Close-out Report for MicroBooNE Operational Readiness Review

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for the Review Committee

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Introduction

- The committee thanks the MicroBooNE collaboration for their very nice 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

- MicroBooNE is to be congratulated for their successful commissioning and their first results, which were produced rapidly upon receiving first beam.

- Bottom line: While a significant amount of work remains, MicroBooNE is well organized and appears to have the resources it needs to produce high quality physics in the coming year.

Question 1

- Is there a completed Experiment Operations Plan (EOP) document? 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 the support required by each institution from the funding agencies.

Question 1

- Findings
  - A preliminary Experimental Operations Plan for the MicroBooNE Experiment has been written (dated November 16, 2015) describing the main operational tasks of the experiment.
  - The EOP references the TSW between the MicroBooNE Experiment and the Fermilab Computing Sector for Support of Computing dated January, 16, 2015.
  - The experiment conducted a failure analysis and developed response procedures for all the major systems, including those related to the facilities, cryogenics, and beam, in consultation with all the relevant experts.

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

A preliminary EOP exists that includes some but not all of the elements requested in the charge.

Question 1

- Comments
  - A signature page and revision page should be added. The relevant signatures should be collected once the EOP is completed.
  - A description of the roles and responsibilities of each institution should be added.
  - The collaboration has not quantified the personnel resources (ie. FTE) required for detector,cryogenics, and beamline maintenance and operations (M&O) and data processing and analysis needs in FY2016 or beyond or the personnel resources available to fill those needs. This list should include support expected from Fermilab for M&O.
  - ESH&Q liaisons should be added to the MicroBooNE Organization Chart.
  - ESH&Q activities and how they will be managed should be added to the EOP.
  - The EOP section on safety could be re-written to summarize the ESH&Q organizational responsibilities and any unusual hazards for MicroBooNE (e.g. ODH, lasers, HV) and perhaps their mitigation including training. A reference to the MicroBooNE SAD should be considered.
  - The EOP states the M&O M&S needs as $220k/year M&O but does not include a clear list of what this covers and who will provide the funding.
  - The spares list needs to include future spares needs and who is responsible for funding them. In many cases there is only one spare at present and it is not clear if that is sufficient. The spares list does not include critical beamline spares such a MicroBooNE horn and target. The spares list does not include cryogenic and purification items such as pumps and valves.
  - The support required by each institution from the funding agencies is not included in the EOP.

Question 1

- Recommendations
  - In cooperation with the relevant stakeholders complete the EOP and obtain the relevant sign-off signatures.
  - Consider formalizing the institutional responsibilities with each collaborating institution to ensure long-term support of the experiment.
  - Consider whether additional formal agreements (e.g. TSW) with the other relevant divisions (e.g ND, PPD) would be helpful.
  - Work with the laboratory and collaboration to ensure adequate spares over the lifetime of the experiment.

Question 2

- Has it been demonstrated that the detector is ready for physics-quality data taking? If not, what actions are required to make the detector ready? Is there a clear plan for monitoring the data quality and has the associated infrastructure been tested? If not, what actions are required to adequately monitor the data quality?

Question 2

- Findings
  - There is a well developed organization chart for the experiment, which lists people responsible for all major systems of the experiment, including data collection.
  - Data-taking shifts started June 1, 2015, with two shifters attending the detector 24/7.
  - Check lists for the shifters are filled-out twice per shift and stored in an E-log.
  - MicroBooNE has a large number of automated tools in all areas of the experiment, including off-line reconstruction, which are used by shifters to monitor the data quality.
  - Limited-duration task forces are utilized to address short-term issues of critical importance to the experiment.
  - The achieved electronegative purity of the argon is > x2 better than the specification.
  - The cathode HV is designed to operate at -120 kV but is limited to -70 kV by instabilities. The causes have not been determined, but the detector can be operated at this voltage primarily because the electronegative purity is better than the specification. The plan is to run at -70 kV. The affect on physics performance appears to be acceptable.
  - The PMT noise is higher than predicted. This necessitates using a higher PE threshold in the PMT trigger than originally envisioned. Studies are underway to develop an optimal PMT trigger. Studies are also underway to determine the cause of the additional noise and potentially reduce it. Radon contamination from the argon purification system is suspected.

Question 2

- Findings
  - About 90% of the wire readout channels are operating. The source of the problem(s) is not yet documented. Preliminary studies show the impact on the detector is performance is not significant. The fraction of operating channels needed to meet the science goals was not defined.
  - There is a list of spares with their location for all major elements of the experiment.
  - MicroBooNE monitors the beam parameters based on the information provided by the accelerator division.
  - Full detector readout rate at 5 Hz has been achieved, data integrity has been tested and found to be appropriate.
  - The experiment is running with ~97% data collection efficiency during neutrino beam delivery.
  - The experiment conducted an internal “Commissioning Review” earlier this year in preparation for first beam.

Question 2

- Has it been demonstrated that the detector is ready for physics-quality data taking? If not, what actions are required to make the detector ready? Is there a clear plan for monitoring the data quality and has the associated infrastructure been tested? If not, what actions are required to adequately monitor the data quality?

While it is clear that the detector is operating stably, the committee is unable to assess whether the detector is performing as required to meet the physics goals since the criteria were not clearly stated. There is well developed monitoring of low-level experimental parameters (e.g. voltages, currents, dead and noisy channel) and some higher level parameters as well, most notably the argon purity. The committee did not see much monitoring of high-level physics quantities extracted from the beam data. These tools should continue to be developed.

Question 2

- Comments
  - High level physics and detector goals are well developed, while detector performance parameters required to reach physics goals have not been clearly presented.
  - A large amount of work has been done during beam-off commissioning of the experiment, which put the experiment in a strong position to rapidly detect neutrino events once beam was delivered. The majority of the beam-off commissioning tasks have been completed and the few remaining are in the final stages.
  - The LAr neutrino community would benefit from an in-depth analysis of the causes for the lower than planned TPC HV, the unresponsive TPC channels, and the PMT noise rates.
  - More detailed studies are needed to determine the physics impact for the unresponsive TPC channels.
  - The experiment might consider implementation of "soft" PMT trigger with a threshold close to the design value since even a modest reduction in the trigger rate could substantially reduce long term load on data storage, reconstruction, and analysis.
  - Existing monitoring tools provide in-depth monitoring of the main hardware parameters of the detector elements, such as power voltages, currents, status of DAQ and off-line systems, etc. while few of the tools provide data-based information, for example about efficiency of the charge collection.

Question 2

- Recommendations
  - Develop a list of the detector operating parameters required for high-quality data collection. Quantify specifications for these parameters to satisfy physics data quality requirements.
  - Continue development of data-based monitoring tools to monitor all parameters required for the physics quality data collection.

Question 3

- Is there a well-understood run plan for FY16, 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
  - MicroBooNE expects to receive 1-2x10^{20} POT in FY16, consistent with the accelerator schedule and performance.
  - Resources have been identified for FY16, but resources needed (FTE) were not presented.
  - There are clear divisions of responsibilities (AD, PPD, ND, SCD, collaboration) for major elements of the operation (beam, cryo, computing, shifts).
  - There are no formal statements of institutional responsibilities beyond FY16.

Question 3

- Is there a well-understood run plan for FY16, 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?

A run plan exists for FY16 consistent with the accelerator schedule and performance. Adequate resources have been identified for FY16 and it is clear who is responsible for what.

Question 3

- Comments
  - In about a year's time, consider re-evaluating the long term stability of the operational model for staffing the Run Coordinator position as far as maintaining a knowledge base and filling the position.
  - Consider utilizing a database to track Shift Training for the collaboration.

Question 3

- Recommendations
  - Create a table which lists the personnel resources required to run the experiment.
  - Consider establishing longer-term formal statements of institutional responsibilities to ensure continuity in the staffing and expertise for the essential operation tasks in the experiment.
  - Work with the collaboration to identify another Online expert.

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 MicroBooNE collaboration is well setup technically and organizationally to carry out data processing, MC production, and data analysis activities.
  - Analysis is predominantly done using centrally produced ntuples, which can be registered in SAM. All users of the collaboration have access to tutorials or documentation to facilitate analysis and access to data.
  - MicroBooNE covered all major tasks related to processing and analysis with effort documented in their org chart.
- Resource needs are covered through the SC PMT process and reflect the needs of MicroBooNE.
- Currently the experiment is writing “open trigger” data at a very high rate.
- The experiment presented a timeline leading up to the neutrino conference in July 2016 detailing the needs for software development, MC production, data and MC re-processing and analysis and data study tasks.

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?

MicroBooNE is technically in good shape to perform all needed processing and analysis tasks. The presented software development, production, processing, and analysis plan leading up to the Neutrino conference in July 2016 is aggressive but achievable and fits into the computing resource envelope established through the Scientific Computing Portfolio Management (SC PMT) process of SCD. Since this requires many activities carried out in parallel, the availability of experts is a concern.

Question 4

- Comments
  - MicroBooNE's LArLite toolkit is being merged with LArSoft and changes are being made to enable efficient usage of both. MicroBooNE commented that the integration process is progressing well.
  - MicroBooNE is currently working on improving the metadata for datasets in SAM to fully utilize it as the collaboration's means of discovering data besides wiki pages.
  - A concern is the availability of experts to carry out all planned tasks.
  - Software validation is technically set up but was suffering from not enough disk space. The plan is to start systematic software validation when sufficient disk space is available.
  - The overall problem of triggering the detector affects the offline processing by increasing the need for every sort of resource, with particular loads on the disk and tape storage requests. The trigger issue needs to be addressed promptly, including intermediate solutions that could partially reduce the data rate.

Question 4

- Recommendations
  - MicroBooNE should produce a concrete plan for the long term support and maintenance of PUBS, including the personnel and technical resources needed.

Question 5

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

Question 5

- Findings
  - MicroBooNE has a focused plan for data analysis and is actively working on the tools and calibrations needed to realize its first analysis.
  - The first analysis, the ν_μ CC inclusive cross section, has been performed entirely with MC. This will be carried over to data, targeting a result for Neutrino 2016.
  - A collaboration process for approving results exists, and has been exercised with MC and "first event" public results.
  - MicroBooNE has published 13 papers on the LAr construction.

Question 5

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

Yes, there are clear goals for reporting and publishing. The collaboration is targeting first physics results for a July neutrino conference.

Question 5

- Comments
  - Studying the low energy excess will be a long and difficult analysis. It is important that MicroBooNE continue to attract strong postdocs and graduate students that can carry the analysis through to completion.

- Recommendations
  - In the short term, continue to study the detector performance and its impact on physics analysis. In the long term, ensure that the analyses are adequately resourced.

Question 6

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

Question 6

- Finding
  - The experiment has established a technical coordination group to study the benefits and costs of added detector and facility enhancements.

Question 6

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

Yes, complete and document studies for the benefit of the Liquid Argon community, particularly concerning the PMT noise, the HV issues, and the unresponsive TPC channel. This appears to already be part of the plan.

Question 6

- Recommendations
  - The experiment is encouraged to produce sensitivity curves and detector performance plots as a function of PMT light threshold and to use these to establish a trigger.
  - The experiment should produce a full and documented response to the PMT noise issues.
  - The experiment should produce a full and documented response to the high voltage issues.
  - The experiment should produce a full and documented response to the causes of the unresponsive TPC channels.

Closing

- These will be posted to Indico after any required fixes.
- Committee will develop a draft of the written report by 07 December.
  - Will be shared with Spokespersons for fact checking.
- Final report is requested by 17 December.
- The recommendations will be followed by Program Planning via the EMG meetings.
- Thank you!