TRIUMF – Advancing Science for Society

How did the Universe begin? Where do we come from? These are questions humans have pondered since we first looked up at the stars and wondered about our world. Particle and nuclear physics play key roles in answering these questions by identifying the fundamental building blocks of nature and how they organise themselves into the elements that make up our bodies and surroundings.

Even after the 2012 discovery of the Higgs boson, many fundamental questions remain: What are dark matter and dark energy? Why is there more matter than antimatter? Where in the Universe are the chemical elements from iron to uranium produced? Large international efforts – involving substantial research infrastructure investment – are underway that may finally bring answers to some of these fundamental questions in the next 5-10 years.

Canada has become a global leader in particle and nuclear physics [1], despite its modest population size, as a result of long-term investments in its research capacity. These include support of university researchers and national facilities such as TRIUMF – Canada's national laboratory for particle and nuclear physics.

TRIUMF is a joint venture of 19 Canadian universities that drives scientific progress in three areas:

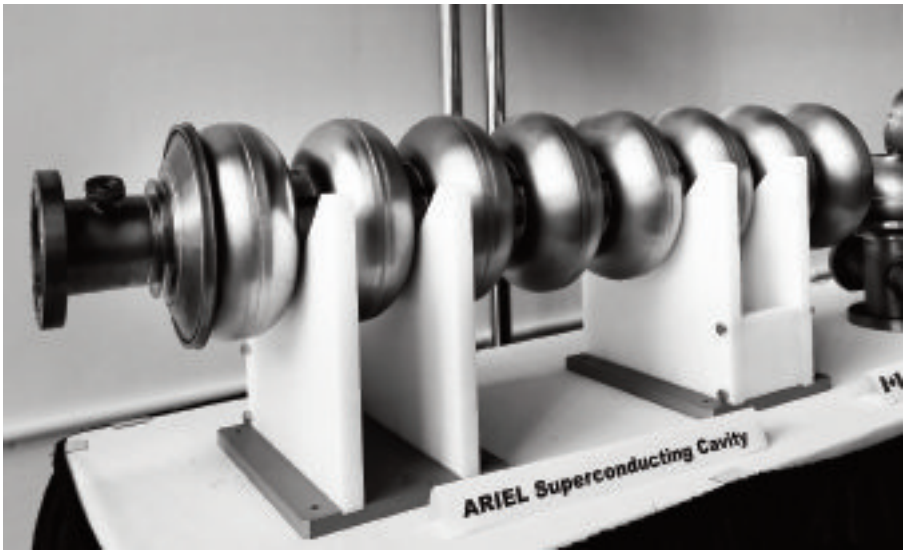

Image: © TRIUMF

Fig 1: Superconducting radiofrequency cavity developed at TRIUMF for the ARIEL electron accelerator and transferred to PAVAC Industries, Richmond, B.C.

- Understanding the basic building blocks that shape our Universe;
- Advancing isotopes for science and medicine; and
- Harnessing particles and beams for science and innovation.

Located in Vancouver, British Columbia, TRIUMF plays a special role in particle and nuclear physics as a truly global player, not only boasting a state-of-the-art accelerator facility but also leading Canada's involvement in high-profile projects around the world.

In nuclear physics, TRIUMF currently operates one of the world's most powerful radioisotope-production facilities. When the Advanced Rare Isotope Laboratory (ARIEL) is completed, TRIUMF will dramatically expand its research capabilities, advancing our fundamental understanding of nuclei, enhancing the search for new forces in nature, and helping determine how and where in the universe the elements were produced.

ARIEL will also further applied research, from studying magnetism at material interfaces, to imaging biological systems and treating cancer with new medical isotopes. With ARIEL, TRIUMF and its industrial partners will co-develop globally-significant technologies, such as the superconducting radiofrequency technology used in the ARIEL electron linear accelerator and chosen for the proposed International Linear Collider, the next global accelerator laboratory. Through technology transfer from TRIUMF, a

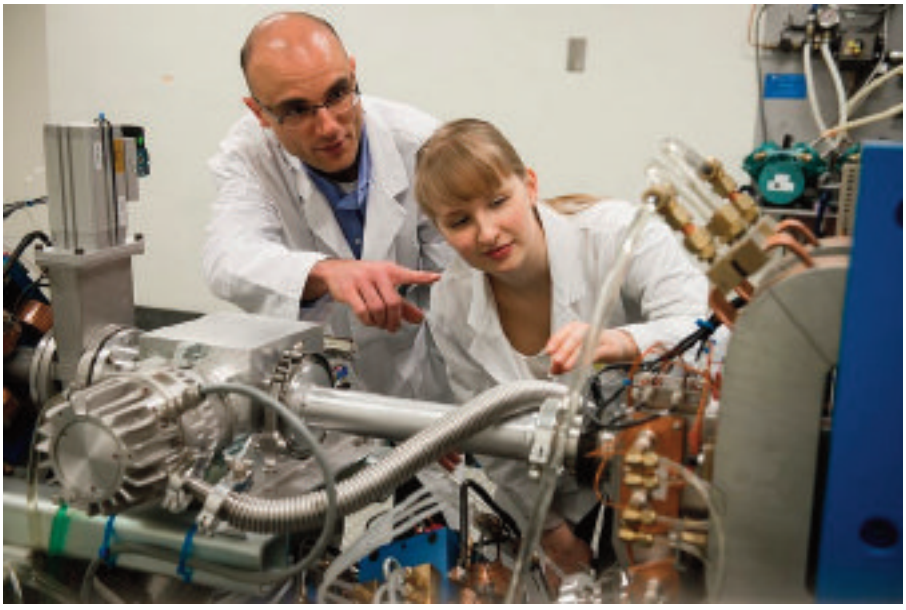

Image: © NSERC

Fig 2: TRIUMF scientist and student working on a medical isotope cyclotron

Canadian company is now among a handful of vendors worldwide that can produce this advanced technology.

In addition, TRIUMF is fully engaged in international particle physics initiatives. CERN remains at the vanguard of global particle physics, where Canada contributes and benefits via TRIUMF and its collaborating universities. From participating in the discovery of the Higgs boson and trapping anti-hydrogen at CERN, to collaborating with Japan in neutrino science, TRIUMF's global engagement provides a superb training opportunity for Canadian students. At home, TRIUMF collaborates with SNOLAB, the world's premier dark matter and neutrino observatory located deep underground near Sudbury, Ontario.

TRIUMF is Canada's steward for developing accelerator and radiation-detection technologies for science and societal benefit. TRIUMF also touches the lives of thousands of people by: inspiring and training the next generation of scientists, innovators or medical doctors; providing isotopes for medical diagnosis and treatment; and transferring leading-edge technologies to industry.

"In nuclear physics, TRIUMF currently operates one of the world's most powerful radioisotope-production facilities."

Through long-standing relationships with several industrial partners, TRIUMF is transferring and licensing technologies developed as part of its research mission. For instance, TRIUMF's 35+ year long medical-isotope production partnership with the global health science company Nordion Inc, benefits over 2 million patients each year. Similarly, TRIUMF collaborates with the Pacific Parkinson's Research Center at the University of British Columbia and the British Columbia Cancer Agency in the development and production of radiotracers for Positron Emission Tomography, a powerful imaging technique.

Recently, a TRIUMF-led team developed a reliable, accelerator-based means to produce Technetium-99m (Tc-99m). This isotope, the world standard for medical imaging, is at risk of becoming unavailable due to a global supply shortage. Every day, 5,000 medical procedures in Canada and 70,000 worldwide depend on Tc-99m. With support from several Canadian funding agencies, the TRIUMF-led team developed technology for medical cyclotrons already in use at major hospitals and radiopharmacies around the world, securing the regional supply of Tc-99m on an ongoing basis.

In conclusion, TRIUMF, a publicly-funded laboratory with basic research mission, is driving discoveries addressing the most compelling questions in particle and nuclear physics, nuclear medicine, and materials science. Also, TRIUMF leverages its extensive expertise by transferring knowledge to industry and commercialising research for economic, social, environmental, and health benefit.

[1] Council of Canadian Academies, The State of Science and Technology in Canada, 2012

Dr. Reiner Krücken
Deputy Director
TRIUMF
Tel: +1 604 222 7365
reiner.kruecken@triumf.ca
www.triumf.ca