U.S. DEPARTMENT OF ENERGY

OFFICE OF SCIENCE

DOE Office of High Energy Physics Perspective on DUSEL

NRC Committee to Assess the DUSEL
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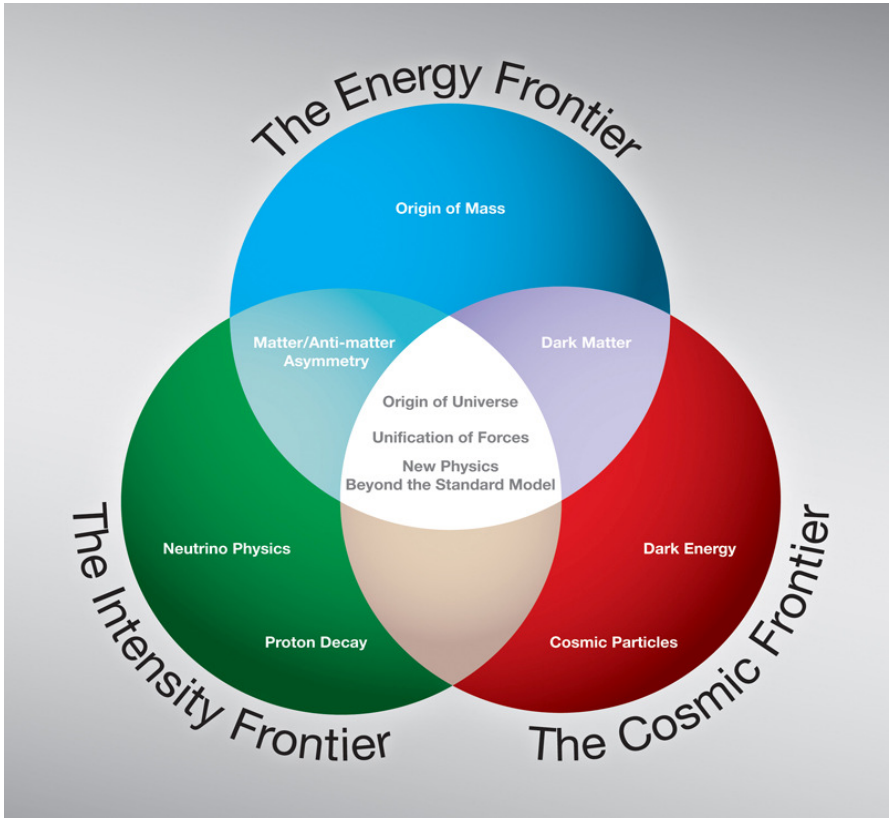
Particle Physics Today
Three Scientific Frontiers

- **The Energy Frontier, using high-energy colliders to discover new particles and directly probe the architecture of the fundamental forces.**

- **● The Intensity Frontier, using intense particle beams to uncover properties of neutrinos and observe rare processes that will tell us about new physics beyond the Standard Model.**

- **● The Cosmic Frontier, using underground experiments and telescopes, both ground and space based, to reveal the natures of dark matter and dark energy and using high-energy particles from space to probe new phenomena.**



Program Planning

The Scientific community

- **Identifies the scientific opportunities and their priorities**
- **Defines the scientific field and recommends future direction**

Federal Advisory Committees

- **DOE/NSF chartered High Energy Physics Advisory Panel (HEPAP) Reports**
- **Astronomy and Astrophysics Advisory Committee (AAAC)**

Other Input

- **Other scientific reports (National Academy studies, etc.)**
- **Lab program advisory committees, DOE Reviews, etc.**

DOE SC HEP's Strategic Plan

The DOE SC High Energy Physics Strategic Plan:

- Addresses the scientific opportunities identified and priorities recommended by the community
- Builds on existing strengths and infrastructure
- Exploits opportunities in which the U.S. HEP can play leadership roles
- Positions U.S. to deliver outstanding science, remain among the leaders, and maintain core competencies

The major elements of DOE's plan are to:

- Exploit the capabilities of the Tevatron and LHC at the **Energy Frontier** to make discoveries
- Implement a world-class **Intensity Frontier** program at Fermilab
- Address compelling high-impact scientific opportunities at the **Cosmic Frontier**
- Develop accelerator technologies needed by Nation and for a U.S. leadership role in particle physics

The implementation of the plan has to evolve and react to:

- Changing circumstances
- Additional information and guidance
- Funding constraints

DOE HEP Strategic Plan

HEPAP (P5) Findings and Recommendations

Progress in achieving the goals of particle physics requires advancements at the

- **Energy, Intensity** and **Cosmic Frontiers**
- Each provides a unique window for insight about the fundamental forces and particles of nature
- **The U.S. should have a strong, integrated research program at all three frontiers**

Energy Frontier

- Continued support for the Tevatron Collider program until LHC operating (next 1-2 years)
- LHC program has the highest priority, including US involvement in planned upgrades
- Accelerator and detector R&D program for next generation lepton collider

Intensity Frontier

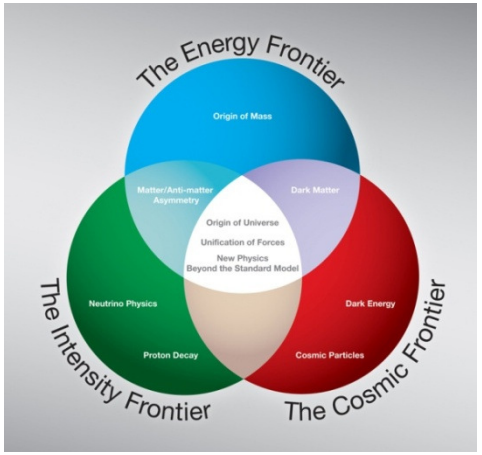
- Recommends a world class neutrino program as a core component
- Long term vision includes a large detector at DUSEL and high-intensity neutrino source at Fermilab.
- Program of rare decays (e.g.: muon to electron conversion – Mu2e)

Cosmic Frontier with an emphasis on dark energy and matter

- Joint Dark Energy Mission (JDEM) in collaboration with NASA
- Large Synoptic Survey Telescope (LSST) in collaboration with NSF
- Direct dark matter search experiments

HEP at its core is an accelerator based experimental science

- Support accelerator R&D to develop technologies
  - that are needed by the field
  - that benefit the nation



HEPAP (P5) Report

The Intensity Frontier

- Recent striking discoveries make the study of the properties of neutrinos a vitally important area of research.
- Measurements of the properties of neutrinos are fundamental to understanding physics beyond the Standard Model and have profound consequences for the evolution of the universe.
- The latest developments in accelerator and detector technology make possible promising new scientific opportunities in neutrino science as well as in experiments to measure rare processes.
- The US can build on the unique capabilities and infrastructure at Fermilab, together with DUSEL, the Deep Underground Science and Engineering Laboratory proposed for the Homestake Mine in South Dakota, to develop a world-leading program of neutrino science.

- Such a program will require a multi-megawatt-powered neutrino source at Fermilab.
- The panel recommends a world-class neutrino program as a core component of the US program, with the long-term vision of a large detector in the proposed DUSEL and a high-intensity neutrino source at Fermilab.

HEPAP (P5) Report (continued)

The Intensity Frontier

- The panel recommends an R&D program in the immediate future to design a multi-megawatt proton source at Fermilab and a neutrino beamline to DUSEL and recommends carrying out R&D on the technologies for a large multi-purpose neutrino and proton decay detector.

- Construction of these facilities could start within the 10-year period considered by this report.
- A neutrino program with a multi-megawatt proton source would be a stepping stone toward a future neutrino source, such as a neutrino factory based on a muon storage ring, if the science eventually requires a more powerful neutrino source.
- This in turn could position the US program to develop a muon collider as a long-term means to return to the energy frontier in the US. The proposed DUSEL is key to the vision for the neutrino program.

- It is also central to non accelerator experiments searching for dark matter, proton decay and neutrinoless double beta decay. DOE and NSF should define clearly the stewardship responsibilities for such a program.

Intensity Frontier

- **Envisioned "world-class" intensity frontier program entails evolution of Fermilab program**
  - MINOS/Minerva → NOvA (700kW) → LBNE (700kW) → SLBNE (2000 kW)
  - Accelerator infrastructure allow: SLBNE → neutrino factory → muon collidier

- **A "world-class" intensity frontier program also entails development of an underground detector**
  - LBNE need a large underground detector (~100-300 ktons)
  - A large detector (~300 kton) at the right depth (~5000 ft) detector can also do proton decay
  - Physics goals: searches for CP violation and proton decay at factors of 10-100 greater sensitivity

- **Goals are ambitious and will take significant combined (DOE, NSF, other countries) resources**
  - NSF has proposied a DUSEL that includes a large detector (for neutrino oscillations and proton decay)
  - Europeans have a large underground detector in their strategic planning
  - Japanese are also interested in the science

- **DOE and NSF have had discussions with OMB and OSTP on how to coordinate planning**
  - NSF has supported the conceptual design of the DUSEL facility and a suite of experiments
  - DOE HEP has obtained Mission Need (CD-0) approval for the Long Baseline Neutrino Detector (LBNE)
  - DOE/NSF has worked together o coordinate efforts, avoid duplication, and optimize investments
  - A Joint Statement of support was issued by DOE (Koonin) and NSF (Bement)

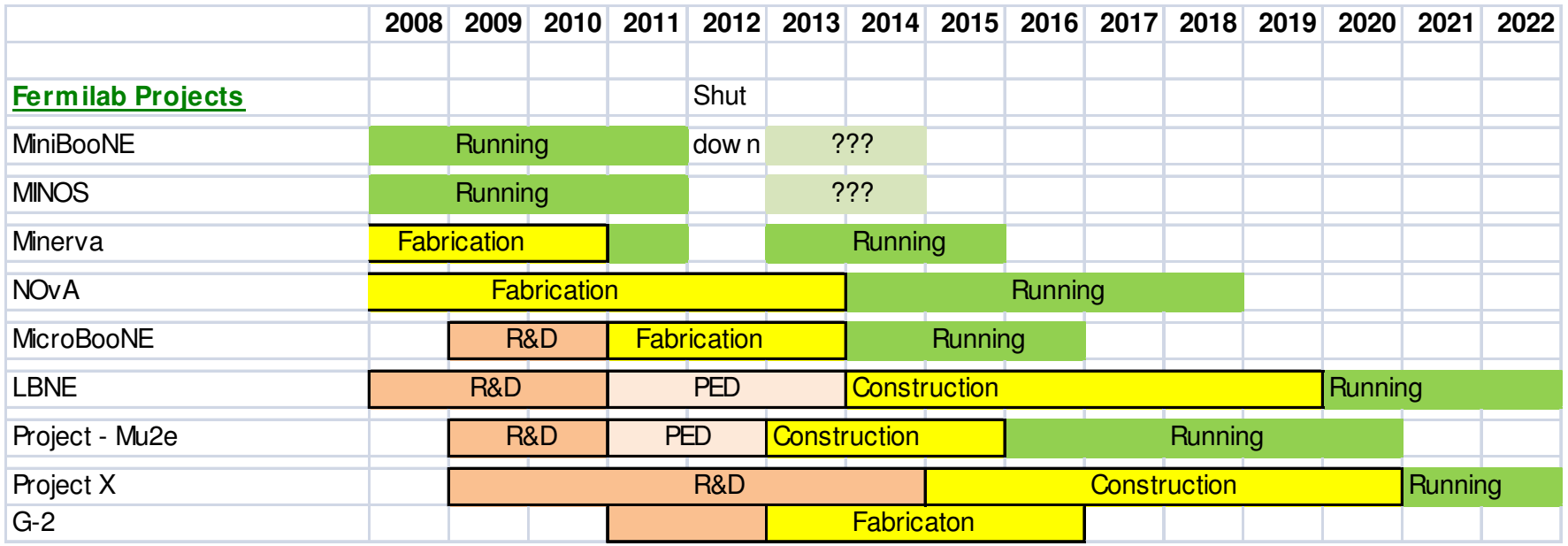
Intensity Frontier

Implementation started at Fermilab

DOE's Neutrino/Rare Decay Program at Fermilab

- **MiniBooNE, MINOS, and MINERVA are taking data**
- **MicroBooNE (Mission Need approved) will soon be in fabrication**
- **Mu2e (Mission Need approved) and Project Engineering and Design (PED) in FY 2011**
- **LBNE (Mission Need approved) and Project Engineering and Design (PED) in FY 2011**
- **Neutrino Source Upgrade (Project X) R&D and pre-conceptual design supported – hope to have CD-0 soon**
- **Muon Anomalous Magnetic Moment (G-2) - reviewed strongly**

Planned/envisioned construction/running schedules



Scientific Frontiers

DOE SC HEP Roadmap