

Sanford Underground Research Facility Joint Appropriations Committee Update

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Executive Director
SD Science and Technology Authority



SD FY2016 Major Goals

- Continue safe facility operations and access underground keeping the number of total recordable injuries to 3 or less.
- Support safe operation of current experiments deployed underground.
- Complete facility construction and deploy experiments in new lab spaces on the 4850L (CASPAR and BHSU Underground Campus).
- Advance Ross Shaft rehabilitation to the 4100L.
- Complete preliminary designs for the Long-Baseline Neutrino Facility (LBNF) experiment facilities planned for South Dakota.
- Continue to support effective, productive partnerships with the South Dakota Universities, American Indian Tribes, and State and Federal Agencies, and Industry Partners.

Current Underground Physics Program

MAJORANA DEMONSTRATOR (MJD):
Studying the neutrino's mass and the
imbalance of matter/antimatter in the universe

Large Underground Xenon (LUX):
Direct detection of dark matter

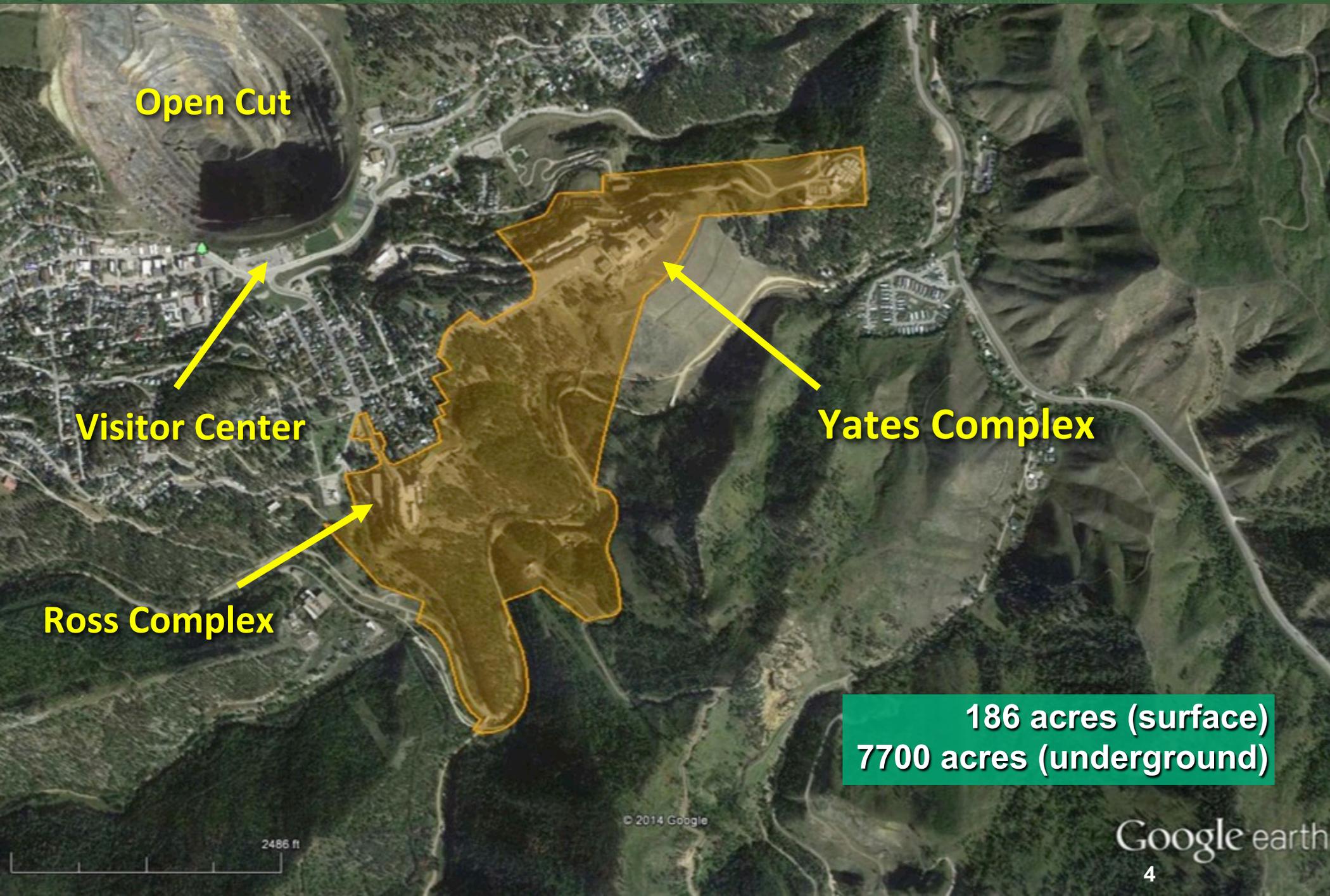


**Compact Accelerator System Performing
Astrophysical Research (CASPAR):**
Nuclear reactions in stars

Black Hills State Underground Campus:
Low Background Counting, Biology, Geology

Sanford Underground Research Facility

(SDSTA property shown in orange shaded area)



Open Cut

Visitor Center

Ross Complex

Yates Complex

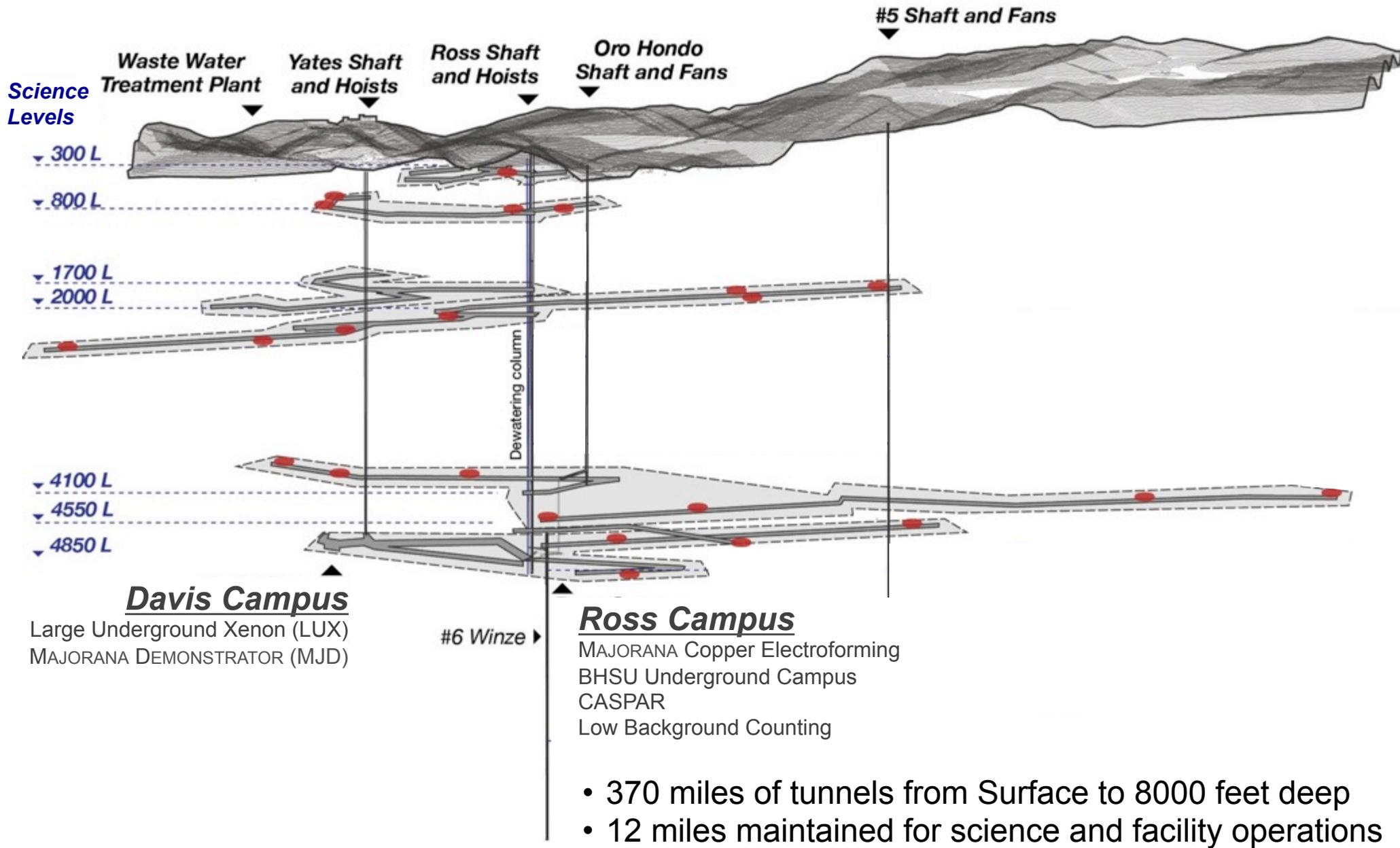
186 acres (surface)
7700 acres (underground)

2486 ft

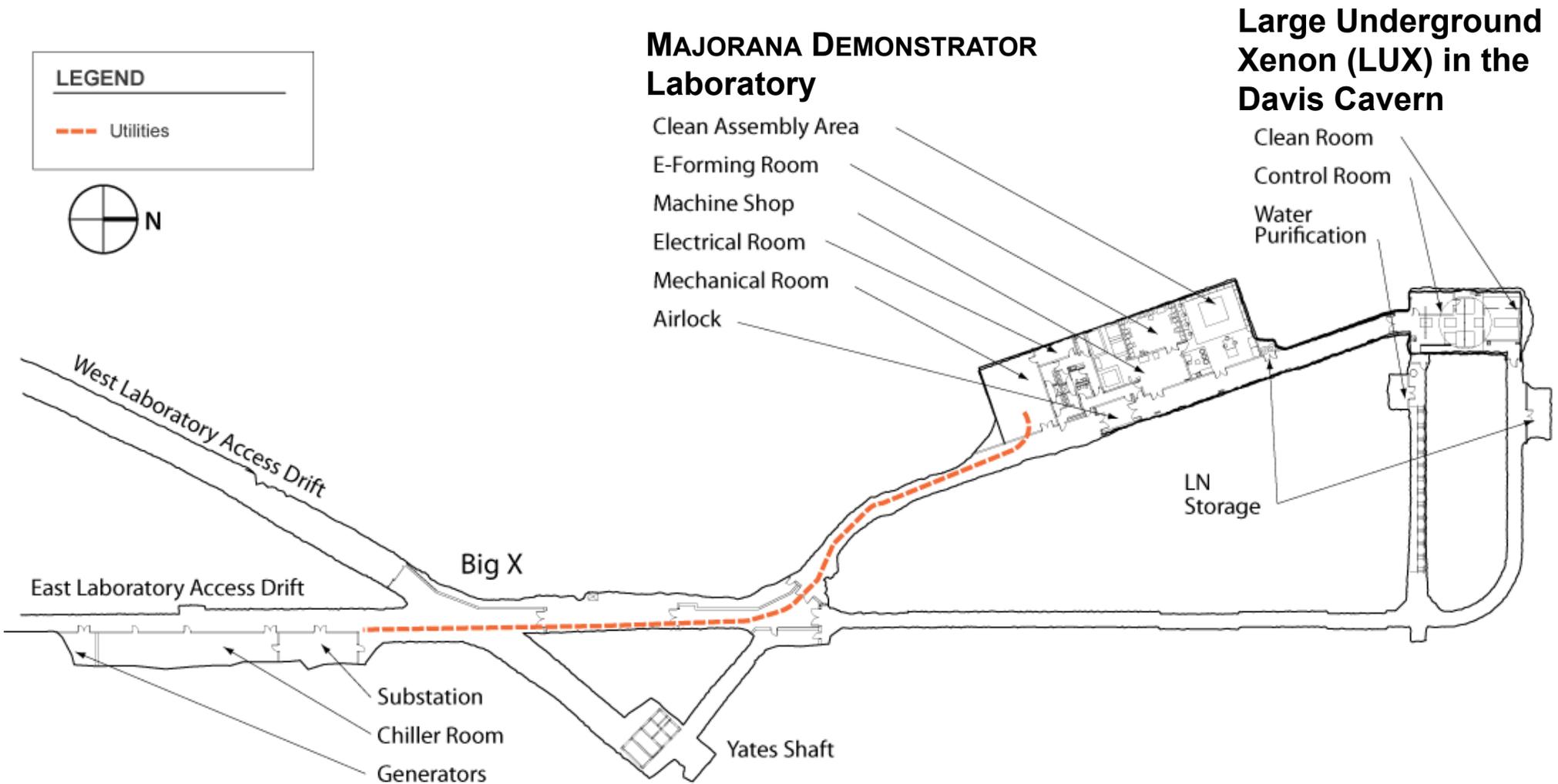
© 2014 Google

Google earth

Underground Lab Geography



4850L Davis Campus



- **\$15.2M South Dakota commitment**
- **Area: 30,000 ft² (Total) / 10,000 ft² (Science)**
- **Construction completed May 29, 2012**

Davis Campus Entrance on 4850L

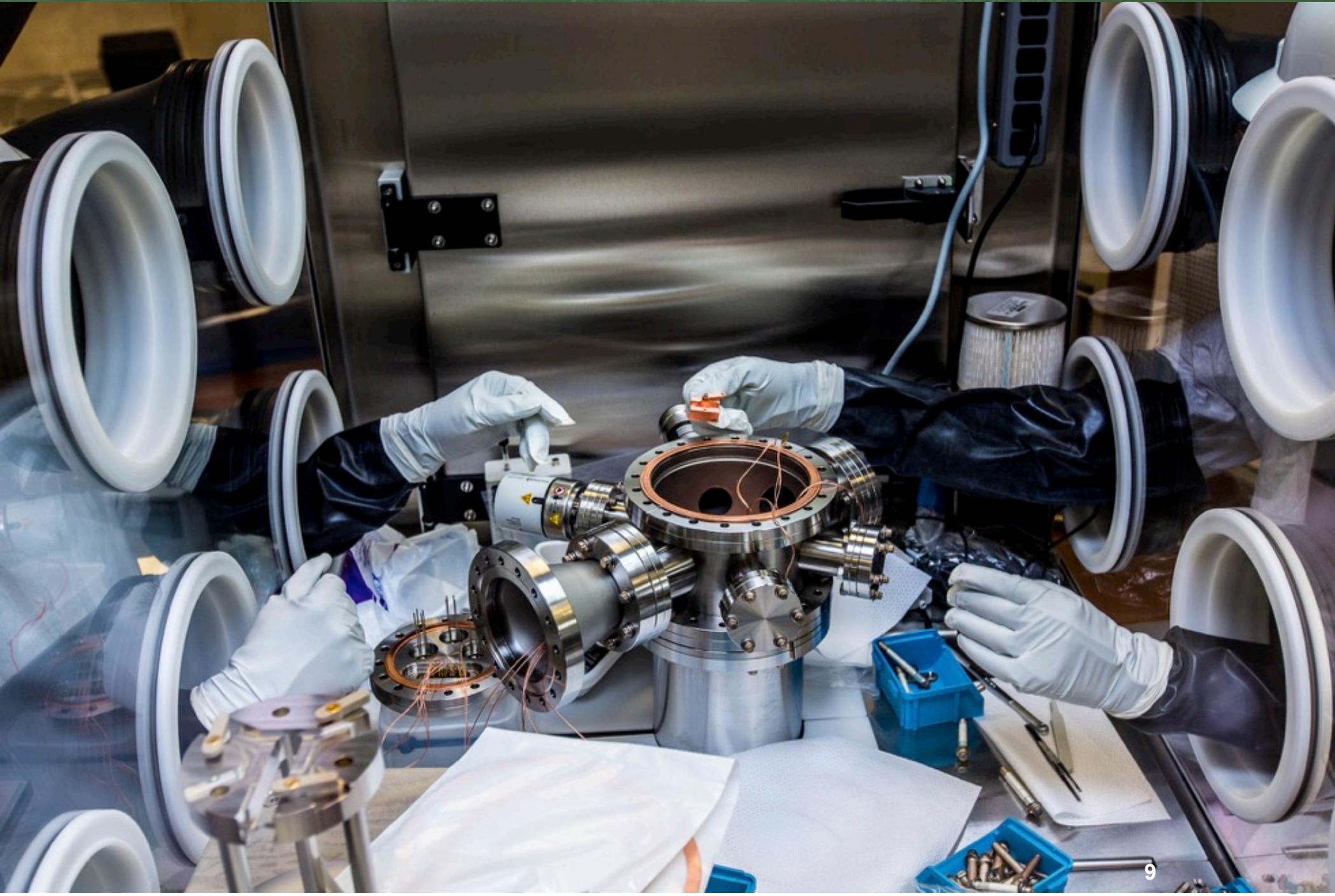


World's Deepest Clean-Room Machine Shop

Producing ultra-pure copper parts and shielding for MAJORANA

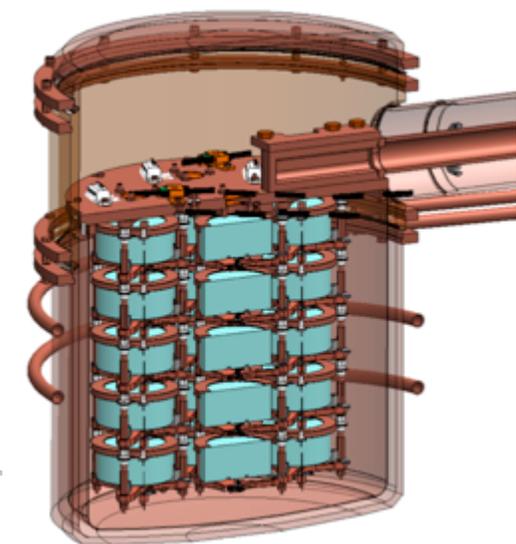
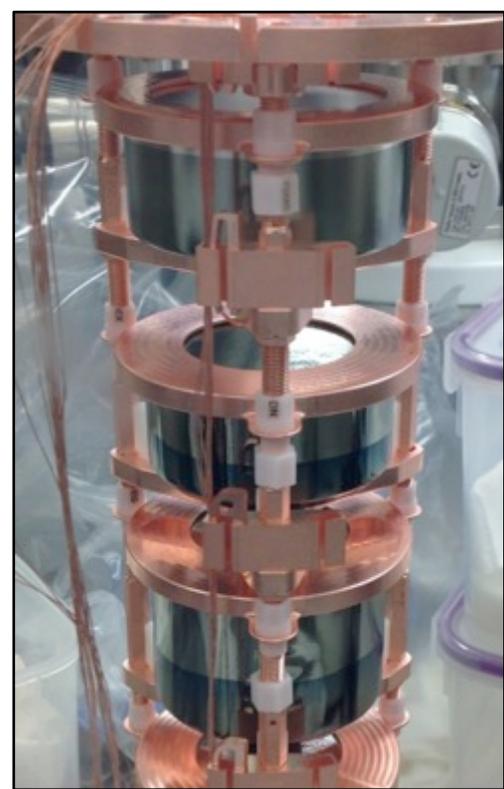


MAJORANA Detector Assembly



MAJORANA Shield and Detector Assembly

Detector is 40kg of enriched Ge^{76} . Data collection starting Q1 CY2015.



LUX Installed in the Davis Cavern



LUX Detector Deployed in Water Shield Tank



World's Most Sensitive Dark Matter Experiment

LUX First Result Announced on October 30, 2013 at Sanford Lab

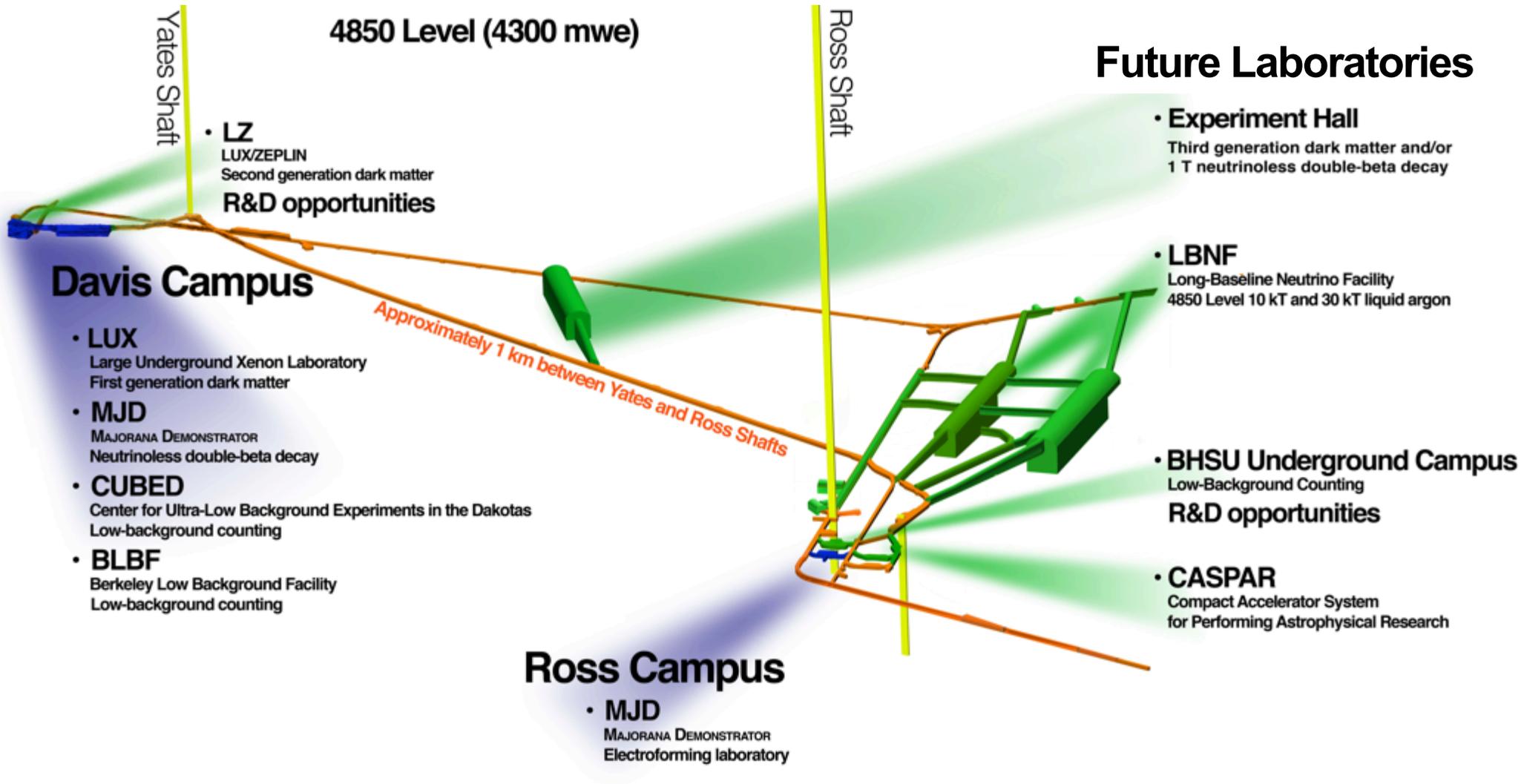


- LUX's initial 85-day run produced the first physics result for Sanford Lab.
- Science journal *Nature* chose the LUX result as a 2013 "Scientific Highlight of the Year."
- LUX remains the most sensitive in the world.
- LUX started a 300-day data taking run in October 2014. Will complete in mid-2016.
- Next generation experiment called LUX-ZEPLIN (LZ) was selected by DOE for construction. Expected to be operational in 2018.



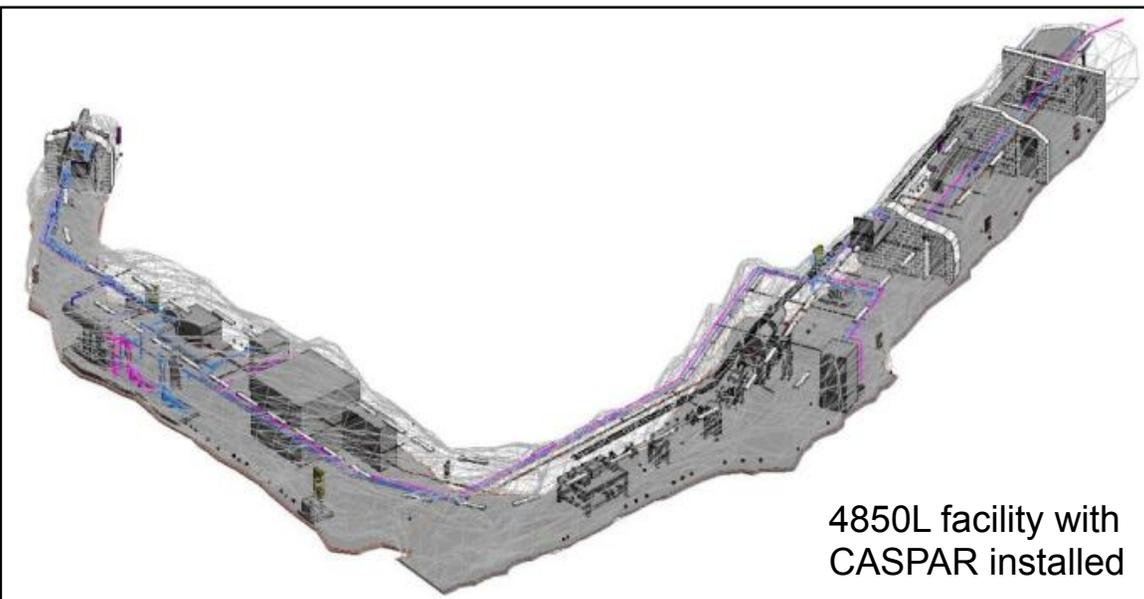
Projected 4850L Science Laboratories

Existing in Blue. Planned in Green. Operations expected beyond 2040.



CASPAR Experiment

Compact Accelerator System Performing Astrophysical Research

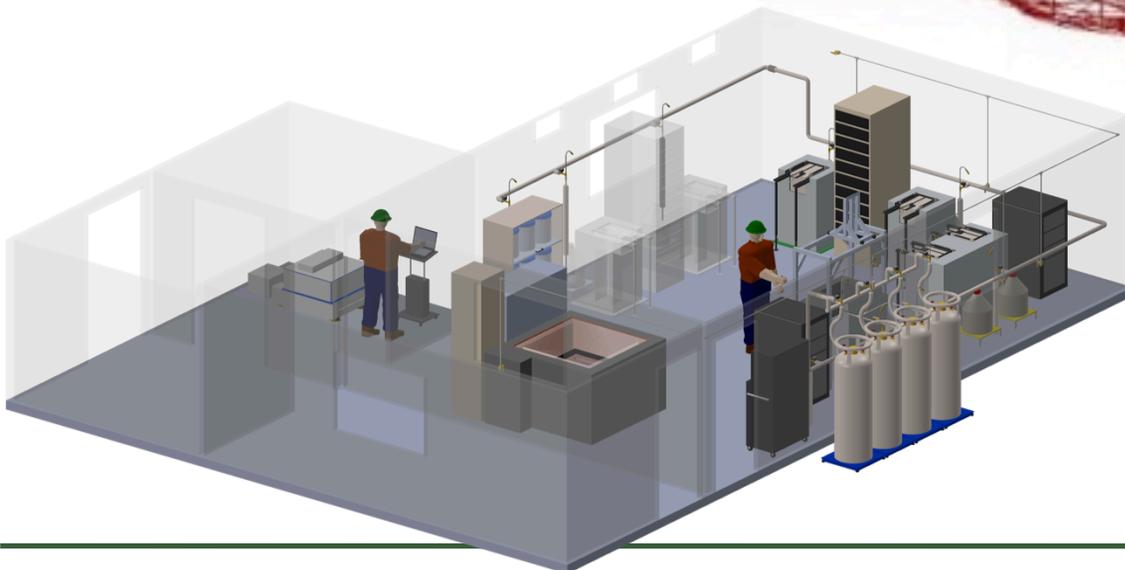
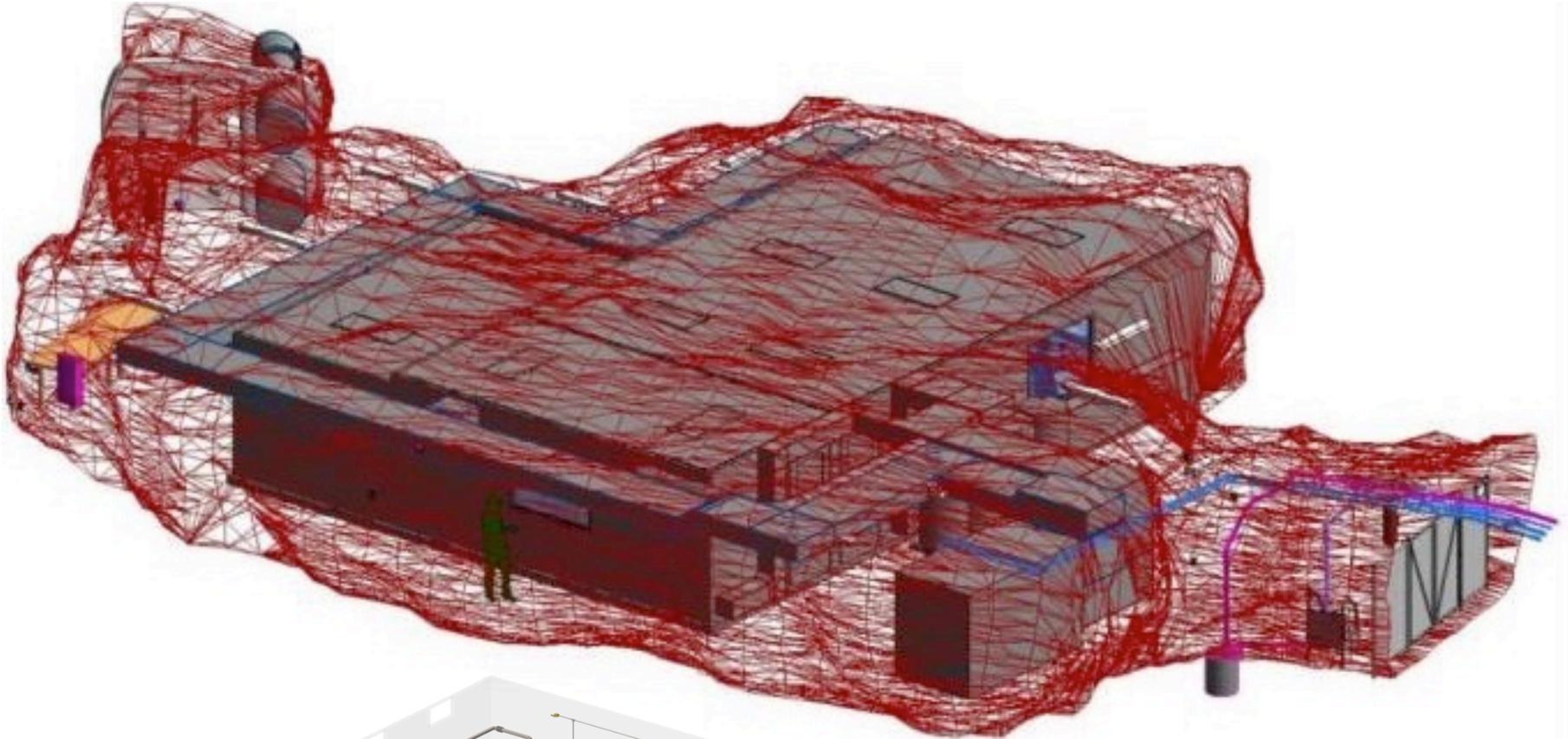


4850L facility with
CASPAR installed

- Low-powered accelerator to study nuclear reactions that occur when stars reach end of life and processes related to generation of ~50% of elements on periodic table.
- CASPAR Collaboration includes SDSM&T, University of Notre Dame, and Colorado School of Mines.
- SDSM&T will operate CASPAR.
- CASPAR will operate 10+ years—helping extend the lab's longevity.
- SDSTA has completed rehabilitation of underground space in Feb 2015.
- Construction contractor outfitting to complete in July 2015.
- Experiment installation and commissioning planned for 2nd half of CY2015.

BHSU Underground Campus

Construction to complete July 2015. Experiment install 2nd half CY2015.



Class 1000 clean room: 20' x 30'

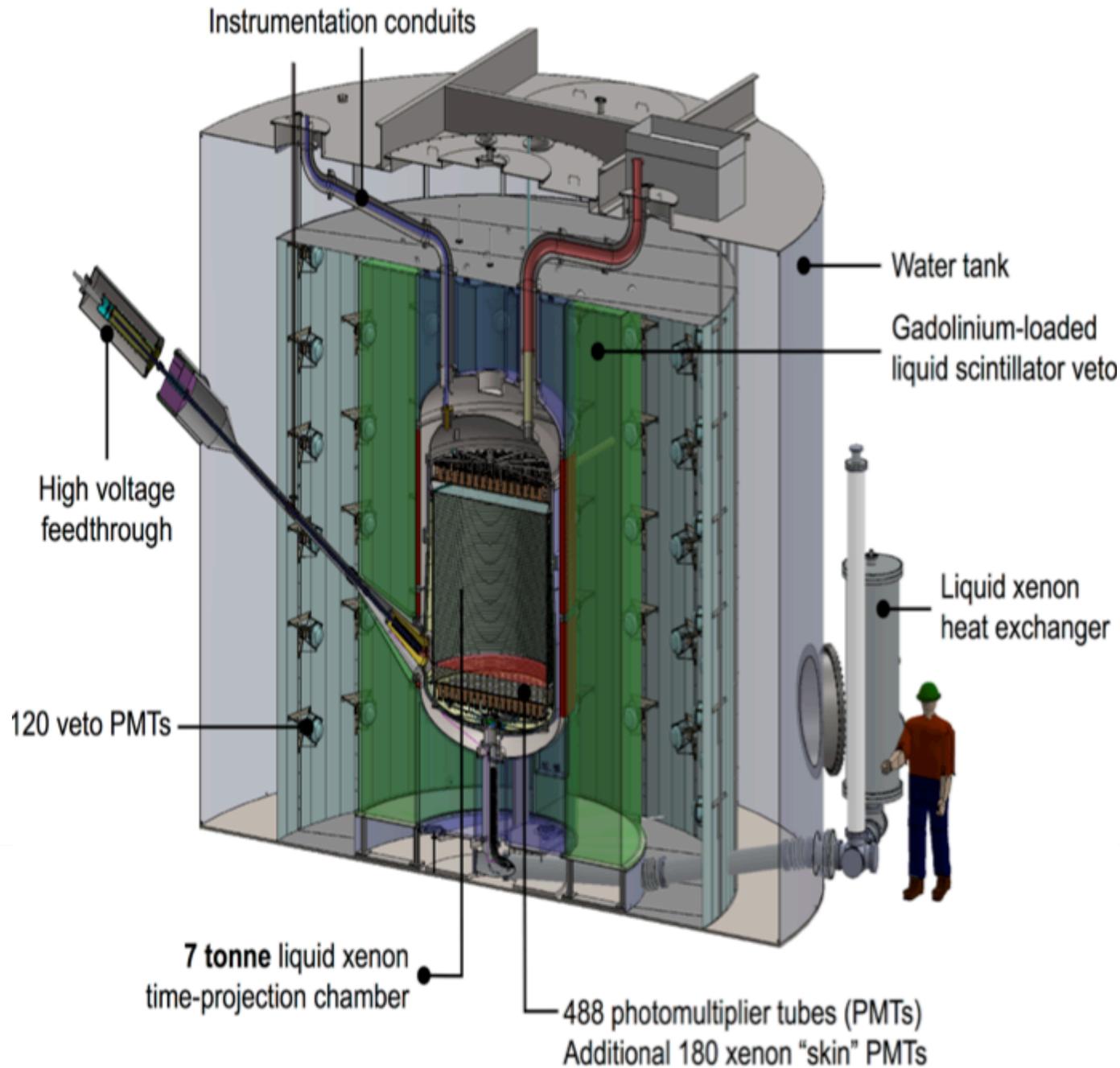
Room for 9 low background counting detectors

Class 10,000 clean room: 20' x 10'

Biology, Geology, and education and outreach including university-level student experiences

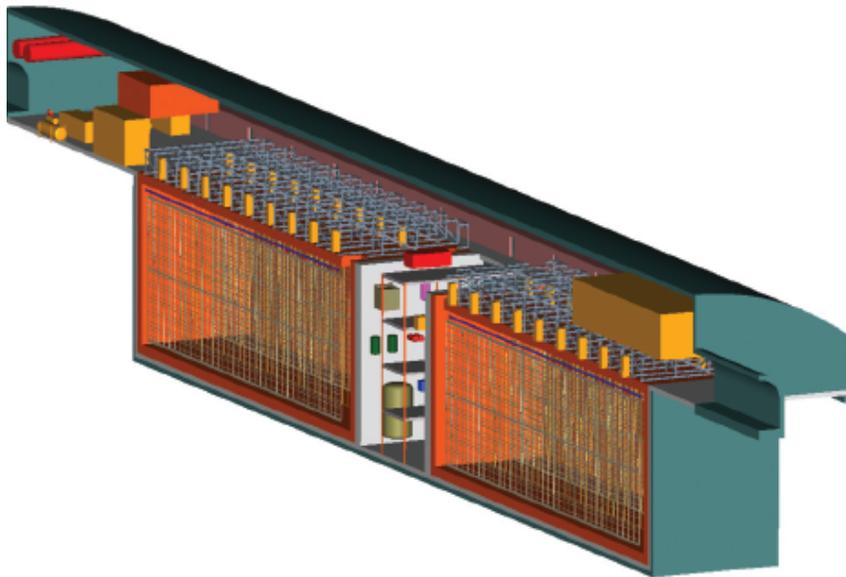
LUX-ZEPLIN (LZ) Dark Matter Experiment

Selected by DOE. 30x larger mass than LUX. Operations expected 2018.



Long-Baseline Neutrino Facility (LBNF)

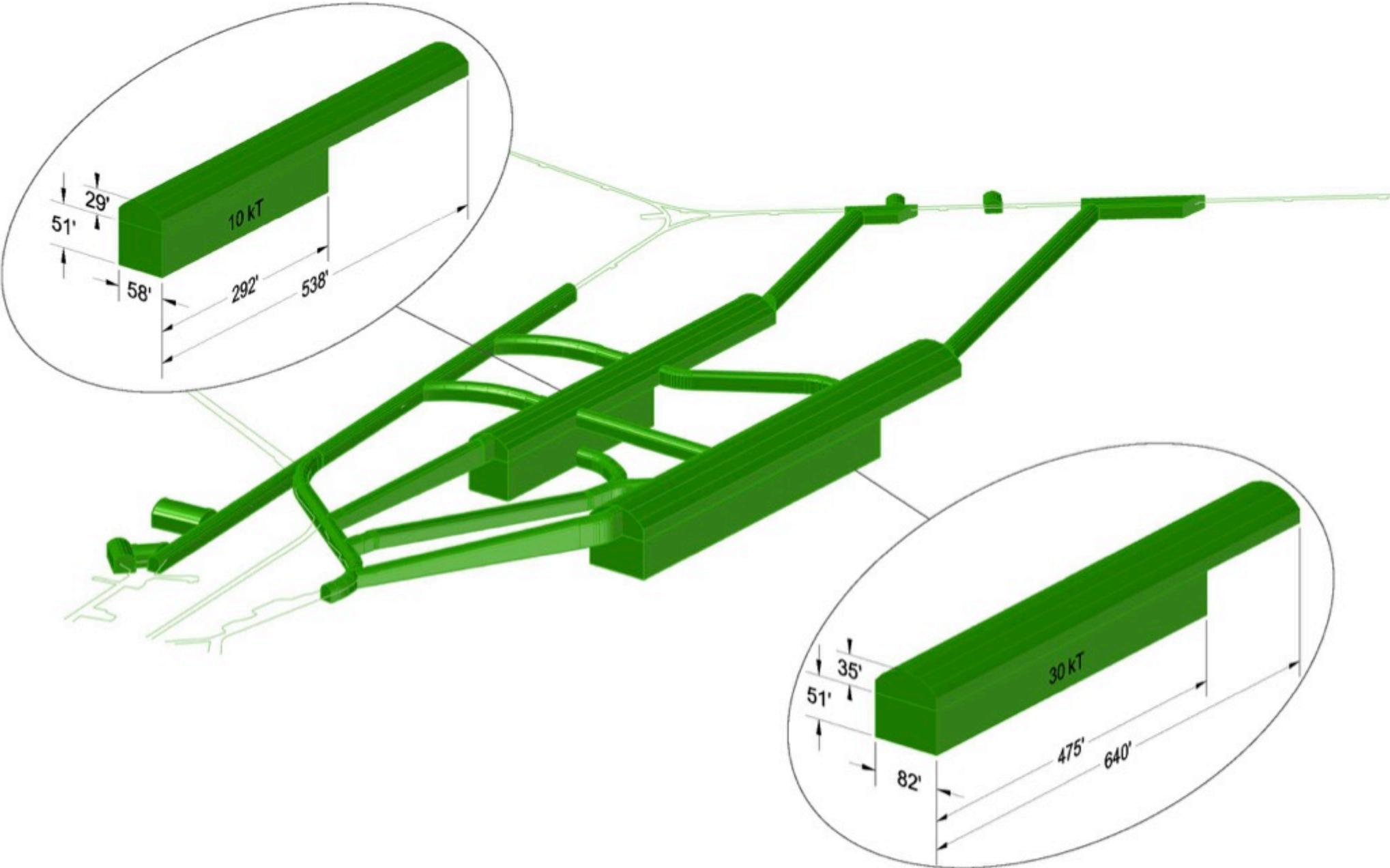
Largest planned science experiment for Sanford Lab



- LBNF is a DOE project led by Fermilab. With release of a new U.S. particle physics strategic plan, LBNF is gaining significant momentum.
- LBNF science collaboration recently was reformulated to expand international participation. Includes 142+ institutions and 500+ collaborators from around the world.
- LBNF plans to construct a large liquid argon neutrino detector on 4850L at Sanford Lab
- SDSTA leading the design and construction efforts for LBNF facilities in SD. SDSTA is currently on contract with Fermilab for SD-based facility design work at ~\$10M.
- SD-based facility construction estimated at \$300M. Experiment ranges \$150M to \$200M.
- Schedule
 - Geotechnical studies completed - mid-2014
 - Preliminary design start - January 2015
 - Facility construction start - mid 2017
 - First 10kT detector operational - 2021

LBNF Excavation Magnitude

600,000 tons of rock in total. 30kT cavern ~2 football fields long.



Ross Shaft Refurbishment Required for LBNF

Completed the top 2,344' (of 5,171' total) or 45% done

Surface	Schedule	
Tramway	Completed	
300 L		
800 L		
1250 L		
1400 L		
1550 L		
1700 L		
1850 L		
2000 L		
2150 L		
2300 L	Q1 CY2014	
2450 L	Q1 CY2015	
2600 L		
2750 L		
2900 L		
3050 L		
3200 L		
3350 L		
3500 L		
3650 L		
3800 L		
3950 L	Q1 CY2016	
4100 L	Q1 CY2017	
4250 L		
4400 L		
4550 L		
4700 L		
4850 L		
5000 L		
		Mid CY2017

- Both Ross and Yates Shafts constructed in 1930s.
- Neither shaft can structurally support the hoisting of waste rock to the surface for large UG construction.
- LBNF construction requires removal of ~600,000 tons of rock starting in 2017 over 2+ year period.
- LBNF facility construction in SD budgeted at \$300M.
- Structural steel raw materials already purchased.
- Project is funded through July 1, 2015. Need \$13M additional. Employs 30 SDSTA FTE and local suppliers.
- SD Governor's FY2016 budget includes \$3.95M for Ross Shaft. Contractors' excise tax on LBNF facility alone will be \$6M (exceeds the \$3.95M request).
- **Ross refurbishment essential for LBNF construction. Not finishing the Ross places Lab's future and the state's investment in jeopardy.**

Traversing Up the Ross Shaft Video

From old steel into new



Ross Refurbishment Recent Progress

Examples of old shaft steel



Ross Refurbishment Recent Progress

New steel recently installed



Ross Shaft Refurbishment

2000L station refurbishment recently completed

Before



After



Economic Impacts in South Dakota

As of January 2015

Spending in South Dakota to date	\$135+ million
Annual total budget (all sources & activities)	\$36.2 million
Annual SURF operations budget (DOE funds) (includes Berkeley and South Dakota activities)	\$15 million
Annual payroll in SD	\$12.4 million
Annual non-payroll expenses in SD	\$16.7 million
Jobs in South Dakota	163
Active research groups	16
Research groups with SD members	14



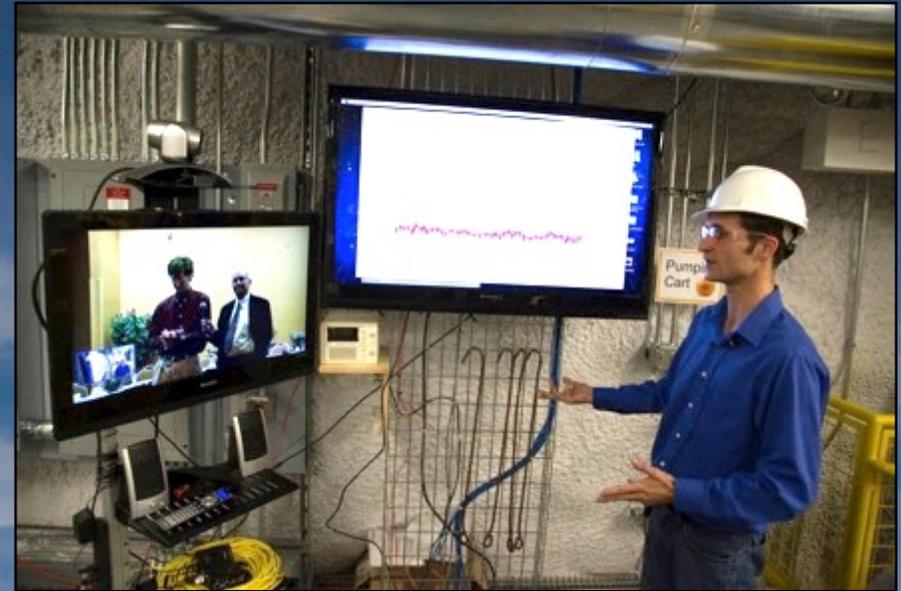
Education and Outreach Impacts

2008 through 2014

Students participating in programs 9,951

Teachers participating in programs 2,185

General public attending programs 15,600+



Funding Commitments as of January 2015

State Appropriated Funding*

2004	\$14.3M
2005	\$19.9M
2010	\$5.4M
2014	\$2.0M

Total **\$41.6M**

*\$12M in restricted accounts

Other Funding

T. Denny Sanford	\$70.0M
HUD Grant	\$10.0M
NSF	\$81.4M
DOE	\$55.0M
LBNF (THROUGH 2017)	\$19.2M
Interest earnings	\$13.3M

Total **\$248.9M**

Experiments

LUX	\$5.0M (+ \$650k/yr ops)
MAJORANA	\$25.3M (+ \$2M/yr ops)
LBNF	\$22.8M (Ops TBD)

DOE Operations Funding Ongoing Today

Funds work at Lawrence Berkeley National Lab and Sanford Lab

- Federal FY2012* - \$11M (SDSTA allocation \$9.3M)
- Federal FY2013 - \$14M (SDSTA allocation \$12.97M)
- Federal FY2014 - \$15M (SDSTA allocation \$13.4M)
- Federal FY2015 - \$15M (SDSTA allocation \$13.5M)

* FY2012 was a transition year from NSF to DOE operations funds.
NSF funded first four months due to a continuing resolution.

SD University Involvement Highlights

	<p>BHSU</p>	<ul style="list-style-type: none"> • Joint Sanford Science Education Center with SDSTA. Facility development underway including Jonas Science Hall remodel to be completed in Oct 2015. • BHSU leads Sanford Lab education and outreach activities. • Joint development and operation of the BHSU Underground Campus on 4850L.
	<p>DSU</p>	<ul style="list-style-type: none"> • DSU supports Sanford Lab information technology security program. • DSU leads <i>Center for Theoretical Underground Physics and Related Areas</i> (CETUP) conference. (2015 program will be the 5th year held. Over 200 participants and many publications).
	<p>SDSM&T</p>	<ul style="list-style-type: none"> • SDSM&T and USD are lead SD institutions for physics PhD program. • SDSM&T has 11 physics PhD students. 7 involved in SURF projects. • 13 faculty members in Physics Department. 6 of them working on SURF projects (LBNF, LUX, LZ, CASPAR). 3 new faculty added in SD FY2015. • SDSM&T faculty in leadership roles for MAJORANA DEMONSTRATOR, CASPAR, and LZ experiments. (see press release on \$1.1M DOE grant for Dr. Richard Schnee) • SDSM&T leading an upcoming conference in SD on <i>Science at the Sanford Underground Research Facility</i> (Being held for the first time in May 2015)
	<p>SDSU</p>	<ul style="list-style-type: none"> • Discussions underway between LBNF and SDSU on research to develop LBNF detector electronics to function in very cold environments. Potential involvement by a local manufacturer.
	<p>USD</p>	<ul style="list-style-type: none"> • USD and SDSM&T are lead SD institutions for physics PhD program. • USD has 8 physics PhD students. 5 involved in SURF projects. • SDSTA scientist enrolled in PhD program at USD. • 7 faculty members in Physics Department. Staff involved in SURF projects. 2 new faculty added in SD FY2015. • USD leads CUBED collaboration with scientists on site at Sanford Lab.

Education & Outreach – New Visitor Center

Construction started July 7, 2014. Planning June 2015 opening.



Visitor Center Foundation Installation Video



Visitor Center Steel Installation Video





Thank You!