

## Annual report

Exploring new frontiers in deep underground science

2019-2020

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Exploring new frontiers in deep underground science 2019-2020

# **Our visionary** partners





Université de Montréal



VALE

SNOLAB has established a bold vision: to be an internationally recognized laboratory and partner of choice in deep underground science, delivering world-class research, scientific discovery, and benefits to Canada and her global partners, by facilitating national and international access to its unique capabilities, facilities, and expertise.







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# Message from the Executive Director

I am delighted to present the 2019-2020 annual report for SNOLAB, which illustrates the strong progress that the SNOLAB staff and research community have collectively achieved during this period. Excellence and teamwork are two of our foundational core values, and this report highlights the successes of an amazing team enacting those values. I hope that you enjoy reading about the people and projects at SNOLAB.

Through the dedicated work of over 100 staff and 850 users, SNOLAB has made progress in its core objective of becoming a leader in underground science, and has fulfilled its vision of becoming an internationally recognised laboratory and partner of choice. This annual report highlights steps made during the fiscal year 2019-2020, the tail end of which was impacted by the global coronavirus pandemic and through which SNOLAB continued to operate with a focus on the health and safety of staff, users, and our community.

SNOLAB has a mission to enable and spearhead world-class science, and this report highlights progress and leading results from several of our underground detector systems. We also have a mission to develop and maintain world-class infrastructure, with several of these developments outlined in this year's report. SNOLAB continues to inspire and educate, with strong outreach and professional engagement programmes leading to a broadening awareness of our capabilities and science.

None of these successes would be possible without the incredible support from a wide range of stakeholders including our Board of Directors and our five Canadian university joint venture members, direct support from the Canada Foundation for Innovation and the Province of Ontario, and access to the 2 km depths by Vale, our mining hosts.

#### Many thanks to all!



Nigel J.T. Smith Executive Director, SNOLAB

# Message from the SNOLAB Board

It gives me great pleasure, on behalf of the Board of Directors, to congratulate the entire staff of SNOLAB for another exceptional year of achievements in keeping the lab and its experiments at the forefront of underground science.

New and notable results from DEAP, SNO+ and PICO (amongst others), and continuing progress on new experiments like NEWS-G and SuperCDMS, make it clear that our science position and outlook are strong; the Canada Foundation for Innovation has recently confirmed a continuation of lab operational funding through 2022; and our staff continue to shine by their dedication.

While 2020 will certainly long be remembered as the year of the global pandemic, this annual report covers the period up to March 31, 2020 - before the impending storm, as it were. The lab is in a strong position, and subsequent events (to be reported upon in next year's annual report) have amply demonstrated our staff's resilience, professionalism, and can-do attitude.

Again, congratulations!

#### Sincerely,



**Dr. Kenneth Ragan** *Chair* SNOLAB Board of Directors

# Foundational drivers

# **SNOLAB** vision

To be an internationally recognized laboratory and partner of choice for deep underground science, delivering world-class research, scientific discovery, and benefit to Canada and her global partners, by enabling national and international access to our unique capabilities, facilities, and expertise.

## **SNOLAB** mission

In support of its vision, SNOLAB will:

- ✓ Enable world-class science
- Spearhead world-class science
- ✓ Catalyze world-class science
- ✓ Promote world-class science
- ✓ Inspire and innovate

# SNOLAB Board of Directors



Kenneth Ragan Chair Professor of Physics, McGill University



**Aksel Hallin** 

Professor and Canada Research Chair in Astroparticle Physics, University of Alberta



Kimberly Strong Vice-Chair

Professor and Chair, Department of Physics, University of Toronto



Tammy Eger Vice President, Research, Laurentian University



Sandra Crocker Associate Vice-President (Research Planning and Operations), Carleton University



**Mike Headley** 

Executive Director, South Dakota Science and Technology Authority, Laboratory Director, Sanford Underground Research Facility



**Robert Svoboda** Professor of Physics, UC Davis



Kim Devooght Director of Sales and Advisory Services, Pivotal Inc.



Julie Moskalyk

Science Director, Science North



Kent Novakowski Associate Vice-Principal (Research) and Professor of Civil Engineering, Queen's University



**John Ryan** Manager, Creighton Mine, Vale

# **Core values**



**Safety** - This is the foundation upon which we realize our mission: we are committed, both individually and as a team, to protecting the health and safety of our staff, users, and visitors.



**Excellence** - SNOLAB is committed to fostering a culture in which individuals make full use of their skills and knowledge, and provides opportunities to develop through continual improvement. Our focus is on delivering high-quality research, through driving, supporting, and enabling excellence in research and operations.



**Teamwork** - Our approach to teamwork is based on the belief that each member brings unique experience and important expertise to the workplace, allowing project challenges to be resolved and creating a work environment that supports cooperation and collaboration in all aspects of work.





**Inspiration** - We strive to educate and inspire as a core component of our commitment to our public sponsors. To showcase the enthusiasm of our staff and users, and the excitement of the research undertaken, SNOLAB will continue to engage fully in professional and public outreach.



**Accountability** - SNOLAB is committed to upholding an environment of trust, responsibility, and accountability to our stakeholders. Accountability to our internal governance structures, external research communities, funding agencies, and public sponsors is an ongoing goal. Strong governance and effective management will guide our organizational development.



GIRLS Camp facilitator training visit to SNOLAB



A scientist works on the CUTE experiment at SNOLAB



Visitors at the New Eyes On the Universe exhibit at Science North



A 3D model of NEWS-G, an experiment under construction at SNOLAB



Data display from the SNO+ experiment during the LAB fill in early 2020













The inner vessel of the PICO-40 experiment



Attendees at the CAM Conference, hosted by SNOLAB and Laurentian University



Wikwemikong High School robotics team competing at the 2019 FIRST Championships



### Financial

**EHS** data

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For every dollar of government investment, SNOLAB generates 3 dollars worth of economic impact

Consecutive lost time injury-free days as of March 31: 683

Injuries/illnesses reported requiring medical attention: 7

#### Showers



14 Publications

Incident reports, including near misses: **43** 

Injuries/illnesses reported requiring no aid: 21

Injuries/illnesses reported requiring first aid: 15

## Funding & in-kind support

\$	CFI \$17,278 Ontario \$5,803	9,000 ,000	<ul> <li>McDonld Institute \$273,000</li> <li>Vale in-kind contributions ~12M</li> </ul>		
	\$23	.35M	+~12M In-kind		
Users		Employees			
863	2		은 127 Full-time employees		
Institutions			A 2 New employees (including re-hires + students)		
128		Social			
Countries			2928 followers		
22			→ 1434 followers → 3227 followers		

# International CC

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SNOLAB hosts representing 12	863 users 8 institutions tries		••		
Americ	as				
Canada					
Mexico					
USA					
Argentina					
Brazil					
Paraguay					
Europe	& Asia				
France	Spain				
Germany	Switzerland				
Greece	Turkey				
Israel	UK				
Italy	China				
Poland	India				
Portugal	Japan				
Russia	South Korea				







### Profile Pietro Giampa

Pietro Giampa holds the Otto Hausser Fellowship at TRIUMF, Canada's particle accelerator centre. Pietro completed both his undergraduate degree and MSc. at Royal Holloway University of London before embarking on a Ph.D. at Queen's University working on the DEAP-3600 experiment at SNOLAB. His time at SNOLAB provided him with experience working in a large-scale laboratory. Prior to coming to SNOLAB, Pietro's experience in experimental physics was academic in nature. Learning about the development and delivery of experiments, how information is shared, and how people work together to support the science program were valuable skills that have allowed him to excel in his current position at TRIUMF.



Strategic Goal 1 Enable and spearhead world-class underground science

#### **DEAP-3600**

DEAP-3600 analyzed a data set spanning over three years, which began in 2016 and ended this year, during which time the detector was stable and operating ~95% of the time. From this analysis, the collaboration published two papers: one setting a limit on the WIMP-nucleon cross section and mass, and the other discussing the electromagnetic backgrounds in argon. DEAP also published three technical papers and is preparing several more for publication. Based on the data from this run, the collaboration is now working on improved analysis techniques and hardware upgrades. These upgrades are designed to allow the experiment run without electromagnetic backgrounds.



#### SNO+

SNO+ has seen significant progress in the past year. In July, the collaboration began filling the detector with liquid scintillator to begin the next phase of the experiment. To date, they have added 360 tonnes of scintillator and are using the underground chemistry lab for the QA associated with the scintillator fill. The collaboration has a paper submitted for publication about neutron detection efficiency in the detector and expects to have more results this year. The tellurium systems for phase three of the experiment are currently commissioning.

#### **CUTE & SuperCDMS**

The CUTE facility at SNOLAB is fully commissioned and has begun testing devices including a Ge HV detector identical to those that will be used in SuperCDMS. These tests will provide information about the detectors and also the background levels of the CUTE facility. 12 of the 24 SuperCDMS detectors are fabricated, as well as all tower mechanical parts. Testing has begun on the electronics, the dilution fridge successfully passed performance testing at FNAL, and the inner detector shield arrived at SNOLAB. Underground, the 3T crane and radon filter system were installed and installation of the seismic platform is ongoing.

#### REPAIR



The REPAIR collaboration measured the background radiation levels in the underground and surface labs where they will be growing their cells and completed modelling of background radiation dosage rates. They also completed construction and commissioning of the low radon glovebox underground and initiated the first set of cell culture experiments in the glovebox in order to examine the effects of sub-background radiation levels.

#### **PICO**

The PICO collaboration assembled the PICO 40 detector underground and began the commissioning process. They have detected their first bubbles through operation without the water shielding in place and will finish commissioning and begin taking data this year. PICO 500, the next iteration of the detector, has begun the process of sourcing materials and parts.



#### HALO

HALO continued taking data over the past year as part of the Supernova Early Warning System network. In June, Laurentian University and SNOLAB hosted the SNEWS 2.0 conference, bringing together scientists working on supernova detectors around the world and looking at future plans for HALO 1kT.

Photo: Fermilab





## Profile Mehwish Obaid

Mehwish is a professional engineer and project management professional who is currently the Integration Manager at SNOLAB. She completed a degree in manufacturing engineering from the University of Ontario, Institute of Technology before earning a Master's in Project Management from Durham College. Mehwish gained valuable experience in coordination and management while working on large scale, international projects at SNOLAB (DEAP-3600, SuperCDMS, NEWS-G, REPAIR, PICO 500 and nEXO). Her engineering background, technical skills, and project management experience enable her to work efficiently across groups and to excel in her role at SNOLAB.





Strategic Goal 2 Develop and maintain world-class facilities and infrastructure

#### Lost power days

To improve the robustness of key infrastructure at SNOLAB, great effort has gone into reducing work delays, power outages, and interruptions to experiment operations. Of the 14 power outages in the last fiscal year, eight were planned for and required to complete work at SNOLAB or Vale. Of the six unplanned outages, four were the result of electrical storms. This initiative to reduce unplanned outages increases user productivity and high-quality project delivery.

#### Underground chemistry lab

The underground Life Sciences & Chemistry Laboratory is shared by the REPAIR experiment and the Scientific Support group. It has capabilities for an assortment of chemical analyses using instrumentation including UVVis spectrophotometer, total organic carbon analyzer, pH, conductivity meter, density meter, turbidimeter, colorimeter, and refractive index. The lab is equipped with space for small bench top experiments, has access to the UPW system, and has a fumehood and chemical storage. REPAIR also has a radon-free glove box in the lab.

#### Cleanliness

SNOLAB's entire underground facility is maintained as a class-2000 cleanroom, reducing possible radiological backgrounds and allowing rapid deployment of smaller-scale experiments. For every cubic foot of air, there are fewer than 2000 particles of ≥0.5 micron in diameter. Cleanliness targets are achieved primarily by cleaning the air coming into the lab through a series of particulate filters, activated charcoal filters, and finally HEPA filtration. In addition, all materials coming into the lab are cleaned prior to entry and the facility is meticulously maintained by a staff of cleaner maintainers.



#### Low background counting lab

SNOLAB has a low background counting facility underground capable of providing assays and measurements for the user community. Currently, the facility provides gamma screening using high-purity germanium detectors, alpha surface screening, passive radon emanation, radon and thoron measurements with electrostatic counters and alpha-beta counters, x-ray fluorescence (ERF) spectrometry, and general gamma spectroscopy.

The facility offers consultation to experiments and projects and tests all materials for current and future experiments for radon emanation levels to ensure they do not interfere with the data collected.







# Jenna Saffin

Jenna Saffin was the Communications Intern at SNOLAB in 2017 from the Laurentian University Master of Science Communication program. Her experience with SNOLAB social media, coordinating public events, and refreshing website content gave her a thorough introduction to the different types of communications and outreach work a research facility like SNOLAB requires. Jenna transferred these skills to a new position at the McDonald Institute to create their website and social media strategy and help coordinate their public launch. Jenna has since returned to SNOLAB as the Science Communication Coordinator, sharing our research with our audiences and inspiring the next generation of scientists.



Strategic Goal 3 Educate, inspire, and innovate

#### **Economic impact**

SNOLAB is a source of economic and social benefits for Sudbury, Ontario, and Canada through job creation, the attraction of scientists and their families to the area, and the provision of custom manufacturing and fabricating requirements to local companies. Based on economic impact models developed by Statistics Canada and determined in an assessment completed by KPMG, SNOLAB's economic impact on the local area is \$3 return for every \$1 of government funding.

#### **Outreach events**

Collaboration with strategic partners is key in promoting the leading-edge science underway in the lab with a broad audience. SNOLAB supported the Interactions Collaboration with the successful delivery the Dark Matter Day initiative. 2019 saw the development of an artist residency project in partnership with the McDonald Institute and the Agnes Etherington Art Centre. SNOLAB brought hands-on science activities to Science North, the WISE Science Olympics, and the Sudbury Market. Through our outreach programming, SNOLAB welcomed five national and international summer schools for secondary and post-secondary students. Our outreach team presented at the Space Educators Institute at Western University for K-12 educators and at the Canadian Conference for Undergraduate Women in Physics.

#### **Sponsorship**

SNOLAB hosted two international conferences with our partners at Laurentian University: SNEWS 2.0, an international workshop for supernova researchers, and the Canadian America Mexico Conference for graduate students in physics. SNOLAB provided sponsorship to six conferences including the teacher workshop at the CAP Congress and the Canadian Conference for Undergraduate Women in Physics. Resources and mentorship were provided this year to three high school robotics teams in our region. SNOLAB sponsored and presented at our local International Day for Women and Girls in Science event that brought together STEM institutions to provide a full day of programming to elementary students.

#### **City of Greater Sudbury**

Sudbury has a rich history of research and innovation and the City of Greater Sudbury (CGS) plays a key role in fostering the ground-breaking research happening in science fields and in the mining and technology sectors. SNOLAB works closely with the CGS and our partners at Sudbury Tourism to highlight the region and welcome researchers and scientists to Sudbury.









#### Profile

# Jeter Hall

Jeter completed his PhD at the University of Utah searching for gamma rays before taking a post-doctoral position at Fermilab working on underground dark matter experiments. While working on CDMS-II and SuperCDMS, much of his work was on focused on electronics and operating the detectors with higher voltages. He spent time underground at SNOLAB working on COUPP and PICO, contributing to acoustic analysis. In his role of Director of Research at SNOLAB, Jeter works with the research scientists and project managers to make sure the current research program is heading in the right direction.



Strategic Goal 4 Develop delivery systems of internationally recognized standard

#### New director structure

To support the development and delivery of the SNOLAB science program, this year saw the hiring of three new directors to strengthen the organizational capacity and support the strategic activities of the Executive Director. The Director of Program Development is in place to lead the development of experiments and facility capabilities. The successful execution of the laboratory's large suite of projects is guided by the Director of Research. Facility resources are maintained and coordinated by the Director of Operations.

#### **Policies and procedures**

This year has seen improvements to SNOLAB processes and procedures with the goal of increasing efficiency, reducing risk, supporting science delivery, and optimizing resources. Formal work request systems have been put in place for the integration, information technology, and scientific support groups. We continue to work towards internationally recognized practices to improve delivery systems and accelerate scientific outcomes.

#### Project life cycle

SNOLAB has a well-defined framework to support the safe, efficient, and successful delivery of its largescale, international science program. A six-phase process, the SNOLAB project life cycle guides each project through initiation, operation, and completion. This process is supported by assessments and reviews at each phase and allows for the systemized allocation of resources.



"Don't shoot for the stars; we already know what's there. Shoot for the space in between because that's where the real mystery lies."

- Vera Rubin

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