*Department of Energy*
*Review Committee Report*

on the

Mini-Review

of the

# D-Zero Detector Upgrade

November 1999

# EXECUTIVE SUMMARY

A Department of Energy (DOE) Office of Science review of the D-Zero Upgrade project was held at the Fermi National Accelerator Laboratory (Fermilab) on November 4, 1999. The Committee was chaired by Mr. Daniel Lehman, Director, Construction Management Support Division, Office of Science. At the time of this review the Upgrade project was estimated to be 90 percent obligated. There was one action item as a result of this review; to conduct a full review in May 2000.

The D-Zero Upgrade project has suffered delays, largely as a result of the high technical risk associated with a very aggressive silicon and fiber tracker design. The Laboratory now assures DOE that a detector will be in place and ready for data by March 1, 2001.

The Silicon Microstrip Tracker (SMT) assembly and installation schedules have been re-evaluated and new milestones have been established. Sensor deliveries from Micron have improved since June. In the response to the June review, silicon management indicated that a decision would be needed by around January 1, 2000, regarding whether to descope the SMT.

Improvement in communication between the D-Zero silicon group; D-Zero project management, and SiDet management was suggested by the Committee. This would help to ensure that D-Zero is aware of the status of their requests for equipment and personnel. The Committee recommended that the D-Zero silicon group be provided with adequate technical manpower, particularly for post-production testing and rework. It was suggested, by the Committee, that Fermilab re-evaluate the January 1, 2000 decision date for descoping the SMT and that by May 1, 2000, the collaboration submit a detailed SMT installation plan to laboratory management. The plan should specify any descoping that is necessary to meet the laboratory schedule.

The total D-Zero Upgrade cost presented at this review, in then year dollars, was $45.9 million. This cost includes equipment Materials and Services, accelerator improvement, and contingency. The comparable cost from the June 1999 review was $45.5 million. At this time, the project is approximately 90 percent obligated. The total estimate to complete is $5.1 million, which excludes $0.6 million in contingency.

The baseline schedule called for detector to be completed in November 1999. The re-evaluated date for detector completion is February 2001. Significant effort has gone into developing a credible schedule with critical path and sufficient milestones identified. The

Committee concluded that the schedule is reasonable but optimistic, unless the collaboration is willing to enact a fallback plan and/or reduce the scope of commissioning. Further commissioning planning is needed.

The Committee recommended that Fermilab develop a fallback plan that will assure D-Zero will meet the ready for beam milestone (stated as February 2, 2001) by May 1, 2000 and further develop a detailed resource-loaded commissioning plan and goals by January 30, 2000.

The Committee concluded that the management team is functioning well.

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# 1. TECHNICAL SYSTEMS OVERVIEW

## 1.1 Silicon Detector System

### 1.1.1 Findings

Sensor deliveries from Micron have improved since June. The problems with F-wedge sensors have largely been resolved, and a second F-wedge vendor (Eurisys) is in production. The delivery of DSDM 90-degree sensors remains slow.

Production of three-chip and nine-chip ladders, and H-half wedges, all to be used in the final Silicon Microstrip Tracker (SMT), is well underway. Approximately 20 percent of all modules have been assembled. Extensive facilities and procedures have been developed for the remaining assembly tasks.

HDI production is complete, but there have been significant quality-control problems in chip mounting and wirebonding at Promex.

Problems with low-mass cable procurement have been solved, and production of the final versions of the low-mass cables has begun.

Major changes in the scope of the interface card have caused substantial delays and cost increases. Two additional prototype cycles are planned before production can begin.

The silicon management does not believe that adequate technical manpower is in place.

The SMT assembly and installation schedules have been re-evaluated and new milestones have been established.

In the response to the June review, silicon management indicated that a decision would be needed by January 1, 2000 regarding whether to descope SMT.

### 1.1.2 Comments

The D-Zero silicon group has done a good job of monitoring sensor production at Micron. Current delivery rates, if they continue, are adequate to meet the proposed schedule.

The Committee commends the SMT team for their excellent progress on assembling production ladders and wedges. The 200 modules already built and now being tested represent major progress.

Quality control of HDI population at Promex has been poor. The Committee endorses the group's efforts to identify an alternate vendor.

The status of the interface card should be carefully monitored. Additional design changes should be avoided.

The ten percent test is a good approach to understanding the remaining assembly and commissioning issues.

Additional efforts should be made to utilize the substantial experience in production already gained in order to better understand the detailed schedule and resource requirements for remaining tasks.

The January 1, 2000 decision date for descoping the SMT is too early, relative to the planned SMT completion date.

The overall schedule is achievable, but optimistic.

### 1.1.3 Recommendations

1. Improve communication between the D-Zero silicon group; D-Zero project management, and SiDet management. Ensure that D-Zero is aware of the status of their requests for equipment and personnel.

2. The D-Zero silicon group should be provided with adequate technical manpower, particularly for post-production testing and rework.

3. Re-evaluate the January 1, 2000, decision date for descoping the SMT, in view of the following recommendation.

4. By May 1, 2000, the collaboration should submit a detailed SMT installation plan to Fermilab management. The plan should specify any descoping that is necessary to meet the laboratory schedule.

5. Develop time contingency in the silicon schedule to allow for unforeseen delays.

## 1.2 Fiber Tracker

### 1.2.1 Findings

Mounting of ribbons on the first production cylinder (3B) was completed in early September.

Problems discovered at that time:

- Connector dimensional change causes interference
- Alignment of axial layers D-Zeroes not meet specification

Consequences:

- Delay in further ribbon mounting, interrupting main production line
- Time required investigating, devising alternative for connector, and arranging machining of new parts
- VLPC production not started yet
- Delays due to vendor problems with manufacture of flexible cables

All other components are available, production steps have been devised, tooling is available, and personnel have been trained.

Most carbon fiber cylinders have been completed; ribbon production is nearly 50 percent complete, tooling for trial nesting assembly of cylinders 7 and 8 should be available by December 1.

A new procedure for mounting and alignment of the silicon barrel and H-disks inside the fiber tracker reduces installation coupling between the systems. Now the fiber tracker and silicon detector delivery to D-Zero are decoupled.

Completion of mechanical assembly has been delayed from January 24 to May 4, 2000.

### 1.2.2 Comments

The production schedule involves tightly orchestrated and interleaved process of fiber procurement, ribbon production and mounting, and nesting of completed cylinders.

There appear to be ways to accelerate some of these steps, for example with early delivery of fiber or faster curing RTV for mounting.

The critical path will continue to be assembly of completed cylinders, which will not be easy to advance from present projected completion date.

Most technical problems have been investigated; the team appears to have sufficient technical manpower and has good control of the assembly steps.

Some tolerances for the mechanical construction may not be achievable and may need to be relaxed in order to keep production underway without further delays.

Nesting of completed cylinders is the critical path for the mechanical assembly.

Timely physicist assessment of CMM data will be essential to maintaining the tight schedule.

Completion of trial assembly of test parts in December is very important for early exposure of unexpected problems and completion of required tooling.

There is adequate float in the scheduled installation date of the Fiber Tracker to accommodate delays in delivery of the mechanical system without compromising March 1, 2001 date for Run II.

### 1.2.3 Recommendations

1. The D-Zero Collaboration and project management should promptly evaluate the impact of looser tolerances for axial ribbon alignment or inter-cylinder alignment on the Level 1 trigger.

2. The D-Zero Collaboration and project management should identify two to three new post-doc level physicists to be added to the Fiber Tracker project in the very near term.

3. Resume production of ribbon-mounting on production cylinders as soon as possible.

4. Complete trial assembly of nested cylinders before the end of December 1999.

5. Explore the consequences of late delivery of the Fiber Tracker on the detector installation schedule.

6. Prepare a commissioning plan for summer and fall cosmic running, including online software and physics goals.

## 1.3 Muon Systems

### 1.3.1 Findings

Production of pixel trigger octants is underway, with 20 out of 48 completed.

The rate of assembly appears to be close to the predicted 1.1-per-week.

Production of MDT planes has not started.

Installation of MDT planes has slipped from April 26 to August 4, 2000.

Delivery of full complement of mini-drift tubes from Dubna has been delayed from October 1999 to January 2000.

There appears to be difficulty in obtaining large area honeycomb back planes, which meet tight flatness specification.

### 1.3.2 Comments

The schedule for this project has eroded by more than three months since the June review, rather than moving forward an accelerated pace as recommended. This appears to be partly due to delays in identifying vendors for components meeting tight flatness specification.

### 1.3.3 Recommendations

1. The D-Zero Collaboration and project management should make timely decisions of relaxing technical requirements and tolerances should these prove difficult to achieve while still maintaining production.

2. Find ways to win back lost schedule contingency by increasing production rates of forward muon systems octant assembly.

# 2. COST

## 2.1 Findings

The D-Zero project developed a new bottoms-up cost estimate for M&S, as well as the Solenoid, in the October-November 1999 time frame. The total cost for M&S, the Solenoid, and contingency, at $45,478 K, is a slight increase from the June 1999 review. This increase is mainly due to increased non-DOE contributions that have been identified since the previous review. There have been change control actions since the previous review that have resulted in utilization of contingency, as indicated in the table below. Currently, 90 percent of the total M&S and Solenoid cost has been obligated.

M&S and Solenoid Costs
(In thousands of then year dollars)

| | June 1999 Review | November 1999 Review | Changes | Obligated | Estimate to Complete |
|---|---|---|---|---|---|
| M&S | 38,533 | 40,244 | 1,711 | 35,119 | 5,125 |
| Solenoid | 4,936 | 4,975 | 39 | 4,975 | 0 |
| Contingency | 2,009 | 635 | -1,374 | 0 | 635 |
| **Total** | 45,478 | 45,854 | 376 | 40,094 | 5,760 |

The major changes since the June 1999 review were in the area of the Silicon Tracker ($1.6 million). The project has not identified any potential significant changes that would further draw on the remaining $635 K of contingency.

Costs for salary, wages, and fringes were reported as $19.1 million through FY 2001 in then year dollars.

## 2.2 Comment

The contingency remaining for the M&S and Solenoid costs at $635 K is 12 percent of the estimate to complete. The project indicated (and the Committee concurred) that this level of contingency is uncomfortable. Further utilization of contingency will have to be carefully executed.

## 2.3 Recommendations

None.

# 3. INSTALLATION and COMMISSIONING SCHEDULE

## 3.1 Findings

The silicon tracker schedule is tight–with no room for hiccups in production/assembly allowed.

The fiber tracker has 1 of 8 cylinders completed. Some decisions have been made recently to reduce alignment specifications. Some loss of float has occurred recently.

The Muon system (MDT portion) of the forward muon system is off to a slow start. Decision on flatness specification vs. survey/mapping will have to be made soon. Some loss of float has/will occur.

While there's a good deal of existing "infrastructure" (cooling, gas, power, etc.) in D-Zero, much of the new detector component infrastructure has not yet been installed on the detector.

Pre-production versions of all the various types of boards and modules (electronics) will be available for testing in March 2000.

The cosmic testing/commissioning of the Central Muon system has testing of all but the silicon tracker system planned to begin by late September 2000.

Commissioning workshops of various kinds have taken place and have provided valuable exchange.

A detailed resource-loaded schedule showing links/dependencies exists and is being updated on occasion.

A commissioning plan exists but is not resource loaded. It may take two to three months of beam commissioning before detector is "physics ready."

Some thinking has transpired, within the collaboration, regarding "fallback" plans should component schedules slip significantly.

## 3.2 Comments

The installation and integration group should proceed at a faster pace in finalizing the design and installation of the infrastructure items–gas system, water, power cabling, interlocks/safety systems, etc.

The "commissioning workshops" for the purposes of communication of plans/goals and problem solving should be continued.

By further refining (or beginning to load) the resource-loaded schedules, project will benefit by identifying skillsets and quantity of resources, and identifying need dates.

Some consideration should be given to displaying schedule and milestone information in a format that allows senior management to more effectively review and understand. Such as:

- One-page GANTT Chart
- Highlighting Critical Path
- Highlighting amount of float in non critical path subsystems

The schedule of D-Zero being complete by February 2, 2001 is reasonable, but optimistic. A fall-back plan is needed.

## 3.3 Recommendations

1. Develop a fall-back plan that will assure D-Zero will meet the ready for beam milestone (stated as February 2, 2001) by May 1, 2000.

2. Further develop a detailed resource-loaded commissioning plan and goals by January 30, 2000.