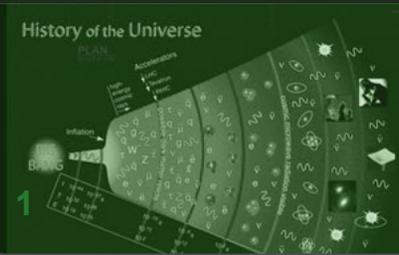
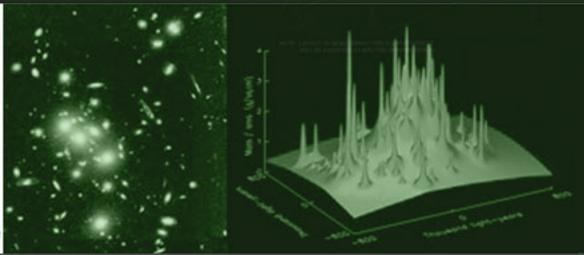
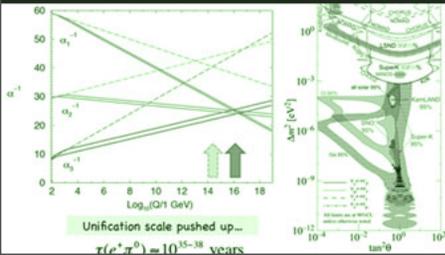




Research Efforts and Scientific Facilities at the Sanford Underground Research Facility

Kevin Lesko
 LBNL
 SURF Operations Head



Outline

- Overview the SURF Facility
- Current Science Program and Projects
- Proposed Research Efforts
- Summary



Current Status of SURF

- Completed in FY 2012

- Facility

- Facility Dewatered below the 6000 foot level Complete ✓
- Yates promoted to primary access Complete ✓
- Davis Laboratory Outfitting Complete ✓
- Ross Shaft Rehab - design completed and reviewed, rehabilitation Initiated (simultaneously provides 2nd egress)

- Science

- LUX Dark Matter, MAJORANA DEMONSTRATOR Neutrinoless Double Beta Decay, & CUBED - Installing ✓
- LBNE 10 kt surface-deployment Conceptual Design Completed ✓
- Proposals for DIANA, LZ, LBC under review, some funding announced

- Activities in FY 2013 so far

- Facility

- Ross Shaft Rehab continues, first ~ 1000 feet completed
- Yates Shaft Inspections and Rehab ongoing

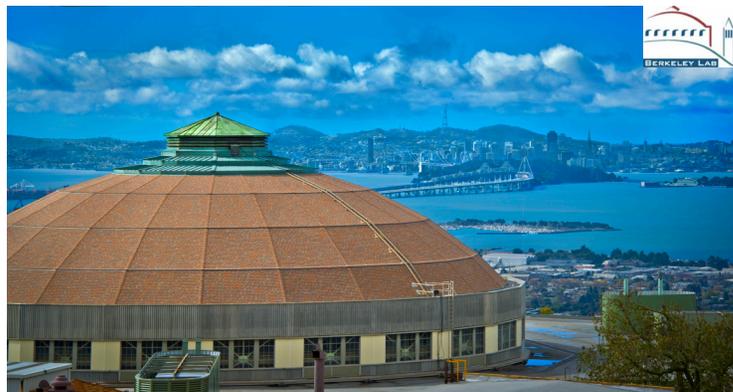
- Science

- **LUX** taking data and MJD characterizing detectors
- LZ R&D funded in the US and Great Britain ✓
- LBNE - CD1 approved December 2012 ✓
- Site-selection by DIANA Project ✓

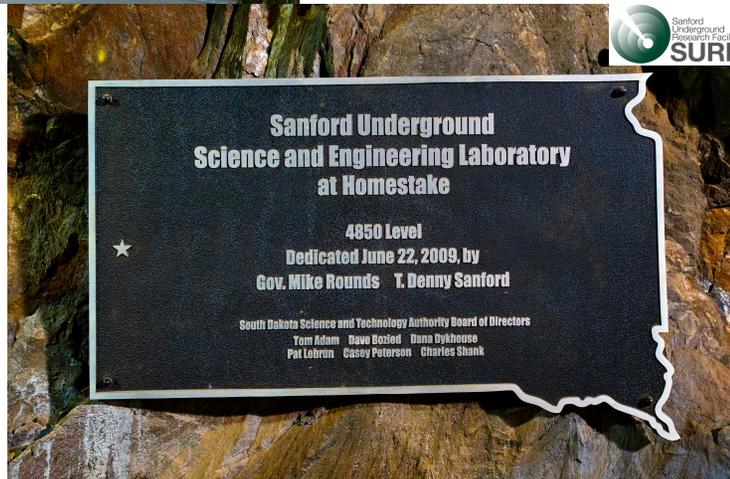


DOE-funded Facility and Organization

DOE assumed responsibility in FY12, Lawrence Berkeley National Lab provides management and oversight of SURF Operations, contracting with the South Dakota Science and Technology Authority (SDSTA)

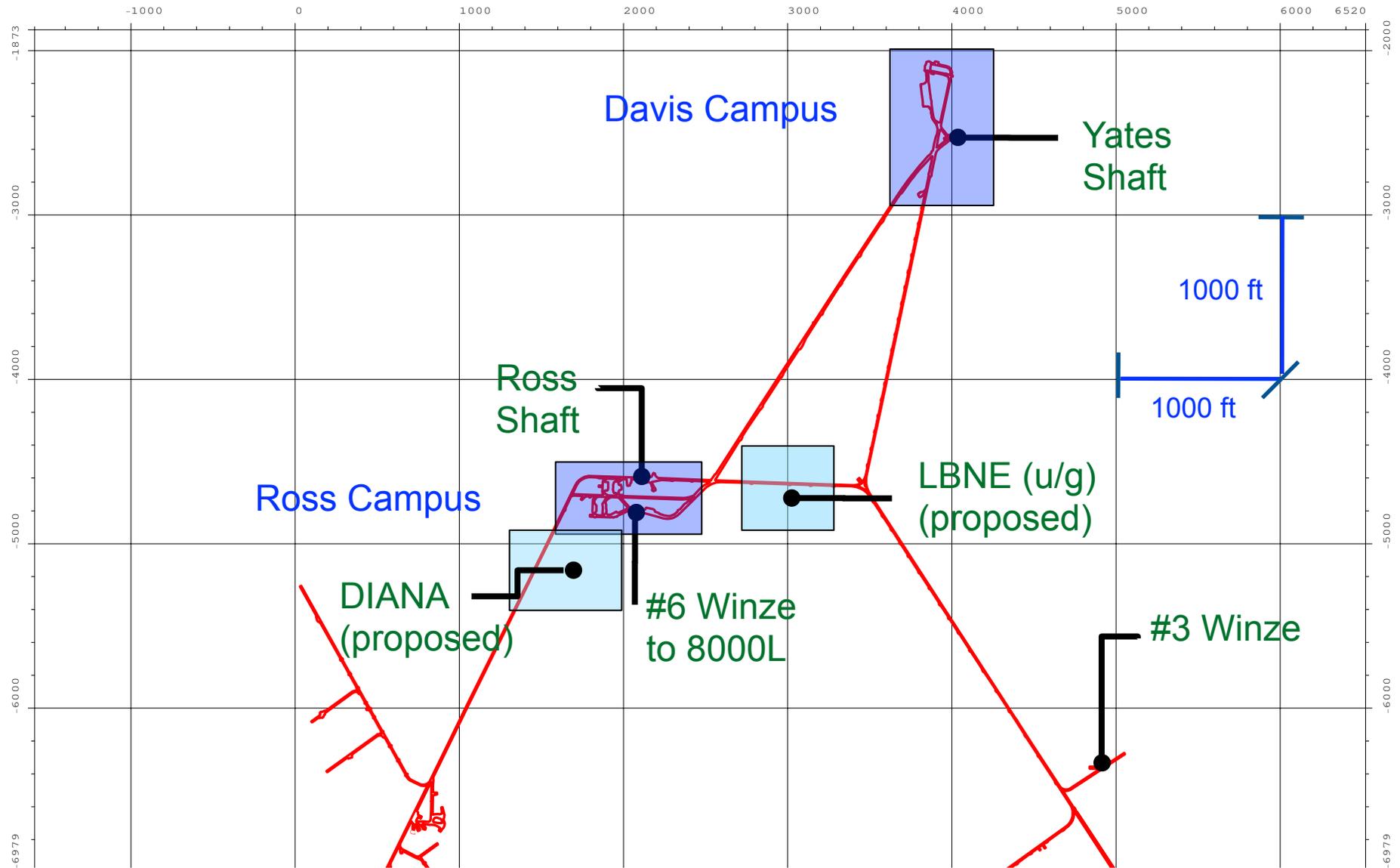


Maintaining facility operations, engineering, science, & EH&S functions. Key staff transferred to DOE support at LBNL/UCB and SDSTA



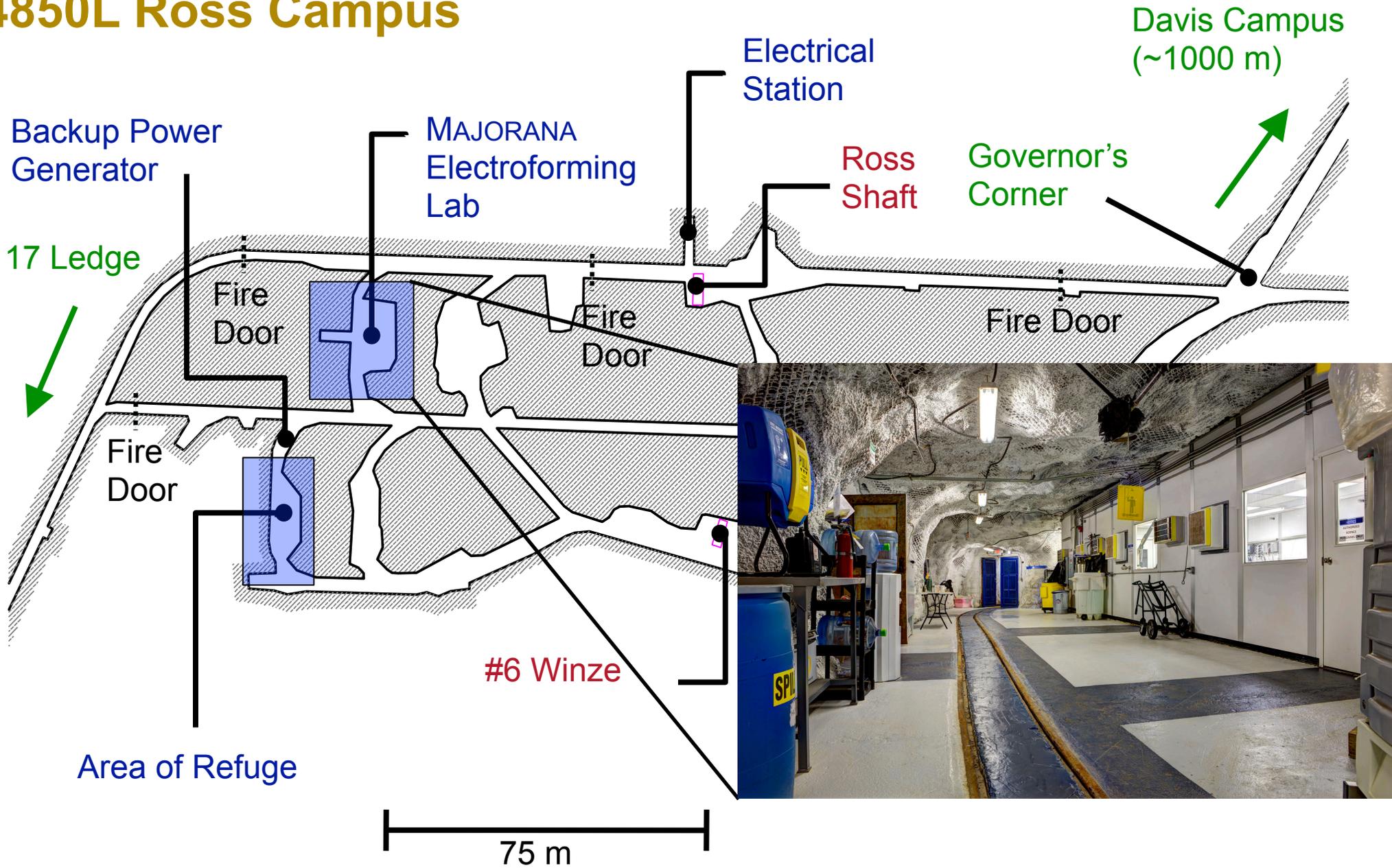
SURF Science Infrastructure: 4850L

4850L Sanford Laboratory



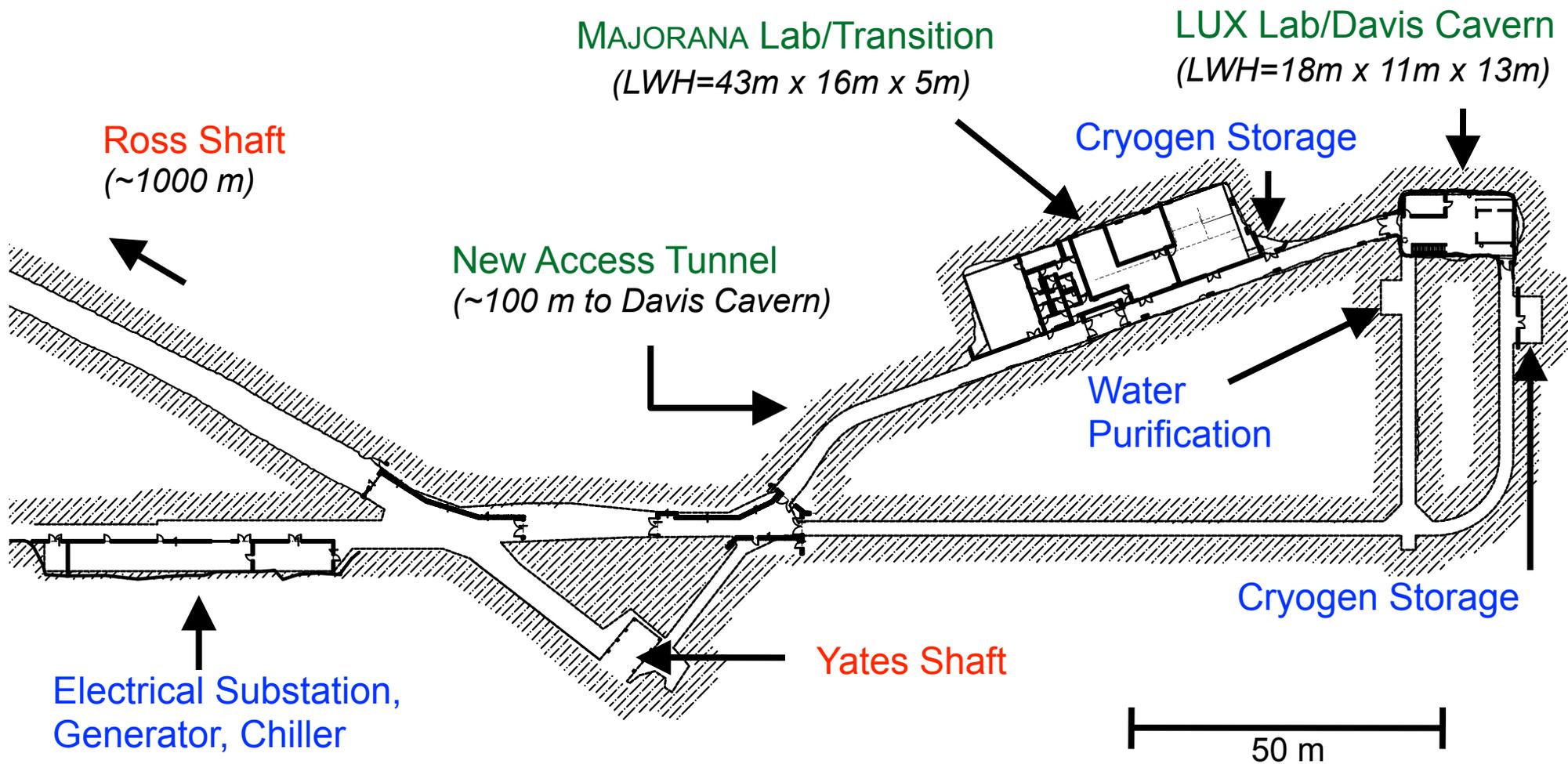
SURF Science Infrastructure

4850L Ross Campus



SURF Science Infrastructure

4850L Davis Campus: 29,402 ft² (Total) / 9,979 ft² (Science)

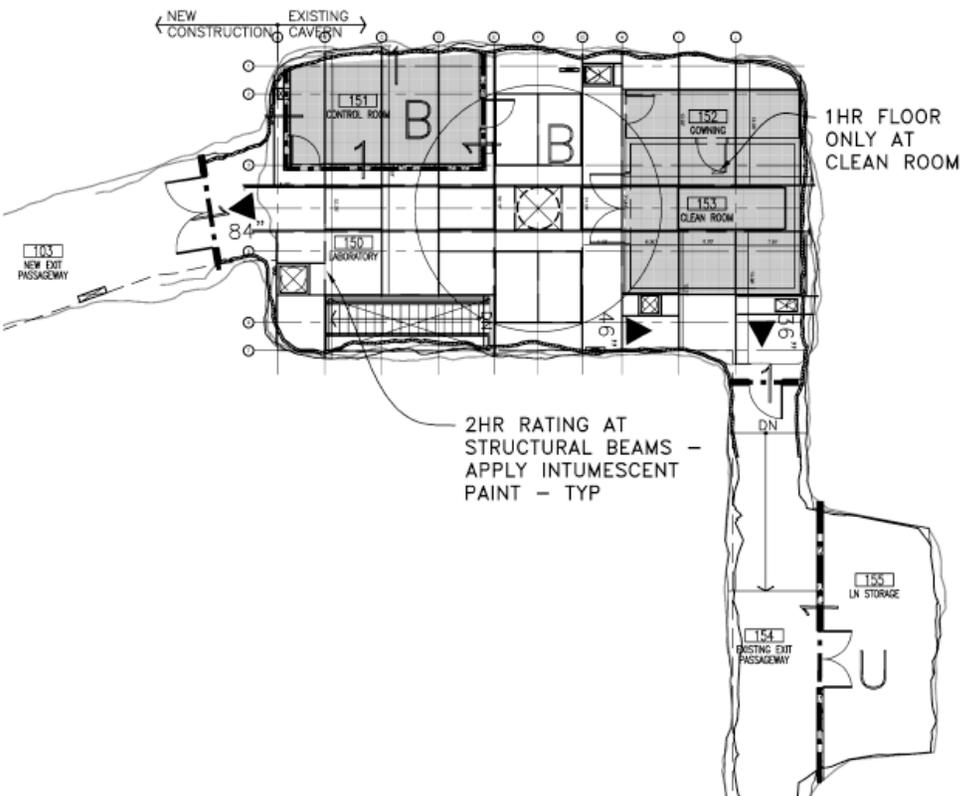


SURF Science Infrastructure

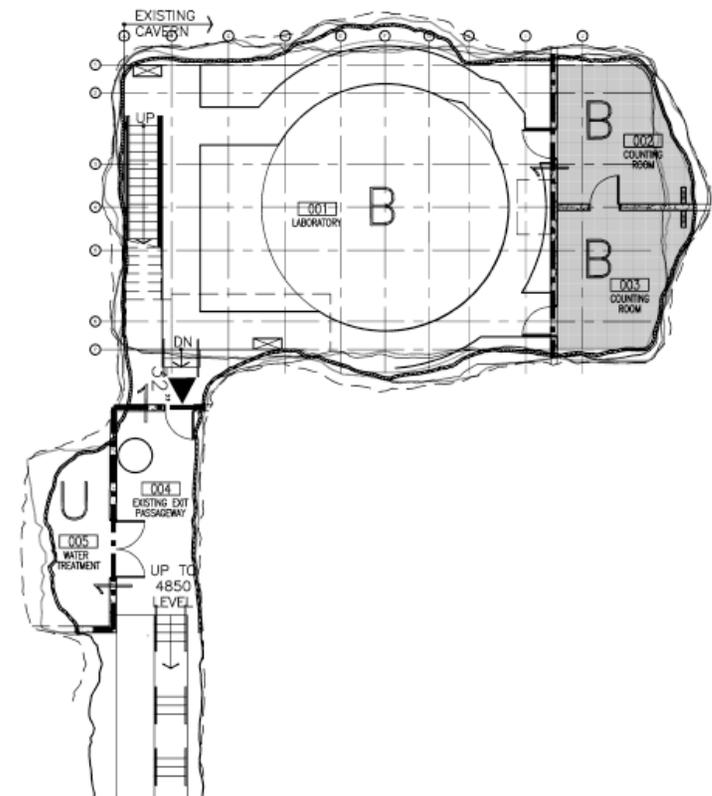
4850L Davis Campus: 2,732 m² (Total) / 927 m² (Science)

Davis Cavern Upper

Davis Cavern Lower



4B DAVIS LABORATORY - 4850 LEVEL CODE PLAN
1/8" = 1'-0"



2B DAVIS LABORATORY - LOWER LEVEL CODE PLAN
1/8" = 1'-0"



Davis Campus

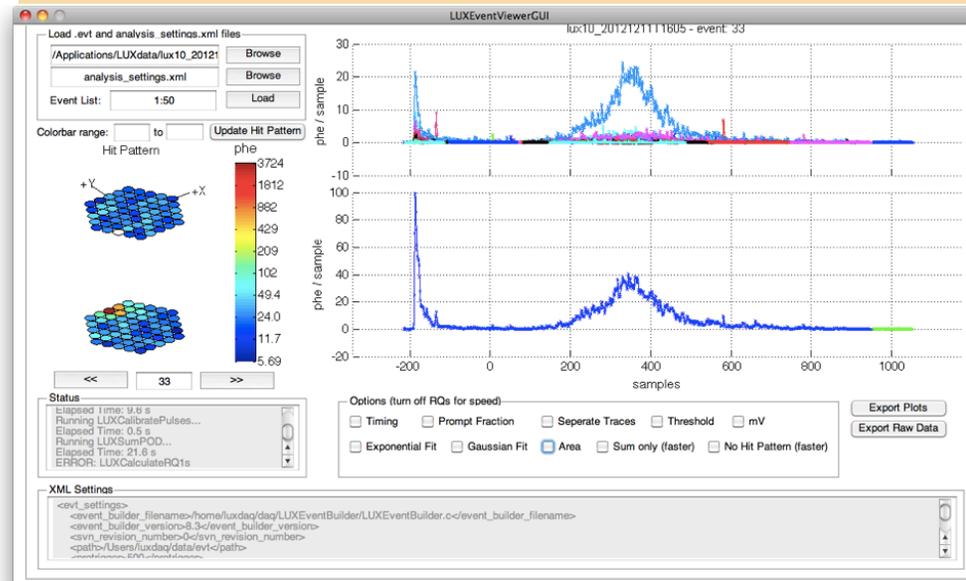
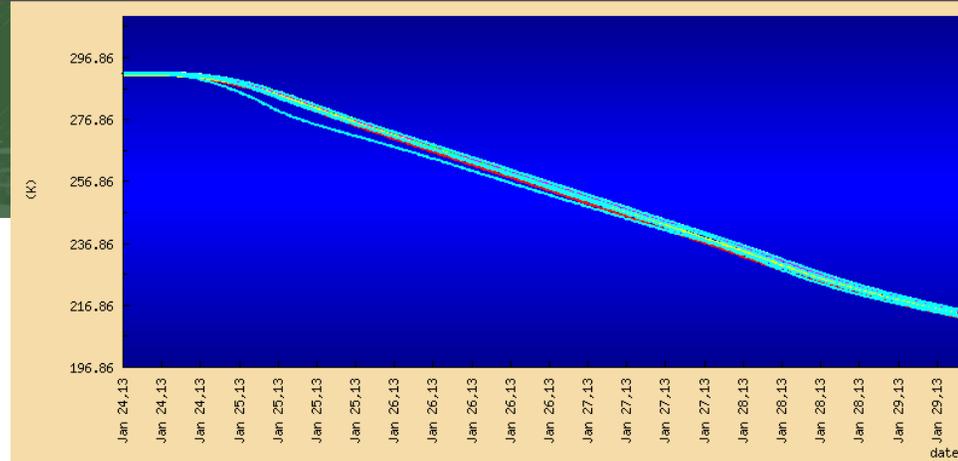


- Outfitting of the Davis Campus Completed May 2012 (~4300 mwe)
 - HVAC, HEPA filtered air, Utilities, Transportation and access, ...
 - Experiment specific infrastructure
 - Clean rooms
 - Water tank
 - Science and EH&S Support Programs
- *Eur.Phys.J.Plus* (2012) **127**:114



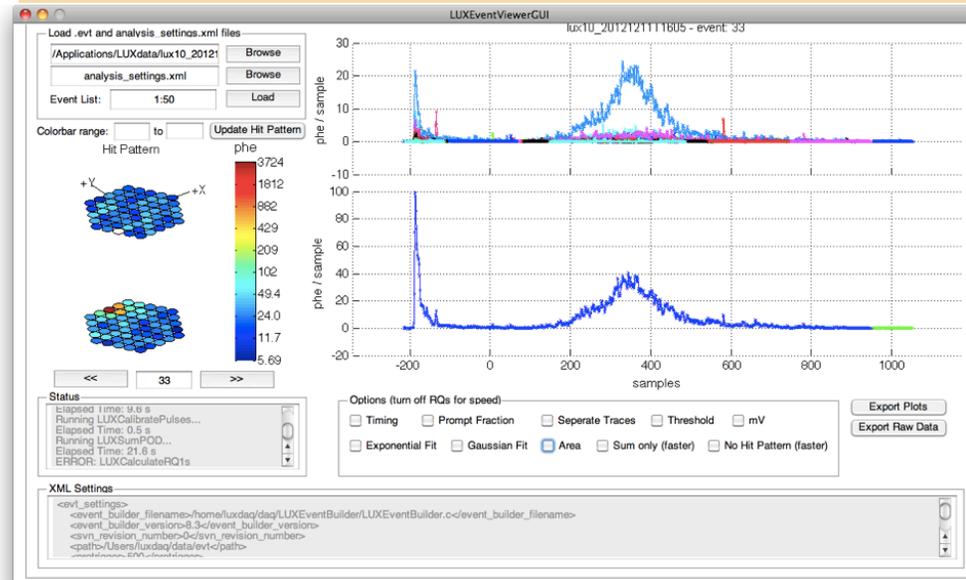
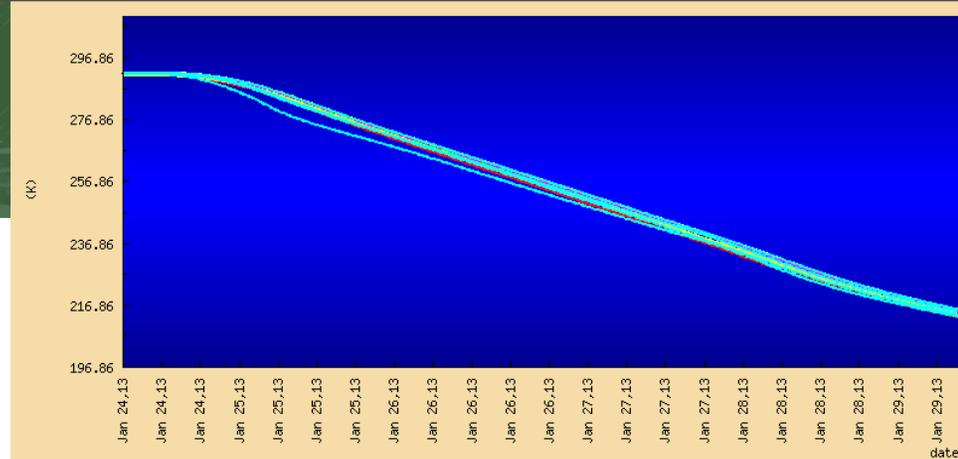
Current Physics Program

- Large Underground Xenon (LUX) – Dark Matter
 - 370 kg dual phase direct detection dark matter detector
 - detector installed, filled and commissioning run underway
- MAJORANA DEMONSTRATOR – Neutrinoless Double Beta Decay
 - 40 kg $^{nat,76}\text{Ge}$ in vacuum cryostats
 - assembling first cryostat of ^{nat}Ge
 - nearing completion of fabrication of parts for a 2nd ultralow background cryostat with ^{76}Ge point-contact detectors
- CUBED – Low Background Assay and Advanced Detectors and Materials
 - Installing and commissioning HPG e



Current Physics Program

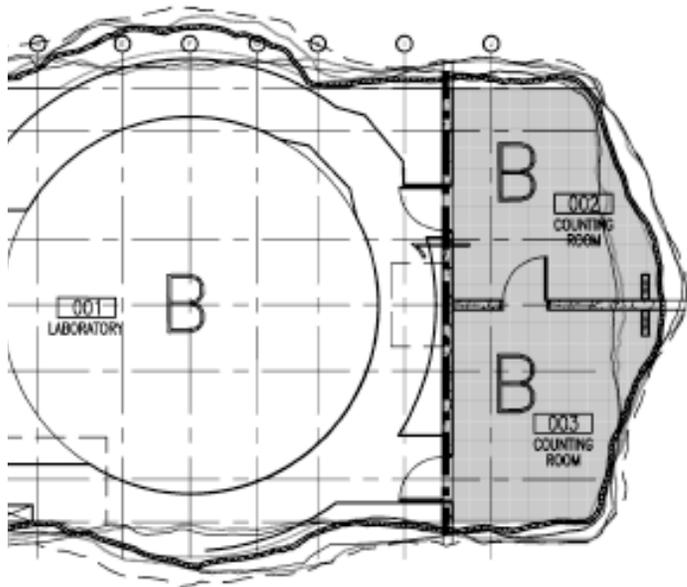
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LUX Dark Matter III Gibson
MJD Dark Matter I Giovanetti
MJD DBD/Neutrino I Green
also multiple Posters

Low-Background Counting

- **CUBED/USD HPG_e:**
 - Installed at 4850L Davis Campus
 - Expected sensitivity 0.1 – 0.01 ppb for U/Th
- **Future:**
 - Looking for opportunities to host/acquire several detectors with various sensitivities
 - Oroville Facility being relocated to an adjacent room, Fall 2013



- ← Lower Davis Cavern,
Dedicated Room (180 ft²)
- ← “Oroville” detector and room
for additional HPG_e detectors

Plans for the Future

4850 Level (4300 mwe)

Proposed Laboratories

- **Experiment Hall**
Third generation dark matter and
1 T neutrinoless double-beta decay

- **LBNE**
Long-Baseline Neutrino Experiment
4850 Level liquid argon

- **Low background counting**

- **DIANA**
Dual Ion Accelerators for Nuclear Astrophysics
4850 Level DIANA Laboratory

Davis Campus

- **LUX/LZ**
Large Underground Xenon Laboratory
First and second generation dark matter
- **MJD**
MAJORANA DEMONSTRATOR
Neutrinoless double-beta decay
- **CUBED**
Center for Ultra-Low Background Experiments in the Dakotas
Low-background counting

Approximately 1 km between Yates and Ross Shafts

Ross Campus

- **MJD**
MAJORANA DEMONSTRATOR
Electroforming laboratory

Sanford
Underground
Research
Facility



SURF R&D Space – Surface

- **Surface Laboratory:**
 - 190 m² lab space (lower 3 levels not fully developed)
 - Cleanroom (~37 m² including anteroom, 3-m ceiling, Class ~1000)
 - Water tank (~25 m³, ~3-m diameter)
 - Communications, network
- *Other options possible, but may require some preparation/rehab*



Main area, hatch covers opening to water tank



LBNE cleanliness tests (Bai-SDSMT)

SURF R&D Space – Underground

- **Davis Campus and Vicinity:**
 - Inside Davis Campus clean space, Lower Davis room: $\sim 17 \text{ m}^2$ (14' ceiling height)
 - Two cutouts outside clean space: $\sim 33\text{-}50 \text{ m}^2$ (with 12' avg ceiling height)
- *Working to formalize these and other options for the community*



Near Davis Campus entrance, sprinklers, concrete floor, power/network installed



Near decline to Water Purification room, less developed, services easy to install

Plans for the future: 2nd Generation Dark Matter Experiment

LZ (LUX-Zeplin)

- 2-phase Liquid Xenon detector
- ~7 tonnes Xe
- ~20 x LUX with improved background rejection
- Liquid scintillator veto outside Xe detector
- **Uses existing water tank at 4850L Davis Campus at SURF**
- Formed from LUX and Zeplin collaborations:
US and UK funding in place for R&D and design (Dec 2012)

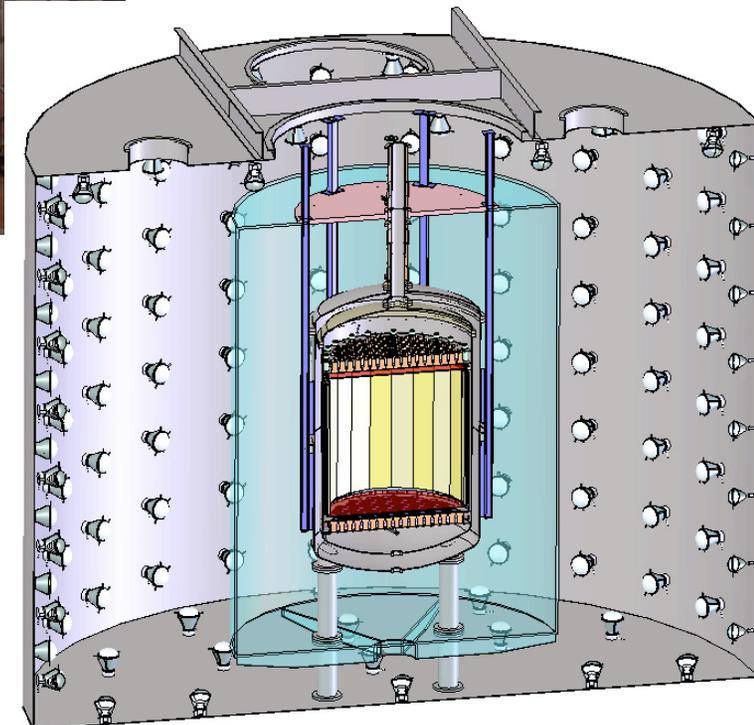
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DAVIS
CAMPUS



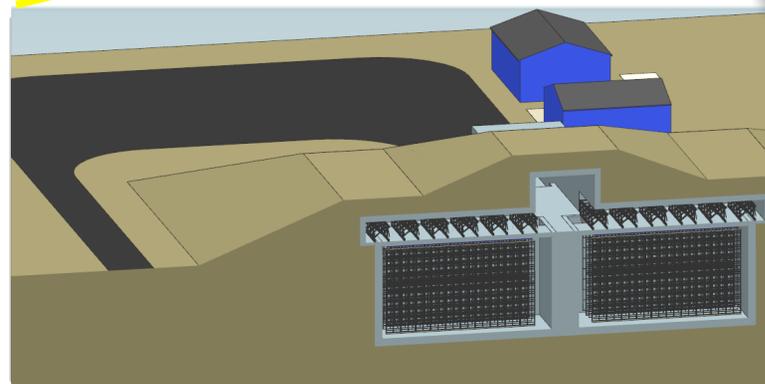
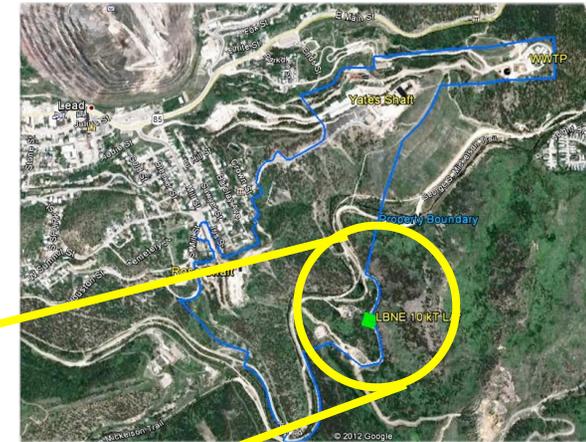
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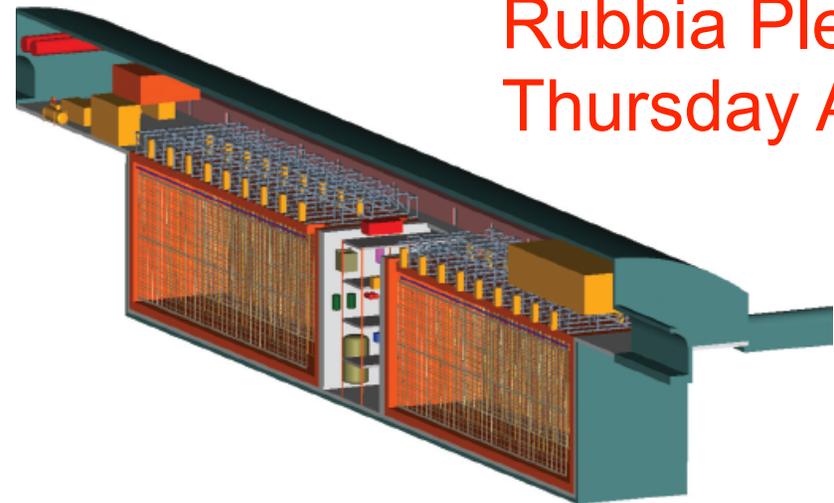
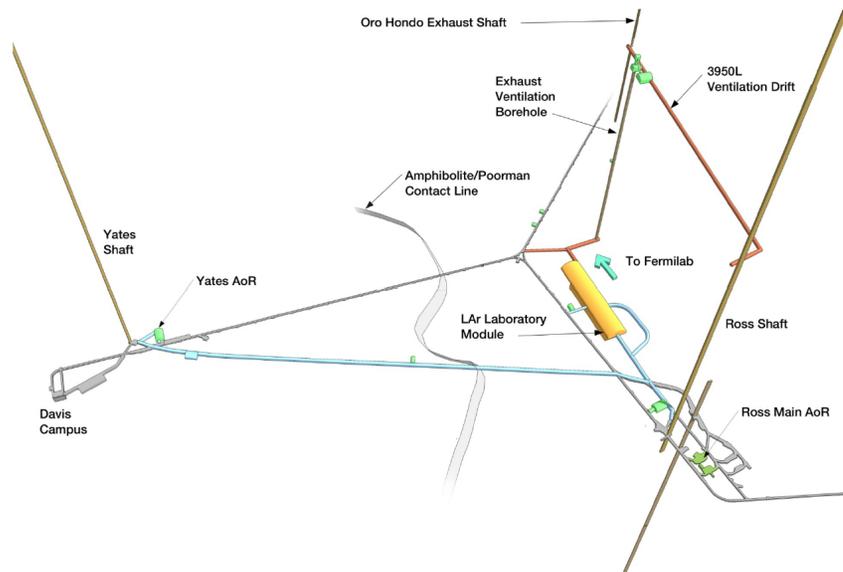
Long-Baseline Neutrino Experiment

- Office of Science accepted LBNE reconfiguration plan (6/12)
 - 10 k-ton (fiducial) LAr on the surface, new FNAL beam-line
 - **Underground Options with new funds identified before CD2**
 - **Conceptual Design Review Oct. 2012**
 - CDR completed, EA work initiated, MOUs drafted, geotech work initiated above and underground
 - CD-1 Signed 10 December 2012
 - Preliminary Design ~ 2015-6



Underground LBNE Option

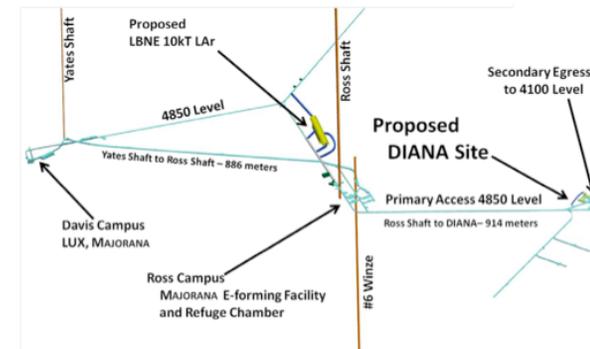
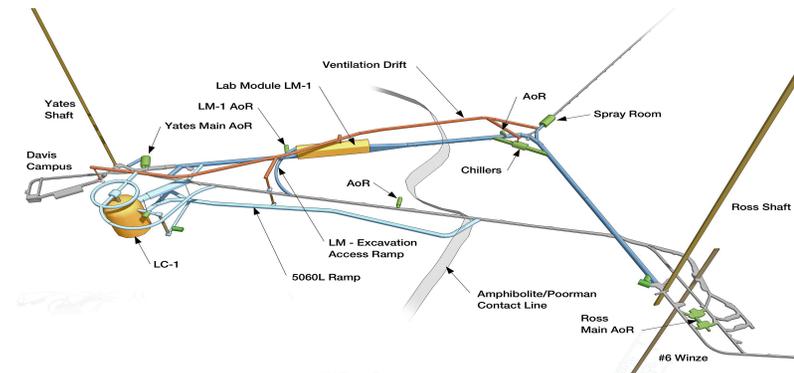
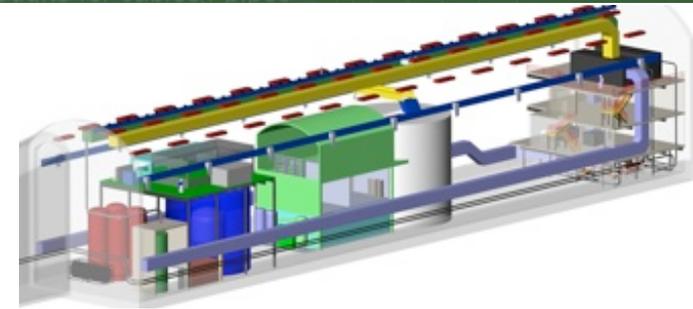
- LBNE has established the goal to place the detector underground with the help of new partners.
- Substantial interest from Europe and CERN following European Planning Document
- Significant u/g Design completed by DUSEL and earlier LBNE versions
 - Ventilation Issues understood
 - Conceptual Designs developed including excavation and rock handling
 - SD-financed Shaft Rehab advancing well to support this option
- Updated-Cost Estimate being refined



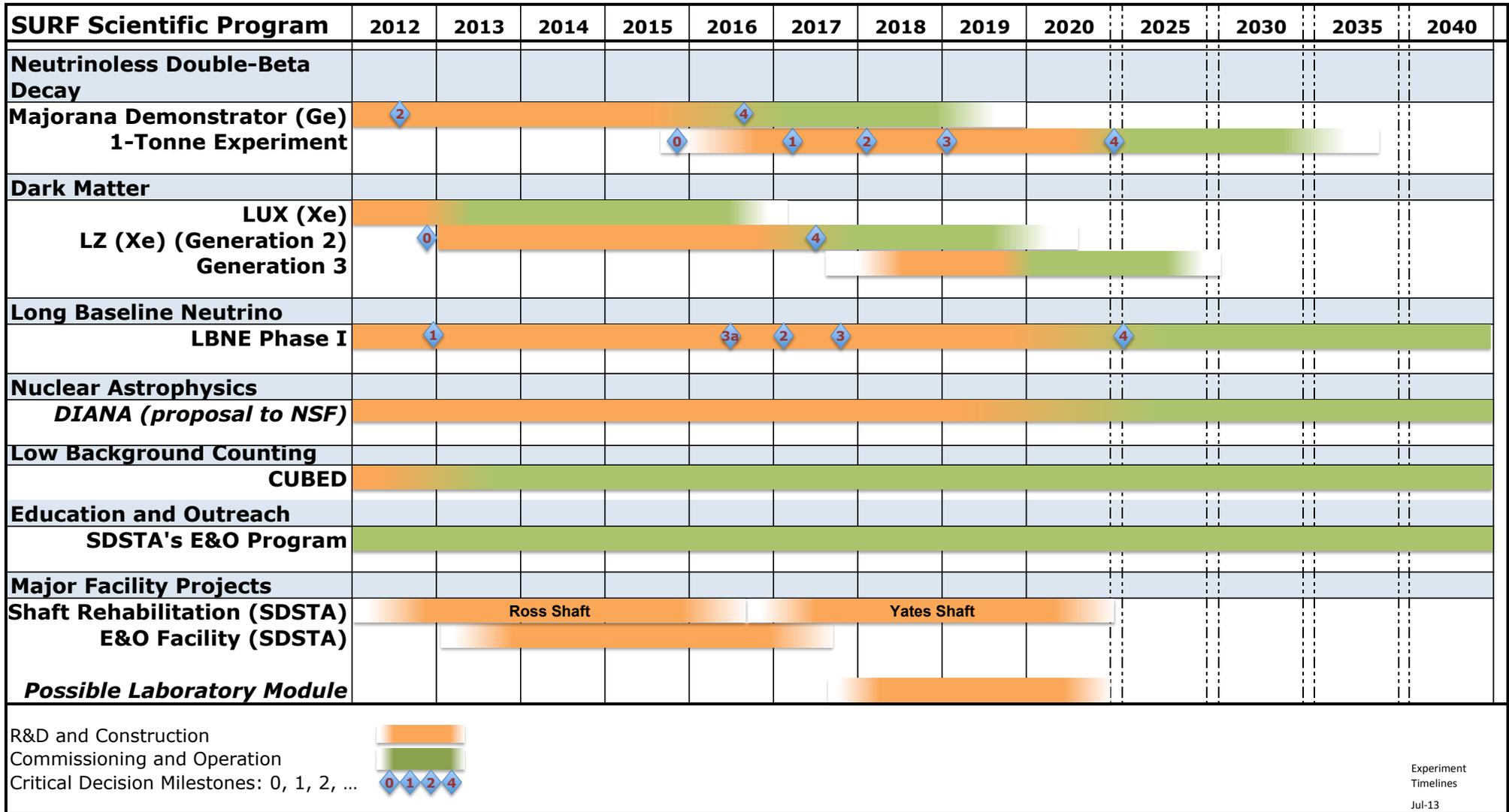
see Walters &
Rubbia Plenary
Thursday AM

Future Plans and Road Maps

- Dark Matter
 - G-2 efforts
 - LZ in the Davis Campus
 - R&D
 - space available, open for discussions
 - G-3 effort
 - May require a new Lab Module, have advanced designs and estimates
- Neutrinoless Double-Beta Decay
 - R&D
 - space available, open for discussions
 - 1-tonne Experiment
 - May require a new Lab Module
- Nuclear Astrophysics
 - Response to DIANA RFI (29/1/2013), site selection by collaboration completed - SURF
- LBNE, Proton Decay, Astronomical Neutrinos
- Low Background Counting/Assay/Materials
 - CUBED + “Oroville” Detectors
 - Existing space can be outfitted to handle ~ 6 or 8 counting stations
 - MJD TCR capable of producing substantial ultrapure Cu
 - AARM-style facility may require new laboratory module



Time-lines for the coming decades



Summary and Conclusions

- We have established a modern, deep, dedicated facility
- SURF has ~10 years of science defined and initiated
 - MJD, LUX - taking data
 - LZ - planning
- Longer term science plans developing
 - LBNE has CD1 and developing momentum for underground option
 - 1 tonne neutrinoless double beta decay identified by ONP in its facility plan
 - G-3 Dark Matter being considered
- Funding for SURF is stabilizing with DOE's oversight of the facility
- Opportunity for increased SD participation recently established PhD Program (8 faculty positions being offered NOW!)

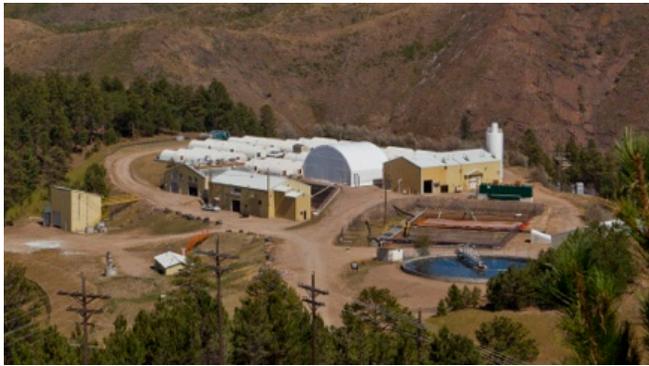
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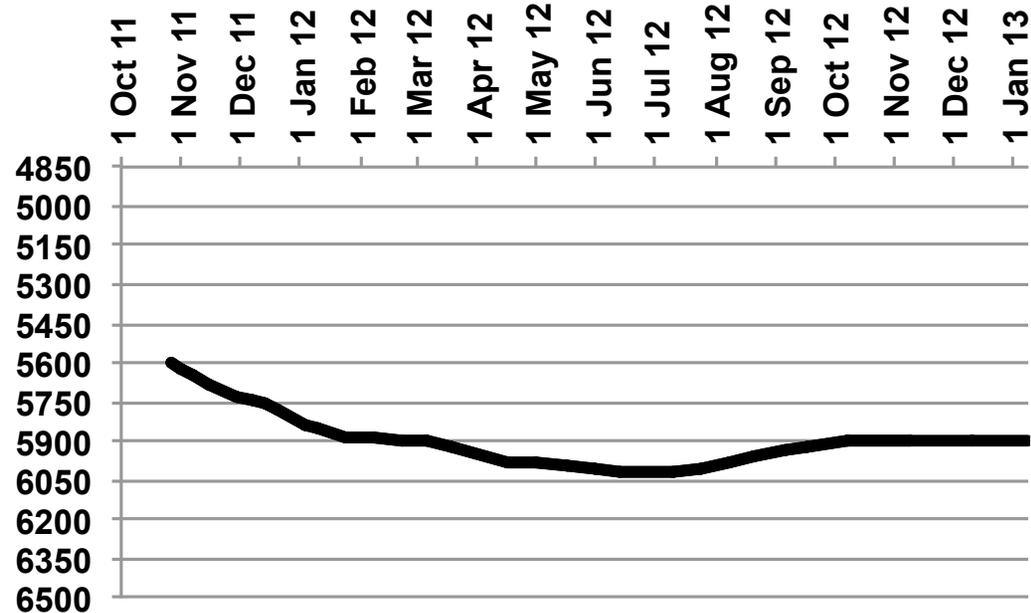
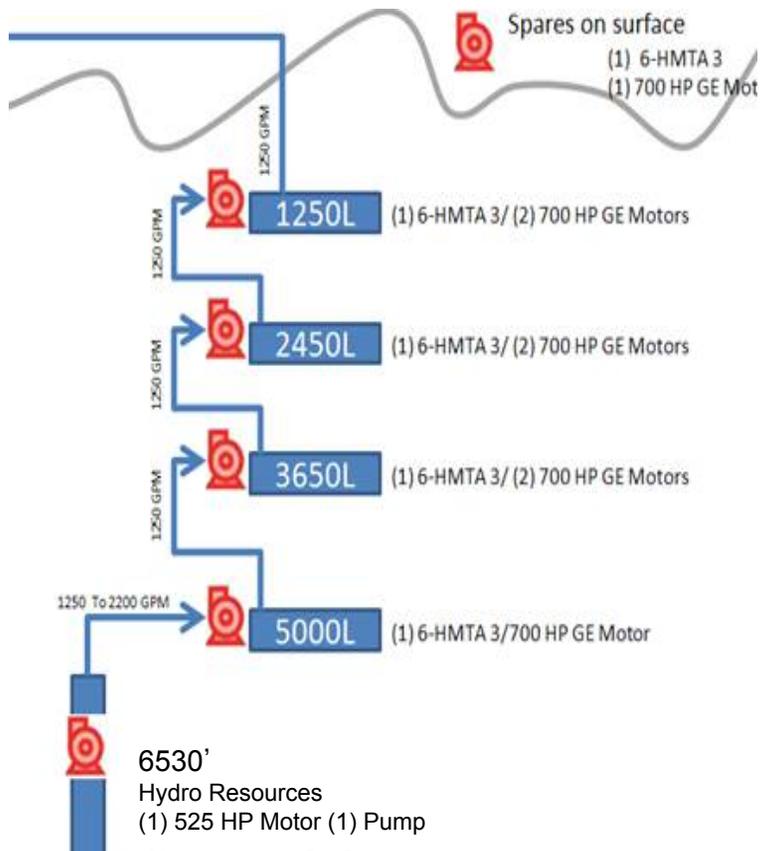


backup slides

Dewatering the Underground Facility

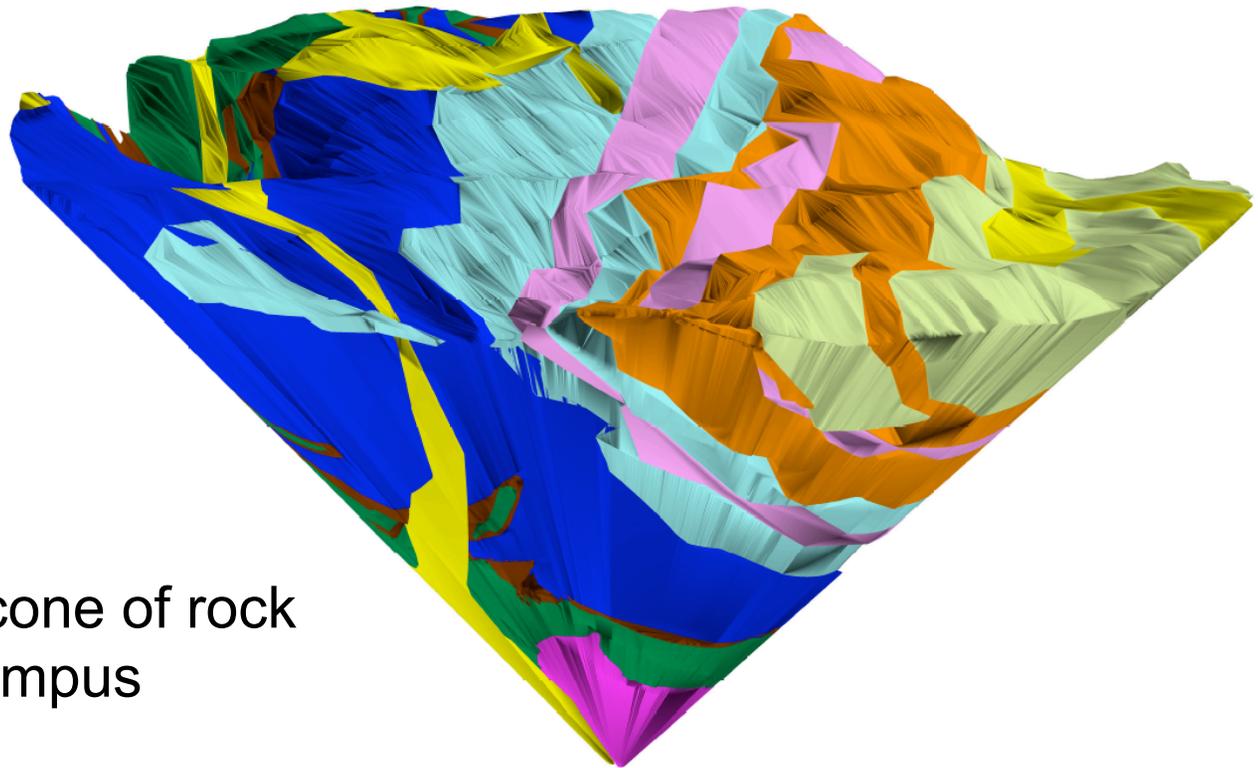


- Dewatered facility from a highpoint of 4530 down to 6000 feet below ground
- holding water at this level
- ~ 1 year of freeboard if pump systems should fail



SURF Geology Model

- 3D model of seven main rock formations
- Detailed surface topology
- Compiling rock geo-chemistry and density data from variety of sources
- Working to increase model extent (~99% muon flux)
- Slicing cone to give geology as function of angle



Representation of 3D cone of rock
above 4850L Davis Campus

SURF in the international context

Comparison of Laboratory Sizes

