## Chapter 7. A Fermilab Plan for Discovery

**The Steering Group's proposed plan**

The Steering Group recommends the following plan for the accelerator-based particle physics program at Fermilab.

* Fermilab's highest priority is discovering the physics of the Terascale by participating in the LHC, being one of the leaders in the global ILC effort, and striving to make the ILC at Fermilab a reality.
* Fermilab will continue its neutrino program with NOνA as a flagship experiment through the middle of the next decade.

The Steering Group plan gives the highest priority to energy-frontier physics with the LHC and the ILC, where experiments will search directly for the physics of the Terascale, addressing the most compelling questions of 21st-century particle physics. Fermilab is the U.S. host laboratory for the CMS experiment at the LHC and a lead laboratory for LHC accelerator development in the U.S.

The ILC's opportunities for discovery have brought the global physics community together to design the proposed new accelerator. Fermilab aims to be one of the leaders in worldwide ILC design and engineering, with the goal of hosting the ILC at Fermilab. Fermilab will pursue the most vigorous possible program of ILC research and development, communication and community outreach toward that goal. Fermilab expects to play a key role even if the ILC is built offshore.

Neutrino science opens another window on the key questions of particle physics. Fermilab will continue to build on the laboratory's world-class neutrino program by constructing the NOνA experiment, a more powerful successor to MINOS, to begin operating in 2011.

* If the ILC remains near the timeline proposed by the Global Design Effort, Fermilab will focus on the above programs.
* If the ILC departs from the GDE-proposed timeline, in addition Fermilab should pursue neutrino-science and precision-physics opportunities by upgrading the proton accelerator complex.
  + If the ILC start must wait for a couple of years, the laboratory should undertake the SNuMI project.
  + If the ILC postponement would accommodate an interim major project, the laboratory should undertake Project X for its science capability and ILC alignment.
* If the ILC is constructed offshore, in addition Fermilab should pursue neutrino-science and precision-physics opportunities by upgrading current proton facilities while supporting the ILC as the highest priority.
  + The laboratory should undertake SNuMI at a minimum.
  + Alternatively, the laboratory should undertake Project X if resources are available and ILC timing permits.

If the ILC is delayed, the Steering Group's plan keeps Fermilab and U.S. particle physics on the pathway to discovery in the domain of neutrinos and precision physics, while advancing the technology of the ILC for the energy frontier. If ILC construction must wait, the plan proposes SNuMI, an upgrade of the current NuMI, to pursue neutrino science with a more powerful neutrino beam. If the ILC start is postponed significantly, the Steering Group proposes Project X, an intense proton-beam facility: a linear accelerator with the planned characteristics of the ILC at about one percent of the ILC's length, combined with existing Fermilab accelerator rings.

Project X at Fermilab would make possible a broad range of intensity-frontier experiments to pursue the fundamental questions of particle physics via the pathways of neutrino science and precision physics. The potential depth and diversity of such an experimental program make the Steering Group's plan both flexible and scientifically compelling. While the plan proposes the outline of a world-class neutrino science and precision physics program at Fermilab, each experiment would be judged on its physics merits at the appropriate time through the laboratory and HEPAP advisory process. Besides providing unique opportunities for discovery, Project X would align with the development of the ILC. Its ILC-based technology would spur U.S. industrialization and reduce costs while creating a system test for key ILC components.

* In all scenarios,
  + R&D support for Project X should be started now, with emphasis on
    - expediting R&D and industrialization of ILC cavities and cryomodules,
    - overall design of Project X.
  + R&D for future accelerator options concentrating on a neutrino factory and a muon collider should be increased.
  + The laboratory should support detector R&D and test-beam efforts for effective use of future facilities.

To prepare for a future decision, the Steering Group recommends that Fermilab immediately seek R&D support for Project X in order to develop an overall design. Project X could create a pathway toward a neutrino factory to produce the intense neutrino beams that would be needed for neutrino-oscillation and CP-violation experiments in case sin22θ13 is extremely small. A neutrino factory could also be a crucial step along the way to regaining the energy frontier in the U.S. by way of a muon collider, relying upon Project X as a muon source, followed by muon cooling.

**Summary**

The LHC and the ILC have the highest priority in the Steering Group's plan. In the event of a delay in the timeline for the ILC, an intense proton-beam facility such as Project X would offer a world-class experimental program in the U.S. and support the effort to host the ILC in the U.S. A physics program with an intense proton source offers strong opportunities for discovery, following alternate pathways to those offered by the LHC and the ILC for answering Quantum Universe questions. Its experiments would serve many scientific users and educate future generations of U.S. particle physicists. Project X would align with the early phases of muon-collider development, starting the field on the path to the energy frontier beyond the ILC. The potential breadth, depth, scale and diversity of the science program, its supporting role for the ILC and its implications for future energy-frontier accelerators make the Steering Group plan flexible, robust and scientifically compelling.