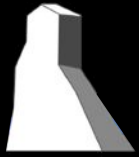


Development of the Sanford Laboratory at Homestake

Jose Alonso

Lab Director ('07-'09)



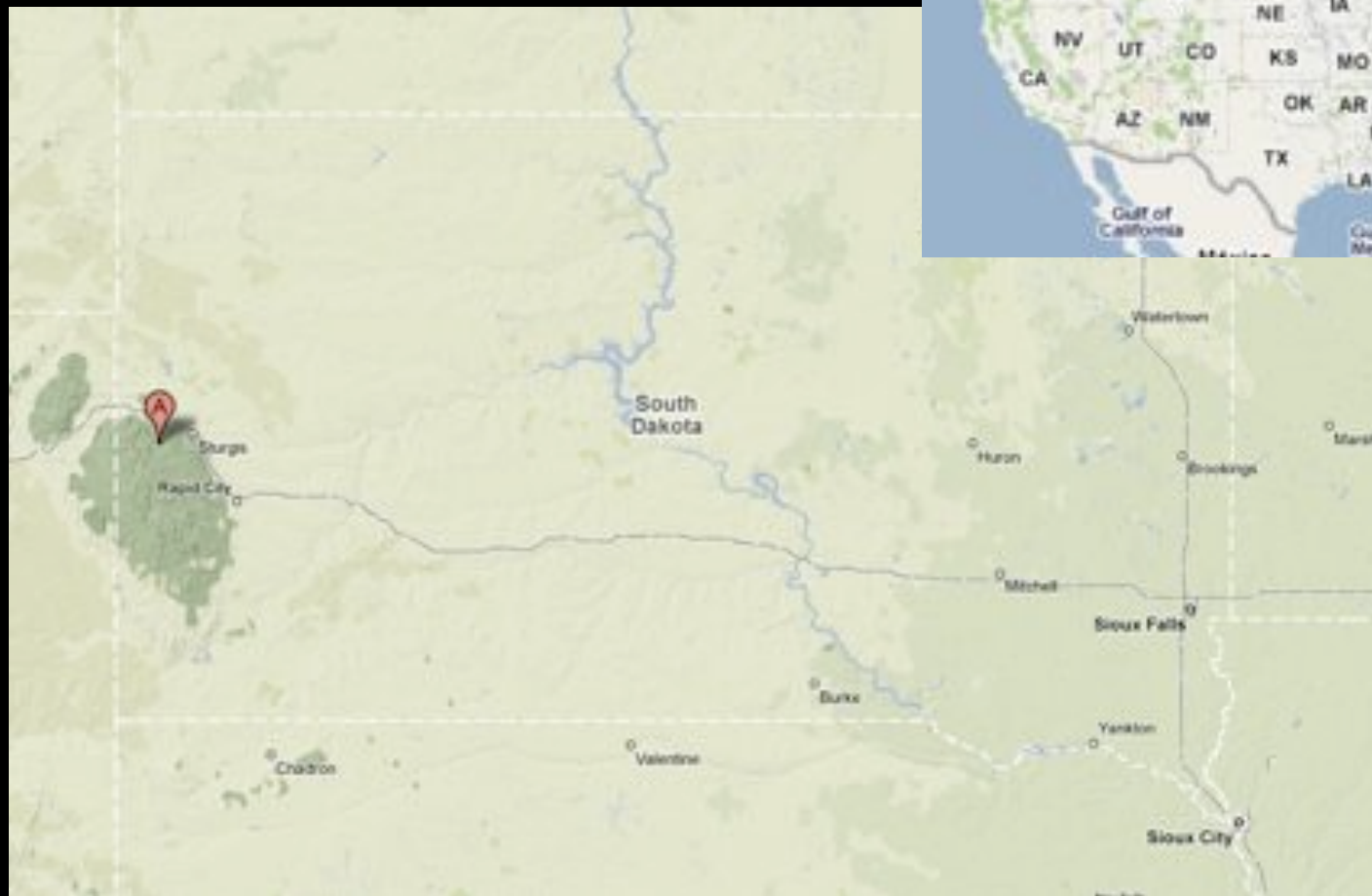


Acknowledgments

- Bill Harlan and Matt Kapust
 - Sanford Lab Communications Department
- Ron Wheeler
 - Executive Director, South Dakota Science and Technology Authority
- LUX and Majorana experimental groups
 - Rick Gaitskell, LUX
 - John Wilkerson, Steve Elliott, Majorana
- DUSEL leadership
 - Kevin Lesko, PI, Bill Roggenthen, Co-PI
 - Gil Gilchriese, Science Director



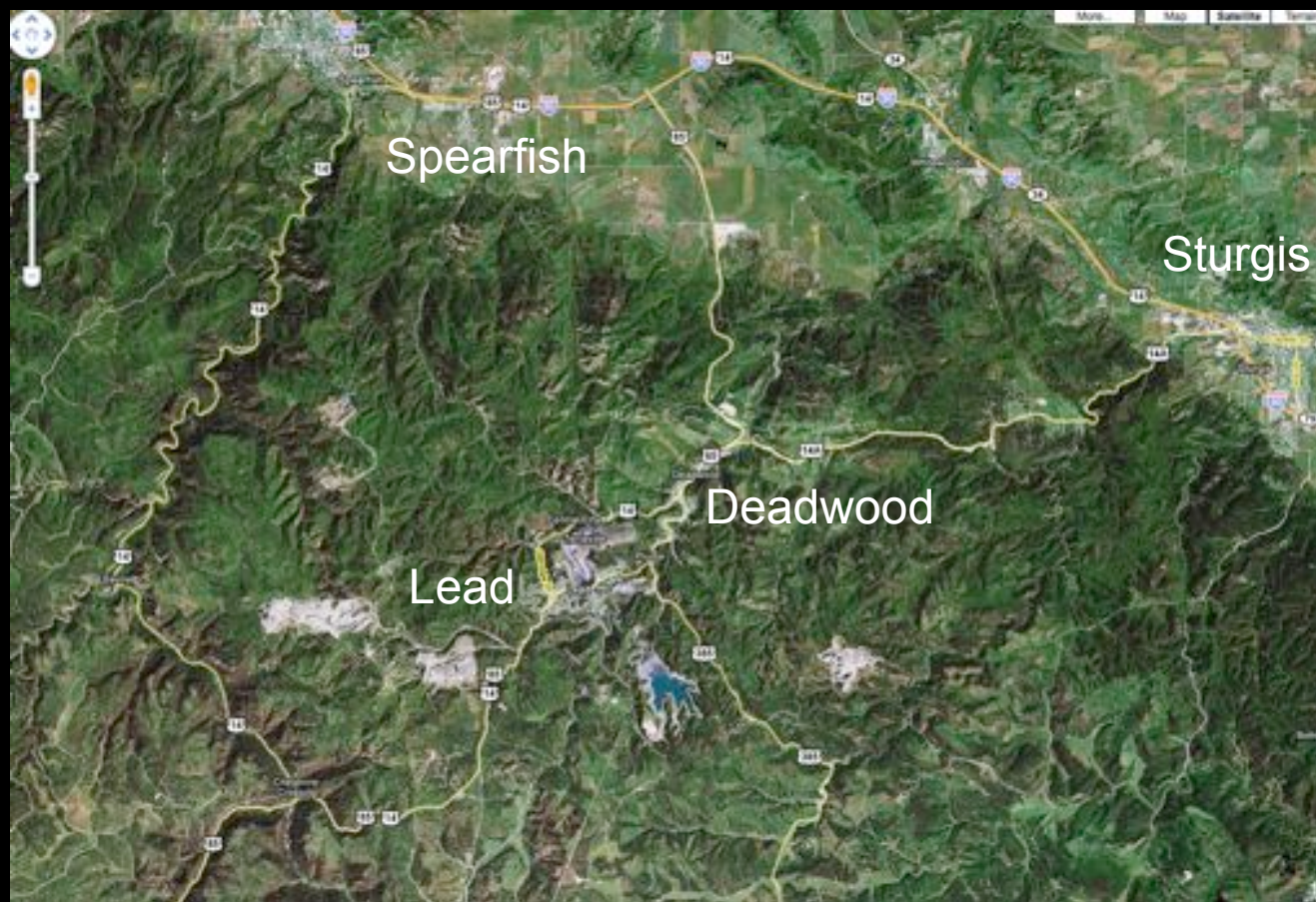
Where is Homestake?



TAKE



Colorful Northern Black Hills



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Lead... Old Mining Town



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Yes... Lots of Snow!



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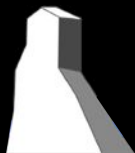
Homestake Local



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Historic Homestake Mine



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Modern Homestake



Underground
Engineering





Homestake Mine at Lead



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Aerial View of Homestake

Ross Headframe

Yates Headframe



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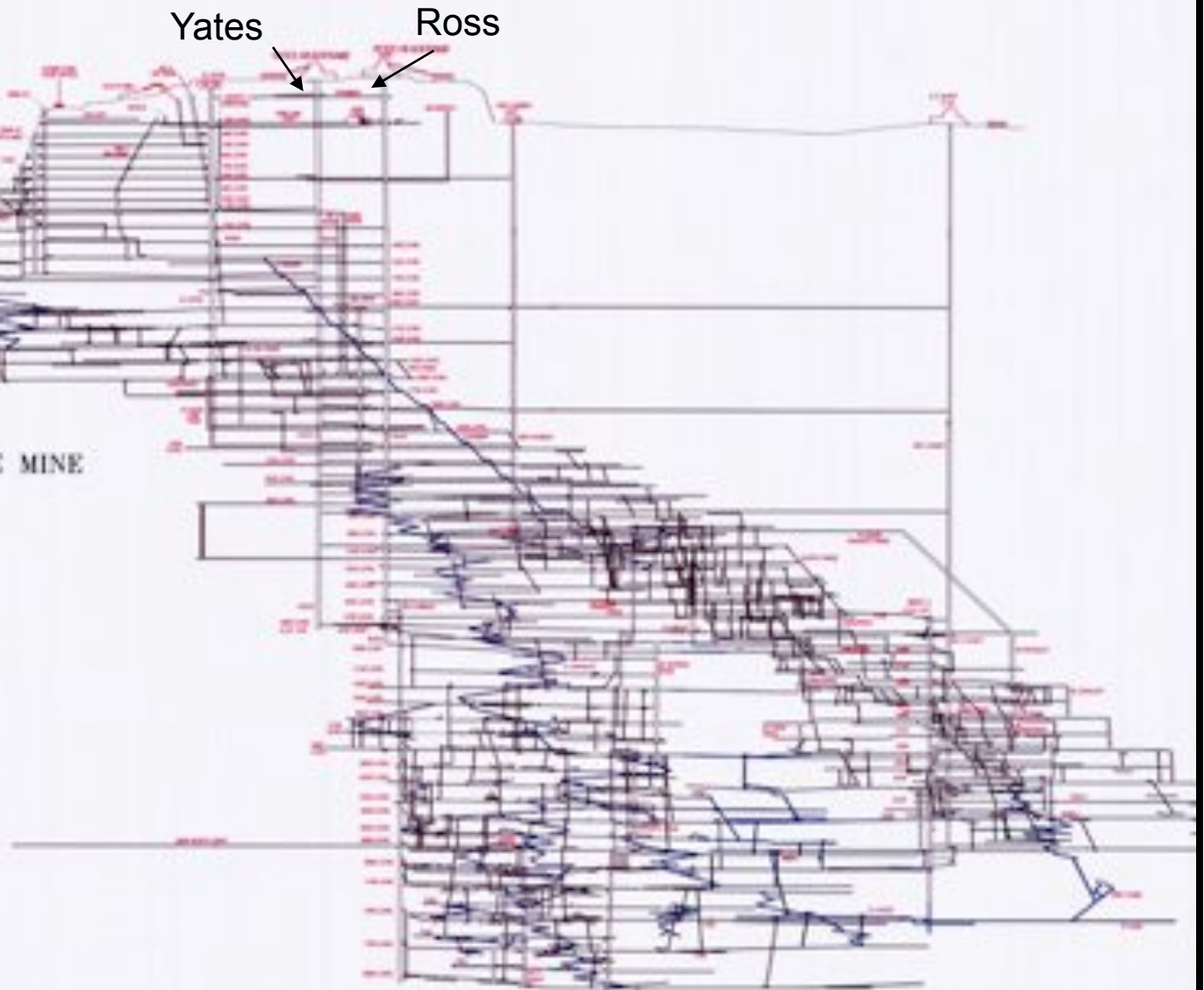
Section View of Homestake Mine

Yates Ross

LONGSECTION OF THE HOMESTAKE MINE
LEAD, SOUTH DAKOTA
1876-2002

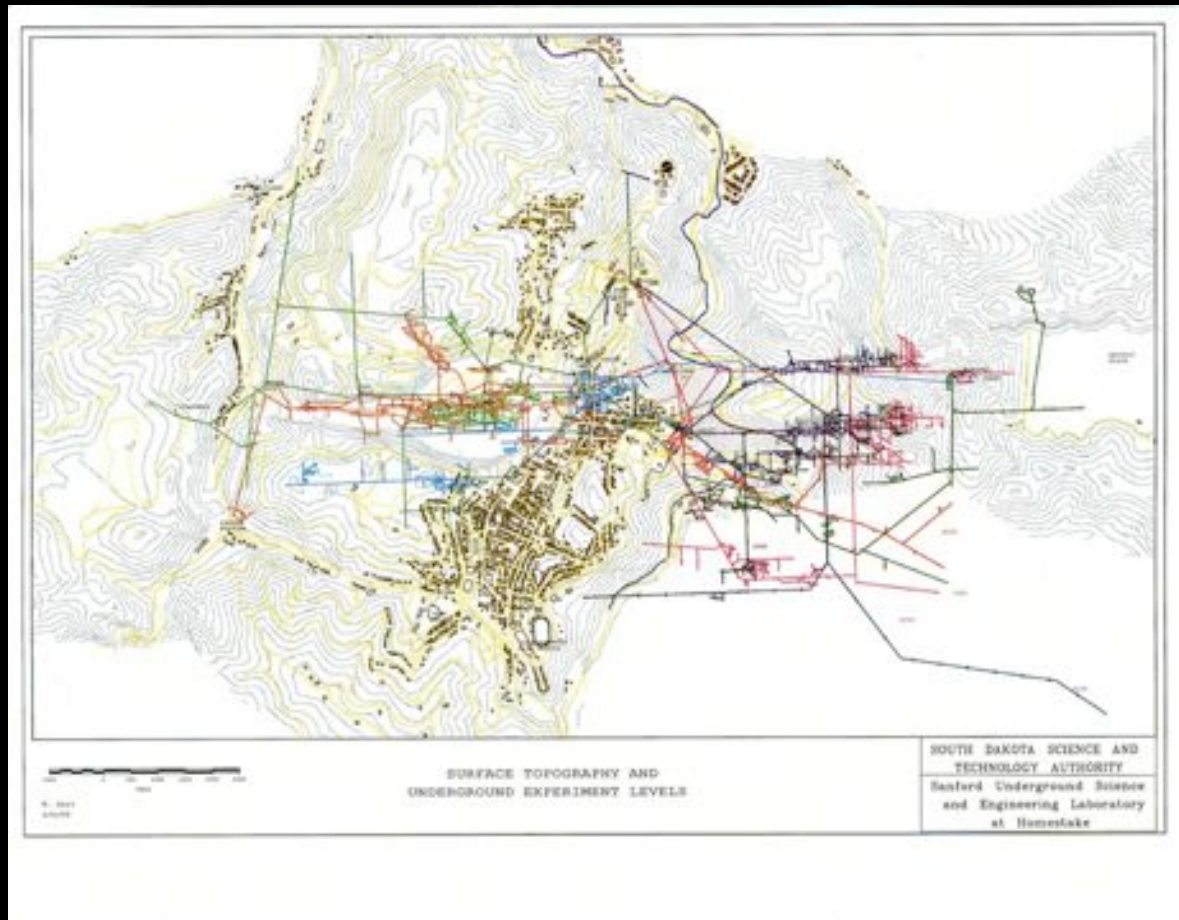


CITY OF LEAD
JUNE 1990





What's beneath Lead...



300	_____
800	_____
2000	_____
4100	_____
4550	_____
4850	_____
7400	_____
8000	_____

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Section View of Homestake Mine

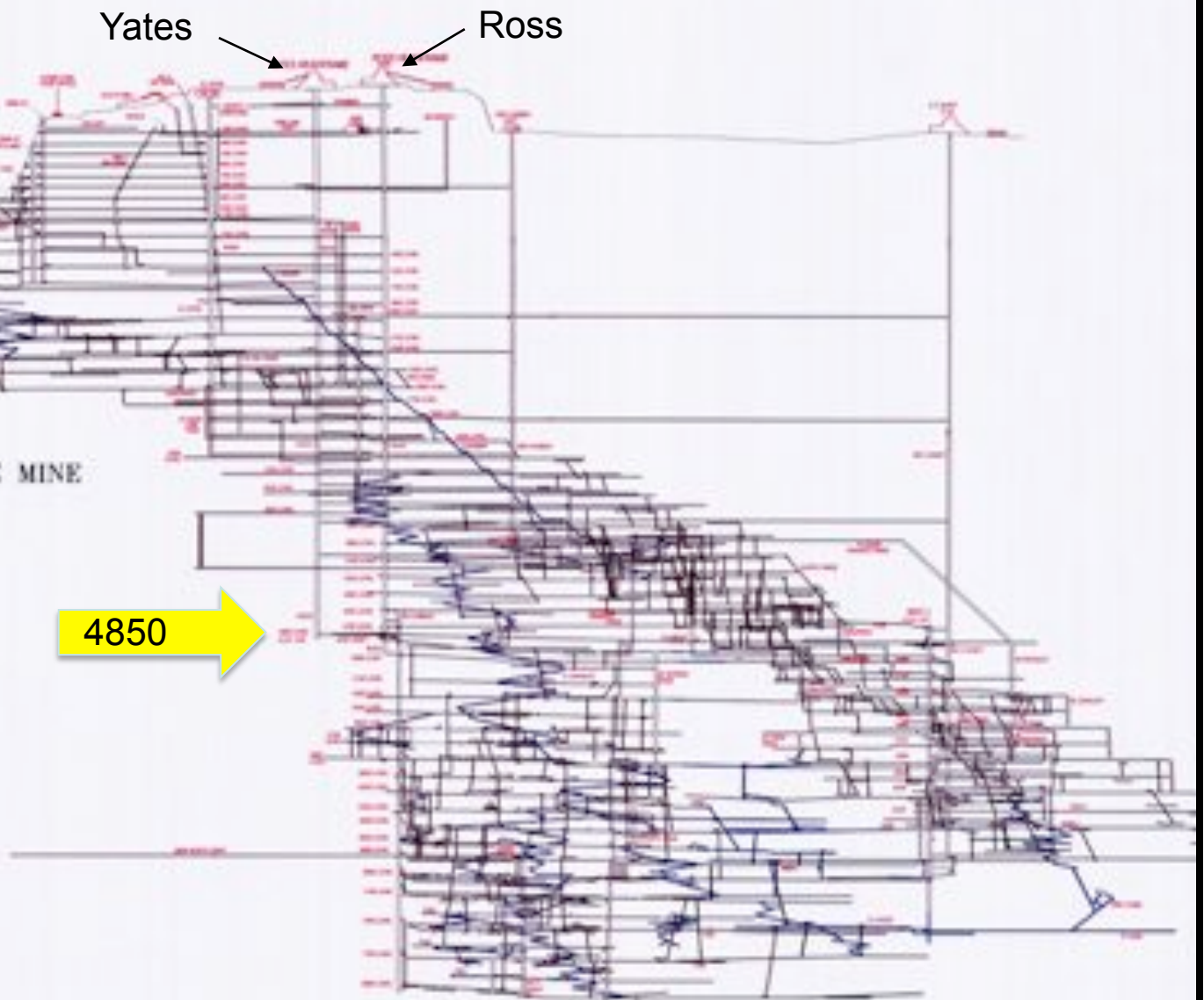
Yates Ross

LONGSECTION OF THE HOMESTAKE MINE
LEAD, SOUTH DAKOTA
1876-2002



CITY OF LEAD
JUNE 1990

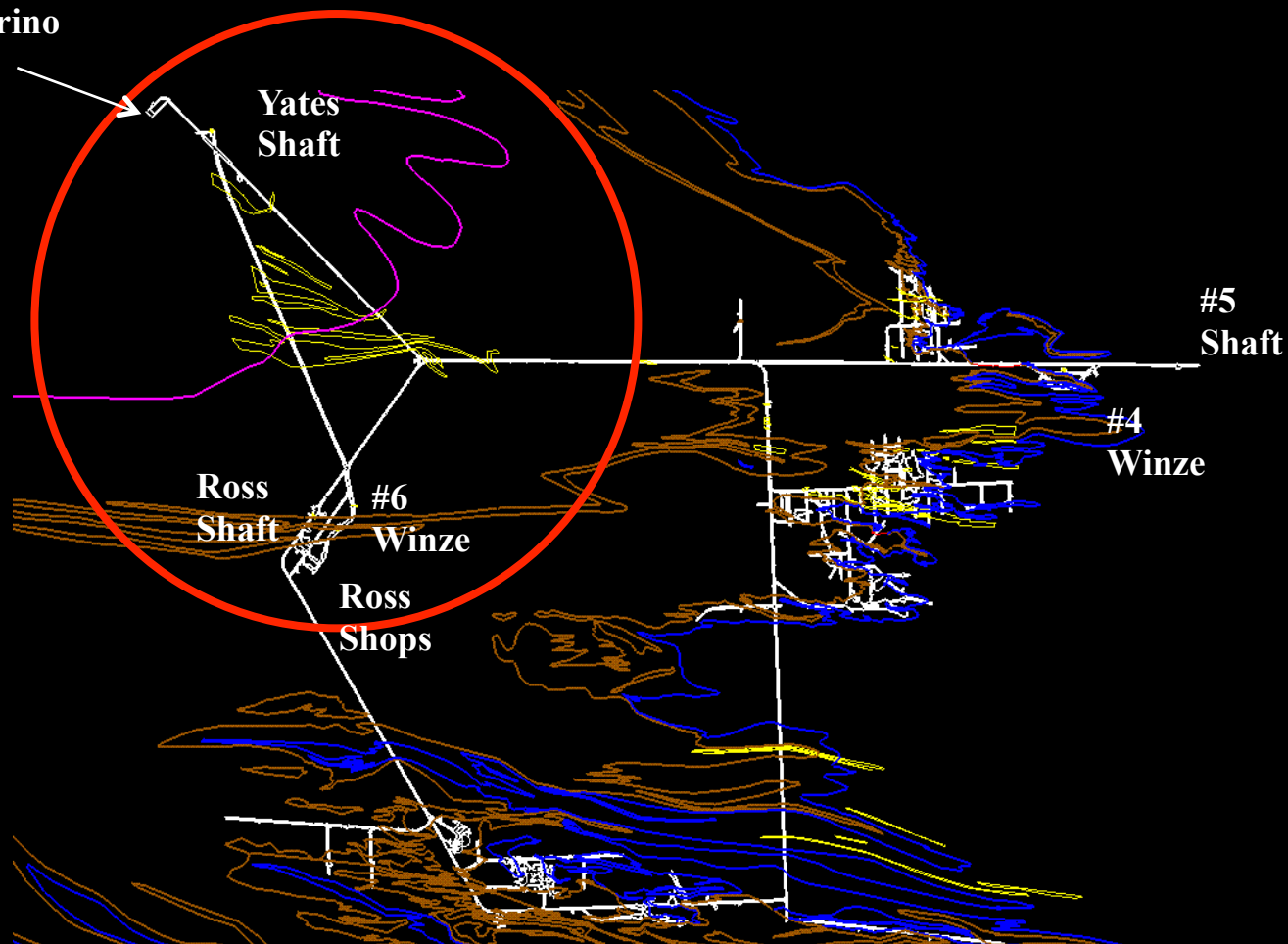
4850





4850 Level Configuration

Davis Neutrino
Lab



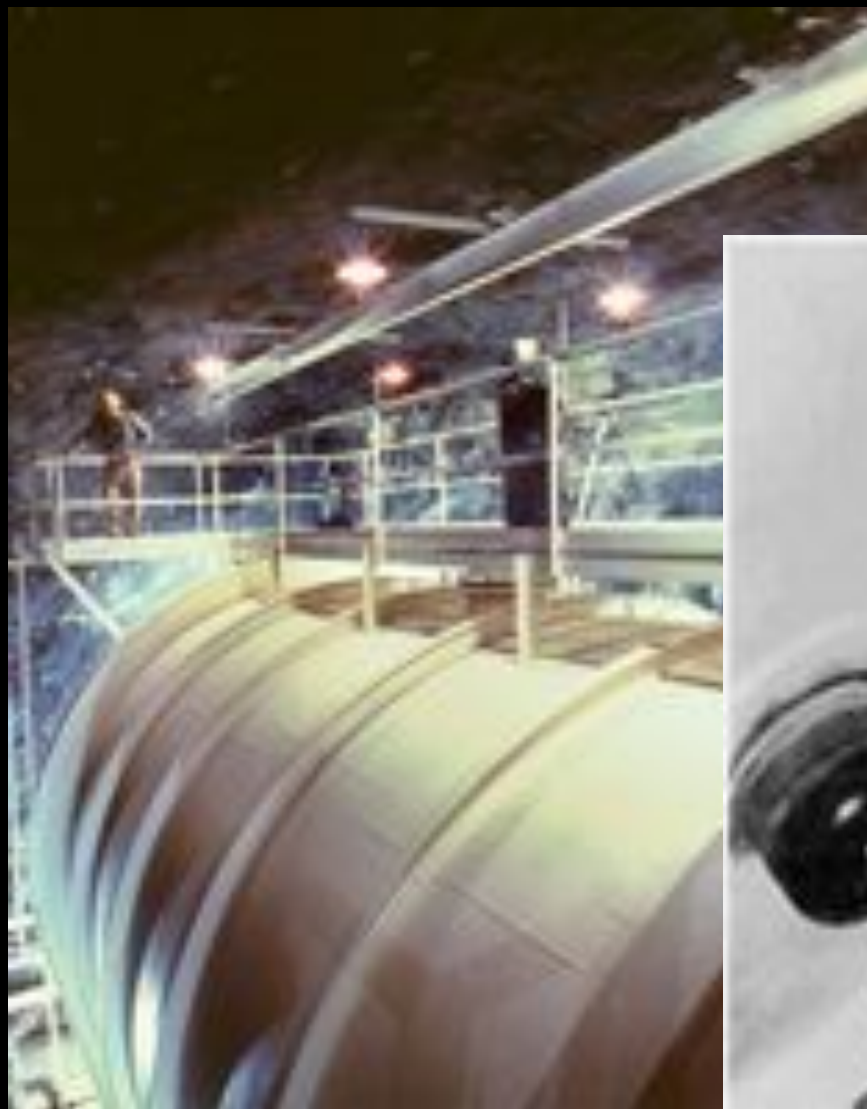
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Legacy of Science at Homestake



1965

Ray Davis John Bahcall





Davis' Solar ν Experiment





“Welcome to Homestake Spa!”



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Stockholm, 2002

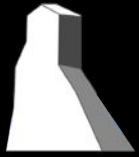


 Nobelprize.org

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Chronology...

2000 Homestake announced closure

2002 NSF Process for Underground Lab starts

2006 Homestake-Barrick donates mine to State

Formation of SDSTA

State provides \$40M, T.Denny Sanford adds \$70M

2007 NSF Downselect occurs

2007 Sanford Lab startup

Re-entry activities begin

Early science begins



Sadoulet Committee Report



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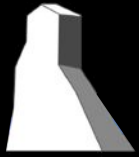
Homestake Property Donation Footprint



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Governor Mike Rounds is True Hero!



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South Dakota Initiatives



SDSTA Established

Sanford Lab is Formed



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Engineering Laboratory



NSF Selects Homestake!

July 10, 2007: Announcement!



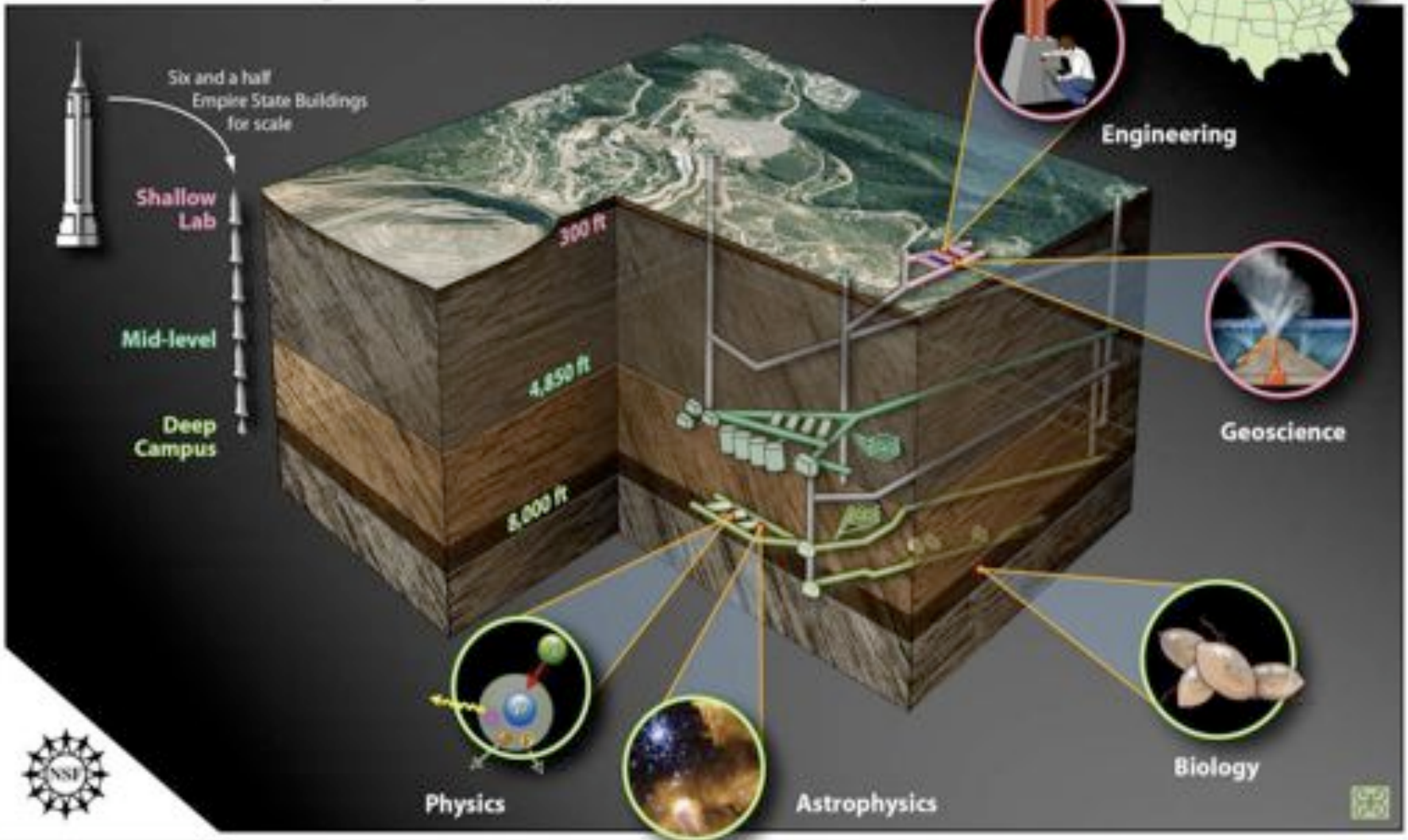
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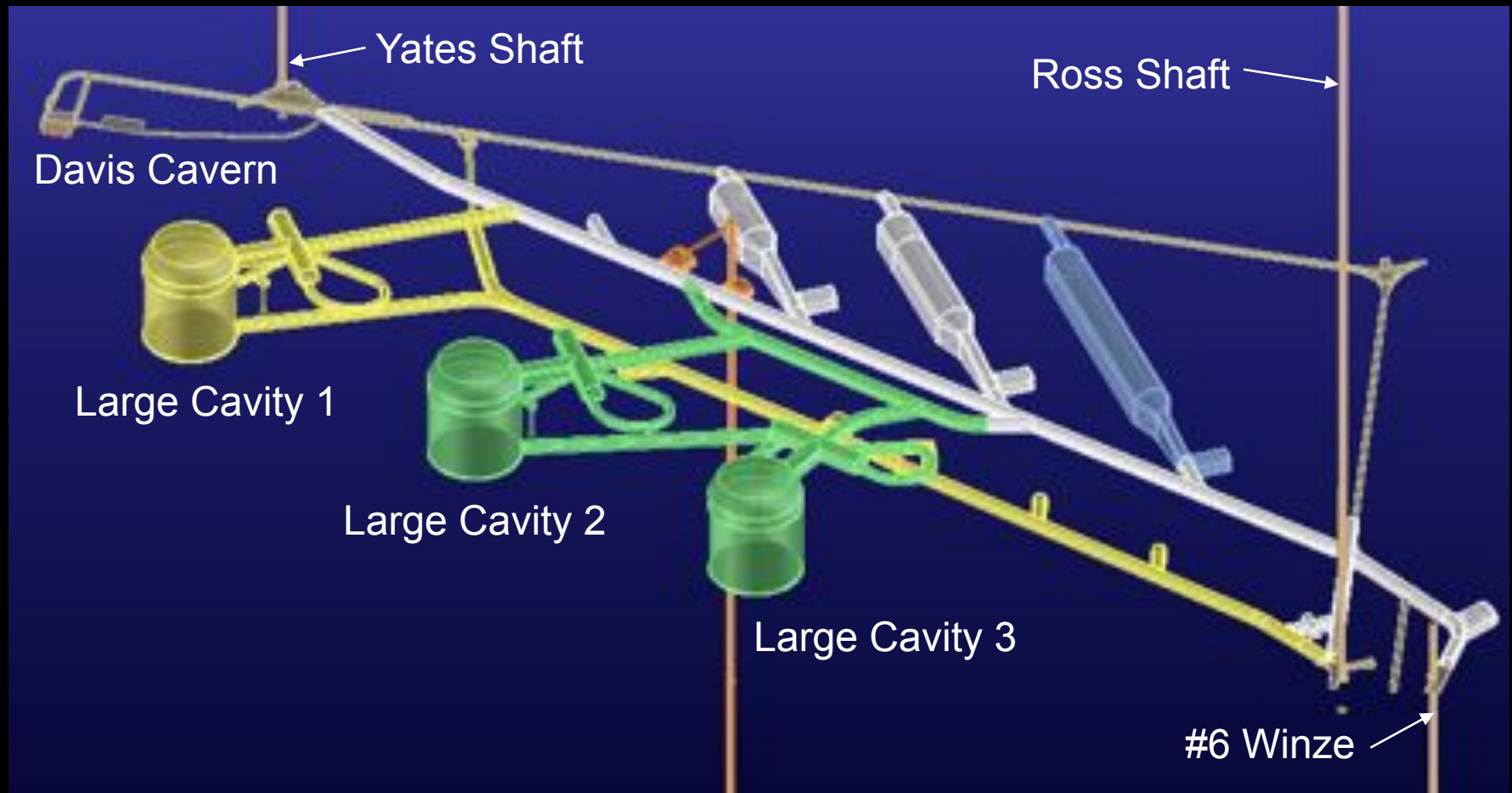
DUSEL Plans (2007)

DUSEL Deep Underground Science and Engineering Laboratory at Homestake, SD





DUSEL 4850 L (2007)



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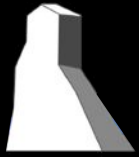
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Re-Start Activities

- Hoist-Shaft rehab
- Inspection, safety of levels
- De-watering
- Refurbishing of 4850
 - Davis Campus
 - Ross Shops area
- Deployment of “Early Science”
 - LUX
 - Majorana Demonstrator
 - Seismometry, tiltmeters
 - Extremophile microbiology



Hoist Equipment Re-Commissioning



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World's largest single-wrap drums





Power at your fingertips!





Cage Door



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Down the Shaft!



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Safety Inspections



Loose rock, back (roof) integrity
Ventilation, escape routes



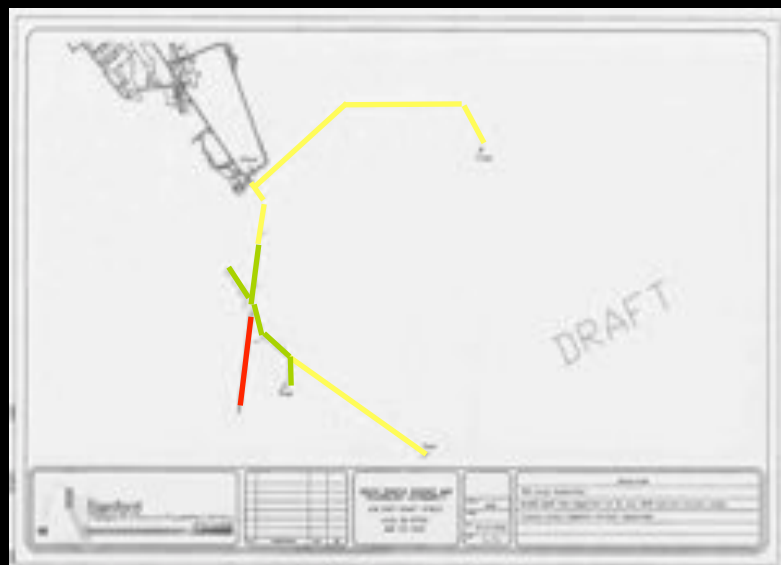
Iron-rich water



Don't Go There!!



Safety is All Important!



Access categories

“Tom is Back!”



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Engineering

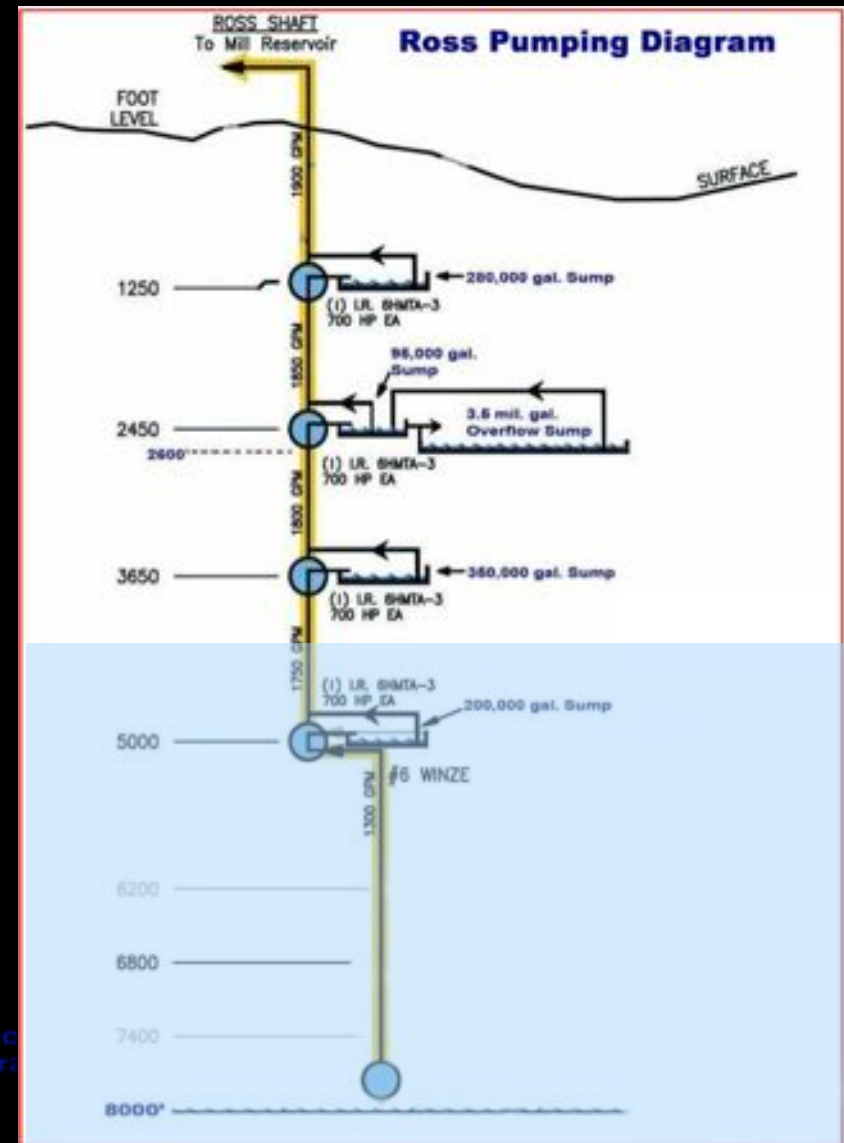


Recommissioning Pumping Chain

Water reached
4550 foot level

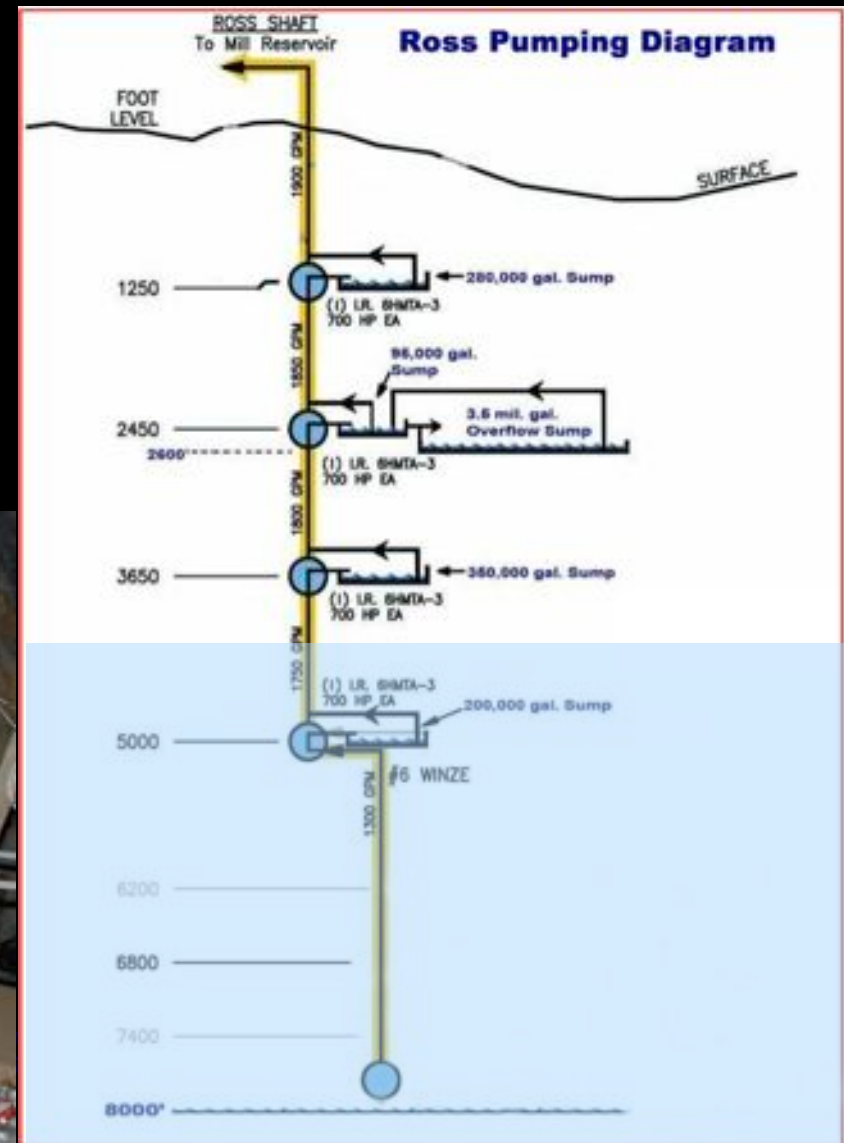
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Recommissioning Pumping Chain



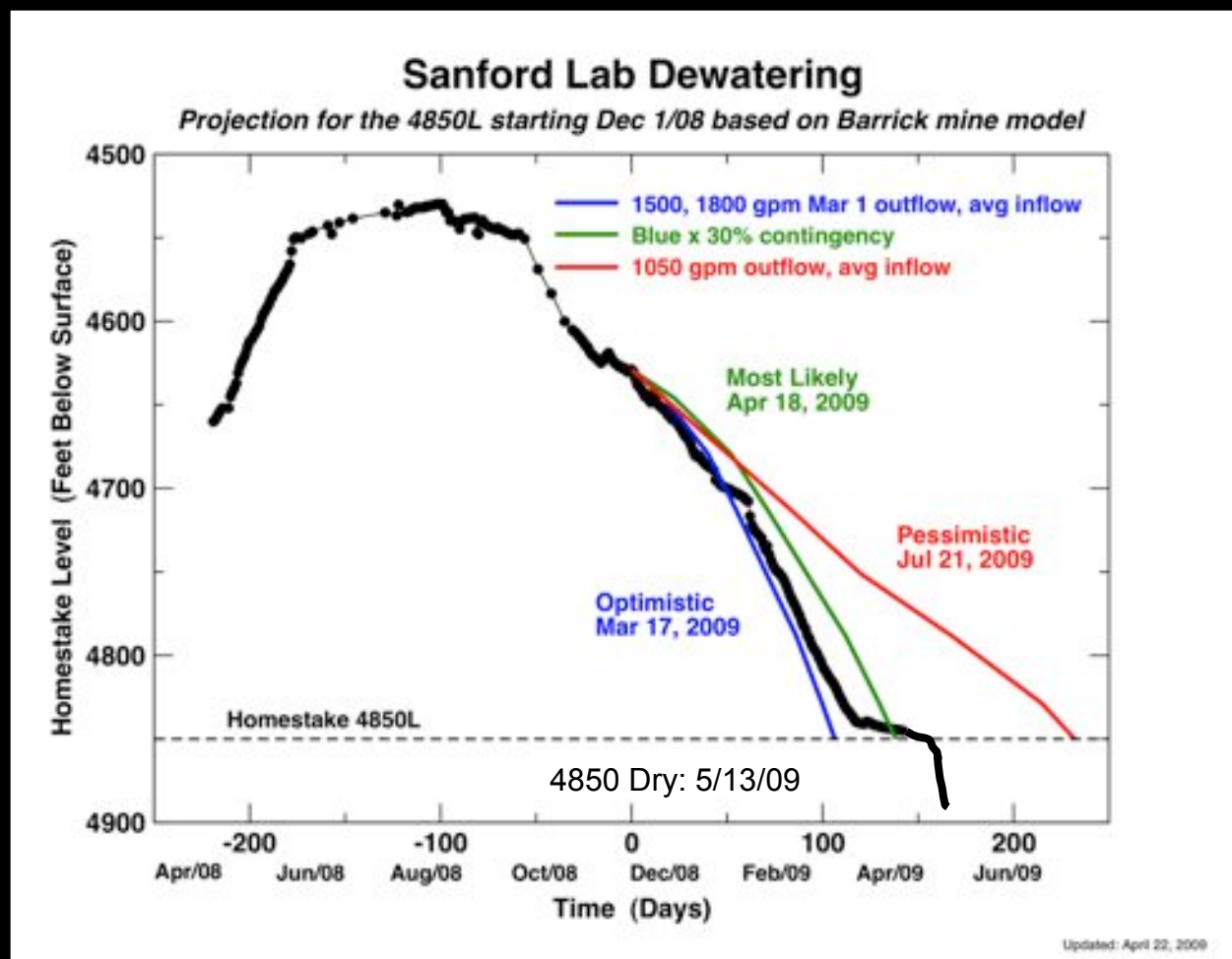
First Pump
Going!

March
2008

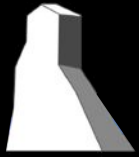




May 13, 2009: 4850 is DRY!



Water level 3/25/11..... 5400 (feet below surface)



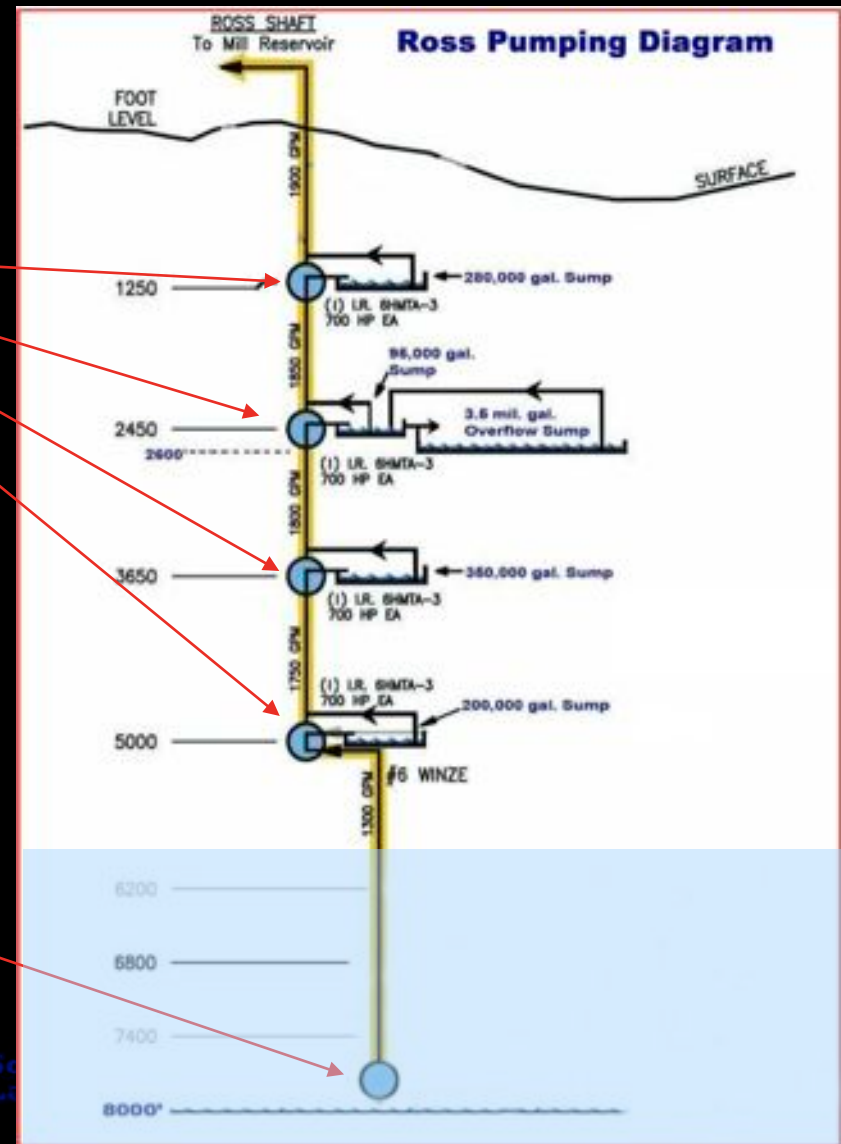
Water-Removal Infrastructure

Installed Pump System

4 stations
2 sets of 1500 gpm pumps
700 hp motors

1250 foot pumping head
12" pump columns

Submersible pump
at 7800 level



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Engineering La



Not only water... it's what's in it!

Pooled water had leached
minerals from rocks
Iron oxide must be removed!



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Mine Water Chemistry:

Temp. = 85-90°F

pH = 7.4

Iron = 20-30 mg/l

Ammonia = 3-4 mg/l

TSS = 50-60 mg/l

Particle Size = 0.01-2.0 microns

TDS = 5000-6000 mg/l

Tailings Dam Water Chemistry:

Temp. = 32-65°F

pH = 8.3

Iron = 2-3 mg/l

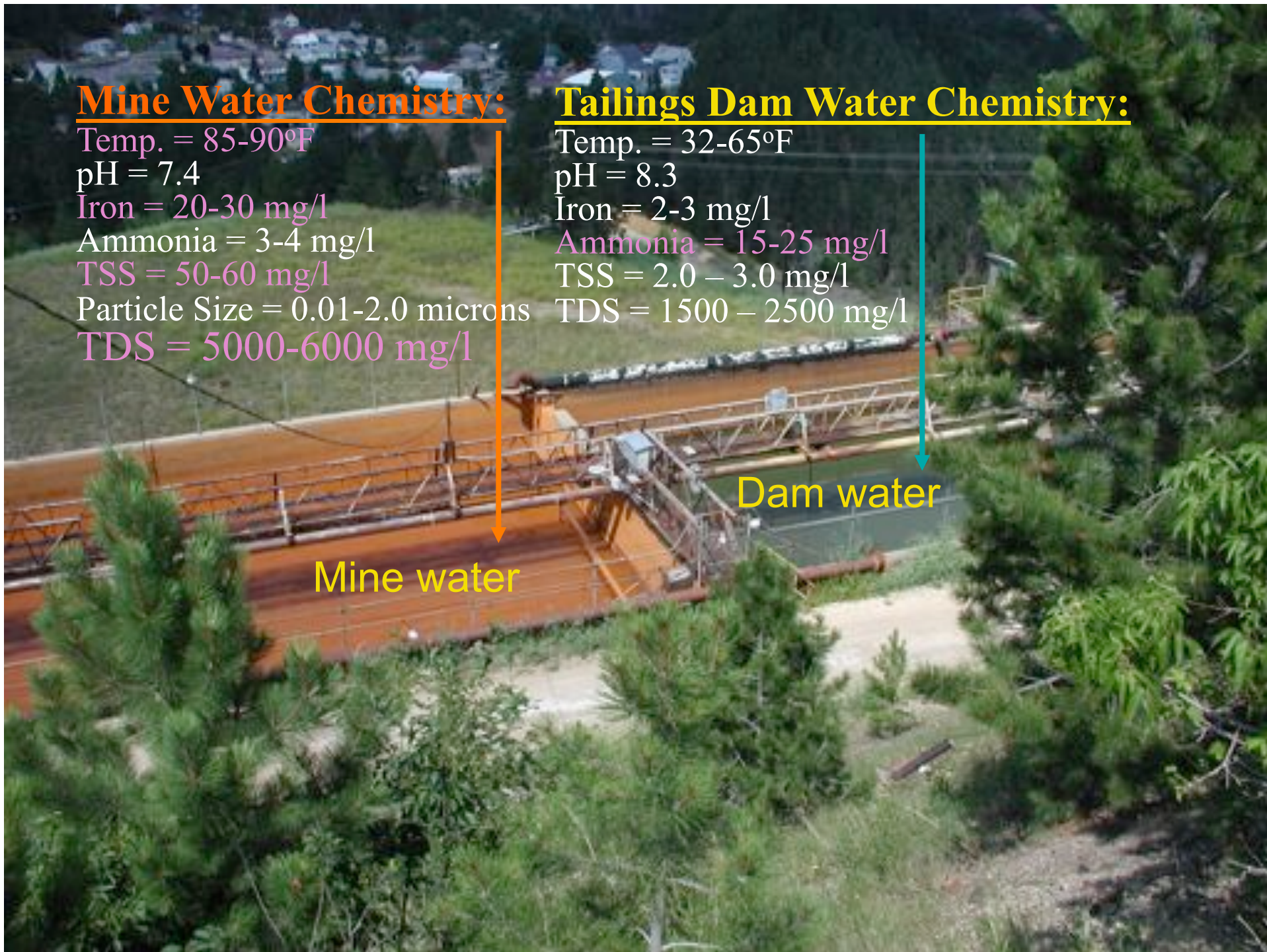
Ammonia = 15-25 mg/l

TSS = 2.0 – 3.0 mg/l

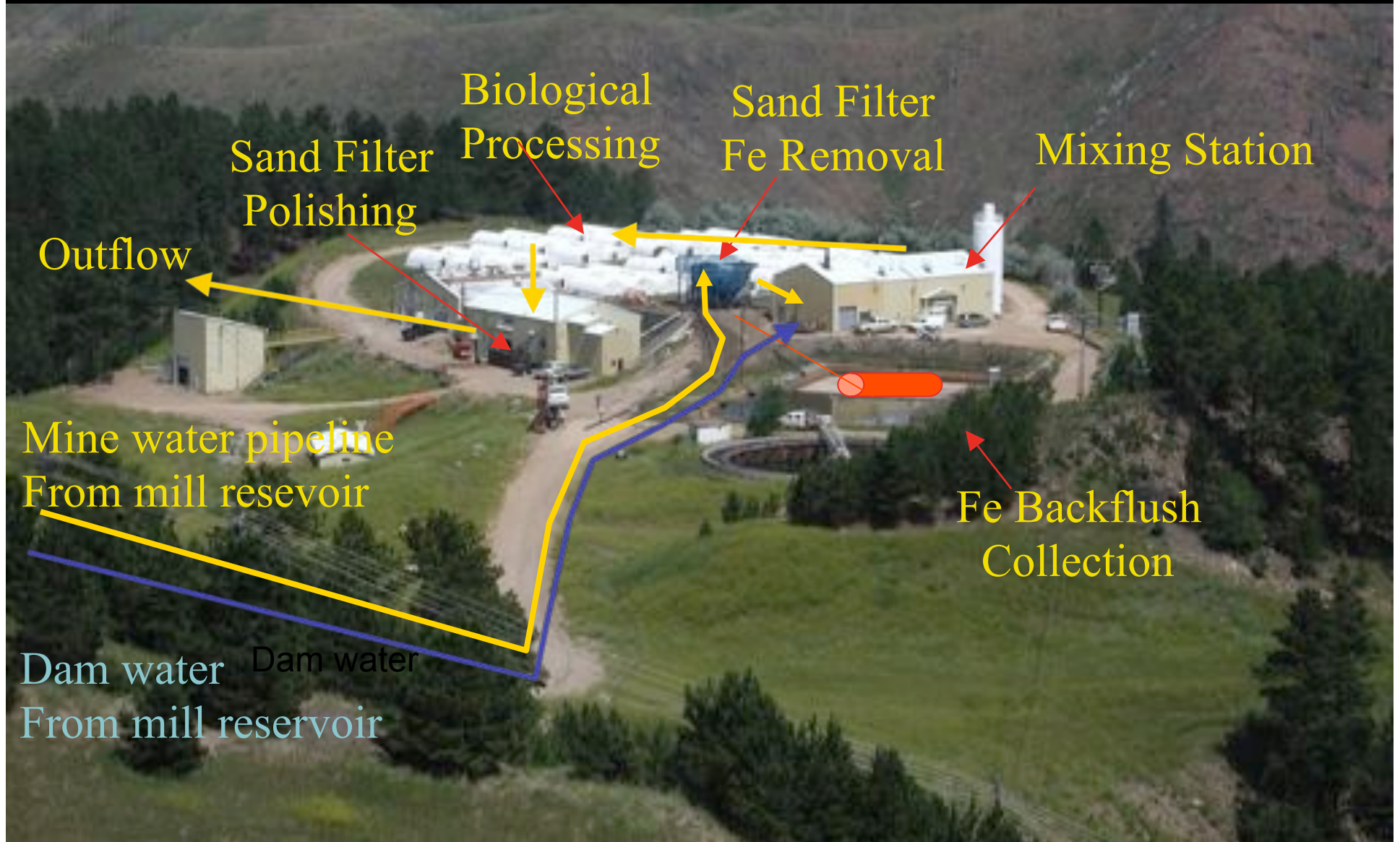
TDS = 1500 – 2500 mg/l

Mine water

Dam water



Homestake Water Treatment Plant





Sedimentation Clarifiers



Coagulant polymers
and flocculants
precipitate iron



More Efficient Sand Filters



“Geotubes” collect Fe sludge
(~ 2 tons/day)

RBC's (Rotating Biological Contactors) remove Ammonia



Final Polishing Filters





Homestake Waterfall Back in Business

~ 3 M gal/day



Fish are happy

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So are the Tourists



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Refurbishment of 4850 L: Before



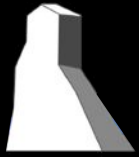
Water isn't best housekeeper



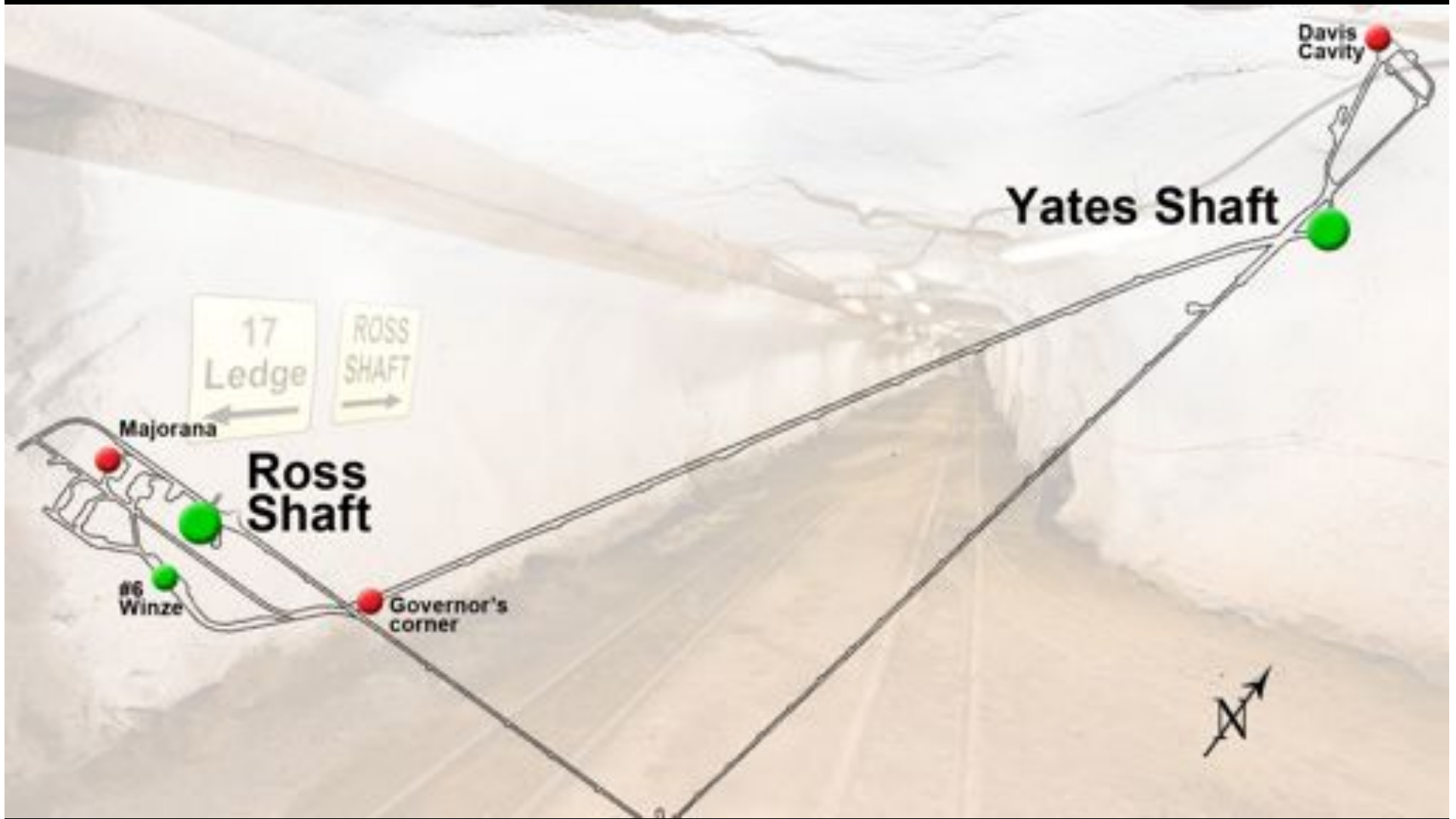
Air bubble



Flat Tire!



4850 Level





Drift to Ross Station 4850L

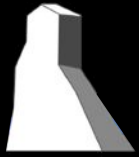




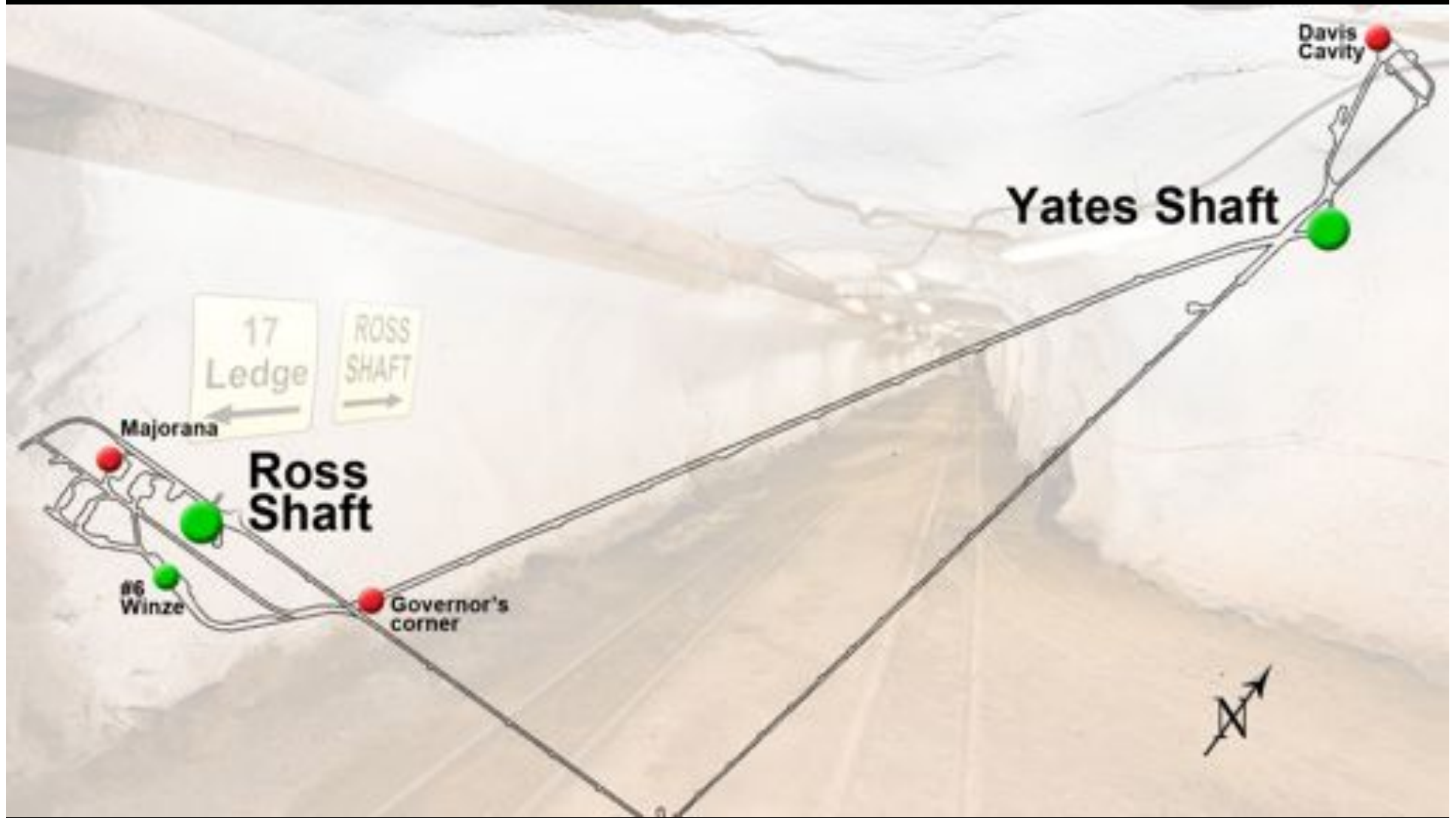
Clean Room for E-Forming Copper



MAJORANA Demonstrator experiment

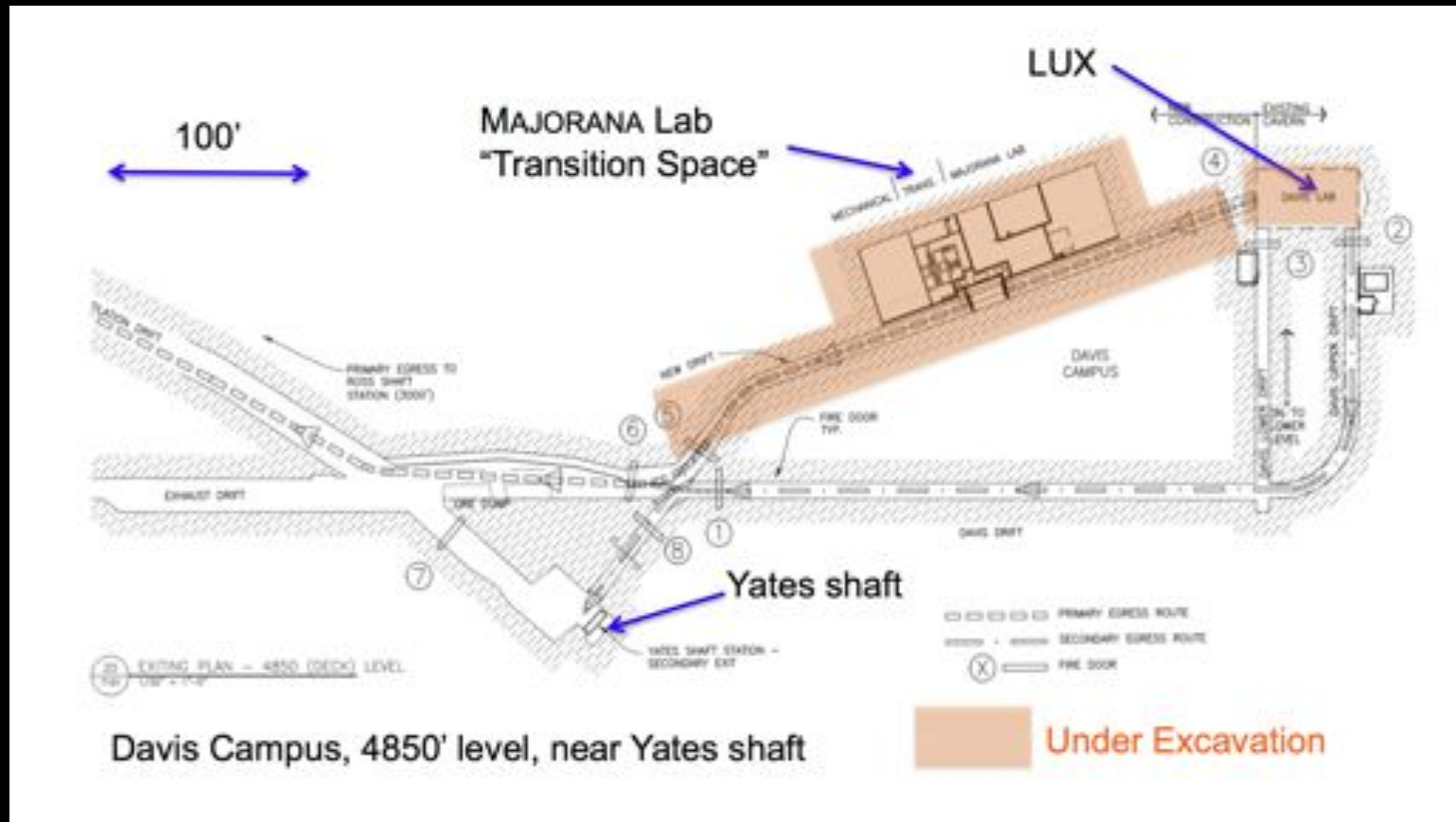


4850 Level





Modernization of Davis Campus





Transition Cavern Excavation



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Davis Cavern Expansion



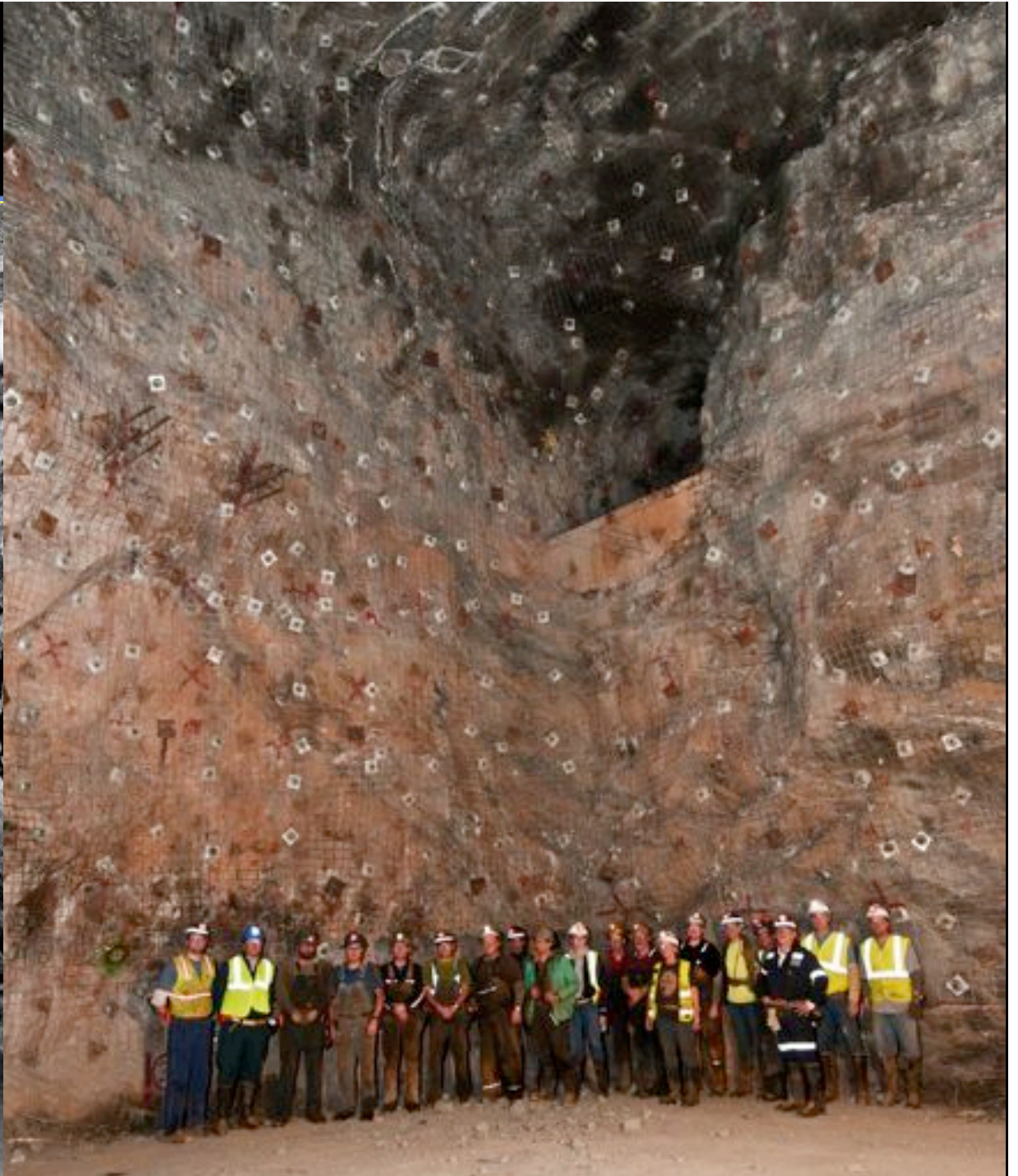
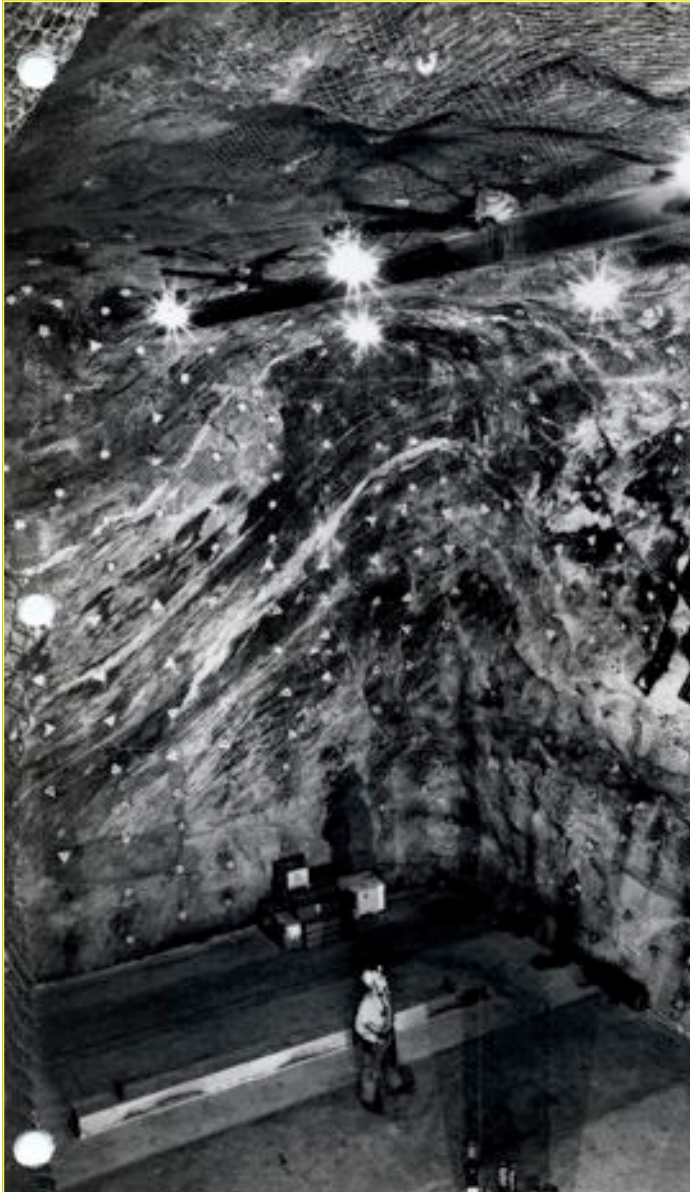
Before

d Science and
g Laboratory

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After...





Shotcreting





Ridin' High!

and Science and
ing Laboratory

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Early Science Deployment

- Presently ongoing
 - Geophysics/Hydrology
 - Microbiology
 - LUX
 - MAJORANA Demonstrator



Geophysics Research

- Seismometers: SDSMT, UCB, LIGO
- Tiltmeters installations: SDSMT, UCB, FNAL
- Hydrometers: SDSMT
- Radiation monitors: Regis, USD
- “Climatology”: SDSMT



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Seismometer installation (LIGO)



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Microbiology

Cynthia Anderson
(Black Hills State)
samples “interesting”
fungus at 2000 L



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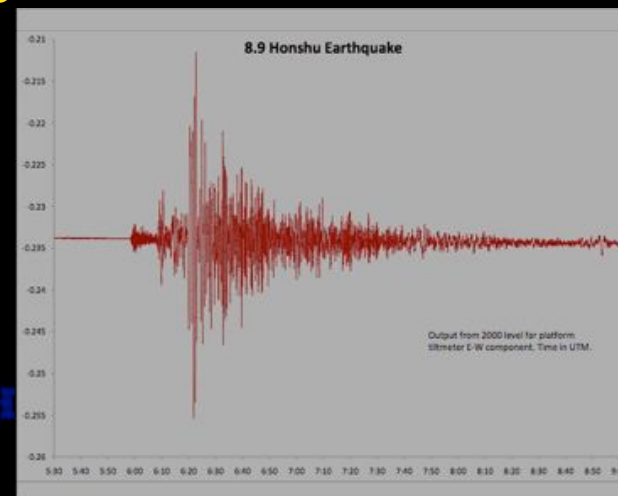
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Geo-Bio Research

- 300 L LIGO – Low-frequency seismometer
- 800 L LIGO
- USD – Background measurements
- 1250 L SDSMT – Climate station
- 2000 L SDSMT – Climate stations (2)
- SDSMT/FNAL – HLS Tiltmeters (2)
- Regis – Muon/neutron monitoring
- SDSMT/UCB – Seismometers/tiltmeters (2)
- LIGO – Seismometer
- BHSU – Bio characterization of fungus colonies
- 2600 L SDSMT – Climate stations (2)
- 3350 L Utah – Extensometers
- 4100 L LIGO – DUGL, seismometers, laser sounding
- 4550 L SDSMT – Hydrometry probes



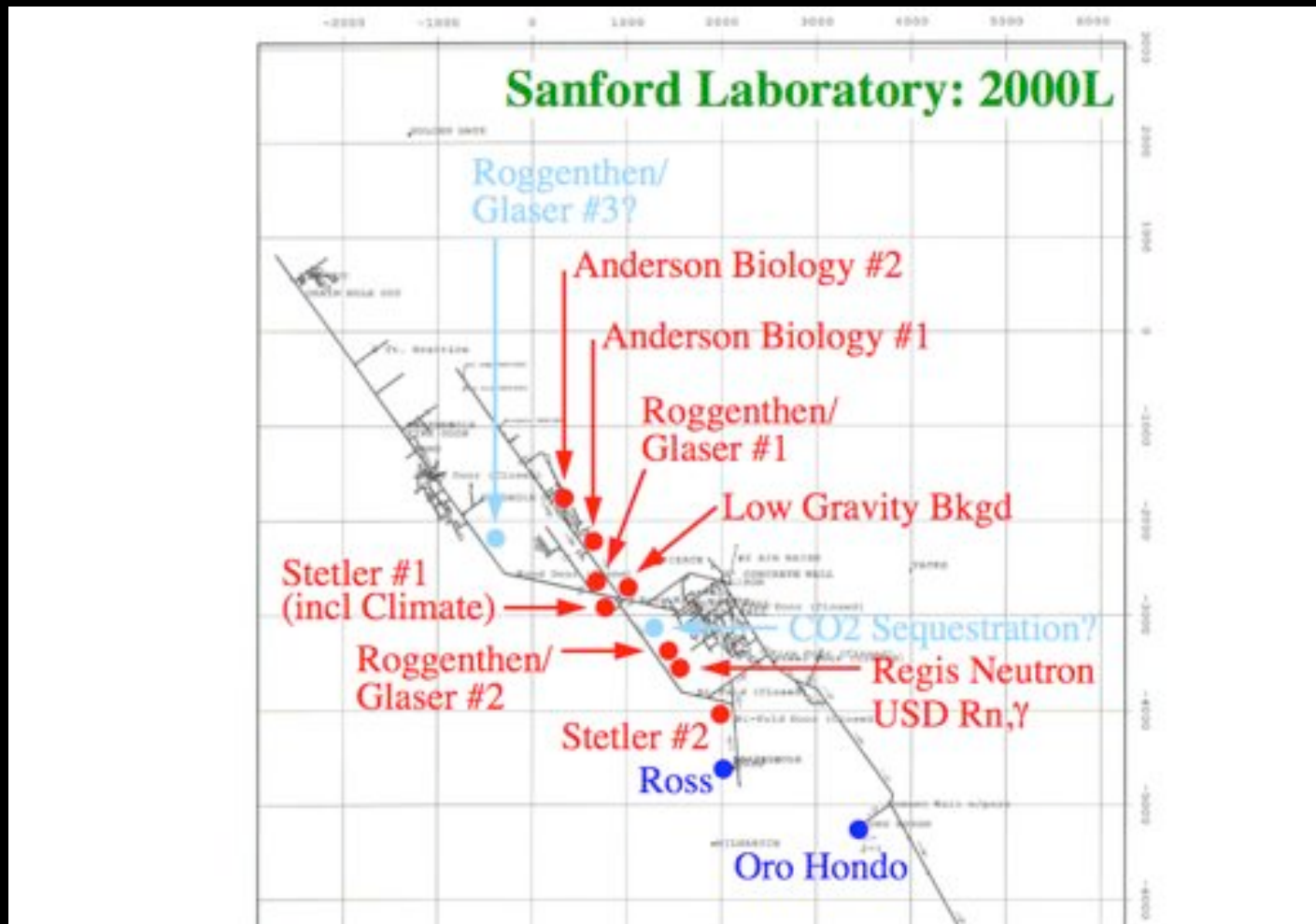
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@ H



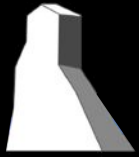
Early Science at 2000 L



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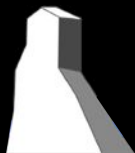
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Major “Early” Physics Experiments

- LUX: Dark Matter search
 - Liquid Xenon TPC (350 kg)
 - Being assembled/tested in surface lab
 - To be deployed in Davis Cavern 4850 L
- MAJORANA Demonstrator: $0\nu\beta\beta$
 - E-forming lab at 4850, Ross Shops area
 - To be deployed in Davis Transition Cavern



LUX Overview

Brown University, Case Western Reserve University, Harvard University, Lawrence Berkeley National Laboratory, Lawrence Livermore National Laboratory, South Dakota School of Mines & Technology, Texas A&M University, University of California Davis, University of Maryland, University of Rochester, University of South Dakota, Yale University



Water Shield

1 In addition to liquid xenon's self-shielding, the 8-meter diameter by 6-meter height water tank reduces gamma background by 7 orders of magnitude.



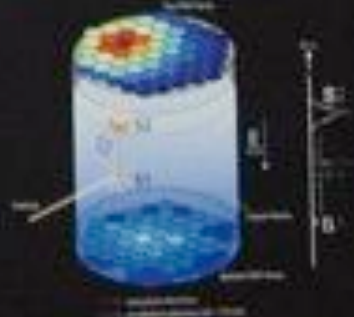
Thermosyphon

2 Closed loop of liquid xenon provides condensation/evaporation. Provides 1.5 kW cooling power to the detector.



Xenon Recirculation and Heat Exchanger

3 Xenon is constantly being recirculated in and out of the detector for purification (top panel for recirculation shown above, with the xenon-purifying getter on the right). Inside the detector, the heat exchanger transfers the heat load from the incoming hot xenon to the outgoing cold xenon from the detector.



Time Projection Chamber

4 The PMT hit pattern provides x-y localization of an event, while the ionization signal provides z localization.



Photomultiplier Tubes (PMTs)

5 Detect scintillation and ionization light of events inside the detector. They are sensitive to xenon 175 nm

Internal Structure

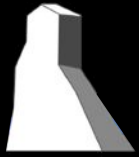
6 The internal supporting frame, shown on the right, is composed of two PMT copper holder plates for the top and bottom PMT arrays and titanium straps. The materials for these components were chosen for their low radioactivity. Teflon reflectors



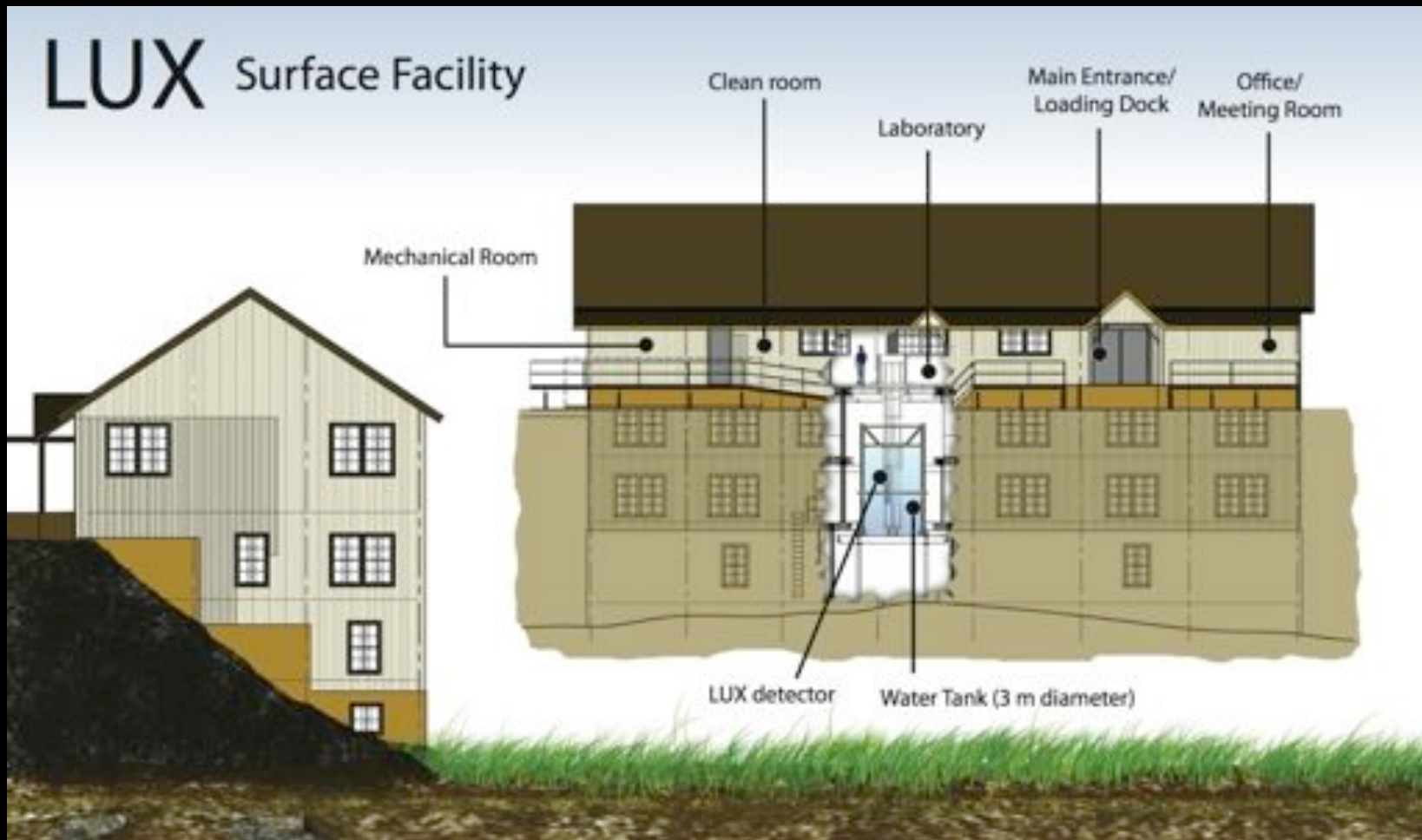
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LUX Deployment in Refurbished Warehouse



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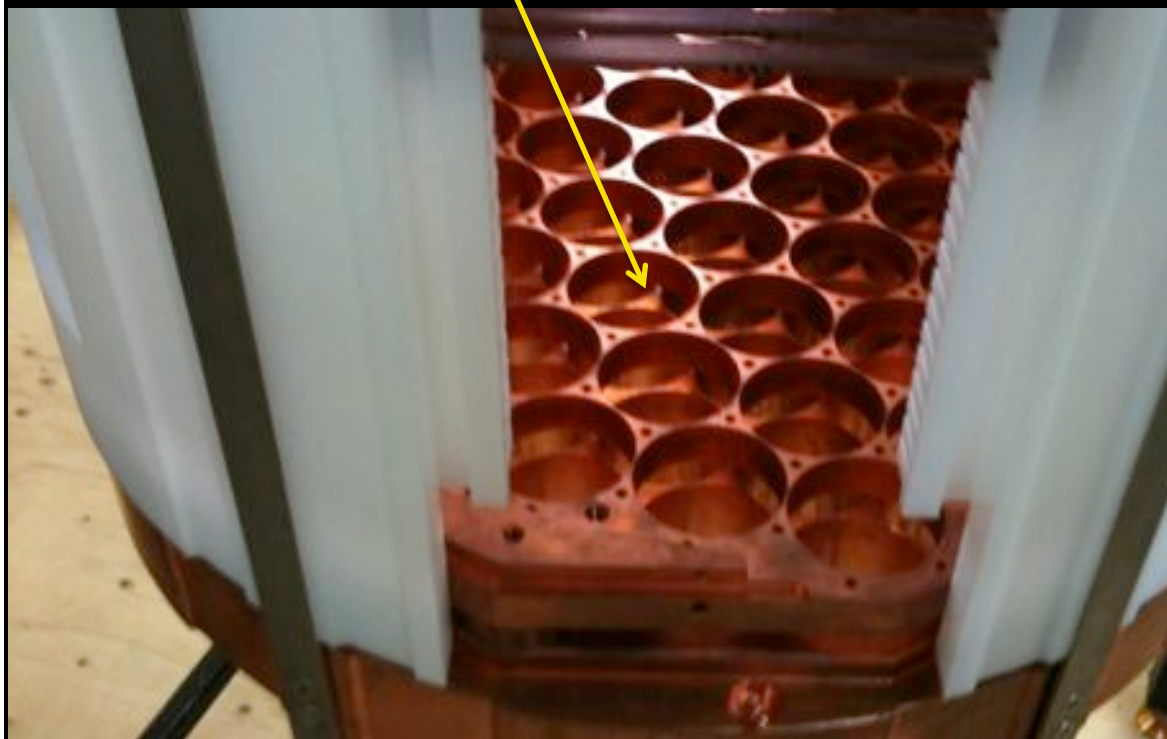
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LUX Assembly

Potential grading rings

PMT Base





Assembled Detector





Deployment



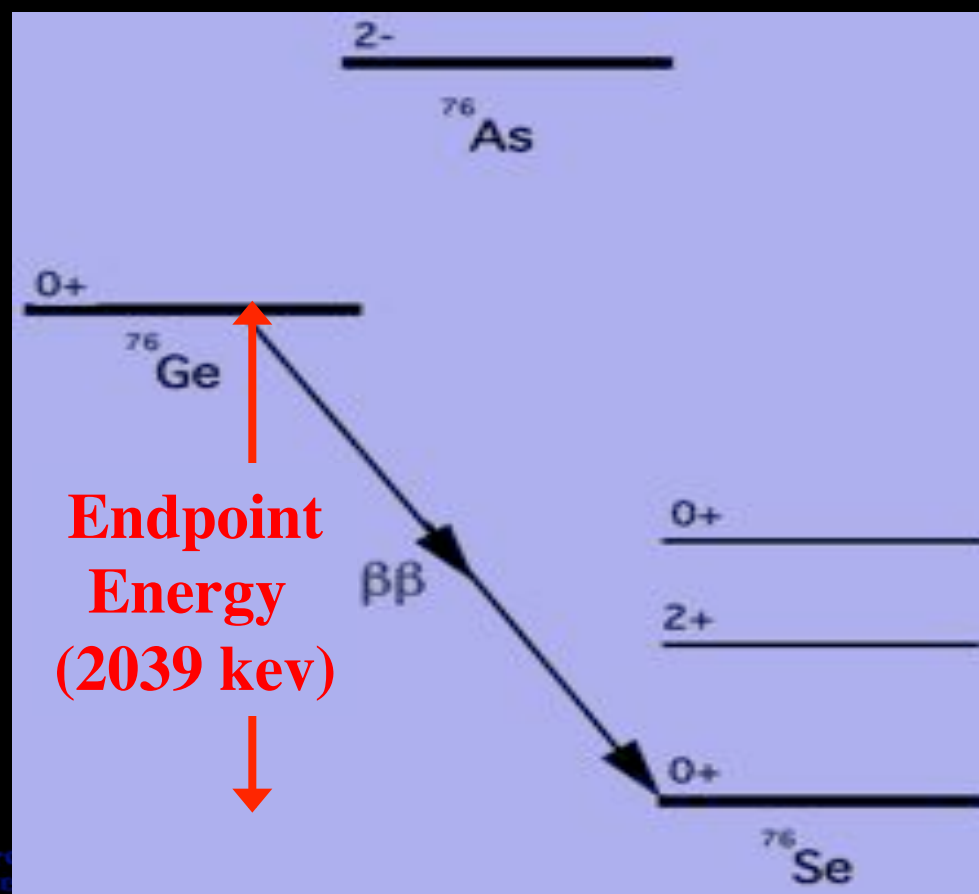


MAJORANA Demonstrator



^{76}Ge $0\nu\beta\beta$ -decay

Background suppression goal:
> 1 count/ton-year
in region of interest
(~4 keV around 2039 keV)

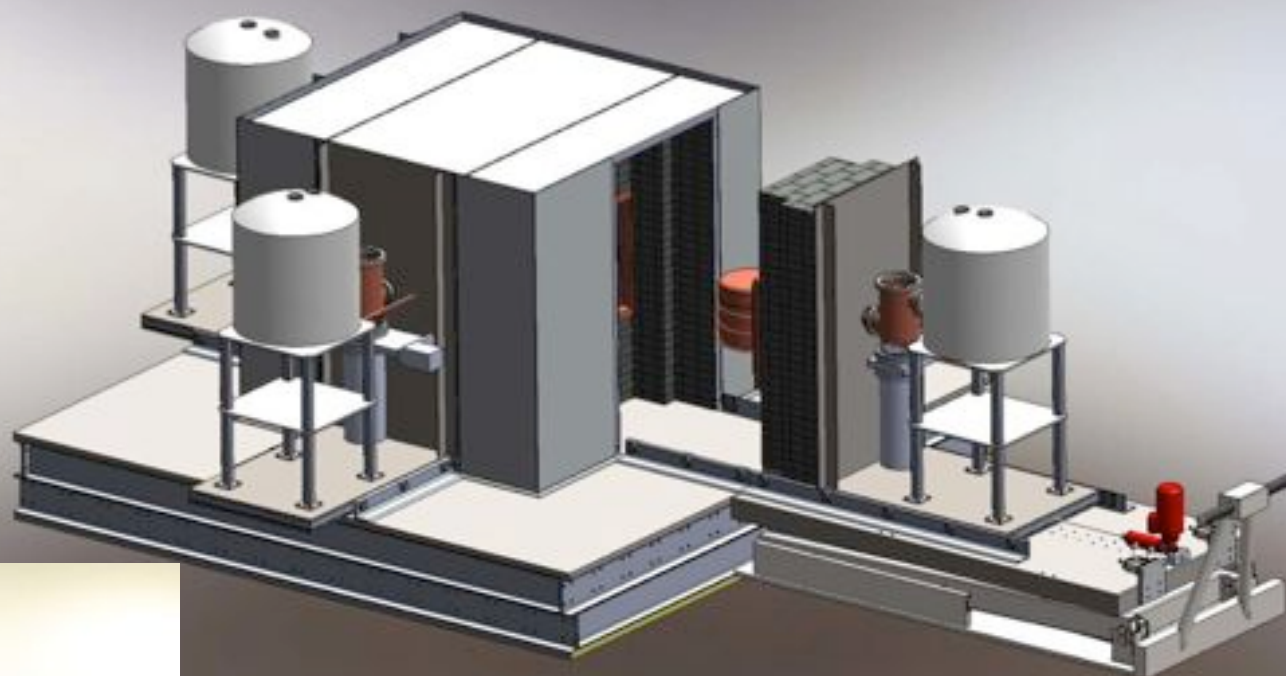


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Undergraduate
Engineer



Plans for Deployment



- Low background cryostats and shields:
- Develop electroforming techniques in underground environment
 - Ultra clean assembly techniques

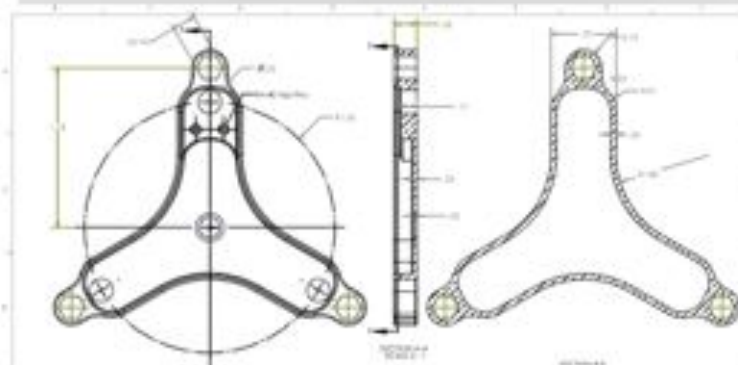
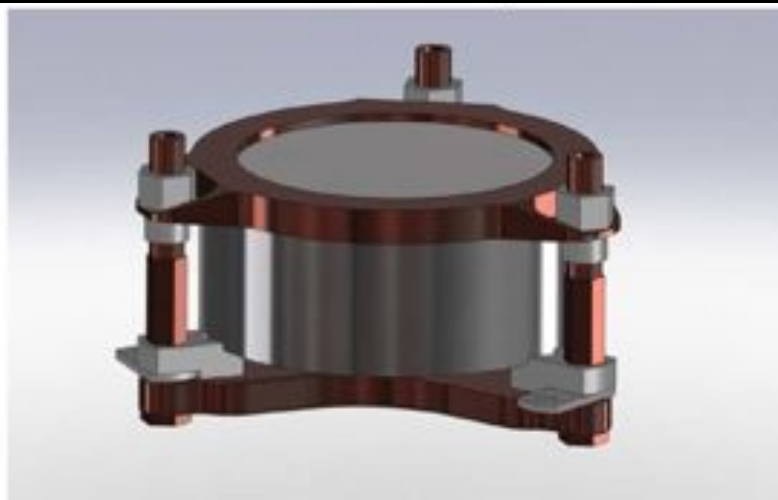


Germanium Detectors



~40 kg Ge (>50% enriched ^{76}Ge)

- Crystal growth, detector manufacture
- Optimized mounting supports

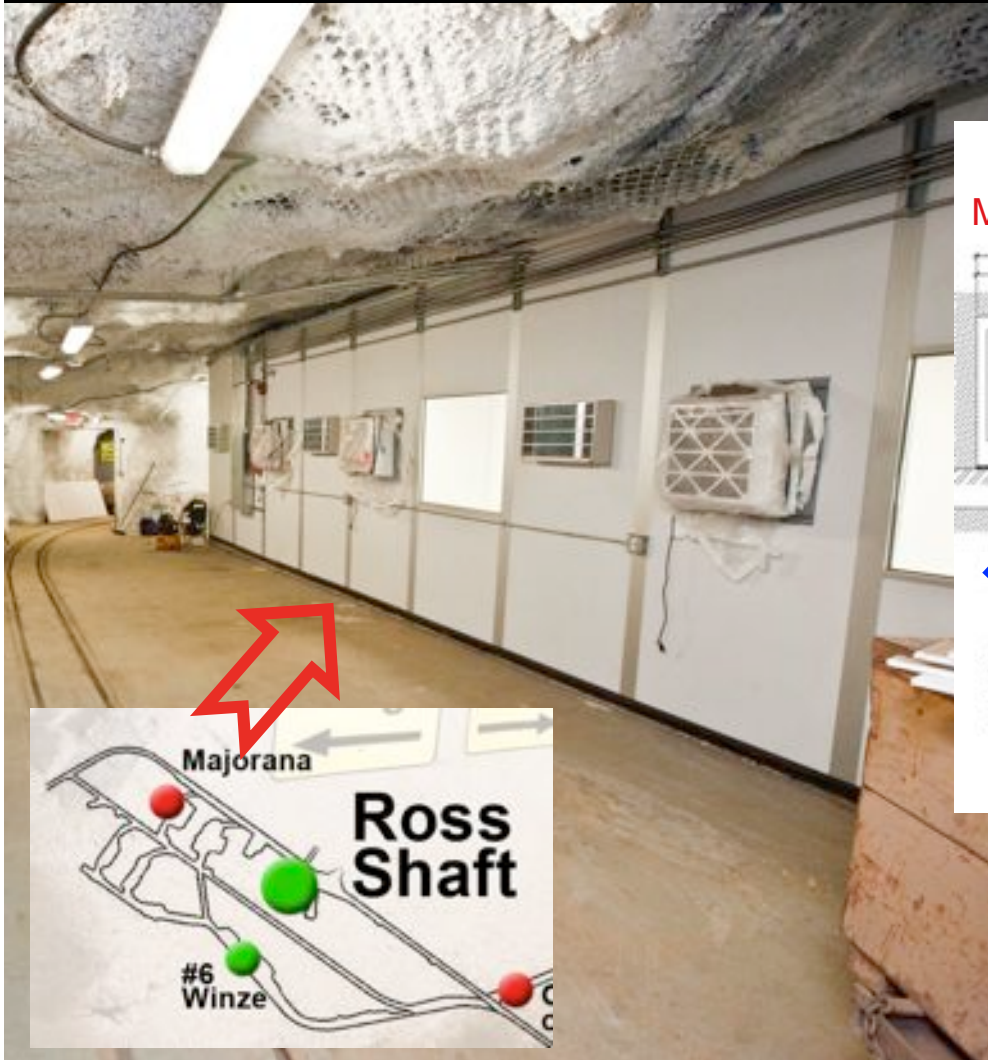




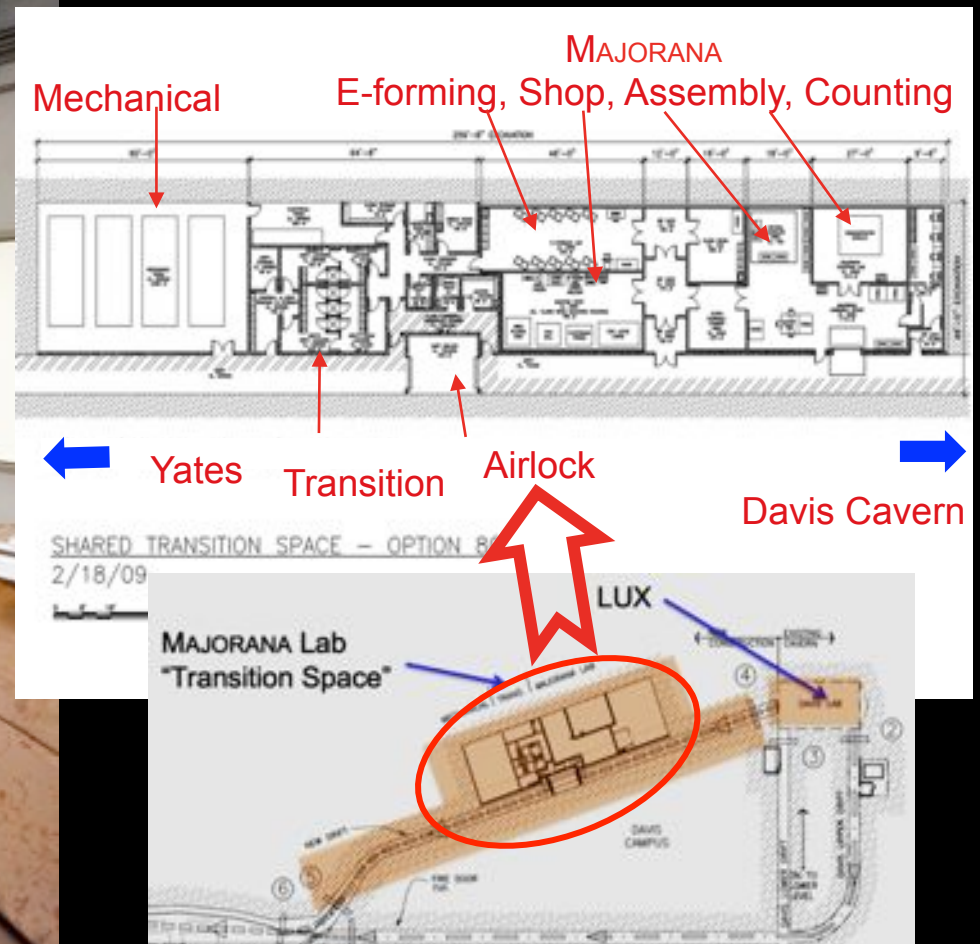
Plans for Deployment



Electroforming lab in Ross Shops area of 4850L



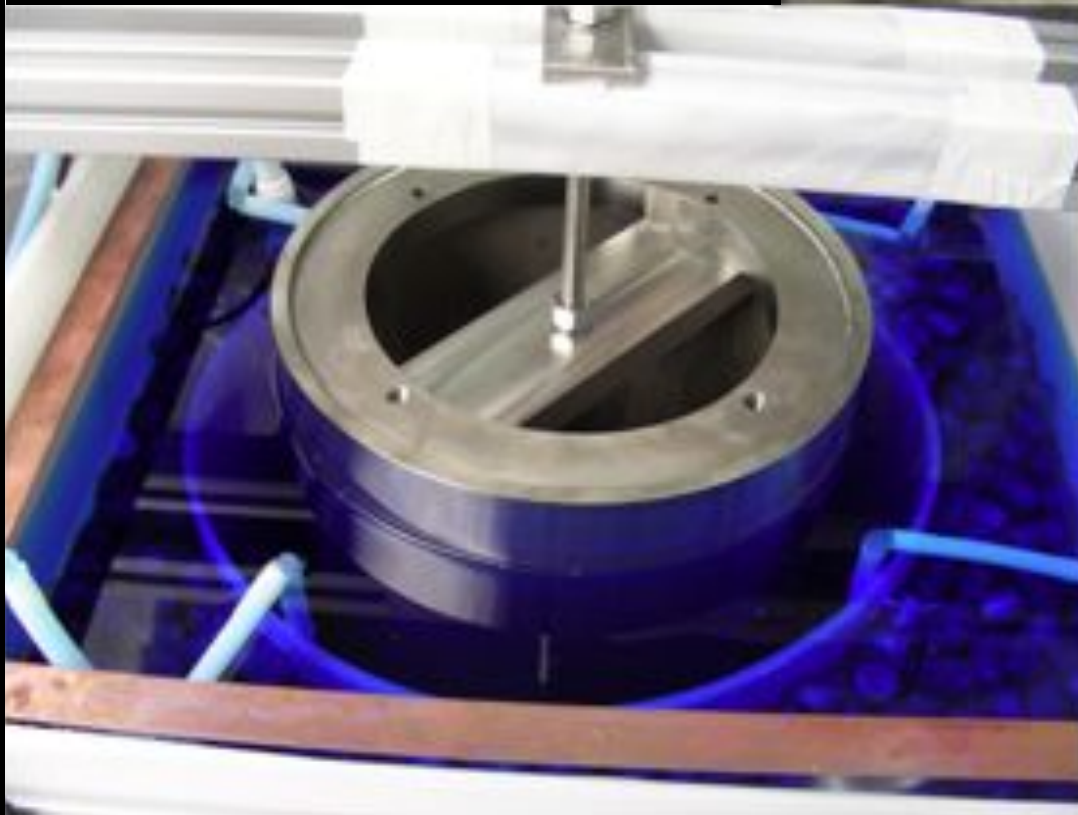
Assembly and counting area
in Davis Campus 4850 L





Electroplating Systems

Copper plating bath

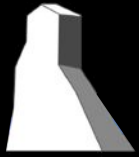


Mandrel



Current Status

- All funding for Sanford Lab activities provided by:
 - State of South Dakota
 - Donations by T. Denny Sanford
- DUSEL PDR (Preliminary Design Report) has been completed
 - Passed internal reviews with high marks
 - Will be delivered to NSF
 - Serves as a “catalog” of options for future lab



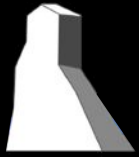
Current Status

- NSF has withdrawn support for DUSEL
 - NSB (National Science Board) refused to authorize any further funding
 - Fiscal climate made cutting easy
- DOE will support “its experiments”
 - Long Baseline (LBNE) from Fermilab
 - Majorana
 - Dark matter (?)



Personal Perspective

- Laboratory will continue
 - DOE will manage and operate
- It will be substantially smaller than originally envisioned
- NSF will participate, supporting experiments and programs DOE not interested in
 - Bio, Geo, Engineering
 - Education, Outreach
- It will take several years to sort things out



Near Term

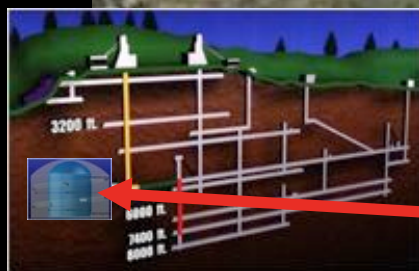
- Sanford Laboratory has great momentum
- Infrastructure rehabilitation and setup of Davis Campus will continue
- “Early Science” program will continue and thrive
 - Small geoscience experiments
 - Microbiological characterization
 - LUX
 - Majorana Demonstrator

There's real gold
at the end of this rainbow!





Long Baseline Neutrino Experiment

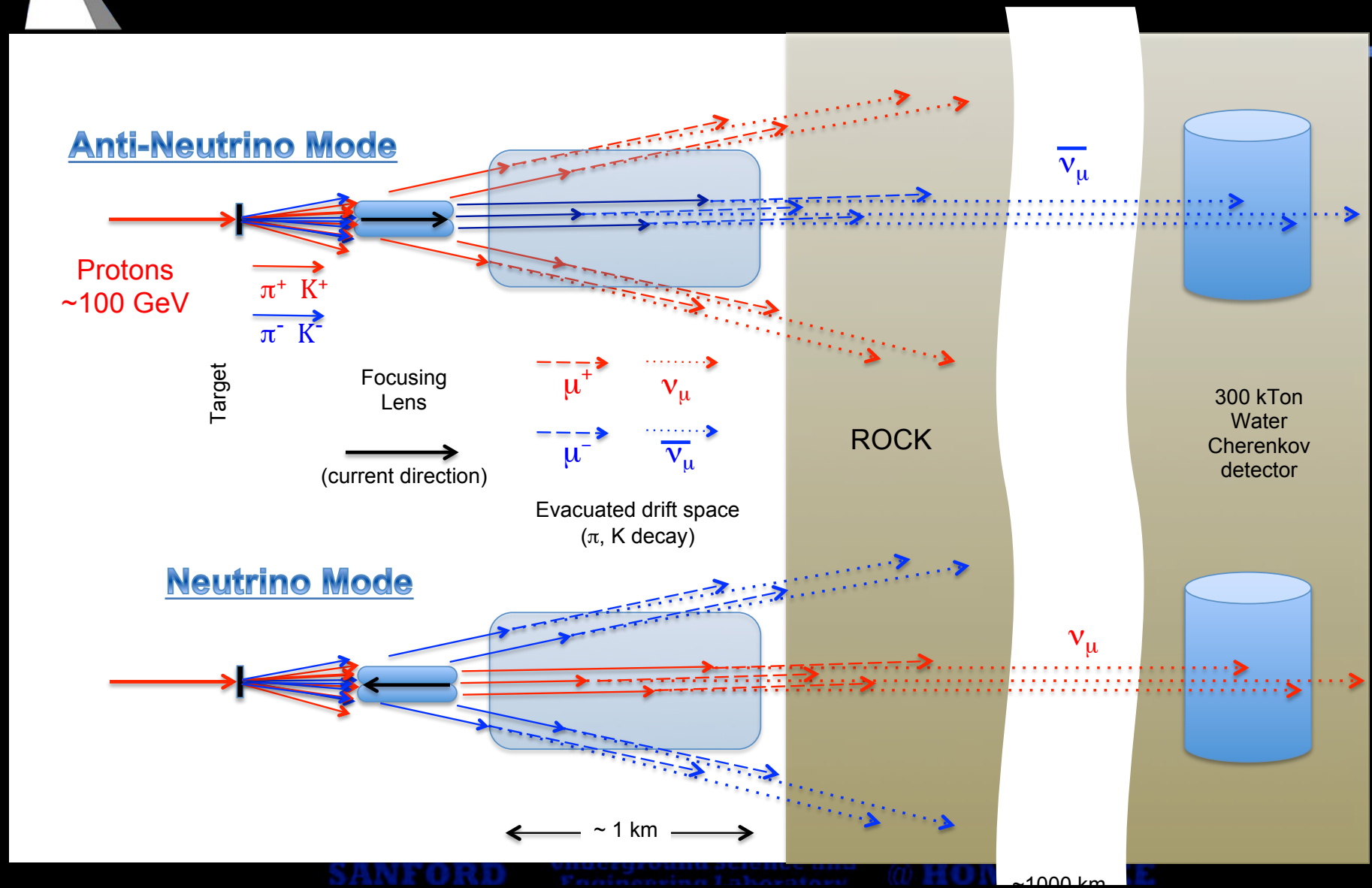


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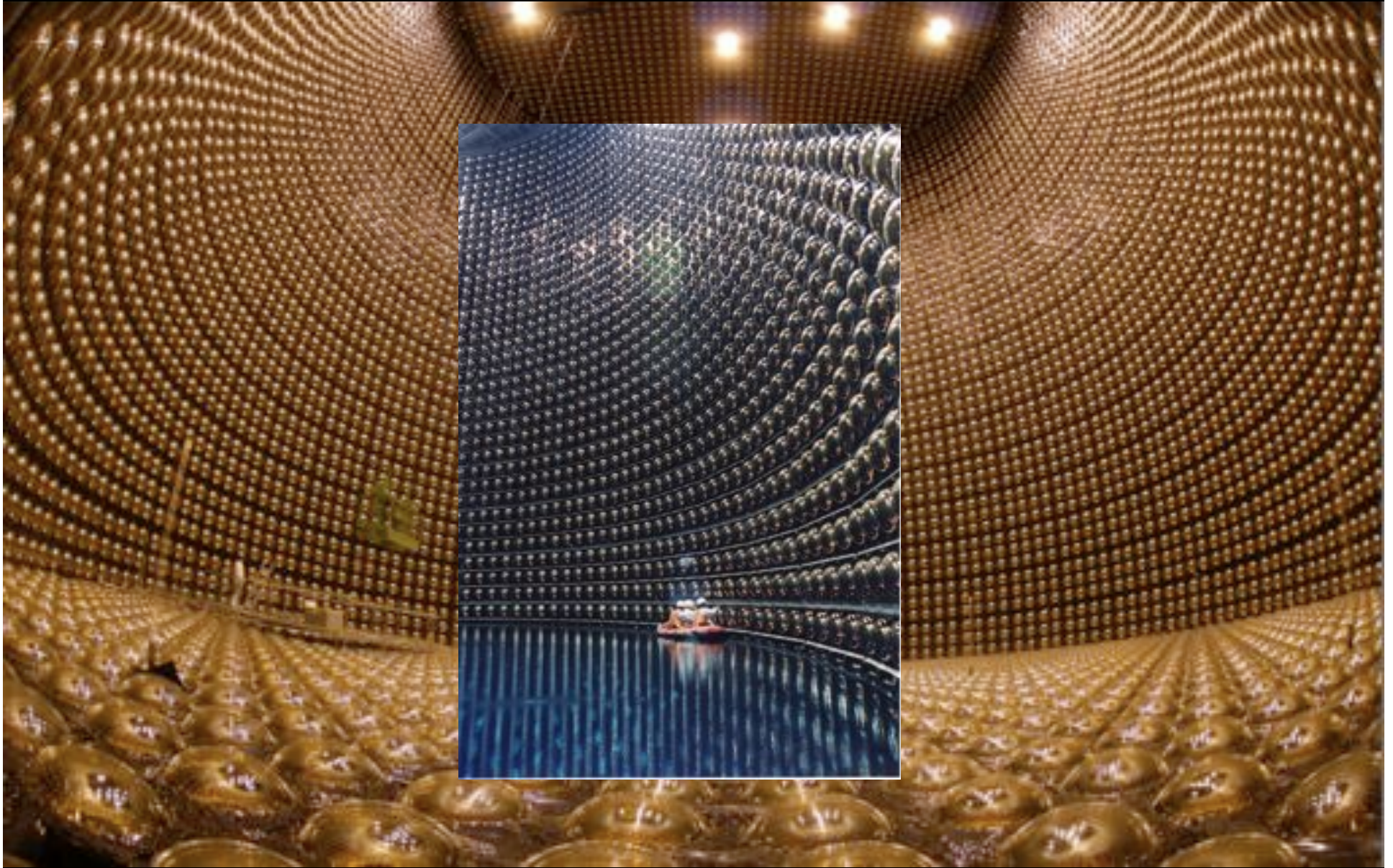
@ HOMESTAKE

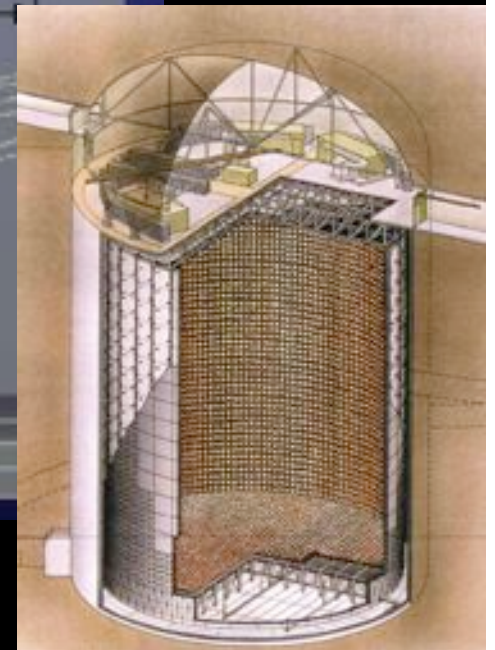
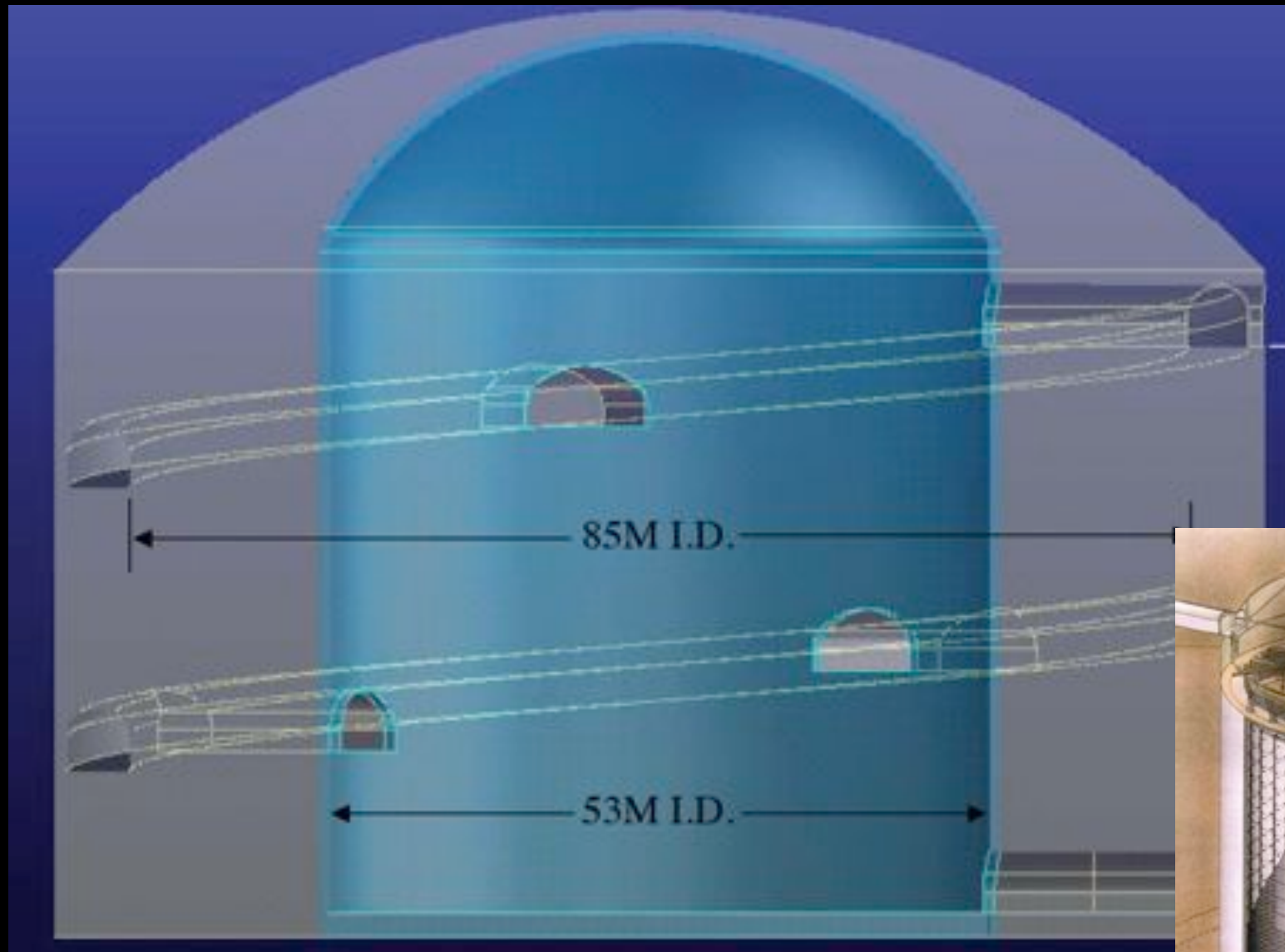
Long Baseline Targeting Schematic



Super-Kamiokande --- Japan

50,000 tons water-Cherenkov

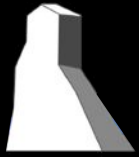




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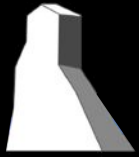
Rock Volume in Perspective



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First inspection crew on 4850 L



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