

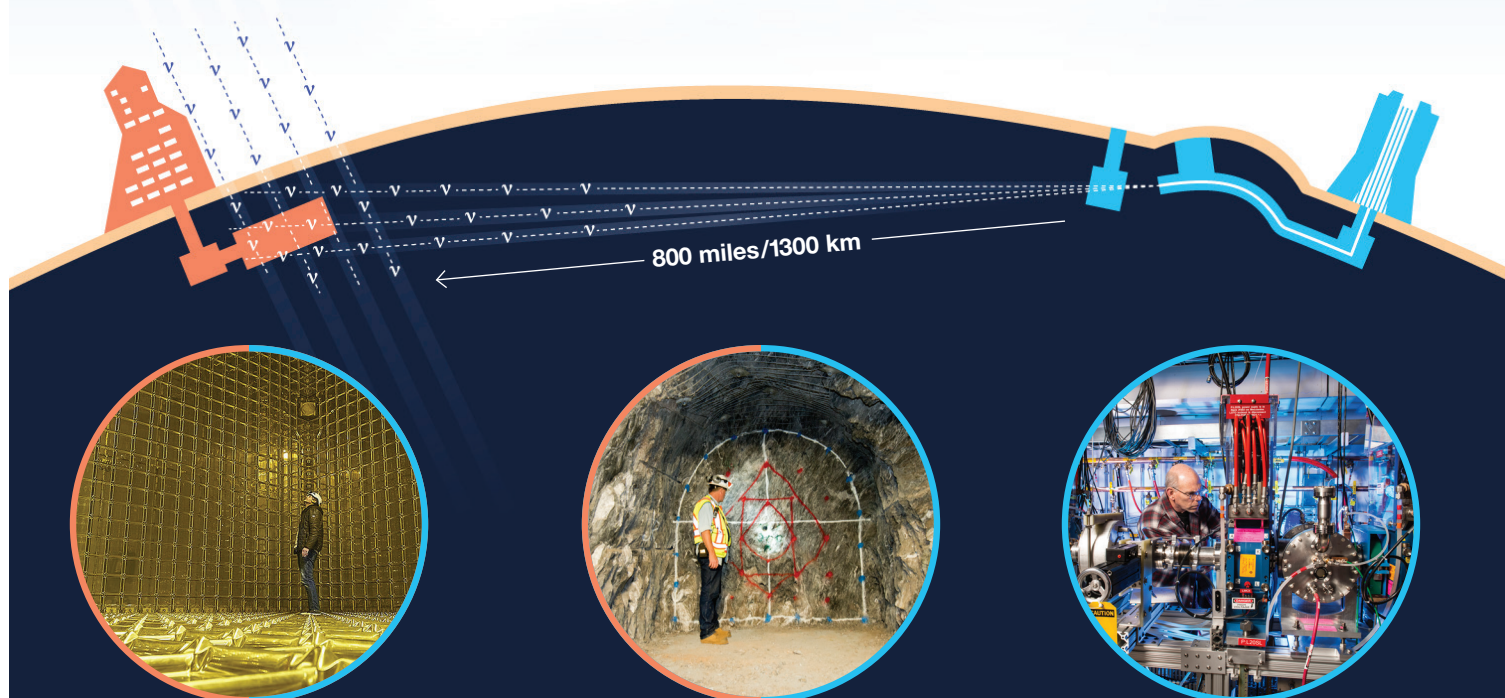
Building an International Flagship Neutrino Experiment

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An international team of over 1,000 scientists and engineers from more than 30 countries is building the most advanced neutrino experiment in the world, which could change our understanding of the universe. Groundbreaking for this revolutionary endeavor—hosted by the U.S. Department of Energy’s Fermilab with contributions from across the U.S. and around the globe—took place in July of 2017. The first of two large prototype detectors started recording data in Sept. 2018.

Sanford Underground Research Facility, South Dakota

Fermi National Accelerator Laboratory, Illinois



Deep Underground Neutrino Experiment (DUNE)

DUNE consists of two state-of-the-art particle detectors: a smaller one at Fermilab 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, and will use 70,000 tons of liquid argon and advanced technology to record neutrino interactions with unprecedented precision. The first of two large prototype detectors began recording data at CERN in Sept. 2018. The full detector and its computing systems will be designed and built by an international collaboration of scientists from more than 30 countries.

Long-Baseline Neutrino Facility (LBNF)

Before the DUNE detectors can be built, they will need underground facilities equipped with intricate cryogenic technology to keep the detectors at their operating temperature of -300 degrees Fahrenheit. LBNF will house the DUNE far detector a mile underground in South Dakota, as well as the smaller near detector at Fermilab. About 800,000 tons of rock will be excavated from Sanford Lab’s underground caverns, and a new scientific facility constructed. At Fermilab, a new beamline will be built to send the laboratory’s intense high-energy beam of neutrinos 800 miles (1300 km) through the earth from Illinois to South Dakota, with 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. Fermilab’s high-energy neutrino beam is already the world’s most intense, but a new particle accelerator, built with major contributions from partners around the world, will make that beam even more powerful. Groundbreaking for the PIP-II project took place in March 2019. The accelerator will be built with the latest superconducting radio-frequency technology developed at Fermilab. Along with other improvements to the accelerator complex, it will deliver the best possible neutrino beam for DUNE.

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, and 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.

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.

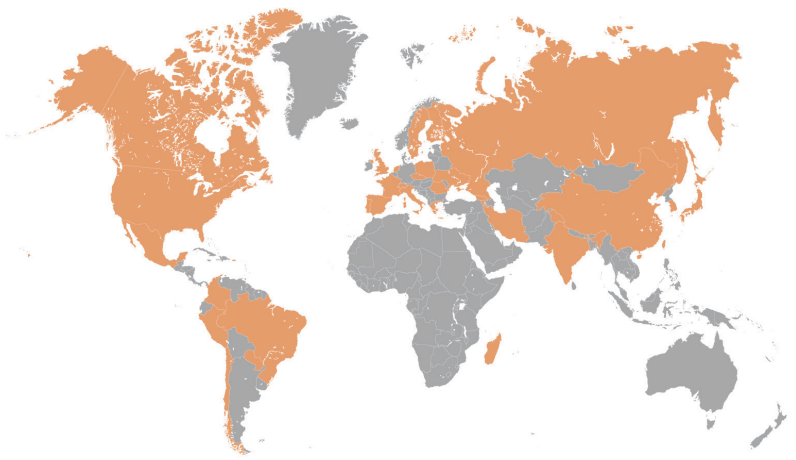


Black hole formation

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 1,000 scientists from more than 30 countries around the world.



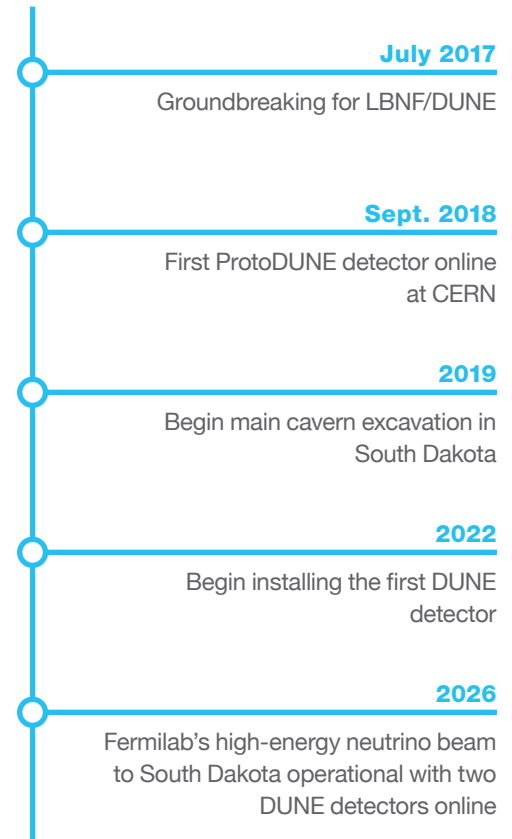
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Peru
Poland
Portugal
Romania
Russia

South Korea
Spain
Sweden
Switzerland
Ukraine
United Kingdom
United States

Planned project timeline



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