LONG-BASELINE NEUTRINO EXPERIMENT - SUMMARY

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Description: The Long-Baseline Neutrino Experiment (LBNE) plans a comprehensive program that will fully characterize neutrino oscillation phenomenology using a high intensity 1300 km baseline accelerator neutrino beam and a massive liquid argon TPC as the far detector. The goals for this program are the determination of leptonic CP violation, the neutrino mass hierarchy, and underground physics, including the exploration of proton decay and supernova neutrinos. The science potential for these goals was characterized as ***absolutely central*** in the 2003 "High Energy Physics Facilities Recommended for the DOE Office of Science Twenty-Year Roadmap." The collaboration and the project are well organized and the U.S. Department of Energy has stated its intention to carry out this program in a phased manner. The scope of the first phase, for which CD-1 approval has been given, focuses on accelerator neutrino physics utilizing a far detector at the surface and a minimal near detector system. LBNE is aggressively pursuing non-DOE partners, both foreign and domestic, to increase the experimental capabilities before the first phase of LBNE is baselined at CD-2. If additional domestic or international commitments are secured, LBNE could include additional scope such as a near neutrino detector, which would not only improve the accuracy of the long-baseline oscillation measurements, but have a rich physics program in its own right, and an underground location for the far detector. LBNE will ultimately be able to exploit the higher beam power from Project X.

Science: In the Standard Model of particle physics, neutrinos are massless, neutral, spin one-half particles. Left-handed neutrinos form an electroweak isospin doublet with their charged, massive partners, electrons, muons and taus. The right-handed neutrinos form an electroweak isospin singlet. Results from the last decade, that neutrinos have nonzero mass, mix with one another and oscillate between generations, are one of the few indications of physics beyond the Standard Model and new theoretical and experimental work is needed to understand neutrino properties and their role in the Universe as the most abundant known particle of matter. As a result of the remarkable progress in understanding neutrino oscillations, we now have all the necessary ingredients for a scientifically well-motivated, comprehensive, and elegant program of measurements of neutrino oscillations and fundamental symmetries using leptons.

The LBNE plans a comprehensive experiment that will fully characterize neutrino oscillation phenomenology using a high-purity ν_μ beam, operated in both ν_μ and $\bar{\nu}_\mu$ beam polarities, which will: measure full oscillation patterns in multiple channels, precisely constraining mixing angles and mass differences; search for CP violation both by measuring the CKM phase δ_{CP} and by explicitly observing differences in ν_μ and $\bar{\nu}_\mu$ oscillations; and cleanly separate matter effects from CP-violating effects, to determine the ordering of the three neutrino mass eigenstates.

A configuration in which the far detector is located deep underground, in the first phase enabled by non-DOE partners or in a later phase, would provide expanded research such as nucleon decay and neutrino astrophysics, including studies of neutrino bursts from locally occurring supernovae.

Collaboration: The LBNE Science Collaboration is the user community that LBNE will serve. The collaboration is also an essential part of the team that is designing and will build the project. It currently consists of more than 360 members from 70 institutions from the United States, India, Italy, Japan and the United Kingdom. The Collaboration is growing, and by the time LBNE starts to take data, it is expected to at least double in size, with substantial increases both from the US and through the addition of collaborators from Europe, Asia and the Americas.

Cost and Schedule: CD-1 for the 1st phase LBNE Project was approved in December 2012 with a Total Project Cost of $867M and 40% contingency on the remaining project cost. Early construction at Fermilab will start in spring 2015, CD-2 is planned by the end of 2015, full construction will start in 2016, and the project will be completed in 2023. Expanding the scope with the help of non-DOE partners could delay completion by 1-2 years, depending on what is added.

Science Classification and Readiness: After almost a decade of community discussion and development of the idea of a super neutrino beam and a large underground detector, the 2008 P5 report stated, "Recent striking discoveries make the study of the properties of neutrinos a vitally important area of research. Measurements of the properties of neutrinos are fundamental to understanding physics beyond the Standard Model and have profound consequences for the evolution of the universe." The discovery of the last mixing angle (θ_{13}~9°) has established a strong scientific case for a long-baseline neutrino program as one of the highest priority new facilities in the world. As a result of the early start in the US, LBNE has been designed with a unique combination of optimal baseline for this physics, an optimized neutrino beam capable of using the multi-megawatt beam power from Fermilab's Project X accelerator upgrades, and large liquid argon TPC far detector. The LBNE Conceptual Design and technical choices are fully documented. The project is in Preliminary Engineering Design phase, and construction is planned to begin in about 2 years.