Canadian Association of Physicists
Association canadienne des physiciens et physiciennes

A Submission to the Panel for

Canada's independent review of federal funding for fundamental science

29 September 2016

Executive Summary

The Honourable Kirsty Duncan, Minister of Science, has asked Canadians to provide comments to an expert Panel that will provide an independent review of federal funding for fundamental science. The Panel seeks feedback on 20 different questions about gaps in Canada's fundamental research funding ecosystem, as well as useful examples of measures that the Government of Canada could use to help address these gaps. The Canadian Association of Physicists, as the voice of physics in our country, recommends the following:

Recommendation 1: Keep the NSERC Discovery model strong. The three parts of the NSERC Discovery envelope (merit-based Fellowships, Discovery Grants with high success rates, and RTI grants with required matching funds) each fill unique roles in the Canadian fundamental science ecosystem. This vision for funding research works well and has been Canada's "competitive advantage" as a small country able to hold its own in the international world of science. To preserve Canada's standing, and to account for inflation and population growth, requires a success rate and funding level that continues to match the long-term historical figures. This, in turn, implies increasing the Discovery funding envelope dramatically over the next few years. [Addresses aspects of Questions 1, 6, 7, 9, 10, 16]

Recommendation 2: Develop a unified approach to funding research infrastructure over its entire life cycle, including: installation, maintenance, and upgrades. This should accommodate small-scale (single lab) equipment as well as large-scale infrastructure (national research facilities, long-term international projects such as CERN, telescopes), and should not be hampered by high matching fund requirements. Good infrastructure maximizes research productivity. [Addresses aspects of Questions 1, 4, 6, 7, 15, 18]

Recommendation 3: Introduce flexible funding avenues to support diverse activities, especially when it comes to supporting international collaborations, multi-disciplinary collaborations, and science outreach and education. [Addresses aspects of Questions 1, 5, 6, 7, 9, 10, 13, 14, 18]

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Recommendation 4: Unbiased peer review for equipment and research grants awarded to individual researchers -- regardless of their institutional affiliations or priorities -- should be held as paramount. Programs that have been targeted for institutions, such as the CFREF and CERC funds, have enabled an expansion of the country's research capacity for a period long after these programs expire. When these programs do expire, we propose diverting these funds to Discovery research to allow the legacy of the focused CFREF and CERC investments to develop optimally over the longer term, by increasing support to a broad range of researchers at early-, mid-, and late-career stages. This will help make the best use of this country's research capacity investments. [Addresses aspects of Questions 2, 4, 6, 11]

Recommendation 5: A government science advisor should have the mandate to monitor and review the status of fundamental science in subsequent years to provide continuity and longevity to this Panel's recommendations. [Addresses aspects of Questions 1, 5, 6, 7, 9, 10, 16, 18, 19]

We will be happy to provide additional information to the Panel, if desired, and we look forward to working together to help revitalize and invigorate fundamental science in Canada.

General Background:

A June 13, 2016 press release outlined the mandate for the Government of Canada's review of fundamental science.

Responding to this mandate, the Canadian Association of Physicists (CAP), with 1700 members, is Canada's national association for physicists working in industry, academia and government. The CAP strives to unleash the full potential of physics and physicists for the benefit of Canada. The CAP is recognized and respected for its science and technology expertise, and has testified at House of Commons Committees, such as the Standing Committee on Industry, Science and Technology for a study on the "State of Disruptive Technologies" on June 9, 2015.

The CAP's recommendations in this document identify changes to fundamental research funding that will help attract and retain Canada's best talent and will have positive impacts in Canada. This will develop a strong base that is essential for building a resilient and innovative workforce that will help drive Canada's international competitiveness in science and technology.

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Specific Background:

Recommendation 1: Keep the NSERC Discovery model strong

The core federal program that enables Canada's leadership in fundamental research is NSERC's Discovery Grants program. The 2016 Federal Budget provided an increase of $30 million to NSERC, which NSERC is using mainly for the Discovery Grants program. The CAP strongly supports this initiative as a good start to meet the demands of the increasing numbers of excellent researchers and thus mitigating the ongoing erosion of this program's capacity.

There is incredible power in the flexibility of NSERC Discovery Grants as "unfettered funds." Sometimes whole areas of new research open up, such as high-temperature superconductors, nanoscience, and quantum information, where Canadian scientists were quickly able to pivot and become leaders in these new fields, partly due to the flexibility afforded them by Discovery Grants.

NSERC Discovery Grants thus positions Canada to be on the leading edge of new, ground-breaking research by giving individuals the flexibility and nimbleness to go into new directions very rapidly.

In Canada, NSERC programs support the training of a large proportion of highly qualified personnel (HQP) in science.[1] NSERC Postgraduate Scholarships and Postdoctoral Fellowships are the cornerstone programs that attract our brightest young people into a research career. However, the numbers of awards from these NSERC programs are dropping rather than keeping pace with the growth of industrial and academic needs for these HQP. For example, between 2010 and 2014, there was a drop from 2520 to 1510 postgraduate awards offered and a decline from 286 to 130 postdoctoral awards offered. The number of postdoctoral awards is slipping far below Canada's HQP needs: in academia alone during 2010-2011, there was a need for 400 full-time university professors in engineering, math, and science, each of whom would have required post-doctoral experience.[2] Canadian industry also has a need for PhD scientists.

[1] The training of HQP in science is supported by programs that fund trainees directly (the NSERC Undergraduate Student Research Award [USRA] program, a number of postgraduate scholarship [NSERC PGS, Alexander Graham Bell Canada Graduate Scholarships, Vanier Canada Graduate Scholarships] programs and postdoctoral fellowship [NSERC Postdoctoral and Banting Postdoctoral] programs), and programs in which there is a training component (the NSERC Discovery Grant Program and the NSERC CREATE Program, and Mitacs).

[2] 2012-2013 Canadian Association of University Teacher's Almanac.

Direct support for HQP in the form of long-term, merit-based scholarships and fellowships that will attract the brightest students and support students throughout their program of studies is of paramount importance to close the gap in training HQP between Canada and its OECD (Organisation for Economic Co-operation and Development) competitors. These HQP will be Canada's future leaders in science, engineering, and beyond. Increasing the number of merit-based awards above 2010 levels will help keep a sufficient number of the best and brightest Canadian trainees in Canada.

Finally, there is a solid international precedent for Canada to increase funds for "non-oriented research". For Germany, "non-oriented research" is 17% of the total budget[3], and 16% for the US (based on 2011 numbers).[4] Other countries are often >20%. However, Canada is only ~14%.[5]

Recommendation 2: Unify infrastructure funding

A key to attracting and retaining the best research talent is the development of and access to globally competitive research infrastructure. Universities can then ensure that students are trained on the most advanced systems, allowing them to be the first to discover new ways of doing things, giving them competitive advantages they can bring to their careers.

On a small scale, individual researchers must be able to renew or acquire equipment in an excellence-based, peer-reviewed competition, as exemplified by the NSERC Research Tools and Infrastructure (RTI) program. NSERC has indicated that it will maintain the RTI program for equipment below $150,000. On larger scales, communities of researchers must be able to find funds to operate shared facilities, exemplified by the Canada Foundation for Innovation (CFI) funds. As the CFI typically funds infrastructure costing over $1.5M, there is a gap in the available programs for equipment or infrastructure in the range of $150,000 to $1.5M. This should be met by expanding the NSERC RTI program into this range and holding competitions annually on a competitive peer-reviewed basis. These awards should include a partial contribution towards the operating costs of the facilities for the first five years of operation, as well as options for renewed operation funding thereafter. Part of the gap could also be addressed by increasing the $150,000 ceiling for RTI funds, which has been constant for over

[3] See Figure 12 in https://www.bmbf.de/pub/Education_and_Research_in_Figures_2016.pdf
[4] See Tables 4-15 in https://www.nsf.gov/statistics/seind14/index.cfm/chapter-4/c4s7.htm and also https://www.nsf.gov/statistics/seind14/index.cfm/chapter-4/c4s.htm#sb8
[5] See Table 10 in http://www.statcan.gc.ca/pub/88-204-x/88-204-x2014001-eng.pdf. Line items are very similar to German data.

25 years even as the cost of equipment has nearly doubled. Increasing the ceiling to $300,000, while at the same time lowering the CFI amount, would address this issue and ensure that no gaps exist.

Another option that the CAP recommends for consideration is the resurrection of the NSERC Major Resource Support (MRS) program for the purpose of supporting on-going operations of NSERC RTI-funded equipment. In this scenario, NSERC would be fully responsible for small-scale equipment (capital and operating funds), while CFI is fully responsible for the big facilities.

The CAP applauds the recent expansion of the CFI Major Science Initiatives (MSI) fund. Originally created for national scale facilities representing over $50M in capital, it began funding 40% of operating costs for medium scale facilities through its competition in 2014. CAP also applauds the $1.33B investment in research infrastructure via the CFI proposed in the 2015 budget. Whether by allocating some of these funds, or injecting new funds, the MSI fund should be renewed and expanded because the limited funds in the 2014 competition resulted in only a small fraction of the facilities in need being funded. The expanded MSI fund should also cover a greater portion of the total operating costs of facilities where appropriate since operations of research facilities that have long-term research goals are generally not suitable for industrial support.

Recommendation 3: Support more diversity in international, multi-disciplinary, and science education/outreach research

One of the most important determinants of knowledge transfer from universities to businesses is the quality and breadth of the research that is pursued in academic settings. While market-driven research can address specific issues for industries in the shorter term, it is the fundamental research, characterized by longer timelines and unexpected discoveries, that can generate and incubate unexpected technologies that will become transformative solutions to today's problems and incubate whole new industries of the future.

For this reason, it is important to have flexible funding available to support Canadian researchers who are involved in collaborations that cross national and/or disciplinary boundaries. For example, there are no programs available for direct support to Canadians involved in Horizon 2020 projects with European collaborations. Also, within Canada, there are no funding programs available to support NSERC-SSHRC collaborations. For research involving Big Data, it is common for there to be both multi-disciplinary and international funding boundaries to negotiate. These kinds of collaborations are very high impact because the focus

is typically on understanding science and technology from multiple perspectives, both disciplinarily and culturally.

Another gap in the current fundamental science funding ecosystem is in STEM education funding, which has fallen through the cracks. Many of the best STEM education researchers are scientists with strong NSERC track records who conduct this research in quantitative and evidence-based manners. As such, this research would seem to fall under NSERC's purview. However, because this research is fundamentally focused on education, it is relegated almost exclusively to SSHRC grants. Most NSERC-stream researchers find it difficult to secure SSHRC grants, and vice-versa. Furthermore, the scientific approach of this research hinders the likelihood of its being funded by SSHRC, and the topic of the research has no current evaluation group at NSERC. Thus, STEM-ED Researchers cannot obtain funding for their research. Minor internal institutional funding is not a viable solution. Evidence-based research should be valued, both in the peer-review process and in the grant award process, whether in SSHRC or NSERC jurisdiction. In other words, a national strategy for funding and evaluating STEM education research is sorely needed.

Recommendation 4: Support more individual researchers, rather than large single-researcher or single-institution grants

Our membership perceives some discrepancies among funding opportunities for researchers at different career stages (early-, mid-, late-) but also perceives strong inequities for funding among different institutions. The concern is that this is suppressing the ability for individual researchers to take on risky, innovative research directions that do not align seamlessly with university priorities, or within university budget envelopes. This has been recognized as an issue at smaller institutions, which are receiving a disproportionately small slice of the research funding pie. However, our members have noted that these discrepancies are also present at mid- and large-size institutions.

We also suggest revisiting NSERC's current evaluation group structure. There is a perception among many of our members that the grant selection committee (GSC) structure and review process that existed prior to 2010 was more fair than the present evaluation group (EG) structure. Under the old system, the same group of people reviewed all grants, which gave room to iterate to ensure that the overall process was fair and accurate. The older system was also less prone to drastically reduced or increased reallocations that are a feature of the present system.

Recommendation 5: Review the status of fundamental science regularly through a National Science Advisor

No matter how effective and well-intentioned the current Fundamental Science Review is, it cannot solve all issues facing Canadian science for all time. Building in regular policy reviews will help make sure that suggestions for improving Canadian science, put forward by the CAP and by other groups, can be assessed for their consequences in practice. Our members believe that is very important for government support of fundamental science to evolve and adapt as needs of researchers, and of Canada, change.