Close-out Report for MINERvA Operational Readiness Review

D. Glenzinski

for the Review Committee

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Introduction

- The committee thanks the MINERvA collaboration for their excellent presentations and their prompt replies to our questions.
- The committee thanks Pushpa Bhat, Steve Geer, and Crae Tate for all their help in preparing for and running the review in such an organized manner.

Introduction

- MINERvA is to be congratulated for the success they have so far enjoyed. The experiment is running well and they are producing a stream of high quality publications.

- Bottom line: The MINERvA collaboration is well organized and appears to have the resources it needs to efficiently collect and publish high quality physics data over the next 2-3 years.

Question 1

- Is there a completed Experiment Operations Plan (EOP) document that has been updated to include the additional scope from the MINOS ND? The document should include: (a) A description of operations tasks and how they will be covered, (b) ES&H activities and how they will be managed, (c) Organization charts showing the management structure for the experiment and how it interfaces with the laboratory, (d) The model for data processing and analysis including the budget and effort required, (e) A list of the identified resources available, and (f) A description of the roles and responsibilities of each institution together with a list of support required by each institution from the funding agencies.

Question 1

- Findings
  - An Experimental Operations Plan for the MINERvA Experiment has been written (updated October 14, 2016) describing the main operational tasks of the experiment.
  - The EOP also describes the roles & responsibilities of the Fermilab Divisions, including ESHQ
  - The 14 mo. Computing cost for data processing and analysis is $726k
  - In addition to the “snapshot” list of institutional roles in the EOP, MINERvA conducts an annual “Who Does What” survey.
  - Footnotes corresponding to asterisks in the EOP are missing in the EOP

Is there a completed Experiment Operations Plan (EOP) document?

Yes, except it needs to be signed.

Question 1

- Comments
  - The EOP contains references to work being done in the FY16 shutdown, which should be updated.
  - Consider including a table of FTE for operations from the laboratory and collaboration in the EOP.
  - The support required by each institution from the funding agencies is not included in the EOP.

Question 1

- Recommendations
  - Finalize the EOP and obtain the required sign-offs.

Question 2

- Are the MINOS ND performance and calibration requirements well established for the needs of the MINERvA physics program, and is there a clear plan for achieving these requirements? Have the necessary resources been identified? Given the availability of resources, are the expectations for the detector performance and data taking efficiencies realistic? Is there a clear plan for monitoring the MINOS ND data quality and has the team available for this task in the coming year tested the associated infrastructure?

Question 2

- Findings
  - MINERvA has begun the process of carrying out routine hardware maintenance of MINOS ND, with Fermilab staff used as advisers.
  - Most components have adequate spares, with inventory to be completed after recovery of some items from Soudan.
  - The MINERvA collaboration contains an expert on the custom light injection system.
  - Tests of calibration and monitoring results obtained by MINERvA and compared directly with the equivalent results from MINOS were not presented.
  - MINERvA has made a detailed analysis of alternatives to full calibration of the MINOS ND, in case simplification is required.
  - Estimates for laboratory resources were presented with uncertainties at the fraction of FTE levels.
  - The expertise for operating the MINOS ND comes primarily from Neutrino Division and Particle Physics Division and carries over to MINERvA. The estimate for all MINOS ND operations is approximately 1~1.5 FTE, assuming no major crises.

Question 2

- Findings
  - The MINERvA operations organization chart lists the MINOS Detector Experts to be Steve Hahn, Donatella Torretta, and Bill Badgett. Their involvement has been at the 0.5 FTE level over the past few years, but the expectation is that this will reduce to the 0.25 FTE level, because collaboration students and postdocs are being trained to take over their responsibilities.
  - The MINOS ND magnet gets an annual checkup, the LeCroy HV1440 units get cleaned out annually, and there is an electronics repair contract with Gary Drake of ANL. There are additional parts coming to Fermilab from the MINOS FD.
  - Automated processes are in place for data validation, bad channel finding, and data quality monitoring.
  - Most MINOS calibrations change very slowly, corresponding to <1% variation yearly. The PE calibration, which has been increasing at ~2%/year, is absolutely needed, while the Drift and Linearity calibrations would be nice to have.
  - MINERvA acknowledges that expertise has been lost and that the biggest concerns are the light detection hardware and the online software.

Question 2

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Yes, MINERvA has understood the need for a smooth transition to the operation of the MINOS ND. Many items required for this transition have been identified. Cross-training for hardware maintenance has begun.

Question 2

- Comments
  - Encourage continued increased involvement of the collaboration to achieve the needed level of effort on the MINOS ND DAQ.
  - Effort to train an additional expert in the light injection system would help reduce the risk of a problem with this system.
  - Greatly simplified calibration will still allow the physics program to proceed.
  - The ability to service underground computing needs to be maintained.

Question 2

- Recommendations
  - Demonstrate and document operations of the full MINOS ND processing chain.
  - Decide in a timely way exactly which MINOS calibrations the experiment will perform. Develop a plan and identify the resources required to complete these calibrations.

Question 3

- Is there a well-understood run plan for FY17, consistent with accelerator schedule and performance? Have adequate resources from the laboratory and the collaboration been identified for an efficient and safe running of the experiment and for maintenance of the detector, and is it clear who is responsible for what?

Question 3

- Findings
  - The PAC has recommended that MINERvA be delivered a minimum of 6E20 POT of anti-neutrino. The total request from the MINERvA experiment is 12E20 POT of anti-neutrino running. Reaching this total is subject to the anti-neutrino-mode run plan for FY18-FY19, which has not yet been determined.
  - The accelerator can deliver 700kW of beam for FY17-FY18, with 630 kW of that allocated for neutrino operation. This corresponds to 3-5E20 POT/yr.
  - Run conditions, neutrino v. anti-neutrino v. special runs, are determined by Program Planning. Significant consideration is given to the discovery potential of NOvA, which is the primary user of the beam. The run plan for FY17 is well defined. The FY17 run plan is to run in neutrino-mode until early 2017 and in anti-neutrino-mode for the remainder of FY17. The MINERvA experiment expects to collect 2E20 Protons-On-Target (POT) for Medium Energy (ME) neutrino running and 1-3E20 POT for anti-neutrino running in FY17. No special runs or changes of run configuration are planned. NOvA is expected to run at least 1 full year, from early 2017 to early 2018, in anti-neutrino running.
  - MINERvA has 62 collaborators from 20 institutions. MINERvA requires a minimum of 30% FTE time commitment to become an author. After taking into account commitments to teaching, other experiments, etc., the total number of FTEs expected for MINERvA is 42. This time commitment accounts for the combined effort to both operations and analyses.
  - The MINERvA FY17 operations resource needs were presented. A total of 8.5 FTE level of effort is needed from the collaboration, which has a commitment of 42 FTE. A level of effort of 0.7 FTE is required from ND, 0.9FTE from PPD, and 1.7 FTE from SCD. MINOS test stand maintenance is expected to be minimal. MINERvA test stands are maintained by the collaboration. The level of effort to operate and maintain MINERvA for FY18 and FY19 is the same, assuming the run extends the full year. The requested M&S budget is between $150k-90k/year.
  - Detector operations is managed by FNAL ND (MINOS expertise), universities, students. A succession plan for operations is in place. Detector experts are students who train the next generation of experts. Howard Budd is the current Run Coordinator. No succession plan for the Run Coordinator was presented.

Question 3

- Findings
  - Hardware spares in hand (enough for 8 years of running) with electronics test stand.
  - Automated monitoring with web interface. Significantly reduced shifting after shutdown (16 days/year/shifter). Lots of lab resources participating, agreement with division directors in EOP.
  - FEB replacement is migrating to detector experts (collaboration resource). PMT replacement is a 2-person operation.
  - 20% of total collaboration effort goes toward operations (detector and computing). The collaboration is reducing the reliance on ND MINOS detector experts by training the MINERvA detector experts (graduate students). 0.35 FTE administrative support, including Latin American program (Julie Saviano). PPD resources support MINERvA detector maintenance (target filling, roof, PMTs, firmware, DAQ) and safety training (Dee Hahn, 0.2 FTE). Total 1.6 FTE from ND and PPD going forward.
  - MINERvA presented a plan to reduce the FTE needs for shift monitoring of the MINERvA experiment by 1/3. This reduction in oversight is expected to allow the shifters time for the additional responsibilities of MINOS monitoring.
  - Collaboration resource needs have been documented in the EOP. Experts and lab resources have been identified by name where possible. A succession plan for experts who are phasing out, either through retirement or from moving onto other experiments, was not presented.
  - ESH&Q safety concerns and mitigation plans were presented. The MINERvA experiment has safety oversight from qualified FNAL ESH&Q personnel. ESH&Q provide training, assessments, and safety reviews. MINERvA experimental hazards are not new (cryogenics/ ODH, electronics, underground).
  - A low energy (LE) neutrino dataset was collected in 2009-2012. The collaboration is using the effort for this dataset to estimate the effort and resource needs for the upcoming ME dataset.
  - The first papers from the LE neutrino data running came out in 2013. A total of 16 cross-section papers have been published thus far. The first 2 papers have over 100 citations.
  - MINERvA started to monitor MINOS detector during MINERvA data taking in the fall 2011.
  - A swap of a MINERvA PMT requires two PPD technicians. Only two technicians are trained to perform this work.

Question 3

- Is there a well-understood run plan for FY17, consistent with accelerator schedule and performance? Have adequate resources from the laboratory and the collaboration been identified for an efficient and safe running of the experiment and for maintenance of the detector, and is it clear who is responsible for what?

Yes, the run plan for FY17 is well understood and consistent with the accelerator performance and schedule. Yes the collaboration has written an EOP that details the FTE needs from the laboratory and the collaboration for efficient and safe maintenance and operation of the experiment.

Question 3

- Comments
  - The laboratory has agreed to deliver the PAC recommended 6E12 POT in anti-neutrino mode. The run plan for FY 2017 is well understood, with an agreement with NOvA of 1-3E20 POT of anti-neutrino running in FY17. The anti-neutrino-mode running in FY18 and beyond will depend on NOvA needs. The MINERvA collaboration should have a prioritized analysis plan based on a total delivered POT of 6E12 for anti-neutrino running.
  - The available resources from the collaboration and the laboratory for the experiment as presented are adequate for FY17 experimental needs.
  - The MINERvA collaboration has been monitoring the MINOS detector during shifts for 5 years. This has given them experience to take on the additional responsibility of MINOS M&O.
  - Responsibility for MINOS detector maintenance is migrating from ND to the collaboration. In many cases, training and succession plans are well thought out. In some cases (e.g. Run Coordinator), a succession plan needs to be defined.
  - MINERvA should consider including a resource need profile for the experiment for FY17-FY20 in the EOP. This resource plan could include succession planning.
  - The collaboration should be commended for making an operations plan to reduce the effort required for MINERvA shift taking in light of the additional oversight that will be required for MINOS detector monitoring. Care should be taken to ensure that the data quality does not suffer with this reduced oversight.

Question 3

- Recommendations
  - Work closely with the Fermilab Program Planning Office to coordinate MINERvA anti-neutrino run plans with the NOvA experiment's plans for FY17 and beyond.
  - Work with the laboratory to identify and train additional personnel to swap MINERvA PMTs.

Question 4

- Are there robust plans for data processing and data analysis? Have adequate resources from the laboratory and the collaboration been identified for data analysis to meet these goals?

Question 4

Findings

- The MINERvA collaboration has completed multiple full production passes over their current LE and ME data, which are similar in scope as to what will be required for the anti-neutrino
- The most recent full MINERvA production campaign took approximately one year from its start to full completion. It involved the integration of multiple changes to the simulation and analysis stack that required validation.
- The MINERvA collaboration presented computing resource estimates for a full analysis of their data that amounted to approximately 18M CPU hours and would require on the order of 550 TB of tape storage in FY17. These resources projections were presented to the Scientific Computing Division and are consistent with what the division can provide to the experiment.
- The MINERvA collaboration is in the midst of migrating their software/computing infrastructure away from the Scientific Linux 5 platform and to being compatible with the Open Science Grid.
- The MINERvA collaboration has taken over responsibility for the MINOS data processing.
- The MINERvA collaboration has an enumeration of the currently active analyses using the ME datasets
- The MINERvA collaboration does not have a formal planning process for determining when a full data processing/re-processing is triggered or scheduled.
- The MINERvA collaboration is planning on releasing results only on the “full” datasets, which are projected at 6E20 POT (12E20 POT requested).

Question 4

Question: Are there robust plans for data processing and data analysis? Have adequate resources from the laboratory and the collaboration been identified for data analysis to meet these goals?

Yes. The MINERvA experiment has demonstrated the ability to plan for and execute the data processing and data analysis necessary for producing physics results. They have demonstrated that they can correctly assess the computing resources they require and have presented reasonable projections of the resources they will need going forward to process and analyze the anti-neutrino data sets.

Question 4

- Comments
  - The production campaigns for the LE and ME datasets are similar in scope as to what will be required for the anti-neutrino data sets
  - The MINERvA collaboration's last full production campaign included numerous changes to the experiment's analysis stack. This campaign is a reasonable model for understanding the scope of work that will be required for known changes that the experiment wishes to make to the analysis suite that will be used for anti-neutrino data analysis.
  - The computing resources and support that have been requested by the MINERvA experiment are reasonable, but in the current constrained budgetary climate, there may be need to adjust resource allocations based on the impact of the work being performed. The MINERvA experiment should consider how they would change the scope or timeline for their anti-neutrino analysis if they were unable to obtain all the computing resources they have requested. The MINERvA experiment is also encouraged to understand and present their current/future analysis efforts in a manner that makes clear the impact the results may have on the neutrino community as a whole.
  - The MINERvA collaboration's effort to modernize their software/computing infrastructure will allow the experiment to leverage more resources for their core production activities and will allow the experiment to absorb more readily any unanticipated computing needs (specifically increase simulation needs). This may be particularly important in a constrained budgetary environment where not all the requested resources are available from the FNAL complex. MINERvA is encouraged to continue this modernization and to look for other ways to expand their available resource pool (i.e. find ways to improve on the current 80% job efficiency or other small optimizations that can help reduce waste and reclaim resources.)

Question 4

- Comments
  - The MINERvA collaboration should be applauded for their efforts to assume the MINOS production infrastructure and data processing. The presented integration between MINERvA and MINOS computing appears to be well motivated and sustainable given the available effort that the collaboration has.
  - The MINERvA collaboration may find it extremely advantageous to formalize their process for determining the “triggers” and timelines that are required for initiating their large scale and common production processing. Moreover they may want to develop analysis strategies that target specific physics results for public consumption on deadlines (meaning at major conferences) that are concurrent with the needs of the larger community. Doing so will allow the experiment to “work backwards” from the conference dates to determine when processing efforts should start and how they can be balanced. This will be a boon to both the experiment and the community.

Question 4

- Recommendations
  - Use a prioritized ME publication plan to develop a schedule for your simulation and data processing.

Question 5

- Are there clear goals set for reporting and publishing the results from the experiment in a timely fashion?

Question 5

- Findings
  - The MINERvA collaboration published 16 papers based on low energy data set collected in 2009-2012: 8 PRLs, 7 PRDs and 1 PLB.
  - 15 W&C talks have been presented by the collaboration.
  - 8 more analyses of low energy data are in various stages of readiness for publication .
  - 11 medium energy analyses are in progress.
  - The Minerva collaboration is planning on releasing results only on the “full” datasets, which for anti-neutrino running is projected to be 6E20 POT (12E20 POT requested).
  - The determination of the (anti-)neutrino fluxes is required for most of the anti-neutrino analysis efforts. This is not yet available for ME running.

Question 5

- Are there clear goals set for reporting and publishing the results from the experiment in a timely fashion?

Yes, there is a well-defined set of low energy and medium energy results that the MINERvA collaboration is working on towards publication.

Question 5

- Comments
  - The collaboration has a well established process and methodology to review results that has resulted in successful journal publications.
  - While the rate of publications is reasonable, the current plan envisions publications approximately a year after all data is on hand. Comments were made as to the possibility of publishing earlier with not all data on hand. This might line up better with the timelines for students and postdocs and possibly help the community to understand earlier the level of accuracy that the experiment can ultimately reach.
  - While the collaboration has not identified "flagship" analyses, the prioritization of the analysis topics could help focus the collaboration efforts in the areas critical for results which are most relevant for the neutrino oscillations community.
  - The presentations did not make it clear how the results from the MINERvA experiment might *quantitatively* affect the reach of the neutrino oscillation experiments or the studies of the EMC effect. It is advisable to pursue this clarification with studies for the most important analyses, including taking into account statistical and systematic uncertainties and different POT numbers.
  - While performing an analysis only on full (complete) datasets may reduce the overall analysis load, having intermediate analysis results either in stages or at definite break points in the experiment's life cycle, may prove to be more impactful to the physics community.
  - Knowledge of the fluxes and uncertainties associated with ME running is a major undertaking and is most likely on the critical path for most of the cross-section measurements. The chance that this portion of the analysis is delayed or stalls due to lack of scientific manpower is a very real risk to the success of the experiment. This work has ramifications beyond MINERvA.
  - The MINERvA collaboration presented the current organization for the active ME analysis work. This should be expanded to map out all of the analysis work that the collaboration wants to accomplish over the next 2-3 years. In particular the relative impact of the different analyses should be considered. This will allow for both prioritization and long term planning for the resources, effort and timelines that will be needed to meet targeted publication and presentation milestones. This will be especially important if there continues to not be enough analysis effort within the collaboration to cover all of the physics topics that the experiment has access to.

Question 5

- Recommendations
  - Develop plan to submit for publication all remaining low energy results within 8-12 months.
  - Together with the accelerator division and other relevant experts work expeditiously on understanding the neutrino flux.
  - Develop a prioritized list of medium energy publications for both neutrino and anti-neutrino datasets.
  - Analyze the pros and cons of publishing some medium energy results based on a partial data set. Consider the possibility of having a more timely impact on the broader community when making this decision.

Question 6

- Does the committee recommend further actions to ensure full exploitation of the MINERvA program?

Question 6

Question: Does the committee recommend further actions to ensure full exploitation of the MINERvA program?

Yes. Ensure adequate resources are devoted to bringing the ME analyses to publication in a timely manner.

Question 6

- Recommendations
  - none

Closing

- These will be posted to Indico after any required fixes.
- Committee will develop a draft of the written report by 28 October.
  - Will be shared with Spokespersons for fact checking.
- Aim to issue Final report by 04 November.
- The recommendations will be followed by Program Planning via the EMG meetings.
- Thank you!