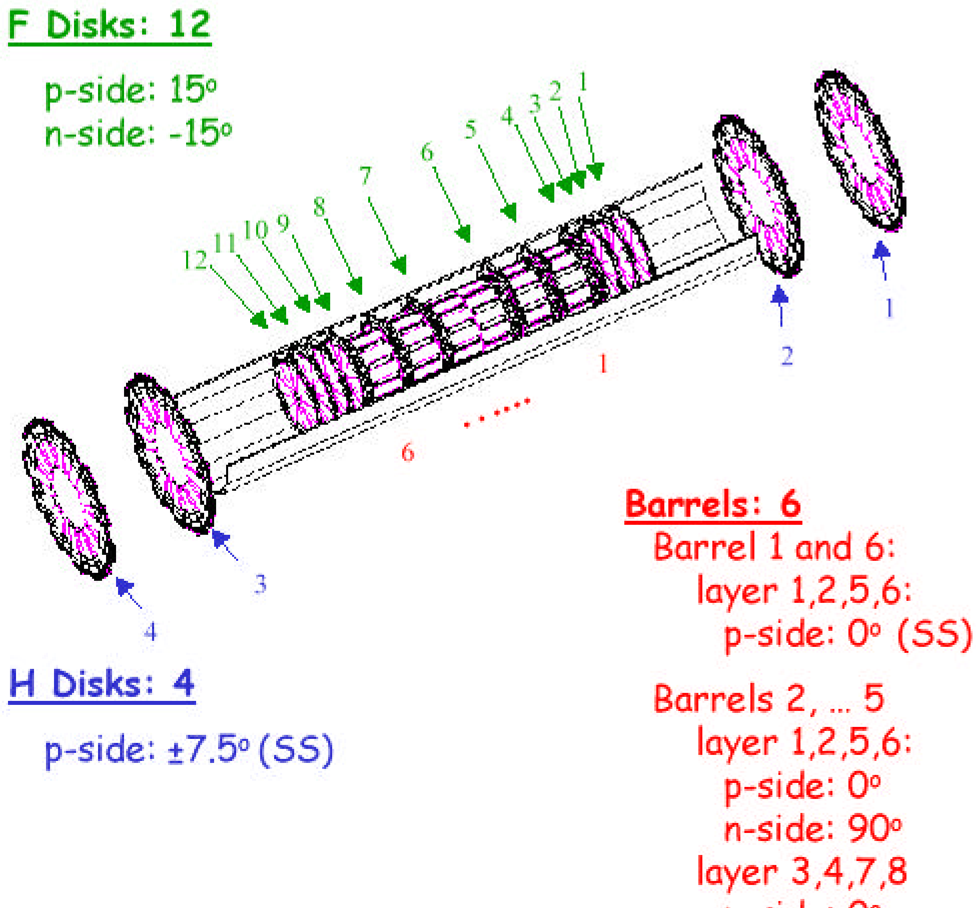
I. We rely on the Tevatron commissioning run ending at the end of October 2000.

II. Liquid helium engines interrupted at most once in January 2001.

==➔ Two months of contingency for the delivery of the silicon tracker

==➔ the completion date for the detector is now February 21, 2001.

==➔ The ECS hookup partially done in the collision hall.



	Barrels	F-Disks	H-Disks
Channels	387120	258048	147456
Modules	432	144	96
Inner R	2.7 cm	2.6 cm	9.5 cm
Outer R	9.4 cm	10.5 cm	26 cm

The outer two barrels in (1 and 6 above) have single sided, axial strip detectors, in radial layers 1 and 3 ("3-chip" ladders). The inner four barrels (2-5) have double sided, double metal, 90-degree stereo detectors in layers 1 and 3, with a two-fold readout ambiguity for the 90-degree strips ("6-chip" ladders). Radial layers 2 and 4 use double sided, small angle stereo detectors ("9-chip" ladders) in all six barrels.

SMT

Areas of schedule concern for the SMT are

- Ladder and wedge construction rates and yields.
- Testing and debugging time and effort at SiDet: unanticipated detector problems
- Parts availability, of sensors from Micron, of HDI (high density interconnect) assemblies, and of sufficient SVX II chips.
- Final assembly effort and engineering.
- Installation.

SMT

- Fallback and descoping options constrained by detector design. The SMT a highly intricate, non-modular device.
- No changes in the central barrel-disk assembly after installation
- Can not add the end F-disks after installation. The H-disks, on the other hand, are accessible and could be installed later.

- Discussions focused on the 90º stereo detectors and the F-disks.
- Do not to compromise the central ($|\eta| < 2$) region
- Some other options considered, but not very attractive to the SMT group: A reduction in the number of barrels is not considered a viable option; the number of barrel layers cannot be reduced without impacting track reconstruction.

SMT Installation Scheme

- Explored an alternative installation technique for the SMT detector =➔ promising.
- The baseline installation scheme SMT to be installed as a single unit.
- Proposed new scheme splits SMT into north and south halves, each with its own support cylinder.
- Possible installation and removal in collision hall (detector “closed”); studying but very promising.
- Adds contingency and flexibility to schedule.

See W.Coopers talk.

Production Rates SMT

All needed ladders and wedges can be produced on schedule. Have the capability to deliver sufficient detectors in time, even if we

a) Include the foreseeable stoppages due to HDI component deliveries,

b) slow rate of 6-chip ladder production to match the (slower) rate of 9-chip ladder production and

c) even allow for an additional and unforeseen one-month hiatus in production.

Single-sided barrel detectors

The “3-chip” ladders 66% complete, are straightforward to build, and have very little risk.

The first barrel assembly, consisting of 72 ladders and using single-sided detectors in layers 1 and 3, will be assembled within a month.

90º barrel detectors

- "6-chip" ladder limited by sensor delivery rates from Micron.
- Micron rate needed is ~10 per week (in January, Micron delivered only 12). Sputterer ...
- Yields of good detectors are low,
- Substantial numbers of lower quality sensors exist & could form part of a fallback plan. 600 devices (600) in process at Micron
- Setting up a second production line in Lab A for 6-chip ladders, to cope with the anticipated large influx.

Options considered:

Considered new single-sided detectors to replace the 90º stereo detectors: rejected.
There is no compelling reason to abandon 90º detectors at this time.

SMT 90 degrees "Options Considered" cont'd:

The preferred fallback: use poorer quality 90º detectors. The optimal way is under study.
Operating poor quality 90º detectors as single-sided devices (reading out only the axial strips) is another option, if this improves the radiation hardness of the devices (and no serious physics impact). Such studies will also be conducted.

Small Angle Stereo Barrel Detectors

The "9-chip" ladders are slowest devices to assemble → production rates are a potential concern. If yields are low, availability of sensors and HDIs may be a problem. The fallback is to accept lower grade units.

F-disks

- Low yields of HDIs, very complex and fragile
- Placed a makeup order for HDIs
- Silicon sensor delivery not a risk: yields from Micron excellent Also 75 wedges from Eurisys. Still ramping up production.

Options:

If F-disk assembly delayed: opt not to install some of the F-disks. Decision not before March, 2000 (later with contingency).

1. Omit the four central F-disks (interleaved between the barrels). Might wish to close the resulting ~5mm gaps between the barrels ➔ the support structure changes. The deadline for a decision is the middle of May.
2. Alternatively, omit some (perhaps two each end) of the forward F-disks. Needs input from physics studies.

H-disks

The “H-wedge” detectors are 50% complete. Production paced by the availability of HDIs. Staged installation of the H-disks is an option, but it only makes sense to delay if resources would be freed up.

Availability of SVX chips

Availability SVX-II chips, for HDIs on the detectors, a concern.

Just about sufficient chips for the full silicon detector and CFT,CPS & FPS. **This includes** the wafers that were “banked” with UTMC.

Strategy:

- Attempt to recover chips. Rejection at Promex for visual defects; test and classify.
- So far, only “A” grade chips have been accepted; test “B” grade devices; can they be used. Use CFT with possibility to install later
- Salvage chips from non-working HDIs.
- If this not sufficient, omit detector elements, guided by the physics impact.

Plans for SMT:

- Full SMT detector can be built by the September 18, 2000 milestone date.
- Not taken credit for the additional 8 weeks of schedule contingency or for the new split-cylinder installation scheme.
- Possible fallback options are identified

Fiber Tracker

- The innermost CFT cylinder (cylinder number 1) forms the support system for the SMT and the construction of the CFT requires *all* eight CFT cylinders.
- Given the above, there are no fallback options for the CFT.
- All eight cylinders must be constructed, nested and installed in DØ, before any other part of the inner tracking system can be installed.

Waveguides:

- Waveguides are fragile and need careful routed. Installed after the CFT is installed. Pre-installation has been considered and is not an option.
- The waveguides installed before the cabling of SMT
- no fallback options are available for the waveguide installation. Has to be complete by the time the SMT starts hooking up.

VLPCs

In case of a delay in the VLPC cassette production, the fallback option is to install the cassettes later. Later can extend up to March 2001 and beyond

Central and Forward Preshowers

The Central Preshower (CPS) is installed. It has Waveguides similar to CFT.

The Forward Preshower (FPS) is mounted on the ECS & ECN. Can be mounted at any time later. Waveguides on the end-cap calorimeter faces. Fall back positions for the waveguide installation could extend to March of 2001 and even beyond.

Tracking Electronics

Needed for cabling up CFT, CPS, FPS and SMT, as well as for commissioning them. If late shorten the commissioning time, The priority in terms of having electronics available would be:

1. Axial readout for CFT (provides trigger)
2. Readout for SMT
3. Readout for stereo CFT
4. Readout for CPS, FPS.

These priorities are essentially already in effect now.

Calorimeter

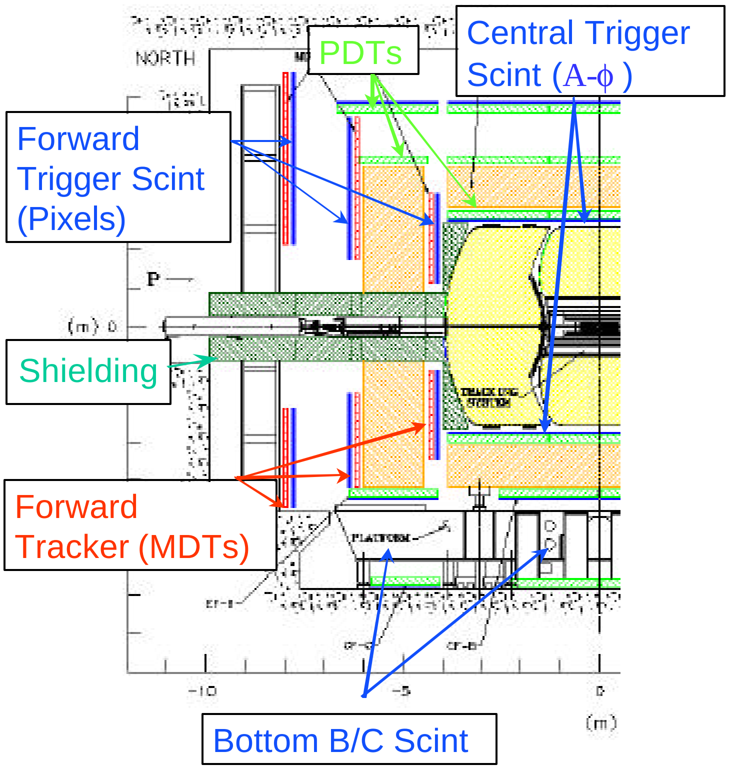
Calorimeter Electronics

System	Schedule Risk	Risk assessment	Fallback Plan	Decision Date
CC, ECN Preamps	Late delivery	Low	Install in collision hall	1/01
ECS cabling	ECS not available due to silicon installation delays	Medium-high	Install in collision hall	1/01
ECS Preamps	ECS not available due to silicon installation delays	Medium-high	Install in collision hall	1/01
ECS Preamp power supplies	ECS not available due to silicon installation delays	Medium-high	Install while ECS is off platform	9/00
BLS's	Late delivery	Medium	Install in collision hall	1/01
BLS power supplies	Slow construction	Medium	Install in collision hall (difficult due to power supply weight)	1/01
Full commissioning completed	Electronics not installed, or silicon installation delayed	Medium-high	Commission with beam in collision hall	3/01

Inter-cryostat Detector

The ICD construction is on schedule. ICD can be installed with all detectors on the platform. Fallback positions range from a delayed installation, which would shorten commissioning, to the extreme position where the ICD is installed in the collision hall.

Muon System



Central Muon System

The central muon system is completely installed. Currently unfinished is the gas recirculation system

The central muon system is being commissioned. It dictates the pace of the commissioning efforts and what is needed from the online, trigger and DAQ systems. We see no schedule risks in this system

Forward Muon System

Pixel status: Pixel layers A & C have been completely assembled and 16 octants exists for each layer. The B layer is currently being assembled into octants and will be complete by the end of February 2000.

MDT status: For MDTs the A layer octants have been completed and are under test. The B & C layer octant assembly is scheduled to start in early March.

Installation status: None of the planes have been installed in the detector yet, but the forward muon system is on schedule and we anticpate that it will stay that way.

Using Scheme I as our installation sequence, the priorities for this system are summarized as follows:

1. Complete the B layer trigger pixel octant assembly.
2. Install the A layer pixel & MDT octants on the detector.
3. Complete the C layer MDT octant assembly.
4. Install the south C layer MDT & pixel planes on the south truss, to be ready for roll into the collision hall in August 2000 (see installation Scheme I).

5. Install the north C layer MDT & pixel plane on the north truss.
6. Complete the B layer MDT octant assembly.
7. Install the B layer MDT & pixel layer on the detector.

Priorities define the fallback options

B layer pixel octants will be finished on schedule and pose no schedule risk.

Schedule risk in the MDT B & C layers ➔ fallback installation sequence is Scheme II

does not require C layer MDT octants until later this fall. If problems C layer higher priority in terms of octant assembly and installation. In this scheme the B layer would be delayed. The extreme fallback position would be installation sequence Scheme II with the B layer plane not installed by the time the detector rolls in. In this case we would start Run II without the B layer. It would be installed during a future shutdown in Run II and it would require the shield wall to be taken down, but the detector would remain in the collision hall.

Muon Electronics

The muon electronics has been delayed compared to our original baseline schedule, but poses no threat for the March 2001 ready-for-beam date. These delays have not yet shortened the commissioning time available, but any further delays in the next few months would result in less commissioning time for the central muon system. At this point we see the schedule risk due to the muon electronics as minimal. In case this evaluation is completely wrong, the extreme fallback position would be to complete any missing electronics during shutdowns early in Run II.

Trigger

The trigger system consists of 4 levels:

1. The inelastic interaction trigger, Level 0
2. The Level 1 trigger, which uses information from CFT, CPS, FPS, calorimeter and muon system.
3. The Level 2 trigger, which essentially uses the same information as Level 1 (with the addition of the silicon) but now can correlate the information from these systems.
4. The Level 3, which is a PC farm based trigger, where the full readout from all detectors is available.

The trigger framework has been at DØ for many months now and is being used to run cosmic ray triggers for commissioning of the central muon system. The trigger system is on schedule and most of its components are located outside the collision hall, so that work, development and implementation can continue after the detector is rolled in. This is especially true for Level 2 and Level 3, which are entirely software based triggers. Even Level 1 is to a large part programmable, but some of the signals needed for Level 1 are generated on the platform and use electronics located on the detector platform. We foresee no problems with the muon and calorimeter Level 1 triggers in this respect. However the Level 1 tracking trigger (CFT, CPS and FPS) use electronic boards for which prototypes are not in hand yet (8MCM and 12MCM boards). The 12MCM boards are not designed and here we are waiting for the 8MCM prototype versions to be tested, because the two boards are closely related. These boards are mounted on the VLPC cryostats and can in principle be installed after the detector is rolled in. The highest priority is to complete the 8MCM boards, because they read out the axial CFT fibers, which form the CFT track trigger at Level 1. The 12MCM boards read out the stereo CFT layer (not in the Level 1 or 2 triggers) and the CPS and FPS. If the 12MCM boards are late, we will start Run II without them and install them during short shutdowns at the beginning of Run II. Until the 12MCM boards arrive we would not be able to include the FPS and CPS in the Level 1 and 2 trigger and stereo CFT would not be available at Level 3.

As already mentioned above, large parts of the trigger system are accessible and are downloaded at the start of each run. So parameters and functionality of the trigger can be changed as conditions change and therefore the trigger system will go through a continual evolution into the final Run II system. The start of this evolution will be during the commissioning time this year and continue into Run II. There is enough flexibility in the trigger system that it is not a schedule risk for the start of Run II in March 2001.

Online

All functionality required from the online system for Run II has been implemented in at least a rudimentary way. The individual components may not be able to handle the data rates expected during Run II, but their functionality exists and enables us to start commissioning the detector. As the requirements from the commissioning efforts demand increased capabilities, these will be implemented and based on previous performance we see no difficulty in obtaining the complete functionality needed in the online system by March 2001. Even more so then the trigger, the online system is not a schedule risk for the start of Run II, because the basic functions need to start Run II are already available today. The fallback option is that we start Run II with less bandwidth than we had anticipated and increase our online bandwidth and capabilities as the detector and accelerator performance increases.

Solenoid

The solenoid is installed, has been operated and should present no schedule risks or uncertainties. Like all other cryogenic devices, it can be operated in the assembly area and in the collision hall.

Summary

We are fully committed to the DØ detector being rolled in and ready for data taking on March 1, 2001. We believe that we have already benefited substantially from the exercise of examining fallback options. Since the December 20 letter was received, we have settled on a new sequence for installation, which has the effect of allowing an extra six to eight weeks of schedule contingency for the completion of the silicon tracker. We have made a working decision to adopt a new installation scheme for the silicon tracker which has many advantages, including additional schedule contingency. We have changed the priorities in the forward muon system production to reflect the desire for the B-layer to be completed last. And we have engaged the collaboration in a serious and informed discussion. We will now integrate these options into our planning, continue with physics studies, and attempt to establish decision dates at which such options would need to be exercised.

Appendix: The Fermilab schedule

October 15, 1999

October 1999 to March 2001 Schedule

CY	1999			2000								
Month	Oct	Nov	Dec	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.
Proton Source	M&D	Operation			M&D	Operation					M&D	Run II Commissioning Run
Main Injector	M&D	Operation			M&D	Operation					M&D	
Recycler	Bake out	Installation and Commissioning			M&D	Commissioning		Engineering Run			M&D	
Pbar Source	M&D	Commissioning	a)	E835 Run	M&D	E835 Run		c)			E-835 Removal	
Tevatron	1 TeV test	Operation		b)	Changeover to Collider Configuration			Run II Engineering Run			Detector Roll-in	
Switchyard	M&D	Operation			OFF							
				1/17								

CY	2000			2001		
Month	Oct.	Nov.	Dec.	Jan.	Feb.	March
Proton Source	Run II Comm. Run	M&D/Studies/Commissioning				Run II
Main Injector		M&D/Studies/Commissioning				
Recycler		M&D/Studies/Commissioning				
Pbar Source		M&D/Studies/Commissioning				
Tevatron		CDF Roll-out & Roll-in and D0 Roll-in				
Switchyard	OFF					

a) Band 1 & 2 Installation and E835 installation

b) Possible KAMI Test

c) Operation for Pbar Source Commissioning, Recycler Engineering Run, and parasitic Run of E835