Pre-Submission of the Canadian Subatomic Physics Community to the European Particle Physics Strategy Update 2025 Process

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This document is intended to inform the European Particle Physics Strategy Update (EPPSU2025) process of the current long range plan of the Canadian subatomic physics community and that further input from our community will be submitted to the EPPSU process prior to the 26 May deadline specified in https://ecfa.web.cern.ch/ecfa-guidelines-inputs-national-hep-communities-european-strategy-particle-physics-0.

The Canadian subatomic physics community is actively involved in a wide range of scientific programs, including collider physics, medium-energy experiments, underground/low background experiments, accelerator physics and nuclear physics. It is engaged in current and future research endeavours having substantial overlap with those of the European particle physics community. The subatomic physics community in Canada is fully engaged in a number of detector development activities for both accelerator and non-accelerator experiments in Europe, North America and Japan. The community, which includes accelerator physicists, is also involved in high energy accelerator research that includes collider technology development such as superconductive cavities, high intensity beams, automatic beam tuning and beam instrumentation for colliders located at CERN, KEK and BNL, as well as R&D work for other accelerator technologies with applications for nuclear and neutrino physics with facilities at CERN, TRIUMF, FNAL, BNL, and KEK/J-PARC. TRIUMF is also collaborating with DESY and HZDR on electron accelerator technologies and with GSI on heavy ion accelerator systems and beam physics. Various interests are briefly described in the Appendix of this document, which is based on the Canadian Subatomic Physics Long Range Plan 2022-26.

The Canadian subatomic physics community establishes its scientific and funding priorities through five-year Long-Range Plans. These plans advise the research community and relevant stakeholders on priorities for current and future endeavours. The current plan covers the period from 2022 to 2026, with an outlook to 2036 and is available at https://subatomicphysics.ca/.

The Canadian subatomic physics community will hold Town Hall meetings in April 2025 and will conduct a survey of its members with a specific focus on our community's interests in European facilities and infrastructure. Following this consultative process within our community, we will submit a document detailing our future interests that are relevant for EPPSU2025.

It is anticipated that our future national submission will inform the EPPSU2025 process of how the European particle physics community can leverage the human and other resources of Canada to our mutual benefit.

Appendix

This appendix is a copy of a section of Chapter 3 of the Canadian Subatomic Physics Long Range Plan 2022-26 (https://subatomicphysics.ca/).

It is included here to provide the context of the interests of the Canadian subatomic research community for the EPPSU 2025 process.

With an established track record; ongoing and newly developing international partnerships; valuable local research facilities such as TRIUMF, SNOLAB and the Perimeter Institute; and significant recent support for the development of experimental infrastructure, the Canadian community is poised to capitalize on a number of science opportunities over the coming five years, and the decade beyond. This chapter outlines the emerging science opportunities and the enabling technologies that will support progress. The research program is then presented in the form of a multi-dimensional portfolio of projects that will help the Canadian community maximize its scientific impact, training opportunities, and benefits to society.

Science opportunities for Canada

Unique features of the Canadian subatomic physics research ecosystem position the community well to seize emerging scientific opportunities, with the goal of maximizing scientific impact, training opportunities and benefits to society. In particular, Canada has significant research infrastructure in TRIUMF, SNOLAB, and the Perimeter Institute. In addition, there are active community organizations and flexible funding structures to support new scientific initiatives. Canada also has an excellent standing as a trusted international partner, and the community has the capacity to train additional highly qualified personnel (HQP).

Several scientific opportunities exist in the coming years, and these are highlighted for each of the science drivers in the sections below.

Higgs, physics at the electroweak scale and beyond

In the coming decade, there will be unique opportunities to thoroughly explore the Higgs sector, study the physics of electroweak symmetry breaking, and search for new physics at the energy frontier, with significant prospects for a wide range of exciting new results. Dedicated searches for unconventional physics signatures will also offer significant discovery potential. There will be several opportunities to indirectly explore new regions of multi-TeV physics through measurements of known and rare physics processes at an unprecedented level of precision, providing complementary possibilities for observing hints of new physics. It is also likely that by the end of the decade, the situation with respect to persisting anomalies in the B-physics sector pointing to possible lepton flavour violation will be clarified.

Building on its expertise and past investments, Canada is well-positioned to pursue further scientific opportunities through its participation and leadership, for example, in the broad physics programs of ATLAS and Belle II, dedicated searches for new physics at MATHUSLA and MoEDAL, and precision programs such as those of MOLLER and NA62. There is also an active Canadian theory community engaged in interpreting new data and pointing to potential signatures of new physics. Finally, there is the opportunity to advance detector and accelerator R&D synergistically with contributions to the HL-LHC, the development of Chiral Belle, the International Linear Collider and the Future Circular Collider projects.

Fundamental symmetries and observed asymmetries

Exploration of the fundamental symmetries in subatomic physics and their violation will continue to be at the forefront of searches for new physics phenomena and principles, providing powerful and complementary sensitivities. Opportunities exist for probing symmetries to a new level of precision by exploiting a variety of different techniques.

Within the landscape of possibilities, the combined Canadian expertise in atomic, nuclear, particle physics and accelerator research offers unique opportunities for Canada to play a scientifically leading role world-wide. TRIUMF can become a global centre for tests of CP and T violation via EDM searches, with the start of operations for the Canadian-led TUCAN project, the FrEDM experiment, and the development of the RAMS facility using radium monofluoride and francium silver molecules. New tests of parity violation can be achieved with FrPNC, studies of beta decays with ISAC and TRINAT at TRIUMF, and the launch of Nab operations at ORNL. Canadians are also well-positioned to play a significant role in future tests of the electroweak symmetry structure and the running of the Weinberg angle with the development of MOLLER, along with Belle II and the possible Chiral Belle upgrade. Spectroscopic tests of anti-hydrogen with significantly improved precision will be feasible with ALPHA-3 and ALPHA-g, and the deployment of Canadian-led HAICU. Tests of lepton flavour universality will continue with NA62 at CERN, and the development of PIONEER. Tests of neutrino properties and CP violation will continue with long-baseline neutrino experiments such as T2K and will move to the next generation of precision with HyperK and DUNE operations. Tests of lepton number violation via neutrinoless double beta decay can be further explored with next generation experiments such as nEXO, LEGEND or other detectors complementing the existing SNO+ program at SNOLAB.

Neutrino properties

The coming decade should be another exciting one for neutrino physics. At its conclusion, it is likely that the mass hierarchy will be determined, and the search for CP violation will be well underway, potentially yielding conclusive results. At the same time, searches for will have continued to push forward, and will likely have achieved sensitivity to span the inverted hierarchy parameter space. Measurements of astrophysical neutrinos will have continued to inform us about the highest energy processes in the cosmos, and neutrinos will have further illuminated our understanding of the workings of the Sun and the interior of the Earth. Research in neutrino physics continues to move forward with vigour, and new breakthrough discoveries are a distinct possibility.

Canada is well-positioned to play a leading role in all of these scientific achievements, with the development of HyperK and DUNE, the evolution of IceCube and potential development of POne, and the primacy of SNOLAB as the preferred location for tonne-scale experiments such as nEXO and LEGEND.

Dark Matter and potential dark sectors

Significant breakthroughs in our understanding of the nature of dark matter are possibly within reach in the next decade. Experiments designed to directly detect the presence of dark matter in our galactic halo are likely to achieve significant increases in sensitivity through the continuing development of experimental techniques. As experimental sensitivity approaches the important background from solar and atmospheric neutrinos (the so-called ”neutrino floor”), possible new directions include the development of experiments capable of exploring diverse mass scales, dark matter electron scattering, and directional capability in the reconstruction of dark matter interactions. In the coming decade, several accelerator-based projects aiming to produce dark matter and particles related to a possible dark sector should also have acquired significant data allowing further direct tests of this paradigm. The search for dark matter through observation of its annihilation signatures will be pursued using a variety of observatories of increasing sensitivity. The Canadian astroparticle theory community is also well-positioned to play a synergistic role in this effort.

Canada has a bright future in the search for dark matter and is in an excellent position to seize these scientific opportunities. The Cryogenic Underground Test Experiment (CUTE) infrastructure at SNOLAB will enable early exploitation of the SuperCDMS crystals for physics results. By the end of the decade, the SuperCDMS experiment at SNOLAB, will have explored a large swath of parameter space for low mass WIMPs and approach sensitivity to the solar and atmospheric neutrino background. The DEAP collaboration has joined the Global Argon Dark Matter Collaboration with the goal of running DarkSide-20k at the Gran Sasso Underground Laboratory (LNGS) in Italy and then a multi-hundred tonne detector ARGO with SNOLAB being the preferred location. The PICO experiment is expected to continue to improve its leading sensitivity in the spin-dependent WIMP sector, while the new SBC experiment will adapt this exciting new scintillating bubble-chamber technology to the search for low mass WIMPs. The NEWS-G experiment is also poised to make interesting contributions to the low mass regime and will explore directional sensitivity using a novel composite central anode in its detector. High-precision accelerator-based dark sector searches will be carried out at ATLAS, Belle II, NA62, MoEDAL and MOLLER. The DarkLight experiment is also preparing a technical design report for use of the intense ARIEL electron beam on a thin target at TRIUMF to explore dark sectors. Canadians will also take part in the commissioning and operation of a demonstrator for the future MATHUSLA project. Indirect searches for dark matter annihilation will continue at IceCube.

New physical principles and structures

Canadian theorists pursuing a deeper understanding of the foundations of subatomic physics have established global stature across a range of research sub-fields. This presents opportunities for progress in several topical areas. Canadian theorists are pursuing basic questions about the underlying structure of quantum field theory, including improved methods for calculating scattering amplitudes, the geometric structures that underpin them, and the consistency constraints on allowed quantum field theories in the strong coupling regime. The role of quantum information theory in quantum field theories is another growing area of theoretical activity across Canada; through the AdS/CFT correspondence, this work is driving an understanding of the black hole information paradox, Hawking radiation, and quantum gravity more generally. Holography (the AdS/CFT correspondence and its extensions) also continues to present opportunities to advance our understanding of strongly coupled gauge theories, with ongoing progress modeling nuclear physics such as the quark-gluon plasma, and hydrodynamics. Further research opportunities within string theory target an explanation for various features of the Standard Model, as well as properties of the vacuum, such as a cosmological constant or dark energy. This also connects to further avenues for progress, as theoretical developments in quantum field theory may provide new ideas about the very early history of the universe and its initial conditions. Cosmological observations promise in turn to provide more information about the high-energy nature of subatomic physics, including the properties of dark matter. The universality of formal theoretical tools used in subatomic physics also presents opportunities for connections to other areas, including astrophysics, condensed matter physics, and quantum computing.

Formal theoretical efforts are primarily motivated by the goal of identifying underlying structures that can systematize and extend our theoretical understanding of fundamental physics. However, over the long term, formal research will continue to feed back to more phenomenological areas of subatomic physics to inform our understanding of many of the other science drivers, as it has in the past. Canadian theorists are strongly positioned to advance formal theory on a number of fronts, providing new directions for phenomenological and experimental subatomic research over the long term.

Hadron Properties

In the coming decade, new experimental capabilities and advances on a range of theoretical fronts will help to shed light on nucleon structure and hadron properties.

Upgraded detectors for GlueX at JLab and at MAMI will extend the reach in precision and available nuclear targets. The proposed JLab Eta Factory (JEF) involves a significant upgrade to the GlueX base instrumentation, enhancing the energy and position resolution, and allowing for unprecedented precision in exotic hybrid meson searches. The Solenoidal Large Intensity Detector (SoLID) at JLab will study Generalized Parton Distributions, which can provide a tomographic 3D picture of the nucleon. Neutron spin polarizability measurements will be possible with a combination of measurements on ^{3}He and ^{4}He at MAMI, with the development of an active, high-pressure helium target.

Looking ahead, the future Electron-Ion Collider (EIC) is the only North American collider to be constructed for the foreseeable future and it is on Canada's doorstep. The new opportunities at the EIC will make it possible to achieve a transformational understanding of the dynamical system of quarks and gluons. There is significant synergy between the EIC and 12 GeV JLab program, with a rich and diverse set of experiments capable of precisely studying QCD, from the nature of the finite temperature many-body problem, to mapping the transition from hadronic to partonic degrees of freedom. Canadian researchers are involved in all these projects, from forefront theoretical activities to the development of enabling technologies for the EIC like crab cavities, and are poised to make significant discoveries about hadron structure.

Nuclear Structure

Developing a predictive understanding of nuclei and their interactions requires a wide variety of complementary experiments and theoretical tools. The coming decade will see the start of operations of new-generation infrastructure that will enable a systematic study of nuclear properties and patterns, potentially opening up a window to new and unexpected phenomena.

In Canada, the ARIEL facility and the CANREB project at TRIUMF will come online, promising a tripling of beam-time and extending the physics capability and reach for nuclear structure research. Canadian scientists will also continue to play a decisive role globally by contributing to the development of unique instruments and leading physics programs at RIBF(Japan), FAIR (Germany) and FRIB (USA).

The development of new ab initio theory, for both nuclear structure and interactions, is also Integral to this program. The synergy between experiment and theory, in terms of designing the most sensitive experiments and the feedback on the theoretical framework, will be crucial to shape a path towards the overarching goal of the field: a predictive standard model of nuclei.

Cosmic formation of nuclei

The next decade will offer new scientific opportunities in studying heavy element synthesis due to the significant increase in the infrastructure for radioactive beams worldwide, combined with multi-messenger observations of neutron star mergers. For example, it will be possible to directly study the key reactions and short-lived nuclei required to understand the reaction pathways of explosive astrophysical events.

Canada is uniquely positioned to assume a leading role in these investigations with the start of operations for the ARIEL and CANREB facilities at TRIUMF. To fully exploit TRIUMF's future beam capacity, various extensions to and upgrades of existing experimental capabilities are planned. For examples, a LaBr3 array is being planned that aims to achieve a ten fold increase in gamma tagging sensitivity of DRAGON. To enable new directions in reaction cross section measurements, especially with ^{3,4}He, an active target time projection chamber (EXACT-TPC) is also being planned.

Offshore infrastructure will also offer new scientific opportunities. For example, higher intensities of rare nuclei will extend the reach in studying exotic decays with, for example, highly-charged ions in storage rings or beta-delayed multi-neutron emitters at GSI/FAIR. Measurement of the neutron skin thickness of neutron-rich nuclei, relevant for exploring the equation of state of asymmetric nuclear matter, is also planned at GSI/FAIR and at FRIB.

Future developments in ab initio theory promise to extend the reach to high-mass nuclei utilizing exascale computing power and the development of quantum computing and algorithmic capabilities. In the modeling of compact object mergers a variety of new developments are planned including molecular dynamics simulations.

In the longer term, the installation at TRIUMF of a low-energy storage ring with a neutron generator is being explored. This infrastructure project could provide a unique capacity for directly measuring the neutron capture cross sections of rare isotopes.

Opportunities arising from synergies with other fields

In the coming decade, knowledge acquired in other research fields may also help to advance our understanding of the subatomic physics science drivers. Examples include:

- Future developments in astronomy and astrophysics; e.g. potential gravitational wave signatures of early particle cosmology, potential signatures of dark matter in a number of future ground-based and satellite observatories, developments in the simulation of galaxy structure and formation, and multi-messenger observations of compact object mergers that could provide insight into the equation of state of high density matter.

- Next generation experiments measuring the cosmic microwave background will achieve a significant increase in precision in constraining the nature of neutrinos, dark matter, and dark sectors.
- Developments in the technology of quantum sensing and computing, and theoretical aspects of quantum condensed matter are occurring rapidly and are likely to open further opportunities in exploring the subatomic physics science drivers; some examples will be outlined below.

Likewise, there are opportunities for future subatomic physics research outcomes to have an impact on other related research fields:

- An experimental measurement of the absolute neutrino mass scale could have direct implications in cosmology.
- Precise measurements of new nuclear properties and rates will enable better understanding and modeling of processes in stellar astrophysics.
- Developments in accelerator and detector technology are likely to open further opportunities for research in other fields; examples include the development of
  - new medical physics diagnostics and treatment.
  - applications supporting green technologies.
  - space systems designed for deep space exploration.
  - imaging and tomography instruments for material science.

Appendix: Glossary

ALPHA (Antihydrogen Laser PHysics Apparatus): A set of experiments at the CERN Antiproton Decelerator trapping and studying the properties of antihydrogen atoms (incorporates ALPHA-3 and ALPHA-g).

ANL (Argonne National Laboratory): A DOE national laboratory in Argonne, Illinois, which is home to a number of facilities, including the ATLAS heavy-ion accelerator.

ARIEL (Advanced Rare IsotopE Laboratory): A project to enhance TRIUMF's capabilities to produce rare isotope beams and to showcase new Canadian accelerator technology.

ATLAS (A Toroidal LHC ApparatuS): An experiment at the CERN Large Hadron Collider, one of the two general-purpose detectors at the Large Hadron Collider, primarily detecting the collision products of proton-proton collisions.

BaBar: A B-hadron physics experiment that studied the particles produced in collisions between electrons and positrons accelerated by the PEP-II collider at the SLAC National Accelerator Laboratory.

Belle II: A B-hadron physics experiment at the SuperKEKB electron-positron collider in Japan.

BNL (Brookhaven National Laboratory): A multipurpose Department of Energy National Laboratory located on Long Island, New York.

BRIKEN (Beta-delayed neutron studies at RIKEN): A large 3He-long counter neutron detection array with an implantation detector which will take data at the Riken Nishina Center until 2021.

BSM (Beyond the Standard Model): As yet undiscovered physics necessary to formulate a complete description of matter and forces.

CANARIE: CANARIE operates and evolves the national backbone of Canada's ultra-high-speed National Research and Education Network (NREN), providing the national and international networking for Canada's subatomic physics community.

CANREB (CANadian Rare-isotope facility with Electron-Beam ion source): A CFI-funded project that will improve the purity of rare ion beams delivered by ARIEL to ISAC.

CARIBU (CAlifornium Rare Isotope Breeder Upgrade): A facility for creating neutron-rich rare isotopes at Argonne National Laboratory.

CERN (the European Organization for Nuclear Research): International laboratory for nuclear and particle physics located on the French-Swiss border near Geneva.

CFI (Canada Foundation for Innovation): Created by the Government of Canada in 1997, CFI makes investments in state-of-the-art research facilities and equipment in a wide variety of scientific disciplines.

CINP (Canadian Institute of Nuclear Physics): A formal organization of the Canadian nuclear physics research community to promote excellence in nuclear research and education, and to advocate the interests and goals of the community both domestically and abroad. It gathered input from the Canadian nuclear physics research community for this document.

CLIC (Compact LInear Collider): A high-energy and high-luminosity collider proposed for CERN aiming at accelerating and colliding electrons and positrons at a nominal energy of 3 TeV.

CPT (Canadian Penning Trap): A mass spectrometer designed to provide high-precision mass measurements of short-lived isotopes. It is located at the Argonne National Laboratory in Argonne, Illinois.

CREX (Calcium Radius EXperiment): Experiment at JLab to measure the neutron radius of 48Ca.

CUTE (the Cryogenic Underground Test Experiment): An underground facility at SNOLAB for testing and characterizaton of SuperCDMS crystals and other cryogenic detectors.

DEAP/DEAP-3600 (Dark matter Experiment using Argon Pulse shape discrimination): A dark matter experiment searching for direct detection of weakly interacting massive particles using scintillation in 3.3 tonnes of liquid argon.

DeepCore: A densely instrumented region of the IceCube array, extending the observable energies to below 100 GeV.

DESCANT (DEuterated SCintillator Array for Neutron Tagging): A 70-element neutron detector array to be used at ISAC.

DOE (Department of Energy): The United States Department of Energy, which operates a number of national laboratories across the USA.

DRAGON (Detector of Recoils And Gammas Of Nuclear reactions): A detector designed to measure the rates of nuclear reactions important in astrophysics, based at ISAC-I.

EDM (Electric Dipole Moment): A relative displacement of positive and negative charge in an object. Permanent electric dipole moments are forbidden for fundamental particles by time reversal violation.

EIC (Electron-Ion Collider): A new DOE nuclear physics user facility under construction at Brookhaven National Lab.

ELENA (Extra Low ENergy Antiproton ring): An Antiproton cooling and deceleration ring under commissioning at CERN, which will serve ALPHA and other experiments. It is a significant upgrade to the Antiproton Decelerator.

EMMA (ElectroMagnetic Mass Analyzer): A device to study the products of nuclear reactions involving rare isotopes at ISAC-II.

EURICA (EUroball-RIKEN Cluster): A γ-ray nuclei spectroscopy project at RIKEN.

EXO (Enriched Xenon Observatory): An experiment to measure neutrinoless double beta-decay in 136Xe. The EXO-200 experiment is located at the WIPP facility in New Mexico, USA. nEXO is under development for installation at SNOLAB.

FAIR (Facility for Antiproton and Ion Research): An accelerator facility for studying nuclear structure and nuclear matter, presently under construction as an upgrade of the GSI facility in Darmstadt, Germany.

FRIB (Facility for Rare Isotope Beams): A new DOE user facility for nuclear science on the campus of Michigan State University in the USA with first experiments in 2022.

FrPNC (Francium Parity Non-Conservation): An experiment to study atomic parity non-conservation in francium, based at ISAC-I.

GlueX (Gluonic Excitations Experiment): An experiment seeking to identify hybrid mesons with explicit gluonic degrees of freedom at Jefferson Lab Hall D.

GSI (GSI Helmholtz Centre for Heavy Ion Research) A research center in Darmstadt, Germany.

GRIFFIN (Gamma-Ray Infrastructure For Fundamental Investigations of Nuclei): A detector at ISAC-I for studying nuclear decays at high resolution.

HALO (Helium And Lead Observatory): A long-term, low-cost, high-livetime, and low-maintenance dedicated supernova detector running at SNOLAB.

HIGS (High Intensity Gamma-Ray Source): A free-electron-laser-based Compton backscattering gamma-ray source at Duke University.

HL-LHC (High-Luminosity LHC): The high-luminosity running phase of the LHC planned to begin in 2027.

HQP (Highly Qualified Personnel): Personnel obtaining advanced skills as a result of NSERC-funded research, including students, postdocs and technicians.

IceCube (IceCube Neutrino Observatory): A particle detector at the South Pole encompassing a cubic kilometer of ice instrumented with a 3D array of photo-detectors.

ILC (International Linear Collider): A proposed linear particle accelerator with planned collision energy of 250 GeV initially with a planned upgrade to 500 GeV initially, with the possibility for a later upgrade to 1 TeV.

ILD (International Large Detector): A detector proposed for the ILC.

IPP (Institute of Particle Physics): A formal organization that promotes Canadian excellence in particle physics research and advanced education. It gathered input from the Canadian particle physics research community for this document.

IRIS (ISAC Charged Particle Reaction Spectroscopy Station): A rare-isotope reaction spectroscopy station utilizing reactions with a frozen (solid) hydrogen and deuterium targets.

ISAC (Isotope Separator and ACcelerator): A rare isotope accelerator facility, based at TRIUMF. There are two experimental halls, ISAC-I and ISAC-II.

ISOL (Isotope Separation On-Line): A technique of radioactive ion production in which spallation and fission of thick targets is used to produce a wide range of radioactive fission fragments.

ISOLDE (Isotope Separator On-Line DEtector): An On-Line Isotope Mass Separator facility at CERN for the study of low-energy beams of radioactive isotopes.

JLab (Jefferson Lab): The Thomas Jefferson National Accelerator Facility, located in Newport News, Virginia.

J-PARC (Japan Proton Accelerator Research Complex): Joint project between KEK and the Japan Atomic Energy Agency, which hosts the proton accelerator used in the T2K experiment (and future HyperK experiment).

KEK (High Energy Accelerator Research Organization and National Laboratory): A Laboratory located in Tsukuba, Japan, specialising in neutrino and B-hadron and other flavour physics.

SuperKEKB (KEK B-physics): An Asymmetric Electron-Positron Collider operating at 10GeV centre-of-mass located at KEK. It hosts the Belle II experiment.

LBNF/DUNE (Long-Baseline Neutrino Facility/Deep Underground Neutrino Experiment): Dual-site experiment for neutrino science and proton decay studies, hosted by Fermilab and the Sanford Underground Research Facility.

LEGEND: A collaboration to search for neutrinoless double beta decay formed with the merger of the Gerda and Majorana collaborations. LEGEND-200 is an experiment under construction at Gran Sasso Laboratory in Italy. LEGEND-1000 is a proposed detector comprising 1000 kg of germanium crystals.

LEP (Large Electron-Positron Collider): Electron-positron collider that used to be sited at CERN.

LHC (Large Hadron Collider): A proton and heavy ion collider at CERN which hosts the ATLAS, CMS, LHCb, and ALICE experiments.

MAMI (Mainz Microtron): An electron accelerator facility, located on the campus of the Johannes Gutenberg University of Mainz, Germany.

MOLLER (Measurement Of a Lepton-Lepton Electroweak Reaction): An experiment to measure the parity-violating asymmetry in electron-electron (Moller) scattering at Jefferson Lab.

MRS (Major Resources Support): An NSERC program to facilitate the effective access by Canadian academic researchers, working in the field of subatomic physics, to major and unique national or international (based in Canada) experimental or thematic research resources by financially assisting these resources to remain in a state of readiness for researchers' to use.

NA62: Experiment at the CERN Super Proton Synchrotron to measure the rare kaon decay $K^+ \rightarrow \pi^+ \nu\nu$.

NDRIO (New Digitial Research Infrastructure Organization): Organization tasked with restructuring Canadian academic research computing. The organization was renamed the Digital Research Alliance of Canada in late 2021.

NEWS-G (New Experiments With Spheres - Gas): Collaboration developing gaseous spherical proportional counters for multiple particle detection purposes. NEWS-G @SNOLAB is an experimental direct search for dark matter, currently operating at SNOLAB.

nEXO (The next phase of the Enriched Xenon Observatory): A next-generation experiment searching for neutrinoless double-beta decay in 5 tonnes of liquefied xenon enriched in 136Xe, proposed for SNOLAB.

NSERC (Natural Sciences and Engineering Research Council of Canada): An agency of the Government of Canada that supports university students in their advanced studies, promotes and supports discovery research, and fosters innovation by encouraging Canadian companies to participate and invest in postsecondary research projects.

NuPRISM: Proposed intermediate water Cherenkov detector for the J-PARC neutrino beam.

PI (Perimeter Institute for Theoretical Physics): Centre for scientific research, training, and educational outreach in foundational theoretical physics based in Waterloo, Ontario.

PICO: A collaboration formed merging the Picasso and COUPP experiments that searched for direct detection of dark matter with bubble chambers at SNOLAB. The current detector, PICO-40L, operates with 40 L of superheated liquids. A 500 kg version, PICO-500, is under construction at SNOLAB.

PIONEER: A proposed next generation pion decay experiment to be hosted at the Paul Scherrer Institute (PSI).

P-ONE (Pacific Ocean Neutrino Experiment): A proposed neutrino telescope in the deep waters of the Pacific Ocean off Vancouver Island, BC, supported by Ocean Networks Canada infrastructure.

PREX (208Pb Radius EXperiment): PREX uses the parity violating weak neutral interaction to probe the neutron distribution in 208Pb at JLab.

Qweak: A precision test of the Standard Model and determination of the weak charges of the quarks through parity-violating electron scattering at JLab. Final results were published in 2018.

QCD (Quantum ChromoDynamics): The theory describing the fundamental interactions between quarks and gluons.

RHIC (Relativistic Heavy Ion Collider): Heavy-ion collider at Brookhaven National Laboratory in the USA.

RIB (Rare Isotope Beam): A beam used in studies of nuclear structure and nuclear reactions of astrophysical importance.

RIBF (Rare Isotope Beam Factory): A user facility for nuclear science, located at RIKEN Nishina Center, Japan.

RIKEN (The Institute of Physical and Chemical Research): Japan's largest comprehensive research institution that performs research in a diverse range of scientific disciplines, including physics, chemistry, medical science, biology and engineering.

RTI (Research Tools and Instruments): NSERC program to financially support research tools and instruments.

SAP (SubAtomic Physics): The broader field of nuclear and particle physics, comprising all knowledge taking place at scales smaller than that of the atom.

SBC (Scintillating Bubble Chamber): Experiment proposed for SNOLAB to search for dark matter and coherent neutrino scattering.

SHARC (Silicon Highly-segmented Array for Reactions and Coulex): A multi-purpose array for charged-particle detection which offers unique capabilities when integrated with the TIGRESS gamma-ray detectors and the post-accelerated beams at the new ISAC-II facility.

SLAC (Standford Linear Accelerator): SLAC National Accelerator Laboratory is a U.S. Department of Energy Office of Science laboratory operated by Stanford University.

SM (Standard Model): The Standard Model of elementary particle interactions.

SNO (Sudbury Neutrino Observatory): A heavy-water based solar neutrino physics experiment that was located deep underground in Sudbury which solved the solar neutrino problem. Professor Arthur McDonald shared the 2015 Nobel Prize for his direction of SNO.

SNO+: An experiment at SNOLAB whose objective is to study neutrinoless double beta-decay and lower-energy solar and geo-neutrinos using a liquid scintillator instead of heavy water in the SNO detector.

SNOLAB (Sudbury Neutrino Observatory Laboratory): A deep underground facility in Sudbury, Ontario, specializing in neutrino physics and the search for dark matter.

SoLID (Solenoidal Large Intensity Device): A high luminosity, large acceptance detector proposed for Jefferson Lab Hall A that makes use of the former CLEO solenoid magnet.

SRF (Superconducting Radio Frequency): Acceleration of charged particles via the use of superconducting cavities operating in the radio frequency range. Examples include the ISAC-II and ARIEL accelerators at TRIUMF and the Continuous Electron Beam Accelerator at Jefferson Lab.

SuperCDMS (Cryogenic Dark Matter Search): A dark matter experiment under construction at SNOLAB, and successor to previous generations of CDMS experiments, that will search for the direct detection of weakly interacting massive particles using cryogenic silicon germanium detectors.

SuperFRS (Super Fragment Separator): A proposed large-acceptance superconducting fragment separator followed by different experimental branches including a combination with a new storage-cooler ring system at GSI.

T2K (Tokai to Kamioka): A long baseline experiment from J-PARC to the Super-Kamiokande neutrino detector in Japan to study the physics of neutrino oscillation.

TIGRESS (TRIUMF-ISAC Gamma-Ray Escape-Suppressed Spectrometer): A detector at ISAC-II for studying nuclear decays at high resolution.

TITAN (TRIUMF's Ion Trap for Atomic and Nuclear science): An ion trap facility at ISAC for high-precision mass measurements of rare isotopes.

TRINAT (TRIUMF Neutral Atom Trap): A device to trap and study the radioactive decays of neutral atoms, based at ISAC-I.

TRIUMF: Canada's national laboratory for particle and nuclear physics and accelerator-based science.

TUCAN (TRIUMF Ultra-Cold Advanced Neutron): A CFI-funded facility to study ultra-cold neutron properties at high precision, under development at TRIUMF.

TUDA (TRIUMF U.K. Detector Array): A detector designed to measure the rates of nuclear reactions important in astrophysics, based at ISAC-I.

TUEC (TRIUMF User-group Executive Committee): An elected body of seven members designed to manage the business and affairs of the TRIUMF Users Group.

UCN: (Ultra-Cold Neutrons): Neutrons with a kinetic energy of approximately 300 neV, or velocities $\simeq 7$ m/s.