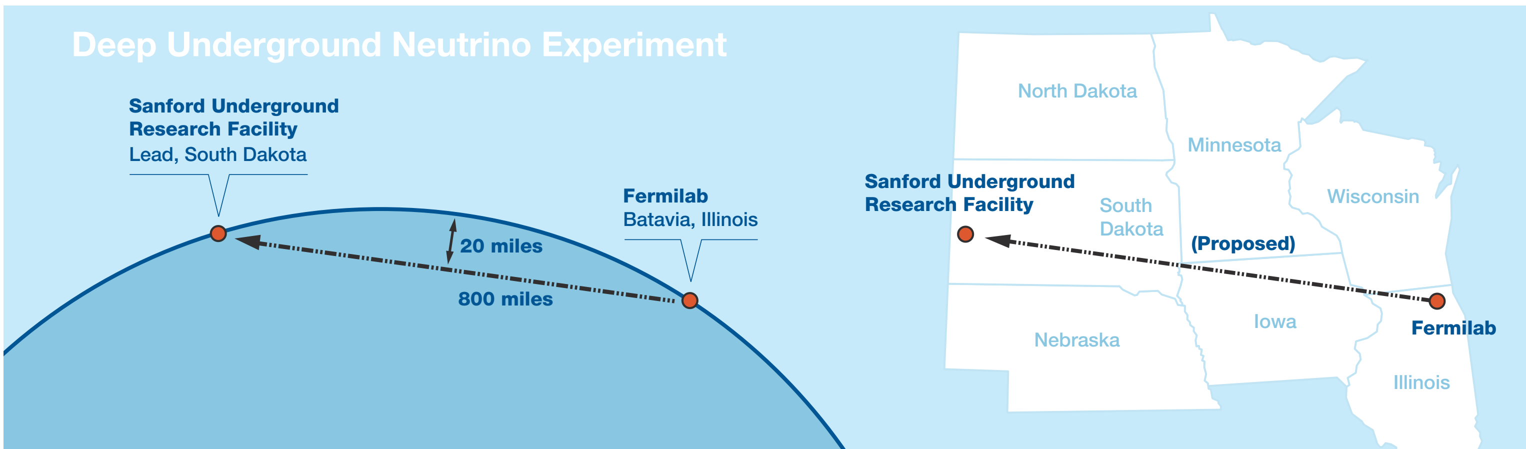
About the Long-Baseline Neutrino Facility and Deep Underground Neutrino Experiment

A new particle physics experiment, planned to take place at Fermilab and the Sanford Underground Research Facility, aims to transform our understanding of neutrinos and their role in the universe.



The proposed Long-Baseline Neutrino Facility would send neutrinos straight through the earth from Fermilab in Batavia, Illinois, to the Sanford Underground Research Facility in Lead, South Dakota. Scientists would use the neutrino beam for the proposed Deep Underground Neutrino Experiment. The neutrinos travel straight through rock and don't require a tunnel for their 800-mile-long trip.

Mysterious neutrinos

Neutrinos are among the most abundant particles in the universe, a billion times more abundant than the particles that make up stars, planets and people. Each second, a trillion neutrinos from the sun and other celestial objects pass through your body. Although neutrinos are all around us, they interact so rarely with other matter that they are very difficult to observe.

The latest developments in particle accelerator and detector technology make possible promising new experiments in neutrino science. The Deep Underground Neutrino Experiment collaboration, which comprises more than 750 scientists from 23 countries, has proposed to build a world-leading neutrino experiment that would involve construction at both Fermi National Accelerator Laboratory (Fermilab), located in Batavia, Illinois, and the Sanford Underground Research Facility (Sanford Lab) in Lead, South Dakota.

Why are neutrinos important?

Neutrinos may provide the key to answering some of the most fundamental questions about the nature of our universe. The discovery that neutrinos have mass, contrary to what was previously thought, has revolutionized our understanding of neutrinos in the last two decades while raising new questions about matter, energy, space and time. Neutrinos may play a key role in solving the mystery of how the universe came to consist of matter rather than antimatter. They could also unveil new, exotic physical processes that have so far been beyond our reach.

Facts about neutrinos

Neutrinos are elementary particles that have no electric charge. They are among the most abundant particles in the universe.

They are very light. A neutrino weighs at least a million times less than an electron, but the precise mass is still unknown.

In nature, they are produced in great quantities in the sun and in smaller quantities in the Earth. In the laboratory, scientists can make neutrino beams with particle accelerators.

Neutrinos pass harmlessly right through matter, and only very rarely do they collide with other matter particles.

There are three types of neutrinos: electron neutrinos, muon neutrinos and tau neutrinos.

The laws of quantum mechanics allow a neutrino of one type to turn into another one as the neutrino travels long distances. And they can transform again and again. This process is called neutrino oscillation.

Understanding neutrino oscillations is the key to understanding neutrinos and their role in the universe.

The distance between Fermilab and the Sanford Underground Research Facility is 800 miles. This is ideal for the proposed Deep Underground Neutrino Experiment.

Proposed LBNF neutrino beamline location on the Fermilab site

What is LBNF?

The proposed Long-Baseline Neutrino Facility would use Fermilab's particle accelerators to create neutrinos and send them through the earth to a new, large, cutting-edge neutrino detector at the Sanford Underground Research Facility. The neutrinos would travel the 800 miles from Illinois to South Dakota straight through the earth—no tunnel is needed for these particles.

The particle detector at Sanford Lab would record neutrinos and measure their oscillation properties. With the data, scientists aim to discover whether neutrinos and antineutrinos oscillate differently. They would also be able to determine which type of neutrino is the lightest and which is the heaviest. This information would help reveal the exact role that neutrinos play in the universe.

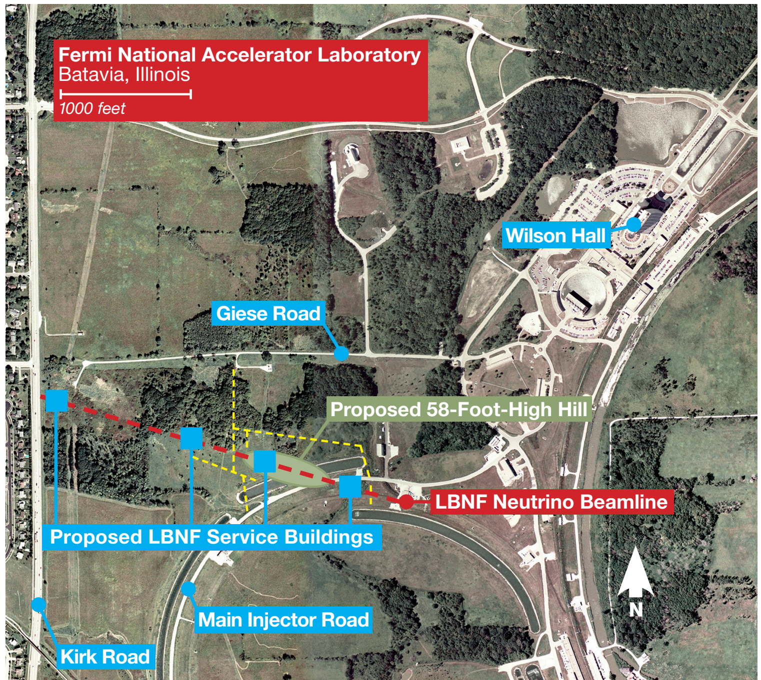
The LBNF neutrino beamline at Fermilab

Scientists can make neutrinos with particle accelerators. At Fermilab, scientists have operated neutrino-producing facilities for more than 30 years.

For the LBNF/DUNE project, scientists plan to construct a new beamline to send neutrinos from Fermilab to the Sanford Lab in South Dakota. It would steer protons from Fermilab's Main Injector accelerator up a small hill (see graphic below) and then point the beam into the ground, toward the Sanford Lab. The protons would smash into a piece of graphite. The particles that emerge from these collisions would go into a 680-foot-long tunnel and generate neutrinos that travel in the same direction as the protons. Scientists would also build a state-of-the-art underground hall for a particle detector that would measure the composition of the neutrino beam as it leaves the Fermilab site.

Traveling at close to the speed of light, the neutrinos would leave the Fermilab site at a depth of about 200 feet, continue straight through the earth and arrive at the Sanford Lab in South Dakota within a fraction of a second. Because neutrinos can travel through rock and all other matter, no tunnel would be necessary for this 800-mile trip.

At the Sanford Lab, a large particle detector would record the arrival of the neutrinos by measuring the rare interactions of neutrinos with the detector. They would transmit the data to computers for storage and analysis. Once the experiment is operational, it would take about a decade to collect enough data to make the hoped-for discoveries that would revolutionize our understanding of the universe.



The LBNF neutrino beamline and the DUNE near detector at Fermilab would be located on the western part of the Fermilab site, near Giese and Kirk roads. The locations of the four proposed service buildings are marked with blue squares and the footprint of the proposed, 58-foot-high hill is marked in green. Proposed access roads are marked in yellow. Kirk Road runs along the western boundary of the Fermilab site.

More information

LBNF website: lbnf.fnal.gov

DUNE website: dunescience.org

Fermilab website: www.fnal.gov

For more information contact:
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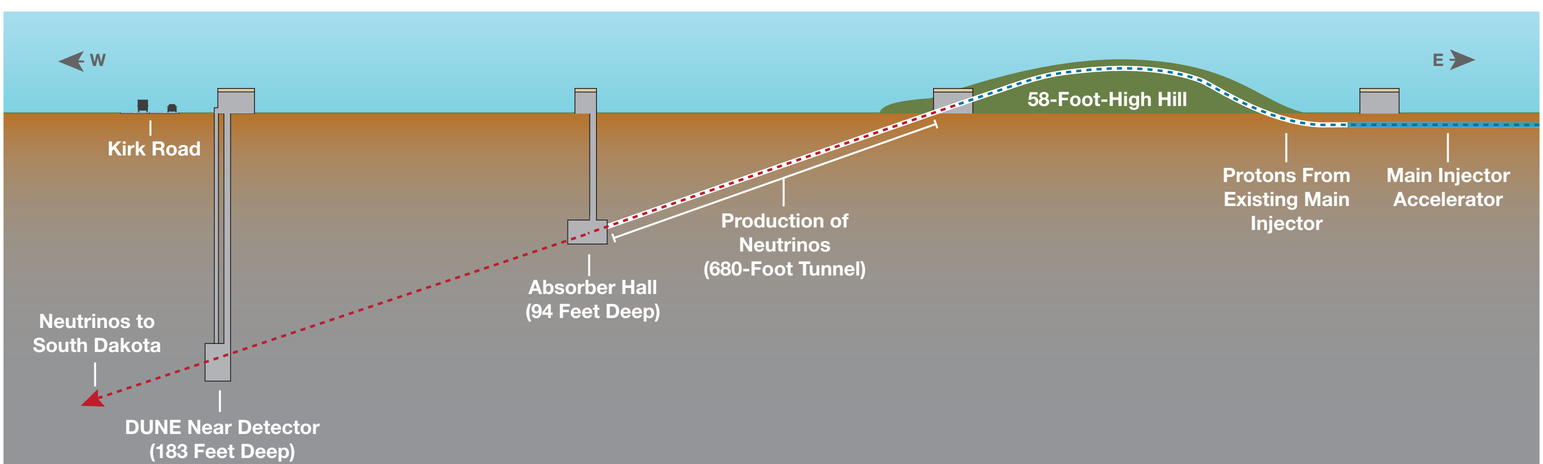


Fermilab plans to use its Main Injector accelerator to make neutrinos and send them through the earth to a particle detector in South Dakota. The project proposes the construction of four buildings, a 58-foot-high hill made of compacted soil and a 680-foot-long tunnel on the Fermilab site.

Proposed DUNE detector location on the Sanford Lab site in South Dakota

The proposed particle detector would be built in a cavern to be excavated near the Ross shaft, on the 4850-level.

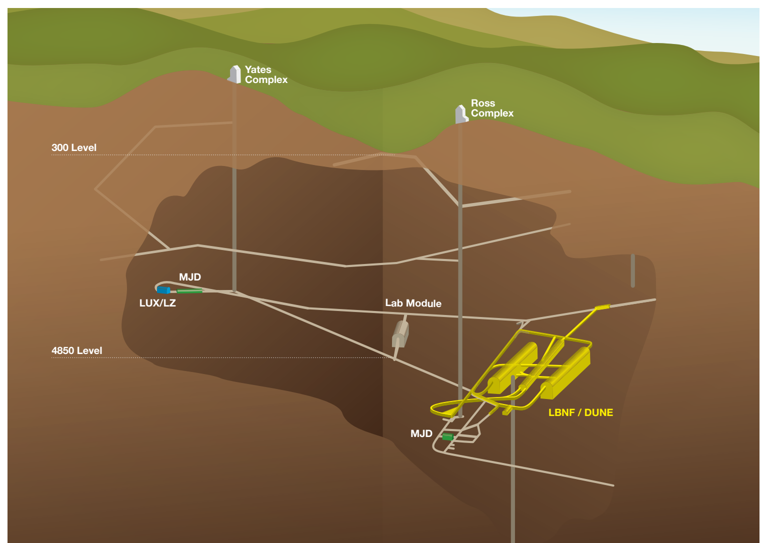
The neutrino detector at Sanford Lab

The proposed DUNE neutrino detector at the Sanford Underground Research Facility would reside in a large cavern to be excavated by the LBNF project on the 4850-foot level, near the Ross shaft. This deep location would shield the detector from the cosmic rays that bombard the Earth, increasing the detector's capability to identify rare interactions of neutrinos and other particles.

The detector would be filled with liquid argon, a material similar to helium, but heavier. Like helium, argon must be cooled to remain liquid. Cryogenic equipment would be installed in the cavern to cool argon to minus 303 degrees Fahrenheit. The rare interactions between neutrinos and the nuclei of argon atoms would create signals that would be transmitted to computers for storage and analysis. Scientists working on the Deep Underground Neutrino Experiment would use the data to learn more about neutrinos and their puzzling behavior.

About the collaboration

The scientists and engineers of the Deep Underground Neutrino Experiment collaboration come from more than 150 universities and laboratories in 23 countries. Collaborators encourage and anticipate further international participation. Funding for the collaboration is provided by the U.S. Department of Energy, the National Science Foundation as well as international funding agencies.



The proposed DUNE particle detector would be built in a cavern (in yellow) to be excavated near the Ross shaft, on the 4850-level. This deep location would shield the detector from cosmic rays. The neutrinos from Fermilab would travel straight through rock and enter the detector from the east.

More information

LBNF website: lbnf.fnal.gov

DUNE website: dunescience.org

Sanford Underground Research Facility website: www.sanfordlab.org

For more information contact:
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Or send e-mail to the LBNF/DUNE project team:
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Environmental Assessment and Historic Preservation Processes

Overview

This fact sheet is intended to acquaint stakeholders—potentially affected state, tribal and local governments, interested organizations and members of the public—with the proposed Long-Baseline Neutrino Facility (LBNF) and the Deep Underground Neutrino Experiment (DUNE). This project would require the construction of buildings and research facilities at both Fermi National Accelerator Laboratory (Fermilab) in Batavia, Illinois, and at the Sanford Underground Research Facility (Sanford Lab) in Lead, South Dakota.

Initial project planning

The U.S. Department of Energy (DOE) has authorized the commencement of initial project planning, part of which is an investigation of the potential impacts to human health and the environment.

The Environmental Assessment process

The National Environmental Policy Act (NEPA) was signed into law in 1970. It sets forth protection of the environment as a U.S. policy and requires that all federal agencies consider the potential environmental impacts of proposed projects. NEPA establishes a framework to ensure that environmental factors receive appropriate consideration along with economic and technical factors in federal agency decision-making. Accordingly, an Environmental Assessment document is being prepared for the LBNF/DUNE project. Information about the project and the Environmental Assessment process is being distributed through letters, fact sheets, websites and public meetings. For more information visit the Web: lbnf.fnal.gov/env-assessment.html

Preparation of the Draft Environmental Assessment

With the help of a number of technical experts, including independent consultants assisted by Fermilab and Sanford Lab staff, DOE is preparing an Environmental Assessment to determine what impacts LBNF/DUNE construction and operation might have on human health and environment. Documentation includes a statement of project purpose and need, a description of the proposed project and alternatives, a description of the current environment, and an analysis of potential impacts to the air, sound, water, soil, safety, traffic flow and other areas. The project team is presenting all these aspects in a Draft Environmental Assessment document. Opportunities to avoid any negative impacts that may exist would be integrated into the project plans.

The Historic Preservation process

The National Historic Preservation Act (NHPA) requires federal agencies to take into account the potentially adverse effects of their actions on historic properties. DOE consults with states, tribes, and other parties to identify those effects. To mitigate potentially adverse effects of the LBNF/DUNE project in South Dakota, a Programmatic Agreement is being prepared. The NHPA public outreach process, although separate from NEPA, will be conducted in conjunction with the EA.

Opportunity for public comment

DOE is making the Draft Environmental Assessment document, which includes the Draft Programmatic Agreement, available to stakeholders in print and electronic form. It is being distributed via mail, posted in libraries and public reading rooms and shared through websites, e-mail and other electronic media. The URL for the pdf file of the draft document is: http://lbnf.fnal.gov/files/LBNF-DUNE-Draft-EA.pdf

Public meetings will be held in South Dakota on June 17-18, 2015, and at Fermilab on June 24, 2015. The public will be able to provide comments either at these meetings or by submitting them in writing. The public comment period runs from June 8 to July 10, 2015. The address for submitting written comments is given below.

Preparation of the Final Environmental Assessment

After considering all comments, DOE will prepare a Final Environmental Assessment document. A record of the comments received will be contained within the document.

Decision-making

If the Final Environmental Assessment indicates no significant environmental impacts, DOE issues a statement known as a Finding of No Significant Impact (FONSI) and makes the Final Environmental Assessment document and the associated FONSI available via mail, libraries and reading rooms as well as electronic media. If the Final Environmental Assessment indicates that potentially significant environmental impacts are likely to occur, a more extensive environmental review, referred to as an Environmental Impact Statement, is undertaken to more fully explore those impacts. Additional public outreach opportunities would also be planned.

The LBNF/DUNE Environmental Assessment Process: Public Outreach

1. Initial project planning
2. Start of the Environmental Assessment process — May 2013
   - Letters, websites, informational meetings for the public, etc
3. Preparation of the Draft Environmental Assessment document
4. Opportunity for Public Comment — June 2015
   - Public meetings, letters, comment forms, e-mail, etc
5. Preparation of the Final Environmental Assessment document
6. Decision-Making

More information

For more information or to submit comments contact:

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