SANFORD UNDERGROUND RESEARCH FACILITY

# SURF Overview

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Theia Site Visit
December 1, 2025

# Sanford Underground Research Facility

## SURF Mission:

**We advance world-class science and inspire learning across generations.**

## SURF Vision:

**The world's preferred location for underground science and education.**

**SURF serves the entire underground science community**

SURF welcomes and encourages research from all disciplines that are able to take advantage of the unique attributes of our laboratory

# SURF in the Global Context

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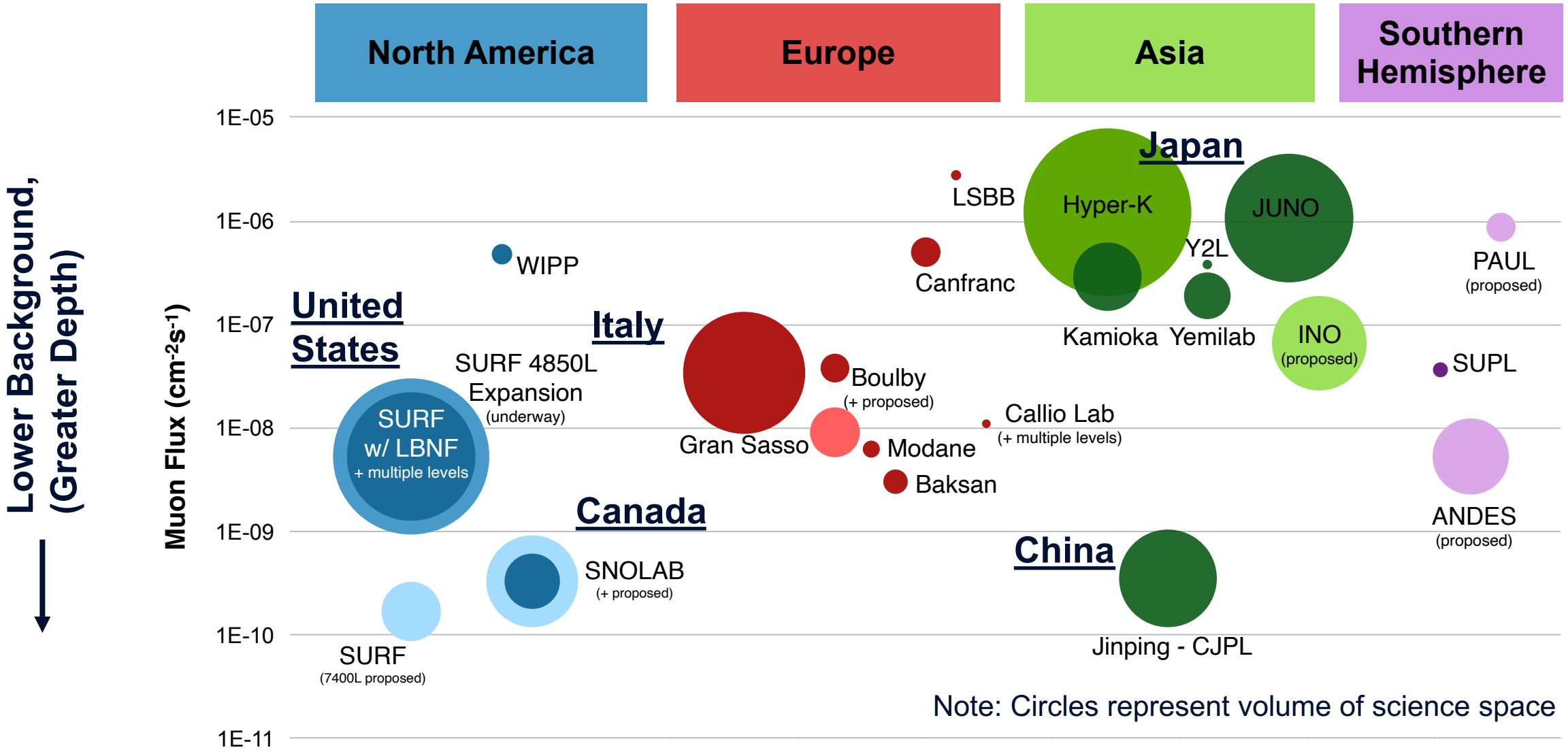
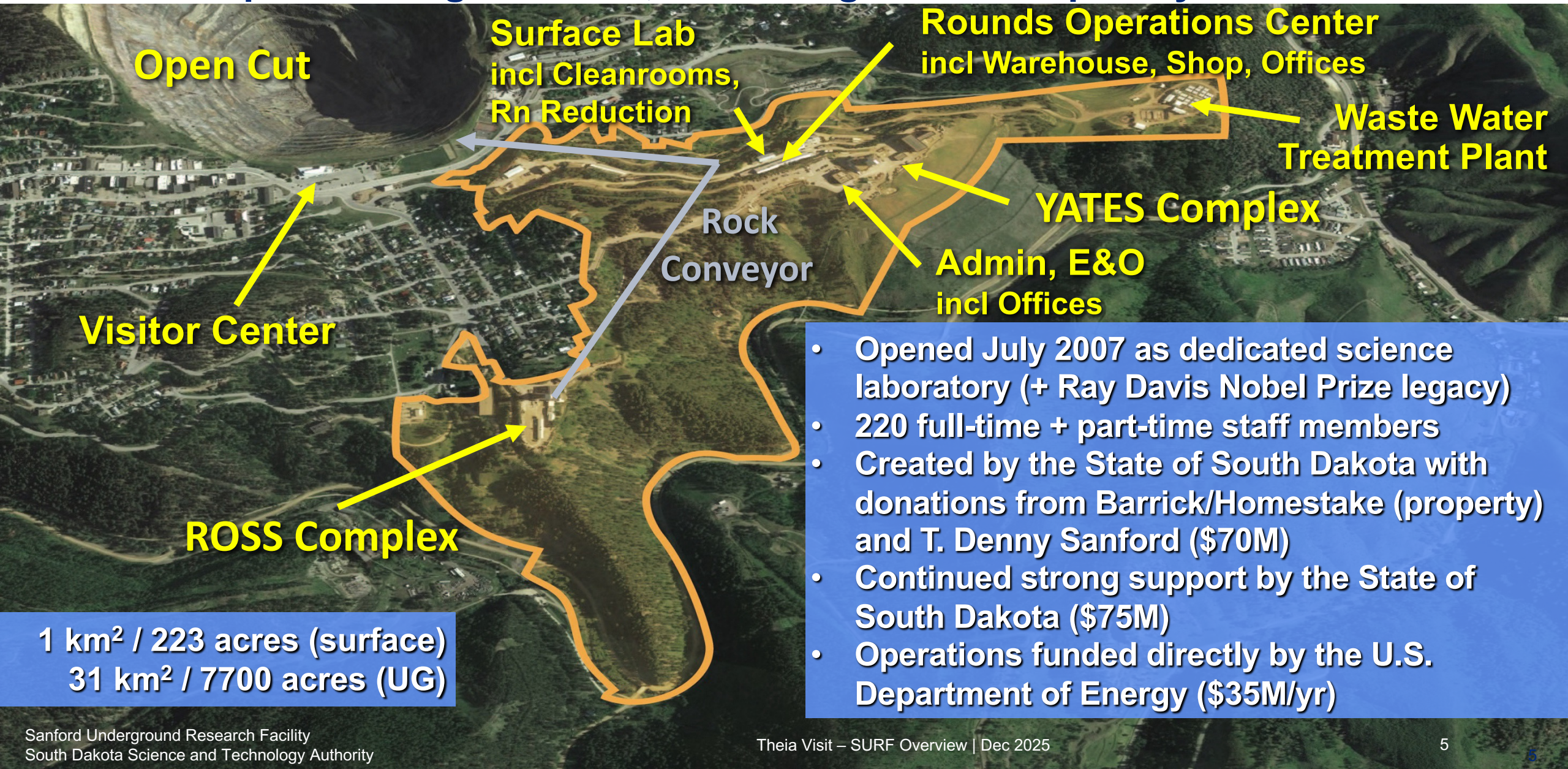


# Sanford Underground Research Facility

## Nation's deepest underground lab, advancing multi-disciplinary research

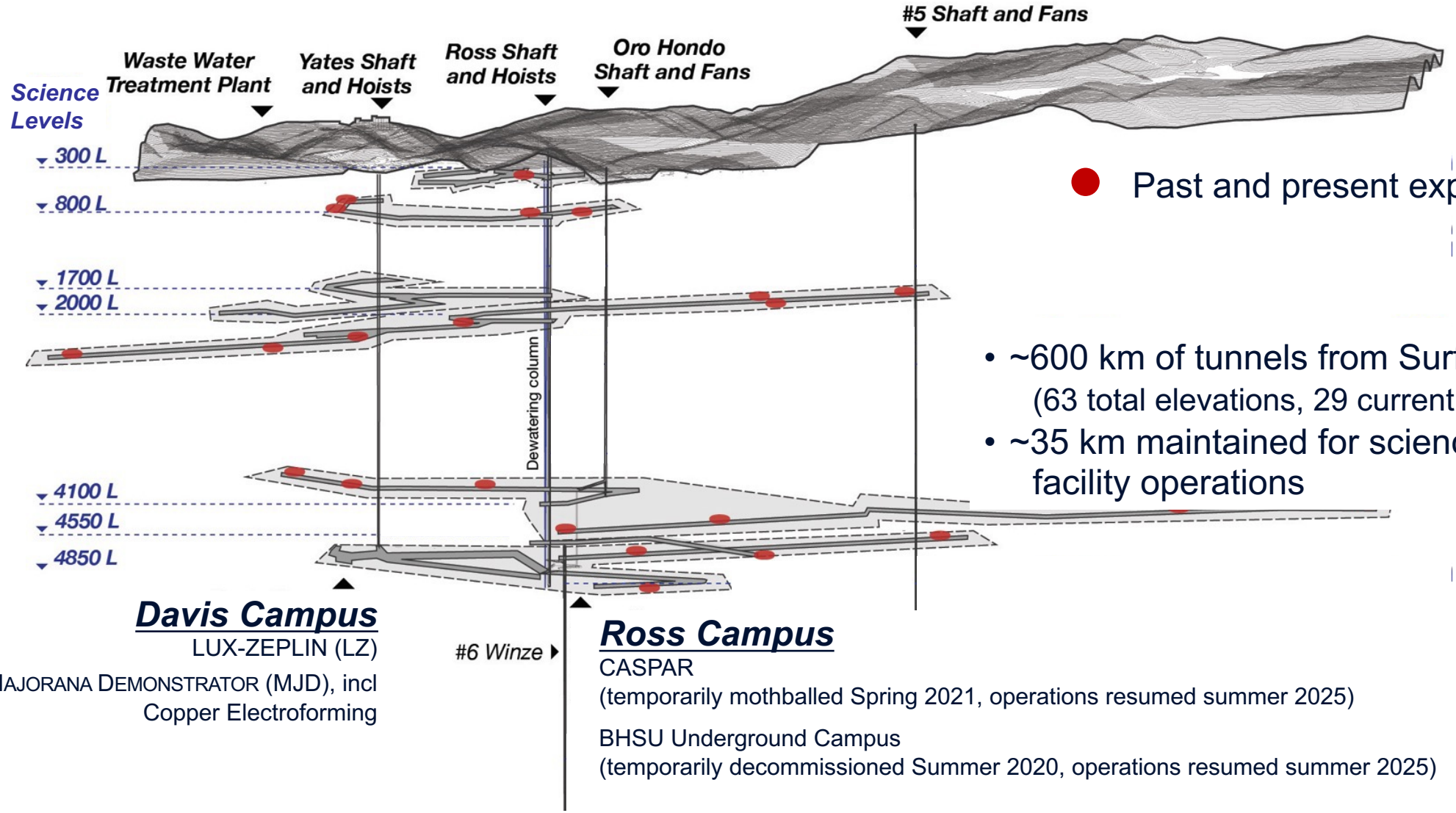



- Opened July 2007 as dedicated science laboratory (+ Ray Davis Nobel Prize legacy)
- 220 full-time + part-time staff members
- Created by the State of South Dakota with donations from Barrick/Homestake (property) and T. Denny Sanford ($70M)
- Continued strong support by the State of South Dakota ($75M)
- Operations funded directly by the U.S. Department of Energy ($35M/yr)

1 km$^2$ / 223 acres (surface)
31 km$^2$ / 7700 acres (UG)

# SURF Underground Lab Geography

## Yates & Ross Shafts + ventilation shafts, multiple levels for science




- Past and present experiment sites

- ~600 km of tunnels from Surface to 2.4 km deep
  (63 total elevations, 29 currently accessible)
- ~35 km maintained for science and facility operations

***Davis Campus***

LUX-ZEPLIN (LZ)

MAJORANA DEMONSTRATOR (MJD), incl Copper Electroforming

***Ross Campus***

CASPAR
(temporarily mothballed Spring 2021, operations resumed summer 2025)

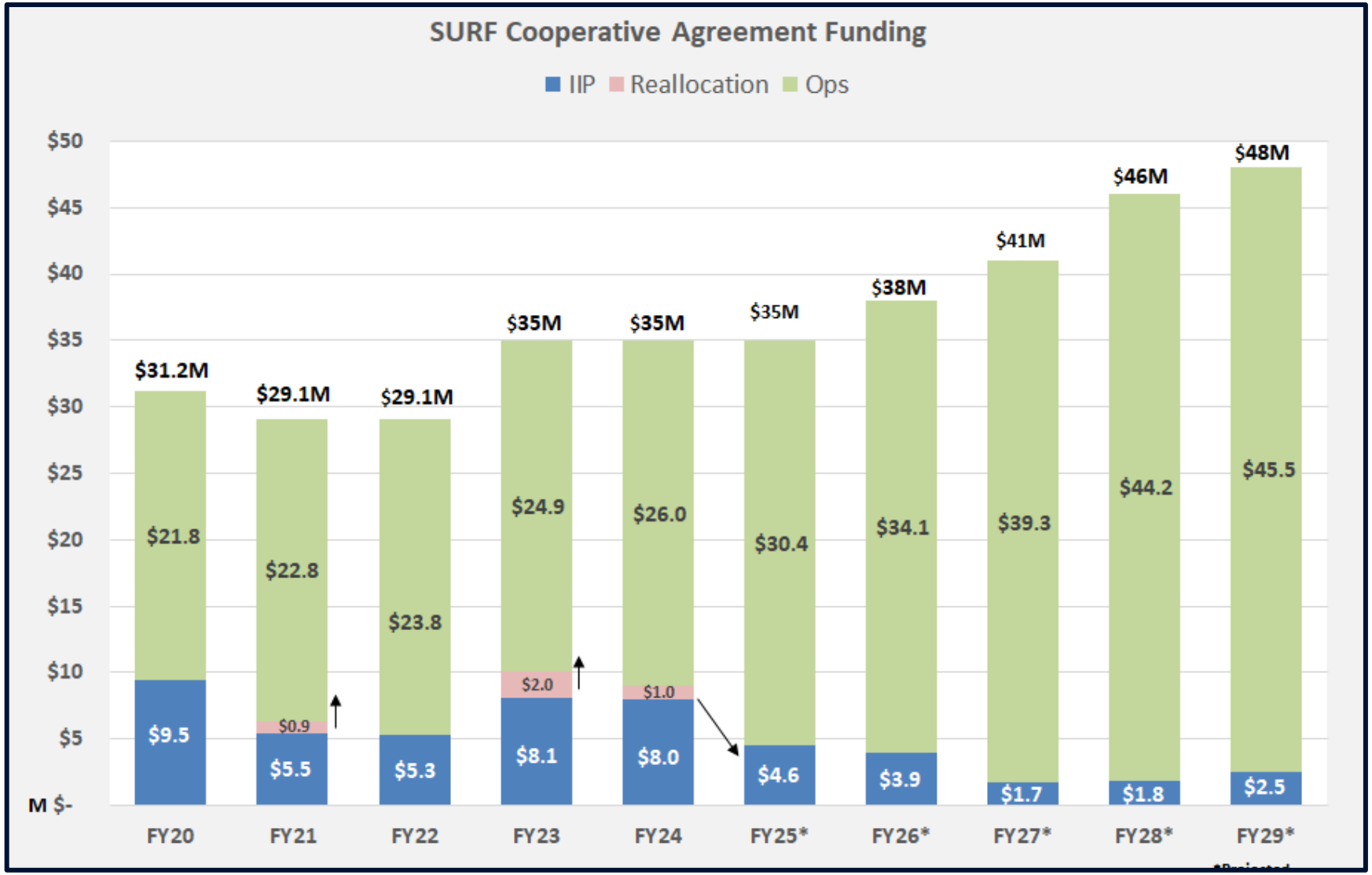
BHSU Underground Campus
(temporarily decommissioned Summer 2020, operations resumed summer 2025)

# SURF Operations Cooperative Agreement (CA)

- CA established a direct relationship between DOE and SDSTA.
- Original agreement included 5 years of SURF ops at $125M total (Federal FY20-24).
- Under the CA, the SDSTA operates and maintains SURF in support of the science mission. Provides all personnel, facilities, equipment, supplies, and services. Manages the overall effort.
- CA scope includes “Basic Support” to approved Non-Proprietary users without charge. The user will pay for costs incurred for services over and above basic support.
  - e.g.: Users needing an exceptional amount of power pay the delta.
- Costs to support Proprietary users must be fully recovered per DOE direction.
- DOE funds SURF Infrastructure Improvement Projects to ensure safe and reliable operations.
- CA “renewal” for an additional five years awarded in Sept 2024. Added $208M.

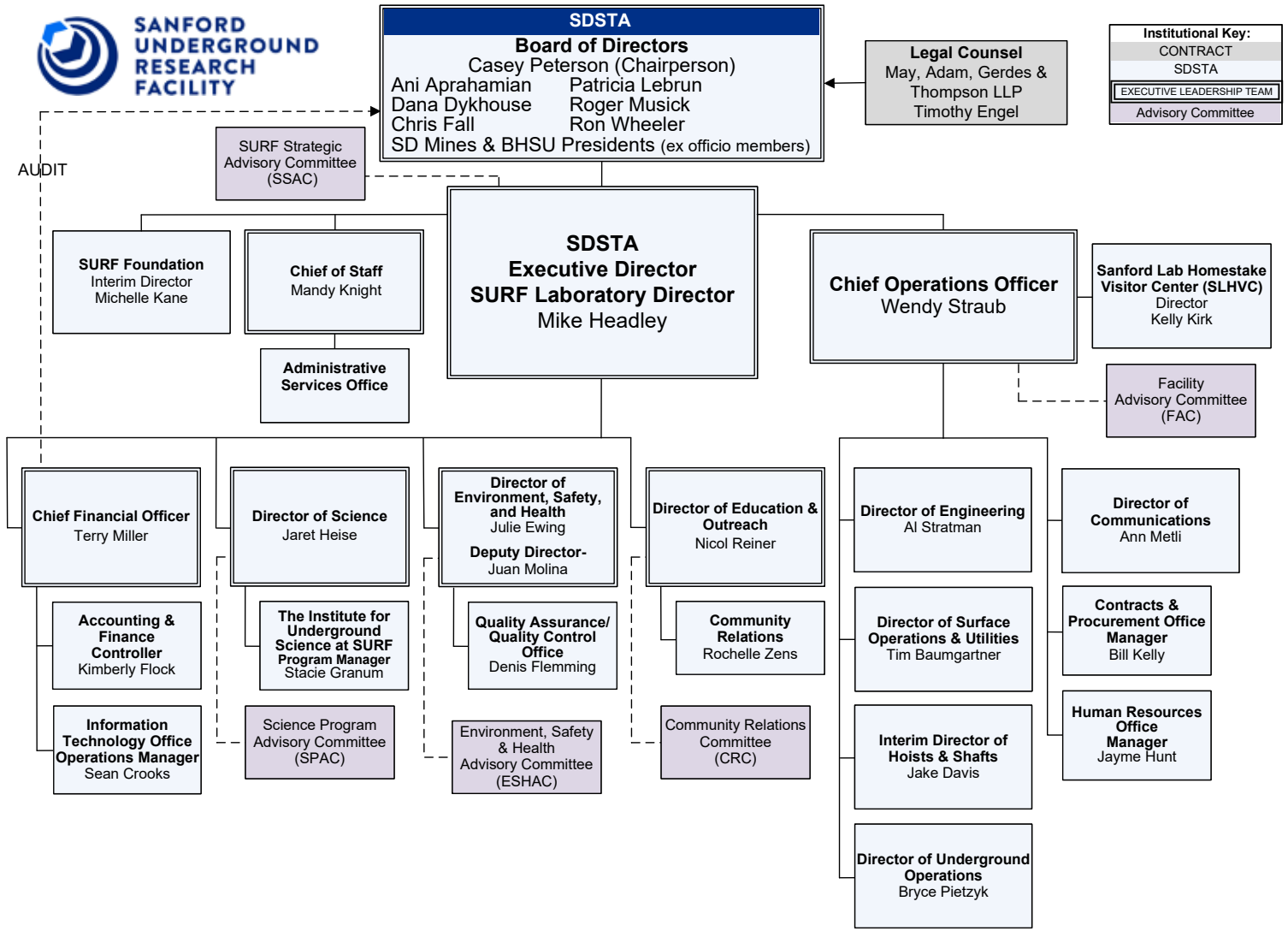
# SURF Ops CA Funding Summary with Renewal

## Additional ops funding appreciated. Working with DOE & Congress to increase IIP funding.



# SDSTA Organization

## Robust organization: 9 depts, 5 offices + Institute, Visitor Center and Foundation




| Staffing Area | Current # ppl (%) | FY29 # ppl (%) |
|---|---|---|
| **Admin / Mgmt** | 31 (15%) | 31 (13%) |
| **Engineering** | 12 (5%) | 12 (5%) |
| **ESH** | 21 (10%) | 23 (10%) |
| **Outreach** | 23 (11%) | 24 (10%) |
| **Scientific** | 5 (2%) | 6 (3%) |
| **Technical / Operations** | 128 (58%) | 142 (60%) |
| **TOTAL** | **220** | **235** |

Current Science Direct Support
= ~19 ppl

# SURF Operations

- 320 miles underground
- 223 acres above ground
- Capabilities to support complex range of infrastructure

# SURF Plans to Become DOE User Facility

## Benefits:

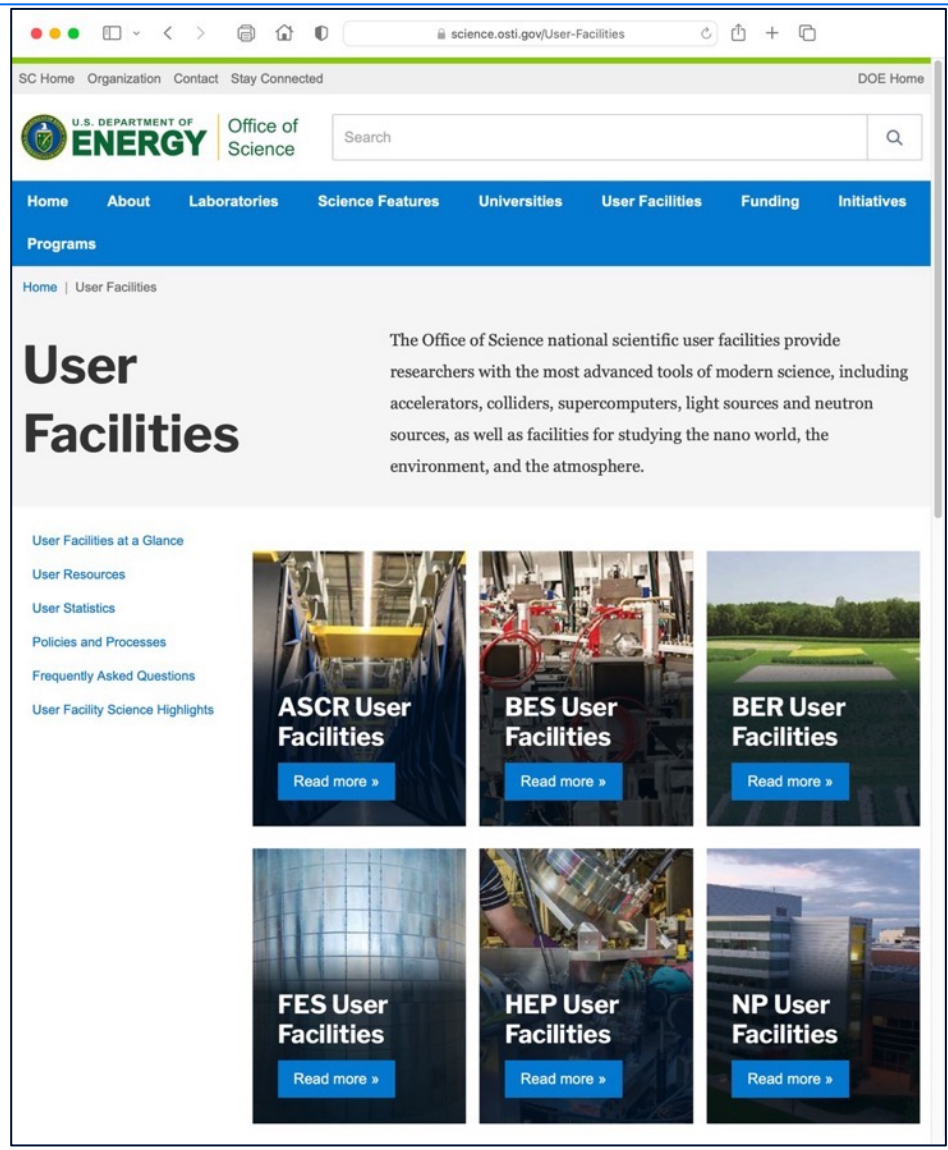
- Expands DOE User Facility portfolio to incl underground lab, raises SURF's stature within DOE community.
- Promotes underground science in U.S., increases funding opportunities.
- Enhances SURF's role in global science community.
- Communicates SURF is open to a broad range of science and users and 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:

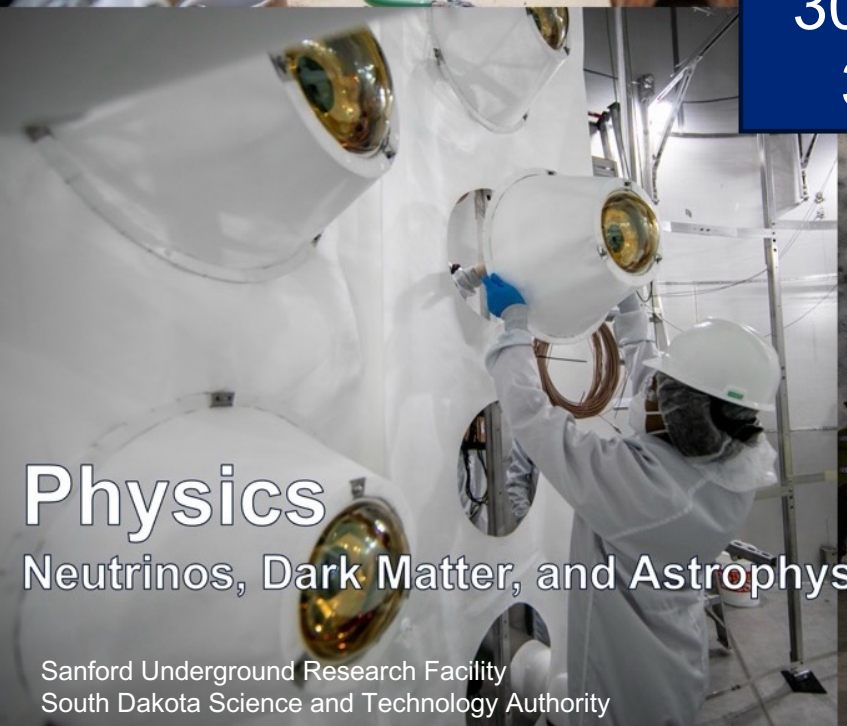
- User Association and Science Program Advisory Cttee established.
- Application draft near final, expect DOE invitation to submit soon.





# Science Program

30 Expts with 2,457 Collaborators,
319 Institutions in 55 Countries

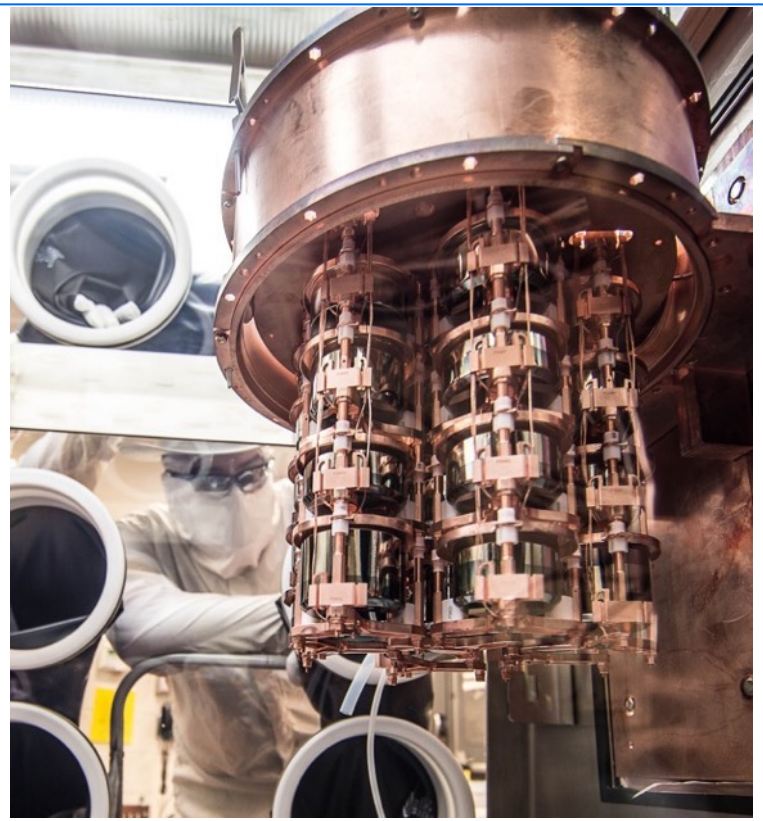



# SURF Science Program – Current Physics Highlights

## Strong and diverse program with exciting future

### LUX-ZEPLIN (LZ)

- Direct search for **dark matter** using 10 tonnes xenon
- World-leading WIMP-search results announced July 2022 + Aug 2024



### MAJORANA DEMONSTRATOR (MJD)

- Investigate **neutrinoless double-beta decay** using 44 kg Ge
- Ge-76 DBD and Ta-180 decay searches complete, decom underway

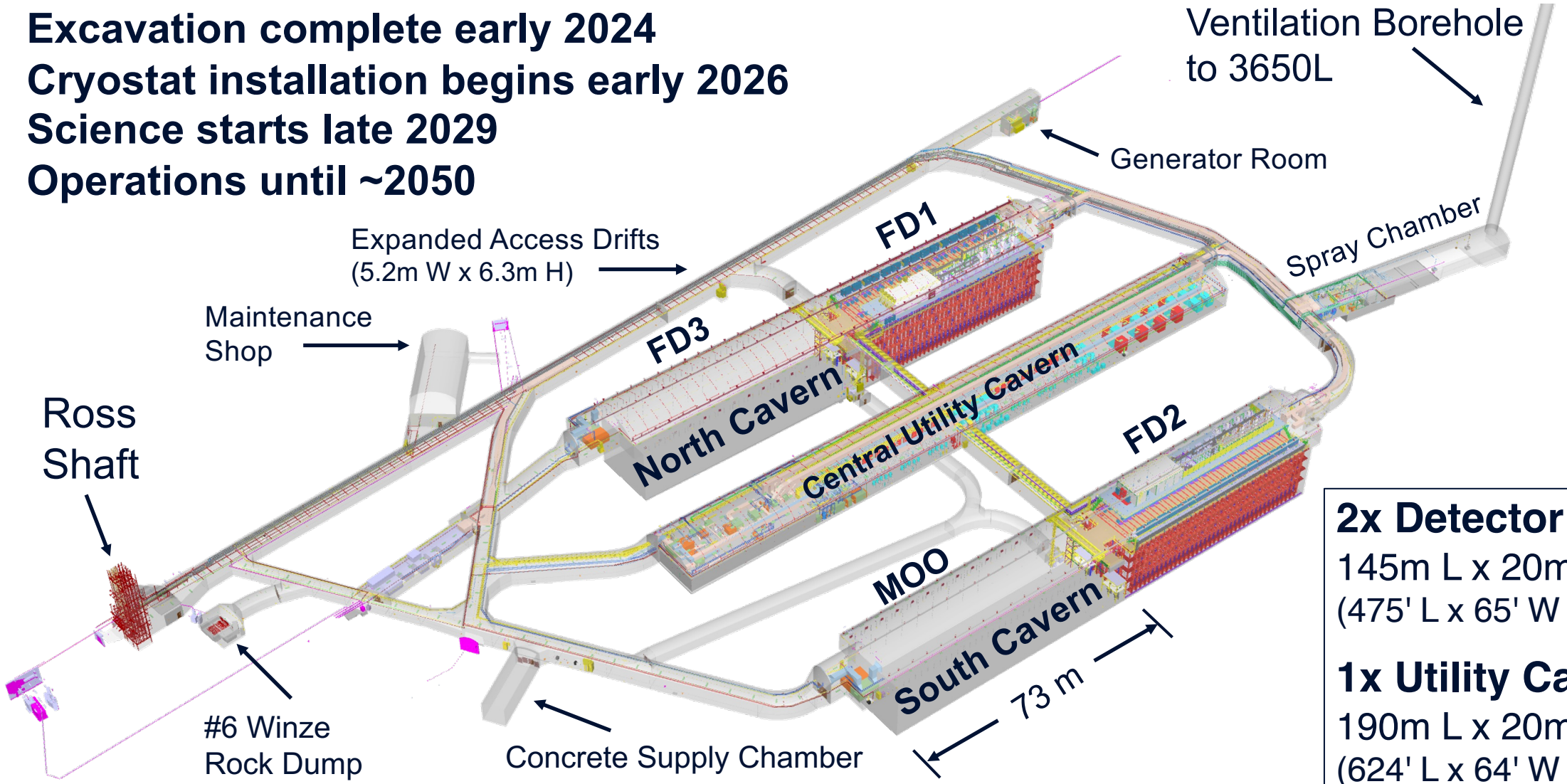
### CASPAR

- Stellar fusion reactions to study **nucleosynthesis** using accelerator
- Initial phase 2015-2021, next phase started in 2025, last for 3+ years

# Long-Baseline Neutrino Facility (LBNF)

## LBNF will host the Deep Underground Neutrino Experiment (DUNE)

**Excavation complete early 2024**
**Cryostat installation begins early 2026**
**Science starts late 2029**
**Operations until ~2050**



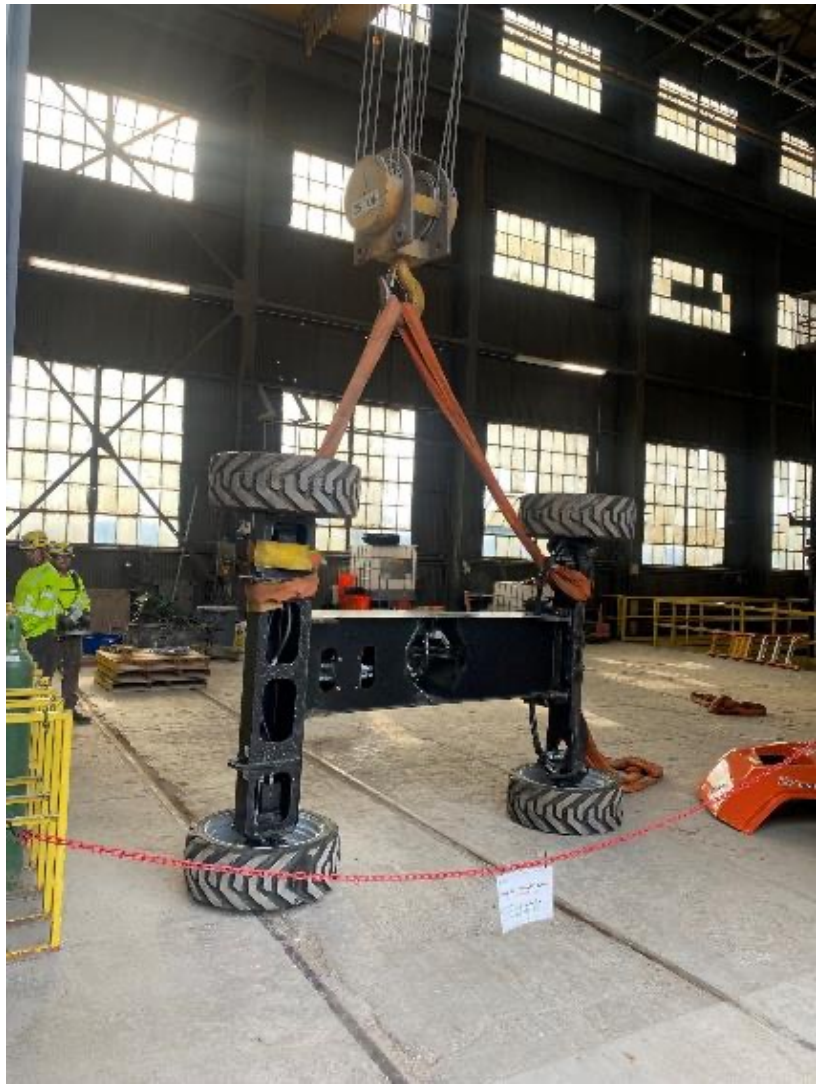

**2x Detector Caverns:**
145m L x 20m W x 28m H
(475' L x 65' W x 92' H)

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

# LBNF/DUNE Support Contracts

| FFDG/SDSTA Contracts | Scope | FTE Allocated |
|---|---|---|
| **BSI Logistical Support #1**<br>April 1, 2021 – December 31, 2026 | • Operate Ross ore and cage hoists.<br>• Installation & maintenance of hoist ropes & conveyances.<br>• Transport people and supplies in the shaft.<br>• 15% charged to the CA for hoist & shaft maintenance and inspections.<br>• FY2027 Budget – all labor moves to the CA. | • 8 Hoist Operators (85%).<br>• 4 Shaft Foreman (85%).<br>• 16 Infrastructure Technicians (85%).<br>• 1 Shaft Superintendent (85%). |
| **SDSTA Professional Staff Support**<br>2009 - present | • Mechanical Engineering Support.<br>• Electrical Engineering Support.<br>• Ventilation Engineering Support.<br>• CAD Support. | • Time allocation varies amongst Engineering disciplines. |
| **BSI Support Services**<br>March 18, 2024 – September 30, 2026 | • Trash removal.<br>• Bottled water delivery.<br>• Sanitary management. | • Existing employees – both surface and shaft personnel. |
| **BSI Logistical Support #2**<br>May 27, 2025 – May 31, 2026 | • Schedule and receive deliveries.<br>• Offload and transport supplies to the shaft.<br>• Transport supplies and materials from the shaft on the 4850L to the caverns.<br>• Maintain and operate transport equipment. | • 27 FTE included in the contract estimate.<br>• 8 additional shaft crew hired.<br>• 1 Ross Scheduler/Planner hired.<br>• 1 QA/QC/ESH rep hired.<br>• Existing FTEs keeping up with workload. |
| ***BSI Infrastructure Maintenance***<br>*October 1, 2025 – December 31, 2027* | • *Routine maintenance and repairs for:*<br>  ○ *Doors in LBNF spaces (fire doors, rollup doors, etc).*<br>  ○ *Mobile and fixed cranes in LBNF spaces.*<br>  ○ *Equipment LBNF spaces.*<br>  ○ *Industrial elevators LBNF spaces.* | • *ROM estimate provided by SDSTA.*<br>• *1 FTE (mechanic) added headcount.*<br>• *Third party contracts utilizing existing SDSTA contracts.* |
| ***FDC Logistical Support***<br>*TBD* | • *RFP posted.* | • *SDSTA not bidding currently, but willing to support through a different agreement.* |

# Ross Shaft Operations – LBNF/DUNE JLG Transport



# SURF Science Strategic Plan

## Physics elements incorporated into organization long-term vision

### 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

### Scope:

- Organize science strategic plan in two parts: Physics and Non-Physics

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

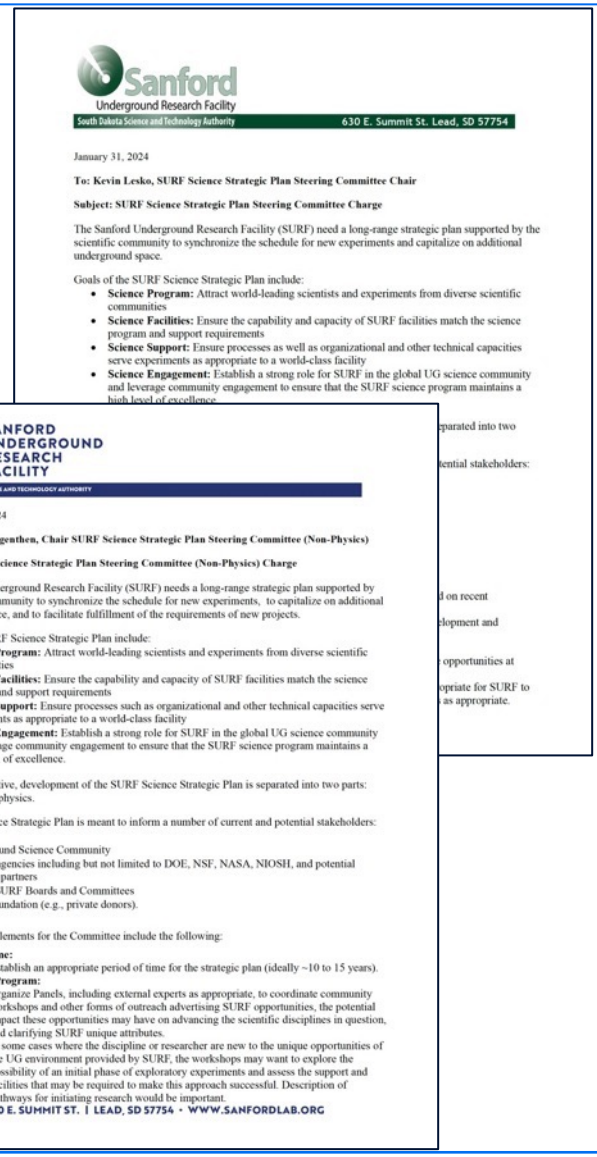
- DUNE support (Phase 1 and Phase 2)
- Generation 3 Dark Matter (XLZD and/or ARGO)
- 'Agile' Experiments / Low-Mass Dark Matter
- General R&D facility

**Cryogenic User Facility w/ dilution refrigerator**

- Generation 2 Dark Matter upgrade (LZ → HydroX, CrystaLiZe, etc)

### Non-Physics:

- Several expert panel discussions so far, aim for report in late 2025



Sanford Underground Research Facility
South Dakota Science and Technology Authority 630 E. Summit St. Lead, SD 57754

January 31, 2024

**To: Kevin Lesko, SURF Science Strategic Plan Steering Committee Chair**

**Subject: SURF Science Strategic Plan Steering Committee Charge**

The Sanford Underground Research Facility (SURF) need a long-range strategic plan supported by the scientific community to synchronize the schedule for new experiments and capitalize on additional underground space.

Goals of the SURF Science Strategic Plan include:

- **Science Program:** Attract world-leading scientists and experiments from diverse scientific communities
- **Science Facilities:** Ensure the capability and capacity of SURF facilities match the science program and support requirements
- **Science Support:** Ensure processes as well as organizational and other technical capacities serve experiments as appropriate to a world-class facility
- **Science Engagement:** Establish a strong role for SURF in the global UG science community and leverage community engagement to ensure that the SURF science program maintains a high level of excellence

SANFORD UNDERGROUND RESEARCH FACILITY
SOUTH DAKOTA SCIENCE AND TECHNOLOGY AUTHORITY

December 15, 2024

**To: William Roggenthen, Chair SURF Science Strategic Plan Steering Committee (Non-Physics)**

**Subject: SURF Science Strategic Plan Steering Committee (Non-Physics) Charge**

The Sanford Underground Research Facility (SURF) needs a long-range strategic plan supported by the scientific community to synchronize the schedule for new experiments, to capitalize on additional underground space, and to facilitate fulfillment of the requirements of new projects.

Goals of the SURF Science Strategic Plan include:

- **Science Program:** Attract world-leading scientists and experiments from diverse scientific communities
- **Science Facilities:** Ensure the capability and capacity of SURF facilities match the science program and support requirements
- **Science Support:** Ensure processes such as organizational and other technical capacities serve experiments as appropriate to a world-class facility
- **Science Engagement:** Establish a strong role for SURF in the global UG science community and leverage community engagement to ensure that the SURF science program maintains a high level of excellence.

To be most effective, development of the SURF Science Strategic Plan is separated into two parts: physics and non-physics.

The SURF Science Strategic Plan is meant to inform a number of current and potential stakeholders:

- SDSTA
- Underground Science Community
- Funding agencies including but not limited to DOE, NSF, NASA, NIOSH, and potential industrial partners
- SDSTA/SURF Boards and Committees
- SURF Foundation (e.g., private donors).

Specific charge elements for the Committee include the following:

1. **Timeframe:**
   a. Establish an appropriate period of time for the strategic plan (ideally ~10 to 15 years).
2. **Science Program:**
   a. Organize Panels, including external experts as appropriate, to coordinate community workshops and other forms of outreach advertising SURF opportunities, the potential impact these opportunities may have on advancing the scientific disciplines in question, and clarifying SURF unique attributes.
   b. In some cases where the discipline or researcher are new to the unique opportunities of the UG environment provided by SURF, the workshops may want to explore the possibility of an initial phase of exploratory experiments and assess the support and facilities that may be required to make this approach successful. Description of pathways for initiating research would be important.

630 E. SUMMIT ST. | LEAD, SD 57754 • WWW.SANFORDLAB.ORG

# 4850L Space Needed for Future Experiments

## U.S. strategic plan recognized need for more UG space, endorsed expansion

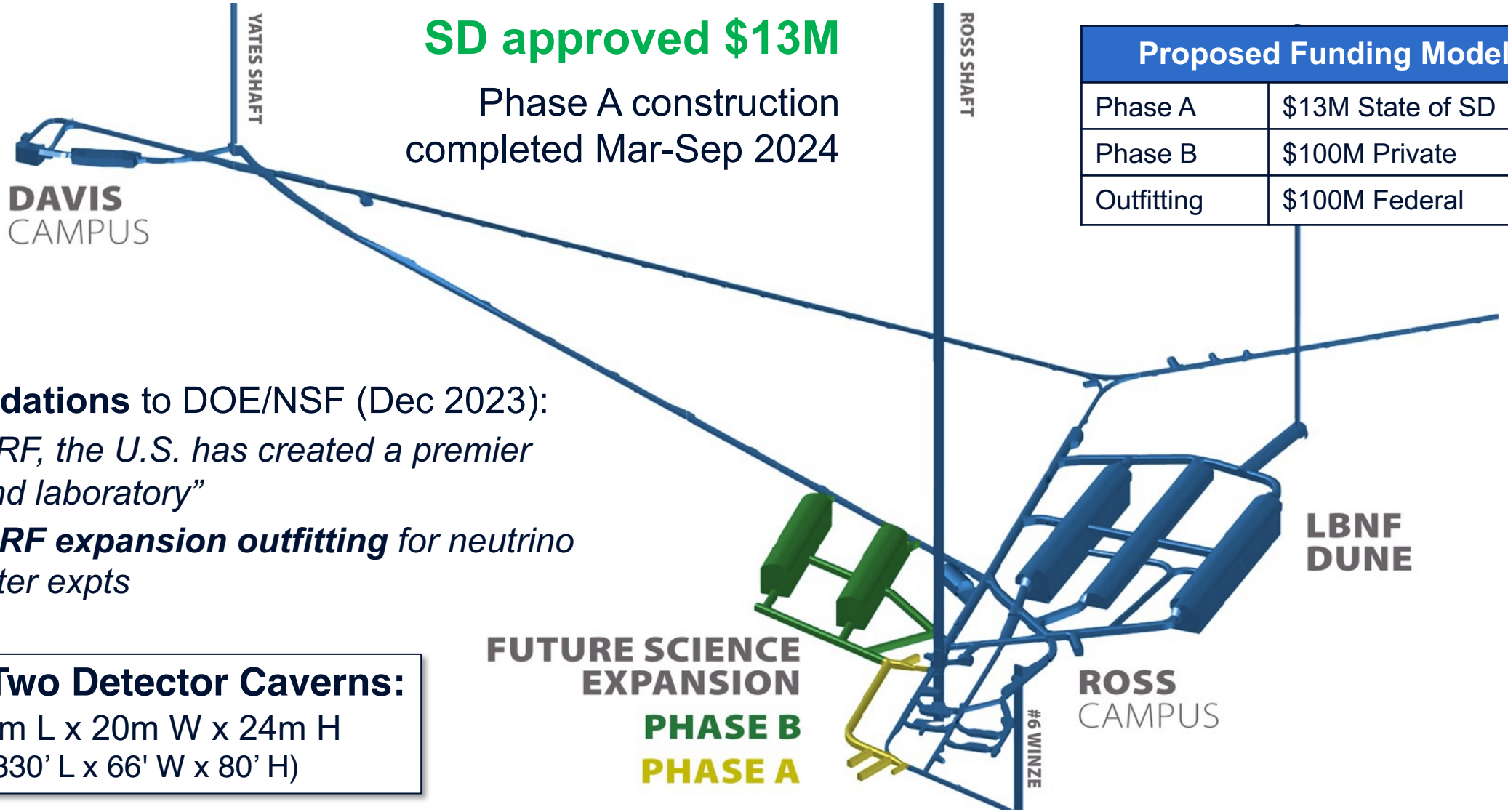
**SD approved $13M**

Phase A construction completed Mar-Sep 2024

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

**P5 recommendations** to DOE/NSF (Dec 2023):

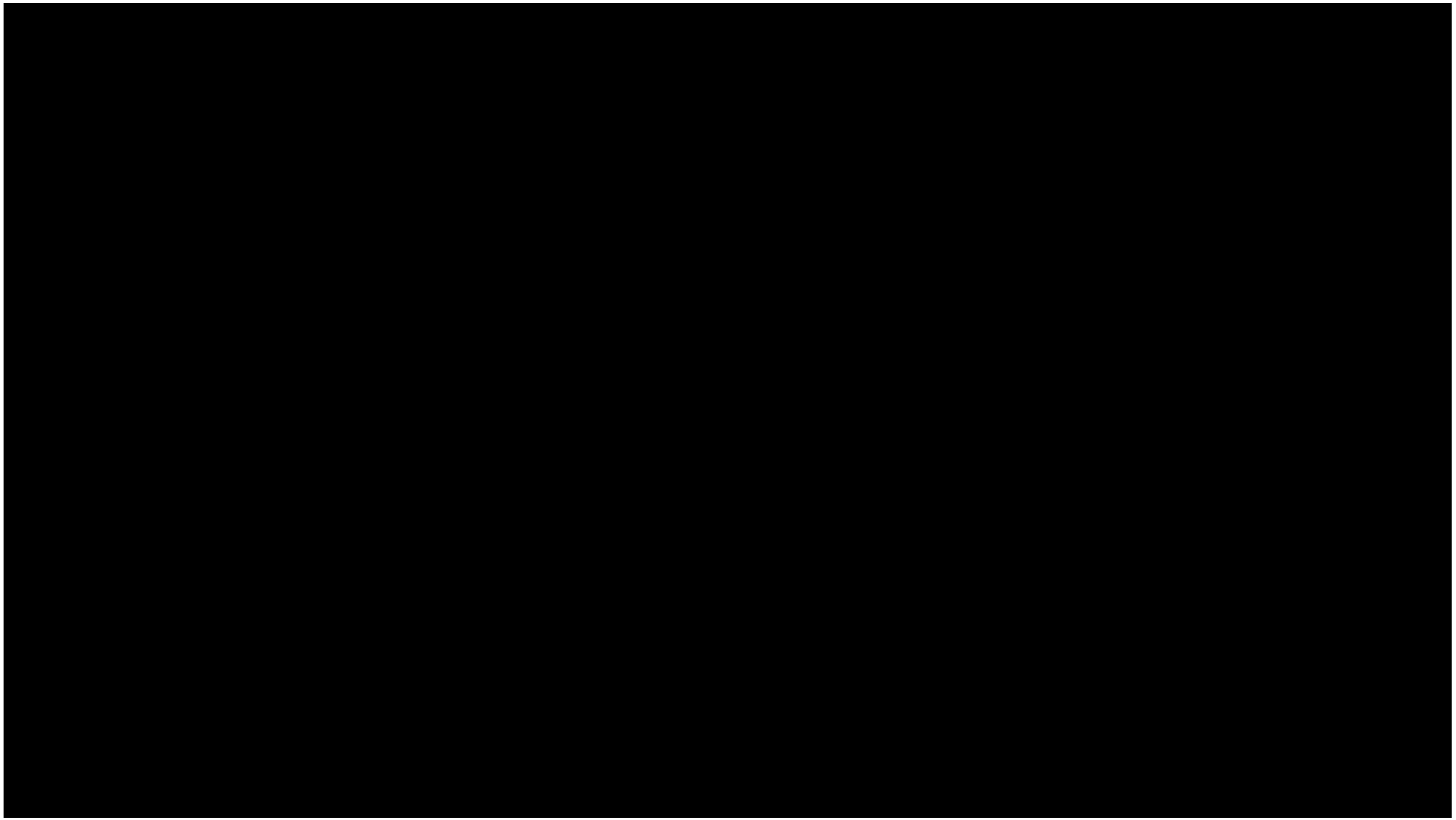
- *"With SURF, the U.S. has created a premier underground laboratory"*
- ***Fund SURF expansion outfitting*** *for neutrino & dark matter expts*




**Up to Two Detector Caverns:**
100m L x 20m W x 24m H
(330' L x 66' W x 80' H)

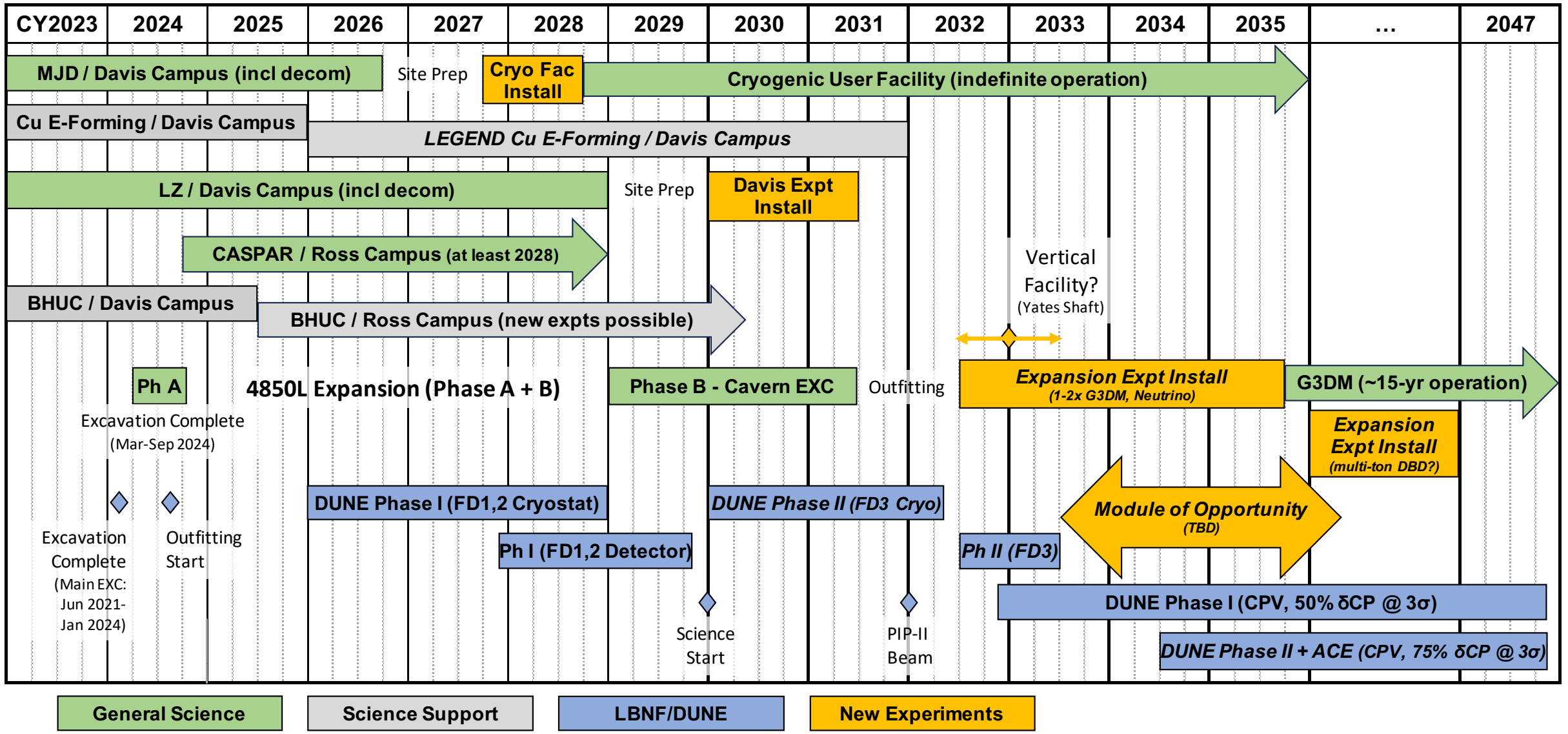
# 4850L Laboratory Expansion – Phase A

## Expansion blasting video: https://vimeo.com/982238458



# SURF Science Strategic Planning

## Timeline



# Institute for Underground Science at SURF

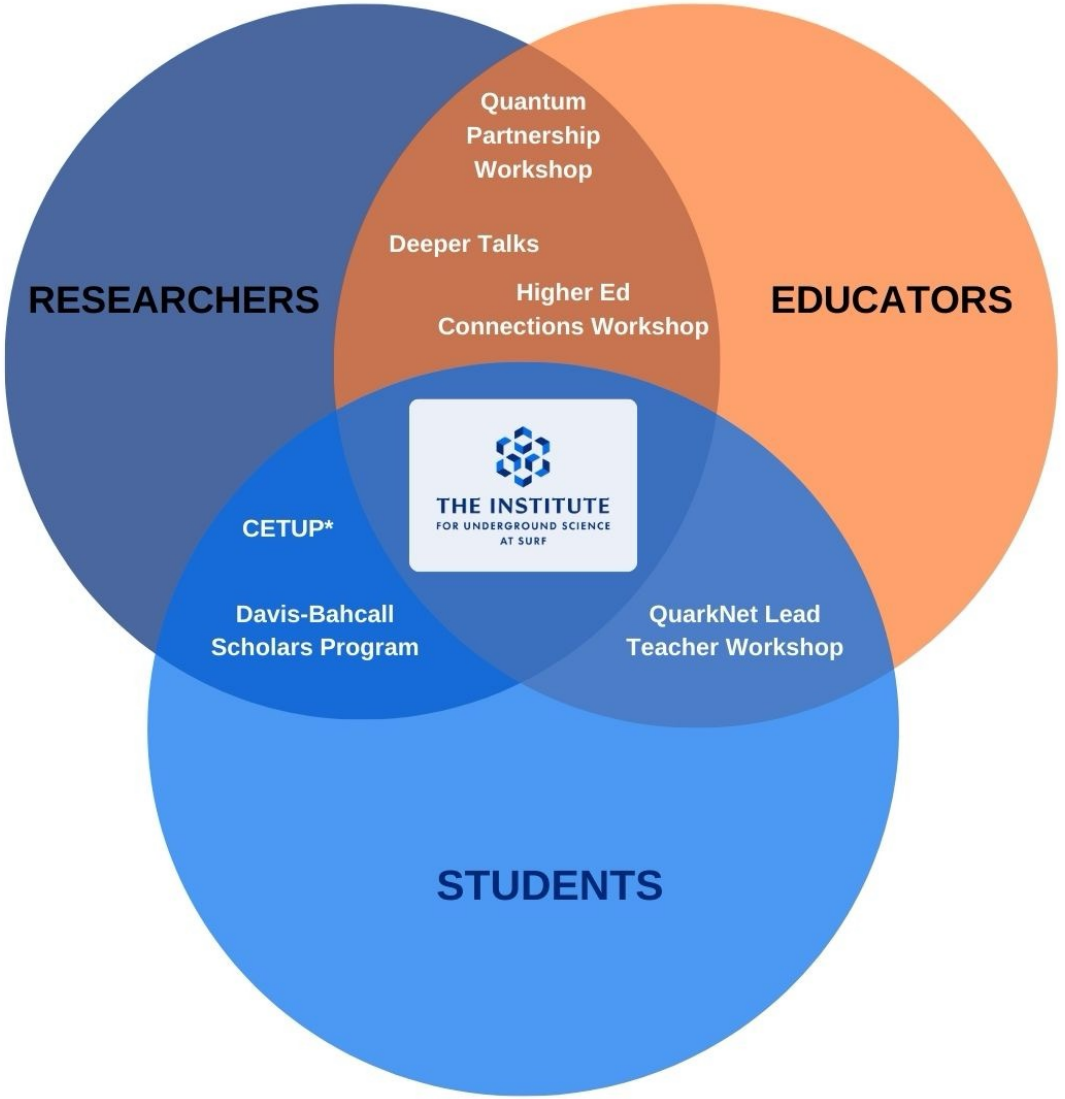
## Advancing program vision using existing resources to build constituency

### Vision

Foster a globally recognized intellectual community by scaling impactful programs, engaging researchers, educators, and students to support underground science initiatives.

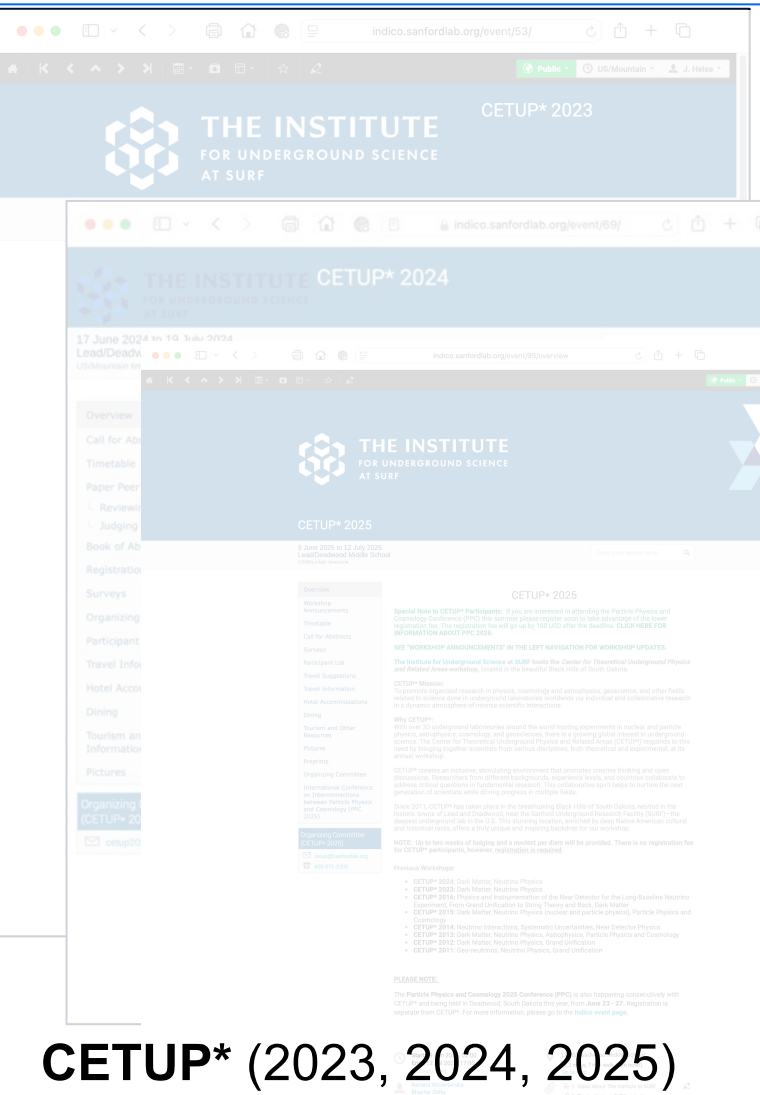
### Priorities

- Build Intellectual Community
- Expand Educational Opportunities
- Foster Interdisciplinary Collaboration
- Establish Passionate Partnerships
- Construct a Path for Future Generations



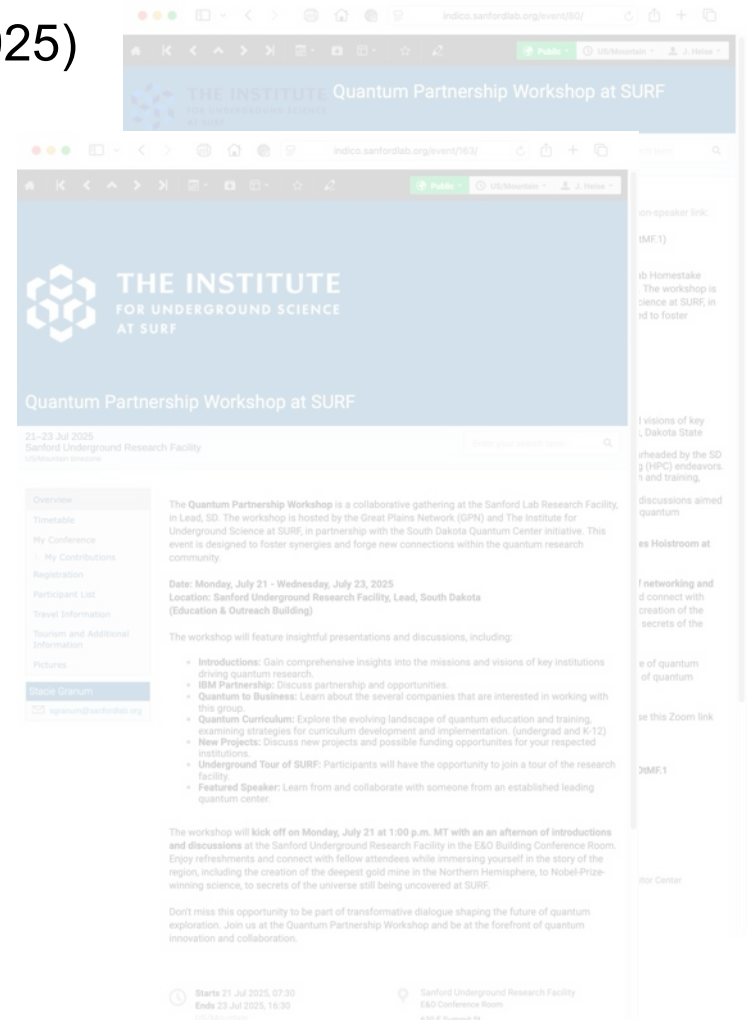
# Institute for Underground Science at SURF

## Activities since June 2023, formally launched December 2023




**Higher Ed Connection Workshop** (2024, 2025)
https://indico.sanfordlab.org/event/76 / 175


**Monthly Seminar Series**
**(May 2024 – Present)**
https://institute.surf/deeper-talks




**CETUP*** (2023, 2024, 2025)
https://indico.sanfordlab.org/e/CETUP2023 / 2024 / 2025

**Quantum Partnership Workshop** (2024, 2025)
https://indico.sanfordlab.org/e/QPW2024 / QPW2025

# SURF Education & Outreach Efforts

| Presentations and Field Trips | Curriculum Units and Resources | Career Exploration and Development | Supporting Teachers |
|---|---|---|---|
| • K12 presentations<br>• Face-to-face<br>• Virtual options<br>• Field trips | • 17 unique curriculum units available for checkout<br>• 5-15 hours of fully designed and resourced science curriculum | • Davis-Bahcall Scholars Program<br>• Summer internship opportunities<br>• Pre-service educator program support | • Professional development offerings<br>• Curriculum resources<br>• Science content support<br>• Just-in-time support |

# Education & Outreach – By the Numbers

| School Year | 2019-2020 (covid begins) | 2020-2021 (during covid) | 2021-2022 | 2022-2023 | 2023-2024 | 2024-2025 |
|---|---|---|---|---|---|---|
| Field Trips | 254 | 58 | 485 | 972 | 966 | 1,437 |
| Classroom Presentations | 3,704 | 2,005 | 14,038 | 12,799 | 10,281 | 14,712 |
| Curriculum Units | 3,236 | 3,384 | 3,718 | 2,554 | 3,965 | 4,171 |
| Other | 918 | 298 | 1,468 | 1,596 | 1,368 | 1,793 |
| Total Student Contacts | 8,112 | 5,745 | 19,709 | 17,921 | 16,580 | 22,113 |

Provide professional development and support to **more than 400** educators during the school year.

# Sanford Underground Research Facility

Thank You!

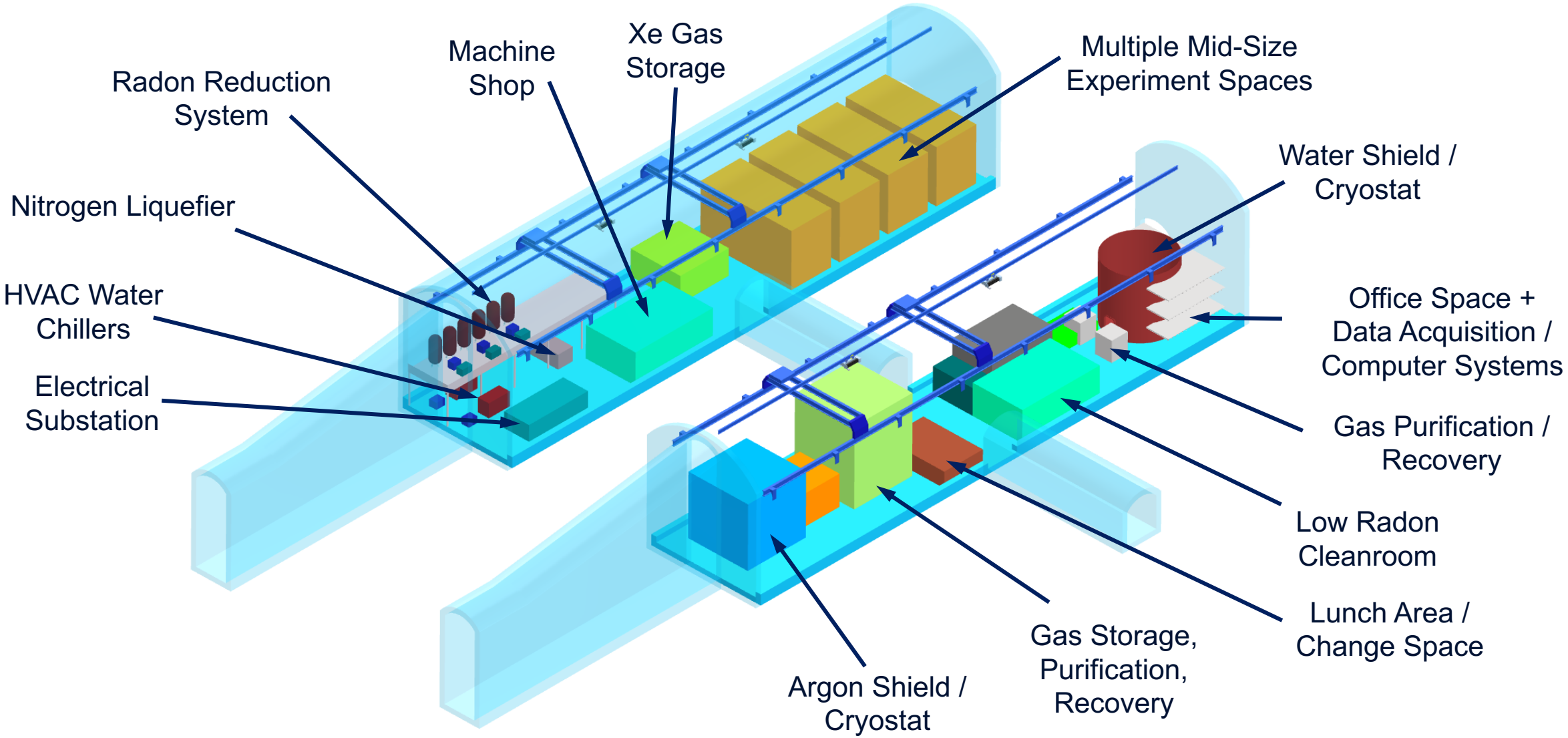

**Agency Acknowledgement:**
The Sanford Underground Research Facility (SURF) is a federally sponsored research facility under DOE-SC HEP Award Number DE-SC0020216 (cooperative agreement)

# SURF Summary

- SURF has strong relationship with DOE that benefits UG science community:
  - SURF has mandate to **support experiments** and ensure **safe and reliable access for decades**.
- SURF offers world-class service to the underground science community:
  - SURF attributes attract **world-leading** experiments and scientists from **diverse scientific communities**.
  - SURF has **proven track record** of enabling high-impact science by leveraging strong **institutional partnerships**.
- SURF is playing a strong role in the UG science community:
  - **User Association** serving as catalyst for community discussions: https://sanfordlab.org/surf-user-association.
  - **Institute** has had significant impact with initial programming, advancing intellectual community building.
- SURF wants to host future world-leading experiments:
  - LBNF excavation done, outfitting started in 2024. **DOE** "**Module of Opportunity**" expanded physics program.
  - Construction underway to **increase underground laboratory space**, plans advancing for new large caverns on 4850L on **timeframe of next-generation experiments (~2030)**.
  - Call for **Letters of Interest (LOIs)** re-affirmed prospective experiments and identified **new avenues**. New facilities in planning (Cryogenic User Facility) and consideration (Vertical Facility).
  - SURF is **deep laboratory** site and offers **largest footprint** in the world for scientific pursuits. **Many options to host future initiatives – big or small!**

# Big Science at SURF

## Conceptual layout (2x 100m caverns), informed by DUSEL PDR, ARGO/XLZD, LZ

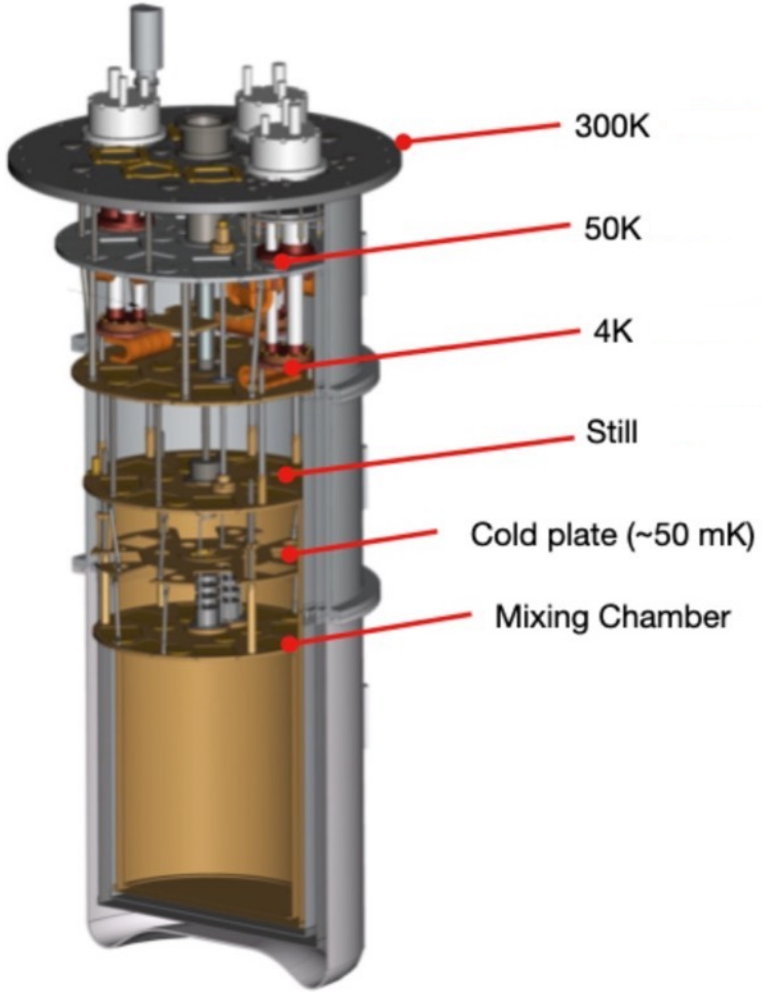


# SURF Cryogenic User Facility

## State investment to leverage federal funding and attract industry leaders

### Multi-user, low-background, ultra-low temperature test facility

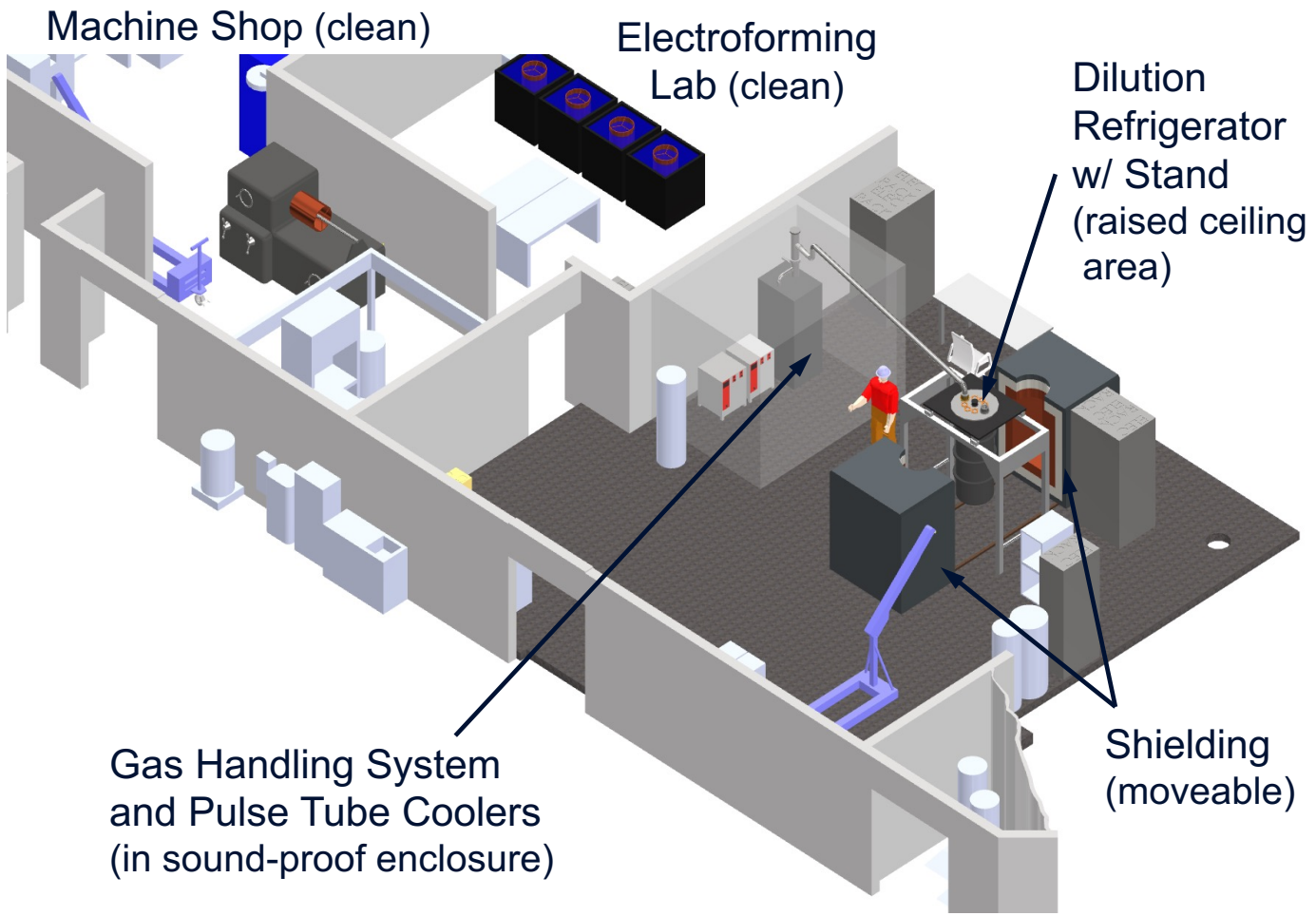
- Cryogenic User Facility at SURF will significantly bolster recent **South Dakota quantum initiative**
  - Center for Quantum Information Science & Technology incl DSU and SD Mines, interest from USD, SDSU and BHSU in facility at SURF
- Cryogenic User Facility at SURF will establish **internationally-competitive research resources** in South Dakota
  - New facility at SURF will bring scientific staff and support development of novel detectors to address questions in fundamental science
  - Significant interest from U.S.-based groups
  - New facility at SURF will attract industry leaders (Google, IBM)
- **No deep underground cryogenic facility** currently exists in the U.S.
  - Due to strategic value, many other countries operate cryo facilities (Europe, Canada) or are planning to build them (several countries in Asia; LBNL currently working with Japan on a facility like this)




Several options for commercial dilution refrigerator that would meet facility needs

# SURF Cryogenic User Facility

## Re-purpose portion of existing Davis Campus space

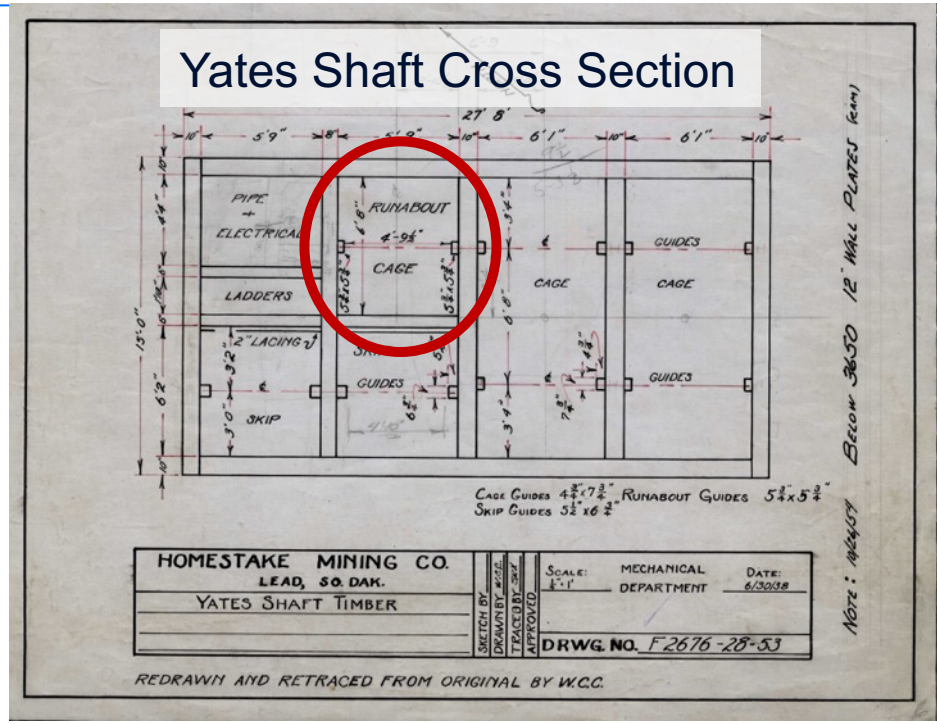



Area (total = **140 m²**): 11 m × 9.8-12.8 m × 2.7 m (H)
Area (raised section): 5.9 m × 5.8 m × 3.2 m (H)

# SURF Potential Vertical Facility

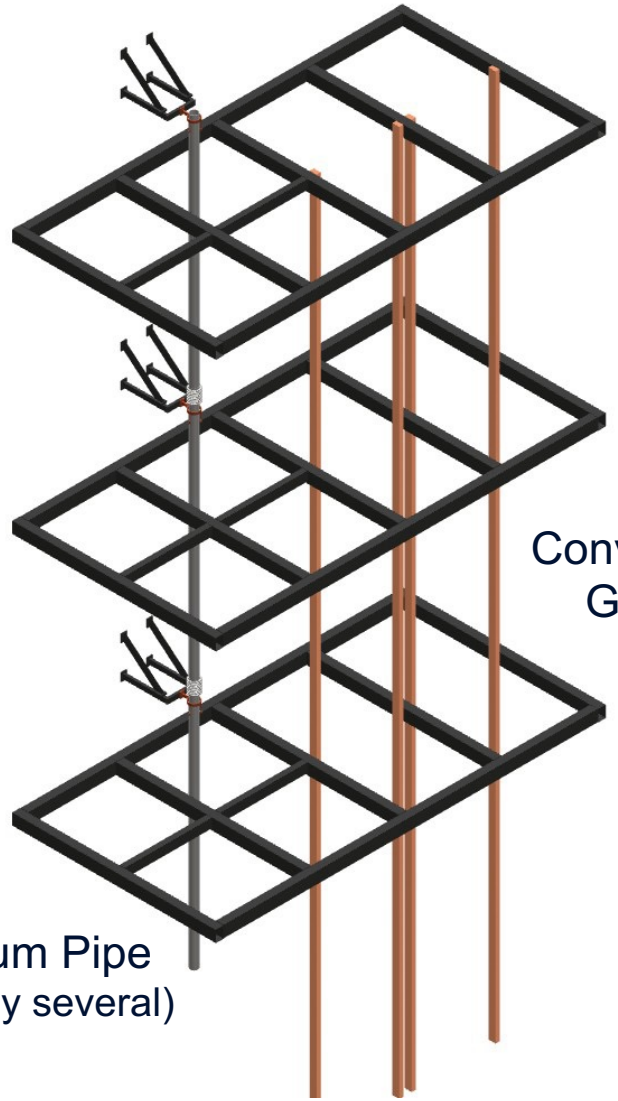
## Unique facility would serve broad range of science communities

- **Science Goals:** Atom interferometry using quantum sensors (ultralight dark matter, gravitational waves), quantum network; also atmospheric cloud chamber, microgravity studies, isotope separation
- **Community Interest:**
  - Early interest at SURF related to vertical facility and atom interferometry (e.g., Vertical Facility workshop Fall 2008)
  - SURF Vision Workshop Sep 2021 incl atom interferometry
  - SURF Quantum Partnerships Workshop series incl interest in gravitational measurements and quantum networks/sensors
  - SURF joined TVLBAI collaboration in Oct 2025 (50+ institutions)
- **Expt Requirements** (TVLBAI https://arxiv.org/pdf/2503.21366):
  - TVLBAI: **1.5-m diameter** shaft (minimum), **15-cm diameter** pipe for ultra-high vacuum; separate pipe for quantum network?
  - Aiming for initial **technical discussions in 2026**
- **SURF Facility:**
  - Initial shaft study completed March 2022, six legacy shafts potentially feasible (but challenging)
  - **Yates Shaft refurbishment** – DOE recognizes investment necessary to ensure safe and redundant access at SURF (especially for LBNF/DUNE); schedule **~2030s** after related upgrades complete
  - Potential for Yates Shaft to accommodate Vertical Facility, “Runabout” compartment **1.75m x 2.0m**



# SURF Potential Vertical Facility

## Accommodate during planned renovation of Yates Shaft (2030s)

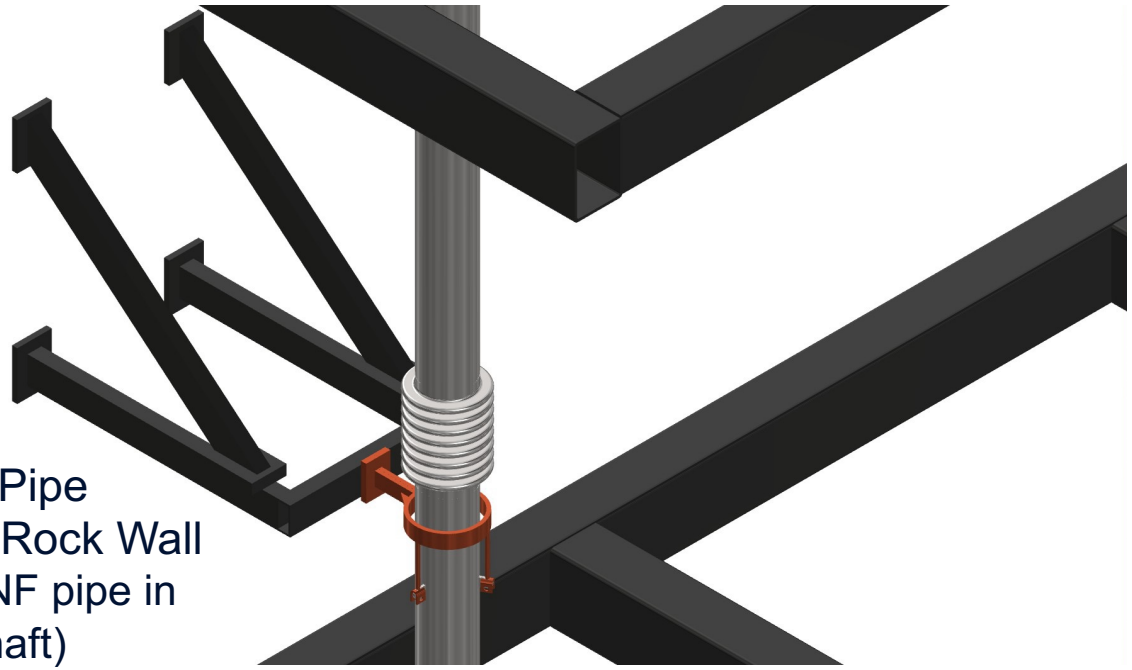


Yates Shaft Sets
(5.5-m spacing)

Conveyance
Guides

Vacuum Pipe
(possibly several)

Vertical Facility
Length up to
1500 m



Vacuum Pipe
Attachment to Rock Wall
(similar to LBNF pipe in
Ross Shaft)

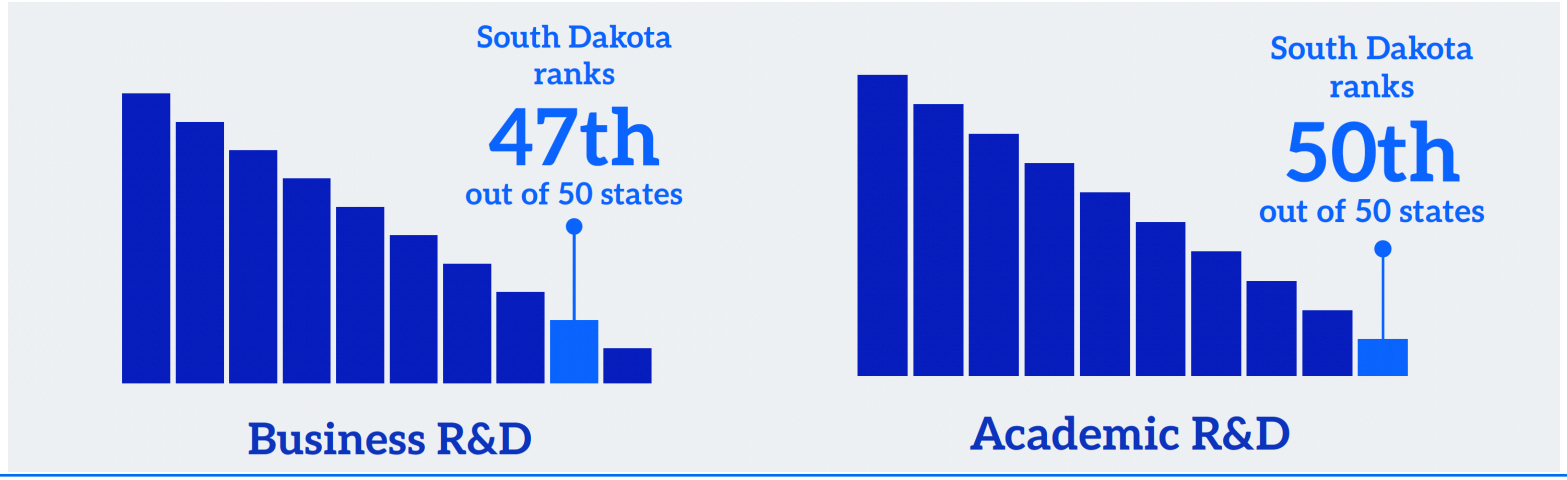
# South Dakota Science & Technology Plan

## Vision:

South Dakota invests in **research and commercialization** to drive economic growth and diversification and to educate a highly prepared **STEM workforce**.

## Strategy with 5 Initiatives:

1. Advance technology commercialization
2. Increase research & commercialization with system-level improvements
3. ‘Grow our own’ initiative to expand STEM workforce
4. Invest $50M (over 10 yrs) in university-industry research & faculty
5. Leverage federal investment to build public-private partnerships




# South Dakota Science & Technology Plan

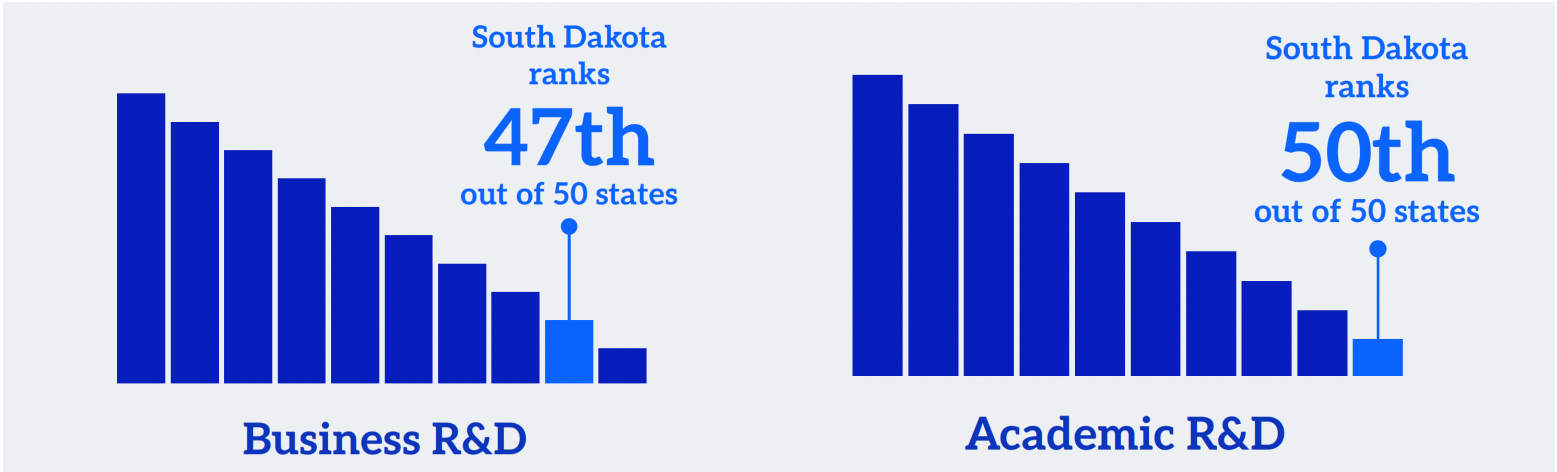
## High-priority research areas have strong links to SURF

### Vision:

South Dakota invests in **research and commercialization** to drive economic growth and diversification and to educate a highly prepared **STEM workforce**.

### High-Priority Research Areas:

- Computational Science
- Cybersecurity
- Fermentation & Bioprocessing
- Health, Food & Nutrition
- Environmental & Biological Sciences
- Materials
- **Deep Underground Science**




# SURF Science & Education Opportunities

## SURF Programs

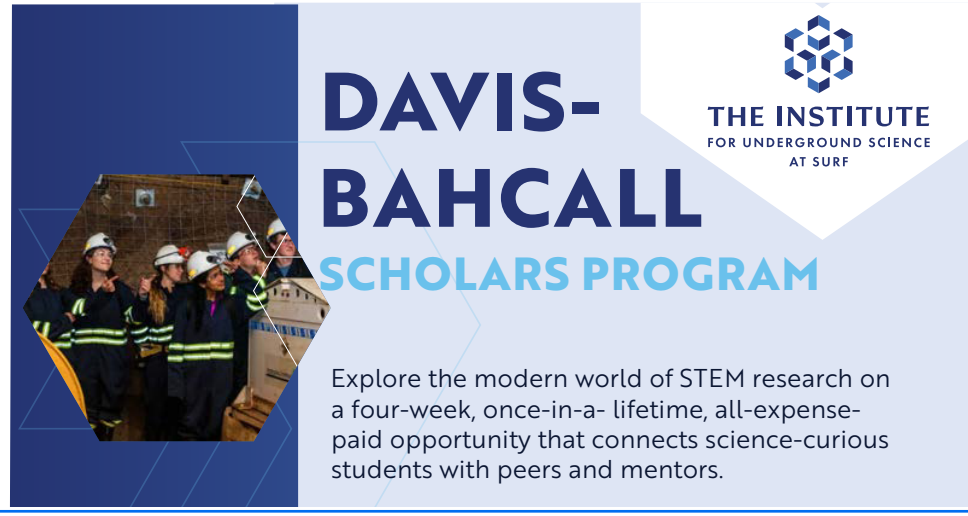
- **Summer Internships** (Bozied/Bauer/Headley)
  - Science, engineering, operations, environmental science and communications, incl underrepresented groups https://sanfordlab.org/internships
- **Davis-Bahcall Scholars Program**
  - Multidisciplinary studies at U.S. & European labs/industries https://sanfordlab.org/dbs

## National Programs

- NSF Research Experiences for Undergraduates (REU):
  - **BHSU** multidisciplinary program since 2016 (physics, chemistry, biology) https://bhsu.edu/academics/programs/physics.html
  - **SD Mines Li-SMART** (Lithium, Mining, Recycling and Technology) started 2025 https://www.sdsmt.edu/news/releases/Li-SMART.html
- DOE Reaching a New Energy Sciences Workforce (RENEW):
  - **RENEW-Midwest:** From the Underground to the Cosmos, student diversity in STEM (BHSU, UMich, Benedictine) https://www.pathwaystoscience.org
  - **NuPUMAS**: Neutrino Physics for Undergraduate Minority Advancement in Science, student diversity in STEM (UHouston / Texas Physics Consortium) https://nupumas.physics.uh.edu

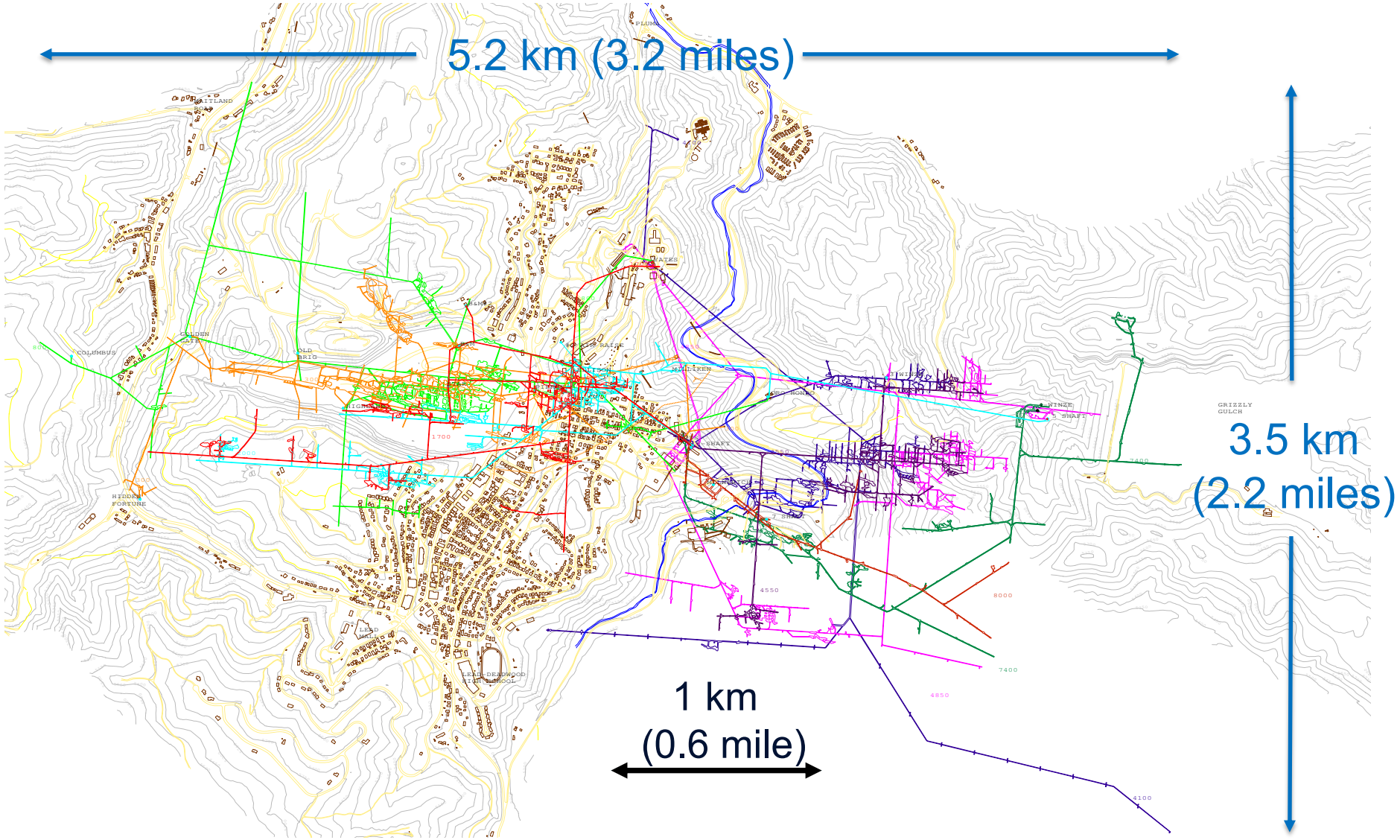
## Other Opportunities

- **BHSU Underground Campus:** Promoting undergraduate research
- **Local Researchers:** BHSU, SD Mines, RESPEC; also USD, SDSU, DSU

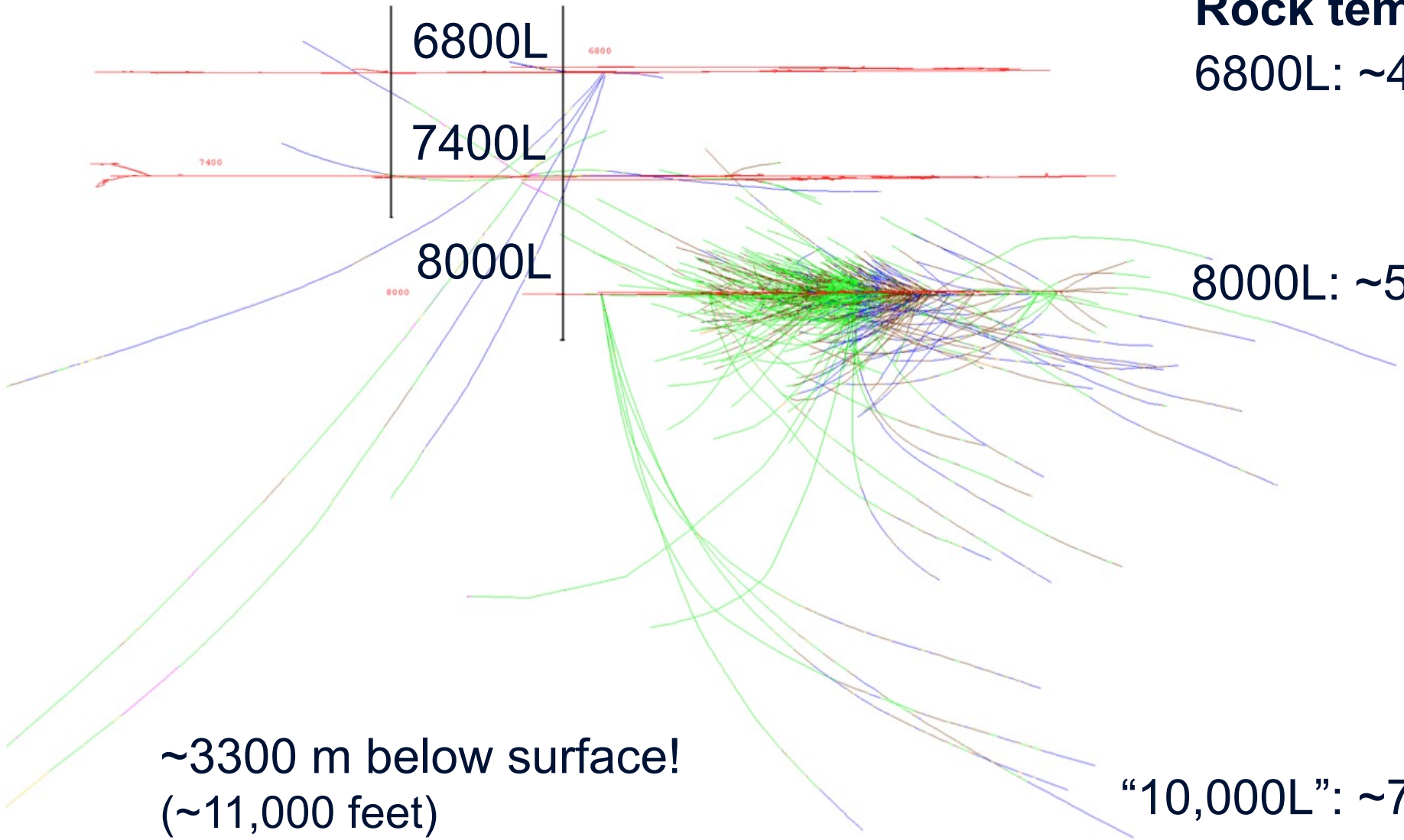
# SURF Underground Lab Geography

## Significant underground footprint for science



# SURF Underground Lab Geography

## Future possibilities to access existing deep holes?




**Rock temperature**

6800L: ~48 C / 119 F

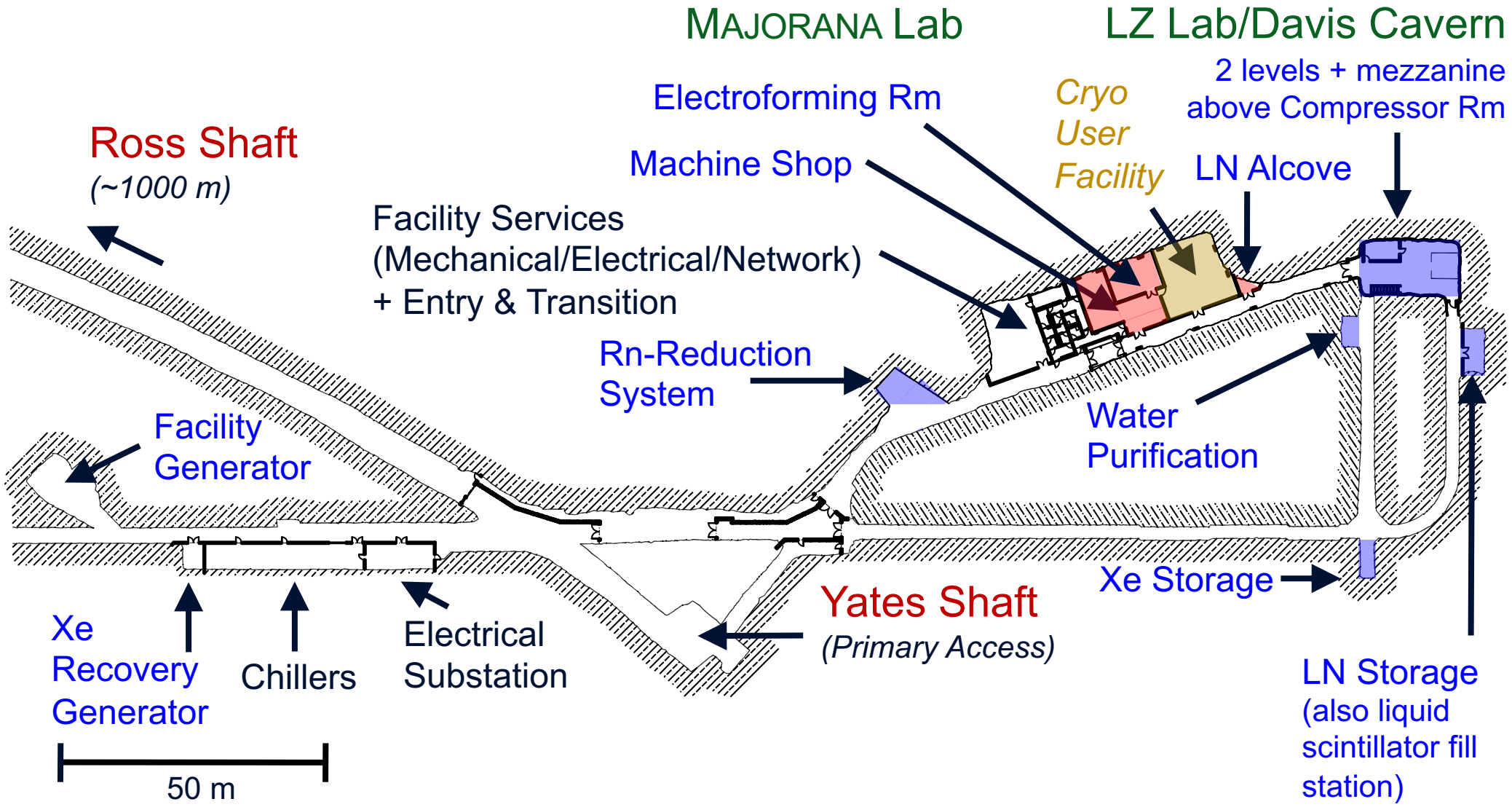
8000L: ~56 C / 133 F

~3300 m below surface!
(~11,000 feet)

“10,000L”: ~74 C / 165 F

# 4850L Davis Campus

## 3,017 m² (Total) / 1,018 m² (Science)



# SURF 4850L Davis Campus

## Examples of laboratory space

**Detector Room (MJD):**
Area =140 $m^2$, 11 m × 9.8-12.8 m × 2.7 m (H)
(raised section: 5.9 m × 5.8 m × 3.2 m (H))

**Davis Cavern, Lower (LZ):**
Area =142 $m^2$, 13.7 m × 9.1 m × 6.4 m (H)
(incl tank: 7.6 m dia. × 6.4 m H). Total Cavern H = 10.8 m

# SURF Designated APS Historical Site

## Announcement Sep 2020, Dedication May 2022

www.interactions.org/press-release/aps-designates-sanford-lab-morgan

INTERACTIONS.ORG
PARTICLE PHYSICS NEWS AND RESOURCES

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A communication resource from the **world's particle physics laboratories.**

### APS designates Sanford Lab, Morgan State University as historic physics sites

**14 September 2020 - Sanford Underground Research Facility**

**The pioneering neutrino research done by Ray Davis over nearly three decades forever changed our understanding of the Standard Model of Physics**

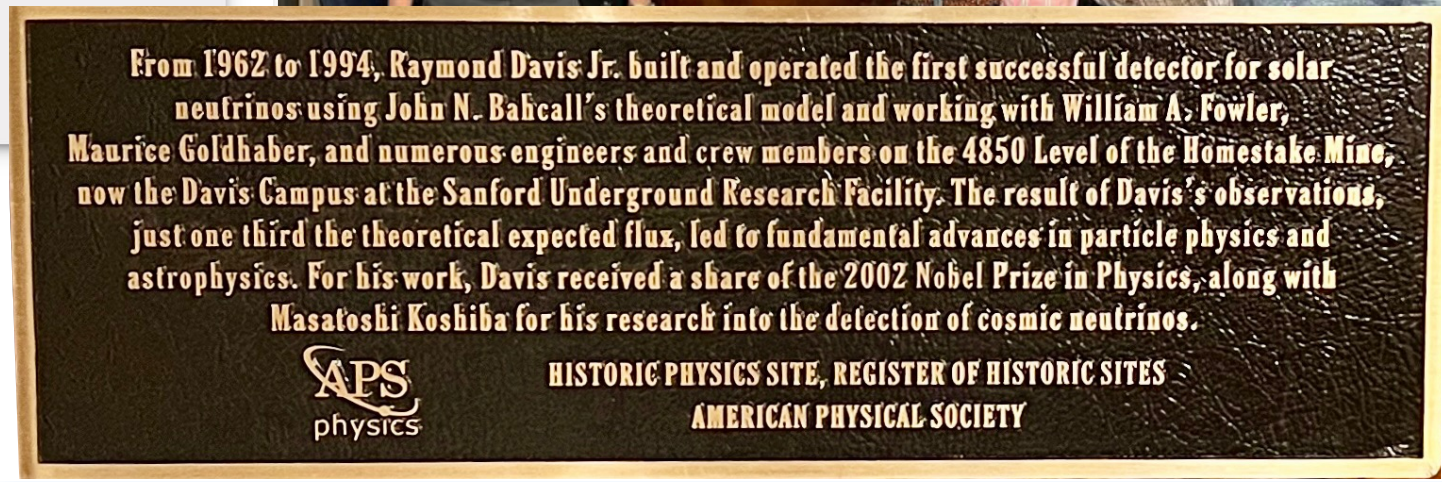
The American Physical Society (APS) today announced it has designated SURF one of two Historic Sites in physics. The other, Morgan State University in Baltimore, Maryland, is recognized as the birthplace of the National Society of Black Physicists (NSBP).

*DATE ISSUED:*
September 14th, 2020

*SOURCE:*
Sanford Underground Research Facility

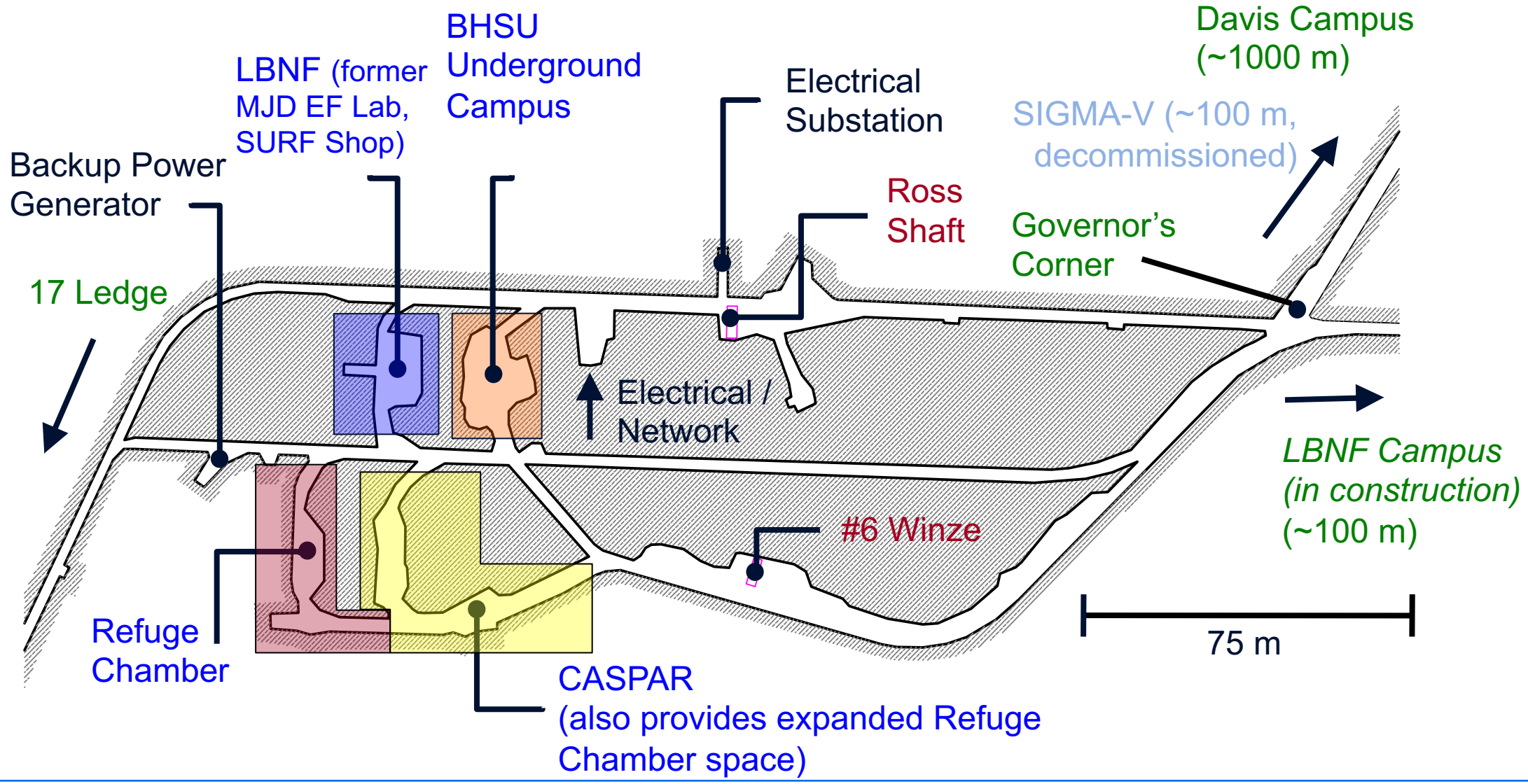
*CONTENT:*
Press Release

*CONTACT:*
Constance Walter
**Communications Director**
cwalter@sanfordlab.org



# 4850L Ross Campus

## 2,653 m² (Total) / 920 m² (Science)



# SURF 4850L Ross Campus

## Examples of laboratory space




**Former MJD Electroforming:**
Area = 228 m$^2$
(Cleanroom removed,
current construction office)


**BHUC Cleanroom:**
Cavern Area = 268 m$^2$,
Cleanroom = 12.1 m × 6.1 m ×
2.4 m (H)

**CASPAR Hall:**
Area = 236 m$^2$,
30 m × 3 m (min) × 2.8 m (H)

# SURF Call for Letters of Interest

## Ensuring SURF used to its fullest scientific potential

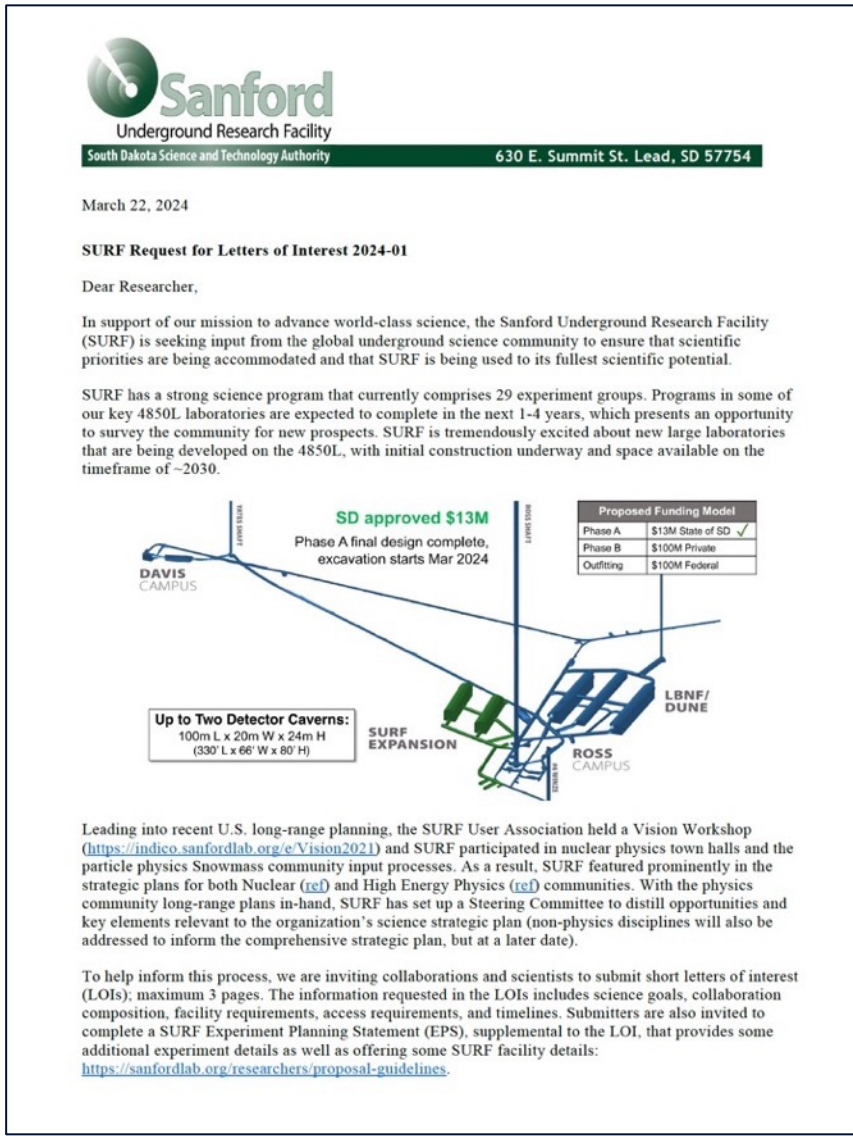
### Significance of 2024 LOI Call:

- 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**

**15 responses received, initial SPAC review complete**



Sanford Underground Research Facility

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.

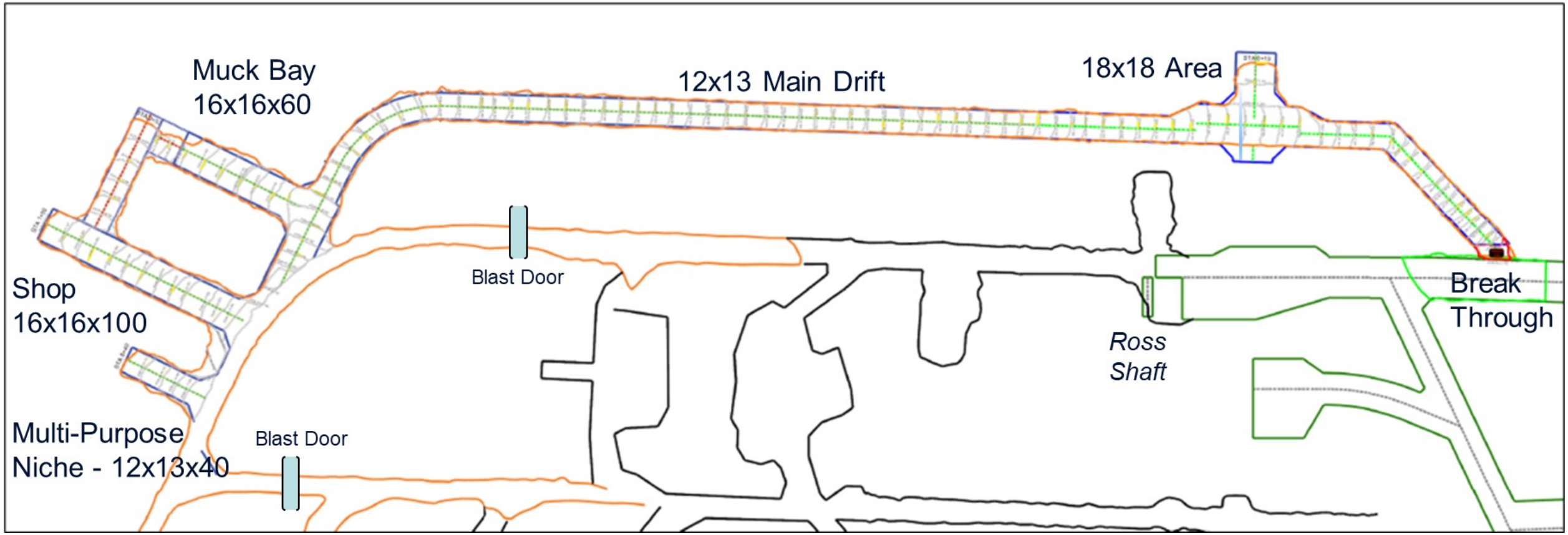


Leading into recent U.S. long-range planning, the SURF User Association held a Vision Workshop (https://indico.sanfordlab.org/e/Vision2021) and SURF participated in nuclear physics town halls and the particle physics Snowmass community input processes. As a result, SURF featured prominently in the strategic 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.

# 4850L Laboratory Expansion – Phase A Complete

## Bypass Drift layout



# 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

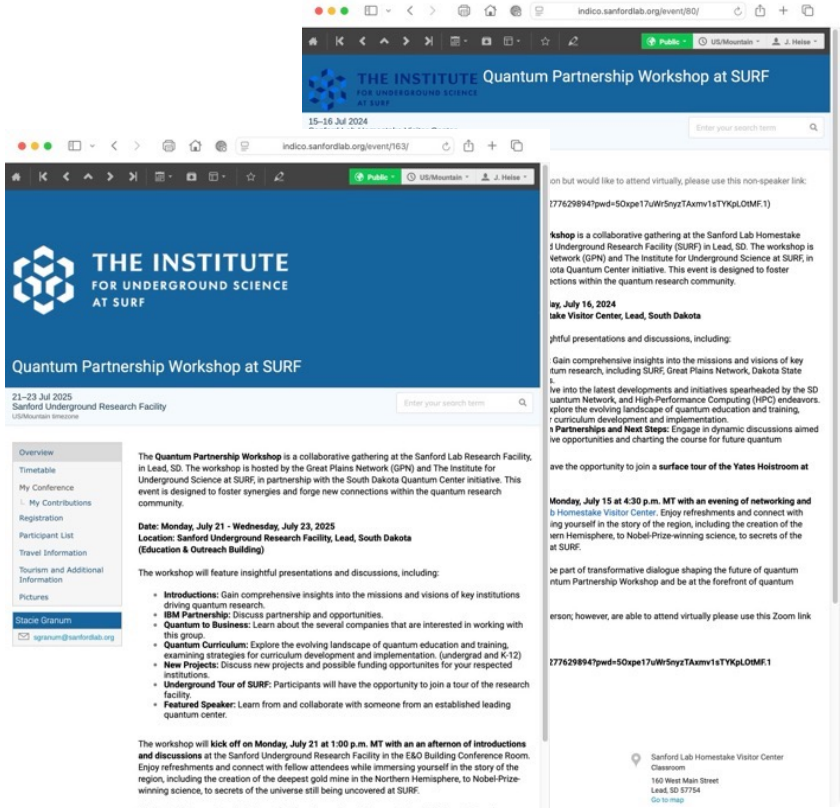
**ENTITLED An Act to make an appropriation for the establishment of a Center for Quantum Information Science and Technology and to declare an emergency.**

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.

**Gov. Noem signs bill to fund Center for Quantum Information Science and Technology**

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




**Quantum Partnership Workshop** (2024, 2025)
https://indico.sanfordlab.org/e/QPW2024 / QPW2025

Growing community both within SD and beyond, **~50%** increase in participation year-over-year

Save the Date for QPW2026: **Jul 22-24, 2026**

# SURF Cryogenic User Facility Partners

## Many more expected once facility available

South Dakota

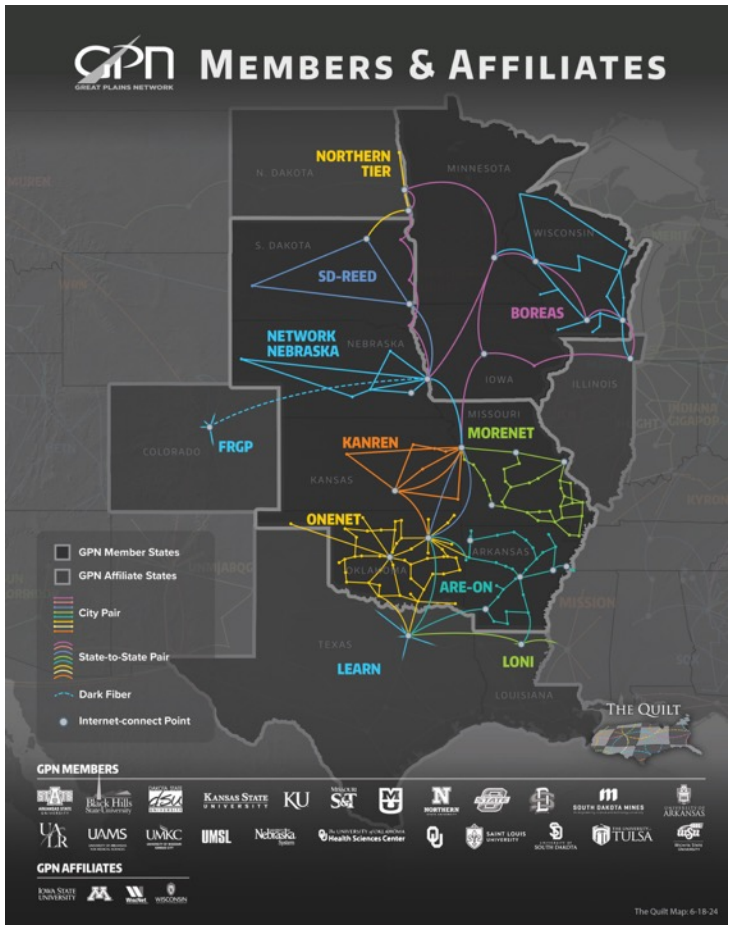
VIRGINIA TECH

Los Alamos NATIONAL LABORATORY

BERKELEY LAB

GPN GREAT PLAINS NETWORK

**6 States,**
**23 Members**
(incl SD)



# SURF Current & Future Facilities

## Summary for various science campuses, including timelines

| Location | Laboratory | Existing/*Planned* Space | | Available (CY) | Comments |
|---|---|---|---|---|---|
| | | Area ($m^2$) | Vol ($m^3$) | | |
| Surface | Surface Lab (+ RRS) | 210 | 600 | 2021 | LZ use ~complete, allowing use by others |
| Davis Campus (4850L) | LZ Lab – Davis Cavern (2 levels) | 372 | 1,956 | ~2028 | LZ data complete early ~2028 + decommissioning |
| | MJD Lab – 3 Rooms *(1 Rm for Cryo Facility)* | 300 | 1,279 | 2027 / ~2032 | Ge-76 DBD + Ta-180m completed, decommissioning complete in 2026; Cu e-forming through ~2031 |
| | Cutout Rooms (4) | 100 | 412 | ~2028 | LZ timeframe for most spaces |
| Ross Campus (4850L) | Former E-forming | 228 | 742 | ? | LBNF use currently, likely unavailable for several yrs |
| | BHUC (BHSU cleanroom) | 266 | 773 | N/A | Low-bkgd counting operations resumed summer 2025. Indefinite use. |
| | CASPAR | 395 | 1,130 | 2027+ | Phase II program underway until at least 2028. Proposals for Phase III (Also expanded Refuge) |
| | Refuge Chamber | 258 | 866 | ? | Long-term use TBD |
| LBNF (4850L) | LBNF | 9,445 | 191,863 | ? | Excavation complete early 2024; MOO/FD4 available |
| 4100L | Geoscience Lab | 334 | 11 drill holes | 2028 | DEMO-FTES use 2023-2025, CUSSP 2025-2027 |
| *4850L* | *Expansion (2 proposed)* | *4,022* | *94,608* | *Earliest new: excavation 2029, complete ~2031* | *Each 20m (W) x 24m (H) x 100m (L)* |
| *7400L* | *New Labs (2 proposed)* | *4,178* | *42,440* | | *Each 15m (W) x 15m (H) x 75m (L) + other supporting* |

# The Institute for Underground Science at SURF

## Goal: The Institute for Underground Science at SURF constructed by Sep 2035

World-leading center for

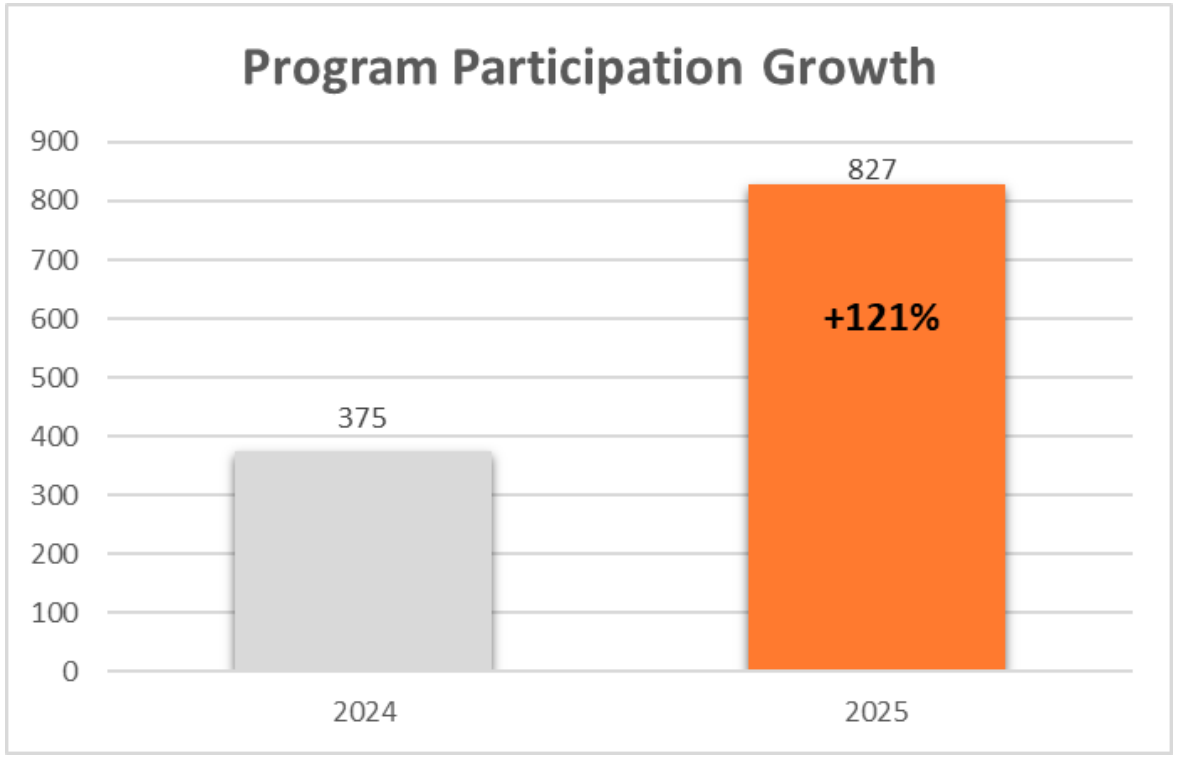
- **Underground science collaboration and intellectual community**
- **K-12 and public education & outreach programs**

THE INSTITUTE
FOR UNDERGROUND SCIENCE
AT SURF

# Institute 2025 Programming Highlights

| By The Numbers | 2024 | 2025 |
|---|---|---|
| **Programs** | 5 | 6 |
| **Participants** | 375 | 827+ |
| ***States/Territories*** | 31 | 29 |
| ***Countries*** | 10 | 24 |
| ***Institutions*** | 89 | 148 |

*States/territories, countries of Institutions (as of Nov 12, 2025)*



# Sanford Lab Homestake Visitor Center

## Acquired January 2022. Greatly expands public outreach opportunities.

# Sanford Lab Homestake Visitor Center (SLHVC)

## Building meaningful relationships with range of audiences

### Audiences

- Intergenerational year-round programming
- Venue space for SURF and its affiliates
- Local community
- Tourists

### Engaging Content

- Docent tours
- Ask-a-Scientist events
- *Deep Talks* lecture series
- *Deep Roots* cultural events
- Tours to hoist room and Čhaŋgléška Wakȟáŋ

### Accessible Opportunities

- Accessibility strategic plan in process
- Serves as SURF's public "front door"
- Multi-use space
- Community partner:
  - Voter polling site
  - Visitor center for tourists
  - Exploring public EV charging station

### By the Numbers

| | 2023 | 2024 |
|---|---|---|
| **Visitors** | 57,317 | 58,136 |
| ***States*** | *50* | *50* |
| ***Countries*** | *33* | *42* |
| **Buses** | 139 | 137 |
| **Events** | 121 | 124 |

# *Čhaŋgléška Wakȟáŋ*, the Ethnobotanical Garden at SURF

## Public tours started summer 2024, expect 2-3 years for native plant growth

# Sanford Underground Research Facility

## General summary

**Site:** Deepest underground lab in U.S., largest footprint for scientific pursuits (former Homestake Gold Mine). Operations funded directly by U.S. Department of Energy ($35M/yr). Robust org, total staff = 213 ppl.

**Science Program:**

- **Past:** Davis Solar Neutrino Experiment, LUX, MAJORANA DEMONSTRATOR ($0\nu\beta\beta$, $^{180m}$Ta), others (incl Deep Underground Gravity Lab, affiliated with LIGO collaboration)
- **Current:** LZ, CASPAR, Low-bkgd counting (BHUC), Geoengineering (esp. geothermal, seismic), Geomicrobiology, Industry/engineering (Caterpillar)
- **Future** (no funding/site decisions yet):
  - Dark Matter: Low-mass (SPLENDOR, HydroX), next-generation WIMP (XLZD, Argo), other (CrystaLiZe)
  - Neutrino: Water-based liquid scintillator (Theia), Multi-ton-scale $0\nu\beta\beta$ (LEGEND 6000), etc
  - QIS, atom interferometry – gravitational waves, ultra-light dark matter (km-scale vertical or horizontal)

**Facility:**

- **4850L Existing:** Davis Campus operating well, Ross Campus re-opened following LBNF blasting
- **4850L Cryogenic User Facility:** Dilution fridge for QIS at Davis Campus (exploring SD funding)
- **4850L LBNF/DUNE:** Excavation complete, “Module of Opportunity” for expanded science program (DOE)
- **4850L Expansion:** Up to 2x caverns (100m L × 20m W × 24m H), complete in early 2030s (private/DOE?)
- **Vertical Facility:** Accommodate during Yates Shaft refurbishment, schedule TBD / ~2030s (DOE/other?)

# Sanford Underground Research Facility

## Physical characteristics

- **Property:** 1 $km^2$ (surface) with ~1600 $m^2$ storage (incl drill core) and 355 $m^2$ staging/assembly space; 31 $km^2$ (total underground) with ~600 km of tunnels extending to over 2450 m below ground.
- **Access:** Vertical; personnel and materials via one of two main shafts (Yates Shaft extensive maintenance campaign completed, DOE funding discussions for full refurbishment). Facility dedicated to science.
  - Yates Shaft: 1.39 × 3.77 × 2.58 m, 4.8 tonnes (lengths up to 7.3 m possible at reduced payload mass)
  - Ross Shaft: 1.40 × 3.70 × 3.62 m, 6.1 tonnes (lengths up to 8.2 m possible at reduced payload mass; new cage soon)
- **Depth:** Main UG level = 4850L (1480 m, 4300 mwe), muon flux = $5.31\times10^{-5}$ $\mu/m^2/s$ (4.6 $\mu/m^2/d$). Several other UG elevations for science: 300L, 800L, 1700L, 2000L, 4100L, 4550L.
- **Space:**
  - Surface (science space, as low as class 10-100): 210 $m^2$ (cleanrooms = 92 $m^2$ / 914 $m^3$)
  - 4850L (science space, as low as class 100): Davis Campus (1018 $m^2$ / 4633 $m^3$), Ross Campus (920 $m^2$ /3144 $m^3$)
  - Radon-reduction: Surface = 2200x reduction @ 300 $m^3/h$ (Ateko), Davis = 700x reduction @ 150 $m^3/h$ (SD Mines)
- **Bkgds** (4850L): Radon* = 180-402 $Bq/m^3$, gamma = 1.9 $\gamma/cm^2/s$, neutron = $1.7\times10^{-2}$ $n/m^2/s$.
- **Utilities:**
  - Power = 24,000 kW capacity (20,000 kW available now, 15,000 kW in FY27); Standby = 3 diesel generators (390 kW)
  - Chilled water (2x 246 kW), purified water (37.8 lpm), compressed air (up to 1100 scfm, 140 scfm at Davis Campus)
  - Network = 20 Gbps internally, 10 Gbps externally (100 Gbps planned), WiFi available surface + underground

* Studies conducted Summer 2024, expect to reduce Rn concentration

# Sanford Underground Research Facility
## Capabilities

- **Unique environments for multi-disciplinary research:** SURF has attracted world-leading experiments and scientists from diverse scientific communities.
  - **Overburden protection from cosmic-ray muons:** SURF is the deepest underground lab in U.S., one of deepest laboratories in the world (1500 m, 4300 mwe). SURF is expanding to meet the needs of next-generation experiments
- **Local radiation shielding:** Water tank and corresponding water purification system, steel shielding; also selection of low-activity facility construction materials/finishes (e.g., concrete, shotcrete)
- **Assay capabilities:** Low-bkgd counting serving national & international community (~10 μBq/kg U/Th)
- **Material production/purification:** One of only a few labs where UG Cu electroforming is performed (average U, Th decay chain ≤ 0.1 μBq/kg)
- **Environmental control:** Experience w/ HEPA filtration cleanrooms, dehumidifier, Rn-reduction systems
- **Implementation and operations support:** Robust organization with support for planning, execution and coordination of science program activities both planned and ongoing at facility. SURF has proven track record of delivering successful science.
- **Community catalyst:** User Association, incl Vision Workshop 2021. Science Program Advisory Cmttee. Both groups support upcoming SURF application to become **DOE Office of Science User Facility**