Fermilab

Closeout Report

Director's CD-1/Trial CD-2 Review of the MINERvA Project

December 13-15, 2005

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Table of Contents

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Executive Summary

The MINERvA experiment is designed for conducting precise high energy physics and nuclear physics neutrino measurements utilizing the high intensity neutrino beam from the NuMI facility at Fermilab.

Technical
A conceptual design report (CDR) dated December 2004 describes the design for the MINERvA detector; a fine grained neutrino detector based on a combination of technologies already demonstrated by one or more prior detectors. Some R&D and prototyping work has been conducted and additional key R&D measurements and prototype efforts are underway with this work continuing through FY2006 and into FY2007. The physics requirements and resulting technical specifications were clearly presented and result in a detector parameters list setting forth the MINERvA project specifications. Good progress is being made and a draft technical design report (TDR) will be issued in March 2006. This will be the key technical document supporting a Baseline Review in the summer. It is planned that approval to begin construction will be granted early in FY2007.

Cost
MINERvA is well along in developing their cost and schedule. The cost estimate is supported by detailed basis of estimate (BOE) documentation presented at this review in binders and maintained in the MINERvA project database docdb. Most of the large purchase cost estimates are based on vendor quotes. The bottoms-up contingency analysis yields a 36% contingency on a $6.7M MIE (major item of equipment) base estimate for the project. In addition to the $9.1M MIE, there are estimated costs of $3.8M R&D and $0.8M Installation and Infrastructure yielding a grand total of $13.8M.

With modest additional work the cost estimate will support a CD-1 determination. The cost estimate may change some when adding in the missing resources and some cost may shift from contingency into the base, but the total cost estimate presented appears to be reasonable for the work scope.

Schedule
The schedule for MINERvA has been prepared using Microsoft Project (MSP). The critical path has been determined and includes Scintillator Plane Assembly, PMT Box prototyping and production, and clear fiber cables. Steps are being taken to address these critical path items including pre-purchase of optical connectors at a cost of less than $100K. Several areas and suggestions for further consideration of addressing critical path issues are included in the details of this report.

The schedule could benefit from some additional scrubbing for task duration, resource requirements and milestones to the point that both the Project Office and the Level 2 Managers are comfortable that the schedule is realistic even if aggressive.

To meet the requirements for CD-1 approval the high level milestones, including CD-4 with sufficient float need to be clearly identified with a documented understanding of what is required to meet these milestones. Additionally completion dates for other high level project milestones need to be established by incorporating schedule contingency / float based on risk considerations. By continuing the process of refining the schedule and incorporating what is learned during the R&D activities early in CY2006 a Resource Loaded Schedule that can be baselined should be achievable by spring 2006.

Management

An appropriate organizational structure is portrayed in the MINERvA organization chart with persons named for all positions. Drafts exist for the formal DOE required documentation (CDR, draft Project Execution Plan [PEP], Acquisition Strategy, and Preliminary Hazard Analysis Report) to support a CD-1 determination. The project team has incorporated other project management principles including Configuration Management, Value Engineering / Management, and Risk Management. A strong emphasis is placed on ES&H/QA.

The committee feels that the PMTs, PMT Boxes, and Electronics and DAQ (WBS elements 5, 6, and 7) need to be closely coordinated. Such close coordination was not evident in this review. One way to improve the coordination would be to collapse all these activities into a single WBS. Another way would be to have an overall "567" Manager / Coordinator. MINERvA should take some action to address this concern.

The committee has the impression that the project could benefit from a strengthening of physicist and engineering participation in some areas.

1.0 Introduction

A Director's CD1/Trial CD-2 Review of the MIVERvA Project was held on December 13-15, 2005. The charge included a list of topics to be addressed as part of the review. The assessment of the Review Committee is documented in the body of this report.

Reference materials for this review are contained in the Appendices. Appendix A is MINERvA's project cost estimate with contingency spreadsheet. The Charge for this review is shown in Appendix B. The review was conducted per the agenda shown in Appendix C. The Reviewer's assignments are noted in Appendix D and E, and their contact information is listed in Appendix F. The Review Participants are listed in Appendix G. Appendix H is a table that contains all the recommendations contained in the body of this report.

2.0 Science

Findings

- The physics goals of the experiment are to measure the charged current neutrino cross sections with high precision. Both inclusive (DIS) and exclusive channels (e.g. coherent hadron production and quasi-elastic) will be measured. These measurements are of use to neutrino oscillation experiments but also of fundamental interest as they provide a complementary means of studying the transition from non-perturbative to perturbative QCD which has is also under intensive study at Jefferson Lab.
- Two areas of particular interest are coherent pion production, which preliminary results from T2K indicate is significantly smaller than expected, and the axial form factor.
- Neutrino physics measurements traditionally require determination of a reasonably small number of kinematic variables. Most important are the angles of the scattered leptonic and hadronic systems, and the energies of the lepton and scattered hadrons. In addition the location of primary vertex needs to be known in order to assure that the interaction occurred in the fiducial volume. The total neutrino energy is estimated from the sum of the lepton and hadron energies.
- Minerva also wishes to measure exclusive channels such as coherent pion and quasi-elastic scattering which add additional requirements on track separation and particle identification.
- The collaboration presented studies of the effects of detector resolutions and efficiencies on physics topics of interest, illustrating the dependence of the physics results on the measurement accuracy for the kinematic variables. The required resolution and scale of these kinematic variables can be considered to be the technical performance specifications for the detector.
- The collaboration also presented the results of detector optimization studies which estimate the dependence of the measurement accuracy of the kinematic variables on the detector scope. These studies were done using a combination of prototypes, experience from MINOS and a dedicated GEANT3 simulation with preliminary pattern recognition but full resolution estimates.
- The studies have been used to optimize the design of the scintillators and readout, in particular with a design goal of 15-16 PE/MIP/doublet layer, estimates from prototypes indicate that the current design should produce 18 PE/MIP.
- From the simulations,
    - the hadron energy resolution indicated by the simulations is *sigma/E = 4%+18%/sqrt(E,GeV).*
    - the electromagnetic energy resolution is *sigma/E = 5-6%/sqrt(E,GeV).*
    - the muon momentum is determined by range below around 10 GeV. For momenta below ~1 GeV range in the Minerva detector yields 5% resolution. Using the Minos detector for range, the resolution for muons from 1-10 GeV is ~7% and above that bend in the magnetic field yields a resolution of 12%.
    - The fine segmentation yields event vertex resolution of order 1 cm in both the transverse and longitudinal directions.

  - pi0's are identified by the presence of two electromagnetic showers separated from the primary vertex by of order one radiation length.
  - At low momenta, charged pions, kaons and protons can be separated via their energy loss in the scintillator.
  - Studies of smearing in DIS were presented but did not include details on resolutions on x, v and Q^2. (available but not presented according to Jorge) However, resolutions in $Q^2 - 2Mv$ were presented for quasi-elastic and x_{Bj} and t for coherent pion production.
    - quasi-elastic cross sections are most sensitive to hadron energy resolution, which drives that parameter.
    - the coherent production is most sensitive to angular resolution and the ability to separate close tracks, which drives the transverse segmentation of the detector.

Comments

- The committee was surprised that measurements of electron neutrino production, which are important for both MINOS and Nova were not presented.
- As part of the optimizations made over the past year,
  - the collaboration has removed magnetization of the detector although the ability to magnetize the detector in future has been preserved. This reduces problems with operation of phototubes in a magnetic field at the expense of muon momentum information from the Minerva detector. Instead, high momentum muons will be detected via range out or bend in the MINOS detector which stands directly behind Minerva. This requires integration of the MINOS data into the Minerva data stream.
  - the thickness of the outer calorimeter has been optimized based on the detailed simulation of physics performance.
- Overall, the studies presented indicate that the proposed detector is well optimized and can achieve the proposed physics performance.

Recommendations

1. Much of the work shown was convincing but has not yet been included in formal documents. In particular, tables indicating the projected resolution in relevant physics variables (Q^2, v, x_{Bj}, t) over the relevant kinematic range would be valuable.
2. In addition, detailed presentation of contributions to the error budget for cross section measurements (flux, statistics, nuclear effects, input from other experiments as well as smearing and calibration) would be very useful.
3. Benchmark cross sections errors, resolutions/purities/efficiencies should be carefully monitored as further knowledge of the performance of the real detector becomes available.
4. In particular, studies of the effects on benchmark quantities of coherent noise within a PMT box, channel to channel variation and gain non-linearities should be done using the simulation to assess the impact of these potential hardware problems on physics results and optimize the testing and calibration procedure.

3.0 Scintillator Extrusions, WLS Fiber and Clear Fiber Cables - WBS 1, 2, 4

Findings

- This part of the review covers WBS 1 (scintillator extrusions), WBS 2 (WLS fibers) and WBS 4 (clear fiber cables) of the MINERvA project.
- The MINERvA Collaboration has presented detailed plan of prototyping, design, procurement and production of detector developed to detect neutrino interactions based on scintillator extrusions with WLS fibers readout with light delivered to multi-anode PMTs using clear fiber cables.
- The detector consists of ~30 thousand sensitive elements with triangular (central part) 33x17 mm^2 or rectangular (outside part) 15x15 mm^2 cross section. Construction of the detector requires production of 13,312 triangular extrusions 3.8m long and 2,736 square extrusions 3.5m long which are then cut into shorter pieces for detector plane assembly.
- The WLS fibers are installed and glued in the center hole of the scintillator extrusions. The selected WLS fiber is Y-11 fiber from Kuraray with diameter of 1.2mm. One end of each WLS fiber is aluminized and the other mounted in an optical connector to deliver light via clear fiber cables to a 64 channel PMT. The lengths of WLS fibers vary between 2.7m and 3.2m.
- The clear fiber is Kuraray S-35 with a 1.2mm diameter. The clear fibers are assembled in cables with length from 1.2m to 1.4m to deliver light from the WLS to the PMT boxes.
- Preliminary measurements and estimates suggest that MINERvA's light yield specification of ~18 PE/ double-layer could be achieved with the proposed design.
- R&D for production of scintillator extrusions, WLS fibers and clear fiber cables is well under way with many prototypes available for evaluation and many important results already obtained. An ~ 1 week production extruder run for prototype planes is expected early 2006.
- Plans for R&D work as well as major steps of procurement, production and quality control, including shipment of the elements for assembly of detector elements at Universities production sites, are being developed.
- There are cost estimates based on quotes from vendors (WLS, clear fibers, connectors) as well as estimates based on production of similar parts at Fermilab and Universities for other experiments.
- The schedule for WBS 1, 2 and 4 has been developed based on existing experience with similar projects and detailed estimates based on available resources.
- The WBS structure for scintillator extrusions, WLS Fibers and clear fiber cables is available.

Comments

- The MINERvA detector is based on a conservative design with major detector elements used previously in such projects as MINOS, CMS, CDF and D0.

- An impressive amount of work has been accomplished by the Collaboration with studies of detector elements parameters and definitions of major specifications. In addition, detailed cost and schedule estimates have been developed.
- Most material cost estimates are based on quotes from vendors. Procurement of scintillator components for extrusion is already complete. Labor estimates are based on experience with similar previous projects and detailed BoE documentation.
- The cost estimate and contingency look reasonable.
- We note that materials procured by the Laboratory in FY05 for the project are not clearly included in the total project cost.
- The schedule is based on delivery times from vendor quotes, the specified production rate of the extruder as well as estimates based on experience with similar projects.
- The schedule looks reasonable, but in some cases requires availability of specific Fermilab experts, for example for polishing/aluminizing fibers, during appropriate time window(s).
- Coordination between different parts of the MINERvA project, which includes many vendors, groups, Universities, will require substantial effort. It is important that detailed technical specifications, especially for parameters which "link" different WBS's together, like specifications of extrusion sizes, be well developed before production is started.
- We were impressed with the knowledge and experience displayed by the Level 2 managers.

Recommendations

1. The collaboration should concentrate on finishing the R&D stage as well as the design of detector elements and tooling required for parts production.
2. The collaboration should develop a detailed list of specifications for all parts to be produced in WBS 1, 2, and 4. These specifications should include "required" as well as "not acceptable" limits.
3. An extended run of the extruder should be performed to verify the production rate and quality of the extrusion as well as the amount of labor required to run the extruder and perform extrusion quality control.
4. Preproduction samples should be used to verify that detector parameters satisfy MINERvA specifications. The results should include light yield for the scintillator-WLS-clear fiber-PMT chain as well as coordinate resolution of the triangular extrusion assembly.
5. Detailed quality control procedures should be developed for use during production of scintillator extrusions, WLS and clear fiber cables.
6. The cost estimate should be updated to include all costs required for the detector construction.
7. The schedule and cost estimate should continue to be updated as information from vendors and R&D studies become available.

4.0 Plane Assembly, Outer Detector Frame, Absorbers, Stand and Module Assembly - WBS 3, 8, 9

Findings

- WBS 3 consists of the design and construction of 196 Inner Detector planes made from triangular scintillator extrusions and 2592 Outer Detector units made from rectangular extrusions. This WBS element includes production tooling, assembly and testing labor, mounting hardware, and packaging materials for the shipment of completed modules to Fermilab. The plane assembly will occur at two sites (William & Mary and Hampton)
- The design of the Minerva planes is based on the MINOS plane design and takes good advantage of the experience from that project, including identification of important simplifications. There has been a considerable effort to adapt and reuse MINOS tooling. Labor estimates for plane assembly incorporated the "as-realized" hours from the MINOS assembly process with appropriate scaling.
- The materials for scintillator packaging were selected for fire safety and ease of assembly. Attention to ES&H issues was notable in all aspects of the presentations.
- WBS 8 includes the design and procurement of 108 steel frames along with iron, lead and graphite absorbers and includes the support stand for the detector as well as other support stands and strong-backs used in the assembly and transport of modules.
- The design for the hexagonal frames is based on 60 degree slotted segments made from 1.25" thick steel will be procured from an outside vendor and welded into hexagon frames at Fermilab.
- The cost of the steel has shown a significant drop in cost since the January 2005 review primarily by adopting a procurement strategy similar to that used for MINOS steel.
- WBS 9 covers the assembly and testing of 108 modules at Fermilab, and includes the design and procurement of a scanner for mapping the modules, a support frame for mounting the PMTs and the construction of a Veto wall made largely from recycled components.
- Tooling and fixtures from MINOS construction are being utilized in several instances.
- Lead handling tasks will be performed by experienced Fermilab personnel who have the appropriate training.
- For each of these WBS elements, presentations in the plenary and breakout sessions provided a concise and complete description of the project.
- Cost and WBS dictionary information has not been transferred to the lowest level activity in MS project for all tasks.

Comments

- Coordination between WBS 3, 8 and 9 is very good.
- The utilization of MINOS construction experience is commendable. There has been considerable attention to value management which has led to the simplifications and improvements. The MINERvA design is simple and robust and labor estimates projected from MINOS experience will be reliable.

- The design, cost and schedule information is well developed and well organized and is very close to CD-1 level.
- Triangular vs. rectangular scintillator extrusion and plastic vs. aluminum plane wrap are significant differences between the MINERvA and MINOS plane assemblies. Construction and testing of plane prototypes are required to verify that these differences will not present difficulties with the current design. Successful completion of half plane and full plane prototypes will be significant milestones.
- The module mapping is a very high labor cost activity and has significant uncertainty at this time leading to a large contingency. Previous experience should be applicable to understanding and reducing this uncertainty.
- The components of these three groups must be highly integrated. Controlling drawings in the areas where purchases will be made may not be sufficient to assure that interfaces between components are controlled appropriately. A change of a feature on a drawing controlled by one group may have a significant impact on a part being manufactured by another group.
- Frame construction and module assembly depend on Fermilab resources, welders and technicians, who are generally unavailable during shutdowns. Resource conflicts with other ongoing activities may adversely affect the overall flow of the MINERvA assembly production lines.

Recommendations

1. Complete the transfer of cost information to the lowest level activities in MS project. Complete the WBS dictionary and scrub the cost and schedule information.
2. Complete prototype construction expeditiously, particularly the half plane and full plane prototypes.
3. Develop a plan for how design interfaces will be controlled and communicated.
4. Include a nominal Fermilab accelerator shutdown explicitly in the schedule planning for module assembly.
5. Develop workaround scenarios to increase flexibility for dealing with Fermilab resource conflicts.

5.0 PMTs and PMT Boxes - WBS 5, 6

5.1 PMT Procurement and Testing - WBS 6

Findings

- MINERvA is planning on using Hamamatsu 64-anode photomultiplier tubes (PMTs) (R5900-00-M64 or in their "assembly" form known as H8804MOD-2) to read out wavelength-shifting (WLS) fibers which collect light from extruded scintillator strips. The design of the detector requires 473 PMTs. MINERvA will purchase 28 more tubes as spares and/or possible waste. So far 10 PMTs have been purchased for a price of $43,000. This cost reflects a one-time charge of $23,000 for a factory tooling providing modifications requested by MINERvA. Until now no significant tests have been performed with these tubes. The budget for 501 PMTs is about $2,000 per tube and is based on the quote from the manufacturer ($1,439/PMT) burdened with relevant overhead rates(16.58%), shipping charges and an estimate for an increased price due to the requested modification (not requested in the original large-quantity bid).
- The testing of the PMTs is in its early planning stage and is primarily based on what was done for the MINOS experiment. The alignment of all PMT mountings (the mountings are budgeted in WBS 5) is planned to be done at JMU, while testing is foreseen at JMU and Athens. The station for aligning PMT mountings has been built at JMU. The two test stands will use the MINERvA front-end electronics boards (FEB), including the PMT bases (FEB and bases are budgeted in WBS 7). The use of the RABBIT readout is planned as contingency.
- The procurement, testing, and related labor are assigned 30% contingency.

Comments

- The committee expresses its gratitude to the MINERvA collaboration for frank and open discussions conducted during this review which made these comments possible.
- The cost per tube is significantly higher as compared to previous experiments which used a similar quantity of these PMTs but perhaps reflects an additional assembly and overhead burdens. It is likely that a careful handling of PMTs could result in 28 spares rather than 14 spares and 14 waste as currently foreseen. (MINOS tested about 2,000 of similar PMTs and only 3 tubes were damaged while handling "bare" rather than "assembly" units.)
- The testing and characterization plans for PMTs should be formulated on the basis of the detector performance dictated by physics goals. Coordination with the front-end electronics specs (e.g., dynamic range) is also necessary. It is likely that even with one testing station the tests can be limited in scope and time, thus matching or exceeding the currently anticipated delivery of 40 PMTs per month. In addition, testing in situ should be explored.
- Tests with the 10 already delivered tubes could provide some guidance regarding possible concerns and goals for testing of all the tubes.
- Since the testing and characterization requirements are currently not documented in detail, the schedule and cost for these activities are uncertain. The committee

believes that the PMT testing can be accelerated to avoid being a critical path item. Contingency will have to be derived after the scope of tests is known better.

Recommendations

1. Develop a full-spec RFQ and re-bid. Explore a faster delivery schedule.
2. Conduct rudimentary tests with a few already delivered PMTs.
3. Derive testing requirements from simulations and experience and develop a new detailed testing plan.
4. Develop a new cost and schedule for testing.
5. Re-analyze contingency on the procurement and testing.

5.2 PMT Boxes and Light Injection System - WBS 5

Findings

- The MINERvA PMTs will be individually housed in boxes which provide light-tight mechanical protection, shielding from magnetic fields, and interfacing with fibers and the Light Injection (LI) System. They also provide a mounting structure for the electronics front-end boards. The design of the PMT box is based on a similar "Alner box" used in the MINOS Near Detector. There will be 473 boxes mounted on the detector, 27 'hot spares', and 50 "spares/wastage" (550 altogether). The boxes will be assembled at Tufts and Rutgers.
- The light injection system will be built to monitor the PMT gain stability and to provide corrections for the PMT gain drifts. The LED light, monitored by PIN diodes, will be delivered to each PMT box via a fiber network. The design of the LI system is conceptual. The main elements will be based on similar systems used in MINOS and K2K. Tufts and Pittsburgh will collaborate on developing and building the LI system.
- Manufacturing of the PMT mountings and fiber cookies (all to be fabricated on a CNC machine) is also budgeted under WBS 5. The machining of the PMT Box cookies and PMT alignment holders will be done at Tufts. The Tuft's group will use a new precision mill on loan from Fermilab and will supply machinist labor at a reduced charge to the project for this work. A few "early issue" PMT holders and fiber cookies have been machined at Tufts.
- For routing fibers inside each box they will use short ODU cables (budgeted under WBS 4). The current schedule for the PMT boxes is dictated partially by the delivery of PMTs and the ODU cables.
- Contingency on the boxes is 34% and 50% on the LI system.

Comments

- The design and prototyping of the PMT box are fairly advanced and benefit from earlier experience in MINOS. The construction appears to be straightforward and low-risk, although weaving the fibers into the cookies will require a good "bookkeeping" and a careful worker. Assembling at two sites reflects a prudent judgment to minimize risk in schedule.
- The cost of the in-house fabrication of the PMT mounting elements and the fiber cookies appear to be high despite the offset of the cost of labor provided by Tufts.

- No specific plans were presented regarding tests to be conducted to certify a PMT box to be "ready to use".
- The schedule for assembling the box, dictated by the delivery of the ODU cables and the DDK connectors, may be sped up if these optical elements are delivered earlier. A more aggressive schedule would be desired.
- The role and specs of the LI are not fully developed. They should be derived from the overall physics requirements and in coordination with the FEB, and PMT testing.

Recommendations

1. Re-analyze the M&S and the labor costs of the PMT boxes.
2. Develop LI system specs.
3. Conduct integration tests with a fully equipped PMT box.
4. Re-analyze the cost and schedule contingency.

6.0 Electronics and DAQ - WBS 7

Findings

- PMT testing (WBS 6), PMT box construction (WBS 5), and module assembly (WBS 9) relies on deliveries from WBS 7 (Electronics/DAQ/Slow Control). PMT testing requires production Cockcroft Walton bases and a DAQ. PMT testing would use a front end board if that were available. PMT box assembly requires tested PMTs and "transition boards". The module mapper (WBS 9) requires a DAQ/Slow control.
- Prototypes exist of the Cockcroft Walton bases and front end boards, which were used in the vertical slice test (albeit with a 16-multianode pmt). The prototype front end boards were also used to exercise token-ring data-passing and time synchronization.
- The cost driver is M&S for the ~500 front end boards, DAQ hardware, and EE design time. The base cost is $497K MIE and $799K R&D.

Comments

- Cockcroft Walton bases have been used in HEP, but to our knowledge, have not been used in demanding calorimetry applications such as Minerva. CW bases have the advantage of simplified cabling, power distribution, and reduced heat load. The collaboration has measured a 0.1% voltage ripple on their prototype bases (implying a 1% gain ripple). There are strong arguments indicating that this should not cause problems for the energy resolution. We encourage verifying this in simulation.
- We recommend repeating the gain ripple measurement with an actual tube and base in a realistic assembly to demonstrate both the unimportance of the gain ripple and the absence of significant noise on the tube outputs due to the CW.
- We were not able to fully assess the DAQ/Slow control, including the event-building and synchronizing with data from the MINOS near detector. But since the data rate is quite modest, we believe that the DAQ should not pose a technical risk. The data rate is about 180 kbytes/spill, assuming 100% occupancy 6 bytes/hit. In spite of the low technical risk, additional manpower and milestones need to be identified for the DAQ. Currently identified milestones are DAQ hardware procurement and installation. Additional milestones might include completion of the needed software for event building and data-synchronization.
- Because of the modest data rate, we recommend exploring this advantage to increase the number of ADC bits sufficiently to absorb operational difficulties posed by internal pmt gain variations, which is about a factor of 3 pixel-to-pixel.
- Since each hit has TDC information, noise hits can be rejected by pattern recognition software. We encourage exploring this in order to relax the requirement for pmt noise-testing in WBS 6, which should advance the schedule in that WBS.
- While we don't see serious technical concerns for WBS 7, the schedule depends heavily on sufficient engineering time to design the FE boards and the CROC boards. We recommend close coordination with PPD/EE on the availability of EE resources given the potential conflicts with other programs.

Recommendations

1. Simulate the effect of 1% gain ripple on the energy measurement

2. Measure gain variation with actual PMT and CW base in a close-to-final assembly.
3. Identify additional manpower and milestones for the DAQ/Slow control.
4. Reoptimize ADC specs to compensate for PMT pixel-to-pixel gain variations.
5. Coordinate closely with WBS 6, as TDC information can be used to relax pmt noise-testing requirements.
6. Coordinate closely with PPD/EE on the engineering resources, given the potential conflicts with other programs.

7.0 Installation and Infrastructure - WBS 11

Findings

- MINERvA will run in the NuMI beamline, and be sited in the hall which currently houses the MINOS near detector. The MINOS Near Detector Hall is a fully-outfitted experimental facility that can accommodate MINERvA with a limited number of additions to the infrastructure. The Installation and Infrastructure leader outlined the scope and activities needed for the preparation of the MINOS Near Detector hall for the installation of the MINERvA project components. In the current plan, these activities are not included in the Project. The preparations include the extension of a drip ceiling to protect the experiments components, installation of stands, electrical power, and some minor modifications to the existing MINOS components. The scope includes the heavy installation of the MINERvA components such as transporting of the frames, lowering them into the hall and installing them on the stands.
- Total burdened base cost is $598K, which, with 39% contingency gives a total cost of $832K.

Comments

- The Minerva Installation Team is composed of technically experienced personnel with substantial directly related experience gained on the NUMI/MINOS project.
- There appear to be some activities in WBS 11 that could be part of the project, such as clear fiber and PMT installation, and that should be considered by the project.
- The reviewers did not examine the work flow and installation pattern in any detail, but have confidence from the description that there are no major problems in doing this work safely and effectively.
- The collision hall pre-installation work needed is relatively minor in nature, and does not appear to have undue technical, cost, or safety risk.

Recommendations

1. The most pressing issue is to determine the scope of activities that can be performed in the hall while the MINOS near detector is taking data. This should be done as soon as possible so that the project can incorporate the results, including an appropriate CD-4 date, before submitting CD-1 materials to DOE.
2. The installation activities should be linked to both project deliverables and the assumed laboratory shutdown schedule, and the project should work with the installation team to insure that there is sufficient schedule float on the deliverables to accommodate changes in the lab schedule that might impact when those deliverables can be installed.
3. The Installation and Infrastructure schedule and costing should extend into FY09 if it retains its current scope, as it is likely to extend past the project end date, which is currently early FY09.

8.0 Cost and Schedule - WBS 10

Findings

- The team presented cost estimates to WBS level 3 unburdened and to WBS level 2 fully burdened. Each WBS level 2 task presented their own cost estimate and obligation profile from FY2006 through FY2008 in a consistent format across tasks. The total project cost with indirects and contingency is $12,935,951.00. Costs for WBS 11, installation and Fermilab infrastructure, were presented separately from all other project elements and totaled $831,553.00. Therefore, the total project cost if installation and infrastructure are to be included is $13,767,504.00. (See Appendix A for MINERvA's project cost estimate spreadsheet.)
- A substantial number of Bases of Estimate (BOEs) were presented serving as backup for presented costs.
- A resource loaded schedule organized by WBS elements and generated in Microsoft Project was presented. The schedule includes 886 lines, the critical path, and 1-Level 1, 11-Level 2 and 93-Level 3 milestones.

Comments

- The committee commends the substantial progress in cost and schedule development since the Jan. 2005 Director's review. The organization of the documentation was straightforward in organization and structurally complete. Also, the project will be using COBRA as a performance monitoring tool although it is not specifically required for a project of this size.
- Obligation profiles were presented through FY2008, although activities will likely continue through FY2009.
- While the committee sensed that the vast majority of activities were accurately represented in cost and schedule and that the overall costs and high level schedules were accurate, a few activities such as PMT Base Production and Testing in WBS 7, review durations, and shipping times were identified as requiring reanalysis. There could be others that were not recognized by the committee. The method used to develop the task durations from the bottom up is a good process. MINERvA management did not have time prior to this review to thoroughly evaluate the schedule in detail to assure that the methodology was consistently used and the durations put in the schedule were appropriate.
- The installation schedule is largely dependent on operational constraints of the MINOS experiment. These constraints are currently undefined.
- Short term R&D efforts mentioned elsewhere in this report should help to firm up the cost and schedule. An important example is the evaluation of the PMT testing program scope.

Recommendations

1. Expand obligation profiles to include FY2009 for applicable activities such as project closeout. Update schedule to include closeout activities.
2. The FTE requirements shown during the review were not calculated using a consistent FTE definition across all WBS elements. The FTE requirements should be consistently defined throughout the project and should take into account an

appropriate inefficiency due to vacation, holidays, sick time, etc. In general 85% availability is used to calculate the number of required FTEs. By not using a consistent FTE definition to calculate the number of required FTEs, it appears that the FTE numbers shown during the review are possibly lower than what are needed.

3. Include an M&S budget for Project Management for items such as travel, media services, office equipment, etc.
4. Assign resources for preparing and conducting reviews.
5. Include all resource efforts, including those of physicists not charged to the project, in the resource loading.
6. Perform another iteration of the project schedule and cost estimate. This should include both a bottom-up and top-down analysis. This will give project management and subsystem managers full confidence in their costs and schedules. Adequate float should be included to demonstrate that schedule is achievable.
7. Plan to closely track near-critical path activities in addition to those on the current critical path.
8. The committee agrees with the MINERvA collaboration that the milestones in the schedule need revision and adjustment based on schedule contingencies. Milestones should be included for CD-1 thru 4 and an additional set of milestones should be added for the Directorate with appropriate completion dates to monitor adherence to higher level milestones. A milestone dictionary should be created.
9. The Project Team should revisit the classification of cost as either R&D or MIE, there were a few tasks which appeared to be mis-identified.

9.0 Management - WBS 10

Findings

- On December 13, 2005 the Project Manager of the Minerva Project presented a high level overview talk that covered:
  - Scope
  - Organization
  - Work Breakdown Structure
  - Value Engineering
  - Quality Assurance
  - Environment, Safety and Health
  - Configuration Management
  - Risk Management
  - Schedule
  - Cost
  - Labor Resource Needs
- In addition, the Project Management Team presented information during a breakout session on December 14, 2005. The Project website contains many links to project management documents.

Comments

- The Minerva Project Management Team is comprised of technically experienced personnel with project and project management experience.
- The Minerva Project Management Team should be applauded for their early attention to key issues relating to ES&H, Quality Assurance and Value Management. All Level 2 Managers presentations included discussion of these topics which reflects Fermilab's commitment to Integrated Safety Management.
- Many Project Management documents necessary for CD-2 Approval are currently in draft form including:
  - Conceptual Design Report (CDR)
  - Project Execution Plan (PEP)
  - Project Management Plan (PMP)
  - Acquisition Plan
  - Value Management Plan
  - Risk Management Plan

  Continued focused development and coordination of these documents should allow the Minerva Project to be prepared for a CD-2/3 review in the Spring of 2006.
- Significant effort is being expended to coordinate within the project using the following:
  - Weekly technical and L2 manager meetings
  - Design reviews (14 in the past and 14 planned for the future)
  - Configuration control and management using the http://minerva-docdb.fnal.gov website.
- The Minerva Project Management Team's proactive adoption of the project management reporting tool COBRA and its earned value reporting capabilities are

commendable. While this type of reporting is not a requirement for this project it will aid in tracking progress and managing changes.

- MINERvA suitably presented plans for their QA activities and potential risks, but no one in MINERvA's Project Office has been identified as being responsible for the overall project QA and Risk Management processes.

Recommendations

1. Increase efforts to develop the Technical Design Report (TDR) to the same level as other project management documents. The TDR forms the basis for the technical justification and technical design of the project and is critical to developing the scope of all subprojects.
2. Work with the Division Management and the Directorate to coordinate the project Funding needs to the latest understanding of FY07 and FY08 budget guidance.
3. Clarify and coordinate the PEP and PMP documents. Inconsistencies were noted in the organizational charts, responsibilities, and change control sections of the current drafts of the PEP and PMP.
4. Work with Procurement to understand if there will be any Davis Bacon Determinations required for the Project.
5. MINERvA should assign the responsibility for the QA and Risk Management function to a position in the Project Office and include this in the PMP.
6. Integration of deliverables between WBS L2 subprojects is a concern and should be closely coordinated by the Project Management team.
7. The committee feels that the PMTs, PMT Boxes, and Electronics and DAQ (WBS elements 5, 6, and 7) need to be closely coordinated. Such close coordination was not evident in this review. One way to improve the coordination would be to collapse all these activities into a single WBS. Another way would be to have an overall "567" Manager / Coordinator. MINERvA should take some action to address this concern.

10.0 Charge Questions

10.1 Are the physics requirements clearly stated and documented?
The physics requirements were largely stated in the CDR and have been further refined since then and presented at this review.

10.2 Have these physics requirements been translated into technical performance requirements / specifications?
Yes, these were presented at this meeting and should be formalized and included in the TDR. It is important that they be monitored as further information about detector performance becomes available to ensure that they remain within specifications.

10.3 Have alternative designs been considered and reasons for selecting one alternative over anther documented and deemed reasonable?
Yes, in particular, the magnetic field in the Minerva calorimeter was eliminated and the outer hadron calorimeter thickness reduced after detailed studies of physics performance indicated that the design goals were not compromised by the optimization.

10.4 Can the design be built? Does the design meet the technical specifications? Is it a reasonable design?
The design is reasonable and meets the technical specifications. It uses refined versions of standard technologies and cab be built within a reasonable time and budget.

10.5 Is the Work Breakdown Structure (WBS) appropriate for the project scope?
Yes, a Work Breakdown Structure does exist and appears to be appropriate for MINERvA's scope of work.

10.6 Do the cost estimates for each WBS (or cost) element have a sound documented basis and are they reasonable?
Yes, cost estimates exist for MINERvA's WBS. The available Bases of Estimate (BOE) documents were assessed and found to vary in accuracy. The cost estimate was found to be reasonable with some minor adjustments.

10.7 Does an obligation profile exist?
Yes, an obligation profile was shown for FY06 thru FY08. The profile needs to be updated to reflect obligation that will be in FY09.

10.8 Is the schedule well developed and resource loaded?
Yes, a resource loaded schedule was presented. Some resources were missing such as physicists working without directly charging the project.

10.9 Are the activity durations reasonable for the assumed resources?
Yes. The majority of activities are based on prior experience but others need to be reassessed and adequate float should be included.

10.10 Is the schedule duration feasible for the resources assigned to accomplish the tasks?
Yes. An important factor will be the available window for installation, which has to be determined.

10.11 Does the schedule contain appropriate levels of milestones, sufficient quantity of milestones for tracking progress and do they appear to be achievable?
A few milestones could be added that are relevant to the Fermilab directorate as noted in Section 8.0. The milestones presented are achievable and can be tracked. A milestone dictionary should also be created.

10.12 Does the schedule include activities for design reviews, which include assessment of the designs readiness for procuring prototypes, preproduction and production materials?
Yes, design reviews are clearly listed in the schedule. Resources and durations required for such reviews should be further analyzed.

10.13 Is there an appropriate management organizational structure in place to accomplish the design and construction?
Yes, as shown in the Project Overview talk.

10.14 Is the organization structure well documented, responsibilities defined and appropriate for the scope of work?
Yes, as outlined in the Minerva Project Management Plan.

10.15 Are there adequate staffing resources available or planned for this effort?
We are unable to comment on the availability of resources as it varies with time. The Project team did present a resource loaded schedule with their planned resource needs.

10.16 Is there a funding plan available or proposed to meet the resource requirements to realize the project?
The Project team presented the project funding needs by fiscal year based on the RLS. The Deputy project Manager supplied the reviewers with the latest understanding of the Budget Guidance which shows that the funding need in FY07 with Contingency is greater than the budget guidance by $995k.

10.17 Has a Risk Assessment been performed, mitigations identified, actions taken and do they seem appropriate?
Yes as outlined in the Risk Management document and presented in the L2 Managers talks.

Appendix A

MINERvA's Project Cost Estimate
for the Director's CD-1/Trial CD-2 Review of the MINERvA Project
December 13-15, 2005

	WBS	Items	MINERvA's Estimate AY$ Base w/Indirects M&S	Base w/Indirects Labor	Base w/Indirects Total	Contingency % M&S	Contingency % Labor	Contingency % Total	Contingency $ M&S	Contingency $ Labor	Contingency $ Total	Total Base w/Indirects and Cont.
MIE	1.0	Scintillator Extrusion	$ 41,237	$ 206,691	$ 247,928	27%	21%	22%	$ 11,009	$ 44,095	$ 55,103	$303,031
MIE	2.0	WLS Fibers	$ 406,771	$ 163,583	$ 570,354	41%	21%	35%	$ 167,622	$ 34,016	$ 201,638	$ 771,992
MIE	3.0	Scintillator Plan Assembly	$ 232,706	$ 712,406	$ 945,112	48%	40%	42%	$ 110,616	$ 284,963	$ 395,578	$ 1,340,690
MIE	4.0	Clear Fiber Cables	$ 334,136	$ 605,394	$ 939,530	39%	38%	38%	$ 129,351	$ 230,247	$ 359,597	$ 1,299,127
MIE	5.0	Photomultiplier Tube Boxes	$ 465,103	$ 305,971	$ 771,074	40%	34%	38%	$ 184,666	$ 104,805	$ 289,471	$ 1,060,545
MIE	6.0	Photomultiplier Tubes	$ 1,068,174	$ 127,635	$ 1,195,809	30%	33%	30%	$ 319,108	$ 42,120	$ 361,228	$ 1,557,037
MIE	7.0	Electronics and DAQ	$ 474,204	$ 22,830	$ 497,034	35%	34%	35%	$ 165,489	$ 7,685	$ 173,174	$ 670,207
MIE	8.0	Frames, Absorbers, Coil and Detector Stand	$ 524,120	$ 134,728	$ 658,849	26%	50%	31%	$ 137,154	$ 67,364	$ 204,518	$ 863,367
MIE	9.0	Module and Veto Wall Assembly & Installatior	$ 55,556	$ 220,341	$ 275,897	44%	89%	80%	$ 24,251	$ 195,316	$ 219,567	$ 495,464
MIE	10.0	Project Management	$ -	$ 584,097	$ 584,097		30%	30%	$ -	$ 175,229	$ 175,229	$ 759,326
MIE		**Total MIE:**	**$ 3,602,007**	**$ 3,083,676**	**$ 6,685,683**	**35%**	**38%**	**36%**	**$ 1,249,265**	**$ 1,185,839**	**$ 2,435,103**	**$ 9,120,786**
OPC		**R&D**	$ 1,018,693	$ 1,776,276	$ 2,794,969	36%	37%	37%	$ 362,029	$ 658,166	$ 1,020,195	$ 3,815,165
OPC		**Total OPC:**	**$ 1,018,693**	**$ 1,776,276**	**$ 2,794,969**	**36%**	**37%**	**37%**	**$ 362,029**	**$ 658,166**	**$ 1,020,195**	**$ 3,815,165**
		TPC:	**$ 4,620,700**	**$ 4,859,952**	**$ 9,480,652**	**35%**	**38%**	**36%**	**$ 1,611,294**	**$ 1,844,005**	**$ 3,455,299**	**$ 12,935,951**
	11.0	Installation and Infrastructure	$ 174,194	$ 424,019	$ 598,213	34%	41%	39%	$ 58,604	$ 174,737	$ 233,341	$ 831,553

Appendix B

Charge for the Director's CD-1/Trial CD-2 Review of the MINERvA Project December 13-15, 2005

This charge is for the Committee to conduct a Director's CD-1 / Trial CD-2 Review of the proposed MINERvA project at Fermilab. The review is to assure that all the requirements have been met for DOE to approve CD-1 and to assess and comment on the level of readiness of the project to meet the CD-2 requirements. As part of this assessment the questions listed in Attachment 1 of this charge should be addressed. Additionally the review committee is to review and comment on Project's response and actions taken on the recommendations from the Director's Preliminary Review of MINERvA on January 10-11, 2005. Constructive comments on presentation content, format, and style are also requested.

Approval of CD-1 by DOE officials is based on a ***Conceptual Design*** for the project, a ***cost and schedule baseline range***, and some additional project management documents. The technical part of the review will focus on the conceptual designs for the Detector. It will answer the questions, **will these designs meet the requirements and specifications** and **are the designs sound**. ***The cost and schedule ranges are usually based on a detailed WBS – Work Breakdown Structure, WBS Dictionary, BOE – Basis of Estimate documentation, risk and contingency analyses, RLS – Resource Loaded Schedule, and time phased funding and cost profiles. The committee is asked to review each of these items, for quality, completeness, and accuracy***. Furthermore, the committee is asked to ***review and assess the quality of and comment on the additional formal project management documentation required for CD-1 approval***.

Fermilab and MINERvA are planning for CD-2/3 approval to allow construction to start the first quarter of FY2007. To achieve this goal MINERvA will need a DOE CD-2/3 Review in the summer of 2006. Therefore, the committee is asked to *comment as appropriate on MINERvA's status regarding readiness to "establish a baseline budget*." Again, appropriate constructive comments on what remains to be done are requested.

Finally, the committee should present findings, comments, and conclusions at a closeout meeting with MINERvA's and Fermilab's management and provide a written report soon after the review.

Charge for the Director's CD-1/Trial CD-2 Review of the MINERvA Project
Attachment 1

Technical

- Are the physics requirements clearly stated and documented?
- Have these physics requirements been translated into technical performance requirements / specifications?
- Have alternative designs been considered and reasons for selecting one alternative over anther documented and deemed reasonable?
- Can the design be built? Does the design meet the technical specifications? Is it a reasonable design?

Cost

- Is the Work Breakdown Structure (WBS) appropriate for the project scope?
- Do the cost estimates for each WBS (or cost) element have a sound documented basis and are they reasonable?
- Does an obligation profile exist?

Schedule

- Is the schedule well developed and resource loaded?
- Are the activity durations reasonable for the assumed resources?
- Is the schedule duration feasible for the resources assigned to accomplish the tasks?
- Does the schedule contain appropriate levels of milestones, sufficient quantity of milestones for tracking progress and do they appear to be achievable?
- Does the schedule include activities for design reviews, which include assessment of the designs readiness for procuring prototypes, preproduction and production materials?

Management

- Is there an appropriate management organizational structure in place to accomplish the design and construction?
- Is the organization structure well documented, responsibilities defined and appropriate for the scope of work?
- Are there adequate staffing resources available or planned for this effort?
- Is there a funding plan available or proposed to meet the resource requirements to realize the project?
- Has a Risk Assessment been performed, mitigations identified, actions taken and do they seem appropriate?

Appendix C

Agenda for the Director's CD-1/Trial CD-2 Review of the MINERvA Project
December 13-15, 2005

Tuesday, December 13, 2005 – Presentations are in the Racetrack (WH7X)

8:00 – 8:45 AM		Executive Session (Comitium-WH2SE)	Ed Temple
9:00 – 9:15 AM	15	Introduction	Hugh Montgomery
9:15 – 9:45 AM	30	Physics Requirements Overview	Jorge Morfin
9:45 – 10:15 AM	30	Detector Overview	Kevin McFarland
10:15 – 11:00 AM	45	Project Overview	Debbie Harris
11:00 – 11:15 AM	15	BREAK	
11:15 – 11:45 AM	30	WBS 1: Scintillator Extrusions	Anna Pla-Dalmau
11:45 – 12:15 PM	30	WBS 2 & WBS 4: WLS Fiber and Clear Fiber Cables	Howard Budd
12:15 – 12:45 PM	30	WBS 3: Scintillator Plane Assembly	Jeff Nelson
12:45 – 1:45 PM	60	LUNCH (WH2X)	
1:45 – 2:15 PM	30	WBS 6: PMT Acquisition and Testing	Ioana Niculescu
2:15 – 2:45 PM	30	WBS 5: PMT Boxes and Light Injection	Tony Mann
2:45 – 3:15 PM	30	WBS 7: DAQ and Electronics	Vittorio Paolone
3:15 – 3:30 PM	15	BREAK	
3:30 – 4:00 PM	30	WBS 8: Outer Detector Frame, Absorbers, Stand	Jim Kilmer
4:00 – 4:30 PM	30	WBS 9: Module Assembly	Robert Bradford
4:30 – 5:00 PM	30	(WBS 11): Installation & Infrastructure	Jim Kilmer
5:00 – 6:30 PM	90	Executive Session	

Wednesday, December 14, 2005 (Morning break will be available outside Comitium at 10:30)

8:00 – 8:30 AM	30	Cost & Schedule Executive Session (Comitium – WH2SE)	Ed Temple
		Breakout Sessions	
8:30 – 12:30 PM		• WBS 1, 2 & 4 Scintillator & Fiber (Snake Pit – WH2NE)	Anna Pla-Dalmau, Howard Budd
8:30 – 12:30 PM		• WBS 3, 8 & 9 Module/Plane, Detector Parts Assembly (Black Hole – WH2NW)	Jeff Nelson, Jim Kilmer, Robert Bradford, Ron Ransome
8:30 – 12:30 PM		• WBS 5, 6 & 7 PMTs, PMT Boxes and Electronics & DAQ (Racetrack – WH7X)	Ioana Niculescu, Tony Mann, Casper, Paolone
9:30 – 12:30 PM		• WBS 10 Management/Cost/Schedule/ WBS 11 I&I (Comitium WH2SE)	Debbie Harris, Nancy Grossman, TJ Sarlina, Sheri Landrud
12:30 – 1:30 PM		LUNCH (WH2X)	
1:30 – 2:30 PM		MINERvA's response to review committees questions (Comitium – WH2SE)	Debbie Harris, Nancy Grossman
2:30 – 4:00 PM		Executive Session	Ed Temple
4:00 PM		Report Writing	

Thursday, December 15, 2005

8:00 – 10:00 AM	Continue Report Writing	
10:00 – 2:30 PM	Closeout Dry Run with working lunch (Comitium – WH2SE)	
2:30 PM	Closeout (Racetrack – WH7X)	

Appendix D

Report Outline and Reviewer Assignments
for the Director's CD-1/Trial CD-2 Review
of the
MINERvA Project
December 13-15, 2005

Executive Summary	Ed Temple
1.0 Introduction	Dean Hoffer
2.0 Science	Heidi Schellman
3.0 Scintillator Extrusions, WLS Fiber and Clear Fiber Cables	Dmitri Denisov, Heidi Schellman
4.0 Plane Assembly, Outer Detector Frame, Absorbers, Stand and Module Assembly	Mike Crisler, Joe Howell
5.0 PMTs and PMT Boxes	Karol Lang, Hogan Nguyen
6.0 Electronics & DAQ	Hogan Nguyen, Karol Lang
7.0 Installation and Infrastructure	Mike Lindgren, Marc Kaducak, Dean Hoffer
8.0 Cost and Schedule	Marc Kaducak, Jeff Sims, Dean Hoffer
9.0 Management	Jeff Sims, Mike Lindgren, Ed Temple
10.0 Charge Questions	
10.1 Are the physics requirements clearly stated and documented?	Heidi Schellman, Dmitri Denisov, Hogan Nguyen, Joe Howell, Karol Lang, Mike Crisler, Mike Lindgren
10.2 Have these physics requirements been translated into technical performance requirements / specifications?	
10.3 Have alternative designs been considered and reasons for selecting one alternative over anther documented and deemed reasonable?	
10.4 Can the design be built? Does the design meet the technical specifications? Is it a reasonable design?	
10.5 Is the Work Breakdown Structure (WBS) appropriate for the project scope?	Dean Hoffer, All
10.6 Do the cost estimates for each WBS (or cost) element have a sound documented basis and are they reasonable?	
10.7 Does an obligation profile exist?	

	10.8 Is the schedule well developed and resource loaded?	Marc Kaducak, All
	10.9 Are the activity durations reasonable for the assumed resources?	
	10.10 Is the schedule duration feasible for the resources assigned to accomplish the tasks?	
	10.11 Does the schedule contain appropriate levels of milestones, sufficient quantity of milestones for tracking progress and do they appear to be achievable?	
	10.12 Does the schedule include activities for design reviews, which include assessment of the designs readiness for procuring prototypes, preproduction and production materials?	
	10.13 Is there an appropriate management organizational structure in place to accomplish the design and construction?	Jeff Sims, All
	10.14 Is the organization structure well documented, responsibilities defined and appropriate for the scope of work?	
	10.15 Are there adequate staffing resources available or planned for this effort?	
	10.16 Is there a funding plan available or proposed to meet the resource requirements to realize the project?	
	10.17 Has a Risk Assessment been performed, mitigations identified, actions taken and do they seem appropriate?	

* Note underlined names are the primary writer.

Appendix E

Reviewer Assignments for Breakout Sessions
for
Director's CD-1/Trial CD-2 Review of MINERvA
December 13-15, 2005

WBS 1, 2 & 4 Scintillator & Fiber (Snake Pit – WH2NE)	Dmitri Denisov, Heidi Schellman
WBS 3, 8 & 9 Module/Plane, Detector Parts Assembly (Black Hole – WH2NW)	Joe Howell, Mike Crisler
WBS 5, 6 & 7 PMTs, PMT Boxes and Electronics & DAQ (Racetrack – WH7X)	Karol Lang, Hogan Nguyen
WBS 10 Management/Cost/Schedule/ WBS 11 I&I (Comitium WH2SE)	Marc Kaducak, Jeff Sims, Mike Lindgren, Dean Hoffer, Ed Temple

Appendix F

Director's CD-1/Trial CD-2 Review of the MINERvA Project
December 13 - 15, 2005

Reviewers' Contact Information

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Appendix G

Director's CD-1/Trial CD-2 Review of the MINERvA Project
December 13-15, 2005

Participant List

Reviewers
Mike Crisler, Fermilab
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Joe Howell, Fermilab
Marc Kaducak, Fermilab
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Michael Lindgren, Fermilab
Hogan Nguyen, Fermilab
Heidi Schellman, Northwestern University
Jeff Sims, Fermilab
Ed Temple, Fermilab

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Howard Budd, University of Rochester
Dave Casper, University of California, Irvine
Nancy Grossman, Fermilab
Deborah Harris, Fermilab
Jim Kilmer, Fermilab
Sheri Landrud, Fermilab
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Jorge Morfin, Fermilab
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Ioana Niculescu, James Madison University
Vittorio Paolone, University of Pittsburg
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Benjamin Ziemer, University of California, Irvine

Appendix H

Director's CD-1/Trial CD-2 Review of the MINERvA Project
December 13-15, 2005

Table of Recommendations

Section & No.	Recommendation	Assigned To	Status/ Action	Date
2.0	**Science**			
2.1	Much of the work shown was convincing but has not yet been included in formal documents. In particular, tables indicating the projected resolution in relevant physics variables *(Q^2, ν, x_{Bj}, t)* over the relevant kinematic range would be valuable.			
2.2	In addition, detailed presentation of contributions to the error budget for cross section measurements (flux, statistics, nuclear effects, input from other experiments as well as smearing and calibration) would be very useful.			
2.3	Benchmark cross sections errors, resolutions/purities/efficiencies should be carefully monitored as further knowledge of the performance of the real detector becomes available.			
2.4	In particular, studies of the effects on benchmark quantities of coherent noise within a PMT box, channel to channel variation and gain non-linearities should be done using the simulation to assess the impact of these potential hardware problems on physics results and optimize the testing and calibration procedure.			
3.0	**Scintillator Extrusions, WLS Fiber and Clear Fiber Cables - WBS 1, 2, 4**			
3.1	The collaboration should concentrate on finishing the R&D stage as well as the design of detector elements and tooling required for parts production.			
3.2	The collaboration should develop a detailed list of specifications for all parts to be produced in WBS 1, 2, and 4. These specifications should include "required" as well as "not acceptable" limits.			
3.3	An extended run of the extruder should be performed to verify the production rate and quality of the extrusion as well as the amount of labor required to run the extruder and perform extrusion quality control.			

Section & No.	Recommendation	Assigned To	Status/ Action	Date
3.4	Preproduction samples should be used to verify that detector parameters satisfy MINERvA specifications. The results should include light yield for the scintillator-WLS-clear fiber-PMT chain as well as coordinate resolution of the triangular extrusion assembly.			
3.5	Detailed quality control procedures should be developed for use during production of scintillator extrusions, WLS and clear fiber cables.			
3.6	The cost estimate should be updated to include all costs required for the detector construction.			
3.7	The schedule and cost estimate should continue to be updated as information from vendors and R&D studies become available.			
4.0	**Plane Assembly, Outer Detector Frame, Absorbers, Stand and Module Assembly - WBS 3, 8, 9**			
4.1	Complete the transfer of cost information to the lowest level activities in MS project. Complete the WBS dictionary and scrub the cost and schedule information.			
4.2	Complete prototype construction expeditiously, particularly the half plane and full plane prototypes.			
4.3	Develop a plan for how design interfaces will be controlled and communicated.			
4.4	Include a nominal Fermilab accelerator shutdown explicitly in the schedule planning for module assembly.			
4.5	Develop workaround scenarios to increase flexibility for dealing with Fermilab resource conflicts.			
5.0	**PMTS and PMT Boxes - WBS 5, 6**			
5.1.0	**PMT Procurement and Testing - WBS 6**			
5.1.1	Develop a full-spec RFQ and re-bid. Explore a faster delivery schedule.			
5.1.2	Conduct rudimentary tests with a few already delivered PMTs.			
5.1.3	Derive testing requirements from simulations and experience and develop a new detailed testing plan.			
5.1.4	Develop a new cost and schedule for testing.			
5.1.5	Re-analyze contingency on the procurement and testing.			

Section & No.	Recommendation	Assigned To	Status/ Action	Date
5.2.0	**PMT Boxes and Light Injection System - WBS 5**			
5.2.1	Re-analyze the M&S and the labor costs of the PMT boxes.			
5.2.2	Develop LI system specs.			
5.2.3	Conduct integration tests with a fully equipped PMT box.			
5.2.4	Re-analyze the cost and schedule contingency.			
6.0	**Electronics and DAQ - WBS 7**			
6.1	Simulate the effect of 1% gain ripple on the energy measurement.			
6.2	Measure gain variation with actual PMT and CW base in a close-to-final assembly.			
6.3	Identify additional manpower and milestones for the DAQ/Slow control.			
6.4	Reoptimize ADC specs to compensate for PMT pixel-to-pixel gain variations.			
6.5	Coordinate closely with WBS 6, as TDC information can be used to relax pmt noise-testing requirements.			
6.6	Coordinate closely with PPD/EE on the engineering resources, given the potential conflicts with other programs.			
7.0	**Installation and Infrastructure – WBS 11**			
7.1	The most pressing issue is to determine the scope of activities that can be performed in the hall while the MINOS near detector is taking data. This should be done as soon as possible so that the project can incorporate the results, including an appropriate CD-4 date, before submitting CD-1 materials to DOE.			
7.2	The installation activities should be linked to both project deliverables and the assumed laboratory shutdown schedule, and the project should work with the installation team to insure that there is sufficient schedule float on the deliverables to accommodate changes in the lab schedule that might impact when those deliverables can be installed.			
7.3	The Installation and Infrastructure schedule and costing should extend into FY09 if it retains its current scope, as it is likely to extend past the project end date, which is currently early FY09.			

Section & No.	Recommendation	Assigned To	Status/ Action	Date
8.0	**Cost and Schedule - WBS 10**			
8.1	Expand obligation profiles to include FY2009 for applicable activities such as project closeout. Update schedule to include closeout activities.			
8.2	The FTE requirements shown during the review were not calculated using a consistent FTE definition across all WBS elements. The FTE requirements should be consistently defined throughout the project and should take into account an appropriate inefficiency due to vacation, holidays, sick time, etc. In general 85% availability is used to calculate the number of required FTEs. By not using a consistent FTE definition to calculate the number of required FTEs, it appears that the FTE numbers shown during the review are possibly lower than what are needed.			
8.3	Include an M&S budget for Project Management for items such as travel, media services, office equipment, etc.			
8.4	Assign resources for preparing and conducting reviews.			
8.5	Include all resource efforts, including those of physicists not charged to the project, in the resource loading.			
8.6	Perform another iteration of the project schedule and cost estimate. This should include both a bottom-up and top-down analysis. This will give project management and subsystem managers full confidence in their costs and schedules. Adequate float should be included to demonstrate that schedule is achievable.			
8.7	Plan to closely track near-critical path activities in addition to those on the current critical path.			
8.8	The committee agrees with the MINERvA collaboration that the milestones in the schedule need revision and adjustment based on schedule contingencies. Milestones should be included for CD-1 thru 4 and an additional set of milestones should be added for the Directorate with appropriate completion dates to monitor adherence to higher level milestones. A milestone dictionary should be created.			

Section & No.	Recommendation	Assigned To	Status/ Action	Date
8.9	The Project Team should revisit the classification of cost as either R&D or MIE, there were a few tasks which appeared to be mis-identified.			
9.0	**Management - WBS 10**			
9.1	Increase efforts to develop the Technical Design Report (TDR) to the same level as other project management documents. The TDR forms the basis for the technical justification and technical design of the project and is critical to developing the scope of all subprojects.			
9.2	Work with the Division Management and the Directorate to coordinate the project Funding needs to the latest understanding of FY07 and FY08 budget guidance.			
9.3	Clarify and coordinate the PEP and PMP documents. Inconsistencies were noted in the organizational charts, responsibilities, and change control sections of the current drafts of the PEP and PMP.			
9.4	Work with Procurement to understand if there will be any Davis Bacon Determinations required for the Project.			
9.5	MINERvA should assign the responsibility for the QA and Risk Management function to a position in the Project Office and include this in the PMP.			
9.6	Integration of deliverables between WBS L2 subprojects is a concern and should be closely coordinated by the Project Management team.			
9.7	The committee feels that the PMTs, PMT Boxes, and Electronics and DAQ (WBS elements 5, 6, and 7) need to be closely coordinated. Such close coordination was not evident in this review. One way to improve the coordination would be to collapse all these activities into a single WBS. Another way would be to have an overall "567" Manager / Coordinator. MINERvA should take some action to address this concern.			