

Memorandum

20-May-2015

To: Mike Lindgren, Chief Project Officer
From: Nigel Lockyer, Director
Subject: Director's Review of LBNF and DUNE

Since the approval of CD-1 for the Long Baseline Neutrino Experiment (LBNE) in December 2012, the LBNE project has been recast as the Long Baseline Neutrino Facility (LBNF) and the Deep Underground Neutrino Experiment (DUNE) in order to allow for enhanced capability through increased international participation. As a result, LBNF and DUNE have developed updated conceptual designs, cost and schedule estimates, management plans, and a Critical Decision tailoring strategy. Please organize and conduct a Director's Review to assess whether LBNF-DUNE meets the requirements of DOE Critical Decision (CD-1) "Approve Alternative Selection and Cost Range" in preparation for the DOE Office of Science "CD-1 Refresh Review" planned for July 2015.

DUNE will yield an experimental program in neutrino physics, nucleon decay, and astroparticle physics at LBNF using a deep underground liquid argon detector time-projection chamber (LAr-TPC) with an ultimate fiducial mass of 40 kilotons, to be built in increments of 10 kilotons at the Sanford Underground Research Facility (SURF) in South Dakota. The goal of the international team is for the first 10 kiloton fiducial mass detector to be deployed as soon as possible, followed by expansion to 40 kilotons as soon as possible thereafter.

The project strategy has been developed to meet the requirements set out in the P5 report and taking into account the recommendations of the European ESPP strategy, adopting a model where the DOE and international funding agencies share costs on the DUNE detectors, and CERN provides large in-kind contributions to the supporting infrastructure.

LBNF will provide:

- Excavation in a single subcontract of four underground caverns at SURF, each capable of hosting a cryostat with a 10 kt fiducial mass LAr-TPCs.
- Surface, shaft, and underground infrastructure to support the outfitting of the caverns, four free-standing steel-supported cryostats, and the cryogenic systems. The installation of the first two cryostats allows for a rapid deployment of the first two 10 kt far detector modules. The intention is to install third and fourth cryostats as rapidly as funding will allow.
- The conventional facilities for the near detector systems at Fermilab.
- The conventional and technical facilities for a 1.2 MW neutrino beam for utilizing the PIP-II upgrade of the Fermilab accelerator complex, upgradable to 2.4 MW with the proposed PIP-III upgrade.

DUNE will provide:

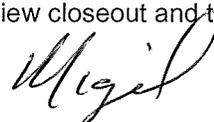
- Four LAr-TPCs, each with a fiducial mass of at least 10 kt. The division of the far detector into four equal mass detectors allows the project flexibility in the installation and funding (DOE vs non-DOE) in the case of new resources being identified, mitigates risks, and allows for an early and graded science return.
- The near detector systems, consisting of a highly-capable neutrino near detector and the muon monitoring system to reach the precision requirements needed to fully exploit the statistical power of the very massive FD coupled to the powerful MW-class neutrino beam.

Based on the reference design described in the LBNF-DUNE conceptual design report, the project plan will first see the first two 10 kt far detector modules operational, with the beam shortly afterward. At this time the cavern space for all four 10 kt far detector modules will be available, allowing for an accelerated installation schedule if sufficient resources (likely international) for the experiment can be established. The project strategy described above meets the goals of reaching an exposure of 120 kt x MW x yr by 2032, and potentially earlier if additional resources are identified. The P5 recommendation of sensitivity to CP-violation of 3σ for 75% of δ_{CP} values can be reached with an exposure of 850 kt x MW x yr with an optimized beam.

The focus of this review is cost, schedule, management, ES&H, and other identified concerns affecting readiness for the DOE CD-1 Refresh. The review committee should respond to the following questions:

1. **Conceptual Design and Scope.** Have the performance requirements been defined and are they consistent with the Particle Physics Project Prioritization Panel recommendations and the DOE mission need? Have independent design reviews been conducted? Based on the design reviews, are the conceptual designs sound and likely to meet the physics requirements? Are the conceptual designs described in the Conceptual Design Report representative of the entire scope and adequately defined to support the associated cost and schedule ranges?
2. **Cost and Schedule.** Are the cost and schedule estimates, including life-cycle costs, credible and realistic for this stage of the projects? Is adequate scope, cost, and schedule contingency included? Is the proposed funding profile supported by DOE and is it adequate to support the cost and schedule ranges? Has the project identified all scope for which DOE will be responsible? Has a common accounting method been developed to allow for discussions between international funding agencies and for tracking progress of in-kind non-DOE deliverables?
3. **Management.** Have the required project management documents been updated for the CD-1 refresh? Are the management teams, including partnering institutions, sufficiently defined and staffed? Have the systems for managing interfaces between LBNF, DUNE, international agencies, and other stakeholders been defined and are they appropriate? Has the tailoring strategy for critical decisions been documented and is it justified? Has a staffing plan been developed and is it sufficient to complete the design and construction of the projects? Is procurement planning sufficiently detailed and coordinated across the organizations involved? Has an alternatives analysis been performed in support of the selected alternative? Have the LBNF/DUNE management teams met all the requirements of CD-1?
4. **Environment, Safety, and Health.** Are the required environmental approvals and permits on track to meet the project schedule? Have the required ESH documents been updated for the CD-1 refresh? Is ESH being appropriately addressed given the projects' stages?

The committee is asked to present a draft of their report at the review closeout and to issue the final report within one week of the review's conclusion.



Nigel Lockyer
Director
Fermi National Accelerator Laboratory

cc:
G. Bock
E. Gottschalk
E. James
J. Lykken
R. Rameika
J. Strait
E. McCluskey
M. Kaducak