Opportunities at the Sanford Underground Research Facility

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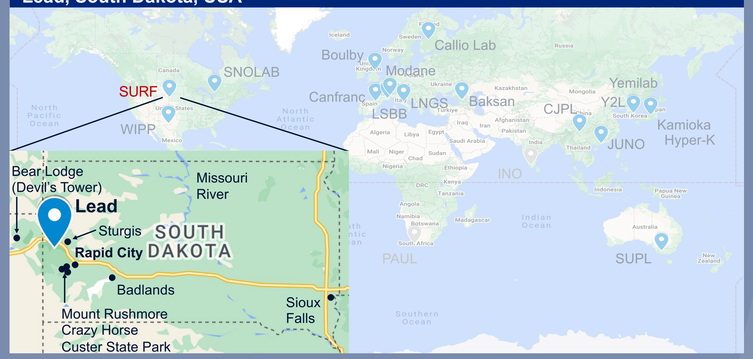
Abstract: The Sanford Underground Research Facility (SURF) began operation in 2007 as a facility dedicated to advancing compelling multidisciplinary scientific research. SURF is one of the deepest laboratory sites and offers the largest footprint in the world for scientific pursuits, including physics campuses on the 4850-foot level where the LUX-ZEPLIN, MAJORANA DEMONSTRATOR, and CASPAR experiments are located. As some experiment activities are completing, a call has been issued for letters of interest for Davis Campus space. SURF is also home to the Long-Baseline Neutrino Facility (LBNF) that will host the international Deep Underground Neutrino Experiment (DUNE). SURF provides ultra-low background environments, low-background assay capabilities, and electroformed copper is produced at the facility.

SURF is eager to host new experiments, and to that end, SURF is preparing to increase underground laboratory space. The initial phase of construction is complete allowing for development of new large caverns on the 4850L (1500 m, 4200 m.w.e.) on the timeframe of next-generation dark matter and neutrino experiments (early 2030s). Other facilities actively being investigated at SURF include a Quantum User Facility and a Vertical Facility, both of which would support quantum information science and additional particle astrophysics opportunities.

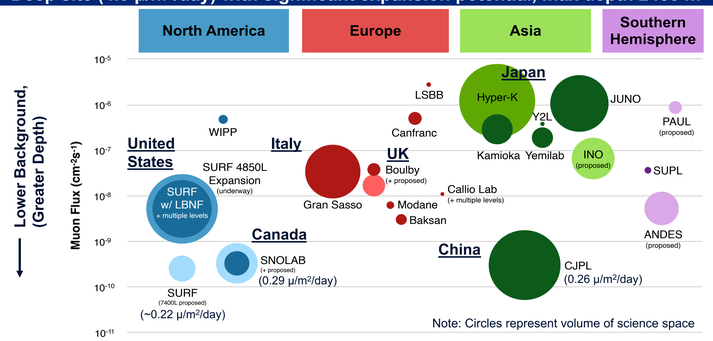
1. Sanford Underground Research Facility

Lead, South Dakota, USA



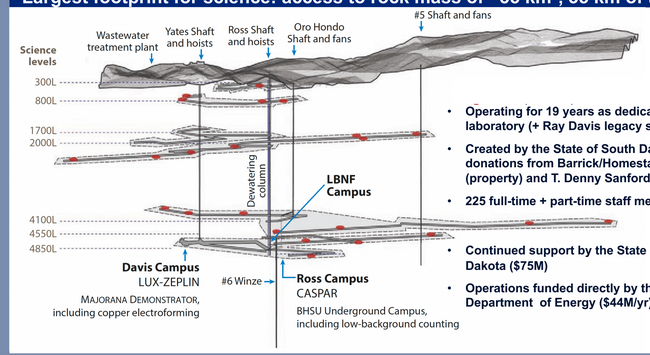
2. SURF in the Global Context

Deep site (4.5 μ/m²/day) with significant expansion potential, max depth 2450 m



3. SURF Underground Laboratory Geography

Largest footprint for science: access to rock mass of ~35 km³, 35 km of tunnels

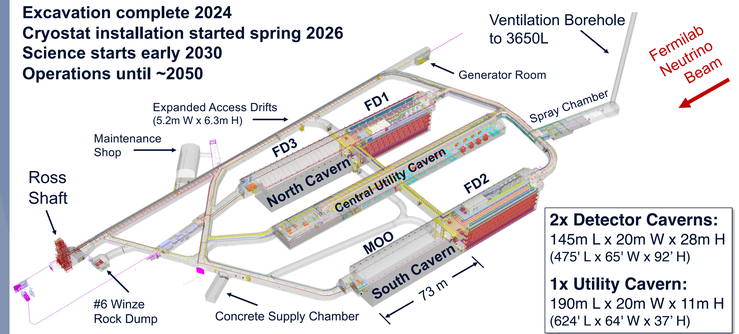


- **Operating for 19 years as dedicated science laboratory (+ Ray Davis legacy since 1960s)**
- **Created by the State of South Dakota with donations from Barrick/Homestake (property) and T. Denny Sanford ($70M)**
- **225 full-time + part-time staff members**
- **Continued support by the State of South Dakota ($75M)**
- **Operations funded directly by the U.S. Department of Energy ($44M/yr)**

5. Long-Baseline Neutrino Facility (LBNF)

LBNF will host the Deep Underground Neutrino Experiment (DUNE)

Excavation complete 2024
Cryostat installation started spring 2026
Science starts early 2030
Operations until ~2050

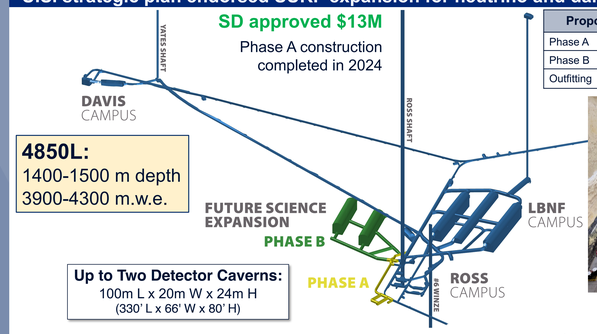


2x Detector Caverns:
145m L x 20m W x 28m H
(475' L x 65' W x 92' H)

1x Utility Cavern:
190m L x 20m W x 11m H
(624' L x 64' W x 37' H)

6. Deep Space Needed for Future Experiments

U.S. strategic plan endorsed SURF expansion for neutrino and dark matter expts

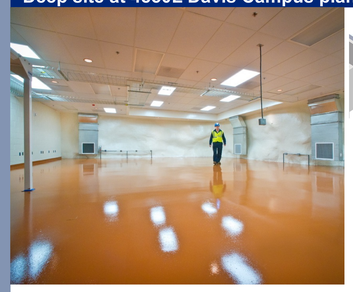


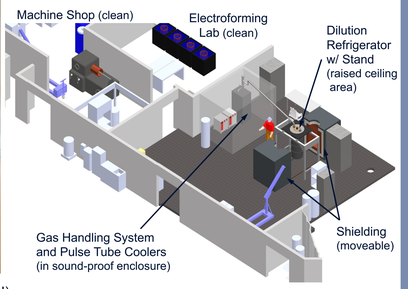
Proposed Funding Model	
Phase A	$13M State of SD ✓
Phase B	$100M Private
Outfitting	$100M Federal/Private

See also:
https://arxiv.org/abs/2603.06504

7. SURF Quantum User Facility

Deep site at 4850L Davis Campus planned to support range of quantum science

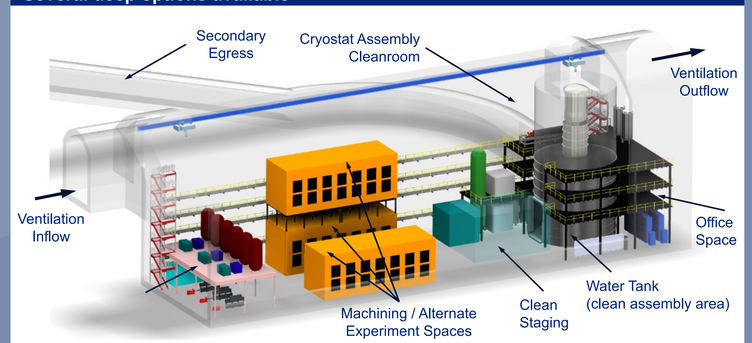




Area (total = **140 m²**): 11 m × 9.8-12.8 m × 2.7 m (H)
Area (raised section): 5.9 m × 5.8 m × 3.2 m (H)

8. Next-Generation Science at SURF

Several deep options available



9. SURF Science Strategic Plan

Long-term vision to ensure SURF continues to serve scientific community

Goals

- **Program:** Attract world-leading scientists and experiments
- **Facilities:** Ensure SURF facilities support science program
- **Support:** Ensure organizational capabilities serve experiments
- **Engagement:** Establish strong SURF role in global UG science community

Physics (closely aligned with top U.S. national priorities)

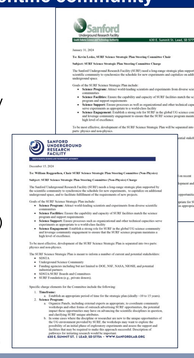
- DUNE support (Phase 1 and Phase 2)
- Generation 3 Dark Matter (XLZD and/or ARGO)
- 'Agile' Experiments / Low-Mass Dark Matter
- General R&D facility

} Quantum User Facility w/ dilution refrigerator

- Generation 2 Dark Matter upgrade (extend LZ ops + low-mass dark matter)

Non-Physics (based on community expert input)

- SURF is critical hub for innovation and discovery:
  - Geology and geomechanics (geothermal, real-time sensing)
  - Biology and microbial systems (extremophiles, incl CO_2 sequestration)
  - Industrial and academic partnerships (e.g., CAT, NSF REU programs)
- Opportunities to streamline operational elements and engage communities



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