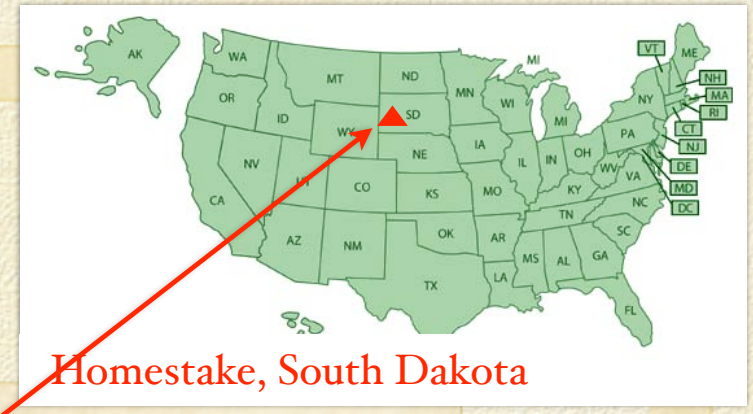
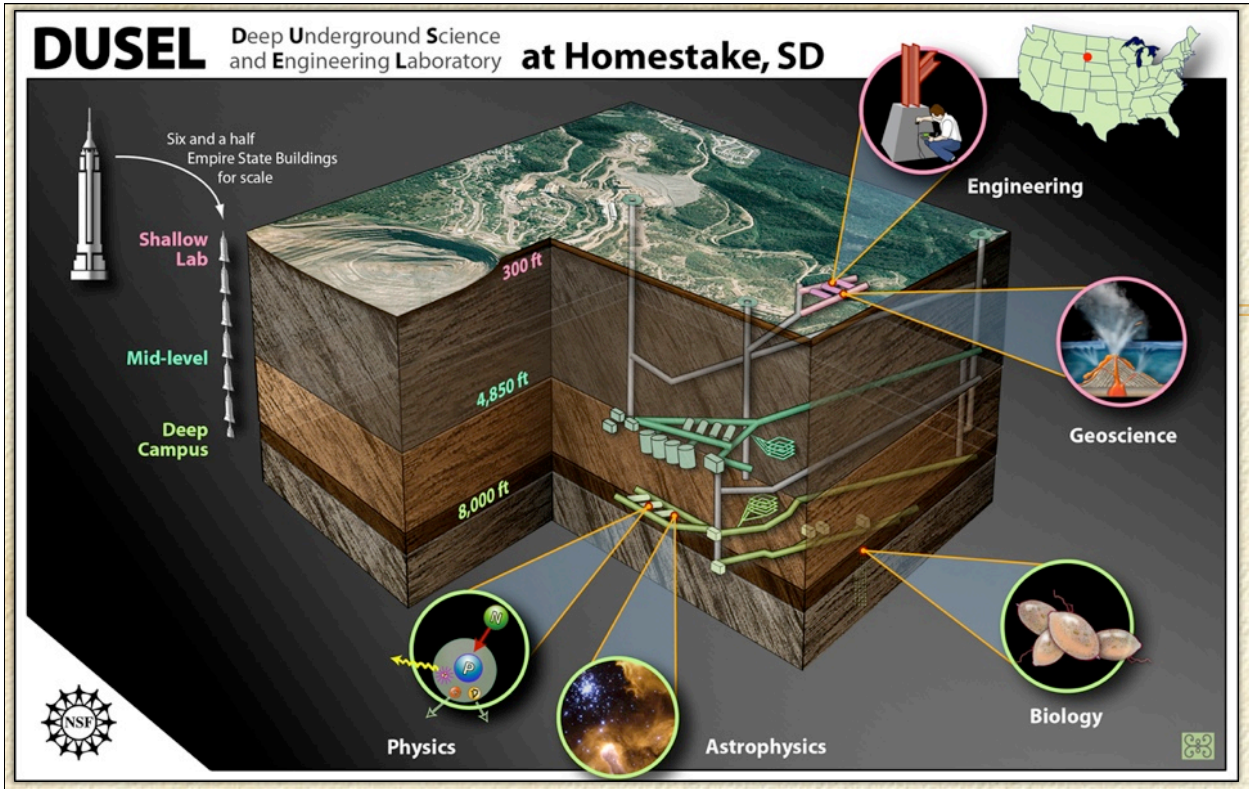


Deep Underground Science and Engineering Laboratory

Kevin T. Lesko

UC Berkeley and Lawrence Berkeley National Laboratory

TAUP 2007
Sendai
12 September 2007



Outline of Presentation

1. The US National Science Foundation's Deep Underground Science and Engineering Laboratory (DUSEL) Progress and Process

2. Progress in establishing DUSEL at Homestake and Early Options for Science at the Sanford Laboratory

DUSEL Progress & Remaining Steps

- ☑ **Fall 06 S-1** Report Released www.dusel.org
- ☑ **January - April 07 S-2** Conceptual Designs reviewed
- ☑ **10 July 07 S-3 awarded** funding for a single site (Homestake) to advanced design to Preliminary & Final phases
  - ☐ Develop baselined DUSEL plan, for review by NSF, MREFC Panel, NSB, … 3 years
  - ☐ Homestake Collaboration Open, additional participation welcomed and encouraged - planning, science, coordination
- ☐ Early Implementation Program at Homestake in parallel with NSF process, Program developing for 2007-08 start
- ☐ **Summer 07 S-4** Call for **Initial Suite Experiments** by NSF (iterative process) Town meeting November 2007
- ☐ **FY10/11 DUSEL funding**, include Experiments and Facility
  - ☐ Experimental apparatus > 50% of ~$500M construction project

S-1 Findings & Recommendations

www.dusel.org

Findings:

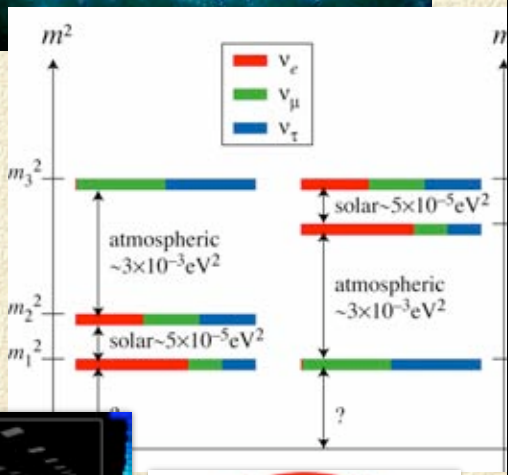
- Deep underground science is an essential component of research at the frontier
  - Disciplines in transformation
- Benefits to society
  - Worldwide need for underground space
- Need for a U.S. world-class deep multidisciplinary facility

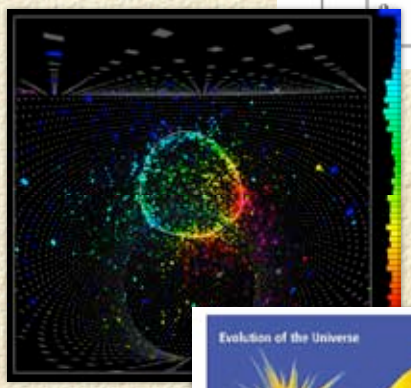
Recommendations:

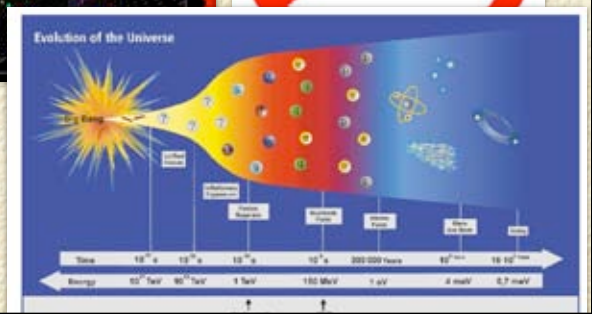
- Strong support for deep underground science
- A cross agency Deep Science Initiative
  - A Deep Underground Science and Engineering Laboratory (6000 mwe, 3000 mwe, 30 to 50 years, ASAP)

Deep Science Questions: Physics & Cosmology

- What is the universe made of?
- What is dark matter?
- What are neutrinos telling us?
- What happened to the antimatter?
- Are protons unstable?
- How did the universe evolve?

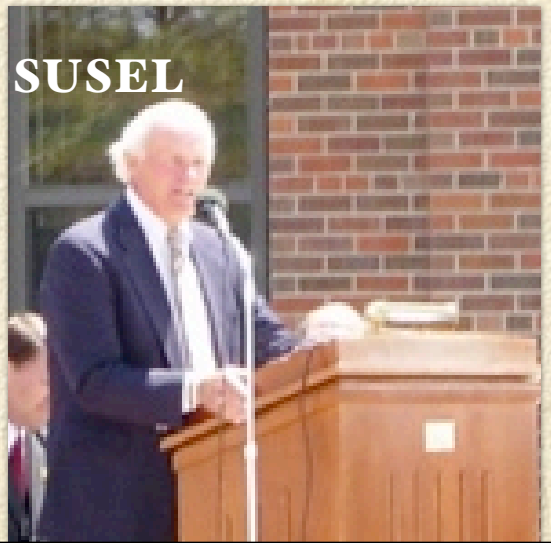


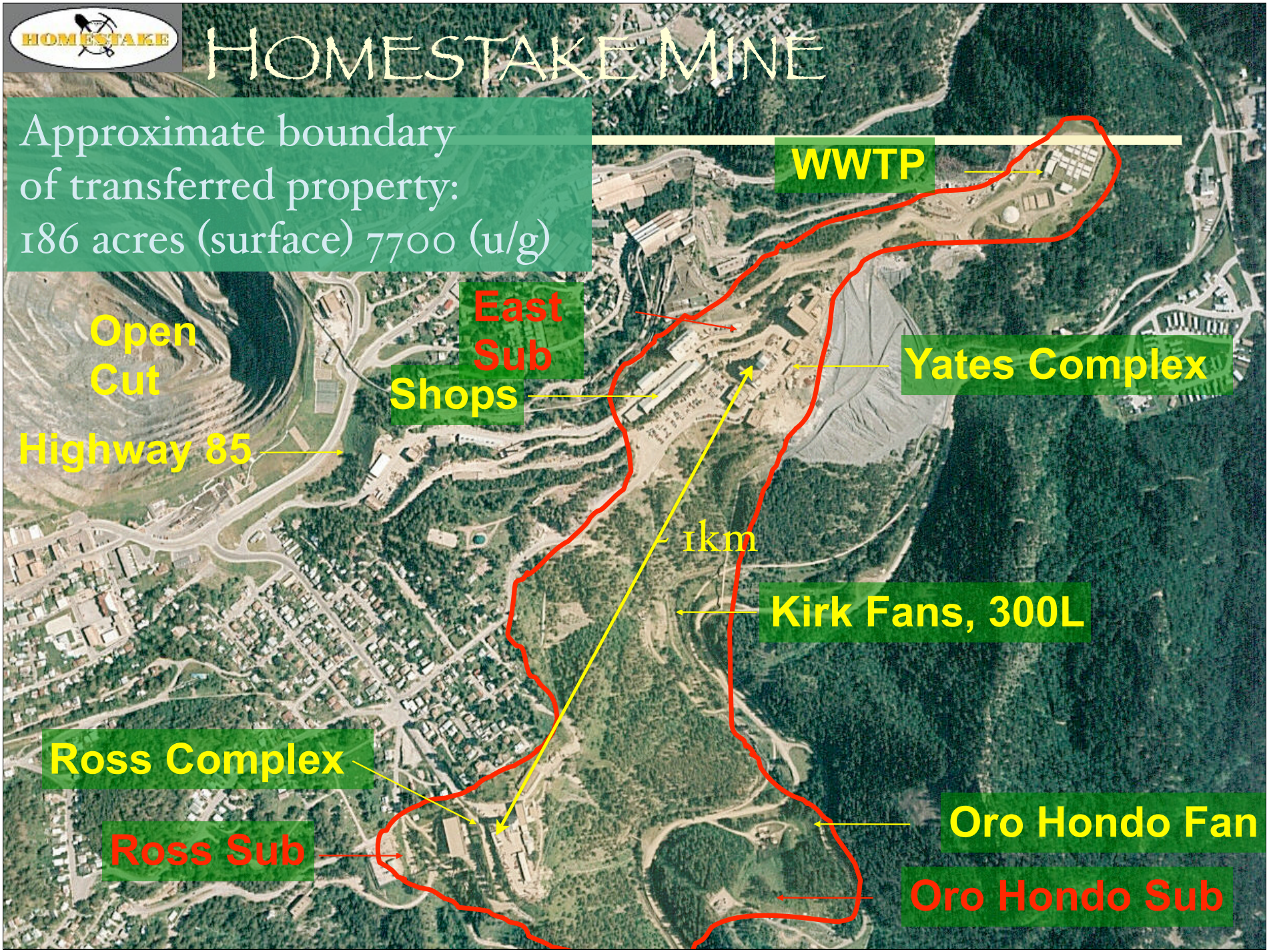




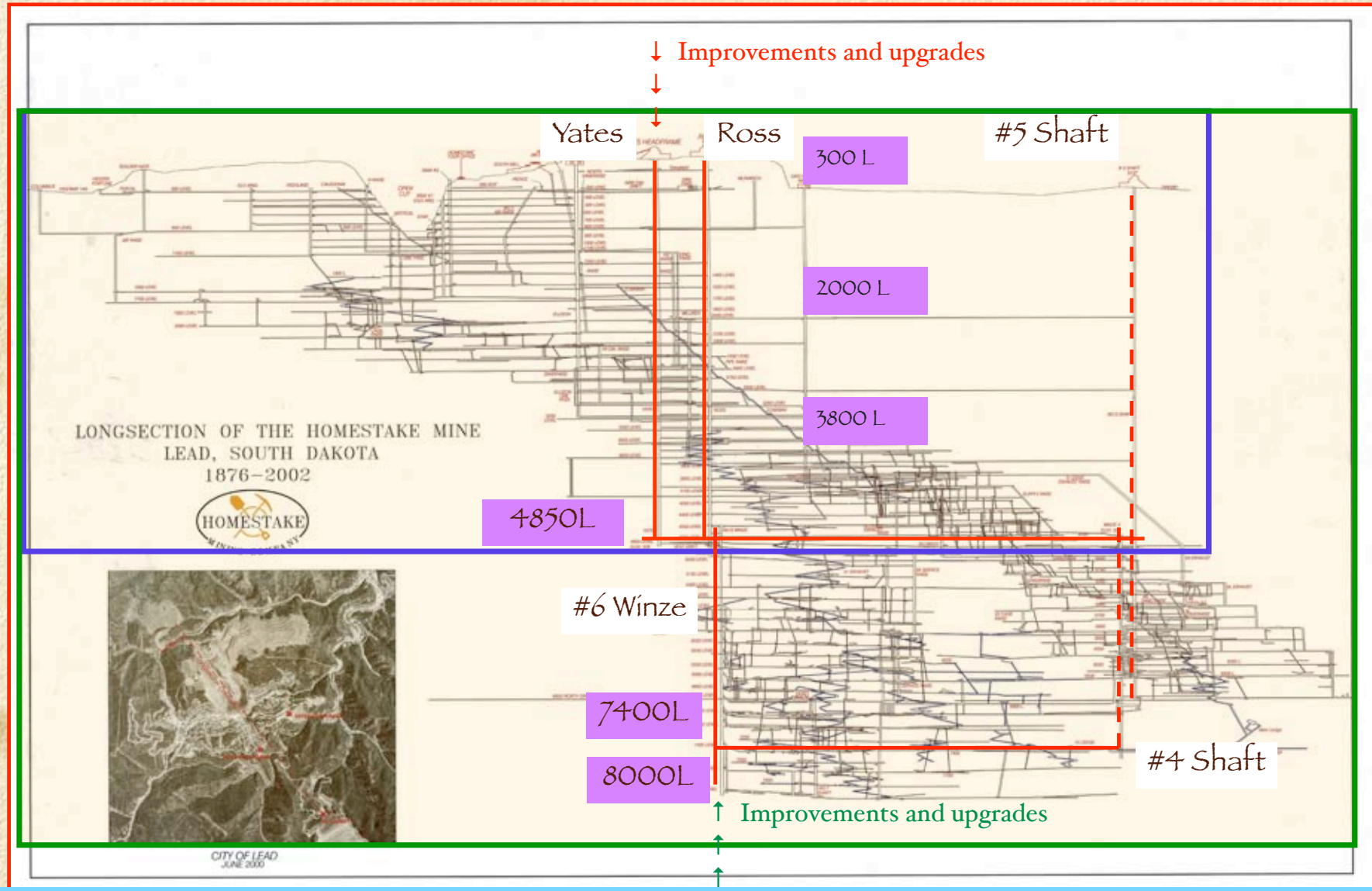
Timeline and Progress at Homestake

- ☑ October 2005, State Legislature approves additional $20M funding for Homestake, **<u>total of $46M</u>** from state controlled sources.
  - Rehab plan: $15M
  - Indemnification fund: $10M
  - Operations: $15M
  - Insurance: $2.5M
  - Contingency: $3.5M
- ☑ 1 November 2005 - First call: Letters of Interest for Homestake - 85 letters responses
- ☑ Property Donation Agreement Completed 14 April 2006, Property transfered to S.D. May 2006, SDSTA hiring staff to oversee and operate Homestake: -30 for rehabilitation, - 25 to 30 staff members
- ☑ T. Denny Sanford pledges **<u>$70M</u>** to develop Homestake into **SUSEL**
- ☑ Conceptual Design Completed January 2007
- ☑ January 2007 Rehab work initiated
- ☐ Early Implementation Program at Homestake 2007 - 2012 "The Sanford Laboratory"
- ☐ DUSEL funding anticipated in FY10 - FY11




HOMESTAKE MINE
Approximate boundary
of transferred property:
186 acres (surface) 7700 (u/g)
WWTP
East
Sub
Shops
Yates Complex
Open
Cut
Highway 85
~ 1km
Kirk Fans, 300L
Ross Complex
Ross Sub
Oro Hondo Fan
Oro Hondo Sub

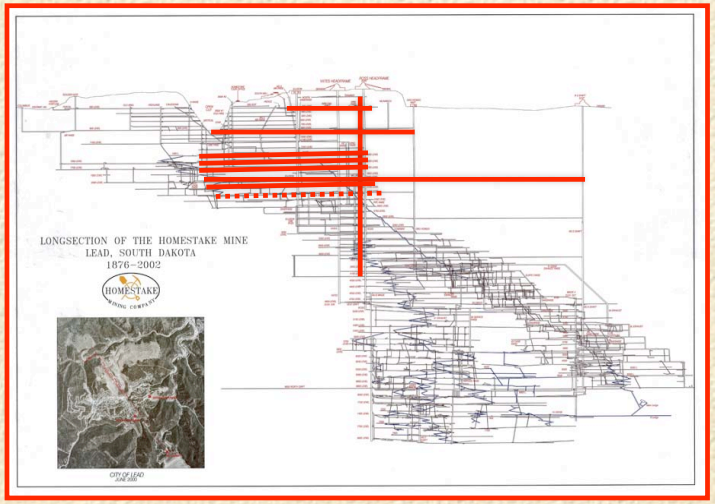
Phased approach to building DUSEL at Homestake



A dedicated science facility without competition or interference from mining, transportation, etc.

Re-entering Homestake and Establishing the Sanford Laboratory

- Surface rehabilitation including hoists and buildings
- Shaft Inspections and Maintenance
  - Level Inspections
  - Pumping
  - Ventilation
- Early Implementation Program at Homestake



Dewatering Homestake

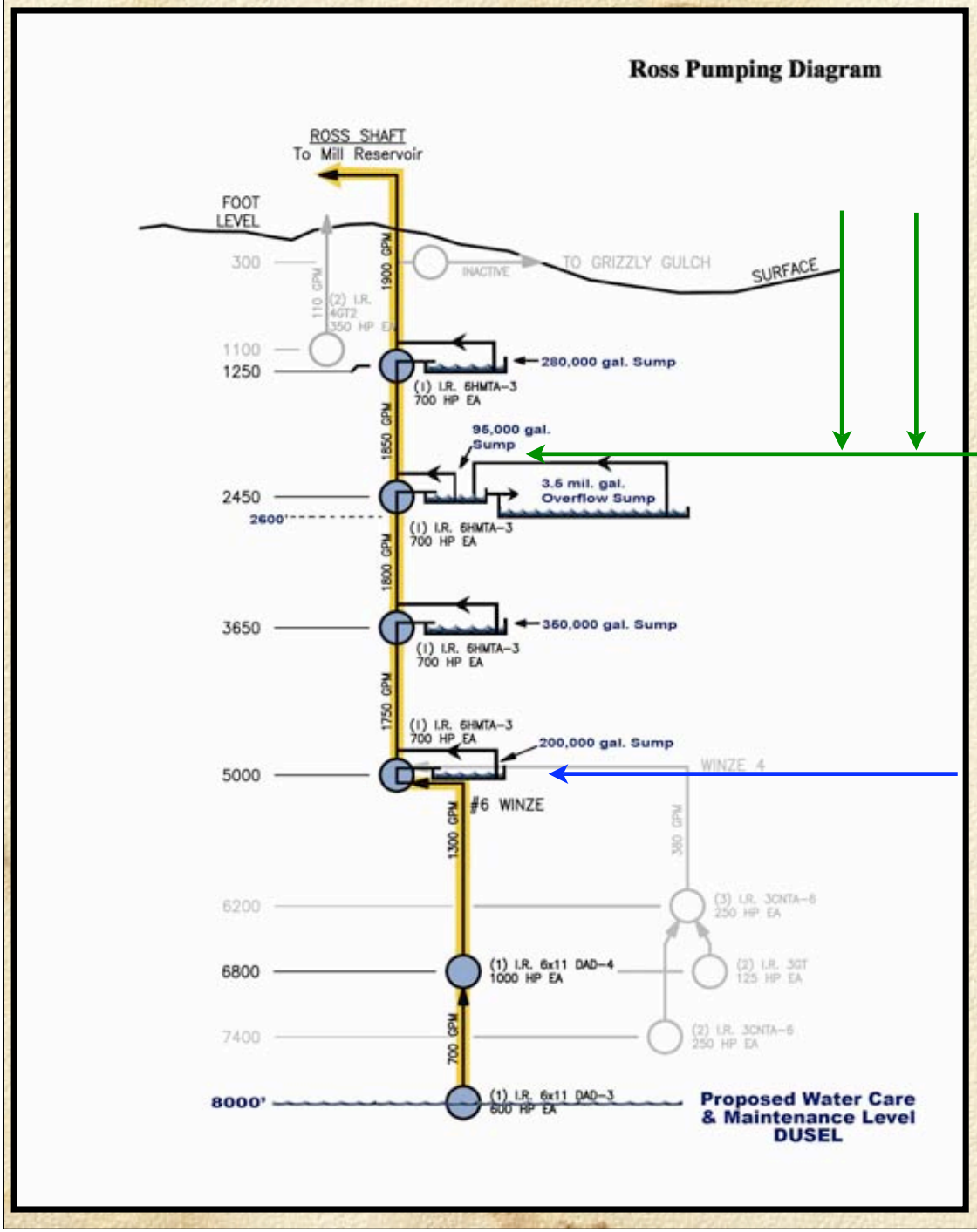
–

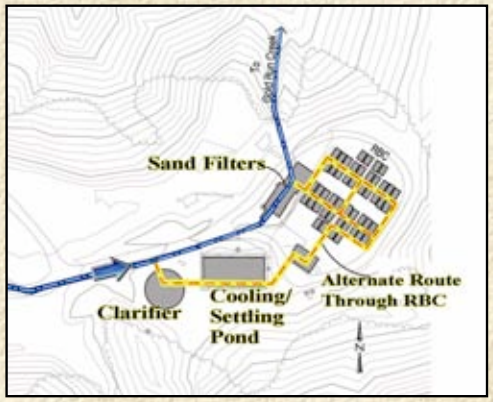
Current Water Levels

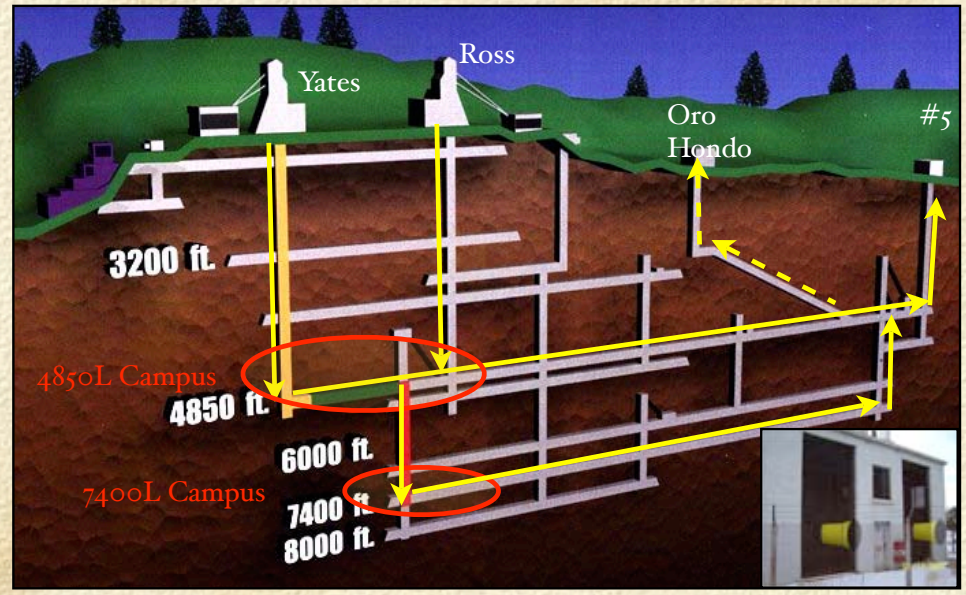
Re-entry Efforts, begun in July, have inspected levels and shafts down to 2100 L

- Immediate Focus on turning on pumps at 1250L and 2450L in August
- Arrest water at 5300L by September

5000 level submerged July 2007







General Plan for Primary Ventilation, Pumping

- Two Exhaust Fans at #5 Shaft (with alternate exhaust at Oro Hondo)
- SDSTA plan for installation of Ross Shaft Pumping System to hold the accumulated water below the 5300 L

Employing ~ 28 locals + 5 Dynatec supervisors

Sanford Laboratory

- 29 August SDSTA Board approved funding Interim Laboratory: $65M State + Sanford funds to develop Sanford Laboratory (surface, access, 4850L)
- SDSTA currently seeking 25 - 30 employees: Interim Lab Director Project Managers, Project Engineers, Safety Director, ...

Experiment Name	PI(s)	Institution	Letter of Interest	Memorandum of Understanding	Brief Description
LUX: Development of a large liquid xenon dark matter detector	Rick Gaitskell Tom Shutt	Brown Case Western	Yes	Yes	Direct Detection of Dark Matter using cryogenic liquid Xe, detection of signals and separation of signal from background using scintillation light. Detector requires several meters of water shielding to reduce backgrounds. 4850L Davis Cavity is appropriat
Collaborative Research Towards Transparent Earth	Steven Glaser Lane Johnson Bill Roggenthen	UCB UCB SDSM&T	Yes	Yes	This proposal presents a plan to install and operate a permanent seismic observatory illuminating the volume of the Homestake Mine from all six possible directions. We have chosen the Homestake DUSEL site because it offers a unique opportunity - the large
Low Background Counting Facility, DOE BES ESPSoR	Dongming Mei Bill Roggenthen	USD SDSM&T	Yes	Yes	Develop a state-of-the-art Low Background Assay Facility in the Davis Cavity (4850L)
miniCLEAN	Andrew Hime	LANL	Yes	MOU under discussion	Direct Detection of Dark Matter using cryogenic noble gases.
Liquid Argon Dark Matter	Dongming Mei Andrew Hime KTL	USD LANL LBNL	Yes	MOU under discussion	Direct Detection of Dark Matter using cryogenic noble gases.
Homestake: Biological, Chemical and Geological Sampling	Sookie Bang Mark Conrad	SDSM&T LBNL	Yes	Yes	Site Characterization and baseline establishment for biology, chemistry, hydrology, and geology
Majorana: Neutrinoless double beta decay R&D	John Wilkerson Steve Elliott	U.W. LANL	Yes	MOU being developed August 2007	Development of ultrapure materials, low background counting and Ge detector demonstration module
Large Cavity Development and R&D	Milind Diwan Ken Lande	Brookhaven Penn	Yes	Yes	Develop plans for large cavities and water-Cerenkov detectors for nucleon decay and long baseline neutrino experiments
Carbon Sequestration Experimental Design	Joe Wang Kevin Lesko	LBNL LBNL	Yes	Yes	Development of experimental designs for carbon sequestration facilities and the behavior of super-critical CO2 in the underground

Dark Matter

Geo/seismic array

Low Background Counting

Dark Matter

Dark Matter

Geo/Bio

Neutrinoless ββ

Large Cavities, LBL νs

Carbon Sequestration

4850L Lab Modules, Shops, and Common Facilities Phased Development Plan

Existing Neutrino Chamber: Davis Experiment 56' x 30' x 26'

Yates Shaft

#1 Excavation in FY2007-9
Yates & Davis Labs
Bio- & Geo-sciences Lab
Construction Shops

#2 Excavation in FY2010-12
Common Facilities
Lab Modules #1 and #2

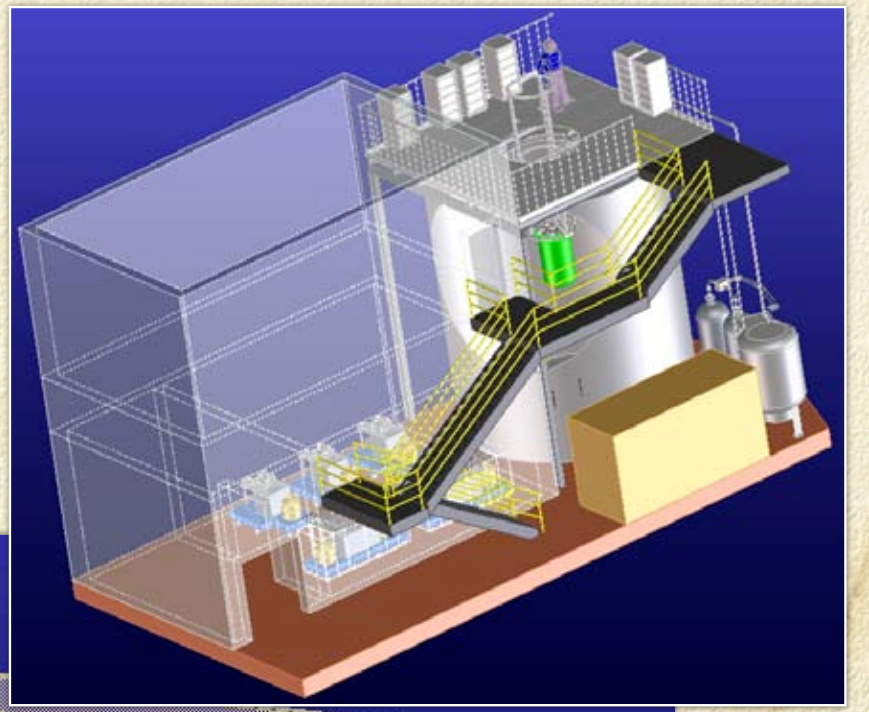
#3 Excavation in FY 2011-13
Lab Modules #3 and #4

Ross Shaft

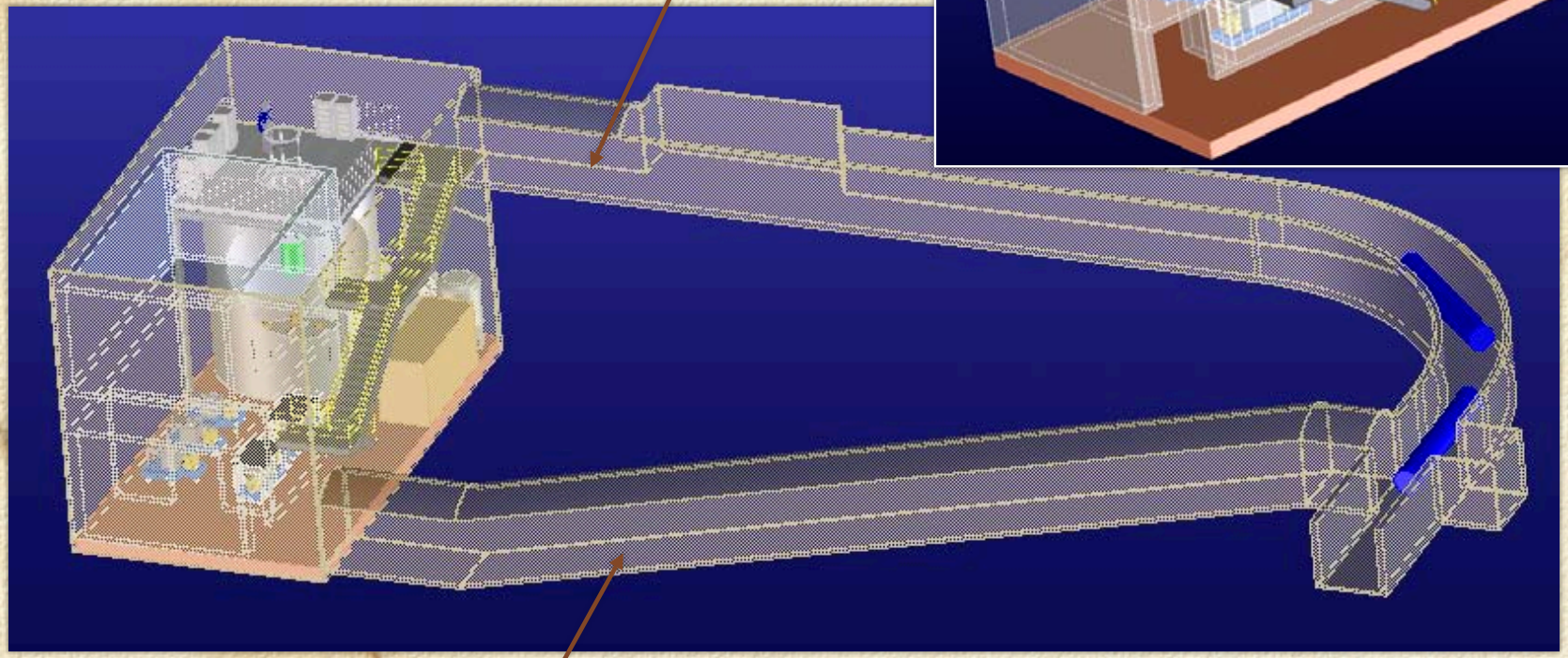
Total excavated space for labs, shops, and common facilities at 4850L: > 6,000 m^2 (65,000 SF)

Dark Matter Experiment with Low Background Facility

Current Davis Cavity Dimensions:
55ft x 30ft x 32ft high



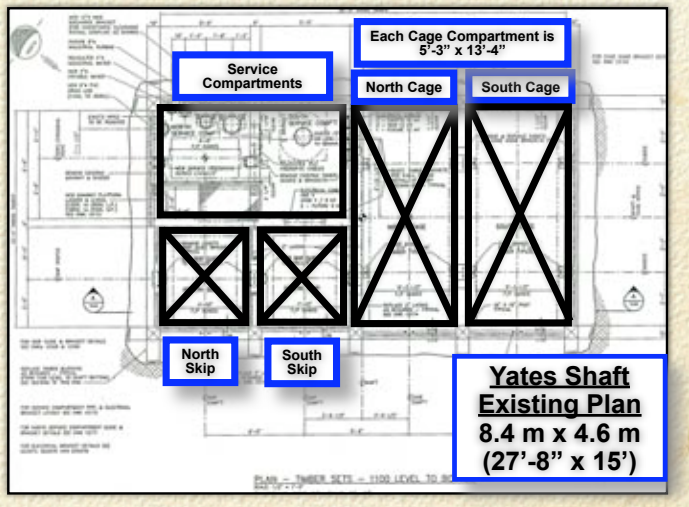
4850L Access



4850L Secondary Access

Yates Shaft Upgrade Plan

Improved access to the 4850 Level for personnel, equipment, and utilities



Existing Cage Dimensions and Capacities

Yates Cage Hoist

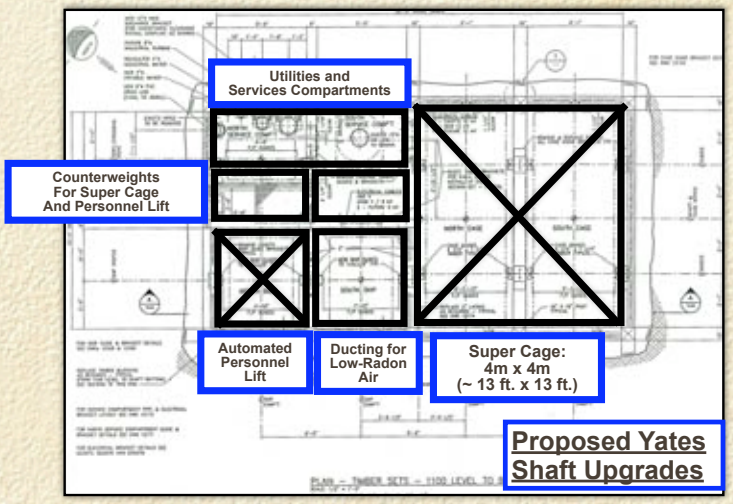
Maximum cage dimensions: 1.4 x 3.7 x 2.2m high (side-by-side)
(4' 8" x 12' 1.5" x 7' 2" high)
Maximum cage payload: 5,450 kg (12,000 lb), nominal
5,900 kg (13,000 lb), allowable at 1/2-speed.

Ross Cage Hoist

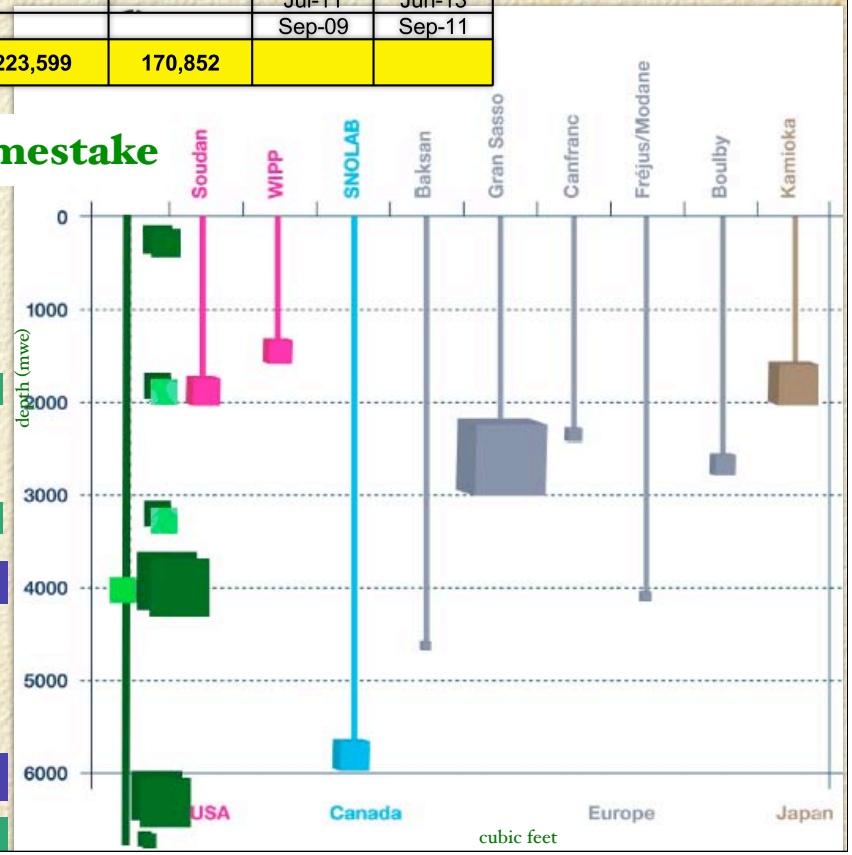
Maximum cage dimensions: 1.3 x 3.8 x 2.2m high (double deck)
(4' 4-5/8" x 12' 5" x 7' 2" high)
Maximum cage payload: 5,450 kg (12,000 lb, nominal
6,100 kg (13,400 lb), allowable at 1/2-speed.

#6 Winze Cage Hoist

Maximum cage dimensions: 1.3 x 3.7 x 2.2m high (double deck)
(4' 4" x 12' 1-1/2" x 2.2m high)
Maximum cage payload: 5,450 kg (12,000 lb), nominal
6,400 kg (14,000 lb), allowable at 1/2-speed.



Homestake Interim Lab and DUSEL Summary of Development of Space and Availability (Underground Space Fully Outfitted and Ready for Detector Installation)		Labs, Shops, Offices Usable Floor Area		Excavation Volume (including access drifts)		Construction Schedule	
		sq. ft.	sq. m.	cu. yd.	cu. m.	Start	Finish
4850 Level	**Subtotal**	**107,351**	**9,973**	**111,115**	**84,903**		
Ross Shops for Construction Staging		12,469	1,158	5,738	4,385	Apr-08	Dec-08
Davis Lab, Sanford Lab, and Bio-Geo Lab		15,738	1,462	13,543	10,348	Sep-08	Jul-09
Lab Module #1 and Common Facilities		26,464	2,459	25,155	19,221	Oct-10	Sep-12
Lab Module #2		17,560	1,631	21,433	16,377	May-11	Apr-13
Lab Module #3		17,560	1,631	23,121	17,667	Sep-13	Jul-15
Lab Module #4 (excavation only, without lab outfitting)		17,560	1,631	22,125	16,906	Aug-14	Jul-15
7400 Level	**Subtotal**	**63,588**	**5,907**	**98,477**	**75,246**		
Lab Module #1 and Common Facilities		28,468	2,645	29,594	22,613	Jan-12	Mar-14
Lab Modules #2 and #3 (excavation only, without lab outfitting)		35,120	3,263	68,883	52,633	Dec-12	Jan-14
300 Level	**Subtotal**	**8,668**	**805**	**14,007**	**10,703**		
Lab #1, Shops, and E&O Rooms		8,668	805	14,007	10,703	Nov-10	Nov-11
Surface	**Subtotal**	**98,000**	**9,104**				
DUSEL Offices and User Support Areas,Phase 1		10,000	929			Dec-10	Jun-12
Sanford Clean Room and Assembly Shop		6,000	557			Dec-10	Jun-12
DUSEL Offices and User Support Areas,Phase 2		32,000	2,973			Jul-11	Jun-13
Sanford Center for Science Education		50,000	4,645			Sep-09	Sep-11
Total		**277,607**	**25,790**	**223,599**	**170,852**		



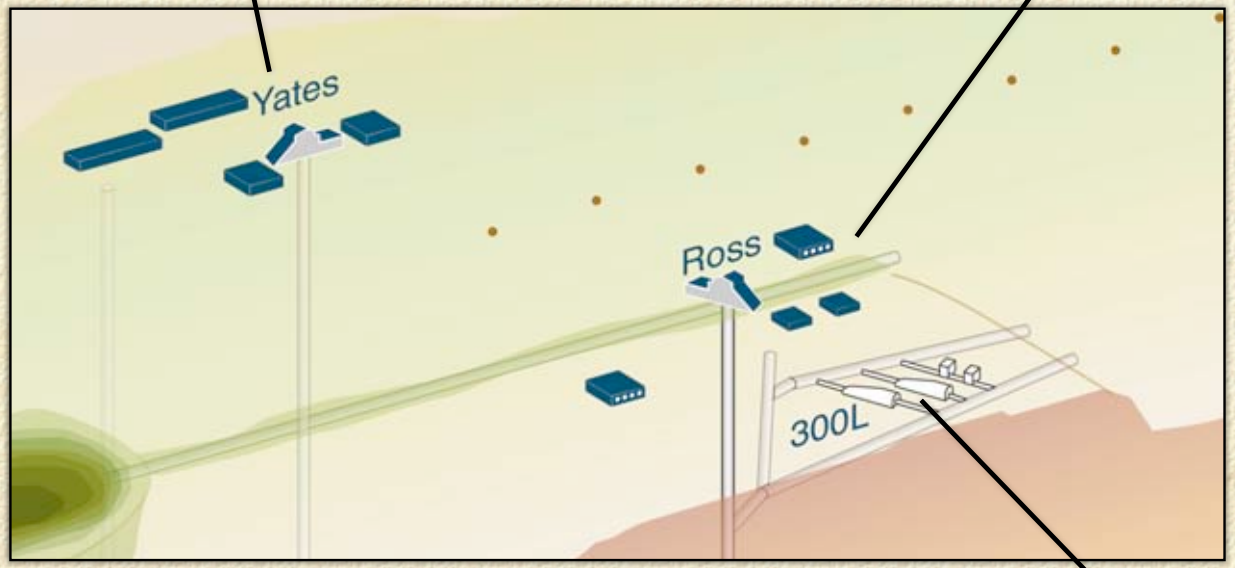
Campus Development Concepts for Surface Facilities and 300 Level

Yates Complex Surface Facilities:

- Laboratory Administration Building and Training
- User Support Services: Clean Room Assembly & Fabrication Shops
- R&D Laboratories, User Offices, Meeting Rooms
- Education and Outreach: Sanford Center for Science Education
- Shipping and Receiving, Storage

Ross Complex Surface Facilities :

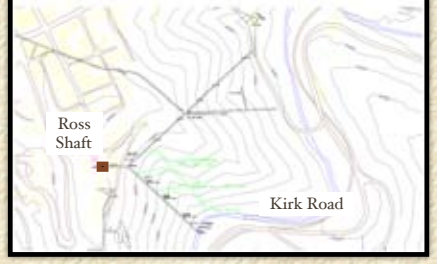
- Construction Materials and Equipment Staging
- Construction Superintendents and Contractor Offices
- Maintenance Shops
- Shipping and Receiving, Storage
- Facility Site Services and Operations



Experiments and Facilities at 300 Level:

- Education and Outreach Classroom and Laboratory
- User Support Shops: Assembly, Fabrication and Underground Storage
- Research and Development Laboratories
- Near-surface Experiments
- Low-background Counting and Calibration Facility

300 Level Campus Plan for near-surface, drive-in access



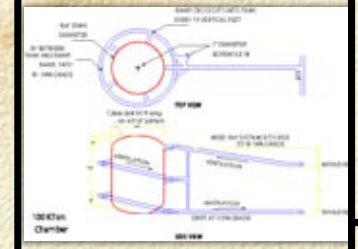
Campus Concepts for Mid- and Deep-level Experiments

Early Implementation Program & Facility Infrastructure Development at 4850L:

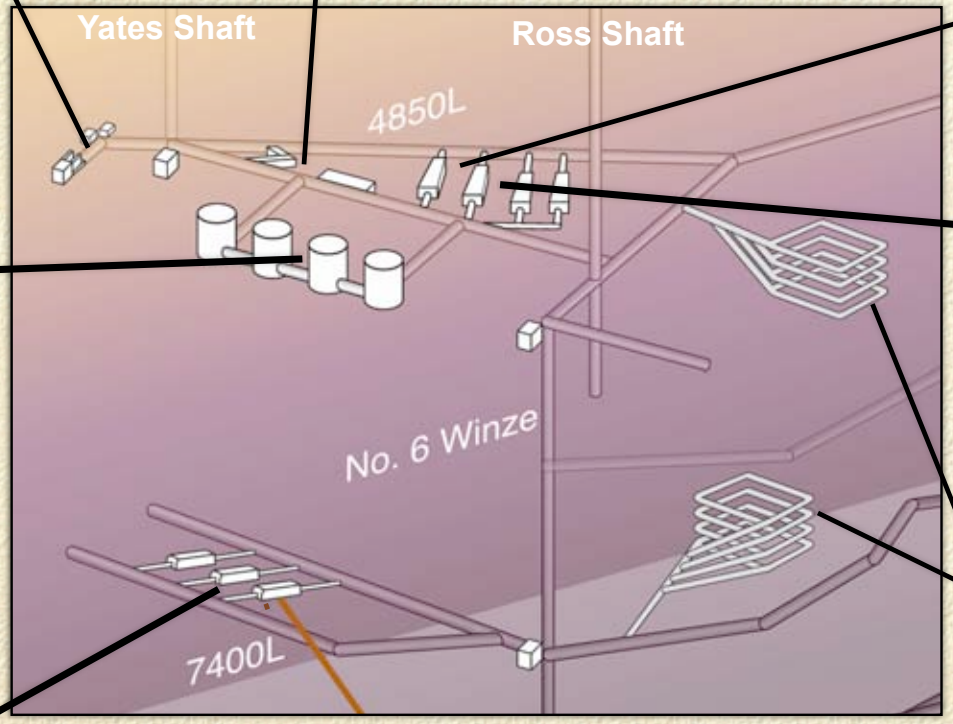
- Low-Background Counting Facility
- Neutrinoless Double Beta Decay
- Dark Matter
- Earth Sciences and Geo-microbiology Lab
- Common Facilities and Clean Room Transition
- Utility Services and Refuge Chamber

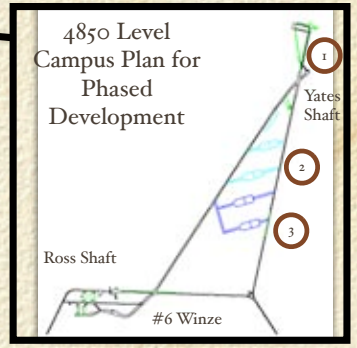
Initial Suite of Experiments at 4850 Level

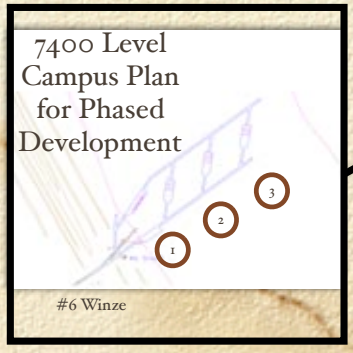
- Dark Matter
- Double Beta Decay
- Nuclear Astrophysics
- Solar Neutrinos
- Geoneutrinos



Design and Excavation concept for future, multiple 100 kTon chambers for Long Baseline Experiment







Geosciences:

Large Block Coupled Processes Experiments

Initial Suite of Experiments at 7400 Level:

- Large Double Beta Decay
- Solar Neutrinos
- Supernovae Detection
- Large Dark Matter

The Initial Suite of Experiments (to be included with Construction Proposal)

- DUSEL Construction in FY10 or 11
  - $250M for the facility
  - $250M for the Initial Suite of Experiments (experimental equipment)
    - Funds to be made available in 2008 to bring the ISE to the same level of "readiness" as the facility, must be submitted together, multidisciplinary suite
    - Process to establish the ISE to be determined
    - Town Meeting 2 - 4 November 2007 to begin process

Homestake PIs, Senior Personnel & Coordinators

- Michael Barnett, LBNL (E+O)
- Yuen-dat Chan, LBNL (Other uses)
- Milind Diwan, BNL (lbl, pdk)
- Reyco Henning, UNC (ονdbd, dm)
- Ken Lande, Penn (lbl, pdk, geo-neutrinos)
- Bob Lanou, Brown (neutrinos, solar neutrinos)
- Chris Laughton, FNAL (engineering)
- Kevin T. Lesko, UCB (physics) PI
- Stu Loken, LBNL (E+O)
- Hitoshi Murayama, UCB (physics theory, neutrinos)
- Tommy Phelps, ORNL (geomicro)
- Bill Roggenthen, SDSM&T (geophysics) coPI
- Ben Sayler, BHSU (E+O)
- Tom Shutt, Case Western (low backgrounds)
- Nikolai Tolich, U.W. (geonus)
- Bruce Vogelaar, Virginia Tech (solar nus)
- Herb Wang, U Wisc. (geology, rock mechanics)
- Joe Wang, LBNL (earth science, geophysics)

Richard DiGennaro, LBNL, Project Manager and Systems Engineer

Dianna Jacobs, LBNL Project Controls

Liz Exter, Dave Plate, Project Engineering

Mark Laurenti, Mining Engineer

Syd DeVries, Mining Engineer

Dave Snyder, SDSTA Exec. Director

Trudy Severson, SDSTA

SDSTA Engineering and Safety Personnel

Ms. Melissa Barclay & Jeanne Miller

http://www.lbl.gov/nsd/homestake

http://neutrino.lbl.gov/Homestake/LOI

http://neutrino.lbl.gov/Homestake/FebWS

http://homestake.sdsmt.edu/HRB/Refer.htm

http://neutrino.lbl.gov/Homestake

http://www.dusel.org