A Brief Look at Current and Future Science Activities at SNOLAB

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SNOLAB
January 5, 2026

Queen's University

Laurentian University
Université Laurentienne

SNOLAB

Science Strategy

- **The science at SNOLAB** is currently focused on fundamental particle physics. Primarily looking at further **investigating the nature of matter**. Specifically:
  - What is the nature of dark matter?
  - What is the nature of the neutrino?
- **SNOLAB is interested in collaborating** on any scientific research that requires deep underground facilities. For example:
  - Neutrino observatories (solar, supernovae, geo, reactor, etc.)
  - Effects of radiation on biological systems
  - Environmental monitoring (nuclear non-proliferation, aquifers, etc.)
  - Effects of radiation on quantum technologies

SNOLAB –
At a Glance

Current Experiments
Future Experiments
Laboratory Facilities
Experiment Areas

Cube Hall
DEAP-3600, PICO500, NEWS-G
(ARGO Concept)

Cryopit
(nEXO2.0/XLZD Concept)

Electrical Shop

Halo Stub
HALO
potential breakthrough for
Future Expansion
(Theia Concept)

J-Drift
SENSEI, DAMIC, Oscura

Machine Shop

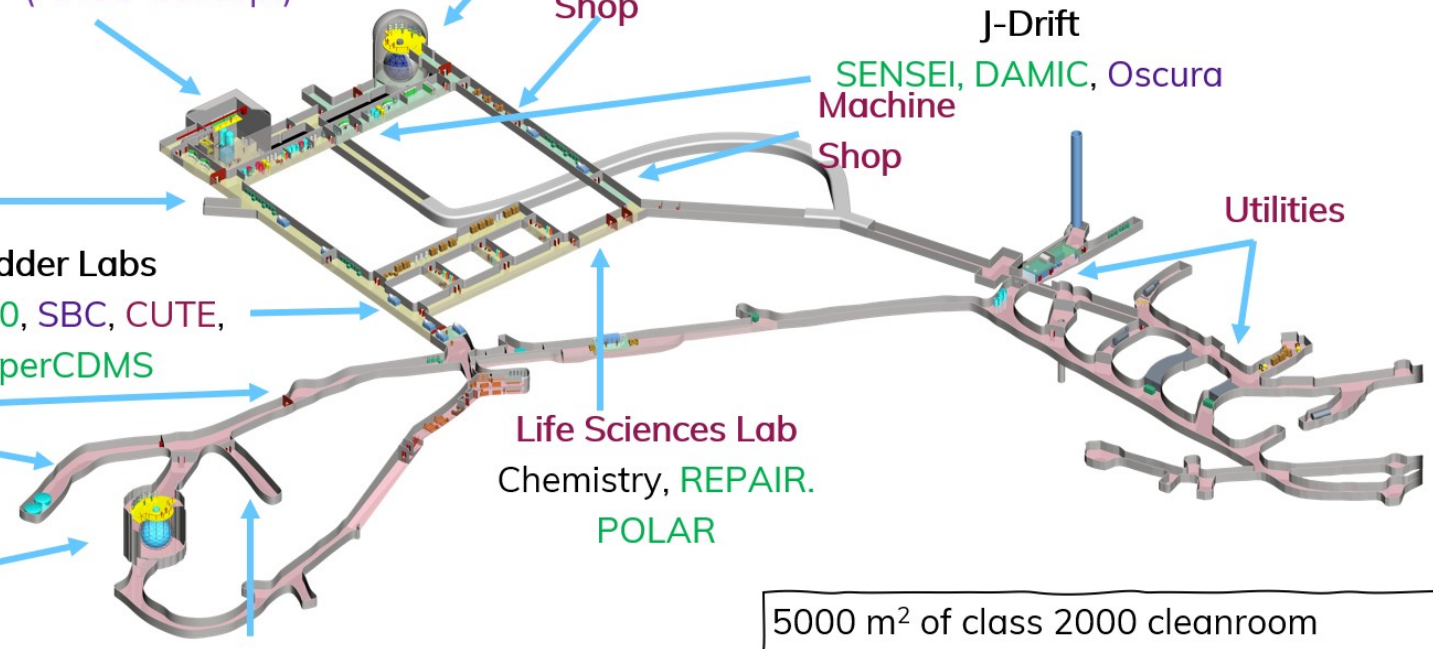
Utilities

Ladder Labs
PICO40, SBC, CUTE,
SuperCDMS

Plants
UPW, Scintillator,
Te Diol, TeA, LN2

Life Sciences Lab
Chemistry, REPAIR.
POLAR

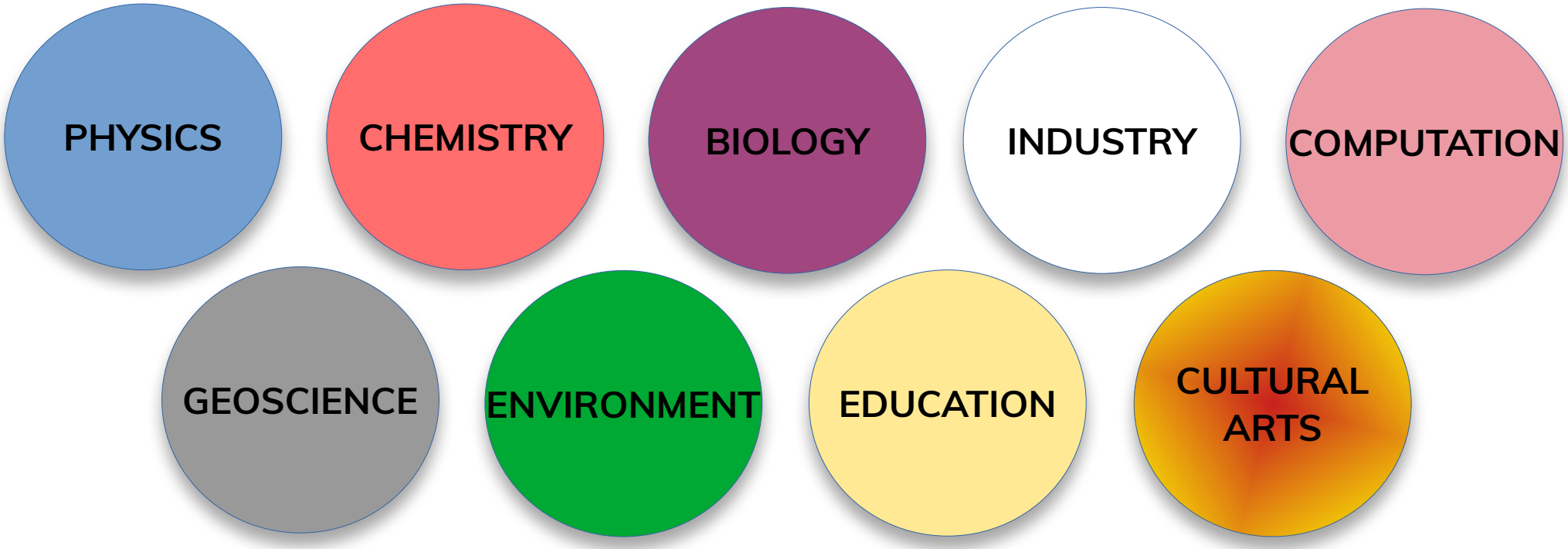
SNO Cavern
SNO+, SNO+ Te
Potential for large
project after 2035



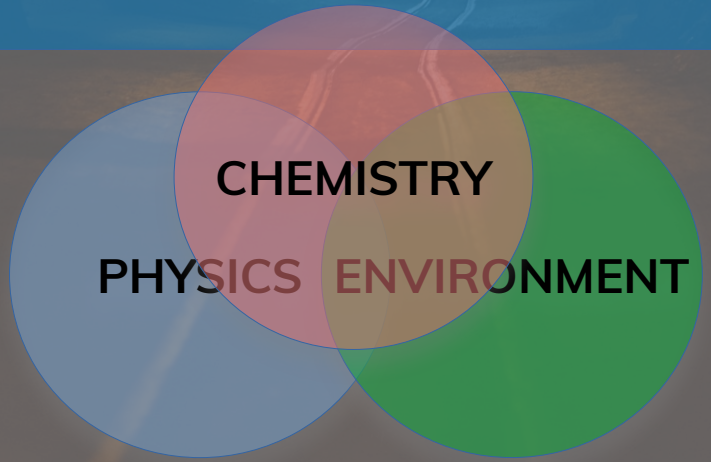
Low Background Lab
HPGe assay/screening, XRF, Radon Boards,
XIA, CTBT Dual HPGe, IceCube DOM Testing

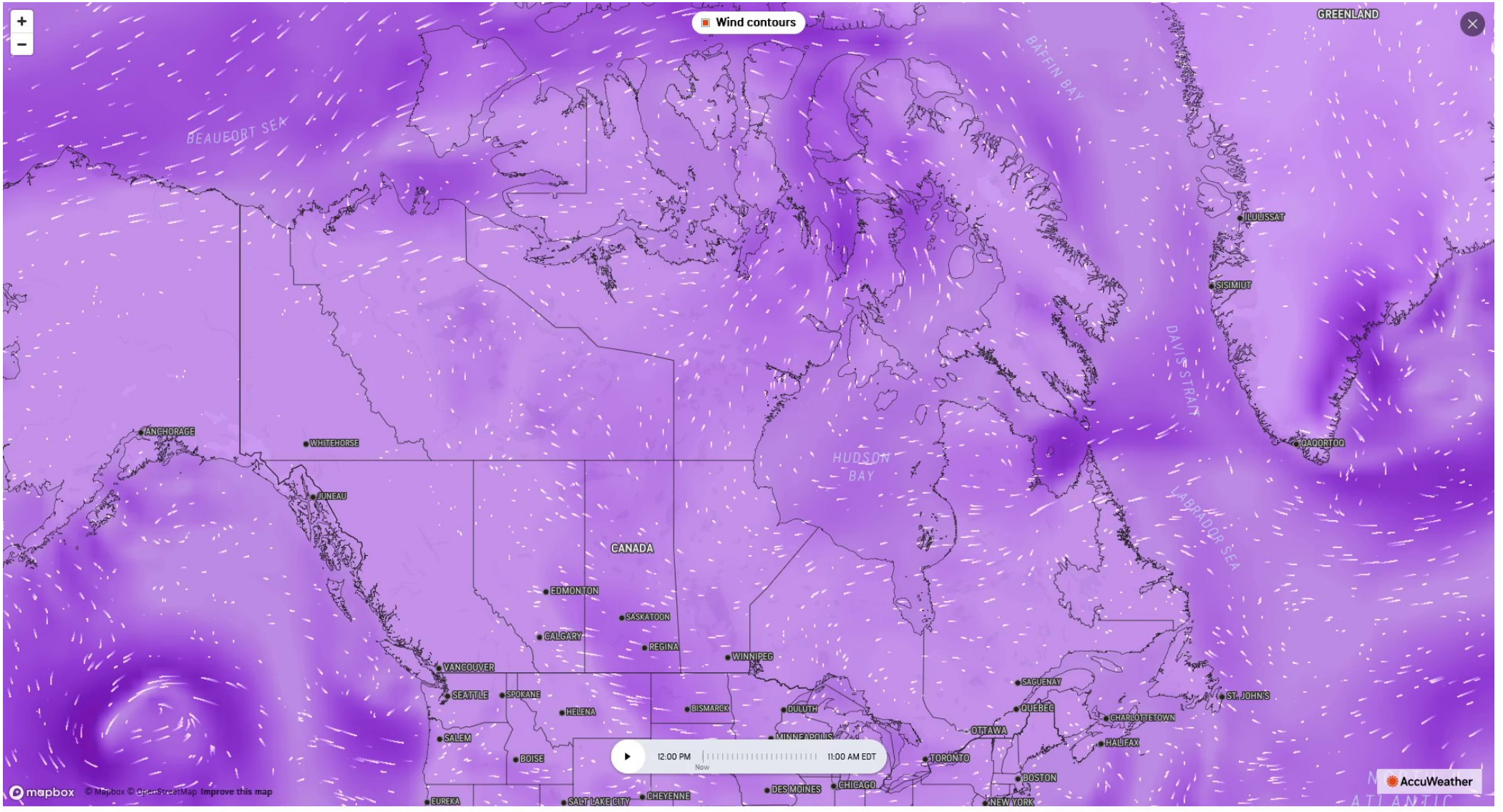
5000 m^2 of class 2000 cleanroom underground.
<2000 particles >0.5 μm in diameter per ft^3
arXiv:2006.12746

Disciplines at SNOLAB



ENVIRONMENTAL MONITORING

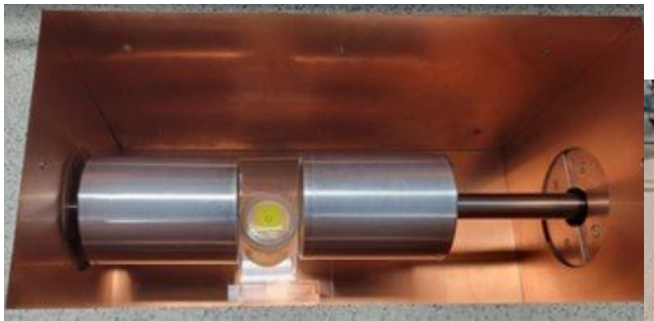



Wind contours
GREENLAND
BAFFIN BAY
BEAUFORT SEA
ILULISSAT
SISIMIUT
DAVIS STRAIT
ANCHORAGE
WHITEHORSE
QAQORTOQ
HUDSON BAY
JUNEAU
LABRADOR SEA
CANADA
EDMONTON
SASKATOON
CALGARY
REGINA
WINNIPEG
VANCOUVER
SAGUENAY
SEATTLE
SPOKANE
ST. JOHN'S
HELENA
BISMARCK
DULUTH
QUEBEC
CHARLOTTETOWN
OTTAWA
SALEM
MINNEAPOLIS
HALIFAX
BOISE
12:00 PM
11:00 AM EDT
Now
TORONTO
BOSTON
DES MOINES
CHICAGO
EUREKA
SALT LAKE CITY
CHEYENNE
NEW YORK
ATLANTIC
mapbox
© Mapbox © OpenStreetMap Improve this map
AccuWeather
<32
32
48
64
80
96
112
>112

NUCLEAR FORENSICS

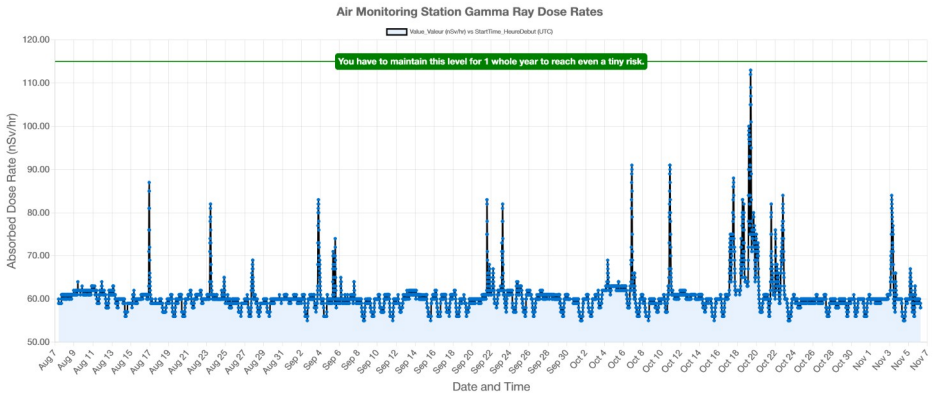
- Dual High-Purity Germanium (HPGe) detector deployed by Health Canada for nuclear forensics
- SNOLAB is working to improve sensitivity to isotopes with γ-γ coincidences (and γ-β using additional PIPS detectors)

“Can we fingerprint interesting phenomena in the environment using radioisotopes?”



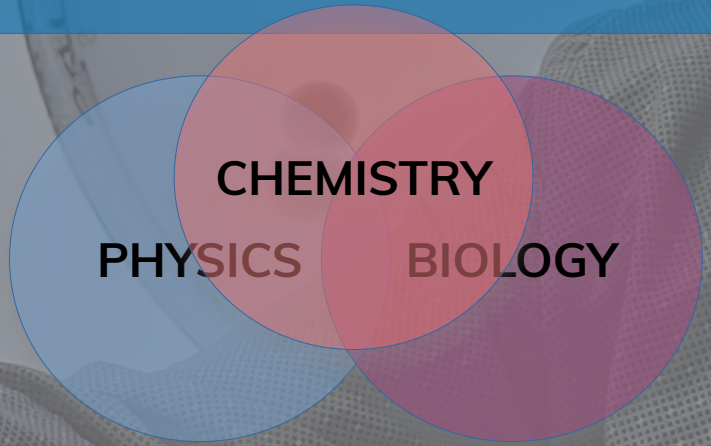
- Health Canada has installed a radiation monitoring station at SNOLAB (overflow parking lot) that is part of the Canada Radiation Monitoring Network
  - Air and water sampling
  - Live radiation monitoring (e.g., dosimetry)

SNOLAB TV



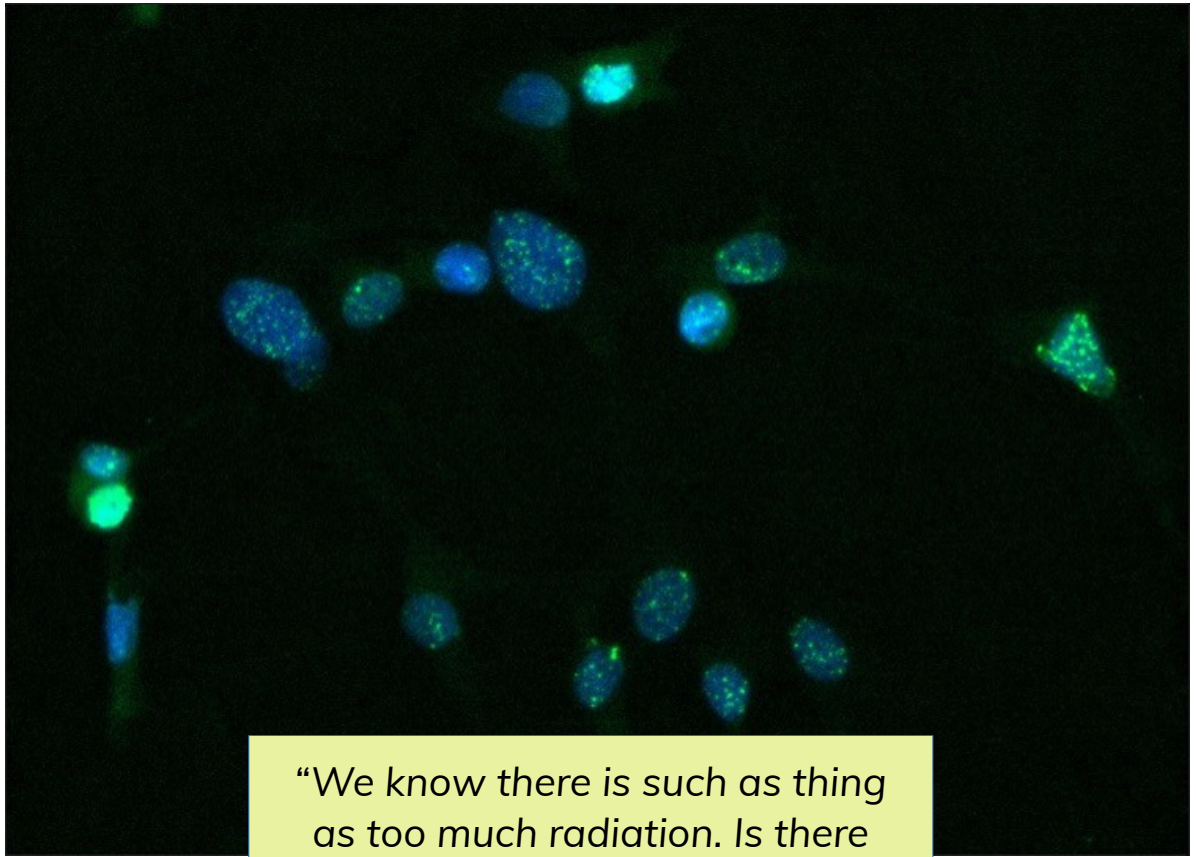
Data from the Health Canada air monitoring station located in the back parking lot of SNOLAB. The above shows a small, harmless, normal level of ambient radiation.

UNDERGROUND BIOLOGY



REPAIR:

Researching the Effects of the Presence and Absence of Ionizing Radiation



"We know there is such as thing as too much radiation. Is there such as thing as too little?"

Study the effects of very low background radiation levels on living organisms.

Assess the markers for carcinogenesis and alterations to DNA in human cells as well as whole organism development and growth using lake whitefish embryos.

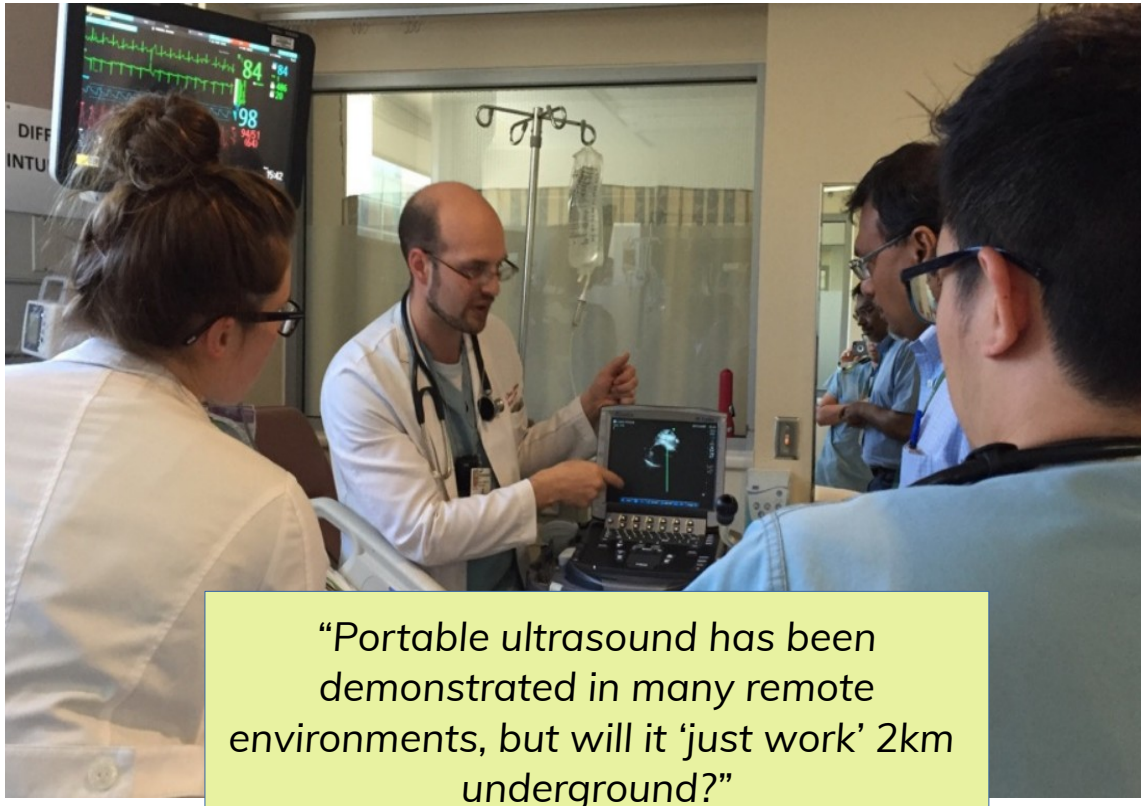
Partnership between Laurentian University and NOSM University.

Lapointe MR, Laframboise T, Pirkkanen J, Tai TC, Lees SJ, Santa Maria SR, Tharmalingam S, Boreham DR, Thome C. Protracted Exposure to a Sub-background Radiation Environment Negatively Impacts the Anhydrobiotic Recovery of Desiccated Yeast Sentinels. Health Phys. 2024 Jun 1;126(6):397-404. doi: 10.1097/HP.0000000000001804. Epub 2024 Apr 3. PMID: 38568172.

ome to SNOLAB!

POLAR

POCUS: Lessons from Austere and Remote environments



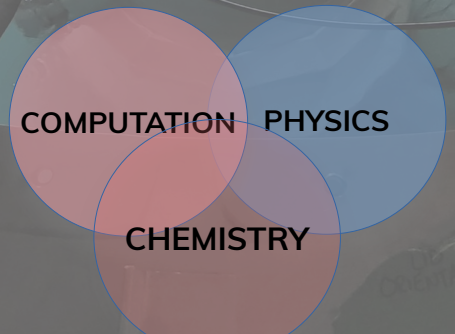
"Portable ultrasound has been demonstrated in many remote environments, but will it 'just work' 2km underground?"

Point-of-Care UltraSound (POCUS) and its use in remote or austere environments is the focus of the POLAR project. Can equipment designed for surface work in the underground environment?

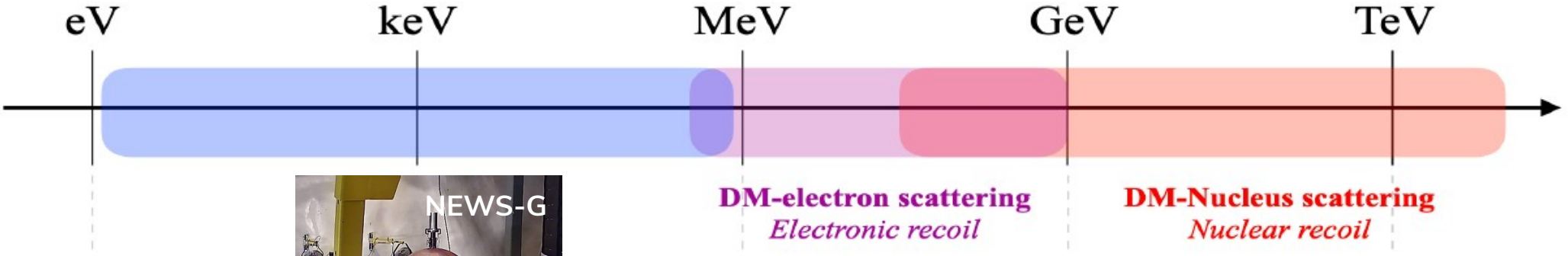
This new project is seeking to enter a first phase in 2026 where hand-held ultrasound equipment will be tested without patients inside SNOLAB.

A future phase would seek to enrol local volunteers for more real-world testing and measurement of medical responses of humans in subsurface environments.

HUNTING FOR DARK MATTER

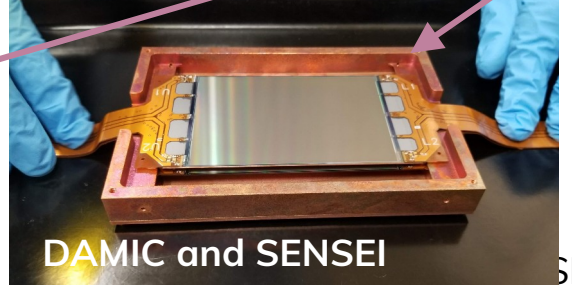


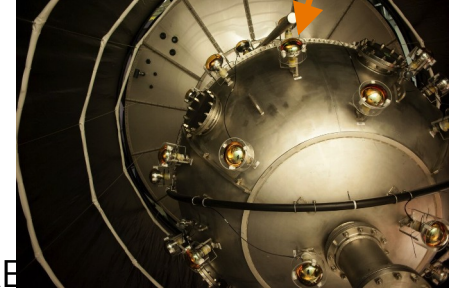
A Part of the Dark Matter Candidate Search Space: Particle Mass



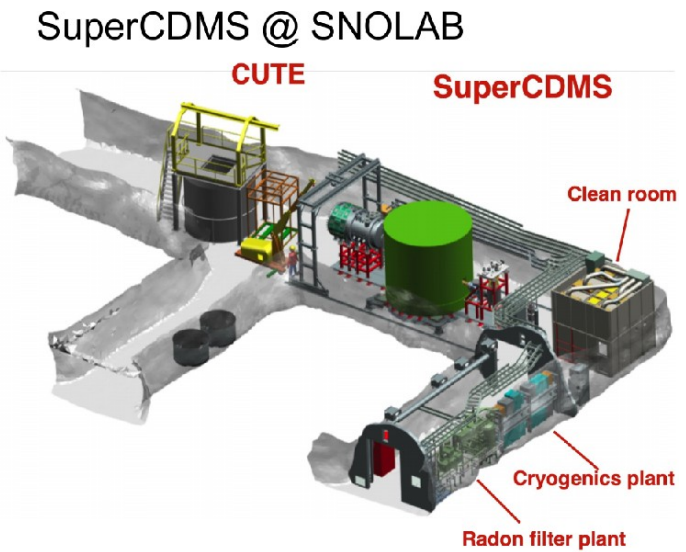
GAS AND SOLID TARGETS

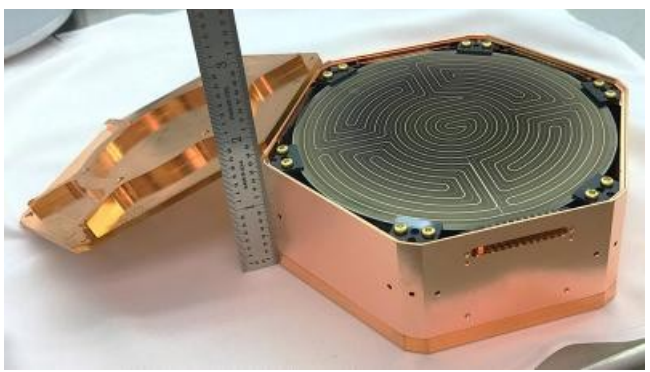
LIQUID TARGETS





Solid-State-Based: SuperCDMS





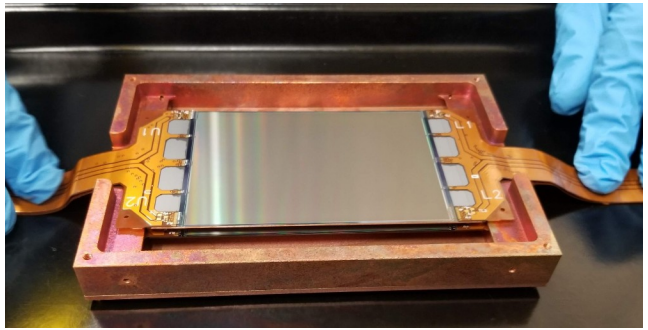
"Ultra-cold, crystalline tuning forks that sing when struck by particles."

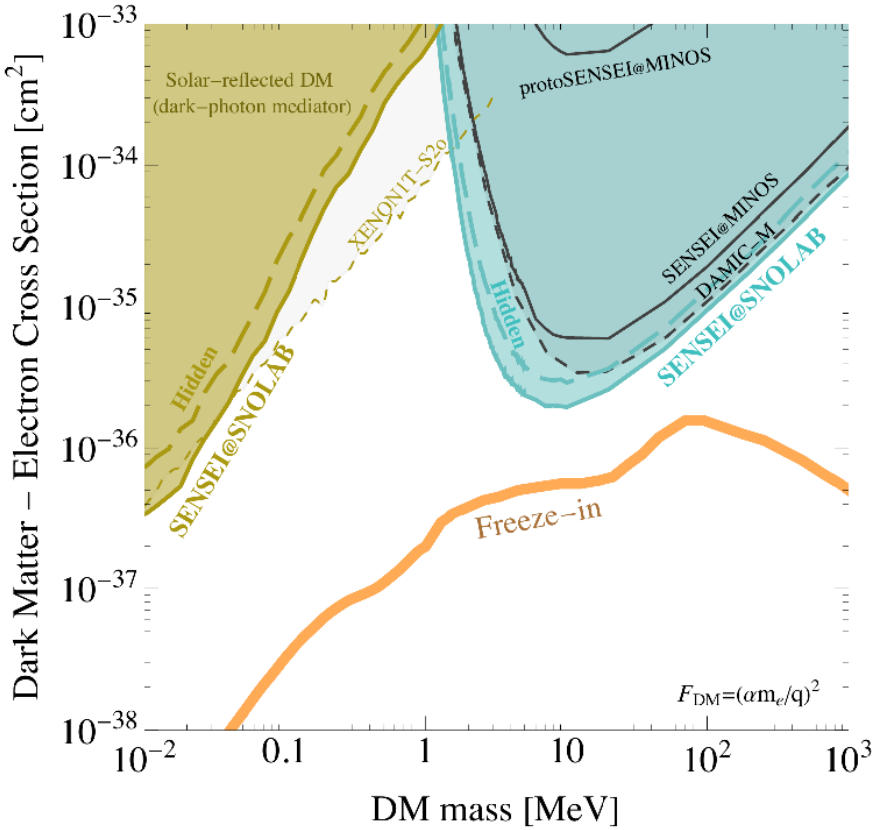
Use ultra-cold semiconducting crystals as tuning forks for dark matter: an interaction causes vibrations, read out as heat.

SuperCDMS has received the approval to proceed to operations – this is a very exciting time for this program!

OLAB!

CCD-Based Detectors: DAMIC and SENSEI

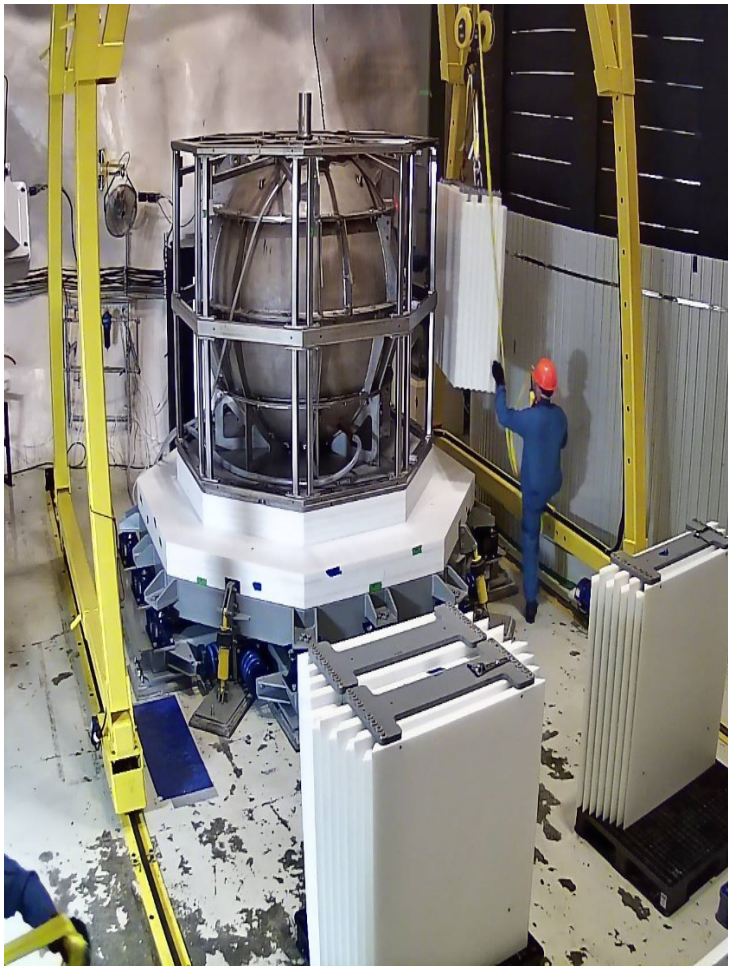


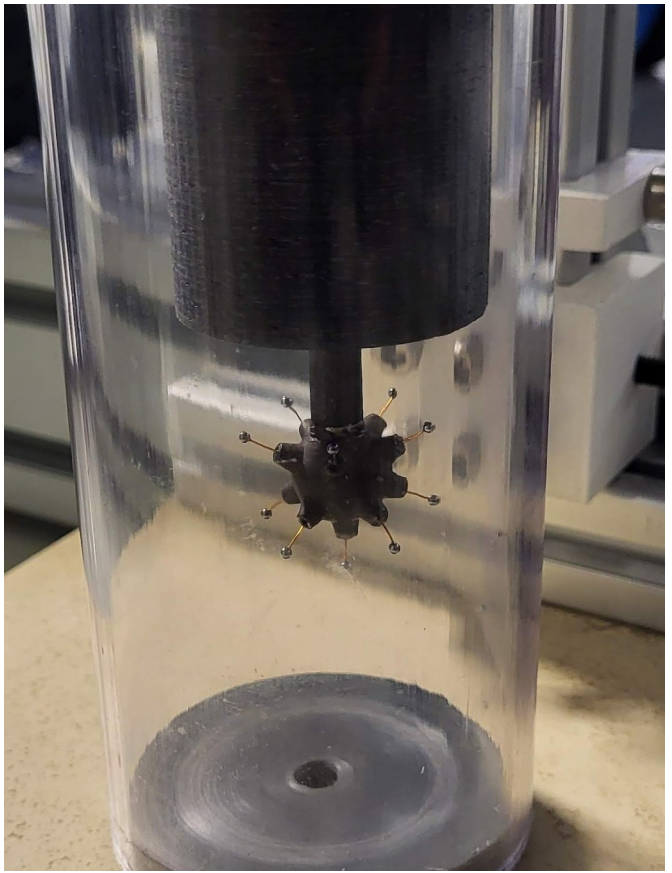


"Cameras taking pictures of themselves in the dark."

SENSEI is pushing sensitivity boundaries in low-mass dark matter space, and SENSEI and DAMIC together are exploring low-energy noise common to many experiments.

Gas-Based Detector: NEWS-G





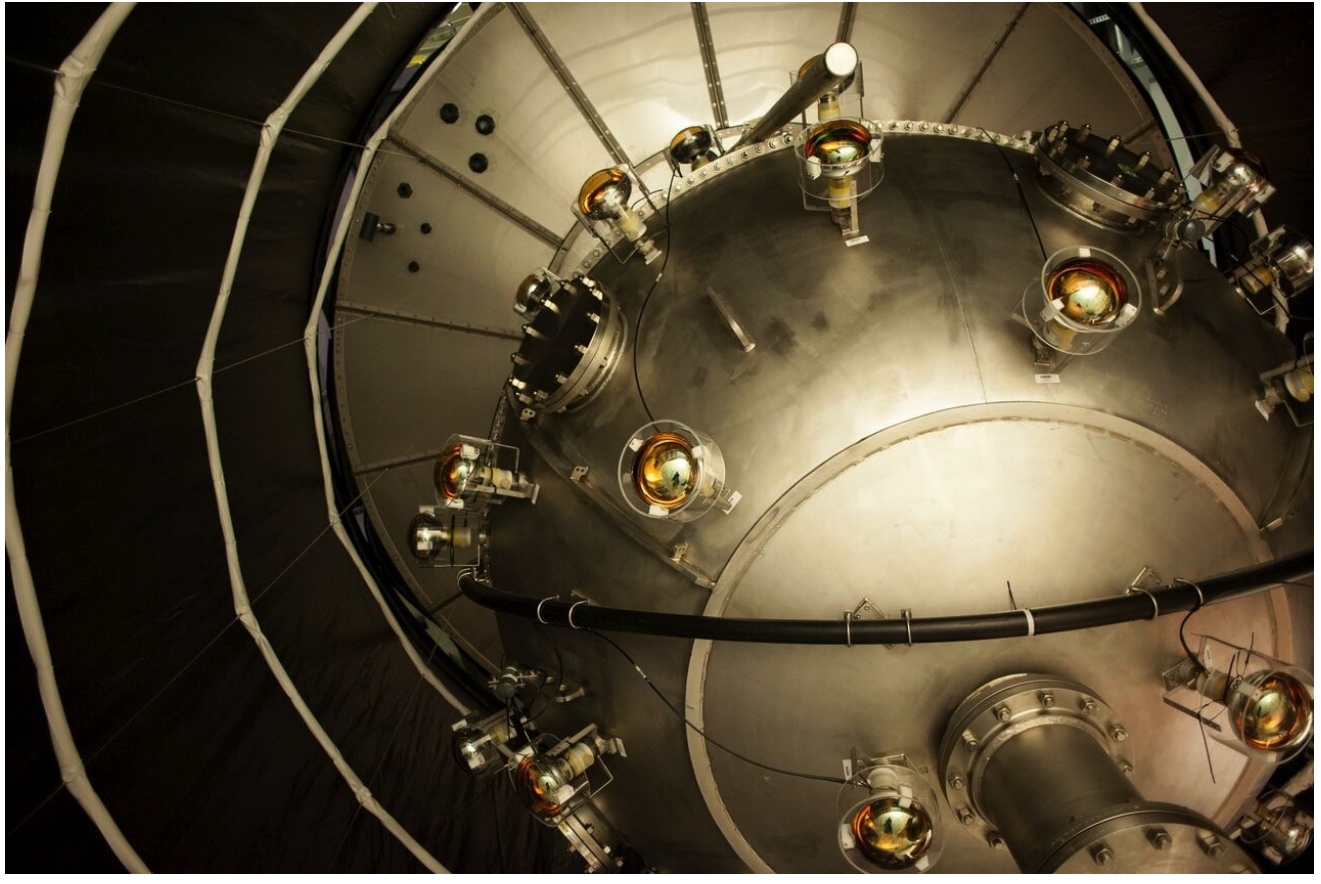
Welcome to SNOLAB!

"An amplifier for the gentle notes from dark matter's plucking."

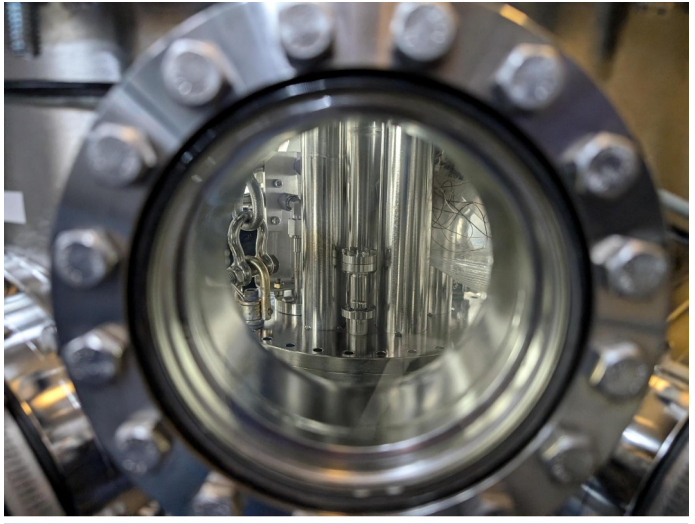
NEWS-G has been taking high-quality data in SNOLAB since 2022. The copper sphere houses methane, providing a low-mass target (hydrogen) sensitive to light dark matter collisions.

A great deal of effort has been put by the collaboration into improving the electric field inside the sphere and reducing noise in the detector. We look forward to increasing science results from this effort!

Liquid Noble Targets: DEAP-3600



Welcome to SNOLAB!

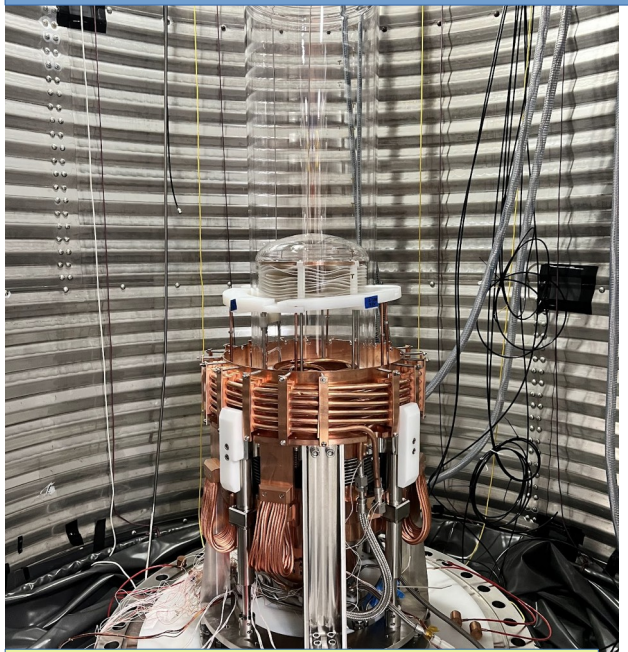


"A liquid lamp that shines when struck by the dark."

DEAP-3600 has just concluded a period of important upgrades and recently started operations! DEAP has strong sensitivity for higher-mass dark matter.

Superheated Fluid Targets for Dark Matter: PICO

PICO-40L (70kg freon target)

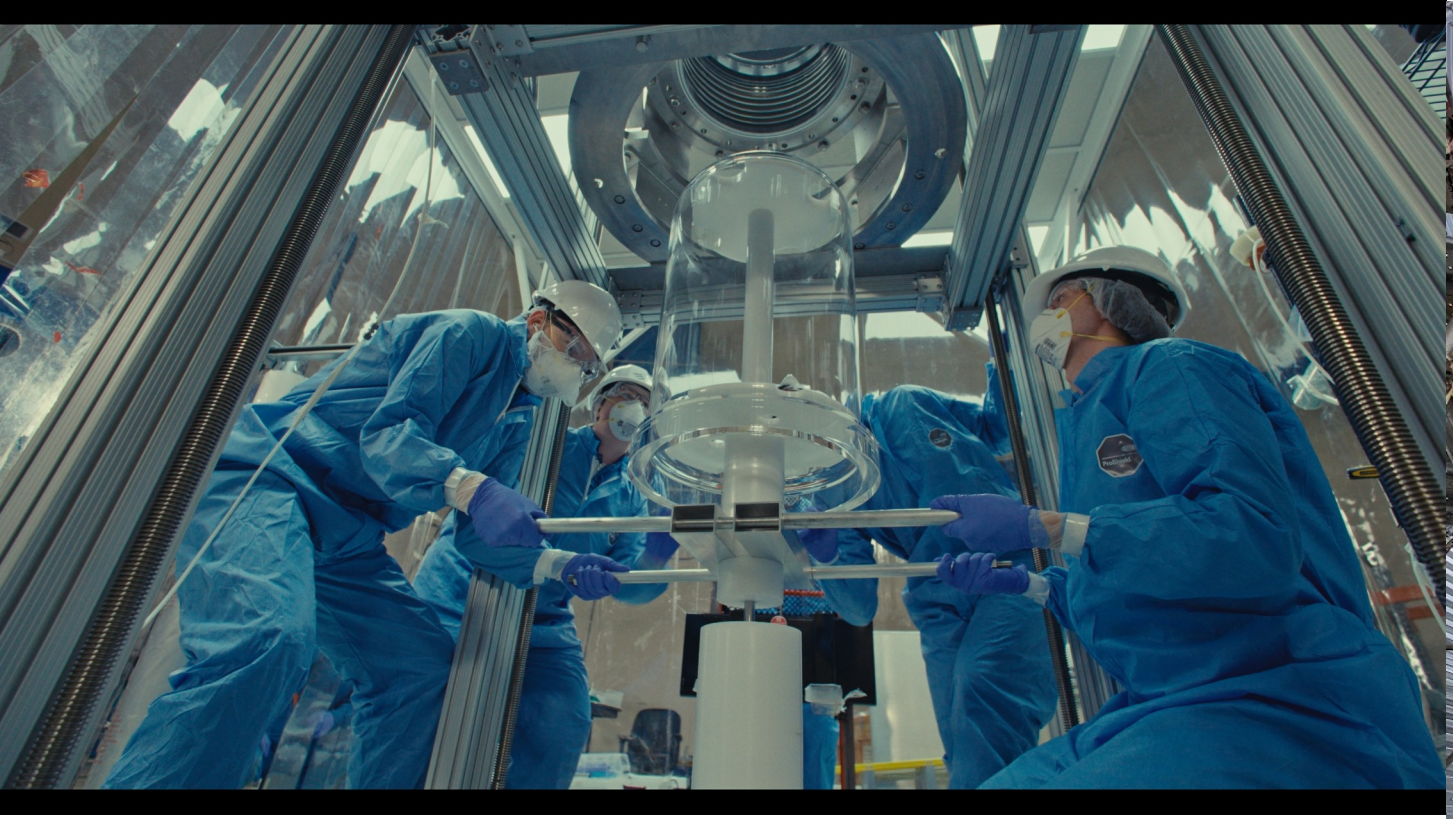


Operations

PICO-500 (250kg freon target)

In Construction

"A bottle of freon that boils at the slightest touch."



PICO-500: Lots of underground activity as construction proceeds through 2025, with the goal of starting operations in 2026.

Welcome to SNOLAB!

Applying lessons

"We apologize to experimentalists for having no idea what is the mass of the Higgs boson, ..., and for not being sure of its couplings to other particles, except that they are probably all very small. For these reasons we do not want to encourage big experimental searches for the Higgs boson..."

John Ellis, Mary Gaillard, Dmitri Nanopolous. "A phenomenological profile of the Higgs boson". Nuclear Physics B, Volume 106, 1976, Pages 292-340.

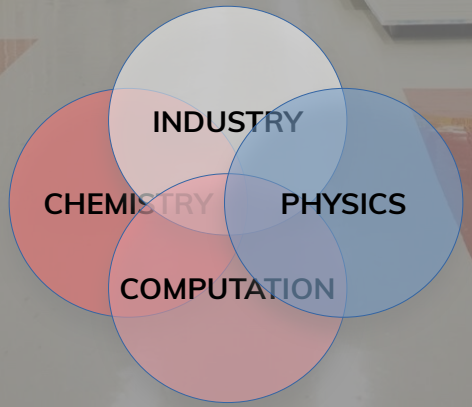
"I've been looking for you for over 20 years."
"Now, you have found me."

Sau Lan Wu's words to Peter Higgs, and his response, on July 4, 2012, upon the moment of their first meeting in real life.

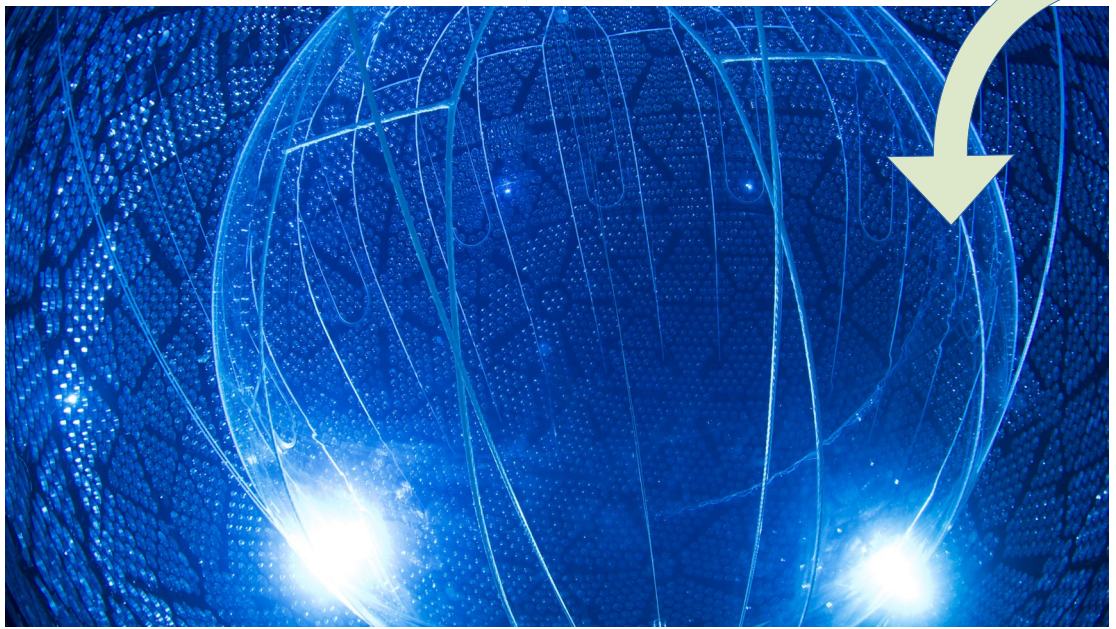
THE NATURE OF DARK MATTER

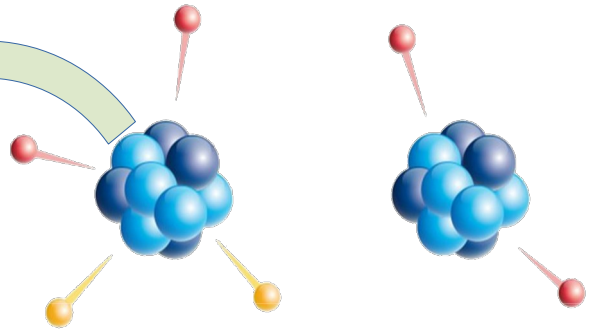
THE MASS OF THE NEUTRINO

NEUTRINO SCIENCE

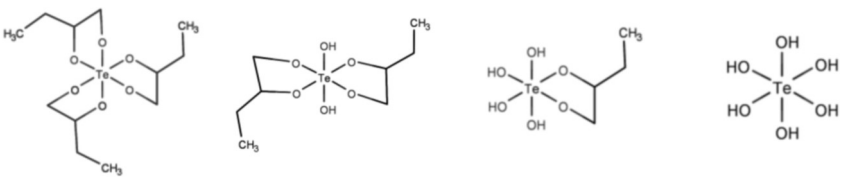


Neutrinos and ultra-rare nuclear processes: SNO+

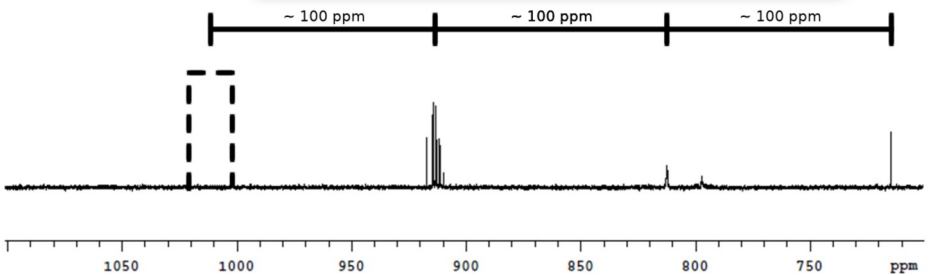




Design Goal: Neutrinoless Double Beta Decay measurement in Te-130



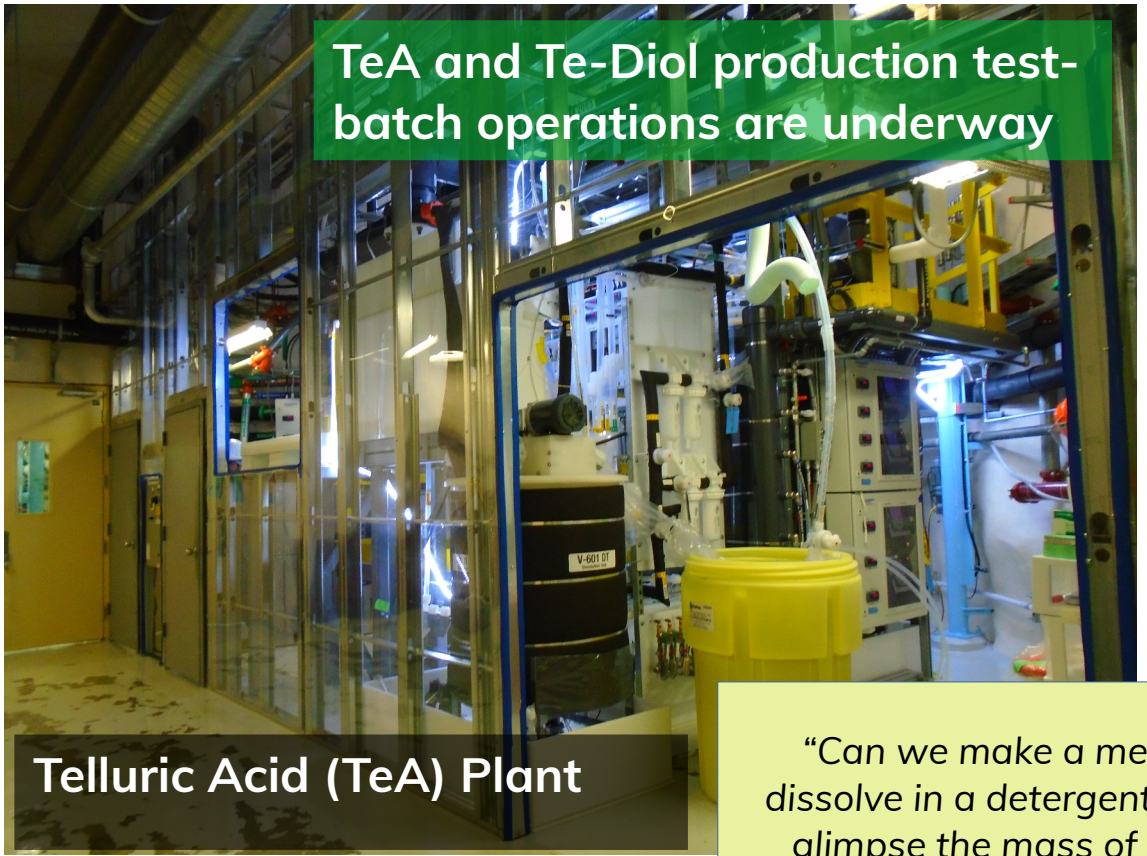
NIM A, Volume 1051, 2023, 168204



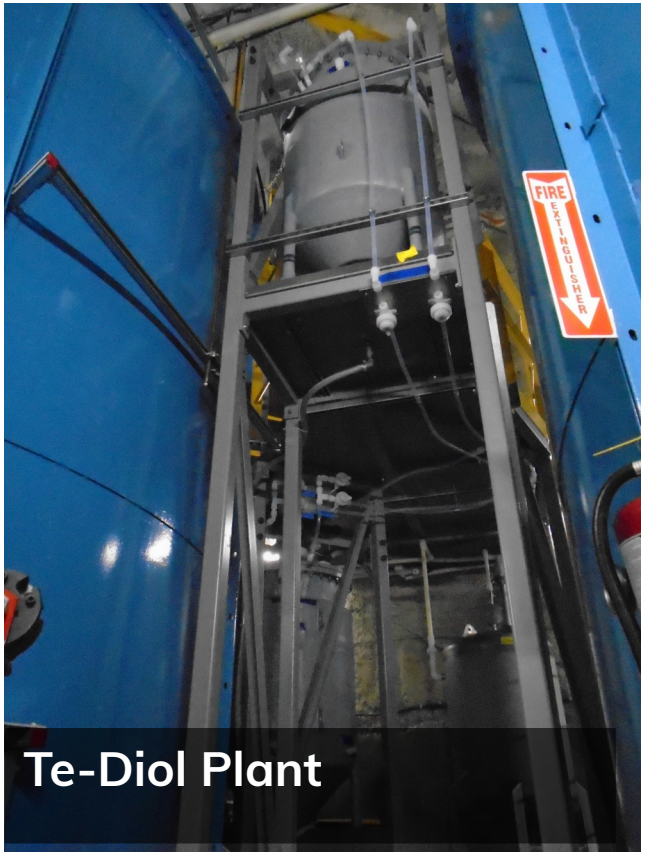
Tellurium-130 has a high natural abundance (34%) and provides a valuable avenue toward neutrinoless double beta decay → needs to be synthesized into a scintillator-soluble molecule at industrial scale (1.3 tonnes of Te-130, corresponding to 3.9 tonnes of Te).

Welcome to SNOLAB!

SNO+ TELLURIUM PLANTS

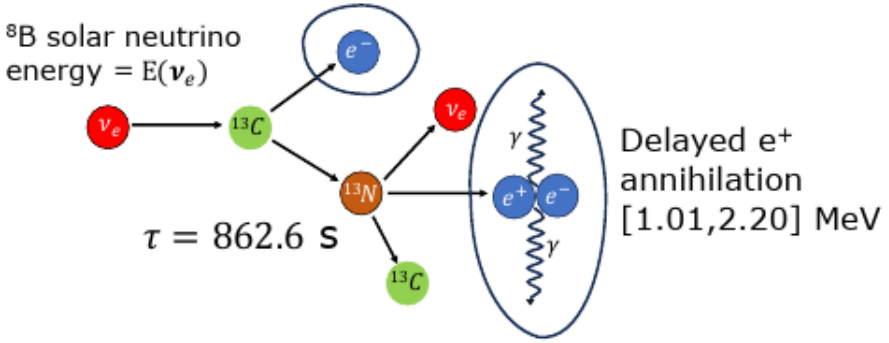


"Can we make a metal dissolve in a detergent and glimpse the mass of the neutrino?"

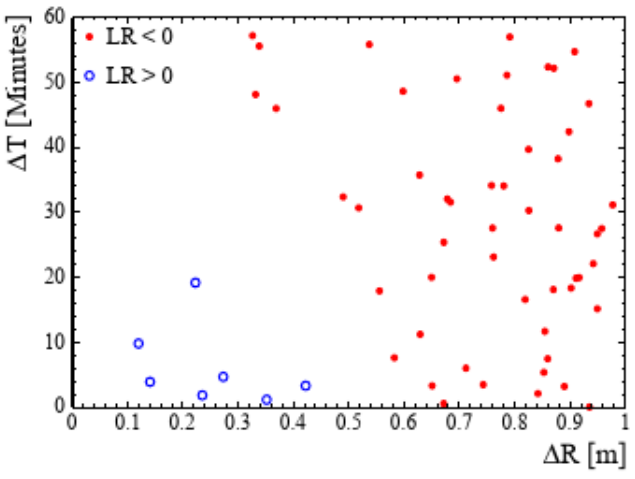


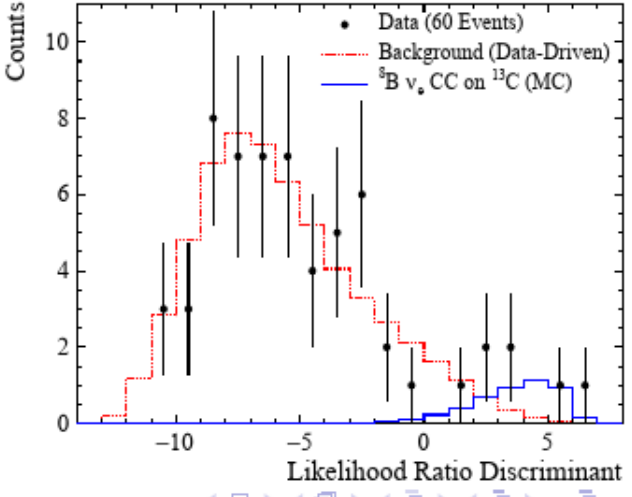
CC Interactions between ^{13}C and ^{8}B Solar Neutrinos

Prompt e⁻ energy = $E(\nu_e) - 2.2\ MeV$



- arxiv:2508.20844
- First observation with solar neutrinos
- Likelihood approach with coincidence selection





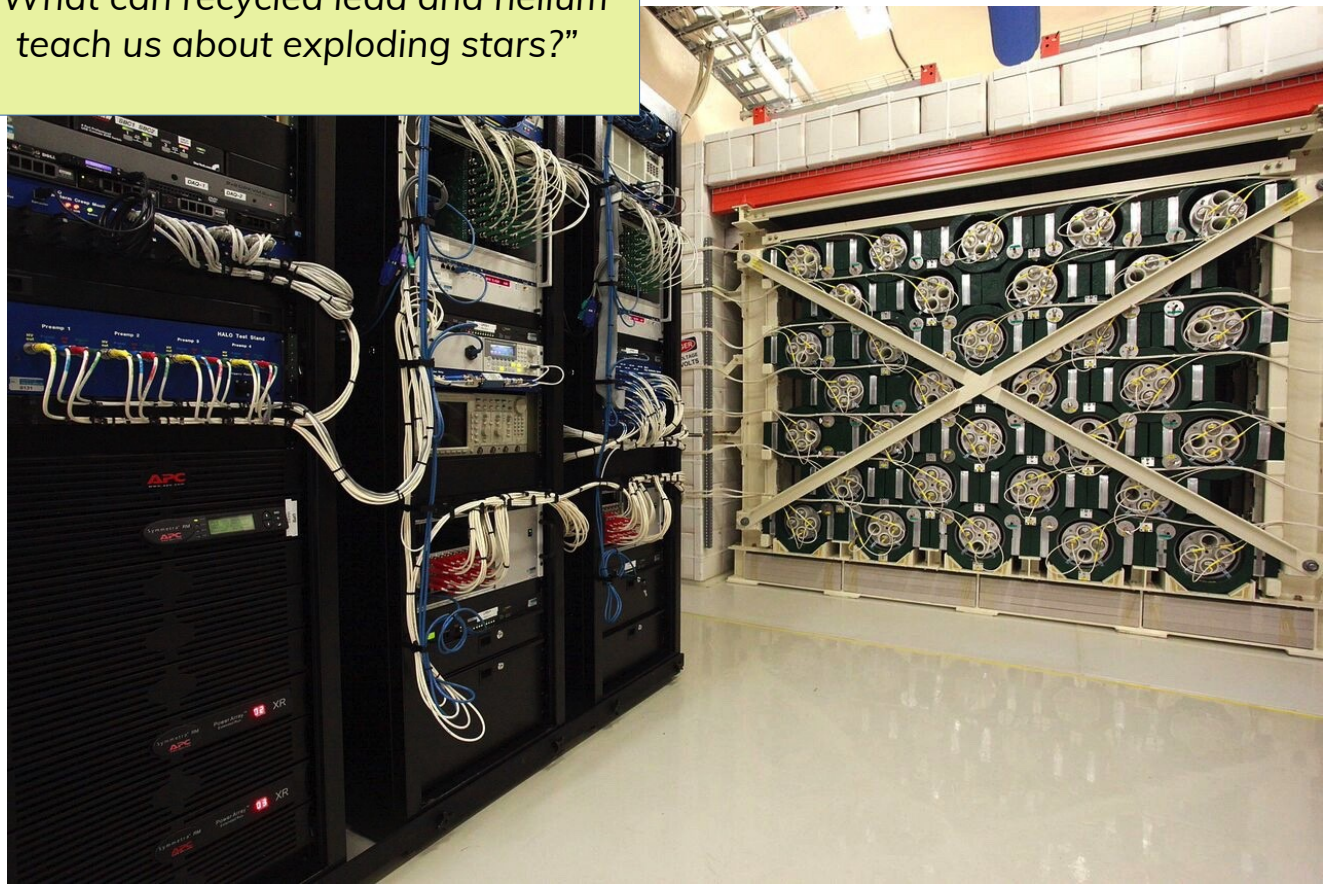
SNO+ has been a science machine, with publications stemming from its “water phase” running (2017-2019) and more recently from its “partial fill” and complete fill scintillator phase (2019-current).

A rich program in reactor, solar, and geoneutrino measurements (recent first observation of solar boron-8 neutrinos interacting with carbon-13 shown left).

HALO

- Supernova Early Warning Detector (neutrino burst detection)
- 79 tonnes of recycled lead and 128 recycled SNO neutral current detectors.
- > 99% uptime
- Longest continuously running experiment at SNOLAB (13 years)

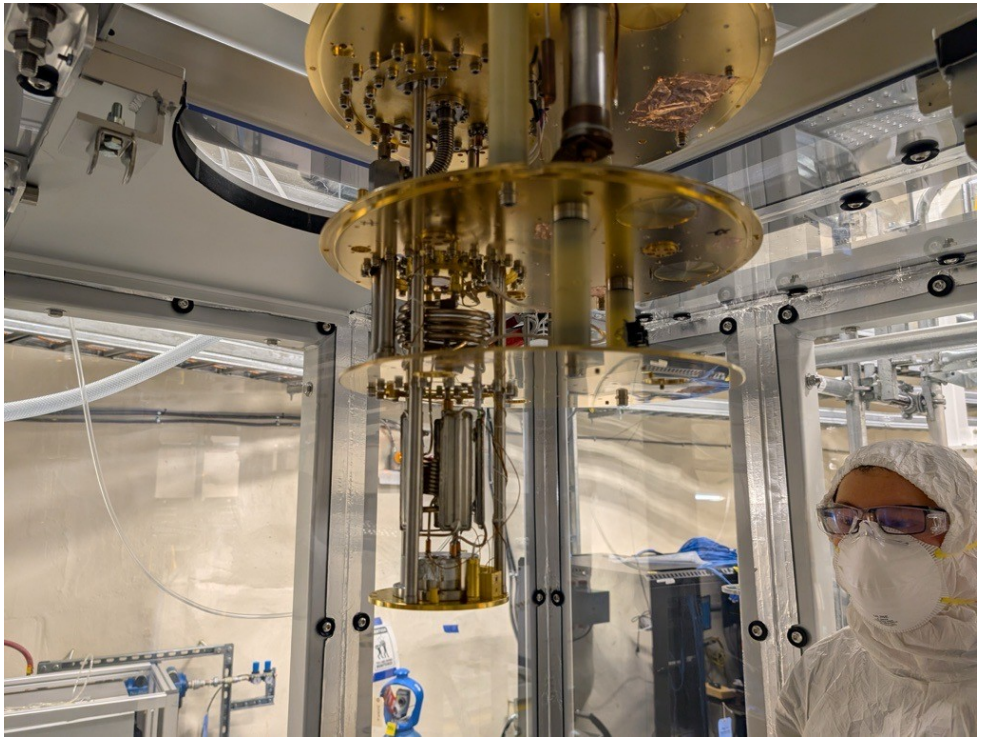
"What can recycled lead and helium teach us about exploding stars?"



UNDERGROUND QUBITS

“QUTEBITS”: Qubits deep underground at the Cryogenic Underground TEst facility

Main system components:
Payload
Cryostat
Magnetic shielding
Water tank
Drywell
Deck
Low activity lead
Very low activity lead
Internal lead
Polyethylene
Suspension system
Extra frame for Pulse Tube (PT)/turbo
Gamma source
Neutron source



“Does an underground quantum computer work better than a surface one?”

W

Qubits have a “coherence problem” where they can only maintain their useful state for several seconds. Study the effect on this decoherence time in a well-shielded underground environment.

FUTURE DIRECTIONS

Underground Science Cafe

An internal science communication effort at SNOLAB, now in its second season.

Take a break, grab a snack, and learn something amazing!

First shows will be underground the week of January 19, with Dr. Michel (“Mike”) Lapointe speaking on underground biology.

Watch for announcements on the SNOLAB site mailing list and via the event website!

Community-Oriented Programs

https://indico.snolab.ca/e/susi2026

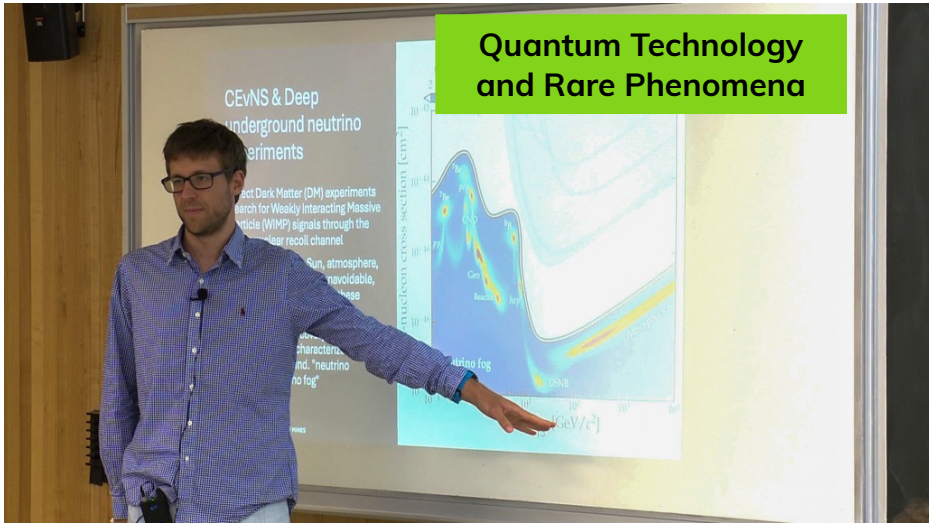
- SNOLAB Underground Science Institute (SuSi) lecture program
  - An intellectual support effort at SNOLAB
  - **Check out last summer's lecture series!**
    - **Visit https://indico.snolab.ca/e/susi2025 for lecture videos**

Lectures

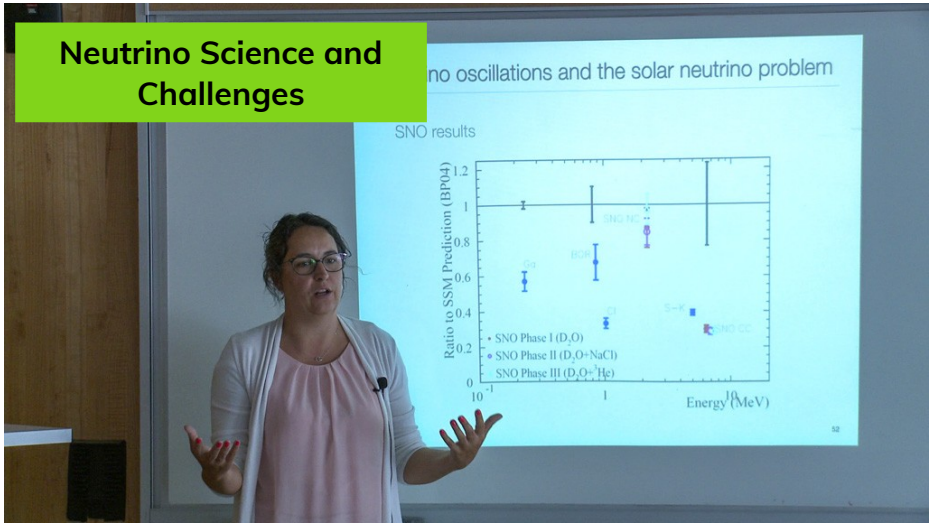
Dan Hooper

Cosmology and Astrophysical Theory

Wouter Van De Pontseele



Quantum Technology and Rare Phenomena



Neutrino Science and Challenges

Roxanne Guenette

https://indico.snolab.ca/e/susi2025

The First 15-Year Plan for SNOLAB

SNOLAB was asked by its federal funding agency to provide detailed and reliable budget estimates (including assessing current facility conditions and assets) for the next 15 years under 3 budget scenarios:

1) *Maintaining the current level of operations*
2) *Fully supporting the needs of the Canadian research community*
3) *Increasing global competitiveness*

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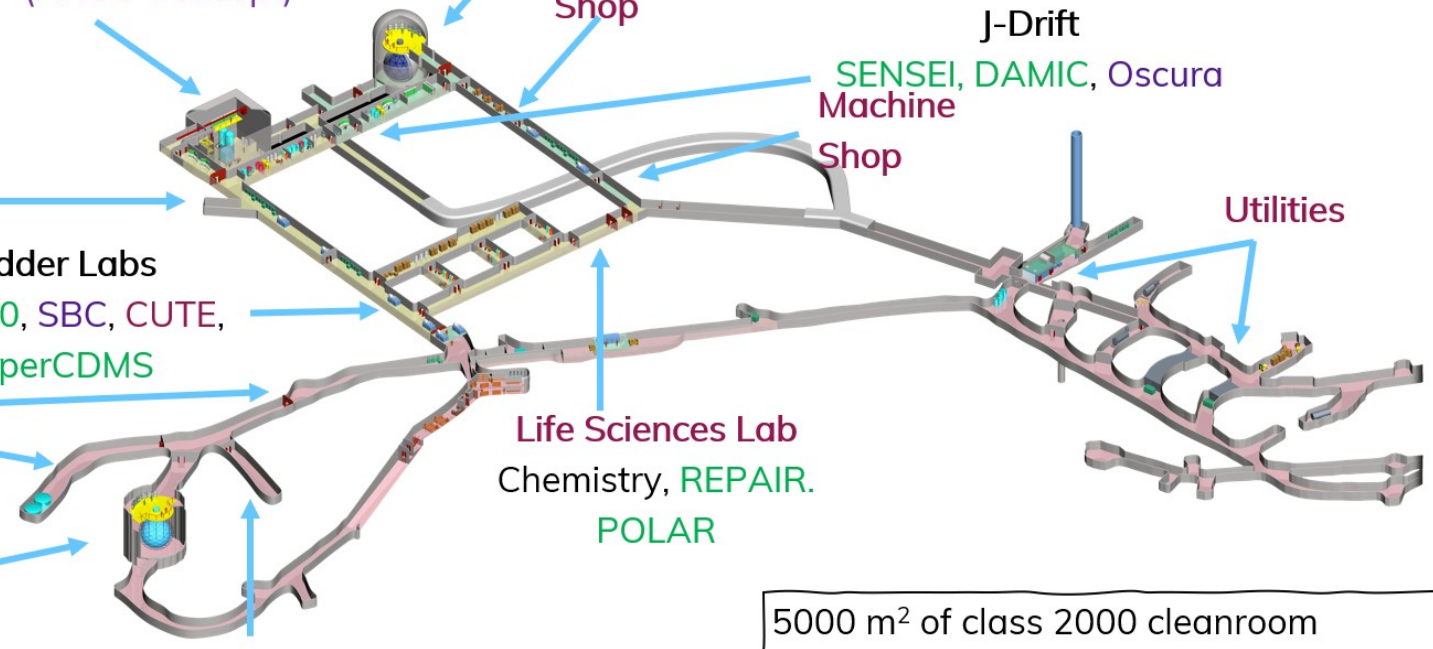

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XIA, CTBT Dual HPGe, IceCube DOM Testing

5000 m^2 of class 2000 cleanroom underground.
<2000 particles >0.5 μm in diameter per ft^3
arXiv:2006.12746

Scenarios: Major Components

New Surface Building

All Scenarios:

- Located outside industrial control zone
- Large auditorium space to accommodate current staff and programs
- New spaces for training and laboratory work

Scenario 2:

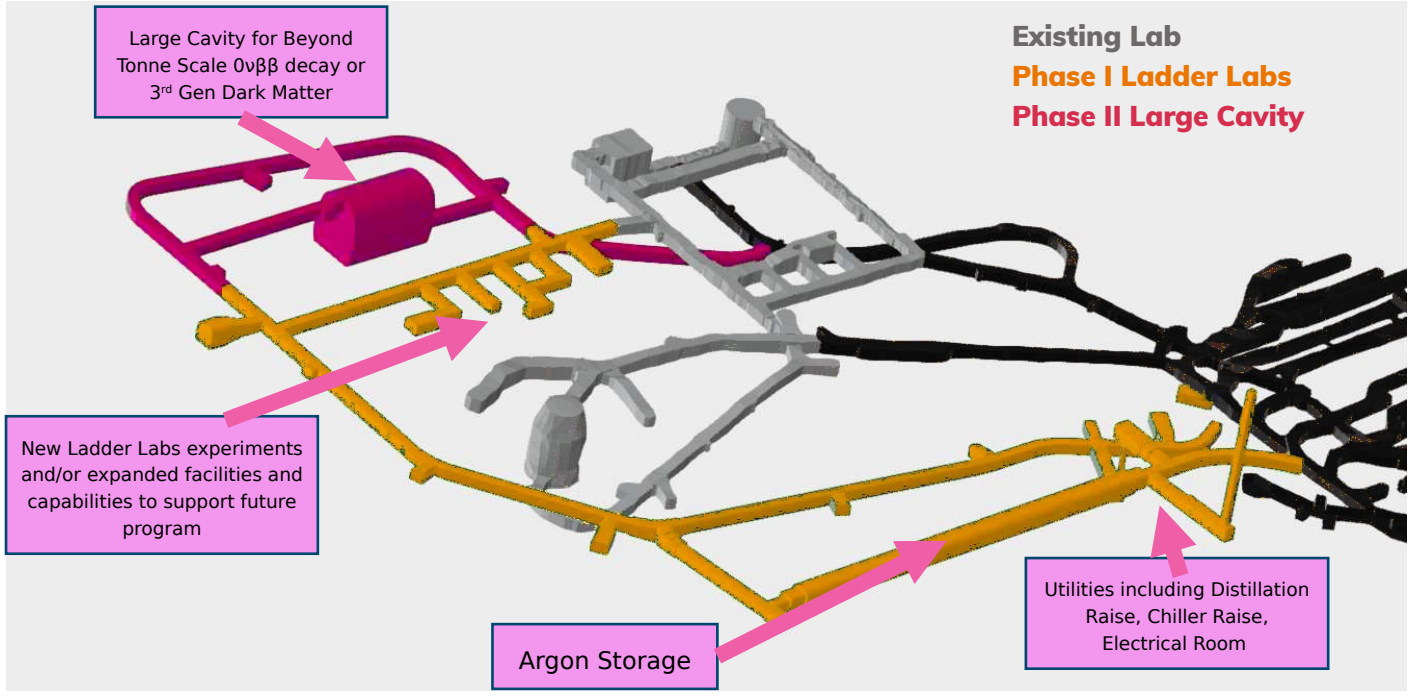
- 50% more lab space and two more floors of office/collaboration space
- Visitor Centre
- Dedicated warehouse

Scenario 3:

- Daycare, Cafeteria, Hostel
- Materials fabrication lab

Underground Laboratory

- **Scenario 1: Refurbishment and Enhanced Capabilities**
- **Scenarios 2 and 3: Additional laboratory expansion**



CONCLUSIONS AND OUTLOOK

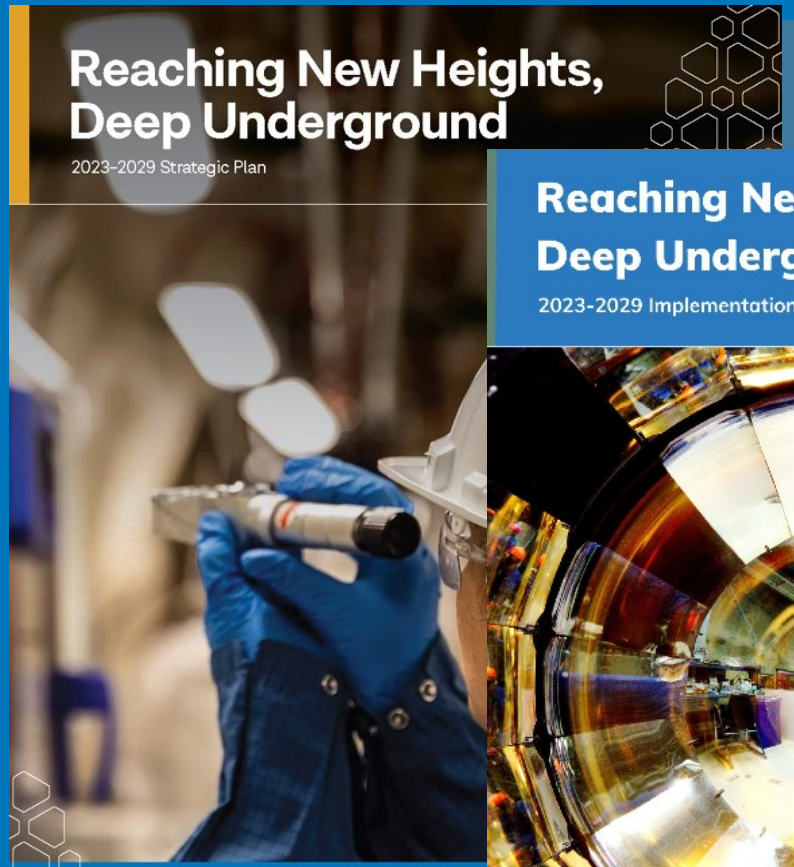
What Wasn't Covered?

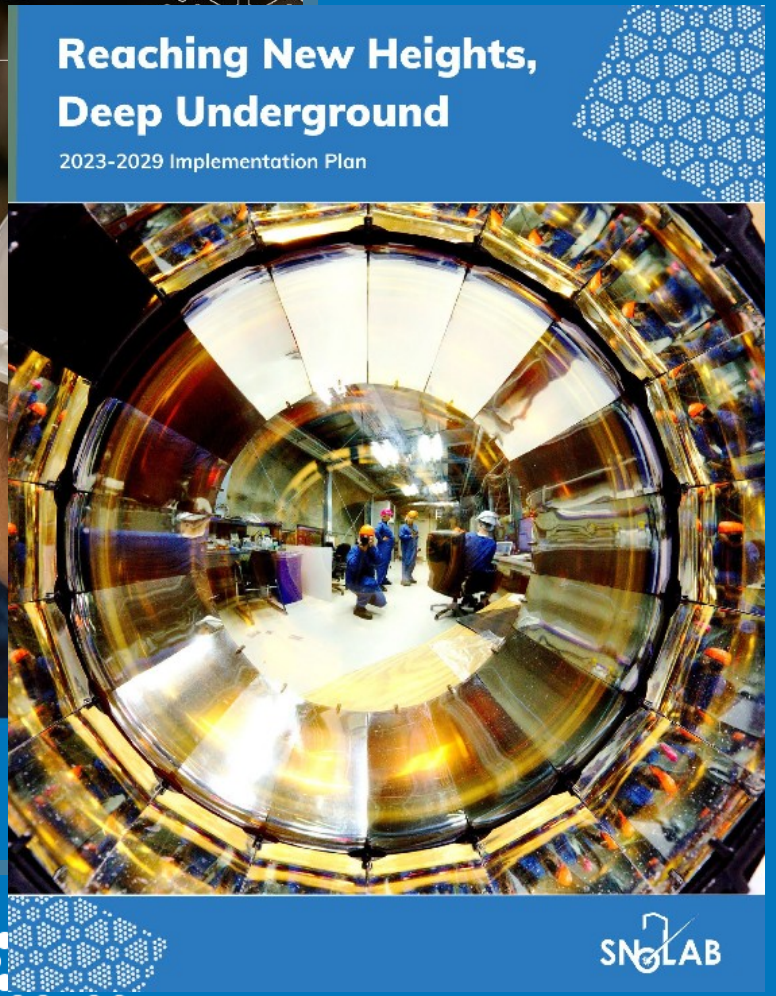
- Geoscience: seismic monitoring
- Cleanliness: techniques and assays → assess the value of choices and actions
- Laboratory characterization: backgrounds throughout the lab (neutrons, gamma rays, radon, etc)
- Broader Environmental Monitoring: air and water quality, low-level environmental radiation monitoring, etc.
- … and a lot more!

Ask Questions.

Seek Answers.

Go Deep.





APPENDIX

SNOLAB's International User Community

1200+
Annual academic users and collaborators

24%
of users from Canadian institutions

166
Institutions

26
Countries

Research & Scientific Community

164
Experiment users who came to the SNOLAB site, up from 158 the year before. SNOLAB continues to serve more than 1,000 remote users.

654
Scientific publications
SNOLAB has contributed to or been referenced in. More than 100 of these have come in 2024 and 2025.

44
Student work terms filled at SNOLAB last year over three cohorts.

Education & Public Outreach

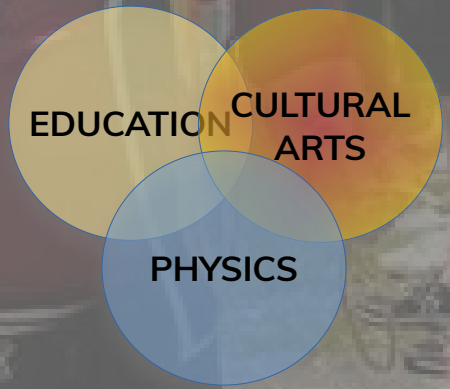
4,644
People reached through Education and Outreach programming.

40
Regional, national, and international media engagements featuring SNOLAB, SNOLAB science, and SNOLAB people.

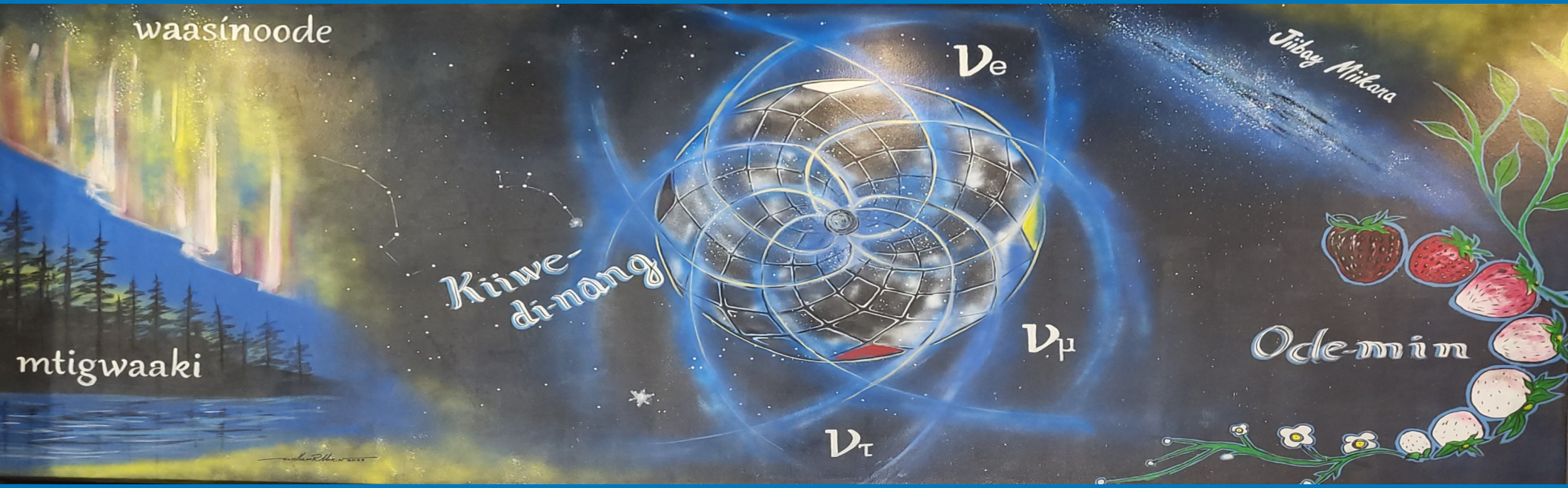
198
Teachers who participated in SNOLAB workshops.

438
K-12 students reached through class visits.

INTERSECTIONS OF SCIENCE AND CULTURE



Will Morin, an artist and knowledge holder, weaves together indigenous knowledge - lessons embedded in stories of the night sky – and traditional planetarium presentation strategies. These are now part of the program for the SNOLAB Underground Science Institute Summer Lecture Program and Canadian Astroparticle Summer Student Talk (CASST) competition hosted at SNOLAB.



“Agaashiinyi: It is Small”
Location: Lobby, SNOLAB Surface Building

Artist: Will Morin

"Star stories"
Artist: Mishiikenh Kwe

Location: 2nd Floor, SNOLAB Surface Building

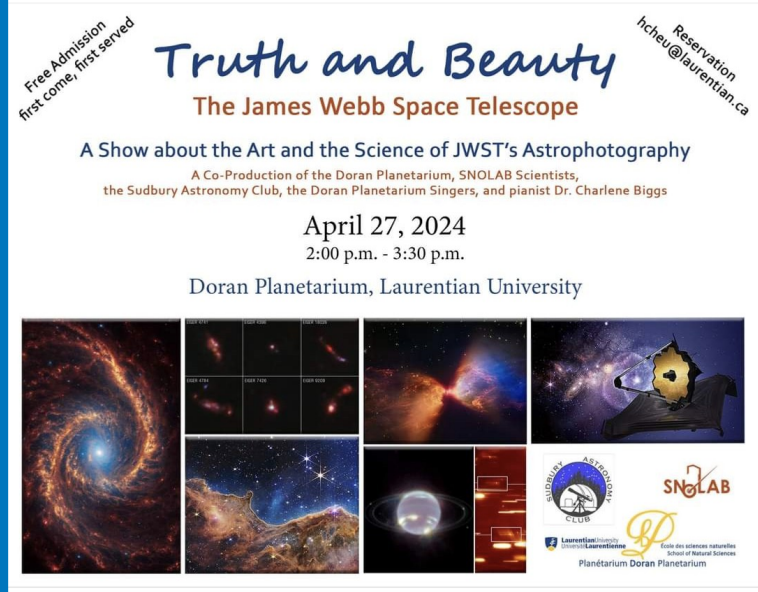
Emerging artist from Magnetawan First Nation -combines traditional woodland style with pop art and modernism.

Inspired by creation stories from Turtle Island told to her by her grandmother. Each of the animals depicted in the mural represents a different aspect of Anishinaabe creation stories.

Doran Planetarium - Laurentian University

5d ·

We need to make sure that our information is correct; astronomer Steve Dodson, SNOLAB astroparticle physicists Stephen Sekula, Christine Kraus, and Yusuf Ahmed will speak about the JWST science. I (Hoi Cheu) as the MC will pull everyone together -- this show is like a documentary film, but performed live, including the music.



The Doran Planetarium at Laurentian University (LU) hosted an art and science synthesis event on the James Webb Space Telescope. This involved the Doran Planetarium singers, LU and SNOLAB staff, and the Royal Astronomical Society of Canada Sudbury Chapter.