

2024/08/07

SNOLAB Update/Plans

Jodi Cooley

Executive Director | SNOLAB

Professor of Physics | Queen's University

Adjunct Research Professor SMU



Land Acknowledgement

SNOLAB is located on the traditional territory of the Robinson-Huron Treaty of 1850, shared by the Indigenous people of the surrounding Atikameksheng Anishnawbek

First Nation as part of the larger Anishinabek Nation.

We acknowledge those who came before us and honour those who are the caretakers of the land and the waters.

Introduction to SNOLAB



- SNOLAB hosts rare event searches and measurements. It's located 2 km underground in the active Vale Creighton nickel mine near Sudbury, Ontario, Canada. [SEP]
- SNOLAB is operated jointly by University of Alberta, Carleton University, Laurentian University, University of Montreal, and Queen's University. [SEP]
- SNOLAB operations are funded by the Province of Ontario, and the Canada Foundation for Innovation.



SNOLAB by Numbers



1000+ 

annual academic
users/collaborators

25% 

of those users/
collaborators are
Canadian researchers

24 

Our international
collaborators come
from 24 countries

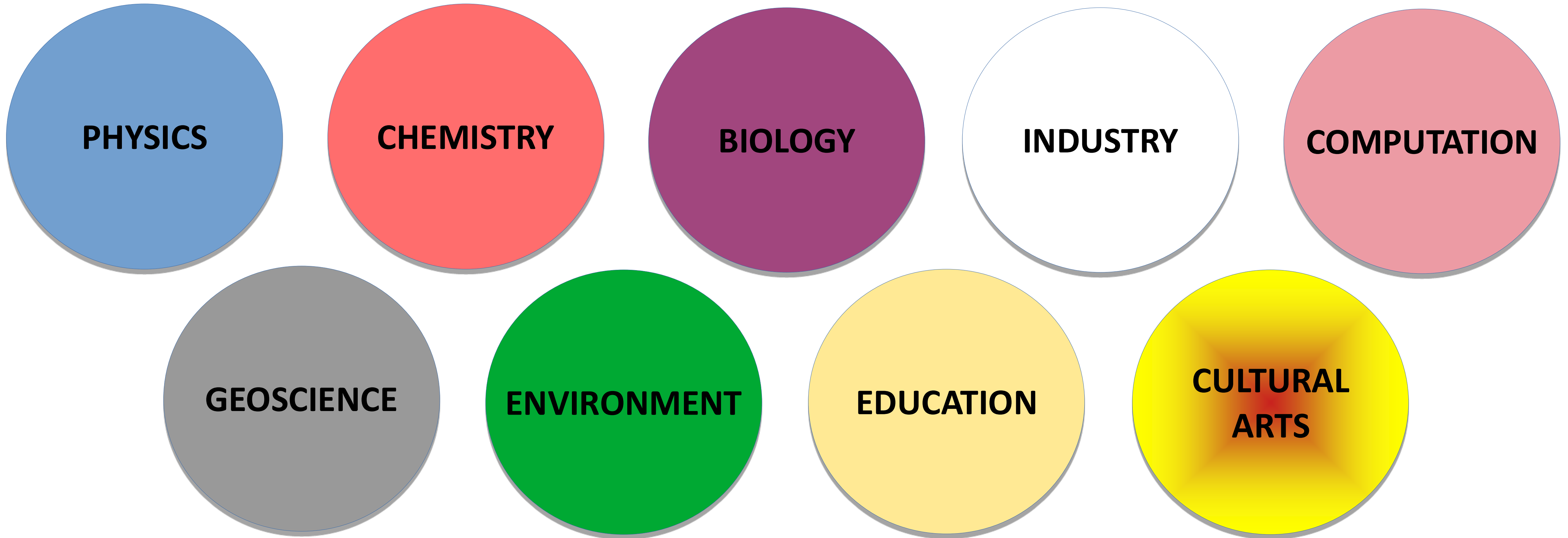
164 

Our international
collaborators come
from 164 institutions

 - Participating Countries

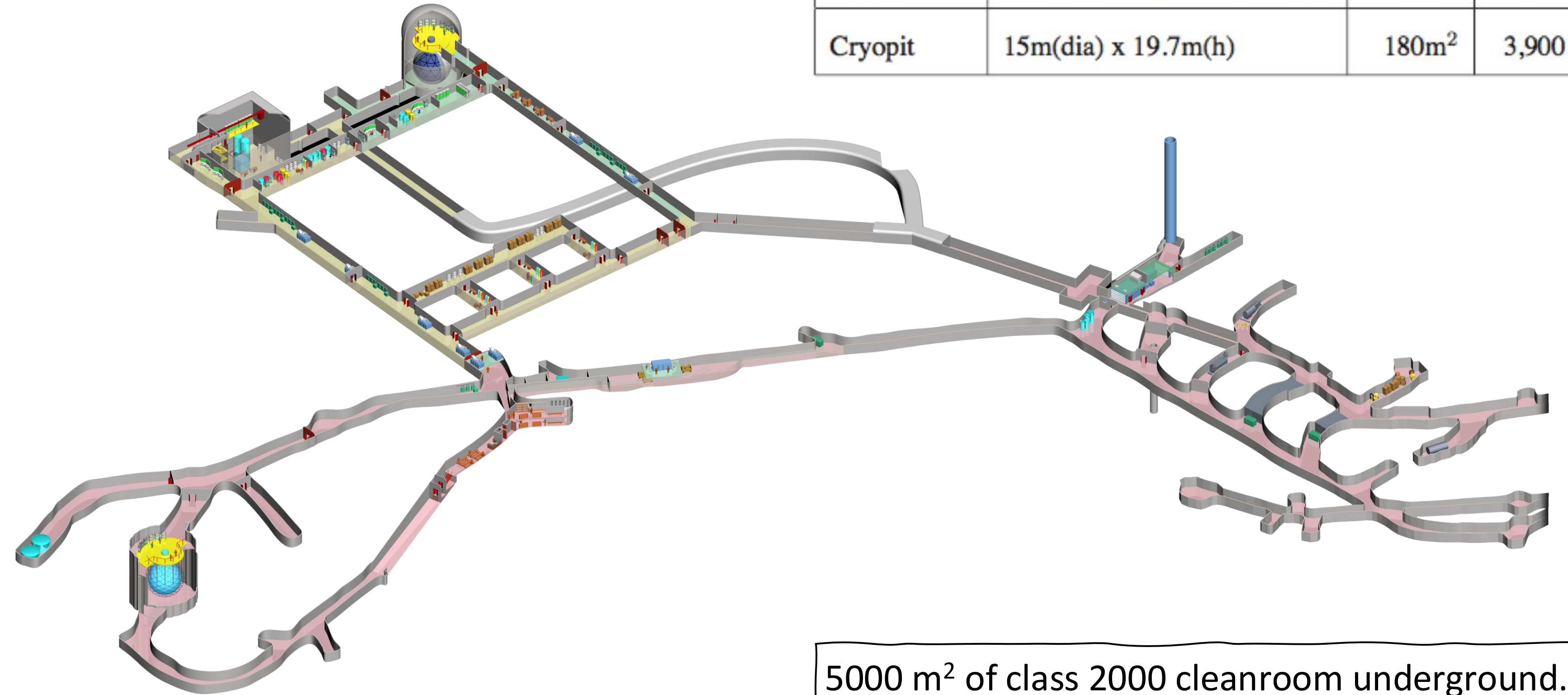


Disciplines at SNOLAB



SNOLAB Layout

Area	Dimensions	Area	Volume
SNO Cavern	24m (dia) x 30m(h)	250m ²	9,400 m ³
Ladder Labs	32m(l)x6m(w)x5.5m(h)	190m ²	960 m ³
	23m(l)x7.5m(w)x7.6m(h)	170m ²	1,100 m ³
Cube Hall	18.3m(l)x15m(w) x 19.7m(h)	280m ²	5,600 m ³
Cryopit	15m(dia) x 19.7m(h)	180m ²	3,900 m ³



5000 m² of class 2000 cleanroom underground.
<2000 particles >0.5 μ m in diameter per ft³

[arXiv:2006.12746](https://arxiv.org/abs/2006.12746)

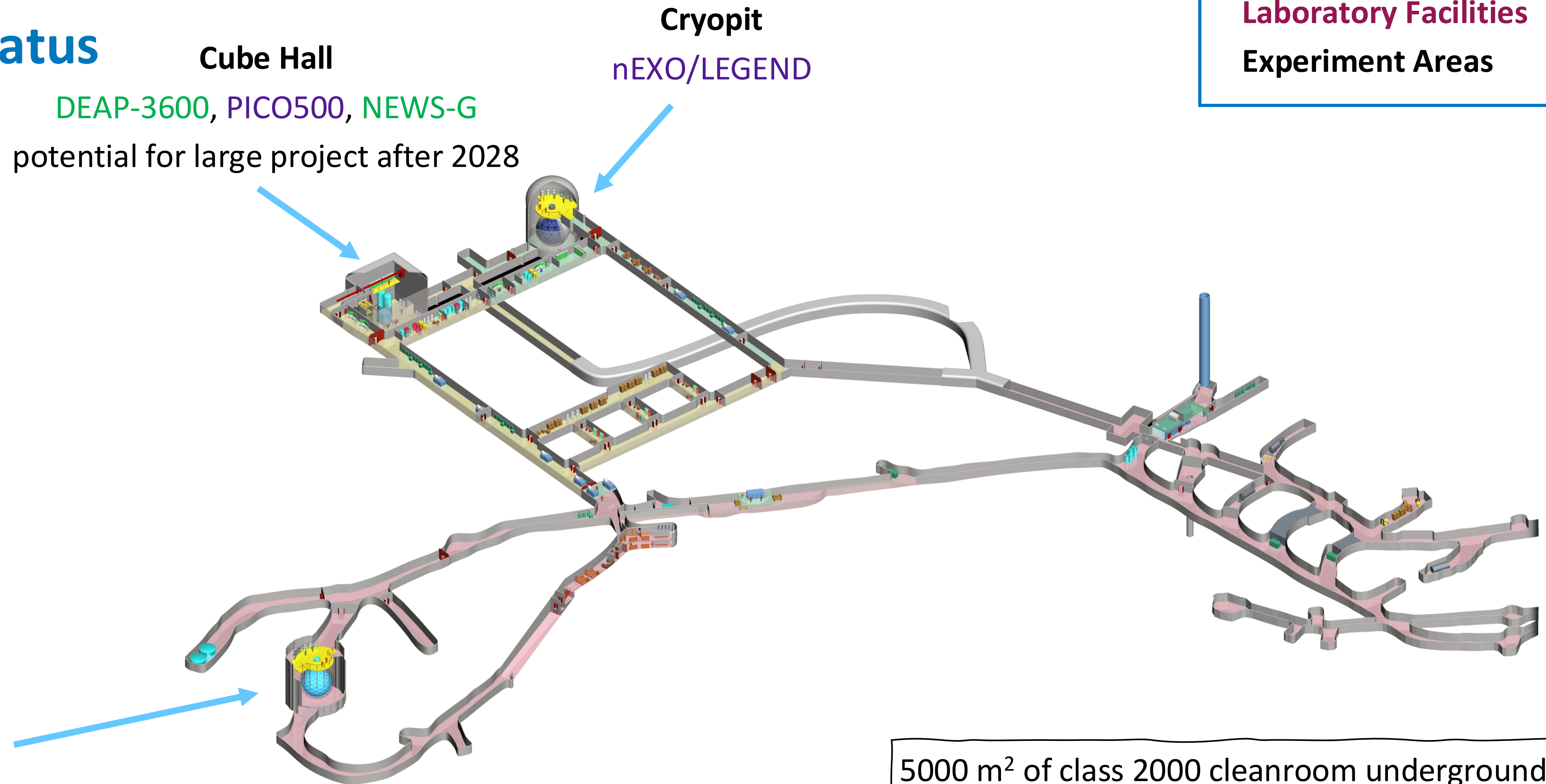
SNOLAB – Large Cavity Status

Current Experiments

Future Experiments

Laboratory Facilities

Experiment Areas



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

5000 m² of class 2000 cleanroom underground.
<2000 particles >0.5 μm in diameter per ft³

[arXiv:2006.12746](https://arxiv.org/abs/2006.12746)

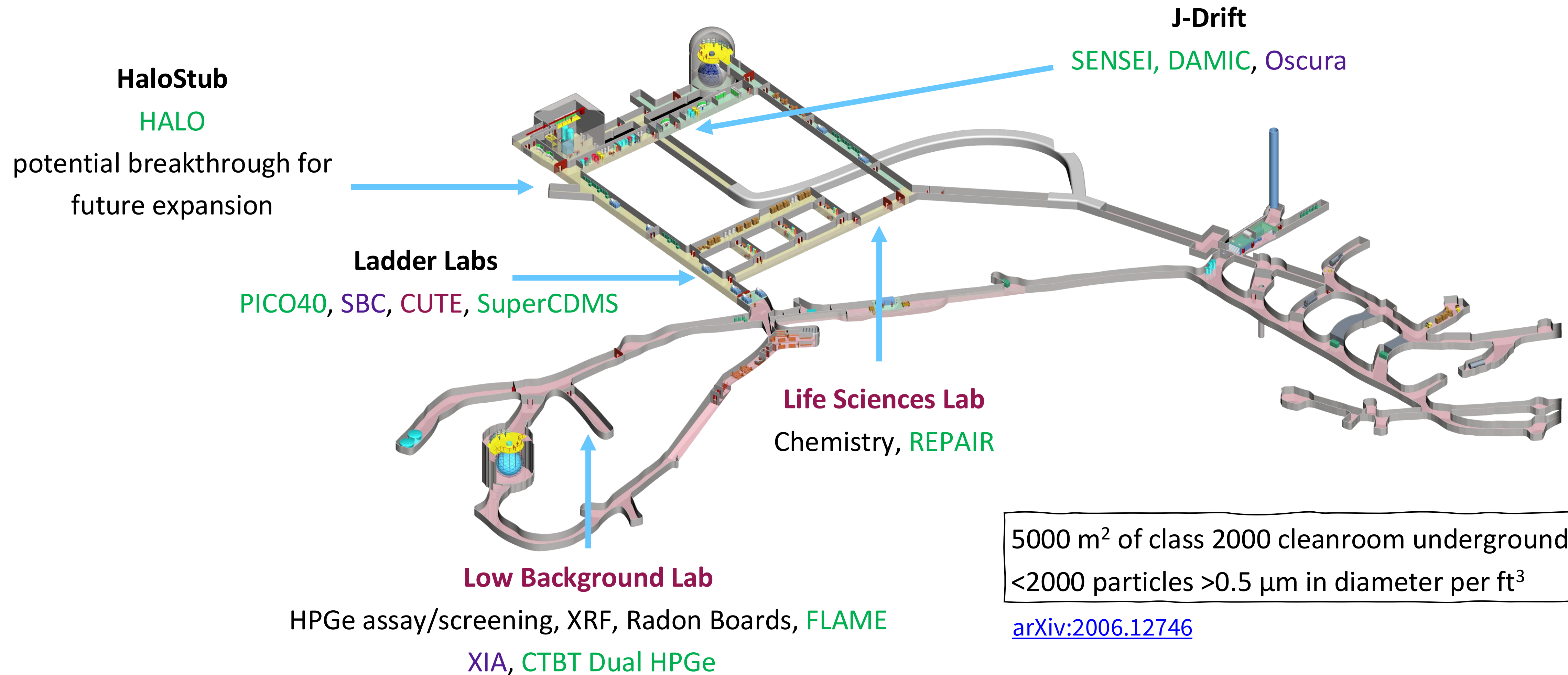
SNOLAB - Small Cavity Status

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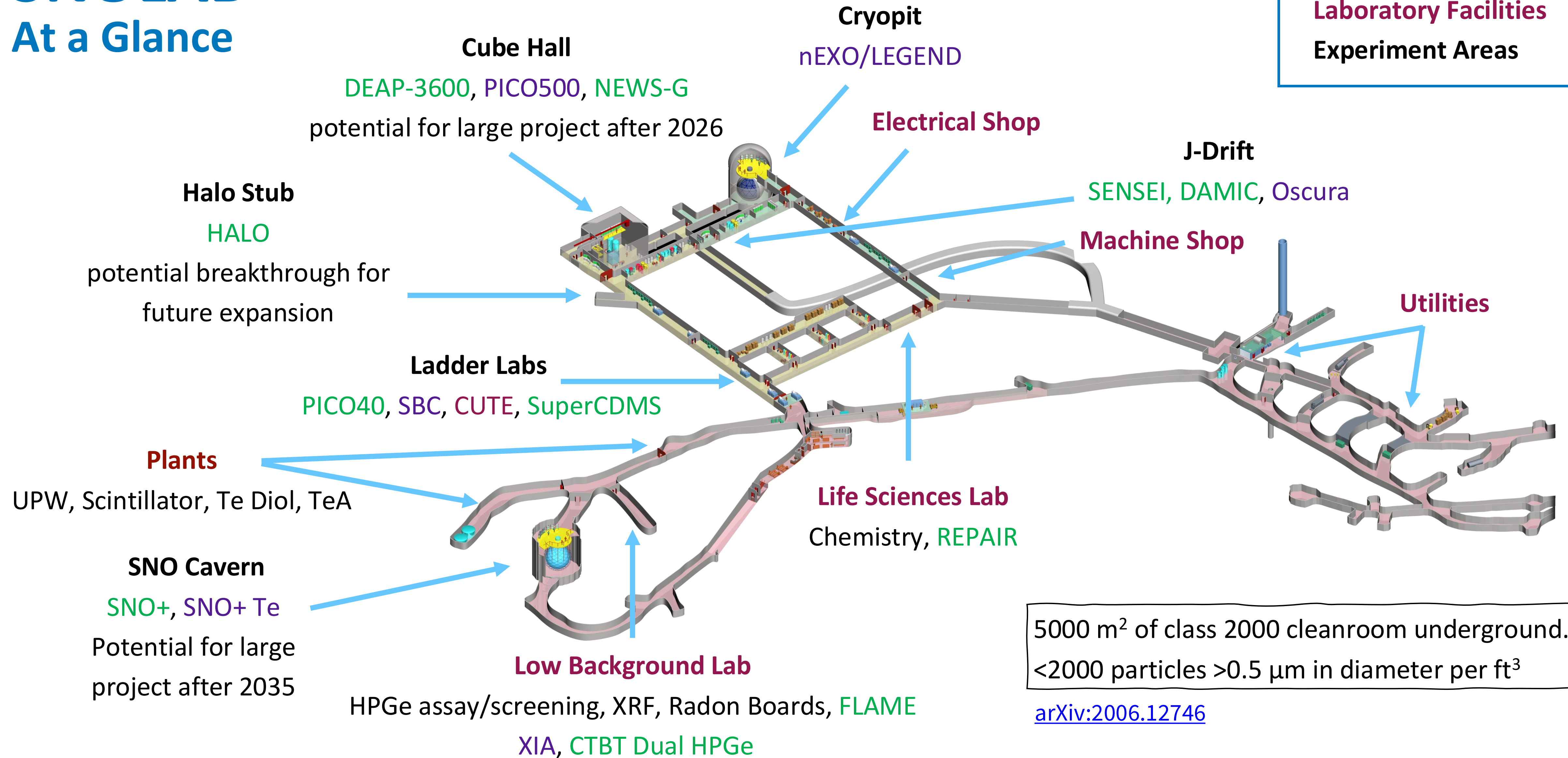
SNOLAB – At a Glance

Current Experiments

Future Experiments

Laboratory Facilities

Experiment Areas



5000 m² of class 2000 cleanroom underground.
<2000 particles >0.5 μm in diameter per ft³

[arXiv:2006.12746](https://arxiv.org/abs/2006.12746)

1

Excellent science

Drive breakthrough discoveries at the frontiers of underground science.

Expected outcomes:

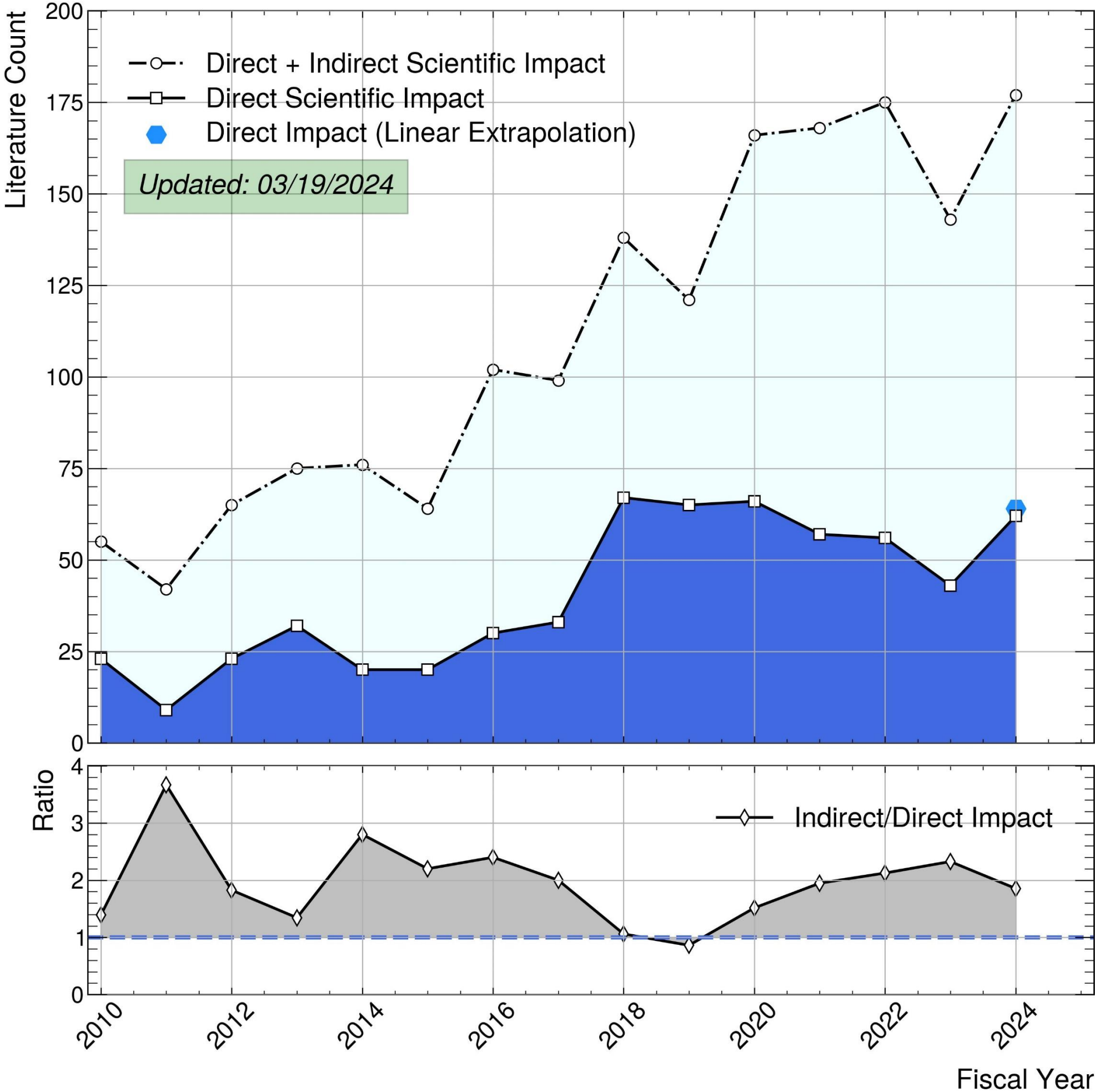
- Cementing of Canada's leadership in deep underground science
- A stronger, more competitive Canada in scientific discovery
- More Canadian researchers positioned as global leaders

Scientific Achievements



- The scientific productivity was excellent last year
- Most experiment collaborations published data taken underground over the last year
- New capabilities were developed including new germanium detectors, mass spectroscopy, radon assay, cleanliness and seismic monitoring
- Thank you for your contributions to these outputs!

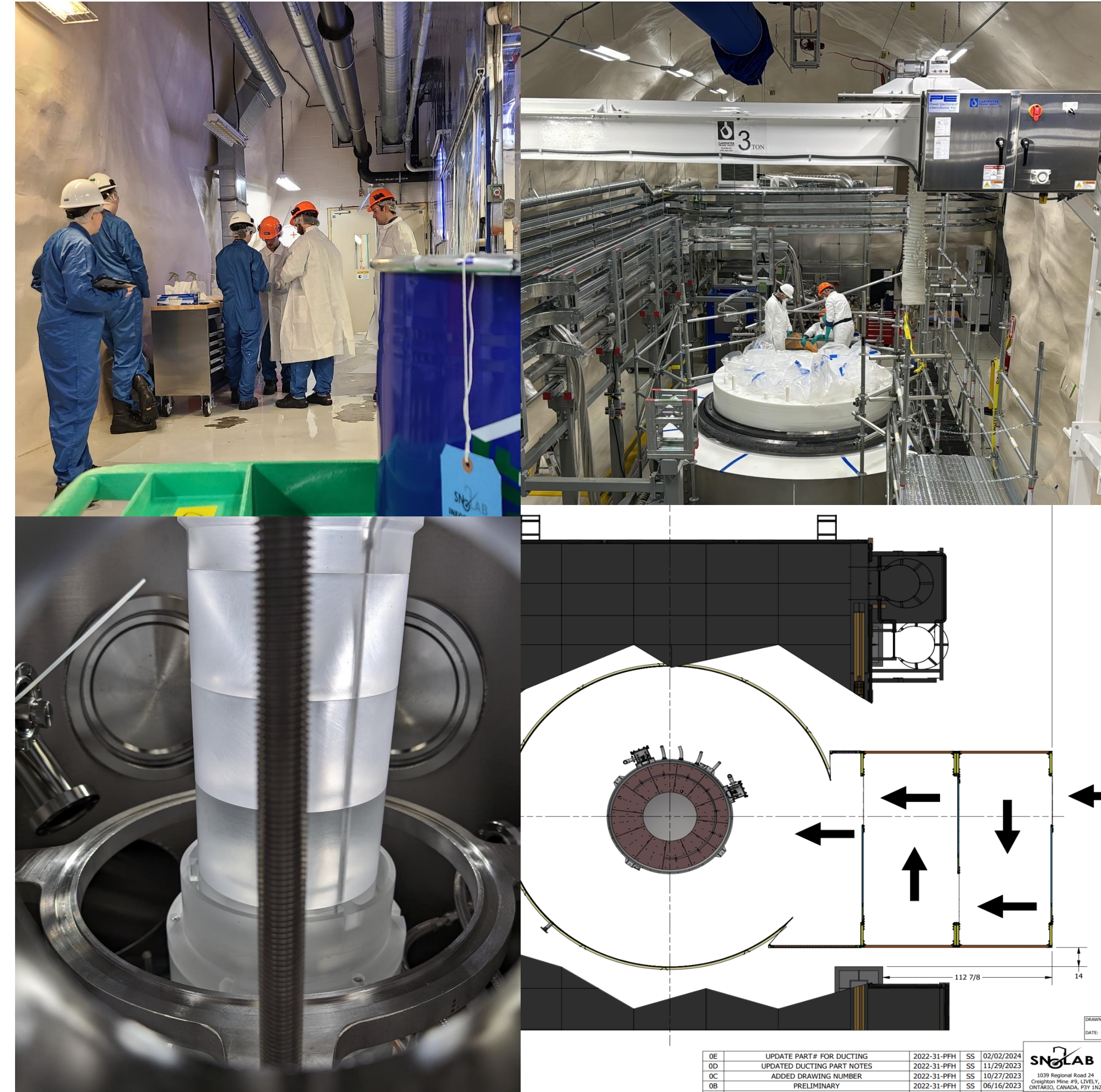
SNOLAB Scientific Contributions + Proceedings + Books/Chapters



Several complex construction activities are scheduled to complete next year

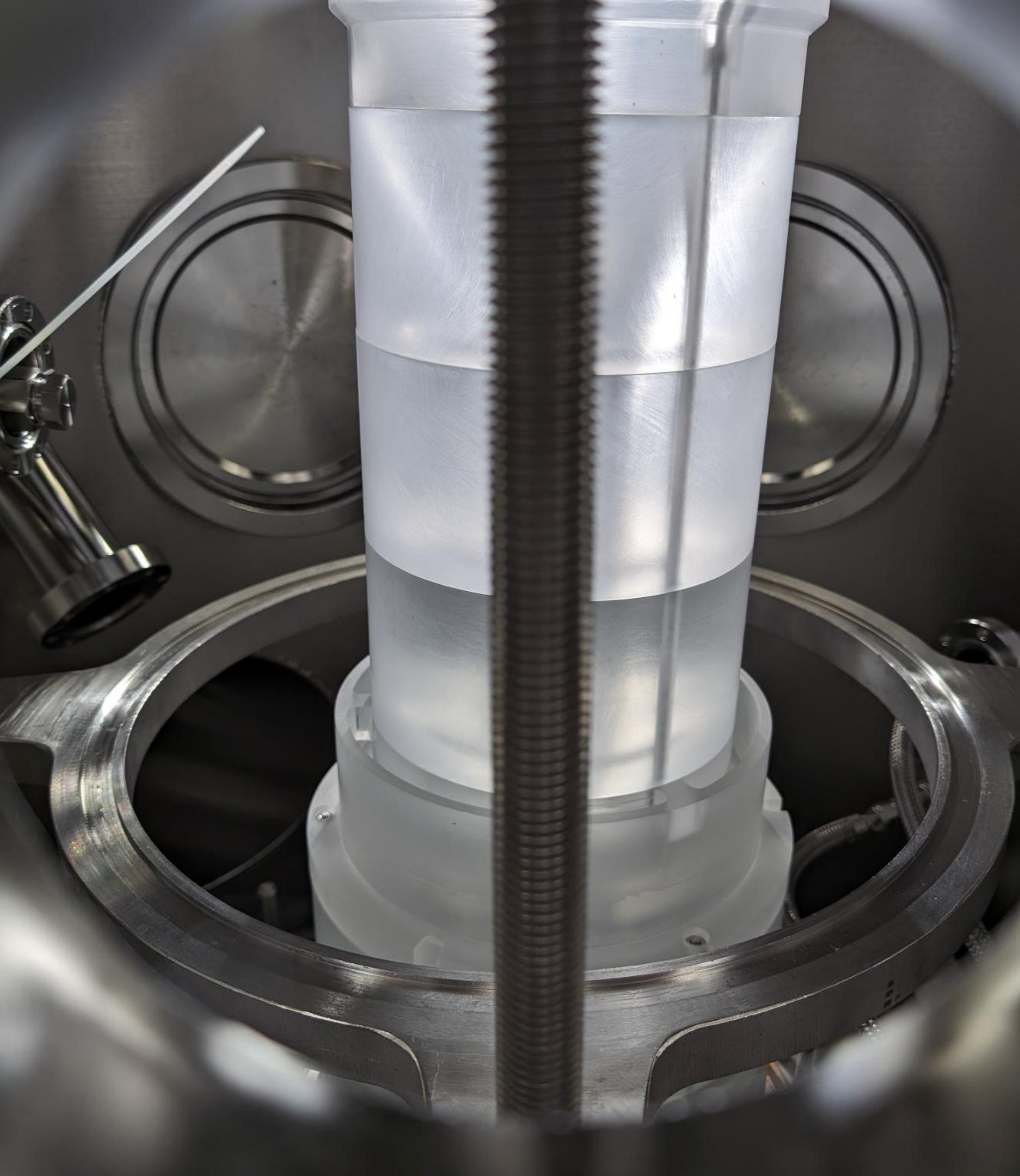


- Many projects are planning to make major progress this year
- In particular, the following experiments have major work that will be ongoing.
 - DEAP-3600
 - PICO-500
 - SNO+
 - SuperCDMS
- The CUTE facility New initiatives



REV	DESCRIPTION	JOB FILE #	BY	DATE
0E	UPDATE PART # FOR DUCTING	2022-31-PFH	SS	02/02/2024
0D	UPDATED DUCTING PART NOTES	2022-31-PFH	SS	11/29/2023
0C	ADDED DRAWING NUMBER	2022-31-PFH	SS	10/27/2023
0B	PRELIMINARY	2022-31-PFH	SS	06/16/2023
0A	PRELIMINARY	2022-31-PFH	SS	05/17/2023

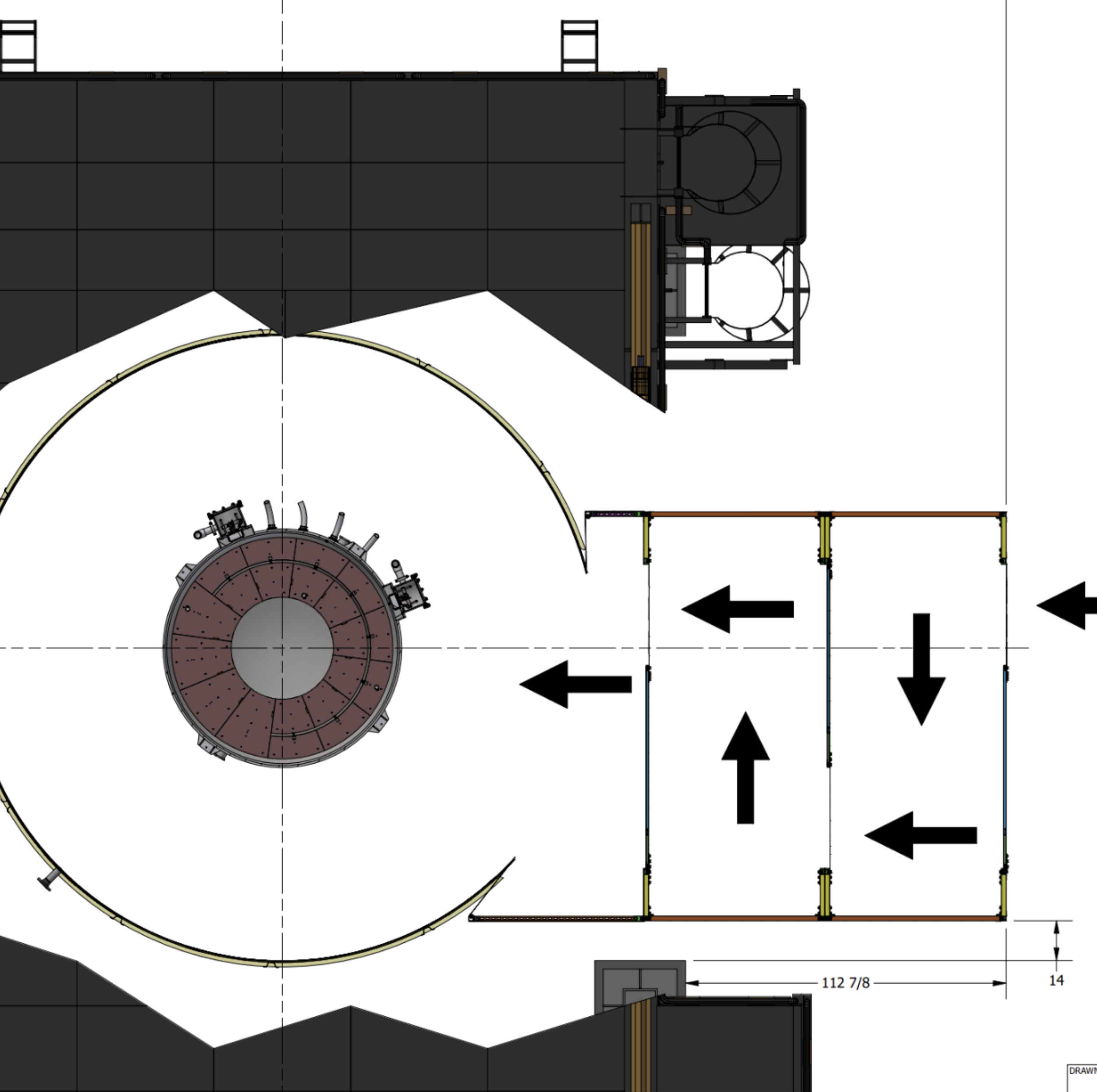
1039 Regional Road 24
Georgetown, ONTARIO, CANADA, P1N 1B5
PICO-500 WELDING
WELDING VESTIG



DEAP-3600

- The DEAP upgrades are rapidly converging to an upgraded detector.
- Construction activities in DEAP should complete this fall and then transition to commissioning.
- The detector will be taking science quality data by this time next year.

PICO-500



- The TDR for PICO-500 was held April 16 and 17th.
- Welding in the Cube Hall will begin later this year.
- PICO-500 will be ready for commissioning next year.

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1039 Regional Road 24
 Creighton Mine #9, LIVELY,
 ONTARIO, CANADA, P3Y 1N2
 TITLE: PICO-500 WELDING C
 WELDING VESTIE

SNO+

- SNO+ is in the middle of a **Telluric Acid** purification campaign (results have been excellent)
- Work will continue with tellurium throughout the year





SuperCDMS

- SuperCDMS operated their first production tower in CUTE for four months
- Construction is ongoing. The team will focus on shield construction interleaved with cryostat assembly.
- The construction will progress to a fully assembled cryostat by this time next year.

Qubits in CUTE

- ‘Characterization of qubits in a deep underground environment’ chosen for funding by the US Army Research Office.
- Prof. Chris Wilson at the Institute for Quantum Computing is the project leader.
- Chalmers University will produce cutting-edge superconducting qubit arrays.
- Arrays will be tested in Sweden, Waterloo, then SNOLAB (housed in CUTE).
- Project was newly selected in 2023 and has begun activities this year.

Quantum challenge to be solved one mile underground

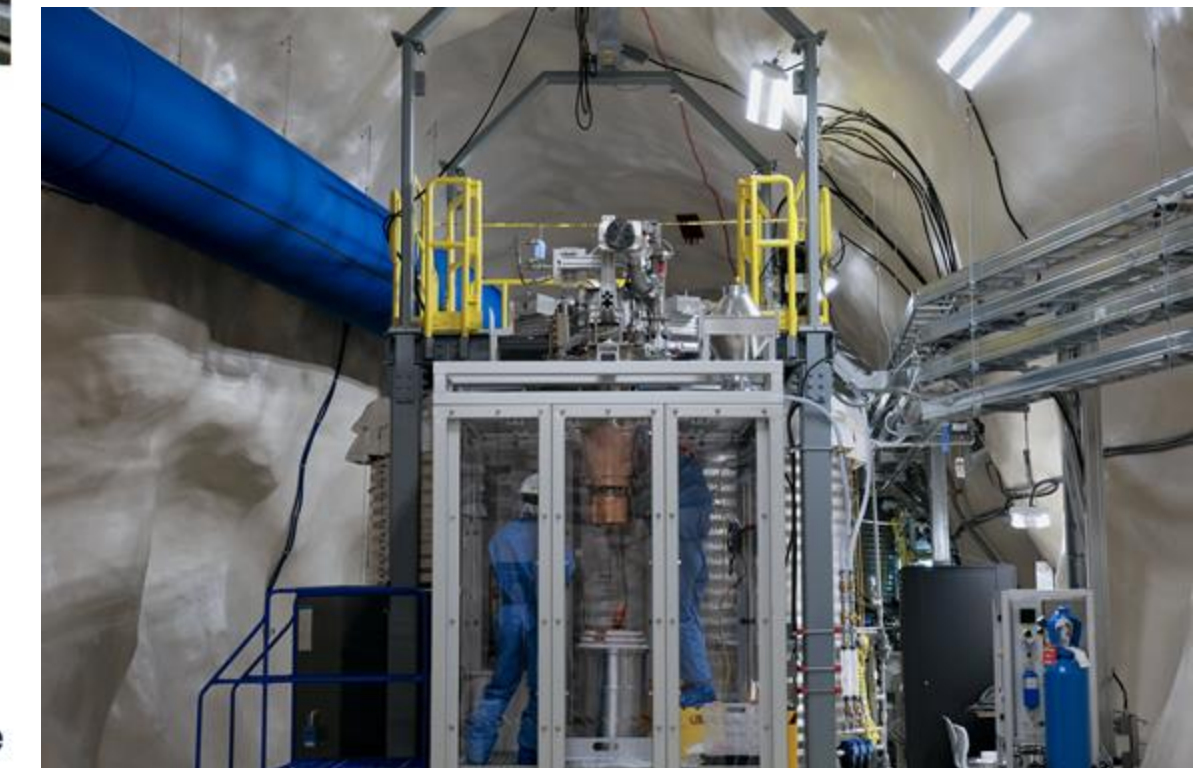
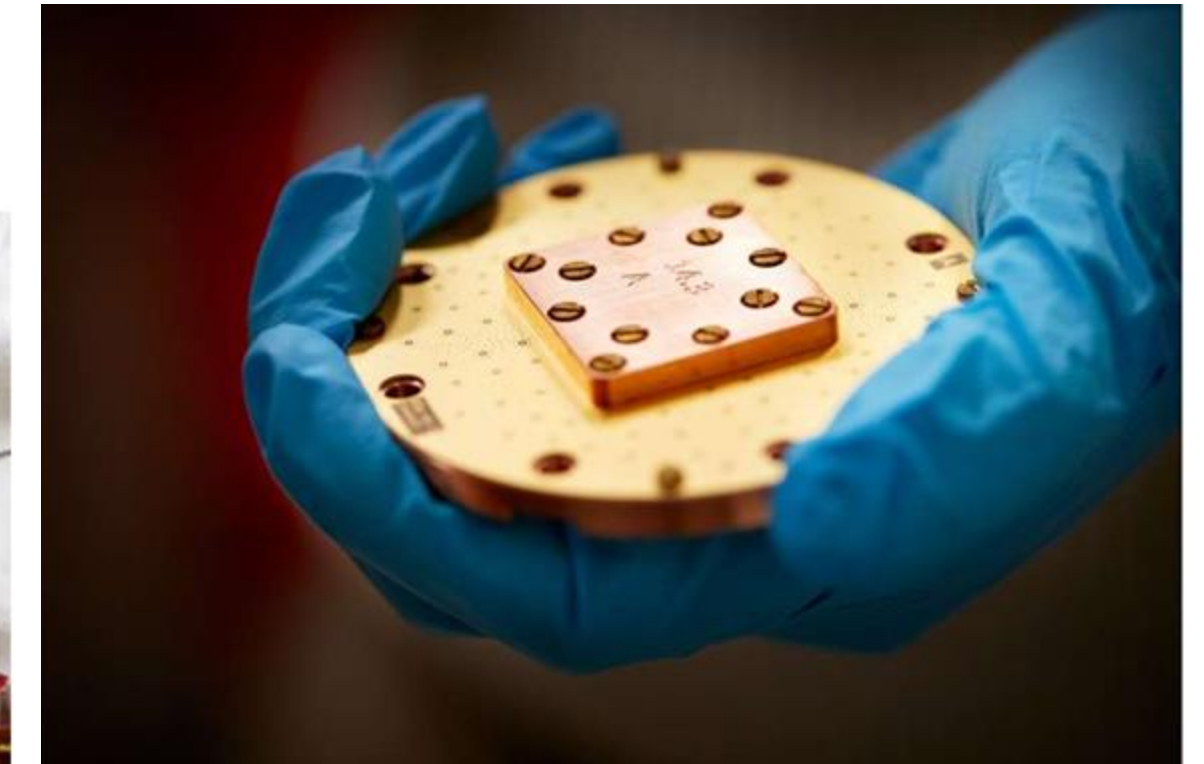
by Chalmers University of Technology



This is where the Swedish qubits are going | The Canadian underground labor...

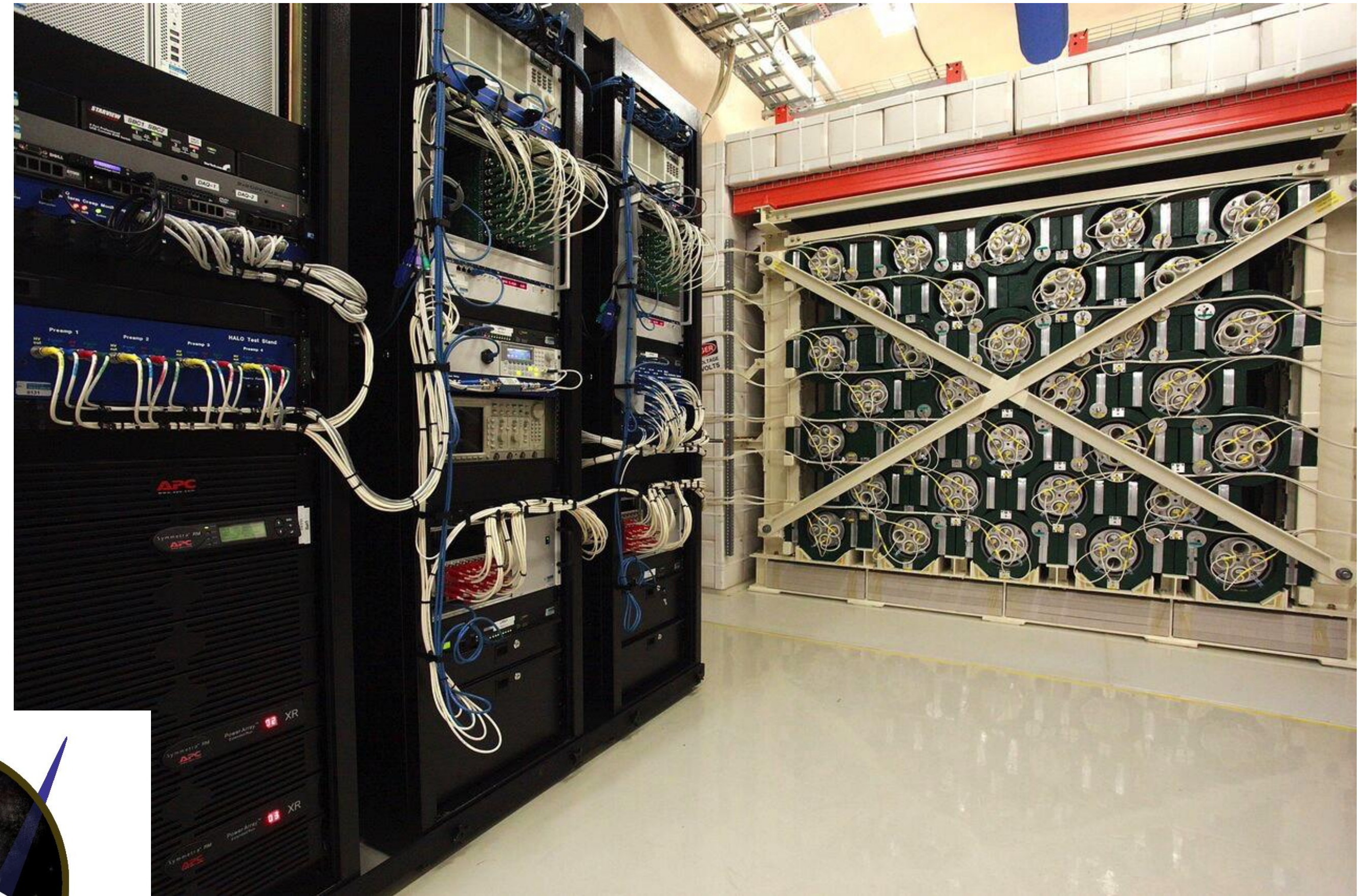
Radiation from space is a challenge for quantum computers as their computation time becomes limited by cosmic rays. Researchers from Chalmers University of Technology, Sweden, and University of Waterloo in Canada are now going deep underground in the search for a solution—in a two-kilometer-deep mine.

A recently discovered cause of errors in quantum computers is cosmic radiation. Highly charged particles from space disturb the



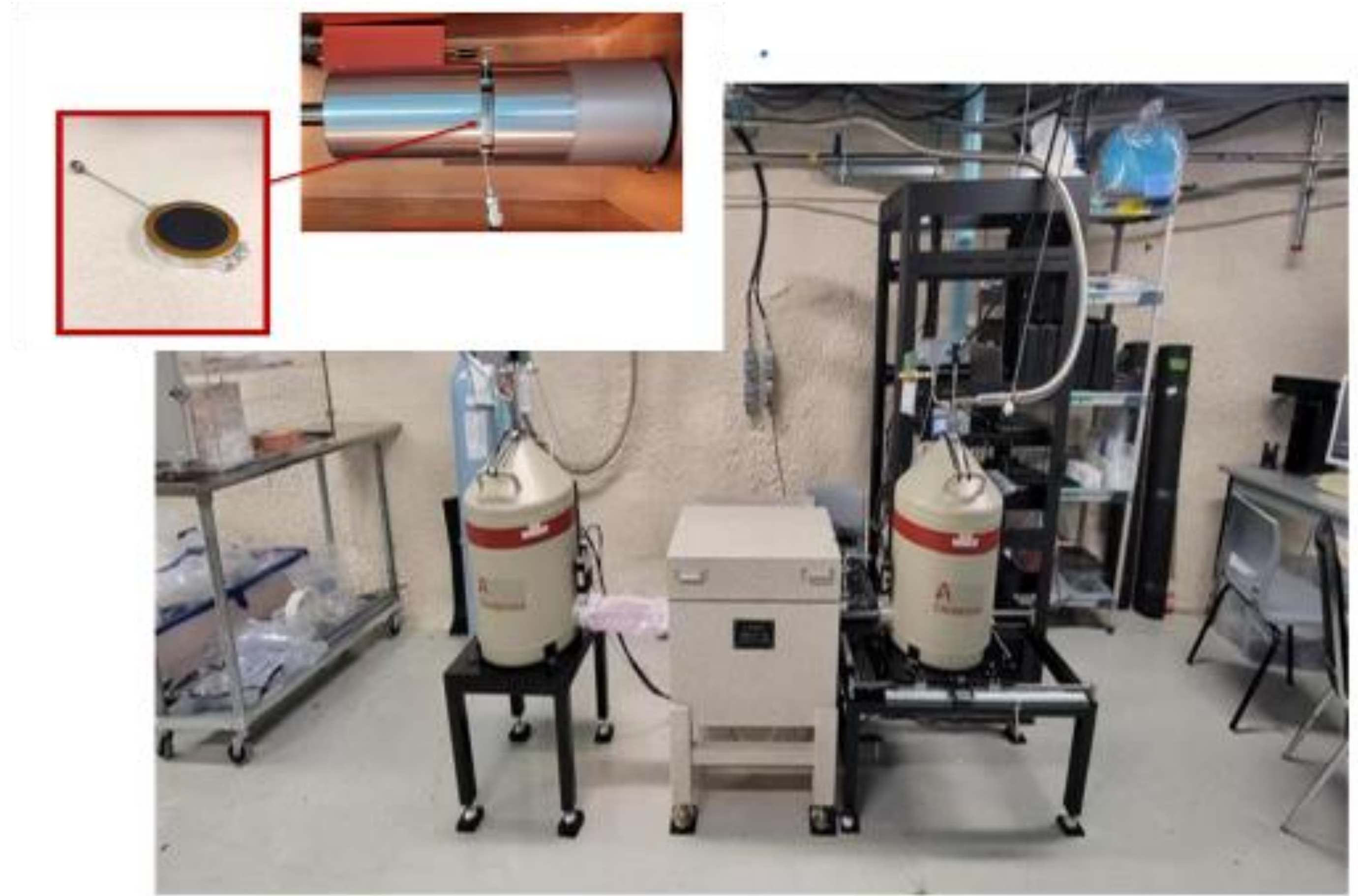
HALO

- 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 (12 years)



Nuclear Forensics

- Dual HPGe detector deployed by Health Canada for nuclear forensics
- SNOLAB is working to improve sensitivity to isotopes with γ - γ coincidences (and γ - β)





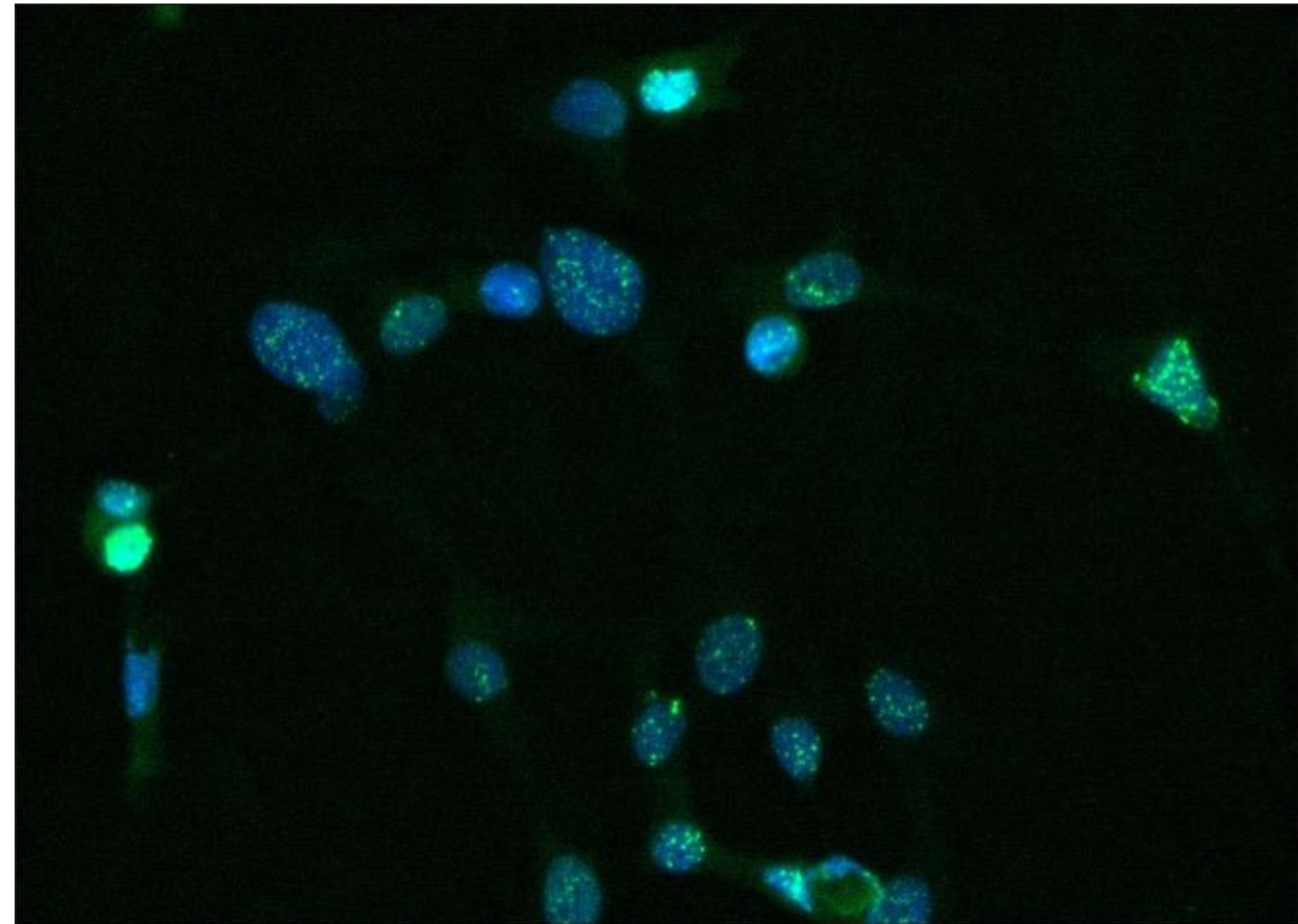
In collaboration with Health Canada has a radiation monitoring station has been installed at SNOLAB (overflow parking lot) that is part of the Canada Radiation Monitoring Network

- Air and water sampling
- Live radiation monitoring (e.g., dosimetry)
- c.f. Jean-Francois Mercier's SNOLAB seminar "Environment Radiation Health Monitoring at Health Canada" (Jan. 22, 2024)

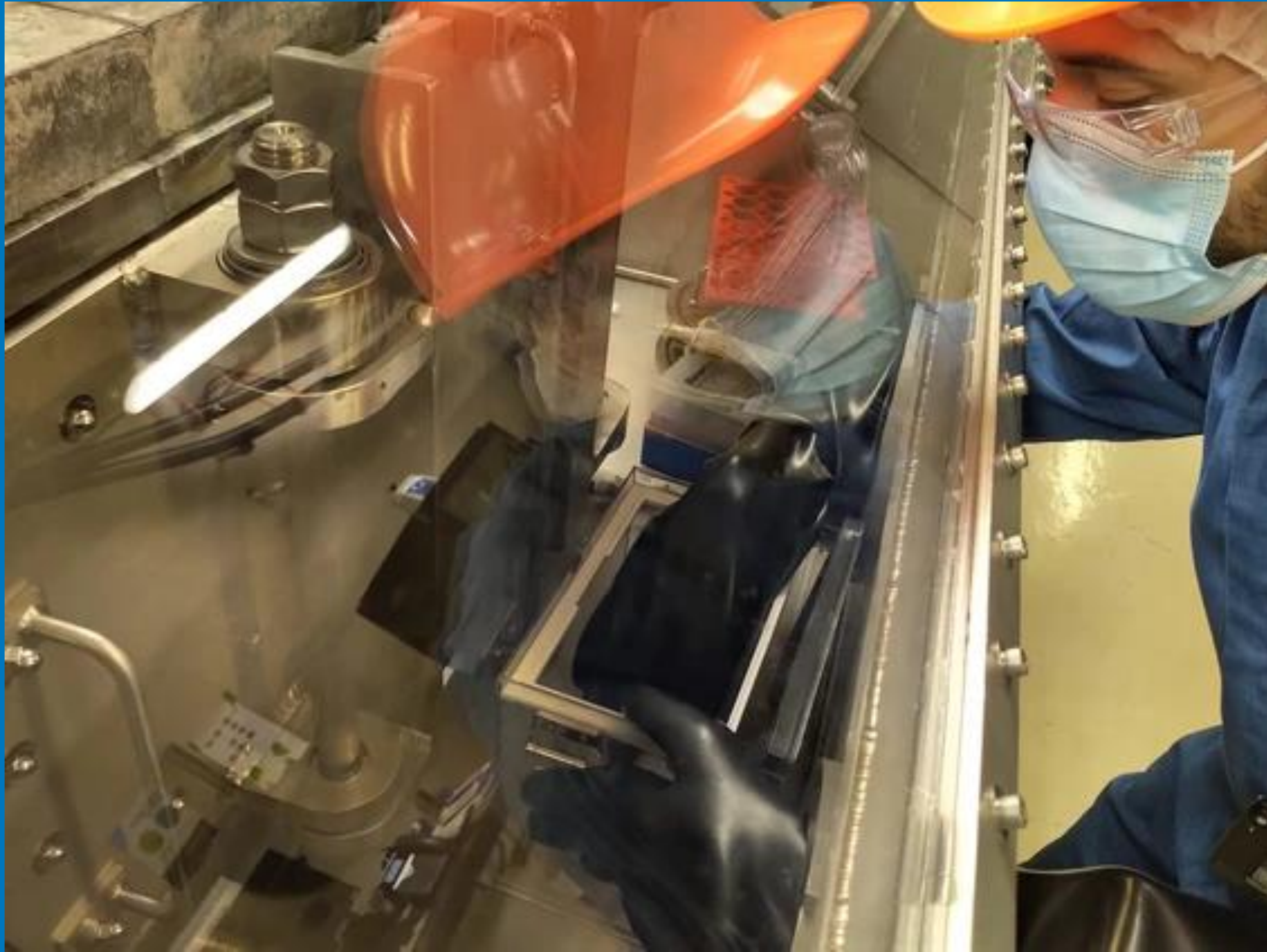
SNOLAB is excited at the expansion in directions and capability that complements our "traditional" astroparticle portfolio!

REPAIR

- 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 with Laurentian University and NOSM, led by university faculty.



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.



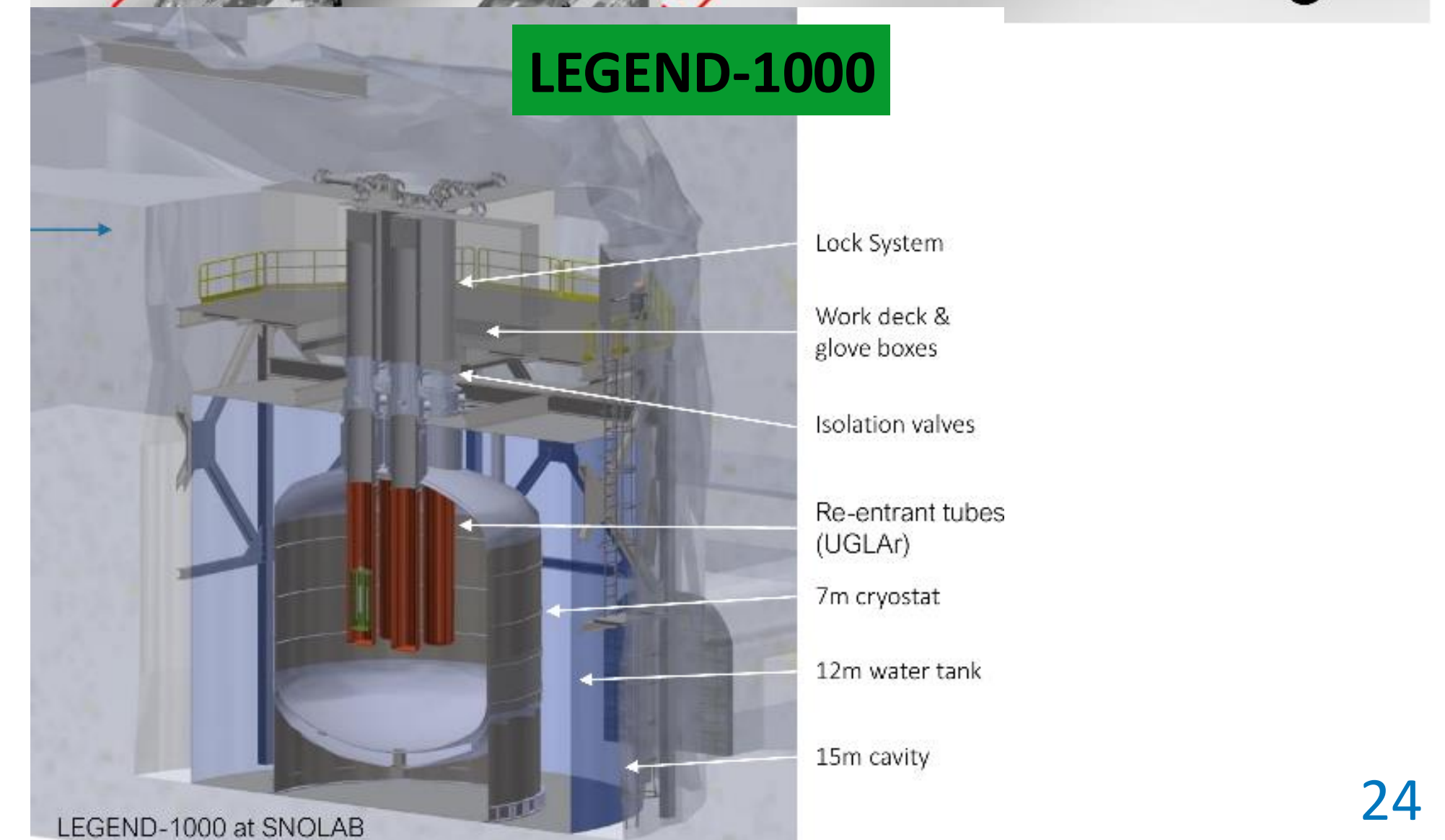
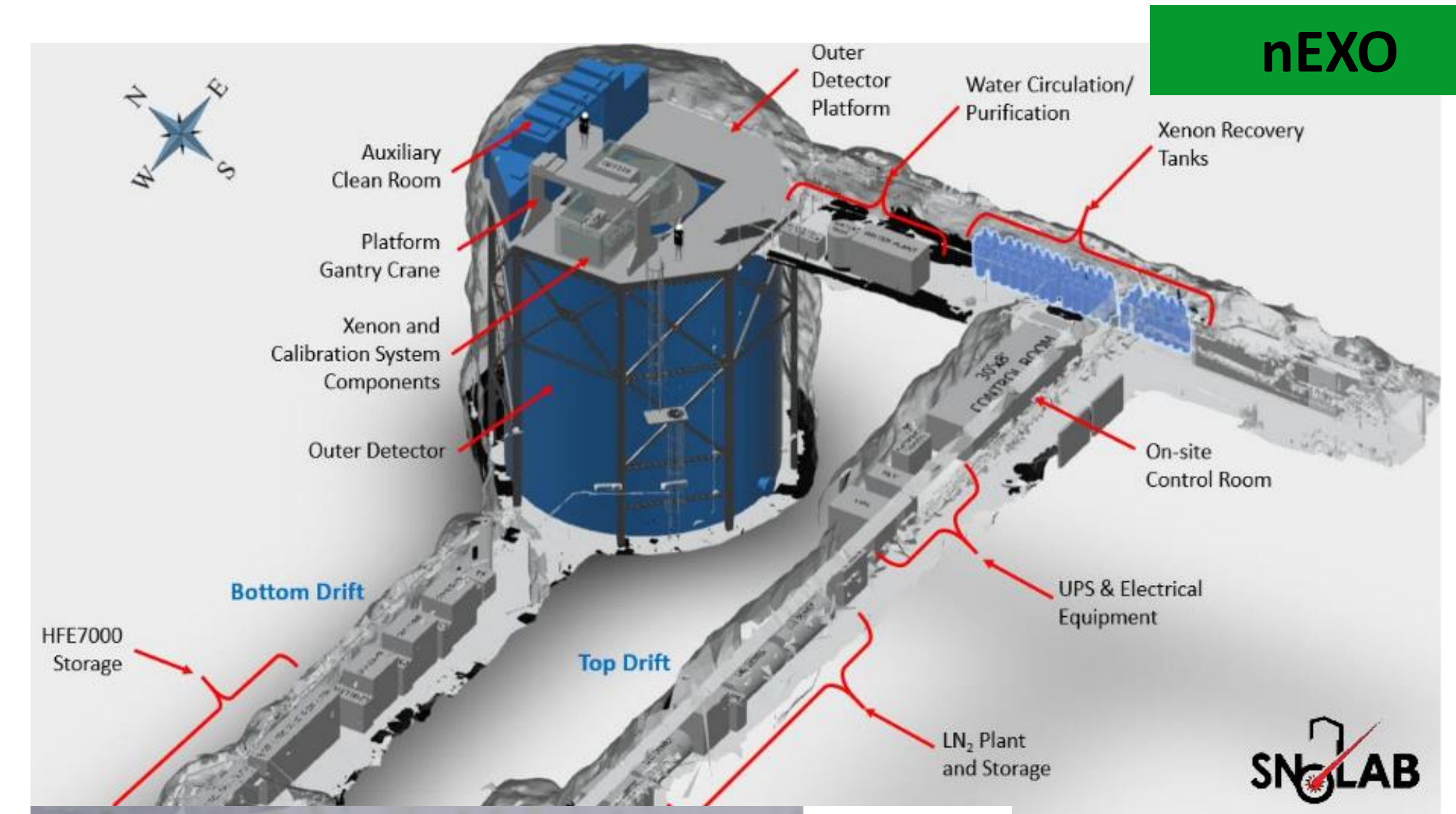
Yeast is produced underground in SNOLAB in the low-radiation environment and dried (it is still alive in this state). This yeast is then used in NASA programs (BioSentinel) aimed at assessing biological impact of deep-space radiation.

Future Directions

Next Generation $0\nu\beta\beta$ Decay

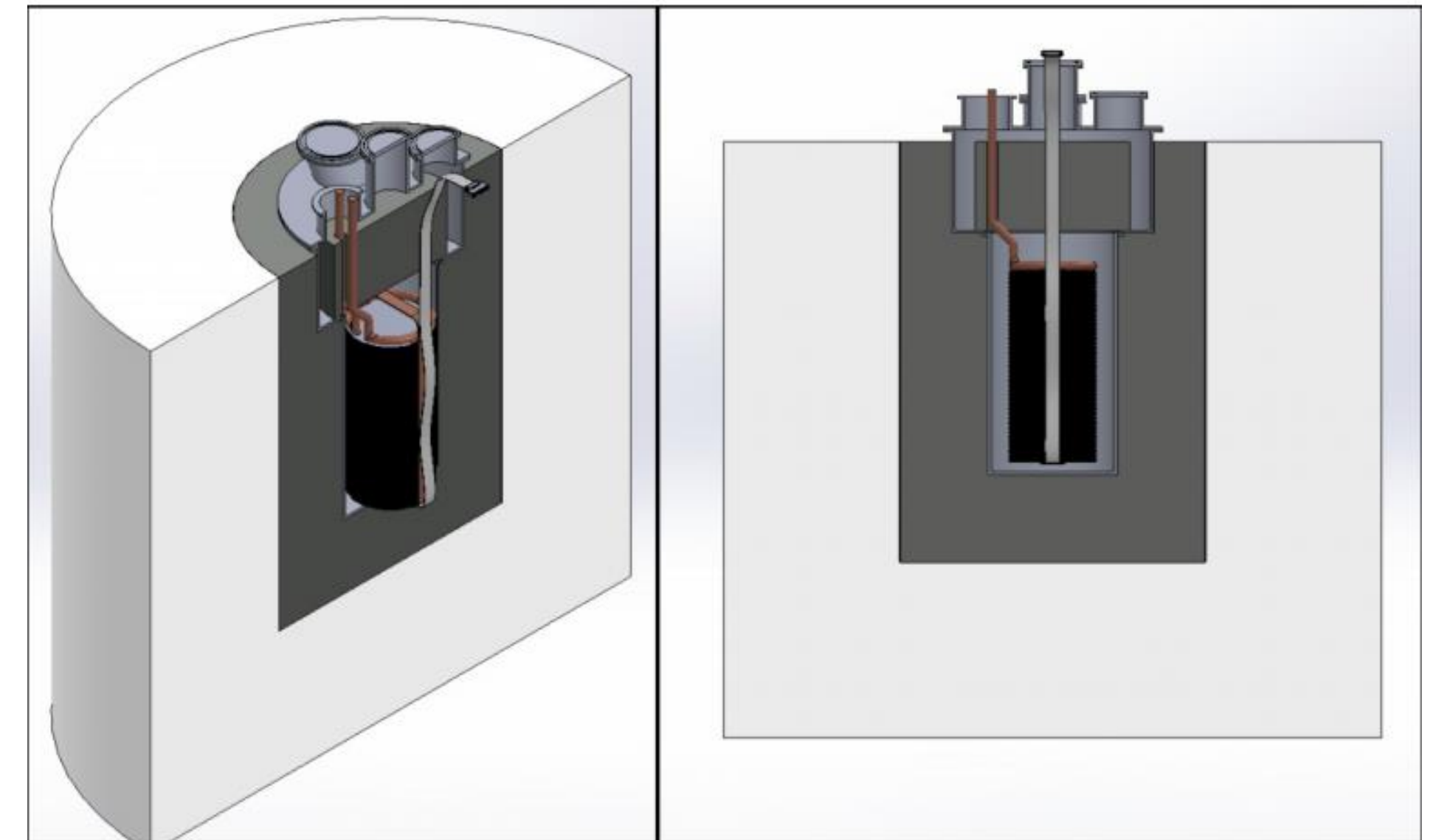


“The international stakeholders in neutrinoless double beta decay research who attended this summit (agencies representing Canada, France, Germany, Italy, UK, and USA) agree in principle the best chance for an unambiguous discovery is an international campaign with multiple isotopes and more than one large tonne-scale experiment implemented in the next decade ... by deploying CUPID, LEGEND-1000, and nEXO with one tonne-scale experiment in Europe and one tonne-scale experiment in North America.”



Dark Matter New Initiatives

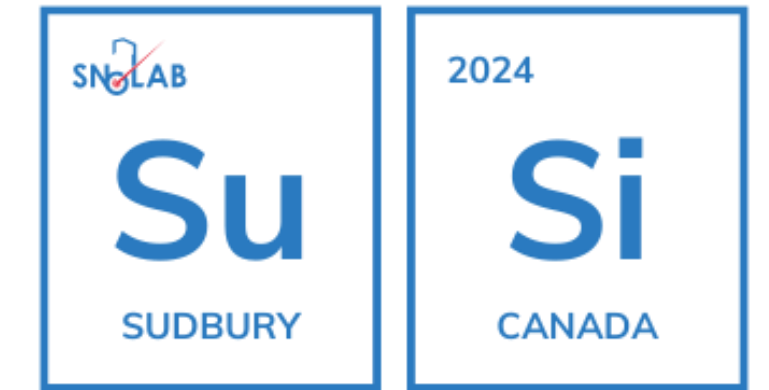
- The OSCURA skipper CCD-based dark matter experiment continues to move through design and review processes and is part of the DMNI program considerations in the US.
- OSCURA aims to be at SNOLAB in the J-Drift, between SENSEI and DAMIC’s present locations.



Concept	DM type	Mass range	Lead lab	Orig R&D request (\$K)	R&D \$K thru FY24	Est. Fab. cost (\$M)
ADMX-EFR	Axions	9-17 μeV	FNAL	1,976	3,140	\$20
DM-Radio	Axions	$<\mu\text{eV}$	SLAC	993	1,560	\$24
LDMX	Hidden sector	10-300 MeV	SLAC	1,960	2,250	\$21
OSCURA	WIMPs	1MeV-1GeV	FNAL	3,943	3,544	\$15
TESSERACT	WIMPs	>10 MeV	LBNL	3,975	1,815	$< \$10$
Total				12,847	12,309	\$90

“DOE has decided to fund TESSERACT starting in FY25 based on its cost effectiveness and the French offer to host. These considerations made it the ideal concept to go next. **We are still working on the process to select other DMNI proposals. Most likely start will be in FY 26.**” (May 9-10, 2024 HEPAP Meeting)

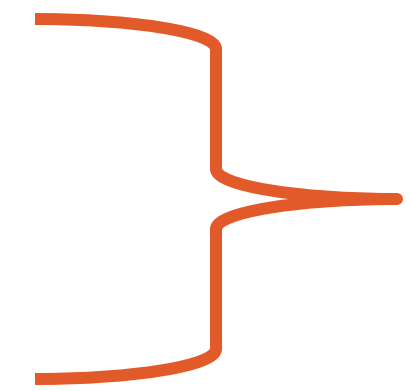
SNOLAB Underground Science Institute



SNOLAB Underground Science Institute

Become an intellectual hub that fosters collaboration and connection.

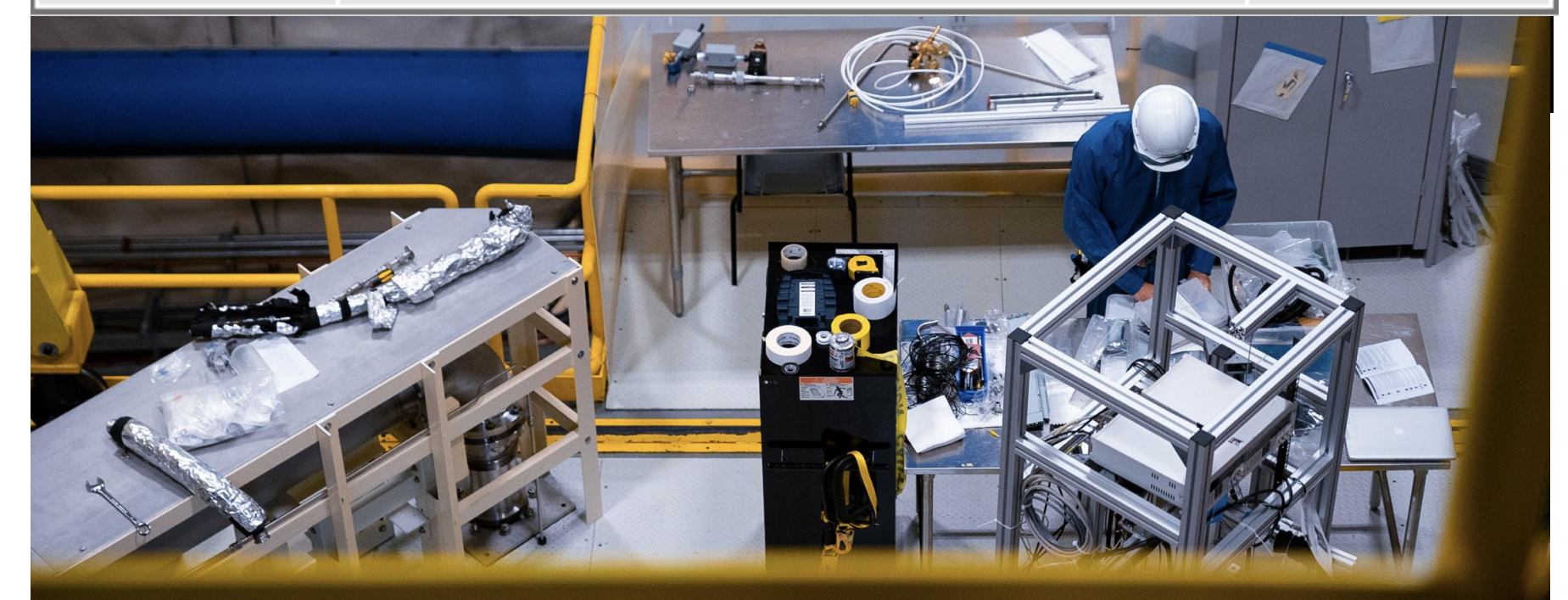
- Pilot a program designed around experimentalists at SNOLAB, **June 24 – August 16.**
- Three core thematic lecture periods (aimed at graduate students and postdocs, all invited)
 - The Dark Cosmos
 - Neutrino Science
 - Quantum Technology
- SNOLAB events around the lecture period:
 - User Meeting: June 26-27
 - TRISEP: July 8-19
 - Collaboration meetings: SNO+, SuperCDMS, DEAP, ...
- More information and application details:



Each period is two weeks in length and has 5 lectures.



Lecturer	Institution	Theme Area
Dr. Aaron Vincent	Queen's University	The Dark Universe
Dr. José Maneira	Laboratório de Instrumentação e, Física Experimental de Partículas (LIP)	Neutrino Science
Dr. Nicola McKonkey	Queen Mary University of London	Quantum Technology



<https://indico.snolab.ca/event/3/>

SuSi – Expanding Programs

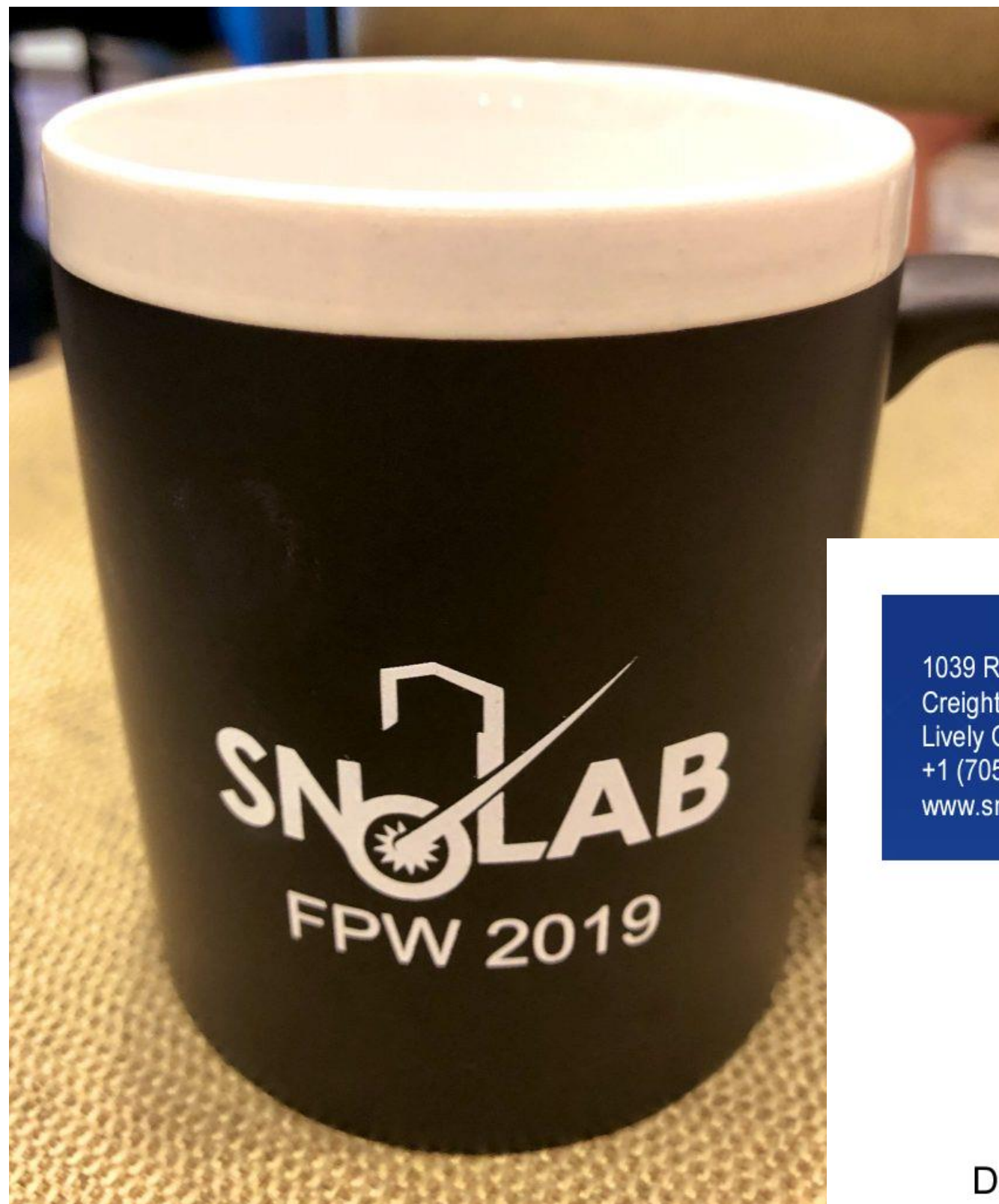


- The SNOLAB Underground Science Institute is an umbrella under which we plan to develop and support multiple programs.
- The SuSi Lectureship pilot program was successful and we are reflecting upon what we learned from this summer to inform how that lectureship program might evolve.
- We are developing an NSERC CREATE training program around the theme of underground science (more details on Friday).
- Funding from the McDonald Institute is essential in expanding these programs.

Coming in Summer 2025



The SNOLAB Future Projects Workshop will return in person!



August 24/25, 2015

The objective of the Future Planning workshop is to provide SNOLAB with potential large scale projects that may require its experimental capabilities on a timescale. It is understood that projects will be at various stages of development.

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 Creighton Mine #9
 Lively ON P3Y 1N2
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 www.snolab.ca

SNOLAB Future Projects Planning Workshop August 20th and 21st, 2013 SNOLAB, Sudbury, Ontario, CANADA

Dear Colleagues:

As part of its strategic planning process, SNOLAB is undertaking a scoping exercise to explore the potential future projects rather than select specific projects. Large-scale experimental areas within SNOLAB, over the next five- to ten-year timeframe are invited to present their capabilities, status, plans and infrastructure requirements.

Future Projects Workshop 2021

May 10 – 12, 2021
 Canada/Eastern timezone

Enter your search term

- Overview
- Timetable
- Contribution List

SNOLAB is continuing to evaluate and develop capabilities that enable science in the clean laboratory 2070m underground in the Creighton mine. The Future Projects Workshop is a fundamental component of the process to define the priorities and future of SNOLAB. Scientific projects interested in a site at SNOLAB over the next five to ten years are invited to present their status and plans as well as their requirements. This workshop will focus on the capabilities needed to the laboratory and the potential space requirements of projects at the site, which covers the period from 2023-2029.

The workshop is to update SNOLAB on potential projects that may require experimental capabilities on a timescale, it is understood that they will be at various stages of development to explore the potential future projects rather than select specific projects through the SNOLAB Project Lifecycle process with advice from the community.

Future Projects Planning Workshop

Aug 16, 2017, 1:00 AM → Aug 17, 2017, 6:00 PM Canada/Eastern

Other Institutes

Ken Clark (SNOLAB)

Description As part of its medium term planning process, SNOLAB is undertaking a scoping review of potential future small- and medium-scale experiments seeking to locate in the underground campus at 2070m in the Creighton mine. This Future Projects Planning workshop is part of this horizon scanning exercise, and experimental collaborations that have an interest in using any space underground, including any of the large-scale experimental areas within SNOLAB, over the next five to ten years are invited to present their capabilities, status, plans, and infrastructure requirements.

Ken Clark [✉ ken.clark@snolab.ca](mailto:ken.clark@snolab.ca)



2

Cutting-edge infrastructure

Continuously improve our research infrastructure to remain state of the art.

Expected outcomes:

- Attraction of the most advanced international experiments to Canada
- Greater global impact and enhanced reputation of Canada's underground science infrastructure

FY25 SNOLAB Experiment and Infrastructure Initiatives



PRIORITY #	STRAT PLAN OBJ	POG PROJECT #		GATEWAY
00-SP4			Imminent Safety Issues and Facility Emergency Repairs	
01-SP4			Facility Operations	
02-SP4			Executive Requirements	
03-SP1			Experiment Operations (HALO, CUTE, DAMIC, FLAME, REPAIR, Xe-Still, SNO+, NEWS-G, SENSEI, PICO-40)	GW-3
04-SP4	P2102		Information Security	GW-1
05-SP2	P2104		MPC Breaker Upgrade	GW-2
06-SP1	P1806		SuperCDMS	GW-2
07-SP1	P2204		SNO+ Te	
08-SP1	P2101		PICO-500	GW-1a
09-SP1	P2006		DEAP Upgrades	GW-2
10-SP1	P2105		SBC	GW-1
11-SP2	P2508		Generator Tie-in and UPS for ICPMS	GW-0
12-SP2	P2503		UG Flooring Pilot	GW-0
13-SP1	P1902		nEXO	GW-0
13-SP1	P1903		LEGEND-1000	GW-0
14-SP1	P2007		CTBT Counter	GW-2
15-SP1	P2206		OSCURA	GW-1
16-SP2	P2511		CUTE Cryogenic Fridge Enhancement	GW-0
17-SP2	P2301		HC Environmental Monitoring Station	GW-2
18-SP2	P2509		GPS Time Server Replacement	GW-0
19-SP2	P2505		UG Monitoring Security	GW-0
20-SP2	P2108		Mobile Etching/Cleaning Cart	GW-0
21-SP2	P2111		UG Compressed Air Upgrades	GW-2
22-SP2	P2504		Electrical Room Wall	GW-0
23-SP2	P2205		Denka Boom	GW-2
24-SP2	P2510		Everbridge Safety Connection	GW-0
25-SP2	P2502		Spherical Proportional Counters as Radon Detector (RnSPC)	GW-0
26-SP2	P2501		Argon Removal from LN2	GW-0
27-SP2	P2011		Surface Cryostat	GW-2
28-SP2	P2506		Underground Monuments	GW-0
29-SP2	P2109		Background Measurement Improvements	GW-2

- 10 experiments operating
- 9 experiments under design or construction.
- 18 initiatives to upgrade instrumentation and infrastructure include:
 - Piloting solutions for the underground lab flooring
 - Upgrades to the CUTE facility and environmental monitoring capabilities
 - Upgrades and additions to background/assay instrumentation
 - Continuation of a multi-year phased information security project

	Responsive Requirements
	Internal Projects
	Science Programme

3

Skilled people

Foster and develop diverse talent in an inclusive environment.

Expected outcomes:

- Canadian leadership in advancing EDI in research facilities
- A new generation of HQPs prepared to discover and innovate in a global economy
- Greater access to STEM skills and opportunities in Northern Ontario

Admission gratuite

Le planétarium Doran présente

Une parallaxe culturelle : histoires sous les étoiles

Animatrice : Sonia B.-Inkster, BA, M.Ed

Samedi le **28 octobre** 2023 à 10 h

Le Planétarium Doran
(Édifice Fraser D-045, Université Laurentienne)

Cette présentation introduit les merveilles du ciel étoilé d'une perspective des Premiers Peuples, avec quelques mots Anishinaabemowin reliés à l'astronomie puisque nous sommes sur le territoire partagé de Wahnapiatae et Atikameksheng Anishinaabe.

Les sponsors de cette présentation :
Bureau des Affaires francophones, SNOLAB



Artiste Anishinaabe : Will Morin, BFA, BA, B.Ed., MA, PhD (abd)



Will Morin, an artist and knowledge keeper, 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 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.**

Formation of the Standing EDI Committee



- The SNOLAB EDI Committee is established under the authority of the Executive Director to support a vision of an equitable, diverse, and inclusive laboratory.
- The EDI Committee provides guidance to the SNOLAB Executive Director on the development, implementation, and ongoing improvement of SNOLAB's EDI action plan.
- We are looking for volunteers – *email Samantha Kuula <samantha.kuula@snolab.ca>!*
 - 2 Members of the SNOLAB Research Group (2)
 - 2 SNOLAB staff
 - One staff member whose primary work site is underground
 - 2 SNOLAB Users
 - SNOLAB-affiliated students
 - One external member (outside of the SNOLAB user and staff community)

Conclusions



- SNOLAB is a clean, underground laboratory hosting a variety of experiments.
- We have launched our 2023-2029 Strategic plan and are making progress towards its goal.
- Experimental collaborations have produced many scientific results at SNOLAB and many more world-leading results are expected over the next decade.
- SNOLAB is working to promote diversity in ideas and people which is required to boost research excellence and drives new ways to frame and perform research.
- I am very excited about the opportunities that SNOLAB provides the scientific community. I believe SNOLAB well positioned to attract world-class experiments and support major discoveries in the next decade.
- SNOLAB has a broad, multidisciplinary science program. I hope to see your experiment in our lab some day soon!