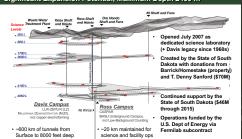
The Sanford Underground Research Facility J. Heise on behalf of SURF

Abstract: Building on rich legacies, the Sanford Underground Research Facility (SURF) has been operating for over 10 years as a facility dedicated to supporting underground research. Laboratory facilities include a Surface Campus with recently upgraded capabilities as well as two main campuses at the 4850-foot level (4300 m.w.e.) - the Davis Campus and the Ross Campus - that host a range of significant physics projects: the LUX-ZEPLIN (LZ) dark matter experiment, the MAJORANA DEMONSTRATOR neutrinoless double-beta decay experiment and the CASPAR nuclear astrophysics accelerator. Furthermore, a laboratory dedicated to critical material assays for current and future experiments is operational. Plans to accommodate the Fermilab-led international Deep Underground Neutrino Experiment (DUNE) at the Long Baseline Neutrino Facility (LBNF) are well advanced. SURF is a dedicated research facility with significant expansion capability, and applications from other experiments are welcome.

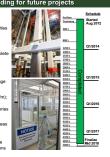
1. Underground Lab Geography



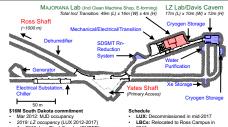
2. Facility Overview

- · Facility Highlights
- Ross Shaft Rehabilitation
- cement of steel & ground support ~ ect \$32M, on track for 2018 comple
- Yates Shaft

- Total underground air flow = 510,000 m³/hr (300,000 cfm); 4850L = 135-170k m³/hr (Yates), 35-43k m³/hr (Ross) Dedicated air handling units + chillers for main laboratories

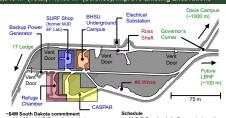


3. 4850L Davis Campus 3,015 m² (Total) / 1,015 m² (Science), New Excavation + Davis Cavern



- LZ: Data 2020, decommission in ~2026
 MJD: Data now, decommission in ~2027

4. 4850L Ross Campus



- Sep 2012: Refuge Chamber ins Aug 2015: CASPAR occupancy Sep 2015: BHUC occupancy

relocated to Davis Car

- BHUC: Indefinite use CASPAR: Data > 2022, then DIANA?

5. Science Overview

Expanding community of researchers from multiple discipline

Science Users 182 Current Active Users

NEW D

Science Support

- specific experiments

 Environment, Safety & Health Dept = 10 people, incl training, industrial hygiene, radiation/expt safety

 Mature experiment implementation & safety programs

 Experience in cryogen/pressure, cleanroom

 operations and maintenance, low-bkgd counting, etc



6. Science Program

- LUX-ZEPLIN (LZ)
- Direct search for **dark matter** using 10 witness water Gd-load ultra-pure stanium cryostat, ultra-pure water Gd-load (LAB) veto/shidel. Sensitivity project be 100x better than LUX 300d ($\sigma_{Lx} = 2 \times 10^{-6} \text{ cm}$) Status: CD-3 approval Feb 2017. Ti cryostat vessels fabricated, cleaned and arrived at SURF May 2018
- MAJORANA DEMONSTRATOR (MJD)
- Threstigate neutrinoless double beta decay using 44 kg Ge in two cryostats, 30 kg enriched ⁷⁴Ge inside Cu/Pb/ HDPE shield (~72 tons) with active muon veto Results: PRL 2018: low blogds + energy resolution: 1.6×10⁻² counts/(keV kg yr), 2.5 keV FWHM; 0vβB T_{1/2} > 1.9×10²⁵ yr Status: Production physics data since 2017, R&D for tonne-scale Ge-based expt (LEGEND)

2012 MJD

7. Science Program

search activities ranging from the surface to the 5000L

Physics LZ - Dark matter, 2-phase Xe TPC GEOX[™] – Optical liber applications, environmental monitoring Hydro Gravity – Local gravity for water tables, densitie water tables, densit.
PODS - Petrology, ore deposits,
structure (mainly drill core)
Transparent Earth - Seismic arrays Radiogenic Analysis - Heat flow. nu's Plus interest from others est from others (e.g., R&D)

ogy NASA Astrobiology Institute - NWU/DF

Biofuels – SDSMT BuG ReMeDEE – SDSMT, Mont, Okla Lignocellulose – SDSU GoLife – Bigelow Lab/DRI

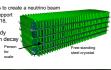
Total Active = 24 groups (39 Total Groups Since 2007)

8. Long Baseline Neutrino Facility

ment (DUNE)



- The first internationally conceived, constructed, and operated mega-science project hosted by the Department of Energy in the United States
- DOE project led by Fermilab. Significant international contributions (incl CERN)
- . LBNF: provides facilities at two locations
- "Near Site": Fermilab, Batavia, IL—facilities to create a neutrino beam
 "Far Site": SURF, Lead, SD facilities to support
 DUNE detectors, construction to start in 2018,
 excavation to start in 2020 and last "3 yrs
- DUNE: large liquid argon detectors to study neutrino oscillations, supernovae, nucleon decay Total of 70 kT (50 million liters) liquid argon First detector by ~2024, data for 20-30 yrs



9. Science Support – Material Assay Establishing national-level capability for low-background assays

[Th] BHUC Install p-type (85%) 2.1 kg (-20 ppt) (-50 ppt) (Davis Car (20 ppt) (-50 ppt) (2015) n-type (60%) 1.3 kg 0.7 0.7 (Davis Campus Apr (60%) (-60 ppt) (-175 ppt) (Oavis Campus Apr 2013) Low-bkgd upgrade 2015-2016, shield p-type 0.6 kg 0.6 0.3 Feb 2016 (35%) 0.6 kg (~50 ppt) (~75 ppt) (from Soudan) p-type 2x ~0.01 ~0.01 Jul 2017 (initial) (>100%) 2.1 kg (~1 ppt) (~3 ppt) Mar 2018

Planned BHUC instruments:
BetaCage (SDSMT proposal)
XIA UltraLo 1800 (LZ, purchased)

- Nearby (offsite) instruments Aglient 7900 ICP-MS (BHSU)

10. Surface Campus Upgrades SURF reduced-Rn system supplies air to new LZ low-Rn cleanroon



- Specs: 1000x Rn reduction, 300 m³/hr Supplier: Ateko, Czech Republic (same as Y2L, Gran Sasso, etc) Design: Compress air to 9 bar, cool to -60C dew point, flow air through carbon adsorption columns, then reduce pressure and reheat as
- Specs: Design/protocols support Class 100
- Design: Metal panels (Al) with careful eration for sealing joints, balancing

11. Davis Cavern LZ Upgrades

ore space / ducts







12. Current & Future Underground Facilities

Future Laboratories is Campus BHSU Underground Co **Existing Facilities** Future Facilities

