US physicists fight to save neutrino experiment

Budget cuts mean rethink for long-baseline project.

Eugenie Samuel Reich

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The future of a pioneering project to study the lightest matter particles known was thrown into jeopardy last week, when officials at the US Department of Energy (DOE) announced that they were reluctant to fund the Long-Baseline Neutrino Experiment (LBNE) in its current form. The experiment's leaders will meet this week at Fermilab in Batavia, Illinois, to discuss ways to allay the agency's concerns.

Reidar Hahn

Homestake Mine was due to play host to a pioneering neutrino experiment.

The stakes are high for advocates of the LNBE who see it as a chance for the United States to maintain a place at the leading edge of particle physics, even as the Large Hadron Collider (LHC) has made CERN, Europe's high-energy physics laboratory near Geneva, Switzerland, the field's undisputed hub. The LBNE would pursue different questions from the LHC by using the behaviour of neutrinos to search for subtle violations in the symmetries that govern the standard model of particle physics.

"If they really didn't want to do the project, they would tell us that, and they haven't done that," says Milind Diwan of Brookhaven National Laboratory in Upton, New York, a spokesman for the LBNE. "We've been asked to come up with a way to break it into smaller pieces so it's financially more manageable."

The LBNE would use more than 30,000 tonnes of liquid argon housed 1,480 metres underground in the Homestake Mine near Lead, South Dakota, to detect a beam of neutrinos or antineutrinos sent from Fermilab, 1,300 kilometres away. The experiment would measure the rates at which neutrinos and antineutrinos oscillate between their three different types, or flavours, and so test a hypothesized asymmetry between matter and antimatter. Detecting asymmetry could explain why there is so much more matter than antimatter in our Universe.

At a cost of between US$1.2 billion and $1.5 billion, the LBNE was expected to come online in 2022–24, and to have a construction budget peaking at roughly $200 million per year. But that is now considered too great a slice of the DOE's annual high-energy physics budget, which was cut by $6 million to $757 million in US President Barack Obama's 2013 budget request. With funding for high-energy physics not expected to increase in the next decade, "there is clearly no money for a large initiative," says Pier Oddone, Fermilab's director. "This administration's emphasis is on advanced manufacturing and energy. High-energy physics and nuclear physics are under pressure," he adds.

So on 19 March, Bill Brinkman, director of the DOE's Office of Science, wrote to Oddone to ask that Fermilab build the LBNE in stages. "I would like Fermilab to lead the development of an affordable and phased approach that will enable important science results at each phase," he wrote.

Phased construction

The DOE has not yet said what its budget would be for each phase, and the future of the project will hang on those figures, says Diwan. But some ideas are already being floated. It would be feasible, for example, to build the liquid argon detector at Homestake first, and use it to study cosmic rays while the neutrino beam at Fermilab is brought online later. Alternatively, the beam could come online first and be used to study the interaction rates of neutrinos with electrons at Fermilab, while the detector awaits construction. A third possibility is to abandon the dream of the LBNE as an underground facility, and build the detector at the surface, says Jim Strait of Fermilab, the LBNE's project manager. Although the high background incidence of cosmic rays would dash hopes of using the detector to study more exotic physics, such as the rare theorized process of proton decay, the primary goals might still be met.

The LBNE was to be part of a proposed underground lab housing a range of experiments to study rare processes away from cosmic-ray interference. Hopes for such a facility, on a par with the Gran Sasso National Laboratory near L'Aquila in Italy or Super-Kamiokande near Hida in Japan, were first placed in jeopardy in 2010, when the National Science Board, the oversight body of the US National Science Foundation, vetoed its officials' plans to built such a facility at Homestake (see 'Funding rejected for underground lab').

Any cancellation of LBNE would be likely to spark widespread concern among physicists. In January, more than 40 leading theoretical physicists wrote to Brinkman calling on the DOE to fund the experiment (see 'US physicists call for underground neutrino facility'). Brinkman did not respond to *Nature*'s request for an interview.

Theorist Steven Weinberg of the University of Texas at Austin, one of three Nobel Prize winners who signed the letter, says that the discovery that neutrinos have a mass is one of the only experimentally established facts that was not predicted by the standard model of particle physics. Although the LBNE would not be cheap, it would cost only as much as a medium-sized space-science mission, and much less than the LHC, says Weinberg. “Perhaps the United States will again pick up the task for developing high-energy facilities beyond the LHC, but until then, this is our best chance of staying in the game of exploring physics at a fundamental level,” he says.

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