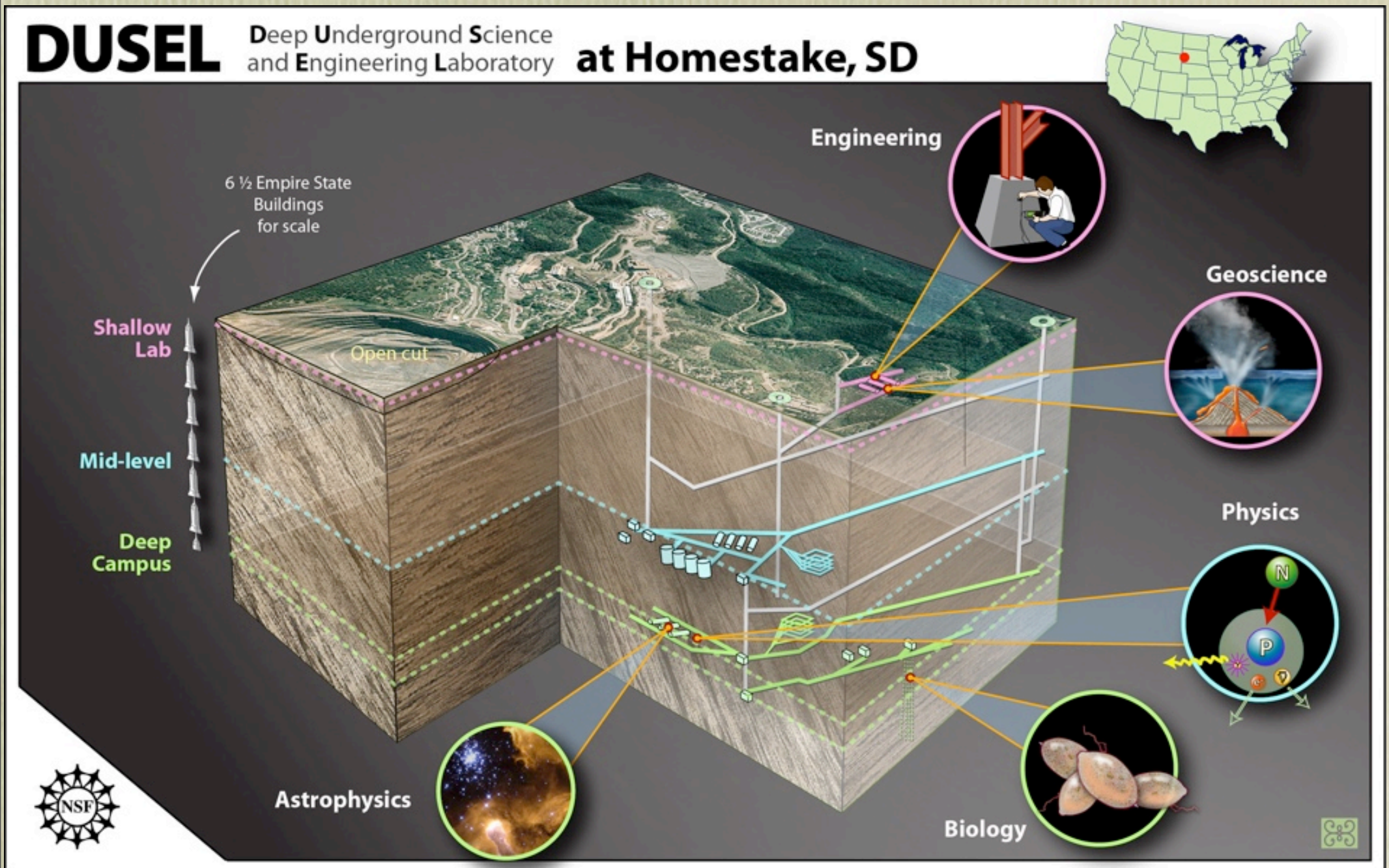
Homestake Deep Underground Science and Engineering Laboratory

Milind Diwan
Brookhaven National Laboratory

NNN07 workshop, Hamamatsu
Oct. 4, 2007

Office of Science
U.S. DEPARTMENT OF ENERGY

BROOKHAVEN
NATIONAL LABORATORY



NSF site decision on advice from a 22 member unanimous panel. July 2007

Office of Science
U.S. DEPARTMENT OF ENERGY

M.Diwan

BROOKHAVEN NATIONAL LABORATORY

NSF: US national science foundation

Where is S. Dakota ? What are black hills ?

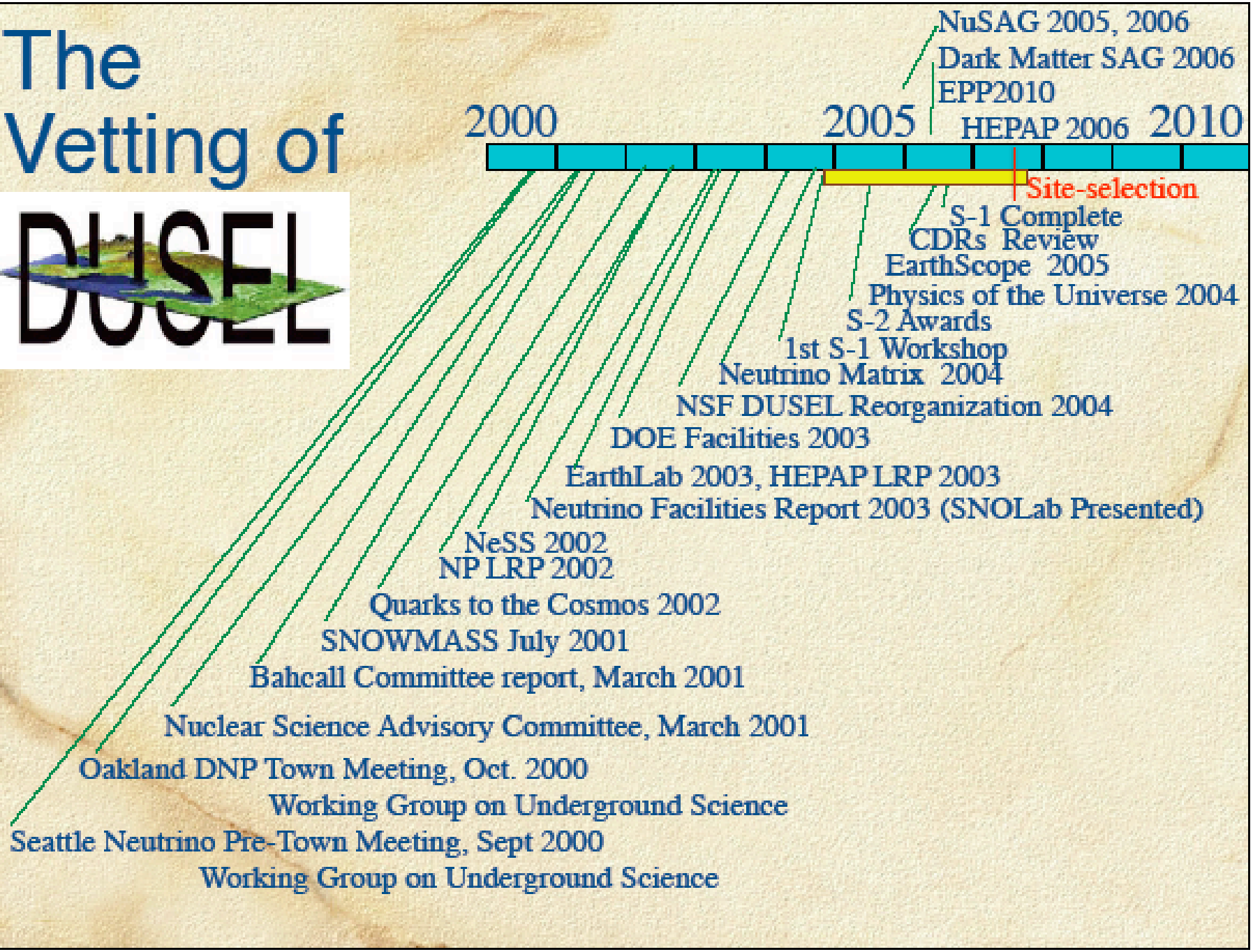
SD has Tradition of mining

- South Dakota has colorful history and is in the middle of US.
- Black hills are ancient forested mountains.
- Large airport at Rapid City about 45 min away on I-90.

Outline

- US National Science Foundation Deep Underground Science and Engineering Laboratory (DUSEL)
- Current Status and Progress at Homestake
- Status and Progress on the Homestake Megaton Multi-Modular Detector.

The Vetting of DUSEL



Office of Science
U.S. DEPARTMENT OF ENERGY

M.Diwan

BROOKHAVEN NATIONAL LABORATORY

DUSEL Progress

- **S-1 Led by**
  Bernard Sadoulet,UC Berkeley
  with Hamish Robertson, U.W.;
  Gene Beier, U. Penn; Charles Fairhurst, U. Minnesota;
  T.C. Onstott, Princeton; James Tiedje, Michigan State
  - Conducted extensive workshops, information gathering, discussions with the agencies, foreign laboratories, etc.
- **S-1** Report Released: www.dusel.org - Deep Science
- **S-2** 8 Candidate sites, 2 awards
  - **July 2006** Henderson and Homestake

DUSEL Progress

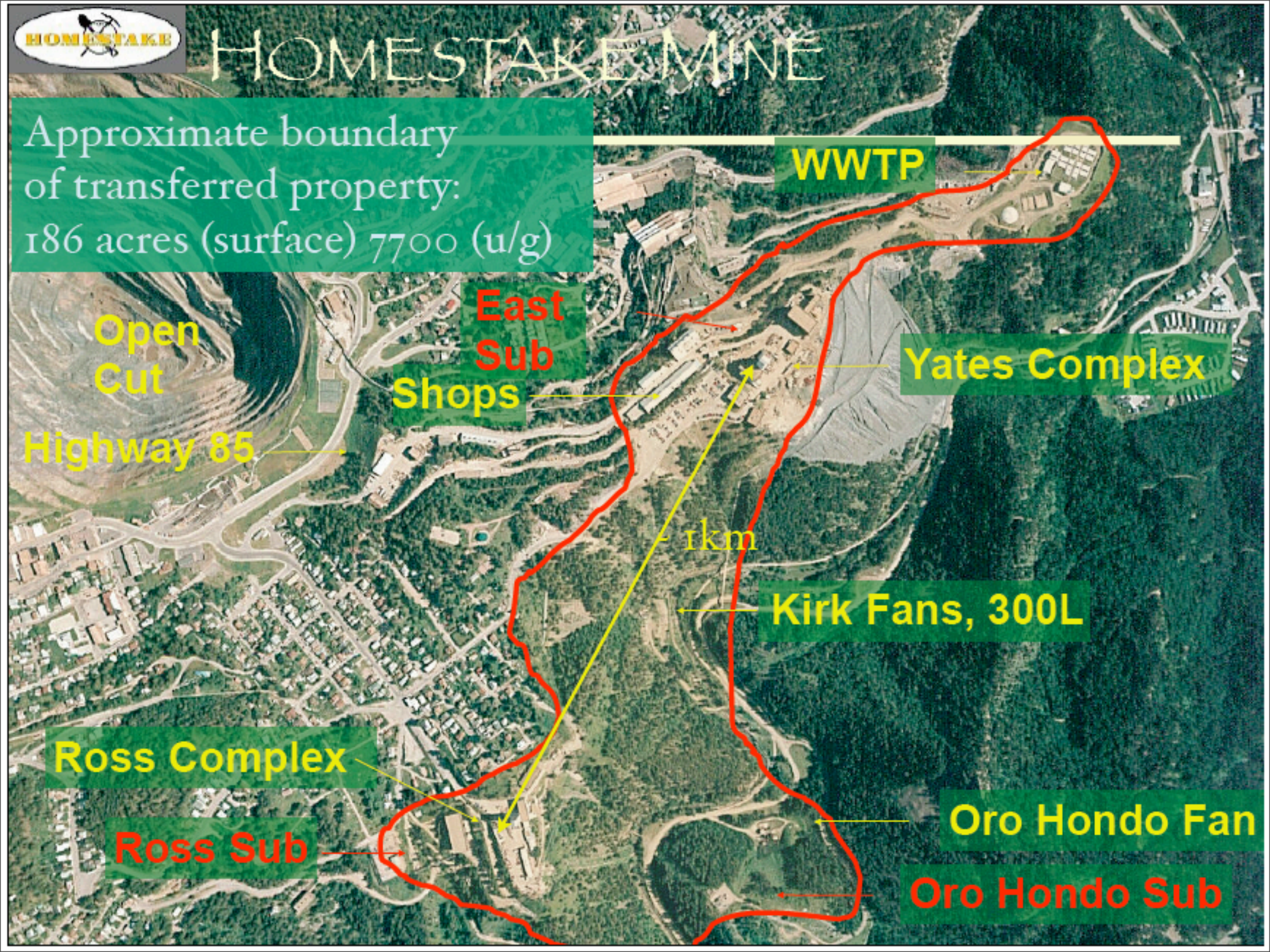
- **August 06** non-competitive review of the two CDRs
- **September 06** S-3 solicitation announced, funds to be provided to develop Preliminary Design, this Report will be the basis for case for DUSEL in the subsequent reviews
- **Fall 06** NSF and DOE announce call for proposals for DUSEL R&D (Jointly reviewed between DOE and NSF)- 50 responses
- **9 January 07** Responses to S-3 Solicitation: 4 proposals
- **9-13 March 07** Review of 4 proposals, including site visits

DUSEL Progress & Remaining Steps

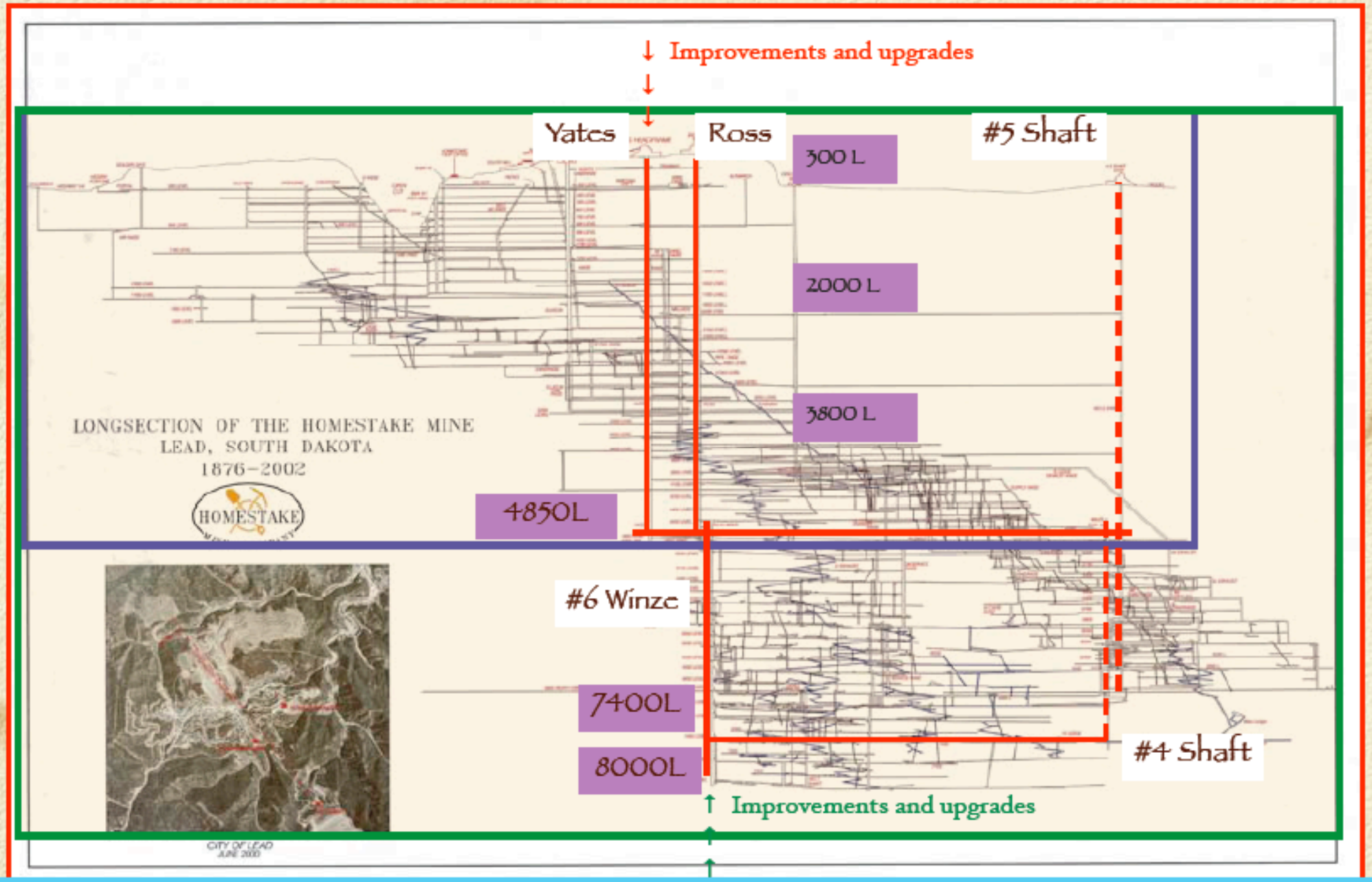
- ☑ **19-22 April 07**, panel review of the 4 proposals
- ☑ **10 July 07** funding for a single proposal to develop advanced plans for DUSEL
  - Next step is to baselined DUSEL plan: Preliminary Design to be prepare for review by NSF, MREFC Panel, NSB, … Development of Final Design, 3 year effort
  - Homestake Collaboration Open, additional participation welcomed and encouraged
- **Summer 07** Call for **Initial Suite Experiments** by NSF (iterative process) S-4 first step
- **FY10/11 DUSEL funding**, include Experiments and Facility
  - Experiments > 50% of ~$500M MRE

Homestake's Progress

- ☑ October 2005, State Legislature approves additional $20M funding for Homestake, total of $46M 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
- ☑ Banker and philanthropist T. Denny Sanford pledges **$70M** to develop Sanford Lab at Homestake
- ☑ Conceptual Design Completed January 2007
- ☑ January 2007 Rehab work initiated
- ☐ Early Implementation Program at Homestake 2007 - 2012 "The Sanford Laboratory"
- ☐ DUSEL Construction funding anticipated in FY10 - FY11


HOMESTAKE
HOMESTAKE MINE
Approximate boundary
of transferred property:
186 acres (surface) 7700 (u/g)
WWTP
East
Sub
Shops
Open
Cut
Yates Complex
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.

Homestake DUSEL Plans

300L R&D, E&O

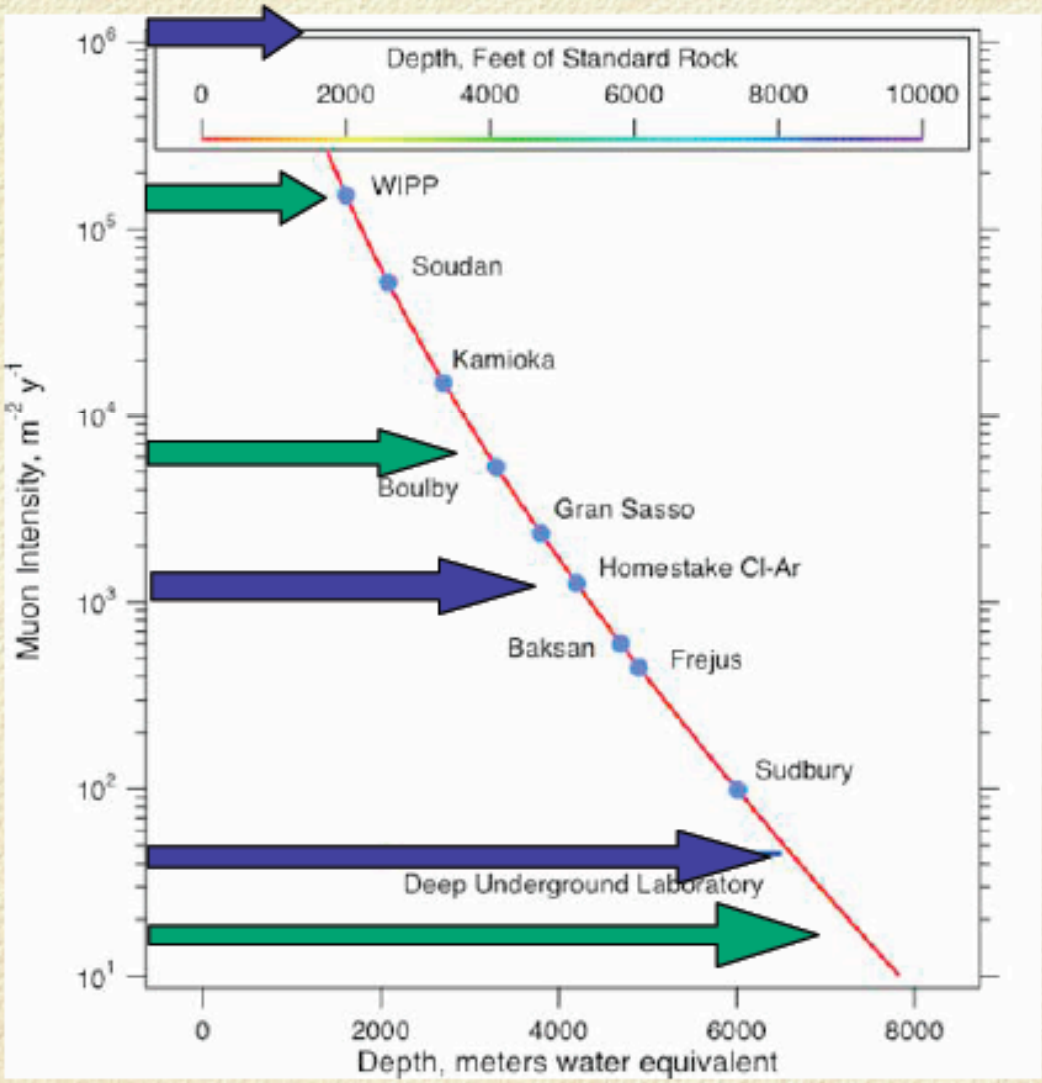
2000L Geo Level

3800L Geo Level

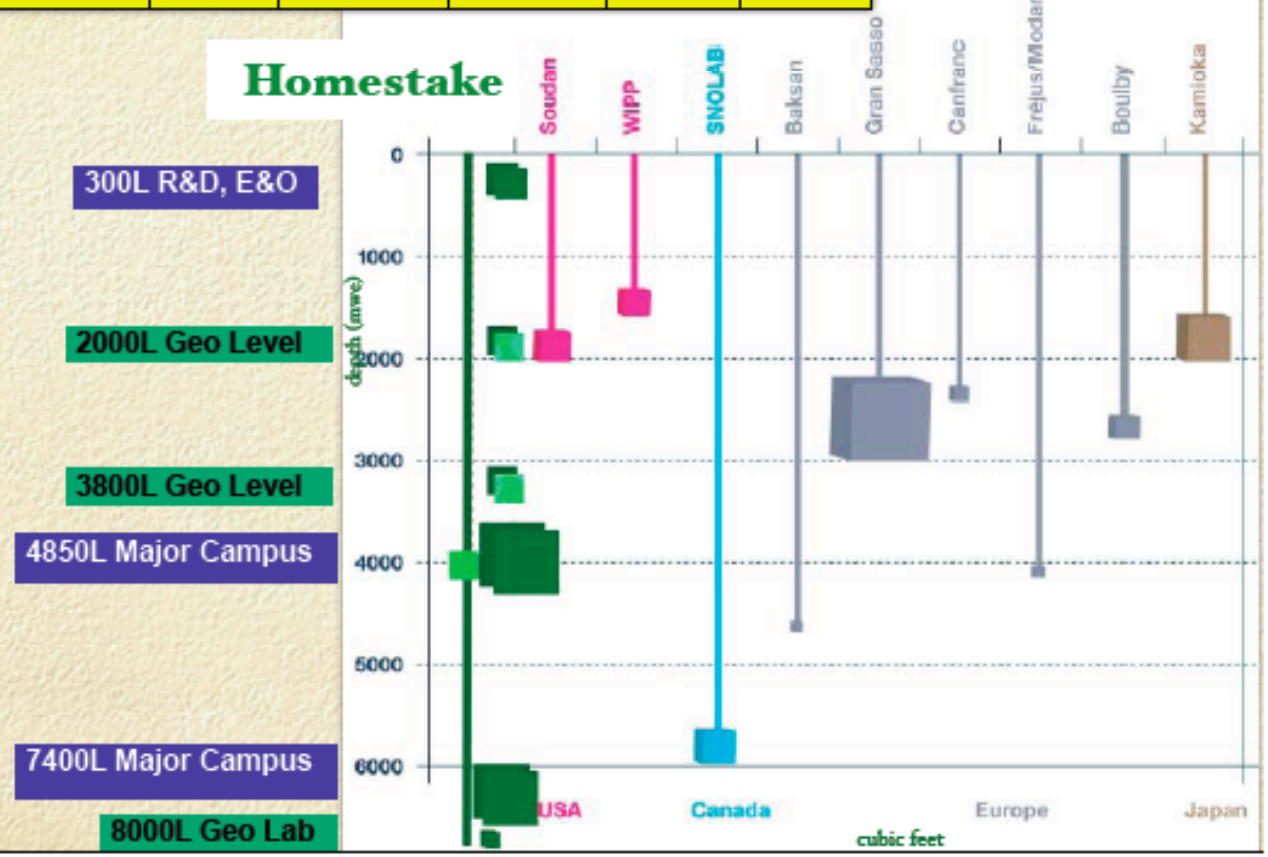
4850L Major Campus

7400L Major Campus

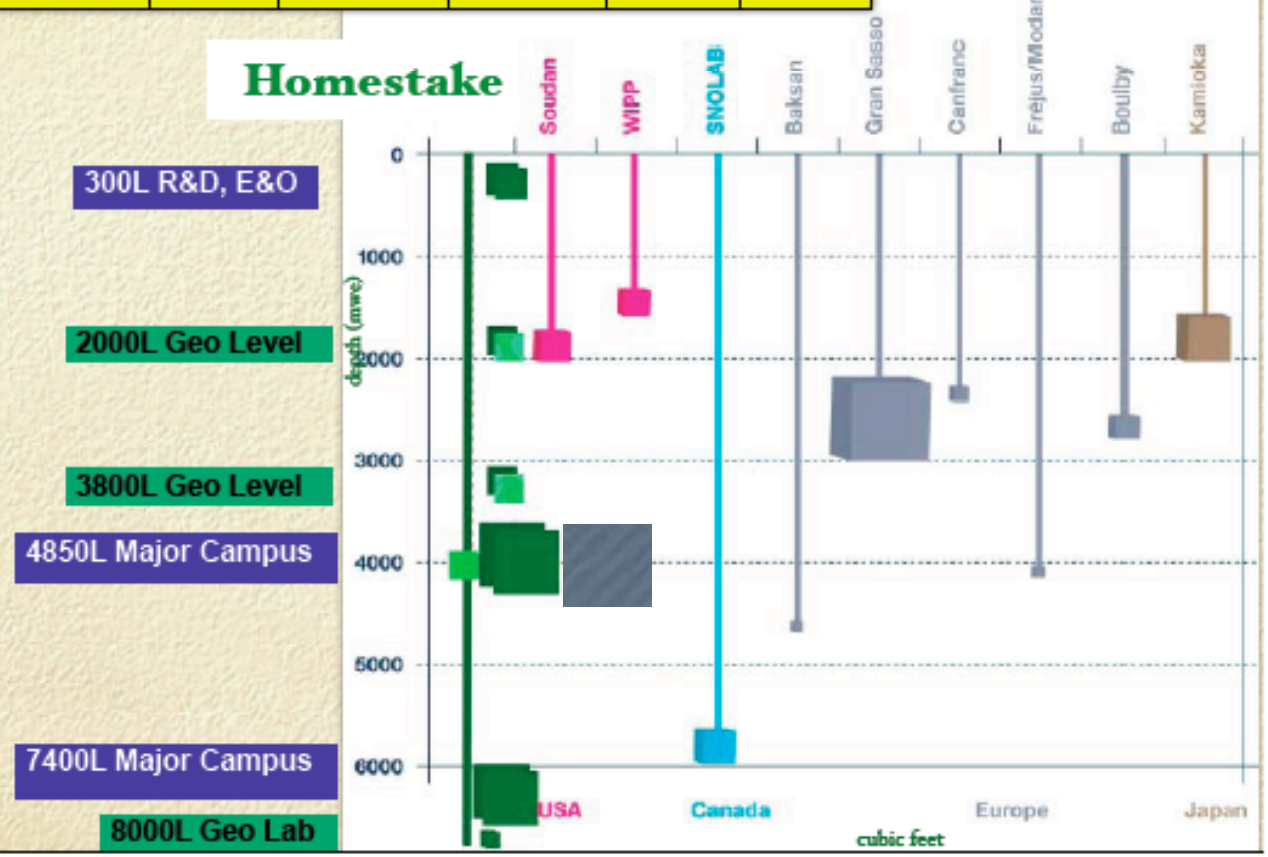
8000L Geo Lab



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**		



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**		



Homestake's Plans & Activities

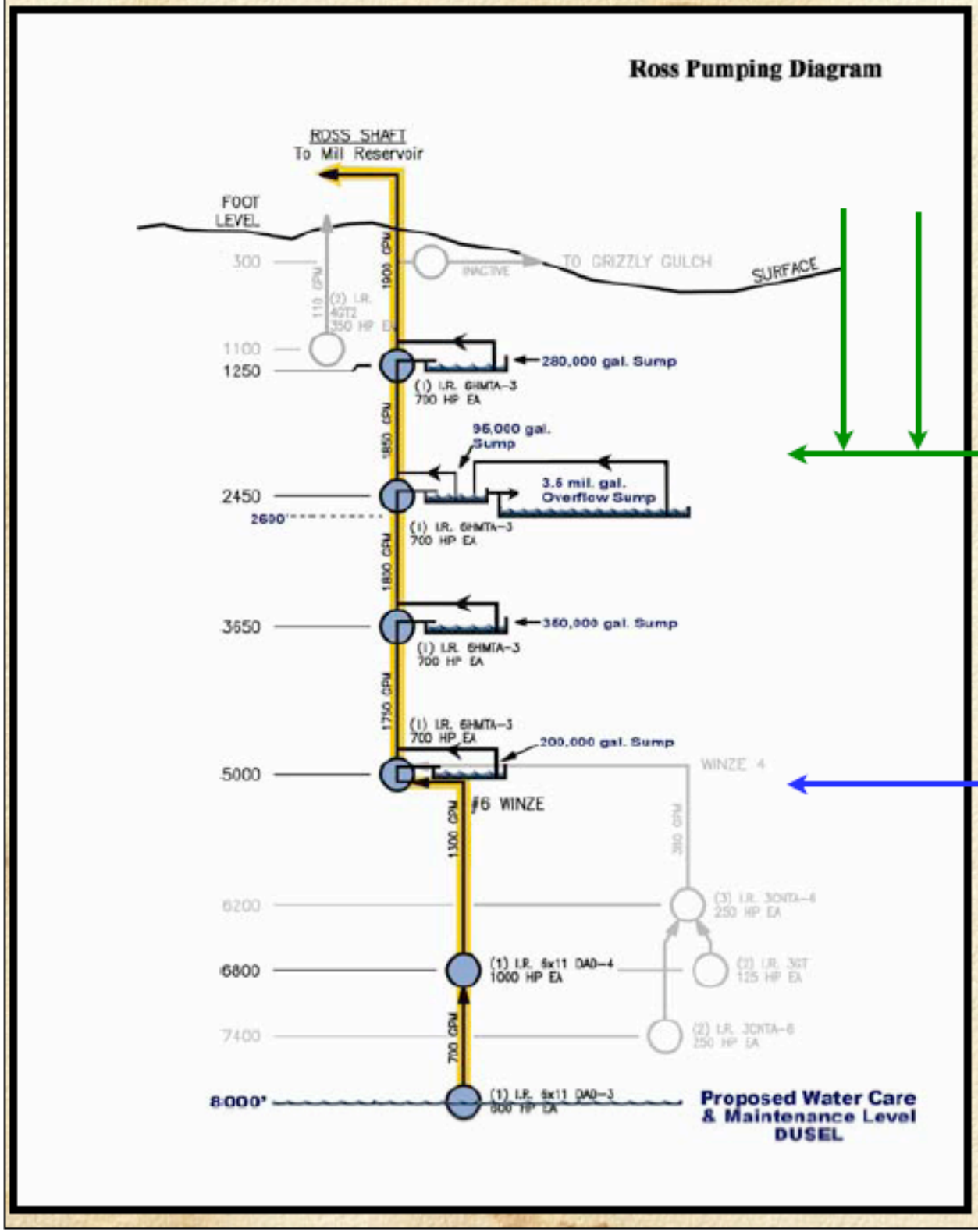
- Near-Term 3 phase rehabilitation of Ross shaft and Pumping
  - Φ1 - Surface work, buildings hoists, ventilation equipment: December 06 - April 07
    - ☑ Video inspection of Shafts
    - ☑ Ross Hoists operational 22 March
    - ☑ Ventilation fans installed and operations (100-120 kcfm)
    - ☑ First water samples from u/g

  - Φ2 - Underground work, including shaft and pumping, April 07 - September 07.
  - Φ3 - Operation of equipment September 07 - May 08

Dewatering Homestake

-

Current Water Levels



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

Focus on turning on pumps at 1250L and 2450L by August

5000 level tripped July 2007 (6 weeks earlier than original model)

Homestake PIs, Senior Personnel & Coordinators

- Michael Barnett, LBNL (E+O)
- Yuen-dat Chan, LBNL (Other uses)
- Milind Diwan, BNL (lbl, pdk)
- Reyco Henning, LBNL (ovdbd, 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, LBNL (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

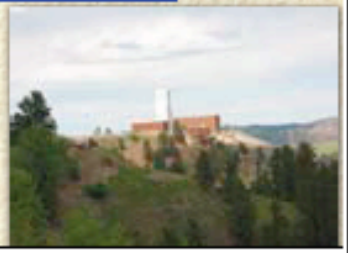
http://neutrino.lbl.gov/Homestake/LOI

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

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

http://neutrino.lbl.gov/Homestake

http://www.dusel.org



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	Dark Matter
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	Geo/seismic array
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)	Low Background Counting
miniCLEAN	Andrew Hime	LANL	Yes	MOU under discussion	Direct Detection of Dark Matter using cryogenic noble gases.	Dark Matter
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.	Dark Matter
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	Geo/Bio
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	Neutrinoless ββ
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	Large Cavities, LBL νs
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	Carbon Sequestration

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			
Low Background Counting Facility, DOE BES ESPSoR	Dongming Mei Bill Roggenthen	USD SDSM&T			
miniCLEAN	Andrew Hime	LANL			
Liquid Argon Dark Matter	Dongming Mei Andrew Hime KTL	USD LANL LBNL			
Homestake: Biological, Chemical and Geological Sampling	Sookie Bang Mark Conrad	SDSM&T LBNL			
Majorana: Neutrinoless double beta decay R&D	John Wilkerson Steve Elliott	U.W. LANL			
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

array

und

ββ

Large Cavities, LBL νs

Carbon Sequestration

Early implementation program at the Sanford Laboratory assisted by an International Program Advisory Committee

Planning for Homestake will be open and deeply international in the best traditions of US laboratories

Progress on the Large Detector at Homestake

- Neutrino beam feasibility and physics potential documented in the US long baseline joint study.
- A proposal written for the US long baseline study (hep-ex/0608023), 11 institutions, ~30 authors.
- Design based on a vertical cylinder geometry where height is limited by PMT pressure limit.

Detector Parameters

- Modular fiducial mass - 100 kilotons
- Modular Shape - Cylinder - 53 m dia x 53 m high
- Depth - 4200 mwe - (cosmic rate ~ 0.1 Hz)
- PMT coverage - 25% (equi. 35% with 20 in.)
- High granularity (at multiple scattering limit)
- Initial Detector - 3 modules (300 kTon)
- Construction time - ~5 yrs for first, 8 yrs for all.
- Cost - ~$115M/module

Phototube Choices

- Working on both R7081 (hamamatsu) and XP1807 (photonis)
- First criteria is pressure capability.
- Second is manufacturing rate. Need 150,000 tubes

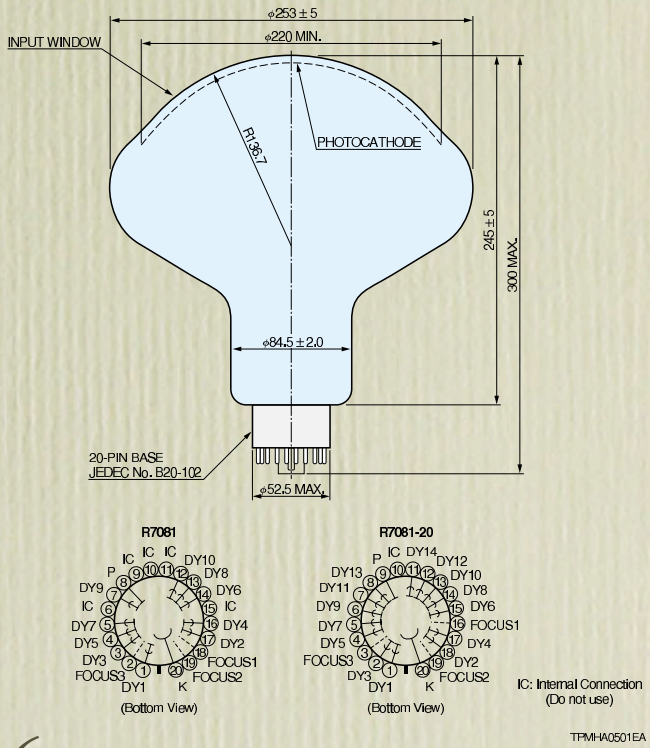
SPECIFICATIONS

Type No.	Cathode Sensitivity: Luminous (2856 K) Min. (μA/lm)	Luminous (2856 K) Typ. (μA/lm)	Radiant at 420 nm Typ. (mA/W)	Blue Sensitivity Index (CS 5-58) Min.	Blue Sensitivity Index (CS 5-58) Typ.	Quantum Efficiency at 390 nm Typ. (%)	Anode Sensitivity: Luminous (2856 K) Typ. (A/lm)	Radiant at 420 nm Typ. (A/W)	Gain Typ.	Applied Voltage for Typical Gain Typ. (V)
R5912	40	70	72	6.0	9.0	22	700	7.2×10^5	1.0×10^7	1500
R5912-02	40	70	72	6.0	9.0	22	70 000	7.2×10^7	1.0×10^9	1700
R7081	40	80	80	6.0	10.0	25	800	8.0×10^5	1.0×10^7	1500
R7081-20	40	80	80	6.0	10.0	25	80 000	8.0×10^7	1.0×10^9	1700
R8055	35	60	65	5.5	8.0	20	600	6.5×10^5	1.0×10^7	1500
R3600-02	35	60	65	5.5	8.0	20	600	6.5×10^5	1.0×10^7	2000
R7250	35	60	65	5.5	8.0	20	600	6.5×10^5	1.0×10^7	2000

NOTE: Anode characteristics are measured with the voltage distribution ratio shown below.
( ): Measured with the special voltage distribution ratio (Tapered Divider) shown below.

Type No.	Supply Voltage: Anode to Cathode (V)	Supply Voltage: Anode to Last Dynode (V)	Average Anode Current (mA)	Operating Ambient Temperature (°C)	Storage Temperature (°C)	Pressure (MPa)	Direct Interelectrode Capacitances: Anode to Last Dynode (pF)	Direct Interelectrode Capacitances: Anode to All Other Dynodes (pF)
R5912	2000	300	0.1	-30 to +50	-30 to +50	0.7	approx. 3	approx. 7
R5912-02	2000	300	0.1	-30 to +50	-30 to +50	0.7	approx. 3	approx. 7
R7081	2000	300	0.1	-30 to +50	-30 to +50	0.7	approx. 3	approx. 7
R7081-20	2000	300	0.1	-30 to +50	-30 to +50	0.7	approx. 3	approx. 7
R8055	2500	300	0.1	-30 to +50	-30 to +50	0.15	approx. 10	approx. 20
R3600-02	2500	300	0.1	-30 to +50	-30 to +50	0.6	approx. 36	approx. 40
R7250	2500	300	0.1	-30 to +50	-30 to +50	0.6	approx. 10	approx. 15

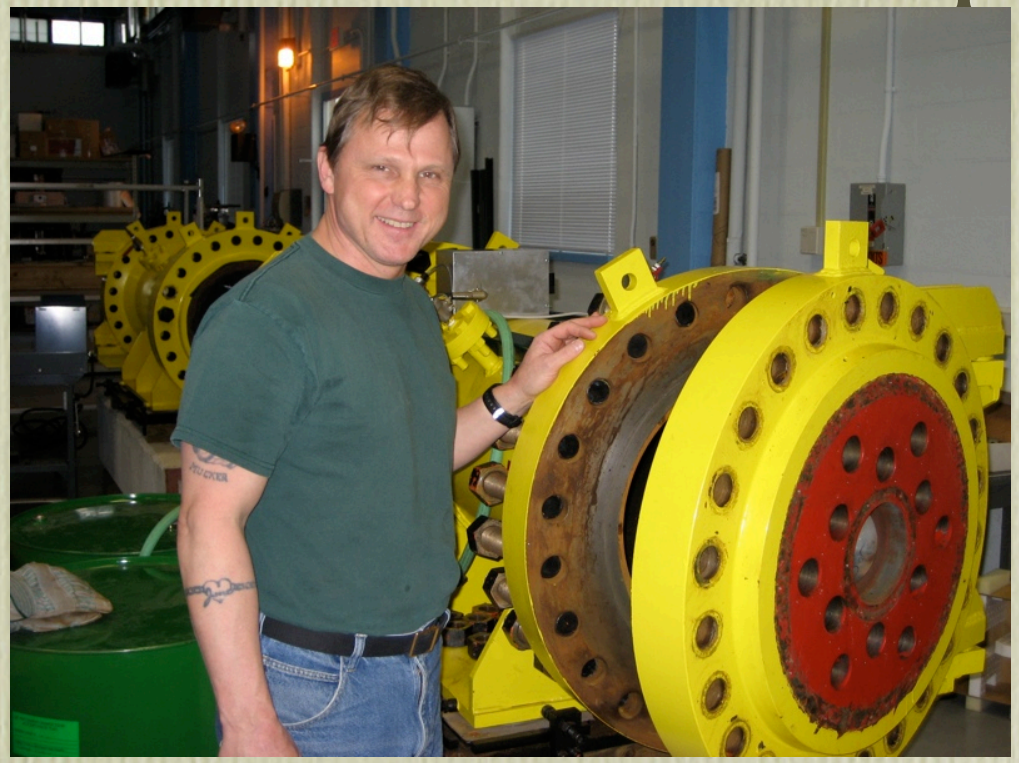
●R7081, R7081-20



The R7081 tube is more efficient than the R3600.

25% *R7081 => 35% *R3600

Phototubes pressure rating



Can test up to 20 atm. Sensors to measure pressure pulse and velocity of glass breakage.

Will test both Hamamatsu R7081 and Photonis XP1807. This R7081 tested at 148 psi(~10 atm)

Office of Science
U.S. DEPARTMENT OF ENERGY

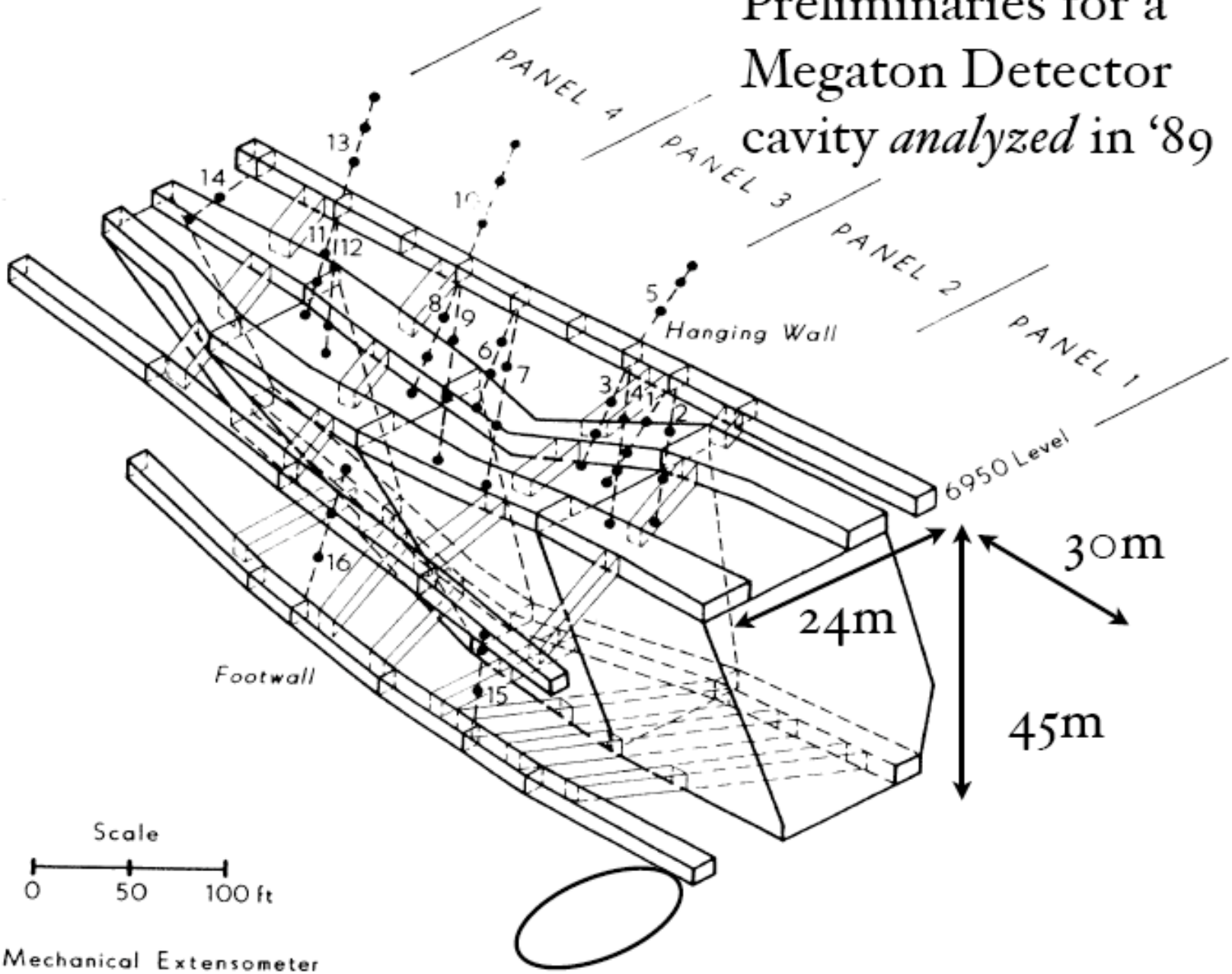
M.Diwan

BROOKHAVEN NATIONAL LABORATORY

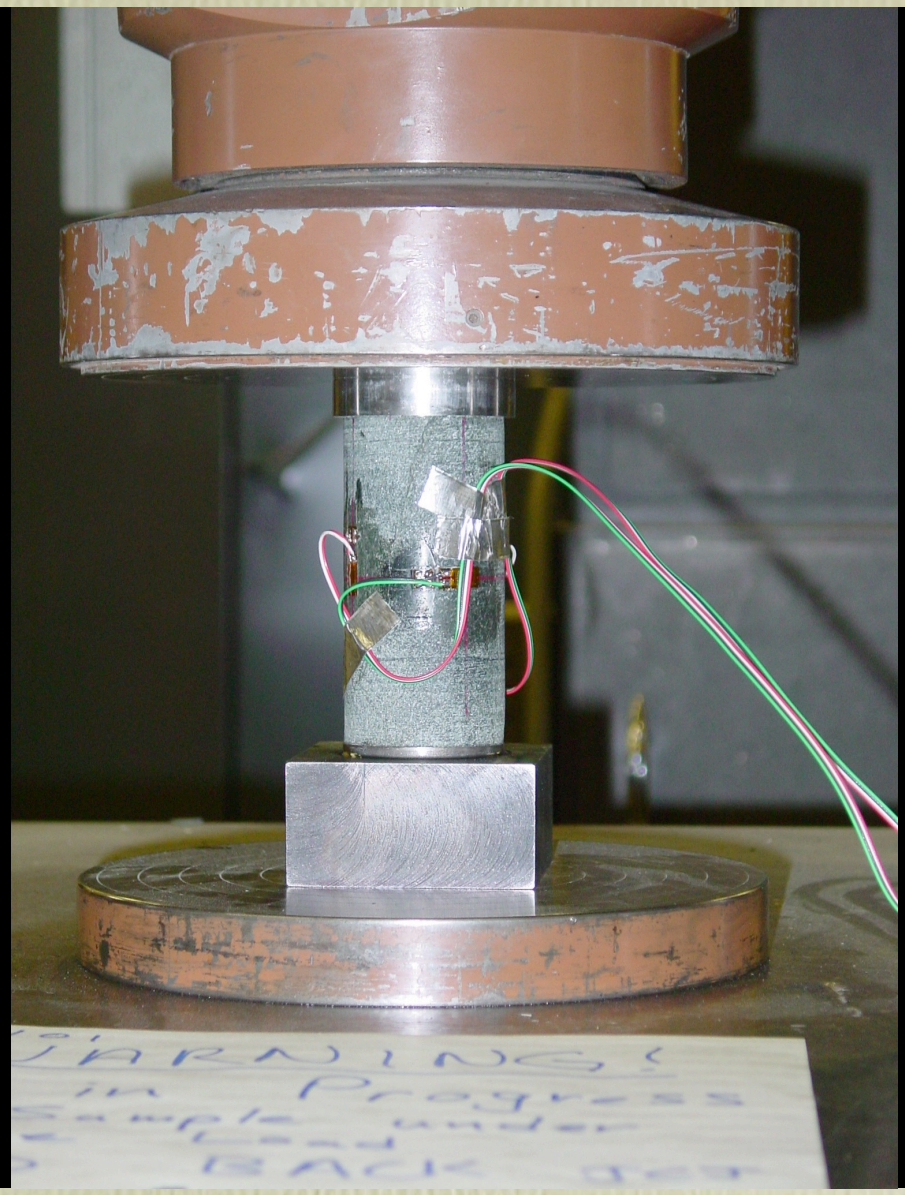
Excavation feasibility.

- Study carried out by D. Tesarik, J. Johnson, Karl Zipf (hard rock stability group of the Spokane Laboratory of NIOSH (former US bureau of mines) (Published)
- Used case history, FLAC 3D numeric model, empirical charts.
- Key finding: No show stoppers for a 50 m span cavity at 6800 or 4850 ft level; comprehensive rock mechanics study and geological investigation is merited.

Preliminaries for a Megaton Detector cavity *analyzed* in '89

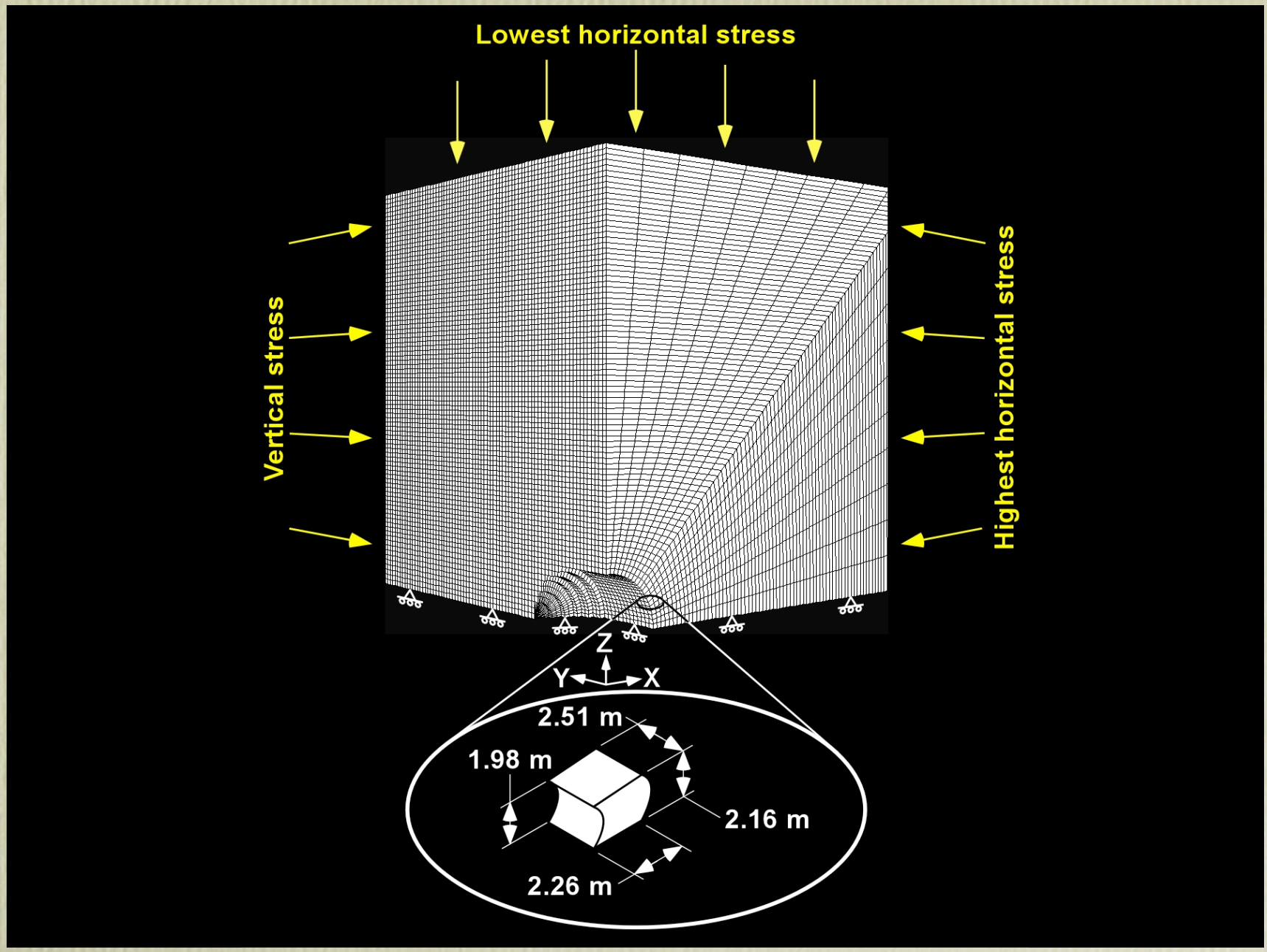


Pariseau, W.G. and F. Duan (1989) "Finite Element Analyses of the Homestake Mine Study Stope: An Update". Proc. 3rd Intl. Symp. on Numerical Models in Geomechanics. (NUMOG III). Elsevier Applied Science, London and New York, pp 566-576.



Rock strength data for modeling

M.Diwan



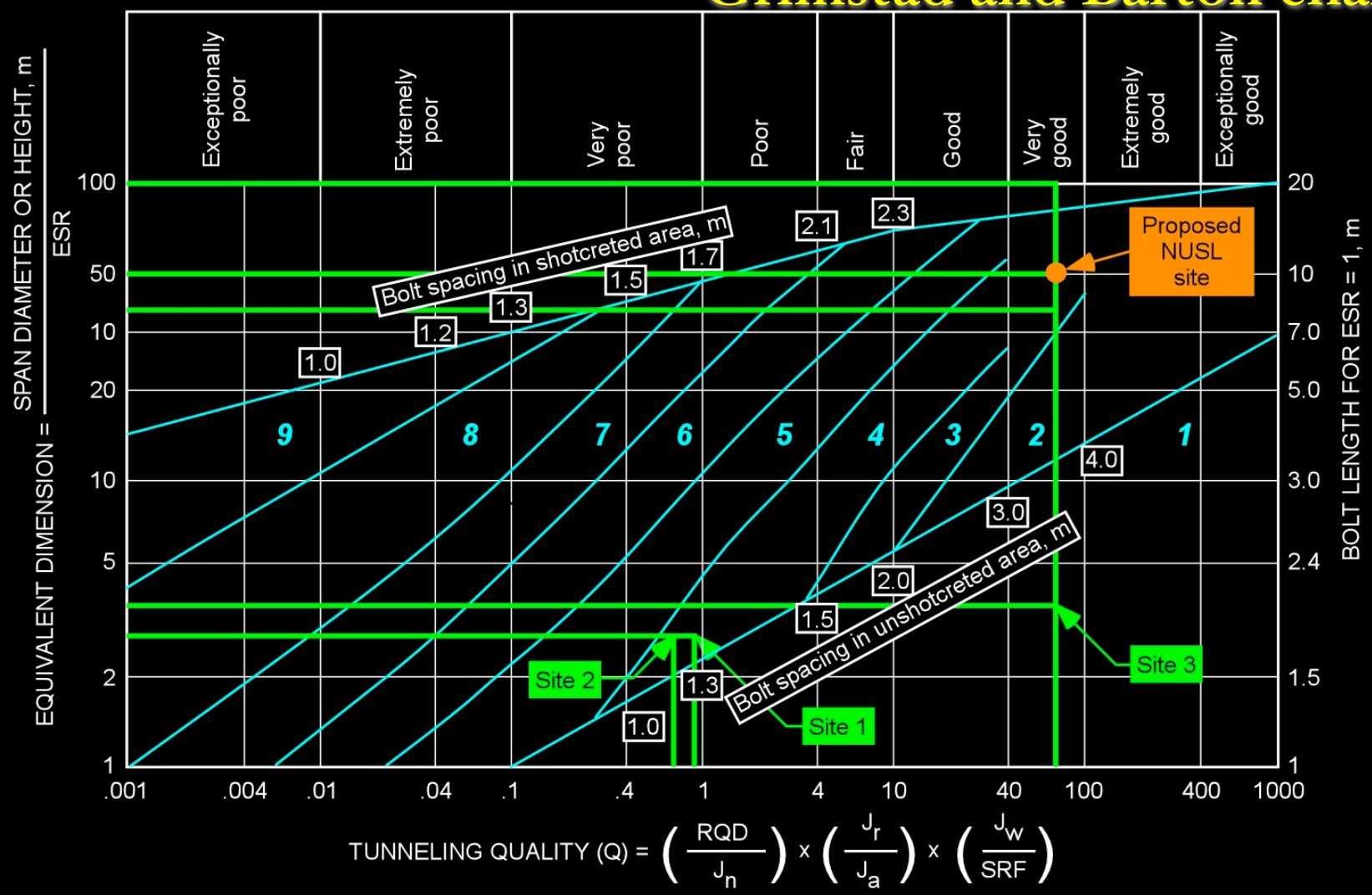
Pill shape with domed roof and floor

M.Diwan

Office of Science
U.S. DEPARTMENT OF ENERGY

BROOKHAVEN
NATIONAL LABORATORY

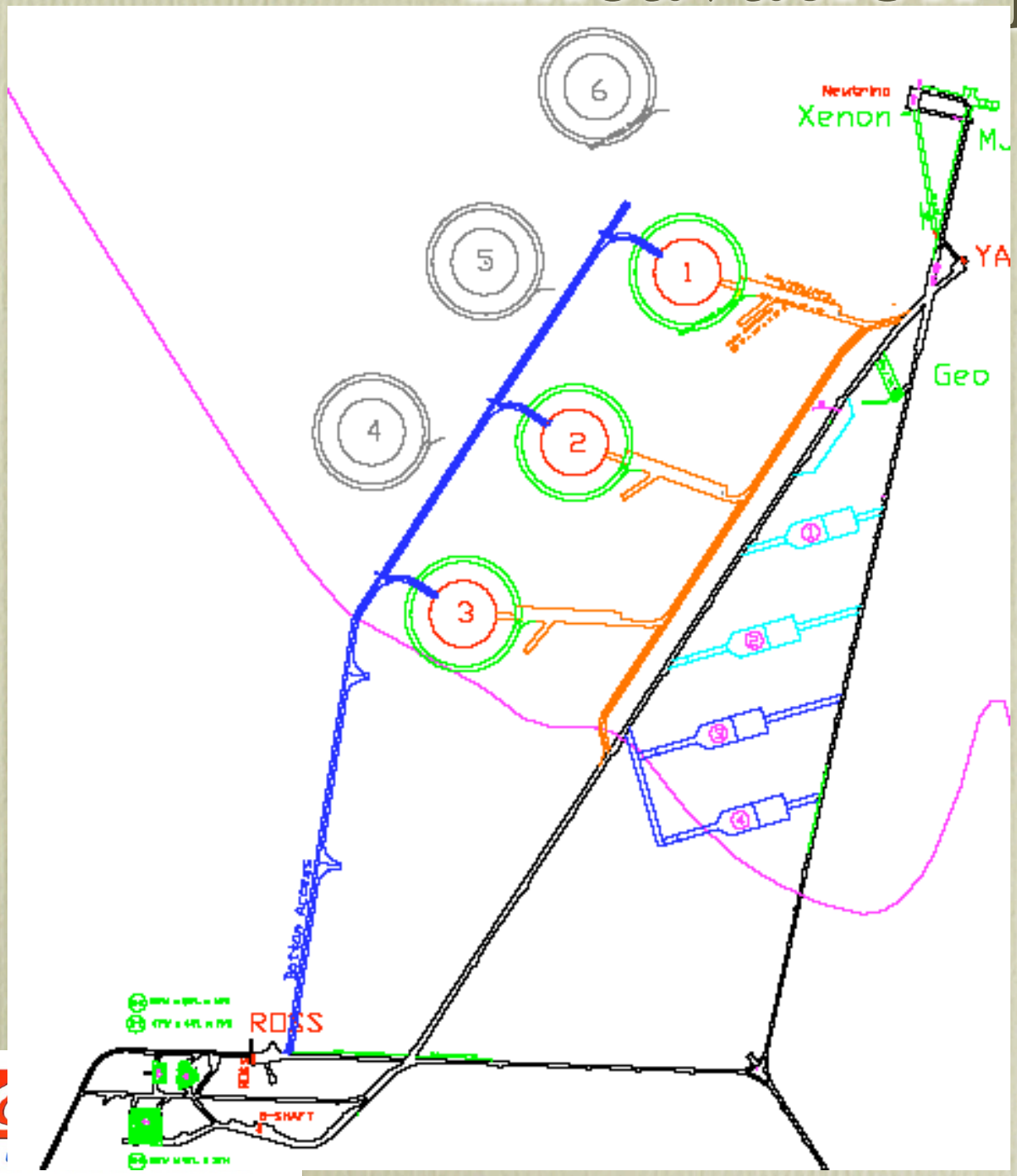
Grimstad and Barton chart



Recommendation for support

- Barton tunneling index: roof support of tensioned bolts, 2-3 m spacing.
- Grimstad and Barton: Systematic bolting and 5 mm shotcrete.
- Our plan: Bolting and cast concrete liner after comprehensive geological investigation.

Excavation plan

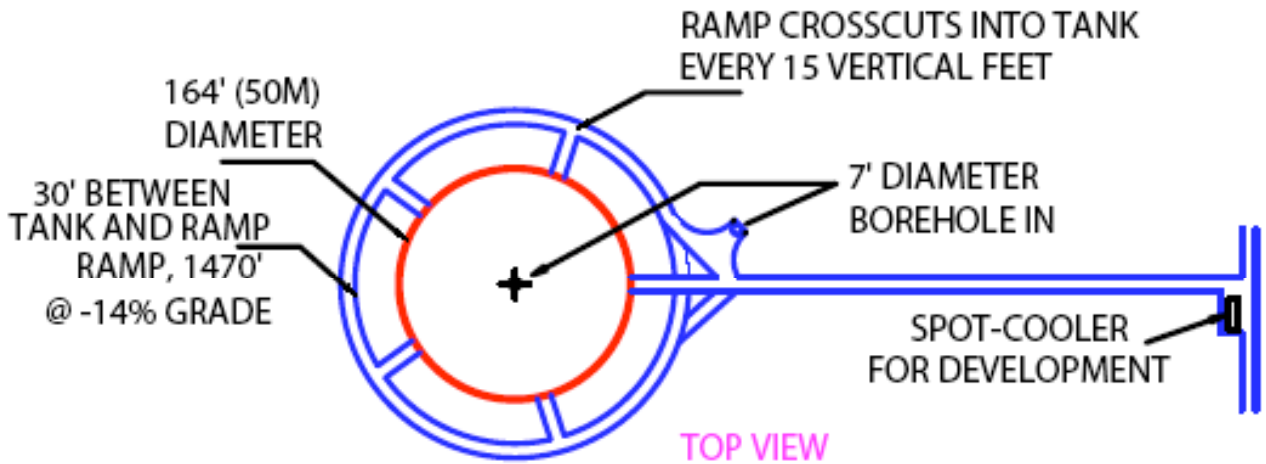


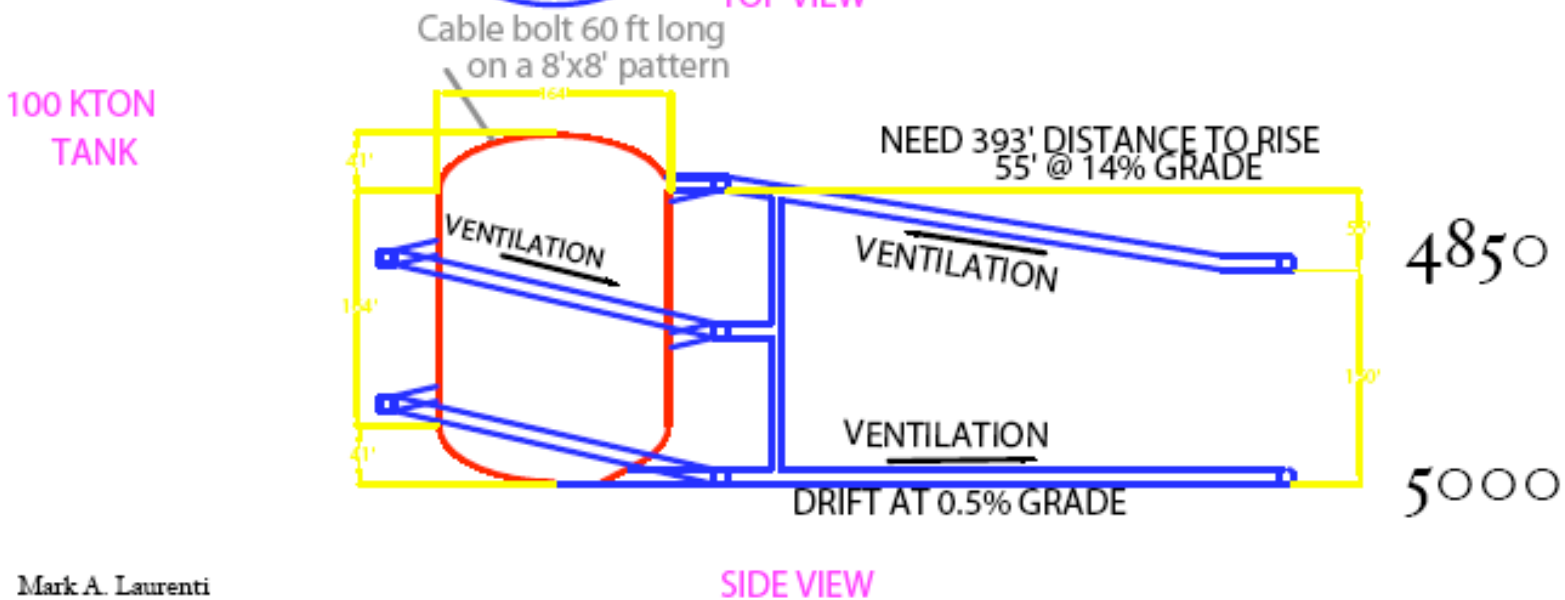
- First 3 chambers will be along the Yates-Ross drift. Top of chambers at 4850 ft.
- Rock will be removed from the Ross shaft using new (blue) drifts at the 5000 ft level.
- Design allows for expansion to additions 3 chambers

BROOKHAVEN NATIONAL LABORATORY

Megaton Modular Multi-Purpose 100kT Neutrino Detector

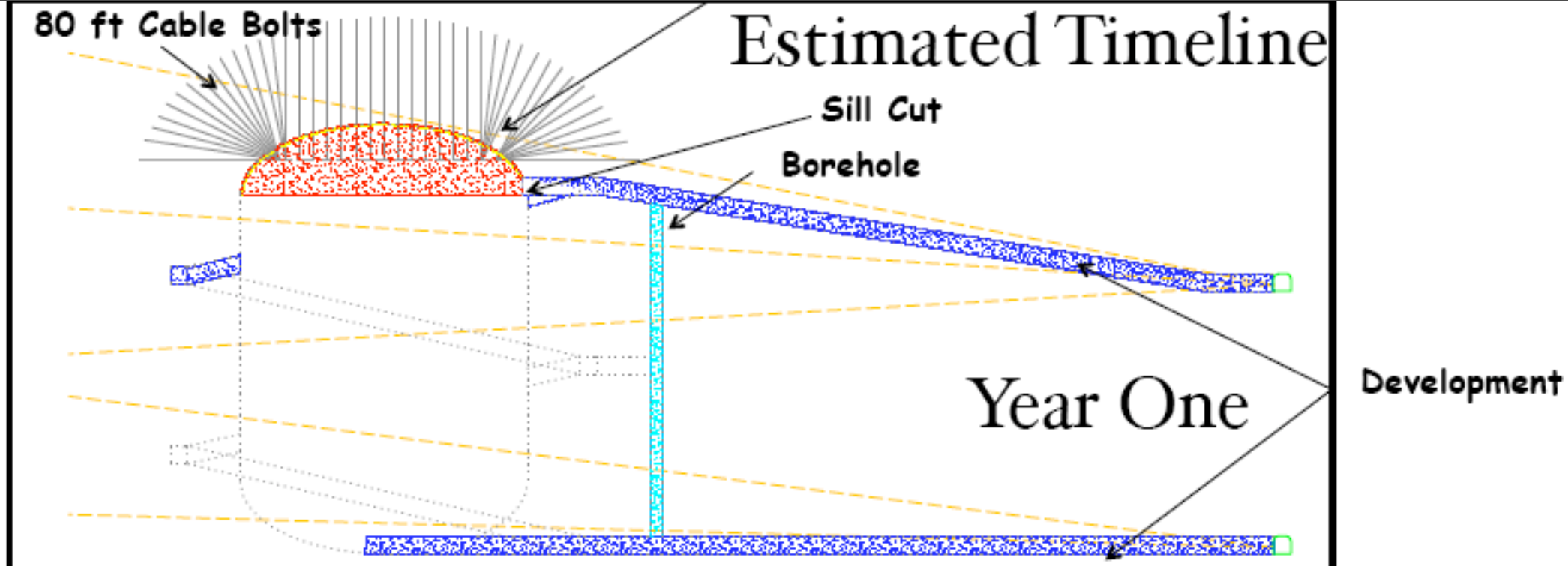
Construction Methodology
(this is one concept, not the only method)

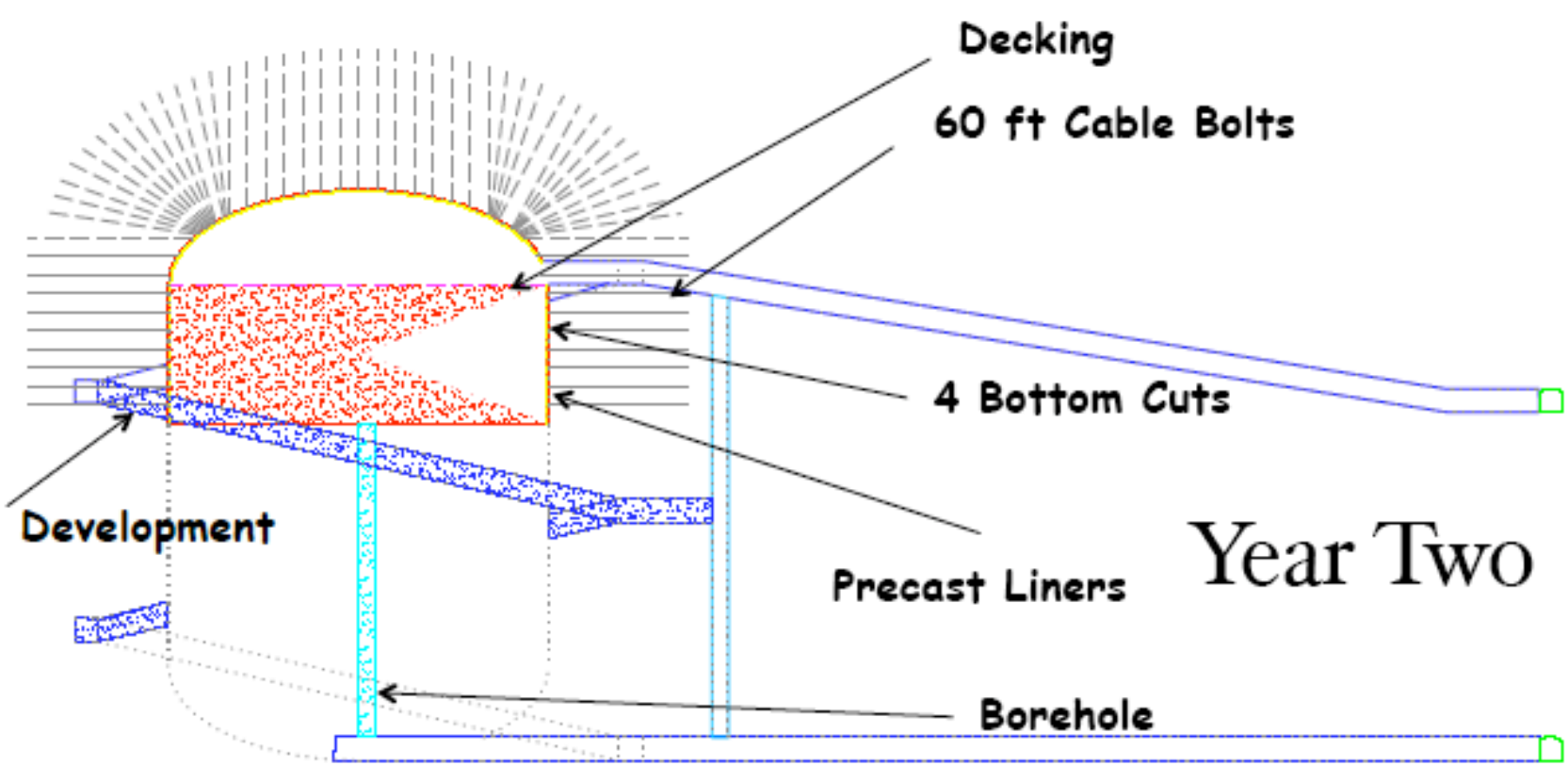




Rock removal would be from the 5000 level, below the main operations

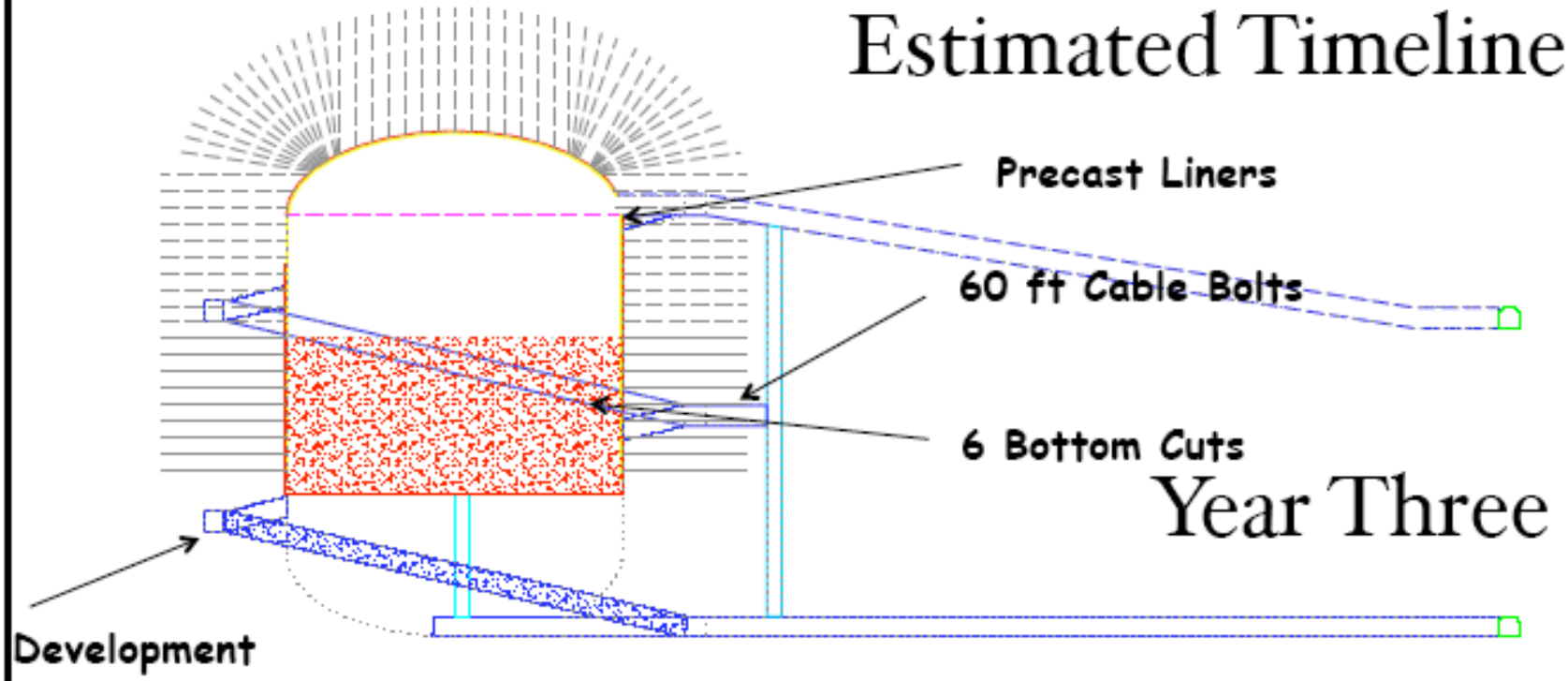
Estimated Timeline

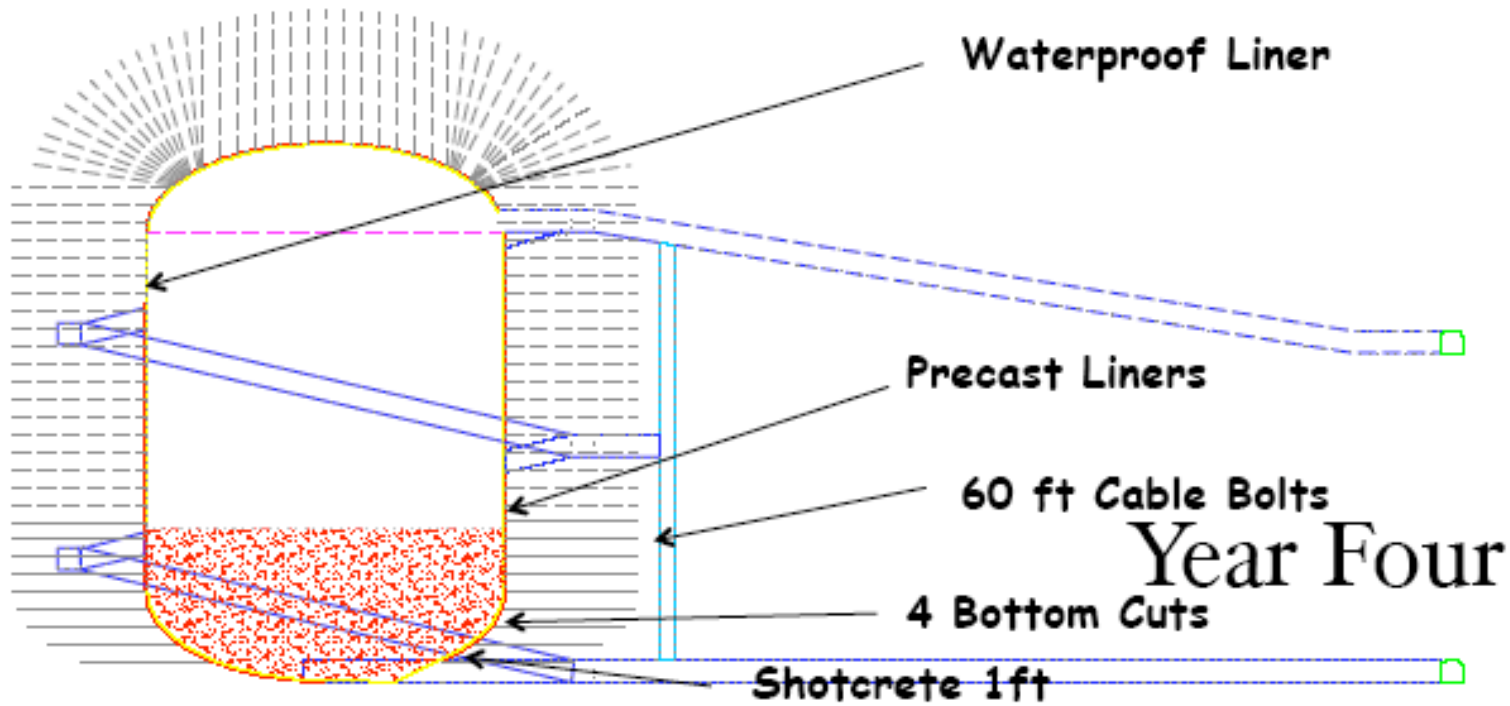




Mark A. Laurenti

Estimated Timeline





Summary cost ($FY07) for 300kT at Homestake

Cavity construction (30% contingency)	$78.9M
PMT+electronics	$171.3M
Installation+testing	$35.7M
R&D,Water, DAQ, etc.	$8.2M
Contingency(non-civil)	$50.8M
Total	$344.9M

- Cost for 3 modules of ~100kT fiducial mass. 6 yrs to first 100kT, 8 yrs for full 300kT.
- Civil cost recently reviewed by RESPEC (consultants) and found to be consistent with other projects. (In addition, construction could be faster).
- Consultations with C. Laughton and Homestake on overhead factors (not included in civil).

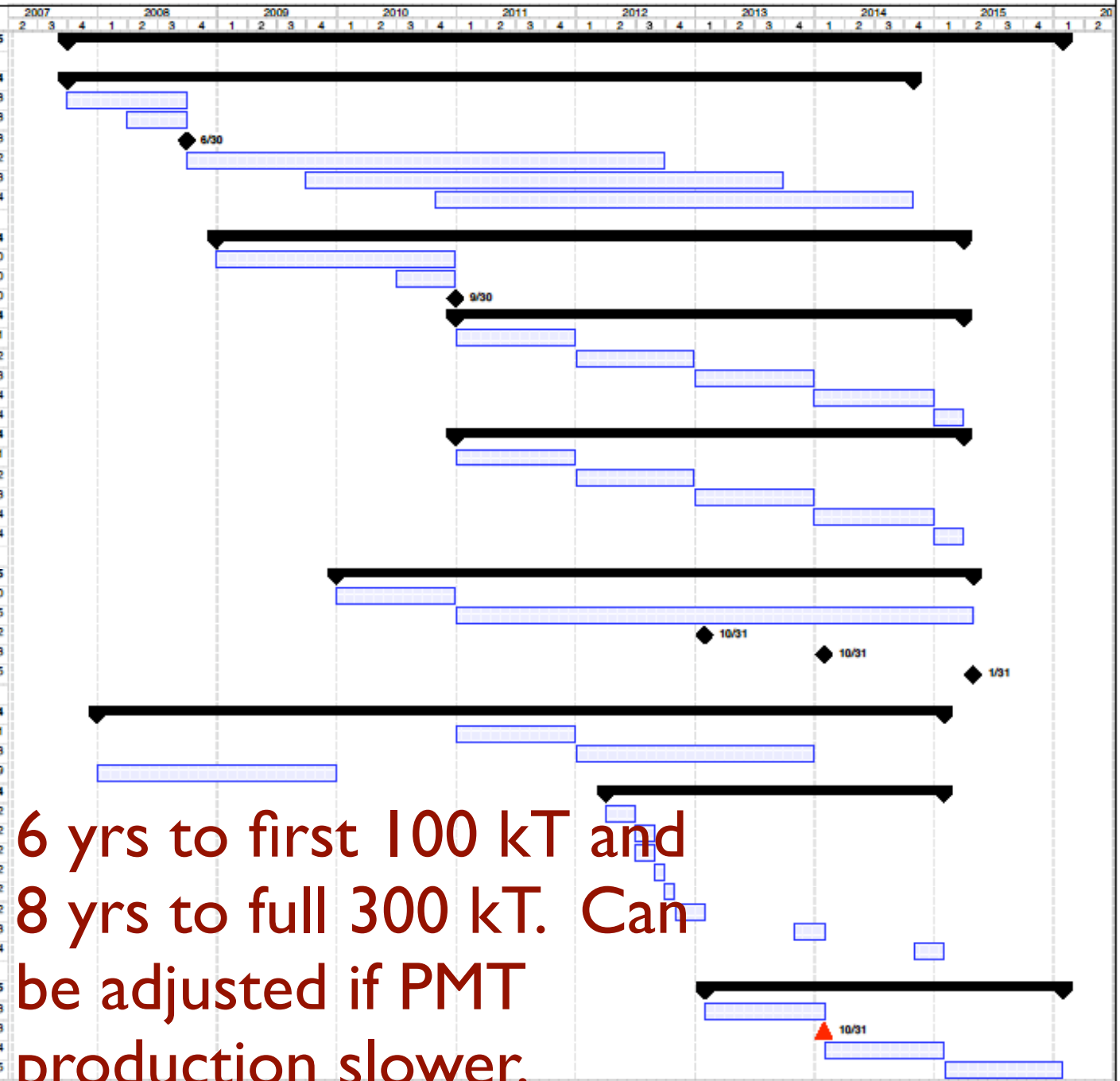
Office of Science
U.S. DEPARTMENT OF ENERGY

M.Diwan

BROOKHAVEN NATIONAL LABORATORY

Long Baseline Neutrinos + PDK
Schedule No. 2

ID	Task Name	Start	Finish
1	**Long Baseline Neutrinos + PDK**	**7/2/07**	**10/30/15**
2			
3	**Chamber Construction**	**7/2/07**	**7/30/14**
4	Chamber R&D	7/2/07	6/30/08
5	Contract Process	1/1/08	6/30/08
6	Chamber Construction Contract Award	6/30/08	6/30/08
7	Module 1	7/1/08	6/29/12
8	Module 2	7/1/09	6/28/13
9	Module 3	8/2/10	7/30/14
10			
11	**PMs**	**10/1/08**	**12/31/14**
12	PM R&D	10/1/08	9/30/10
13	Contract Process	4/1/10	9/30/10
14	PMs Contract Award	9/30/10	9/30/10
15	**Vendor 1**	**10/1/10**	**12/31/14**
16	Qty 10,000 PMs	10/1/10	9/30/11
17	Qty 20,000 PMs	10/3/11	9/28/12
18	Qyt 20,000 PMs	10/1/12	9/30/13
19	Qty 20,000 PMs	10/1/13	9/30/14
20	Qty 5,000 PMs	10/1/14	12/31/14
21	**Vendor 2**	**10/1/10**	**12/31/14**
22	Qty 10,000 PMs	10/1/10	9/30/11
23	Qty 20,000 PMs	10/3/11	9/28/12
24	Qyt 20,000 PMs	10/1/12	9/30/13
25	Qty 20,000 PMs	10/1/13	9/30/14
26	Qty 5,000 PMs	10/1/14	12/31/14
27			
28	**Testing**	**10/1/09**	**1/31/15**
29	Test Facility	10/1/09	9/30/10
30	Testing of PMs	10/1/10	1/30/15
31	1st Module PMs ready for Installation	10/31/12	10/31/12
32	2nd Module PMs ready for Installation	10/31/13	10/31/13
33	Final Module PMs ready for Installation	1/31/15	1/31/15
34			
35	**Other Equipment**	**10/1/07**	**10/31/14**
36	Calibration Equipment R&D	10/1/10	9/30/11
37	Calibration Equipment	10/3/11	9/30/13
38	Development Labor	10/1/07	9/29/09
39	**Water Purification**	**1/2/12**	**10/31/14**
40	Purchase Order	1/2/12	3/30/12
41	Vendor	4/2/12	5/31/12
42	Shop Conversion	4/2/12	5/31/12
43	Install Water Systems (3 systems)	6/1/12	6/29/12
44	Test Water (to see if suitable)	7/2/12	7/31/12
45	Fill up 1st Chamber	8/1/12	10/31/12
46	Fill up 2nd Chamber	8/1/13	10/31/13
47	Fill up 3rd Chamber	8/1/14	10/31/14
48			
49	**Installation**	**11/1/12**	**10/30/15**
50	Module 1	11/1/12	10/31/13
51	Physics Turn-On	10/31/13	10/31/13
52	Module 2	11/1/13	10/31/14
53	Module 3	11/3/14	10/30/15



6 yrs to first 100 kT and 8 yrs to full 300 kT. Can be adjusted if PMT production slower.

Summary

- Homestake site has been chosen in the US for a Deep Underground Science Laboratory.
- The planning (cavity design) for a mega-detector will be performed as part of the initial suite of projects in Homestake.
- A conceptual design with cost (~$350M) and schedule (~6-8 yrs) is ready for the Homestake 300kT detector.
- Work on the detector will proceed according to the recommendations of national panels (NuSAG).