

RECOMMENDATION

As Canada emerges from the pandemic, the federal government should commit significant new funding to strengthen its network of major research facilities, to foster innovation, build domestic capacity, and position Canada to better respond to the many challenges that the country and world will face in the years to come.

TRIUMF: A history of collaboration and excellence in fundamental science

TRIUMF is Canada's particle accelerator centre and an international hub for discovery and innovation. For more than 50 years, we have been advancing fundamental, applied, and interdisciplinary research for science, medicine, and business. Owned and operated by a consortium of 21 member universities from coast to coast, we are located on the campus of the University of British Columbia in Vancouver. TRIUMF's vision is for Canada to lead in science, discovery, and innovation, improving lives and building a better world.

TRIUMF supports Canadian prosperity by unleashing discovery, supercharging innovation, and nurturing talent. We have a history of excellence in fundamental research, supporting core programs in particle and nuclear physics, nuclear medicine, quantum materials, and accelerator science. We translate our research into innovations that benefit Canada — from transferring state-of-the-art technology to Canadian industry to developing life-saving medical isotopes for treating critically ill patients. Over the decades, we have trained generations of discoverers and innovators, equipping them with the skills they need to keep Canada competitive in the global knowledge economy.

Today, TRIUMF is home to more than 500 staff and students, whose scope and expertise allow us to address questions that are beyond the reach of any single Canadian institution. Our global record of excellence is the product of federal and provincial investments into the core infrastructure of the laboratory. Our accelerator complex — featuring the world's largest cyclotron and the most powerful superconducting electron linear accelerator — is the foundation upon which our competitive advantage is built. It is a magnet for attracting leading talent to Canada.

TRIUMF: Driving innovation with tangible societal benefit for Canada

Although rooted in fundamental science, TRIUMF drives innovation that solves problems and delivers real-world impact to Canada and the world. This sets TRIUMF apart from most other major research investments in Canada, and even from its international peers. TRIUMF is a clear leader in its ability to realize socioeconomic benefits through the cutting-edge science. From impacting sectors as diverse as medicine, natural resource extraction, and aerospace, TRIUMF's technologies extend widely across the Canadian economy.

Central to this success has been a 40-year partnership with BWXT (formerly Nordion) that has delivered over 50 million patient doses of medical isotopes for use around the world. Having produced over 9.5 million doses of medical isotopes in the last five years, we are improving the health of Canadians. Through ongoing research and development of next-generation cancer treatments, TRIUMF is also providing Canada a competitive advantage in this important global market and offering new hope to patients.

Most recently, during this pandemic, TRIUMF was a lead partner in an international project, described more fully below, that developed a novel, low-cost, ventilator in less than 3 months.

And when the pandemic massively disrupted the global supply chain of medical isotopes, we worked with industry and health care partners to ensure a stable supply of critical medical isotopes for Canadians.

TRIUMF Innovations: Accelerating commercialization from science

TRIUMF is a major success story in Canada's science and innovation landscape. In a national ecosystem that struggles to capitalize on ideas and innovations, TRIUMF is moving scientific and technological breakthroughs to market. From 2012-2018, TRIUMF was responsible for \$1.1B in gross economic output, generating over \$600 million in GDP activity. And from 2013-2017, TRIUMF generated almost \$15.5 million in commercial revenue; a 67% increase as compared to 2008-2012.

TRIUMF is an engine for innovation, generating intellectual property that fuels the creation of new technologies and spin-off companies. Supported by TRIUMF Innovations – a commercialization platform described below – the laboratory is intensifying its efforts to bring discoveries to the market. Having filed more than 50 patents since 2013, TRIUMF is actively working to realize the commercial potential of its research. In recent years, TRIUMF has incubated five spin-off companies that have attracted a total of \$35M in private sector funding, with several already achieving sustainability and boasting growing international customer bases. For example, ARTMS, a TRIUMF Canadian spinoff created through a national R&D collaboration to address the medical isotope shortage with innovative intellectual property and new technology, was successfully incubated at TRIUMF and closed a US\$19M financing deal in April 2020, securing funds from leading global venture funds.

Creating new opportunities to leverage the world-leading research done at TRIUMF has long been a priority for the laboratory. Building on this success, TRIUMF Innovations was established in 2017 to connect TRIUMF to the business world. TRIUMF Innovations provides market opportunities for physics-based technologies that emerge from the TRIUMF network by streamlining access to TRIUMF's world-class expertise and infrastructure, and by connecting TRIUMF researchers and technologies to the world via industry partnerships, licensing, and business development.

TRIUMF Innovations helps startups navigate complex intellectual property management, assisting with patent filings, invention disclosures, fundraising, partnering and investment. In partnership with the University of British Columbia's Sauder School of Business and Entrepreneurship UBC, TRIUMF Innovations has started a new program to provide entrepreneurship training and coaching to TRIUMF scientists. It will further enhance our scientists' business skills and strengthen connections with industry through a wide range of courses, workshops, networking, internships and mentorship. This program is just another tangible example of TRIUMF's commitment to the goal of translating scientific breakthrough to economic benefit for Canada.

TRIUMF: Fighting COVID-19

The COVID-19 pandemic offers a graphic demonstration of the vital role that TRIUMF and other major research facilities play in Canada, as well as the benefits these institutions offer to all Canadians.

When the threat of COVID-19 became clear, Canada's multidisciplinary "big science" institutions quickly mobilized to contribute our expertise and capabilities to the response. In a far-reaching collaboration, TRIUMF, Canadian Nuclear Laboratories, SNOLAB and the MacDonald Institute joined to become lead partners in an international project that developed a novel, low-cost, ventilator in less than 3 months. The expertise of Canada's scientists was critically important to this initiative, as was our partnership with the federal government. The Government of Canada has ordered 10,000 of these ventilators to be produced by Canadian manufacturers.

Canadian multi-disciplinary research institutions can, and are, helping to create better ventilators, develop vaccines, produce medical isotopes, and discover effective therapeutics, all in an effort to help our country better respond to COVID-19. But this is simply the start of what Canadian scientists and Canadian science facilities can contribute to Canada.

When needed — and most importantly, when working together — the depth and breadth of scientific and engineering excellence within Canada's network of national research facilities can be redeployed to solve some of the most demanding and urgent of problems facing our country and the world. Our laboratories stand ready to be of service to the nation especially when borders are closed, international supply chains are limited, and the country needs to employ its own ingenuity and know-how to weather a storm.

During the pandemic, we designed much-needed ventilators; in the past, we mobilized to produce medical isotopes in the face of a global shortage; and tomorrow we stand ready to tackle the next challenge our country will face.

Leveraging Science to Drive Economic Recovery

Canada's large-scale multidisciplinary research laboratories are uniquely positioned to aid in Canada's immediate, medium-range and long-term economic recovery.

Research and big science institutions will undoubtedly play a role in bolstering Canada's recovery in a variety of economic sectors, ranging from agri-food and health to transportation, energy, and beyond. From developing clean sources of energy for Canada's northern communities, to pioneering new technologies for monitoring air quality, to creating new therapeutics to treat untreatable cancers, to harnessing the quantum world, Canada's big science facilities are primed to help power Canada's economic recovery.

Not only can science fuel Canada's rebound, it can also act as a springboard for sustained economic growth. An essential element is important role we play in training and developing world-class talent. Our national research institutes allow Canada to compete internationally, enabling Canadian researchers to make major contributions to some of the world's most challenging problems – both at home and abroad. With this unique capacity, our research institutions play a critical role in ensuring Canada has the experts and innovators it needs to thrive in the increasingly competitive global knowledge economy.

The competitiveness of Canada's economy critically depends on its investment and support of research, including discovery-driven fundamental research. Fundamental research is critical for Canada to develop the technologies that are transformative, the so-called "disruptive technologies" which will ensure the global competitiveness of our economy and secure prosperity and safety of current and coming generations of Canadians.

For the safety, security, health and economic prosperity of all Canadians, the federal government must increase its investments in Canada's large-scale scientific infrastructure. These investments will foster innovation, address the immediate and long-term needs of the research sector, and position the facilities to respond to the many challenges the country and world will face in the years to come.

Canada's big science and leading physics laboratories are a critical part of Canada's scientific and economic infrastructure, able to provide solutions to today's most pressing problems while creating the foundation for future economic growth and resiliency.

With our innovative spirit and our drive to provide solutions to complex problems, Canada's national laboratories, as well as the networks they support, are a tremendous asset to the nation. When they are brought together, the opportunity is boundless and the potential to propel Canada's prosperity is great.

As Canada develops its plans for recovery, TRIUMF stands ready to assist in whatever way is most useful. We are prepared to work with federal and provincial governments on a range of projects and initiatives to support your vision for a resilient nation and prosperous economy, including:

- Enabling new medical innovation capacity, ensuring and de-risking the commercial supply chain essential to unlocking new treatments for critical illnesses, including promising new therapies for patients with late-stage metastatic cancers (see www.rarestdrug.com)
- Funding critical infrastructure in fast-moving fields of strategic national interest, including advanced materials development and the quantum and data sciences
- Advancing STEM education, skills training and talent development to help supply Canada with the workforce we need for a sustainable knowledge economy.



As we learned during the pandemic, when supply chains were disrupted and borders were closed, there is no substitute for domestic capacity. When properly resourced, Canada's large-scale research facilities provide that capacity, and offer critical support to Canadians in times of need.

In the longer term, Canada's prosperity hinges on a robust knowledge-based economy. We look forward to working with the Government of Canada to strengthen the nation's large-scale research facilities, enabling them to foster innovation that addresses both immediate and future needs and positions Canada's economy for a bright and prosperous future.