



**SANFORD
UNDERGROUND
RESEARCH
FACILITY**

Quantum Initiatives at the Sanford Underground Research Facility

Jaret Heise, Science Director

jaret@sanfordlab.org

Quantum Partnership Workshop

July 16, 2024

South Dakota Support for Quantum Initiatives

Notable state investment attracting interest, also federal congressional support

24.585.12 99th Legislative Session 45



2024 South Dakota Legislature

Senate Bill 45

ENROLLED

AN ACT

ENTITLED An Act to make an appropriation for the establishment of a Center for Quantum Information Science and Technology and to declare an emergency.

BE IT ENACTED BY THE LEGISLATURE OF THE STATE OF SOUTH DAKOTA:

Section 1. There is hereby appropriated from the general fund the sum of **\$3,034,444** to the Board of Regents, for the purpose of establishing a Center for Quantum Information Science and Technology.

Information Science and Technology



Governor Kristi Noem signed SB 45, which funds the establishment of a Center for Quantum Information Science and Technology.

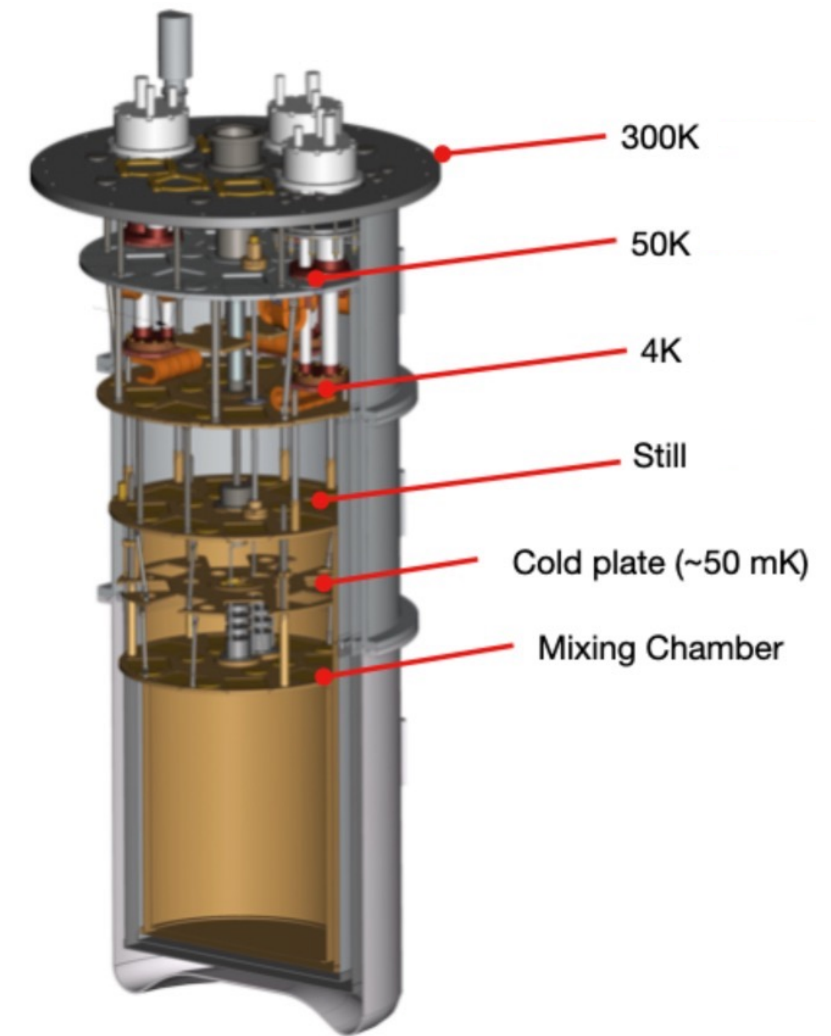
The screenshot shows the Indico event page for the Quantum Partnership Workshop at SURF. The event is scheduled for July 16, 2024, at the Sanford Lab Homestake Visitor Center. The page includes a search bar, a navigation menu with options like Overview, Timetable, Registration, Travel Information, and Tourism and Additional Information, and a contact for Stacie Granum. The main content area provides an overview of the workshop, its location, and a list of topics to be discussed, including Institutional Overviews, Quantum Initiatives, Quantum Curriculum, and a Brainstorming Forum on Partnerships and Next Steps. It also mentions a surface tour of the Yates Hoistroom at SURF and an evening networking event on Monday, July 15.

Jul 16, 2024:
Quantum Partnerships Workshop
<https://indico.sanfordlab.org/event/80>

SURF Cryogenic User Facility

Proposal inline with becoming DOE scientific user facility

- **Multi-user, low-background, ultra-low temperature test facility for cryogenic detectors:**
 - Applications in **fundamental nuclear and particle physics research** (neutrinos and dark matter)
 - Detectors with extremely low energy thresholds and excellent energy resolution require **isolation from ionizing radiation** at deep facility like SURF to be effective
 - Detectors often rely on quantum thermal sensors with operating **temperatures in milli-Kelvin range** requiring dilution refrigerator
- **Cryogenic User Facility at SURF:**
 - **No deep underground cryogenic test facility in U.S.** (recent shallow sites addressing general shortage of underground cryogenic test infrastructure in U.S. – PNNL & FNAL)
 - **Significant interest from U.S.-based groups:** Low-mass dark matter (TESSERACT, SPLENDOR), neutrinoless double-beta decay (CUPID), quantum information systems (MIT, UIUC); collaborating with Virginia Tech
 - Underground cleanroom, cooling infrastructure available; clean shielding Pb and surface lab space possible.



Proposing Bluefors XLD1000SL dilution refrigerator to accommodate large payload (detectors/shielding)

Quantum Opportunities

- **Opportunities at SURF:**

- Premium deep underground space becoming available (see call for LOIs)
- Very interested in fostering QIS partnerships (commercial, academic). Current partnerships with multi-national companies, have worked with semi-conductor companies like Xilinx now AMD

- **Other Facilities:**

- A lot of interest in this domain: SURF 1 of 10 facilities represented at workshop
- New dedicated qubit facilities at FNAL (shallow and surface)
- PNNL also has dedicated qubit facilities (shallow and surface); also assay labs
- Many facilities have fridges already

May 30-31, 2024:

Radiation Impacts on Superconducting Qubits

<https://indico.fnal.gov/event/63132/>

The image displays two side-by-side screenshots of the Indico event page for "Radiation Impact on Superconducting Qubits (RISQ 2024)". Both screenshots show the event details, including the dates (May 29 - 31, 2024) and location (Wilson Hall, America/Chicago timezone). The left screenshot shows the "Day 1" timetable, and the right screenshot shows the "Day 2" timetable. The timetables list various sessions, including registration, plenary overview, coffee breaks, and technical presentations. The right screenshot highlights "Lab Tours" for Day 2.

SURF Plans to Become DOE User Facility

Benefits:

- Expands DOE User Facility portfolio to incl underground lab, raises SURF's stature within DOE community.
- Promotes underground science in U.S., increases funding opportunities.
- Enhances SURF's role in global science community.
- Communicates SURF is open to a broad range of science and users and that we have a standard process, accepted by DOE, for hosting science.

Main Requirements:

- Facility open to users regardless of nationality or institution.
- Allocation of facility resources determined by merit review.
- Facility resources for users to conduct work safely and efficiently.
- The facility supports a formal user organization.

Status:

- User Association and Science Program Advisory Cttee established.
- Application draft near final, expect DOE invitation to submit soon.

The screenshot shows the DOE Office of Science User Facilities website. The page features a blue header with navigation links: Home, About, Laboratories, Science Features, Universities, User Facilities, Funding, and Initiatives. Below the header is a search bar and a list of programs. The main content area is titled "User Facilities" and includes a paragraph describing the facilities: "The Office of Science national scientific user facilities provide researchers with the most advanced tools of modern science, including accelerators, colliders, supercomputers, light sources and neutron sources, as well as facilities for studying the nano world, the environment, and the atmosphere." Below this text is a grid of six facility cards, each with a "Read more" button: ASCR User Facilities, BES User Facilities, BER User Facilities, FES User Facilities, HEP User Facilities, and NP User Facilities. A sidebar on the left contains links for "User Facilities at a Glance", "User Resources", "User Statistics", "Policies and Processes", "Frequently Asked Questions", and "User Facility Science Highlights".



Sanford Underground Research Facility

Thank You!



Agency Acknowledgement:
The Sanford Underground Research Facility (SURF) is a federally sponsored research facility under DOE-SC HEP Award Number DE-SC0020216 (cooperative agreement)



SURF Call for Letters of Interest

Ensuring SURF used to its fullest scientific potential

Significance of 2024 LOI Call:

- SURF's first formal call to UG science community since 2005!
- Initial calls selected strong physics anchors for Davis Campus: MJD and LUX (which led to current LZ)
- 2024 call is opportunity for SURF to advance scientific strategic plan goals, ensure strong science program continues

Overview of 2024 LOI Call:

- Open to all disciplines: Physics, Geology, Biology, Engineering
- Identifies specific existing space on 4850L and 4100L, other undeveloped areas may be available now
- 4850L Expansion started Mar 17, 2024, space available ~2030 (nominally two detector caverns: 100 m L x 20 m W x 24 m H, LOIs and subsequent discussions will inform final design)
- LOIs reviewed by SURF Science Program Advisory Committee
- Nominal deadline May 17, 2024, **LOIs still being accepted (if interested, please reach out: loi@sanfordlab.org)**



South Dakota Science and Technology Authority 630 E. Summit St. Lead, SD 57754

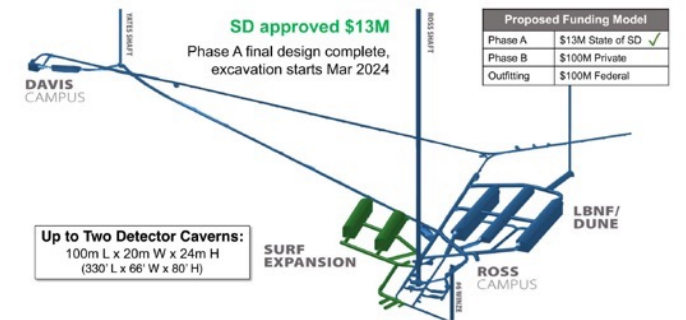
March 22, 2024

SURF Request for Letters of Interest 2024-01

Dear Researcher,

In support of our mission to advance world-class science, the Sanford Underground Research Facility (SURF) is seeking input from the global underground science community to ensure that scientific priorities are being accommodated and that SURF is being used to its fullest scientific potential.

SURF has a strong science program that currently comprises 29 experiment groups. Programs in some of our key 4850L laboratories are expected to complete in the next 1-4 years, which presents an opportunity to survey the community for new prospects. SURF is tremendously excited about new large laboratories that are being developed on the 4850L, with initial construction underway and space available on the timeframe of ~2030.



Leading into recent U.S. long-range planning, the SURF User Association held a Vision Workshop (<https://indico.sanfordlab.org/e/Vision2021>) and SURF participated in nuclear physics town halls and the particle physics Snowmass community input processes. As a result, SURF featured prominently in the strategic plans for both Nuclear ([ref](#)) and High Energy Physics ([ref](#)) communities. With the physics community long-range plans in-hand, SURF has set up a Steering Committee to distill opportunities and key elements relevant to the organization's science strategic plan (non-physics disciplines will also be addressed to inform the comprehensive strategic plan, but at a later date).

To help inform this process, we are inviting collaborations and scientists to submit short letters of interest (LOIs); maximum 3 pages. The information requested in the LOIs includes science goals, collaboration composition, facility requirements, access requirements, and timelines. Submitters are also invited to complete a SURF Experiment Planning Statement (EPS), supplemental to the LOI, that provides some additional experiment details as well as offering some SURF facility details: <https://sanfordlab.org/researchers/proposal-guidelines>.

