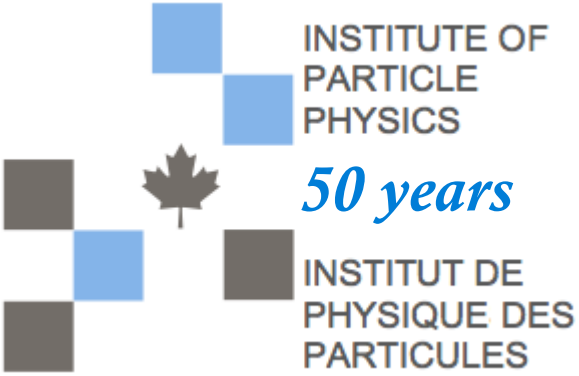
# Institute of Particle Physics Brief to the Canadian Subatomic Physics Long Range Plan

# Overview and Updates

Canadian Subatomic Physics Long Range Plan
Community Townhall Meeting
20 April 2021




J. Michael Roney
IPP Director

# Outline

- Overview of the IPP Brief
- Updates to the IPP Brief:
  - New IPP Projects approved since IPP Brief submission
  - Updates on submissions including new CFI funding announcements since IPP Brief submission
  - TRIUMF 20-year Vision - possible new projects of interest to IPP
  - New Digital Research Infrastructure Organization (NDRIO) Update
  - SNOLAB Strategic Plan
  - McDonald Institute Developments
  - Laurentian University

# Subatomic Physics Long Range Plan 2022-2026

Co-sponsored by NSERC, IPP, and CINP

- In effect from 2022 through 2026 with scope extending to 2036
- From LRP Terms of Reference: “These briefs must summarize the scientific vision and priorities put forward by the sub-communities they represent and serve, including both experimental and theoretical facets.”
- Extensive particle physics community consultation
- IPP Brief submitted 1 Dec. 2020

# IPP Brief Writing Committee consists of the IPP Scientific Council of 2019-20 and 2020-21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# IPP Process for Long Range Plan

February 26th email announcing the LRP process with the general call April 1st to IPP Membership for input into the LRP, via written submissions. A follow-up survey of members was conducted in October.

- 12 IPP Projects made submissions
- Other initiatives that may be IPP Projects in the future
- Submissions related to technical support needs: detector development support; computing; accelerator R&D
- Submissions on theory activity related to experimental program
- 30 submissions were received in total
- Note that some projects of interest to both CINP and IPP

# Guidelines for project submissions to IPP Long Range Plan Brief

**Section 1: Plans for the project in the five year period starting in 2022** (Include table of grant eligible members w/ FTEs)

**Section 2: Equity, Diversity and Inclusion Considerations**

**Section 3: Plans for the project from to 2036**

**Section 4: Broader Societal Impact** (Include table of HQP trained – i.e. students and postdocs)

(see Additional Material section for more details)

# Canadian Particle Physicists Address the 'Big Questions' of our Time

- Is there new physics at or above the TeV scale accessible to the LHC direct searches and precision measurements or rare decays from multiple experiments?
- What is the nature of the dark matter (DM) that comprises 85% of matter in the universe?
- Is there a hidden "dark sector" ?
- What is the origin and nature of the matter-antimatter asymmetry that produced our matter-dominated universe?
- What is the nature of the neutrino and what can we learn by probing neutrino oscillations?
- How are gravity and dark energy incorporated into the rest of the particle physics theoretical framework, and how can that knowledge be used to understand the history of the universe?

# Canadian Particle Physics Landscape

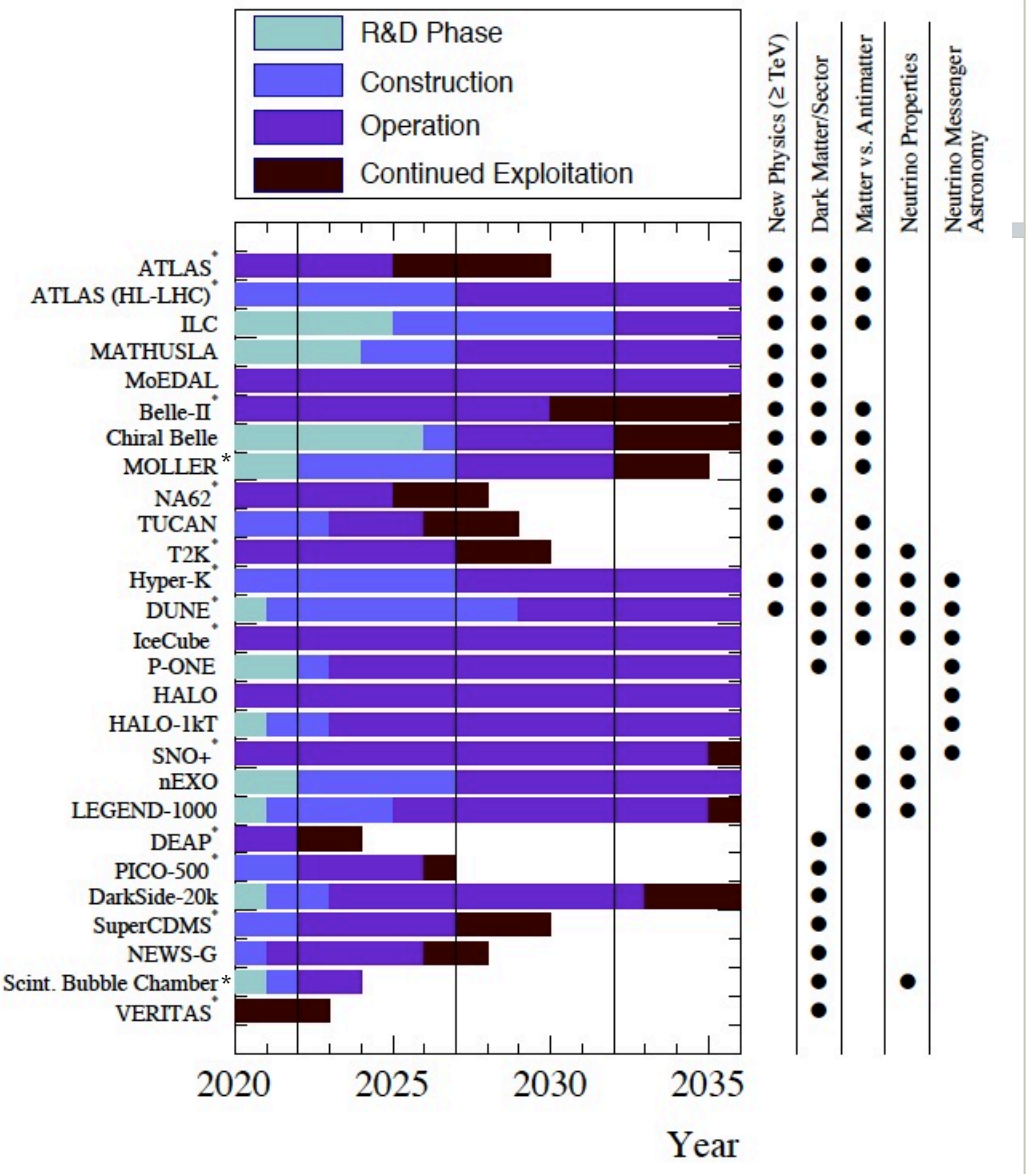



Figure 1: Projects discussed in this report, and the physics topics each addresses. The "*" indicates approved IPP projects. The filled circles on the right indicate the physics topics addressed by each experiment.

# Theorists in Canada

work on a very wide range of topics and try to address the "Big Questions" - from the dynamics of strong force to origin of dark matter to the nature of quantum gravity.

| Name | Institution | Subject |
|---|---|---|
| Mohammad Ahmady | Mount Allison | hep-ph |
| Aleksandrs Aleksejevs | Memorial | hep-ph, hep-th |
| Jonathan Bagger | TRIUMF | hep-th |
| Svetlana Barkanova | Memorial | hep-ph, hep-th |
| Ian Blokland | Alberta | hep-ph |
| Vincent Bouchard | Alberta | math-ph |
| Nassim Bozorgnia | York | astro-ph, hep-ph |
| Joe Bramante | Queen's/PI | hep-ph |
| Robert Brandenberger | McGill | astro-ph, hep-th |
| Alex Buchel | Western/PI | hep-th |
| Cliff Burgess | McMaster/PI | gr-qc, hep-ph, hep-th |
| Bruce Campbell | Carleton | hep-ph |
| Margaret Carrington | Brandon | hep-ph, hep-th |
| James Cline | McGill | hep-ph |
| Gilles Couture | UQAM | hep-ph |
| David Curtin | Toronto | hep-ph |
| Andrzej Czarnecki | Alberta | hep-ph |
| Keshav Dasgupta | McGill | hep-th |
| Rainer Dick | Saskatchewan | hep-ph |
| Mariana Frank | Concordia | hep-ph |
| Andrew Frey | Winnipeg | hep-th |
| Steve Godfrey | Carleton | hep-ph |
| Jaume Gomis | PI | hep-th |
| Thomas Gregoire | Carleton | hep-ph |
| Derek Harnett | Fraser Valley | hep-ph |
| Bob Holdom | Toronto | gr-qc, hep-ph |
| Calvin Kalman | Concordia | ed-ph |
| Pat Kalyniak | Carleton | hep-ph |
| Joanna Karczmarek | UBC | hep-th |
| Gabriel Karl | Guelph | hep-ph |
| Achim Kempf | Waterloo/PI | gr-qc, quant-ph |
| Nikolay Kolev | Regina | hep-ph |
| Pavel Kovtun | Victoria | hep-th |
| Helmut Kroeger | Laval | hep-lat, hep-th |
| Gabor Kunstatter | Winnipeg | gr-qc, hep-th |
| Randy Lewis | York | hep-lat, hep-ph |
| Heather Logan | Carleton | hep-ph |
| David London | Montréal | hep-ph |
| Michael Luke | Toronto | hep-ph |
| Richard MacKenzie | Montréal | hep-ph, hep-th |
| Alexander Maloney | McGill | hep-th |
| Kim Maltman | York | hep-lat, hep-ph |
| Rob Mann | Waterloo/PI | gr-qc, hep-th |
| Luc Marleau | Laval | hep-ph |
| Pierre Mathieu | Laval | hep-th, math-ph |
| David McKeen | TRIUMF | astro-ph, hep-ph |
| Vladimir Miransky | Western | cond-mat |
| Nader Mobed | Regina | gr-qc, hep-th |
| John Moffat | Waterloo/PI | gr-qc |
| M. de Montigny | Alberta | gr-qc |
| David Morrissey | TRIUMF | hep-ph |
| Robert Myers | PI | hep-th |
| John Ng | TRIUMF | hep-ph |
| Rachid Ouyed | Calgary | astro-ph, nucl-th |
| Manu B. Paranjape | Montréal | cond-mat, gr-qc, hep-th |
| AW Peet | Toronto | hep-th |
| Alexander Penin | Alberta | hep-ph |
| Levon Pogosian | SFU | astro-ph |
| Erich Poppitz | Toronto | hep-th |
| Maxim Pospelov | Victoria/PI | astro-ph, hep-ph |
| Saeed Rastgoo | York | gr-qc |
| Adam Ritz | Victoria | hep-ph |
| Moshe Rozali | UBC | hep-th |
| Ruben Sandapen | Acadia | hep-ph |
| Gordon Semenoff | UBC | cond-mat, hep-th |
| Kris Sigurdson | UBC | astro-ph |
| Rafael Sorkin | PI | gr-qc, hep-th |
| Tom Steele | Saskatchewan | hep-ph |
| Daniel Stolarski | Carleton | hep-ph |
| Sean Tulin | York | astro-ph, hep-ph |
| Mark Van Raamsdonk | UBC | hep-th |
| Aaron Vincent | Queen's | astro-ph, hep-ph |
| Peter Watson | Carleton | hep-ph |
| Richard Woloshyn | TRIUMF | hep-lat |
| Yue Zhang | Carleton | hep-ph |
| Ariel Zhitnitsky | UBC | astro-ph, hep-ph |

Table 1: Theory members of the IPP. Subject is the arXiv category(ies) of the majority of recent work.

# Theory work in Canada includes:

- Precise predictions for the Standard Model (SM) and beyond.
- New theoretical methods to better understand quantum field theory.
- New theories that address deficiencies of the SM.
- Proposals for new experiments and techniques.
- Developments in quantum gravity.

# Canadian particle physics community has been successful in prioritizing resource allocation for projects by determining:

- Whether a project addresses some of the most important scientific questions of our time;
- How effectively the project addresses the question(s);
- How much impact the Canadian team has on the overall effort based on the excellence of research team and their contributions to the overall project;
- Whether a project maintains the successful Canadian practice in particle physics of focusing our limited resources and effort on non-competing projects to ensure we have the highest impact on those projects with which we are already involved.

# IPP Projects

ATLAS

Belle II

DEAP-3600 (and DarkSide-20k)

DUNE

HYPER-K

IceCube (and P-One)

NA62

# IPP Projects

PICO

SNO+

SuperCDMS

T2K

VERITAS

# Other Projects

Physics Motivation of Future Accelerators

Chiral Belle R&D for SuperKEKB e- Polarization Upgrade

HALO

ILC and ILD

LEGEND-1000

MATHUSLA

# Other Projects

MoEDAL

MOLLER - *Now approved as an IPP Project*

NEWS-G

nEXO

Scintillating Bubble Chamber – *Now approved as an IPP Project*

TUCAN

# Community Resources: R&D and Infrastructure

- Research and development for radiation-hard semi-conductor devices for tracking detectors in future collider experiments
- Photon to Digital Converter R&D and Silicon Photonics-based low power cryogenic (+room temp) data communication system
- Particle Accelerator R&D
- Detector Development and Infrastructure
- Research Computing and Digital Infrastructure

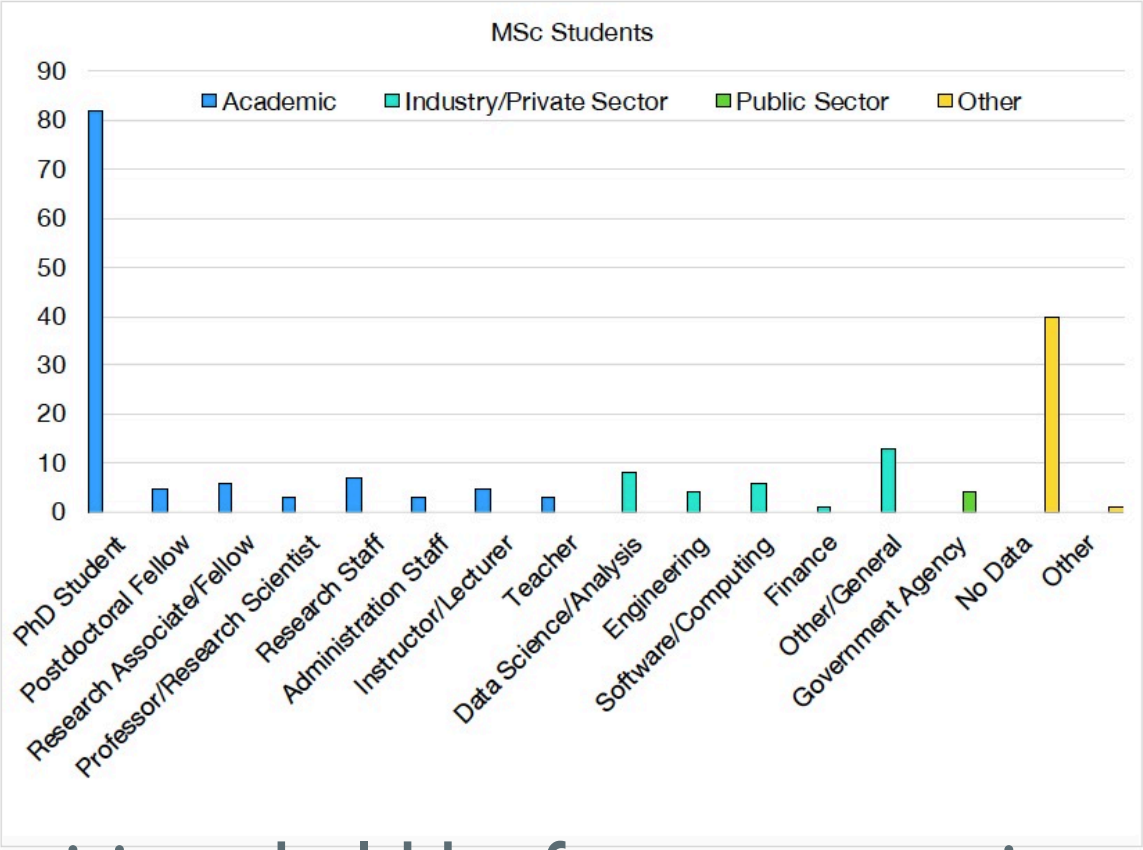
# Equity, Diversity and Inclusion

- Systems and Policies to Promote Equity, Diversity and Inclusion
- Programs to Promote Equity, Diversity and Inclusion
- Challenges to Achieve Equity, Diversity and Inclusion
- Goals for 2022-2026 Period

# Broader Societal Impact

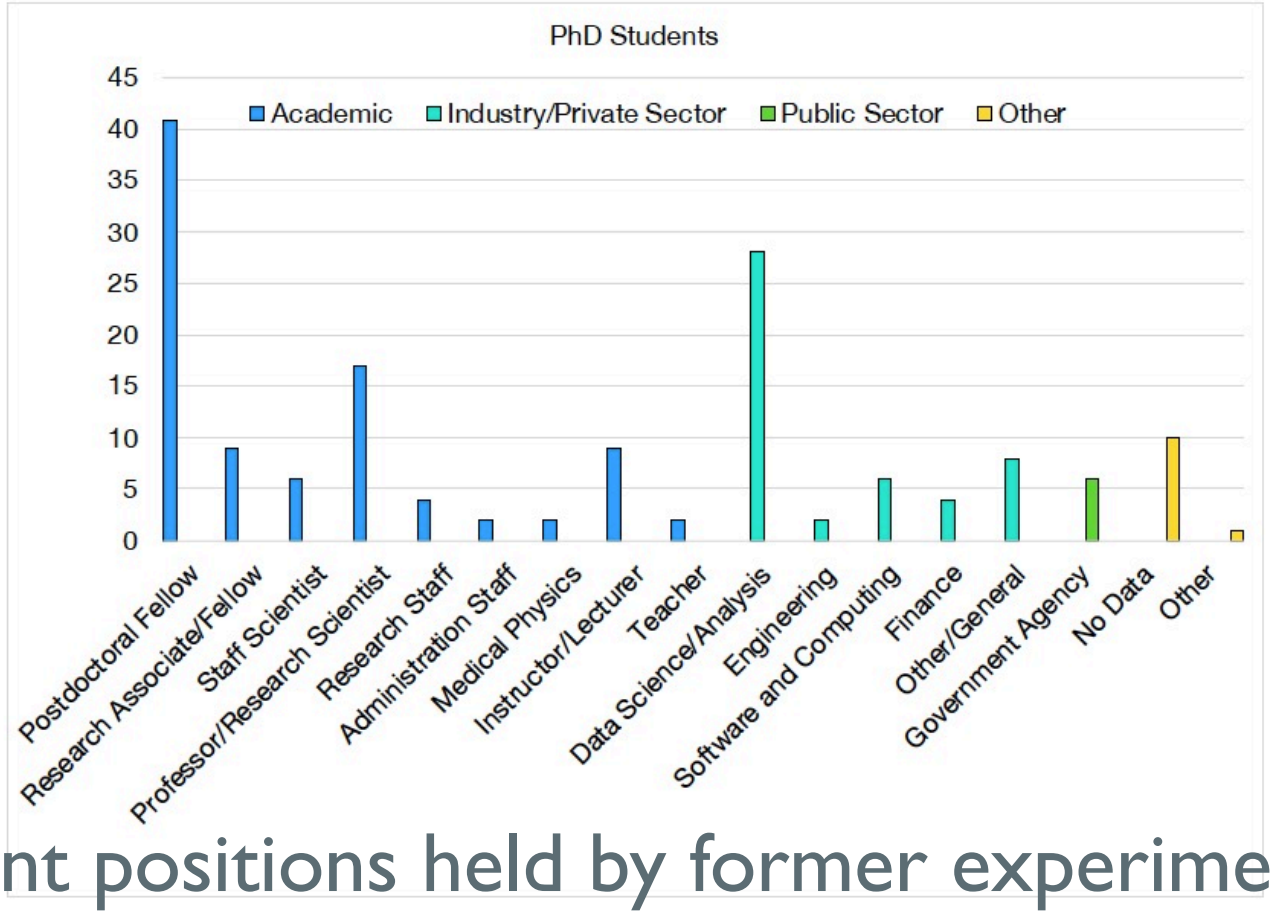
- Includes examples of direct engagement with industrial partners
- Includes small sample of stories of HQP careers post-graduation
  - Balancing across regions and areas of research
  - Some emphasis on those who have gone outside academia

# Graphical representation of Broader Societal Impact




Current positions held by former experimental particle physics HQP – restricted to last decade.

# Graphical representation of Broader Societal Impact

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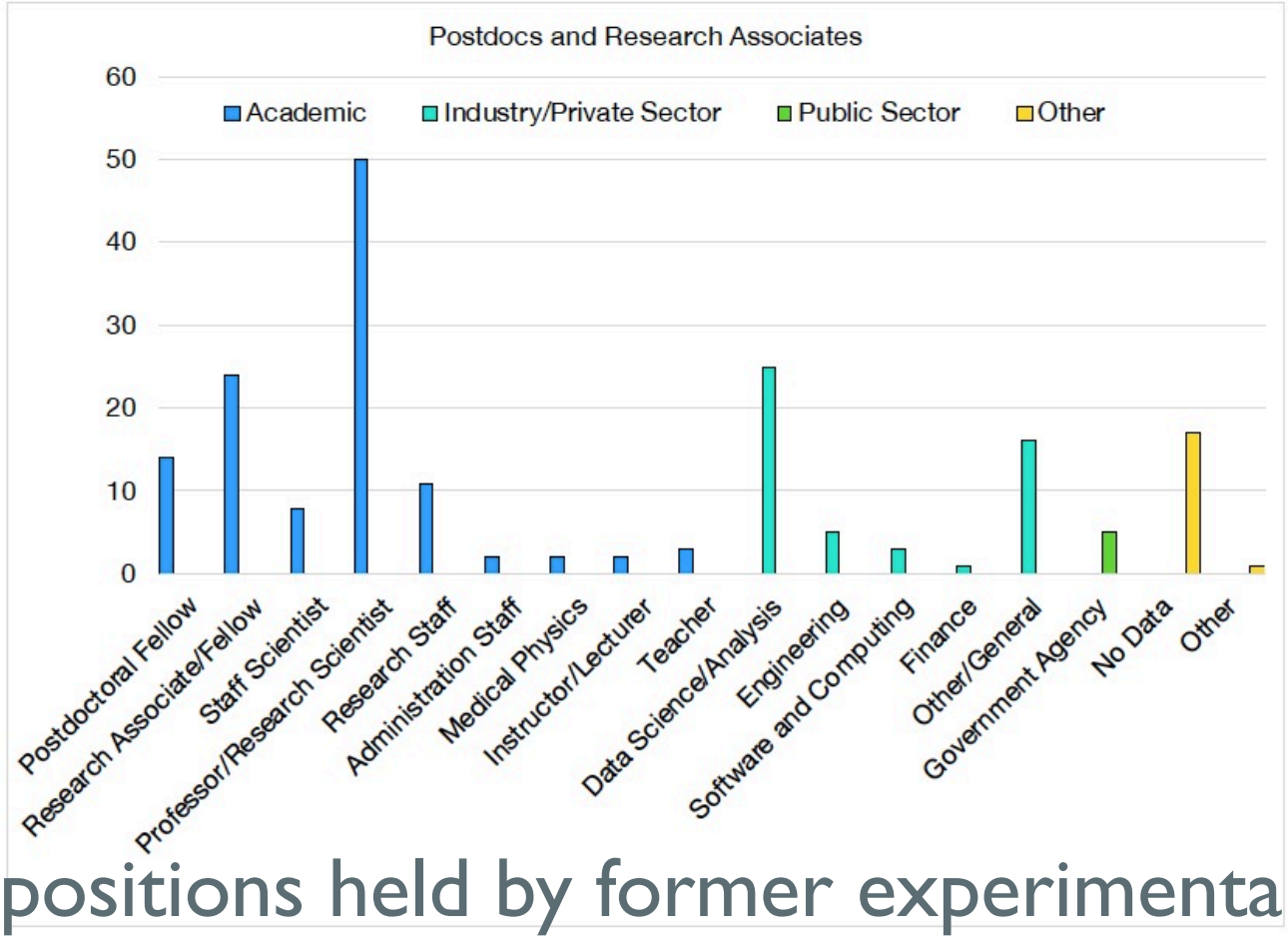



Current positions held by former experimental particle physics HQP – restricted to last decade.

# Program Priorities

- **HQP Training**: a key metric in assessing priorities – note that the numbers of postdocs and student that members of the IPP community can train is largely limited by the funding available in Discovery and Project grants
- **Theory:** it is essential that the IPP theory community continue to be adequately supported from the NSERC subatomic physics envelope - necessary to maximize the scientific output of the experimental program. IPP advocates funding to support an increase in the number of theory students and postdocs at a similar rate to the experimental members of the community.

# Program Priorities: Current Experimental Program

- **Group of *"essential projects"* which will be taking data during this period and in which there has been significant Canadian investment already.** In each of these essential projects the Canadian teams have a substantial contingent of fully engaged grant eligible personnel who are supervising students and who are making important, and in some cases critical, impact on the experiment. Scientific benefits from the investments will be realized during the Long Range Plan period. These are projects that are approved by the host country's funding agencies and labs and span the range of physics being probed by IPP researchers. This group of projects covers the greatest phase-space for discovery in the program. These essential projects also have successful records of HQP training.

- **Set of "important projects" that are complementary to the essential projects but which may involve a smaller number of investigators allocating substantial fraction of their research time or which may address a similar discovery goal as an "essential project" but with a more focused discovery phase-space.** They are indeed important because there is a potential that they may be the best way of making a major discovery.

- **The program should also support small, low cost projects with a compelling physics case but which involves a small group of people taking advantage of particular technological opportunities that enable the project and keep the costs low.** For a balanced program, it is important to ensure that some resources are allocated to smaller projects, especially those in the early stages of development.

# Program Priorities: Current Experimental Program

**Current Project Areas Deemed Essential/Important by the Community**

- **Energy Frontier**
- **Precision Frontier**
- **Neutrino Oscillations**
- **Direct Dark Matter Detection**
- **Neutrinoless Double-beta Decay**

# Summary of Particle Physics Priorities Looking Forward

## NSERC supported areas

- The particle physics community considers the IPP Research Scientist Program to be its highest funding priority from the SAP envelope for particle physics. It has ensured that the field in Canada is functioning at the highest levels in the world and that Canadians are in the highest leadership positions in the international particle physics experiments.
- It is essential to maintain and fully support the subatomic physics Major Resources Support facilities. These community resources, to which there is good and transparent access from across the country, have become increasingly critical to ensuring that the experiments can be designed and built. This is particularly true now as resources at TRIUMF have become extremely stretched because it has ARIEL-II as a top construction priority.
- IPP strongly endorses with high priority the subatomic physics RTI program. It provides modest but critical and timely moderate levels of funding for equipment essential to experiments and R&D initiatives that are often subsequently the basis for substantial CFI requests.
- As the SAP envelope increases, it is essential for the subatomic physics theory community to be secured in maintaining increased operating grants to support increased HQP funding.

# Summary of Particle Physics Priorities Looking Forward

## NSERC supported areas

- ATLAS is the highest priority project in particle physics in Canada and with the approval of the high luminosity LHC running it will continue to be an essential IPP project.
- Belle II and TUCAN are essential projects at the precision frontier and will take data throughout this Long Range Plan period and beyond.
- T2K and IceCube are essential projects that probe neutrino properties, oscillation, CP violation and mass hierarchy. DUNE, as discussed in Section 9.3.3, is complementary to Hyper-K, but currently has a small Canadian group.
- DEAP, transitioning to DarkSide-20k, is a high-priority program with sensitivity to the direct detection of Dark Matter over a wide mass range, SuperCDMS has high sensitivity at lower masses, and PICO-500 has world-leading sensitivity to Dark Matter if it has interactions that depend on the spin of the target nucleus. All three have committed Canadian teams and are essential projects.
- SNO+ continues to be a high priority neutrinoless double-beta decay experiment. The nEXO neutrinoless double-beta decay project has a large Canadian commitment, but is awaiting funding approval by the U.S.
- As the science develops and new opportunities and ideas arise, it is important to ensure that some resources (at the level of several percent in total) be available to support smaller efforts that are in the early stages of research and development or require limited resources. In all cases, the scientific excellence and significant potential for major scientific advances are the minimal criteria for support.

# Summary of Particle Physics Priorities Looking Forward

## NSERC supported areas

Among the set of projects that will take data during the period of the Long Range Plan, a subset was identified as “essential" to the Canadian particle physics community based on the level of engagement of the researchers in the projects, scientific and technological training of the next generation, Canadian investments in those projects to date, and on their potential scientific payoff.

These essential projects are:

- ATLAS, directly probing the energy frontier;
- Belle II and TUCAN, two precision frontier experiments which are sensitive to new physics;
- DEAP, PICO-500 and SuperCDMS which are complementary direct dark matter detection projects;
- SNO+, the search for neutrinoless double beta decay;
- T2K and IceCube, complementary programs probing neutrino mixing.

Three of these essential projects are transitioning programs, with the new phases also at the highest priority but not necessarily taking data during the Long Range Plan period. These transitioning programs are: ATLAS at the upgraded High Luminosity LHC; DEAP at SNOLAB with the Canadian team moving to DarkSide-20k at LNGS; and T2K with the group largely moving to Hyper-K.

# Summary of Particle Physics Priorities Looking Forward

## NSERC supported areas

There are also a number of "important" projects that will not be taking data during this period, including DUNE and MOLLER - both of which are IPP Projects- as well as Chiral Belle, MATHUSLA, and nEXO. Some of these experiments will become essential as they approach data-taking operation depending on the level of Canadian effort and breadth of the physics program, while the last three projects also require final approval.

Other projects that will be taking data during the LRP period with focussed discovery potential include MoEDAL, NA62, P-ONE, HALO/HALO-1kT, NEWS-G, the Scintillating Bubble Chamber (SBC) and LEGEND- 1000 (if approved). VERITAS is in the final data analysis phase of the project. It is important to ensure that some resources are allocated to smaller projects, especially those in the early stages of development.

# Summary of Particle Physics Priorities Looking Forward

## NSERC supported areas

- The community is waiting for a Japanese decision on the ILC. Should Japan proceed with the ILC, IPP sees this potentially becoming a high priority initiative of our community.
- It is essential to ensure some funds, on the order of \$1M–\$2M per year in total, from the SAP envelope are available for detector and accelerator R&D, including both generic R&D and R&D directed towards specific projects. The future of the field depends on it and R&D provides outstanding HQP training opportunities in skills that are directly transferable to industry. The ongoing R&D programs discussed in this document, such as RD50 and advanced photon detectors, represent such efforts.

# Summary of Particle Physics Priorities Looking Forward

### 9.4.2 Areas with other support

- The CFI MSI program that supports SNOLAB and Compute Canada are absolutely essential for our field to function now.
- The New Digital Research Infrastructure Organization (NDRIO) is a new, national non-for-profit organization that will provide Canadian researchers digital tools, services and infrastructure. Among the NDRIO mandate is a transition of large-scale computing support from Compute Canada to the NDRIO. Particle Physics has pioneered many aspects of advanced, large-scale distributed computing for scientific use, and IPP strongly encourages NDRIO to work with members of our community to ensure that the evolution of Canadian digital research infrastructure meets our needs.
- CANARIE has developed significant network infrastructure that is used by the IPP community. Continued support for CANARIE is absolutely essential for the success of the IPP program.
- The important role of TRIUMF, SNOLAB, and PI for the IPP community cannot be overstated. These institutions have enabled the particle physics community to succeed in the past and will be critical to our future successes.

# Updates to the IPP Brief:

- **New IPP Projects approved since submission:**
  - MOLLER
  - Scintillating Bubble Chamber

# Updates to the IPP Brief:

**New CFI funding announcement March 2021**

Innovation Fund Awards related to particle physics (CFI amount is listed – from www.innovation.ca/funded-projects spreadsheet)


| | | | |
|---|---|---|---|
| Simon Fraser University | Stelzer, Bernd | ATLAS Tier-1 Data Centre | $2,169,811 |
| The University of British Columbia | Kruecken, Reiner | Enabling the search for neutrinoless double-beta decays in Xe-136 with nEXO | $6,849,313 |
| University of Victoria | Karlen, Dean | Intermediate Detector for the Hyper-Kamiokande Neutrino Oscillation Experiment | $5,665,000 |
| University of Victoria | Sobie, Randall | Belle II Canadian Research Data Centre | $2,000,000 |
| University of Manitoba | Gericke, Michael | The MOLLER Detector: Expanding our understanding of matter in the universe with a new, precision electron detector | $2,336,900 |
| Carleton University | Boulay, Mark Guy | Development of Next Generation Liquid Argon Dark Matter Detector and of an Underground Argon Storage Facility at SNOLAB | $7,247,719 |

# Updates to the IPP Brief:

**nEXO** (from Thomas Brunner)

nEXO CFI IF2020 project of $16.6M titled " Enabling the search for neutrinoless double-beta decays in Xe-136 with nEXO" ***has been approved with the condition that nEXO has to be selected as next-generation experiment by the US Department of Energy.*** The CFI will enable the Canadian contingent within nEXO to develop critical infrastructure towards the construction of nEXO.

**Components requested in the CFI proposal are:**

1) Infrastructure to measure and monitor the performance of nEXO's photosensors (SiPMs) throughout the assembly stages. TRIUMF will characterize SiPMs on the waver level, Carleton University will measure the performance of interposers, a low radioactivity circuit board, and McGill will characterize the performance of integrated SiPM modules.

2) The group at Sherbrooke will continue their development of a novel photosensor technique which has the potential to be implemented in nEXO if developed in time.

3) The group at Laurentian University will expand their capabilities to screen materials for Rn outgassing rates. This is a critical contribution towards characterizing and selecting materials suitable for application inside the nEXO detector. Only material that meet stringent background levels are acceptable as construction materials for nEXO.

4) Infrastructure at Laurentian University to test PMTs for the nEXO muon veto. We plan to reuse PMTs from the Daya Bay experiment after its decommissioning in early 2022. At Laurentian University, they plan to characterize all PMTs in a dark box and pressure test a fraction of them for quality assurance.

# Updates to the IPP Brief:

**nEXO** (from Thomas Brunner)

* Update from the US DOE: Tim Hallman, Associate Director at the Office of Science for Nuclear Physics, gave a presentation at the NSAC meeting that contained an update for the 0v2B program. For the first time a specific date has been provided for the long awaited portfolio review (previously called the down select). The dates of the review are July 13-16. Please see this in his slides (slide 10):https://science.osti.gov/np/nsac/Meetings/202103. Tim also said that he believes 2 experiments (2 different isotopes) are required to address the challenge and therefore DOE-NP is looking to partner with Europe to find the resources to build two experiments. This is consistent with public statements he made at the previous NSAC. A summit is scheduled for September 27-29 to discuss these possibilities. This is also on slide 10 of his presentation. According to Nigel Smith, Canadian funding agencies are aware of this meeting and may attend.

Since CFI approval ...
I am sure you have heard the devastating news that Laurentian University is terminating its physics program, among other programs. This has been a shock to all of us. While we are trying to understand the situation and its implications, nEXO Canada is working with SNOLAB to ensure that Laurentian deliverables will not be impacted. We will update you accordingly.

# Updates to the IPP Brief:

MOLLER

University of Manitoba

## MOLLER Experiment Update

**High precision measurement of the Weak mixing angle at low momentum transfer, using electron-electron scattering at 11 GeV.**

**❑USD 65M Project**

- 6M NSF (approved)
- 4M CFI (approved)
- 55M DOE (CD1 stage, first funding in 2020, CD2 in 2021)

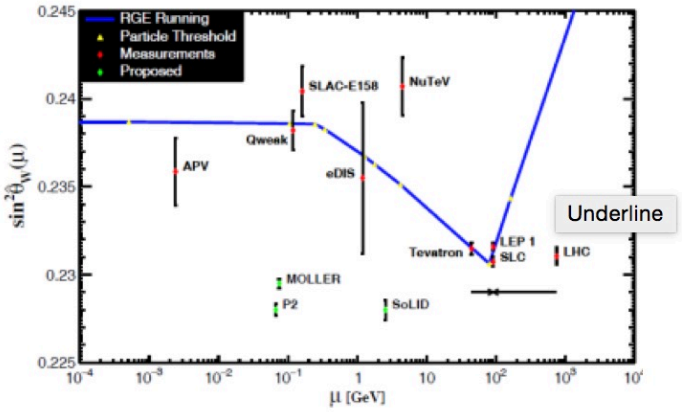
**❑Current People and Schedule:**

- Presently 9 faculty from U. Manitoba, U. Winnipeg, U. Memorial, UNBC
- Presently 2 postdocs and 7 students
- New U. Manitoba faculty advertisement soon
- Construction: 2022 – 2024
- Installation: 2024 – 2025
- Running: 2025 – 2027

**❑Ongoing R&D Work (potential to contribute):**

- General detector design and construction
- Pixel detectors (electronics / cooling / firmware / DAQ)

**❑We welcome new collaborators**




Underline

**Some BSM sensitivities include:**

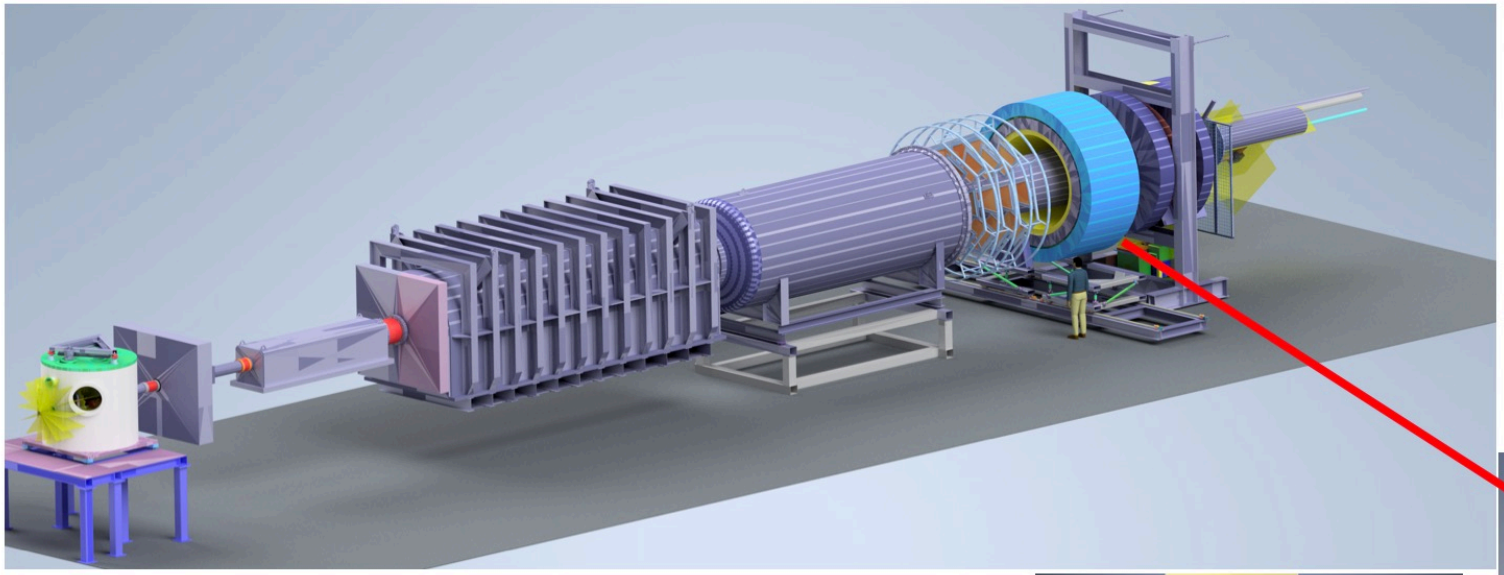
- massive $Z'$ boson interactions
- dark photon / $MeV$ level $Z$
- new parity violating interactions
- lepton compositeness $(47\ TeV)$

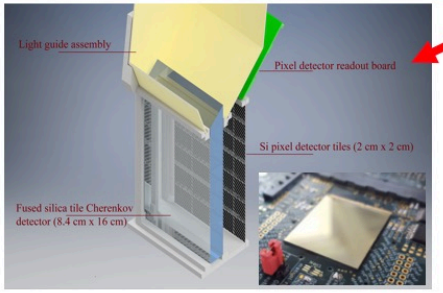
# Updates to the IPP Brief:

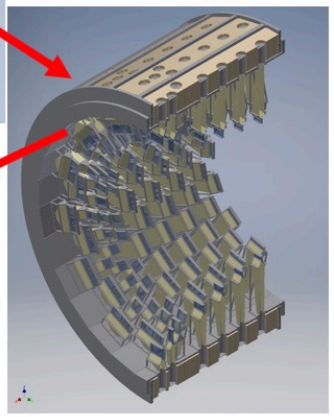
MOLLER

University of Manitoba

**High precision measurement of the weak mixing angle at low momentum transfer, using electron-electron scattering at 11 GeV.**





❑ **CAD 6M CFI/IF funding approved in 2020 round:**

- **Main detectors: 224 quartz DIRC detectors**
- **512 Channels of electronics (preamp + ADC)**
- **Profile mapper: 2688 2x2 cm HVMAP chips**
- **Associated operational equipment**
- **R&D and Testing Infrastructure**

# Updates to the IPP Brief:

**DARKSIDE** (from Aksel Hallin)

The Darkside CFI in 2020 was successful, and approved a grant of $12,735,973 (CFI+provincial matching), or $15,919,966 (including matching contributions from collaborators). This included funding for the acrylic TPC, the wavelength shifting and conductive coatings, electronics and TPC, costs associated with underground argon, as well as $425000 for DEAP upgrades. They are still waiting for word on the provincial contributions.

As soon as they hear from NSERC on the Darkside grant, assuming that it is successful, they will be looking to apply for full IPP Project status.

# Updates to the IPP Brief:

**RD50** (from Thomas Koffas)

"Development of Radiation Hard Semiconductor Sensor Devices for Tracking Detectors in Future Collider Experiments"

Some funding updates in addition to what was mentioned in the brief itself:

1) An NSERC-RTI grant of $147k for instrumentation/infrastructure development at Carleton

2) A CERN award (CERN-RD50-2021-02) for a total of 140k CHF together with resources from NRC in Canada and CNM-Barcelona (from AIDA-2020 funds) for the "Characterization of GaN Based Materials, Electronics and Sensors Subject to Large Radiation Doses".

In addition there are two LOIs submitted to TRIUMF that will allow for R&D work on AC-LGAD devices for PieNuX and NA62 experiments and develop infrastructure for radiation-hard device R&D at TRIUMF, UBC and Carleton. If successful, they will be followed by NSERC applications, the scope is still to be determined.

**Chiral Belle R&D for SuperKEKB e- Polarization Upgrade** (from M. Roney)

Has NSERC project funding and university support for hosting workshops extended

# Updates to the IPP Brief:

- **Detector R&D** (based on email from F. Retiere)

Encourage considering possibility of one or more project grants dedicated to the development of detector technologies for future experiments, that can be judged on its technical merit and its prospect to lead to breakthrough enabling new physics. Such grants would foster synergy within Canada and help reach critical mass. It would also help establish the management tools and organization for managing high risk projects as it would be required for success.

# Updates to the IPP Brief:

- **ILC Developments:** (from A. Bellerive)

A ILC-Canada mailing list has been setup and ready to be deployed.
Most people are really waiting for a positive sign from Japan, or plainly for ILC to be 'approved'.
We are expecting funding news from Japan about the PreLab by May 2021, which will be communicated to the people registered with the ILC-Canada mailing list

Plan to organize a virtual meeting with the people registered onthe ILC-Canada mailing list to self-prepare for the ILC Workshop on Potential Experiments (ILCX) October 26–29, 2021, Tsukuba, Japan. (At the moment that workshop is in-person for the Japanese, and virtual for others.)

Activity in Canada:

- TPC (Carleton)
- CALICE (McGill)
- Accelerator (TRIUMF)
- Theory
- Some new interest to build muon chambers for ILD (presented at LCWS2021)

# Updates to the IPP Brief:

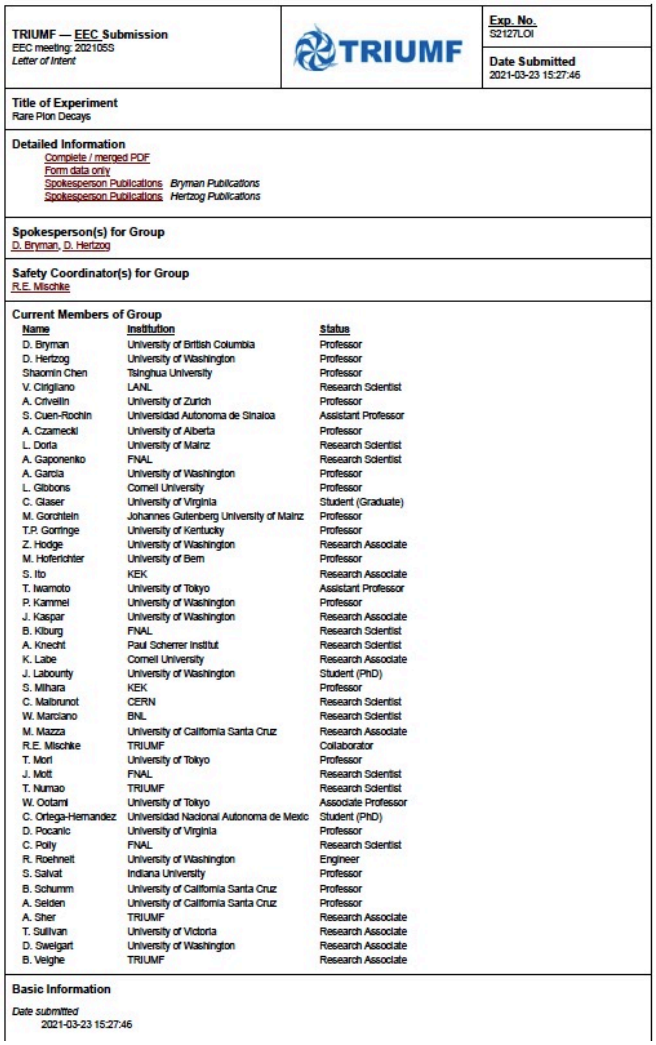
- **TRIUMF** 20-year Vision –
- possible new projects of interest to IPP

  **PI2ENUX**

  LOI submitted to TRIUMF EEC

  29 March 2021

  TRIUMF S2127LOI: Rare Pion Decay



TRIUMF — EEC Submission
EEC meeting: 202105S
*Letter of Intent*

TRIUMF

Exp. No.
S2127LOI

Date Submitted
2021-03-23 15:27:46

**Title of Experiment**
Rare Pion Decays

**Detailed Information**
Complete / merged PDF
Form data only
Spokesperson Publications *Bryman Publications*
Spokesperson Publications *Hertzog Publications*

**Spokesperson(s) for Group**
D. Bryman, D. Hertzog

**Safety Coordinator(s) for Group**
R.E. Mischke

**Current Members of Group**

| Name | Institution | Status |
|---|---|---|
| D. Bryman | University of British Columbia | Professor |
| D. Hertzog | University of Washington | Professor |
| Shaomin Chen | Tsinghua University | Professor |
| V. Cirigliano | LANL | Research Scientist |
| A. Crivellin | University of Zurich | Professor |
| S. Cuen-Rochin | Universidad Autonoma de Sinaloa | Assistant Professor |
| A. Czarnecki | University of Alberta | Professor |
| L. Doria | University of Mainz | Research Scientist |
| A. Gaponenko | FNAL | Research Scientist |
| A. Garcia | University of Washington | Professor |
| L. Gibbons | Cornell University | Professor |
| C. Glaser | University of Virginia | Student (Graduate) |
| M. Gorchtein | Johannes Gutenberg University of Mainz | Professor |
| T.P. Gorringe | University of Kentucky | Professor |
| Z. Hodge | University of Washington | Research Associate |
| M. Hoferichter | University of Bern | Professor |
| S. Ito | KEK | Research Associate |
| T. Iwamoto | University of Tokyo | Assistant Professor |
| P. Kammel | University of Washington | Professor |
| J. Kaspar | University of Washington | Research Associate |
| B. Kiburg | FNAL | Research Scientist |
| A. Knecht | Paul Scherrer Institut | Research Scientist |
| K. Labe | Cornell University | Research Associate |
| J. Labounty | University of Washington | Student (PhD) |
| S. Mihara | KEK | Professor |
| C. Malbrunot | CERN | Research Scientist |
| W. Marciano | BNL | Research Scientist |
| M. Mazza | University of California Santa Cruz | Research Associate |
| R.E. Mischke | TRIUMF | Collaborator |
| T. Mori | University of Tokyo | Professor |
| J. Mott | FNAL | Research Scientist |
| T. Numao | TRIUMF | Research Scientist |
| W. Ootani | University of Tokyo | Associate Professor |
| C. Ortega-Hernandez | Universidad Nacional Autonoma de Mexic | Student (PhD) |
| D. Pocanic | University of Virginia | Professor |
| C. Polly | FNAL | Research Scientist |
| R. Roehnelt | University of Washington | Engineer |
| S. Salvat | Indiana University | Professor |
| B. Schumm | University of California Santa Cruz | Professor |
| A. Selden | University of California Santa Cruz | Professor |
| A. Sher | TRIUMF | Research Associate |
| T. Sullivan | University of Victoria | Research Associate |
| D. Swetgart | University of Washington | Research Associate |
| B. Velghe | TRIUMF | Research Associate |

**Basic Information**

*Date submitted*
2021-03-23 15:27:46

# Updates to the IPP Brief:

- **TRIUMF** 20-year Vision –
- possible new projects of interest to IPP

  **DarkLight at ARIEL**

  LOI submitted to TRIUMF EEC

  end of March 2021

  Expect result of PP-EEC review

  this spring

TRIUMF EEC New Research Proposal  Detailed Statement of Proposed Research for Experiment #: 2134

DARKLIGHT

## Search for New Physics in $e^+e^-$ Final States With an Invariant Mass of 10-20 MeV Using the ARIEL Electron Accelerator

*The DarkLight Collaboration*

R. Alarcon, R. Dipert, G. Randall – **Arizona State University**, Tempe, AZ, USA; A. Christopher, T. Gautam, M. Kohl, J. Nazeer, T. Patel, M. Rathnayake, M. Suresh – **Hampton University, Hampton, VA, USA**; S. Benson – **Thomas Jefferson National Accelerator Facility, Newport News, VA, USA**; J. Bessuille, P. Fisher, D. Hasell, E. Ihloff, R. Johnston, J. Kelsey, I. Korover, S. Lee, X. Li, P. Moran, R. Milner, C. Vidal, Y. Wang – **Laboratory for Nuclear Science, MIT, Cambridge, MA, USA**; R. Kanungo – **Saint Mary's University, Halifax, Canada**; J. C. Bernauer[1], E. Cline, R. Corliss, K. Dehmelt, A. Deshpande – **CFNS, Stony Brook University, Stony Brook, NY, USA**; J. Dilling, O. Kester, R. Laxdal, T. Planche, S. Yen – **TRIUMF, Vancouver, Canada**; M. Hasinoff – **University of British Columbia, Vancouver, Canada**; W. Deconinck, M. Gericke – **University of Manitoba, Winnipeg, Canada**; J. Martin – **University of Winnipeg, Winnipeg, Canada**; I. Friščić – **University of Zagreb, Croatia**

**Co-Spokespeople:** Jan Bernauer[2], Ross Corliss, and Richard Milner

### Abstract

The DarkLight collaboration proposes a run of 2000 hours at the electron accelerator of the Advanced Rare IsotopE Laboratory (ARIEL) at TRIUMF, initially with 31 MeV beam and 150 µA current, to search in the $e^+e^-$ invariant mass region 10−20 MeV in electron scattering from tantalum for evidence of new physics, motivated by anomalies resulting from the muon $g-2$ determination and reported in the decays of excited $^8$Be and $^4$He (Atomki anomaly). As the energy available with the ARIEL electron accelerator increases, we envisage further requests for additional beamtime to cover all the remaining untested coupling range. It will then provide a definitive experimental constraint on the existence of a dark fifth-force carrier, proposed to explain the Atomki anomaly. If scientifically approved, the experiment can begin data-taking about 12 months after funding is made available. The experiment can form the basis for M.S. and Ph.D. theses for graduate students at collaborating universities.

### 1. Scientific Motivation

The Standard Model (SM) describes the physical universe in terms of interactions between point-like fermions (quarks and leptons), gauge bosons which mediate those interactions, and the Higgs field that provides mass to the fermions. Combined with Einstein's theory of gravity (General Relativity), this theory has been incredibly successful. The vast majority of experiments have been consistent with the SM, and no credible alternatives have been put forth.

[1]Also with Riken BNL Research Center, Upton, NY

1

# Updates to the IPP Brief:

- **New Accelerator Project**

  of interest to IPP being initiated:

  **Wire Corrector Systems for the Compensation of Long-Range Beam-beam Interactions in HL-LHC**

**TRIUMF** **PROJECT INITIATION SHEET**

Commitment No:

Date:

**PROJECT TITLE:** Wire corrector systems for the compensation of long-range beam-beam interaction in HL-LHC

**PROJECT LEADER:** XXX **TRIUMF CONTACT:** Marco Marchetto

**PRINCIPAL COLLABORATORS:** Rick Baartman, Doug Preddy, Mathew Brownell, Dobrin Kaltchev, Philippe Belanger, Oliver Stelzer-Chilton
CERN: Yannis Papaphilippou, Adriana Rossi, Guido Sterbini, Oliver Bruening, Alessandro Bertarelli

**PROJECT SPONSOR:** Oliver Kester

**ABSTRACT & BROADER IMPACTS (in plain English):**

Long-range beam-beam interaction and its influence on beam quality affects the maximum achievable luminosity of HL-LHC by limiting the minimum crossing. Long-range beam-beam (LRBB) effect compensation / correction with physical wires, running high currents, are considered a valuable option for HL-LHC to increase the dynamic aperture (DA) at small crossing angles either in conjunction with Crab Cavities or as solution to run with a reduced number of crab cavities. Tests with four wire prototypes in LHC have demonstrated the potential of a wire corrector.

Modelling of the long-range beam-beam effects in the LHC by TRIUMF beam physics department could explain the effectiveness of the wire compensation with a Hamiltonian based beam physics model and why the compensation of the effects works so well. D. Kaltchev solved numerically the problem assuming horizontal crossing angle. D. Kaltchev showed that by compensating the first two non linear Fourier coefficients of the Hamiltonian, one compensates all of them.

This project will enable Canada via TRIUMF ACC to develop and build the wire correctors for HL-LHC and being recognized at the forefront of international research. It will support Canadian researchers in gathering data in successful beam campaigns in the high luminosity LHC operations era in an early stage as the project is not yet in the baseline of the HL-LHC project, but will become baseline, if Canada will engage.

**PROJECT DESCRIPTION:**

DC solid wires at distances compatible with collimation hierarchy of the LHC are able to partially restore integrated luminosity in the absence of crab cavities or for smaller crossing angle in conjunction with the crab cavities. The wire system for HL-LHC requires one wire per beam per side of IP1 (Interaction Point 1) and IP5, which sums to 8 wires. The concept foresees a single 3 m long wire with about 1 mm diameter, positioned in a Cu-vacuum chamber per beam. Space of 4.5 m on both beams was reserved on either side of IP1 and IP5, allowing 1 unit per beam per location in the future. The mechanical design is based on a preliminary set of given requirements which may evolve or be scaled. TRIUMF is supporting the requirement development and to develop the prototype.

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# Updates to the IPP Brief:

- **New Digital Research Infrastructure Organization (NDRIO) Update**

  - NDRIO Researcher Council : “The Researcher Council is foundational to NDRIO’s commitment to involve the Canadian research community in the design and delivery of a National Service Delivery Model to support an enhanced nation-wide Digital Research Infrastructure (DRI) Strategy. Currently consisting of a multi-disciplinary Council of 22 researchers, regular meetings are held to ensure the diverse perspectives of Canada’s research community are represented as NDRIO establishes a researcher-centric DRI ecosystem crosses all disciplines”

  Recent news is the IPP Research Scientist Randy Sobie is the Chair of this body.

  - Between May 4 and 7, NDRIO will host a series of Virtual Town Hall events as the latest consultation step in the Canadian Digital Research Infrastructure (DRI) Needs Assessment.

  - Initiated 2021 Survey of Canadian Research Software Developers

# Updates to the IPP Brief:

- **SNOLAB Strategic Plan**

Message communicated to community at the end of March 2021:

"SNOLAB is embarking on an update to its strategic and implementation plans to guide the facility from 2023 through to 2029, which is expected to be an era of world-class scientific discoveries. These documents will provide direction in requesting and prioritizing SNOLAB's resources for its operations throughout this period.

To ensure that SNOLAB remains aligned with the strategic aims of its community and stakeholders, we are seeking engagement in this survey from our community. The feedback received will influence the development of SNOLAB's next strategic and implementation plans.

This anonymous survey will remain open for two weeks; from March 29$^{th}$through to April 12$^{th}$. The results of the SNOLAB Strategic Plan development survey will be presented and discussed at the SNOLAB Future Projects Workshop that will take place virtually from May 10th to 13th, 2021."

# Updates to the IPP Brief:

- **McDonald Institute Developments** (from Tony Noble)

Arthur B. McDonald
Canadian Astroparticle Physics Research Institute

CANADA FIRST RESEARCH EXCELLENCE FUND

The McDonald Institute in the Canadian Astroparticle Physics Landscape

Contribution to IPP presentation at Long Range Planning Town Hall
April 20/2021

Tony Noble

# Updates to the IPP Brief:

- **McDonald Institute Developments** (from Tony Noble)

Arthur B. McDonald
Canadian Astroparticle Physics Research Institute

A partnership of 8 Universities and 5 institutes, the McDonald Institute is a globally recognized centre for research and learning, coalescing Canadian and international expertise in underground particle astrophysics and benefitting from the unique SNOLAB facility to deliver world-leading science focused on the big questions in particle astrophysics, cosmology and astronomy.

Queen's University
SNOLAB
CIFAR Canadian Institute for Advanced Research
Carleton University
Institute of Particle Physics
Laurentian University / Université Laurentienne
McGill
Perimeter Institute
The University of British Columbia
TRIUMF
University of Alberta
Université de Montréal
University of Toronto
Canada First Research Excellence Fund

# Updates to the IPP Brief:

- **McDonald Institute Developments** (from Tony Noble)

The CFREF Grant and leveraging support:

- **$63,744,000** in direct and indirect support (3:1) from CFREF
- > **$10,000,000** in cash contributions from the partner Contributions.
- **$4,650,000** in the form of 11 successful CFI-JELF Awards to date (others in preparation)

Period of grant, nominally Sept 2016 – August 2023. 2 ½ years to go.

- one extra year to spend residual funds. → Aug 2024
- possibility of "no cost extension" of up to two years due to Covid-19 delays. Likely will not be used as our grant is heavily dominated by personnel salaries, and these people are already in place. No obvious need or mechanism for a long extension.

**Takeaway:** Funding will stop flowing in August 2023

Spending will be complete in August 2024

All faculty transition to regular faculty by August 2023

Working on sustainability plan for MI post CFREF (post August 2024) 3.5 years from now.

# Updates to the IPP Brief:

- **McDonald Institute Developments** (from Tony Noble)

Abridged synopsis of what the MI currently supports

- Education and Outreach
- Knowledge Translation/Mobilization
- HQP Training – Professional Development
- Gov Relations
- HQP recruitment/retention
- Communication
- Networking and Connections
- EDII Best practices support

- These are time intensive programs.
- They need significant administrative support
- Enables big science by creating "the full package"
- Creates highly skilled, deeply connected, community
- Relatively inexpensive, but beyond scope of most individual projects

- Faculty Salaries
- Student Salaries
- Engineering and Technical Support Salaries
- Seed funding for novel R&D

- Dominates overall costs to MI.
- Less overhead required to manage
- Builds capacity in community and research potential

# Updates to the IPP Brief:

- **McDonald Institute Developments** (from Tony Noble)

## Potential Model for a Sustained MI at Queen's University Post CFREF

| | |
|---|---|
| • Education and Outreach ++<br>• Knowledge Translation/Mobilization ++<br>• HQP Training – Professional Development ++<br>• Gov Relations ++<br>• HQP recruitment/retention ++<br>• Communication ++<br>• Networking and Connections ++<br>• EDII Best practices support ++ | • These are time intensive programs.<br>• They need significant administrative support<br>• Enables big science by creating "the full package"<br>• Creates highly skilled, deeply connected, community<br>• Relatively inexpensive, but beyond scope of most individual projects<br>• New MI at Queen's 1 – 1.5 M$/a |
| • ~~Faculty Salaries~~ | • Subsumed by universities. |
| • ~~Student Salaries~~ | • Picked up by NSERC |
| • Engineering and Technical Support Salaries<br>• Seed funding for novel R&D<br>• Novel/targetted positions | • To be funded through new MI grant to MSI, MRS, CFREF', SNOLAB MSI', Gov…<br>• Ball Park: Funded externally 3 – 4 M$/a |

# Updates to the IPP Brief:

- **McDonald Institute Developments** (from Tony Noble)

## Potential Model for a Sustained MI at Queen's University Post CFREF

| | |
|---|---|
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| • ~~Faculty Salaries~~ | • Subsumed by universities. |
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| • Engineering and Technical Support Salaries<br>• Seed funding for novel R&D<br>• ~~Novel/targetted~~ positions | • To be funded through new MI grant to MSI, MRS, CFREF', SNOLAB MSI', Gov…<br>• Ball Park: Funded externally 3 – 4 M$/a |

# Updates to the IPP Brief:

- **McDonald Institute Developments** (from Tony Noble)

In this model:

- Faculty salaries are picked up by the Universities
- Their basic research costs covered by NSERC
- Value added core programs continue to support Canadian astroparticle physics (and expanding on that) through the McDonald Institute at Queen's
- We work with the community to create a means of supporting the essential engineering and technical staff, and manage the prioritization of those resources in an "MRS like" resource centre (likely widely distributed). Looking at a variety of funding models.

# Updates to the IPP Brief:

- **McDonald Institute Developments** (numbers from Tony Noble)

New Faculty supported by MI and impact on Subatomic Physics Evaluation Section Envelope

- 12 SAP faculty-equivalent hires enabled by MI : 3 SAP theory + 9 SAP experiment (+ 3 not in SAP)
- Of 3 theorists, 2 are already funded through NSERC
- Of 9 experimentalists, 2 are already funded through NSERC.
- Hence: number of new faculty expected to come into the envelope in 2023 = 1 theorist + 7 experimentalists

**This will require further increases to the NSERC Subatomic Physics Envelope aligned with the demographics-driver for allocation decisions**

# Updates to the IPP Brief:

**Laurentian University**

Our community has been very hit hard with the announcement on 9April 2021 of the closure of the Physics Department at Laurentian University in Sudbury, Ontario as part of the closure of 58 undergraduate and 11 graduate programs (roughly 1/3 of their programs)

- Public statement that decision on programs to terminate were based on enrollment numbers (primarily undergraduate)

- Quality of program or research – as determined, e.g. by competitive funding decisions did not enter into the decision

# Updates to the IPP Brief:

**Laurentian University**

A Joint Statement of condemnation from IPP and CINP has been circulated to our members urging them to send letters and sign petitions (see the Joint Statement in "Additional Materials")

Dear IPP Member,

Please find attached the Joint Statement from CINP and IPP on the planned closure of the physics programs at Laurentian University. We will be sending this to
the Ontario government - Douglas Ford MPP, Premier of Ontario; Ross Romano MPP, Minister of Colleges and Universities;
Peter Bethlenfalvy MPP, Minister of Finance and Pres. of Treasury Board;
the Government of Canada - Prime Minister Justin Trudeau, Minister François-Philippe Champagne(ISED), Minister Mélanie Joly (Economic Development and Official Languages), Minister Chrystia Freeland (Finance);
as well as relevant Sudbury-area politicians.

The cover email will state that IPP and CINP are joining the call for Laurentian University's Administration to be held accountable, and for the Ontario and Canadian governments to provide real solutions for preserving the programs at the University, their faculty, and the value they bring to the community and to academia.

We encourage you and your students and postdocs to participate in any or all of the following avenues of support:

- Use this form-letter to send a message to your MP
- Sign a petition started by the Laurentian University Faculty Association
- Add your name to a list of Academics in support of Laurentian University

# Updates to the IPP Brief:

**Laurentian University**

The Joint Statement of condemnation from IPP and CINP was sent last week to senior Ontario and Canadian government leaders as well as to local politicians

The Honourable Douglas Ford, M.P.P.
Premier of Ontario
premier@ontario.ca

Dear Premier,

Please find attached the Joint Statement of the Canadian Institute of Nuclear Physics (CINP) and the Institute of Particle Physics (IPP Canada), which together represent subatomic physics researchers from across Canada, condemning the planned closure of the physics programs at Laurentian University. This scale of destruction of a Canadian university has never been seen before and, if carried out, will greatly damage the reputation of the Province of Ontario, as well as Canada.

Our research communities join the call for Laurentian University's Administration to be held accountable, and for the Ontario and Canadian governments to provide real solutions for preserving the programs at Laurentian, their faculty, and the value they bring to the community and to academia.

Sincerely,

J. Michael Roney
Director, IPP Canada

Garth Huber
Executive Director, CINP

# Updates to the IPP Brief:

**Laurentian University**

An email received from a colleague in the UK on hearing this news:

“The role that Laurentian has played on international collaborations such as SNO and SNO+ cannot be overstated... Laurentian has always pulled far more than its fair share of work on site at SNOLAB and underground ...(especially critical) in this past year of global pandemic... They've trained so many physicists that are now part of an international community!

Is there some way that you know of to give us in the international community a voice?”

**Contact us** (admin@ipp.ca) **if you would like to take further action and would like the email addresses of senior government officials who could turn this around.**

**IPP will keep pushing to get this disgraceful decision overturned.**

# Additional Material

# Guidelines for project submissions to IPP Long Range Plan Brief

**Section 1: Plans for the project in the five year period starting in 2022** (up to 5 pages + Table 1)

1) Physics and other research goals for the project;

2) Canadian hardware or software interests and contributions to the project;

3) Relationships with international partners including relative size of Canadian team within the collaboration;

4) Expected HQP training; include numbers and roles in the project

5) Equipment and/or infrastructure needs – including cost estimates and time profile, whether NSERC or CFI will be requested for funds, other partners;

6) Computing requirements – CPU and storage, time profile;

7) Expected calls on technical support and/or infrastructure from TRIUMF, SNOLAB or the MRS facilities;

8) Relationships with other projects being conducted by Canadian subatomic physicists – either physics or technical.

Table 1: Canadian grant eligible members on the project and their FTEs

# Guidelines for project submissions to IPP Long Range Plan Brief

**Section 2: Equity, Diversity and Inclusion Considerations** (1 page)

Describe the existing and planned policies and practices for the Project to support:

1) an equitable, diverse and inclusive team environment; and

2) the recruitment of a diverse group of HQP and an inclusive training environment.

**Section 3: Plans for the project from to 2036** (up to 2 pages)

1) Physics and other research goals for the project;

2) Information about resource requirements associated, for example, with upgrades in the period from 2028 to 2036;

3) R&D plans (e.g. detector, accelerator) for efforts that extend into 2028 to 2036;

4) Relationships with other projects being conducted by Canadian subatomic physicists – either physics or technical;

5) Relationships with international partners

# Guidelines for project submissions to IPP Long Range Plan Brief

**Section 4: Broader Societal Impact** (up to 2 pages + table of HQP trained)

1) Profiles of a sample of HQP that have been trained in past. Use this section to highlight a few exceptional examples of HQP training and list all HQP trained in Table 2 (see below),

2) Role of the project in fostering physics education in general;

3) Public education and outreach associated with the project;

4) Application of particle physics research and connections of the project to industry, including existing or potential economic impact that the project may have;

5) Plans to further facilitate greater economic and broader societal impact of the project and the field in general.

Table 2: List of HQP that have been trained on the project over the past 10 years, or less. Include name (if possible), dates of training, role in project, what they are doing now

# Updates to the IPP Brief:

- **McDonald Institute Developments** (from Tony Noble)

A feeling for the personnel numbers:

47

| | 2016 "Base" | 2020 "Base" | 2020 "MI Supported" |
|---|---|---|---|
| | | | |
| Faculty | 22 | 33 | 14 |
| | | | |
| Research Scientists | 10 | 14 | 3 |
| RA and PDF | 16 | 14 | 35 |
| Grad Students | 34 | 42 | 42 |
| Engineers and Tech | 10 | 14 | 17 |
| | | | |
| **Total HQP** | **70** | **84** | **97** |

181

**In Astroparticle Physics:**

- **The HQP community size has more than doubled since the start of MI (70 → 181)**
- **MI is currently supporting more than ½ of the community HQP. (97 vs 84)**
- **Faculty base in this field has doubled. MI faculty plus other new hires, research pivots (22 → 47)**

# Joint CINP/IPP Statement Condemning Closure of Laurentian Physics Department

Institute of Particle Physics
Institut de Physique des Particules

J. Michael Roney, PhD, PPhys,
Director
director@ipp.ca 250-721-7705

CINP ICPN

Canadian Institute of Nuclear Physics
Institut canadien de physique nucléaire

Garth Huber, Ph.D., *Executive Director*
*huberg@uregina.ca 306-585-4240*

15 April 2021

**Closure of Physics Programs at Laurentian University**

The Canadian Institute of Nuclear Physics (CINP) and the Institute of Particle Physics (IPP) strongly condemn the closure of the physics undergraduate and graduate programs at Laurentian University, which was announced earlier this week. This scale of destruction of a Canadian university has never been seen before and, if carried out, will greatly damage the reputation of the Province of Ontario, as well as Canada.

Laurentian University is a key partner of the SNOLAB underground physics laboratory, and the members of the Department of Physics have contributed greatly to the important internationally renowned experiments being performed there. Not only have the Laurentian Physics Department contributions been vital to the 2015 Nobel Prize in Physics being awarded to SNO Director Arthur McDonald, but the Physics Faculty members continue to lead a new generation of experiments probing the nature of the neutrino and the identity of dark matter – two of the most pressing questions in science today. This world-leading research has given Laurentian University physics students unique opportunities that prepare them well for their future careers. It also brings students based in Northern Ontario vital international experience and exposure as they collaborate with researchers coming to Sudbury from around the globe. The Laurentian University Department of Physics has clearly played a critical role in helping place Ontario on the map of international cutting-edge research.

Moreover, Laurentian University's impressive history of supporting English, French and Indigenous communities has not only benefited the people of Northern Ontario by enabling their young people to study locally, but in bringing this diverse population into our field, it has benefited physics research across Ontario, and indeed across Canada.

This disastrous and short-sighted decision must be reversed and we call on the Government of Ontario to take action and rectify the situation immediately and minimize the damage to Ontario's reputation it has created.

J. Michael Roney
Director
Institute of Particle Physics (Canada)

Garth Huber
Executive Director
Canadian Institute of Nuclear Physics