Canadian Neutron Initiative

The Canadian Neutron Initiative: Securing a Critical Tool for Materials Research and Innovation for Canada

A Submission to the House of Commons Finance Committee

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Submitted on behalf of

Canadian Neutron Initiative Working Group leaders:

University of Saskatchewan
McMaster University
Canadian Nuclear Association
Canadian Institute for Neutron Scattering

Summary

Canadians and Canadian businesses need 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. To prevent the loss of an irreplaceable tool for materials research when Canada's primary source of neutron beams closes in 2018, a working group proposes the Canadian Neutron Initiative (CNI) to establish a new framework for stewardship of Canada's capability for research with neutron beams. This framework will train students for highly-skilled careers and retain experts so that Canada can remain on the leading edge of science and technology in the coming decade. The framework will cost less than the fiscal room gained when our current facility closes.

Industries Use Neutron Beams to Enhance Productivity

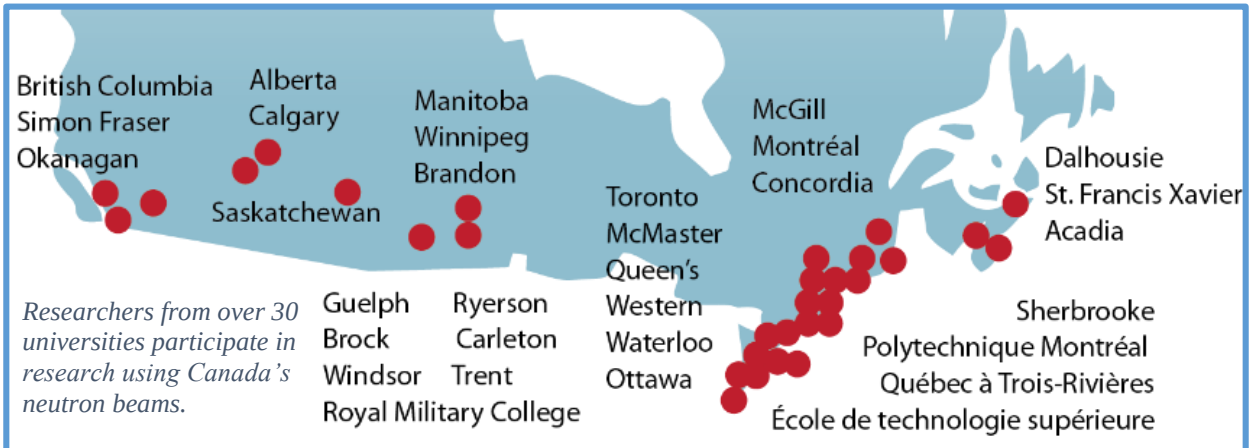
"Neutron beams are an essential and unique tool for evaluating the reliability of critical components for the **automotive** industry."

- 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



Researchers from over 30 universities participate in research using Canada's neutron beams.

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.

Enhancing Canadian productivity requires a complete toolkit

If the Canadian construction industry no longer had hammers and drills, its productivity would suffer, its apprentices would seek training and work elsewhere, and ultimately it would be unable to compete with foreign contractors. So would Canada's education, research and innovation activities lose out if it no longer had a complete toolkit for developing better materials and for training Canadians in using these tools. Such research tools include beams of light or particles, such as neutrons and electrons from large national and regional science facilities, down to the microscope in an entrepreneur's basement.

A complete 21st century research toolkit is vital for innovation in materials that are needed for:

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

Clean Growth: Advanced manufacturing of clean and energy-efficient, light-weight planes, ships, and cars powered by electricity or alternate fuels.

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.

Scientific discovery and technological advancements in these areas, and in many others, depend on having the tools for materials research, since everything is made of materials, after all.

The Urgent Issue

Canada faces the imminent loss of an irreplaceable tool – neutron beams – essential to Canada's clean economy, security and health goals. The value of neutron beams is clear from $8B in capital investment for neutron facilities worldwide so far in this century, as innovative nations ensure their people can acquire critical knowledge not accessible by other scientific techniques. In addition, the 1994 Nobel Prize in Physics, shared by McMaster Professor Bertram Brockhouse as one of the two pioneers of neutron beams, was a global acknowledgement of the cumulative value of these irreplaceable tools for understanding and developing materials since the 1950's.

Canada's loss will occur in March 2018 when the NRU reactor at Chalk River closes. Over 800 scientists, engineers, and students from Canada and abroad participated in research projects that depended on neutron beams from that facility in the last five years. Also in 2018, Canada's only agreement for access to a foreign neutron beam facility will expire. Inaction will cripple Canada's ability to apply this tool to achieve our innovation agenda, affecting researchers in over 30 Canadian university departments and in government and industry, creating a void in Canada's capabilities. Once that capability is lost, it will be difficult to regain, hampering Canada's ability to consider investing in a new research reactor, and to maximize return on that investment.

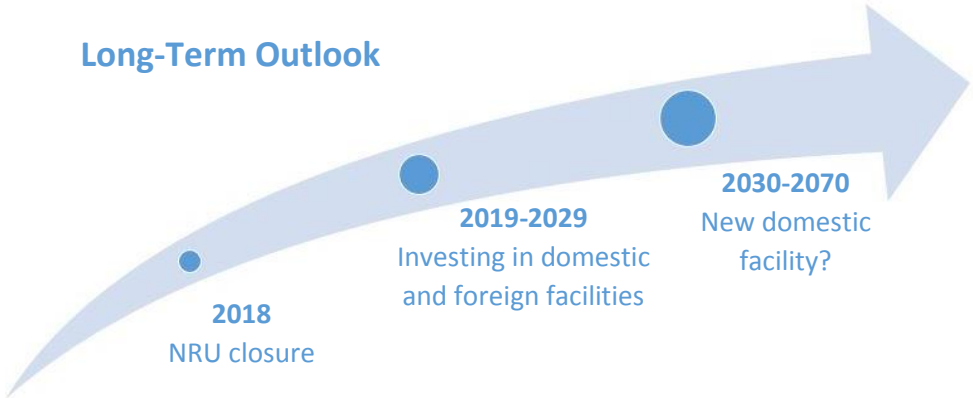
"World-class research and innovation require large, national-scale science facilities that are accessible and maintained at the state-of-the-art. Neutron beam facilities are critical tools for materials research and technology development in areas such as clean energy, clean transportation, heath, and 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 imminent closure of Canada's primary source of neutron beams – the NRU reactor" **– Dr. Art McDonald, Nobel Laureate in Physics (2015)**

A National Solution

The Canadian Neutron Initiative (CNI) is a response to the urgent challenge, aiming to sustain access for Canadians to this critical scientific tool, today and tomorrow. If successful, the CNI would 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 ensure Canadians can access neutron beams for world-class research and innovation in materials as well as training students for highly-skilled careers.

A university-led framework, the CNI addresses two time horizons. For the next decade, the CNI must focus on coordinating access to leading neutron-beam facilities abroad after the NRU closes. The CNI will also need to fully exploit domestic, university-based capabilities, including the McMaster Nuclear Reactor, which will be Canada's most powerful research reactor by far at that time. Both aspects will be needed to maintain and rejuvenate a capable community of researchers in this field.

The framework will provide a stable foundation for materials researchers to participate in any national road-mapping process or decision-making about large-scale research infrastructure, which could include a new research reactor for 2030 and beyond, with contributions from other stakeholders: nuclear power, manufacturing and medicine.



Canada needs to address two time horizons. 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.

Funding Requirements

The envisioned national program for Canadian access to neutron beams is a coherent package of activities covering Canada's needs for the next decade. This holistic approach seeks to avoid the challenges of piecemeal funding of Major Research Facilities, identified by Canada's fundamental science review (Naylor, p132-3).

The total funds required to initiate the new framework over the next three years, 2018-2020, is $24M. On-going operations from 2021 to 2029 is expected to average $19M/yr, of which less than $7M/yr represents the incremental investment for neutron beam facilities compared to the expiring framework. These amounts are much less than the fiscal room that will be gained by the federal government from the closure of the NRU reactor, whose costs have reached over $100M/yr in recent years. Furthermore, Canadian university research programs 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 Canada's investment in these programs.

While there are opportunities to leverage contributions from partners, primarily provincial governments, federal support in the form of stable baseline funding is essential, especially for the activities to secure access to foreign neutron-beam facilities. Special consideration by the Government of Canada is needed because the required funds are larger than can be accommodated through a normal competition of a research granting agency, such as the Canada Foundation for Innovation.

Summary of Recommendation

Canadians and Canadian businesses need a complete 21st century scientific toolkit for developing materials for innovation. To prevent the immediate loss of an irreplaceable tool – neutron beams – a commitment in the 2018 budget should be made to a 10-year university-led framework for the materials research and innovation enabled by neutron beams, with the federal government funding a majority of the cost of the framework's activities, expected to be $24M over the next three years, 2018-2020, ramping up to on-going operations from 2021 to 2029 about $19M/yr. These amounts are less than the fiscal room to be gained from the closure of the NRU reactor.

Description of the Canadian Neutron Initiative

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

At this time, the CNI is also supported by resources from the National Research Council of Canada, Innovation Saskatchewan, the Sylvia Fedoruk Canadian Centre for Nuclear Innovation Inc, the Canadian Light Source, and the Canadian Neutron Beam Centre.

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 not-for-profit organization that represents the Canadian community of neutron beam users and promotes scientific research with neutron beams. CINS has over 200 individual members from Canada and abroad.

Bibliography of Referenced Materials

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