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Neutrino Program at Fermilab - Enhancing proton beam power and accelerator infrastructure

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The upcoming long baseline neutrino experiments aim to enhance proton beam power to multi-MW scale and utilize large-scale detectors to address the challenge of limited event statistics. The DUNE experiment at LBNF will test the three neutrino flavor paradigm and directly search for CP violation by studying oscillation signatures in the high intensity ν_μ (anti-ν_μ) beam to ν_e (anti-ν_e) measured over a long baseline.
Higher beam power and improved accelerator up-time will enhance neutrino flux for the neutrino program by increasing the number of protons on target. LBNF/DUNE, as well as PIP-II upgrade and Accelerator Complex Evolution (ACE) plan, play a vital role in this effort. The scientific potential of ACE plan extends beyond neutrino physics, encompassing endeavors such as the Muon Collider, Charged Lepton Flavor Violation (CLFV), Dark Sectors, and exploration of neutrinos beyond DUNE.\par
In the era of higher-power accelerator operation, research in target materials and beam instrumentation is crucial for optimizing design modifications.
This abstract discusses Fermilab ACE, the science opportunities it provides, and how Fermilab is pushing the limits of proton beam power and accelerator infrastructure. By tackling neutrino beam challenges and exploring research and development ideas, we are advancing our understanding of fundamental particles and their interactions.

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