Canadian Subatomic Physics
LONG-RANGE PLAN

2022–2026

WITH AN OUTLOOK TO 2036

OVERVIEW

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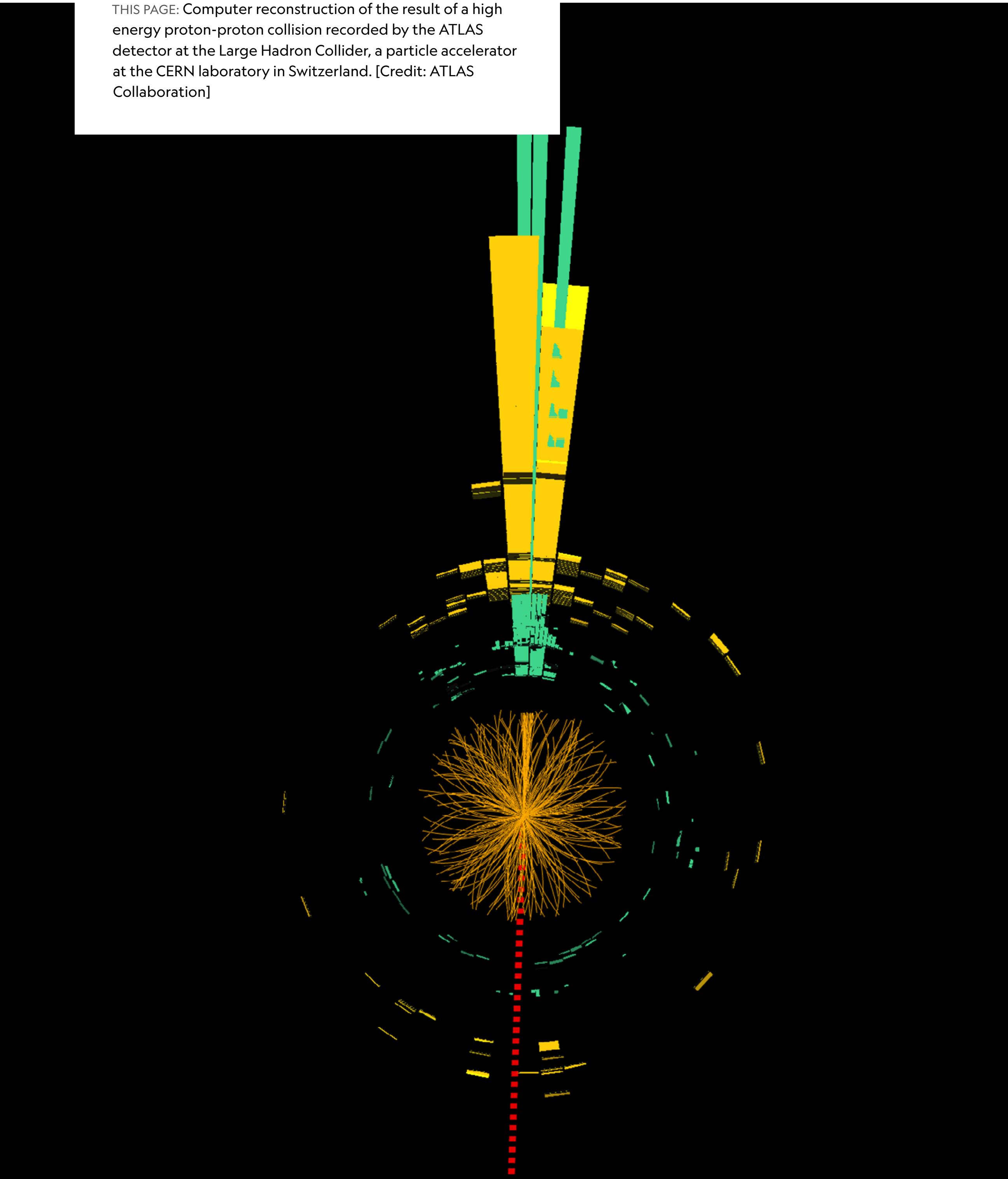
THIS PAGE: Computer reconstruction of the result of a high energy proton-proton collision recorded by the ATLAS detector at the Large Hadron Collider, a particle accelerator at the CERN laboratory in Switzerland. [Credit: ATLAS Collaboration]

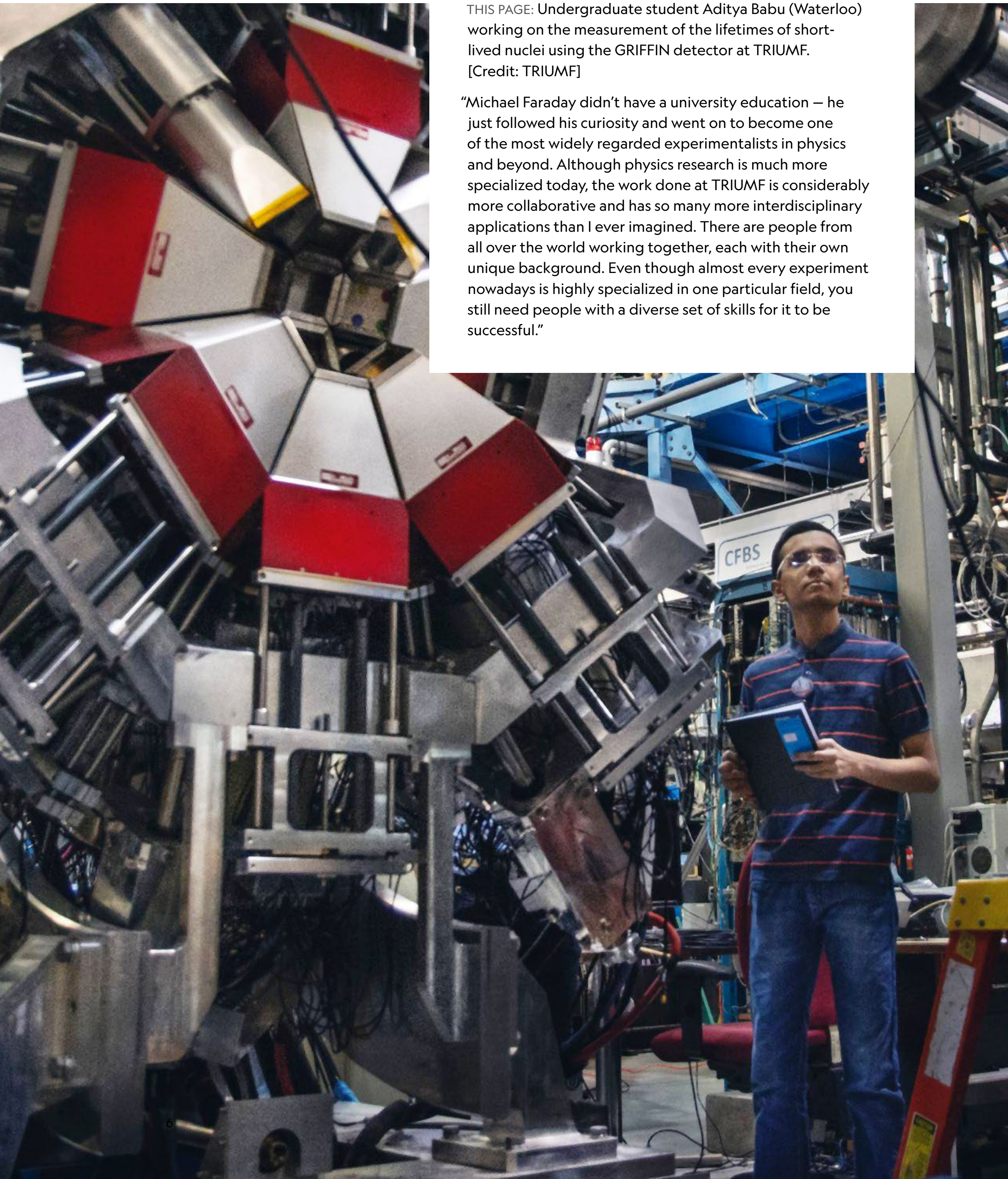


SUBATOMIC PHYSICS

is a fundamental science that seeks to understand the basic building blocks of the universe and the laws that explain the behaviour of those constituents.

Over the past century, the global subatomic physics community has developed an increasingly detailed understanding of this realm, culminating in the development of the Standard Model of particle physics. This theoretical framework unifies electromagnetism, the strong force that binds protons and neutrons, and the weak forces that control neutrinos and nuclear decay. The ongoing development of this theoretical framework most recently led to the discovery of the Higgs boson in 2012. While remarkable progress has been made in this field, many deep questions remain. Future goals include identifying the nature of dark matter and the origin of neutrino mass, explaining how nuclear structure emerges from the theory of quarks and gluons, and improving our understanding of quantum mechanics and relativity to uncover the basic structures underlying matter and the fundamental forces.

The development of our collective knowledge in subatomic physics is a collaborative global endeavour, involving a synergy between advanced theoretical work, cutting edge computational analysis, and experiments which utilize some of the most sophisticated machines ever devised, such as the Large Hadron Collider at CERN. Within this global community, Canadian subatomic physics has an enviable reputation, with leadership and impact on many of the major projects that have advanced our understanding in recent decades. In particular, Canadian researchers have played leading roles on experimental projects connected with recent Nobel Prize awards for the discovery of the Higgs boson and the discovery of neutrino flavour change.



THIS PAGE: Undergraduate student Aditya Babu (Waterloo) working on the measurement of the lifetimes of short-lived nuclei using the GRIFFIN detector at TRIUMF. [Credit: TRIUMF]

"Michael Faraday didn't have a university education — he just followed his curiosity and went on to become one of the most widely regarded experimentalists in physics and beyond. Although physics research is much more specialized today, the work done at TRIUMF is considerably more collaborative and has so many more interdisciplinary applications than I ever imagined. There are people from all over the world working together, each with their own unique background. Even though almost every experiment nowadays is highly specialized in one particular field, you still need people with a diverse set of skills for it to be successful."

Over the past five years, Canadians have taken on significant roles in national and international experiments, ranging from substantial involvement in the ATLAS experiment at the LHC, to a variety of strategic efforts on projects at world-class Canadian and international facilities. The focus of these projects has been to test neutrino properties and search for dark matter, test the structure of protons, neutrons and increasingly complex nuclei, and to perform a variety of precision tests of fundamental symmetries and foundational properties of the Standard Model. Canada is also uniquely positioned to play a major role in the future development of this international field, hosting the Perimeter Institute for Theoretical Physics in Waterloo, Ontario, and two world-class experimental facilities, the SNOLAB deep underground laboratory in Sudbury, Ontario, and TRIUMF, Canada's particle accelerator centre in Vancouver, BC. The Canadian community has pursued projects at these domestic facilities, and has also strategically invested in international laboratories that provide world-leading and complementary infrastructure.

Investment in subatomic physics research leads to returns that are multi-faceted. In addition to expanding our collective understanding of nature, the field provides inspiration and a rich and unique training ground for students and research personnel. In addition to the core skills in problem solving that are typical of physics education, the highly collaborative nature of subatomic physics research also provides trainees with valuable "soft skills", and the strong synergies between subatomic physics and other fields, including astronomy and cosmology, materials science, quantum technologies, and high-performance computing, provide many opportunities for cross-disciplinary research. Subatomic physics research also drives the development of technology, with spin-off developments now important in many areas such as health care, energy, and computing.

The impact of the Canadian subatomic physics community in recent years has been bolstered by collective organization, and cohesive effort on carefully identified projects with significant science outcomes. The Subatomic Physics Long-Range Plan Committee, in consultation with the Canadian subatomic physics community, has developed a roadmap for continued success over the period 2022–2026, with an outlook to 2036. The research plan follows from the same guiding principles that have supported past success:

- tackle the most important research problems in the field;
- maximize impact by concentrating effort and taking on leadership responsibilities in select major projects, while strategically engaging in a range of smaller-scale projects with the potential for high reward;
- maintain flexibility to adjust to new scientific advances; and
- fully engage an increasingly diverse population of students and postdocs in all aspects of research, and support their career development.

FIGURE 1. Schematic representation of the three broad science directions and the eight science drivers for the field of subatomic physics research.

The scientific drivers for subatomic physics research, and the associated opportunities, can be structured around three broad science directions:

BROAD SCIENCE DIRECTION —

From quarks and gluons to nuclei.

Canada's TRIUMF Laboratory, with its Advanced Rare Isotope Laboratory (ARIEL) upgrade and associated suite of targets and experiments utilizing rare isotope beams, presents an opportunity for Canada to continue its leading role in mapping out nuclear structure and properties. In addition, strategic investment in new and complementary offshore facilities in US and Europe will broaden research capacity.

BROAD SCIENCE DIRECTION —

Matter in the weakly coupled universe.

Seeking the identity of dark matter in the universe, and the underlying properties of neutrinos is a growing area of focus worldwide. Canada is very well-positioned to continue its central role in this international effort, with the SNOLAB underground facility in Sudbury currently hosting a variety of world-leading experiments and being well-placed to take a leading role in next generation searches. Canada is also actively involved in major international neutrino experiments.

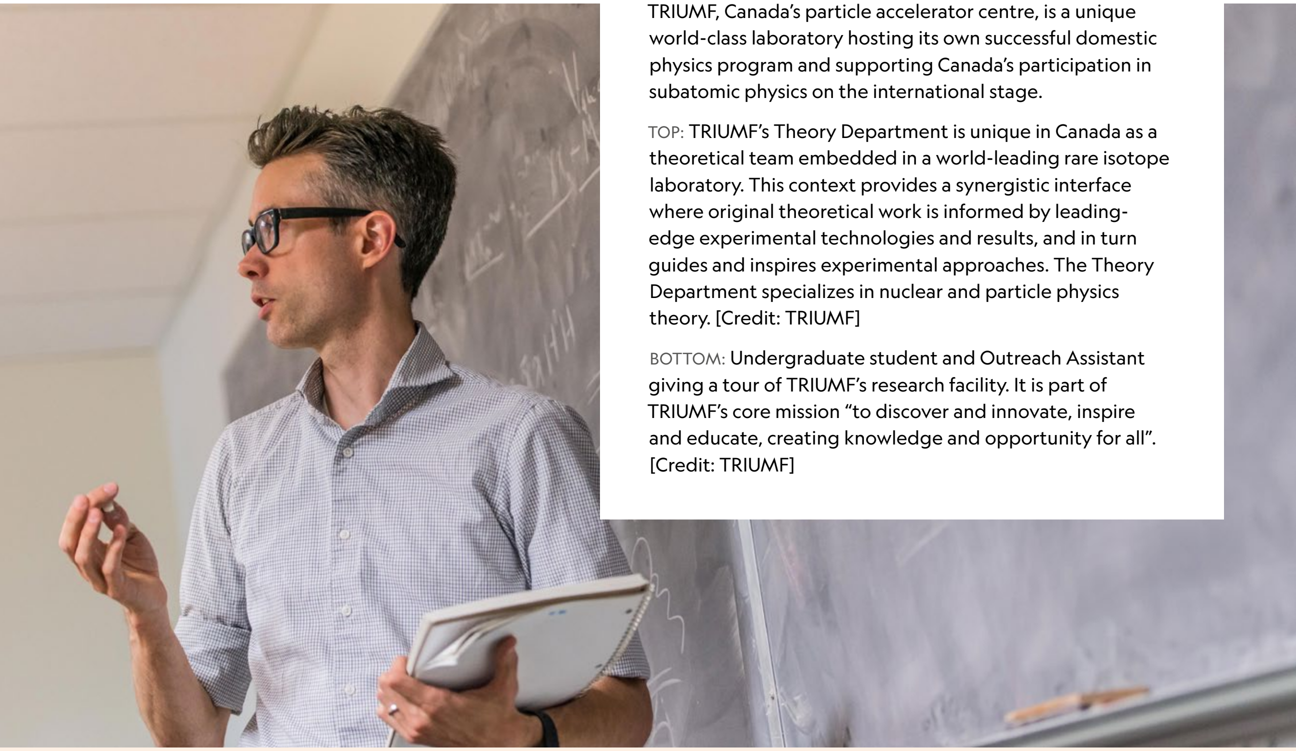
BROAD SCIENCE DIRECTION —

Beyond the electroweak energy scale.

The Canadian community is well-positioned to explore the high energy frontier through its long-standing involvement in international particle collider projects in Europe and Japan, and strategic involvement in smaller-scale precision experiments. In addition, Canada's TRIUMF Laboratory has the opportunity to position itself as a world-leading facility for future high-precision tests of physics at the energy frontier using rare isotopes. Canada is also poised to take a significant role in the development of the next generation of particle colliders.

Theoretical work by Canadian subatomic physicists on all of these themes is critical to future progress. This includes work that is closely tied to analysis and interpretation of experiments, and also fundamental theory that seeks the new ideas that will explain existing puzzles and shape our understanding of subatomic physics in the future.

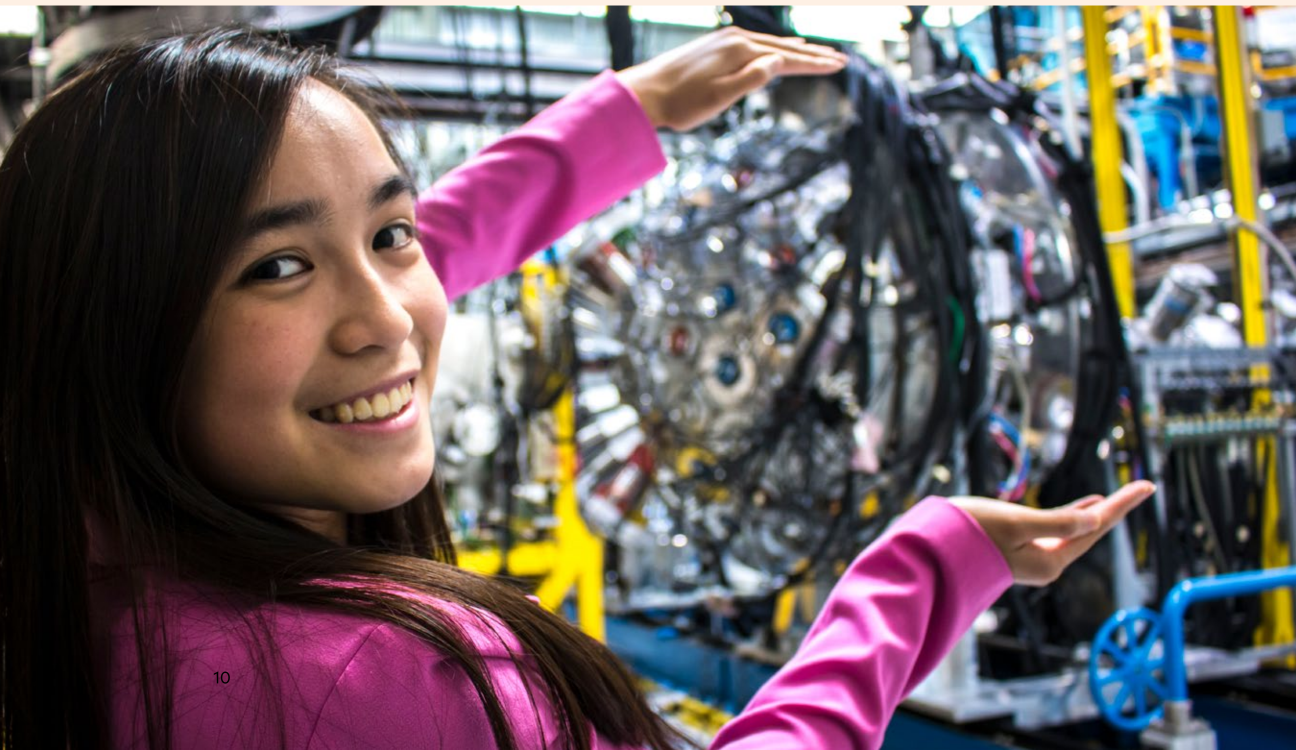
A number of external and internal sources of support will be required for the subatomic physics community to take full advantage of these opportunities for Canada. Moderate but critical increases to operational funding via the NSERC subatomic physics envelope, and continued access to capital funding at current levels for new experimental projects via CFI, are required.



TRIUMF, Canada's particle accelerator centre, is a unique world-class laboratory hosting its own successful domestic physics program and supporting Canada's participation in subatomic physics on the international stage.

TOP: TRIUMF's Theory Department is unique in Canada as a theoretical team embedded in a world-leading rare isotope laboratory. This context provides a synergistic interface where original theoretical work is informed by leading-edge experimental technologies and results, and in turn guides and inspires experimental approaches. The Theory Department specializes in nuclear and particle physics theory. [Credit: TRIUMF]

BOTTOM: Undergraduate student and Outreach Assistant giving a tour of TRIUMF's research facility. It is part of TRIUMF's core mission "to discover and innovate, inspire and educate, creating knowledge and opportunity for all". [Credit: TRIUMF]



Substantial and stable funding is also necessary to maximize the impact of Canada's unique world-class facilities: SNOLAB, TRIUMF, and the Perimeter Institute. Computing and network infrastructure is critical to this field, and Canada's new Digital Research Alliance (formerly NDRIO) and CANARIE are vital components of the subatomic physics research ecosystem. Funding opportunities to develop enabling and emerging technologies are also critical in support for future research projects. Maintaining support for Canada's Institute of Particle Physics (IPP) Research Scientist Program is a high-priority for the community. In addition, initiatives developed and run by the Arthur B McDonald Institute have added considerable value to the subatomic physics ecosystem in Canada. At the governmental level, future scientific developments would be greatly facilitated by the existence of high-level national structures to coordinate costs for large-scale science endeavours, and to aid international engagement in multi-national projects. Finally, achieving a more equitable, diverse and inclusive Canadian subatomic physics community is vital to ensure research excellence and that the societal benefits stemming from subatomic physics research are equitably distributed. Sustained efforts by individuals and organizations to improve equity, diversity and inclusion need to encompass training, career development and outreach.

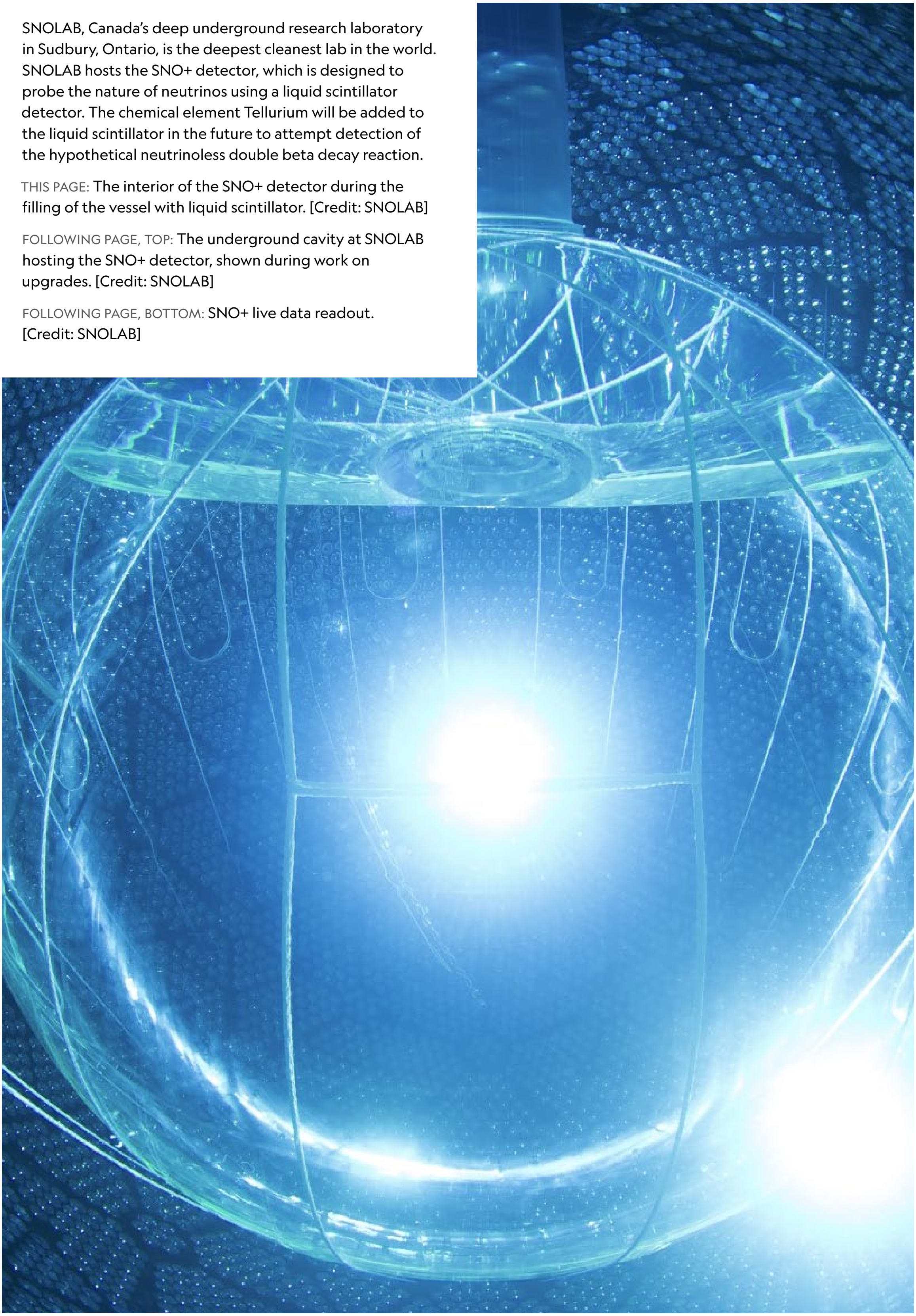
The subatomic physics community in Canada has achieved great success, and is well-positioned to take on future challenges in unlocking the secrets of fundamental physics at the subatomic scale. The Long-Range Plan for 2022–2026 is described in detail in the accompanying report, with the key action items, some of which were highlighted above, expressed in a series of recommendations on Science, Funding, Policy, and Community.

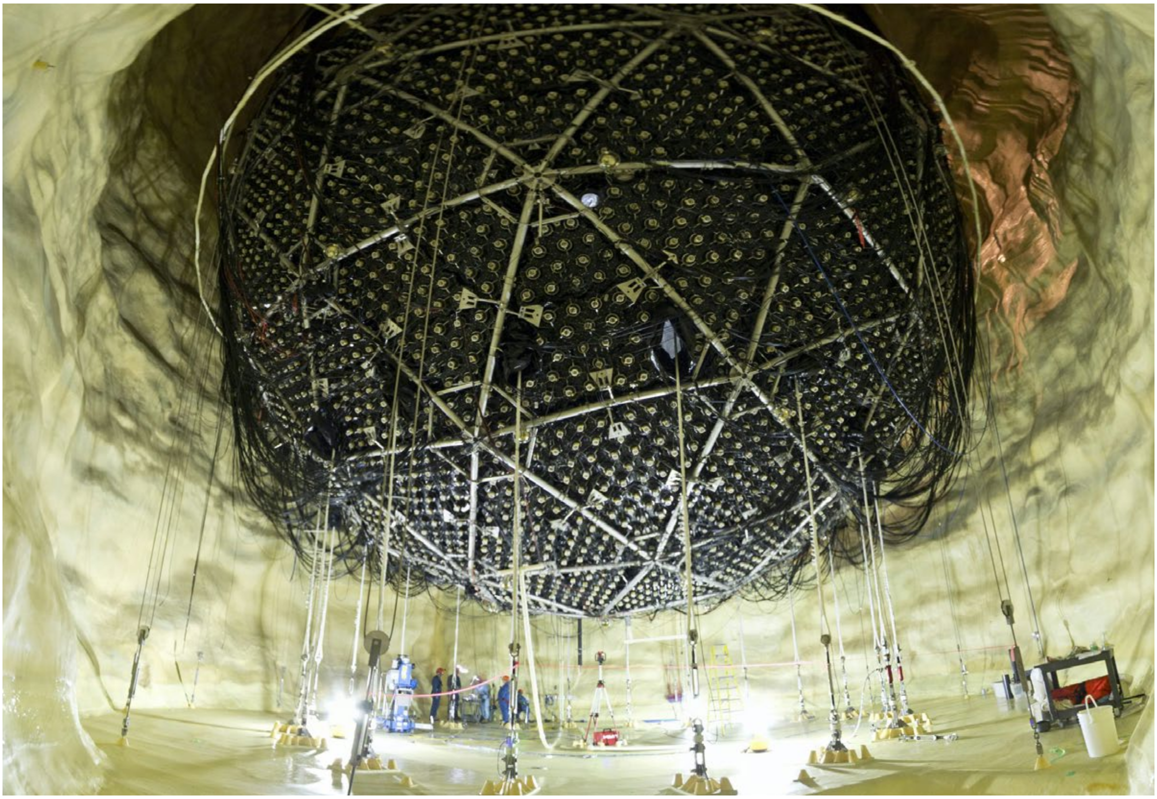
SNOLAB, Canada's deep underground research laboratory in Sudbury, Ontario, is the deepest cleanest lab in the world. SNOLAB hosts the SNO+ detector, which is designed to probe the nature of neutrinos using a liquid scintillator detector. The chemical element Tellurium will be added to the liquid scintillator in the future to attempt detection of the hypothetical neutrinoless double beta decay reaction.

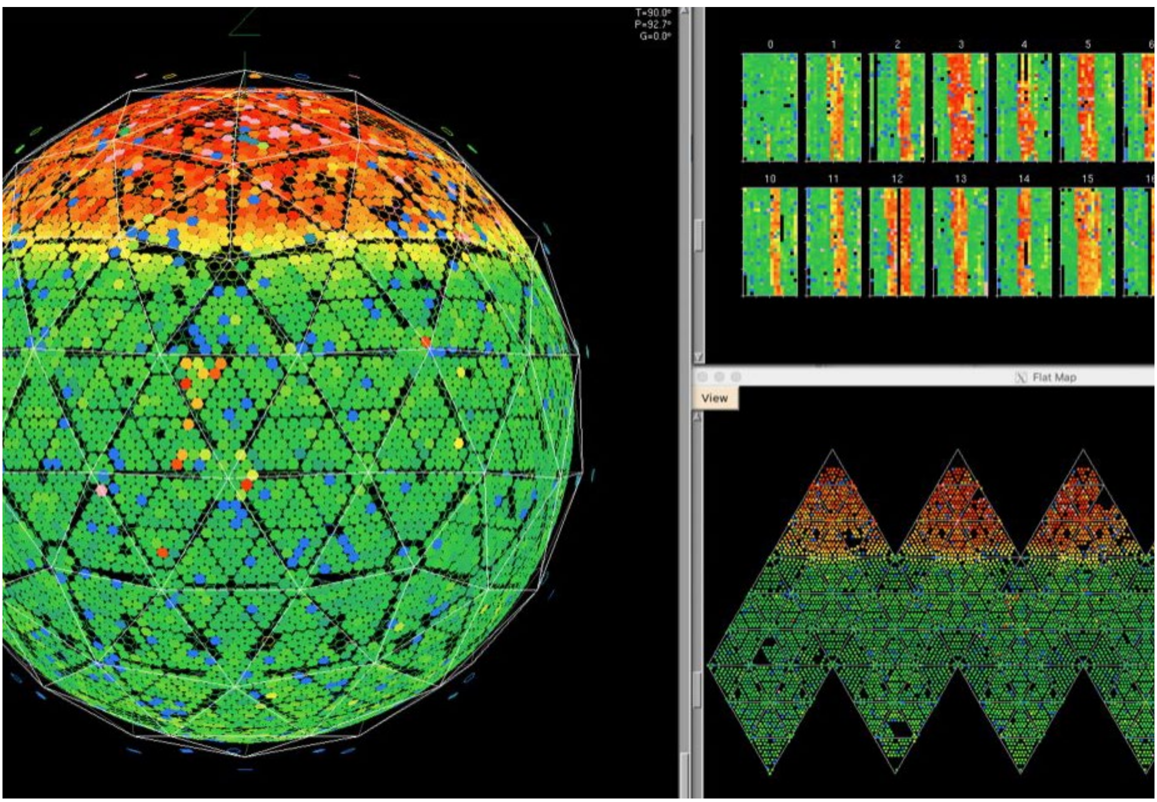
THIS PAGE: The interior of the SNO+ detector during the filling of the vessel with liquid scintillator. [Credit: SNOLAB]

FOLLOWING PAGE, TOP: The underground cavity at SNOLAB hosting the SNO+ detector, shown during work on upgrades. [Credit: SNOLAB]

FOLLOWING PAGE, BOTTOM: SNO+ live data readout. [Credit: SNOLAB]



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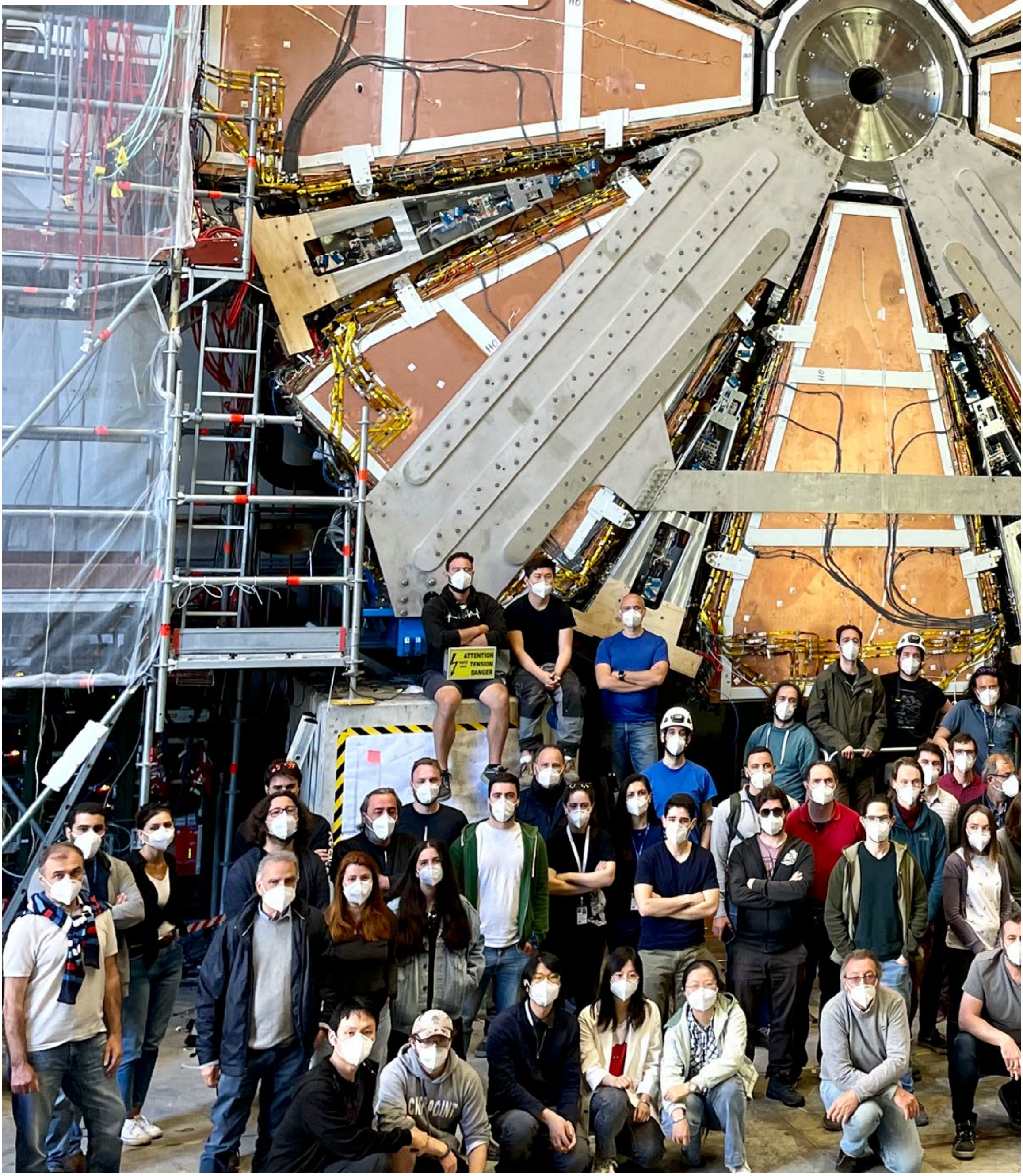
Flat Map
View

THIS PAGE AND FOLLOWING PAGE: Researchers marking the successful completion of the first of two muon New Small Wheels (NSW) for the upgrade of the ATLAS experiment at the CERN laboratory in Switzerland.

The ATLAS experiment enables researchers to study the results of high energy proton-proton collisions produced at the Large Hadron Collider, with the aim of studying the properties of the Higgs boson and mechanism of electroweak symmetry breaking, as well as searching for evidence of new physics phenomena. [Credit: F. Lanni.]

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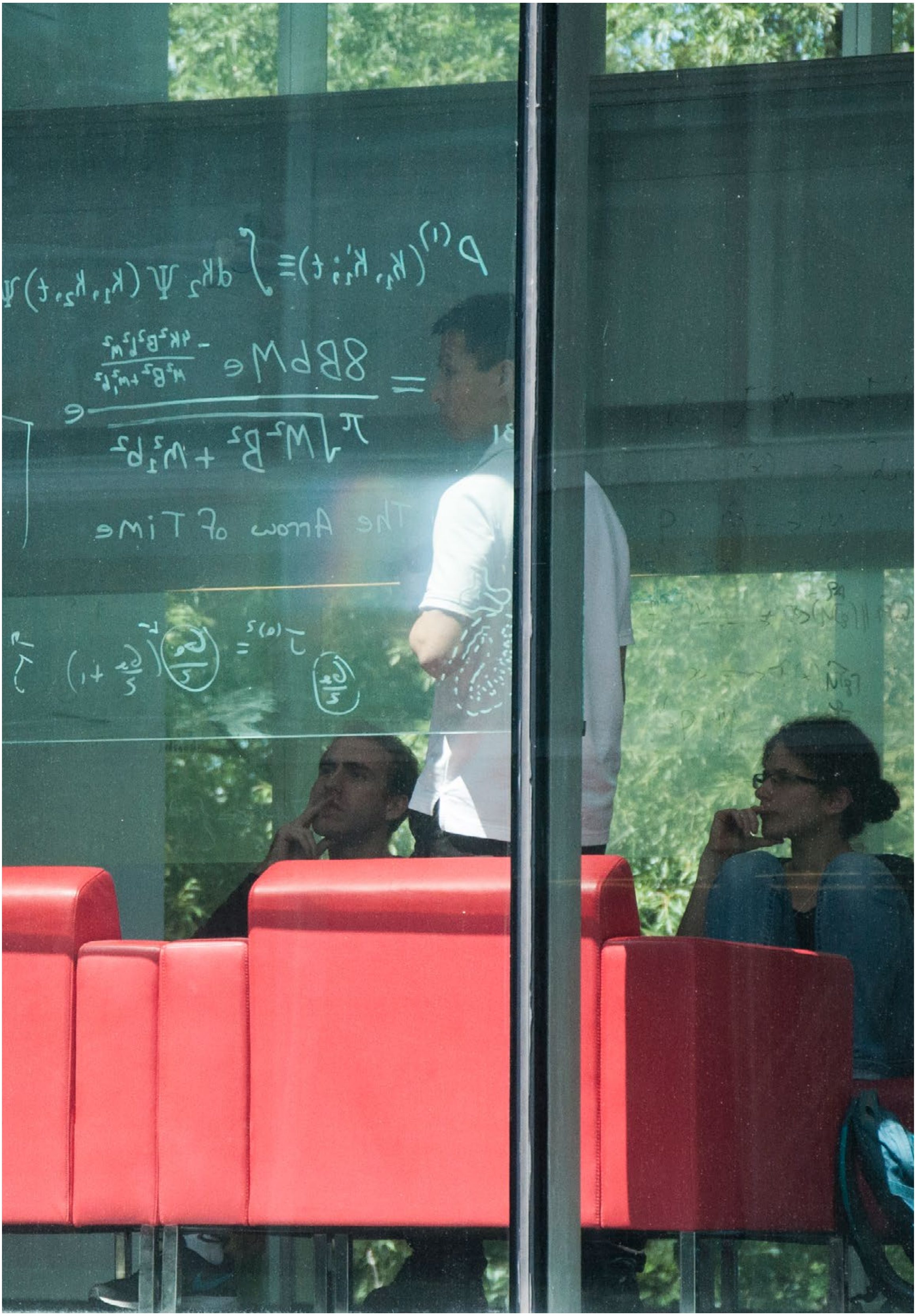
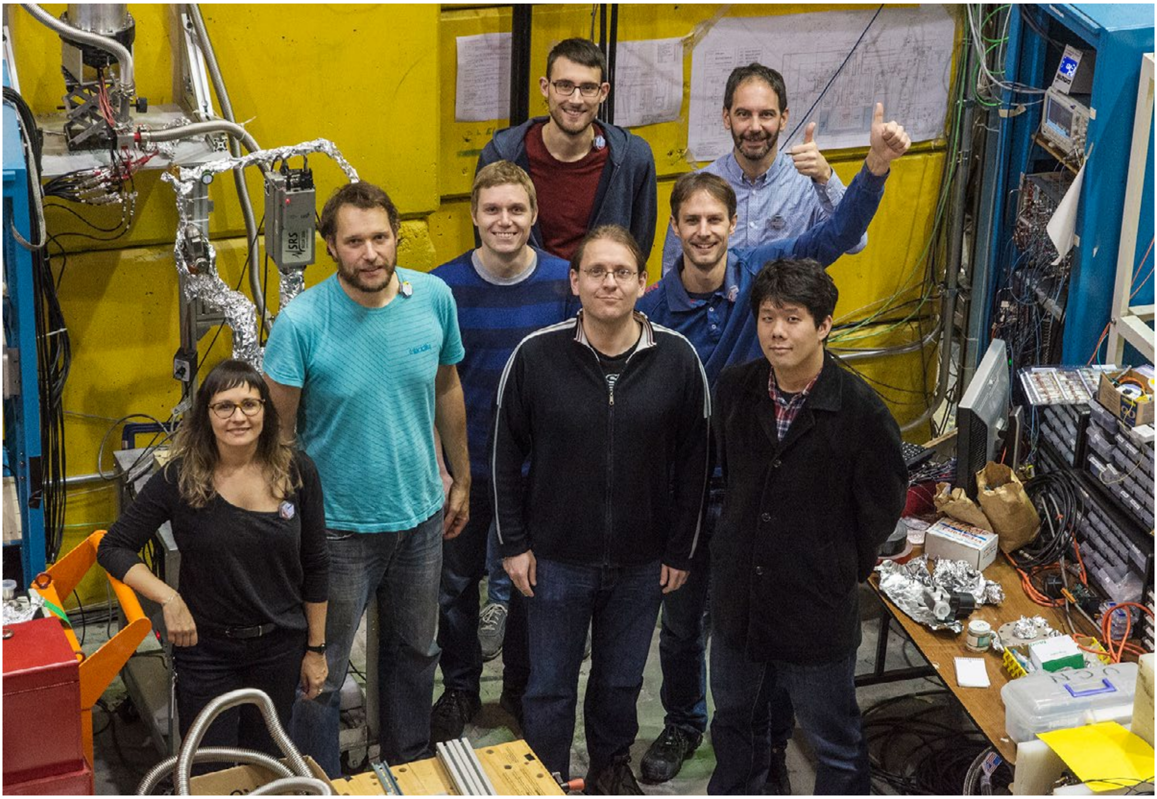
The Perimeter Institute for Theoretical Physics, in Waterloo, Ontario, is a world-leading and internationally recognized center for fundamental research, graduate training, and educational outreach.

THIS PAGE AND FOLLOWING PAGE: Researchers interacting at the Perimeter Institute for Theoretical Physics. [Credit: Perimeter Institute]


The Arrow of Time



TOP: Researchers from the Canadian-Japanese TUCAN collaboration gathered on the experimental floor at TRIUMF. The TUCAN experiment aims to measure the electric dipole of the neutron at an unprecedented level of precision, to provide insights into the puzzle of why there is much more matter than antimatter in the universe. [Credit: TRIUMF]

BOTTOM: Researchers working on the PICO experiment at Canada's SNOLAB. The goal of the PICO experiment is to search for experimental evidence of dark matter particles through possible interactions with nuclear matter that depend on the target nucleus spin. [Credit: SNOLAB]

Recommendations

SCIENCE RECOMMENDATION
1 — **CANADIAN INFRASTRUCTURE**

We recommend fully capitalizing upon the unique science opportunities provided by the SNOLAB and TRIUMF infrastructure, and by the Perimeter Institute, in pursuit of the science drivers.

SCIENCE RECOMMENDATION
2 — **THEORY PROGRAMS**

Critical mass and research breadth are vital for the theory community in Canada, to maximize the future impact of subatomic physics research. We recommend strong support for theoretical subatomic physics research over the next decade, both to explore new purely theoretical directions and to support the synergistic interaction between subatomic theory and experiment.

SCIENCE RECOMMENDATION
3 — **EXPERIMENTAL PROGRAMS**

A broad experimental program is required to address the scientific drivers of subatomic physics research. We recommend pursuit of the following high-priority scientific directions.

- **FROM QUARKS AND GLUONS TO NUCLEI** — *The future program should explore the structure of hadrons and nuclei using rare isotope and accelerator-based facilities. It should include the full exploitation of TRIUMF, offshore electron beam and rare isotope beam (RIB) facilities, and a future electron-ion collider.*

- **MATTER IN THE WEAKLY COUPLED UNIVERSE** — *The future program should incorporate the search for dark matter using complementary direct and indirect techniques, including via multi-ton scale direct detection. The future program should include the further exploration of neutrino properties via neutrinoless double-beta decay experiments, long baseline experiments and neutrino observatories.*

- **BEYOND THE ELECTROWEAK ENERGY SCALE** — *The future program should study matter and its interactions at increasingly higher energy scales, including the exploitation of a future Higgs factory and energy frontier collider, as well as high-precision indirect techniques.*

This scientific program is currently implemented through Canadian leadership in a set of flagship projects identified based on their potential scientific payoff, Canadian core expertise, the level of community engagement, opportunities for the scientific and technological training of the next generation, and Canadian investments to date:

	Flagship projects with broad physics outcomes	***Flagship projects with strategic physics outcomes***
FROM QUARKS AND GLUONS TO NUCLEI	TRIUMF ARIEL-ISAC experiments, EIC	JLab 12 GeV program, Offshore RIB experiments
MATTER IN THE WEAKLY COUPLED UNIVERSE	T2K/HK, IceCube, SNO+	DEAP, PICO-500, SuperCDMS
BEYOND THE ELECTROWEAK ENERGY SCALE	ATLAS(LHC/HL-LHC), Belle II	ALPHA/HAICU, MOLLER, TUCAN

We recommend the support of these projects and also those initiatives within the scientific program, with the potential for high impact, that are under development or may be developed in the coming years. Potential future projects with ongoing development activities and their timelines are listed in the research portfolio presented in FIGURE 4.

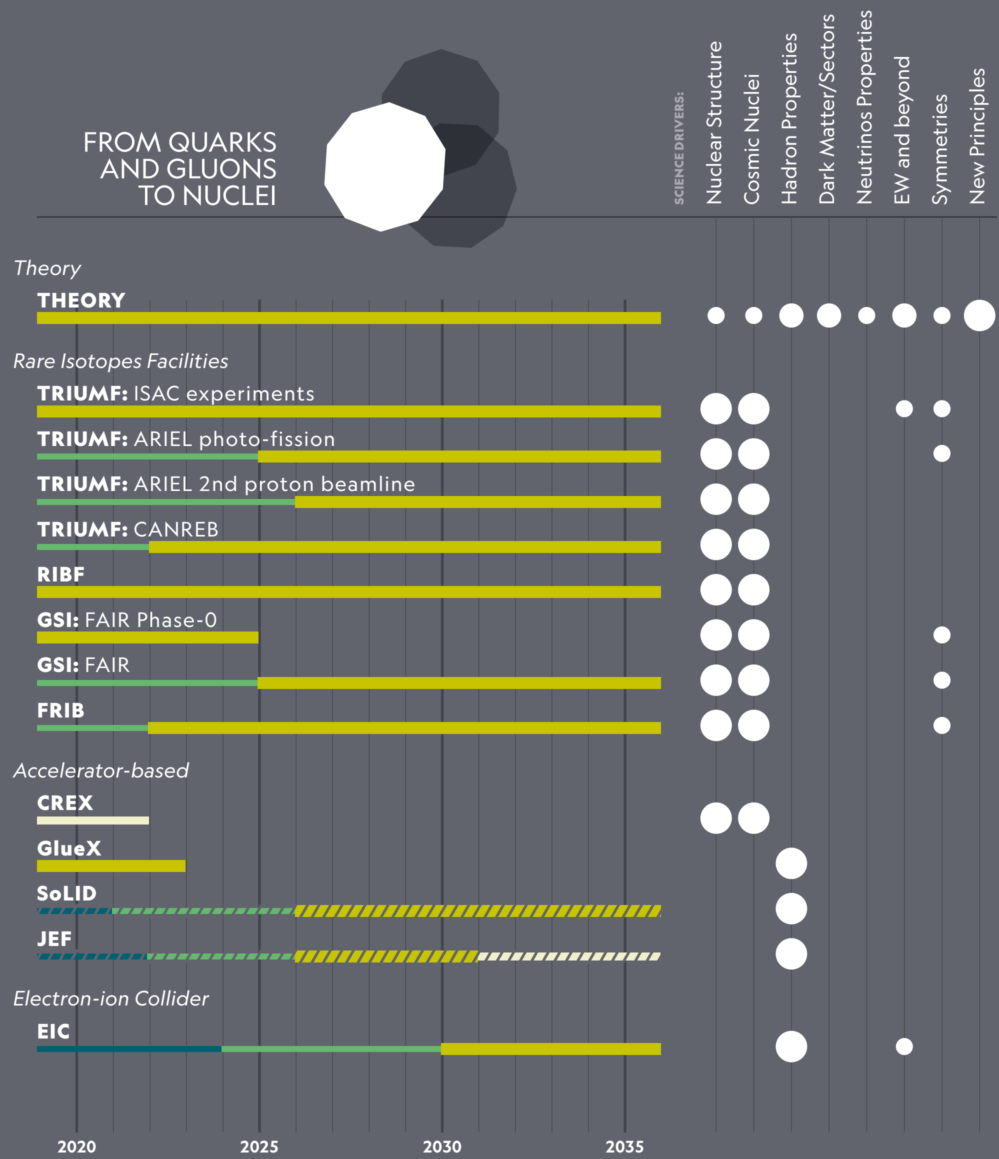
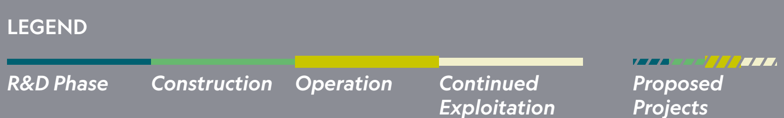
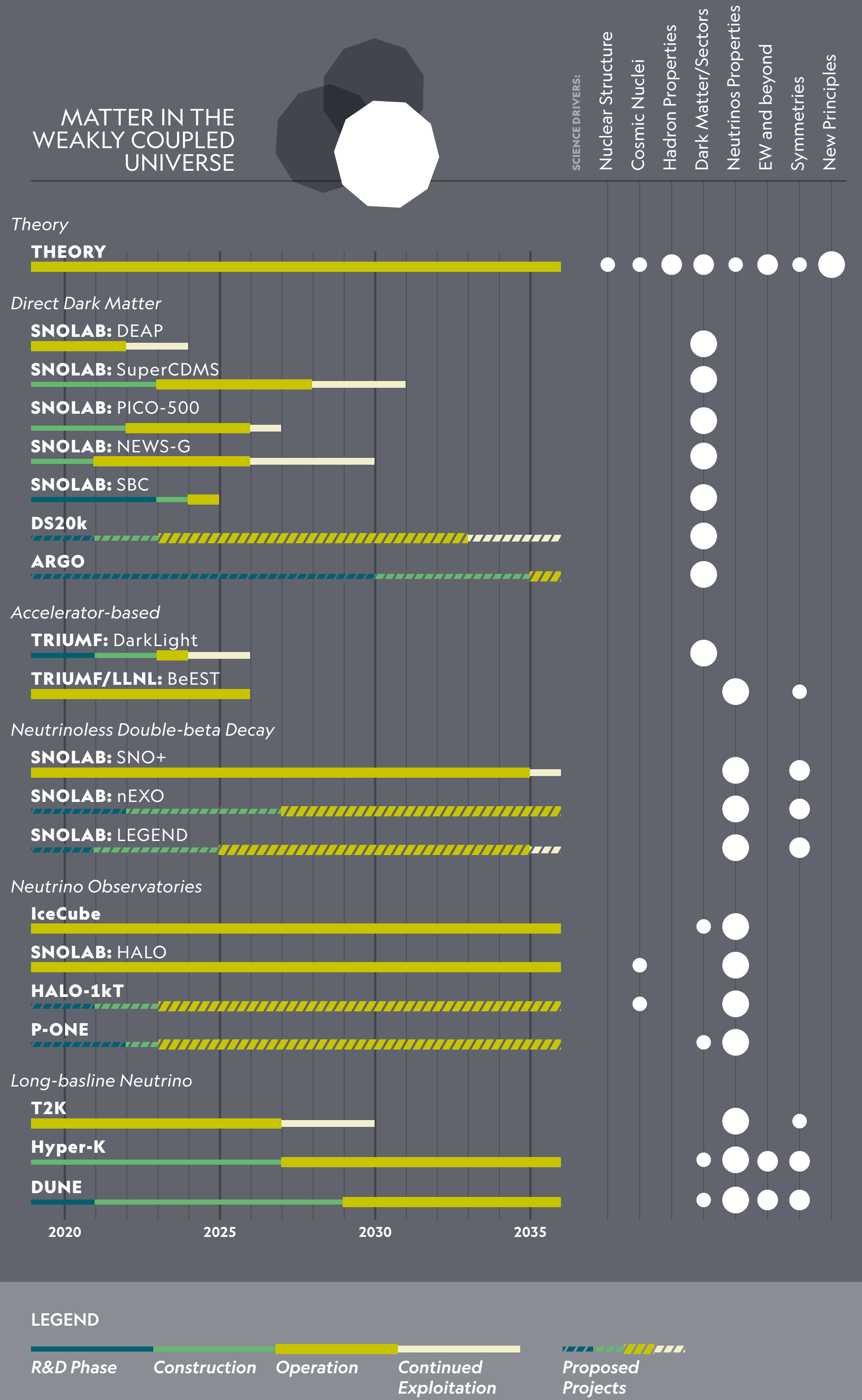
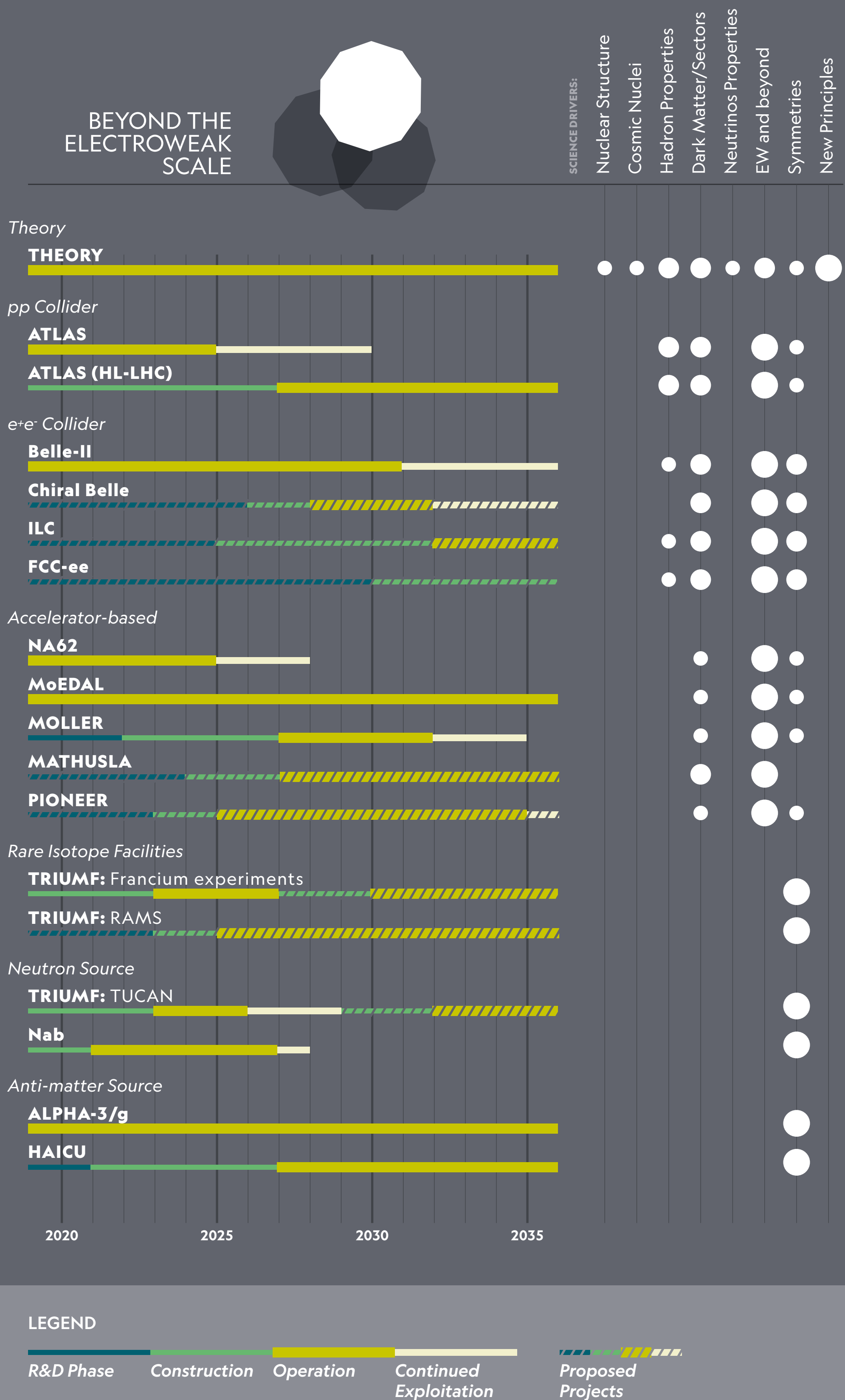


FIGURE 2. A schematic representation of the Canadian subatomic physics research portfolio, with current and approved projects shown in solid colours, and potential future projects with concrete timelines at the time of writing shown in hatched colours.



MATTER IN THE WEAKLY COUPLED UNIVERSE




BEYOND THE ELECTROWEAK SCALE
SCIENCE DRIVERS:
Nuclear Structure
Cosmic Nuclei
Hadron Properties
Dark Matter/Sectors
Neutrinos Properties
EW and beyond
Symmetries
New Principles
Theory
THEORY
pp Collider
ATLAS
ATLAS (HL-LHC)
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Belle-II
Chiral Belle
ILC
FCC-ee
Accelerator-based
NA62
MoEDAL
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MATHUSLA
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TRIUMF: RAMS
Neutron Source
TRIUMF: TUCAN
Nab
Anti-matter Source
ALPHA-3/g
HAICU
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2035
LEGEND
R&D Phase
Construction
Operation
Continued Exploitation
Proposed Projects

SCIENCE RECOMMENDATION
4 — **R&D ACTIVITIES**

We recommend the support of R&D activities for the future development of particle accelerators and detector technology, and the development and use of emerging technologies including novel computational and analysis tools.

COMMUNITY RECOMMENDATION
5 — **EQUITY, DIVERSITY & INCLUSION**

The Canadian subatomic physics community lacks diversity, as do some other science and technology fields. This lack of representation has many causes, and spans the full career range from graduate students to senior faculty. It is widely recognized that diversity is valuable for the research enterprise, and that a lack of diversity in itself creates a barrier to entry into the field.

- *We recommend the pursuit of further sustained actions aligned with the Tri-Council Dimensions Charter, including regular data-gathering and analysis, targeted initiatives to enhance equity, diversity and inclusion within community activities, and community use of formal committees through the Institutes to support these efforts and/or coordinate with partners.*

- *We recommend that the subatomic physics community promote balanced representation in high visibility leadership roles, as individuals in these positions are important role models, while recognizing that achieving adequate representation can increase the workload for members from under-represented groups.*

- *We recommend that the subatomic physics community promotes inclusion through acknowledgement of the legacy of colonization in Canada, e.g. with the use of land acknowledgements at events held in Canada, consistent with the spirit of the Calls to Action of the Truth and Reconciliation Commission of Canada and of the United Nations Declaration on the Rights of Indigenous Peoples.*

COMMUNITY RECOMMENDATION
6 — **TRAINING & CAREER DEVELOPMENT**

To enable highly qualified personnel to receive training that makes use of the national collaborative structure of subatomic physics research, we recommend the coordination and sharing of training opportunities across Canadian centres, institutes, and universities.

To support early career development, we recommend that Early Career Researchers be supported to quickly gain knowledge of the Canadian subatomic physics research support and funding ecosystem, and be given opportunities to interact broadly with the community.

COMMUNITY RECOMMENDATION
7 — **COMMUNICATION & ENGAGEMENT WITH AGENCIES & GOVERNMENT**

We recommend the formalization (e.g. by CINP and IPP) of a subatomic physics consultation committee for engagement and advocacy to funding agencies and government.

FUNDING RECOMMENDATION
8 — **CFI PROGRAMS**

Support for the development of capital infrastructure through CFI has been instrumental for the development of subatomic physics research in Canada. We recommend continuation of this investment at current annualized levels, which will be critical for the success of the Canadian subatomic physics research plan including many of the proposed future initiatives.

FUNDING RECOMMENDATION
9 — **NSERC SUBATOMIC PHYSICS ENVELOPE**

To maximize the impact of current and future investments, and to take advantage of future science opportunities, growth of the NSERC subatomic physics envelope is required for operational support.

- *We recommend retention of the NSERC subatomic physics envelope structure, and its programs, which have been instrumental for the operational funding of subatomic physics research.*
- *We recommend growth of the NSERC subatomic physics envelope by $6.2M in 2021 dollars over the next five years to ensure that the Canadian program remains globally competitive. This growth is required for several reasons: to accommodate the transition of McDonald Institute faculty requiring NSERC support; to utilize the full community capacity for training of highly qualified personnel and maximize the return on capital investment; and to ensure sufficient availability of funds for small infrastructure projects and the development of future science opportunities.*
- *We recommend continued support for all the program categories available within the NSERC subatomic physics envelope; this includes the Major Resources Support (MRS) program, which critically supports the efficient collaborative use of unique technical resources in the development and construction of new instruments, and the Research Tools and Instruments (RTI) program which provides important support for detector and accelerator development.*
- *We recommend the monitoring and protection of the NSERC subatomic physics envelope fraction allocated to fund theory investigators. In addition, the minimum award threshold should not be below the level of funding required to support graduate training, as is the case in other Physics Evaluation Sections.*

FUNDING RECOMMENDATION
10 — **SUPPORT FOR CANADA'S WORLD-LEADING CENTRES**

Canada's large-scale centres for subatomic physics research have global stature, and provide competitive advantages in pursuing high-priority scientific programs.

We recommend maintaining strong support for Canadian centres (TRIUMF, SNOLAB, Perimeter Institute) so that they remain at the forefront of research worldwide.

FUNDING RECOMMENDATION
11 — **IPP RESEARCH SCIENTIST PROGRAM**

The IPP Research Scientist program has had a major impact on Canada's leadership and contributions to international projects.

We recommend maintaining full support for the IPP Research Scientist program.

FUNDING RECOMMENDATION
12 — **ARTHUR B MCDONALD INSTITUTE**

The existence of the Arthur B McDonald Institute and its research support and outreach programs has added considerable value to the community. However, its CFREF funding is coming to an end.

We recommend that in addition to growth of the NSERC subatomic physics envelope to support operational costs, new mechanisms be identified to fund and maintain continuity of the research and technical support programs provided by the Institute.

FUNDING RECOMMENDATION
13 — **CANADA'S DIGITAL RESEARCH INFRASTRUCTURE**

All components of digital research infrastructure (e.g. Compute Canada, CANARIE) are critical to the success of subatomic physics research.

We recommend that CANARIE continues to be funded by the Canadian federal government for operation of the national research network and key links to our international partners. Further, we recommend that critical computing infrastructure provided by national computing organizations (Compute Canada and the Digital Research Alliance (formerly NDRIO)) continue to be strongly supported by federal and provincial governments, at a level appropriate to address the needs of the subatomic physics research community.

FUNDING RECOMMENDATION
14 — **FUNDING FOR R&D ACTIVITIES**

New research opportunities are enabled by the development of novel instruments and technologies. This development relies upon the ability to explore technological frontiers that are beyond the scope of individual subatomic physics experiments.

We recommend that appropriate mechanisms be identified to efficiently fund modest and timely investments in generic R&D activities that have the potential to address the scientific goals of subatomic physics research.

POLICY RECOMMENDATION
15 — **SUPPORT FOR LARGE-SCALE SCIENCE ENDEAVOURS**

Coordination of the capital costs and operational funding over the life-cycle of large-scale (≳ $50M) science endeavours and infrastructure projects is difficult within the current ecosystem.

We recommend the formation of a new administrative structure to provide this coordination (as articulated in Recommendation 4.7 of Canada's Fundamental Science Review 2017: Investing in Canada's Future, *http://sciencereview.ca*).

POLICY RECOMMENDATION
16 — **CANADIAN OFFICE FOR INTERNATIONAL RESEARCH ENGAGEMENT**

Subatomic physics research is intrinsically global, and increasingly requires complex multinational agreements.

We recommend the identification of an office in Canadian government responsible for engaging with the international community with the goal of advancing major new science initiatives.

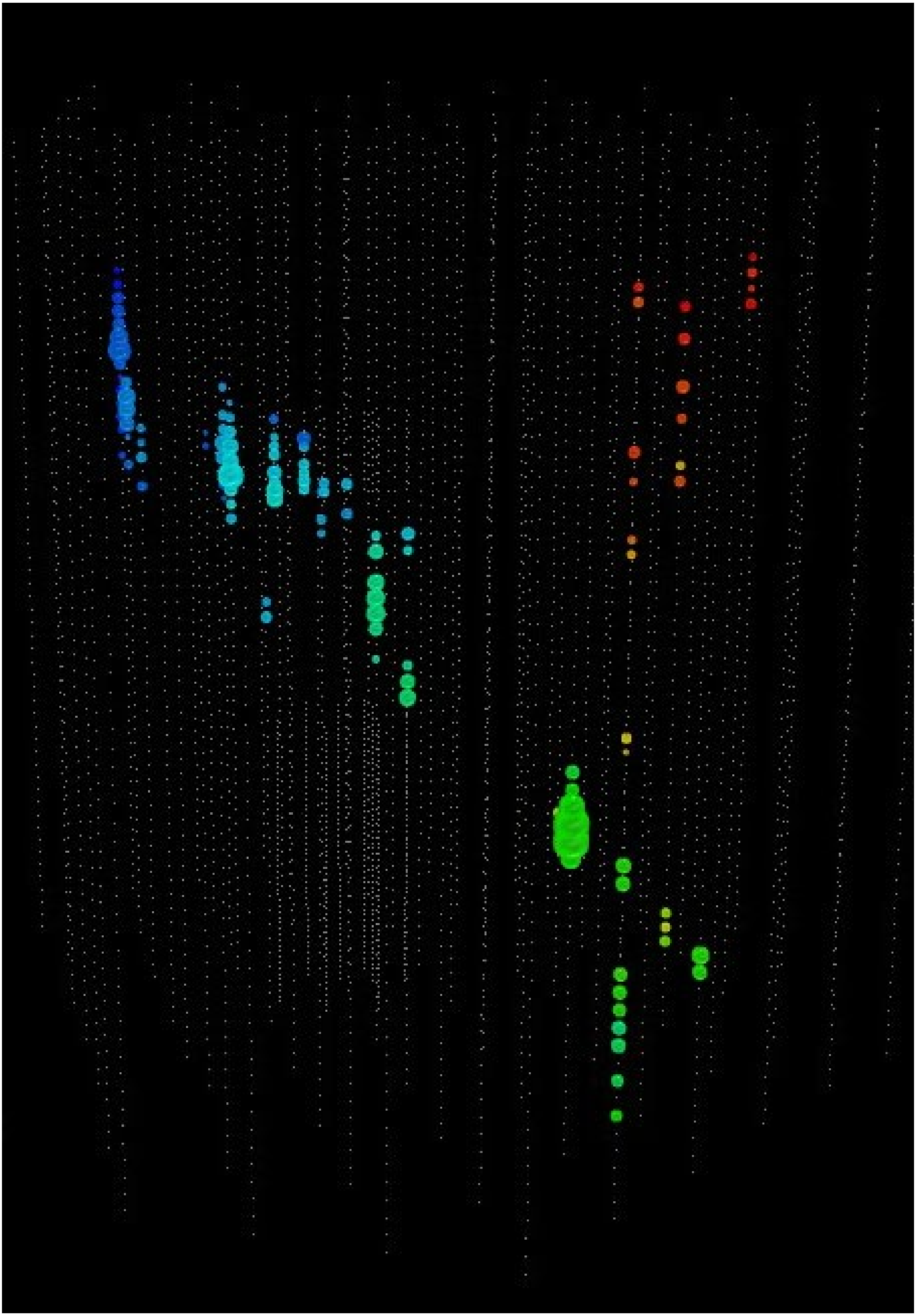
TOP: A researcher working on the ALPHA experiment at the CERN laboratory. The ALPHA experiment uses anti-hydrogen to perform tests of the fundamental CPT symmetry of nature and the universality of gravitational interactions between matter and antimatter. [Credit: TRIUMF]

BOTTOM: Researchers at TRIUMF developing novel photodetector modules for the Hyper-Kamiokande experiment. This future world-leading project will provide new insights into the puzzling nature of neutrinos. [Credit: TRIUMF]

The IceCube Neutrino Observatory is the world's largest neutrino detector, conceived to detect high energy neutrinos originating from the cosmos. These cosmic messengers provide information to learn about the unique properties of the neutrino, the nature of dark matter, and mechanisms underlying the most violent astrophysical events in the universe.

THIS PAGE: The IceCube Laboratory at the Amundsen-Scott South Pole Station in Antarctica. [Credit: F. Pedreros, IceCube/NSF.]

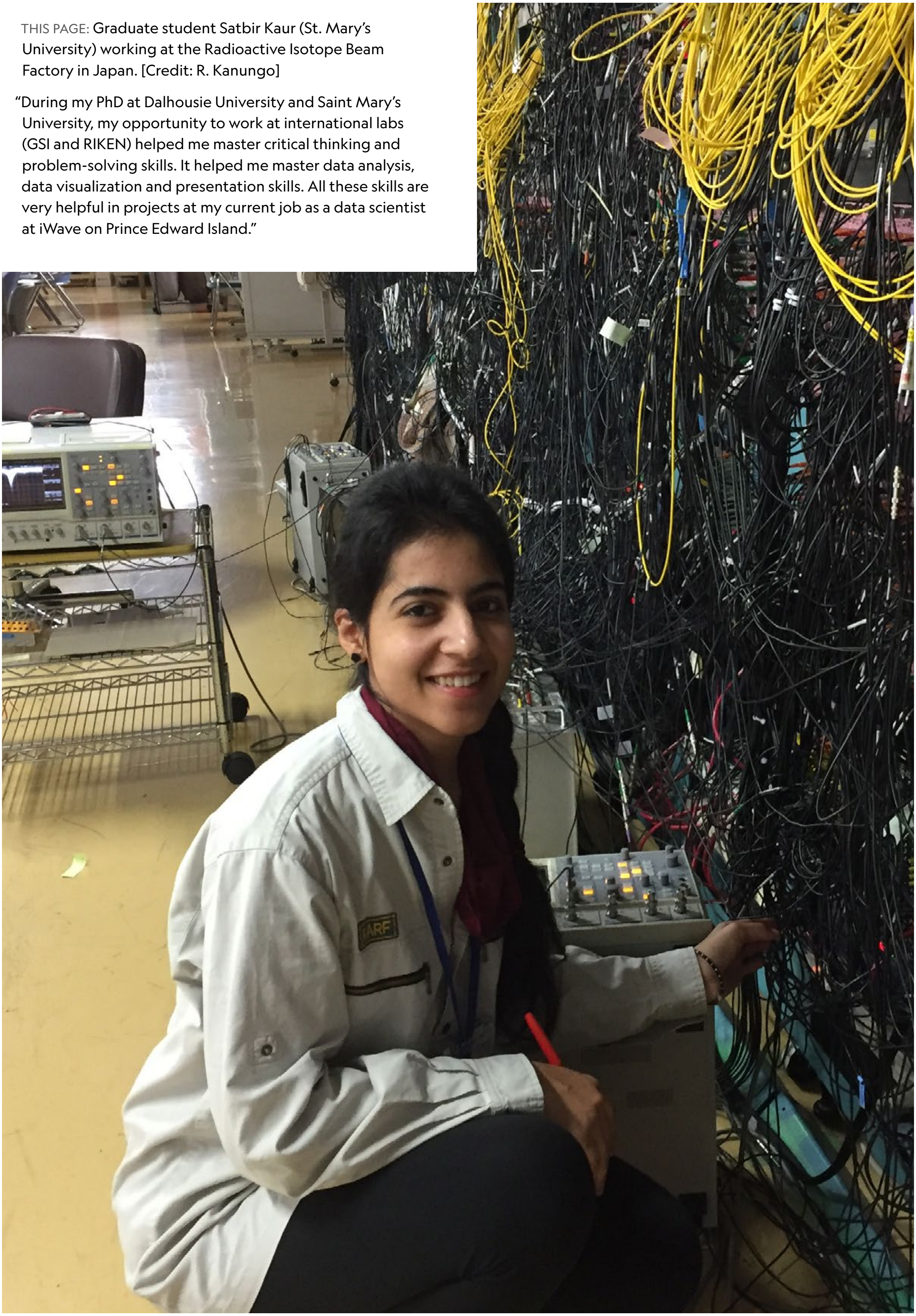
FOLLOWING PAGE: Computer reconstruction of a neutrino interaction in the Antarctic ice recorded by the IceCube detector. [Credit: IceCube Collaboration]



THIS PAGE (TOP & BOTTOM): The Perimeter Institute's "Inspiring Future Women in Science" conference mixes science talks with discussion of the rewards, challenges, and possibilities of a STEM career. [Credit: Perimeter Institute]

THIS PAGE: Graduate student Satbir Kaur (St. Mary's University) working at the Radioactive Isotope Beam Factory in Japan. [Credit: R. Kanungo]

"During my PhD at Dalhousie University and Saint Mary's University, my opportunity to work at international labs (GSI and RIKEN) helped me master critical thinking and problem-solving skills. It helped me master data analysis, data visualization and presentation skills. All these skills are very helpful in projects at my current job as a data scientist at iWave on Prince Edward Island."



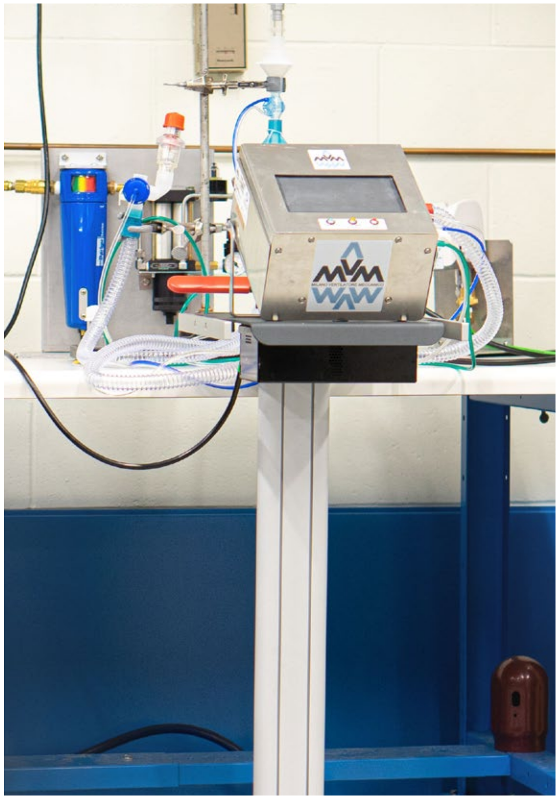
The SuperCDMS collaboration is searching for dark matter particles with masses smaller than ten times the mass of the proton. Detecting these particles would revolutionize our understanding of the subatomic world and open a window into a completely unknown set of new particles.

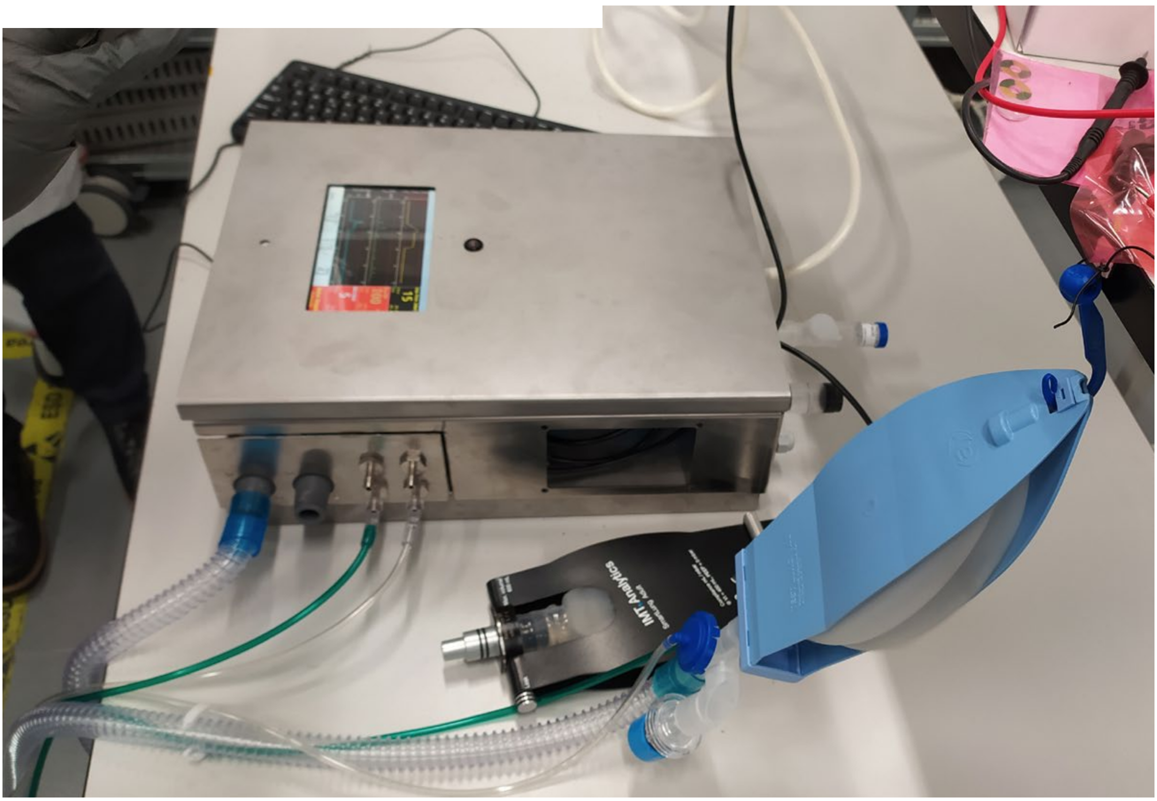
THIS PAGE: Undergraduate student helping to prepare a new SuperCDMS detector for a first test under low-background conditions in the Cryogenic Underground TEst facility (CUTE) at SNOLAB. [Credit: SNOLAB]

THIS PAGE (TOP & BOTTOM): In response to the global COVID-19 pandemic, the MVM Collaboration, an international collaboration of subatomic physics laboratories from Italy, Canada, the United States, and other countries, leveraged its collective expertise to develop a ventilator that can provide both mandatory and assisted ventilation. The simplicity of the design, which is made possible by the MVM's sophisticated control system, allows for ease of availability of parts, and rapid manufacturing in different countries.

Guided by medical experts and in cooperation with industrial partners Elemaster in Italy as well as Vexos and JMP Solutions in Canada, the MVM Collaboration succeeded — in record time — to design, develop, build and certify a safe ventilator. In Canada the effort was led by Nobel laureate Art McDonald, involving team members from Canadian Nuclear Laboratories Chalk River, McDonald Institute, SNOLAB, and TRIUMF. In September 2020, the MVM received approval by Health Canada under the Interim Order and Vexos started to deliver the 10,000 units that have been ordered by the Federal Government of Canada.

The rapid development of this project was only possible due to around the clock work by a large team spread across nine time zones, enabling effective hand-off and progress on the various development tasks. The MVM development is a prime example of how the expertise of nuclear and particle physicists — who are trying to unravel the mysteries of the foundations of the Universe — can be effectively mobilized in real time to help tackle our major global societal challenges. [Credit: MVM Collaboration]





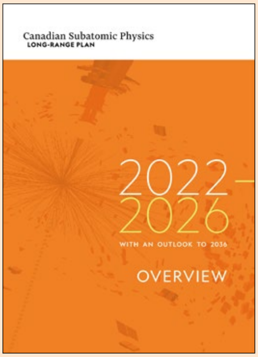
One of the advantages of performing my graduate studies at Simon Fraser University is that I had direct access to TRIUMF. This allowed me to not only preform my own research, but I was able to participate in numerous other experiments. Additionally, I got to observe the day to day workings at TRIUMF that not only include preparations for upcoming experiments, but also preparations for long-term advancements as the beginnings of ARIEL were in the works. My experiences at Simon Fraser and at TRIUMF prepared me for the work that I am doing now as a Project Scientist at Lawrence Berkeley National Laboratory. I know how to utilize all of the resources that are at my disposal. I also recognize the importance of building strong collaborations with fellow researches both locally and at other institutions to create the necessary support to generate a solid scientific program. I feel confident in my career moving forward.

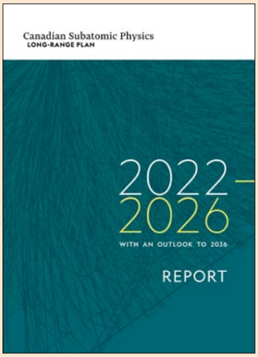
— DR JENNIFER PORE (PHD, SIMON-FRASER UNIVERSITY, 2016),
PROJECT SCIENTIST, LAWRENCE BERKELEY NATIONAL LABORATORY,
BERKELEY, CALIFORNIA

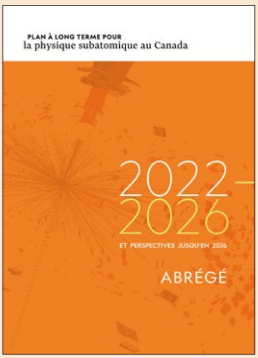
Studying subatomics physics presented many challenges that helped me learn mechanical, coding, research, analysis and problem solving skills. But perhaps most importantly it showed me that I am a capable learner. This gives me confidence in my competence as I move forward in another career path. More practically, I was able to engage in science communication projects throughout my Master's degree that gave me experience which directly relates to my current position. Being supported in my science communication projects gave me soft skills that complemented the harder skills I got in physics.

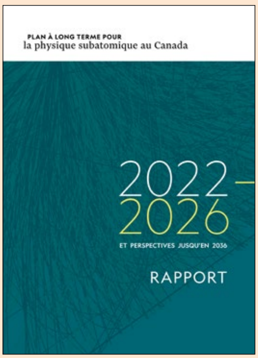
— LIA FORMENTI (MSC MCGILL 2021),
ONLINE EVENTS COORDINATOR, LET'S TALK SCIENCE

FIGURE 3. The Canadian institutions participating in subatomic physics research in 2021.









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Long-Range Planning Committee, "Canadian Subatomic Physics Long-Range Plan 2022–2026: Overview", 2022, Canada, https://subatomicphysics.ca

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