

# Notes on DUSEL

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DUSEL Site Visits  
27-31 March 2006

# Conclusions from Advisory Panels

- NSAC, Mar 2001:
  - “*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.”
- HEPAP Long Range Plan, Jan 2002:
  - “We believe that experiments requiring very deep underground sites will make important contributions to particle physics for at least the next 20 years, and should be supported by the high-energy physics community. *Particle physics would benefit from the creation of a national underground facility.*”

# Conclusions from Advisory Panels

- National Research Council Committee on Physics of the Universe, 2003:
  - “Recommendation: Determine the neutrino masses, the constituents of dark matter, and the lifetime of the proton. *The committee recommends that the DOE and NSF work together to plan for and fund a new generation of experiments to achieve these goals. It further recommends that an underground laboratory with sufficient infrastructure and depth be built to house and operate the needed experiments.*”
- National Research Council Neutrino Facilities Assessment Committee, 2003:
  - “A deep underground laboratory can house a generation of experiments that will advance our understanding of the fundamental properties of neutrinos and the forces that govern elementary particles, as well as shedding light on the nature of the dark matter that holds the Universe together. *Recent discoveries about neutrinos, new ideas and technology, and the scientific leadership that exists in the U.S., make the time ripe to build such a unique facility.*”

# Conclusions from Advisory Panels

- Quantum Universe – The Revolution in 21<sup>st</sup> Century Particle Physics, 2004
  - NSF-DOE HEPAP Sub-Panel Report identifies key science drivers, identifies need for DUSEL to address key questions

# DUSEL Scientific Program

- Multidisciplinary, diverse suite of experiments:
- Neutrino physics
  - Neutrino-less double beta decay
  - Solar neutrinos
  - Other neutrino mixing angles, CP violation
  - Nuclear astrophysics
- Dark matter searches
- Matter stability
  - Proton decay
- Supernovae neutrino observatory
- Life at depth
  - Study of subsurface biosphere: isolated underground life forms, life forms at high temperature, etc.
- Fluid flow and transport at depth
  - Applications include stability of water supplies, hazardous waste disposal, remediation of contaminated groundwater.

# DUSEL Scientific Program

- Rock formation at depth
  - Seismic transmission, etc.
- Mineral resources and environmental geochemistry
- Science, technology and engineering innovation
  - Novel microorganisms, analytic techniques for geomicrobiology, drilling and excavation technology, environmental remediation, subsurface imaging, ...
  - Create pure crystals without cosmic ray induced “impurities”
  - Creating very large stopes
- Homeland security
  - Very low level counting facility, experiments

# DUSEL Scientific Program

- Broad, rich scientific program, potentially strong program for education, outreach
- Excellent match to the NSF mission
- Offers opportunity for growth, diversity during very hard time in science, particle physics
- All involved are creating something quite new and unique not only to the NSF, but in the US:
  - New, multi-purpose national laboratory that will serve variety of scientific communities over many decades
  - Such new initiatives require new approaches, are intrinsically challenging
- Size, scope of DUSEL suggest a phased approach

# Some Important Attributes of a DUSEL

- Depth
  - Dark matter, double-beta, solar, mega-detector all suggest min  $\sim 4500$  mwe
  - More depth as experimental sensitivity increases
- Detector Halls
  - Capability to customize underground space, experimental areas
- The capacity to accommodate a mega-detector at appropriate depth
  - Excavation, integrity of rock, etc.
- Cleanliness
  - Natural underground radiation backgrounds, clean facilities, etc.
- Importance of round-the-clock access
- Safety, special materials, and materials handling
- Environmental assessments, considerations
- Access for large and heavy equipment
- Quietness and stability: electrical, mechanical, seismic
- Adequate support facilities and strong scientific environment
- Baseline for high intensity neutrino beam, CP violation
  - 1000 – 3000 km
- Education and outreach

# NSF/DOE Partnership

- Future health of science in US will require interagency collaboration
  - Tightening budgets
  - Magnitude of relevant projects
  - Increasing move to consolidate US programs
  - Growing interdisciplinary nature of relevant scientific questions
  - Questions being addressed remain deep, fundamental, but arguably narrower in scope
- Makes it possible for agencies to accomplish together what neither could alone
- Successful paradigm has been established with LHC JOG in HEP
- Other successes will provide crucial foundation, roadmap for future U.S.-based initiatives
- Attempting to establish this from outset with DUSEL

# DOE/NSF DUSEL Working Group

- Division/Office representatives:
  - R. Boyd, NSF, Division of Physics (Nuclear Astrophysics)
  - R. Fragaszy, NSF, Division of Civil & Mechanical Systems (Engineering)
  - G. Henry, DOE, Office of Nuclear Physics (Nuclear Physics)
  - J. Kotcher, NSF, Division of Physics (Experimental Particle Physics)
  - D. Lambert, NSF, Division of Earth Sciences (Geosciences)
  - G. Crawford, DOE, Office of High Energy Physics (High Energy Physics)
  - N. Woodward, DOE, Office of Basic Energy Sciences (Geosciences)
- First discussion at DOE Germantown, 15 February 2006
- MoU being drafted that outlines initial agreement to participate in early DUSEL planning & process and interagency discussions
  - Goal is to ensure compatibility with planning needs of each of the agencies
  - Will grow in complexity as project, experimental plans mature
- Laboratory infrastructure responsibility of NSF, experiments will be joint DOE/NSF (+ foreign) initiatives.

# DUSEL Process

- Three-tier process, announced to community March 2004:
- Solicitation 1:
  - January 2005, \$400k award, Chair: B. Sadoulet
  - Site-independent science and engineering cases evaluated and endorsed
- Solicitation 2:
  - 15 September 2005: \$500k awards to PIs for Henderson (CO - Jung) and Homestake (SD - Lesko)
  - Proponents developing site-specific conceptual designs. Will detail:
    - How the site will accommodate the science and engineering objectives;
    - Management and organizational plan for construction and operations;
    - Geologic, environmental, permitting and safety issues;
    - Risk analysis and mitigation;
    - Initial scientific program and timeline;
    - Engineering needs for accommodation of longer-term scientific program.
  - Submission of CDRs due to NSF June 23, 2006
  - Target: down-select in summer/fall 2006.

# DUSEL Process

- Solicitation 3:
  - Develop site-specific technical design, cost, schedule for construction of DUSEL infrastructure, and initial suite of experiments
  - Evaluate proposal(s) ~ fall 2006
  - Award amount(s) under discussion – at least few \$M, Fall 2006
- Process could result in construction start in FY09

# Draft P5 Charge

- Our current understanding of projects P5 will be considering:
  - Operations of existing facilities, consistent with your recommendations concerning the Tevatron and PEP-II
  - US contributions to LHC operations, computing, and upgrades
  - International Linear Collider R&D
  - The elements of a neutrino program under consideration by the Neutrino Scientific Assessment Group (NuSAG), including: neutrinoless double beta decay experiments, reactor experiments, off-axis detectors, and high intensity, long-baseline neutrino experiments.
  - Proton Driver, or other technique, by which high intensity neutrino beams will be delivered to a proposed experiment.
  - Deep Underground Science and Engineering Laboratory (DUSEL) and the associated scientific program, including accelerator- and non-accelerator-based experiments.
  - Next-generation dark matter experiments
  - Dark energy experiments
  - Other proposals (g-2, astroparticle experiments, flavor studies etc.)
- First P5 meeting in Washington, end March

# Potential FY07 DUSEL-related Funds

- The Physics Division is preparing to allocate up to \$6M for DUSEL in FY07, which will target:
  - Site-non-specific, DUSEL-related R&D
    - Competitive evaluation of proposals
  - Site-specific technical design after the down-select
- Funding level quoted above assumes allocations are commensurate with the FY07 request

# Preliminary topics for candidate DUSEL R&D projects

- Dark Matter Detection
- Neutrino-less Double Beta Decay
- Nuclear Astrophysics (accelerator based cross-section measurements)
- Geoneutrinos
- Solar and Supernovae Neutrinos
- Low Background Counting Facilities (LBCF) and Common Infrastructure
- Long Baseline Neutrinos and Proton Decay: Megaton Detectors

# Closing Remarks

- High priority of DUSEL within NSF has been reflected in presentations at March '06 HEPAP meeting Bement (NSF Director) and Dehmer
- Both, plus Staffin, emphasized the need for more interagency cooperation

# Closing Remarks

- “We respond to proposals.”
- NSF tries to facilitate scientific research as defined and expressed by the community
  - Scientific proposals are developed by the investigators
  - Community input sought at every step in decision-making process
- There must be community interest of sufficient depth, breadth and coherence in order to justify launching a project of this size, complexity, and cost, particularly in this climate.
- Such large initiatives demand a close, collaborative approach.