



**SANFORD  
UNDERGROUND  
RESEARCH  
FACILITY**

# The Sanford Underground Research Facility

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**Quantum Partnership Workshop**

**July 16, 2024**

# Sanford Underground Research Facility



## **SURF Mission:**

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

## **SURF Vision:**

**The worlds 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



# Sanford Underground Research Facility

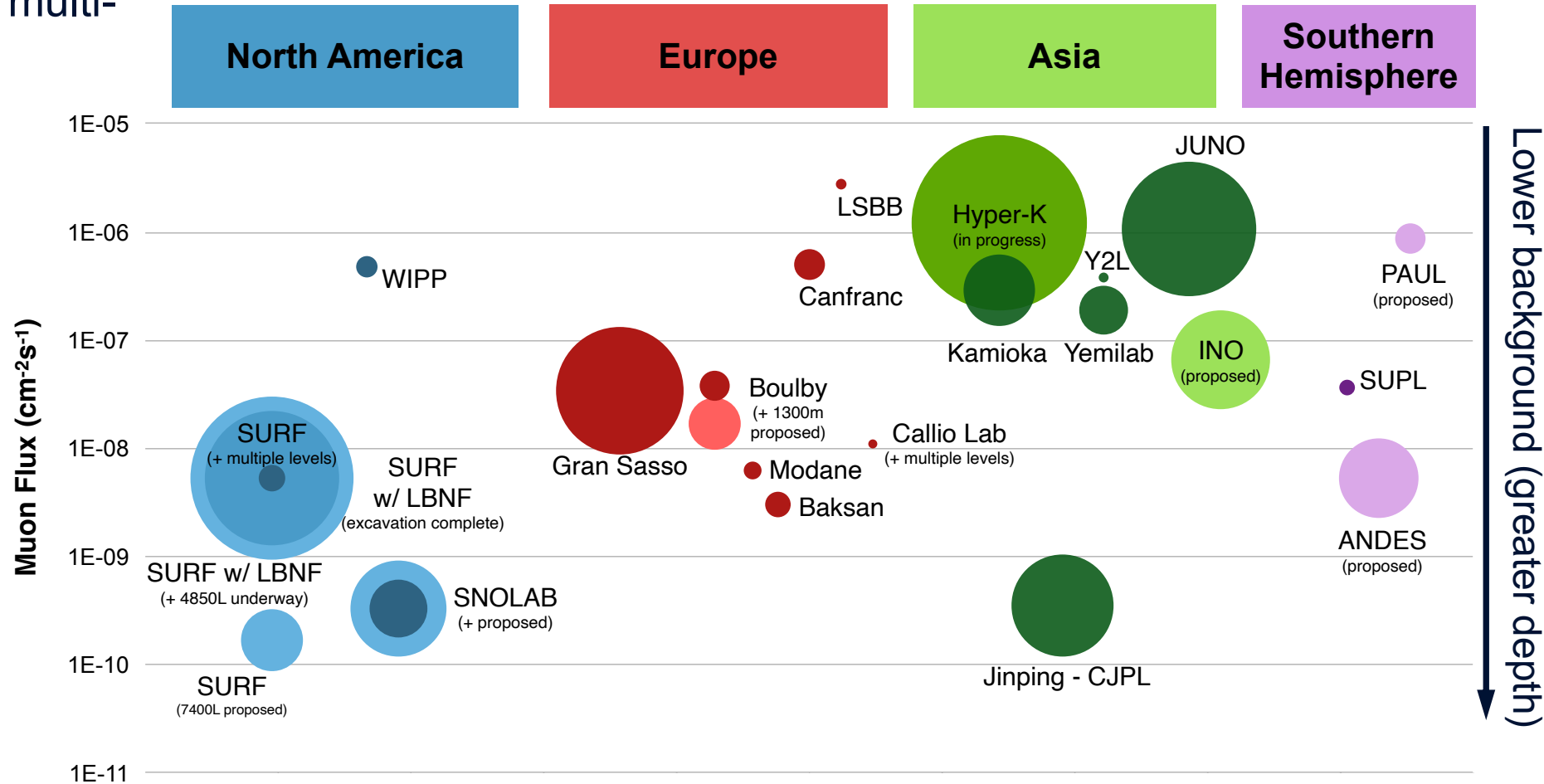
## Where in the world is SURF?



# SURF in the Global Context

## SURF can provide:

- Unique environments for multi-disciplinary research
  - Overburden protection from cosmic-ray muons
- Local radiation shielding
- Assay capabilities
- Material production/purification
- Environmental control
- Implementation and operations support
- Community catalyst

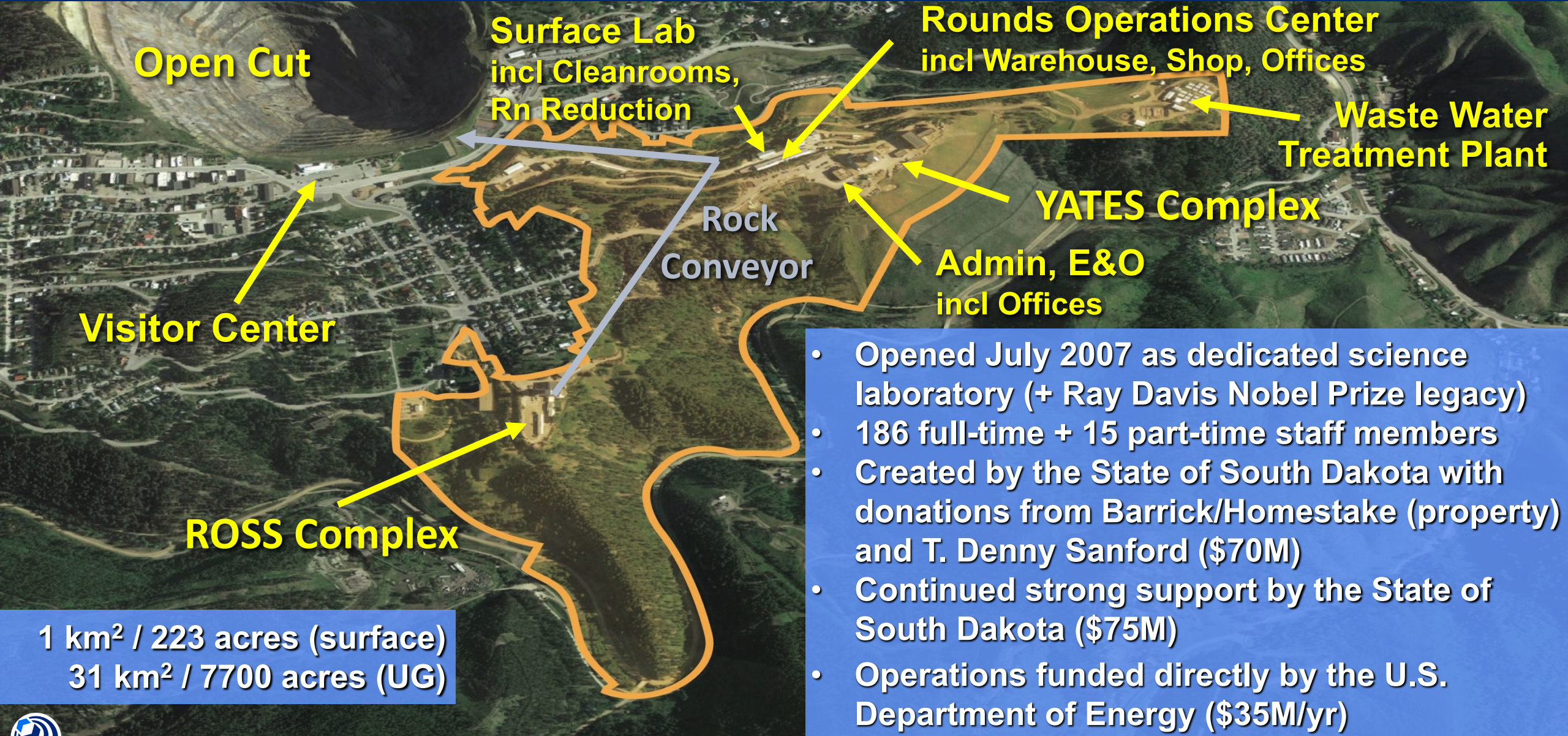


Note: Circles represent volume of science space



# Sanford Underground Research Facility

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



1 km<sup>2</sup> / 223 acres (surface)  
31 km<sup>2</sup> / 7700 acres (UG)

- Opened July 2007 as dedicated science laboratory (+ Ray Davis Nobel Prize legacy)
- 186 full-time + 15 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)



# Sanford Underground Research Facility

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



Ross Shaft

Yates Shaft



Administration Bldg



Rounds Operations Center

Surface Lab + RRS



Yates Hoistroom



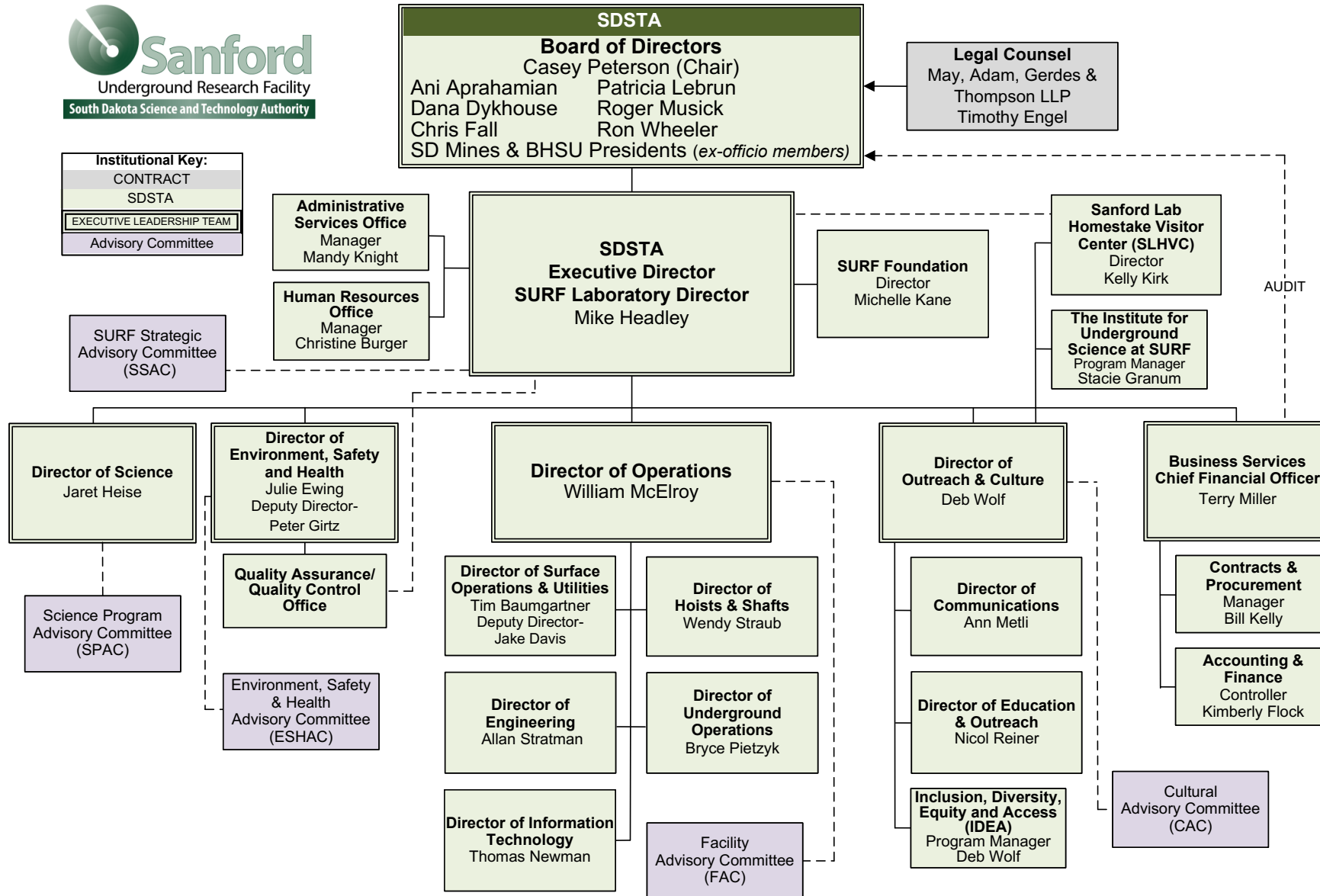
# Čanĝlěška Wakĥán, the Ethnobotanical Garden at SURF

Construction complete, planting (native plants) completed June 12



# SDSTA Organization Structure

Robust organization: 11 depts, 3 offices (+ Visitor Center, Institute, Foundation)



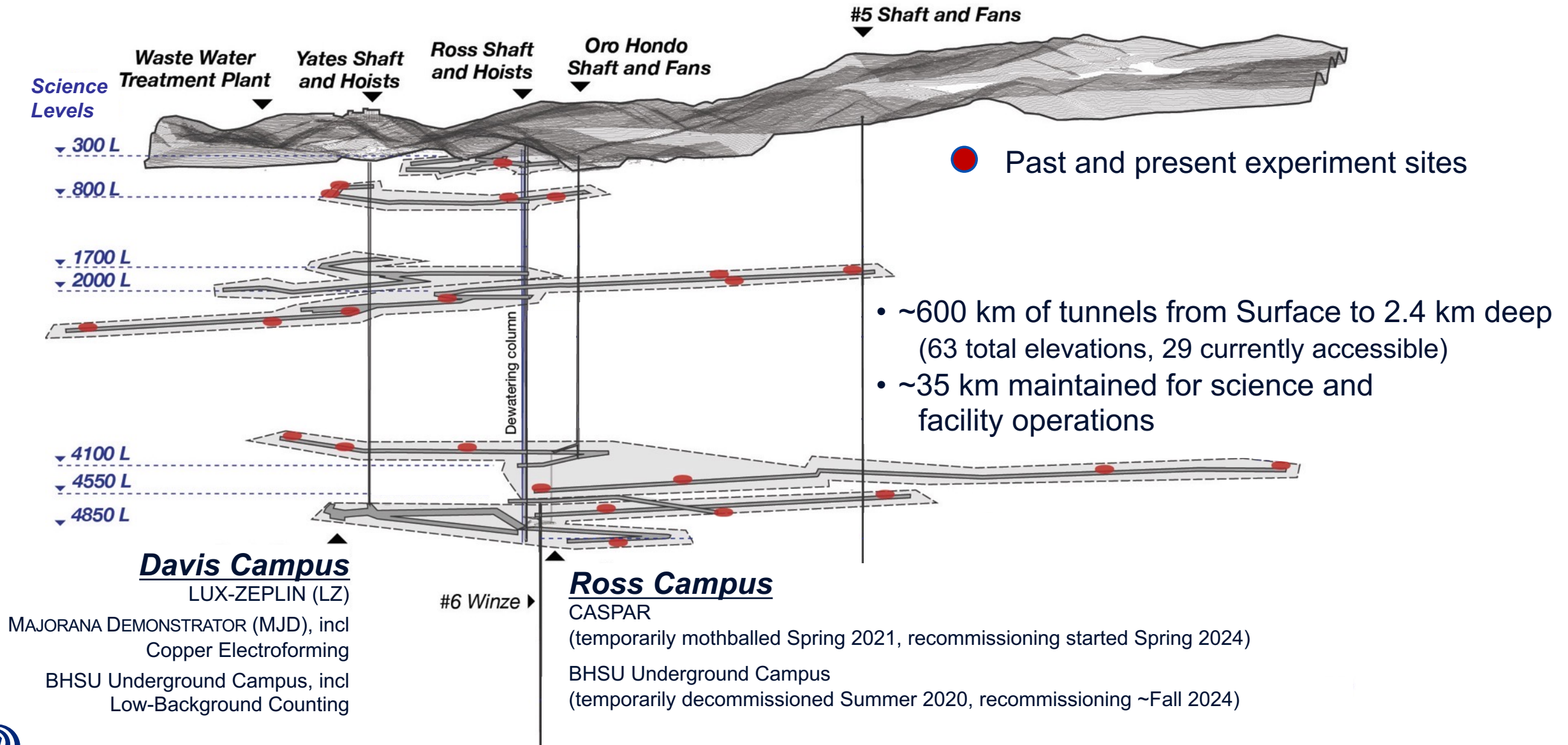


# Why Go Underground?



# SURF Underground Lab Geography

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



# SURF 4850L Davis Campus

## Examples of laboratory space



### Detector Room (MJD):

Area = 140 m<sup>2</sup>, 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<sup>2</sup>, 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





**Dark Matter**  
LUX-ZEPLIN



**Neutrinos**  
MAJORANA DEMONSTRATOR  
LBNF/DUNE

**Science Program**  
30 Expts with 2268 Collaborators,  
301 Institutions in 40+ Countries



**Biology**  
Extreme Life  
Astrobiology



**Geology & Engineering**  
Geothermal Energy  
Mining Technologies



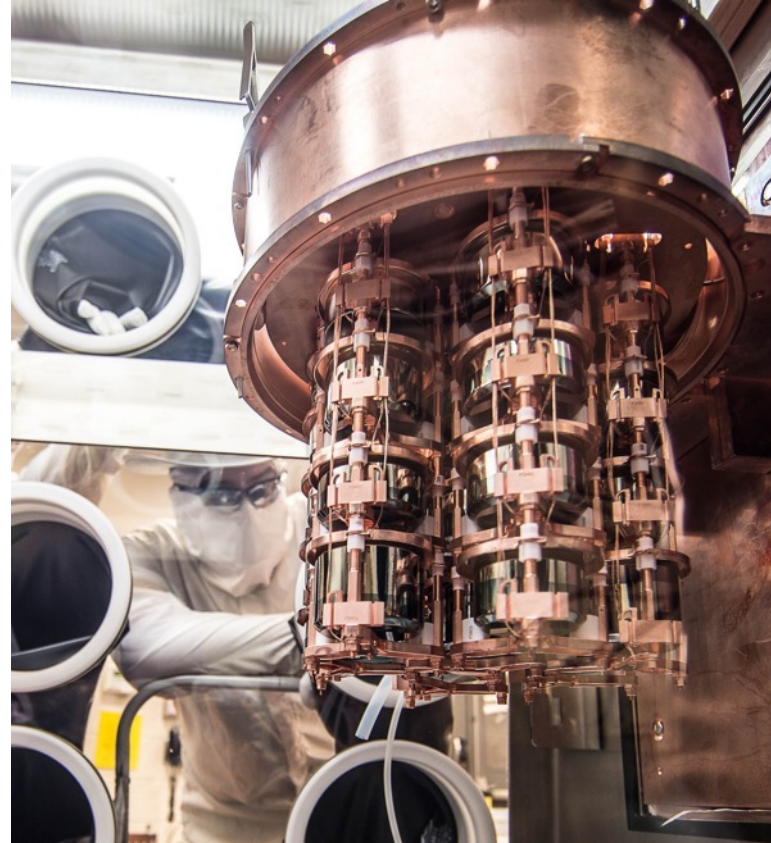
# SURF Science Program – Current Physics Highlights

Strong and diverse program with exciting future



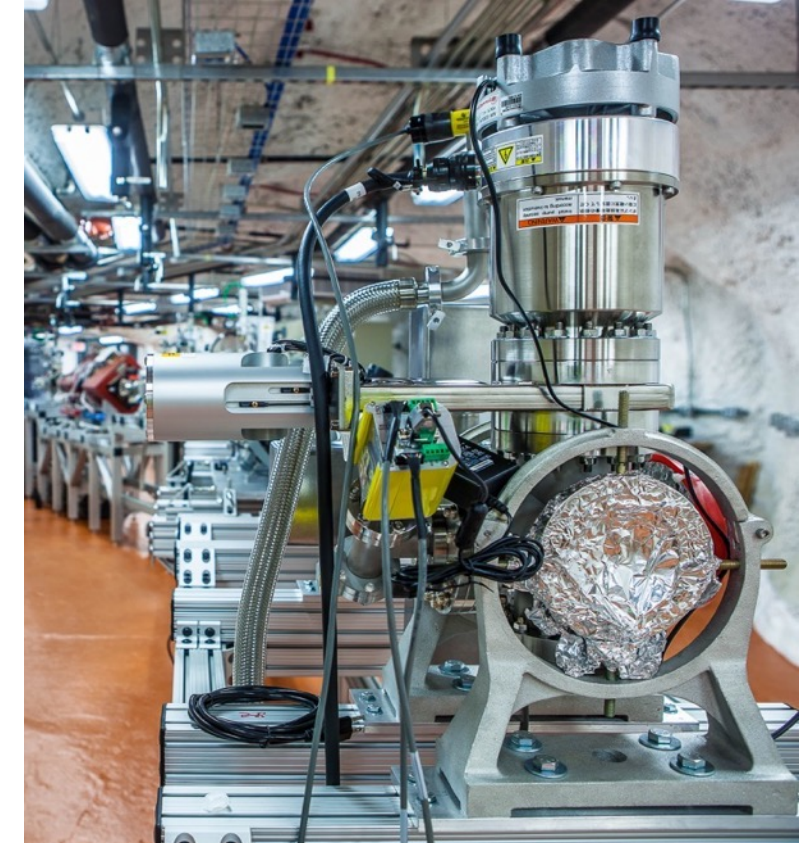
## LUX-ZEPLIN (LZ)

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



## MAJORANA DEMONSTRATOR (MJD)

- Investigate **neutrinoless double-beta decay** using 44 kg Ge
- Final Ge result July 2022, Ta-180 decay search first results June 2023



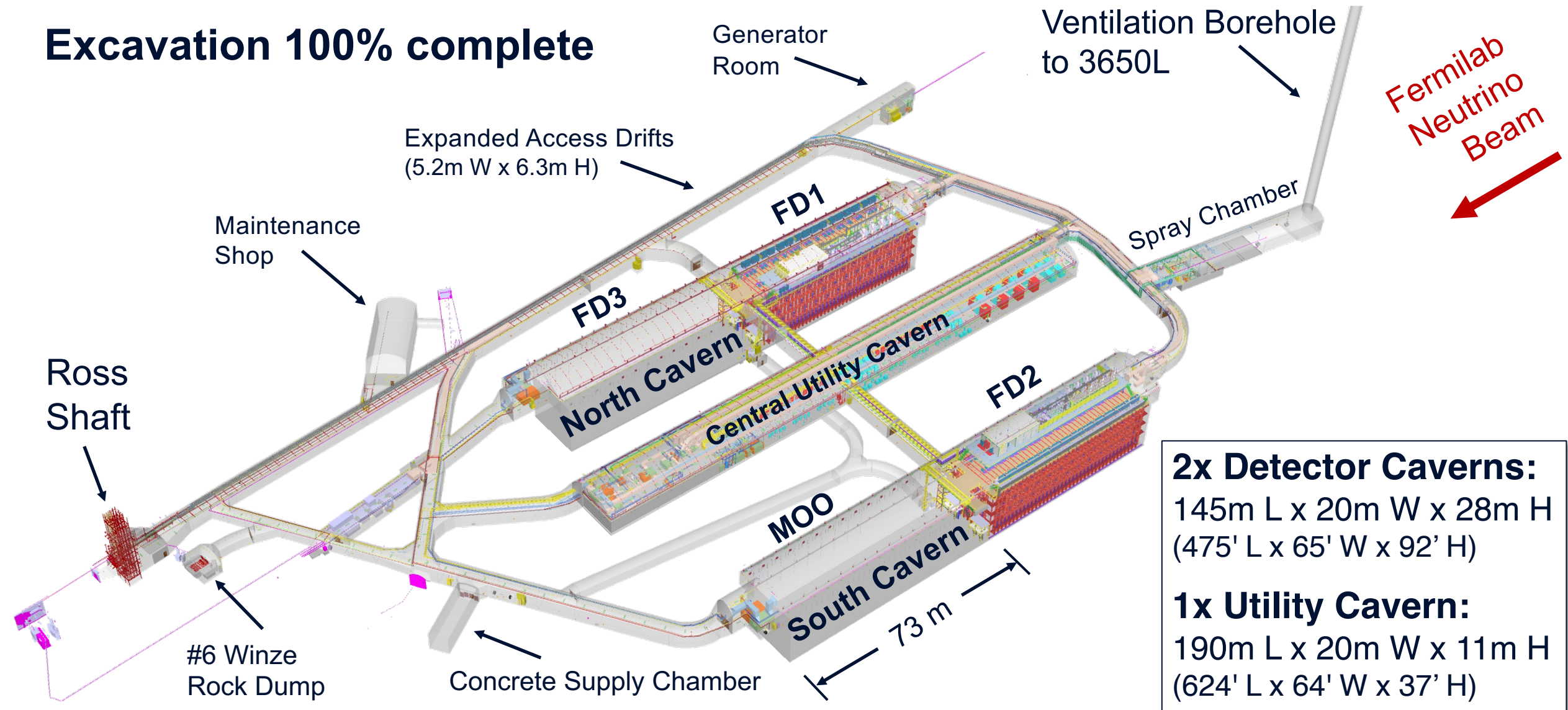
## CASPAR

- Stellar fusion reactions to study **nucleosynthesis** using accelerator
- Initial phase ended in 2021, next phase starting in 2024

# Long-Baseline Neutrino Facility (LBNF)

LBNF will host the Deep Underground Neutrino Experiment (DUNE)

**Excavation 100% complete**



**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)

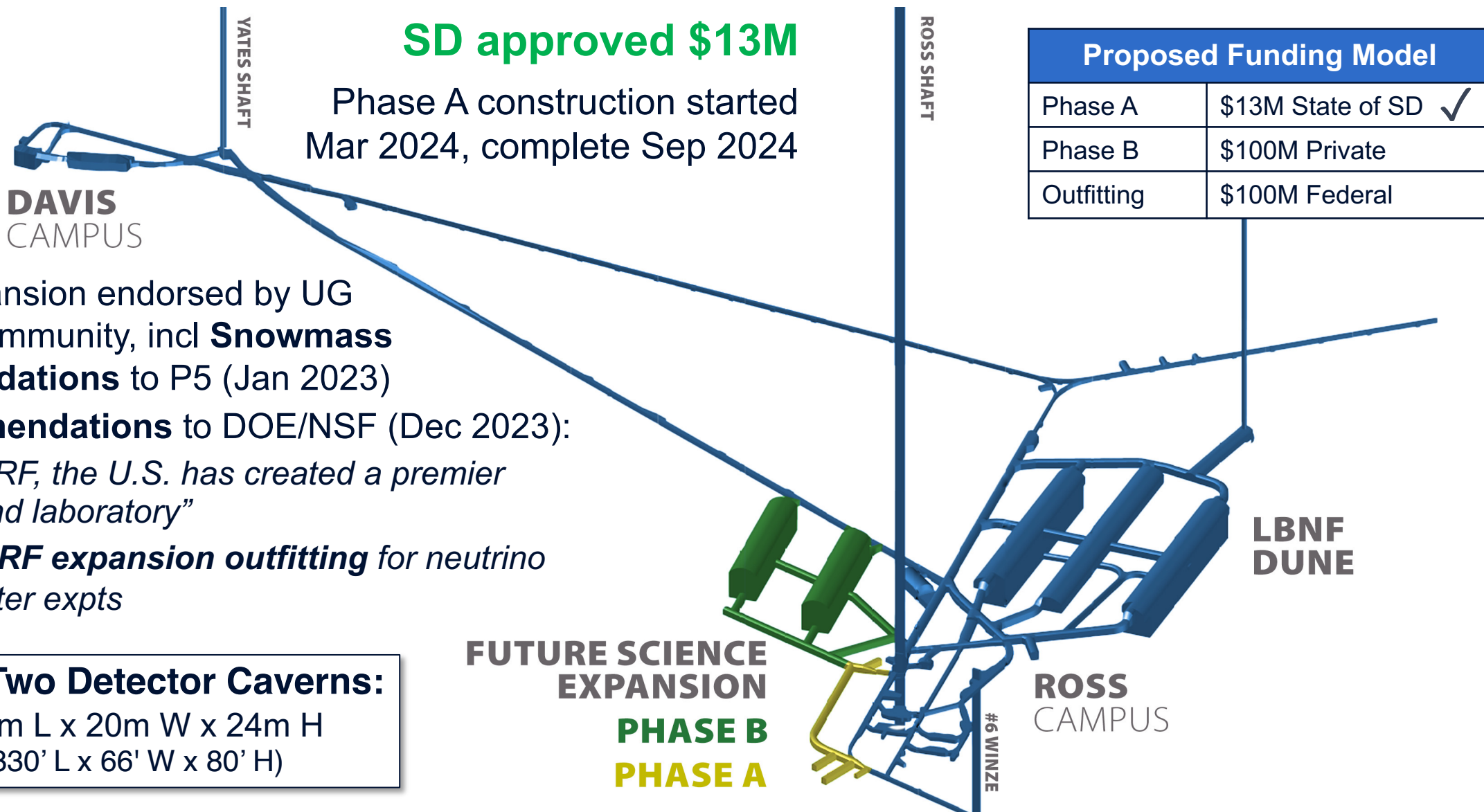


# LBNF North Cavern



# 4850L Space Needed for Future Experiments

U.S. strategic plan requires more space, community has endorsed expansion



**SD approved \$13M**

Phase A construction started  
Mar 2024, complete Sep 2024

- SURF Expansion endorsed by UG Science Community, incl **Snowmass recommendations** to P5 (Jan 2023)
- **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

**FUTURE SCIENCE EXPANSION**  
**PHASE B**  
**PHASE A**

**ROSS CAMPUS**

**LBNF DUNE**

**DAVIS CAMPUS**

YATES SHAFT

ROSS SHAFT

#6 WINZE





# 4850L Laboratory Expansion – Phase A

## Breakout Excavation Phase



Expansion: Multi-Purpose Niche



Expansion: Shop Drift



# 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](mailto:loi@sanfordlab.org))**



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

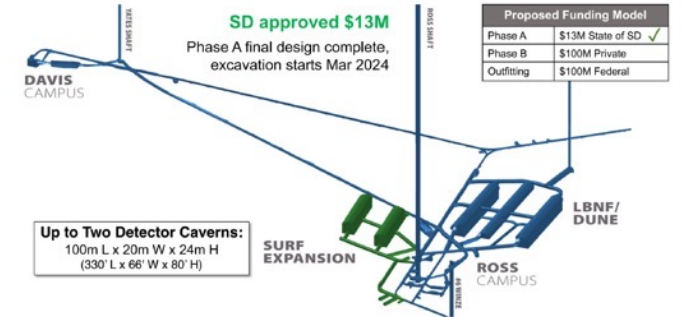
March 22, 2024

#### 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.



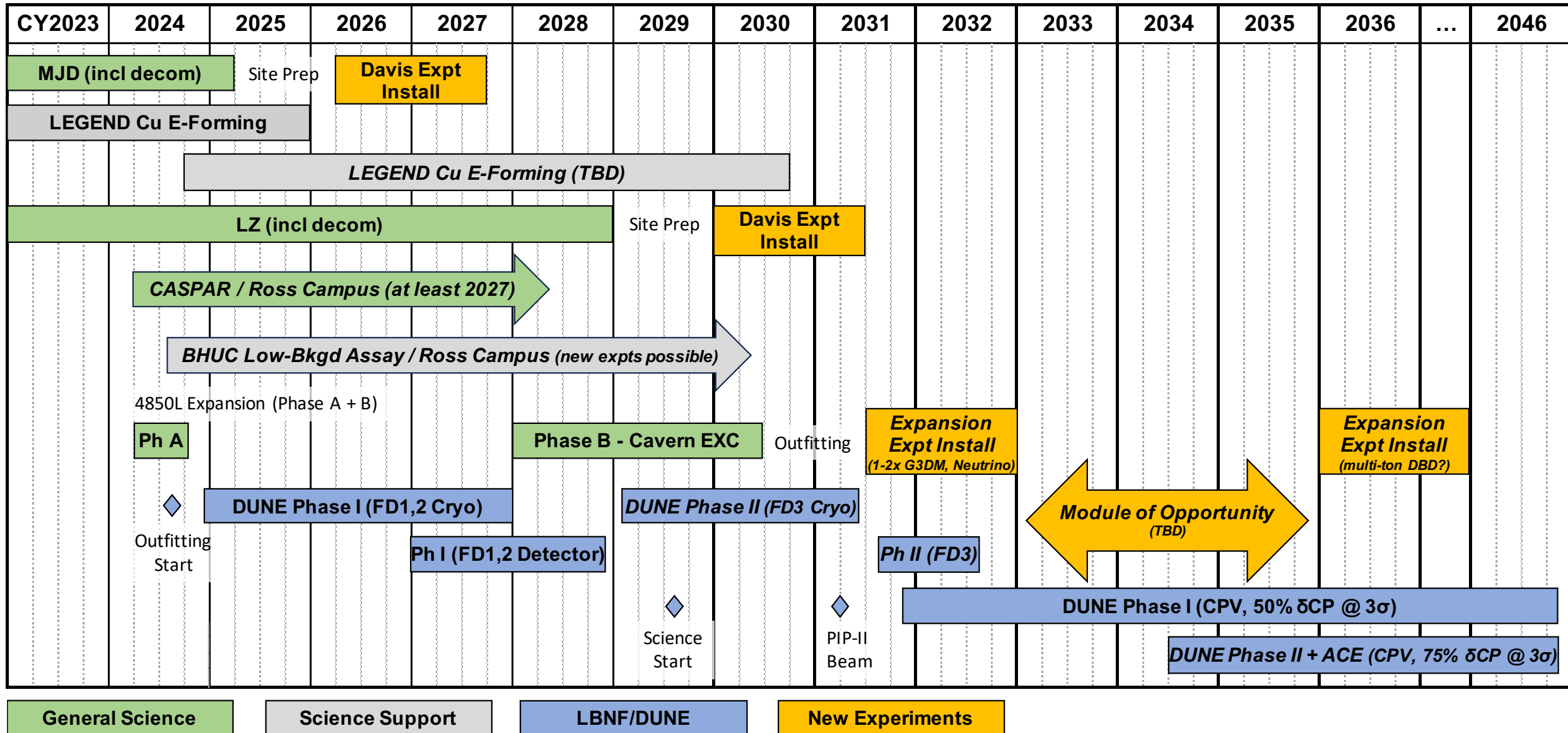
Leading into recent U.S. long-range planning, the SURF User Association held a Vision Workshop (<https://indico.sanfordlab.org/e/Vision2021>) and SURF participated in nuclear physics town halls and the particle physics Snowmass community input processes. As a result, SURF featured prominently in the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



# SURF Science Strategic Planning

## Timeline



# SURF Summary

- SURF has strong relationship with DOE that benefits UG science community:
  - DOE funding for SURF operations incl **mandate to support experiments**; anticipating DOE User Facility designation.
  - DOE funding for SURF infrastructure ensuring **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 experiments to deliver high-impact science, incl leveraging strong partnerships with U.S. national laboratories.
- SURF is playing a strong role in the UG science community:
  - **User Association** serving as catalyst for community discussions: <https://www.sanfordlab.org/surf-user-association>.
  - **Strong recognition** and support for SURF by community and in recent **P5 report for U.S. strategic planning**.
- SURF wants to host future world-leading experiments:
  - LBNF excavation done, outfitting starting in 2024. **DOE “Module of Opportunity”** expanded physics program.
  - Construction underway to **increase underground laboratory space**, plans advancing for new large caverns on 4850L (1500 m, 4100 mwe) on **timeframe of next-generation experiments (~2030)**.
  - **Call for Letters of Interest (LOIs)** underway to ensure existing and future space used to its fullest scientific potential, incl options for **cryogenic user facility** in existing laboratory space.
  - **SURF offers multiple deep laboratory options to host future new initiatives!**



# 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)



# Sanford Underground Research Facility

## General summary

**Site:** Deepest underground lab in U.S., dedicated to science (former Homestake Gold Mine). Significant footprint with multiple tunnels, access from surface to ~1500 m (total depth = 2450 m).

## Science Program:

- **Past:** Davis Solar Neutrino Experiment, LUX, MAJORANA DEMONSTRATOR ( $0\nu\beta\beta$ )
- **Current:** LZ, MAJORANA DEMONSTRATOR ( $^{180\text{m}}\text{Ta}$ ), CASPAR, Low-bkgd counting (BHUC), Geomicrobiology, Geoengineering (esp. geothermal), other industry/engineering
- **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  $0\nu\beta\beta$ , etc
  - QIS, atom interferometry (gravitational waves, dark matter), etc

## Facility:

- **4850L Existing:** Davis Campus operating well, re-open Ross Campus in 2024 (closed due to LBNF)
- **4850L LBNF/DUNE:** Excavation complete for all caverns, outfitting expected complete in 2026
- **4850L Expansion:** Up to 2x caverns (100m L x 20m W x 24m H), develop in 2 phases (Phase A fully funded), excavation complete by ~2030, outfitting by DOE-HEP (or private)
- **7400L Expansion:** One or more caverns (75m L x 15m W x 15m H), funding/schedule TBD



# Sanford Underground Research Facility

## Physical characteristics

- **Property:** 1 km<sup>2</sup> (surface) with ~1600 m<sup>2</sup> storage (incl drill core) and 355 m<sup>2</sup> staging/assembly space; 31 km<sup>2</sup> (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 currently undergoing extensive maintenance). 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 =  $5.31 \times 10^{-5}$   $\mu\text{m}^2/\text{s}$  (4.6  $\mu\text{m}^2/\text{d}$ ). Several other UG elevations for science: 300L, 800L, 1700L, 2000L, 4100L, 4550L.
- **Space:**
  - Surface (science space, as low as class 10-100): 210 m<sup>2</sup> (cleanrooms = 92 m<sup>2</sup> / 914 m<sup>3</sup>)
  - 4850L (science space, as low as class 100): Davis Campus (1018 m<sup>2</sup> / 4633 m<sup>3</sup>), Ross Campus (920 m<sup>2</sup> / 3144 m<sup>3</sup>)
  - Radon-reduction: Surface = 2200x reduction @ 300 m<sup>3</sup>/h (Ateko), Davis = 700x reduction @ 150 m<sup>3</sup>/h (SD Mines)
- **Bkgds (4850L):** Radon = 170-570 Bq/m<sup>3</sup>, gamma = 1.9  $\gamma/\text{cm}^2/\text{s}$ , neutron =  $1.7 \times 10^{-2}$  n/m<sup>2</sup>/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.



# 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 ( $\sim 10 \mu\text{Bq/kg}$  U/Th)
- **Material production/purification:** One of only a few labs where UG Cu electroforming is performed (average U, Th decay chain  $\leq 0.1 \mu\text{Bq/kg}$ )
- **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**





# Sanford Underground Research Facility

## Where in the world is SURF?



# SURF Plans to Become DOE User Facility

## Benefits:

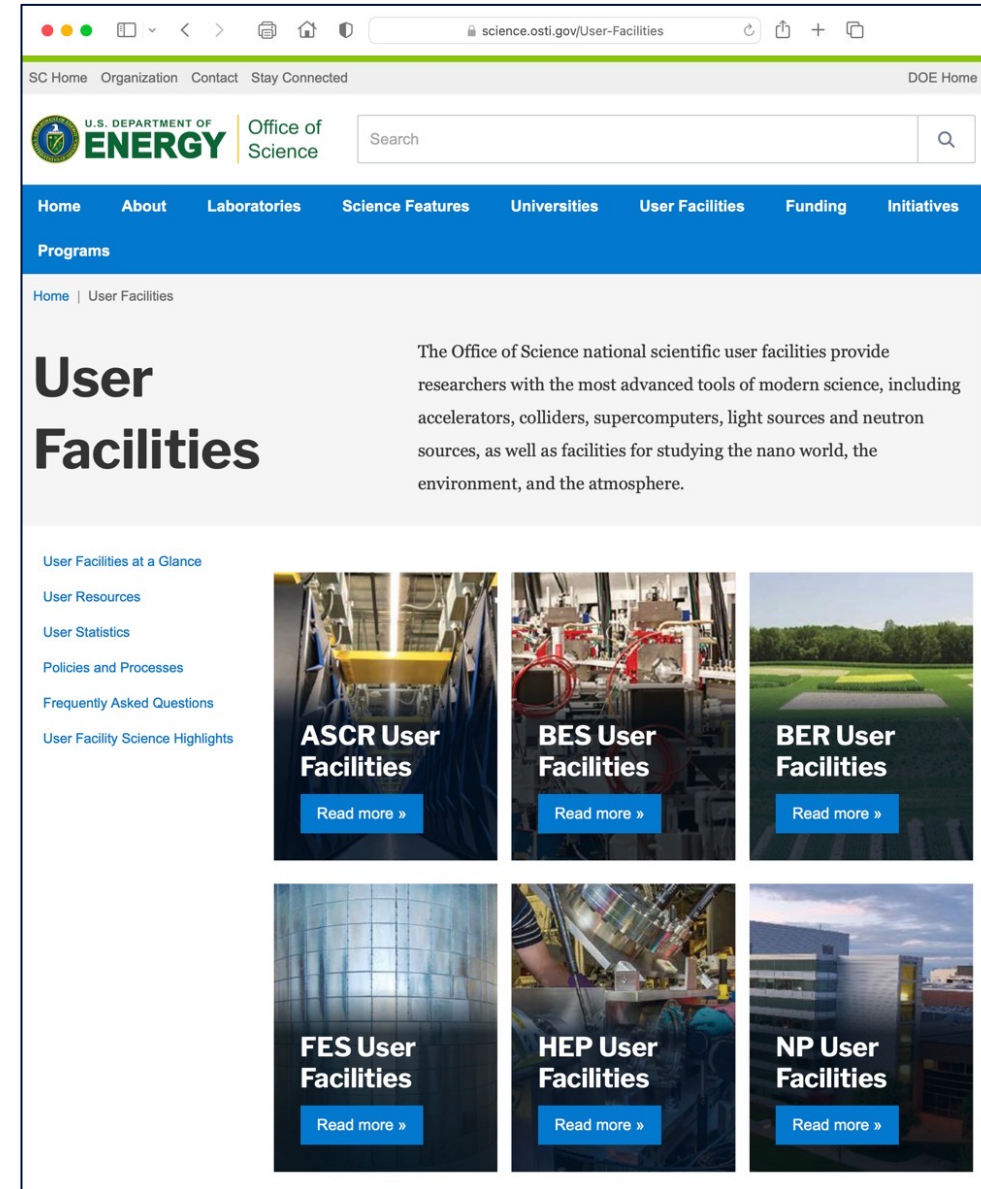
- Expands DOE User Facility portfolio to incl underground lab, raises SURF's stature within DOE community.
- Promotes underground science in U.S., increases funding opportunities.
- Enhances SURF's role in global science community.
- Communicates SURF is open to a broad range of science and users and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



# SURF Organization – Science Staffing

Resources to enable safe and successful implementation of experiments



**Markus Horn (PhD)**  
*Research Scientist*  
- Surface + UG Campuses

**Gavin Cox (MS)**  
*Expt Support Scientist*  
- LZ Operations



**Jaret Heise (PhD) - Director**  
- Manage dept and experiment implementation program



**Mark Hanhardt (MS)**  
*Expt Support Scientist*  
- Surface + UG Campuses



**Julia Delgaudio (BS)**  
*Expt Support Scientist*  
- LZ Operations



**Robyn Weis - Lab Custodians (Surface + UG) - Dee Espinosa**



**Doug Tiedt (PhD)**  
*Research Scientist*  
- Surface + UG Campuses

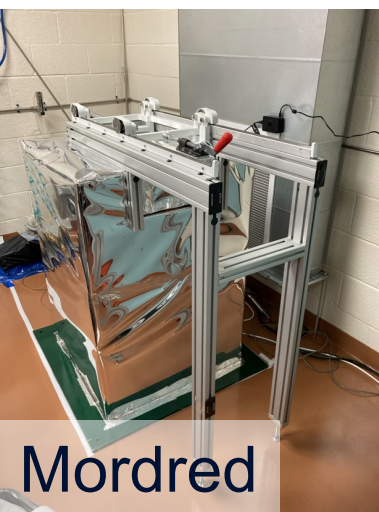
**+ Many Others!**  
**Engineering, ESH, OPS...**

**Christopher Kreitzinger**  
*Support Associate*  
- Admin, User Association

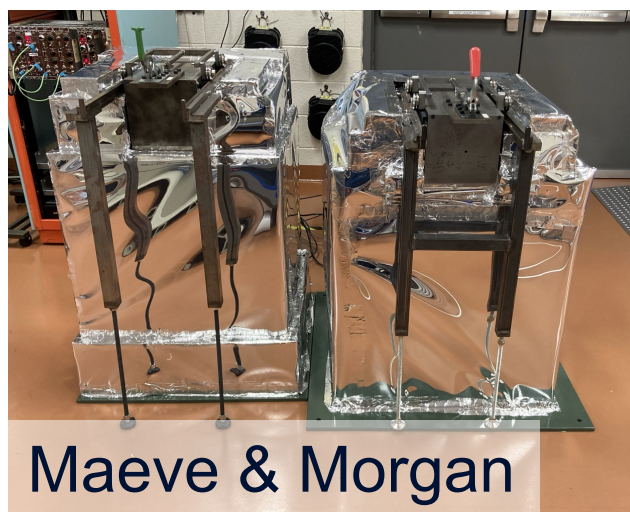


# SURF Material Assay at BHUC: Davis Campus

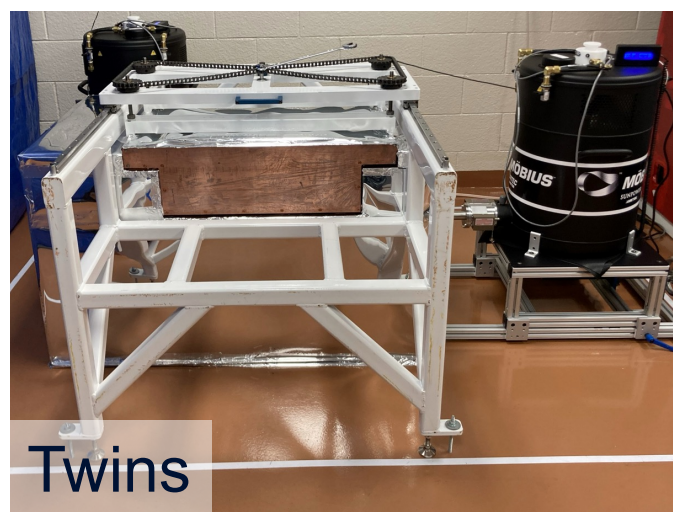
Low-background counting capabilities serving national & international community



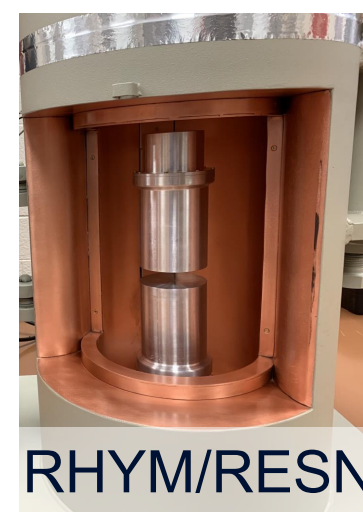
Mordred



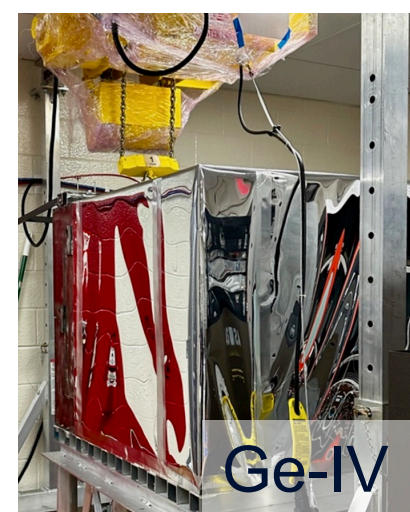
Maeve & Morgan



Twins



RHYM/RESN



Ge-IV

# SURF High-Impact Science

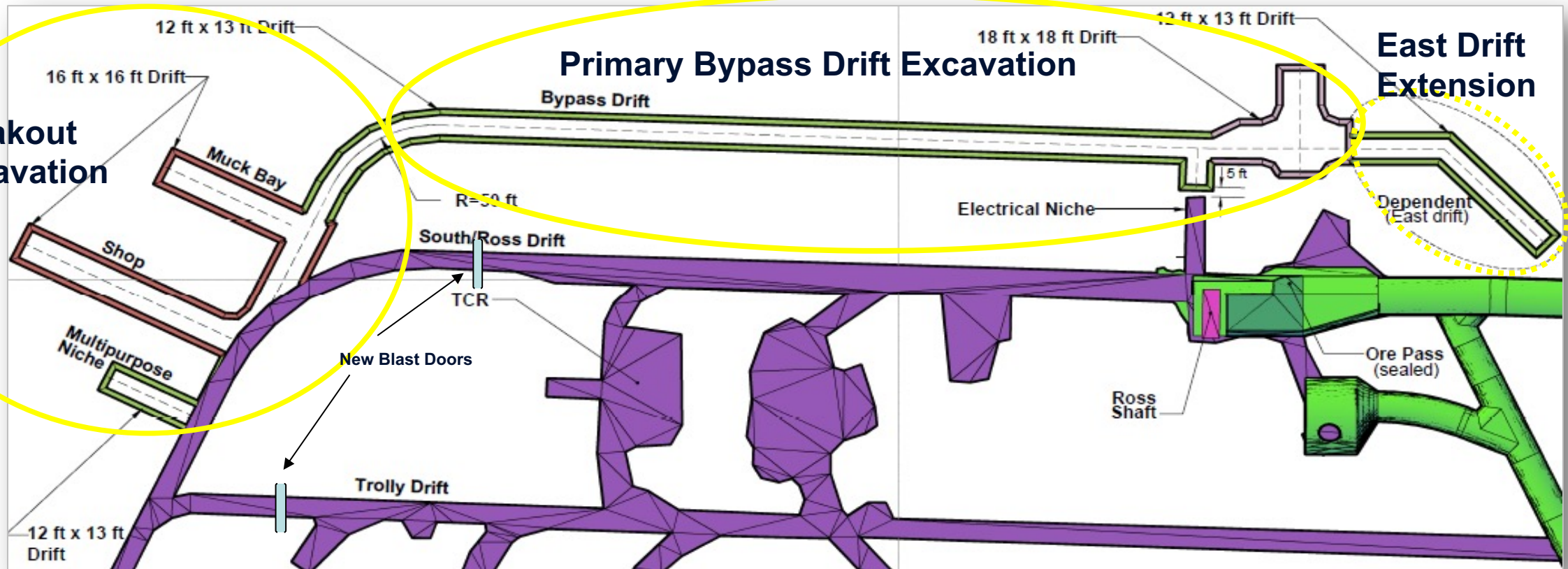
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# 4850L Laboratory Expansion – Phase A

## Bypass Drift layout and excavation phases



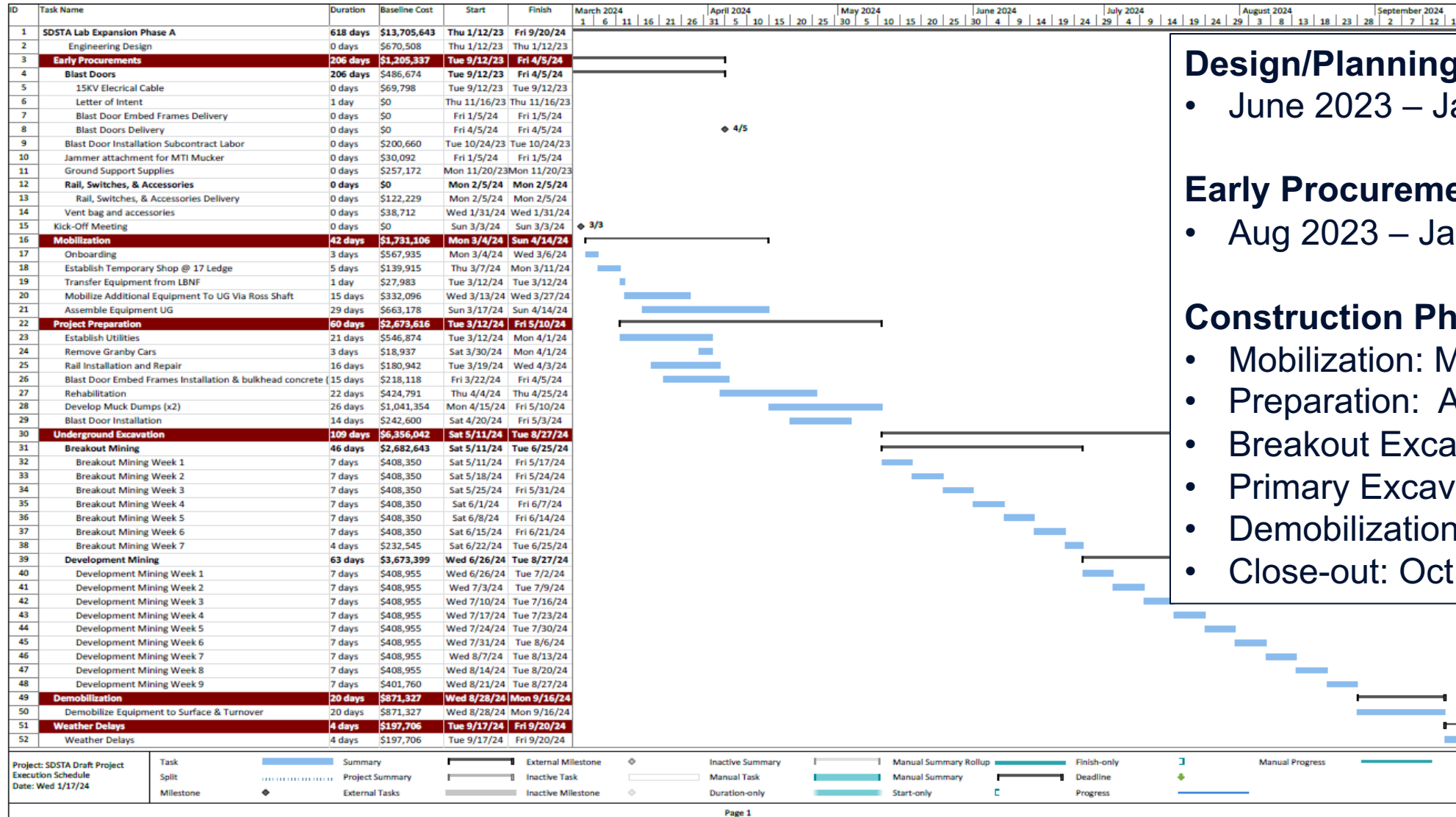
### Bypass Drift Excavation Phases:

- Breakout Excavations: Shop, Muck Bay, Multi-Purpose Niche
- Main Bypass Drift (3.7m x 4.0m / 12' x 13') & Ore Pass Development (5.5m x 5.5m / 18' x 18')
- East Drift Extension (3.7m x 4.0m / 12' x 13') [funding dependent]

*Excavation muck volume calculated as 8,800 LCY (using 8% overbreak), 4850L storage ~9,300 LCY*

# 4850L Laboratory Expansion – Phase A

## Project Schedule – Summary as of May 31<sup>st</sup>



### Design/Planning Phase – 7 months

- June 2023 – Jan 2024

### Early Procurements – 6 months

- Aug 2023 – Jan 2024

### Construction Phase – 6-7 months

- Mobilization: Mar - Apr
- Preparation: Apr - May
- Breakout Excavation: May-Jun
- Primary Excavation: Jun-Aug
- Demobilization: Sep
- Close-out: Oct

Project: SDSTA Draft Project Execution Schedule Date: Wed 1/17/24

Task Split Milestone

Summary Project Summary External Tasks

External Milestone Inactive Task Inactive Milestone

Inactive Summary Manual Task Duration-only

Manual Summary Rollup Manual Summary Start-only

Finish-only Deadline Progress

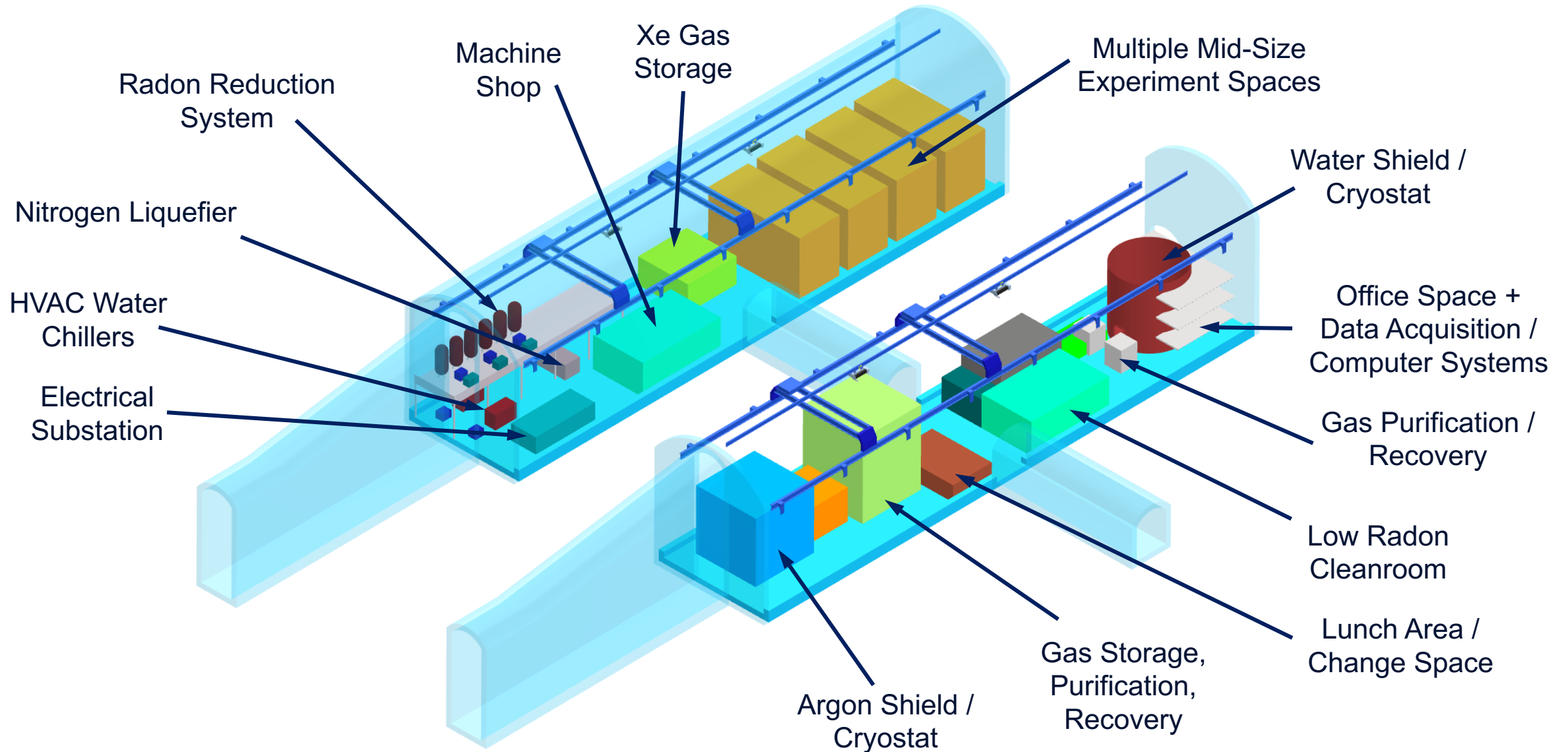
Manual Progress

Page 1



# Big Science at SURF

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







**North Cavern**



**South Cavern**

# 4850L Ross Station: LBNF Excavation Phase Ends!

Before



After



# SURF Infrastructure Improvement Projects (IIP)

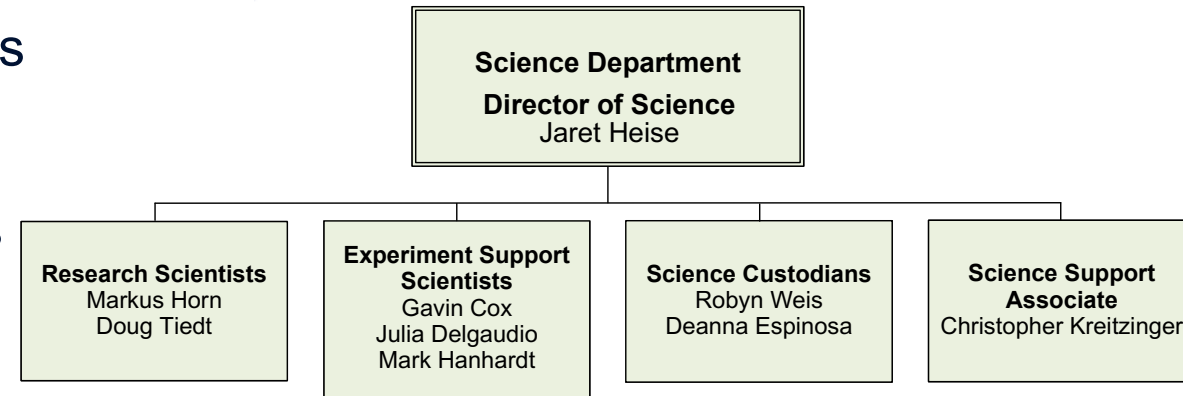
Significant ongoing DOE investments ensure safe and reliable facility for science

- **FY20** (\$9.5M)
  - Refuge Chamber
  - Headframe Security
  - Yates Cage MG Set
  - Davis Campus Chillers
  - Ross Complex Waterlines
  - Water Inflow System Replacement (Phase I)
- **FY22** (\$5.3M)
  - 3650L Pumproom Rehabilitation (Phase I)
  - Ross/Yates Hoistroom Roof Drains, Repointing
  - Replace Power Cables East Switchyard
  - WWTP RBC Replacement (Phase I)
- **FY24** (\$8.0 + \$1.0M)
  - WWTP RBC Replacement (Yr 2)
  - Dewatering System PLC
  - 1250L Pumproom Rehabilitation (Design)
  - 4850L Ross Campus Bathrooms
  - Electrical Distribution System Rehabilitation (Yr 1)
- **FY21** (\$5.5M)
  - Water Inflow System Replacement (Phase II)
  - Yates Shaft Concept Study
  - Industrial and Potable Water to Yates Complex (Phase II)
  - WWTP Gravity Flow Upgrades
  - Upgrade Oro Hondo Backup Ventilation System
- **FY23** (\$8.1M)
  - 3650L Pumproom Rehabilitation (Phase II)
  - Replace Yates Hoistroom Roof
  - WWTP RBC Replacement (Yr 1)
- **FY24-31** (TBD)
  - *Yates hoists (IIP?) and shaft refurbishment (DOE 413)*
  - *Surface Science Assembly Facility*
  - *Etc...*

# Science Organization and Scope

## Resources to enable safe and successful implementation of experiments

- **Main point of contact** for experiments and researchers
- **Experiment implementation process** management, incl coordination of review and authorization processes
- **Scientific support**, incl participation as collaboration members and technical experiment support (e.g., low-background counter operations, specialized welding, other experiment procedures as needed)
- **Science facility support**, incl coordination and oversight (e.g., laboratory coordinators), specialized custodial support and management of cleanliness protocols, technical monitoring, development of some laboratory orientation training
- **Represent SURF** (facility and science) at venues ranging from public presentations to scientific conferences to DOE strategic planning



### Dedicated Science Support (Current)

#### Science Support:

- Cox (1.0 FTE LZ)
- Delgaudio (1.0 FTE LZ)

#### Engineering Support:

- Taylor (up to **0.5 FTE general**)
- Maupin (0.2 FTE LZ, 0.8 FTE LBNF)
- Dunbar (0.5 FTE LZ, **0.5 FTE general**)

#### Engineering Technical Support:

- Geffre (1.0 FTE LZ)
- Jankord (0.05 FTE LZ, 0.95 FTE Other)
- Curran (0 FTE LZ, 1.0 FTE SDSTA)



# SURF Science Program

Research activities ranging from the surface to 1500+m underground

**Physics** LZ – *Dark matter, 2-phase Xe TPC*  
MAJORANA DEMONSTRATOR / LEGEND –  
*Neutrinoless double-beta decay,  
Ge-76, Ta-180m, also Cu e-forming*  
CASPAR – *Nuclear astrophysics with  
1 MV accelerator*  
LBNF/DUNE – *Neutrino properties, etc*  
BHUC – *BHSU Underground Campus,  
mainly material screening*  
  
Berkeley LBF – *Low-bkgd counter (x3);  
also CUBED – Low-bkgd counter (x1)  
(possibly future Crystal Growth)*  
nEXO – *Low-bkgd counter (x1)*  
LLNL – *Low-bkgd counter (x1)*  
SDSMT – *Neutron bkgds*

**Biology** Astrobiology/DeMMO – *In-situ culture, isolate DNA*  
2D Best – *Biofilms*  
Biodiversity – *Microbial communities*  
Biofuels – *Extremophile bioprospecting*  
m-sense – *Microbes and environment*  
Chemistry – *Env characterization*  
Liberty BioSecurity\* – *Extremophiles*  
Plant Growth – *Low EM, cosmic ray muons*

**Geology** CUSSP – *Geothermal*  
DEMO-FTES – *Geothermal*  
3D DAS – *Seismic monitoring using fiber*  
Core Archive\* – *Mainly gold deposits*  
Hydro Gravity – *Gravity for water tables*  
BH Seismic – *Global monitoring*  
Transparent Earth – *Seismic arrays*

**Engineering** AMD (was Xilinx, Inc)\* – *Chip error testing*  
Thermal Breakout – *In-situ stress*  
Shotcrete – *Mining safety*  
Enviro Monitoring – *Ventilation airflow*  
Caterpillar\* – *Mining technology*  
MAP – *Microbe-assisted phytoremediation*

**Total = 30 groups**

**22 Active Projects**

**68 Total Groups Since 2007**

Significant interest from others  
**(26 groups in 2023)**

\* Denotes  
proprietary group

Also Science Programs for Students: 2x DOE RENEW, 1x NSF REU



# SURF Material Assay at BHUC

Low-background counting capabilities serving national & international community

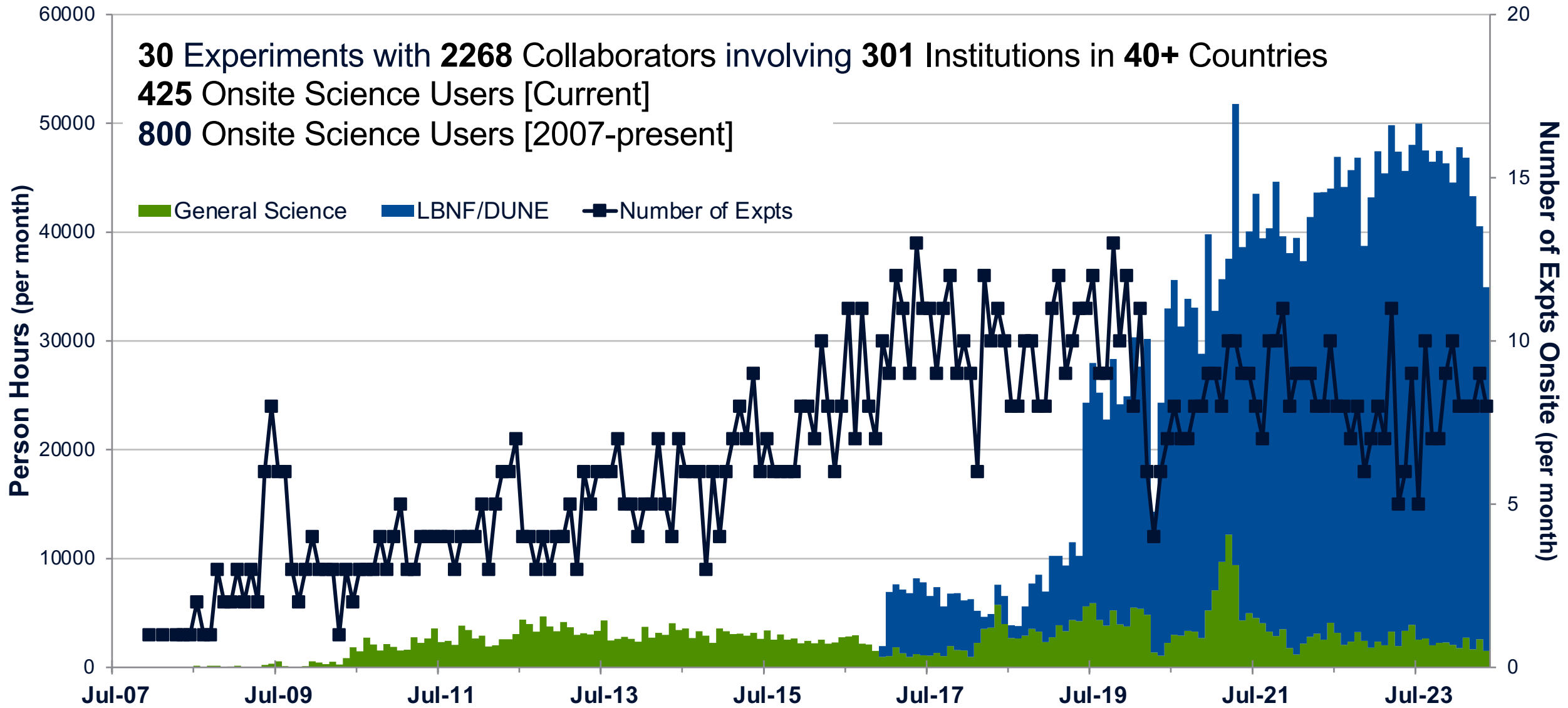
Detector	Crystal		[U]	[Th]	Install Date	Status	Comments
	Type	Size	mBq/kg	mBq/kg			
<b>Maeve</b> (BLBF)	p-type (85%)	2.2 kg	<b>0.1</b> (10 ppt)	<b>0.1</b> (25 ppt)	Davis Campus: Nov 2020 (Ross Campus: Nov 2015; Davis Campus: May 2014)	Production assays	Relocated from Oroville. Old Pb (200-yr old) inner shielding. Cooling system upgrade 2020.
<b>Morgan</b> (BLBF)	p-type (85%)	2.1 kg	<b>0.2</b> (20 ppt)	<b>0.2</b> (50 ppt)	Davis Campus: Nov 2020 (Ross Campus: Nov 2015; Davis Campus: May 2015)	Production assays	Low-bkgd upgrade 2015. Cooling system upgrades 2020.
<b>Mordred</b> (USD/CUBED, BLBF)	n-type (60%)	1.3 kg	<b>0.7</b> (60 ppt)	<b>0.7</b> (175 ppt)	Davis Campus: Nov 2020 (Ross Campus: Jul 2016; Davis Campus: Apr 2013)	Production assays	Low-bkgd upgrade 2015-2016, shield access upgrade. Cooling system upgrades 2020.
<b>Dual HPGe (“Twins”)</b> (BLBF, BHSU, UCSB)	p-type (2x120%)	2x 2.1 kg	<b>~0.01</b> (~1 ppt)	<b>~0.01</b> (~1 ppt)	Davis Campus: Sep 2020 (Ross Campus: Mar 2018, Jul 2017 (initial))	Operating	Low-bkgd upgrades 2016-2017; flexible shield. Cooling system upgrades 2020.
<b>Ge-IV</b> (Alabama, Kentucky)	p-type (111%)	2 kg	<b>0.04</b> (3 ppt)	<b>0.03</b> (8 ppt)	Davis Campus: May 2023, Nov 2020 (initial) (Ross Campus: Jul 2018, Oct 2017 (initial))	Operating until recently due to cryocooler issues	Vertical design, requires gantry + hoist. Cooling system upgrades 2020.
<b>Dual HPGe (“RHYM+RESN”)</b> (LLNL)	p-type (2x65%)	2x 1.1 kg	<b>&lt;0.1</b> (<10 ppt)	<b>&lt;0.1</b> (<25 ppt)	Davis Campus: Feb 2022, Sep 2020 (initial)	Operating	Cryocooler, low-E <sup>210</sup> Pb (<2 mBq/kg).

Also see: LZ Assay Paper <https://arxiv.org/pdf/2006.02506>

Local universities have some additional material screening capabilities: **HPGe** (SOLO [0.6 kg]/BHSU, [0.2-0.4 kg]/SD Mines), **ICP-MS** (BHSU), **Rn emanation** characterization (0.1 mBq/SD Mines), **Alpha** (1 mBq/m<sup>2</sup> <sup>210</sup>Po/SD Mines; XIA UltraLo-1800/LZ purchased)

# SURF Science Program

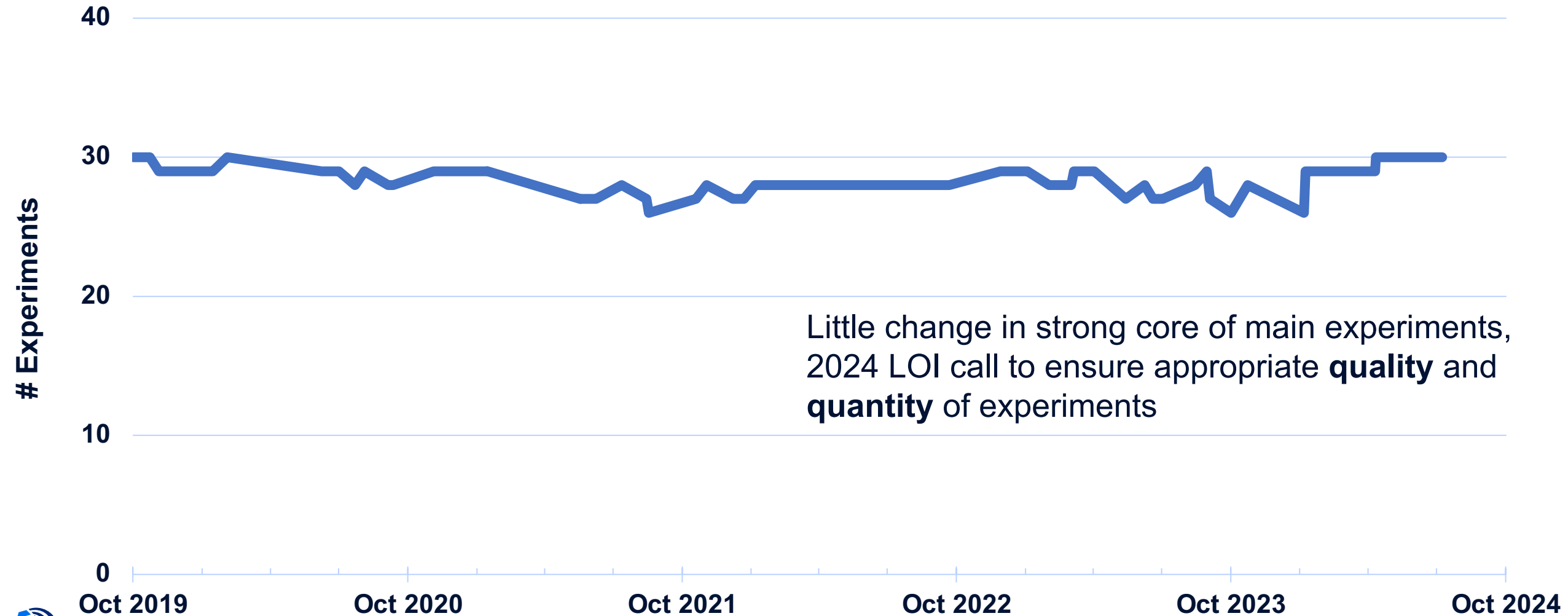
Hosting world-leading experiments and researchers from diverse scientific communities



# SURF Science Program

Hosting world-leading experiments and researchers from diverse scientific communities

## SURF Experiment Trend



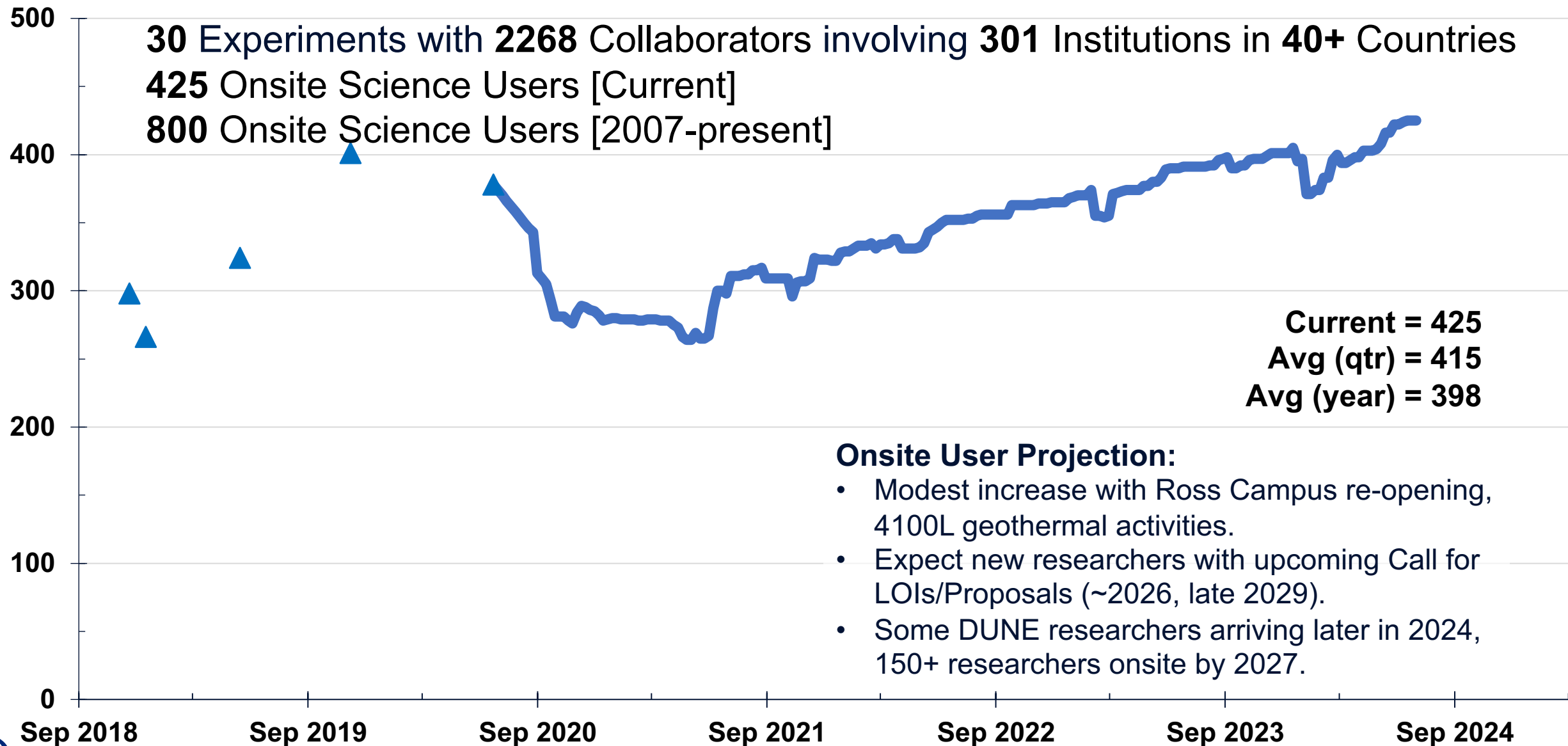
Little change in strong core of main experiments, 2024 LOI call to ensure appropriate **quality** and **quantity** of experiments





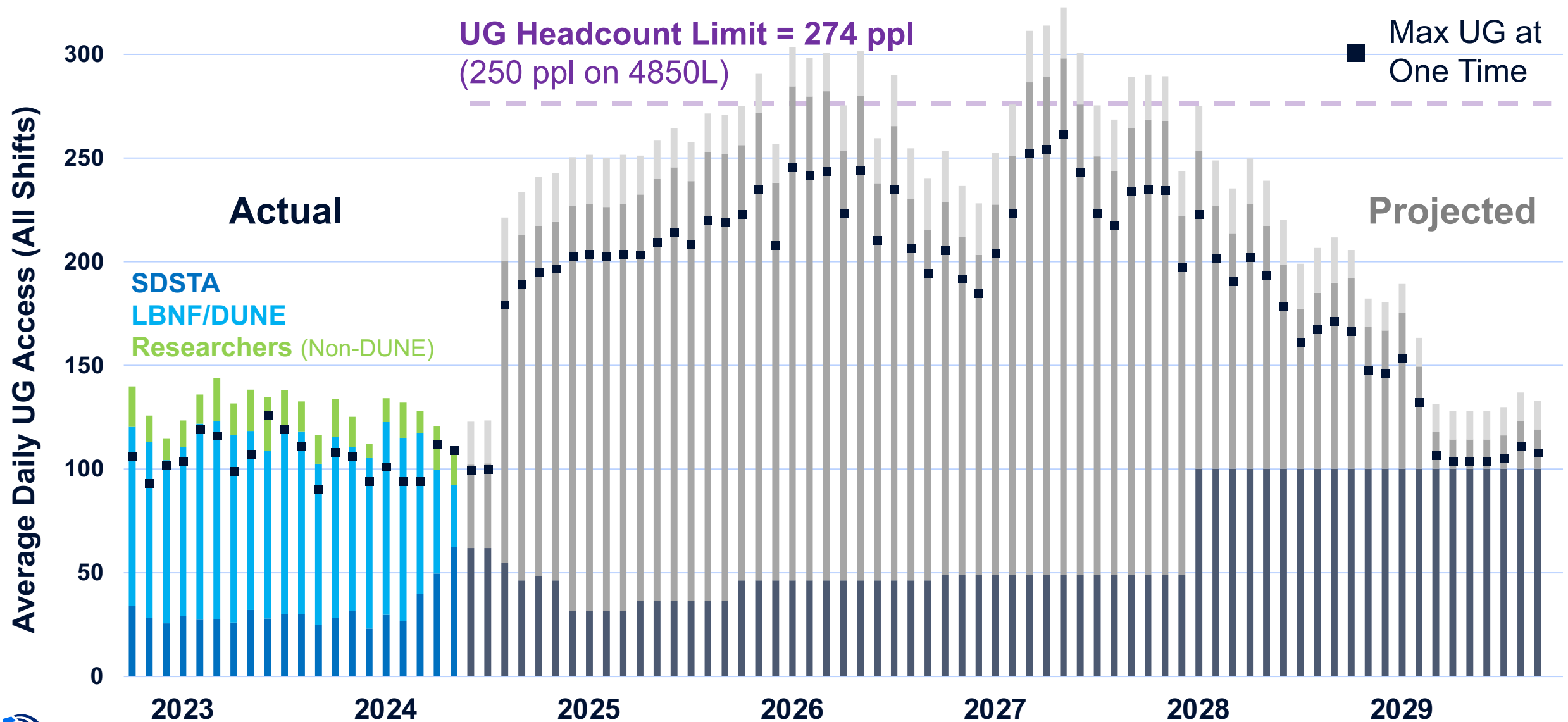
# SURF Onsite Users

Significant user base, expect more engagement with UG science community



# SURF Average Daily Underground Access

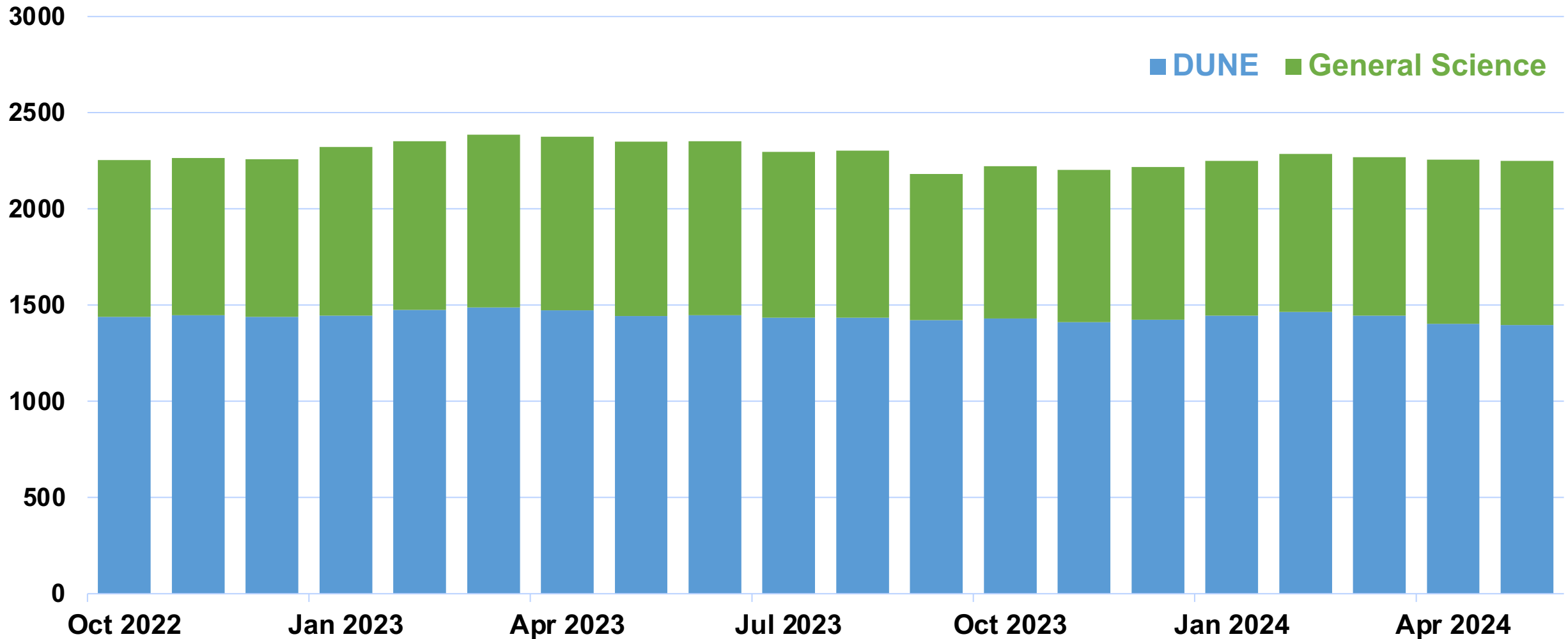
Includes SDSTA + Contractors, Researchers, LBNF/DUNE (BSI, FDC, Consortia)



# SURF Science Program

Hosting world-leading experiments and researchers from diverse scientific communities

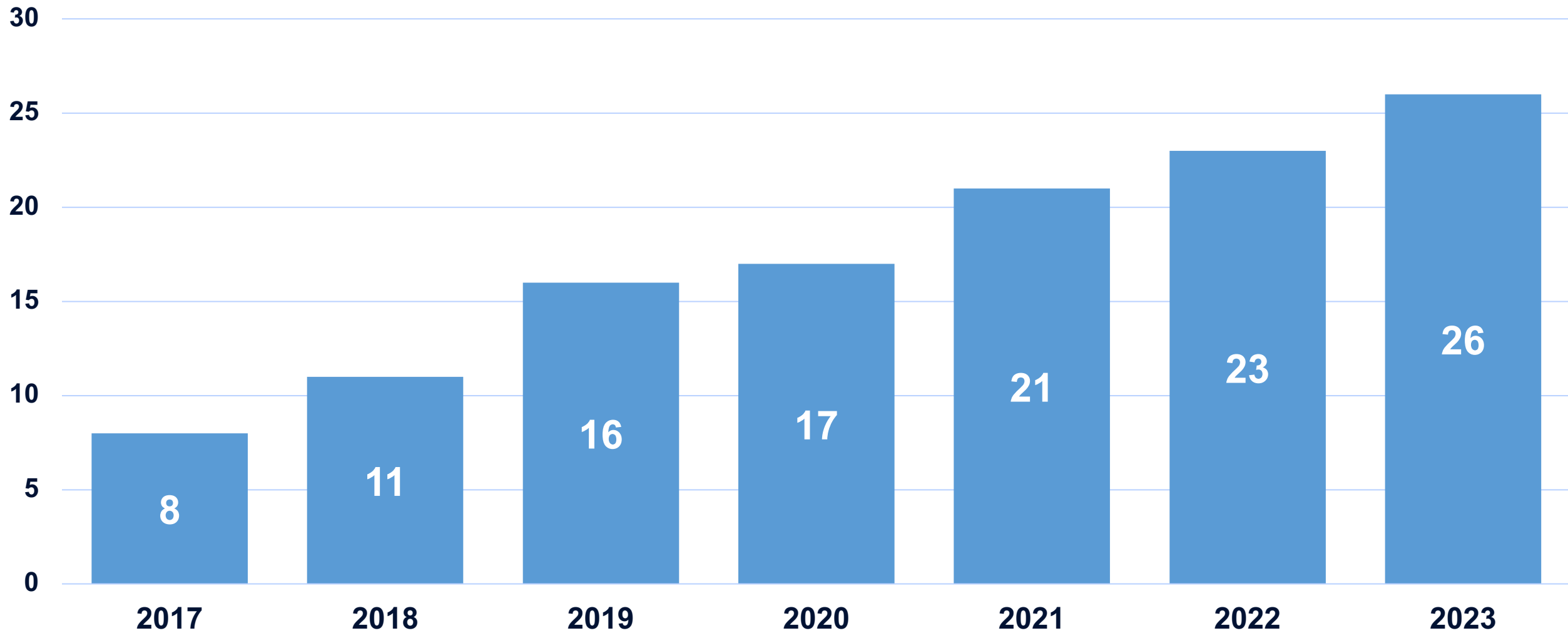
## SURF Collaborator Trend



# SURF Science Program

Hosting world-leading experiments and researchers from diverse scientific communities

## SURF Expressions of Interest



# SURF User Association

<https://www.sanfordlab.org/surf-user-association> (incl registration)

## Purpose

- **Two-way communication** on topics important to researchers.
- Promotes a **sense of community** amongst SURF experiments and researchers.
- Articulates and promotes **scientific case for UG science** and significance to society, provides channel for **advocacy**.

## Organization

- **Membership** open to all UG science community.
- **Executive Committee** consists of 9 individuals across scientific disciplines, incl early career. Quarterly meetings with SURF Management.

## Meetings

- **General meetings** typically held annually, session planned for CoSSURF (May 16, 2024).
- **Topical workshops**, incl community planning (e.g., Vision Workshop 2021). Next workshops 2024/2025.

The screenshot shows a detailed timetable for an event on May 16, 2024. The 'SURF User Association Meeting' is highlighted with a red circle. The meeting is scheduled for 14:00 at the Surbeck Center, SD Mines, and is presented by Frank Strieder. Other events include a lunch break, coffee break, and several scientific presentations.

Time	Event	Location	Presenter
12:00	Lunch		
13:00			
14:00	<b>SURF User Association Meeting</b>	Surbeck Center, SD Mines	Frank Strieder
15:00			
16:00			
17:00			

**May 16, 2024:**

SURF User Association Session During CoSSURF  
<https://indico.sanfordlab.org/event/68/timetable/-20240516.detailed>



# 2023 Particle Physics Strategic Plan

New 10-year goals established within globally-aware 20-year vision

Exploring  
the  
Quantum  
Universe

Pathways to Innovation  
and Discovery  
in Particle Physics

Report of the 2023 Particle Physics Project Prioritization Panel

## 2023 P5

P5 (Particle Physics Projects Prioritization Panel) reports to **HEPAP** (High-Energy Physics Advisory Panel) that advises High-Energy Physics of DOE Office of Science and Division of Physics of NSF. We will build on the “Snowmass” community study to hash out priorities for the next 10 years within 20-year context.

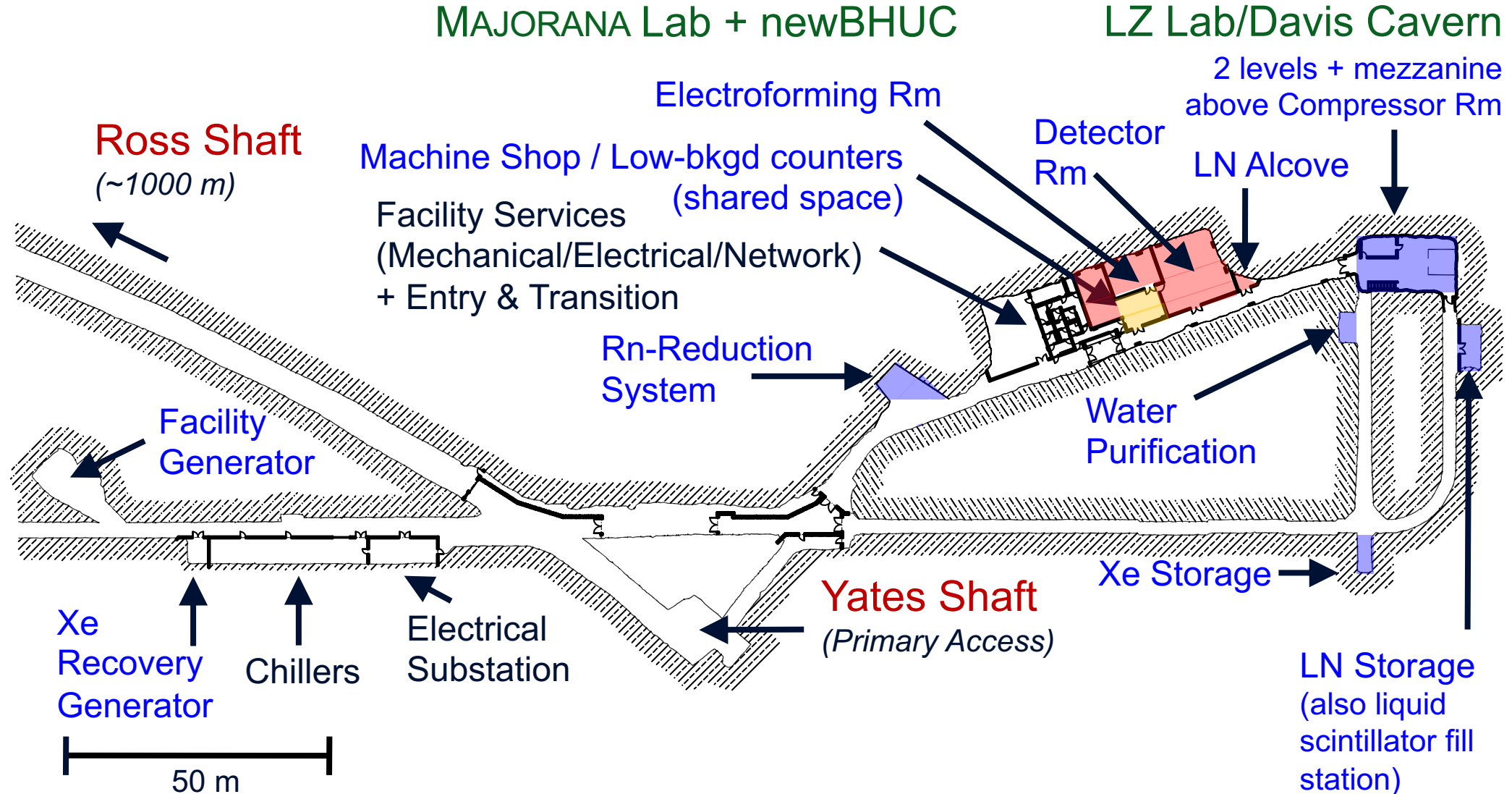
- Community input process “Snowmass” conducted through 2022
- Snowmass recommendations to P5 (Jan 2023):
  - **LBNF/DUNE Phase I & II and PIP-II**
  - Leverage LBNF to **increase underground space at SURF**
  - **Designate SURF as a formal U.S. DOE User Facility**
- P5 recommendations to DOE/NSF (Dec 2023):
  - “With SURF, the U.S. has created a premier underground laboratory”
  - **LBNF/DUNE Phase I & II and PIP-II (also “Module of Opportunity”)**
  - **G3 dark matter experiment (at least one), preferably sited at SURF**
  - **Fund SURF expansion outfitting for neutrino & dark matter expts**

A strategic plan for the High Energy Physics Advisory Panel



# 4850L Davis Campus

3,017 m<sup>2</sup> (Total) / 1,018 m<sup>2</sup> (Science)



# 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

Home About News Physics Hubs Fighting COVID-19 [Subscribe to Newswire](#)

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

**DATE ISSUED:**  
September 14th, 2020

**SOURCE:**  
Sanford Underground Research Facility

**CONTENT:**  
Press Release

**CONTACT:**  
Constance Walter  
**Communications Director**  
[cwalter@sanfordlab.org](mailto:cwalter@sanfordlab.org)

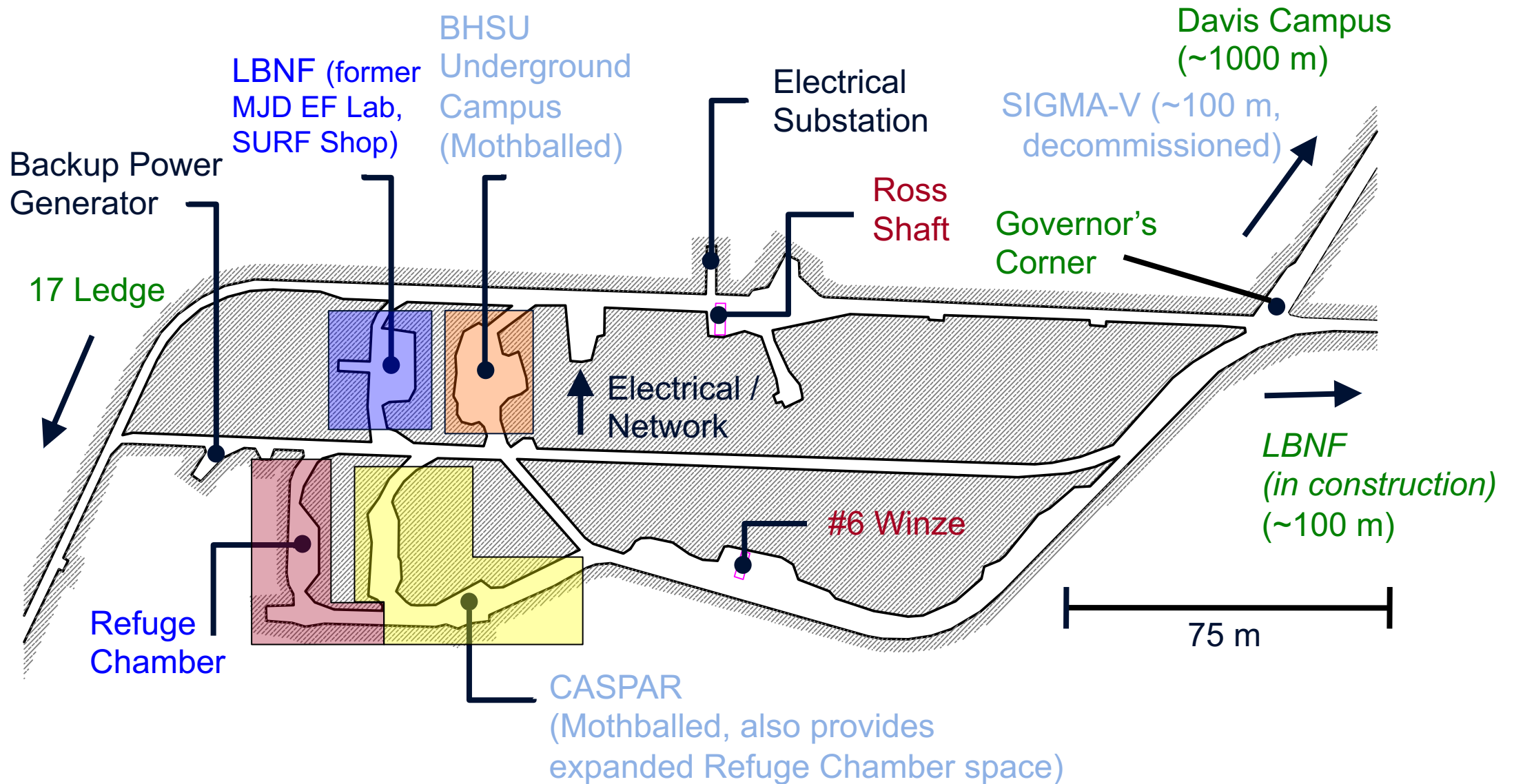
The American Physical Society (APS) today announced it has designated SURF one of two Historic Sites in physics. The other, Morgan State University in Baltimore, Maryland, is recognized as the birthplace of the National Society of Black Physicists (NSBP).





# 4850L Ross Campus

2,653 m<sup>2</sup> (Total) / 920 m<sup>2</sup> (Science)



# SURF 4850L Ross Campus

## Examples of laboratory space



2010-2017

### Former MJD Electroforming:

Area = 228 m<sup>2</sup>  
(Cleanroom removed,  
current construction office)

### CASPAR Hall:

Area = 236 m<sup>2</sup>,  
30 m × 3 m (min) × 2.8 m (H)



Copper Electroforming



2015-2020, resume 2024

### BHUC Cleanroom:

Cavern Area = 268 m<sup>2</sup>,  
Cleanroom = 12.1 m × 6.1 m ×  
2.4 m (H)



2015-2021, resume 2024



# SURF Current & Future Facilities

## Summary for various science campuses, including timelines

Location	Laboratory	Existing/ <i>Planned</i> Space		Available (CY)	Comments
		Area (m <sup>2</sup> )	Vol (m <sup>3</sup> )		
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 – 2 Rooms + BHUC share	300	1,279	~2025+/2026+	Initial scope completed 2021, Ta-180m data 2022-24 + decommissioning; Cu e-forming through 2025+
	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	Mothballed, equip and systems relocated to Davis Campus; re-occupy 2024 after LBNF excavation
	CASPAR	395	1,130	2027+	Mothballed, equip remains, re-occupy 2024 after LBNF excavation. (Also expanded Refuge Chamber)
	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	2025	DEMO-FTES use 2023-2024, CUSSP 2024-2027
4850L	<i>Expansion (2 proposed)</i>	4,022	94,608	<i>Earliest new: excavation 2027, complete ~2030</i>	<i>Each 20m (W) x 24m (H) x 100m (L)</i>
7400L	<i>New Labs (2 proposed)</i>	4,178	42,440		<i>Each 15m (W) x 15m (H) x 75m (L) + other supporting</i>

# SURF Experiment Implementation & Support

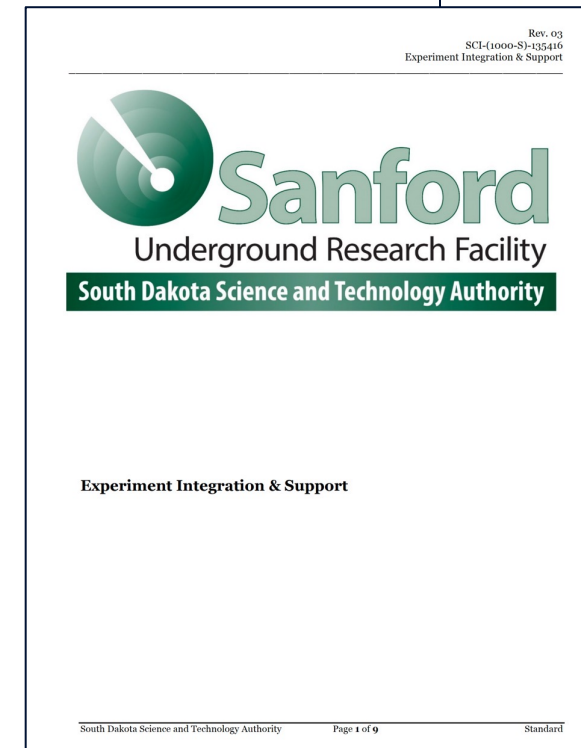
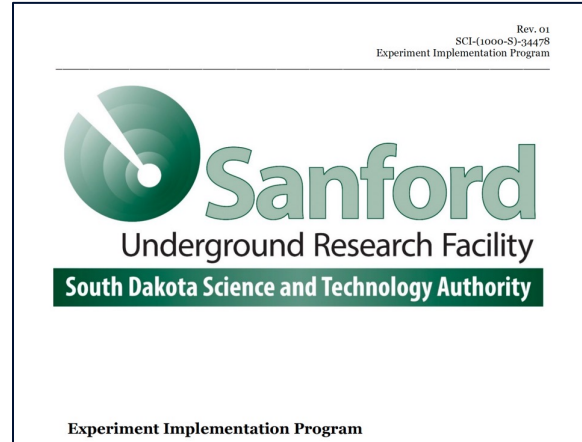
## Main Science documents under IMS/ISO document control

### Experiment Implementation Program

- Integral to the SDSTA institutional mission is advancement of compelling underground, multidisciplinary research
- EIP framework allows experiments to be implemented at SURF in effective and efficient manner
- References several key elements:
  - Experiment Planning Statement
  - User Agreement (was MOU)
  - Publication Policy
  - Experiment Decommissioning Statement

### Experiment Integration & Support

- In partnership with research groups, SDSTA aims to maintain a robust organization with resources to promote safe and successful experiment operations at SURF
- References several key elements:
  - Several specific ESH Standards (incl WPC)
  - SURF Applications/Databases (TAP, SARF, etc)
  - Table of responsibilities (SDSTA and Experiment)
  - Perception Survey, Information for Researchers Wiki, etc

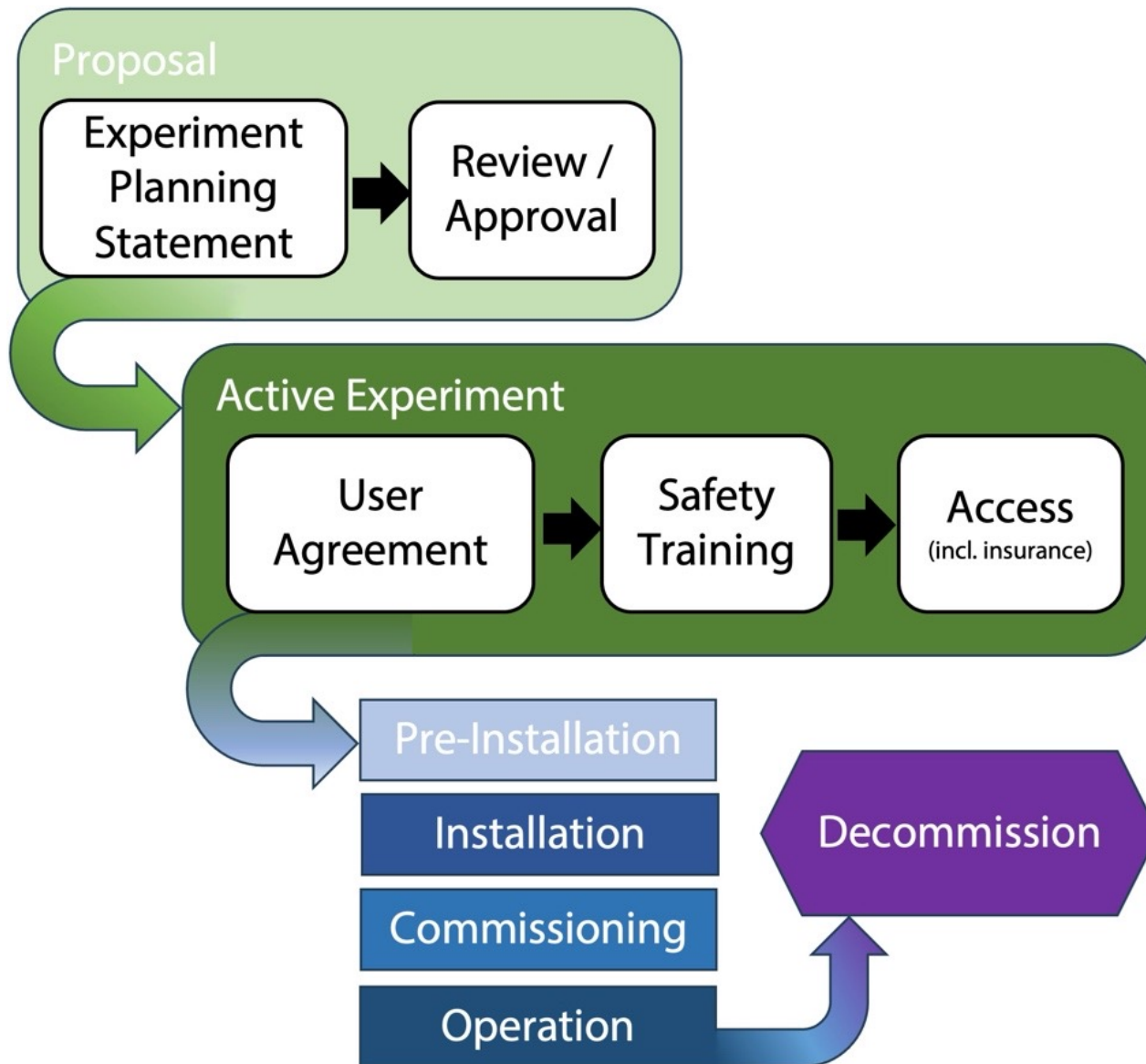


Technology Authority Page 1 of 21 Standard



# SURF Experiment Implementation Program

Identify interfaces and hazards within approval framework



<https://www.sanfordlab.org/proposal-guidelines>

The screenshot shows the Sanford Underground Research Facility's Research Proposal Guidelines webpage. The page title is "RESEARCH PROPOSAL GUIDELINES" and it states "All proposals must follow these guidelines". Under the "RESEARCHER RESOURCES" section, there is a list of links: "Proposal Guidelines", "Science Liaison Office", "SURF User Association", and "Visitor information". A numbered list of five steps is provided: 1. Read the [Experiment Implementation Program](#). 2. Read the [Experiment Integration and Support](#) document. 3. Complete a draft of the [Experiment Planning Statement](#) describing your project. 4. Contact the [SURF Science Director](#). 5. Complete the [User Agreement](#). The User Agreement references the SURF [waiver](#) required for underground access, the SURF [ESH Standards](#) and the SURF [Publication Policy](#). At the bottom, there is a "PROPOSAL DOCUMENTS" section with a list of downloadable files, including "SCI-(1000-S)-135416 Experiment Integration & Support.pdf", "SCI-(1000-F)-69417 User Agreement", "SCI-(1000-F)-34460 Experiment Planning Statement", "SCI-(1000-F)-212612 User Agreement Acknowledgement.docx", "SCI-(1000-S)-186874 Publication Guidelines.pdf", "Acknowledgement of Risk and Waiver", and "SCI-(1000-S)-34478 Experiment Implementation Program.pdf".



# The Institute for Underground Science at SURF



THE INSTITUTE  
FOR UNDERGROUND SCIENCE  
AT SURF

KNOWLEDGE.  
PEOPLE. PLACE.

BENEATH THE BLACK HILLS of South Dakota, researchers advance the future of world-leading science. The Institute for Underground Science at SURF will unite today's research and tomorrow's discoveries.



# Institute for Underground Science at SURF

## Activities since June 2023, formally launched December 2023

**THE INSTITUTE FOR UNDERGROUND SCIENCE AT SURF**  
CETUP\* 2024

17 June 2024 to 19 July 2024  
Lead/Deadwood Middle School  
US/Mountain timezone

**Overview**

- Call for Abstracts
- Timetable
- Paper Peer Reviewing
  - Reviewing Area
  - Judging Area
- Book of Abstracts
- Registration
- Surveys
- Organizing Committee
- Participant List
- Travel Information
- Hotel Accommodations
- Dining
- Tourism and Additional Information
- Pictures

**CETUP\* Mission:**

To promote organized research in physics, cosmology and astrophysics, related to science done in underground laboratories worldwide via individuals in a dynamic atmosphere of intense scientific interactions.

Around the globe more than 20 underground laboratories provide space for particle physics, astrophysics and cosmology, and geosciences, drawing scientists from all over the world. In response to the growing interests in underground science, the Center for Underground Physics and Related Areas (CETUP\*) brings together scientists to discuss experimental aspects of a variety of disciplines during its annual workshop.

CETUP\* provides a stimulating environment for creative thinking and open discussion, - and from different countries and scientific backgrounds - rising young scientists, discuss a broad range of topics, and collaborate. This intellectual community to address the most pressing questions in fundamental physics.

Since its inception in 2011, the workshop has been hosted in the Black Hills National Forest, near Lead/Deadwood, with the Sanford Underground Research Facility (SURF), the largest underground laboratory in the United States. The area's natural beauty attracts tourists and provides unique connections to Native American cultures and history.

**Previous Workshops:**

- CETUP\* 2023: Dark Matter, Neutrino Physics
- CETUP\* 2016: Physics and Instrumentation of the Near Detector for the Short-Baseline Neutrino Experiment, From Grand Unification to String Theory and Back, Dark Matter
- CETUP\* 2015: Dark Matter, Neutrino Physics (nuclear and particle physics), Cosmology
- CETUP\* 2014: Neutrino Interactions, Systematic Uncertainties, Near Detector
- CETUP\* 2013: Dark Matter, Neutrino Physics, Astrophysics, Particle Physics
- CETUP\* 2012: Dark Matter, Neutrino Physics, Grand Unification
- CETUP\* 2011: Geo-neutrinos, Neutrino Physics, Grand Unification

Starts 17 Jun 2024, 02:00  
Ends 19 Jul 2024, 17:00  
US/Mountain

Lead/Deadwood (0.3 miles, 7 min walk)  
Go to map

**THE INSTITUTE FOR UNDERGROUND SCIENCE AT SURF**

PROGRAMS DONATE CONTACT

## DEEPER TALKS: SURF SEMINAR SERIES

### Monthly Seminar Series

<https://institute.surf/deeper-talks>

Register for the next Deeper Talks

REGISTER HERE

May 8 - LAUNCH OF SERIES  
Speaker: Magdalena "Maggie" Osburn Ph.D.  
Topic: A decade of DeMNO: Microbes a mile underground at SURF

Event Details  
When: 2<sup>nd</sup> Wednesday of each month from 9:00 - 10:00 a.m. MT, launching May 8, 2024

**THE INSTITUTE FOR UNDERGROUND SCIENCE AT SURF**  
Quantum Partnership Workshop at SURF

Center

The **Quantum Partnership Workshop** is a collaborative gathering at the Sanford Lab Homestake Visitor Center, near the Sanford Underground Research Facility (SURF) in Lead, SD. The workshop is organized by the Great Plains Network (GPN) and The Institute for Underground Science at SURF, in partnership with the South Dakota Quantum Center initiative. This event is designed to foster synergies and forge new connections within the quantum research community.

**Date: Monday, July 15 - Tuesday, July 16, 2024**  
**Location: Sanford Lab Homestake Visitor Center, Lead, South Dakota**

The workshop will feature insightful presentations and discussions, including:

- **Institutional Overviews:** Gain comprehensive insights into the missions and visions of key institutions driving quantum research, including SURF, Great Plains Network, Dakota State University, and SD Mines.
- **Quantum Initiatives:** Delve into the latest developments and initiatives spearheaded by the SD Quantum Center, GPN Quantum Network, and High-Performance Computing (HPC) endeavors.
- **Quantum Curriculum:** Explore the evolving landscape of quantum education and training, examining strategies for curriculum development and implementation.
- **Brainstorming Forum on Partnerships and Next Steps:** Engage in dynamic discussions aimed at identifying collaborative opportunities and charting the course for future quantum endeavors.

Additionally, participants will have the opportunity to join a **surface tour of the Yates Hoistroom at SURF**.

The workshop will kick off on **Monday, July 15 at 4:30 p.m. MT with an evening of networking and camaraderie at the Sanford Lab Homestake Visitor Center**. Enjoy refreshments and connect with fellow attendees while immersing yourself in the story of the region, including the creation of the deepest gold mine in the Northern Hemisphere, to Nobel-Prize-winning science, to secrets of the universe still being uncovered at SURF.

Don't miss this opportunity to be part of transformative dialogue shaping the future of quantum exploration. Join us at the Quantum Partnership Workshop and be at the forefront of quantum innovation and collaboration.

Starts 15 Jul 2024, 16:30  
Ends 16 Jul 2024, 15:00  
US/Mountain

Sanford Lab Homestake Visitor Center Classroom  
160 West Main Street  
Lead, SD 57754

**Jun 17-Jul 19, 2024:  
CETUP\* 2024**

<https://indico.sanfordlab.org/e/CETUP2024>

**Jul 16, 2024:  
Quantum Partnership Workshop**

<https://indico.sanfordlab.org/event/80>



# The Institute for Underground Science at SURF

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

\$115M Projected Budget

- Breakdown:
  - \$65M Main Building
  - \$20M Housing
  - \$22.6M Annual



**THE INSTITUTE**  
FOR UNDERGROUND SCIENCE  
AT SURF



<https://institute.surf>

(Also: <https://vimeo.com/834559440>)

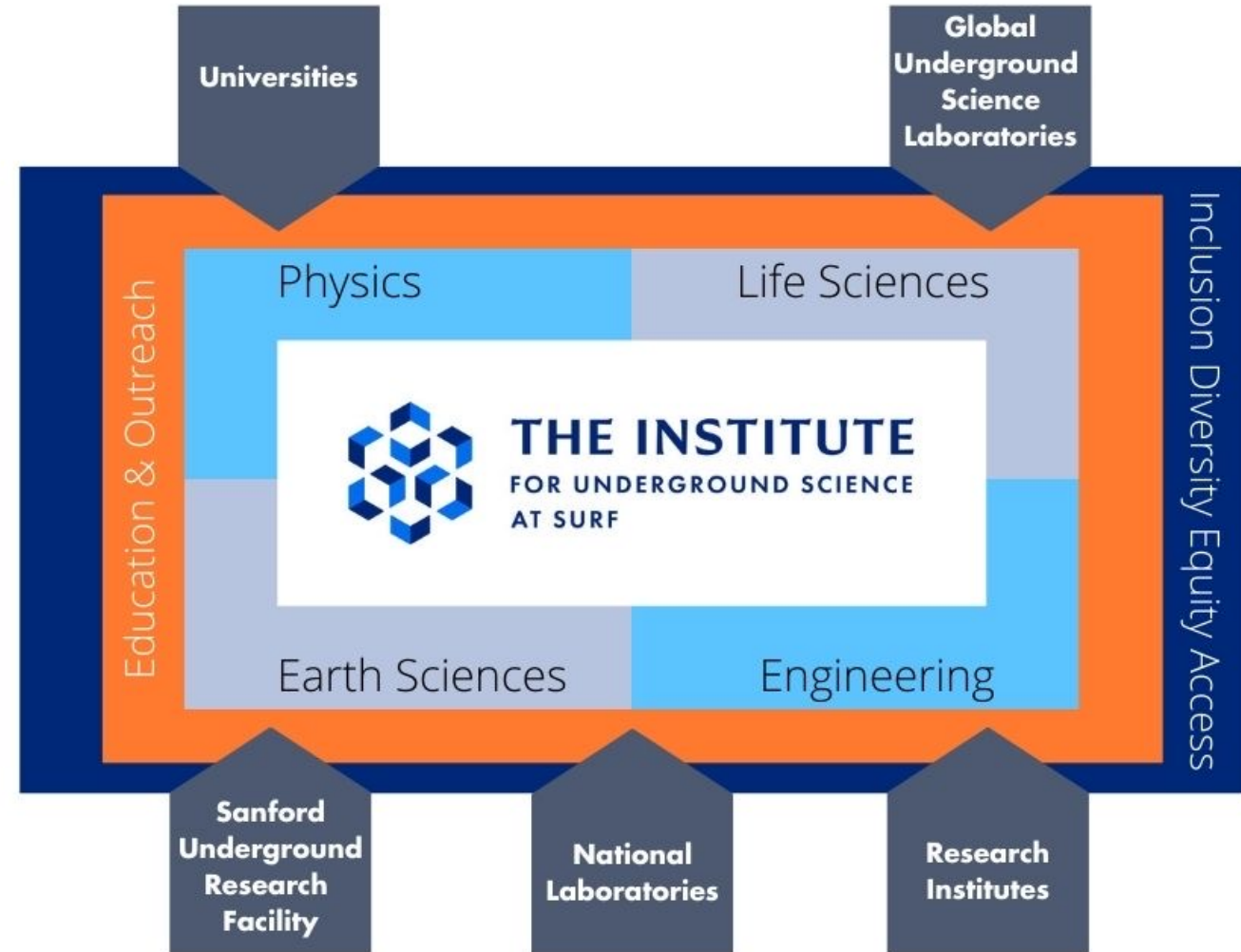




# Institute for Underground Science at SURF

Launched December 14, 2023

- World-leading center for underground science collaboration and intellectual community.
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- “Hub” for information on global underground science.
- Close collaboration and integration with the science and outreach programs.
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# Jaret Heise – Science Director

- **15 years** SDSTA Science Director
- **20 years** science management experience
- **27 years** experience in underground science

Participation in Sudbury Neutrino Observatory (SNO) experiment (6800-ft level of active nickel mine, now SNOLAB), which resolved Solar Neutrino Problem first posed by Ray Davis Homestake Chlorine Experiment

- Univ BC PhD Student at SNO  
(detector construction, supernova neutrino search)
- LANL Postdoctoral Researcher at SNO  
(led neutron detector installation)
- Queen's Univ SNO Detector Operations Manager  
(member of onsite management team)

