Implementation plan

2017 - 2022

Implementation Plan

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Our Visionary Partners

SNOLAB is enabled by an alliance of visionary partners.
This includes the six founding partners that provide direction in all affairs of the organization to ensure that SNOLAB has the means, quality, depth and continuity of management required to realize its major scientific and operational objectives.

Carleton University
VALE
Université de Montréal
University of Alberta
Laurentian University / Université Laurentienne
Queen's University

SNOLAB also extends sincere thanks to the many funding partners that contribute essential investment for its facilities, research capabilities, infrastructure and operations that support leading-edge discovery, physics research and innovation to the benefit of all Canadians.

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Part A **The Vision**

Letter from the Chair

Dear Colleagues,

It is with great pleasure that, on behalf of the SNOLAB Institute Board of Directors, I present to you the SNOLAB Five-Year Plan for 2017- 2022. This plan articulates a bold vision for SNOLAB to capitalize on its unique combination of depth and cleanliness to be an international leader, and partner of choice, in deep underground science. It will enable a broad range of scientific initiatives, from core subatomic physics research into the properties of neutrinos and the search for dark matter to mining data analytics and deep underground studies of biology, engineering, and geology, that will be pursued by SNOLAB scientists and staff, researchers from the five partner universities of the SNOLAB Institute, and colleagues from across Canada and abroad.

The process leading to this Strategic Plan and Implementation Plan was initiated by the SNOLAB Institute Board of Directors in 2015 and was guided by a Strategic Planning Committee comprised of members of the Canadian and international research communities. Following broad consultation, including a Town Hall meeting at SNOLAB in April 2016, a draft report was circulated to the stakeholder communities for further feedback and consultation. The final Strategic Plan was approved by the SNOLAB Institute Board of Directors in February 2017.

This Strategic Plan defines the vision and goals of SNOLAB for the next five-year period. It is complemented by a more detailed Implementation Plan that describes how SNOLAB will achieve these goals. Together, they will ensure that SNOLAB continues to bolster Canada's reputation as an international leader in deep underground science.

Sincerely,

Carl Svensson
Chair, SNOLAB Institute Board of Directors

A.1.1 Purpose of this Document

This document aims to address the needs of several target audiences served by SNOLAB. The Implementation Plan works in conjunction with the Strategic Plan and these documents will guide SNOLAB management in the prioritization of resources, enabling a sharp focus on projects that directly support and align with the strategic goals of the SNOLAB community.

The Strategic and Implementation plans are owned by the SNOLAB Board, and will serve as a benchmarking documents for oversight, to assess the effectiveness and impact of the facility and the management team. Finally, the entire SNOLAB community drives the strategic direction, and, as such, this document provides a vehicle for continued engagement and alignment with the community we serve.

SNOLAB extends thanks to all our stakeholders who contributed to the development of the SNOLAB Strategic and Implementation Plans. We welcome your ideas and feedback; please contact the SNOLAB Communications Office at communications@snolab.ca.

A.1.2 Executive Summary

SNOLAB is an epicentre of global astroparticle physics and underground science discovery and research located 2 kilometres below the Earth's surface in the operational Vale Creighton nickel mine near Sudbury, Ontario, Canada. One of the deepest, cleanest underground laboratories in the world, with an experienced and skilled support staff, SNOLAB is an expansion of the existing facilities constructed for the Nobel Prize-winning Sudbury Neutrino Observatory (SNO) solar neutrino experiment. The combination of SNOLAB's great depth, cleanliness, in-house scientific and research expertise, and specialized technical and project management support allows researchers to build underground experiments; study extremely rare interactions, weak processes, and deliver world-class science in a highly productive way. This enables a world-class science programme that is currently focused on neutrino and dark matter investigations – and it is attracting internationally renowned scientists and experiments from across Canada and around the world.

SNOLAB has established a bold vision: to be an internationally recognized laboratory and partner of choice for deep underground science, delivering world-class research, scientific discovery, benefits to Canada and her global partners, by enabling national and international access to its unique capabilities, facilities and expertise. This vision is anchored on the following four key strategic goals that underpinned SNOLAB's inaugural strategic plan, and will guide the next five years of SNOLAB's evolution:

- Enable and spearhead world-class underground science
- Develop and maintain world-class facilities and infrastructure
- Educate, inspire and innovate
- Develop quality delivery systems of internationally recognized standard

This implementation plan for 2017 - 2022 outlines how SNOLAB will work closely and collaboratively with the scientific community to build on the scientific, technical and operational progress and accomplishments achieved to date, and take strategic and coordinated action to further realize these goals. It builds directly on guidance, feedback and recommendations from a Strategic Planning Committee established by SNOLAB, and members of its community. As part of the Strategic Planning process, SNOLAB commissioned and executed a stakeholder survey; hosted a town hall meeting and team-based consultations; and conducted individual interviews. This enabled the organization to gather critical feedback on key objectives and programs to date, and solicit input to the next five-year strategic planning process.

Over the last five years, SNOLAB has established its role and position as a world-class underground laboratory within the national and international arena. It has made significant progress against strategic objectives established for this period including the:

- Official launch of the facility in 2012;
- Visits from internationally renowned leaders such as Dr. Stephen Hawking;
- Co-awarding of the 2015 Nobel Prize for Physics to Dr. Arthur B. McDonald, a highly accomplished and internationally recognized Canadian astrophysics researcher, founder and inaugural Director of the Sudbury Neutrino Observatory;

- Successful completion of several high-profile SNOLAB-supported experiments that generated important scientific results; these include PICASSO; COUPP; and DEAP-1;
- Initial results delivered from ongoing SNOLAB experiments including: PICO (formed from the merger of two existing groups, PICASSO and COUPP) and DAMIC (searching for low mass WIMPs);
- Successful construction of major projects including DEAP-3600, a second generation experiment that will search for dark matter particle interactions in liquid argon; HALO, which aims to detect supernovas; SNO+, a new experiment that uses the existing SNO detector to study low energy solar neutrinos, geoneutrinos and reactor neutrinos as well as conduct a supernova search; MiniCLEAN, a dark matter experiment using 500 kg of liquid argon to search for Weakly Interacting Massive Particles (WIMPs), a possible form of dark matter; and PICO-60, a spin-dependent dark matter detector;
- Implemented new research threads into the scientific program supported by SNOLAB, spanning genomics, bioinformatics, and data analysis for the mining industry; these projects include: FLAME which uses flies to study genetics and metabolism and the effects of working in a mine, specifically working deep underground; the REPAIR project which examines the biological effects of prolonged growth and development in low radiation environments; and the Mining Observatory Data Control Centre (MODCC), a data processing and analysis facility with accessibility and capability unlike anything currently available to mining/exploration companies and researchers;
- Evolution of core infrastructure, underground research capabilities and project management expertise and processes to support the delivery of experiments; this represents a key differentiator for SNOLAB within the global field of underground science laboratories;
- Increasing support for SNOLAB as an internationally recognized laboratory of choice by organizations such as the US Department of Energy (DOE) and National Science Foundation (NSF) for the deployment of highly sought after global research experiments such as the $30-million dollar SuperCDMS;
- Increase in SNOLAB's research capacity with the expansion of its internal research team; these scientists demonstrate leadership on physics projects housed at SNOLAB, and make a significant contribution to the delivery of underground experiments, associated research outcomes and intellectual capital. They also serve as Adjunct Professors with Laurentian University, enabling SNOLAB to participate as collaborators on proposals and projects with the Natural Sciences and Engineering Research Council (NSERC).

SNOLAB provides a distinct competitive advantage to Canada by enabling ease of access to very deep, clean experimental halls capable of hosting kilo-tonne scale projects, and providing expert technical and administrative support and infrastructure. This is a unique combination within the global community of deep underground facilities. As SNOLAB supports the development of more sensitive scientific experiments, the requirements for great depth and low radiological backgrounds become even more stringent, positioning SNOLAB as a leading site to undertake these projects. As an affirmation of this competitiveness, SNOLAB continues to attract great interest from new international collaborations wishing to deploy projects at SNOLAB. For example, the 'Future Projects' workshop series has had six large scale detector systems present plans for deployment within the Cryopit, including the upgrade plans for the two leading US neutrinoless double-beta decay projects.

Moreover, in March 2016, KPMG conducted an independent assessment of SNOLAB's economic impact on the Province of Ontario, and Canada more broadly.

Based on economic impact models developed by Statistics Canada, the total (gross) economic activity generated by SNOLAB in Ontario and Canada over the past three years, and forecasted over the next five years, is estimated to be in the order of $358 million.

This includes a contribution of:

- ***$159 million to Ontario's gross domestic product (GDP);***
- ***$176 million to Canada's GDP.***

This translates into a host 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.

Given SNOLAB's sharp focus on the delivery of experiments as its core mandate and top priority, the organization deferred a few objectives originally established in the Strategic Plan for 2012 - 2017. The laboratory will address outstanding priorities, such as the attainment of ISO accreditation and the development of a low background counting facility, during the next five-year period.

Its unique combination of research capabilities, supported access, expanding project management capacity, and expertise in the design, development and implementation of complex experiments, differentiate SNOLAB among underground laboratories around the world. Over the next five years, SNOLAB will work with the community to create even more robust infrastructure and research capabilities that address the needs of physics researchers at the leading edge of this scientific field.

The science arena is highly dynamic and evolving with increasingly ambitious quests for scientific discovery. The scientific focus of SNOLAB is at the

forefront of global research in sub-atomic particle physics and astrophysics, the study of sub-atomic particles existing or created within the cosmos, and their influence on the universe. This field includes the search for rare and weak interactions from galactic dark matter or natural neutrino sources, and the study of the fundamental properties of neutrinos. The nature of dark matter is one of the most fundamental questions in all of science today, which motivates experiments around the world, from SNOLAB to the South Pole to the International Space Station to the Large Hadron Collider at CERN. The discovery of neutrino mass and mixing is the first confirmed observation of physics beyond the Standard Model, and neutrino-less double beta decay experiments have unique potential to elucidate the nature of neutrino mass. Neutrino particle astrophysics has opened a new observational window into the universe, and shown that we have much to learn about how stars work, and how heavy elements are produced. This reinforces the demand for the research capabilities and expertise provided by SNOLAB, and the world-class experiments it supports.

Over the next five years, SNOLAB will:

- Remain at the forefront of sub-atomic and astroparticle physics by delivering world-class science and demonstrating scientific leadership through its increased contribution to global experiments and the achievement of scientific outcomes; this includes the development of a new long-term plan for SNOLAB beyond 2022;
- Attract, develop and retain some of the most exciting and robust experiments from around the world;
- Play a pivotal role in bringing the Canadian particle astrophysics research community to define its vision for the future; this may include consolidation around technologies and next-generation experiments in dark matter and double-beta decay;
- Maintain a strong focus on the delivery of science, and contribute to the continued progress of current and future experiments including:
    - SNO+, which aims to publish results from its water and LAB phases, and run stably and reliably with 0.5% Te loading
    - DEAP-3600, which aims to publish results on dark-matter limits (or discovery) during its execution phase from 2016-2018
    - SuperCDMS, which aims to successfully initiate installation at SNOLAB
    - Several smaller multi-disciplinary projects (such as those in genomics and biology) that aim to publish or achieve actionable and commercially-oriented results
    - A new major experiment to be identified for installation in the Cryopit; this includes the completion of conceptual and engineering studies and an installation plan
- Facilitate increased collaboration with fellow Canadian research leaders on world-class science, as well as governance and operational best practices for national research facilities that leverage scientific resources and funding, and increase the impact of all organizations within Canada's research ecosystem;
- Establish new global partnerships that promote Canada's track record in world-class physics research to the world, and help our researchers to seize new scientific opportunities, acquire new investment, and increase their contribution to world-class global physics research projects and outcomes;
- Catalyze new discoveries that translate into scientific knowledge, future applications and associated benefits in industry sectors such as mining, geology, biology and medicine; and
- Enable economic impact that helps to create a high quality of life for generations to come.

A.2 Foundational Drivers

A.2.2 Vision Statement

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 the unique capabilities, facilities and expertise at SNOLAB.

A.2.3 SNOLAB Mission

In support of its vision, SNOLAB will:

- **Enable world-class science performed at SNOLAB by national and international collaborative research and experimentation teams** that specialize in underground research. SNOLAB:
  - Provides access to the capabilities, technical skills and knowledge required to conduct leading-edge science projects and execute successful experiments;
  - Generates and develops international connections and collaborations;
  - Contributes to the development of a strong Canadian reputation in the global physics and scientific arena; and
  - Provides risk mitigation for scientific delivery, reacting quickly to challenges and crises, further enabling the efficient execution of scientific programs and experiments.
- **Spearhead world-class science at SNOLAB** through its own research group as part of the international and national scientific community, developing synergies with other groups worldwide;
- **Catalyze world-class science at SNOLAB** by being a sought after collaborator in its own right and through providing transformational opportunities for collaboration and knowledge exchange to other groups through workshops, external connections and local interactions;
- **Promote world-class science and societal benefits** through strong public and professional outreach programmes, and through technical knowledge development and transfer; and
- **Inspire the next generation of innovators** through strong educational outreach, knowledge transfer and the training of highly qualified personnel.

A.3 Framework for Success

A.3.1 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.

Professor Stephen Hawking surrounded by the SNOLAB science team during his visit to the underground laboratory in September 2012. Photo Credit: SNOLAB

A.3.2 Research Focus

SNOLAB enables world-class underground science with a focus on sub-atomic and particle astrophysics. This area of research addresses some of the fundamental questions within contemporary cosmology and particle and nuclear physics:

- What is the nature of dark matter that pervades and shapes our universe?
- What are the masses and fundamental nature of neutrino families?
- How have neutrinos and dark matter shaped the evolution of the universe?
- What caused the asymmetry that led to a matter-dominated universe?

The SNOLAB science programme has expanded significantly over the last five years. Although approximately 95% of SNOLAB's scientific programme is dedicated to the conduct of sub-atomic and particle astrophysics experiments, it also facilitates research and discovery in other scientific fields such as biology, geo-physics and mining innovation. Overall, the SNOLAB programme now encompasses subatomic and nuclear physics, astrophysics, genomics and mining innovation. Specifically, SNOLAB now has dark matter, neutrinoless double-beta decay, supernova neutrino, low dose radiation, genomics, and mining engineering experiments within its underground laboratory.

Key areas of focus include:

- Astro-particle and Particle Physics – Dark Matter Studies;
- Astro-particle and Particle Physics – Neutrino Studies;
- Mining data analytics – MODCC;
- Biology, Engineering and Geology; and
- Centre of Excellence for Low Background Studies

Over the period of this Strategic Plan and Implementation Plan, the SNOLAB research programme will remain predominantly focused on astroparticle physics. A high-level overview of the research fields supported by SNOLAB is provided below.

Astroparticle Physics

Astroparticle physics is a field of research that studies subatomic particles associated with astronomical sources and events. On the one hand, astronomical sources can produce energetic particles (such as neutrinos and cosmic rays) in quantities and at energies that can't be achieved in Earth-based particle accelerators. The initial Big Bang and early formation of the universe has also created prodigious numbers of relic particles, which influence the evolution of the universe and galaxies. As such, particle physicists turn to extraterrestrial sources to study some aspects of particle properties. On the other hand, understanding the properties of these particles gives insight into the creation and evolution of stars, galaxies and ultimately the universe itself.

The principal topics in particle physics under investigation at SNOLAB include:

- Low Energy Solar Neutrinos;
- Neutrinoless double-beta decay;
- Cosmic Dark Matter Searches; and
- Supernova Neutrino Searches.

Astroparticle physics measurements at SNOLAB often involve extremely rare events that deposit small amounts of energy in detectors (for example, one event per tonne of detector material per year in dark matter searches). To address this challenge, the detectors need to be very large and must be shielded from background interactions that can mask or interfere with the signals being studied. A major source of background comes from cosmic rays, the energetic particles produced throughout the cosmos and which are constantly bombarding the Earth. Astroparticle physics experiments are shielded from cosmic rays by locating the detectors deep underground.

SNOLAB is located 2070m underground which allows for a cosmic ray reduction of approximately 50 million times less than that experienced on the surface of Earth. This translates to 0.29 cosmic rays per square metre every day underground compared to 150 cosmic rays per square metre every second on surface.

Solar Neutrino Physics

Solar neutrinos are produced by the same fusion reactions in the core of the Sun that produce the heat and light which makes life on Earth possible. The density of the Sun is so great, it takes a million years for the light and heat produced by these reactions to travel the 700,000 km from the centre of the Sun to its surface (and then a mere eight minutes for the light to travel the intervening 150 million kilometers from the Sun to the Earth). Solar neutrinos, on the other hand, interact so weakly that they have almost no interactions inside the Sun and escape almost immediately, travelling at nearly the speed of light.

This property of neutrinos offers astrophysicists a view into the heart of the sun and the ability to study the solar furnace that powers it. At the same time, because the sun is such an enormous source of neutrinos (about 60 billion solar neutrinos pass through your thumb nail every second), it can be used to study the properties of neutrinos themselves. Experiments such as SNO have made measurements of neutrinos from the sun and have revealed new properties of the neutrino (that they undergo flavour oscillations) and confirmed, to very good precision, that we understand the mechanisms that make the sun shine.

The next generation of solar neutrino experiments such as SNO+ will be able to make precision measurements at lower energies, which will further our understanding of the solar fusion mechanisms and ultimately the evolution and fate of the sun.

Search for Neutrinoless Double-Beta Decay

One form of radioactivity is beta decay, in which a neutron inside a nucleus changes into a proton, an electron and an antineutrino. This process led to the postulation of the neutrino as a particle, to explain the energetics of beta beta decay, which otherwise looks like a two-body process. However, for some atomic nuclei, this decay is energetically forbidden; for a few of these nuclei, it is instead possible to undergo double-beta decay, in which the nucleus emits two electrons and two antineutrinos at the same time. To date there are only about 13 nuclides where double beta decay has been observed. These are extremely rare decays. Their half-lives (the time it takes for half of the parent material to decay) is typically on the order of 10^{18} to 10^{21} years. For comparison, the universe is 10^{10} years old. Theoretically, there is a process related to double-beta decay called neutrinoless double-beta decay, in which the nucleus emits two electrons and no neutrinos. This can only happen if the two neutrinos that would have normally been emitted by the decaying nucleus annihilate. Such a cancellation can occur if the neutrino is a Majorana particle, having the property of being its own antiparticle. SNO+ is one example of a SNOLAB-supported project that is focused on the search for neutrinoless double-beta decay.

Supernova Watch

A supernova is the spectacular death of a massive star in an explosion that for a few brief weeks outshines the entire galaxy the star is situated in. Neutrinos are intimately connected to supernovae. During the bulk of a star's life, about 99 percent of the energy produced is in the form of light and about one percent as neutrinos. For a supernova, almost all of the energy released is in the form of neutrinos.

It is now thought that neutrinos are an integral part of the explosion mechanism for supernovae and in the production of heavy elements created during the explosion. Neutrinos also have an important feature in that they escape the exploding star before the light emerges. So detecting a burst of neutrinos from a supernova would provide an early warning to optical astronomers, allowing them to study the "turn on" of the supernova long before it would normally be observed. There exists a network of neutrino detectors around the world that belongs to SNEWS (Supernova Early Warning System) and, in the event that a burst of neutrinos is detected, SNEWS will alert the astronomy community (and the amateur astronomer community as well). Experiments at SNOLAB that can detect supernovae neutrinos include the dedicated supernova neutrino detector HALO (currently connected to SNEWS) and SNO+.

Search for Galactic Dark Matter

Astronomers and astrophysicists have determined with ever increasing certainty from dynamical studies at all scales in the universe, gravitational lensing and cosmic microwave background studies, that about 85% of the matter in the universe is non-luminous or 'dark' matter. Dark matter is not the 'ordinary' baryonic matter that makes up the chemical elements that compose the stars, Earth and ourselves. This non-baryonic dark matter makes up about 27 percent of all the mass-energy in the universe, while the ordinary matter that we are made of only comprises about five percent (the remaining 68 percent of the universe is called 'dark energy'). Dark matter is fundamental to the development and evolution of galaxies including our own, as its gravitational interaction initiates the formation of galaxies and holds them together.

The composition of galactic dark matter is one of the leading issues in contemporary astrophysics and cosmology. Initially thought to be neutrinos, it is now clear that while neutrinos do have mass, they are not heavy enough to explain the observed quantity of dark matter. A leading candidate for the dark matter from particle physics theories is a WIMP, or a 'Weakly Interacting Massive Particle'. Such a particle is the neutralino predicted by the Supersymmetry theory in particle physics, which would connect the world of subatomic physics to the evolution of the universe as a whole. SNOLAB hosts several experiments that are undertaking the search for WIMPs, including: the DEAP-3600 and MiniCLEAN liquid argon detectors, the DAMIC CCD-based detector, the NEWS-G high pressure gas experiment, the PICO bubble chamber and the SuperCDMS cryogenic experiment project.

Geophysics, Seismology and Biology

The questions that can be answered at SNOLAB are not limited to particle and astrophysics. SNOLAB also enables research in fields such as geophysics, nuclear science and biology.

SNOLAB has established a strong working relationship with the Centre of Excellence in Mining Innovation (CEMI), a national not-for-profit organization that directs and coordinates step-change innovation in exploration, deep mining, integrated mine engineering, underground mine construction and environment and sustainability for the metal mining industry. Together with CEMI, SNOLAB now hosts the Mining Observatory Data Control Centre (MODCC). This venture aims to address key challenges in deep mining, such as those related to mine efficiency and rock mass characterization, through the development of data analytics projects and support of Small-Medium Enterprises working in this area.

SNOLAB also facilitates genomics and biological explorations. The underground laboratory enables scientists to assess the impact of sub-background radiation levels on cell mutations through the REPAIR project and how the underground environment influences the fruit fly metabolism with the FLAME experiment.

Access to underground sites also creates new opportunities to study geo-chemistry and the evolution of gases within rock masses. These projects also benefit from the data management, deep mine accessibility, assay and chemistry support available at SNOLAB.

As of April 2017, SNOLAB houses and supports thirteen experiments; please find a summary of these projects in the table below.

Experiment	Focus
SNO+	A tonne-scale double beta decay detector making use of the existing SNO detector and loading liquid scintillator with tellurium. The collaboration extends across 23 institutions.
SuperCDMS SNOLAB	A second generation dark matter detector using cryogenic germanium crystals supported by 135 researchers from 26 institutions.
HALO	An experiment to detct neutrinos from supernovae that is part of the global network SNEWS using 79 tonnes of lead and 128 tubular He-3 detectors.
DEAP-3600	A second-generation dark matter experiment and collaborative effort with 65 researchers from 10 institutions in Canada, the United Kingdom and Mexico using 3.6 tonnes of liquid argon.

Experiment	Focus
MiniCLEAN	An alternative technology detector with researchers from 7 US institutions using 500kg of liquid argon.
PICO	A second generation detector using super heated fluids to search for dark matter across 17 institutions worldwide.
DAMIC	A dark matter experiment using charged couple devices with a worldwide collaboration of scientists.
NEWS-G	A Canada-France collaborative effort in dark matter detection in the low mass range using high pressure gases.
FLAME (Flies in a MinE)	A genetics experiment that takes advantage of the increased pressure to study the impacts of working deep underground using fruit flies as a model organism.
REPAIR	A Canadian bioinformatics experiment that explores cellular mutations in low radiation environments.
Cryogenic Underground Test Facility (CUTE)	A Cryogenic Underground Test Facility (CUTE) to be installed at SNOLAB with the goal to do performance tests, calibrations and background measurements.
Low Background Counting	SNOLAB is developing a low background centre of excellence, which will incorporate the local expertise and capitalises on the low background HPGe detectors currently at SNOLAB while adding additional hardware to this suite.
Mining Operations Data Control Centre (MODCC)	This co-located centre will capitalize on existing data integration and sharing expertise at SNOLAB as well as the significant investments already made in its deep underground facility to look at large date collection, integration and storage.

A.3.3 SNOLAB's Capabilities and Role as a Host Laboratory

In support of its mandate to deliver world-class underground science with a focus on sub-atomic and particle astrophysics, SNOLAB offers a unique facility with great depth, cleanliness, scientific expertise and project support to experiments. This makes SNOLAB an internationally recognized laboratory of choice for the scientific community. This is evidenced by a three-fold increase in demand for the capabilities and services that SNOLAB offers to researchers and scientists over the last three years alone.

A.3.3.1 The Laboratory

SNOLAB features 10,300 square metres of space including:

- 5,000 square metres of clean space underground for experiments and supporting infrastructure located 2.07 kilometres below the Earth's surface; and
- 3,100 square metres above ground which houses a SNOLAB building and a host of project design and management expertise to support the underground experiments.

The underground laboratory is a Class 2000 cleanroom that spans the entire underground research facility, reducing possible radiological backgrounds and allowing the rapid deployment of smaller-scale experiments. It is currently the second deepest underground laboratory in the world after the China Jinping Underground Laboratory (CJPL). It features three large detector cavities, as well as safety systems and user support services, and supporting infrastructure for experiments including: HVAC, electrical power, ultra-pure water, compressed air, radiological source control, radio-assay capability, chemical analytic facilities, information technology and networks, material handling capabilities and transportation.

Low background counting capabilities currently exist with HPGe counters, alpha counting and radon emanation studies with planned future developments to provide more extensive and sensitive assay capabilities as determined by community consultations. The laboratory operates more than 11,000 underground person-shifts per year, which equates to about 60 people working in the facility each day.

The astroparticle physics program delivered by SNOLAB also requires a variety of highly sensitive detector technologies with multi-tonne detectors that are only viable in the ultra-low radioactivity background environment that SNOLAB provides. These detectors have long lifecycles, taking many years of design, construction, and operation before they can deliver science – and they are built by large collaborative teams that come together in Sudbury at SNOLAB.

In addition to the infrastructure built at Vale's Creighton Mine, SNOLAB leverages a facility at Laurentian University for radio-isotope production and measurements, and water analysis.

A.3.3.2 Scientific, Technical and Project Management Expertise

In addition to underground research infrastructure, SNOLAB provides specialized scientific, technical and operational support to projects and users, enabling them to deploy and conduct complex experiments in this unique underground environment. SNOLAB employs a seasoned team with core competencies in science; governance and management; design engineering, construction, and installation; logistics; project management; technical support; and instrumentation. SNOLAB employees bring a wealth of knowledge and experience in the successful deployment of highly complex underground experiments. This expertise includes:

- Scientific Research: SNOLAB employees serve as collaborators in the research programmes, providing local coordination and extensive experience within the underground environment, benefits and restrictions of the facility. They are responsible for driving SNOLAB scientific deliverables, and coordinating collaborators and students.
- Information Technology (IT): SNOLAB provides a full range of services and information technology spanning network management, scientific computing support, access to automation systems, backup and redundancy, and office services.
- Engineering: SNOLAB provides specialised knowledge of the underground laboratory environment and services, working closely with projects and facility groups to provide mechanical and process design for project construction integration.
- Scientific Support Services: SNOLAB provides a wide range of physics support, chemical and radiological assay, chemical process development, surface laboratory operations, and management of the Safety Data Sheet (SDS) and chemical safety programme.
- Projects Office: has responsibility for coordinating the delivery of projects at SNOLAB, and includes the management of the new project lifecycle process. All projects have a project coordinator associated with them who acts as the interface to SNOLAB resources.
- Programme Integration: SNOLAB provides skilled mechanical and electrical trades to construct all bespoke infrastructure and install all main electrical systems. This group also maintains the clean-rooms at Class2000 or better, and manages all material entering the facility.
- Programme Operations: SNOLAB operates all process systems underground. The team maintains and manages all conventional services, including building instrumentation and automation, the surface facility, and logistics delivery.
- Strategic Risk Management: The SNOLAB Risk group includes finance, health and safety, communications, human resources and Q.A. expertise. These positions report directly to the Executive Director and have responsibility for delivery of the financial budget and oversight, site policies and procedures, and ensures compliance with regulations and best practice for finance, H&S, human resources, project management and administrative practices.

Building on the knowledge of this talent base, SNOLAB leverages many partners that provide the laboratory and its user community with a broad array of research expertise and capabilities for experiments. These include:

- Vale, a multinational mining powerhouse with extensive expertise in underground operations, technical capabilities and regulatory requirements; and
- Science North, an interactive science centre in Greater Sudbury, which provides expert advice and resources for public engagement.

Over the last five years, SNOLAB has made a significant investment in the development of its internal programme, project management capacity and process to consistently improve the value delivered to experiments and research teams at the laboratory and increase the potential for successful research outcomes. To fulfill its role as a host laboratory for international underground scientific experiments, SNOLAB has established more than 500 criteria-driven operational policies, processes and procedures that detail all aspects of SNOLAB business.

For example, SNOLAB has established a formal project life cycle management process to enable the development and delivery of deep underground experiments. This process directly supports funding agency requirements to review the financial and resource viability of projects that request funding from the Canada Foundation for Innovation (CFI). As articulated in this Implementation Plan, SNOLAB will seek to consistently strengthen and improve this process over the next five years for the benefit of current and future SNOLAB-supported teams.

In addition to this well-defined project management process, SNOLAB also established Key Performance Indicators (KPIs); a set of quantifiable measures that a company uses to gauge its performance over time[1]. SNOLAB puts this data to work to assess progress against strategic and operational goals and to make key decisions within laboratory management and operations.

[1] *http://www.investopedia.com/terms/k/kpi.asp*

SNOLAB also established a Facility Business Plan that actively tracks the development of its research capabilities, and facility risks and hazards. This living and dynamic document connects the strategic objectives to laboratory operations and provides a transparent management process for SNOLAB. It is updated regularly with select components approved annually by the Board of Directors. The Facility Business Plan features:

- Agreed upon delivery milestones against each strategic goal to ensure the plan serves as an effective mechanism for Board oversight on delivery of the SNOLAB five-year strategic plan and annual operating plans;
- A risk and hazard management plan which is reviewed during each meeting;
- Finance and budget development;
- A staff development plan; and
- Tactical priorities and associated resource allocation.

A.3.3.3 Understanding the Needs of the Research Community

The introduction of the Project Lifecycle process at SNOLAB ensures frequent interactions between the experimental teams and the SNOLAB facility staff. This ensures that the needs of individual projects are being identified and incorporated into SNOLAB planning and execution, with regular updates to these requirements.

To remain fully apprised of the needs of its research community, the organization created the SNOLAB Experiment Forum (SEF). This group is comprised of representatives from each active experiment and the facility more broadly and meets at least biannually. This forum helps to ensure that SNOLAB addresses the collective needs of scientists, and acquires feedback on the effectiveness and impact of its program and project management approach. This allows SNOLAB to consistently evaluate its performance, impact and user satisfaction, and make any changes that may be required.

To ensure scientific excellence, SNOLAB established an Experiment Advisory Committee (EAC) that reports directly to the SNOLAB Executive Director and steers the scientific program. This committee is currently chaired by Dr. Stewart Smith, Princeton University, and is comprised of leading physicists from around the world.

In addition to the above forums, SNOLAB also engages the broader scientific community to determine future requirements of the community, and ensure that SNOLAB is well positioned to support the next generation of experiments. Such engagement includes:

- Contributing to community and funding agency strategic planning exercises to provide an overview of global research direction;
- Engaging the community in quinquennial strategic planning exercises that define research priorities and deliverables to determine long-term research needs and requirements; and
- Conducting biennial 'Future Project Workshops' that facilitate the informal presentation of new projects to provide medium-term research needs and requirements for planning purposes.

A.3.4 Partnerships

SNOLAB recognises the power of partnership to advance scientific discovery. We know we are stronger when we work together, harnessing the expertise and resources of our academic, government and industry partners from around the world to deliver long-term, sustainable science research programming. SNOLAB operates within a framework that includes a scientific user base from 79 institutions in 15 countries. We have strong ties to several U.S. National Laboratories including FNAL, PNNL, SURF and SLAC. Outside of North America, SNOLAB has developed close ties to other facilities including Gran Sasso, Boulby, Canfranc and Modane.

SNOLAB also invests in the development of strong collaboration with universities and other large facilities within the country. There are currently 15 Canadian universities and research institutions engaged in SNOLAB-supported research projects and governance. SNOLAB also continues to strengthen its relationship and linkage to TRIUMF, CLS and Perimeter Institute from a technical and management level.

TRIUMF, as Canada's national laboratory for particle and nuclear physics, specializes in large detector development and construction, and naturally augments the capabilities of SNOLAB. TRIUMF directly supports researchers on SNOLAB-supported projects such as SuperCDMS, SNO+, HALO and DEAP. TRIUMF's project management process is also aligned with that of SNOLAB to ensure strong synergy on common projects. The organization also contributes to experiment reviews, and engages in national big science discussions, initiatives and events. Building on its productive collaboration to date and its highly relevant capabilities and expertise, SNOLAB aims to pursue new and impactful opportunities with TRIUMF over the next five years.

The Canadian Light Source is a synchrotron radiation source and the "brightest light" in Canada, used by scientists to get detailed information about the structural and chemical properties of materials at the molecular level. As a fellow science institution with national reach, research infrastructure and physical assets, SNOLAB works closely with CLS on national science opportunities and challenges, advocacy, management and operational issues. This helps to create a more collective, cohesive and unified voice for science in Canada, increasing influence and stimulating action.

The Perimeter Institute, renowned as the centre for Canada's theoretical physics activities, provides the theoretical support for the experimental programs, especially in the area of dark matter, which is quickly emerging as a key area of focused research activity at the national and global level. SNOLAB currently collaborates with the Perimeter Institute on the development of Canada's next generation of physicists through its support of the International Summer School of Young Physicists (ISSYP). It also engages the Institute on matters related to governance, operations, advocacy and science policy.

The collective and complementary physics research capabilities and expertise provided by SNOLAB, TRIUMF, CLS and the Perimeter Institute provide a solid foundation on which to consistently grow the talent required to provide Canada with a truly global advantage in the rapidly evolving field of sub-atomic physics and related underground scientific disciplines. A direct example of this is the TRISEP summer school for graduate students in particle and astroparticle physics, annually organised in rotation by

SNOLAB, TRIUMF and the Perimeter Institute. By working together as an integrated and collaborative community within this environment, Canada's physics community will be well-positioned to exercise influence and generate new opportunities that will benefit generations to come.

Locally, SNOLAB has become a vibrant member of the Sudbury community and has partnered with institutions like Science North, the Centre for Excellence in Mining Innovation and the City of Sudbury. The organization has also developed a strong partnership with Vale that extends beyond the physical location of the laboratory at its Creighton Mine. Vale makes a significant in-kind contribution to SNOLAB that is valued at more than $10 million per year. This includes the use of the mine site for SNOLAB's above and underground facilities; supporting underground infrastructure and systems; and operational support and services. Vale's contribution represents substantial support for innovation as SNOLAB enhances scientific research production and generates and disseminates new knowledge into the mining chain. The initial SNO excavation provided the mining company with invaluable lessons and experience in deep mining excavation that have directly impacted operations to date. These outcomes have also permitted Vale to explore the Creighton Mine site more deeply in their continued pursuit to discover ore bodies. More recently, the development of the MODCC directly supports data analytics SME in the mining sector.

This community and stakeholder support from all levels make SNOLAB the location of choice for deep underground science

A.3.5 Community

As part of the Strategic Plan development, SNOLAB enlisted several community engagement activities that input and comments on areas of the scientific programme, the vision statement, and SNOLAB Strategic Goals.

The engagement activities dialogue on priorities, opportunities and challenges that are addressed in the Strategic Plan. The feedback received has been incorporated into our strategic vision for the next 5 years.

Key Messages from our community;

- Maintain strong focus on the delivery of world-class science
- Develop and implement a strategy to attract more world-class research projects, and make SNOLAB the global lab of choice for underground experiments
- Define a leadership role for SNOLAB that directly supports and complements the research community, and addresses key gaps within Canada's big science ecosystem
- SNOLAB funding to increase the capabilities available to scientists, and the long-term sustainability of the lab
- Continue to explore new research opportunities that expand SNOLAB's stakeholder reach and impact
- Address key challenges with the potential to impair global brand and reputation within the scientific community
- The assessment of SNOLAB's impact on the research community and Canadians

A.4 Realizing the Vision

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

This vision is anchored on the following four key strategic goals that underpinned SNOLAB's inaugural strategic plan, and will guide the next five years of SNOLAB's evolution:

- Enable and spearhead world-class underground science
- Develop and maintain world-class facilities and infrastructure
- Educate, inspire and innovate
- Develop quality delivery systems of internationally recognized standard

SNOLAB will consistently assess performance against the goals outlined in this section. It will establish and incorporate key targets into its KPIs and program management dashboard on an annual basis, and consistently track and report on progress to the board.

A.4.1 Strategic Goal One: Enable and Spearhead World-Class Underground Science

Goal: Ensure SNOLAB supports, maintains and executes a world-class research program and plays its own significant role in the shaping and delivery of science.

Objective: Working closely with current and prospective stakeholders, SNOLAB will continue to evolve, maintain and implement a world-class research program (with the current focus) that leverages the capabilities, core competencies and benefits of this internationally recognized laboratory. This objective encompasses the ongoing delivery of existing approved projects and the expansion of SNOLAB's research programme.

SNOLAB Action	Target Outcomes
Bring the Canadian particle astrophysics research community together and help define its vision for the future; this may include consolidation around technologies for next-generation experiments in dark matter and neutrino-less double beta decay.	Increased community alignment, cohesion and collaboration; maximization of Canadian research expertise and resources in particle astrophysics; increased efficacy and impact of this Canadian research community within the global arena as demonstrated by discoveries, awards and publications.
Maintain a strong focus on the delivery of science, and directly contribute to the continued progress of current and future experiments.	Catalyze progress on: → SNO+, which aims to publish results from its water and LAB phases, and run stably and reliably with 0.5% Te loading. → DEAP-3600, which aims to publish results on dark-matter limits (or discovery) during its execution phase from 2016-2018. → SuperCDMS, which aims to successfully conclude installation at SNOLAB. → Several smaller multi-disciplinary projects (such as those in genomics and biology) that aim to publish or achieve actionable and commercially-oriented results. → A new major experiment to be identified for installation in the Cryopit; this includes the completion of conceptual and engineering studies, and an installation plan.
Attract more internationally acclaimed, world-class physics research projects and global scientists with specialization in neutrinos, dark matter and neutrinoless double-beta decay to SNOLAB and Canada.	Acquisition of new high profile, internationally recognized science projects that leverage the unique capabilities of SNOLAB, enhance its global positioning and recognition, and add value to the research community.
Stimulate and help facilitate the increased participation of Canadian researchers in high profile global physics research projects at SNOLAB, attracting significant international capital funding.	Creation of new opportunities for Canadian researchers to conduct world-class research on global projects, acquire new skills; attraction of $50 million of capital funding for international projects sited at SNOLAB; 20 percent increase in the number of Canadian researchers who contribute directly to international research projects.

SNOLAB Action	Target Outcomes
Increase collaboration with fellow big science facilities such as TRIUMF and CLS to take collective action on shared opportunities and challenges that strengthen our big science ecosystem, increase the potential for research outcomes and further differentiate Canada's physics research capabilities globally.	Engage in a new major collaborative initiative with fellow big science facilities that leverage collective capabilities, funding and expertise.
Serve as an active and influential champion for the Canadian physics research community to increase global profile, investment and opportunity.	Transfer of knowledge within and beyond SNOLAB's current scientific community; enable new scientific publications with a physics focus; and new publications in other scientific domains (such as biology and genomics).
Increase strategic contributions to Canadian physics research proposals that help to secure the investment required to keep Canada at the leading-edge of this field.	Contribution to at least one successful new large research proposal within Canada that facilitates new funding into Canadian physics research.
Increase and diversify SNOLAB funding to help facilitate the continued implementation and expansion of the scientific programme delivered by SNOLAB.	Secure over $70 million in new funding for SNOLAB from 2017 to 2022; this includes new investment and in-kind contributions to the science program from both public and private sector sources to further enhance SNOLAB's long-term sustainability.
Recruit new internationally recognized scientists in physics and other relevant disciplines to contribute to the governance and strategic direction of SNOLAB.	Attract two new international Directors of the Board and five new globally-recognized scientists; this includes at least two experts from relevant fields outside of physics.
Develop engagement with the international community and funding agencies, and serve as a broker or interface to the Canadian physics research community.	Facilitate engagements with members of the international scientific community and help to broker new global collaborations with Canadian researchers that bolster Canada's contribution to science.
Attract and maintain a strong team of research scientists, staff scientists and technologists to support technical excellence to the projects.	Introduce a User Satisfaction Survey through the SNOLAB Experiments Forum to measure the efficacy of the SNOLAB Scientific Support services.

Critical Success Factors

- Strong working relationship and consistent communication with project teams conducting research experiments at SNOLAB
- Close collaboration with the Canadian physics research community, including scientists, research institutions, universities, public and private funders as well as stakeholders
- Well-defined value proposition and simple, seamless process for international researchers to come to Sudbury and perform research at SNOLAB
- SNOLAB access to the talent and financial resources required to bolster its scientific program and project management capabilities
- High visibility of SNOLAB and the Canadian research community on the global stage, increasing international recognition of SNOLAB's leadership role within, and contribution to, world-class physics research

A.4.2 Strategic Goal Two: Develop and Maintain World-Class Facilities and Infrastructure

Goal: Ensure SNOLAB remains at the forefront of infrastructure provisions for underground science.

Objective: To address the evolving needs of the underground science community by providing the research capabilities, services and project management support required to successfully design, develop and perform leading-edge neutrino and dark matter experiments within a relevant and reasonable timescale as well as deliver a world-class science program that generates world-class research outcomes.

SNOLAB Action	Target Outcomes
Conduct an annual assessment of the research capabilities required by SNOLAB users through the SNOLAB Experiments Forum and implement enhancements that ensure the laboratory addresses the needs of the research community, helps researchers to capitalize on new opportunities.	Capabilities that address the changing needs of researchers to facilitate desired scientific output.
SNOLAB to explore the development of new underground facilities required to address the needs of the research community.	Assessment of the feasibility of an expansion to SNOLAB's underground laboratory (caverns) and specification of space and associated research capabilities.

SNOLAB Action	Target Outcomes
Improve the reliability and robustness of key existing infrastructure in the underground laboratory including continued development of robust power distribution and underground to surface network capacity.	Reduction in delays, power outages and experiment interruptions to planned events only, helping to increase the productivity of users and the potential for high quality, on-time project delivery.
Introduce new research capabilities required by the physics research community that align with and support the NSERC Long-Range Plan of the Sub-Atomic Physics Community; this includes the development of a world-class low background counting facility.	Acquisition of positive and constructive user feedback; demonstrated usage and impact on the achievement of scientific output and outcomes; this includes awards and citations that acknowledge SNOLAB's underground infrastructure and research capabilities in international scientific journals and publications.
Continue to leverage the Experiment Advisory Committee and SNOLAB Experiment Forum to gather near-term and long-term insight, feedback and recommendations that aim to improve SNOLAB capabilities and the potential for successful experiment outcomes.	Implementation of new recommendations emerging from the Experiment Advisory Committee and Experiment Forum that generate continual improvements to SNOLAB's performance, value delivered to the research community and impact on world-class science discoveries and related outcomes.
Completion of deferred facility projects including the completion of the low background counting facility once additional research infrastructure requirements are identified.	Completion of the low background counting facility by 2019 with completion of the clean room extension by 2018.

Critical Success Factors

- Strong working relationship and consistent communication with project teams conducting research experiments at SNOLAB to ensure a strong understanding of current needs, opportunities and challenges;
- Close collaboration with the Canadian physics research community, including scientists, research institutions, universities, public and private funders and stakeholders, on the future direction of physics research and big science in Canada
- Access to the financial resources required to consistently enhance and expand the above ground and underground capabilities of SNOLAB

A.4.3 Strategic Goal Three: Educate, Inspire and Innovate

Goal: To enable broad economic impact for Canada and our surrounding region by educating and inspiring stakeholders through both public and professional outreach, developing highly qualified personnel and delivering innovation through small- and medium-scale enterprises.

Objective: To enable the development of highly qualified personnel, public and professional inspiration through outreach and to generate long-term economic and social benefits to our local, national and international communities.

SNOLAB Action	Target Outcomes
Contribute to community planning exercises and actively engage key stakeholders and partners to position and promote SNOLAB's research capabilities and infrastructure to target members of the scientific community.	Attraction of 25 new faculty to the SNOLAB research programme.
Work with local partners such as Laurentian University, the City of Sudbury and Science North to consistently contribute to, enhance and promote the region as an epicenter of world-class science, research opportunity and innovation.	Increased profile, influence opportunity and investment for the local Sudbury innovation ecosystem, including SNOLAB, Laurentian University, Science North and other local research centres such as the Centre of Excellence in Mining Innovation (CEMI) that address shared objectives.
Contribute to the development of new curricula at Canadian schools and Laurentian University and hands-on training opportunities at SNOLAB that facilitate the transfer of knowledge from supported experiments.	Expansion of the SNOLAB curricula delivered at Laurentian University; introduction of SNOLAB curricula at local schools; development of at least 250 highly qualified people by 2022 who have benefitted from SNOLAB; this includes Canadian and international researchers and students.
Explore the development of a sector-specific project (such as the Mining Observatory Data Control Centre) that could leverage SNOLAB capabilities and add value to an industry sector.	The novel application of new technologies, processes and discoveries emerging from SNOLAB-supported projects by industry.

SNOLAB Action	Target Outcomes
Host national and international conferences and workshops that showcase key Canadian research achievements and enabling capabilities provided by SNOLAB.	Host at least one international conference. Host two events per year that aim to address key needs of the research community and promote the ongoing development of a world-class science program at SNOLAB. Contribute to the development and training of new highly qualified personnel through SNOLAB sponsored collaboration meetings, worshops and community meetings.

Critical Success Factors

- The human resource capacity required to successfully execute key actions that fall outside of SNOLAB's direct core mandate to enable world-class physics research.
- Consistent engagement and collaboration with partners, leveraging of all available resources to implement these activities successfully; this includes Vale, SNOLAB-supported universities and researchers, members of the local community, fellow big science institutions and investors.
- Well-established and effective channels by which to access and facilitate collaboration with community members.
- Continued support from the Board of Directors, Committees and investors to undertake these activities.

A.4.4 Strategic Goal Four: Develop Delivery Systems of Internationally Recognized Standard

Goal: To continue to develop SNOLAB internal project and program management capacity to enable and optimize its impact on the effective and efficient design, development and implementation of science experiments and contribute to the achievement of research outcomes. This includes internationally recognized practices and processes to ensure efficient and effective governance, management of resources, the mitigation of key risks and exemplary quality and safety standards.

Objective: To ensure that SNOLAB continues to remain a safe and productive working environment with clear facility operational and management practices and well-defined interfaces into the science programme.

SNOLAB Action	Target Outcomes
Facilitate the incorporation of SNOLAB as a non-profit corporation to establish independent legal status for engagements with government agencies while retaining full connections to university partners through an Institute Council.	Incorporation of SNOLAB by summer 2018; realization of the associated benefits (including improved organizational agility and program flexibility) by SNOLAB. and the community
Further strengthen SNOLAB's project management capacity and capabilities to support successful scientific program delivery; help researchers design, develop and implement experiments on-time and on-budget with quality.	Continual improvement to the mitigation and management of experiment and research project risks at SNOLAB; achievement of at least 80 percent of defined milestones in experiment schedules (on-time and on-budget).
Continually improve the efficacy and impact of existing processes to ensure that SNOLAB is delivering the highest quality science in the safest and most expeditious ways possible, and attain ISO9001 and OHSAS18001 certifications.	Process improvements that consistently improve the timely and safe delivery of experiments; reduce risk; optimize scientific and operational resources; and accelerate scientific outcomes.
Implement a staff plan to support experimental requirements, proactively address key resource gaps and operational risk; ensure no single points of failure.	Hire 25 new employees within the next five years to continually strengthen the operational capacity of the organization and further enable the strategic activities of the Executive Director. This includes expanding the engineering and scientific support capabilities to augment the project management and technical excellence available at SNOLAB.

Critical Success Factors

- Alignment of all founding institutions and associated stakeholders on the objectives, implementation and operational changes incurred with SNOLAB's incorporation as a non-profit corporation
- Access to the highly skilled people required to expand the operational capacity of SNOLAB and the ability to recruit and retain this talent
- Strong working relationship and consistent communication with project teams conducting research experiments at SNOLAB to ensure a strong understanding of current needs, opportunities and challenges and to establish a constructive approach to project management that achieves the desired results

Part B **Organizational Development**

B.1 About SNOLAB

SNOLAB is an epicentre of global sub-atomic and astroparticle physics discovery, research and big science located 2 kilometres below the Earth's surface in the operational Vale Creighton nickel mine near Sudbury, Ontario, Canada. It is an expansion of the facilities constructed for the Sudbury Neutrino Observatory (SNO) solar neutrino experiment.

SNOLAB currently serves a growing community of scientists, researchers, students and collaborators across Canada and around the world. This includes researchers from 78 institutes from four Canadian provinces (Ontario, British Columbia, Alberta and Quebec) and 14 other countries. To date, SNOLAB has enabled training for more than 1,700 highly qualified personnel (HQP) such as Ph.D. students, M.Sc. students, scientists, post-doctoral fellows, technicians and engineers. This includes 1,246 Canadians; and 533 non-Canadians. These skilled personnel acquire hands-on experience and learning in SNOLAB-supported projects, and apply this knowledge to future positions in academia and industry.

The laboratory is operated under the auspices of the SNOLAB Institute whose founding member institutions include: Carleton University, Laurentian University, Queen's University, the University of Alberta and the Université de Montréal.

SNOLAB is governed by a Board with 13 Directors who hail from internationally recognized universities, research institutions, and industry. Under the leadership of Dr. Nigel Smith, Executive Director of SNOLAB, 102 full-time SNOLAB employees (when fully staffed) manage the daily operations of the laboratory.

From its inception to March 2016, SNOLAB received approximately $86 million in operational funding from the Province of Ontario through the Ministry of Research, Innovation and Science, the Ontario Innovation Trust (OIT) and the Northern Ontario Heritage Fund Corporation (NOHFC); from the Government of Canada through the Canada Foundation for Innovation (CFI), the Natural Sciences and Engineering Research Council (NSERC); and FedNor, a regional economic development organization in Ontario, for research infrastructure, capabilities and operations. SNOLAB has also benefited significantly from the contribution of its five founding partners and Vale, including; Carleton University; Queen's University; Laurentian University; the University of Alberta; and the Université de Montréal.

B.2 Environmental Analysis

SNOLAB within the Dynamic and Evolving Science Landscape

SNOLAB has continued to strengthen its position as one of the premier underground laboratories in the world. It is poised to increase its scientific leadership and contribution to fundamental research in sub-atomic particle physics and astrophysics. This includes the search for dark matter and study of neutrinos – prominent research quests around the world.

B.2.1 The Canadian Landscape

Canada's well established reputation and longstanding track record in physics research and discovery is anchored by:

- Top physics research talent who have made internationally recognized discoveries and led renowned and award-winning projects such as Dr. Arthur B. McDonald who received the Nobel Prize for Physics in 2015, and the Breakthrough Prize for Fundamental Physics in 2016; and Dr. David Sinclair, a professor of physics at Carleton University and senior scientist at TRIUMF who received the 2011 CAP-TRIUMF Vogt Medal for Contributions to Subatomic Physics for his exceptional vision and contributions to the study of neutrino physics in the pioneering SNO experiment, and for exemplary leadership in establishing the SNOLAB facility.
- World-class universities with leading-edge physics research programs and scientific outcomes. Sub-atomic physics researchers and scientists work at 31 Canadian universities and facilities. Canada's strong track record in physics research is among the key drivers for continued public investment in this scientific field.
- Internationally recognized research institutions such as TRIUMF, the Canadian Light Source, and SNOLAB make significant contributions to Canada's big science ecosystem, and provide researchers with access to the expertise, resources and support required to conduct leading-edge research in this globally competitive field. These organizations leverage critical investment from the federal, provincial and municipal governments, and the support of many other science, technology and innovation-based organizations.

The Canadian physics research community, including SNOLAB and the many researchers it serves, directly contribute to Canada's science ecosystem. Within the national fabric, SNOLAB continues to strengthen its collaboration with fellow research institutions such as TRIUMF and CLS, universities, funding agencies and scientists. This includes support for existing research teams and collaborations, and emerging physics research networks such as the Canadian Particle Astrophysics Research Centre (CPARC) established by Queen's University.

Increasing Canada's Physics Research Capacity and Intellectual Capital: The Canadian Particle Astrophysics Research Centre

In September 2016, Queen's University announced the receipt of $63.7 million from the Government of Canada's Canada First Research Excellence Fund to support the creation of the Canadian Particle Astrophysics Research Centre (CPARC). This new research centre will engage seven Canadian universities, and partner with five Canadian research institutions including SNOLAB. CPARC aims to:

- Expand on the scientific culture at Queen's University and partner institutions by building a powerful team working on all aspects of particle astrophysics;
- Extract maximum scientific output from the current suite of SNOLAB experiments by strengthening the scientific resources at Canadian universities and engaging the broader community in the undertaking;
- Create a research team with the ability to lead global-scale, next generation experiments and attract international collaboration; and
- Create opportunities to embed students at all stages of their careers in this scientific culture, developing skills and creating training opportunities through linkages to colleges, industries and international programs.

The funding will support 41 new positions for researchers, engineers, designers and technicians while supporting numerous graduate and postgraduate students. CPARC will expand the pool of Canadian physics research expertise, and enable more scientists to exploit and benefit from the unique capabilities offered by SNOLAB. This will help to facilitate a new generation of scientific discoveries.

These national linkages are essential to consistently enhance the research capabilities that differentiate Canada on the global science stage. These key relationships enable SNOLAB to:

- Execute a world-leading science program, with national and international collaborations, at the forefront of global research;
- Make educated decisions about the world-class infrastructure and capabilities required to achieve research objectives, maintain a leading-edge science program and laboratory; and maximize usage by researchers;
- Stay apprised of key research needs, opportunities and directions in the dynamic and competitive field of physics;
- Identify and help researchers to capitalize on new and unexpected opportunities in physics and other scientific disciplines; and
- Disseminate and promote key research findings to academia and other members of the research community.

SNOLAB contributed to the Canadian Sub-Atomic Physics Long-Range Plan developed with the Canadian subatomic physics community for 2017-2022, with a look ahead to 2026. Officially launched by the Natural Sciences and Engineering Research Council (NSERC), this process is driven by the Canadian subatomic physics community with contributions from a host of stakeholders across the country.

Given the broad mix of skills, long project timelines, and very costly resources that enable physics research, collaborative initiatives that bring together leading Canadian scientists, universities and research institutions are essential to keep Canada at the leading edge of this competitive field. This cooperation is required to advance fundamental science, facilitate new discoveries and create the next-generation of highly qualified scientists and professors.

SNOLAB welcomed the release of the "Review of Fundamental Science in Canada" report commissioned by Minister of Science, Kirsty Duncan. Minister Duncan convened a nine-member advisory panel to review the system of federal funding and support for research at universities, colleges, hospitals and other institutions that sit outside of government departments and agencies. The panel, led by former University of Toronto president David Naylor, received 1,275 written submissions including input from SNOLAB and met with 230 researchers at round tables in five major cities. The recommendations detailed in the report provide a framework for strengthening the coordination across the Canadian federal research structures, and for reinvigorating the foundations of Canadian research. SNOLAB welcomed the recommendations related to the development of robust coordination and oversight mechanisms for Major Science Facilities, and the development of a stable funding stream for research infrastructure. These recommendations serve to make an immediate and major impact, addressing future needs in the scientific landscape and ensuring Canadian research can maximise federal investments.

This creates a unique opportunity for SNOLAB, institutional research partners such as TRIUMF and CLS, universities and Canadian physics researchers more broadly to directly influence the future of big science and related investments in Canada.

B.2.2 The International Landscape

The global scientific landscape is highly dynamic and competitive with increasingly ambitious quests for scientific discovery. As new results emerge from the push toward higher energies at CERN, and more scientists contribute to the search for dark matter and dark energy, the global physics landscape and conduct of research is changing rapidly.

The underground science and research community continues to expand and evolve at a rapid rate. This drives increasing demand for the highly relevant research capabilities and expertise at SNOLAB. The infrastructure, technical and project management expertise and investment required to successfully conduct world-class physics research is becoming increasingly complex, diverse and costly. This is catalyzing the need for increased collaboration and aggregation of resources and capabilities across researchers, institutions, universities and countries. It is imperative that SNOLAB continue to increase its role within, and contribution to, national and international research collaborations, and help stimulate research cooperation that leverages collective resources and expertise. It is only through such collaboration that increasingly ambitious and grand scientific objectives can be achieved, and that research program gaps can be addressed.

SNOLAB has become a leading laboratory and research collaborator within a growing network of underground research facilities around the world. As the demand for underground scientific capabilities continues to increase, new facilities and expansions to existing sites are continuing emerge. The following matrix provides an overview of 13 global underground laboratories and associated attributes such as the status of construction, depth and size. As noted in this chart, SNOLAB is currently the second deepest underground laboratory in the world (behind the China Jinping Underground Laboratory or CJPL).

Overview of Underground Laboratories

Site	Depth (m)	Access (V or H)	Muon Flux (m/m2/s)	Radon (Bq/m3)	Cleanliness
Kamioka	1000	H	10^{-3}	80	Only in sectors
SNOLAB	2070	V	$3.1\ 10^{-6}$	130	2000 or better
LSC	850	H	$3\ 10^{-3}$	100	Only in sectors
CJPL	2400	H	$2\ 10^{-6}$	40	Only in sectors
SURF	1480	V	$5.3\ 10^{-5}$	300	3000
Gran Sasso	1400	H	$3\ 10^{-4}$	80	Only in sectors
CJPL-II	2400	H	$2\ 10^{-6}$	40	Only in sectors

Site	Depth (m)	Access (V or H)	Muon Flux (m/m2/s)	Radon (Bq/m3)	Cleanliness
Boulby	1100	V	$4\ 10^{-4}$	<3	10000
LSM	1400	H	$4.6\ 10^{-5}$	15	ISO9
LSC-CUNA	850	H	10^{-3}	100	Only in sectors
LBNF/SURF	1480	V	$5.3\ 10^{-5}$	300	3000
ANDES	1750	H	$5\ 10^{-5}$	-	-
Baksan	1550	H	$3\ 10^{-5}$	40	Only in sectors

The most common types of underground laboratories include:

- Cavities excavated within operational or dormant mines; and
- Cavities excavated within tunnels through mountains

Access to underground research facilities varies broadly. It is determined by a myriad of factors such as: the national or international nature of the laboratory; access protocols; experiment peer-review processes and criteria; experiment requirements (such as depth, cleanliness and shielding for a detector); funding and cost of operations. These elements influence decision-making on the ideal location of an underground experiment.

Over the last five years, SNOLAB has increased the visibility and influence of the laboratory both nationally and internationally. Working closely and collaboratively with its stakeholders, SNOLAB has continued to invest significantly in the global promotion of its research capabilities and expertise; the establishment of international linkages through networking and conferences; and contributing to global physics strategic planning activities. For example, over the last five years, SNOLAB:

- Hosted or contributed to many international workshops, conferences and lectures including the Global Science Forum and the Astrophysics International Forum;
- Engaged leading international funding agencies such as the US Department of Energy (DOE) and the National Science Foundation (NSF). This engagement contributed to the successful selection of SNOLAB as the host of the next phase of the SuperCDMS research project;
- Contributed to several global physics research strategic planning groups, exchanging information with many research communities, institutions and facilities; for example, SNOLAB contributed to the Particle Physics Projects Prioritization Panel (P5); and the Snowmass and Nuclear Science Advisory Group (NSAG); and
- Established and maintained the international Underground Lab Directors Forum with members from other deep underground facilities.

This positioning is becoming increasingly important as high profile physics research projects, such as the next generation Double Beta Decay Program, makes decisions about where to locate world-class experiments.

SNOLAB is also a driver for international collaboration within the global science arena. For example, it is collaborating with Italy's Gran Sasso National Laboratory on a framework for a coherent and coordinated world-wide development and operation of global research infrastructures. The outcomes of this initiative could form a blueprint for globally-shared research assets and resources, helping to maximize the utilization, investment and impact of these resources worldwide.

It is critical for SNOLAB to continue to exercise leadership with Canadian physics researchers and partners, and contribute to this evolving global scientific landscape. SNOLAB must continue to adopt an innovative and agile approach to its research programme to address the changing needs of scientists; respond to emerging opportunities; and continue to have impact within the global science community.

B.2.3 Overview of Existing and Planned Underground Science Laboratories

The following summaries are drawn from the websites or related communications materials from the profiled laboratories or their public investors.

[2] *http://www.sciencedirect.com/science/article/pii/S1875389214007317*

ANDES (Agua Negra Deep Experiment Site) is an underground laboratory, proposed to be built inside the Agua Negra road tunnel that will connect Chile (IV Region) with Argentina (San Juan Province) under the Andes Mountains. The Laboratory will be 1750 meters under the rock, becoming the 3rd deepest underground laboratory of this kind in the world, and the first in the Southern Hemisphere. ANDES will be an international Laboratory, managed by a Latin American consortium, and it will host experiments in particle and astroparticle physics, such as neutrino and dark matter searches, seismology, geology, geophysics and biology[2].

Baksan Neutrino Observatory (BNO) is a scientific laboratory of INR RAS located in the Baksan River gorge in the Caucasus mountains in Russia. It started operations in 1977, becoming the first such observatory in the USSR. It consists of the Baksan Underground Scintillation Telescope, located 300m below the surface, a gallium–germanium neutrino telescope (the Soviet–American Gallium Experiment, SAGE) located 3,500m deep, as well as a number of ground facilities.

Boulby Underground Laboratory, the UK's deep underground science facility, is located 1100 metres below ground in the Boulby Mine on the North East coast of England. Studies underway at Boulby range from the search for dark matter in the universe, to studies of cosmic rays and climate, astrobiology and life in extreme environments, development of techniques for deep 3D geological monitoring and studies of radioactivity in the environment.

Canfranc Underground Laboratory (LSC) is an underground scientific facility located in the former railway Tunnel of Somport in the Spanish Pyrenees under Monte Tobazo in Canfranc, Spain. The laboratory is mainly devoted to study rarely occurring natural

phenomena such as the interactions of neutrinos or dark matter.

China Jinping Underground Laboratory (CJPL) is a deep underground laboratory located in Sichuan, China. The laboratory is owned by the YaLong River Hydropower Development Company, and managed by Tsinghua University, China. There are two projects operating at the CJPL: The Chinese Dark Matter Experiment (CDEX) led by Tsinghua University, and the dark matter project PandaX with liquid xenon detector led by Shanghai Jiaotong University.

Gran Sasso National Laboratory (LNGS) is one of the four national laboratories within Italy's National Institute for Nuclear Physics (INFN). It conducts theoretical and experimental research in the fields of subnuclear, nuclear and astroparticle physics. It is the largest of the underground laboratories, and hosts a very broad scientific programme.

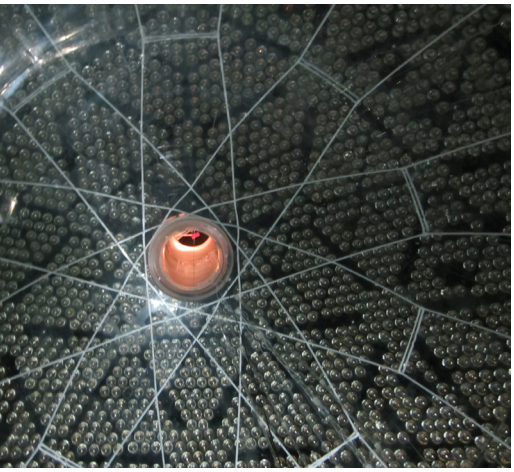
The India-based Neutrino Observatory (INO) is a proposed particle physics research project to primarily study atmospheric neutrinos in a 1,300 meter (4,300 foot) deep cave under Ino Peak near Theni, Tamil Nadu, India. This project is expected to provide a precise measurement of neutrino mixing parameters. The project is a multi-institute collaboration and one of the biggest experimental particle physics projects undertaken in India.

Kamioka Observatory is a premier physics laboratory located underground in the Mozumi Mine of the Kamioka Mining and Smelting Co. near the Kamioka section of the city of Hida in Gifu Prefecture, Japan. Kamioka Observatory is currently host to the Super-K, Kamland-Zen, XMASS and KAGRA experiments.

The Modane Underground Laboratory (LSM) is a subterranean particle physics laboratory located within the Fréjus Road Tunnel near Modane, France. It is jointly operated by the French National Center for Scientific Research and the Atomic Energy and Alternative Energies Commission in partnership with the University of Savoie.

The Sanford Underground Research Facility (SURF) located in Lead, South Dakota aims to enable compelling underground, interdisciplinary research in a safe work environment and to inspire the next generation through science, technology, engineering, and math education. SURF will house critical infrastructure for the Deep Underground Neutrino Experiment (DUNE) and The Long-Baseline Neutrino Facility (LBNF). The LBNF is an internationally designed, coordinated, and funded programme comprising the world's highest intensity neutrino beam and will be located at Fermilab. The infrastructure necessary to support the massive cryogenic detectors will be installed deep underground at SURF.

B.3 Comprehensive Review of Current and Near-Term Experiments



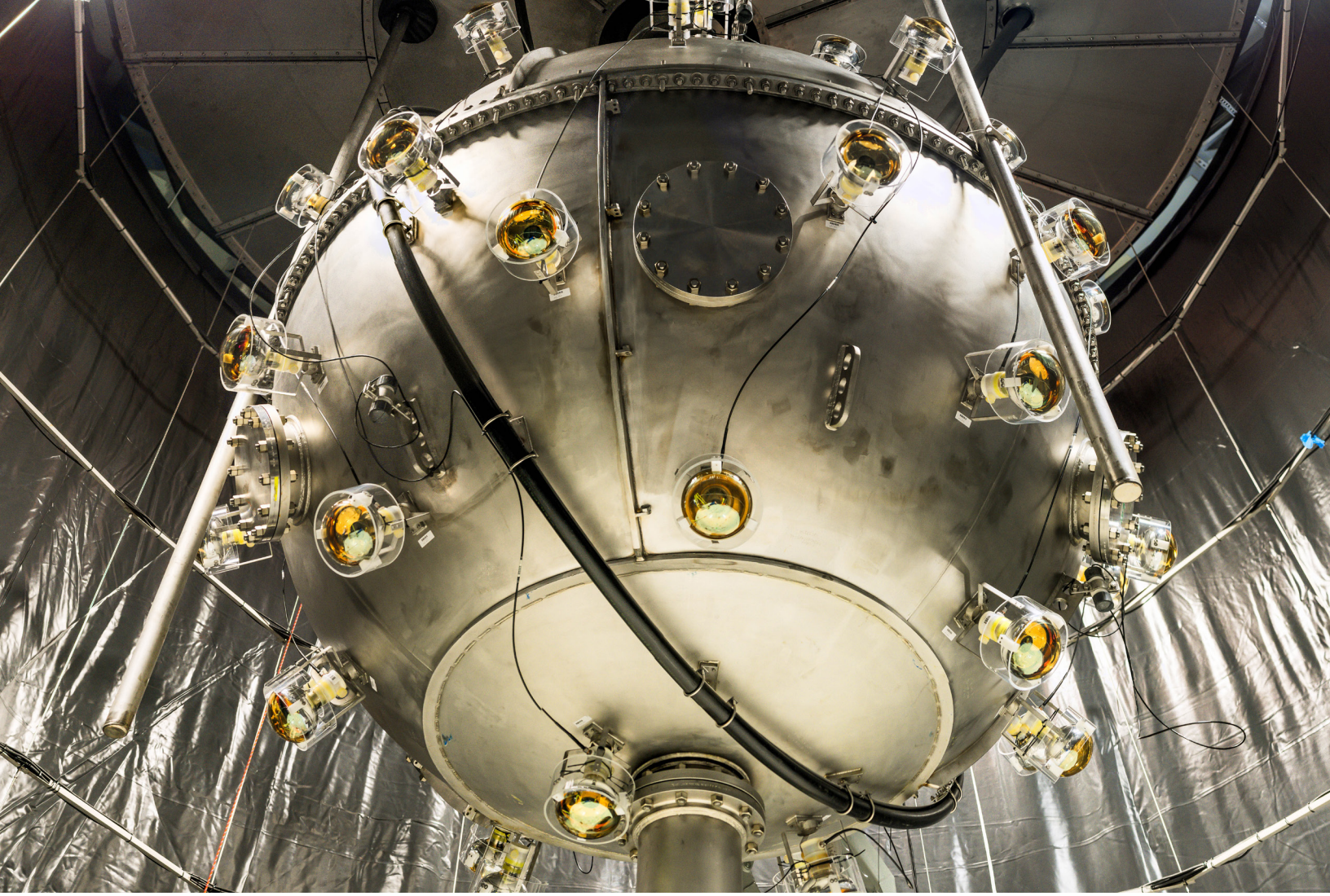
SNO+

About SNO+: SNO+ uses the existing SNO detector to study neutrinos and neutrinoless double beta decay. uses liquid scintillator to study low energy solar neutrinos, geoneutrinos, and reactor neutrinos, as well as conduct a supernova search. SNO+ will also add tellurium to search for neutrinoless double beta decay. The heart of the SNO+ detector will be a 12m diameter acrylic sphere filled with 800 tonnes of liquid scintillator, surrounded by 10,000 photomultiplier tubes. The acrylic sphere, PMTs, and PMT support structure are being reused from the SNO experiment.

Liquid scintillator is an organic liquid that gives off light when charge particles pass through it. neutrinos interact with electrons and nuclei in the detector, produc charged particles which, in turn, create light as they pass through the scintillator. The flash of light is then detected by the PMT array.

Collaborating institutions:

- University of Alberta
- Armstrong Atlantic State University
- University of California, Berkeley
- Black Hills State University
- Brookhaven National Laboratory
- University of California, Davis
- University of Chicago
- Dresden University of Technology
- Laurentian University
- LIP Lisbon and Coimbra
- University of Lancaster
- University of Liverpool
- University of North Carolina at Chapel Hill
- Oxford University
- University of Pennsylvania
- Queen Mary, University of London
- Queen's University at Kingston
- SNOLAB;
- University of Sheffield;
- University of Sussex
- TRIUMF
- University of Washington.



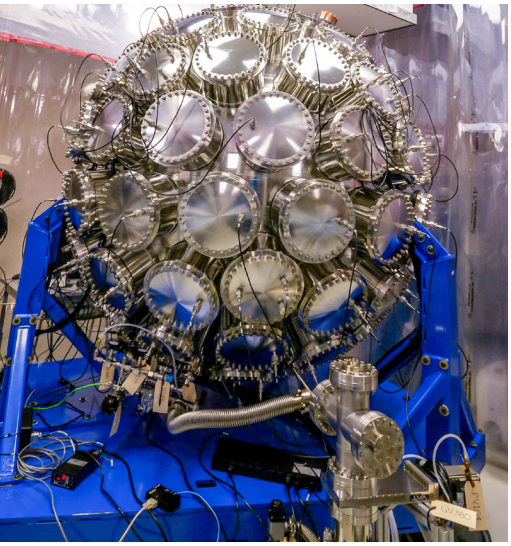
DEAP-3600

About DEAP-3600: DEAP-3600 is a novel detector for the direct detection of dark matter using liquid argon as its target. Argon is used because any interaction in it creates scintillation light that can be recorded by photomultipliers.

The target liquid is maintained at -270 degrees Celsius 266 photomultiplier tubes surrounding the vessel cannot operate at temperature, so light guides made of the cleanest acrylic are used to create a temperature gradient that the scintillation light can pass through.

Collaborating institutions:

- University of Alberta, Canadian
- Nuclear Laboratories
- Carleton University
- Laurentian University
- National Autonomous University of Mexico
- Queen's University
- Royal Holloway University of London
- Rutherford Appleton Laboratory
- SNOLAB
- TRIUMF
- University of Sussex



MiniCLEAN: Dark Matter

About MiniCLEAN: MiniCLEAN is a dark matter experiment searching for WIMPs using 500 kg of liquid argon. The detector uses 92 sensitive phototdetectors to look for flashes of light from WIMPs hitting the liquid argon. The acrylic light guides are coated with a wavelength shifter to the scintillation light to visible light that can be recorded by the PMTs. To differentiate between WIMP recoils from electronic recoils, MiniCLEAN uses pulse shape discrimination.

Collaborating institutions:

- Boston University
- University of California(Berkeley)
- Los Alamos National Laboratory
- Massachusetts Institute of Technology
- National Institute of Standards and Technology (Boulder, Colorado)
- University of New Mexico
- University of North Carolina
- University of Pennsylvania
- University of London
- SNOLAB
- University of South Dakota
- Syracuse University
- Yale University

PICO

About PICO: PICO uses bubble chamberto detect dark matter. The PICO collaboration designed a new bubble chamber technology for dark matter searches eliminates the need for a buffer liquid, which was adding background in earlier iterations.

The detector uses the target fluid in a superheated state, so that a dark matter particle interaction with a fluorine nucleus causes the fluid to boil and creates a tell-tale bubble.

Collaborating institutions:

- University of Alberta
- University of Chicago
- Czech Technical University
- Fermilab
- Indiana University South Bend
- Kavli Institute for Cosmological Physics
- Laurentian University
- Université de Montréal
- Northwestern University
- Universidad Nacional Autonoma de Mexico
- Pacific Northwest National Laboratory
- Queen's University at Kingston
- Saha Institute of Nuclear Physics, India
- SNOLAB
- University of Toronto
- Universitat Politecnica de Valencia
- Virginia Tech

HALO

About HALO: About HALO: HALO is a dedicated supernova neutrino detector. It was designed to be long term, low cost, high live time, and low maintenance. It uses 79 tonnes of annular lead blocks instrumented with 128 tubular helium-3 neutron detectors to identify neutrinos from supernovae within our galaxy. The lead for HALO was obtained from a decommissioned cosmic ray station in Deep River, Ontario and re-used in its original form. The neutron detectors for HALO are the 3He detectors from the 3rd phase of SNO. As part of the worldwide Supernova Early Warning System (SNEWS), it helps detect supernovae their neutrino burst before their light reaches earth, allowing astronomers to be notified in time to observe the light. HALO's data will contribute the unravelling the supernova neutrinos signal and extracting physics from the next galactic supernova.

Collaborating institutions:

- Armstrong Atlantic State University
- Center for Experimental Nuclear Physics and Astrophysics at the University of Washington
- Digipen Institute of Technology
- Duke University
- Laurentian University
- Los Alamos National Laboratory
- Technische Universität Dresden
- TRIUMF
- University of Minnesota Duluth
- University of North Carolina
- SNOLAB

DAMIC

About DAMIC: The DAMIC (Dark Matter In CCDs) experiment employs a new technique for searching for the elusive particles that we think make up most of the matter in the universe—dark matter. DAMIC uses charged coupled devices—the CCDs that have been used for many years in digital cameras, but these are not your average CCDs. They are the high-tech ones also used in the Dark Energy Camera, which Fermilab installed on the Blanco telescope in Chile. The detectors were developed and fabricated at Berkeley Lab and were tested and installed in the camera at Fermilab. They are unusually thick (250 microns instead of the usual 30) and have low intrinsic noise levels, making them ideal for the long exposure times needed to search for the rare interactions expected for dark-matter particles.

Collaborating institutions:

- Facultad de Ingenieria
- Universidad Nacional de Asuncion (Paraguay)
- CNEA/CONICET
- Centro Atomico Bariloche (Argentina)
- Enrico Fermi Institute
- University of Chicago
- Fermilab
- Kavli Institute for Cosmological Physics
- Universidad Nacional Autonoma de Mexico
- University of Michigan
- University of Zurich

MODCC: Mining Innovation

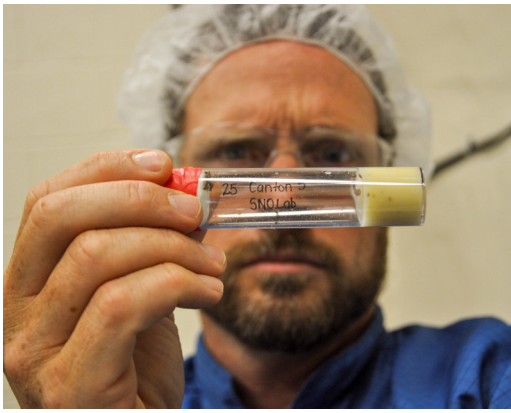
About MODCC: The global mineral industry collects data constantly for the purpose of decision making on issues, but mining industry datasets remain segmented, under-utilized, and, at times, unreliable. There is no universally accepted data collection or storage format and no easy way to integrate data sets from different sources. In addition, data takes up an incredible amount of space on servers and, as a result, it is common practice to discard it after a set period of time. These data sets are important to researchers seeking to help the mineral community understand how to find ore bodies, as well as better understand existing ones through studies relating to their rock mass quality, stability, type and composition.

The creation of a co-located MODCC (Mining Observatory Data Control Centre) will capitalize on existing data integration and sharing expertise at SNOLAB as well as the significant investments already made in the deep underground facility there. Streaming data that will originate from sensor arrays in operating mines will eventually be assessed in real-time, thereby making the MODCC a "living data centre". The MODCC will be a powerful user – and data – interpretation interface that searches, collects, filters and analyzes mining/exploration related datasets. The result will be a data processing facility with accessibility and capability unlike anything currently available to mining/exploration companies and researchers anywhere in the world.

Collaborating institutions:

- SNOLAB
- Mira GeoScience
- Objectivity
- Vale
- Sudbury Integrated Nickel Operations: A Glencore Company
- Rio Tinto
- Canadian Mining Innovation Council (CMIC)
- Northern Ontario Heritage Fund (NOHFC)

FLAME

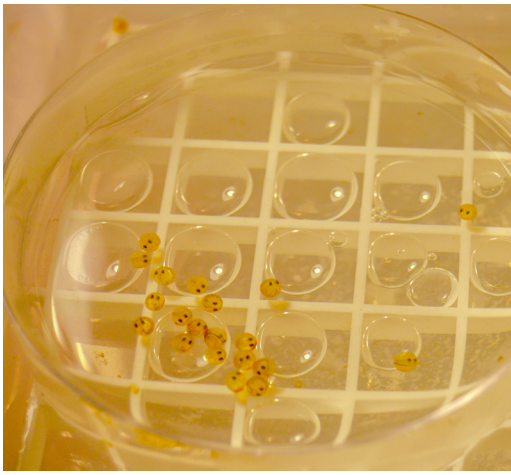


About FLAME: FLAME uses fruit flies to study metabolic changes that happen when spending time underground. The pressure in SNOLAB is about 20% than on surface, and flies are used as a model to examine the effects of long-term exposure to increased pressure. By examining the changes to individual metabolites in the fruit flies, it may be possible to learn more about the health impacts on humans that come with working underground for extended periods of time.

Collaborating institutions:

- SNOLAB
- Laurentian University

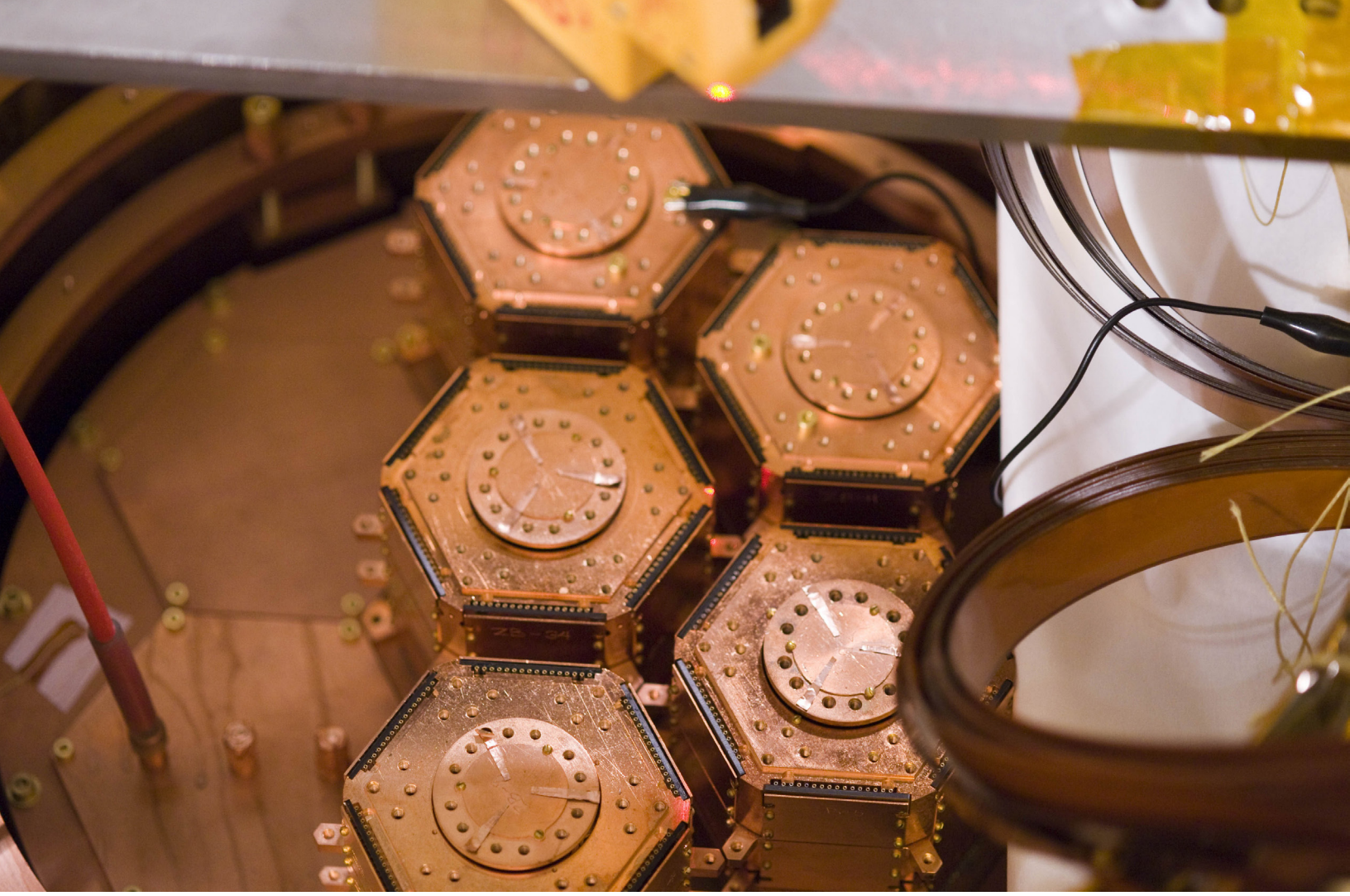
REPAIR



About REPAIR: REPAIR uses whitefish embryos to study development in an environment devoid of the background radiation ever-present on earth's surface. Biologists have hypothesized that through evolution, life on earth may have adapted to the presence of this radiation to the point that removing it may be detrimental to development. REPAIR compares whitefish that develop in SNOLAB with those that develop on earth's surface to determine, what, if any, differences result from the difference in background levels.

Collaborating institutions:

- Northern Ontario School of Medicine



SuperCDMS SNOLAB

About SuperCDMS SNOLAB: The CDMS collaboration has pioneered the use of low-temperature solid state detectors to search for dark matter. This technology provides excellent background rejection, detailed information on each interaction, and very low energy thresholds. This allows unparalleled sensitivity especially to dark matter particles with small masses.

Collaborating institutions:

- California Institute of Technology
- Durham University
- Fermilab National Accelerator Laboratory
- National Institute of Science Education and Research
- Northwestern University
- Pacific Northwest National Laboratory
- Queen's University
- Santa Clara University
- SLAC National Accelerator Laboratory
- South Dakota School of Mines and Technology
- Southern Methodist University
- SNOLAB
- Stanford University
- Syracuse University
- Texas A&M
- University of British Columbia
- University of California Berkeley
- University of Colorado Denver
- University of Evansville
- University of Florida
- University of Minnesota
- Université de Montréal
- University of South Dakota
- University of Toronto

CUTE

About CUTE: CUTE is a well-shielded cryogenic underground test facility. It will be installed at SNOLAB to conduct performance tests, calibrations, and background measurements with cryogenic dark matter detectors in support and preparation for the installation of CDMS-SNOLAB. The facility's main components will be a cryogen-free dilution refrigerator mounted in a drywell, in the centre of a shielding water tank. Additional lead and polyethylene shielding will be installed to further reduce background levels.

CUTE will also offer the opportunity for the European Underground Rare Event Calorimeter Array (EURECA) to test detector designs for their cryogenic dark matter searches with the CDMS-SNOLAB infrastructure. This creates the possibility of bringing EURECA detectors into CDMS-SNOLAB.

Lead institution:

- Queen's University
- Centre national de la recherche scientifique
- SNOLAB

NEWS

About NEWS: NEWS is a network of physicists interested in developing gaseous spherical detectors for multiple particle detection applications. The sphere is made of copper and surrounded by two shields. The inner part of the Compact Lead shield is cast from archeological lead, and the outer part is made from low activity lead. Each piece of the lead shield has a stainless steel skin used as a support. The whole system is sitting in a high-density polyethylene (HDPE) shield to thermalize and capture the neutrons.These types of detectors have low capacitance, low thresholds, excellent energy resolution, single readout channel capability, low cost, robustness, and flexibility in gas choice and pressure. This versatile technology could be applied to dark matter searches, neutrino scattering studies, double beta decay searches, and gamma ray and neutron spectroscopy.A prototype already exists, and the next goal for the NEWS collaboration is to build a 1.4 m diameter spherical detector to increase the physics reach in the GeV and sub Ge-V range using very light nuclei targets.

Collaborating institutions:

- Queen's University
- Institut de Recherche sur les Lois Fondamentales de L'Univers (IRFU)/CEA SACLAY
- Laboratoire Souterrain de Modane (LSM)/IN2P3/University of Chambery
- Aristotle University of Thessaloniki
- Laboratoire de Physique Subatomique et de Cosmologie (LPSC Grenoble)
- Pacific Northwest National Laboratory
- Royal Military College of Canada
- SNOLAB
- University of Birmingham
- TRIUMF

B.4 SNOLAB Progress and Achievements

(Left to right): *John Pollesel, Glenn Thibeault, Dr. Nigel Smith, and Professor Stephen Hawking at SNOLAB in 2012.*

B.4.1 SNOLAB Enables Scientists to Chart New Frontiers

Since its official launch in 2012, SNOLAB has continued to establish the underground laboratory as the location of choice for global sub-atomic and astroparticle physics discovery, research and big science with specialization in neutrino and dark matter research.

The laboratory enjoyed an inspirational visit by Dr. Stephen Hawking in September of 2012. Professor Hawking is a world-renowned theoretical physicist. His work on the origins and structure of the universe, from the Big Bang to black holes, has revolutionized the field, while his best-selling books have appealed to readers who may not have scientific background.

In 2015, the Royal Swedish Academy of Sciences awarded the Nobel Prize in Physics to SNOLAB's Dr. Arthur McDonald (Queen's University) alongside Dr. Takaaki Kajita of Japan for key contributions to the experiments demonstrating that neutrinos change flavours. The discovery led to the far-reaching conclusion that neutrinos, which for a long time were considered massless, must have mass. It was a historic discovery in the field of particle physics.

Dr. McDonald was later elected to the National Academy of Sciences (NAS) in the United States for his research on neutrino oscillations. He is one of only 18 Canadians to be named a Foreign Associate of the Academy. Established under a congressional charter signed by President Abraham Lincoln in 1863, the NAS recognizes achievement in science and provides science, technology and health policy advice to the US federal government and other organizations.

The 2016 Breakthrough Prize was presented "for the fundamental discovery of neutrino oscillations, revealing a new frontier beyond, and possibly far beyond, the standard model of particle physics" to Dr. Art McDonald and the SNO Collaboration at a ceremony at the NASA Ames Research Centre in Moffett Field, California. The ceremony, hosted by comedian Seth MacFarlane, was broadcast live in the U.S. The $ 3 million prize was shared with four other international experimental collaborations studying neutrino oscillations: The Superkamiokande, Kamland, T2K/K2K and Daya Bay scientific collaborations.

Building on these and other achievements, SNOLAB increasingly serves as a magnet for top scientific talent, attracting highly sought after physics researchers from around the world. Dr. Gilles Gerbier, a world-renowned expert in astroparticle physics joined the SNOLAB programme; a Canada Excellence Research Chair in Astroparticle Physics based at Queen's University and former Director of the Modane Underground Laboratory in France, Dr. Gerbier brought a wealth of experience and expertise in dark matter research and underground science.

In the summer of 2016, SNOLAB participated in the XXVII International Conference on Neutrino Physics and Astrophysics (Neutrino 2016) and showcased SNO and SNOLAB science at Canada House, in Trafalgar Square in London. The interactive exhibit highlights the Nobel Prize winning results from SNO and the current experiments underway at SNOLAB. Following the initial showcase at Canada House the exhibit will travel internationally demonstrating the capabilities of the world-class research community flourishing in Sudbury.

Dr. Gilles Gerbier.
Photo Credit:
Kingston Whig Standard

B.4.2 Benefits to Canada

B.4.2.1 Economic Benefits

KPMG conducted an assessment of SNOLAB's economic impact on the Province of Ontario, and Canada more broadly, and published the results in March 2016. Based on economic impact models developed by Statistics Canada, the total (gross) economic activity generated by SNOLAB in Ontario and Canada over the past three years, and forecasted over the next five years, is estimated to be in the order of $359 million. As outlined in the tables below, this represents a contribution of:

- $159 million to Ontario's gross domestic product (GDP); and
- $176.5 million to Canada's GDP.

Gross Output	Ontario	National Total
Direct economic impact	$154.2 million	$154.2 million
Indirect economic impact	$99.8 million	$99.8 million
Induced economic impact	$71.6 million	$71.6 million
Total economic impact	$325.6 million	$325.6 million

Value Added (GDP Impact)	Ontario	National Total
Direct economic impact	$58.6 million	$58.9 million
Indirect economic impact	$57.7 million	$66.1 million
Induced economic impact	$42.5 million	$51.5 million
Total economic impact	$159.1 million	$176.5 million

Employment (Full-time Equivalent Years)	Ontario	National Total
Direct economic impact	754	754
Indirect economic impact	568	649
Induced economic impact	395	483
Total economic impact	1,717	1,886

Source: KPMG analysis of Statistics Canada Input-Output Models

This impact translates into a host of economic and social benefits for Sudbury 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.

B.4.2.2 Bolstering Canada's Reputation and Profile as an International Leader in Science

Since its inception, SNOLAB has bolstered Canada's reputation and profile as an international leader in science. This is underscored by SNOLAB's association with the Nobel and Breakthrough Prizes awarded to Dr. Arthur McDonald for the SNO Project, and the substantial interest in the SNOLAB program from the international research community and media.

Moreover, in 2012, the Council of Canadian Academies (CCA) published The State of Science and Technology in Canada, 2012. The findings of the report ranked Canada as a world leader in nuclear and particle physics and the report expands upon the rationale behind Canada's ranking noting Canada gains its advantage from four facilities: Canadian Light Source (CLS), TRIUMF, the Perimeter Institute for Theoretical Physics and SNOLAB.

B.4.2.3 Knowledge Transfer

SNOLAB facilitates the transfer of knowledge acquired through the laboratory and supporting activities with universities, fellow research institutions, innovation-based organizations and community partners. For example, SNOLAB:

- Directly contributed to the fulfilment of key objectives established by the International Joint Venture Fund managed by the Canada Foundation for Innovation (CFI); this includes the attraction of the second generation SuperCDMS Project to SNOLAB
- Mobilizes and distributes knowledge acquired through supported projects to international partners, national institutes and experiments. For example, the DAMIC project has two patents in process (as of August 2016); SNOLAB has connected IP through the Advanced Applied Physics Solutions (AAPS), the nationally designated Centre of Excellence for Commercialization and Research established at TRIUMF; and
- Collaborates directly with the Centre of Excellence in Mining Innovation (CEMI) and the mining community on the Mining Observatory Data Control Centre which will generate and apply new data and processes that help to improve the productivity of this important Canadian industry; this initiative has the potential to be replicated for genomics research.

B.4.2.4 Enabling the Development of Highly Qualified People

SNOLAB has achieved a substantial increase in the highly qualified people trained to work underground, exceeding original targets proposed in the initial SNOLAB Strategic Plan (2011 - 2016). The 488 highly qualified personnel trained by SNOLAB in 2016 includes:

- 210 Canadians; and
- 278 Non-Canadians.

The following demographic breakdown of the SNOLAB user base highlights the evolution of this community over the last five years.

Location	No. of Institutes in 2016	Type of Personnel	August 2011	March 2016
USA	37	Research	60	81
		HQP*	65	112
Canada	15	Research	30	40
		HQP	81	146
		SNOLAB	**48**	**54**
Europe (UK, Portugal, Czech Republic, Germany, France, Spain, Switzerland)	17	Research	14	28
		HQP	1	38
Asia	3	Research	60	81
		HQP	65	112
Central/South America (Mexico, Brazil, Argentina, Paraguay)	6	Research	0	11
Total	78	Research	106	164
		HQP	197	354

**HQP or Highly Qualified Personnel include students, post-doctoral fellows, technical and other professional personnel.*

SNOLAB also directly contributes to the attraction of international research talent in physics to Canada. As an example, SNOLAB has contributed to the recruitment of global researchers to the Canada Excellence Research Chairs (CERC) Program at Queen's University, and supports the Tier 1 and 2 Canada Research Chairs in Physics across the country. It also facilitates strong professional development and related outreach through the Canadian Association of Physicists (CAP) and TRISEP, the tri-institute summer school on elementary physics. These initiatives directly contribute to the development of Canada's next generation of physics research talent.

B.4.2.5 Future Applications of SNOLAB-Enabled Innovations

SNOLAB enables research that will accrue benefits in the future. These include technology developments in high efficiency photon sensors that are expected to have application in medical imaging, national security and public safety solutions. These advancements are also expected to facilitate the development of low background techniques that enhance medical and environmental remediation studies.

SNOLAB-supported initiatives such as the Mining Observatory Data Control Centre (MODCC) will deliver direct benefits to the Canadian mining industry by stimulating innovation in mine development and production efficiency by fostering the development of new research and innovation threads in local Small and Medium Enterprises. Downstream, the application of these novel technologies will enhance the productivity of Canadian mining operations and support job creation.

B.4.3 Governance

Over the last five years, the original SNO governance structure has evolved significantly from an international collaboration working on an experiment to a fully operational underground laboratory and scientific facility that supports multiple world-leading physics research projects. Working closely with Directors, investors and other key stakeholders, SNOLAB:

- Established a new constitution that came into effect on February 1, 2013;
- Created a new governance structure based on a more corporate model and approach to establish a solid foundation for SNOLAB's future incorporation as a not-for-profit corporation;
  - Formed an Institute Council that appoints the Board of Directors; the council is comprised of representatives of the five Canadian University trustees and meets bi-annually to address strategic governance opportunities and matters;
- Further defined and bolstered the capabilities of the Board of Directors, which appoints the Executive Director of SNOLAB, and meets on a quarterly basis;

- Led by Dr. Carl Svensson, University of Guelph, the Board is currently comprised of 13 members, including five leaders from the post-secondary community, one leader from Vale and seven independent representatives from the national and international stakeholder community;
- The Board of Directors has played a significant role in the development of this Strategic Plan for 2017 to 2022 and actively participates in the annual planning process orchestrated by SNOLAB; and
- The Board has also established sub-committees to bolster oversight in key areas of SNOLAB operations; these include the Finance and Audit Sub-Committee, Governance Committee and Science and Technical Review Sub-Committee.

B.4.4 Progress Against Strategic Plan Objectives (2011-2016)

This section aims to provide SNOLAB stakeholders with a high-level overview of progress against Strategic Plan Objectives from 2011 to 2016.

Progress Against Strategic Plan Objectives (2011-2016)

1 - Enable and Spearhead World-Class Underground Science

Critical Success Factors

- ✔ Engage with the SNOLAB Experiments Forum to determine the level of 'user satisfaction' with the science delivery at SNOLAB;
- ✔ Maintain metrics associated with facility planning and milestone delivery for experimental infrastructure – such as number, timescale and quality;
- ✔ Maintain metrics associated with the user base size, science program delivery through program size, cost and impact, space and resource utilization and outreach engagement metrics.

Overview of Progress and Outcomes

Achieved substantial progress on construction of projects

- ✔ Imminent physics data taking for the DEAP/MiniCLEAN projects.
- ✔ SNO+ LAB process plant close to operation.
- ✔ Te plant being specified.
- ✔ SNO+ project water-filling again and taking data.
- ✔ COUPP detectors constructed and operated. These detectors led to world-leading results.
- ✔ PICASSO project relocated, executed and decommissioned; this project generated world-leading results.
- ✔ The PICASSO/COUPP merger led to the creation of PICO which arrived at SNOLAB; installed and executed; this project is generating new world-leading results.

- DAMIC project approved, constructed, and operating; this project is generating new results.
- HALO project main construction completed; the project is now live and underway.
- SuperCDMS project selected as a second generation dark matter detector within the U.S.
- CUTE project development underway.
- NEWS-G project specifications well advanced.

Initial science program already delivering world-leading results

- PICASSO/COUPP/PICO project spin-dependent dark matter limits in 2012, 2015, 2016.
- New results from the DAMIC project.

Broadening of science program from traditional deep underground science

- Completion of the infrastructure for the Mining Observatory Data Control Centre (MODCC).
- Genomics projects operational and underway; these include the REPAIR (Researching the Effects of the Presence and Absence of Ionizing Radiation) Project which studies the effects of ultra low background radiation on biological systems using whitefish embryonic development as a model, and the FLAME project studying metabolism effects at depth using fruit flies as a model.

Fostering collaboration between research teams

- This includes the merger of the PICASSO and COUPP projects into the PICO project.

Engagement of science teams through the SNOLAB Experiment Forum (SEF) and user groups

- Biannual SEF meetings held, specifying experiment requirements and needs.
- Major projects fortnightly or weekly meetings conducted.
- Strengthened process and feedback systems for the SEF.

Strengthened oversight of program by Experiment Advisory Committee

- Meets bi-annually.
- Provides updates to Board of Directors (when requested) .
- Tracks and monitors recommendations between meetings.

2 - Develop and Maintain World-Class Facilities and Infrastructure

Critical Success Factors

- Determine, through the SNOLAB Experiments Forum, the level of 'user satisfaction' with the facilities at SNOLAB.
- Maintain metrics associated with facility planning and milestone delivery for experimental infrastructure, including rapid development.
- R&D and prototyping projects – such as number, timescale and quality; assess the usage of the SNOLAB facility infrastructures by maintaining metrics on the space utilization at SNOLAB, the level of interest through letters of intent and approaches and the scale of the user community.

Overview of Progress and Outcomes

Substantial projects completed

- Underground facility now contiguous and operational.
- Life safety systems implemented throughout occupied areas.
- Extensive experiment support infrastructure completed.
- Underground machine shop established.
- Emergency systems implemented throughout lab and external drifts.
- Enhanced surface capabilities with third floor refurbishment completed for the Mining Observatory Data Control Centre (MODCC).
- IT systems upgrades include new fibre run and telecommunications systems.

3 - Educate, Inspire and Innovate

Critical Success Factors

- Maintain metrics associated with outreach opportunities, such as the scale and breadth of the engaged audience, the number of events and workshops.
- Maintain metrics associated with highly qualified personnel, such as student numbers, academic progression, awards, fellowships, keynote and conference organization.
- Develop new linkages to the local mining innovation community, and maintain metrics of direct economic impact to the region.

Overview of Progress and Outcomes

Multiple media interactions

- Significant media coverage of the Nobel Prize including PBS news-hour, BBC, CTV, CBC, Globe and Mail, Toronto Star.
- Grand Opening on May 17, 2012 followed by a visit from Dr. Stephen Hawking in September 2012.

Overview of Progress and Outcomes Continued

Local community engagement

- Collaborative development of physics exhibits with Science North (Sudbury's local science centre); this includes the SNOLAB display that attracts more than 125,000 visitors per year.
- Science North CEO sitting on the SNOLAB Board of Directors.
- Award-winning object theatre enjoyed by 12,300 visitors during the first 18 months.
- Establishment of a cloud chamber with the City of Sudbury and Laurentian University.

Education

- Contributing to Ontario high school curricula with information packs delivered to more than 1,000 students at Northern Ontario schools .
- Facilitating educational connections through universities; the Perimeter Institute (through the annual International Summer School for Young Physicists tour to SNOLAB); the Deep River Science Academy; the TRISEP summer school; and the Canadian Association of Physicists (CAP).

4 - Develop Systems of Internationally Recognized Standard

Critical Success Factors

- Reconstruction of the financial and budgetary control by summer 2011.
- Complete all experiment MoU and agreements for the current program and have them in place by the end of 2011.
- Ensure experiment Project Implementation Plans are completed on a timescale commensurate with deployment and, for the currently deployed projects, ensure required components are in place by the time of readiness reviews.
- Achieve ISO9001 and OSHA18001 accreditation by the end of 2013.

Overview of Progress and Outcomes

Community Engagement

- Established user groups and forums and future projects planning processes

Environment, Health and Safety

- Overhauled hazard management policies, emergency response process and Material Safety Data Sheet (MSDS/SDS)/Chemical programmes

Environment, Health and Safety

- Developing robust quality systems aiming for Occupational Safety and Health Administration (OSHA) and ISO accreditation

- ✔ Established, documented and managed almost 500 policies loaded in the last two years.
- ✔ Implemented non-conformance management system.

Enhanced Financial Management, Procurement, Human Resource and IT Processes, Services and Infrastructure

Improved Risk and Hazard Analyses

- ✔ Established a Project Risk Register and extensive Facility Hazard Framework that is maintained by SNOLAB; this includes the conduct of monthly reviews and re-evaluation with Risk Group.

B.5 Looking Ahead

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

This vision is anchored the four key strategic goals that underpin SNOLAB's inaugural strategic plan, and will guide the next five years of SNOLAB's evolution:

- Enable and spearhead world-class underground science
- Develop and maintain world-class facilities and infrastructure
- Educate, inspire and innovate
- Develop quality delivery systems of internationally recognized standard

The strategic plan and implementation plan for 2017 - 2022 will guide SNOLAB's collaborative and coordinated action with the scientific community to further realize these goals. Over the next five years, SNOLAB will:

- Remain at the forefront of sub-atomic and astroparticle physics by delivering world-class science and demonstrating scientific leadership through its increased contribution to global experiments and the achievement of scientific outcomes; this includes the development of a new long-term plan for SNOLAB beyond 2022;
- Develop, attract and retain some of the most brilliant research minds and physics experiments from around the world that leverage the depth, cleanliness and capabilities provided by SNOLAB;
- Play a pivotal role in bringing the Canadian particle astrophysics research community to define its vision for the future; this may include consolidation around a single technology and next-generation experiments in dark matter and double-beta decay; this will include the development of a vision, strategic long term plan and proposal for SNOLAB beyond 2022;
- Maintain a strong focus on the delivery of science, and directly contribute to the continued progress of current and future experiments;
- Facilitate increased collaboration with fellow Canadian big science leaders such as TRIUMF, one of the world's leading subatomic physics laboratories, on world-class science, as well as governance and operational best practices that leverage scientific resources and funding, and increase the impact of both organizations within Canada's physics research toolset;
- Establish new global partnerships that promote Canada's track record in world-class physics research to the world, and help our researchers to seize new scientific opportunities, acquire new investment, and increase their contribution to world-class global physics research projects and outcomes;
- Catalyze new discoveries that translate into scientific knowledge, future applications and associated benefits in industry sectors such as mining, geology, biology and medicine; and
- Enable economic impact that helps to create a high quality of life for generations to come.

Appendix A: SNOLAB Board of Directors

Dr. Carl Svensson
Chair
University of Guelph

Ms. Margaret McCuaig-Johnston
Vice-Chair
University of Ottawa

Dr. Sandra Crocker
Carleton University

Dr. Janice Deakin
University of Western Ontario

Mr. Kim Devooght
Pivotal

Dr. Aksel Hallin
University of Alberta

Dr. Cynthia Fekken
Queen's University

Mr. David Pisaric
Vale Limited

Dr. Rui Wang
Laurentian University

Dr. Kenneth Ragan
McGill University

Dr. François Schiettekatte
Université de Montréal

Dr. Gabriella Sciolla
Brandeis University

Ms. Julie Moskalyk
Science North

Appendix B: SNOLAB Experiment Advisory Committee

Dr. Stew Smith, Chair
Princeton University (USA)

Dr. Mariangela Lisanti
Princeton University (USA)

Dr. Lee Roberts
Boston University (USA)

Dr. Stefan Schönert
Technische Universität München (Germany)

Dr. Isabel Trigger
TRIUMF (Canada)

Dr. Mark Vagins
University of California, Irvine (USA)
University of Tokyo, Kavli IPMU

Appendix C: SNOLAB Strategic Plan Development Process

SNOLAB embarked on a refresh of its Strategic Plan for 2017 to 2022, the organization established a Strategic Planning Committee and a stakeholder engagement process to facilitate critical input and feedback from the research community on SNOLAB's strategic direction. The consultation and construction process for this strategic plan has been extended to ensure full engagement with SNOLAB's stakeholders. This process has been approved by the Board of Directors, who formally take ownership of the Plan and responsibility for oversight of delivery.

The mandate of the SNOLAB Strategic Plan Steering Committee is to:

- Engage, and solicit input to the Strategic Plan from, the SNOLAB scientific community
- Distil the community input into a coherent view, presented to the SNOLAB Executive Director as a 'community input report'
- Inform the construction of the Strategic Plan to ensure the community view is fulfilled.

Please find below the members of the SNOLAB Strategic Plan Steering Committee.

Member	Institute	Representitive of
Hiro Tanaka (Chair)	University of Toronto	Physics Community
Isabelle Blain	NSERC	Funding Community
Cliff Burgess	Perimeter Institute	Theory Community
Doug Boreham	Laurentian / NOSM	Genomics Community
Gabriel Orebi Gann	Berkeley University	International Physics Community
Christine Kraus	Laurentian University	Local Community
Aksel Hallin	University of Alberta	SNOLAB Board of Directors
Reiner Kruecken	TRIUMF	National Facilities
Tony Noble	Queen's University	CFREF
Jocelyn Munroe	Royal Holloway, London	International Physics Community

Member	Institute	Representitive of
Isabel Trigger	TRIUMF	SNOLAB EAC
Nigel Smith (ex officio)	SNOLAB	
Samantha Kuula (ex officio)	SNOLAB	
Blaire Flynn (ex officio)	SNOLAB	
Sonya Shorey	Consultant	

The strategic planning engagement process included several key activities including:

- A web-based survey to gather wide-ranging input related to the community requirements for the next five years, and to assess the perception of the current vision, mission and goals of SNOLAB. Additionally, SNOLAB hosted a Town Hall meeting on April 1st, 2016, to provide a face-to-face forum for additional input from the community. During both of these exercises, the community expressed broad support for the further development of SNOLAB's strategic goals, primarily to support the delivery of science through project management support and increased research capabilities. The current vision and mission were deemed to be generally appropriate, with this caveat.
- SNOLAB also contracted a consultant to assess this community input and construct the Plan itself. The consultant also performed targeted individual interviews with several stakeholder groups, including Board members, key community members, advisory committee chairs, SNOLAB, and national and international facility management. These interviews explored strategic themes identified within the Town Hall meeting and survey input.
- To ensure the final Strategic Plan aligns appropriately with user requirements, the document was iterated with the community through the Steering Committee and Board of Directors prior to release.

Creighton Mine #9, 1039 Regional Road 24, Lively, ON P3Y1N2 | 705.692.7000 | www.snolab.ca