

Underground Physics Research at the National Science Foundation

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Outline

- **Background**
- **Current status**
- **Recent studies, events**
- **Funding, thresholds, etc.**
- **Closing remarks**
- **Questions**

Introduction

- **The Deep Underground Science and Engineering Laboratory (DUSEL) has been under development by the relevant U.S. research communities since the year 2000 via support from the National Science Foundation (NSF).**
- **DUSEL has been envisioned by the community as a unique, dedicated international underground education & research facility that would support potentially transformational experiments in multiple disciplines.**

DUSEL Solicitation Process

- Initiated at Town Meeting at NSF, March 2004.
- **Solicitation 1 (S1):**
 - Define site-independent, multi-disciplinary science scope and infrastructure needs; unify the community (awarded Jan 2005).
- **Solicitation 2 (S2):**
 - Develop conceptual designs (8 received, 2 awarded, Sep 2005).
- **Solicitation 3 (S3): (facility)**
 - Site selection to initiate facility design for 1 potential MREFC candidate (4 received, 1 awarded – Homestake, U.C. Berkeley [UCB]).
 - Total facility design: \$53M from FY 2007 through FY 2011.
- **Solicitation 4 (S4): (experiments)**
 - Initiate technical designs for candidates for the DUSEL suite of experiments (all disciplines).
 - 25 proposals received January 9, 2009; reviewed spring 2009.
 - \$21M total physics awards (+\$3M BGE) over three years, beginning in FY09.

DUSEL Site Selection (S3)

- **Proposal deadline January 2007, four proposals received.**
- **Open competition.**
- **Goal was selection of single site for further development.**
 - **Or no site, if none were considered viable.**
- **Exhaustively reviewed by 22-member world-class panel:**
 - **PHY, GEO, BIO, ENG, ES&H, underground construction, geotechnical/civil engineering, mining and operations, large project management, cost & schedule, E&O, US & foreign representation.**
- **Review included site visits and reverse site visits.**
- **Cost estimates reviewed by independent cost consultant.**
- **Panel voted unanimously to recommend the UCB/Homestake proposal on first (blind) vote.**
- **Recommendation reviewed by NSF Director's Review Board.**
- **NSF announcement July 2007.**

Developing the DUSEL Experimental Program: S4

- **Solicitation 4 (S4):** called for proposals to develop designs and pursue targeted R&D for potential DUSEL experiments. Jan 2009.
- **25 proposals received; 300 senior researchers; 91 institutions.**

- **Nine proposals funded in physics:**

- Dark matter (4)
- Neutrino-less double-beta decay (2)
- Large water Cerenkov detector (multipurpose)
- Underground accelerator
- Assaying sub-facility

- **Total physics awards: \$21M over 3 years.**

- **Seven proposals funded in BIO, GEO & ENG sciences:**

- Fracture processes
- Coupled processes
- Subsurface imaging and sensing
- Fiber optic strain monitoring
- CO₂ sequestration
- Eco-hydrology & deep drilling
- Underground monitoring

- **Total BGE awards: \$3M.**

South Dakota Development of Sanford Laboratory

- **South Dakota Science and Technology Authority (SDSTA) holds \$124M for development of Sanford Laboratory.**
 - \$70M private benefactor (Sanford), \$44M state SD, \$10M HUD.
- **Funds to support:**
 - Education center.
 - Reentry and partial refurbishment of 4850L & 7400L.
 - Operations & maintenance of Sanford Laboratory activities.
- **Approximately 85 staff.**
- **SDSTA began mine re-entry late July 2007. Dewatering & treatment began 21 April 2008.**
- **Various BGE experiments have been deployed since reentry.**
- **4850L dry since May 2009 and being prepared to support early physics experiments (LUX, MJD).**

Sanford Laboratory Development



Ray Davis
1965

Sanford Laboratory physics program
in preparation.
Being initiated in Davis Cavern.



Davis Cavern
Sep 21, 2009

Sanford Laboratory Build-Out at 4850L



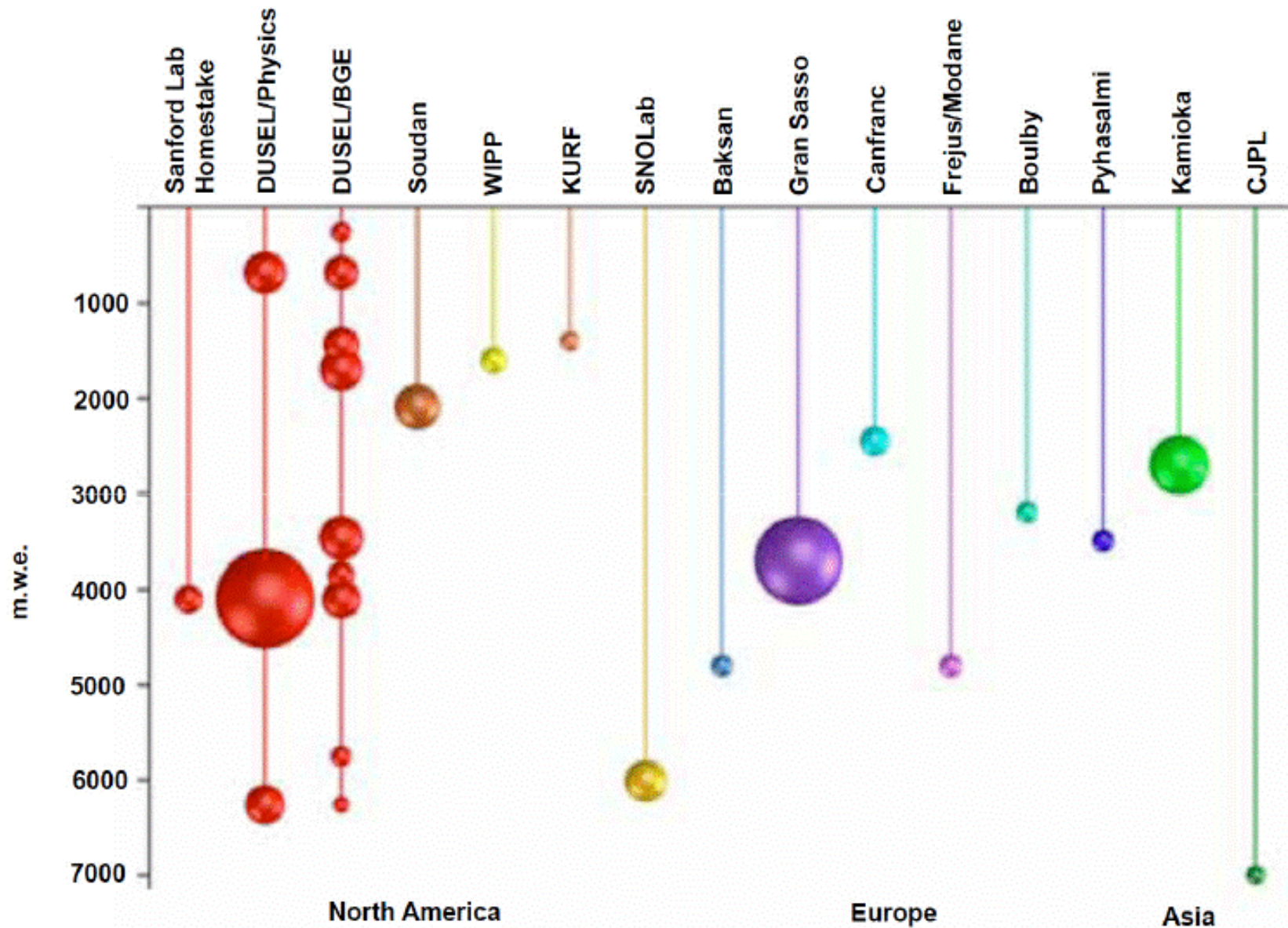
Davis Cavern and associated spaces being outfitted to house LUX (DM) and MAJORANA demonstrator (DBD) for early science.

Davis Cavern
Excavated and Shotcreted
May 2, 2011



Majorana Clean Room
May 31, 2011

World-Wide Underground Laboratories



NSF DUSEL-Related Funding to Date

DUSEL Awards	NSF Funding (\$M)
<i>Facility Design (to UCB)</i>	
S3	15
S3 Supplement	3
PDR	29
PDR Supplement	6
<i>Subtotal Facility Design</i>	53
<i>Physics Experimental Design</i>	
S4 (nine PI awardees)	21
<i>DUSEL R&D</i>	
Individual awards	12
<i>Dewatering in FY11</i>	4
<i>TOTAL</i>	90

Excludes ~ \$3M in BIO, GEO and ENG (BGE) awards from S4 and support from individual programs.

Excludes funding for DUSEL-related development from the State of South Dakota (\$124M) and DOE (~ \$50M).

Current Status (1)

- **In December 2010, the Committee on Programs and Plans (CPP) of the National Science Board (NSB) voted to discontinue further DUSEL design funding.**
- **NSF DUSEL activities were zeroed out in the FY12 budget.**
- **The Department of Energy subsequently established a review process intended to inform their decision on if and how they wish to move forward with the project.**
 - **See talks this session by Shochet, Brinkman.**
- **NSF subsequently provided an additional \$4M in FY11 to continue dewatering and maintain security in the mine for the remainder of the fiscal year (June – September).**

Current Status (2)

- **NSB has raised concerns over the following issues in various forums:**
 - **Need for an independent assessment of the science opportunities.**
 - **NSF/DOE stewardship model for DUSEL was deemed to be “unacceptable”.**
 - **Important that there be reliable costing for MREFC construction and long-term operations.**
- **These are discussed in the next slides.**

DUSEL NRC Study

- **As part of the \$29M DUSEL design award funded in September 2009, the NSB mandated that a broad and independent review of DUSEL be conducted.**
- **This study was intended to inform NSB project prioritization. It was co-funded by NSF PHY, DOE HEP and DOE NP.**
- **Resulting National Academy study was released in July 2011. It contains a strong endorsement of both the DUSEL research program, and the US pursuit of an on-shore leadership role in underground science.**
 - **See talk this session by Fisher.**

DUSEL Stewardship Model

- From NSF/DOE MoU (September 2010):

Program Element	Steward	Contributing Partners
Neutrino-less double-beta decay	DOE NP	NSF
Long baseline neutrino experiment	DOE HEP	NSF
Proton decay	DOE HEP	NSF
Dark matter	NSF	DOE HEP
Smaller physics experiments	NSF/TBD	TBD
DUSEL facility and infrastructure	NSF	N/A

- These stewardship roles, negotiated by the programs, can be easily and readily adapted to accommodate other models.

The DUSEL PDR (1)

- **UC Berkeley submitted the DUSEL Preliminary Design Report (PDR) to the NSF in May 2011.**
- **The PDR is a comprehensive plan describing all elements in the full DUSEL scope, as defined by the community through the DUSEL solicitation process (begun in 2004).**
- **In accordance with the terms and conditions of the cooperative agreement between NSF and UCB, the PDR was reviewed July 19-21, 2011 at the Sanford Laboratory in Lead, SD.**
- **An expert Review Panel evaluated cost and schedule; environment, safety and health; underground and surface construction; and management.**
 - **Other PDR elements being reviewed separately.**

The DUSEL PDR (2)

- **Review Panel concluded that the PDR provides a sound basis for establishing a project baseline. They noted its extremely high quality.**
 - **Project maturity analogous to DOE Critical-Decision 2 (CD-2).**
- **The Panel stated that the PDR satisfied all requirements for an NSF construction project, as called out in the NSF Large Facilities Manual.**
- **The Panel noted that UCB has assembled a strong, skilled project team, highly capable of executing the project.**
- **Reviewed PDR contains a superset of all ingredients required for construction, should this or a descoped version of the project advance.**

NSB Funding Thresholds, MREFC

- **NSF Directorate of Mathematical and Physical Sciences (MPS) has annual program budget of ~ \$1.4B.**
- **Funding requests > 1% of the MPS budget (\$14M) must be approved by NSB.**
- **In addition, projects > 10% of the MPS budget (\$140M) are funded through the Major Research Equipment and Facilities Construction (MREFC) budget line, and must be approved by NSB.**
- **DUSEL fell into this category.**

MRI, Mid-Scale Program

- **Major Research Instrumentation (MRI) program supports acquisition or development of instrumentation at universities. Range = \$0.1M - \$4M.**
- **Mid-scale instrumentation program is currently under development in PHY that would fill gap between few M\$ (PNA, MRI) and \$140M (MREFC). Unlikely to be in place before FY13.**

PNA Program

- **Particle and Nuclear Astrophysics (PNA) program supports a broad portfolio of non-accelerator physics research.**
 - Dark energy, dark matter, DBD, UHE cosmic rays, CMB, etc.
- **(Non-DUSEL) underground physics and R&D are supported through the PNA program.**
- **PNA projects are ~ few M\$ in scale, frequently co-funded with partners (DOE, foreign, etc.).**
- **Examples of PNA-supported underground experiments and R&D (funding levels vary):**
 - XENON, CUORE, LUX, CDMS, WARP, COUPP, PICASSO, CoGeNT, DRIFT, DMTPC, MJD, EXO-200, NEMO-3, BOREXINO, SNO+, Mini-LENS, DarkSide, (Double Chooz, IceCube, Daya Bay...)

Closing Remarks

- **Particle-, nuclear- and astrophysics are poised to probe a series of rich, fundamental and potentially accessible questions, a number of which can only be addressed underground.**
- **DUSEL is crucial to an on-shore, facility-based HEP future.**
- **Despite a strong NRC study, a robust PDR and positive peer review, and an adaptable stewardship model, DUSEL remains in a highly precarious state.**
- **The PNA, MRI, and future mid-scale programs offer a variety of funding opportunities at NSF that could support underground physics research, albeit at a far more modest level.**

Questions