

Update on the Deep Underground Science & Engineering Laboratory (DUSEL)

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Nuclear Science Advisory Committee
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Outline

- Introduction
- Homestake site
- Status of Sanford Laboratory
- Recent community ten year plans: NSAC & P5
- Discussions with DOE
- Working models for project planning
- Closing remarks

Acronyms:

DOE = Department of Energy

HEPAP = High Energy Physics Advisory Panel

JOG = Joint Oversight Group

NSAC = Nuclear Science Advisory Committee

OHEP = DOE Office of High Energy Physics

ONP = DOE Office of Nuclear Physics

P5 = Particle Physics Project Prioritization Panel

DUSEL Overview

- DUSEL is an underground laboratory supporting unique science and engineering research.
- The primary motivation has been for fundamental physics research, exploiting the shielding from cosmic rays.
- DUSEL, if approved, would be the world-leading underground laboratory, resulting in transformational and innovative streams of research.



Fundamental Physics Questions Addressed by DUSEL

- We see only 4 percent of the mass of the universe; of what is the other 96 percent composed?
- Is visible matter stable?
- What are the mass and fundamental properties of the neutrino, and how can these inform our understanding of:
 - The matter/antimatter asymmetry in the universe?
 - The unification of the fundamental forces that govern physical laws?
 - Of what the universe is made; how the elements of the universe were created?
 - The origin and pattern of particle masses?
- What is the spectrum of neutrinos from supernovae and the Big Bang, and what can this tell us about the history and evolution of our universe?

DUSEL Physics Experiments

- The aforementioned questions are addressed at DUSEL via a variety of experimental probes:
 - Direct Detection of Dark Matter
 - Neutrino-less Double-Beta Decay
 - Nuclear Astrophysics
 - Accelerator-based cross-section measurements
 - Solar Neutrinos
 - Long Baseline Experiment, Proton Decay, and Supernovae Remnants (Mega-Detector)

DUSEL MREFC funding would support the construction of forefront experiments in nuclear- and astro-physics, and in particle physics using the Fermilab accelerator as a high intensity neutrino source.

Why DUSEL?

“A national underground laboratory offers the United States some vital scientific opportunities that will affect a number of important international efforts and provide a center in the United States for some of the most exciting physics at the beginning of the 21st century.”

- » From “Neutrinos and Beyond”
- » National Research Council Report, 2003

The community is now detailing the case.

Community Planning Activities & Reports

- Community Activities, Advisory Committee Reports
 - Bahcall report (2001)
 - Nuclear Science Advisory Committee (NSAC) Long-Range Plan (2002)
 - International Workshop on Neutrinos and Subterranean Science (NESS, 2002)
 - High Energy Physics Advisory Committee (HEPAP) Long-Range Plan (2003)
 - *EarthLab* (2003)
 - DOE 20-yr. Facility Plan (2003)
 - The Neutrino Matrix (Four APS Divisions, 2004)
 - Quantum Universe – The Revolution in 21st Century Particle Physics (2004)
 - *Deep Science* (2006)
 - The Frontiers of Nuclear Science: A Long Range Plan (2007), Nuclear Science Advisory Committee (NSAC).
 - Particle Physics Project Prioritization Panel (P5): A Strategic Plan for the Next Ten Years (2008)
- National Research Council, National Science and Technology Council Reports
 - Connecting Quarks to the Cosmos (2003)
 - Neutrinos and Beyond (2003)
 - Physics of the Universe – A Strategic Plan for Federal Research at the Intersection of Physics and Astronomy (2004)
 - Revealing the Hidden Nature of Space and Time (*EPP2010*, 2006)

DUSEL Solicitation Process

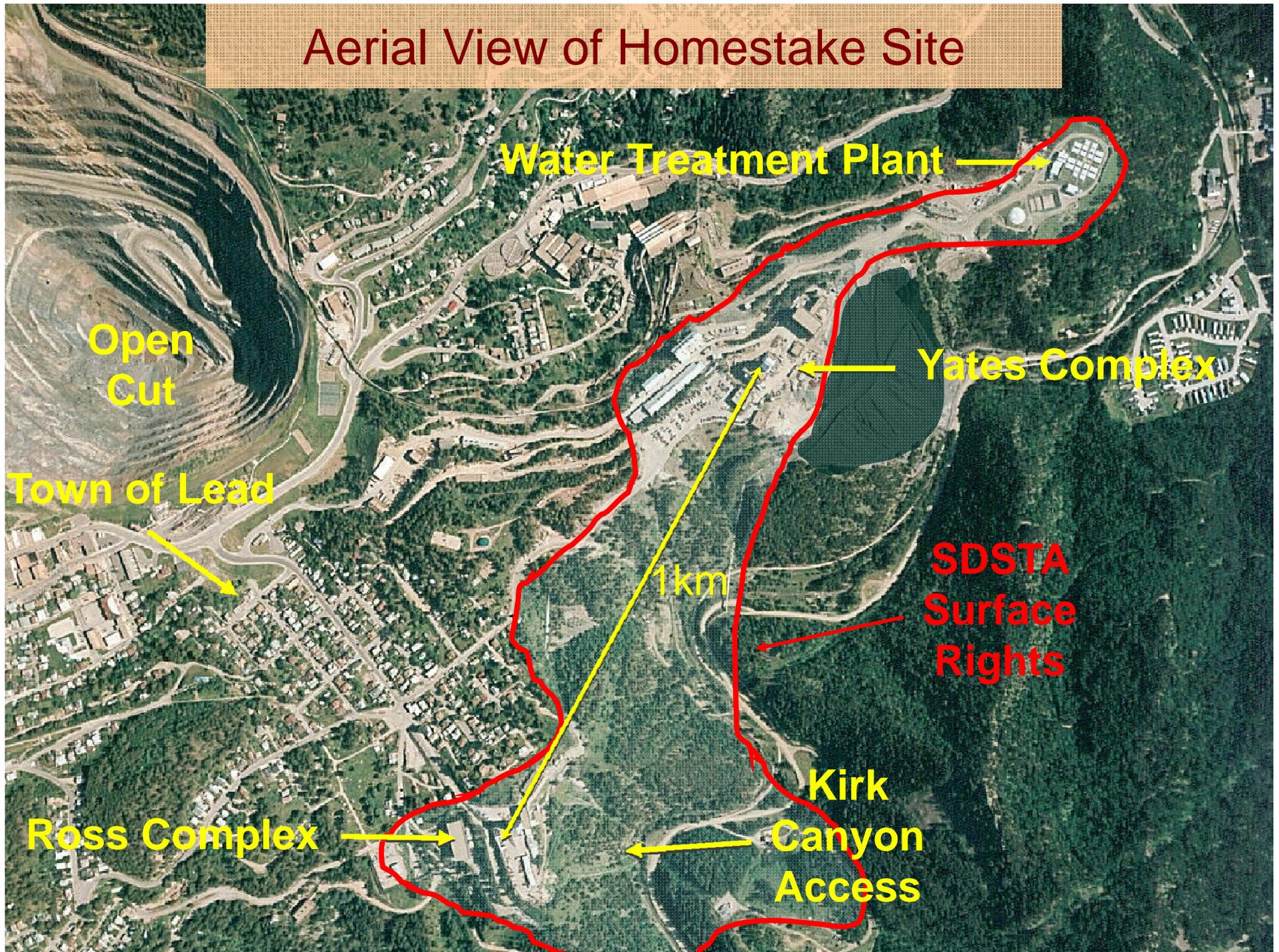
- Initiated at Town Meeting at NSF, March 2004.
- **Solicitation 1 (S1)**: define site-independent science scope and infrastructure needs; unify the community (awarded Jan 2005).
- **Solicitation 2 (S2)**: develop conceptual designs for one or more sites (two awarded, Sep 2005).
- **Solicitation 3 (S3)**: facility design for an MREFC candidate (one awarded – Homestake, U.C. Berkeley).
 - \$15M total over three years, starting in September 2007.
- **Solicitation 4 (S4, in clearance)**: technical designs for candidates for the DUSEL suite of experiments.
 - \$15M total over three years.

**S3 & S4 enable costs to be estimated
for infrastructure, experiments & operations.**

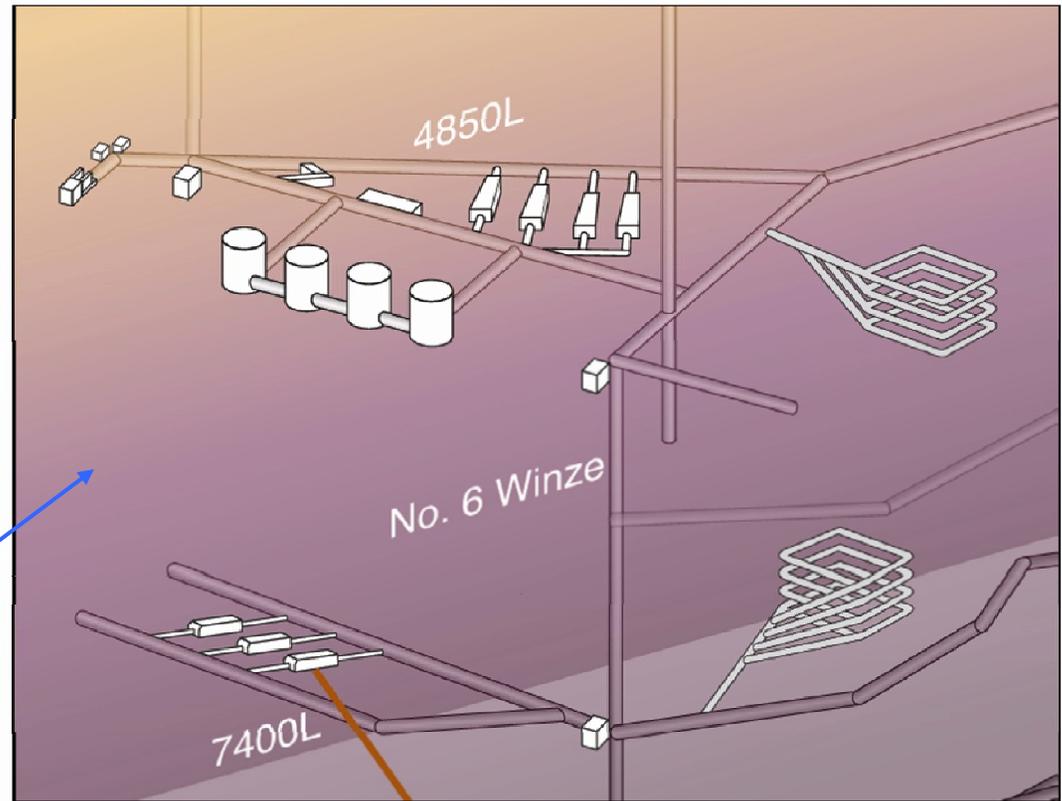
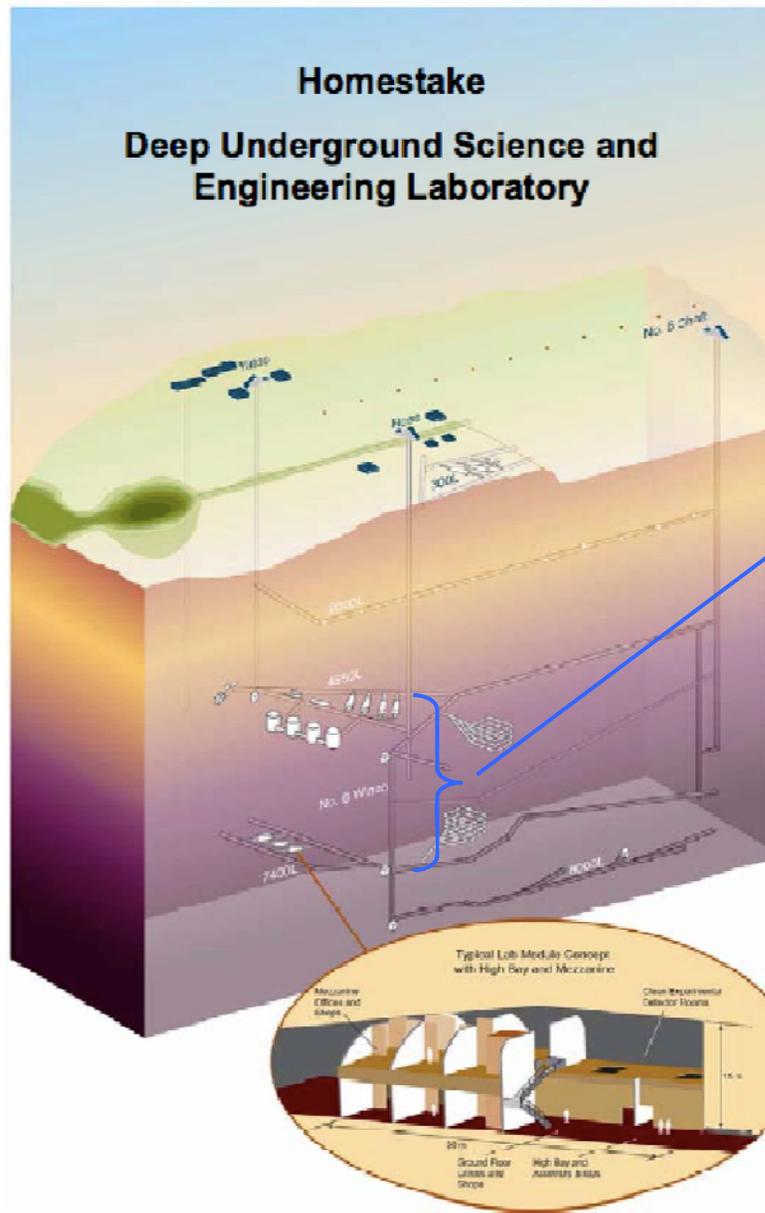
Solicitation 3: DUSEL Site Selection

- Goal was to select single site and team to develop technical design of facility.
- Four proposals were reviewed by multidisciplinary 22-member expert panel.
- Review included site visits & reverse site visits.
- Panel unanimously voted by secret ballot to recommend the Homestake proposal to the NSF for funding. NSF concurred.
- Cooperative agreement to University of California, Berkeley in Sep 07. Total award \$15M over 3 years.
- \$10M awarded in FY07 + FY08.

Aerial View of Homestake Site



An Illustrative DUSEL Laboratory Concept



- **Scope is being driven by needs of physics experiments, E&O at/near surface.**
- **Modular design being pursued will facilitate future scope adjustments.**

DUSEL Scope Considerations

- Only the most compelling, transformational experiments will be considered for DUSEL.
- This is one factor that will contribute to determining the overall DUSEL scope.
- Cost is another.
- DUSEL solicitation process provides funds to allow the community to estimate costs, including operations, up front.
- Allows NSF approval decisions, and potential scope adjustments, to be made in an informed manner.

Solicitation 4

- Solicitation 4 (S4): call for proposals to develop project plans for potential candidates for the DUSEL suite of experiments
- Design funds to address: what do you need to execute the experiment you propose?
- Up to \$15M total from Physics/MPS, spread over 3 years
- In clearance; under review by NSF upper management.

Comments on S4 Review Criteria

- In addition to the NSB-approved criteria of Intellectual Merit and Broader Impacts, some general DUSEL-specific criteria under consideration for evaluation of S4 proposals:
- Compatibility with the envisioned DUSEL science & engineering program
 - Cogency, world-class nature of the research
 - Need for unique DUSEL characteristics and environment
- Appropriateness for inclusion in the envisioned facility & expt'l suite
 - Depth, infrastructure requirements; anticipated cost/schedule; safety, environmental, security, or related concerns; physical access requirements; etc.
- Potential for developing a complete, realistic Preliminary Design for a world-class research project matched to DUSEL mission, capabilities
 - Includes strength of team, commitment by performing institutions, broader impacts, etc.

DUSEL Experiment Development Committee

- S1 Panel passed the baton for continuing the definition & development of experiments to DEDC
- DEDC will coordinate the development of the superset of candidate experiments & project plans
 - Steve Elliott, LANL – Nuclear Physics
 - Derek Elsworth, Penn State – Engineering
 - Daniela Leitner, LBNL – Nuclear Astrophysics
 - Larry Murdoch, Clemson – Geology
 - T.C. Onstott, Princeton – Biology
 - Hank Sobel, UC Irvine – Particle Physics

Status of Sanford Laboratory

- SDSTA holds \$124M for development of Sanford Laboratory.
 - \$70M private benefactor (Sanford), \$44M state SD, \$10M HUD.
- Will fund:
 - Education center.
 - Refurbishment of 4850L & 7400L (partial).
 - O&M of Sanford Laboratory activities.
- Initial allotment (\$60M) released, in use.
 - Release of these and remaining funds is conditional.
- Key staffing underway, including Laboratory Director.
- SDSTA began mine re-entry late July 2007.
 - Dewatering began 21 April 2008.
- Access to 4850L scheduled February 2009.
- Decoupled from MREFC process, but integrated into DUSEL facility planning.

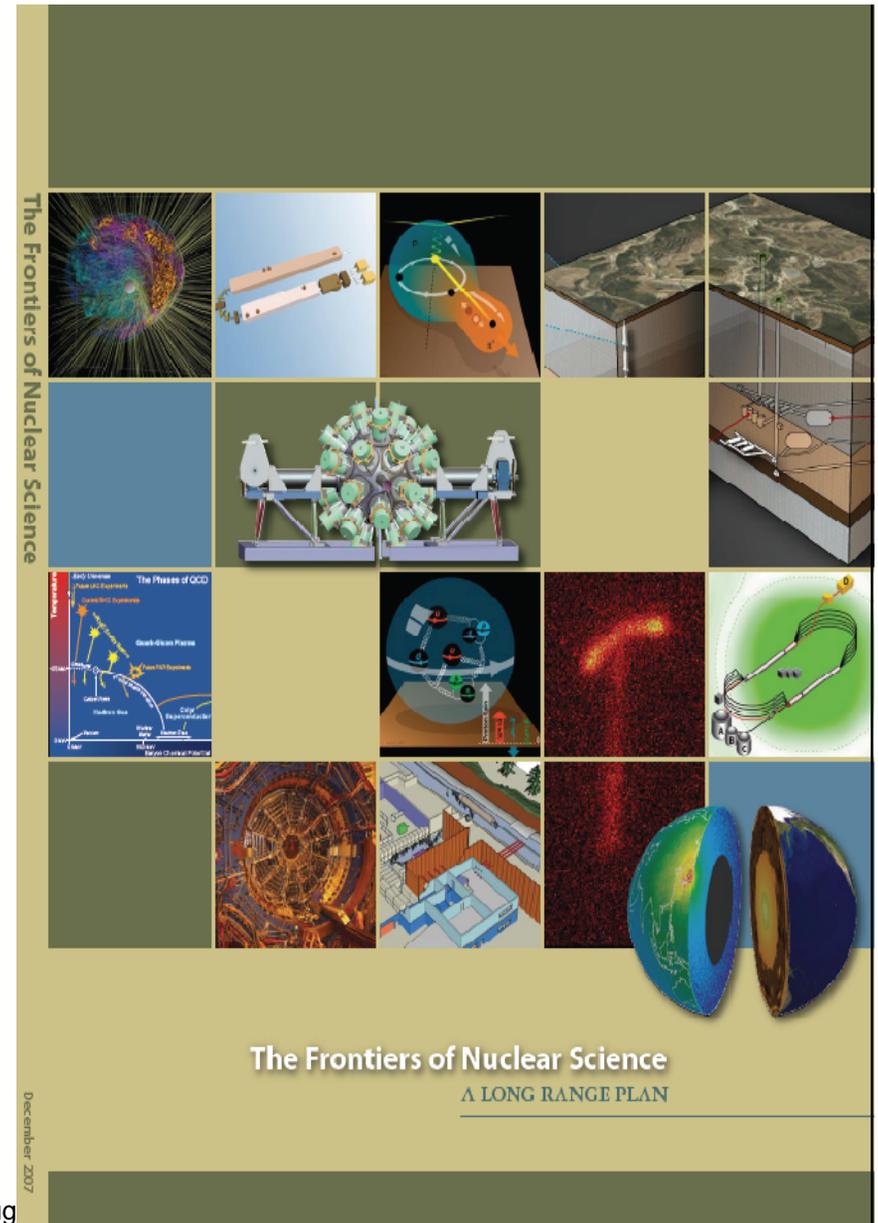
DUSEL Events

- 13 September 2007, Town Meeting in Rapid City, SD
 - Organized by Senator Thune
 - Attended by Senator Johnson's office (ill), Representative Herseth Sandlin, SD Governor Rounds' office, MPS AD (Chan)
 - Also state senators, Governor's office, Board of Regents, university presidents, local business people, other stakeholders
- 2 November 2007, DUSEL Town Meeting, National Academy of Sciences, Washington, D.C.
 - Attended by Thune, Herseth Sandlin, Johnson's office, Governor Rounds
 - NSF, DOE and science communities
- 3-4 November 2007, DUSEL Community Workshop, Washington, D.C.
 - 220 participants
- 17 April 2008, Western South Dakota Hydrology Conference, Rapid City, SD
 - Keynote Speaker, John Marburger, OSTP
 - Tour of Homestake by Marburger, with Governor Rounds, Lead, SD
- 20-26 April 2008, DUSEL Homestake Workshop, Lead, SD
 - 350 participants
 - Opening remarks by Governor Rounds

Nuclear Science Advisory Committee (NSAC)

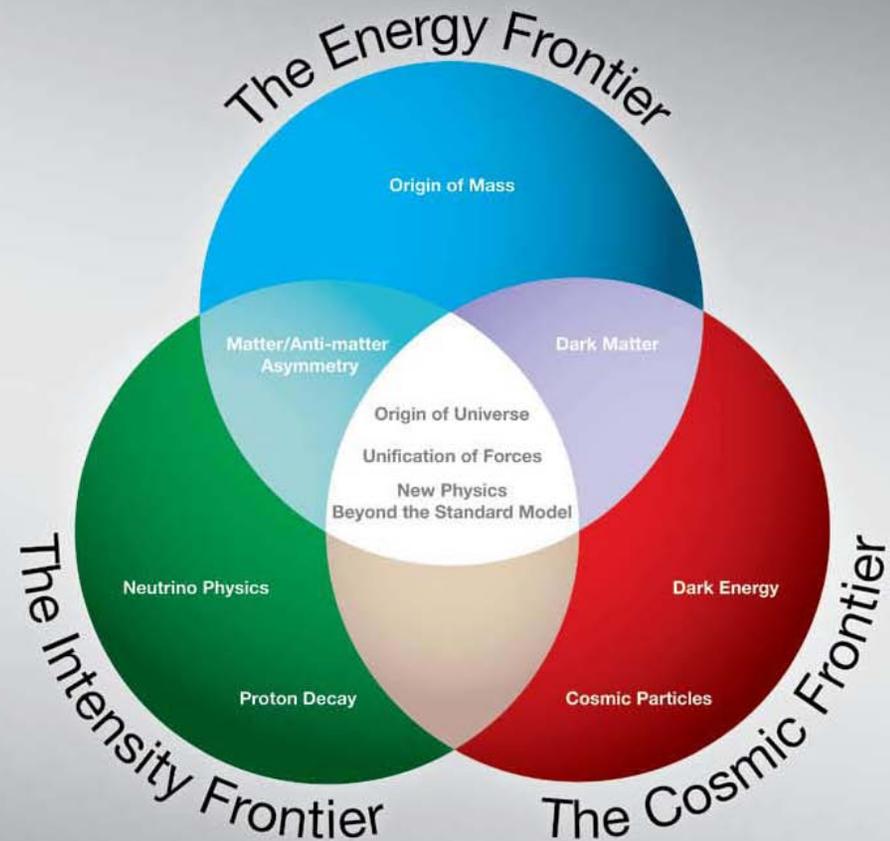
- NSAC charged by DOE and NSF in July 2006 with developing a long range (ten year) plan.
- From Dec 2007 report, Overview and Recommendations:

“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 symmetry, 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.”



Particle Physics Project Prioritization Panel (P5)

- The Particle Physics Project Prioritization Panel (P5) is a sub-panel of the High Energy Physics Advisory Panel (HEPAP).
- Charged in Jan 2008 by NSF and DOE with recommending a 10-year road map for particle physics.



The three frontiers of research in particle physics, as expressed by the P5 Panel, which form an interlocking framework that addresses fundamental questions about the laws of nature and the cosmos.

P5 Recommendations

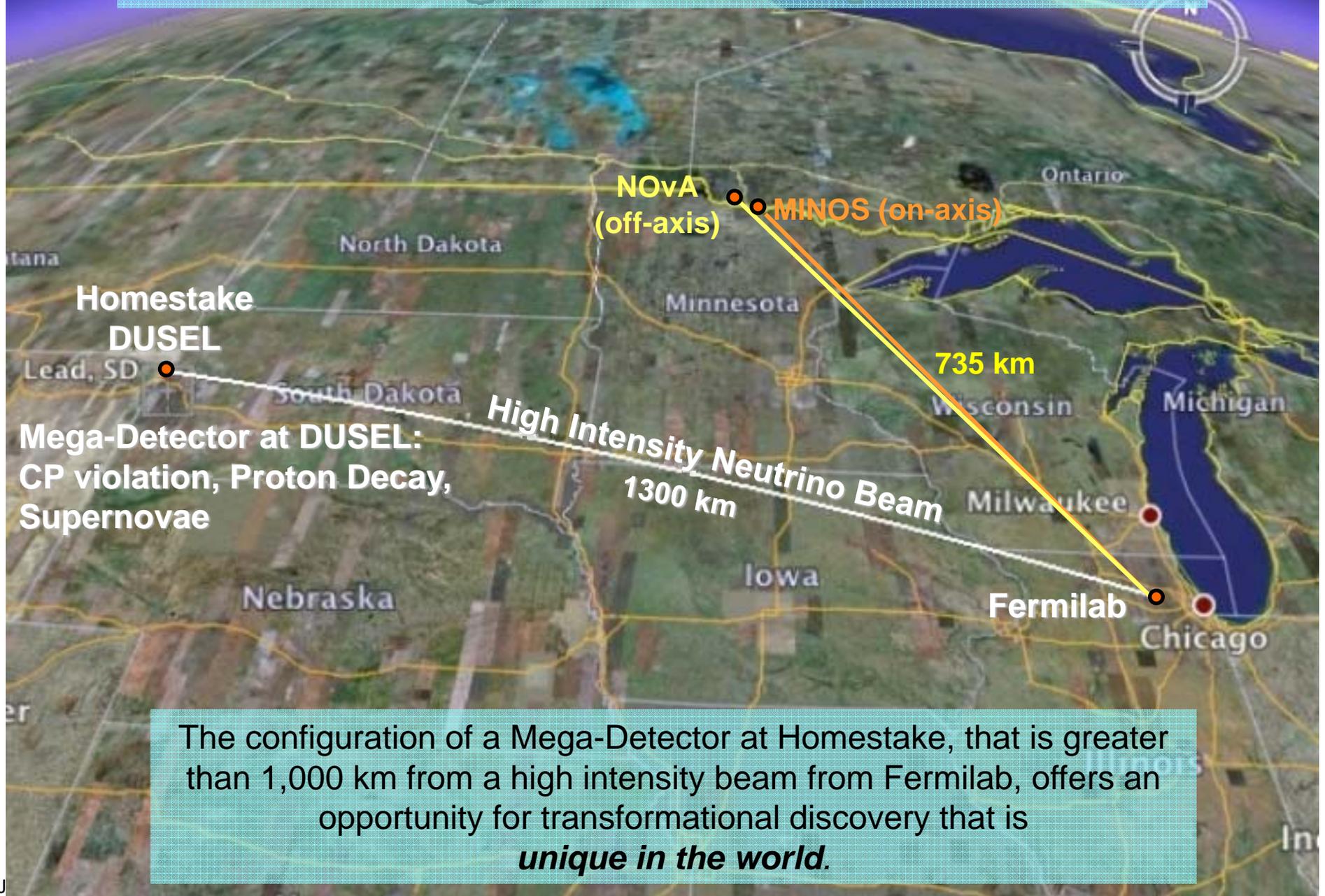
- Report approved by HEPAP at their May 2008 meeting in Washington.
- From Executive Summary:

“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 laboratory and a high-intensity neutrino source at Fermilab.”

“The panel endorses the importance of a deep underground laboratory to particle physics and urges NSF to make this facility a reality as rapidly as possible. Furthermore the panel recommends that DOE and NSF work together to realize the experimental particle physics program at DUSEL.”

- Fermilab/DUSEL program recommended by P5 constitutes the primary element of the on-shore U.S. particle physics program during the coming decade.

The Long Baseline Experiment



The configuration of a Mega-Detector at Homestake, that is greater than 1,000 km from a high intensity beam from Fermilab, offers an opportunity for transformational discovery that is *unique in the world.*

Discussions on DUSEL with DOE

- NSF/DOE DUSEL Physics Joint Oversight Group (JOG) under discussion at agencies.
- JOG would oversee those DUSEL physics experiments jointly implemented by NSF and DOE.
- Roles & responsibilities being based on past models.
 - Among them, successful DOE/NSF JOG oversight of US participation in the Large Hadron Collider (LHC) at CERN.
- Four meetings held in June/July/Aug 2008.
 - Attending: NSF PHY (& MPS), DOE OHEP & ONP.
- Draft MoU describing NSF/DOE cooperation is under development.
- First JOG meeting date, agenda under discussion.

DUSEL Schedule

- Project team has established baseline target date of December 2009.
 - NSF Preliminary Design Review (PDR), analogous to DOE CD-2.
 - Would imply FY12 construction funding start.
- Recent events have prompted a reconsideration:
 - Mine dewatering has proceeded more slowly than planned.
 - S4 solicitation later than anticipated.
 - Mega-Detector represents significant new scope that must be integrated into facility plan.
 - Enabling NSF/DOE collaboration requires time to establish.
- Schedule update will be announced at appropriate venue in Fall.

Project Reviews

- Facility design team held internal review of facility, 16-18 July, UC Berkeley.
- Planning for initial NSF review underway, scheduled for January 2009.
- Will review facility & experiments, as appropriate.

Working Model for DUSEL Facility Planning

- Planning assumes facility infrastructure construction costs would be borne by NSF.
- Partnerships with DOE & others anticipated for experiments.
 - International, public, private, etc.
- At this early stage, Physics Division uses following rough planning targets:
 - \$500M for MREFC, split evenly between facility and experiments.
 - 7-8 year construction period, experiments deployed as they are ready.

**All models are coarse, used for planning purposes only.
Project will produce final numbers that will be
peer-reviewed, baselined.**

Working Model for DUSEL Operations

- Operations costs for facility infrastructure would be borne by MPS/PHY.
 - Operations costs for experiments supported by experiment construction partners.
- DUSEL O&M will ramp up as facility takes shape & experiments are deployed.
 - O&M assumed to plateau to ~ \$50M/yr as lab moves toward full ops mode, ~ 2017.
- Physics Division has proposed a plan to realize this funding profile, under consideration by MPS.

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DUSEL-related R&D Funding

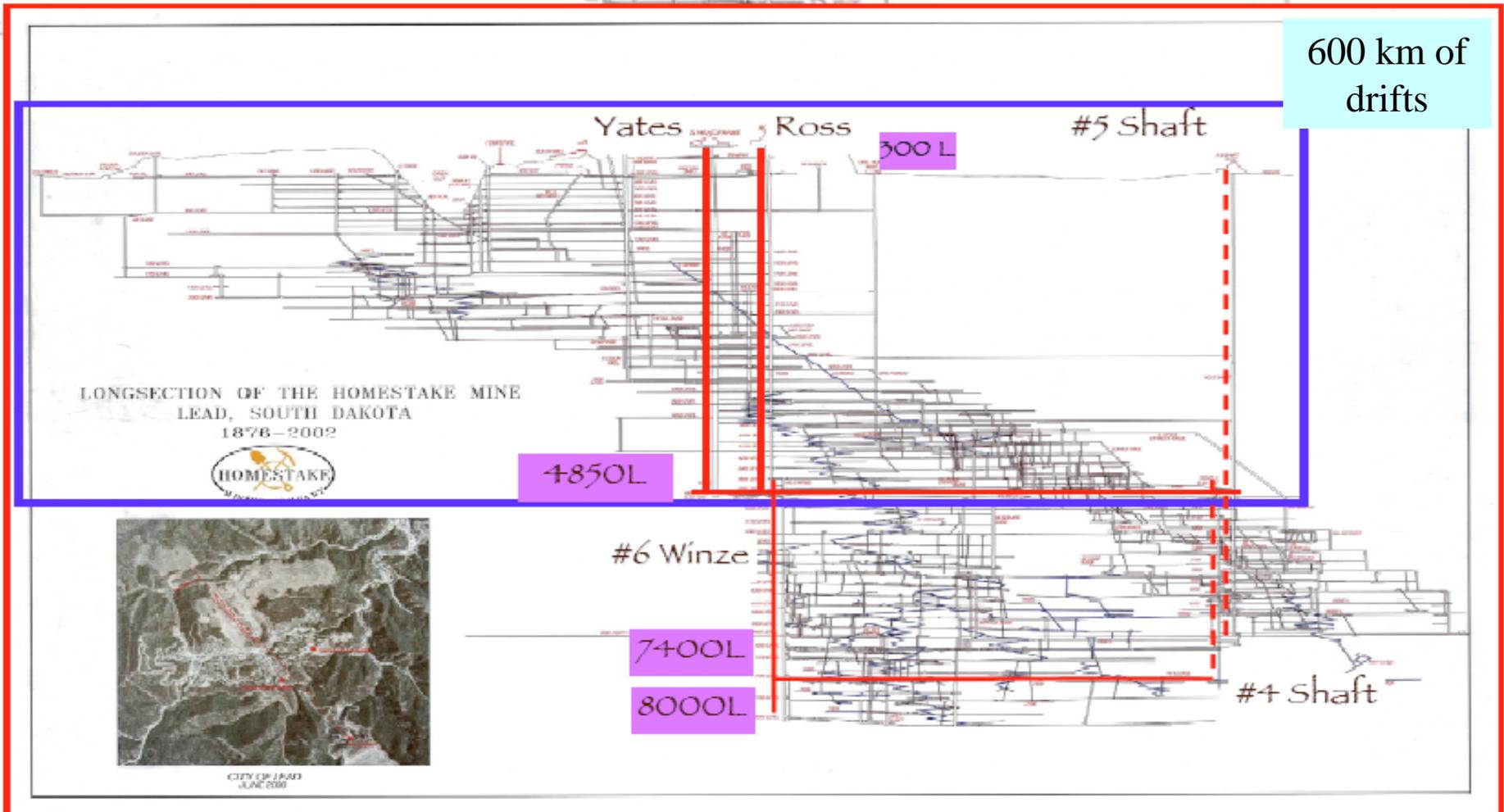
- NSF Physics Division encouraged submission of DUSEL-related R&D proposals for FY07
 - Targeted detector R&D for underground applications
- Joined by DOE HEP and NP
- Proposals were submitted to both agencies; reviewed, prioritized by joint DOE/NSF panel in March 07
 - \$3.1M (NSF) + \$0.6M (DOE) = \$3.7M FY07
- Program continuing in FY08:
 - \$3.0M (NSF) + \$0.4M (DOE) + \$2.7M continuing 07 grants = \$6.1M FY08
- NSF Geomechanics & Geotechnical Systems Program also funding DUSEL-related R&D. Proposals reviewed in April 07, 3 awards made (2 collaborative), ~ \$900k total (over 3 years)
 - Program continued '08
- Program will continue in 09, funding permitting.

Closing Remarks

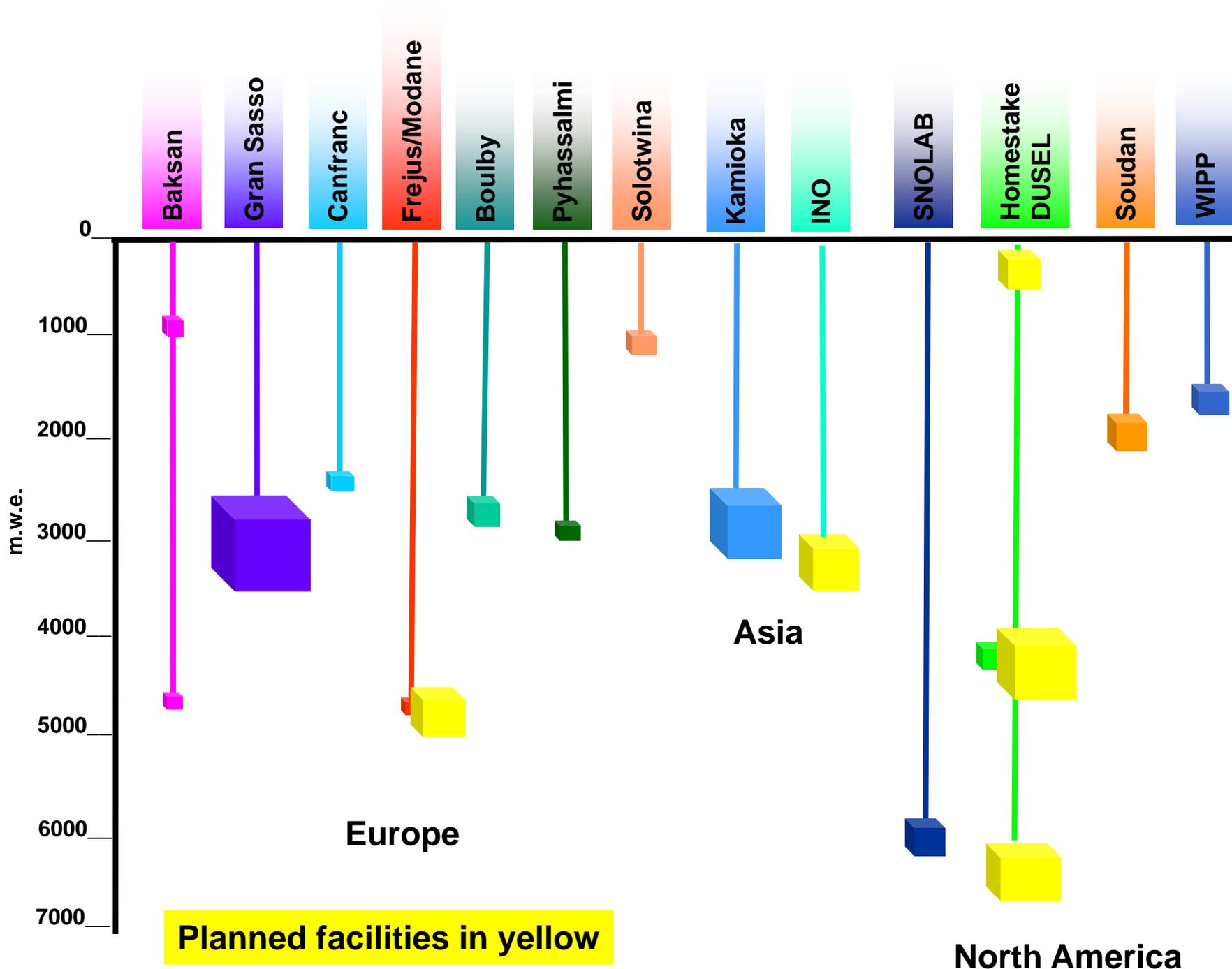
- Recent community reports have further strengthened and broadened the case for DUSEL in the US physics program.
- Facility design continues to advance, and is being adjusted to accommodate new scope.
- S4 is in final stages of internal NSF review.
- Design work will be used as input to NSF decision on whether to move forward with DUSEL.
- Discussions between NSF & DOE on cooperation on the DUSEL physics experiments have begun.

Backup Slides

Homestake Mine Workings

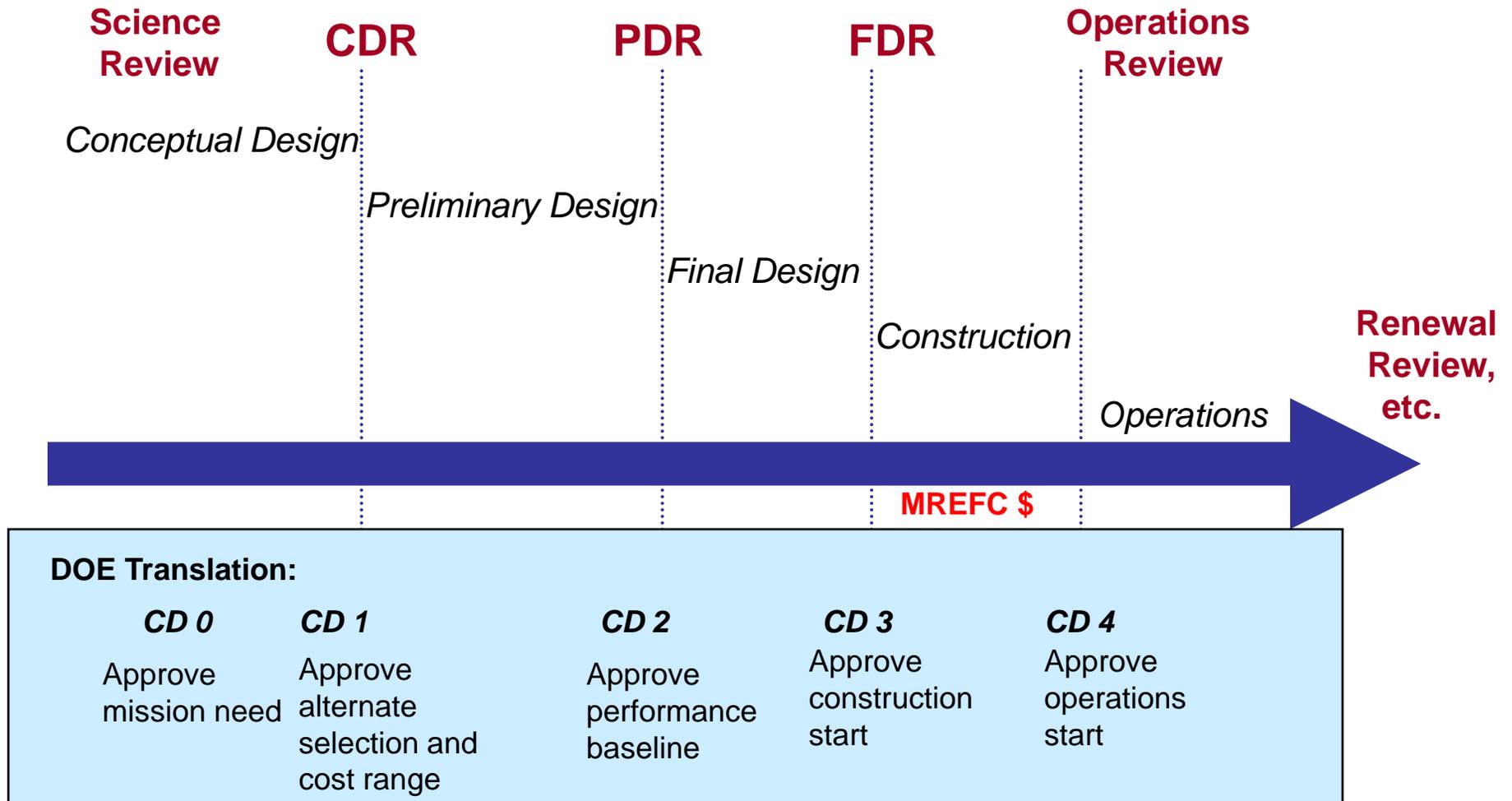


- South Dakota Science and Technology Authority (SDSTA) owns land (footprint and below) outright and in perpetuity.
- Future use dedicated to research and education.



Planned facilities in yellow

NSF Pre-Construction Planning Process



DUSEL Status in MREFC Process

- S3 site selection review played dual role as Conceptual Design Review for facility.
- DUSEL passed this requirement.
- Recommendation to formally enter Preliminary Design phase was considered by MPS Advisory Committee, April 08 (Witherell, Chair).
- Committee voted to recommend DUSEL enter this next phase.
- Will next be considered by MREFC Panel.
 - Office of the Director, NSF Assistant Directors