



**SANFORD
UNDERGROUND
RESEARCH
FACILITY**

Biology Research at SURF

Markus Horn

Research Scientist, SDSTA





Dr Markus Horn

More than 15 years in underground physics / laboratories

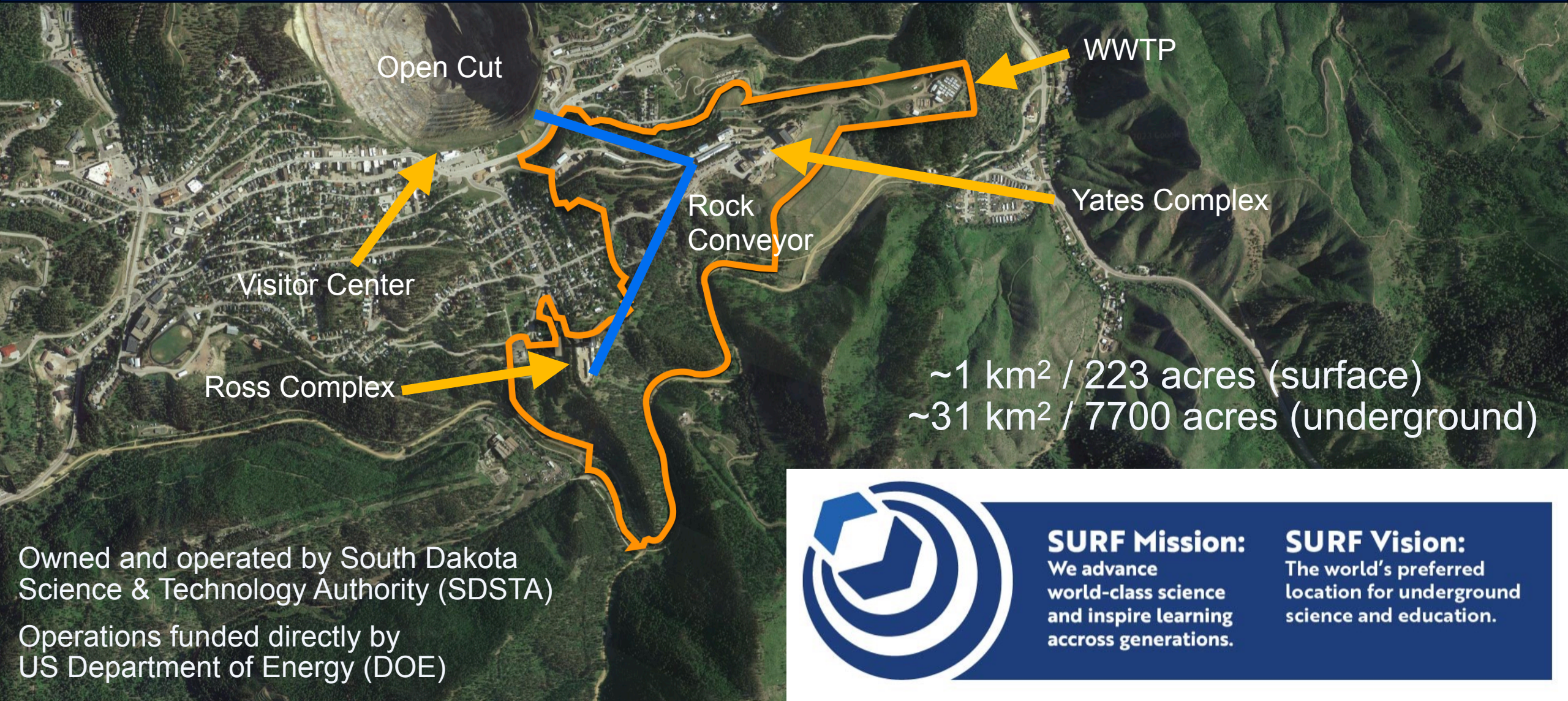
- PhD Astroparticle Physics University of Karlsruhe (KIT), GER
- Scientist at Imperial College London, Oxford University, Yale and UC Berkeley / LBNL
- Underground laboratory experience in France, United Kingdom and USA

2016 - present: Research Scientist, SDSTA

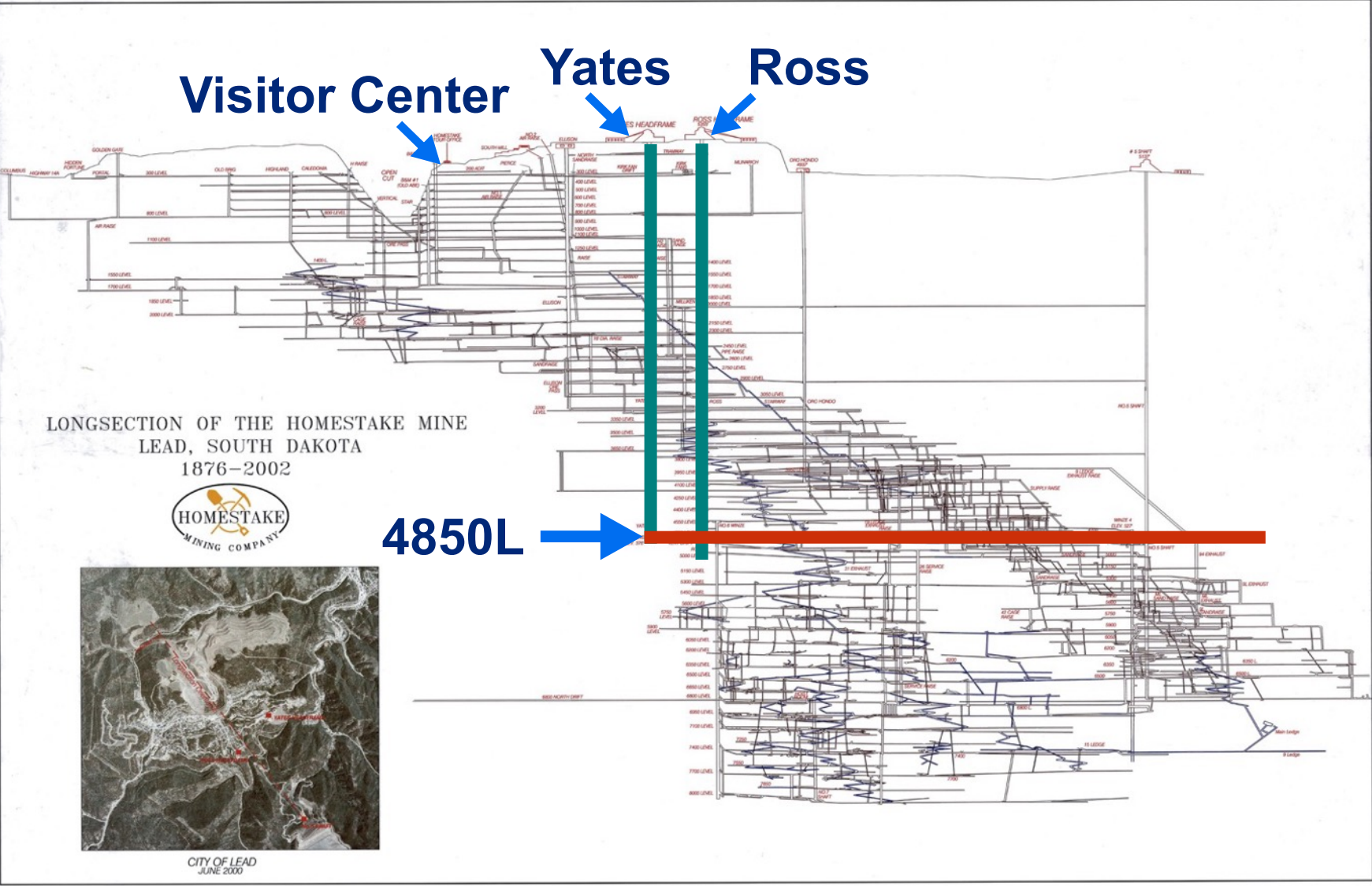
- Experiment point-of-contact (MJD, Bio-Geo-Eng & others)
- Member of LUX-ZEPLIN collaboration



Sanford Underground Research Facility



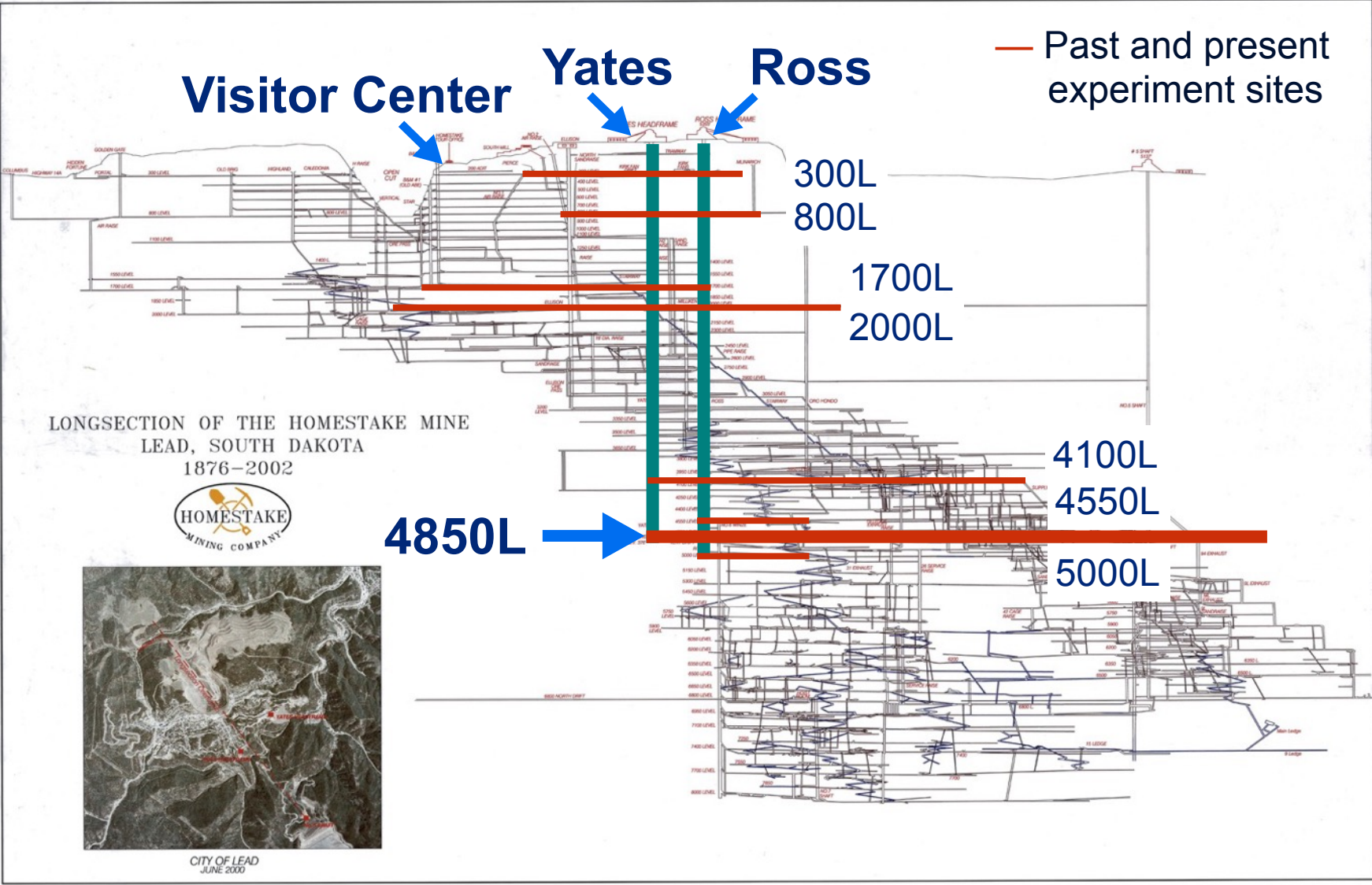
Homestake Mine Legacy



- ~ 600 km / 380 miles of tunnels from surface to 2.4 km / 8000 ft deep, 63 total elevations, 29 currently accessible
- ~ 35 km / 22 miles maintained for science and facility operations



Homestake Mine Legacy

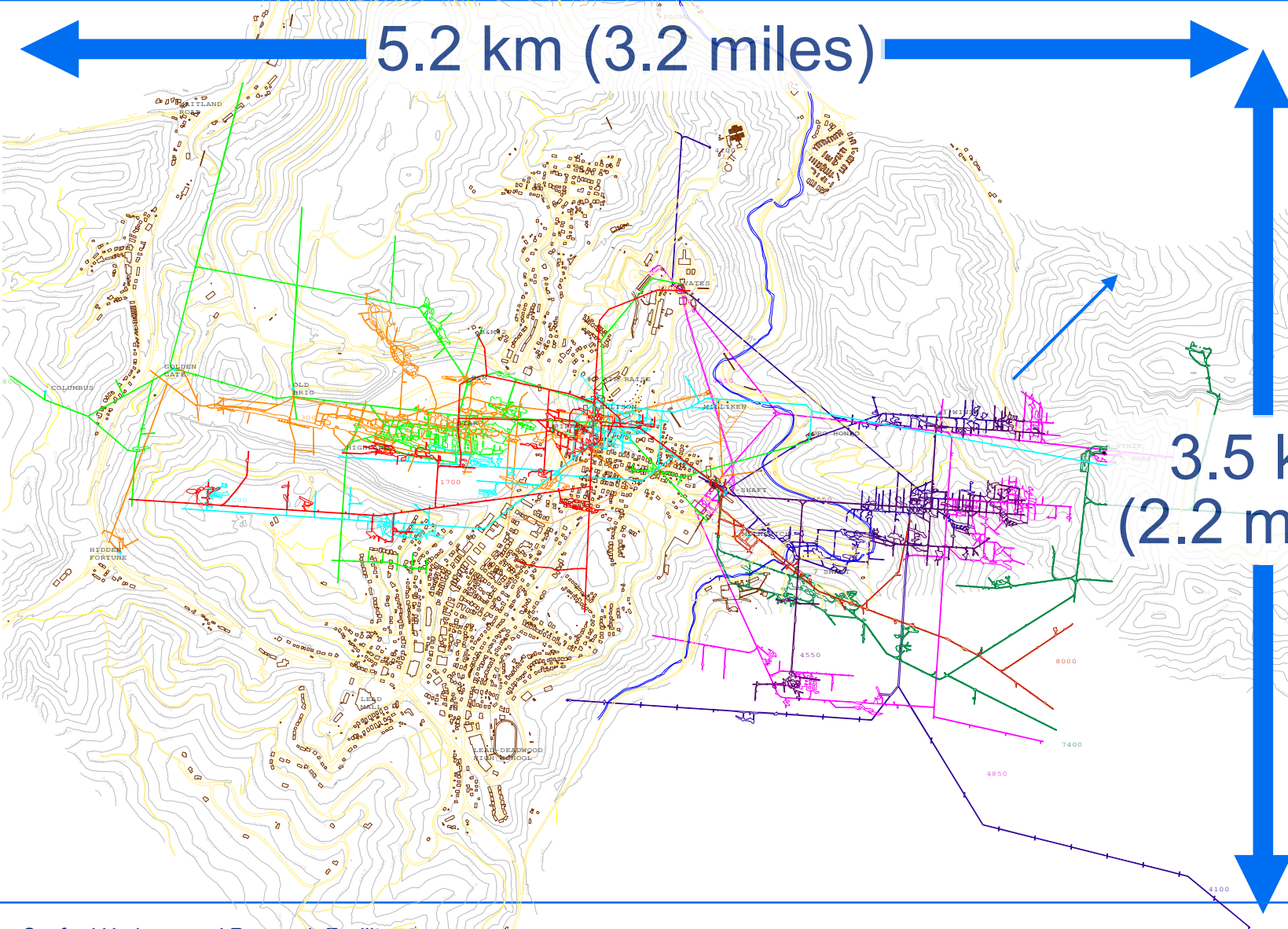


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Homestake Mine Legacy

← 5.2 km (3.2 miles) →

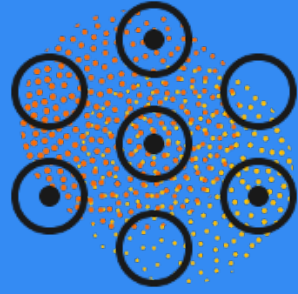


3.5 km
(2.2 miles)

- ~ 600 km / 380 miles of tunnels from surface to 2.4 km / 8000 ft deep, 63 total elevations, 29 currently accessible
- ~ 35 km / 22 miles maintained for science and facility operations



- BHUC
- CASPAR
- LBNF/DUNE
- LUX-ZEPLIN
- MAJORANA
DEMONSTRATOR



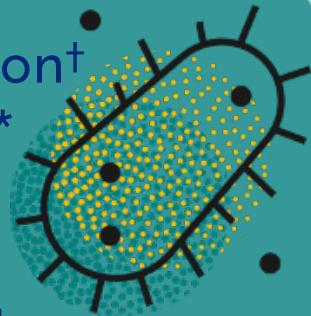
PHYSICS

ENGINEERING



- NIOSH - Heat Stress Study[†]
- Caterpillar*
- Thermal Breakout
- Xilinx (AMD)*
- Blast Monitoring
- DoD - Pedestrian Dead Reckoning[†]
- Shotcrete

- BHSU Biodiversity
- BuG ReMeDEE[†]
- Carbon Sequestration[†]
- Liberty BioSecurity*
- m-sense
- 2D BEST
- DeMMO / Astrobiology
- Phytoremediation (MAP)
- Chemistry



BIOLOGY



SCIENCE PROGRAM

30 GROUPS
68 total since 2007

GEOLOGY



- 3D DAS
- BH Seismic
- CUSSP
- DEMO-FTES
- Geochemistry
- Core Archive*
- EGS Collab[†]



Biology Research @ SURF

- Underground “extreme” environment
 - Unique physical-chemical conditions
 - incl. total darkness or low light level
 - high humidity
 - low/high stable temperature
 - high pressure
 - differing pH
 - salinity
 - scarcity of nutrients
 - Research typically performed via sampling, off-site cultivation and genome sequencing

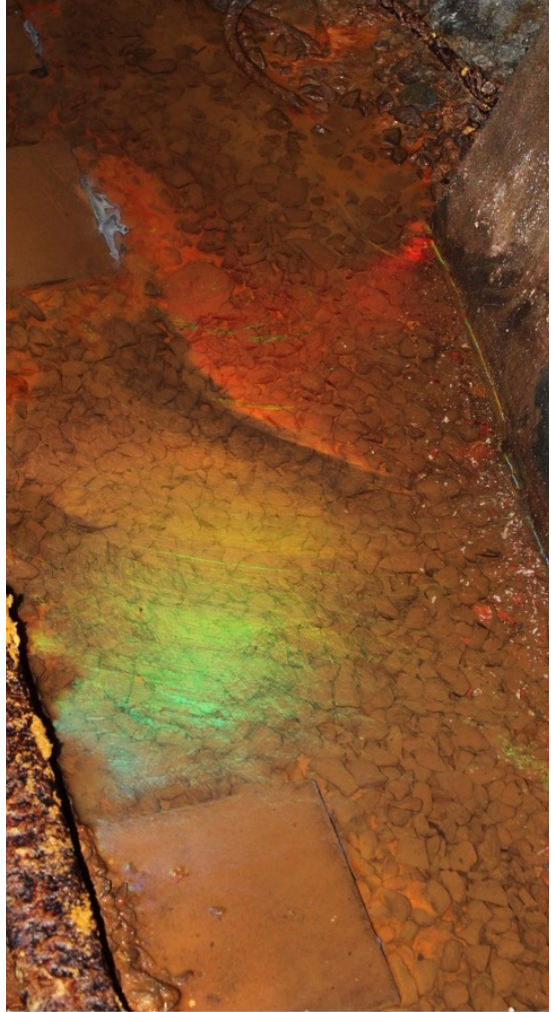


Biology Research @ SURF

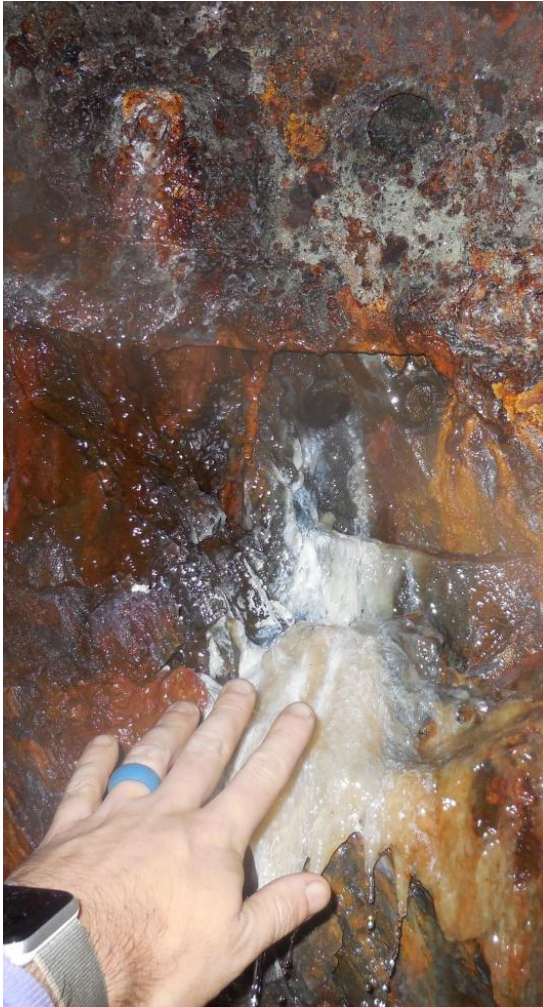
- **Extremophiles** - microorganism in extreme conditions (e.g. temperature, pressure, pH, salinity, etc.)
 - Methane regulation/oxidation, ammonia-oxidation and nitrification
 - Carbon sequestration in rock accelerated via microbial enzymes
 - Biofuels/bioplastics - bacteria and enzymes assisting lignocellulose conversion
- **Biofilms** - layers of bacteria adhering to surfaces
 - Potential to develop superior corrosion-resistant metals (e.g. oil & gas industry)
 - Agriculture - nitrogen-fixing bacteria to supplement crops
 - Microplastics - influence of biofilms on microplastics and possible ecological consequences
- **Microbial “Dark Matter”** Nano-sized bacteria (“Omnitrophota”)
- **Astrobiology**
 - In-situ, electrode-assisted cultivation of subsurface microbes using novel and traditional techniques, also repeating, long-term studies



Biology Research @ SURF



Biology Research @ SURF

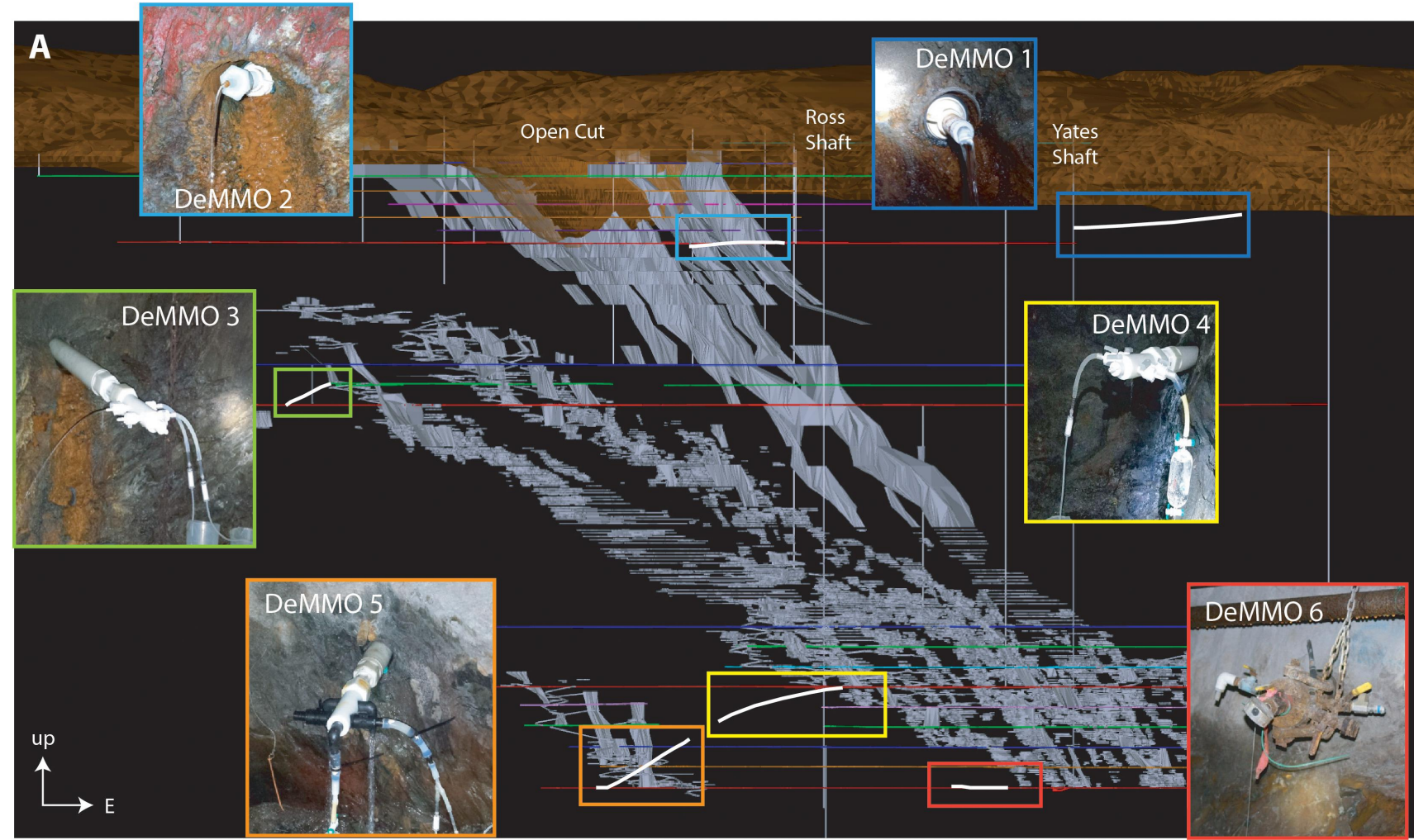


Biology Research @ SURF - in action!



DeMMO: Deep Mine Microbial Observatory

- Multi-year study funded by NASA Astrobiology / Exobiology
- SURF offers variety of sites:
 - Depths
 - Geochemistry
 - Flow rate / pressure / water temperature
 - Age / History
 - Perturbation / drilling purpose

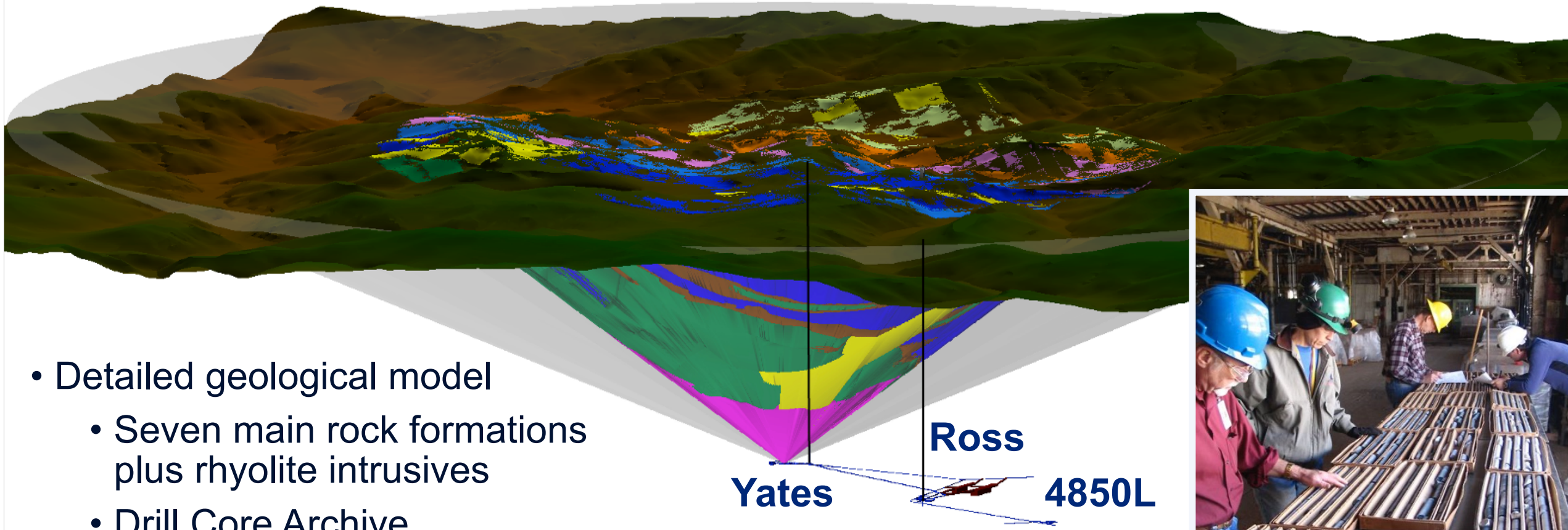


BHUC - Black Hills State University Underground Campus

- Low Background Counting Facility
 - Material assaying facility
 - BHSU Prof. Brianna Mount
 - *Currently on hold during LBNF/DUNE excavation, estimated re-occupation Fall 2024*
- Cleanroom Class 1000 / ISO 6 (-ish)
 - Available space for Biology / Geology / Other research
 - Also proprietary research possible (cost recovery via fees)



Geological Model / Core Archive



- Detailed geological model
 - Seven main rock formations plus rhyolite intrusives
- Drill Core Archive (2688 holes, ~90km)
- DB support (Vulcan, drill core)



SDSTA Organization and Science Support

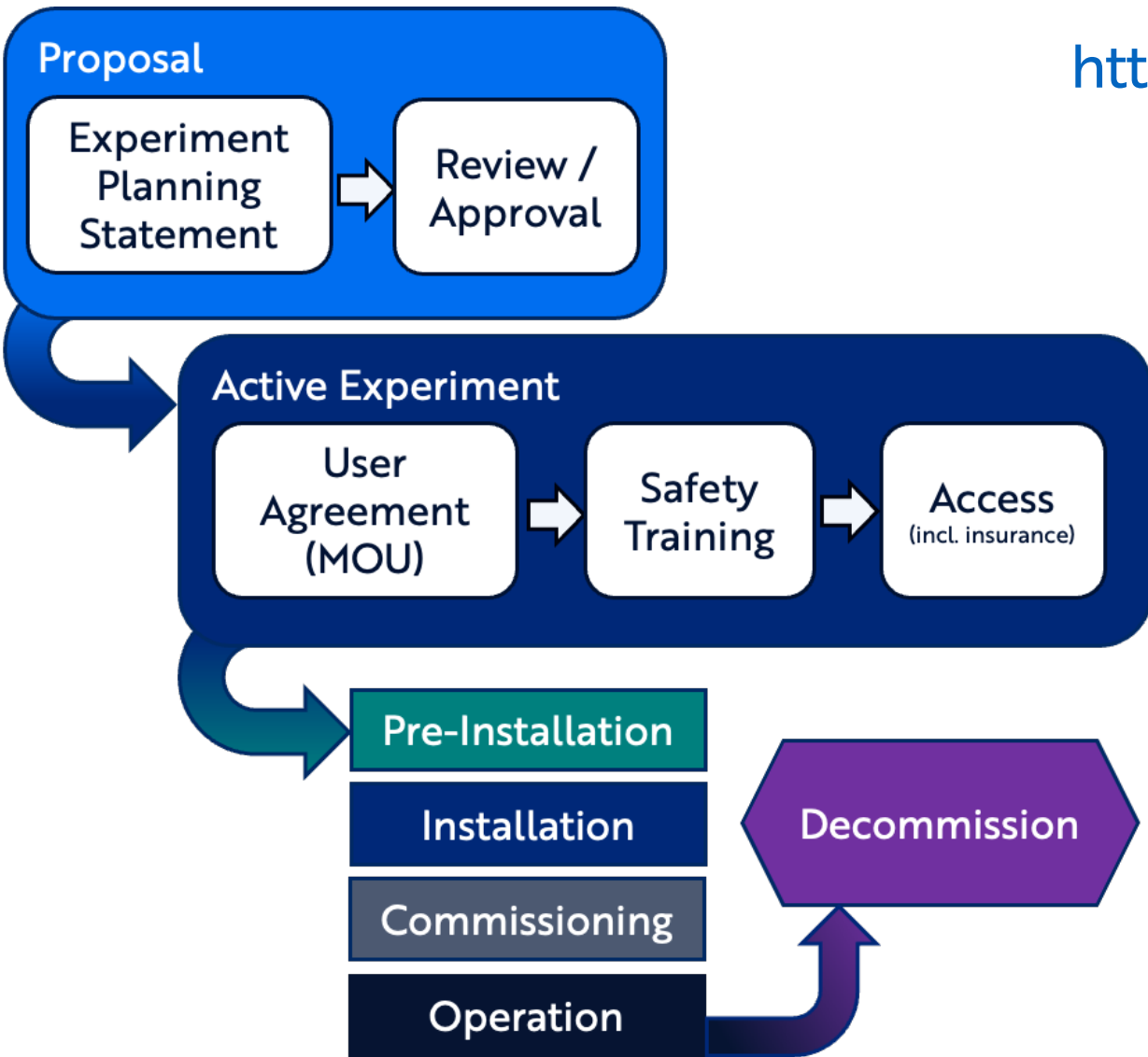
- Operations
 - Infrastructure, access, hoists/shafts, services (power, network, etc.), exp. site preparation, transportation, shipping/receiving via warehouse, IT systems/security, wastewater treatment plant
- Engineering
 - Eng. support for Operations, lab development/upgrades/maintenance, assessment, process design
- ESH
 - Safety standards, training, hazard analysis, reviews, industrial hygiene, environment, waste. 24/7 ERT.
- Business Services / Finance / Administrative Services / HR
 - Contracts and procurement, accounting and finance, user support (incl. event planning)
- Outreach & Culture
 - Education and outreach, science teacher education, communications, community relations
- Sanford Lab Homestake Visitor Center*, SURF Foundation*, The Institute for Underground Science*
- Science
 - Point of contact for all researchers, coordinate facility resources
 - Scientific/technical experiment support
 - Experiment Implementation Program

* out of scope entities



Science Implementation Program

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



The screenshot shows the website for the Sanford Underground Research Facility's Research Proposal Guidelines. The page features a navigation bar with links for Events, News, Subscribe, Work with Us, Log In, and Search. Below the navigation bar is the Sanford Underground Research Facility logo and a list of menu items: About, Visitor Center, Research, Education, and Support SURF. The main heading is "RESEARCH PROPOSAL GUIDELINES". Below the heading, it states "All proposals must follow these guidelines". There are sections for "RESEARCHER RESOURCES" and "PROPOSAL DOCUMENTS".

RESEARCHER RESOURCES

- Proposal Guidelines
- Science Liaison Office
- SURF User Association
- Visitor information

We are excited at Sanford Lab to contribute to cutting-edge science by providing the best environment for experiments that require unique underground facilities. We are glad to work with you to get your experiment running. To begin the process of approval and installation, follow the steps in the order listed below:

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](#).

PROPOSAL DOCUMENTS

- SCI-1000-SJ-135416 Experiment Integration & Support.pdf
362.8 KB | PDF
- SCI-1000-FJ-69417 User Agreement
44.7 KB | DOCX
- SCI-1000-FJ-34460 Experiment Planning Statement
74.2 KB | DOCX
- SCI-1000-FJ-212612 User Agreement Acknowledgement.docx
31.8 KB | DOCX
- SCI-1000-SJ-186874 Publication Guidelines.pdf
255.3 KB | PDF
- Acknowledgement of Risk and Waiver
101.2 KB | PDF
- SCI-1000-SJ-34478 Experiment Implementation Program.pdf
1 MB | PDF



Experiment Planning Statement

Rev. 03
SCI-(1000-F)-34460
SURF Experiment Planning Statement

Project Name

Date Submitted: mm/dd/yyyy.

Status: Preliminary (Expression of interest, Support letter request) Formal implementation request Update

1. Project Summary

Discipline: Physics Biology Geology Engineering Other: _____

Project Description
Provide a brief project description, including purpose, scientific merit and scope. Add relevant citations or references as appropriate. If necessary, add additional space to this form.

[Empty text area for Project Description]

Community Relations
SDSTA is committed to creating a culture that centers on inclusion, diversity, equity and access (IDEA) through the Community Relations Department; see <https://www.sanfordlab.org/about-us/who-we-are>. It is critical that all partners and stakeholders embody SDSTA's commitment to IDEA as both a moral imperative and a necessary ingredient for a successful collaborative scientific environment. Describe project efforts and considerations in these areas.

[Empty text area for Community Relations]

- Project description, incl. funding
- Experiment equipment, incl. chemicals
- Infrastructure needs, e.g. area, site environment / location / levels, power, network/WiFi, etc.
- Hazards and ESH, incl. waste generation / recycling
- Access requirements & schedule
- Operations, duration, and Decommissioning plans



Outreach & Culture

- **Deep Talks: Public lecture series**
- Neutrino Day: Annual city-wide Science Festival in Lead with >2000 visitors
- “Ask a Scientist” @ SLHVC: Opportunity for scientist and public to engage in conversations
- Deep Roots: Summer speaker series connecting science and the humanities, hosted at Čhaŋgléška Wakhánj (ethnobotanical garden at SURF)
- Deeper Talks: Science seminar series to foster interdisciplinary connections
- Education Department hosting school field trips, class room presentations, providing K-12 curriculum units for regional schools
- Teacher Workshops for Science teachers to develop skills and bring SURF Science into classrooms



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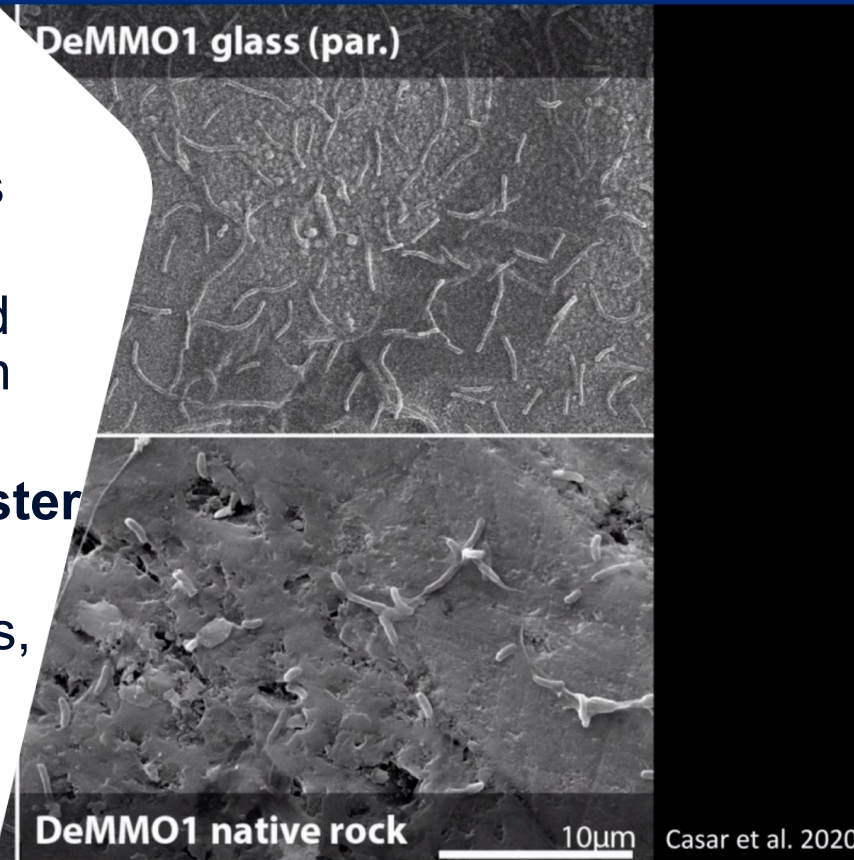
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SURF User Association and The Institute for Underground Science

- SURF User Association
 - Membership open to all underground science community
 - Promotes sense of community and provides two-way communication
 - General Meetings annually (last May 2024 @ CoSSURF)
 - Topical Workshop (next 2024/2025)
- Call for Letters of Interest 2024
 - Open to all disciplines
 - Opportunity to advance scientific strategic plan
 - loi@sanfordlab.org

<https://sanfordlab.org/surf-user-association>



[Home](#) | SURF User Association

SURF USER ASSOCIATION

Membership is open to individuals with a professional interest in the scientific program at SURF.

RESEARCHER RESOURCES

[Proposal Guidelines](#)

[Science Liaison Office](#)

[SURF User Association](#)

[Visitor information](#)

The SURF User Association promotes open discussion on relevant topics for researchers performing science at SURF; promotes a sense of community among SURF researchers; articulates and promotes the scientific case for underground science and its significance to society; and provides a means for SURF management to inform users on issues including current and future plans for the facility.

Membership

Membership includes active researchers with a professional interest in the science at SURF. An Executive Committee conducts the day-to-day business of the Association and consists of nine individuals:

- At least one (1) early career researcher (less than 5 years post-Ph.D.)



The Institute for Underground Science @ SURF



THE INSTITUTE FOR UNDERGROUND SCIENCE AT SURF

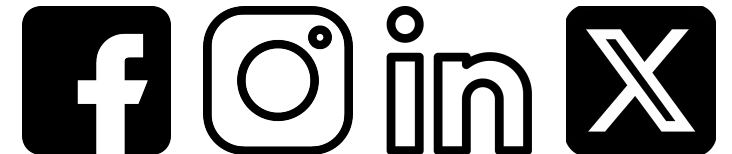


Summary

- Sanford Underground Research Facility’s mission is to be a “true” multi-disciplinary research facility, incl. Biology, Geology, Engineering and Physics.
- Active Biology research program at SURF for more than 10+ years, resulting in many high-impact publications
- Robust Science Implementation Program in place to support all projects (small or large, incl. proprietary research).
- SURF User Association and Call for Letters of Interest 2024
- Extensive Outreach & Culture program, vision of The Institute for Underground Science

- Contact: mhorn@sanfordlab.org or jheise@sanfordlab.org

or follow us:





SANFORD UNDERGROUND RESEARCH FACILITY

The Institute at SURF

Neutrino Day

SURF Visitor Center

