

**Critical Decision 3b**  
**Approve Start of Full Construction**  
**of the**  
**Micro Booster Neutrino Project**  
**at the**  
**Fermi National Accelerator Laboratory**  
Office of High Energy Physics  
Office of Science

**A. Purpose**

The purpose of this document is to record the review and approval by the Office of Science Energy Systems Acquisition Advisory Board-equivalent for Critical Decision (CD) 3b “Approve Start of Full Construction” for the Micro Booster Neutrino (MicroBooNE) Project at the Fermi National Accelerator Laboratory (Fermilab).

**B. Project Description and Scope Baseline**

The goal of the MicroBooNE experiment is to use Liquid Argon (LAr) Time Projection Chamber (TPC) detector technology to conduct a forefront neutrino measurement using a neutrino beam at Fermilab. The analysis of low energy neutrino interactions in the MiniBooNE experiment will provide the MicroBooNE experimental collaboration with a physics measurement goal for which to develop the capabilities of the LAr TPC detector. These low energy events are at the limits of most detector technologies, in particular the ability to distinguish between electrons and gammas. LAr TPC detectors have the potential for good particle identification, high spatial resolution and measurement of energy down to the MeV scale. These capabilities are needed to more precisely identify the events observed by MiniBooNE, and they will also be required of future, larger-scale detectors such as for Long Baseline Neutrino Experiment (LBNE).

The MicroBooNE Project consists of the design and construction of:

- infrastructure needed to support the MicroBooNE operation, including HVAC, safety, and communications systems;
- a LAr TPC system for precise measurements of inclusive and exclusive neutrino cross sections to enable the low energy “excess” events observed by the MiniBooNE experiment to be identified and classified;
- photomultiplier detectors;
- a cryostat to house the LAr TPC and PMT systems;
- cryogenics system;
- readout and data acquisition systems for the detector; and
- detector assembly, installation, and integration.

Integration and commissioning of the detector components with liquid argon will be handled as operating R&D outside of the MicroBooNE Project; the R&D program will study the filling requirements for LAr TPC detectors and may choose to fill the MicroBooNE detector several times under varying conditions of cleanliness and argon purity. Filling and commissioning of MicroBooNE with liquid argon will begin after the project has completed acceptance testing for CD-4.

The project is defined to be completed when it has achieved the Key Performance Parameter (KPP). The Key Performance Parameter (KPP) for the project is:

Liquid Argon Time Projection Chamber Detector positioned in the Booster Neutrino Beam with a total capacity for at least 100 tons of liquid argon after filling.

Completion of the KPP is demonstrated by accomplishment of the following items that enable readiness for initial filling with liquid argon:

1. Experiment infrastructure complete and operational;
2. Safety systems operational;
3. Detector installation complete;
4. Detector subsystem checkouts complete;
5. Cryo-plant tests complete;
6. Operational readiness clearance granted by the Laboratory.

### **C. Approval Prerequisites**

#### **Design Sufficiently Mature to Start Procurement**

The MicroBooNE Project has completed the design of all the major systems, and where appropriate, is testing versions of the components that could be the final versions. For the elements that are not finalized, the project showed that there are no major issues that need to be addressed. The table below presents the design status broken out by subsystem.

Work Breakdown Structure	Design Status
1.2 Cryogenics Systems	Design nearing completion. 3D model completed, and LAr Demonstration at Fermilab experience incorporated in design.
1.3 Cryostat	Cryostat vessel Request for Proposals has been issued, with responses due April 15.
1.4 Time Projection Chamber*	LAr TPC parts being procured. Wire winding starting at Syracuse and planned to start in April at Yale.
1.5 Front-end Electronics	Version 4 of the CMOS ASIC chip is underway. Design and prototyping of the rest of the front-end electronics has progressed well.
1.6 Experiment Infrastructure	The General Plant Project to construction the multi-use facility that will house MicroBooNE is well ahead of schedule due to the mild winter. This will enable WBS 1.6 work to begin ahead of schedule.
1.7 Systems Installation	Preparation of an area within the DZero Building at Fermilab for the detector installation activities is well underway. Plans are ready and area will be ready to begin assembly activities when parts arrive.
1.8 PMT System*	Design completed. All 30 photomultiplier tubes have passed tests at air temperature and are in the process of

	being tested in liquid nitrogen.
1.9 DAQ, Monitoring, and Control	Finishing final design.
1.10 Detector Assembly Integration	Building and cryostat integration issues addressed. PMT rack and installation fixtures progressing. HV feed thru design advancing.
1.11 Electronics Readout*	Prototype 2 (system) testing is in progress.

\*NSF-funded in-kind contributions

## **Project Documentation**

Required documentation, including the Project Execution Plan, approved on September 19, 2011, and the Acquisition Strategy, approved on July 7, 2010, were approved at or prior to the time of CD-2/3a approval. No significant changes have been required to the documentation.

## **Quality Assurance (QA) Program**

Project work at Fermilab is covered by the laboratory QA plan. The subject is addressed in the Project's Quality Management Plan.

## **Environment, Safety and Health**

The Categorical Exclusion (10CDF1021, Subpart B, Appendix B1.15 and B3.10) for the MicroBooNE Project was approved on March 18, 2011.

A MicroBooNE Hazard Analysis report has been updated for this project in preparation for CD-3b. Liquid argon is the most significant safety hazard on the Project, and safety measures are integrated in the designs. Fermilab has a history of performing similar work in a safe manner.

The MicroBooNE Project work at Fermilab will be conducted under the Integrated Safety Management (ISM) plan developed by Fermilab in consultation with DOE.

## **Independent Project Review**

The Office of Project Assessment, at the request of the Acquisition Executive (AE), conducted a review to validate the MicroBooNE readiness for CD-3b on February 29-March 1, 2012. The MicroBooNE Project and documentation were reviewed and judged to be ready for CD-3b.

## **D. Project Cost and Schedule Baseline**

### **Cost**

The MicroBooNE Project is a Major Item of Equipment (MIE). The DOE Total Estimated Cost (TEC) for the MicroBooNE Project is \$14.76 million in then-year dollars. The DOE Total Project Cost (TPC) is \$19.90 million in then-year dollars. In addition, the detector systems include fully-funded in-kind contributions of scope from NSF-funded university groups valued nominally at \$1.89 million. As of March 19, 2012, the contingency was \$3.65 million or 32 percent of the costs to complete.

The CD-3a approval enabled the Project to place orders for the three long-lead cryogenics procurements.

### **Scheduled**

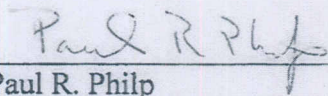
The table below presents the Critical Decision milestones for the MicroBooNE Project. Schedule float has been added to each milestone based on the level of the milestone. As of March 19, 2012, the float on the CD-4 milestone was approximately 13 months. Filling of the detector with liquid argon and subsequent commissioning of the detector are not part of the Project.

**MicroBooNE Project – Critical Decision Milestones**

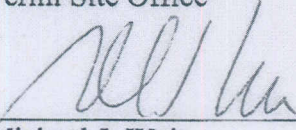
Milestone	Description	Baseline Date
0.0	CD-0: Approve Mission Need	Sept 28, 2009 (A)
0.1	CD-1: Approve Alternative Selection and Cost Range	July 9, 2010 (A)
0.2	CD-2: Approve Performance Baseline	Sept 27, 2011 (A)
0.3a	CD-3a: Approve Limited Construction	Sept 27, 2011 (A)
0.3b	CD-3b: Approve Start of Full Construction	June 2012
0.4	CD-4: Approve Project Completion	Sept 2015

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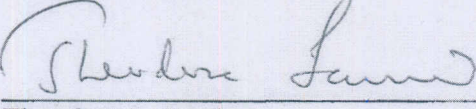
**Submitted by:**

  
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Paul R. Philp  
MicroBooNE Federal Project Director  
Fermi Site Office

3-26-12  
Date

  
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Michael J. Weis  
Manager  
Fermi Site Office

3/26/12  
Date

  
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Theodore L. Lavine  
MicroBooNE Program Manager  
Office of High Energy Physics

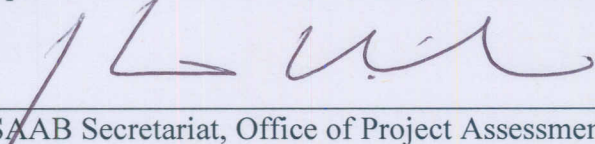
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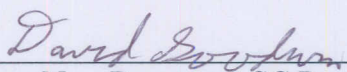


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**Recommendations:**

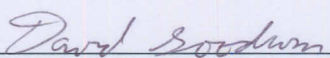
The undersigned "Do Recommend" (Yes) or "Do Not Recommend" (No) approval of CD-3b, Approve Start of Full Construction, for the MicroBooNE Project at Fermilab as noted below.

  
\_\_\_\_\_  
ESAAB Secretariat, Office of Project Assessment      Date      Yes ☒ No ☐

  
\_\_\_\_\_  
Representative, Non-Proponent SC Program Office      Date 3/29/12      Yes ☒ No ☐

\_\_\_\_\_  
Representative, Office of Budget      Date      Yes ☐ No ☐

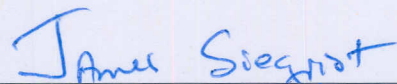
  
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Representative, Environmental, Safety and Health Division      Date      Yes ☒ No ☐

  
\_\_\_\_\_  
Representative, Safeguards and Security Division      Date 3/29/12      Yes ☒ No ☐

  
\_\_\_\_\_  
Representative, Facilities and Infrastructure Division      Date      Yes ☒ No ☐

**Approval of CD-3b**

Based on the information presented above and at this review, Critical Decision-3b, Approve Start of Full Construction, for the Micro Booster Neutrino (MicroBooNE) Project is approved.

  
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James L. Siegrist, Acquisition Executive  
Associate Director for High Energy Physics  
Office of Science      Date 3/29/12