2019/20 Annual Report Supplement

Covering the Objectives, Activities, and Finances
for the period of August 1, 2019, to July 31, 2020

Submitted by: Robert C. Myers, Director
To: The Hon. Navdeep Bains, Canadian Minister of Innovation, Science, and Industry

Contents

Reporting on the objectives of the 2019/20 Corporate Plan,
covering the period from August 1, 2019, to July 31, 2020.

"Perimeter is unique in the scientific landscape, with a forward-looking, innovative, collaborative and inclusive climate. It has greatly raised Canada's reputation in the field of high-level theoretical physics, and has shown a very high return on government investment, and at a fast pace.

"PI has stayed true to its inspiring and ambitious founding mission while adapting to new opportunities and changing times. Institute scientists have made a number of landmark discoveries in several different research areas, and an increasing number of very talented and diverse young scientists have emerged from its training programs. It is greatly valued in the scientific community for the ways in which it shares new knowledge and brings the community together to collaborate. Its remarkable outreach programs bring the adventure of discovery to students of many ages and may well incubate a new generation of Curies and Einsteins.

"Perimeter has major research strengths in several exciting areas of physics that are likely to see major advances, and others that will be realized in new technologies. The institute is well-positioned for growth in these areas, and potentially to make important, long-lasting contributions to science and technology."

– Final Evaluation Report
Perimeter Institute Scientific Advisory Committee
October 2020

Objective 1: Achieve breakthroughs in our understanding of the universe

Summary of Achievements

- Advanced fundamental research through 743 high-calibre papers.[1]
- Since inception, Perimeter researchers have produced 6,282 papers appearing in more than 250 journals and on the arXiv, which have earned 290,360 citations, attesting to the importance and long-term impact of Perimeter research.[2]
- Recognized with 20 major national and international honours; for a list of honours, awards, and major grants received by Perimeter researchers, refer to **pages 18-19** of the Annual Report.
- Underwent two major external reviews of scientific activities: a report from the Scientific Advisory Committee and a bibliometric analysis by Clarivate. Further information can be found on **pages 4-5** of the Annual Report.
- For descriptions of several research highlights of the year, including discoveries in quantum matter and quantum simulation, refer to **pages 8-15** of the Annual Report.
- For a look ahead at Perimeter's planned strategic development in research with enormous potential, see **pages 38-39** of the Annual Report.

Supplementary Information (beyond the Annual Report Contents)

Grants

In 2019/20, seven Perimeter faculty members and researchers were awarded Discovery Grants totalling $1.45 million over terms of five years from the Natural Sciences and Engineering Research Council of Canada (NSERC) to support graduate students.

- Faculty member Lucien Hardy was awarded $120,000 ($24,000/year over five years)
- PSI Fellow David Kubiznak was awarded $170,000 ($34,000/year over five years)
- Computational Scientist Dustin Lang was awarded $132,500 ($24,000/year over five years, plus a $12,500 Discovery Launch Supplement)
- Daniel Family James Peebles Chair Kendrick Smith was awarded $250,000 ($50,000/year over five years)
- Mike and Ophelia Lazaridis Niels Bohr Chair Neil Turok was awarded $250,000 ($50,000/year over five years)
- Clay Riddell Paul Dirac Chair Pedro Vieira was awarded $350,000 ($70,000/year over five years)
- Faculty member Chong Wang was awarded $177,500 ($33,000/year over five years, plus a $12,500 Discovery Launch Supplement)

[1] This reflects the one-year period from August 1, 2019, to July 31, 2020. Each publication has been counted only once, regardless of how many Perimeter researchers collaborated on it.
[2] This data comes from Google Scholar, Research Gate, INSPIRES, ads (Harvard astrophysics data system), APS, and others, and reflects the period from inception to July 31, 2020.

Other grants and awards to Perimeter faculty, associate faculty, and initiatives include:
(Figures in Canadian dollars unless otherwise specified)

- Perimeter Institute, $195,000 USD in support of the creation of SciTalks.ca, from the Simons Foundation
- Faculty member Bianca Dittrich, 219 core years and 27 GPU years, valued at $92,277, from Compute Canada
- Daniel Family James Peebles Chair Kendrick Smith (along with 13 collaborators), $2.6 million USD for CHIME outriggers, from the Moore Foundation
- Faculty member Laurent Freidel and Faculty member Lucien Hardy, $105,000 from the John Templeton Foundation (as co-investigators on "The Quantum Information Structure of Spacetime")
- Faculty member Lee Smolin and postdoctoral researcher Mark Penney are co-investigators with University of Waterloo collaborators on a $50,000 NSERC COVID-19 Alliance Grant
- Clay Riddell Paul Dirac Chair Pedro Vieira, $100,000 USD per year for three years from the Simons Non-Perturbative Bootstrap Collaboration
- Associate Faculty member Daniel Siegel, 2,051 core years, valued at $251,285, from Compute Canada
- Associate Faculty member Daniel Siegel, $84,300 from the Arthur B. McDonald Institute HQP Pooled Resources Competition grant
- Associate Faculty member Matthew Johnson, $7,500 USD for "Vacuum Decay in the Lab" workshop, from the Foundational Questions Institute
- Associate Faculty member Michele Mosca, $100,000 from the National Research Council (NRC) via the University of Sherbrooke for research on secure and reliable quantum key distribution networks
- Associate Faculty member Ue-Li Pen, €89,603 Humboldt Research Award
- Associate Faculty member Will Percival, $52,800 from Euclid Science
- Associate Faculty member Will Percival, 235 core years, valued at approximately $34,000, from Compute Canada
- Faculty member Yin-Chen He, 228 core years, valued at approximately $33,000, from Compute Canada

Objective 2: Create the world's strongest community of theoretical physics researchers

Summary of Achievements

- Conceived and planned the opening of the Clay Riddell Centre for Quantum Matter, supported by a $10 million commitment from the Riddell Family Charitable Foundation.[3] Information about the Clay Riddell Centre for Quantum Matter can be found on **page 9** and on **pages 40-41** of the Annual Report.
- Director Robert Myers and Faculty Chair Luis Lehner led a complement of 24 faculty and 22 associate faculty, including nine Perimeter Research Chairs. For a list of research chairs, (including one additional Research Chair, Visiting, for a total of 10) refer to **page 21**. For complete faculty and associate faculty bios, see **pages 51-58** of the Annual Report.
- Welcomed Sergey Sibiryakov as an associate faculty member, cross-appointed with McMaster University. Refer to **page 20** for more information about Sibiryakov's research specialties.
- Launched several initiatives aimed at increasing equity, diversity, and inclusion, and strengthened others. Highlights of Perimeter's equity, diversity, and inclusion successes, including achievements of the Simons Emmy Noether Fellows, can be found on **pages 16-17.** Additional information can be found below.

Supplementary Information (beyond the Annual Report Contents)

Perimeter Institute has an ongoing comprehensive attraction and retention strategy, including the following:

- Comprehensive ongoing support for researchers' families, including career support to partners, assistance accessing social services and childcare, and social gatherings to help them build a support network and become established in the local community
- Numerous ongoing wellness and social activities for resident researchers and staff, contributing to a positive work environment

New attraction and retention initiatives in 2019/20:

- Group benefit plan revised to better fit the needs of members, with an increase to psychology benefits
- On-site mental health professional provided for group discussions
- Additional supports during the work-from-home period included one-on-one mental health support for students, virtual fitness classes, financial support for required home office equipment and supplies, a childcare assistance program, and a weekly list of wellness resources

[3]Due to pandemic restrictions, the official launch was pushed to October 15, 2020, and celebrated virtually.

Equity, diversity, and inclusion initiatives beyond those included in the Annual Report include the following achievements of the Inclusive PI Platform working groups:

- The seminar working group created a set of guidelines to structure seminars and research group meetings more effectively and inclusively. In addition, there is a Perimeter-wide effort to ensure at least 20 percent of seminar and conference presenters are women.
- The PhD working group is forming a mentoring system for PhD students and preparing a handbook for PhD students and supervisors.
- The community and communication working group is spearheading an in-depth Perimeter-wide survey of researchers and administration, scheduled to take place in 2020, and is creating guidelines and information regarding gender-neutral and non-binary language.

Objective 3: Attract and develop the next generation of brilliant minds

Summary of Achievements

- Welcomed 25 new postdoctoral researchers from a pool of about 700 applicants, while 22 completed their research terms and moved on to careers in research and industry. For details of the postdoctoral program, including a profile of the Francis Kofi Allotey Fellow Estelle Inack, see **page 28** of the Annual Report. For insight into the research of Flaminia Giacomini, see **page 12** of the Annual Report; for Lena Funcke see **page 11** of the Annual Report. For a complete list of all postdocs at Perimeter in 2019/20, see **page 59** of the Annual Report.
- Provided ongoing training for 77 PhD students in residence and 26 associate PhDs. For details of the PhD program, including a profile of T.C. Fraser, see **page 29** of the Annual Report. For a list of PhD students at Perimeter in 2019/20, see **page 61** of the Annual Report.
- Perimeter students include six NSERC Vanier Canada Graduate Scholars; see **page 29** of the Annual Report.
- Successfully ran the Perimeter Scholars International (PSI) master's program for 26 students; in 11 years, 336 students have completed the PSI program. The program continues to be very popular and selective, with 688 applications for the 2019/20 cohort. For details of the PSI program, see **page 30** of the Annual Report. For a full list of PSI faculty see **page 60** of the Annual Report, and for a list of students, see **page 62** of the Annual Report.
- Expanded the Undergraduate Summer Accelerator, launched in 2018 with a gift from Michael Serbinis and Laura Adams, welcoming 54 students selected from more than 700 applicants. For details of the undergraduate program, see **page 30** of the Annual Report.
- Welcomed 19 Visiting Graduate Fellows from 13 countries. For more information, refer to **page 29** of the Annual Report.
- Expanded Career Trajectories initiatives for young scientists at all levels, including industry talks, one-on-one academic and career counselling, interview preparation, and résumé building. For more information, including alumni successes, refer to **page 31** of the Annual Report.

Objective 4: Attract outstanding visiting scientists

Summary of Achievements

- Appointed two new leading scientists as Distinguished Visiting Research Chairs (DVRCs) and renewed 12 others, bringing the total to 42. For details of the DVRC program including testimonials and a profile of DVRC Carlo Rovelli, see **pages 22-23** of the Annual Report. For a full list of DVRCs, see **page 60** of the Annual Report.
- Appointed five new accomplished researchers as Visiting Fellows and renewed seven more, bringing the total to 55. For more information, see **page 21** of the Annual Report; a full list of Visiting Fellows is on **pages 23-24** of this supplement.
- Appointed eight early-career researchers as Simons Emmy Noether Fellows, including *New York Times* notable author, cosmologist, and science communicator Katie Mack. For details on the Simons Emmy Noether Fellows program, including its place in Perimeter's broader Emmy Noether Initiatives, refer to **page 17** of the Annual Report. For a full list of Simons Emmy Noether Fellows, refer to **page 22** of this supplement.
- Held 12 conferences and workshops, attended by 995 scientists from around the world. For information about Perimeter's conference program, including the "Emmy Noether Workshop: The Structure of Quantum Space Time," see **page 24** of the Annual Report. A full list of 2019/20 conferences is on **page 62** of the Annual Report.
- Presented 289 scientific talks, seminars, and colloquia. For more information, including details of Perimeter's new SciTalks platform, refer to **page 25** of the Annual Report.
- Hosted 353 visiting scientists including DVRCs, Visiting Fellows, Visiting Researchers, Affiliates, scientific collaborators, Simons Emmy Noether Fellows, and more.[4]

[4] The reduction from the typical number of yearly scientific visitors is due to pandemic travel restrictions.

Objective 5: Serve as Canada's premier hub for foundational physics research

Summary of Achievements

- Close ties between Perimeter researchers and those at other Canadian universities have elevated the stature of physics research in Canada across the board. Through its associate faculty, Perimeter has enabled seven Canadian universities to attract and hire outstanding scientists who those institutions could not have hired on their own. In 2019/20, Perimeter jointly appointed one new associate faculty member with McMaster University (see Objective 2).
- Partnered with the University of Waterloo to hold the PSI master's program and involved faculty from Canadian universities as lecturers (see Objective 3).
- Continued to strengthen ties to 28 universities and research organizations across the country through Affiliate members, who have an open invitation to visit Perimeter. In 2019/20, 18 Affiliates were appointed or renewed, bringing the total to 108.
- Sponsored four off-site workshops and conferences across Canada; see the list on **page 62** of the Annual Report.

Supplementary Information (beyond the Annual Report Contents)

Catalyzing the Quantum Valley ecosystem

Perimeter continued to work with key partners in Waterloo Region's Quantum Valley to ensure Canada remains at the forefront of international efforts to create new quantum industries. These industries will in turn spark major job and value creation.

Quantum Valley partners include those in the surrounding academic community (including the Institute for Quantum Computing), the region's vibrant start-up incubators (including Communitech), industries (including ISARA), and venture capitalists (such as Quantum Valley Investments).

Perimeter helped catalyze the creation of IQC in 2002, and it continues to be Perimeter's closest experimental partner. Perimeter's ties to IQC include jointly appointed Associate Faculty members Raymond Laflamme, Debbie Leung, Michele Mosca, and Christine Muschik, as well as joint postdoctoral researchers Anurag Anshu, Justin Hilburn, Aleksander Kubica, Felix Leditzky, Fereshteh Rajabi, and Michael Vasmer.

Partnerships and collaborative efforts

Perimeter continues to strengthen Canadian networks in physics research through collaborative efforts at the regional, provincial, and national level.

- A partnership between Perimeter and the NRC supports four co-funded postdoctoral fellowships and two graduate fellowships – all with three-year terms – in two exciting frontier areas: radio astrophysics and quantum intelligence.
- Other national partnerships include those with the Fields Institute for Research in Mathematical Sciences at the University of Toronto, and the Arthur B. McDonald Canadian Astroparticle Physics Research Institute, a national research network of 13 Canadian partners dedicated to understanding dark matter and neutrino science.

Experiment and observation are the tests of all theory. Recognizing this, Perimeter scientists have the opportunity and freedom to forge strong partnerships with **observational and experimental** centres and initiatives across Canada.

- The Institute has formal partnership agreements with SNOLAB, an underground science laboratory specializing in neutrino and dark matter physics, and TRIUMF, Canada's particle accelerator centre.
- Daniel Family James Peebles Chair Kendrick Smith and Associate Faculty member Ue-Li Pen are deeply involved with fast radio burst research with the Canadian Hydrogen Intensity Mapping Experiment (CHIME) and Dominion Radio Astronomy Observatory, along with Perimeter Computational Scientist Dustin Lang; joint Perimeter/NRC postdoctoral researchers Simon Foreman and Meiling Deng; and PhD students Utkarsh Giri, Masoud Rafiei-Ravandi, and Alex Roman.

- The Perimeter Institute Quantum Intelligence Lab (PIQuIL) is an innovative venture aimed at leveraging Perimeter's many ties and world-class talent to conduct unique, multidisciplinary research at the intersection of machine learning and quantum systems. Researchers at PIQuIL come from a mix of academia, government, and industry and co-exist in a unique research space designed to foster cross-disciplinary collaboration. Quantum computing start-up 1Qbit has research staff at PIQuIL to take advantage of research synergies. Located in the Communitech Data Hub, a five-minute walk from Perimeter, PIQuIL works in collaboration with artificial intelligence centres and experts in Montreal, Ottawa, Sherbrooke, Toronto, Edmonton, and Vancouver.

Objective 6: Raise Canada's profile as a global leader in fundamental physics research

Summary of Achievements

- Perimeter has a measurable, positive effect on Canada's reputation for research. An independent study by Clarivate Analytics in 2020 showed that by 2019, Canada ranked first in key measures of research quality and impact among G7 countries; without Perimeter, Canada would have ranked fourth. For more information, refer to **page 5** of the Annual Report.
- Faculty member Neil Turok, a founder of the African Institute for Mathematical Sciences (AIMS), worked with colleagues there to develop new algorithms for "pooled" COVID-19 testing. For details, see **page 15** of the Annual Report and additional information below.

Supplementary Information (beyond the Annual Report Contents)

Among the top 20 most productive organizations in the world on the subject of quantum computing

A 2020 report from the QuantX Group of École Polytechnique in France puts Perimeter Institute in the top 20 institutions in the word based on publications on the subject of quantum computing over the last decade, among prestigious organizations such as the University of Waterloo, Harvard University (US), the Quantum Technologies Centre (Singapore), Oxford University (UK), and ETH Zurich (Switzerland). According to the study of 2,506 organizations that published on quantum computing, Perimeter was one of only 11 institutions that had a citation impact above the average. The report was prepared by Michel Kurek, an engineer with 25 years in the finance industry.[5]

South American Institute for Fundamental Research

Since 2015, Perimeter has partnered with the South American Institute for Fundamental Research (SAIFR), an emerging centre of excellence in theoretical physics located at São Paulo State University in Brazil. The two institutes have a great deal in common, including several research areas of focus and active visitor and conference programs.

In 2019/20, Perimeter continued to leverage the expertise of its research and administrative staff to assist with SAIFR's growth.

- Pedro Vieira, the Clay Riddell Paul Dirac Chair in Theoretical Physics at Perimeter Institute, continues to spend up to six months per year in Brazil, helping to develop SAIFR, while Faculty Chair Luis Lehner serves on SAIFR's Scientific Council.
- Perimeter's Outreach team continues to assist SAIFR in developing its own outreach efforts, including delivering 31 teacher training workshops to 1,048 educators in Brazil in 2019/20.

[5] M. Kurek, *Quantum Technologies Patents, Publications & Investments*, Le Lab Quantique (in partnership with QuantX), Paris, 2020.

- The Portuguese Resource Centre was launched in March 2019, with 14 translated educational resources now available, allowing for a vastly greater impact in Brazil.
- The American Physical Society provided a grant from its COVID-19 Innovation Fund that will help expand access to modern physics resources in high schools throughout Latin America. The grant supports Spanish translations of 15 volumes of educational material developed by Perimeter, so they can be used online during the pandemic and in classrooms when schools reopen. The translation project is led by Nathan Berkovits at São Paulo State University.

African Institute for Mathematical Sciences

AIMS was founded in Cape Town, South Africa, in 2003 by Perimeter Director Emeritus and current Faculty member Neil Turok and is now a globally recognized centre of excellence for postgraduate education and research. There are five AIMS campuses across Africa: one each in Cameroon, Ghana, Rwanda, Senegal, and South Africa.

- In 2020, Turok worked with a multidisciplinary team that included Wilfred Ndifon, a mathematical biologist who is the director of research at AIMS, and Leon Mutesa, a geneticist at the University of Rwanda and coordinator of that nation's COVID response task force, to develop new methods of "pool" or "batch" testing. Early efforts show that the new group testing scheme can drastically reduce the number of tests needed to identify infected individuals, demonstrating a cost reduction of more than a factor of 15 relative to simply testing everyone individually. With further refinements, cost reductions of a factor of 100 appear within reach. The testing scheme is being used in a trial at the University of Rwanda's state-of-the-art Center for Human Genetics, where team member Mutesa is the director, and on a smaller scale is being used in a practical application to regularly test one of the top rugby teams in South Africa.

Engagement with international experimental and observational centres

Perimeter researchers act as leaders in fundamental physics by connecting their strengths to experimental and observational centres around the world, working on some of the most promising, challenging, and potentially world-changing problems of our time. Perimeter's global connections include the Large Hadron Collider at CERN, the Laser Interferometer Gravitational-Wave Observatory, the Simons Observatory, Kavli Institute for Theoretical Physics, the Harvard Quantum Initiative, the Flatiron Institute, Scuola Internazionale Superiore di Studi Avanzati, the Asia Pacific Center for Theoretical Physics, the International Centre for Theoretical Physics, the Institute for Quantum Studies at Chapman University, the Institute for Quantum Optics and Quantum Information, and various other experiments including HIRAX, eBOSS, Euclid, DESI, ARIADNE, GNOME, and BaBAR.

Perimeter also has collaborations and partnerships with private sector industry labs such as Google, IBM, and others.

- Associate Faculty member Will Percival is a senior member of the Extended Baryon Oscillation Spectroscopic Survey (eBOSS); see **page 13** of the Annual Report), which seeks to precisely measure the expansion history of the universe; the Dark Energy Spectroscopic Instrument (DESI), which aims to measure the effect of dark energy on the expansion of the universe; and the Euclid experiment of the European Space Agency, which hopes to map the precise geometry of the universe.
- Delaney Family John Archibald Wheeler Chair Avery Broderick is a leader in the international Event Horizon Telescope (EHT) collaboration. In 2020, the EHT team conducted the highest-resolution measurements yet of a quasar, using the same interconnected array of telescopes utilized to capture the now iconic first image of a black hole, published in 2019. He is also one of several Perimeter researchers associated with the Institute's EHT Initiative, which involves a team of faculty members, postdoctoral researchers, and graduate students conducting leading-edge analysis of astrophysical data collected by the EHT. Faculty Chair Luis Lehner is also involved.
- Perimeter is a collaborating institution in the Simons Observatory, with Faculty member Kendrick Smith, Associate Faculty member Matthew Johnson, and several postdoctoral researchers and students involved.
- Stavros Niarchos Foundation Aristarchus Chair Asimina Arvanitaki is part of the ARIADNE (Axion Resonant InterAction Detection Experiment) collaboration, which is looking for axion mediated interactions in matter.

Objective 7: Share the transformative power of theoretical physics

Summary of Achievements

- Facilitated 6.8 million student interactions through educational programs and resources, bringing the total to more than 59 million to date. For more information, refer to **page 35** of the Annual Report.
- Delivered 200 workshops to 4,507 educators across Canada and abroad. Perimeter's Teacher Network has reached 35,688 educators since 2006. For details of EinsteinPlus and teacher workshops, plus ongoing collaboration with Indigenous educators, see **page 34** of the Annual Report.
- Hosted the 18th International Summer School for Young Physicists (ISSYP) online for 40 students. For more information, including successes of former ISSYP participants, refer to **page 35** of the Annual Report.
- Hosted the "Inspiring Future Women in Science" conference for 155 Canadian high school students; for more information, see **page 36** of the Annual Report.
- Presented five engaging public lectures and panels to capacity audiences on site, plus one virtual public lecture, with a combined 745,752 views via livestream, YouTube, and media partnerships. For details, see **page 37** of the Annual Report.
- Continued the Institute's science communications efforts with more than 10.5 million YouTube video views in total since 2009 and continued growth across all social media channels. For more information, refer to **page 36** of the Annual Report.
- Engaged global audiences through media coverage of Perimeter science by major news outlets. For a list of Top 10 media stories, see **page 37** of the Annual Report.
- Won four Prix d'Excellence awards for outstanding achievements in communications and publications from the Canadian Council for the Advancement of Education; see the list on **page 37** of the Annual Report.

Objective 8: Continue to strengthen Perimeter's partnerships with the public and private sectors

Summary of Achievements

- Continued five-year, $50 million funding agreements with the Government of Ontario and the Government of Canada.
- Secured new private sector commitments, bringing Perimeter's major $100 million fundraising campaign to a total of $53 million in commitments to date.
- For details about government support and Perimeter's public-private partnerships, including information about support from the Riddell Family Charitable Foundation, refer to **pages 40-41** of the Annual Report. This includes a list of donors who have made cumulative gifts of more than $100,000 since 2014, the membership list of the Perimeter Institute Leadership Council, and tributes to Perimeter supporters Clay Riddell and Charlie Fischer.
- Continued private sector support of the prestigious Perimeter Research Chairs (see **page 21** of the Annual Report) and the Distinguished Visiting Research Chair program (see **pages 22-23** of the Annual Report).
- Continued support of Emmy Noether Initiatives, which support women and girls in physics, through the Emmy Noether Council, the Emmy Noether Circle, and the Simons Foundation. For a list of Emmy Noether Council members and details about the Institute's Emmy Noether Initiatives, see **pages 16-17** of the Annual Report.
- Continued private sector support of training and outreach programs, ensuring that economic factors are not a barrier to entry. These supporters include, but are not limited to, the Hellenic Heritage Foundation, Brad and Kathy Marsland, Margaret and Larry Marsland, The Savvas Chamberlain Family Foundation, Michael Serbinis and Laura Adams, RBC Foundation, Linamar Corporation, and BMO for Women.
- For a full list of public and private supporters, refer to **pages 42-43** of the Annual Report.

Governance and Financials

For Perimeter's governance structure, including all members of the Board of Directors, the Scientific Advisory Committee, and the Senior Leadership team, refer to **pages 44-45** of the Annual Report.

Biographies of Board members can be found at ***perimeterinstitute.ca/people/board-directors***.

More information about the Scientific Advisory Committee members can be found at ***perimeterinstitute.ca/people/scientific-advisory-committee***.

Performance Evaluation Strategy

Perimeter Institute uses an array of performance monitoring and evaluation policies, systems, and processes (both internal and external) that are re-evaluated and updated on a regular basis. These mechanisms to measure outcomes, results, and impact include:

Performance Monitoring – Internal

- Annual reports on research activity submitted to the Institute's Director by all faculty and associate faculty members for evaluation
- Annual performance reviews of all staff
- Ongoing monitoring of publication and citation records
- Post-conference reports and evaluations
- Visitor research activity reports and ongoing tracking of all output
- Regular updates and monitoring of progress of all scientific programs
- Mid-term performance reviews for junior faculty and junior associate faculty
- Postdoctoral researcher mentorship program
- Monitoring of postdoctoral researchers' post-Perimeter placement success
- Monitoring of researchers' international presence and impact through collaborations and invitations to lecture
- Internal review and evaluation of PSI and PhD students, and all outreach programs and products

Performance Monitoring – External

- Regular reporting to the international Scientific Advisory Committee, with subsequent performance assessment and recommendations
- Review of tenured faculty hires and promotions by the Scientific Advisory Committee
- Peer review of publications
- Annual audit of financial statements by an independent auditor
- Other performance audits and reviews in accordance with grant agreements
- External review and evaluation of all outreach programs and products

Public-Private Partnership

Perimeter Institute exists through a cooperative and highly successful funding model that provides for ongoing operations while, at the same time, safeguarding future opportunities.

Public partners contribute to research, training, and outreach activities and, in keeping with individual grant requirements, receive ongoing updates, reports, and yearly audited financial statements as required to ensure value for money while remaining aware of the Institute's research productivity and outreach impact.

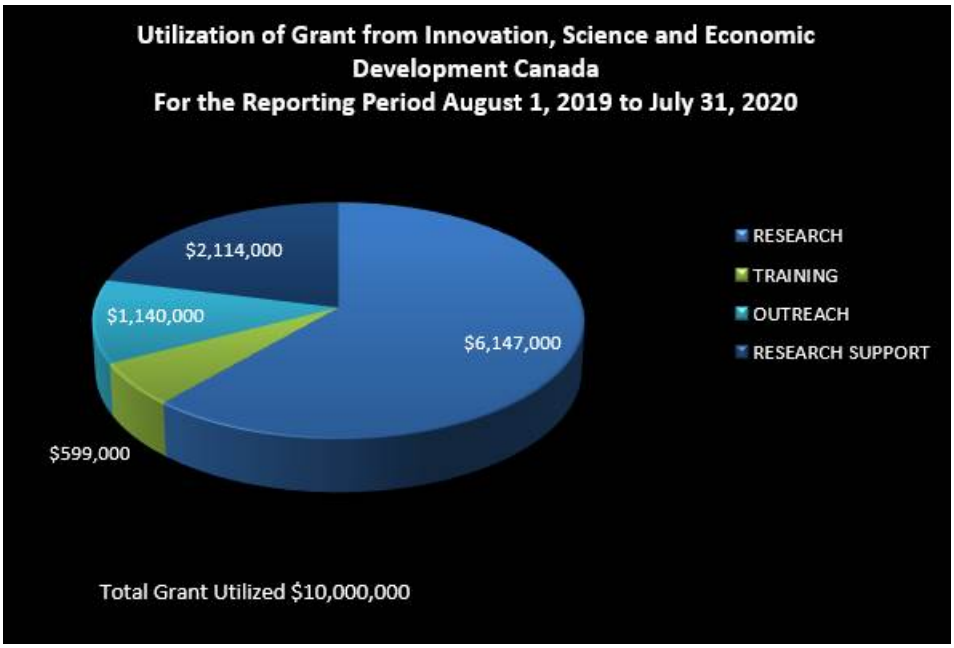
Private funds from a growing donor base are used to fund research, training, and outreach activities, while a portion is protected in an endowment that ensures the strongest possible long-term financial health of the Institute.

Perimeter Institute continues to be an innovative example of how government and philanthropists can unite in a common quest to secure the transformative potential of scientific research in Canada.

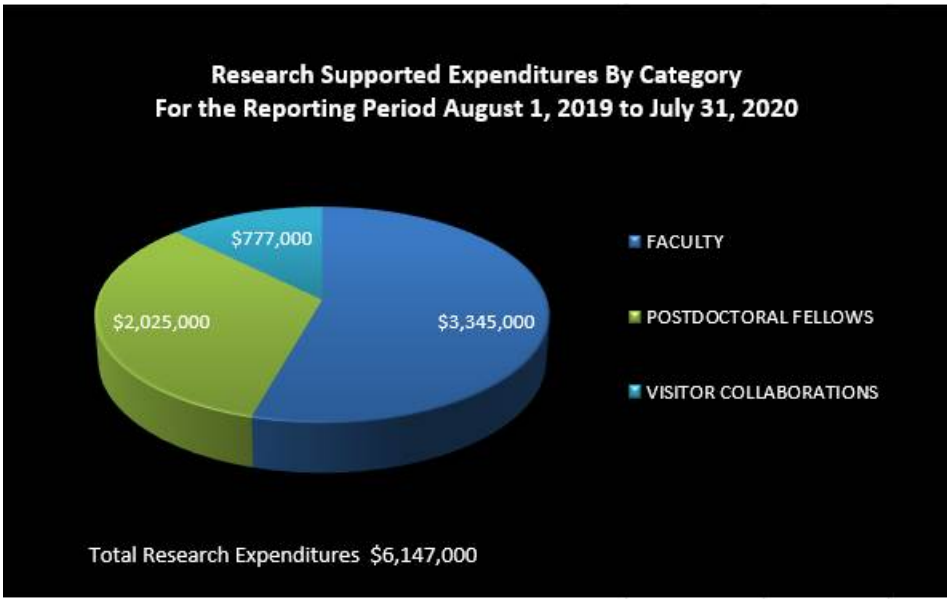
Overview of Financial Statements, Expenditures, and Investment Strategy

For Perimeter's summary of operating costs and details about its income, financial position, and long-term plan, refer to **pages 46-47** of the Annual Report. For the Institute's audited financial statements and the report of the auditor on the audited financial statements, refer to **pages 48-50** of the Annual Report.

Expenditure of Innovation, Science, and Economic Development Canada Grant



Research Supported Expenditures by Category



Statement of Objectives for 2020/21

Perimeter Institute is on track to achieve its paramount long-term goal: to create and sustain the world's leading centre for foundational theoretical physics research, to make discoveries that will change the world, and to train the next generation of scientific innovators. To build on the Institute's momentum, Perimeter has established a set of strategic objectives to guide its continued development and to create an optimal and inclusive research, training, and working environment. The Institute's core mission will continue to inform every facet of its research, training, and outreach efforts, supported by a sustainable funding model.

Note that while the Institute's objectives provide overarching guidance, the ongoing pandemic may affect their implementation, as noted throughout this report.

Objective 1: **Achieve breakthroughs in our understanding of the universe**, drawing insights from and contributing to the whole spectrum of theoretical physics, focusing strategically on research areas that offer the greatest opportunity for major discoveries.

Objective 2: **Create the world's strongest community of theoretical physics researchers** by continuing to attract and retain top international talent and providing them with unparalleled infrastructure and support to help maximize productivity. Continue to support and develop integrated programs, practices, and procedures aimed at ensuring an optimally equitable, diverse, and inclusive environment.

Objective 3: **Engage the worldwide research community** by holding timely, focused conferences, workshops, and seminars on cutting-edge topics and facilitating scientific interactions among eminent and emerging researchers.

Objective 4: **Serve as Canada's premier hub for foundational physics research**, strengthening connections with institutions across the country and enabling frontier research, high-quality training, and public engagement.

Objective 5: **Raise Canada's profile as a global leader in fundamental physics research** by establishing and maintaining strategic international partnerships, providing access to excellence for vast new pools of scientific talent, and attracting top talent from around the world.

Objective 6: **Attract and develop the next generation of brilliant minds** by providing exceptional training to graduate students and postdoctoral researchers, developing their potential as innovators with powerful, widely applicable skills that will fuel successful individual careers and the knowledge economy more broadly.

Objective 7: **Share the transformative power of theoretical physics** across Canada and around the world, inspiring a new generation of scientific explorers through high-impact educational outreach, while engaging the general public with the wonder and excitement of basic physics research.

Objective 8: **Continue to strengthen Perimeter's partnerships with the public and private sectors** by demonstrating excellent return on investment, securing sustained funding from government partners, and expanding the Institute's private sector support base.

APPENDIX

Simons Emmy Noether Fellows

Simons Emmy Noether Fellowships enable fellows to spend periods of up to one year wholly focused on their research. Many fellows return to continue their research and collaborations during the subsequent three years.

2019/20

Sayantani Bhattacharyya, School of Physical Sciences, National Institute of Science Education and Research
Cecilia Chirenti, Universidade Federal do ABC
Lavinia Heisenberg, ETH Zurich
Wei Li, Institute of Theoretical Physics, Chinese Academy of Science
Katherine (Katie) Mack, North Carolina State University
Catherine Meusburger, Friedrich-Alexander University Erlangen-Nürnberg
Monika Mościbrodzka, Radboud University
Sylvie Paycha, University of Potsdam

2018/19

Valentina Forini , City University of London
Ling-Yan (Janet) Hung, Center for Quantum Control, Fudan University
Karen Livesey, University of Colorado – Colorado Springs
Christine Muschik, University of Waterloo
Phiala Shanahan, Massachusetts Institute of Technology
Sherry Suyu, Max Planck Institute for Astrophysics

2017/18

Olalla Castro Alvaredo, City University of London
Emanuela Dimastrogiovanni, Case Western Reserve University
Paula Mellado, Adolfo Ibáñez University
Yaping Yang, University of Melbourne

2016/17

Céline Boehm, Durham University
Radja Boughezal, Argonne National Laboratory
Gemma de las Cuevas, University of Innsbruck
Mairi Sakellariadou, King's College London
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