



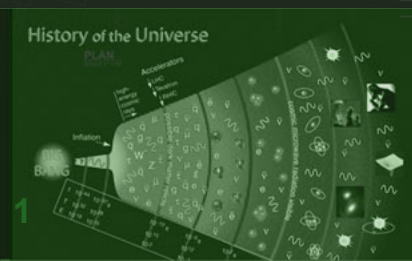
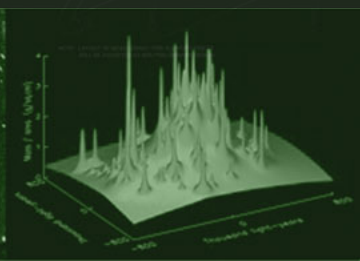
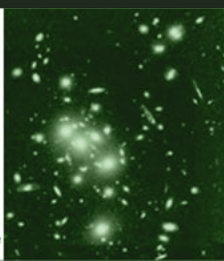
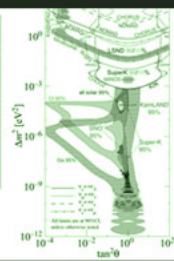
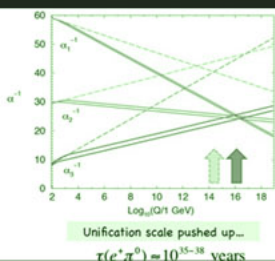
# Status of Sanford Underground

## Laboratory

January 19, 2012

Jaret Heise

Sanford Laboratory Science Director



# Sanford Lab Current Science Program

## LUX

- **Dark Matter:**
  - *LUX will perform direct search for WIMPs using 350 kg xenon within ultra-pure titanium cryostat*
  - *Surface Laboratory configured to allow LUX to exercise procedures, test installation and detector operation*

## MAJORANA DEMONSTRATOR

- **Neutrinoless Double Beta Decay:**
  - *Investigate neutrinoless double beta decay using 40 kg Ge in two cryostats (start with natural Ge, add up to 30 kg enriched  $^{76}\text{Ge}$ )*
  - *Temporary lab to electroform copper for shielding and detector components*
  - *MAJORANA DEMONSTRATOR will illustrate technology for 1-tonne scale*

## Biology, Geology, Engineering (BGE)

- **Rich program of characterization (including physics):**
  - *Biology sampling, seismic/frequency, microclimate, physics backgrounds*
- **Take advantage of unique opportunities:**
  - *Dewatering, sampling from core drilling, effects due to excavation, etc*



# Sanford Lab Current Science Program

**Physics** **LUX-350** – *Dark Matter*  
**MAJORANA DEMONSTRATOR** –  $0\nu\beta\beta$   
**CUBED** – *Crystal growth*  
**Bkgd Characterization** –  $\mu, n, \gamma, Rn$  [1,2]  
(also Low Bkgd Counting Lab in future)  
**DUGL** – *Seismic characterization* [3]  
*for gravity wave lab R&D*

**Geology** **GEOX™** – *Optical fiber applications, tiltmeters for deformation* [4]  
**Hydro Gravity** – *Local gravity for water tables, densities*  
**PODS** – *Petrology, ore deposits, structure*  
**Transparent Earth** – *Seismic arrays*

**Biology** **Biodiversity** – *BHSU, SDSMT* [5,6]  
**Lignocellulose** – *SDSU*  
**Biofuels** – *SDSMT* [7,8,9]  
**Bioprocessing R&D** – *SDSMT*  
**Syngas/Biofuels** – *SDSMT*

**Engineering** **None currently, but several interested, including Xilinx**  
  
*Previous incl Signal Propagation, Submersible*

**Other** **Cumingtonite** – *Geology (NSSGA)*  
**Vertical Array** – *Geophysics (SJSU)*  
**THMCB** – *Geology (NSF S4)*  
**Fracture Group** – *Geology (NSF S4)*  
**EcoHydro Group** – *Geology (NSF S4)*

**Total Active = ~14 groups**  
(Plus Others)

# Sanford Lab Current Science Program

## Surface

**LUX-350** – Detector assembly  
 Bkgd Char – Gamma, muon, Rn  
**Microclimate/SUL** – Temp, precip  
 Vertical Fac – Mag field, Ross/Yates  
**Hydro Gravity** – Site markers  
**PODS** – Core archive  
**Transparent Earth** – Core archive

## 300L

**DUGL** – Low-freq seismometer  
 Bkgd Char – Rn  
 Signal Prop – EM prop in drifts  
 Biodiversity – Baseline samples

## 800L

**DUGL** – Low-freq seismometer  
**Bkgd Char** – Gamma, muon, Rn, neutron, Pb storage  
 CO<sub>2</sub> Sequestration – Env monitor  
 MAJORANA – Pb, Cu storage  
 PODS – Geologic mapping

## 1250L

**Microclimate/SUL** – Temp, humidity  
**Bkgd Char/SUL** – Rn

## 1700L

Lignocellulose – Bio samples

## 2000L

**Transparent Earth** – Seismo/tilt (x2)

## 2000L (cont)

**GEOX™** – Tiltmeters (x3), climate

**DUGL** – Low-freq seismometer (x2-3)  
 Bkgd Char – Gamma, Rn, muon neutron

**Biodiversity** – Seeps, fungus (multi)  
**CO<sub>2</sub> Sequestration/SUL** – Env monitor

## 2600L

Microclimate/SUL – Temp, humid (x2)

## 3350L

**Utah/SUL** – Extensometers

## 4100L

**DUGL** – Low-freq seismometer (x2-3)  
**GEOX™** – Optical extens, temp  
**Transparent Earth** – Seismo/tilt  
**Biology (x2)** – Seeps, soil

## 4550L

Biofuels – Soil samples  
**GEOX™** – Hydrology  
 Bkgd Char – Gamma, Rn  
 Bio-Manifold – Pump water

## 4850L

**MAJORANA** – Cu eforming, Pb storage  
**GEOX™** – Hydrology, tiltmeters  
 CO<sub>2</sub> Sequestration – Env monitor  
**Biology (x6)** – Seeps, soil, core holes  
**Bkgd Char/SUL** – Rn, gamma, xray

## 5000L

**Biofuels** – Soil, water samples



# Sanford Lab Current Science Program

## Onsite Research Activities

Expts	2007		2008				2009				2010				2011				2012			
	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
LUX-350																						
Majorana Demonstrator																						
CUBED																						
Bkgd Characterization																						
DUGL																						
GEOX™																						
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Bioprocessing R&D																						
Syngas/Biofuels																						
Vertical Facility																						
CO2 Sequestration																						
Climate/Hydrology																						
Manifold Sampling																						
Signal Propagation																						
Submersible																						

 Research activity (dark > 100 hours)  
 External Reviews  
 Collaboration Meetings

 Proposed activity (dark > 100 hours)

# Sanford Laboratory Science

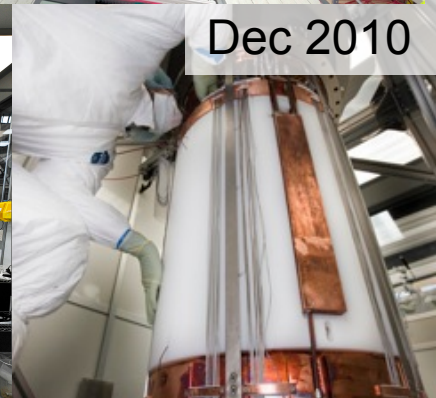
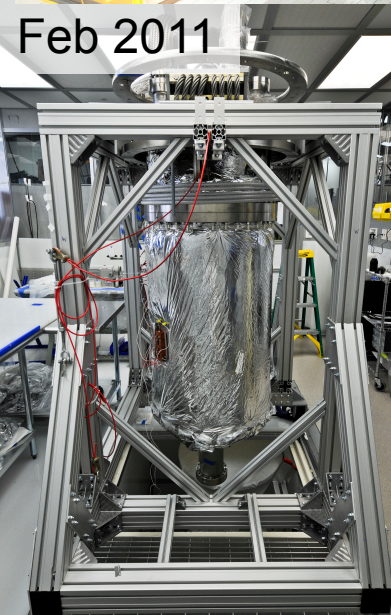
## Large Underground Xenon (LUX-350)

- **Status & Milestones:**

- Sep 2009: Regular onsite activities begin
- Dec 2009: Surface Laboratory occupancy
- Nov 2010: **Surface Lab Readiness Review**
- May 2011: First detector cooldown (Ar gas)
- Oct 2011: **Davis Campus Readiness Review**
- Oct 2011: Xenon detector operation begins
- Nov 2011: LN distribution installed, calibration program begins
- Dec 2011: Stable detector operations
- Jan 2012: Xenon purification studies

- **Schedule:**

- Jan 2012: Surface run ends, detector disassembly begins
- Mar 2012: **Davis Campus occupancy**
- May 2012: Detector transport underground
- Jun 2012: Detector installation complete
- Sep 2012: Detector cooldown
- Nov 2012: Detector commissioning complete
- **Data taking (until ~2014/2015)**

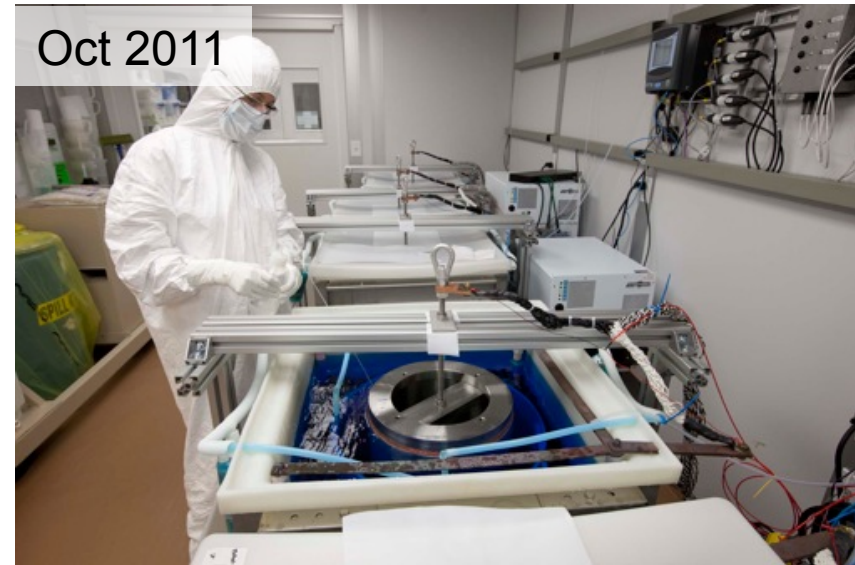




# Sanford Laboratory Science

## MAJORANA DEMONSTRATOR

- **Status & Milestones:**
  - Dec 2009: Rehab work begins on TCR area
  - Nov 2010: Ge detectors (19) on 4850L
  - Dec 2010: Initial cleaning preparations
  - Jan 2011: **Eforming Safety Readiness Review**
  - Feb 2011: Start of cleanroom cleaning
  - Jul 2011: Electroforming begins (10 baths)
  - Aug 2011: Bath inspection
- **Schedule:**
  - Jan 2012: **Davis Campus Readiness Review**
  - Feb 2012: Mandrel change on first baths, electrowinning begins at TCR,
  - Mar 2012: **Davis Campus occupancy**
  - May 2012: First mandrel changes complete
  - Jun 2013: Cryostat 1 installation begins
  - Feb 2014: TCR eforming operations complete
  - Mar 2014: Module 1 commissioning complete
  - May 2014: Cryostat 2 installation begins
  - Feb 2015: Module 2 commissioning complete
  - **Data taking (until ~2017/2018)**

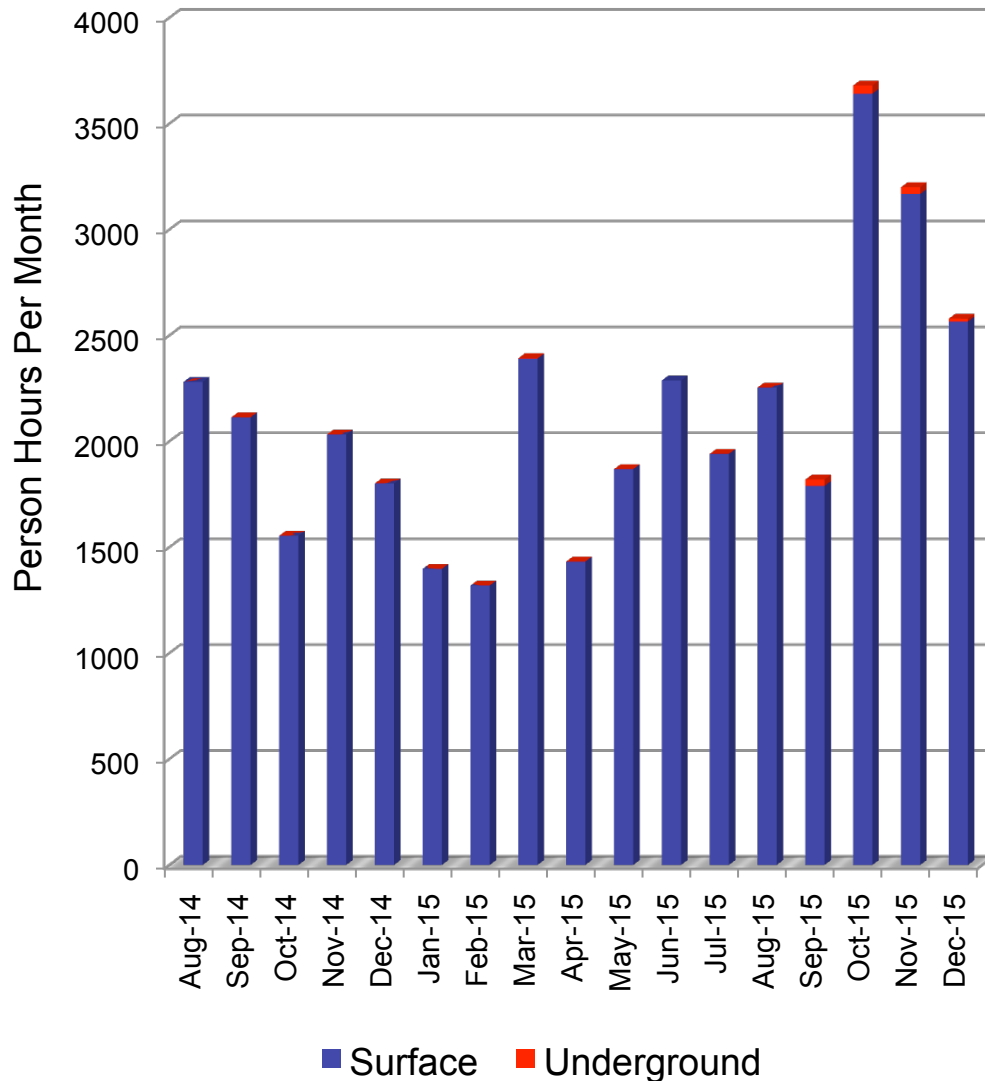




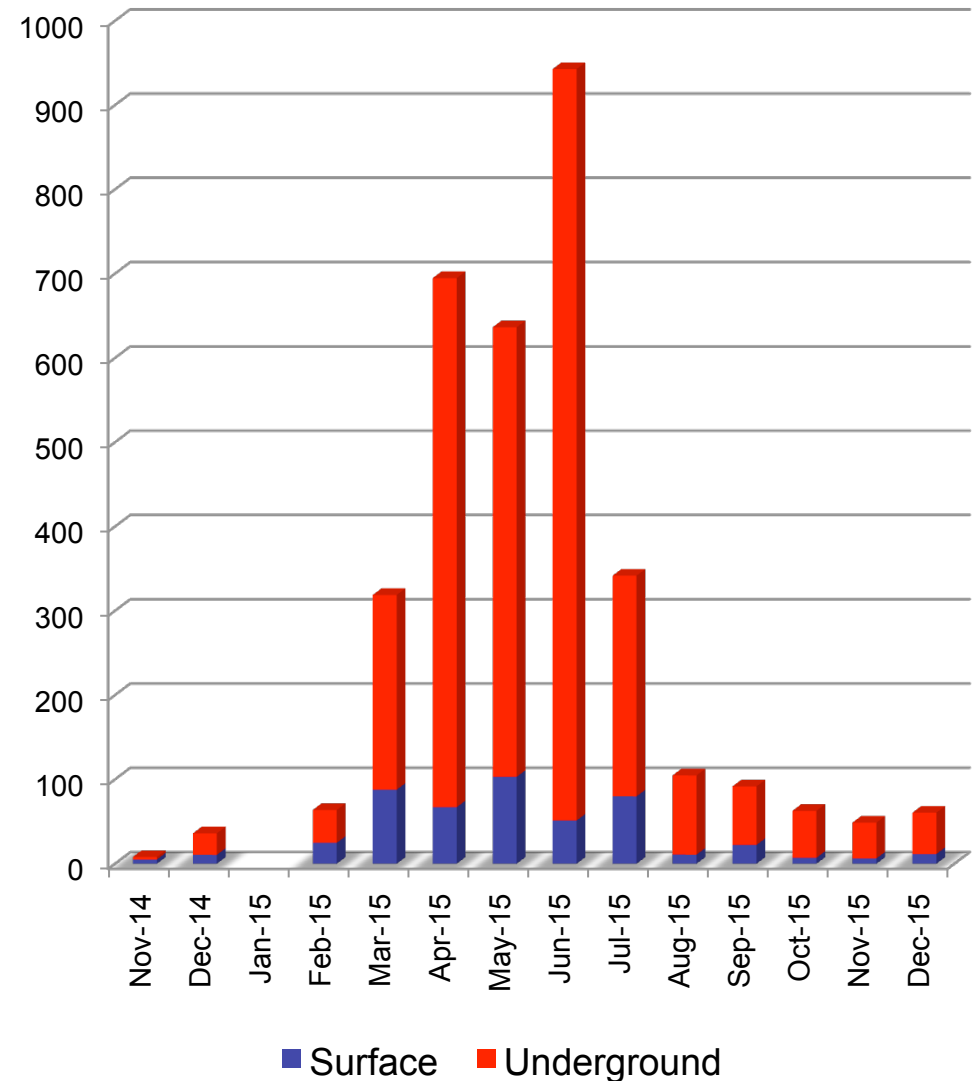
# Sanford Laboratory Science

## Onsite Research Activities

### LUX



### MAJORANA



## Science Integration & Communication

- Numerous dedicated coordination meetings:
  - Weekly meetings with LUX/MJD, schedule integration meetings
  - Planning discussions (eg., CUBED, DUGL, etc)
  - Starting weekly Davis Campus integration meetings in Feb

## Preliminary Weekly Underground Occupancy

[illegible]

**Green:** Personnel numbers based on initial collaboration input (subject to modification)

**Red:** Highest occupancy during overlap with contractors (Davis Campus ramp down, LBNE geotech). Contractor numbers expected to be conservative, under maximum occupancy limit in all cases.

- Underground personnel limit = **72 people**.
- Davis Campus personnel limit subject to Occupancy Permit (not yet issued).



# Sanford Lab Experiment Support

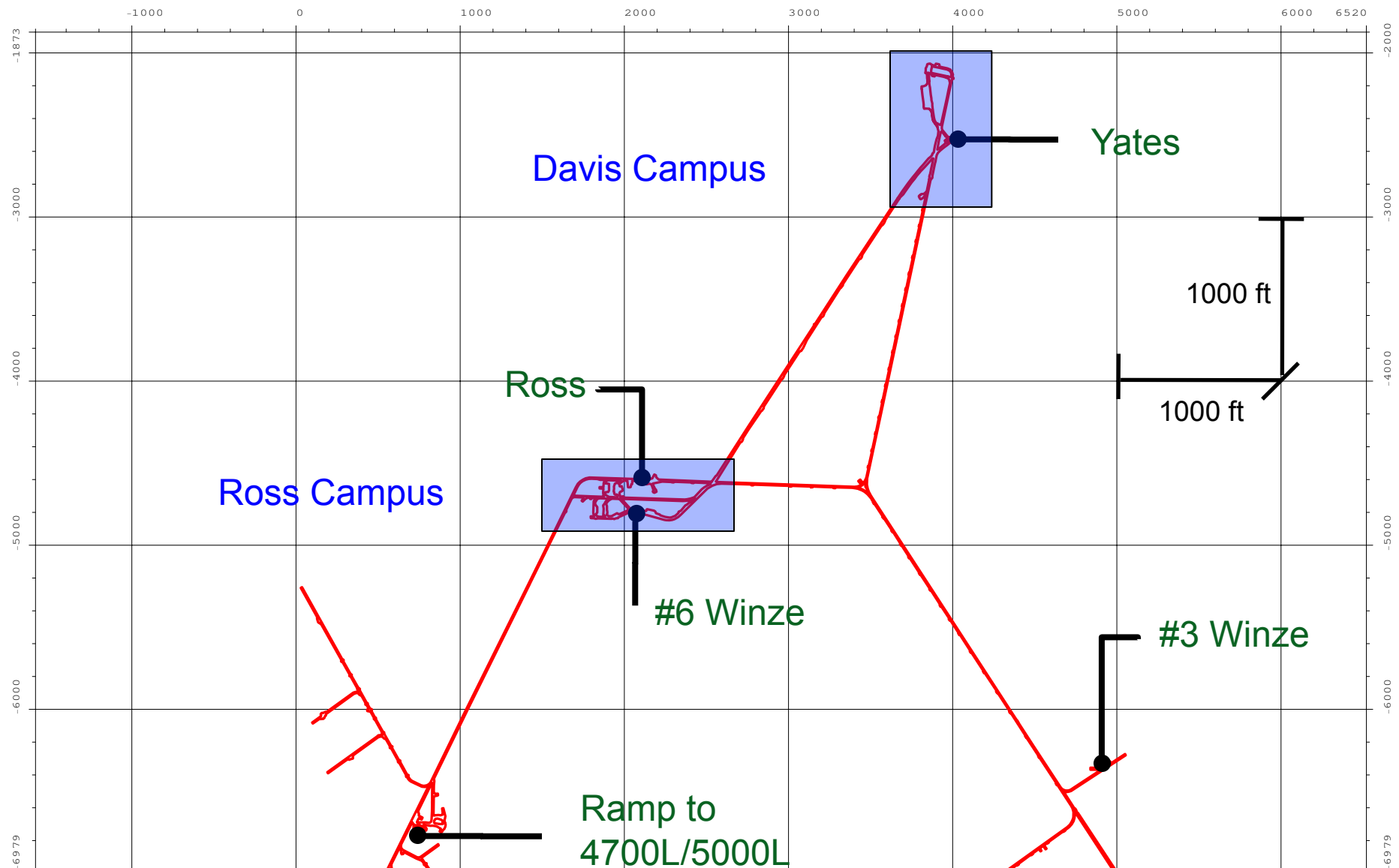
Examples: LN, Acid Waste, Detector Transport, Radiation)





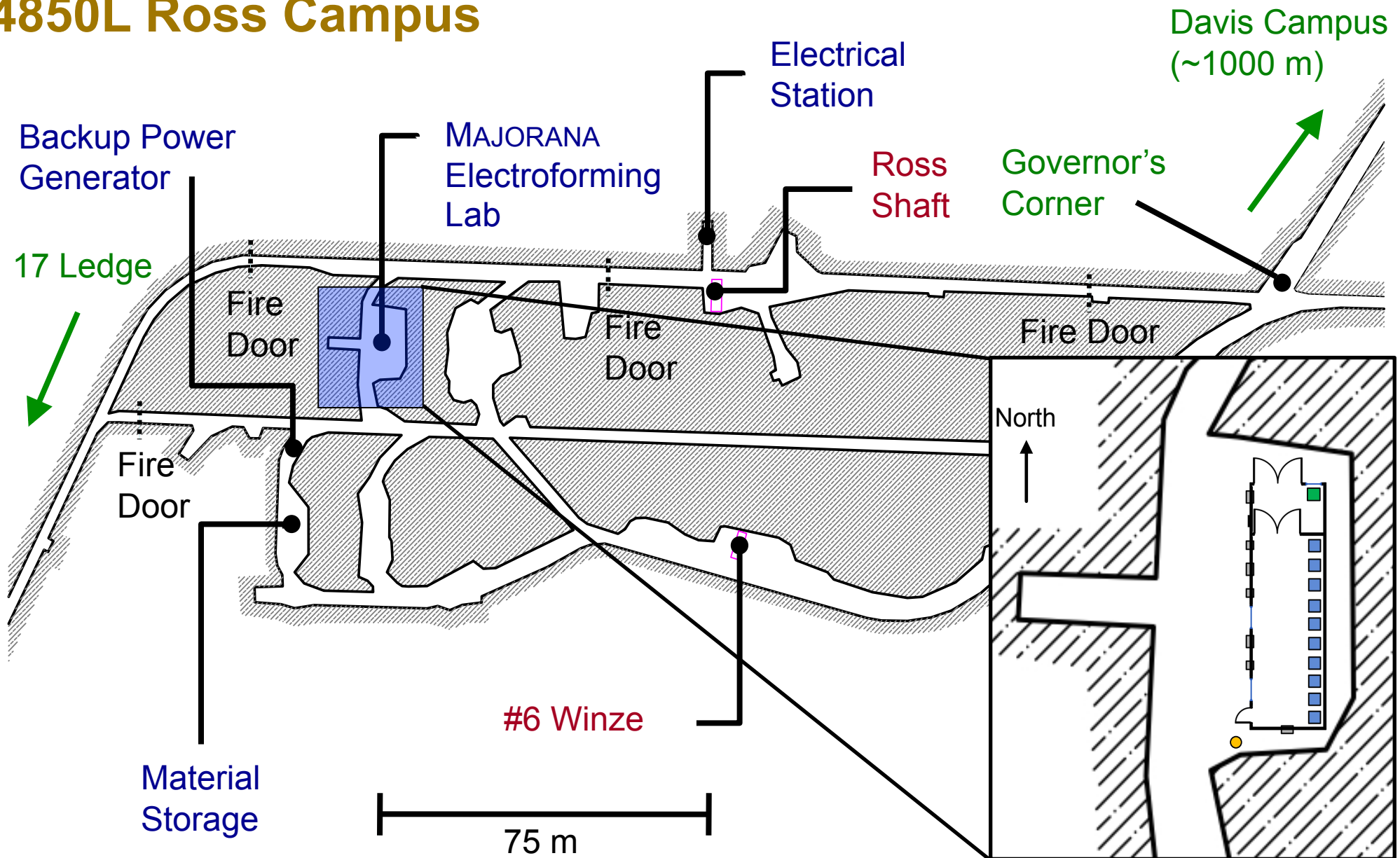
# Sanford Lab Science Infrastructure

## 4850L Sanford Laboratory



# Sanford Lab Science Infrastructure

## 4850L Ross Campus





# Sanford Lab Science Infrastructure

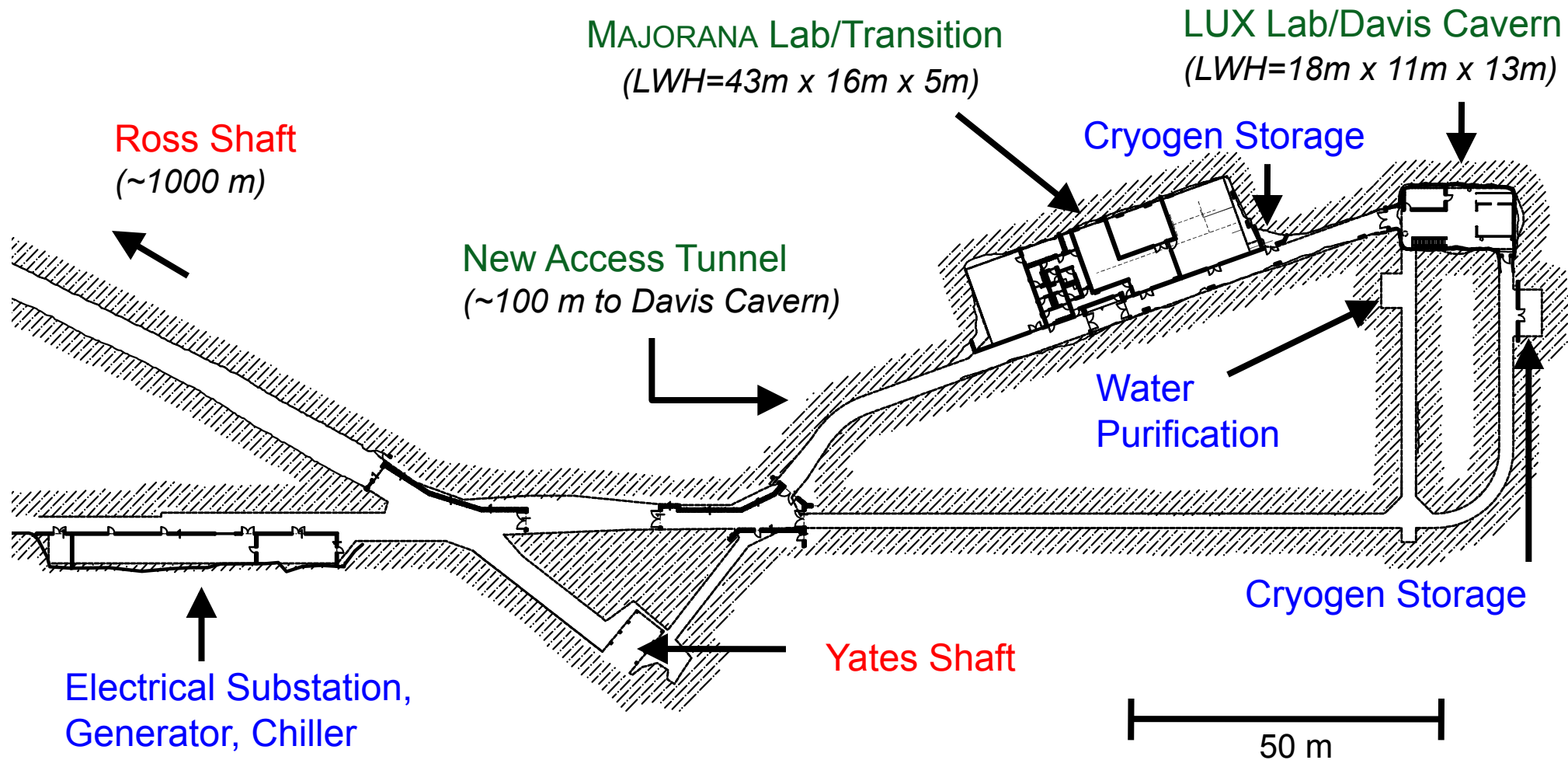
## 4850L Ross Campus: MAJORANA Electroforming Lab





# Sanford Lab Science Infrastructure

**4850L Davis Campus: 745 m<sup>2</sup> (Total) / 455 m<sup>2</sup> (Science)**



**Weekly Project Updates:**

<https://docs.sanfordlab.org/docushare/dsweb/View/Collection-15330>

# Sanford Lab Science Infrastructure

## 4850L Davis Campus Overview

- **Milestones:**

- **Sep 2009 - Jan 2011:** *Excavation: performed in-house, no accidents, 16,632 tonnes rock*
- **Jan 2011 – Jun 2011:** *Shotcreting: 563 m<sup>3</sup> (1,264 – 2,000 lb bags) applied*
- **Apr 2011:** *\$8M award to Ainsworth-Benning Construction, SD (+ value engineering)*
- **Jun 2011:** *Contractor mobilized underground, 9-month construction period planned*

- **Schedule:**

- **Project is 65% complete (as of Jan 12, 2012):**
  - Majority of concrete, block, steel complete, painting underway, 2/3 air handlers installed
  - LUX water tank fabrication complete
  - Power/network cable pulls Jan 2012, Davis Cavern decking installation Feb 2012, water purification system installation Feb/Mar 2012
- **Davis Campus occupancy Mar 22, 2012** *(specific areas may be available sooner)*
- **Project is on budget and on schedule**

- **Construction Stats:**

- *525 cubic yards of concrete (incl 29 tons of rebar)*
- *13,000 CMU (concrete) blocks*
- *80,000 lbs. spiral ductwork, 75,000 lbs. rectangular ductwork*
- *7 miles of conduit, 30 miles of wire*



# Sanford Lab Science Infrastructure

## 4850L Davis Campus: MAJORANA/Transition Area

Aug 24, 2011



Sep 1, 2011



Oct 13, 2011



Nov 2, 2011





# Sanford Lab Science Infrastructure

## 4850L Davis Campus: MAJORANA/Transition Area

Jan 13, 2012



Jan 12, 2012



Jan 12, 2012



# Sanford Lab Science Infrastructure

## 4850L Davis Campus: LUX/Davis Cavern

Jan 12, 2012



Dec 27, 2011



Dec 1, 2011



Dec 9, 2011





# Sanford Laboratory Status Summary

## Current Science Synopsis

- **Current:**

- *14 active research groups: 9+ research papers (many from the BGE community)*
- **LUX:** Surface Lab occupancy since Dec 2009, stable operations since Dec 2011
- **MAJORANA:** E-forming Lab occupancy since Dec 2010, operational since July 2011
- *Interactions continue with other groups (Lab development and site location)*
- *Support of existing facilities and activities working well with current resources, Davis Campus on schedule and on budget*
- *Experiment implementation:*
  - Includes many facets, include Readiness Reviews
  - Support from entire Lab
- *Experiment integration:*
  - Coordination commensurate with activity
  - Other examples: Guide policy, developing Researcher Work policy, Davis Campus training materials

- **Near-Term:**

- *Expect continued access to current Lab footprint (incl non-4850L levels)*
- *Davis Campus beneficial occupancy March 22, 2012*
  - Additional engineering support in place to ensure successful integration
  - **Underground installation of LUX and MJD to start by March 2012**

# Status of Sanford Underground Lab



Thank You!



# Sanford Lab Science Program

## Publications

- [1] Mei, Zhang, Thomas, Gray, *Astroparticle Physics* **34**, 33-39 (2010)
- [2] Gray, Ruybal, Totushek, Mei, Thomas, Zhang, *Nuclear Instrumentation & Methods A* **638**, 63-66 (2011)
- [3] Harms et al., *Classical and Quantum Gravity* **27**, 225011 (2010)
- [4] Volk et al., *Journal of Instrumentation* **7**, P01004 (2012)
- [5] Waddell, Elliott, Vahrenkamp, Roggenthen, Sani, Anderson, Bang, *Environmental Technology*, **31 (8-9)**, 979-991 (2010)
- [6] Rastogi, Muppidi, Gurram, Adhikari, Bischoff, Hughes, Apel, Bang, Dixon, Sani, *Journal of Industrial Microbiology and Biotechnology* **36**, 585-598 (2009)
- [7] Rastogi, Bhalla, Adhikari, Bischoff, Hughes, Christopher, Sani, *Bioresource Technology*, **101**, 8798-8806 (2010)
- [8] Rastogi, Osman, Kukkadapu, Engelhard, Vaishampayan, Andersen, Sani, *Microbial Ecology*, **60 (3)** 539-550 (2010)
- [9] Rastogi, Stetler, Peyton, Sani, *Journal of Microbiology* **47**, 371-384 (2009)

Plus others we may not be aware of...

# Sanford Lab Science

## Implementation Framework

- **Project Documentation:**
  - *Experimental Planning Statement (update as necessary)*
  - *Memorandum of Understanding (update as necessary)*
  - *General Services Agreement (update annually)*
  - *Insurance*
  - *Decommissioning Plan*
- **EHS:**
  - *Critical procedures, hazard analysis, training*
  - *Chemical, electrical, radioactive source inventories*
- **Review Process:**
  - **Small** projects reviewed by Science/EHS + Subject Matter Experts
  - **Large** projects may also be reviewed by panel of experts
- **Laboratory Integration:**
  - *Advisory committees, internal evaluation*
  - *Policies, access, work planning/reporting, use of Lab resources*
- **Authorization To Proceed**
  - *Lab Management (Headley/Lesko) and/or Science Director*



# Sanford Lab Science Implementation

## Safety Readiness Reviews

- **LUX:**

- *Hazards = pressure, cryogenics, electronics, hoisting/rigging, radiation*
- **Surface Operations Readiness Review** (Held Nov 2010 + Pre-Readiness Dec 2008)
  - Chan (chair) + 5 committee members to address formal charge, in-person review
  - Final committee report Dec 2010 with recommendations (followup via reviews, walk-throughs)
- **Davis Campus Readiness Review** (Held Oct 2011)
  - Chan (chair) + 9 committee members (incl external and observers) to address formal charge, in-person review
  - Final committee report Dec 12, 2011 with recommendations

- **MAJORANA DEMONSTRATOR:**

- *Hazards = chemicals, cryogenics, pressure, electronics, hoisting, structural, radiation*
- **Ross Campus Electroforming Readiness Review** (Held Jan 2011 + Initial Jan 2010)
  - Kadel (chair) + 5 committee members to address formal charge, in-person review
  - Final committee report Feb 2011 with recommendations (followup via reviews, walk-throughs)
- **Davis Campus Readiness Review** (To Be Held Jan 2012)
  - Taylor/Garcia-Sciveres (co-chairs) + 8 committee members (incl external and observers) to address formal charge, in-person review
  - Take advantage of MAJORANA internal reviews (eg., pressure, ODH, structural)
  - Initial draft of committee report due Feb 17, 2012 (finalize shortly afterward)

# Sanford Lab Experiment Support

## Participation From All Departments

- **Science:**
  - *Main point of contact, coordinate with other depts, direct supervision, etc*
- **Operations:**
  - *Maintain and provide access to Laboratory (surface and underground):*
    - Hazard mitigation, site prep (and related technical advice to science groups)
    - Installation and maintenance, incl filters and services (power, network)
    - Equipment and personnel transportation, etc (incl fabrication)
- **EH&S:**
  - *Policies, guidelines, forms (eg., Action Plan, Job Hazard Analysis, etc)*
  - *Safety resource (eg., training, inspections, monitoring, waste, reviews, etc)*
- **Engineering (incl Systems Engineering):**
  - *Lab development, contract support*
  - *Engineering assessments incl hazard mitigation, Safety Readiness reviews (incl tracking recommendations)*
- **Administration (incl IT, Project Controls, Communications, E&O):**
  - *Shipping and receiving, event planning, badging, IT, PDA compliance*
  - *Schedule development and tracking*
  - *Public outreach, showcase science and scientists locally, state, national*



# Sanford Lab Science Implementation

## Integration: Policies

- **EHS Policies:**

- *General:*

- Work planning and hazard analysis, “Stop Work”, etc
    - Laboratory Access (max underground occupancy currently 52 people)

- *Section 8000: Science Safety:*

- Expt review thresholds, cryo systems review, ODH analysis, etc

- **Experiment Implementation Policy:**

- *Documentation, EHS, training, reviews, integration, authorization*

- **Researcher Work Policy (mainly surface, updating for underground):**

- *Daily/Weekly work plans*

- *Lab access outside regular business hours (surface)*

- *No working alone in Laboratory space*

- **Laboratory Guide Policy:**

- *Sets guide ratios (in most underground areas ratio = 4:1 visitor-to-guide)*

- *Defines baseline “Guide” requirements, “Knowledgeable Person” (trainer)*

- *Defines “Designated Lab” space, minimum 1 guide*

# Sanford Lab Experiment Support

## Science Department



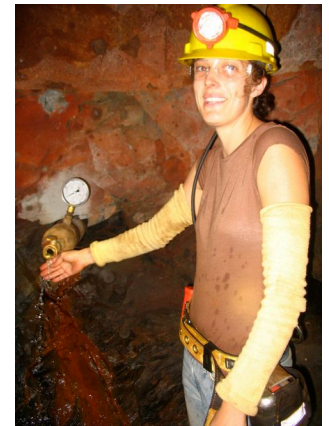
**Connie Giroux (MS)- Laboratory Supervisor**  
- Surface / Underground Lab Supervisor (LUX/MJD)



**Wendy Zawada- Engineer**  
- Planning/scheduling/logistics (esp underground)



**Tom Trancynger (MS,PG)- Science Supervisor/  
Lab Geologist**  
- Underground Lab Supervisor/guide, geology



**Tessa Jones- Researcher/Guide**  
- Underground guide, hydrology  
- Hydrology, Microbiology



**Jaret Heise (PhD)- Director**  
- Manage initial science program



**Jason Van Beek (~MS)- Researcher/Guide**  
- Underground guide, core archive  
- Transparent Earth, Hydrology, GEOX™