Neutrons Canada

Written Submission for the Pre-Budget Consultations in Advance of the Upcoming 2024 Federal Budget

By: Neutrons Canada

August 2023

Recommendations

- **Recommendation 1:** That the government provide $95 million in funding over six years, starting in 2024-25, and $25 million ongoing, for a national program for research and development with neutron beams to be managed by Neutrons Canada.

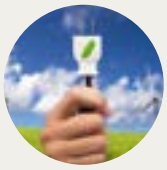
- **Recommendation 2:** That the government implement the recommendation of the *Report of the Advisory Panel on the Federal Research Support System* to create a framework for Major Research Facilities that takes a lifecycle, road-mapping and portfolio approach to the governance and funding of these national assets.

Neutrons Canada

A NATIONAL NEUTRON BEAM INFRASTRUCTURE PROGRAM

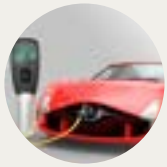
Canada's future social, environmental, and economic prosperity will require a comprehensive 21st-century scientific toolkit for research and development in materials.

Advanced materials innovation underpins nearly all technology advances for national priorities, including:



CLEAN ENERGY

Producing, storing and distributing clean, reliable, and renewable energy.

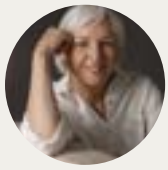


NET-ZERO MANUFACTURING

Developing material processing methods to cut emissions, accelerate electric vehicle advances, and effectively use Canada's critical minerals.

SAFETY AND SECURITY

Aiding nuclear non-proliferation, ensuring pipeline airline and rail safety, and determining fitness-for-service of naval ships.



HEALTH AND FOOD SUSTAINABILITY

Understanding the molecular mechanisms of health and disease, designing drugs and medical devices, and developing more sustainable plant-based foods.

QUANTUM INNOVATION

Understanding and designing materials for quantum computers, quantum communication devices, and quantum sensors.

Access to neutron beams for research is essential for materials innovation in the above areas. For this reason, Neutrons Canada requests $95 million in funding over six years, starting in 2024-25, and $25 million ongoing for a national infrastructure program for research and development with neutron beams. This program will enable Canadian students, scientists, and engineers to address significant scientific, social, environmental and economic challenges by giving them access to versatile and irreplaceable materials and research tools. To that end, the program will (1) forge partnerships with world-leading neutron beam facilities in other countries and (2) build up and maintain neutron beam capabilities in Canada. The ongoing funds should be rolled into the funding framework for Major Research Facilities developed by the Government of Canada.

Neutron beams were vital to explaining and preventing leaks at Canada's fleet of nuclear power reactors, thus reducing downtime.

Neutron beams were critical to ensuring reliability of car engine parts manufactured with innovative methods.

Neutron beams were crucial to explaining cracking issues in Canada's aging pipelines and developing industry standard practices to ensure reliability.

Neutron beams are being used at the University of Saskatchewan to advance global food security.

What are neutron beams? Why are they needed?

Neutron beams are versatile and irreplaceable tools for materials research and one of several probes that engineers and scientists need to advance knowledge and improve materials.

Like beams of light in a microscope that reveal details 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.

Is Canada a leader in such materials research?

Canadians have led in the field of materials research with neutron beams for over 70 years, resulting in significant socio-economic impacts, such as preventing downtime from leaks at Canada's nuclear power reactors; ensuring the reliability of energy-saving car engine parts, and reducing cracking issues in Canada's aging pipelines. One particular impact—**saving hundreds of millions of dollars by lowering downtimes of Canada's fleet of nuclear power stations**—has outweighed Canada's cumulative investments in neutron beam facilities.[1]

Figure 1. About 800 engineers, scientists, and students from Canada and abroad, representing over 30 Canadian universities, are advancing materials with knowledge from the now-closed Canadian Neutron Beam Centre in its last 5 years.

How does this research field impact student training?

Neutron beams are highly effective training tools that greatly enhance a student's research experience: A recent study[2] found that 60% of the Canadian *undergrads* who used the now-closed Canadian Neutron Beam Centre went on to earn a graduate degree, and two-thirds of these earned a Ph.D. Alumni credited their neutron beam experience as contributing to their later academic achievement and career success, citing skills such as working safely and effectively under time pressure in highly regulated, complex industrial research environments. Over 80% of alumni went on to careers in the sectors where homegrown innovation is most needed, including manufacturing, scientific and engineering services, and academia.

Why does Canada need to invest now?

While other nations have invested about $10B in research infrastructure to provide neutron beams since 2000, **Canada's primary neutron source at Chalk River closed**

"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 national neutron strategy proposes a single program for orderly stewardship of Canadian access to neutron beam facilities."

PROF. ART MCDONALD
Nobel Laureate
in Physics (2015)
Queen's University

"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

in 2018. Without neutron beam infrastructure, Canada's scientific toolkit is incomplete. Since 2018, over 90% of Canadian neutron users have not been able to get enough access to alternate sources in other countries, according to a recent survey, and 40% have had none at all.[3] As a result, Canadian researchers now frequently or altogether avoid research questions for which neutron beams are needed. As experts exit the field, Canada's capability to apply them to advance our innovation agenda will decline. Failure to invest will compromise Canada's leadership in materials research with neutron beams and ultimately hamper Canada's long-term ability to innovate to meet our social, environmental and economic challenges.

What is being done to address the neutron gap?

Canada is just beginning to rebuild its neutron beam infrastructure. Canadian universities are leading the way by developing the **national neutron strategy**, **creating Neutrons Canada**, and **securing funds for a $50M project** that will (1) develop the neutron beam user laboratory at the McMaster Nuclear Reactor and (2) establish short-term partnerships with two foreign neutron sources. Investment is now needed to operate the domestic facility as a national resource and to forge long-term partnerships to provide Canadians with access to world-leading neutron beam infrastructure.

What is the National Neutron Strategy?

The National Neutron Strategy[4] represents the consensus of the Canadian neutron community on rebuilding Canadian capacity for materials research with neutron beams. It was formed under the leadership of the Canadian Neutron Initiative working group, which was an executive-level forum through consultations with universities across Canada, government agencies, industry, and potential foreign partners, as well as with researchers individually and collectively.

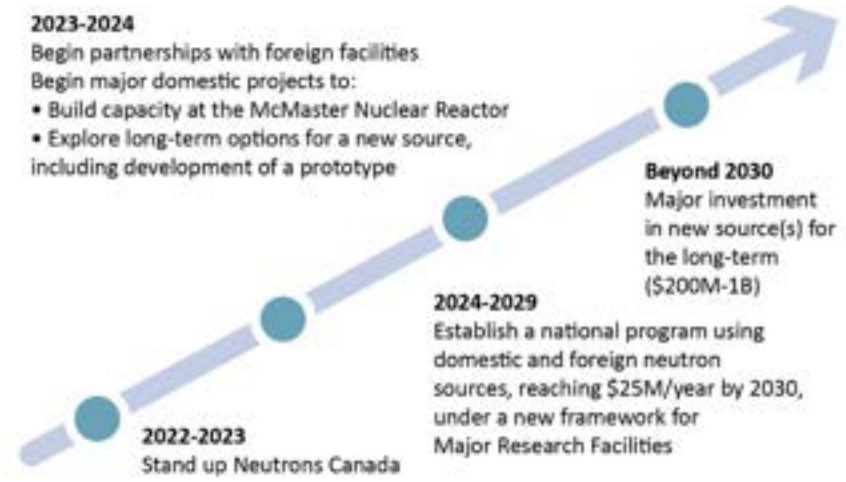


Figure 2. Illustration of key activities and timelines in the national neutron strategy.

Research using neutron beams provided critical knowledge needed to understand the cracking phenomenon in feeder pipes, 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, the 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

What is Neutrons Canada?

Neutrons Canada was founded in October 2022 as a not-for-profit corporation and has 14 member universities. Neutrons Canada is led by an independent board of directors,[5] composed of experts in science policy, corporate governance and research facility management to oversee the requested funds and implementation of the national neutron beam program. Neutrons Canada aims to govern, manage, and represent Canada's infrastructure program for research and development with neutron beams. This program includes international partnerships to secure access to world-leading neutron laboratories, operation of Canada's domestic neutron beam facilities, and national initiatives for future neutron sources to address significant social and economic challenges.

How should the funds for the requested program be allocated?

The ongoing $25M/year beginning in 2030 for the neutron beam infrastructure program should be included in the proposed funding framework for Major Research Facilities (MRFs), which is currently under consideration by Innovation, Science and Economic Development Canada. The Advisory Panel on the Federal Research Support System reviewed the proposed framework and recommended that the Government of Canada ensure that the framework for MRFs will take a lifecycle, road-mapping and portfolio approach to the governance and funding of these strategic national assets. The current *ad hoc* approach needs to be revised, lacking any long-term vision for building and maintaining MRFs.

In the short-term, until such a funding framework emerges, direct government investment of $95M over 2024 to 2029, as shown in the following table, should be made through a contribution agreement with Neutrons Canada, thus enabling the ramp-up of Canada's neutron beam program.

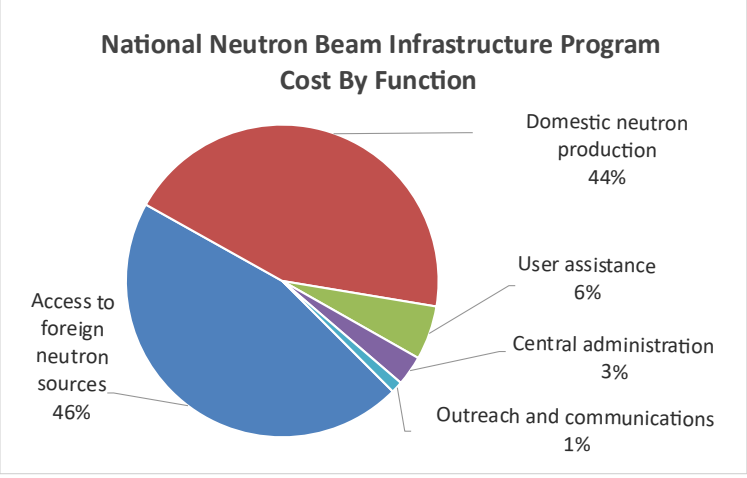


Figure 3. Breakdown of functions in the national program for research with neutron beams

Implementation of the funding over six years from 2024/25 to 2029/30 should be rolled into a funding framework that should follow this trajectory:

	2024-25	2025-26	2026-27	2027-28	2028-29	2029-30	Ongoing
Neutron Beam Program	3.0	11.7	16.8	19.6	22.7	21.2	25.0

How is this program connected to Major Research Facilities (MRFs)?

Neutron beams are among a set of complementary tools for materials research that are available only at MRFs, 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. The requested $25M/year national neutron beam program will leverage access to neutron sources whose replacement values are between $200M and $2B. This scale and complexity will place Neutrons Canada among Canada's MRFs.

Has FINA endorsed funding for this program previously?

The House of Commons Finance Committee (FINA) endorsed the recommendations of the Canadian Neutron Initiative to establish a national neutron beam program in its reports leading up to the 2018 and 2019 federal budgets.[6] In the interim, the Canadian Neutron Initiative focused on laying further groundwork for this national program by completing the national neutron strategy and creating Neutrons Canada. Neutrons Canada's members collaborated to secure research infrastructure funding for a McMaster University-led $50M project, described earlier. This project is a critical seed for the national neutron beam program. **Neutrons Canada is now ready to begin implementing the program if funded in Budget 2024.**

Conclusion

With a complete 21st-century scientific toolkit, Canadians can accelerate innovation in green manufacturing, in clean and energy-efficient vehicles, in clean energy production, and in fighting diseases such as Alzheimer's and cancer. Canadians will also lay foundations for breakthroughs in new materials, such as biomaterials and quantum materials, with greatly enhanced performance that will have a transformative influence on many technologies—and with such innovations come the promise of **enhanced quality of life for all Canadians**.

ENDNOTES

[1] These impact examples and many more are available from: cins.ca/discover

[2] Strategic Policy Economics. Study of the CNBC performance and impacts. February 2019. https://cins.ca/docs/Strapolec_2019.pdf

[3] Canadian Institute for Neutron Scattering. Survey of Canadian neutron beam users. January 2023.

[4] Canadian Neutron Initiative. The national strategy to rebuild Canadian capacity for materials research with neutron beams. https://neutrons.ca/national-neutron-strategy/

[5] Neutrons Canada Board of Directors: https://neutrons.ca/board-of-directors/

[6] Driving Inclusive Growth: Spurring Productivity and Competitiveness in Canada. Report of the Standing Committee on Finance. December 2017. https://neutrons.ca/wp-content/uploads/2022/09/FINA_2017.pdf; Cultivating Competitiveness: Helping Canadians Succeed. Report of the Standing Committee on Finance. December 2018. https://neutrons.ca/wp-content/uploads/2022/09/FINA_2018.pdf