Canadian Neutron Initiative

Written Submission for the Pre-Budget Consultations in Advance of the 2019 Budget

Submitted on behalf of the

Canadian Neutron Initiative Working Group leaders:

University of Saskatchewan

McMaster University

Canadian Nuclear Association

Canadian Institute for Neutron Scattering

August 2018

Recommendation

Allocate $24M of new funding in Budget 2019, and $100M over five years, starting in 2021-22, to the Canada Foundation for Innovation to establish, via the Canadian Neutron Initiative, a pan-Canadian, university-led framework for materials research and innovation with neutron beams.

Summary

Canada's long-term competiveness relies on a complete 21st century scientific toolkit to develop materials for innovation in priority areas, such as producing and storing clean energy, growing the economy through advanced manufacturing and clean technologies, and promoting health through biomedical and life sciences. Canada lost access to an irreplaceable tool for materials research, neutron beams, when Canada's only major domestic neutron source, the NRU reactor in Chalk River, was closed permanently. Budget 2019 should commit funds to establish a new pan-Canadian, university-led framework for materials research and innovation with neutron beams. This framework will train students for highly-skilled careers and retain experts so that Canada can maintain our place among leaders in materials research and innovation that enables long-term competitiveness in a changing world.

Industries Use Neutron Beams to Enhance Productivity

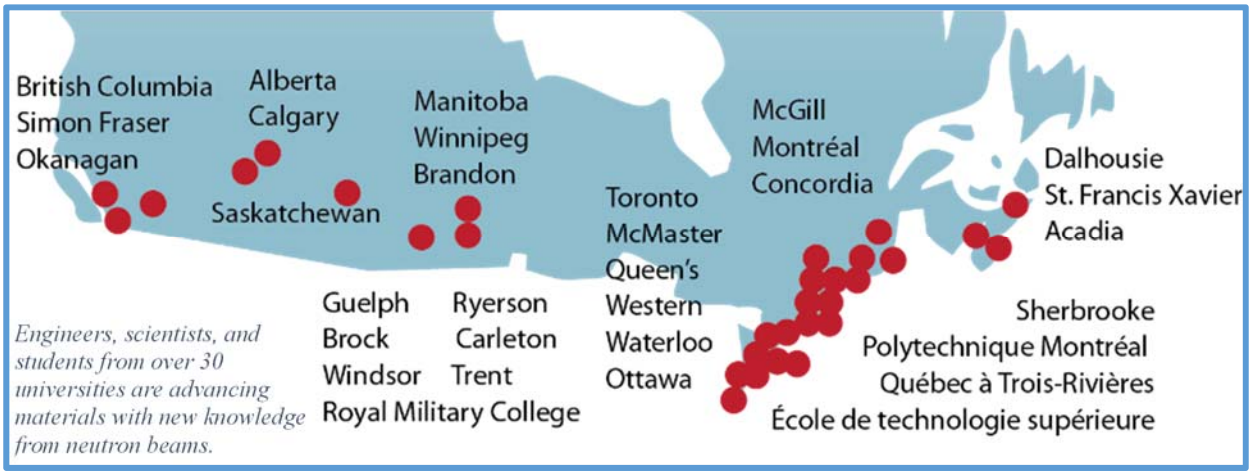
"Neutron beams are an essential and unique tool for evaluating the reliability of critical components for the **automotive** industry."

- Glenn Byczynski,
R & D and Engineering Manager,
Nemak USA & Canada

Research using neutron beams provided critical knowledge needed to understand the phenomenon of cracking in feeder pipes, which was impacting some of **Canada's nuclear power plants**. This understanding allowed inspections of feeders across the industry to be targeted to areas of vulnerability. As a result, radiation dose received by plant inspection staff was significantly reduced, and plant downtime was also decreased.

- Paul Spekkens, (former) VP S&T Development (2004-2016),
Ontario Power Generation

Researchers across Canada Use Them to Advance Research and Innovation



What Are Neutron Beams?

Just like beams of light are used in a microscope to learn about materials on a micrometre scale, beams of neutrons reveal nanometre-scale details about materials' molecular structures and motions that cannot be seen with other scientific tools – details that are critical to how materials perform.

A full research toolkit enables long-term competitiveness in a changing world

If the Canadian construction industry no longer had some of the most basic tools of the trade, such as hammers and drills, it would quickly become less competitive and less resilient to changing demands. Similarly, materials scientists and engineers rely on versatile and irreplaceable tools to enable research on pressing and important questions – thereby providing knowledge to fuel innovation that ultimately enables competitiveness and resiliency. The tools of the materials research 'trade' are versatile in application because everything is made of materials. Nearly all technology advances have a material component. A few examples of complex challenges requiring a complete 21st century toolkit for materials research include: [1]

A clean environment: Producing clean energy, whether by wind, solar, or nuclear power, and storing it effectively in an efficient electricity grid.

Clean Growth: Making parts for clean and energy-efficient, light-weight planes, ships, and cars, using 3D printing or other advanced manufacturing technologies.

Safety and Security: Aiding nuclear non-proliferation, pipeline and rail safety, and determining fitness-for-service of naval ships.

Health and Food Security: Understanding the materials of our bodies, designing medical devices, and developing resilient crops for global food security.

Canadians use neutron beams to contribute to scientific discovery and technological advancements in all of the above areas, and in many others.

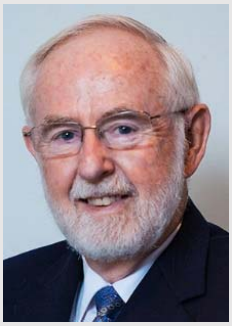
Neutrons beams: an irreplaceable tool for materials research and innovation

Over 800 scientists, engineers, and students from Canada and abroad, representing over 30 Canadian university departments in addition to government and industrial labs, have participated in research using neutron beams in Canada in the last five years, because neutron beams have become irreplaceable. They provide insights about materials that cannot be obtained by other scientific techniques – the reason McMaster Professor Bertram Brockhouse, a pioneer of neutron scattering for materials research, was honored with the Nobel Prize in physics in 1994. The continuing value of neutron beams is recognized by innovative nations who have committed $8.6B in the 21st century to date in capital re-investment in neutron facilities.

Neutron beams are among a set of complementary tools for materials research that are available only at major research facilities, which require special consideration in the federal budget from time to time because of their national scope and scale: for example, the Canadian Light Source for x-rays and TRIUMF for muons. These facilities provide, in addition to access to the tools, essential user support services to ensure Canadians can apply these tools effectively.

[1] CINS. Discover Neutrons For Materials Research. http://cins.ca/discover/

"World-class research and innovation require large, national-scale science facilities that are accessible and maintained at the state-of-the-art. Neutron beam facilities are critical tools for materials research and technology development in areas such as clean energy, clean transportation, health, and food security. The Canadian Neutron Initiative proposes a single program for orderly stewardship of Canadian access to neutron-beam facilities for a decade beyond the closure of Canada's primary source of neutron beams – the NRU reactor" **– Dr. Art McDonald, Nobel Laureate in Physics (2015)**



The urgent challenge

Canada's neutron source, the National Research Universal (NRU) reactor at Chalk River, closed in March 2018. The neutron beam lab at NRU is winding down, dispositioning the research equipment. Canada's only agreement with a foreign neutron source expired this year, and no funding programs support research operations at foreign sources. These losses are displacing the research community, forcing many to avoid research questions for which neutron beams are needed. As experts exit the field, Canada's capability to apply this tool to achieve our innovation agenda will decline, ultimately hampering Canada's long term competitiveness and resiliency.

The Canadian Neutron Initiative (CNI) offers a national solution

Allocate $24M of new funding in Budget 2019, and $100M over five years, starting in 2021-22, to the Canada Foundation for Innovation to establish, via the Canadian Neutron Initiative, a pan-Canadian, university-led framework for materials research and innovation with neutron beams.

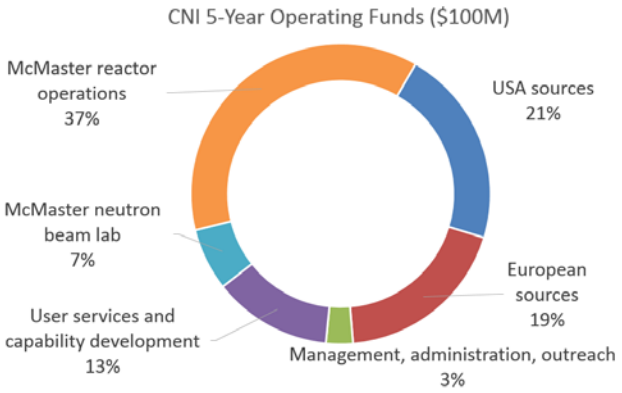
The CNI is a response to the urgent challenge, aiming to sustain and rejuvenate a community of engineers and scientists who can use this critical scientific tool, today and tomorrow. The CNI working group, whose composition is described the Appendix, is committed to establish a new framework for leadership, management and funding of Canada's capacity for materials research with neutron beams, building on existing national and international resources.

The new framework will centre around a program that ensures Canadians can access neutron beams for world-class research and innovation in materials as well as training students for highly-skilled careers and fostering international exchanges of ideas and expertise. The proposed program is a holistic, coherent collection of activities covering Canada's needs for the next decade, thereby avoiding the inefficiencies and limitations of piecemeal funding of Major Research Facilities, identified by Canada's Fundamental Science Review.[2]

The program will fully exploit domestic, university-based capabilities, including the McMaster Nuclear Reactor, which is now our best remaining neutron source. To enable research that requires brighter sources of neutrons, the program will form partnerships with leading facilities abroad. The program will retain as much activity within Canada as possible, including development of new technology, thereby playing a role similar to the National Research Council's role in managing Canada's participation in international astronomy facilities.

[2] Naylor, David et al. (Canada's Fundamental Science Review). "Investing in Canada's Future: Strengthening the Foundations of Canadian Research". April 2017. http://www.sciencereview.ca

The $24M for the start-up phase of up to three years will enable short-term mitigation of the present lack of access to neutron beams through interim agreements with leading foreign facilities, and it will begin domestic capacity building in preparation for full operations of the program. A lump sum is requested for flexibility to deal with contingencies inherent in negotiations with the neutron sources.



Estimated breakdown of expenditures for the on-going program

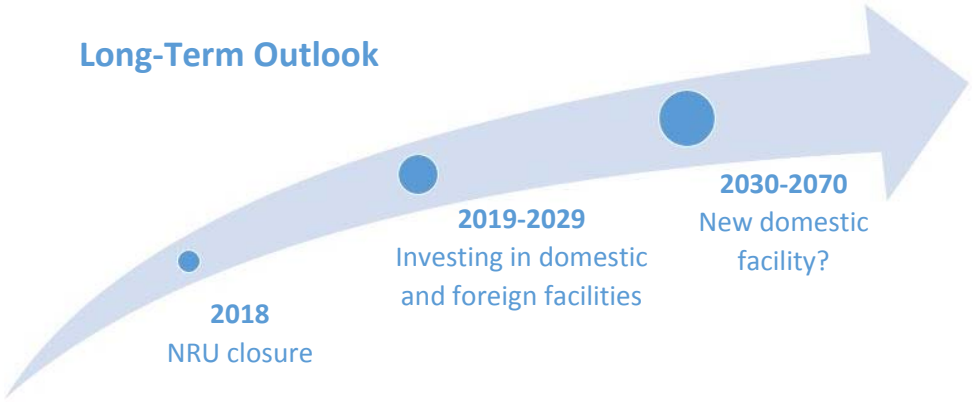
A commitment to a five-year renewable funding term will enable orderly planning of activities that require substantial lead-time, such as upgrading the capacity of the McMaster Nuclear Reactor. The $20M/yr for the ongoing operating phase is much less than the $100M/yr or more that Canada had invested in the NRU reactor. Furthermore, Canadian university research labs that access neutron beams – whether frequently or occasionally – represent investments of about $90M/yr from all sources. Continuing to provide access to this irreplaceable tool is important to ensure a maximum return on these investments.

While some provincial matching funds may be obtainable, continued federal leadership in funding is essential, especially for the program's international-facing activities. As the current leader in funding Major Research Facilities, the Canada Foundation for Innovation is the appropriate federal agency to provide funding oversight.

Graduate students learn about materials research with neutron beams.

CNI participation in government decision-making

As a result of its consultation for the 2018 budget, the House of Commons Finance Committee recommended that the Government "implement the Canadian Neutron Initiative."[3] Following testimony of CNI participants, the Natural Resources Committee recently called for the Government to consider options "to provide a reliable, high-flux neutron source for Canadian researchers."[4] The Government Response identified access to foreign facilities and upgrades to the McMaster Nuclear Reactor as short and medium term solutions, a new research reactor for the longer term, and cited its engagement with the neutron beam community among others.[5] The CNI's proposal will maintain and rejuvenate the neutron beam community, enabling it to participate coherently, along with other stakeholders in nuclear power and medicine, in national road-mapping or decision-making processes about long-term investments, such as a new research reactor for 2030 and beyond.



Investing in existing facilities is needed immediately to prevent loss of capability while consideration is given to investments for the longer term, which could include a new domestic facility.

[3] House of Commons Finance Committee report on its consultations for the 2018 budget. Dec 8, 2017.
[4] The nuclear sector at a crossroads: Fostering innovation and energy security for Canada and the world. Report of the Standing Committee on Natural Resources. June 2017.
[5] Government of Canada response to the House of Commons Natural Resources Committee report on the nuclear sector. Oct 5, 2017.

Appendix

Description of the Canadian Neutron Initiative

Participation in the CNI is open to Canadian stakeholders, collaborators and observers. Executive leadership is provided by:

University of Saskatchewan:	VP Research, Dr. Karen Chad – Chair
McMaster University:	VP Research, Dr. Rob Baker
Canadian Nuclear Association (CNA):	President and CEO, Dr. John Barrett
Canadian Institute for Neutron Scattering (CINS):	President, Prof. Thad Harroun

The CNI working group also includes the following institutions:

- Canadian Neutron Beam Centre
- Sylvia Fedoruk Canadian Centre for Nuclear Innovation
- Canadian Light Source
- Innovation Saskatchewan

Official supporters of the CNI working group include the following institutions:

- Nemak Canada Corporation
- Brock University
- Dalhousie University
- Queen's University
- University of Guelph
- Université du Québec à Trois-Rivières
- University of Windsor
- University of Winnipeg

The CNA is a non-profit organization established in 1960 to represent the nuclear industry in Canada and promote the development and growth of nuclear technologies for peaceful purposes.

CINS is a non-profit organization that represents the Canadian community of neutron beam users and promotes scientific research with neutron beams.