Building an International Flagship Neutrino Experiment

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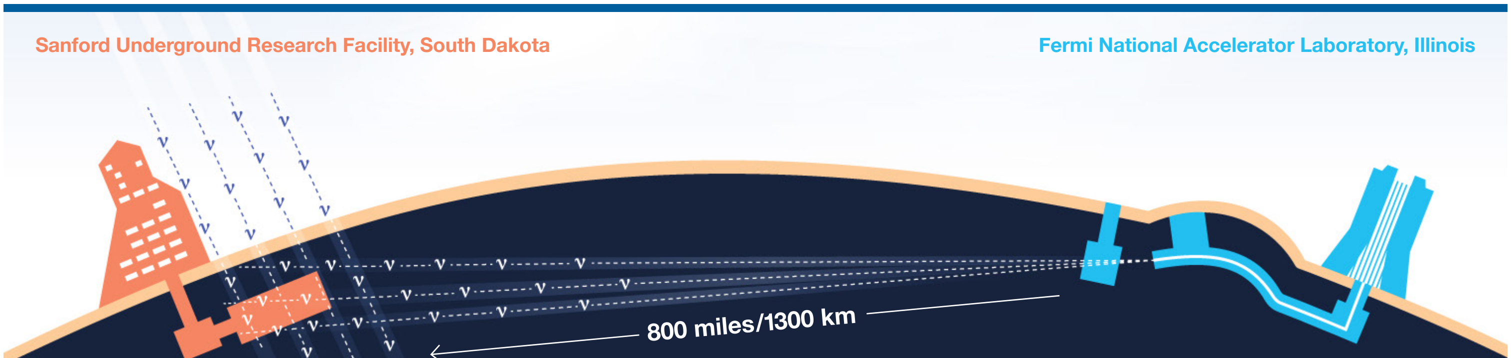
An international team of 1,400 scientists and engineers from over 35 countries is building the most advanced neutrino experiment in the world. Hosted by the U.S. Department of Energy's Fermilab with contributions from across the U.S. and around the globe, the Deep Underground Neutrino Experiment could change our understanding of the universe. The UK, CERN and other partners are producing and testing detector components. Cavern excavation in South Dakota is complete. Detector installation will begin in the fall of 2024.



Deep Underground Neutrino Experiment (DUNE)

DUNE consists of two state-of-the-art particle detectors: a smaller one at Fermilab in Illinois and a much larger one to be constructed a mile beneath the surface at the Sanford Underground Research Facility in South Dakota. The South Dakota detector will be the largest of its type ever built. It will use 70,000 tons of liquid argon and advanced technology to record neutrino interactions with unprecedented precision. Collaborators in the UK have begun the mass production of components for the first of four huge particle detector modules for DUNE. Testing is taking place at CERN. DUNE collaborators also are working on components for the detector at Fermilab.

Long-Baseline Neutrino Facility (LBNF)

LBNF will house the DUNE far detector in South Dakota, as well as the neutrino beamline and the smaller near detector at Fermilab. The excavation of the huge caverns a mile underground at the Sanford Underground Research Facility is complete. The new space will be equipped with intricate cryogenic technology to keep the DUNE detector modules at their operating temperature of -300 degrees Fahrenheit. At Fermilab, a new beamline will be built to send the laboratory's intense high-energy beam of neutrinos 800 miles through the Earth from Illinois to South Dakota. The neutrinos will travel straight through rock, no tunnel needed.

Proton Improvement Plan II (PIP-II)

The DUNE experiment requires the most particle-packed high-energy neutrino beam in the world, and that's exactly what Fermilab will deliver. A new, 700-foot-long particle accelerator, built with major contributions from partners around the world, will power the intense neutrino beam. The accelerator will be built with the latest superconducting radio-frequency technology developed at Fermilab. Tests at the PIP-II Injector Test Facility successfully concluded in 2021, including the acceleration of protons through a superconducting section. The PIP-II cryoplant building was completed in 2022. Construction of the complex that will house the accelerator is underway.

Why neutrinos?

The Deep Underground Neutrino Experiment, powered by the Long-Baseline Neutrino Facility and Fermilab's PIP-II accelerator upgrades, will study elusive subatomic particles called neutrinos. They are the most abundant matter particles in the universe. They are all around us, but we know very little about them. Each second a trillion neutrinos pass harmlessly through our bodies. In nature, they are produced in great quantities by the sun and other stars, yet even bananas emit neutrinos.

Scientists can create neutrinos in the laboratory with huge particle accelerators, and these neutrinos can be tracked with extremely sensitive detectors. Learning more about neutrinos, particularly the unique mechanism that allows them to change from one type to another over long distances, will tell us more about the universe and how it works. It may even give us the key to understanding why we live in a matter-dominated universe—in other words, why we are here.

Three major discovery areas

Origin of matter

DUNE scientists will look at the differences in behavior between neutrinos and antineutrinos, aiming to find out whether neutrinos are the reason the universe is made of matter.

Unification of forces

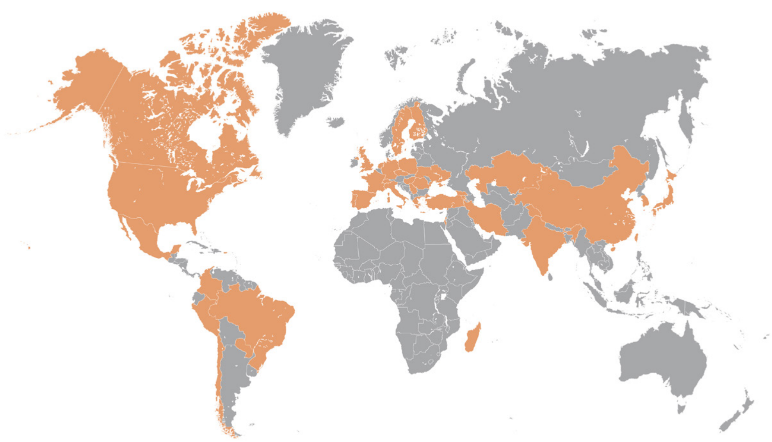
DUNE's search for the signal of proton decay—a signal so rare it has never been seen—will move scientists closer to realizing Einstein's dream of a unified theory of matter and energy.

Black hole formation

DUNE will look for the gigantic streams of neutrinos emitted by exploding stars to watch the formation of neutron stars and black holes in real time, and learn more about these mysterious objects in space.

An international effort

The Deep Underground Neutrino Experiment brings together over 1,400 scientists and engineers from more than 35 countries around the world.



Armenia	Georgia	Kazakhstan	Serbia
Brazil	Germany	Madagascar	South Korea
Canada	Greece	Mexico	Spain
Chile	Hungary	Netherlands	Sweden
China	India	Paraguay	Switzerland
Colombia	Iran	Peru	Turkey
Czech Republic	Israel	Poland	Ukraine
Finland	Italy	Portugal	United Kingdom
France	Japan	Romania	United States

Project timeline

July 2017
Groundbreaking for LBNF/DUNE

Sept. 2018
First ProtoDUNE detector online at CERN

Jan. 2019
Pre-excavation work begins in South Dakota

Nov. 2019
LBNF/DUNE site preparation starts at Fermilab

Feb. 2024
Cavern excavation in South Dakota is complete

2024
Begin installing the first DUNE detector

2028
Begin operating the first DUNE detector

For more information on the international collaboration and the institutions involved, please visit lbnf-dune.fnal.gov