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

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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
- Comments on international issues
- Closing remarks

Acronyms:
DOE = Department of Energy
E&O = Education & Outreach
HEPAP = High Energy Physics Advisory Panel
JOG = Joint Oversight Group
MPS = NSF Directorate of Mathematical & Physical Sciences
MREFC = Major Research Equipment & Facilities Construction NSF funding line
NSAC = Nuclear Science Advisory Committee
OHEP = DOE Office of High Energy Physics
ONP = DOE Office of Nuclear Physics
PHY = NSF Division of Physics
P5 = Particle Physics Project Prioritization Panel
SDSTA = South Dakota Science & Technology Authority

# DUSEL Overview

- DUSEL is a proposed deep underground laboratory in the U.S. that would be dedicated to the support of scientific research.
- Its primary motivation stems from the pursuit of fundamental physics, exploiting the shielding from cosmic rays.
- If approved, DUSEL would be a world-leading addition to the global network of underground laboratories.

# 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”)

**Above is a superset of categories from which the DUSEL suite of experiments might be chosen. Peer review will guide the selections made.**

# 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 21$^{st}$ 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

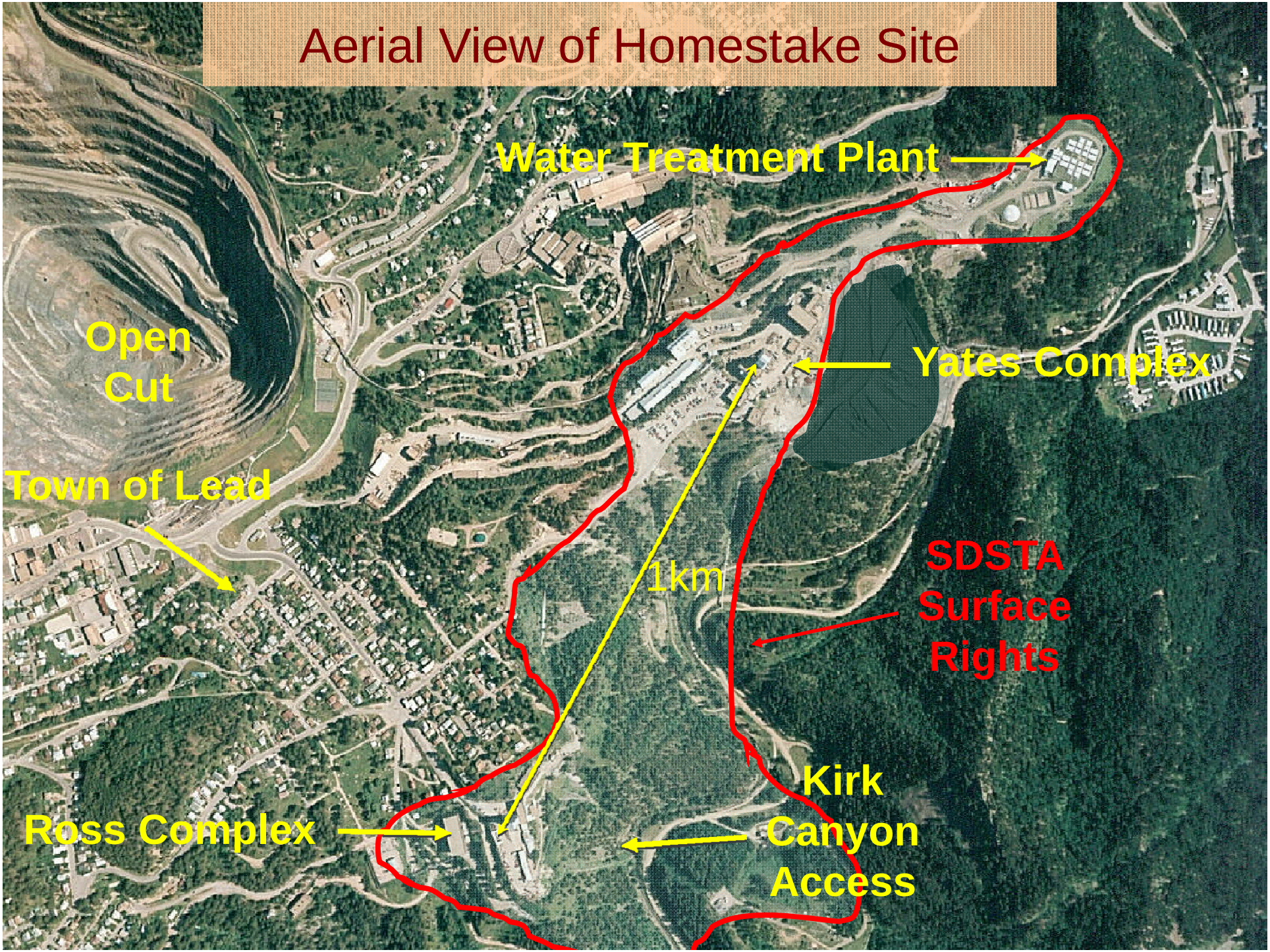
- Initiated at Town Meeting at NSF, March 2004.
- Solicitation 1 (S1): define site-independent science scope and infrastructure needs; unify the community (awarded Jan 2005).
- Solicitation 2 (S2): develop conceptual designs for one or more sites (two awarded, Sep 2005).
- Solicitation 3 (S3): facility 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 cost estimation for infrastructure, experiments & operations to begin.**

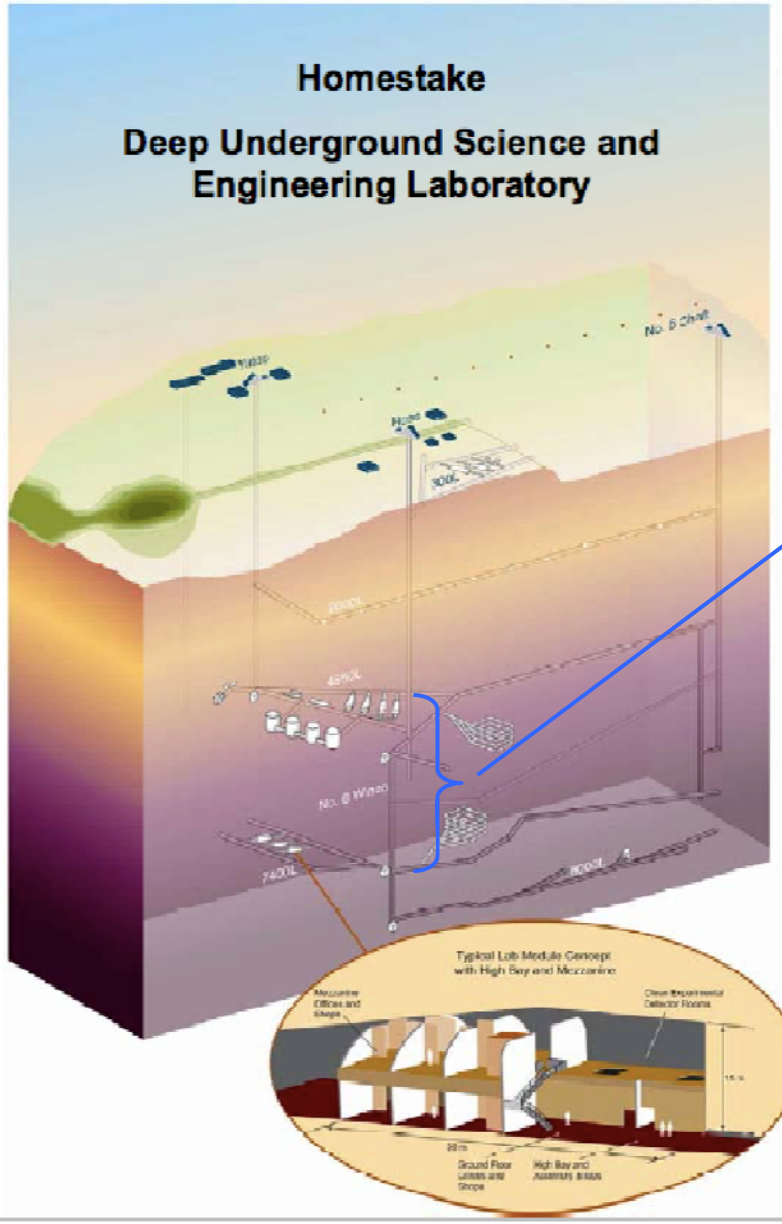
# Solicitation 3: DUSEL Site Selection

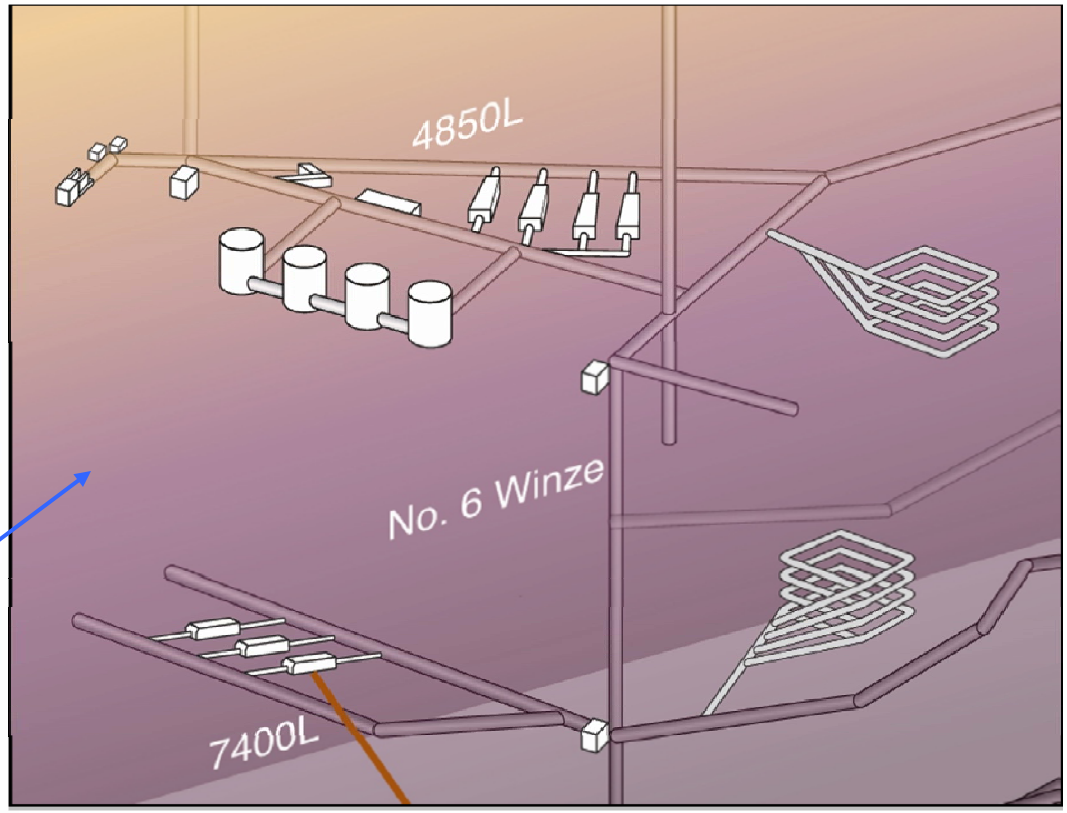
- Goal was to select single site and team to develop technical design of facility.
- Four proposals were reviewed by multidisciplinary 22-member expert panel.
- Review included site visits & reverse site visits.
- Panel unanimously voted by secret ballot to recommend the Homestake proposal to the NSF 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

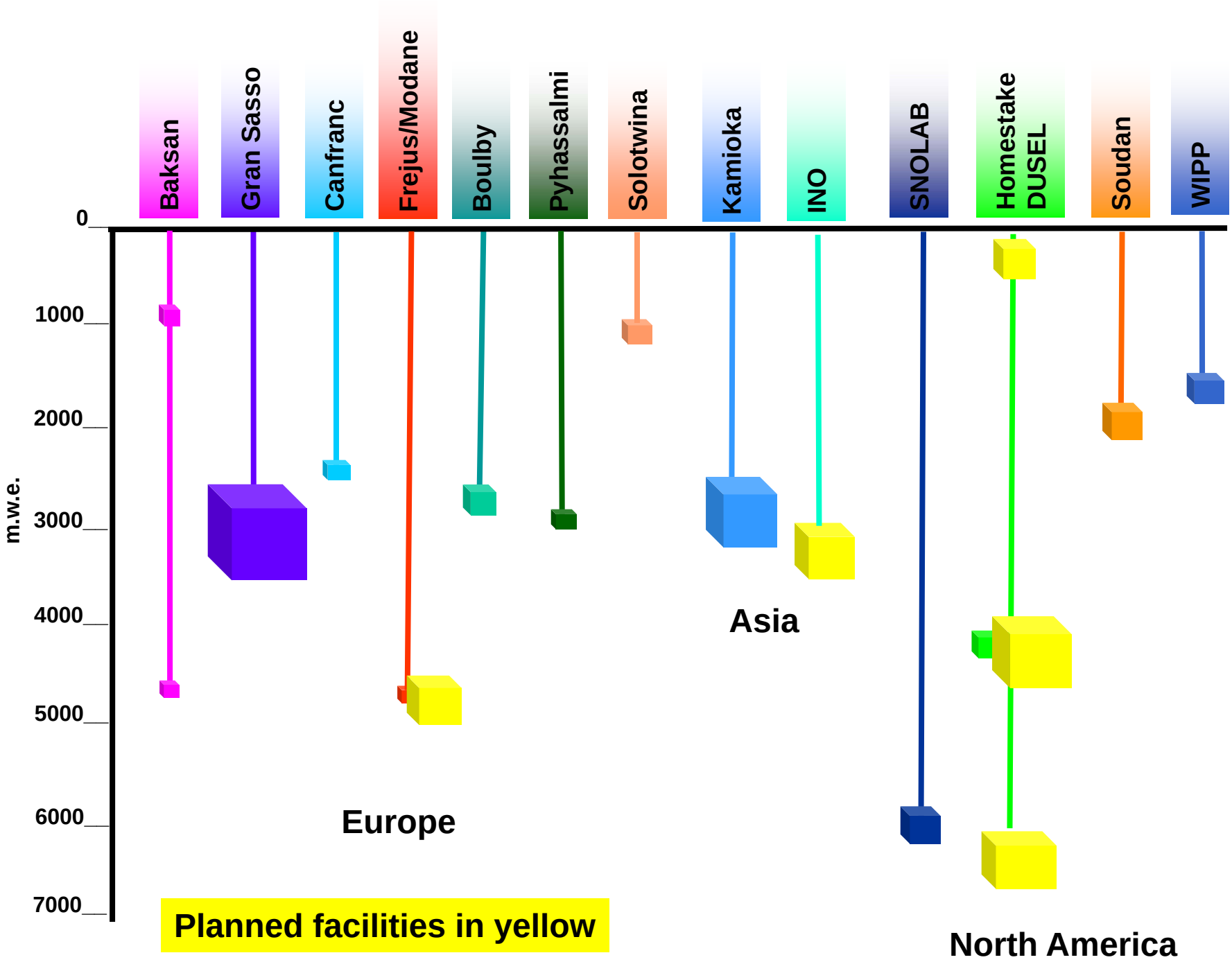


# An Illustrative DUSEL Laboratory Concept




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


Baksan
Gran Sasso
Canfranc
Frejus/Modane
Boulby
Pyhassalmi
Solotwina
Kamioka
INO
SNOLAB
Homestake
DUSEL
Soudan
WIPP
0
1000
2000
3000
4000
5000
6000
7000
m.w.e.
Europe
Asia
North America
Planned facilities in yellow

# DUSEL Scope Considerations

- The DUSEL scientific program will consist of only the most compelling, transformative experiments.
- This is one factor that will contribute to determining the overall scope.
- Cost is another.
- Facility planning includes accommodation of a large detector.
- A diverse scientific program must also be preserved.
- Partnerships matter here.
- DUSEL solicitation process provides funds to allow the community to begin 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.

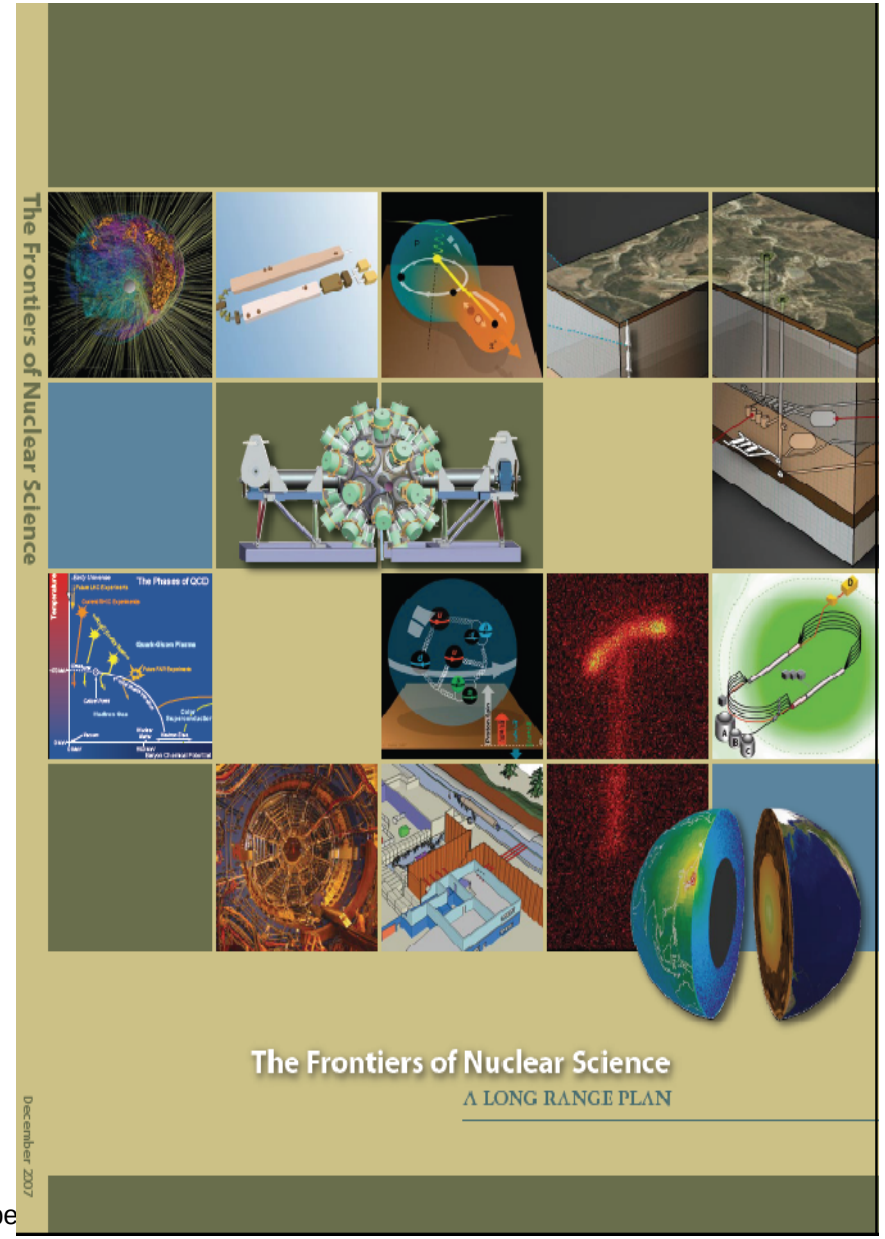
# Status of Sanford Laboratory

- State of South Dakota holds $124M for development of Sanford Laboratory. 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.
- State began mine re-entry late July 2007.
  - Dewatering began 21 April 2008.
  - Water treatment underway, full plan under development.
- Access to 4850L scheduled early CY09.
- Decoupled from MREFC process, but integrated into DUSEL facility planning.

# Nuclear Science Advisory Committee (NSAC)

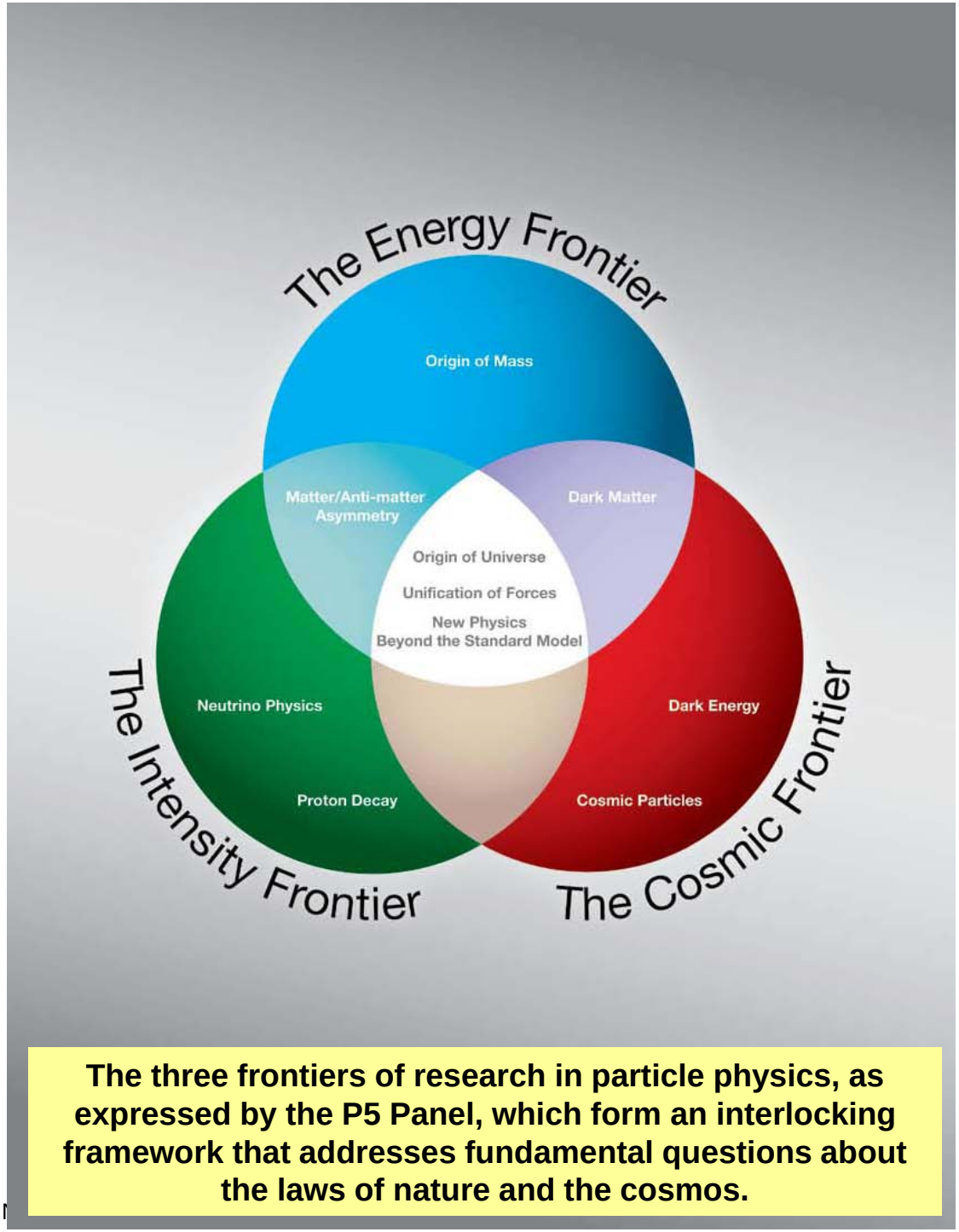
- NSAC charged by DOE and NSF in July 2006 with developing a long range (ten year) plan.
- From Dec 2007 report, Overview and Recommendations:

***"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. <u>Construction of a Deep Underground Science and Engineering Laboratory is vital to U.S. leadership in core aspects of this initiative</u>."***



# 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

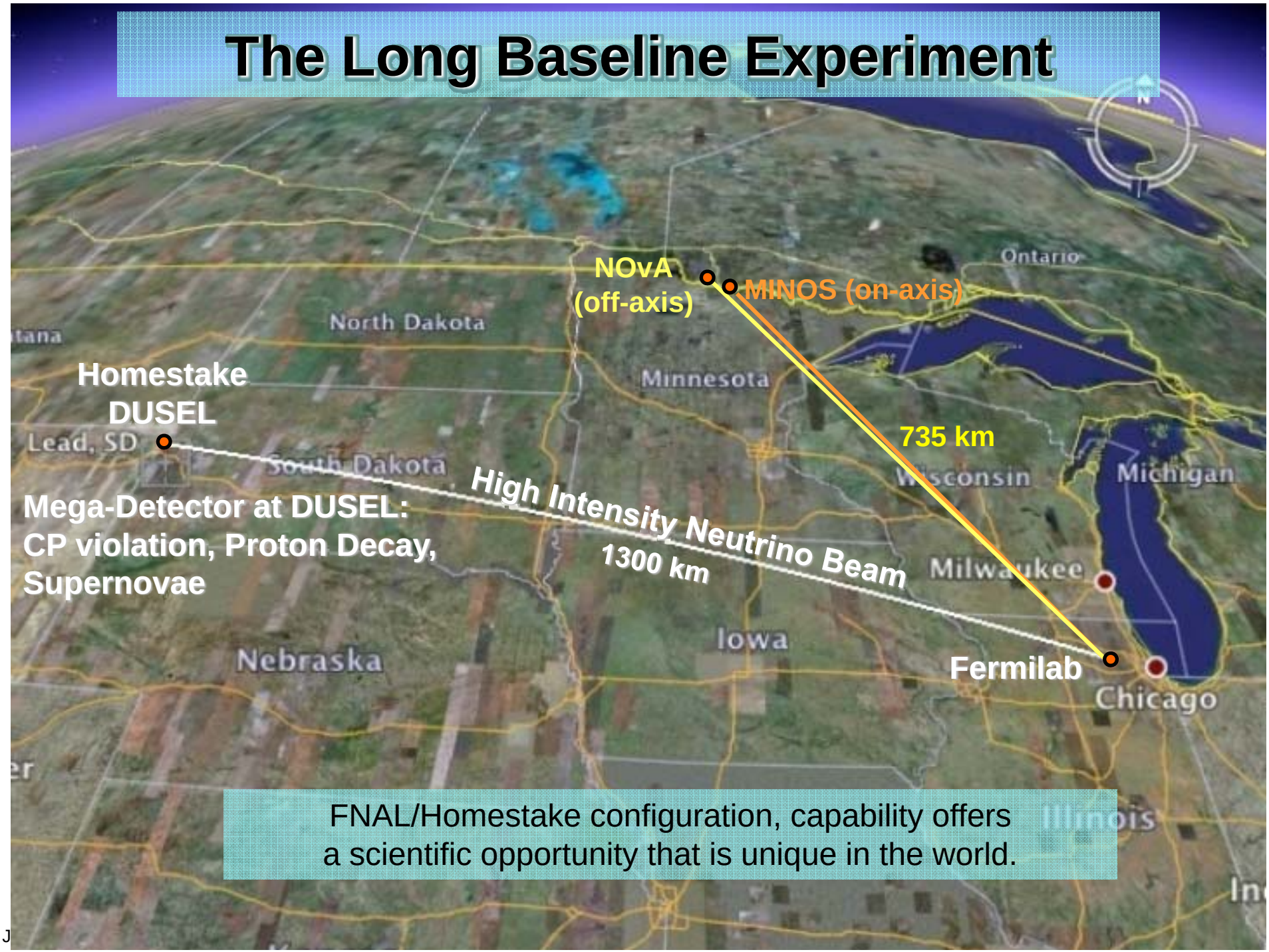
- Report approved by HEPAP at their May 2008 meeting in Washington.
- From Executive Summary:

***"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 is the primary element of the on-shore U.S. particle physics program recommended by P5.

# The Long Baseline Experiment




FNAL/Homestake configuration, capability offers a scientific opportunity 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.

# 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.
- 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 DUSEL Schedule

- Project team has established baseline target date of December 2009.
  - NSF Preliminary Design Review (PDR), analogous to DOE CD-2.
  - Would imply October 2011 construction funding start (U.S. FY12).
- Recent events have prompted a reconsideration:
  - Mine dewatering has proceeded less rapidly than planned.
  - S4 solicitation later than anticipated.
  - Large detector represents significant new scope that must be integrated into facility design, costing exercise.
  - Enabling NSF/DOE collaboration requires time to establish.
- Schedule update will be announced at appropriate venue in Fall.

# Comments on International Issues

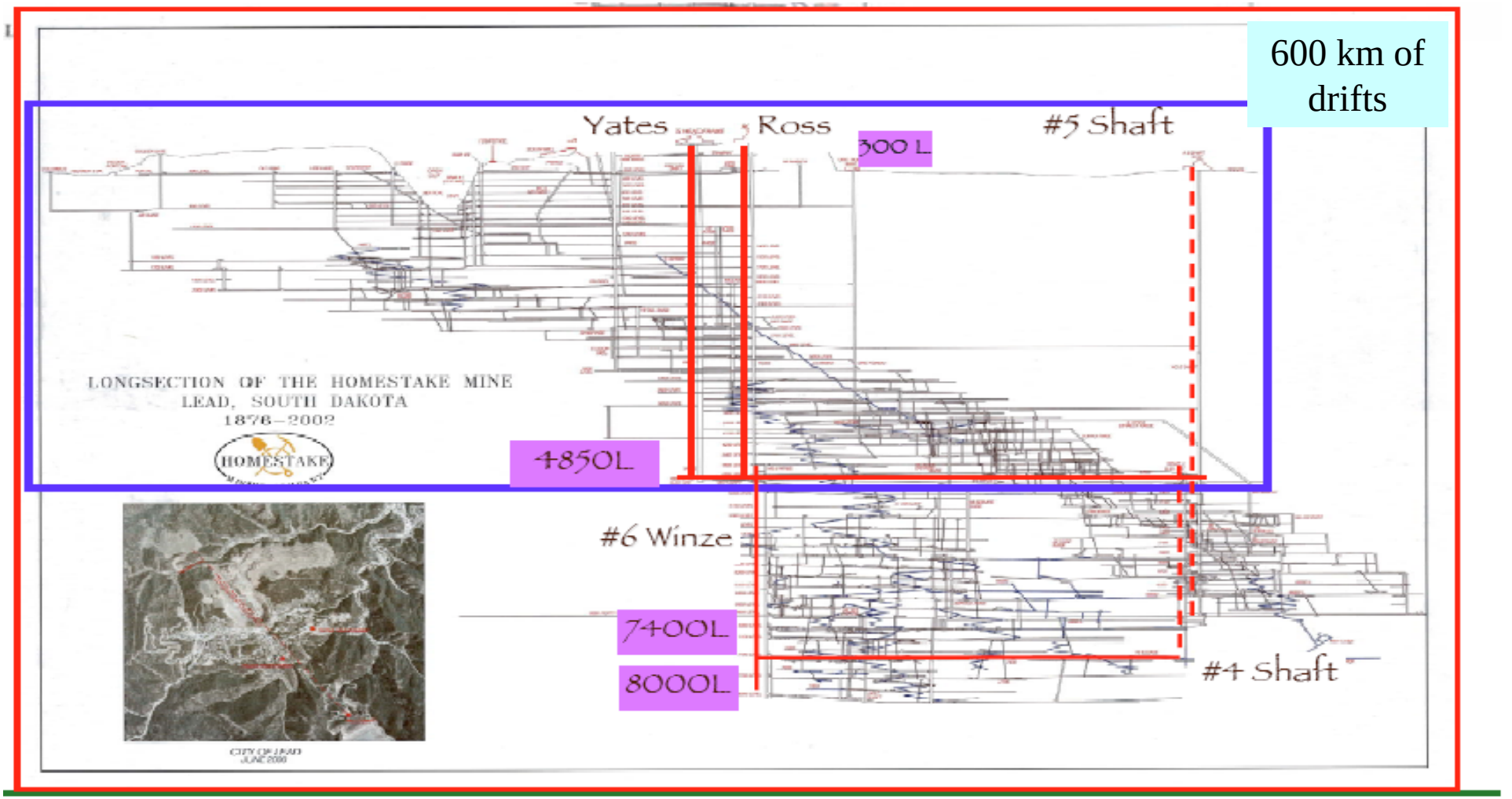
- NSF is interested in exploring opportunities for international collaboration in R&D for underground physics.
- Might include:
  - Detector R&D
  - Experiment design & simulations
  - Common technical problems related to facility design.
- Inclusion of DUSEL plans in discussions related to world-wide programmatic planning is also of interest.

# Closing Remarks

- Recent community reports have further strengthened and broadened the case for DUSEL in the U.S. 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.
- NSF is interested in exploring international partnerships in R&D and overall program planning.

# 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.