Long-Baseline Neutrino Experiment Near Detector Complex
Conceptual Design, Cost and Schedule Reviews
Closeout Report

At the request of the LBNE Project Manager, an LBNE Near Detector Complex design, cost and schedule review took place in Santa Fe on October 4-5, 2010. The agenda can be found in appendix 1. The reviewers were Steve Brice, Deborah Harris, Jon Kapustinsky, Stephen Pordes, HirohisaTanaka, Ronald Ransome.

- Is the scope of the subproject well defined?

Finding: the overall scope of the LBNE NDC was presented, and was defined as providing measurements that will enable the far detector oscillation analyses to have minimized systematic uncertainties. The sub-project is divided into several Level 3 projects: Measurement Strategy, Neutrino Detectors, Magnets, Beamline Instrumentation, each of which gave presentations. There are three other Level 3 sub-projects that did not give presentations, namely Management, Global DAQ and Computing. For the Neutrino Detectors Level 3 project, there were several technology options that were presented: two different Liquid Argon TPC designs, and two different fine grained tracker designs.

Comment: The overall scope of the NDC was clearly presented and well-defined. Individual sub-project scopes were not as well developed at the time of this review.

For the measurement strategy, it was not clearly stated whether the electron neutrino appearance measurement is the only analysis that determines the technical requirements or if muon neutrino disappearance measurements are also being considered.

For the beamline, it was not clear whether or not the hadron production experiments are part of the scope.

For the Neutrino Detector Level 3 project, the technology choices have not yet been made, in part because the far detector technology choice has not yet been made.

A strategy for making these choices that melds with the schedule for the CD-1 review has not been developed.

The reviewers expressed concern about the additional personnel and financial resources needed to add a hadron production experiment to the scope of this project. There was no cost and schedule documentation provided about such an experiment, were it to be added to the project.

Recommendations

The project should clarify what they expect to happen in the realm of hadron production measurements in the coming year.

Although many of these scope decisions may not be possible by the time of a CD-1 review, a plan and schedule for making those decisions should be developed by that time.

The highest priority scope decision to make is that of whether electron charge identification is required, and we recommend that this decision be made expeditiously.

- Are the requirements (scientific, technical, etc.) appropriately defined and documented, with appropriate flow-down from the most basic high-level requirements to more detailed requirements?

Finding: There is a preliminary requirements document that was made available on the LBNE review page. The Measurement Strategy presented a plan to further define the requirements over the next 18 months, given adequate personnel. The existing requirements document does not make reference to what else may be learned about theta_13 in the coming years.

The CD-1 review is scheduled tentatively for 6 months from now, in March 2011.

The Level 3 project managers stated that they depend on the results of the Measurement Strategy study before they can narrow the set of options under consideration.

For the Liquid Argon TPC it hasn't been determined if calorimeters are needed to surround the TPC or if the downstream detector is sufficient.

At the request of the reviewers, the level 4 manager for the Liquid Argon TPC promptly constructed a work and resource list required to answer these questions.

For the Liquid Argon TPC, the project has not been able to decide if a magnetic field is part of the scope. This is partly due to the novel nature of the device, and to the uncertainty in whether or not a magnetized LAr TPC will indeed identify efficiently the charge of the electron.

For the tracker detector, the requirement of electron charge identification has not yet been decided, which then affects the technology choice.

There is a proposal to the DOE for University funding (Proposal to Support the Design of the Long Baseline Neutrino Experiment) that would provide support for scientists to do the Measurement Strategy development.

A plan was presented for determining the detailed detector requirements from the high-level requirements.

Comment:

For the beamline, it is not clear whether the beamline monitors that were proposed are necessary for the oscillation analysis: they are clearly useful for operations.

Scientific support as requested in the above-named proposal is important for the timely development of the Near Detector Requirements and the choice of technologies.

The detector subgroups need to recognize that the flow-down to the detector-level from the high-level requirements may not be as prescriptive as they would like.

There is concern that the beamline monitoring design choices are being made without a properly derived set of requirements. Conversely the committee believes that some neutrino detector design features could be made prior to final requirements being determined.

Recommendation:

The requirements should be developed recognizing the potential changes to the detector requirements based on improvements in our knowledge of theta_13 over the next decade.

The LBNE Project should consider more globally what can be done in the far detector to reduce the far detector oscillation systematics: an example of this is looking at fully reconstructed neutral current pi0 events in the far detector to constrain that background.

The project should consider what kinds of decisions can be made in advance of the final requirements document.

- Are the assumptions for this subproject documented?

Findings: the project has what it calls a living "Key Assumptions" document which applies to the whole LBNE Project. This document is incomplete and does not include key assumptions associated with the cost and schedule, for example the advice for contingency assignments and the labor and M&S escalation rates to be used in costing,

Comments:

A complete Assumptions Document should also provide the schedule assumptions such as when the near detector needs to be ready with respect to the far detector.

A complete Assumptions Document would also include guidance for treatment of items that the project assumes it is getting from other experiments. Similarly, there should be guidance for adding contingency for uncosted (scientific) labor.

Recommendations: Update and complete the Key Assumptions Document, particularly with respect to cost and schedule issues.

- Are interfaces to and dependencies on other LBNE subprojects and the DUSEL facility defined and documented?

Findings: The interfaces between the Measurement Strategy and other level 3 sub-projects were described on one of the plenary talk slides. Similarly, at Level 4 the scintillator tracker

interfaces were described, as were the magnet interface to the conventional facility. There were no interfaces described between the Near Detector sub-project and the Far Detector.

There is a plan in place to hire a project engineer at LANL for the LBNE Near Detector Complex whose tasks include managing the interfaces between different parts of the Sub-Project, and also between the NDC and the Conventional Facilities.

There is no Measurement Strategy Level 3 Sub-Group in the Far Detector WBS.

There is no uniform description of all the interfaces in the Conceptual Design Report.

Comments:

There is concern that at present not enough consideration is given to the interface between the Straw Tracker Level 5 sub-group and the Conventional Facility.

We are happy to see the plan for hiring a project engineer for the Near Detector Complex.

Recommendations:

The Project Engineer should be hired expeditiously so that interfaces can be managed.

The interfaces throughout the entire sub-Project should be described in a more uniform fashion in the project documentation.

- Is there a complete conceptual design for all elements of the subproject, that
  - achieves the system requirements?
  - is backed up by sufficient engineering analysis to ensure that it meets the requirements?
  - is well documented?

Findings:

There were conceptual designs presented for the magnets, for a MicroBooNE style LAr TPC, a straw tube tracker, reuse of the MINERvA tracker and electromagnetic calorimeter and downstream muon tracker, ionization chambers for muon monitoring, and a Measurement Strategy. A pre-conceptual design was presented for the magnetized Liquid Argon TPC, and for the beamline muon Michel and beamline muon Cerenkov detectors.

The Conceptual Design Report was submitted for review.

There were no conceptual designs presented for the water targets that would be a part of the tracker detector.

Comments:
The reviewers recognize that a large amount of work has been done to develop and present these designs. It is not possible to say whether or not the designs meet the requirements for two

independent reasons: 1) because some of the requirements have yet to be defined, and 2) the project did not present how well the stated designs work (electron ID purity, energy resolution, etc.). This is due partly to the lack of scientific support to develop the simulations.

The chapters of the CDR that describe parts of the project that are being re-used from earlier designs come from documentation that already exists. Where the project is proposing new technologies the documentation is less complete and needs more work to be ready for a CD-1 review.

The CDR sections on Value Engineering, ES&H, Quality Assurance, and risks are incomplete.

Recommendation:

More complete documentation of the new designs should be included in the Conceptual Design Report. The project should do the simulations on the detector performance, and when that is completed it should also be included in the Project documentation.

Complete the CDR sections on Value Engineering, ES&H, and Quality Assurance.

- Have alternate designs been considered, and has there been sufficient engineering analysis performed to allow evaluation of the relative strengths and weaknesses of the alternates relative to the reference design?

Findings: There are many technologies under consideration for the near detector technology choices. The project presented a "reference design" which did assume both a liquid argon TPC and a water target, and used the straw tubes for the downstream tracking device. This choice was made primarily for the purposes of costing.

For the ionization chambers, three alternatives were presented along with side by side comparisons of each design.

For the straw tube tracker, two options for the density of tubes were presented. Also, two options for the design of the barrel electromagnetic calorimetry were presented.

Comments: For the magnets, established designs were used and this choice (based on the UA1 and MINOS designs) seems sensible. Similarly, for the ionization chambers for muon monitoring, the choice of using the NuMI or CNGS beamline monitoring design as a reference is also sensible.

Recommendations: None

- Is there a defined R&D plan that will address open issues regarding the reference and alternate designs, leading to an eventual CD-2 baseline design?

Findings: There were R&D needs presented for the magnetized LAr TPC. R&D plans for the Tracker Detectors and for the Beamline Monitoring were presented.

Comments: Additional R&D by the LBNE project is required neither for the magnets nor for the MicroBooNE TPC.

Recommendations:
A schedule and a plan for adequate R&D for a magnetized LAr TPC needs to be developed. An R&D schedule that incorporates the decision making and far detector construction schedule should be developed for all the detector components.

The performance of any alternate straw tube tracker and barrel ECAL designs should be evaluated and a single design presented at a CD-1 review.

- Is there a WBS developed to sufficient detail, for the conceptual design stage, to
  - capture all of the required work to deliver the subproject scope?
  - form the basis for a complete cost and schedule estimate?

Is there a resource loaded schedule (RLS), which follows from the WBS, has appropriate internal linkages, milestone linkages to other subprojects, and properly applies external constraints?

Findings: A WBS for each major component was presented for review.

Comments:

Clearly much work has been put into developing the WBS so far and much more is needed to be ready for a CD-1 review.

A fairly complete WBS and RLS was presented for the Measurement Strategy sub-project, but does not include a mechanism for assigning contingency.

At the request of the reviewers, the magnet group provided a more complete description of the project tasks than what was in the original RLS.

There are aspects of the project that are well-understood, but not listed in the WBS.

There needs to be more communication between the L3 managers and the project office to incorporate the plans in place for detector R&D and construction into the WBS.

There are also aspects of the project that have not been fully enough developed to put into a WBS.

There’s currently no way of indicating in the WBS the elements of a system that are coming from outside of the LBNE project (for example, MicroBooNE).

The WBS is currently not complete enough to form the basis of an RLS.

Many of the costs and durations of the tasks in the RLS have been provided by the deputy project manager, not by the level 4 managers.

Because the WBS is not complete, we cannot evaluate if the appropriate linkages are present.

Recommendations:

The L3 managers should review the information that is currently in the WBS and RLS.

The L3 managers need to interface with the project office until the plans are accurately reflected in the WBS. Then those tasks should be resource loaded, again with the guidance from the L3 and L4 managers.

There needs to be a mechanism developed whereby contingency can be assigned for items that are of no cost to the project (scientific labor, existing equipment).

There needs to be a mechanism for appropriate schedule linkages to exist between the near detector and the far detector construction schedule, the Fermilab site civil construction.

- Are there Basis of Estimate (BOE) documents for each lowest-level WBS element in the RLS, and are the bases of estimate sound?

Findings: the project is developing a procedure for uniform BOE documentation across the entire LBNE project. This will be the same BOE format as will be used by MicroBooNE.

Formal BOE documentation was provided by the scintillator tracker subproject,

The straw tube tracker subproject presented tables of costs and the detectors whence the estimates came, the magnet subgroup presented costs based on previous magnet costs. The MicrobooNE LAr TPC is basing its cost estimates on those of MicroBooNE. The costs for the magnetized LAr TPC were largely developed by the Deputy Sub-Project Manager.

There were no costs presented for the Global DAQ or for Computing.

Comments: the BOE documentation is incomplete and not adequate for a CD-1 review.

Recommendations: The project management should unify and distribute the BOE documentation as soon as possible.

The L3 and L4 managers then need to update the BOE documentation well enough before a CD-1 review so that internal reviews of that documentation can take place.

The Project Management should determine a dollar threshold for the tasks that need to have formal BOE's associated with them.

- Do the cost and schedule estimates roll up properly, and numbers be traced from the highest level down to the BOE numbers?

Given the current state of the cost and schedule estimates, this roll up was not evaluated.

- Have quality assurance, value engineering, and ES&H been considered in the design?

Findings: Costs for quality assurance were presented, however details of quality assurance procedures were not described.

Value engineering has not yet been performed on the designs for any of the subcomponents, although ideas for reducing the cost were presented in some cases.

ES&H issues were presented in all cases except for the Beamline Monitoring sub-project.

Engineering for the mitigation of the liquid argon ODH issues is in progress.

Comments: For this stage of the project the ES&H issues are adequately identified but not addressed. For a CD-1 review the ES&H issues and mitigation steps need to be clear and complete. There may be a significant cost impact here.

Recommendations: Incorporate ES&H mitigation into the schedule, and work closely with ES&H professionals and conventional facility personnel.

- Have risks been identified for this subproject, and have estimates been made of the required contingency and schedule float required to cover the risks?

Findings: Risks were presented for all parts of the subproject. These risks were not all reflected in the risk table that was linked to the review web page.

The risk table is not linked to the WBS and the RLS.

No estimates of required contingency and schedule float have been made based on the risks that were presented.

Comments: A risk analysis that is updated across the entire sub-project needs to be made.

The risks described in the risk register seemed focused more on design risks rather on technical, cost, or schedule risks.

It is not clear how the RLS is incorporated into the Risk Analysis.

Recommendations: Project Management should set a date by which the Risk Analysis should be in place.

- Are there any other issues regarding preparation of the conceptual design and of the cost and schedule estimates for CD-1 that should be addressed?

None.

Appendix I: Review Agenda

Agenda

Monday 4 October 2010

Start	Title	Speaker
08:30	Committee Executive Session	
	Plenary	
09:15	Near Detector Overview	C. Mauger
09:45	WBS 1.3.2 Measurement Strategy	S. Zeller
10:45	**Break**	
10:55	WBS 1.3.3 Beamline Measurements	G. Mills
11:15	WBS 1.3.4, 1.3.5 Neutrino Detectors, Magnets	W. Louis
11:45	Structure of Cost and Schedule Estimates	D. Lee
12:00	Lunch	
13:00	**Breakout Sessions**	
	1) Beamline Measurements: Measurement Strategy; DAQ; Computing Reviewers: S. Brice, H. Tanaka	
	Beamline 1	A. Marino
	Measurement Strategy	S. Zeller
	2) Neutrino Measurements: Scintillator Tracker; Straw Tube Tracker; Reviewers: D. Harris, R. Ransome	
	Straw Tube Tracker 1	R. Petti
	Straw Tube Tracker 2	S. Mishra
	3) Neutrino Measurements: Liquid Argon TPC, Magnets; Reviewers: J. Kapustinsky, S. Pordes	
	Liquid Argon TPC 1	G. Horton-Smith
	Liquid Argon TPC 2	K. Lee
16:30	Adjourn Breakout Session	
16:30	Committee Executive Session	
17:30	Questions from Review Committee	
18:00	Adjourn for the day	

Tuesday 5 October 2010

Start	Title	Speaker
08:00	Answers to Questions	
09:00	**Breakout Sessions**	
	1) Beamline Measurements: Measurement Strategy; DAQ; Computing	
	Beamline 2	G. Mills
	Beamline 3	E. Zimmerman
	DAQ and Computing	C. Mauger
	2) Neutrino Measurements: Scintillator Tracker; Straw Tube Tracker	
	Scintillator Tracker	B. Bradford
	3) Neutrino Measurements: Liquid Argon TPC; Magnets	
	Magnets	D. Naples

12:30	Working Lunch/Committee Executive Session
13:30	Committee Executive Session/Report Writing
17:30	Closeout
18:00	Adjourn