

Interdisciplinary Activities at SNOLAB

Stephen Sekula

(SNOLAB and Queen's University)

Presented at the Multidisciplinary Workshop
Laboratoire Souterrain de Modane
October 18, 2023

Multidisciplinary Workshop/LSM



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.

INTERSECTIONS OF SCIENCE AND CULTURE

EDUCATION

CULTURAL
ARTS

PHYSICS

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.

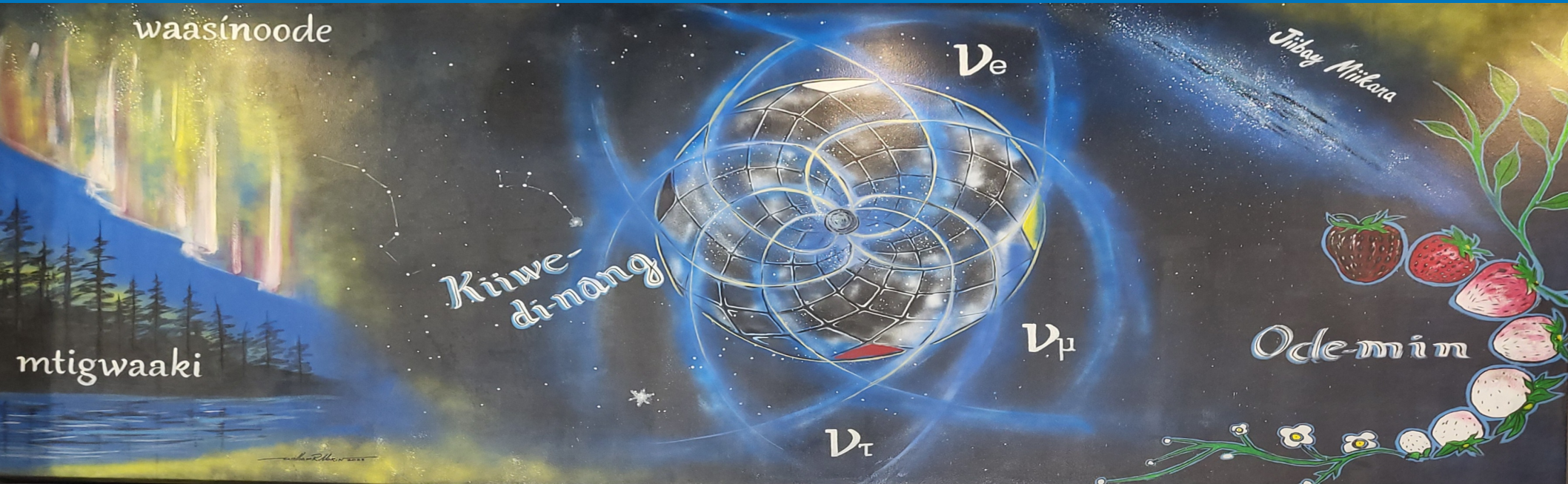
Les sponsors de cette présentation :
Bureau des Affaires francophones, SNOLAB



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.

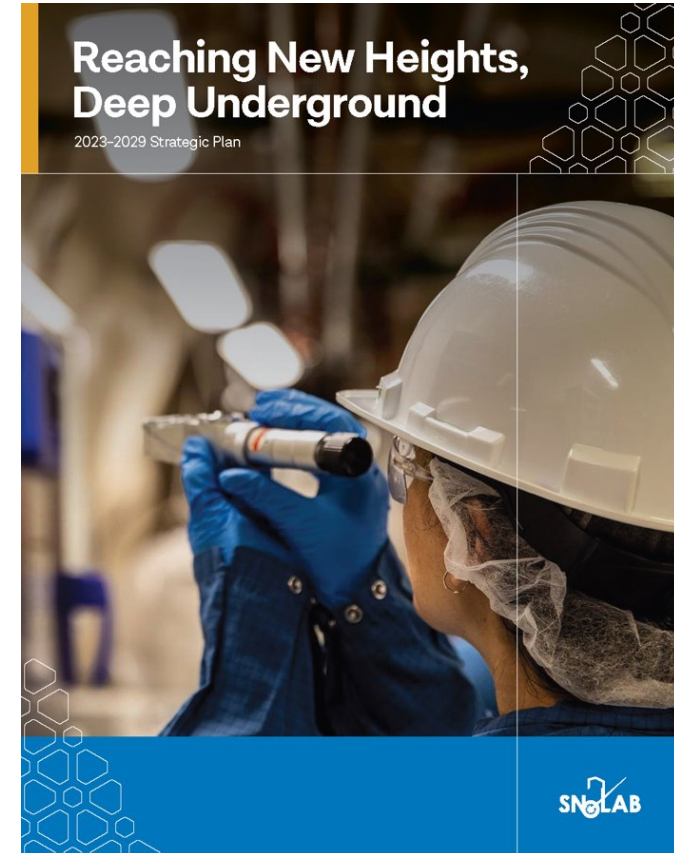
Inspired by creation stories
from Turtle Island told to
her by her grandmother.
Each of the animals
depicted in the mural
represents a different
aspect of Anishinaabe
creation stories.



Science Strategy

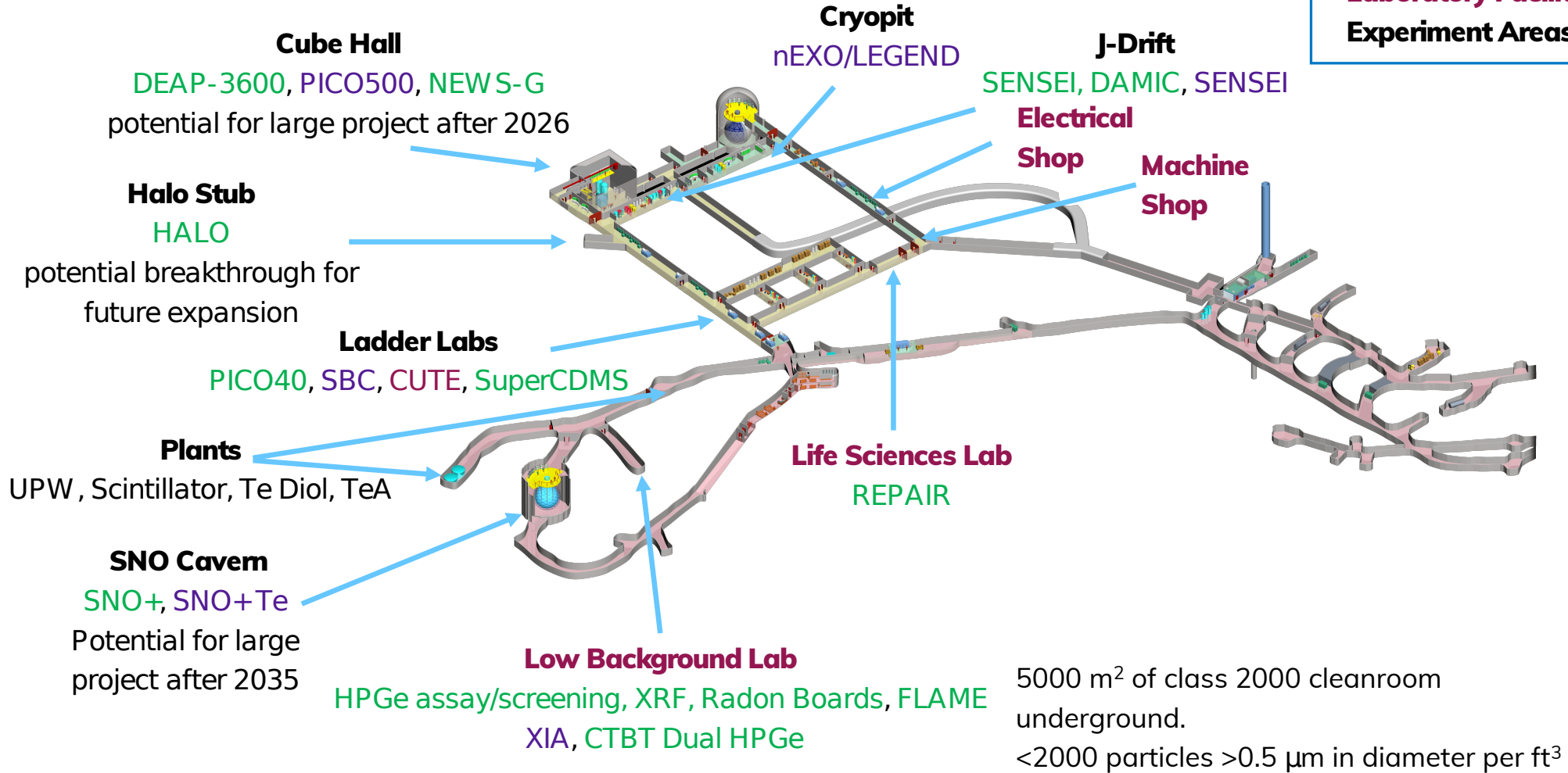


- **The science at SNOLAB** is currently focused on fundamental particle physics. Primarily looking at further **investigating the nature of matter**. Specifically:
 - What is the nature of dark matter?
 - What is the nature of the neutrino?
- **SNOLAB is interested in collaborating** on any scientific 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 Layout

Current Experiments
Future Experiments
Laboratory Facilities
Experiment Areas



Disciplines at SNOLAB



PHYSICS

CHEMISTRY

BIOLOGY

INDUSTRY

COMPUTATION

GEOSCIENCE

ENVIRONMENT

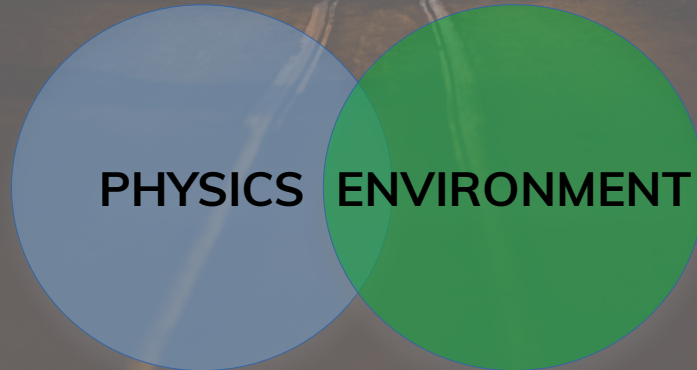
EDUCATION

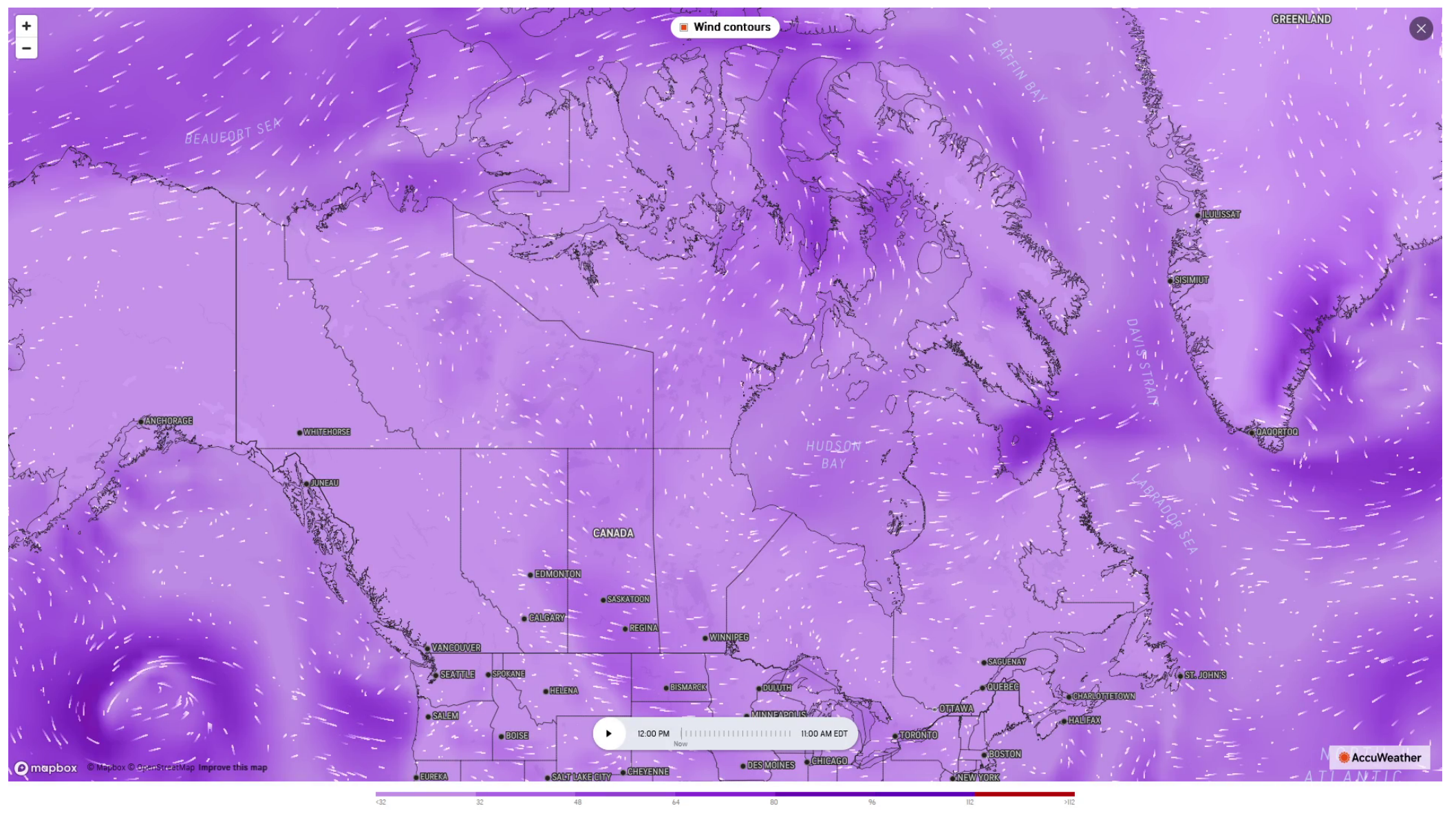
**CULTURAL
ARTS**

INTERSECTIONS OF PHYSICS AND ENVIRONMENT

PHYSICS

ENVIRONMENT





Wind contours

GREENLAND

BEAUFORT SEA

BAFFIN BAY

ILLULISSAT

SISMIJUT

DAVIS STRAIT

QAQOQTUQ

HUDSON BAY

LABRADOR SEA

CANADA

ANCHORAGE

WHITEHORSE

JUNEAU

EDMONTON

SASKATOON

CALGARY

REGINA

VANCOUVER

WINNIPEG

SEATTLE

SPOKANE

HELENA

BISMARCK

DULUTH

MINNEAPOLIS

SAGUENAY

QUEBEC

CHARLOTTETOWN

ST. JOHN'S

SALEM

BOISE

TORONTO

HALIFAX

EUREKA

SALT LAKE CITY

CHEYENNE

DES MOINES

CHICAGO

OTTAWA

BOSTON

NEW YORK

12:00 PM Nov 11, 2023 11:00 AM EDT

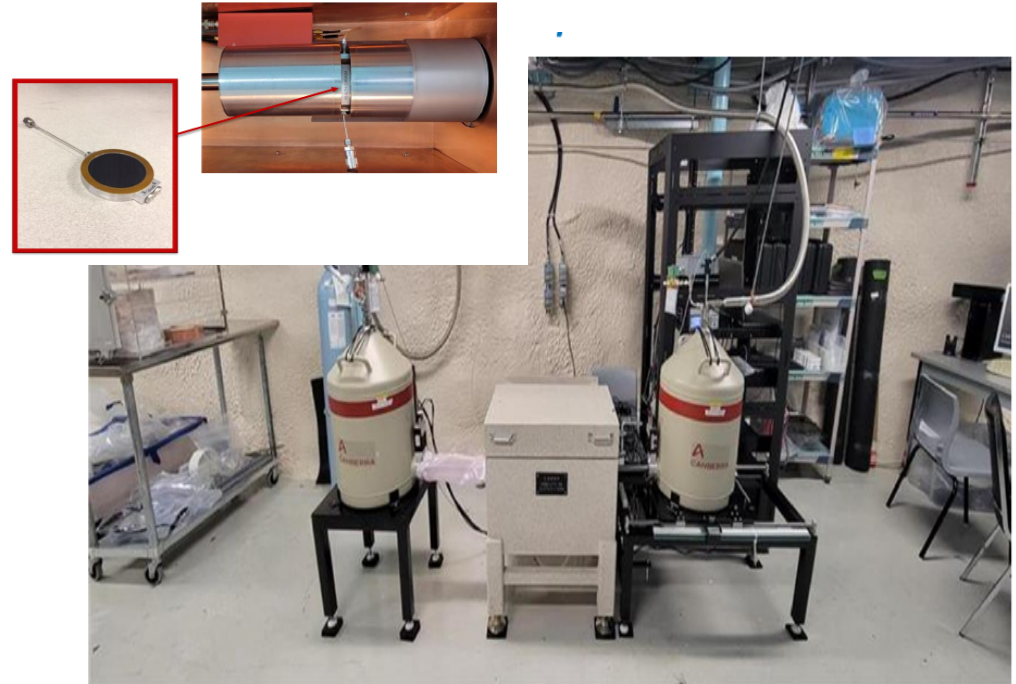
AccuWeather

mapbox © Mapbox © OpenStreetMap Improve this map

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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)



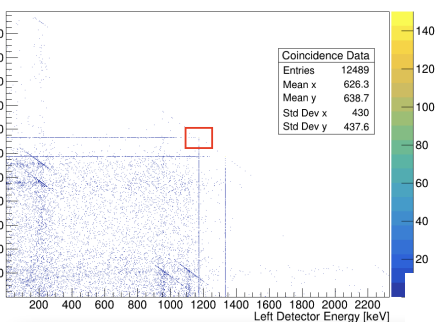
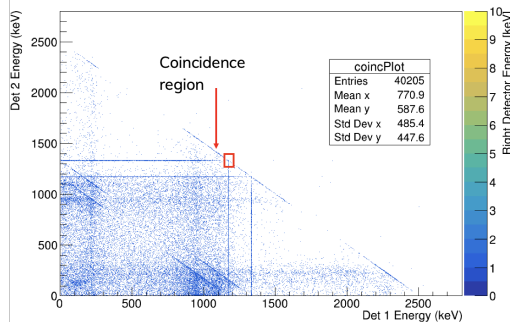


Maxwell Bridgewater
Simulation/
analysis of
coincident
events

Simulation and Analysis of Coincidences



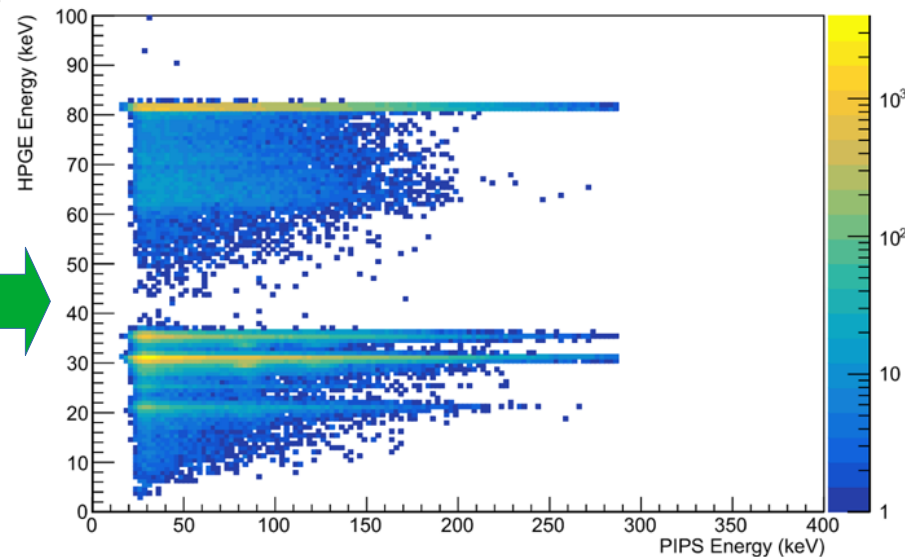
- GEANT4 ion decay of coincidence producing isotopes
- Coincidence events come from the same decay
- Allows for easy data analysis
- Real events are tagged as a coincidence if they occur between 9 μ S of each other.



β - γ coincidence calibration
using a Xe-133 sample
from Health Canada



Coincidence Events (Events per Day per PIPS)



INTERSECTIONS OF PHYSICS AND BIOLOGY

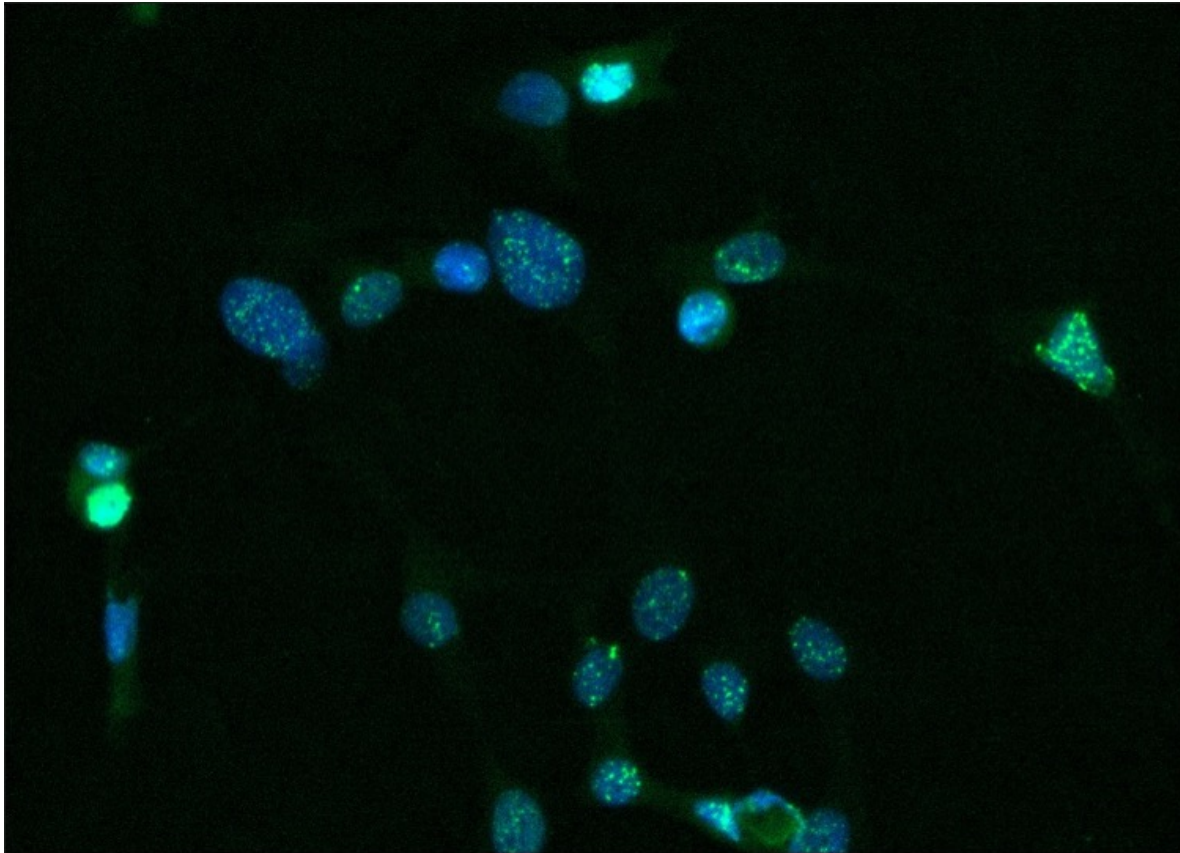


A Venn diagram consisting of two overlapping circles. The left circle is light blue and contains the word 'PHYSICS'. The right circle is light purple and contains the word 'BIOLOGY'. The overlapping area in the center is a darker shade of purple.

PHYSICS

BIOLOGY

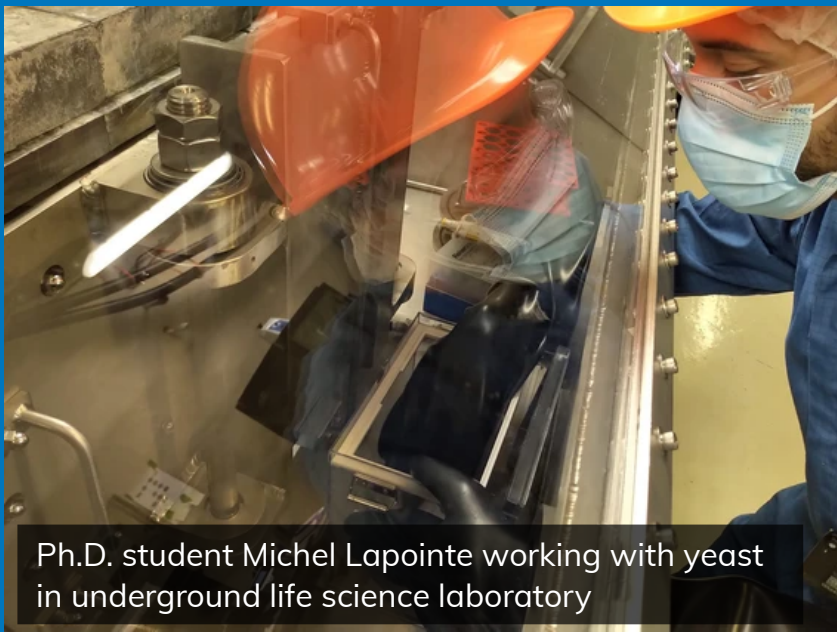
REPAIR



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.



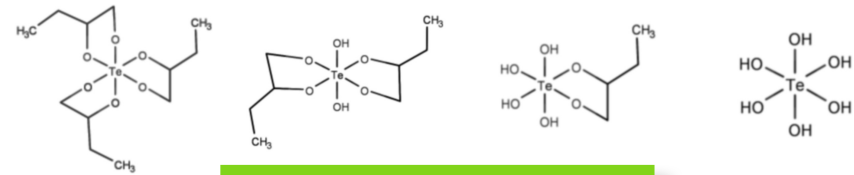
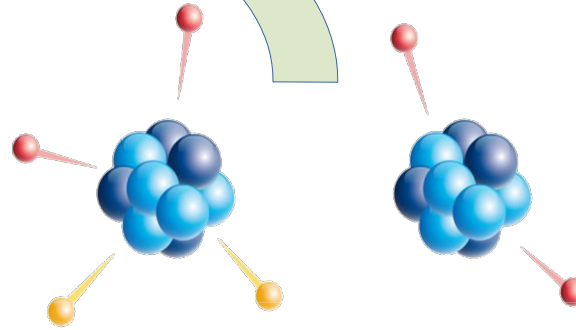
Ph.D. student Michel Lapointe working with yeast in underground life science laboratory

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.



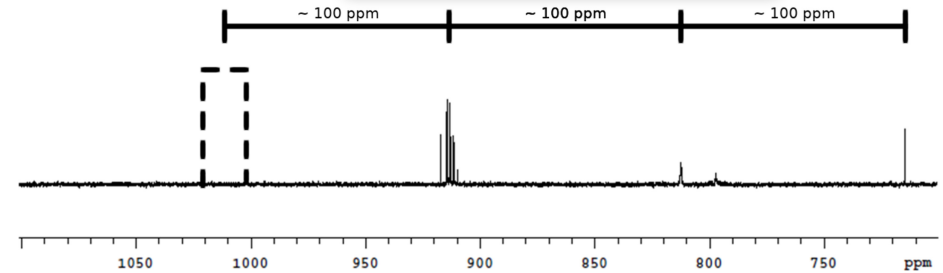


INTERSECTIONS OF SCIENCE AND INDUSTRY



arXiv:2212.12444

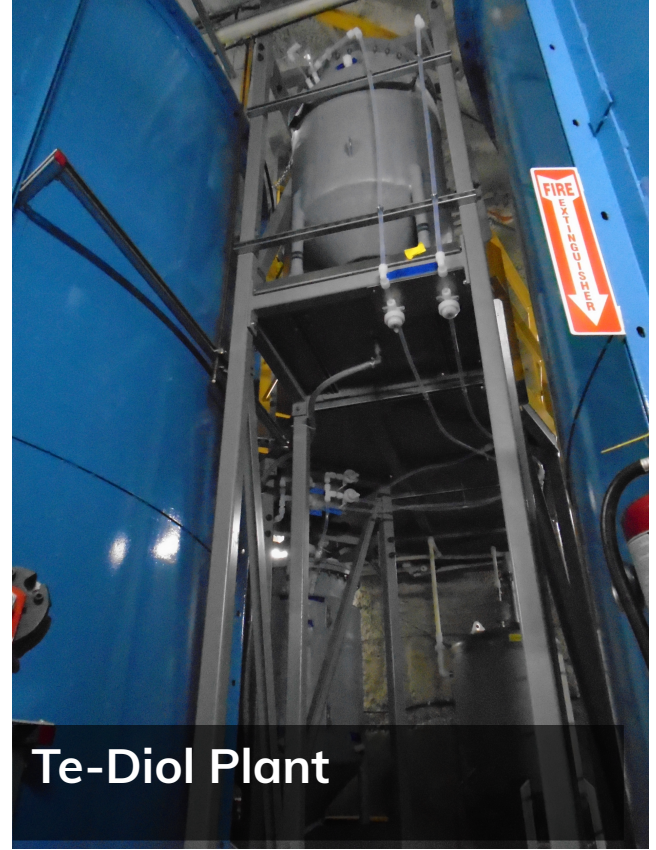
Tellurium-130 has a high natural abundance (34%) and provides a valuable avenue toward neutrinoless double beta decay → needs to be synthesized into a scintillator-soluble molecule at industrial scale (1.3 tonnes of Te-130, corresponding to 3.9 tonnes of Te).



SNO+ TELLURIUM PLANTS



Telluric Acid Plant

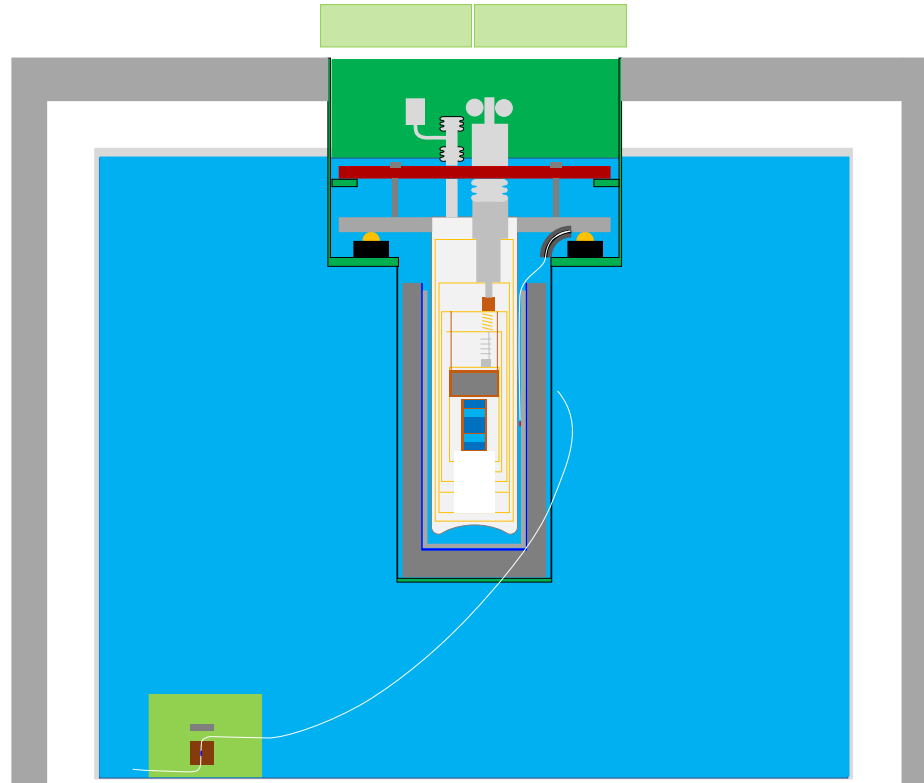


Te-Diol Plant

A scientist in a plaid shirt is working on a large, complex, cylindrical scientific instrument in a laboratory setting. The instrument is composed of various metal components, including pipes, valves, and a central chamber. The scene is dimly lit, with a blue and yellow color palette. A semi-transparent blue banner is overlaid across the middle of the image, containing the text "INTERSECTIONS OF PHYSICS AND COMPUTATION" in white, bold, uppercase letters.

INTERSECTIONS OF PHYSICS AND COMPUTATION

CRYOGENIC UNDERGROUND TEST ENVIRONMENT (CUTE) 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

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 is newly selected, contracting has just started.



Silvia Scorza has worked on counting parts of the qubit readout system





CONCLUSIONS AND OUTLOOK

Perspectives



- 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, radon, etc), as well as air and water quality.
 - ...

Summary



- SNOLAB welcomes opportunities to cross disciplines in order to solve challenging problems
 - Strategic Plan
 - Community Engagement
- The problems of this century will benefit from a combination of many experts with varied perspectives → we aim to facilitate this.

ACKNOWLEDGEMENTS

I would like to thank SNOLAB and its staff for support through underground space, logistical and technical services. SNOLAB operations are supported by the Canada Foundation for Innovation and the Province of Ontario, with underground access provided by Vale Canada Limited at the Creighton mine site.

The background image is a dark, moody photograph of an industrial or construction site at night. It features a complex network of pipes, scaffolding, and structural elements, illuminated by a few warm, yellow lights. A prominent blue horizontal band runs across the middle of the image, serving as a background for the text. The overall aesthetic is industrial and somewhat mysterious.

APPENDIX

SNOLAB by the 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

