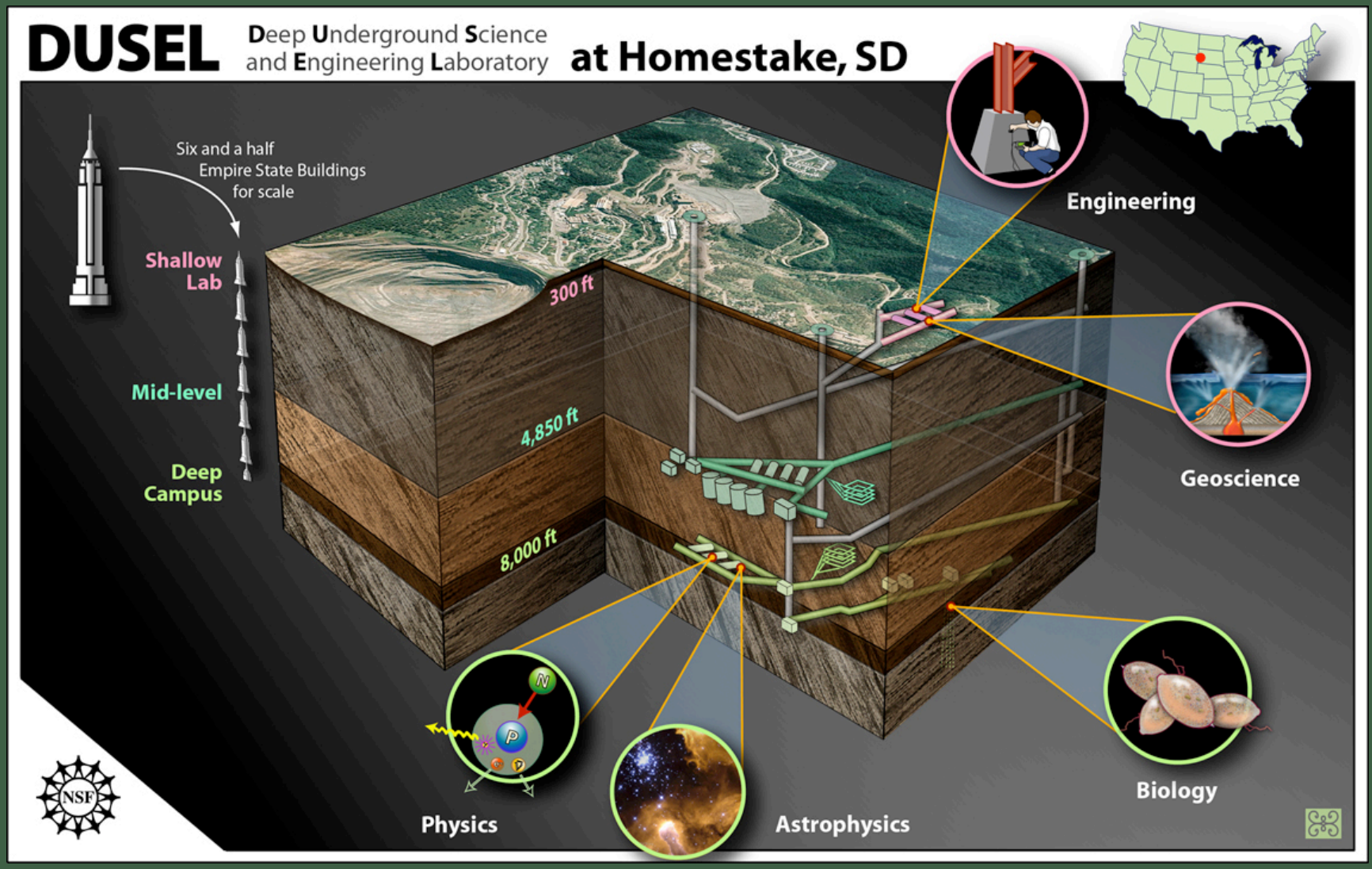
DUSEL Experiment Development and Coordination (DEDC)

Washington Visit

March 19 - 21, 2008

Kevin T. Lesko & William Roggenthen



Homestake Facility - Outline

- Homestake DUSEL
  - Preliminary Experimental Program
    - Physics
    - Earth Science
    - Biology
    - Engineering
    - Education and Public Outreach
  - Facility Concepts to Support the Experiments
  - South Dakota Efforts and the Sanford Lab
  - Integrated Schedule
  - The DUSEL Experiment Development Committee

DUSEL Initial Suite of Experiments (ISE)[1]	Experimental Cavity Size (m^2)[2a]	Required U/G Support Space (m^2)[2b]	Minimum Depth (mwe)[3]	Approximate Construction Start Date for "Generations" or Experiments[4]
Dark Matter (WIMPS)				
Generation 0 (PreDUSEL)				
Sensitivity 10^-44 - 10^-45				
Noble Liquid (2 phase)	100	250	4100	LUX 300 proposal for Sanford Lab (2008) (Xe)
Low Temperature Solid State	100	250	2000	CDMS Experiment in Soudan (running) (Ge + Si)
Low Temperature Solid State	100	250	4100	SuperCDMS Proposal to SNOLab (2009) (Ge + Si)
Noble Liquid (1 phase)	*N/A*	N/A	N/A	miniClean Proposal to SNOLab (2008) (Ar)
Noble Liquid (2 phase)	*N/A*	N/A	N/A	WARP Experiment to Gran Sasso (running) (Ar)
Noble Liquid (2 phase)	*N/A*	N/A	N/A	Xenon10 Experiment to Gran Sasso (completed) (Xe)
Noble Liquid (2 phase)	*N/A*	N/A	N/A	Xenon100 Proposal to Gran Sasso (2008) (Xe)
Generation 1 (DUSEL ISE)				
Sensitivity 10^-45 - 10^-46				~ 2011 - 2013
Technology 1 TBD	100	250	4100	detector construction to commence earlier on the surface
Technology 2 TBD	100	250	4100	detector construction to commence earlier on the surface
Generation 2 (DUSEL ISE)				
Sensitivity 10^-46 - 10^-47				~ 2015
Technology 1 TBD	200	500	6400	detector construction to commence earlier on the surface
Technology 2 TBD	200	500	6400	detector construction to commence earlier on the surface
Neutrinoless Double Beta Decay				
Generation 0 (PreDUSEL)				
Degenerate Mass Scale Sensitivity				
Solid State (Ge)	100	200	4100	R&D for demonstator prior to MREFC at Sanford Lab (2009)
Noble Liquid (Xe)	150	200	2000	EXO200 running at WIPP
Bolometric (Te European)	N/A	N/A	3200	Cuoricino running, Cuore being built at Gran Sasso (2010)
Generation 1 (DUSEL ISE)				
Atmospheric Mass Scale Sensitivity				~ 2015
Solid State (Ge)	250	500	6400	
Noble Liquid/Gas (Xe)	500	200	6400	

Concepts for Initial Suite of Experiments - to be revised with community based program

Dark Matter

Sanford Lab

4850L

7400L

Neutrinoless ββ Decay

Sanford Lab

7400L

DUSEL Initial Suite of Experiments (ISE)[1]	Experimental Cavity Size (m^2)[2a]	Required U/G Support Space (m^2)[2b]	Minimum Depth (mwe)[3]	Approximate Construction Start Date for "Generations" or Experiments[4]
Long Baseline Neutrinos and Nucleon Decay				
Large Cavity R&D (~ 100kt first cavity)	2400	250	4100	
Site Investigations, coring, geotech work				~ 2008 - 2009
Continued geotech work, and Initial mobilization, instrumentation, access drifts 1-time equipment costs				~ 2011
Excavation ~ 55m cavity				~ 2012
Instrumentation				~ 2015 (PMT production to start earlier)
1 Ton Liquid Argon Module at 300 Level	500	200	230	~2013
Nuclear Astrophysics				
Low Energy Accelerator	800	200	4100	~ 2013
Heavy Ion Medium Energy Accelerator				~ 2015
Geoneutrino (multipurpose)				
1 kt liquid Scintillator Detector	250	250	4100	~ 2015
Low Energy Solar Neutrinos				
Generation 0 (PreDUSEL) (7Be, CNO?, pep?)				
Borexino	1000		3700	Borexino running at Gran Sasso
KamLAND	300	200	2000	Kamland Solar being developed in Kamioka
miniLENS	100	100	4100	miniLENS stage II proposal for Sanford Lab (2009)
Generation 1 (DUSEL) (pep, pp)				
Charged Current (CC)	250	200	4100	~ 2013
1 kt liquid Scintillator Detector (ES)	250	250	4100	~ 2015
3000kg Noble Gas (ES)	500	200	6400	~ 2015
Characterization of Low Vibration Studies for Future Gravity Wave Experiments				
Low vibration and microseismic studies	20000		1690	~ 2013

Long Baseline ν & Nucleon Decay

300L

4850L

Nuclear Astrophysics

4850L

Geoneutrinos

4850L

Low Energy Solar ν

4850L

7400

Gravity Waves

2000L

DUSEL Initial Suite of Experiments (ISE)[1]	Experimental Cavity Size (m^2)[2a]	Required U/G Support Space (m^2)[2b]	Minimum Depth (mwe)[3]	Approximate Construction Start Date for "Generations" or Experiments[4]
GeoBiology				
Biology Observatory	50	200	6400	~ 2014
Pristine Fracture Zone		300	6400	~ 2016
Intermediate Bio/Geo Drilling	50	300	4100	~ 2011
Deep Bio/Geo Drilling	50	300	7000	~ 2015
Deep Engineering and Excavation Research Facility				
Cavity Engineering	200	100	4100	~ 2011
Excavation Research (TBM)	400	200		
Excavation Research (Drilling)	200	100		
Cavity Engineering	200	100	6400	~ 2016
Excavation Research (TBM)	400	200		
Excavation Research (Drilling)	200	100		
Scale Effects Experiment				
Run-of-Mine Fracture Characterization	50	50	4100	~ 2011
State-of-Stress and Deformation Research	50	50		
Multiphase Fluid Flow Research	50	50		
Run-of-Mine Fracture Characterization	50	50	6400	~ 2016
State-of-Stress and Deformation Research	50	50		
Multiphase Fluid Flow Research	50	50		
Seismic Array - surface	1000		100	~ 2008
Seismic Array - 3800	1000	10	3200	~ 2009
Active Processes Laboratory				
Transparent Earth (Shallow)		200	4100	~ 2011
Transparent Earth (Deep)	200	100		
THMBC (Chemical Migration)	200	100		
THMCB (Multiphase Migration)	200	100		
Fracture Processes Facility	1000	200		
Transparent Earth (Deep)	200	100	6400	~ 2016
THMBC (Chemical Migration)	200	100		
THMCB (Multiphase Migration)	200	100		
Fracture Processes Facility	1000	200		
CO2 Sequestration and Flow	bore holes		Various	~ 2011
Low Background Counting				
Prescreening array, ICPMS & NAA Assay Facility	50	100	230	~ 2011
Gamma, Beta, Alpha, Whole Body Assays and Radon Emanation Measurements	200	100	4100	~ 2011
Materials Storage				
	150		230	~ 2013
	150		4100	~ 2011
	150		6400	~ 2013
Ultralow Background Materials Processing				
Copper Facilities including Ultraclean Machine Shop	350	150	4100	~ 2011
Education and Outreach				
Shallow Lab	250	100	230	~ 2013
Intermediate Depth Lab	100	100	4100	~ 2013
Prototyping and R&D				
	500	500	230	~ 2013
	250	500	4100	~ 2015
	250	500	6400	~ 2017

Geobiology

0 - 16,000

Engineering and Excavation Research

4850L

7400L

Scale Effects

4850L

7400L

Active Processes

4850L

7400L

Low Background Materials

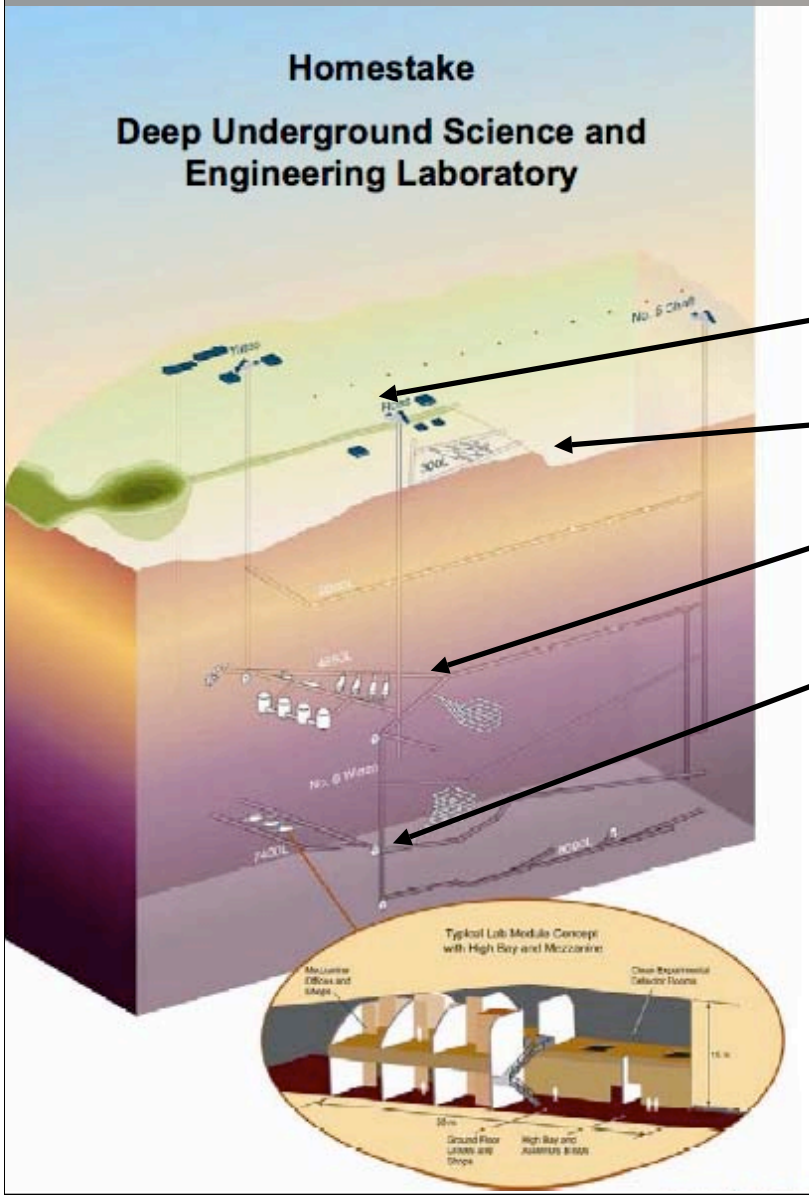
300L

4850L

Education and Outreach

300L

Campus Concepts for DUSEL



Planning to develop four primary campus locations for research:

1. Surface campus at Yates Complex
2. Near-surface campus at 300 Level
3. Mid-level campus at 4850 Level
4. Deep-level campus at 7400 Level

Infrastructure will be maintained for access to additional, selected levels for bio- and geo- sciences and for unique experiments that require specific or isolated sites.

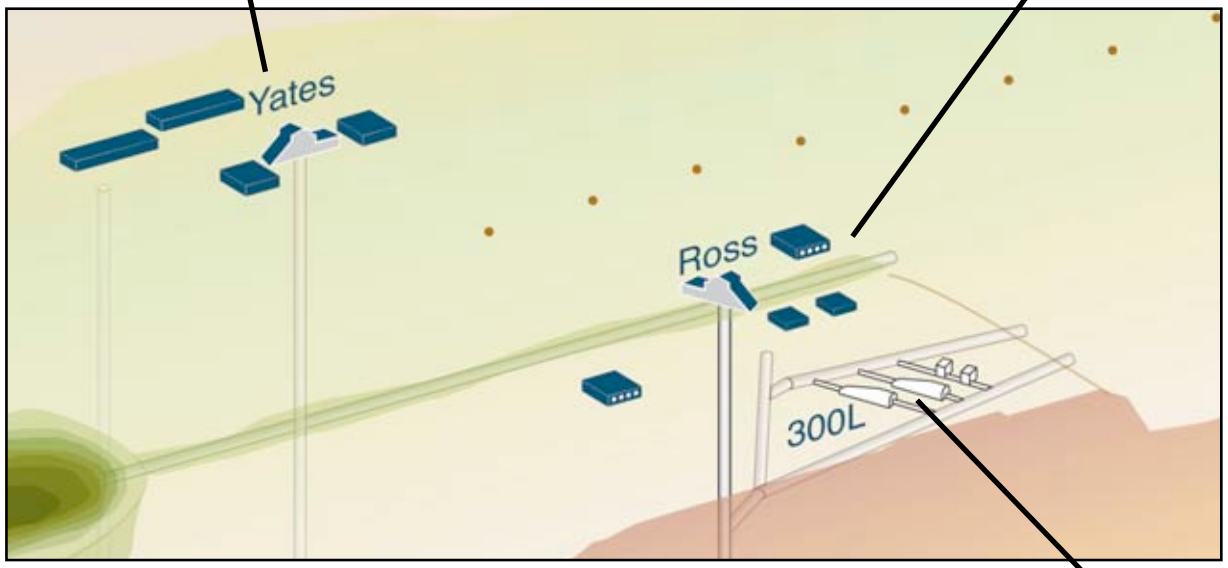
Campus Development Concepts for Surface & 300 Level

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 :

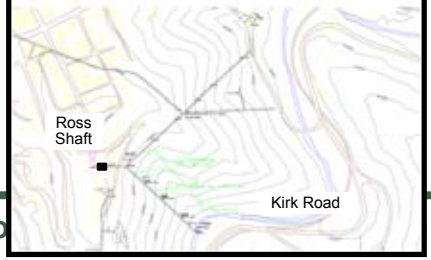
- Construction Materials and Equipment Staging
- Construction Superintendents and Contractor Offices
- Maintenance Shops
- Shipping and Receiving, Storage
- Facility Site Services and Operations



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



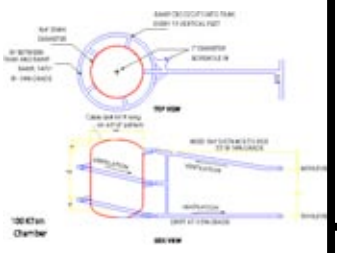
Concepts for Mid- & Deep-level Experiments

Early Implementation Program & Facility Infrastructure Development at 4850L:

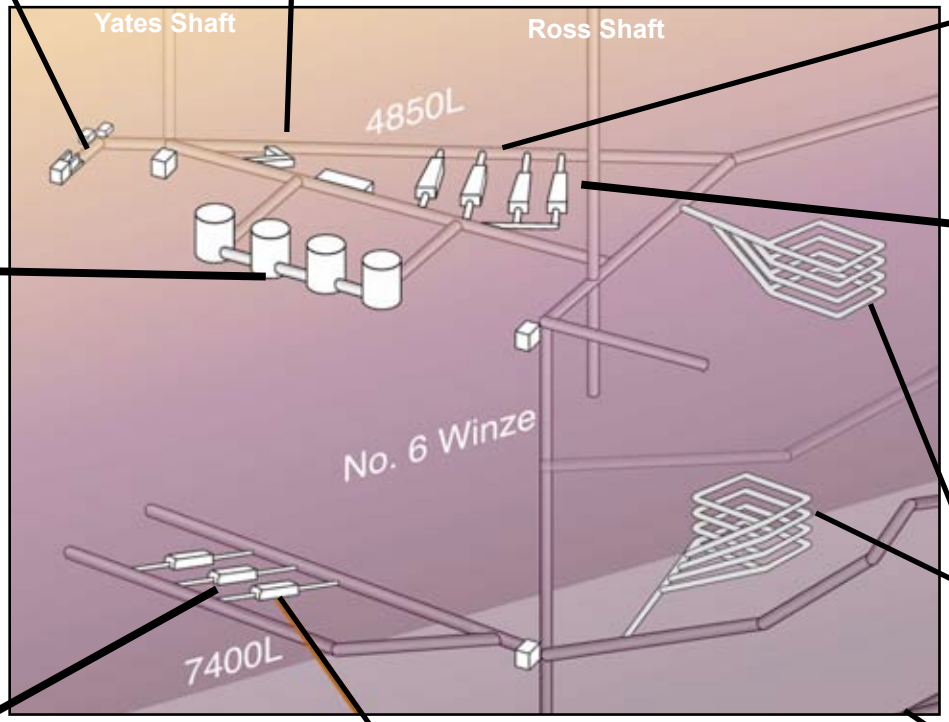
- Low-Background Counting Facility
- Neutrinoless Double Beta Decay
- Dark Matter
- Earth Sciences and Geo-microbiology Lab
- Common Facilities and Clean Room Transition
- Utility Services and Refuge Chamber

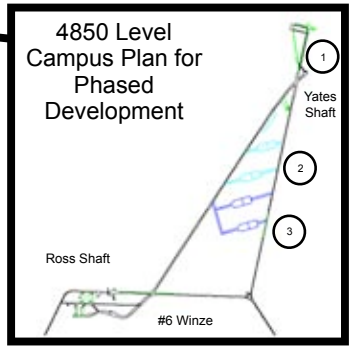
Initial Suite of Experiments at 4850 Level

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



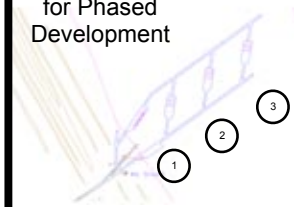
Design and Excavation concept for future, multiple 150 kTon chambers for Long Baseline Experiment





Geosciences:

Large Block Coupled Processes Experiments



#6 Winze

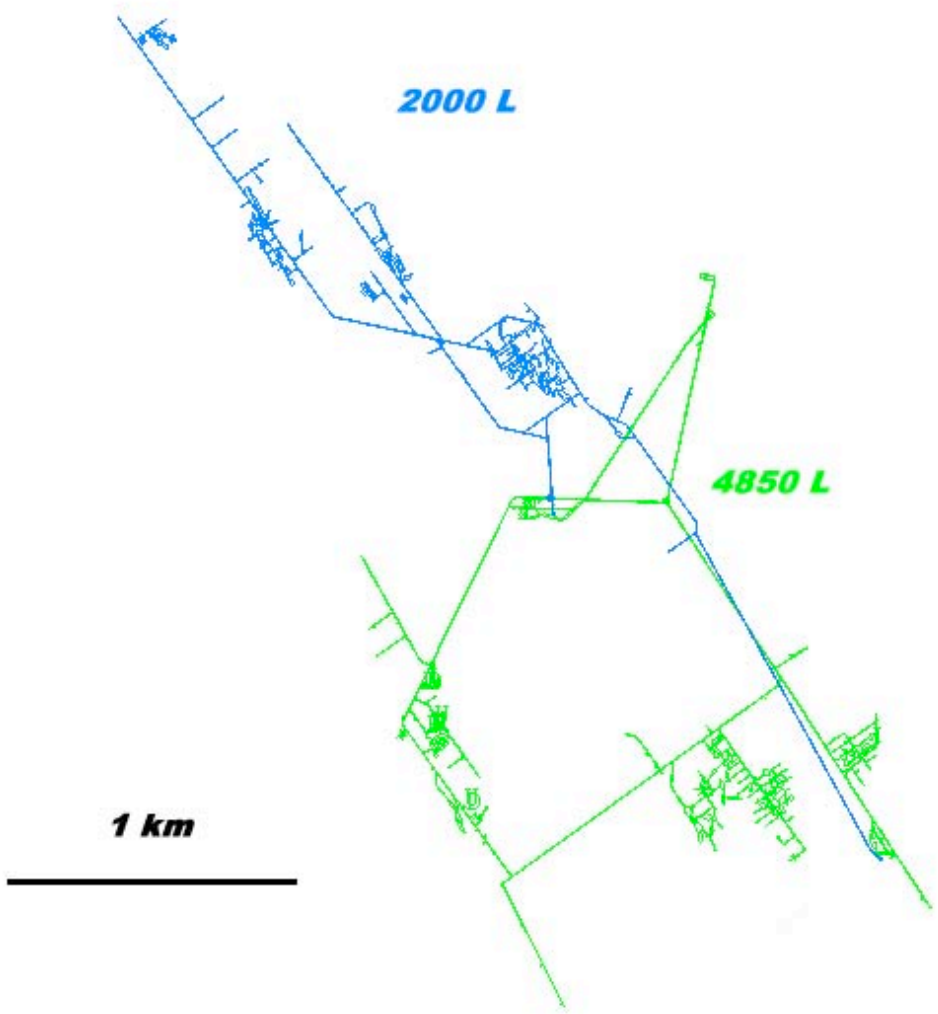
Initial Suite of Experiments at 7400 Level:

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

Geosciences:

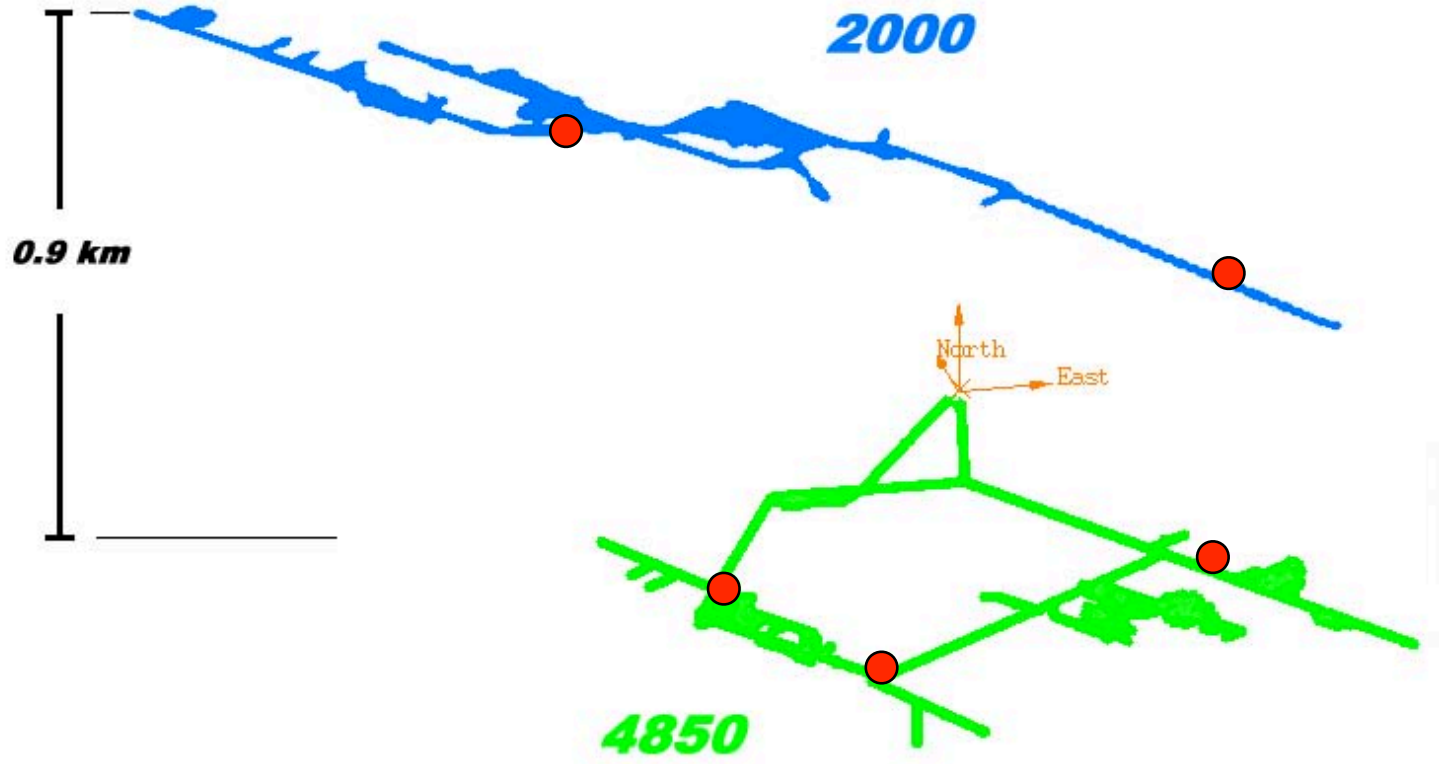
Deep Drill Room at 8000L

Levels to be maintained



Levels
300L
800L
1100L
2000L
2600L
3800L
4100L
4850L
5900L
6800L
7400L
7700L
8000L

Example- 2000 L and 4850 L



isometric view
2000 - 4850 ft levels

Progress at Sanford Lab

- October 2005, State Legislature approves additional $20M funding for Homestake, total of $46M
- Property Donation Agreement Completed 14 April 2006, Property transfered May 2006, SDSTA hiring staff to oversee and operate Homestake: ~30 for rehab, ~ 25 to 30 staff
- June 2006 $70M Sanford Gift, $15M gifted in 2007
- January 2007 Rehab work initiated, $60M in hand
- October 2007 SDSTA Hires Jose Alonso
- Early Implementation Program at Homestake 2008 - 2012 "The Sanford Laboratory" *Total Budget* ~$126M

Homestake DUSEL

Approximate boundary
of transferred property:
186 acres (surface) 7700 (u/g)

WWTP

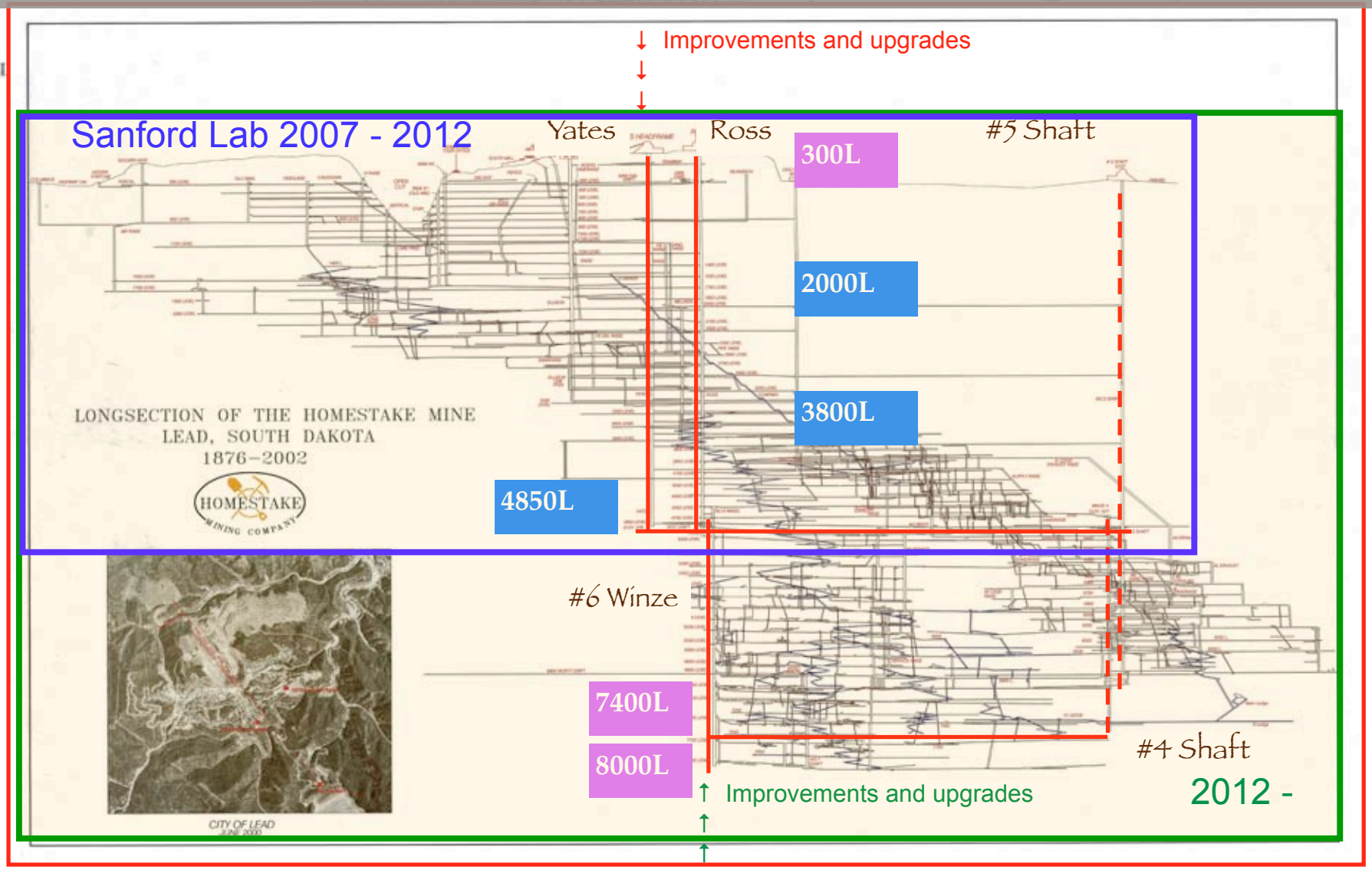
Open
Cut

Yates
Complex

~ 1km

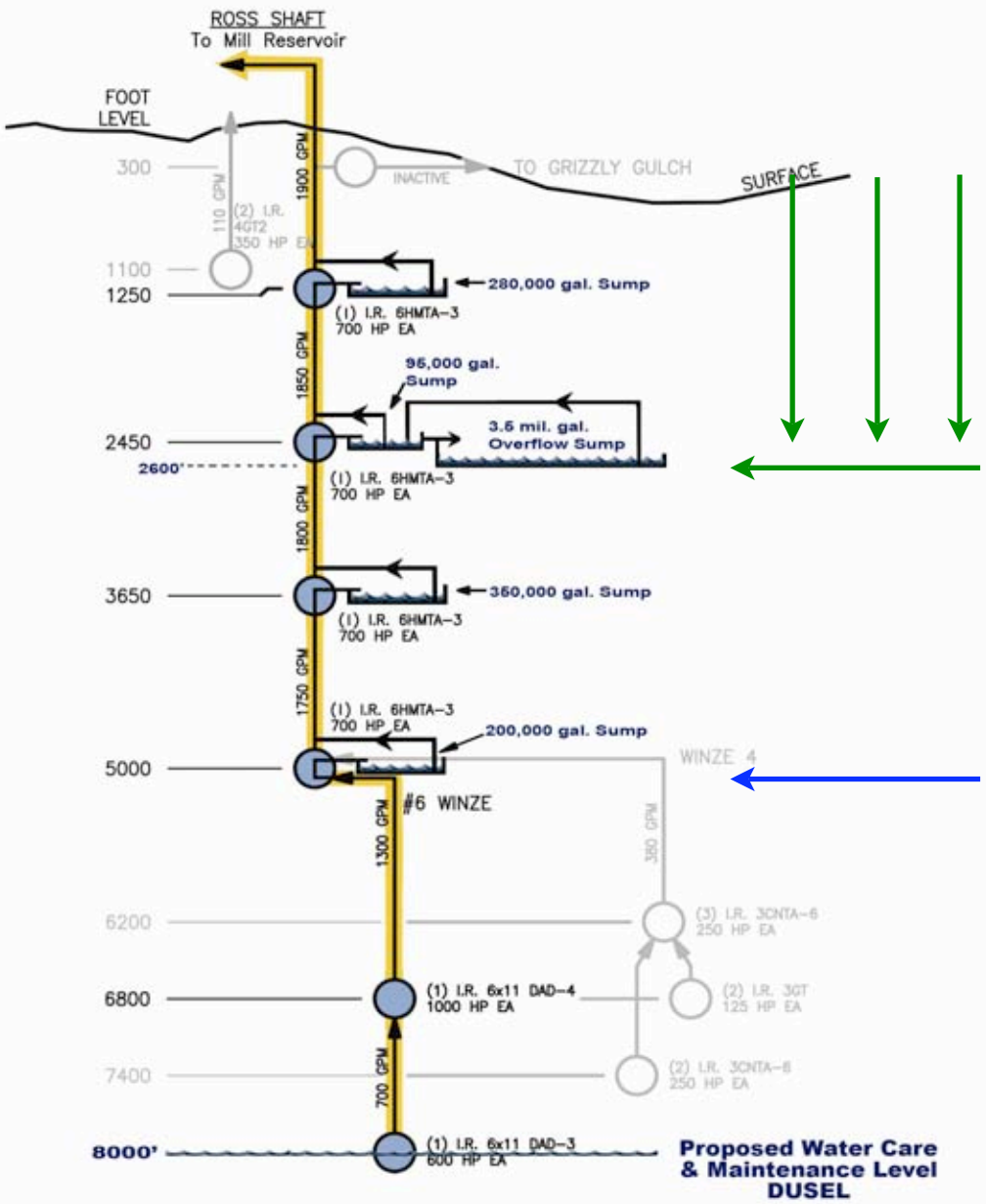
Ross Complex

Phased approach to building DUSEL



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

Dewatering Homestake - Current Water Levels

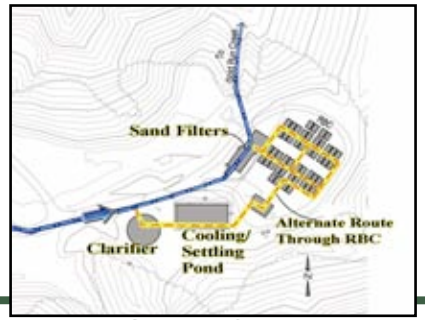


Re-entry Efforts, begun in July, have inspected levels and shafts down to 2600 L

Will focus on turning on pumps at 1250L and 2450L,

14 March 1250L Pumps activated

5000 level tripped July 2007

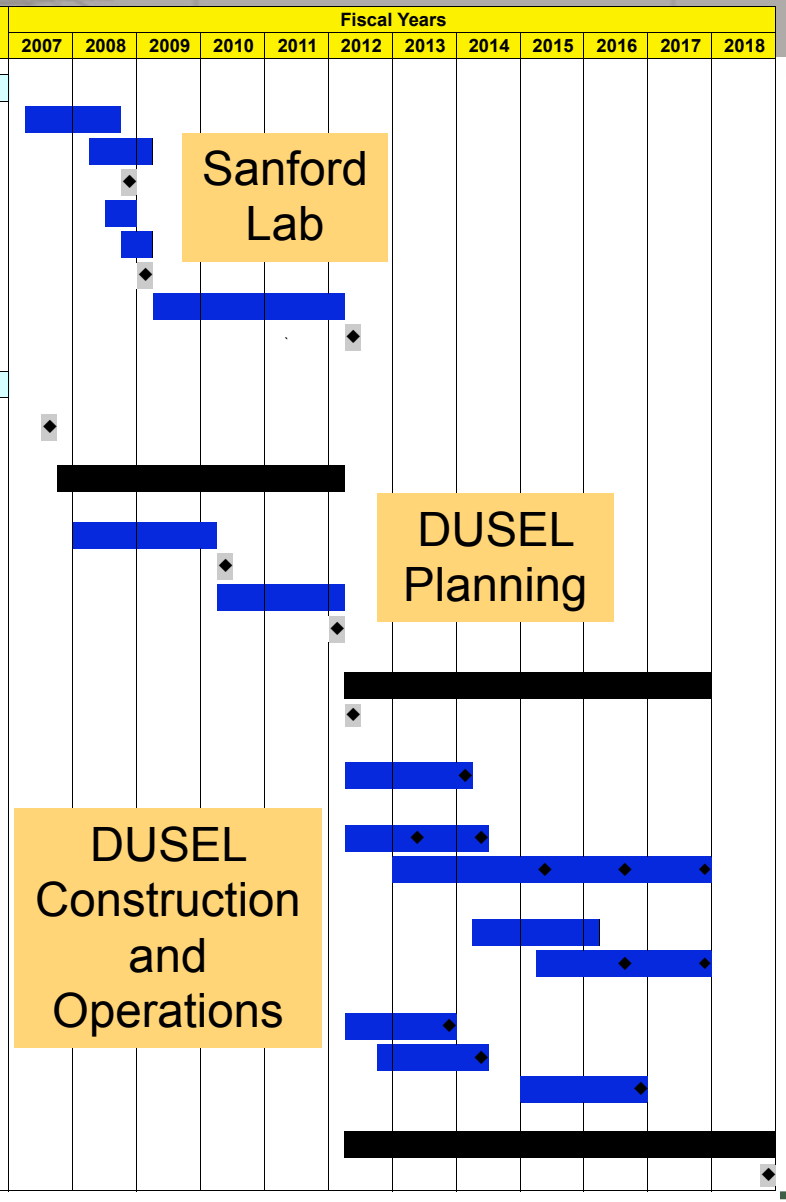


Major Milestones for the Homestake Facility & Initial Suite of Experiments

- November 2007 Town Meeting
- April 2008 Lead Workshops
- July 2008 Internal Review of DUSEL
- Late Spring S-4 Solicitation Announcement
- Fall 2008 S-4 Funds for Experiment PDRs
- December 2008 NSF Review of DUSEL (Facility + ISE)
- Summer 2009 Review of ISE by NSF Panel
- Summer/Fall 2009 Integration ISE and Facility
- Fall 2009 Completion of DUSEL PDR & Review
- Winter 2009-10 Preliminary Baseline Review by NSF
- March 2010 Presentation to NSB (upon passing review)
- FY2012 MREFC funding (projected)

Milestone Schedule

Proposed Timeline for Sanford Laboratory and DUSEL	Start	Finish
Sanford Laboratory at Homestake		
Ross Shaft Rehab and Pumping Column Commissioning	Jan-07	May-08
Yates Shaft Rehab.	Mar-08	Dec-08
Gain safe access to 4850L for EIP construction start, and hold water level at 5000L		Jun-08
Install facility infrastructure for Davis Lab early experiments	May-08	Sep-08
Install and commission research instrumentation in Davis Lab	Jul-08	Dec-08
Early experiments in Davis Lab ready for operation		Dec-08
Continued rehabilitation and infrastructure upgrades for Sanford Lab		Dec-11
Transition from Sanford Lab to DUSEL Operations		Jan-12
NSF Deep Underground Science and Engineering Laboratory at Homestake		
Homestake site selection announcement		Jul-07
DUSEL Preconstruction Planning and Development (R&RA)	**Oct-07**	**Dec-11**
Preliminary Design Phase to develop Baseline Cost and Schedule	Oct-07	Dec-09
Preliminary Design Review and National Science Board Recommendation		Mar-10
Final Design Phase	Mar-10	Dec-11
Final Design Review and Authorization for Construction Start		Dec-11
DUSEL Facility - Construction and Commissioning (MREFC)	**Jan-12**	**Sep-17**
Construction Start		Jan-12
Near-Surface Campus Construction at 300L		
300L Laboratories and Education and Outreach Facilities	Jan-12	Dec-13
Mid-Level Campus Construction at 4850 Level		
4850L Common Facilities and Lab Module #1 (Excavation & Lab Build-out)	Jan-12	Jan-14
4850L Lab Modules #2, #3 and #4	Oct-12	Jul-17
Deep-Level Campus Construction at 7400 Level		
7400L Common Facilities and Lab Module #1 (Excavation & Lab Build-out)	Jan-14	Dec-15
7400L Lab Modules #2 and #3	Jun-15	Jul-17
Surface Campus Construction		
Infrastructure to support Underground Construction and Operations	Jan-12	Sep-13
Phase 1 Offices and Laboratories	Jul-12	Mar-13
Phase 2 Offices and Laboratories	Oct-14	Sep-16
DUSEL Initial Suite of Experiments - Construction and Commissioning	**Jan-12**	**Sep-18**
MREFC Construction Finish		Sep-18



DUSEL Experiment Development and Coordination

Homestake DUSEL Initial Suite of Experiments

Summary

- World-class Scientific Programs
- Unique capabilities in the world
  - 3 to 5 flag-ship experiments identified
- Efforts underway at Sanford Lab to prepare the site ($126M) independent of and parallel to the DUSEL efforts, with $60M in hand FY08
  - phased program for experiments
- Long-term site
  - tailored access
  - 30 + year horizon
  - no competition

Community DUSEL Activities

- S-1 Report
  - culminated in Deep Science
- November 07 Town Meetings
  - 220 participants
  - White Papers and Roadmaps
  - http://cosmology.berkeley.edu/DUSEL/Town_meeting_DC07/working_groups.html
  - Working Groups
    - Geo/Solar Neutrinos - Vogelaar & Tolich
    - Neutrino Double Beta Decay - Elliott & Gratta
    - Long Baseline Neutrinos & PDK - Sobel, Diwan & Rameika
    - Dark Matter - Akerib & Gaitskell
    - Nuclear Astrophysics - Leitner

www.deepscience.org

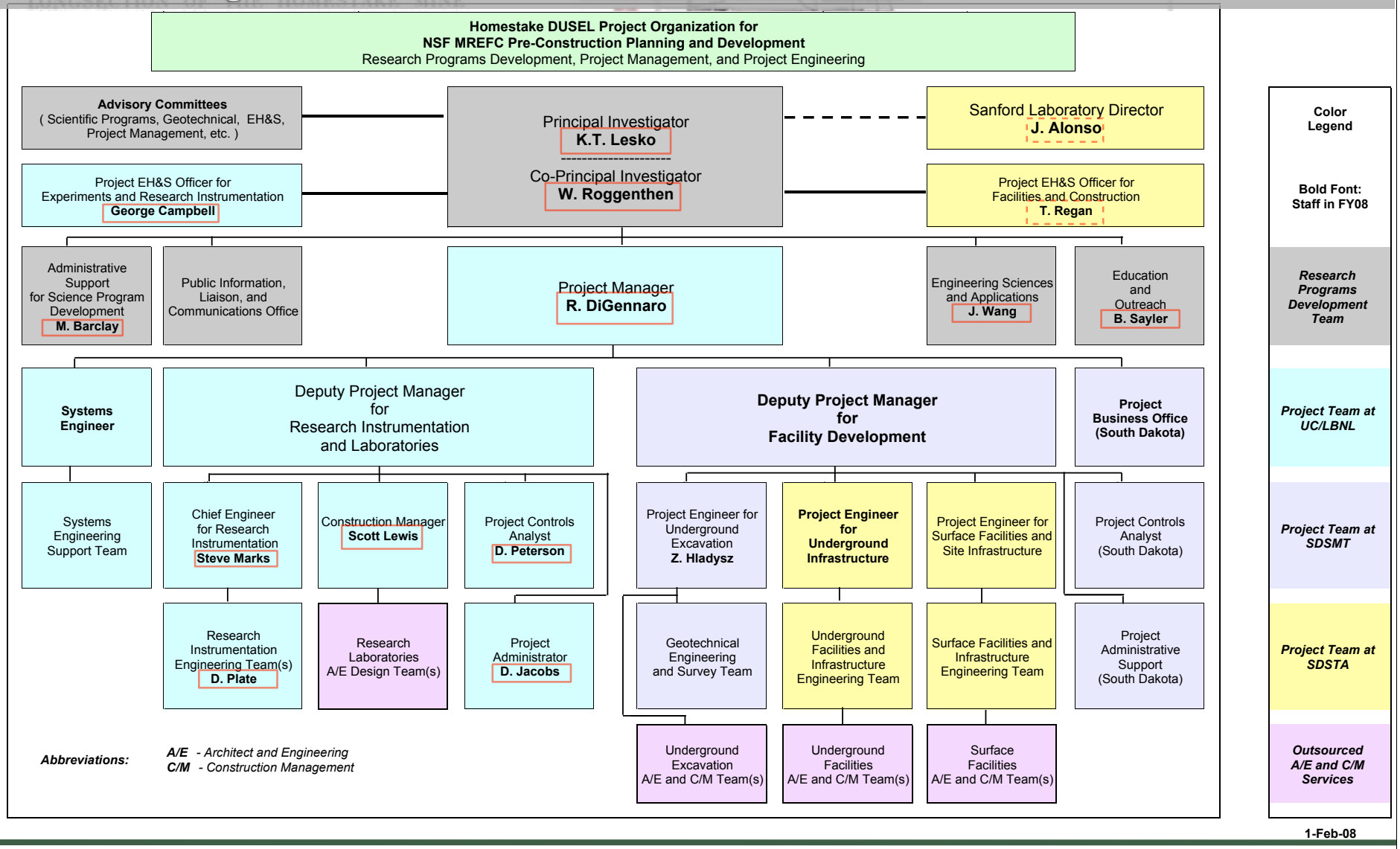
DUSEL Experiment Development Committee

- Follows on from S-1 (New Guard)
  - Hank Sobel (UCI) Phy
  - Steve Elliott (LANL) Phy
  - T.C. Onstott (Princeton) Geo/Bio
  - Derek Elsworth (Penn State) Geo/Eng
  - Larry Murdoch (Clemson) Geo/Eng
    - November Town Meeting Workshop Leaders
- Working with Facility Team (S-3)
- To help underground community develop the Initial Suite of Experiments (S-4)

Backup slides

Homestake DUSEL Planning and Engineering funded: $15M over three years:

- Produce Preliminary Design Report for the DUSEL Facility
- Integrate efforts with S-4 and Sanford Lab



Sanford Lab Science Program: 2007 - 2012

Dark Matter: Gaitskell, Shutt and collaboration

Geo/seismic array: Glaser, Johnson, Roggenthen

Low Background Counting: Mei and collaboration

~~Dark Matter: Hime, McKinsey~~ **Declined**

Dark Matter: Mei and collaboration

Geo/Bio Sampling: Bang, Conrad & collaboration

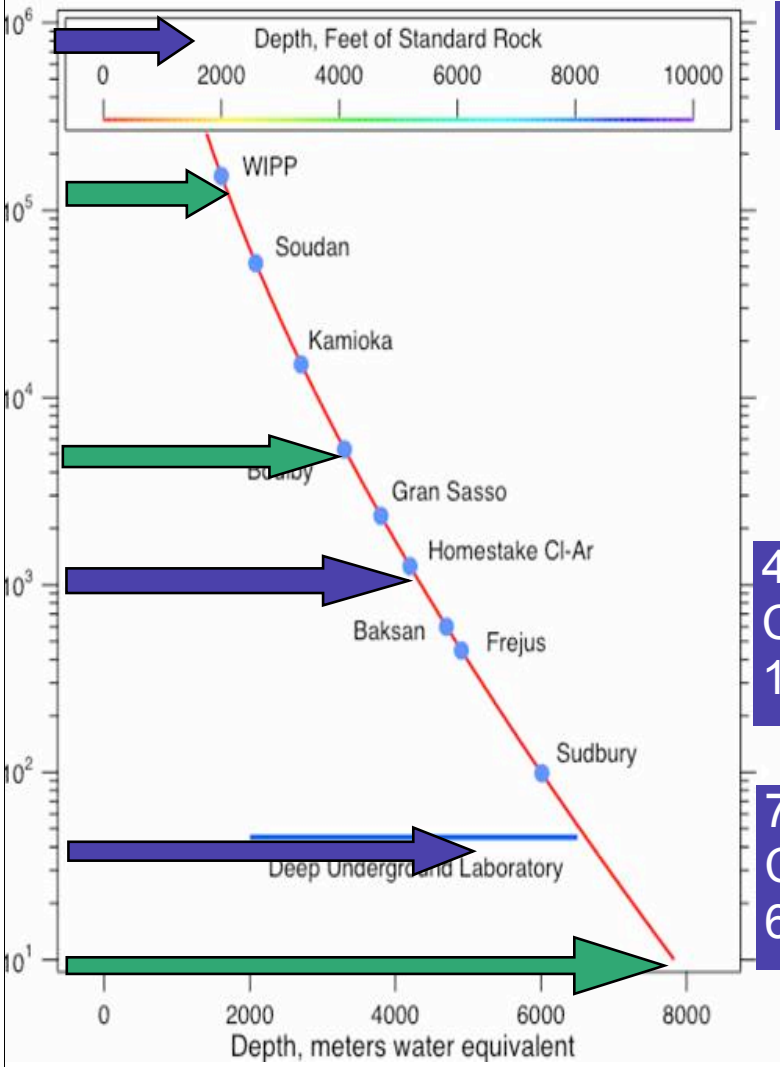
Neutrinoless ββ: Elliott, Wilkerson & collaboration

Large Cavities, LBL νs: Lande, Diwan et al.

Carbon Sequestration: Wang and collaboration

USGS Gravity Line: Anderson and collaboration

Campus Footprints



300L R&D, E&O 10k ft^2

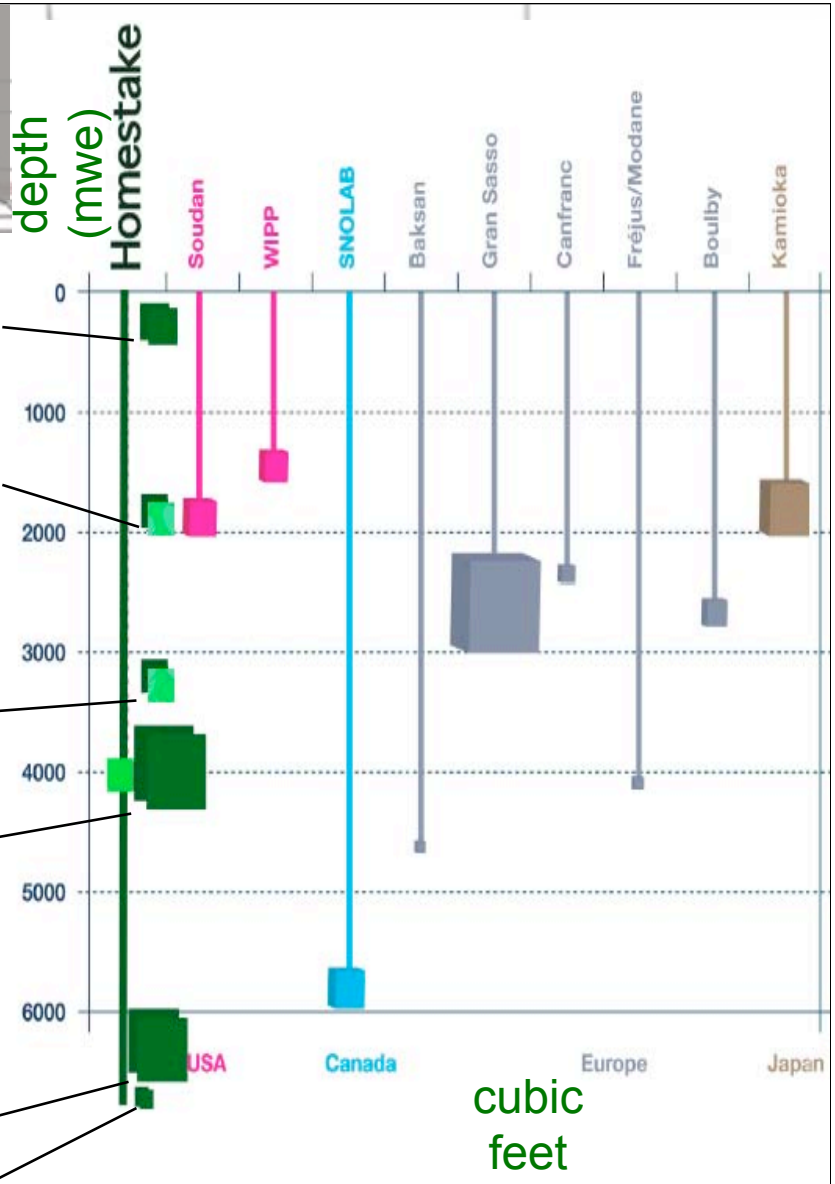
2000L Geo Level

3800L Geo Level

4850L Major Campus 100k ft^2

7400L Major Campus 65k ft^2

8000L Geo Lab



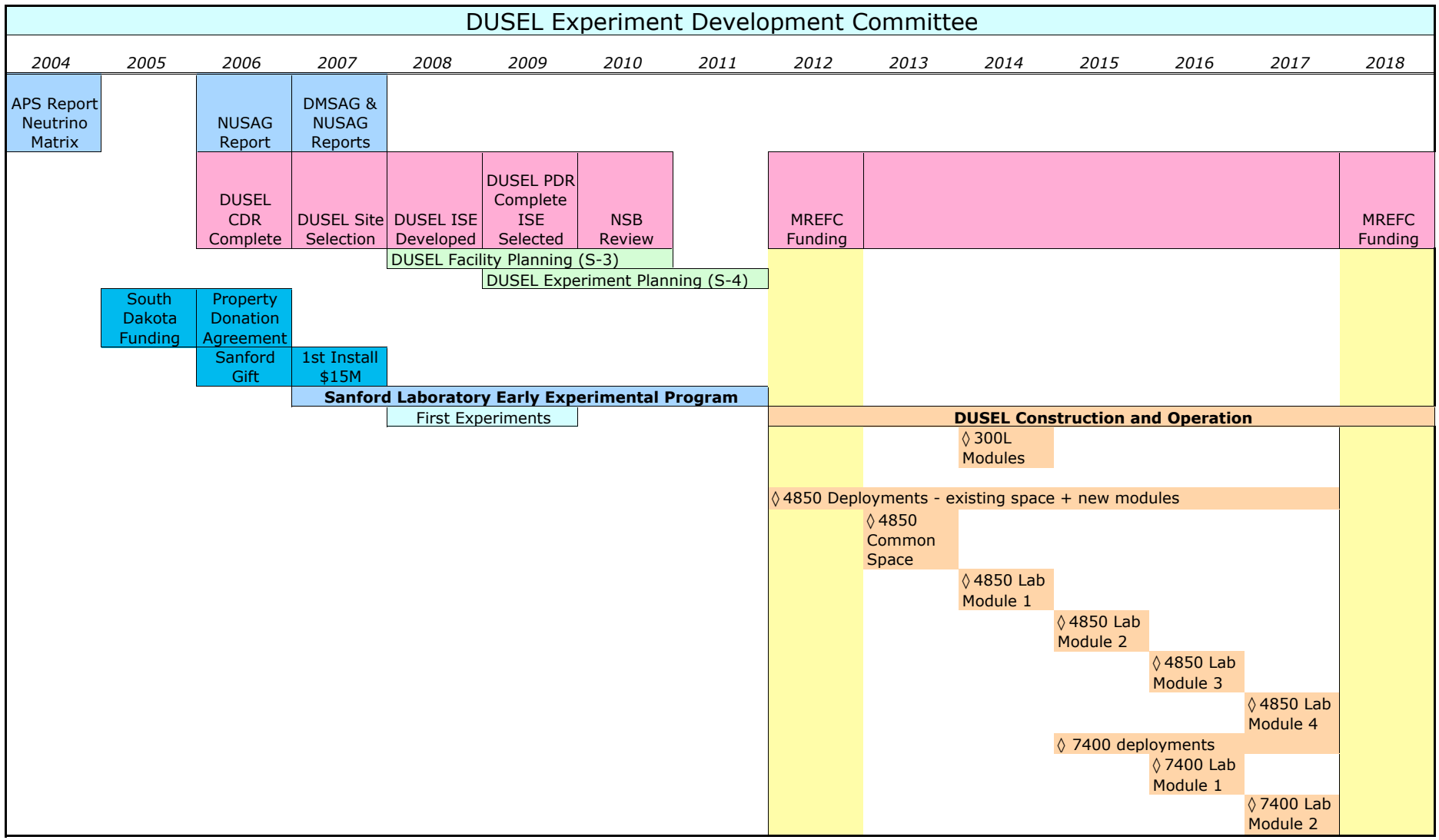
cubic feet

Estimates do not include MegaTon Detectors

There is a World-wide Need for Space Underground

Site	Location	Depth (kmwe)	Total Space for Research (m^2)	Total Available Space (m^2)
Europe				
Baksan Neutrino Observatory (BNO)	Russia	0.9	600	0
		4.7	600	0
Boulby	UK	2.8	1,500	0
Center for Underground Physics at Pyhasalmi	Finland	4.0	2,050	2,050
Gran Sasso (LGNS)	Italy	3.2	17,300	0
Canfranc	Spain	2.4	1,000	1,000
Laboratoire Subterrain de Modane	France	4.7	400	0
Solotwina Underground Laboratory (SUL)	Ukraine	1.1	700	500
Total Europe			***24,150***	***3,550***
Total Europe below 4.0 kmwe			***1,050***	***50***
Asia				
Kamioka	Japan	2.1	10,000	0
OTO-Cosmo Observatory	Japan	1.4	80	0
Y2L	Korea	2.0	100	0
INO	India	3.0	0	0
Total Asia			***10,180***	***0***
Total Asia below 4.0 kmwe			***0***	***0***
Americas				
SNOLab	Canada	6.0	3,055	500
Soudan Underground Laboratory (SUL)	US	2.0	2,300	0
Waste Isolation Pilot Plant (WIPP)	US	1.6	920	400
Total Americas			***6,275***	***900***
Total Americas below 4.0 kmwe			***3,055***	***500***
WORLD TOTAL			***40,605***	***4,450***
WORLD TOTAL BELOW 4.0 KMWE			***4,105***	***550***
DUSEL	***US***	*0.3*	*640*	*640*
		1.7	*20,000*	*20,000*
		3.2	*1,010*	*1,010*
		4.1	*7,200*	*7,200*
		6.4	***4,500***	***4,500***
		7.0	***100***	***100***
Space required for Initial Suite of Experiments		***0.3***	***2,350***	
		1.7	***20,000***	
		3.2	***1,010***	
		4.1	***12,300***	
		6.4	***7,900***	
		7.0	***350***	

Assessment and vetting by Homestake Team, S-1 Panel, Town Meeting Group leaders, and community spokespeople


DUSEL Experiment Development Committee
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
APS Report Neutrino Matrix
NUSAG Report
DMSAG & NUSAG Reports
DUSEL CDR Complete
DUSEL Site Selection
DUSEL ISE Developed
DUSEL PDR Complete ISE Selected
NSB Review
MREFC Funding
MREFC Funding
DUSEL Facility Planning (S-3)
DUSEL Experiment Planning (S-4)
South Dakota Funding
Property Donation Agreement
Sanford Gift
1st Install $15M
Sanford Laboratory Early Experimental Program
First Experiments
DUSEL Construction and Operation
◊ 300L Modules
◊ 4850 Deployments - existing space + new modules
◊ 4850 Common Space
◊ 4850 Lab Module 1
◊ 4850 Lab Module 2
◊ 4850 Lab Module 3
◊ 4850 Lab Module 4
◊ 7400 deployments
◊ 7400 Lab Module 1
◊ 7400 Lab Module 2

Initial Suite of Experiments Estimates

Initial Suite of Experiments*	Experimental Discipline
$520,000k	Physics
$119,000k	Biology, Geology & Engineering
$8,600k	Common Usage (LBCF)
$644,600k	Total Experiment Capital Costs

DM	2 technologies @ 2 generations
DBD	2 ~ 1 tonne experiments
LBL νs PDK	1 150-kt cavity + detector + LAr R&D
Nuclear Astro	LE + HI accelerators
Geo/LE Solar ν	~ 1kT scale

* Estimates obtained from Proposals and CDRs, vetted through the Town Meeting Group Leaders, S-1, Homestake.
For rapidly evolving fields, such as DM, these are clearly estimates for detectors.
Capital Costs only.
S-4 will establish PDR and estimates