



U.S. DEPARTMENT OF
ENERGY

Office of Science

Report from the Office of High Energy Physics

DUSEL Workshop

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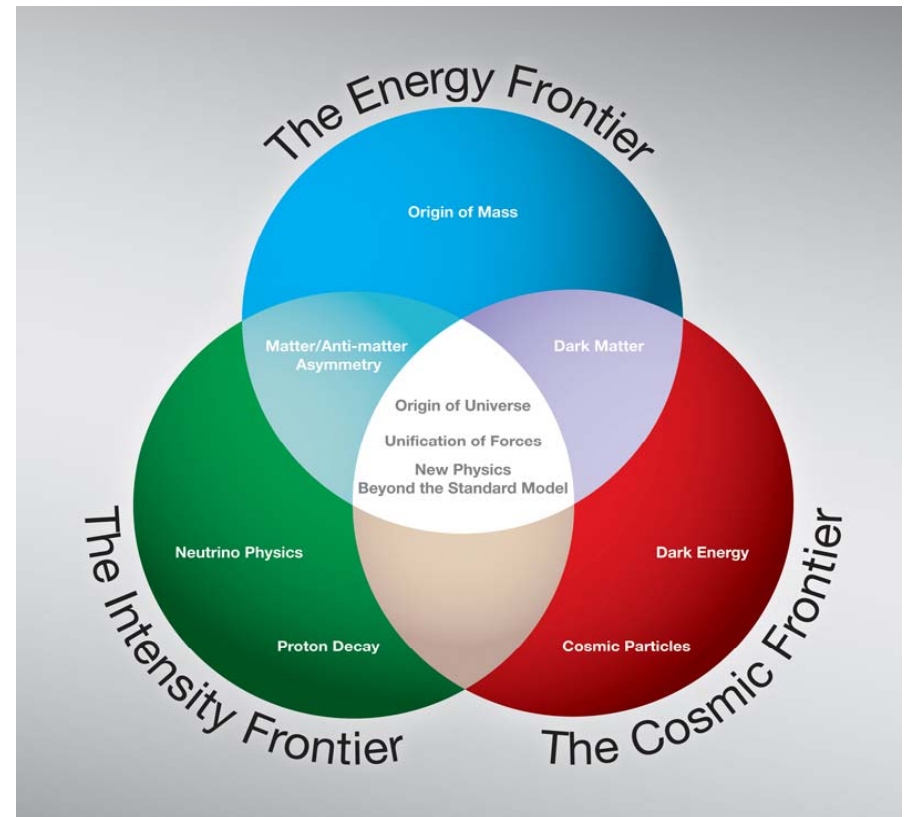
OHEP Activities Related to DUSEL

- **Following the P5 Roadmap**
- **Intensity Frontier**
- **Cosmic Frontier**
- **Nuclear Physics**

Particle Physics Today

Three Scientific Frontiers

- ***The Energy Frontier***, powerful accelerators are used to create new particles, reveal their interactions, and investigate fundamental forces;
- ***The Intensity Frontier***, intense particle beams and highly sensitive detectors are used to pursue alternate pathways to investigate fundamental forces and particle interactions by studying events that occur rarely in nature; and
- ***The Cosmic Frontier***, ground and space-based experiments and telescopes are used to make measurements that will offer new insight and information about the nature of dark matter and dark energy, to understand fundamental particle properties and discover new phenomena.

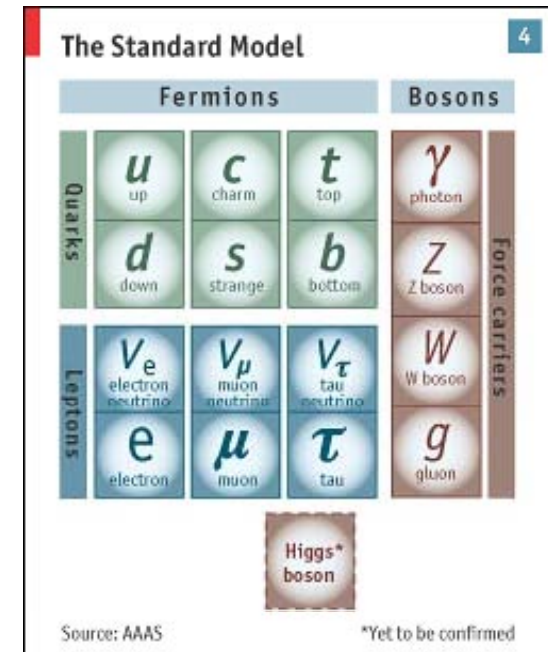




Particle Physics at an exciting period today

What has been presented to DOE, OMB, etc

- **Studies over the last decade and recent discoveries have revealed the Standard Model of particle physics to be highly successful, but incomplete -- the model**
 - Does not predict all the properties of the known particles
 - Fails at extremely high energies
 - Describes only a small fraction of the matter and energy filling the universe



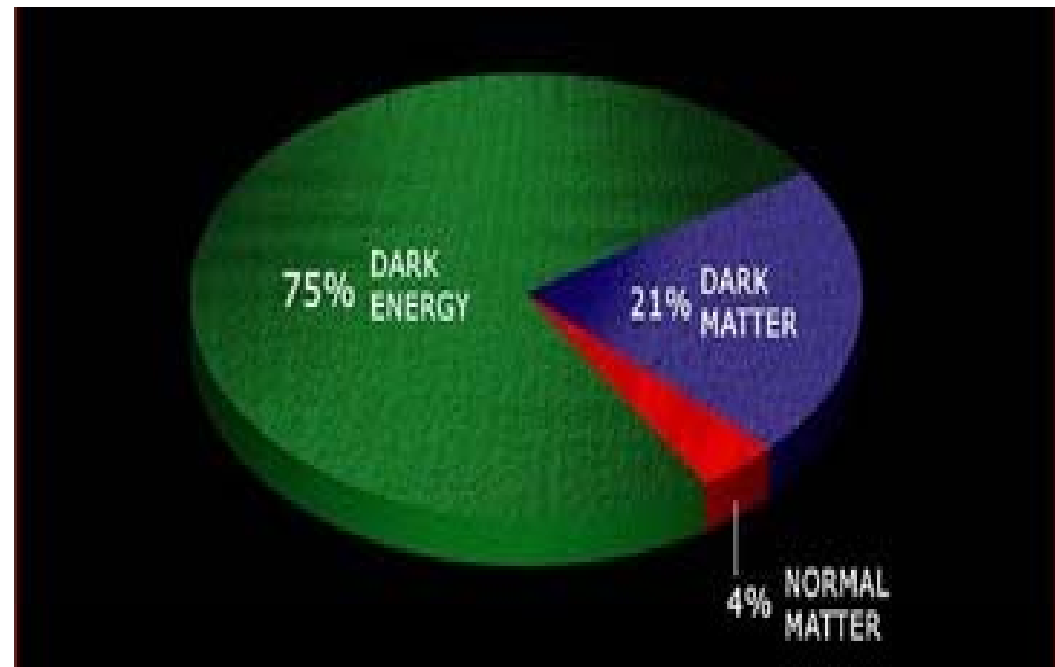
The field is on the verge of significant discoveries and probably paradigm changes but needs critical experimental results and observations!

- The Standard Model will break at $O(1 \text{ TeV})$...but how?
- Measuring the small neutrino mixing angle will determine how rich this sector is: can we see CP Violation in leptons?
- Dark matter just "around the corner" of direct detection?
- The elephant in the room: Dark Energy. What is it?



- **Additional results will be needed**
 - Requires results from all three scientific frontiers
 - Requires significant resources
 - International / interagency
 - Coordination / collaboration

- **The U.S. needs to play a part in these discoveries!**





Planning Investments at All Three Frontiers

- **Energy Frontier**
 - LHC accelerator upgrades
 - LHC detector upgrades
- **Intensity Frontier**
 - MINERvA & NOvA
 - **Long Baseline Neutrino Experiment**
 - Mu2e
 - Project X
- **Cosmic Frontier**
 - DES
 - **Dark matter experiments**
 - JDEM/LSST

Intensity Frontier Plans

- **MiniBoone and MINOS are running.**
- **MINERvA and NOvA are under construction.**
- **OHEP is pursuing CD-0s for MicroBoone, LBNE, and Mu2e.**
 - **The larger the project the higher up in DOE it goes for approval.**
 - **More preparation required.**
 - **LBNE requires coordination with NSF.**
- **Project X is still in the R&D phase.**



Long Baseline Neutrino Experiment (LBNE)

- OHEP is seeking approval from the Department for approval of Mission Need (CD-0) for the LBNE project. The project includes both a neutrino beam and a large detector.
- OHEP has identified FNAL, working with BNL as lead on the detector, to take responsibility for performing the work needed for approval of CD-1 (Exploration of Alternatives). This includes conceptual design, alternatives analysis, etc.
- We have received a “work plan” to reach CD-1 from FNAL/BNL.
 - Will take 12-18 months to carry the work.
 - Will cost \$25-30 million.
 - With the approval of CD-0, DOE R&D funds will be made available to support this work, which is expected to involve participants from laboratories and universities.
 - There are \$15 million of ARRA funds available to support this.
- As recommended by P5 we are working with NSF to coordinate LBNE and DUSEL efforts.

New Leadership

DEPARTMENT OF ENERGY

Approving Official



Reviewing Office

Had to wait for new senior management to be confirmed

* The Deputy Secretary also serves as the Chief Operating Officer

Cosmic Frontier

- **National Academy of Science's Astronomy and Astrophysics Decadal Survey (Astro2010)**
 - **Major planning activity for NASA and NSF astronomy.**
 - **Doe is participating.**
 - **Town Hall meeting at APS in Denver**
 - **Over 200 proposals for projects were submitted to the Program Prioritization Panels – some will be asked to present at their meeting in early June.**
 - **http://sites.nationalacademies.org/bpa/BPA_049810**

- **Particle Astrophysics Scientific Assessment Committee (PASAG) also underway.**
 - **An effort to prioritize which astrophysics is most important to HEP.**
 - **Steve Ritz (chair) reported on the PASAG at the APS meeting.**
 - **Four subgroups have been formed and are holding regular phone calls.**
 - **Draft report by early August.**

Dark Matter

- We currently support three WIMP dark matter experiments CDMS, LUX, and COUPP which are or are expected to either detect evidence for dark matter or push down current upper bounds on WIMP cross sections with nuclear matter. We also support the axion search experiment ADMX.
- We are waiting on the advice of PASAG with regard to the appropriate DOE level of funding for direct dark matter experiments. With more funding directed to direct dark matter detection searches, DOE would be likely to support at least one other promising intermediate scale noble gas dark matter experiment. In the absence of a signal, these experiments sort out the technologies which can be economically scaled to larger experiments with greater sensitivities.
- In the future, DOE expects to support at least two large scale direct dark matter experiments with different target nuclei. Choosing the experiments will likely depend on the advice of advisory committees (which may include a DMSAG in 2010 or 2011).

Nuclear Science and Underground Experiments

Historical Perspective--

▪ Ray Davis' chlorine experiment in the Homestake Mine

"Neutrinos are fascinating particles, so tiny and fast that they can pass straight through everything, even the earth itself, without even slowing down," said Davis at the time of his Nobel award. "When I began my work, I was intrigued by the idea of learning something new. The interesting thing about doing new experiments is that you never know what the answer is going to be!"

In research that spanned from 1967-1985, Davis consistently found only one-third of the neutrinos that standard theories predicted. His results threw the field of astrophysics into an uproar, and, for nearly three decades, physicists tried to resolve the so-called "solar neutrino puzzle".

From the BNL website



Davis with his chlorine solar neutrino experiment at the 4800 foot level in Homestake Mine (~1968).

- **Nuclear physicists and chemists involved in underground experiments around the world to elucidate the physics of solar, atmospheric, and reactor neutrinos**
 - Radiochemical experiments: Gallex, SAGE, GNO...
 - Real time detectors: Super-K, SNO, KamLAND, Borexino...
- **The next generation of neutrino experiments**
 - The nature of the neutrino and its mass: CUORE, Majorana, and others...



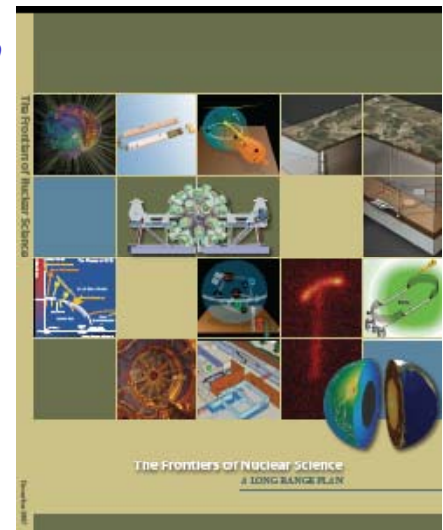
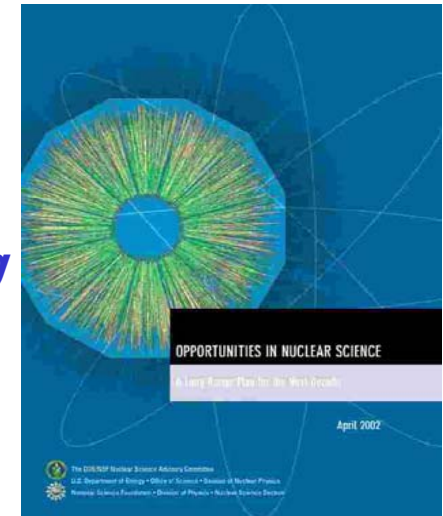
DOE/NSF Nuclear Science Advisory Committee Strategic Planning

- **2002 NSAC Long Range Plan:**

"We strongly recommend immediate construction of the world's deepest underground science laboratory. This laboratory will provide a compelling opportunity for nuclear scientists to explore fundamental questions in neutrino physics and astrophysics."

- **2007 NSAC Long Range Plan:**

"We recommend a targeted program of experiments to investigate neutrino properties and fundamental symmetries. These experiments aim to discover the nature of the neutrino, yet-unseen violations of time-reversal, and other key ingredients of the New Standard model of fundamental interactions. Construction of a Deep Underground Science and Engineering Laboratory is vital to U.S. leadership in core aspects of this initiative."



Nuclear Science at DUSEL

- **DUSEL represents a compelling opportunity for neutrino research supported by the Office of Nuclear Physics**
 - The DUSEL facility and research at DUSEL are recommended by the nuclear science community
 - NSAC and HEPAP formed the Neutrino Scientific Assessment Group (NuSAG) in 2005
 - **Resulted in three reports on different aspects of neutrino science**
 - <http://www.sc.doe.gov/np/nsac/nsac.html>
 - **Neutrino-less Double Beta Decay (DBD) Experiment, Approve Mission Need (CD-0), joint with HEP in November 2005**
 - NP has supported DUSEL R&D with NSF and HEP since 2007
 - **Effort supported by NP has been directed toward a Ge-based DBD experiment at a deep underground site**
 - NP is supporting planning and R&D on DBD in the base program at universities and laboratories
 - NP is planning a review of the Majorana Demonstrator R&D project in the Fall 2009
 - **A successful demonstration of DBD technology with ^{76}Ge may lead to a forefront international experiment at DUSEL, dependent on funding**

- Other nuclear science research at DUSEL could be of interest in the future

OHEP Positions

- **Research and Technology Division (to be advertised shortly)**
 - Theory Program Manager
 - Non-Accelerator Program Manager
 - Interdisciplinary Computer Scientist/Physicist (Computational HEP)
 - Administrative Support Specialist (Position open to internal DOE candidates)
 - Program Analyst (Position open to internal SC candidates)

- **Facilities Division**
 - Interdisciplinary General Engineer/Physicist
 - (Instrumentation and Major Systems)
 - FNAL Program Manager