Building for Discovery

Strategic Plan for
U.S. Particle Physics
in the Global Context

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The P5 Report provides the strategy and priorities for U.S. investments in particle physics for the coming decade.

The top four priorities in 2019

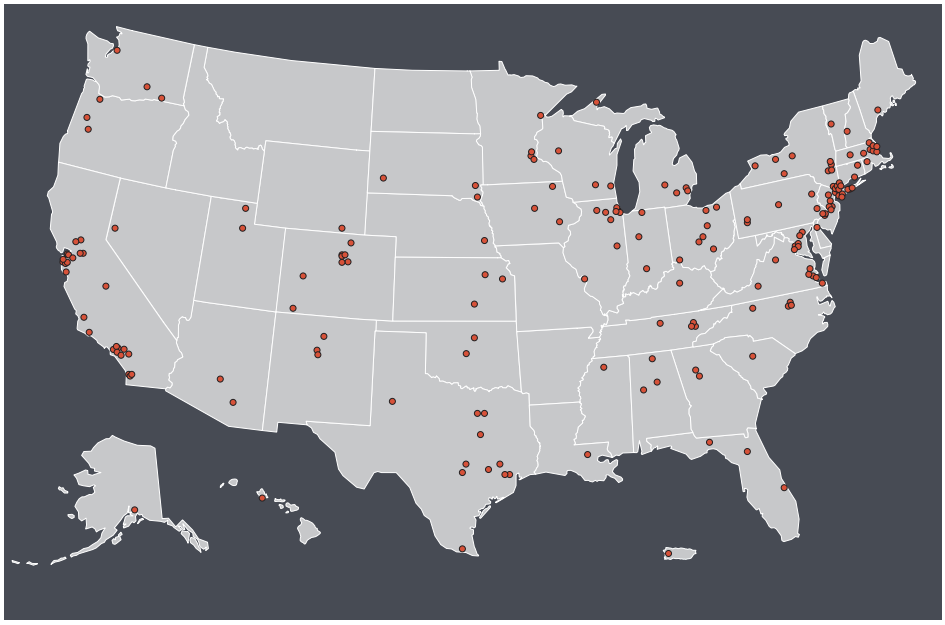
Advance the High-Luminosity LHC (HL-LHC) accelerator and ATLAS and CMS detector upgrade projects on schedule, continuing the highly successful LHC program and bilateral partnership with CERN. This is P5's highest-priority near-term large project.

Advance the Long-Baseline Neutrino Facility (LBNF), Deep Underground Neutrino Experiment (DUNE), and Proton Improvement Plan II (PIP-II), working with international partners on the design, prototypes, initial site construction, and long-lead procurements. This is P5's highest-priority large project in its time frame.

Support scientific research at universities and national laboratories, which includes data analysis, R&D, and a vibrant theory program. These activities are essential for extracting scientific knowledge from the data, as well as maintaining U.S. leadership and training the next generation of scientists and innovators.

Support the existing construction projects enabling the next major discoveries in particle physics, including LSST, DESI, Mu2e, LHCb, LZ, and SuperCDMS-SNOLAB.

These carefully chosen investments will enable a steady stream of exciting new results for many years to come and will maintain U.S. leadership in key areas.



Particle physics is both global and local. Scientists, engineers, and technicians at more than 180 universities, institutes, and laboratories throughout the U.S. are working in partnership with their international colleagues to build high-tech tools and components, conduct scientific research, and train and educate the next generation of innovators. Particle physics activities in the U.S. attract some of the best scientists from around the world.

The P5 strategy has been very successful. Projects are on schedule and within budget.

Recent results

The NOvA experiment has now **seen anti-neutrino oscillations**, with an analysis run in record time on a supercomputer cluster of more than a million CPU cores.

New constraints on the characteristics of the mysterious **dark matter** were obtained by the IceCube, LUX, ADMX, SuperCDMS, XENON1T, and LHC experiments.

The LHC experiments reported many exciting results, including observation of **Higgs boson** interactions with additional known particles, an important and challenging milestone in the program to use the Higgs as a new tool for discovery.

The Dark Energy Survey (DES) released its first supernova-based cosmology results using the first three years of data.

Program advances in 2018

Building upon the historic 2015 and 2017 bilateral U.S.-CERN agreements, U.S. and CERN scientists successfully continued their cooperative partnership at the LHC and the international neutrino program hosted by Fermilab.

The new CMS pixel detector at the LHC began operations, HL-LHC accelerator upgrade construction started, and the HL-LHC ATLAS and CMS detector designs advanced.

The community continues to move rapidly toward a new era of neutrino physics. Development of LBNF and DUNE became truly international, providing a worldwide focus of scientific research hosted at Fermilab. In addition to the planned UK contributions, India recently expanded its bilateral partnership to include LBNF/DUNE and Italy has agreed to collaborate on the development of PIP-II. The protoDUNE detector is now operational.

The Muon g-2 experiment construction was completed successfully, and its first physics run is now underway.

Next-generation dark matter and dark energy experiments progressed. The selected dark matter experiments SuperCDMS-SNOLAB and LZ continued construction. Recent pathfinder experiments, advances in quantum technology, and theoretical insights have opened the potential for dark matter discovery in a mass range once thought inaccessible. DES successfully completed its survey. The Dark Energy Spectroscopic Instrument (DESI) and the Large Synoptic Survey Telescope (LSST) construction projects continued on schedule.

Community efforts are underway to develop the next-generation cosmic microwave background facility, CMB-S4, which will probe in unique ways the physics of the very early Universe at energies far higher than can be achieved in earthbound accelerators and will also reveal neutrino properties.

Looking forward

All eyes are on the LHC, as its sensitivity to new physics will continue to improve for many years to come.

Eagerly anticipated new data from operating experiments will advance the understanding of the intertwined Science Drivers identified in the P5 Report.

The particle physics theory community will continue to play key roles interpreting results from current experiments, motivating future experiments, and pursuing answers to the deepest questions.

Japan is considering hosting the International Linear Collider (ILC), which would provide new opportunities for discovery.

Theoretical and experimental particle physicists are advancing Quantum Information Science (QIS), providing solutions to problems in computation, data analysis, sensors, and simulations.

U.S. researchers are pursuing R&D on advanced technologies to enable future generations of accelerators and detectors with a wide variety of applications.