Snowmass 2021 Letter of Interest

The Sanford Underground Research Facility

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1. Introduction

Building on rich legacies in both mining and transformational physics research, the Sanford Underground Research Facility (SURF) is the deepest underground facility in the United States, developed to advance compelling research in a variety of disciplines, including physics, biology, geology and engineering [1].

With strong support from the scientific community as well as federal, state and private funding, SURF has been operating as a dedicated research facility for over 13 years. Funding for SURF operations and capital infrastructure projects is provided by the U.S. Department of Energy's Office of Science through a Cooperative Agreement.

SURF has a robust organization with resources to ensure safe and successful science, including personnel who directly support science as well as personnel who provide important services such as a full-time occupational health nurse, a 24-hour emergency response team and support in areas such as safety, engineering and operations. The SURF science program currently includes 28 experiments (14 projects active on regular basis) with members from 82 institutions in 9 countries. There are approximately 310 active SURF users. SURF is launching a User Association in 2020 and has a goal to become a DOE User facility within the next 3 years.

2. Facilities

SURF property comprises approximately 1 km^2 on the surface, and more than 31 km^2 underground. In total, the facility consists of more than 600 km of tunnels extending to over 2450 meters below ground. Two main shafts provide redundancy in terms of safe access and some services such as power and network. Of the 29 underground elevations that are currently accessible, the following have been identified as key levels for science activities: 300L, 800L, 1700L, 2000L, 4100L, 4550L, 4850L. Enhanced services are available on the 4850L (1500 m, 4300 m.w.e.) to support significant research needs and laboratory facilities.

On the surface, the Surface Laboratory provides approximately 210 m^2 of lab space (265 m^2 total) in the top-most level of a four-story building. The Surface Laboratory facility includes a cleanroom that was installed in 2009 (37 m^2) as well as new systems installed in 2017 to support LUX-ZEPLIN (LZ) detector assembly activities, including a new metal, low-radon cleanroom (55 m^2) served by a radon-reduction system fabricated by Ateko capable of providing air-flow at a rate of approximately 300 m^3/hr; the system can deliver a radon reduction of ~770x.

Near the Yates shaft on the 4850L, a state-of-the-art laboratory complex called the Davis Campus has been operating since 2012. It includes the cavern originally developed for Ray Davis in the mid-1960s and has a total footprint consisting of 3020 m^2, including clean laboratory spaces that are typically maintained around Class 3000 or lower. A custom vacuum-swing adsorption radon reduction system is available to serve the Davis Campus – the system is capable of providing a maximum air-flow rate of 150 m^3/hr and is able to deliver a maximum reduction of ~400x to the Davis Cavern water tank. Space at the Davis Campus may be available starting 2022, with additional space available by ~2026.

The 4850L Ross Campus encompasses a set of four existing excavations that were used to support previous mining activities, with a total footprint comprising 2650 m^2, including air handling to support clean laboratory spaces. Science laboratories have operated since 2011, and more recently space usage has been evolving especially as excavation for the Long-Baseline Neutrino Facility (LBNF) is beginning nearby. Regular access for experiment groups is expected to resume once LBNF excavation is completed in 2024 (or possibly sooner).

Construction started January 2019 for the DOE LBNF campus that will host the international Deep Underground Neutrino Experiment (DUNE) experiment [2] on the 4850L. LBNF space, including any opportunities for complementary experiments, will be coordinated and managed by the LBNF/DUNE project. (See LBNF/DUNE LOI(s) in NF10 and IF8.)

SURF is exploring opportunities to accommodate new experiments that can exploit SURF's unique potential, and there is significant opportunity for expansion to meet the needs of a wide range of research disciplines into the future. In particular, SURF's 2020 strategic plan includes a bold vision for adding significant space over the next 15 years:

- Broader access to depths below the 5000L (1560 m) for all science disciplines;
- Two additional lab modules on the 4850L (1500 m, 4300 m.w.e.);
- Two lab modules on the 7400L (2260 m, 6500 m.w.e.).

Preliminary design plans have been developed for expansion of the 4850L and 7400L lab space.

3. Science Community Support

In addition to significant support from facility staff, SURF experiments currently offer a number of services to the science community:

- Ultra-pure electroformed Cu production continues (avg U, Th decay chain ≤ 0.1 μBq/kg) as well as some machining using tools dedicated to processing ultra-pure materials [3];
- Material assays using six germanium-based counters, with sensitivities of ~0.01 mBq/kg [4]. Local universities have some additional material screening capabilities: ICP-MS (Black Hills State University) and radon emanation characterization (SD Mines).

4. Summary

SURF is a deep underground research facility dedicated to scientific uses. Space in existing laboratories is expected to be available starting 2022. Plans for additional space are in development to advance research in multiple disciplines. Applications from new experiments are welcome!

References

[1] J. Heise, `arXiv:1710.11584 [physics.ins-det]` (2017), to be published in in the proceedings of the XV International Conference on Topics in Astroparticle and Underground Physics.

[2] B. Abi *et al.* (The Deep Underground Neutrino Experiment collaboration), *JINST* **15** T08009 (2020); `arXiv:2002.02967 [physics.ins-det]`.

[3] N. Abgrall *et al*. (The MAJORANA collaboration), *Nucl. Instrum. Meth. A* **828**, 22–36 (2016); `arXiv:1601.03779 [physics.ins-det]`.

[4] D.S. Akerib *et al.* (The LUX-ZEPLIN collaboration), arXiv:2006.02506 [physics.ins-det] (2020).