Testimony of

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Chairman Lummis, Ranking Member Swalwell and Members of the Subcommittee, I appreciate being invited here today to provide the Fermilab view on the future of particle physics in the US and in the context of the new report from the P5 subpanel of the High Energy Physics Advisory Panel. The P5 report lays out a bright future for the particle physics community and Fermilab strongly supports the recommendations of the P5 report and has embraced its role in implementing the strategic vision for the field.

Fermi National Accelerator Lab (Fermilab) is unique to DOE as it is a single-program laboratory and the only one devoted to particle physics. The laboratory's 1732 employees, and 2097 users drive discovery in particle physics by building and operating world-leading accelerator and detector facilities, performing pioneering research with national and global partners, and developing new technologies for science that support US industrial competitiveness. Fermilab's accelerator complex is the nation's largest and produces the world's most powerful high- and low-energy neutrino beams. Fermilab Research Alliance, LLC manages Fermilab for the Department of Energy. FRA is an alliance of the University of Chicago and the Universities Research Association Inc., a consortium of 88 universities. Fermilab's 6800 acres site, much of which is open to the public, is located 42 miles west of Chicago, in Batavia Illinois, and includes a small herd of bison.

The context for the P5 report "Building for Discovery" can best be understood by a quick summary of recent history of the U.S. participation and leadership in the field. Until 2012, the Tevatron Collider at Fermilab operated at the highest energy in the world for 26 years. To develop and operate the Tevatron, Fermilab pioneered superconducting magnet technology – a capability which now enables other fields in science and energy. It was the world's first large accelerator (4 miles in circumference) using superconducting magnet technology. As a testament to the role these DOE facilities play in the education and training of the nation's next generation workforce, there were 1047 peer reviewed scientific publications and 1021 Ph.D students that graduated from the two main experiments. Scientifically speaking, the discovery of the top quark, the heaviest fundamental particle ever observed, was the crowning achievement.

Fast forward to today, the Large Hadron Collider (LHC) at CERN, Geneva Switzerland, now provides the highest energy particle collisions and will do so for the foreseeable future. The rapid discovery of the Higgs Boson in 2013 is a tremendous testament to the technical skill and devotion of thousands of scientists and engineers from around the world in constructing what has been argued to be the most complex scientific instrument ever built. The LHC has been a huge success by any measure and the U.S. role is not insignificant – with over 2000 U.S. scientists, comprising over 25% of the total number of scientists involved. Clearly the US should be proud of their contribution to this worldwide effort.

With this as the context, based on extensive community input, the recent P5 report lays out a decade long plan for the US particle physics community and clearly identifies the central role of Fermilab within that plan. Congress routinely asks the scientific community to set priorities. The P5 recommendations endorse a portfolio of projects that will keep the US at the frontiers of the field. It plays to the strengths of the US program such as accelerator and detector technology, big data, and data analysis. Accelerator stewardship is our field's preeminent core technology that will drive future scientific discovery in particle physics, in related sciences, such as the accelerator-based light sources at Argonne National Laboratory (ANL), Brookhaven National Lab (BNL), Lawrence Berkeley National Lab (LBNL), and the SLAC National Accelerator Laboratory (SLAC), as well as in new technologies to create future businesses.

The plan also would ensure the LHC program is fully exploited. The US contribution to the high luminosity upgrade is critical, as the quadrupole magnets utilize a new high field strength superconducting wire technology, Nb3Sn, never before used in an accelerator. This magnet technology was developed by Fermilab, BNL, and Lawrence Berkeley National Laboratory (LBNL) by extensive R&D over the last twenty years. Our field has a laudable history of producing superconducting accelerator magnets, which was a primary genesis for MRI magnets now found in nearly every hospital throughout the nation.

The P5 report also highlights the excitement over potential major discoveries in the areas of dark matter and dark energy. My colleague on the panel, Natalie Roe, will expand upon these.

The P5 report also recognizes the importance of U.S. based efforts and recommends that Fermilab hosts the world accelerator-based neutrino flagship project, the Long Baseline Neutrino Facility, LBNF. The global partnership model for neutrinos is appropriate because of the large scale of the experiment. We do the science together but at the end of the day, we own the technology intellectual property (IP) that has broad value to the nation.

The LBNF project will build on the momentum generated by the existing Long Baseline Neutrino Experiment (LBNE) collaboration, which already comprises over 500 scientists, 83 institutions and 10 countries. Tremendous progress has been made in preparing for the neutrino beams and the so called near-detector at Fermilab and the huge far-detector located 800 miles to the west in the Sanford Underground Research Facility (SURF) at the Homestake mine is South Dakota. SURF has been built with funds from the state of South Dakota, generous private donations, and federal funding, creating a modern state of the art underground laboratory. The far-detector will sit almost a mile underground. Core samples have been taken and the conditions are now known to be ideal. The R&D phase is ready to move into the detailed design stage. With the strong endorsement of the P5 report, the team is ready to grow quickly and move rapidly forward.

Let me back up and explain why we should even care to study neutrinos. The neutrino is the most prevalent particle with mass in the universe. It has to be important. As one of the most mysterious of particles we have studied it continues to surprise its practitioners at each step of discovery. There are properties of neutrinos, such as the ultra-tiny mass, the type of mass, and the nature of matter and anti-matter that continue to confound the standard model of particle physics. At this moment, there are 100 billion neutrinos passing through your thumbnail per second, mostly generated in the core of the sun, but we can also make them. However, not one will leave a trace. In order to study neutrinos, massive detectors are required and intense neutrino beams from accelerators will enable the mysteries of these particle to be further unraveled.

To be a global leader in a project like this and be successful, Fermilab and the U.S. must be a reliable partner, as we are in the LHC abroad, throughout the lifetime of the project. We have already begun intense discussions to enable the vision of this project to be a reality. Fermilab has begun conversations with CERN, Italy, UK, India, Brazil, and Japan on the subject of forming a new collaboration on neutrinos, building on the success of LBNE collaboration. This enlarged international partnership will offset the U.S. share of the total project cost and leverage the tens of millions of dollars invested to date.

In addition, the technology to generate these neutrinos will be transformative for the field and the world. Accelerators at Fermilab today produce the most powerful beams of neutrinos in the world, comparable to that of the sun. In order to study the mysterious properties of the neutrino, even more intense beams are required. The scientific pressure to produce more and more intense beams of neutrinos demands more powerful and more energy-efficient accelerator technologies. We are pleased that the P5 report endorsed the PIP-II superconducting radiofrequency (SRF) linear accelerator project that once constructed will ensure the US continues to lead the world with the most powerful neutrino beams. It will also ensure the US leads in the SRF accelerator technology. The Department of Energy has recently recognized Fermilab with one of its prestigious early career awards in this area.

The SRF accelerator technology is taking the world by storm and has the potential for enormous scientific and economic value. One scientific example is the International Linear Collider (ILC). Japan is now seriously considering hosting this approximately 20 mile long accelerator using SRF technology. The P5 report highlights the potential exciting science if it is constructed.

Many breakthroughs in SRF technology came from R&D associated with the initial development aimed at the ILC. Fermilab is launching a new commercialization initiative, for the first time in its history, to exploit this technology for applications in natural gas, microelectronics, transportation, cleaning of flue gas, and water treatment.

The P5 report lays out a bright future for the particle physics community and Fermilab strongly supports the recommendations of the P5 report and has embraced its role in implementing the strategic vision for the field. Along with our DOE Office of Science partner labs, Argonne National Laboratory, Brookhaven National Laboratory, Jefferson Lab, Lawrence Berkeley National Laboratory, Pacific Northwest National Laboratory, and SLAC National Laboratory, we are excited, energized, and up to the challenge.