

**Approval of Alternative Selection and Cost Range (CD-1),
Performance Baseline (CD-2), and
Start of Limited Construction (CD-3a)
for the
Main Injector Experiment ν -A (MINER ν A) Project
at the
Fermi National Accelerator Laboratory
Office of High Energy Physics
Office of Science**

A **Purpose**

This document is submitted to the Office of Science Energy Systems Acquisition Advisory Board (ESAAB)-equivalent for approval of Critical Decision 1 (CD-1), Alternative Selection and Cost Range, Critical Decision 2 (CD-2), Performance Baseline, and Critical Decision 3a (CD-3a), Start of Limited Construction for the Main Injector Experiment ν -A (MINER ν A) Project at Fermi National Accelerator Laboratory (FNAL). This request for approval of CD-1/2/3a is due to the advanced state of planning for the project.

The Acquisition Executive (AE), upon signature of this document, will grant approval of CD-1/2/3a. A description of the project and status of the prerequisites necessary for critical decision approval are detailed in this document.

B **Project Description**

The Neutrinos at the Main Injector (NuMI) beamline at FNAL provides a neutrino beam of extremely high intensity. With the NuMI beam, statistically significant neutrino measurements are feasible with much lighter targets than was previously the case. The goal of the MINER ν A experiment is to perform a high-statistics neutrino-nucleus scattering experiment using a fine-grained, fully active scintillator detector. The MINER ν A detector will be located in the NuMI beam, directly upstream of the existing Main Injector Neutrino Oscillation Search (MINOS) Near Detector in the Near Detector hall at FNAL. The MINER ν A detector will consist of an active target made of solid scintillator bars, surrounded on all sides by an electromagnetic calorimeter and a hadronic calorimeter. The upstream end of the detector contains nuclear targets of graphite, iron, and lead. The detector is hexagonally shaped and has three stereo views for precise tracking. It will be located as closely as possible to the MINOS Near Detector, which may serve as a muon identifier for MINER ν A. The MINER ν A Project encompasses the fabrication and testing of the MINER ν A detector. The installation and operation of the detector are excluded from the project to provide the needed flexibility to complete the project to CD-4, Project Completion, independently of scheduling issues associated with NuMI/MINOS and the FNAL accelerator complex.

C **Mission Need**

The MINERvA Project is the fabrication of a high resolution neutrino detector capable of distinguishing explicit final states in the energy range of 0.5 to 3.0 GeV and measuring their neutrino cross-sections. The project supports Strategic Theme 3, Scientific Deiscover & Innovation, of the 2006 Department of Energy's Strategic Plan. It supports Strategic Goal 3.1, Scientific Breakthroughs: Achieve the major scientific discoveries that will drive U.S. competitiveness; inspire America; and revolutionize our approaches to the Nation's energy, national security, and environmental quality challenges; and Strategic Goal 3.2, Foundations of Science: Deliver the scientific facilities, train the next generation of scientists and engineers, and provide the laboratory infrastructure required for U.S. scientific primacy. Specifically, MINERvA supports the High Energy Physics Program Goal (03.1/2.46.00): Explore the Fundamental Interactions of Energy, Matter, Time and Space - Understand the unification of fundamental particles and forces, and the mysterious forms of unseen energy and matter that dominate the universe; search for possible new dimensions of space; and investigate the nature of time itself.

The AE, Dr. Robin Staffin, Associate Director of the Office of High Energy Physics (HEP), approved Critical Decision 0, Mission Need, on June 23, 2006.

D **Approval Prerequisites**

- i) **Design Reports** – A Conceptual Design Report is required for CD-1, a Preliminary Design Report is required for CD-2, and a final design sufficiently mature to start procurement is required for CD-3. Technical design documents for the project were reviewed as part of the Independent Project Review conducted by SC on December 5, 2006 and determined to be adequate.

- ii) **Project Execution Plan** – The Preliminary Project Execution Plan is a prerequisite for CD-1 and the final Project Execution Plan (PEP) is a prerequisite for CD-2 approval. The final PEP has been completed and is being presented to the AE for approval. It describes the scope and management of the DOE responsibilities and establishes the performance baseline for the project.

- iii) **Project Scope Baseline** – The baseline scope of the Project is the fabrication and testing of the MINERvA detector to be installed in the MINOS Near Detector Hall at FNAL. The CD-4, Project Closeout, requirements have been established, and are as follows:

| Subsystem | Measurement | Commissioning Goal |
|-----------------------------------|--|--|
| Detector Modules | Modules Mapped with Radioactive Source | 108 loaded frames of the Detector Modules assembled and mapped; and greater than or equal to 86 frames (80%) have greater than or equal to 119 strips per plane sensitive to a radioactive source (93% of strips per plane). |
| Electronics and DAQ Readout Chain | Module data read out through DAQ system | Read out radioactive source data through the entire MINERvA Electronics and DAQ chain through one module. |
| Nuclear Targets Complete | Visual inspection | Nuclear Targets of carbon, steel and lead assembled and passed inspection. |
| PMTs and PMT Boxes | PMTs and PMT Boxes tested in test stands | Greater than or equal to 449 (95% of total deployed) of PMTs and associated bases, boxes, and electronics pass PMT and PMT box testing criteria. |
| Clear Fiber Cables | Cable Transmission | 3784 clear fiber cables (100% of total deployed) produced and tested; and for at least 80% of the cables, 8 of 8 fibers pass quality control test. |

- iv) Project Funding – The Total Project Cost (TPC) for the project is \$16.8M. This consists of \$10.7M Total Estimated Cost (TEC) MIE funding, and \$6.1M of Other Project Costs (OPC) operating funding. The MINERvA funding table is as follows:

MINERvA Resource Requirements (\$ in Thousands)

| | FY 2006 | FY 2007 | FY 2008 | FY 2009 | FY 2010 | Total |
|------------|----------------|----------------|----------------|----------------|----------------|--------------|
| MIE | 0 | 0 | 5,400 | 4,900 | 400 | 10,700 |
| OPC | 800 | 4,900 | 400 | 0 | 0 | 6,100 |
| TPC | 800 | 4,900 | 5,800 | 4,900 | 400 | 16,800 |

- v) Project Cost and Schedule Baselines – The schedule is described by the project’s Critical Decision milestones, which are given below:

Critical Decision Milestones

| Milestone Description | Baseline Date |
|---|------------------------|
| CD-0 Approve Mission Need | June 23, 2006 (actual) |
| CD-1 Approve Alternative Selection and Cost Range | March, 2007 |
| CD-2 Approve Performance Baseline | March, 2007 |
| CD-3a Approve Start of Limited Construction | March, 2007 |
| CD-3b Approve Start of Full Construction | September, 2007 |
| CD-4 Approve Project Completion | April, 2010 |

The cost baseline broken down by WBS item is shown below:

Cost by WBS Element (\$ in Thousands)

| WBS Element | Item | Base |
|-----------------|-----------------------------|--------|
| 1.0 | Scintillator Extrusion | 400 |
| 2.0 | Wavelength Shifting Fibers | 700 |
| 3.0 | Scintillator Plane Assembly | 800 |
| 4.0 | Clear Fiber Cables | 1,100 |
| 5.0 | PMT Boxes | 500 |
| 6.0 | PMT Procurement & Testing | 1,100 |
| 7.0 | Electronics & DAQ | 900 |
| 8.0 | Frame, Absorbers & Stand | 600 |
| 9.0 | Module & Veto Wall Assembly | 400 |
| 10.0 | Project Management | 1,300 |
| TEC Contingency | Contingency on MIE | 2,900 |
| TEC | Total TEC | 10,700 |
| | | |
| Base OPC | Base OPC | 4,800 |
| OPC Contingency | Contingency on R&D | 1,300 |
| OPC | Total OPC | 6,100 |
| | | |
| TPC | MINERvA TPC | 16,800 |

- vi) Acquisition Strategy – An Acquisition Strategy is required for CD-1 approval. The MINERvA Acquisition Strategy was approved and signed on November 26, 2006. The site selection for MINERvA was driven by the availability of an intense neutrino beam. The NuMI beam at Fermilab is among the most intense neutrino beams in the world; there is no alternative in the United States.

Fermilab Research Associates (FRA) will serve as the prime contractor, due to its and its predecessor organization, University Research Associates (URA), long experience managing Fermilab and planning, supporting, and assembling high energy physics experiments.

- vii) Independent Project Review – An Independent Project Review was conducted by the Office of Science (SC) Construction Management Support Division on December 5, 2006. The goal of this review was to verify that the Project's technical design adequately addressed the technical requirements, the estimated cost was credible and sufficiently documented, and there was a team capable of managing the fabrication effort. In addition, the review was to verify the adequacy of the final design for a limited number of detector components to be

procured. The Committee judged that the CD deliverables were sufficiently complete and that the project is ready for CD 1/2/3a approval.

Ten recommendations were made. All recommendations have been accepted and are being responded to by the Project. The recommendations and responses related to CD 1/2/3a are summarized below:

| Recommendation | Project Response |
|--|--|
| The collaboration needs to re-evaluate CD-4 requirements for module qualification. | CD-4 requirements have been re-drafted to reflect this recommendation. |
| To minimize project risk and maintain the planned project schedule, the project should move forward with the long-lead procurement of the clear fiber, optical connectors, and the plastic to be used for the PMT alignment holders. | Procurement of these items will proceed on schedule after the project receives CD-3a authorization. |
| Update the Hazard Assessment Document to include work done at university sites. | The document is being revised to include university sites. The list of hazards now includes all those associated with items for CD-3a. |
| Provide a less ambiguous MINERvA CD-4 project completion milestone for PMTs and PMT boxes passing tests to a fixed number (such as 425 PMTs and boxes). | CD-4 requirements have been re-drafted to reflect this recommendation. |
| Obtain the appropriate signatures for the Project Execution Plan, the Project Management Plan, and the Quality Assurance Plan. | The PEP is ready for the Acquisition Executive's signature. The PMP and QAP have been signed. |

- viii) Environmental Strategy – In compliance with the National Environmental Policy Act, the MINERvA Project submitted an Environmental Evaluation Notification Form, on the basis of which a Categorical Exclusion was granted on December 2, 2005.
- ix) Safety Analysis Document – A Safety Assessment Document specific to MINERvA will be produced prior to sustained operations. A Hazard Assessment has been prepared and was reviewed as part of the December 5, 2006 SC review.

E Justification and Definition of CD-3a

In order to accelerate the detector fabrication schedule, the MINERvA Project is seeking CD-3a approval. The MINERvA detector fabrication takes place along two parallel paths: one starts with the scintillator bar extrusion, instrumentation, and assembly into planes of scintillator which are then inserted in lead and instrumented steel frames to form the calorimeter. The other path is associated with the detector readout: phototubes must be acquired, aligned in precision holders and tested, and then placed in special housings which take the signals from the scintillator through the phototubes and then to

the electronics. Clear fiber cables connect the light from the scintillator planes to the phototube housings, and shortened versions of those cables are used internally in the housing. Because of the long lead-time for the delivery of these items, the time required to both make the clear fiber cables that are used internally in the boxes, and the subsequent weaving of the strands of those cables in the boxes, the second path is four months longer than the first path.

The Independent Project Review held on December 5, 2006 concluded that the proposed long-lead items were adequately designed and ready for CD-3a approval. The items specifically examined for CD-3a approval were: clear fiber cables, optical connectors, plastic for the PMT alignment holders, and wavelength shifting fiber. Approval of CD-3a will be an indication to our collaborators in the Minerva project that DOE is declaring a limited portion of the project to be ready. Our collaborators can then begin to take any preparatory actions necessary to maintain the planned schedule.

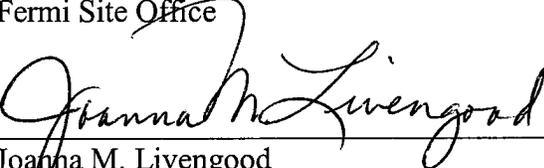
**MINERvA Project
Critical Decision 1/2/3a Project Review**

Submitted by:



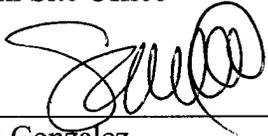
Stephen L. Webster
Federal Project Director
Fermi Site Office

3/19/07
Date



Joanna M. Livengood
Manager
Fermi Site Office

3/19/07
Date



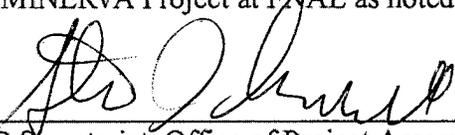
Saul Gonzalez
Program Manager
Office of High Energy Physics

3/29/07
Date

**MINERvA Project
Critical Decision 1/2/3a Project Review**

Recommendations:

The undersigned "Do Recommend" (Yes) or "Do Not Recommend" (No) approval of CD-1/2/3a for the MINERvA Project at FNAL as noted below.



ESAAB Secretariat, Office of Project Assessment Date 3/30/07 Yes No



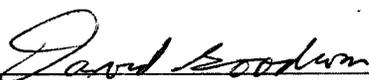
Representative, Non-Proponent SC Program Office Date 3/30/07 Yes No



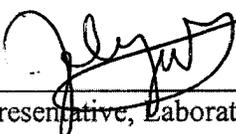
Representative, Office of Budget and Planning Date 3/30/07 Yes No



Representative, Environmental, Safety and Health Division Date 3-20-07 Yes No



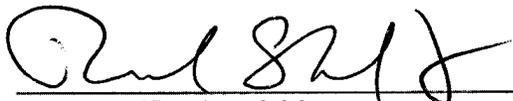
Representative, Security Management Team Date 3/30/07 Yes No



Representative, Laboratory Infrastructure Division Date 3/30/07 Yes No

Representative, Grants and Contracts Division Date Yes No

Approval of CD-1/2/3a



Robin Staffin, Acquisition Executive
Associate Director for High Energy Physics
Office of Science Date 3/30/07