

Excellence with impact

The new mantra for science...

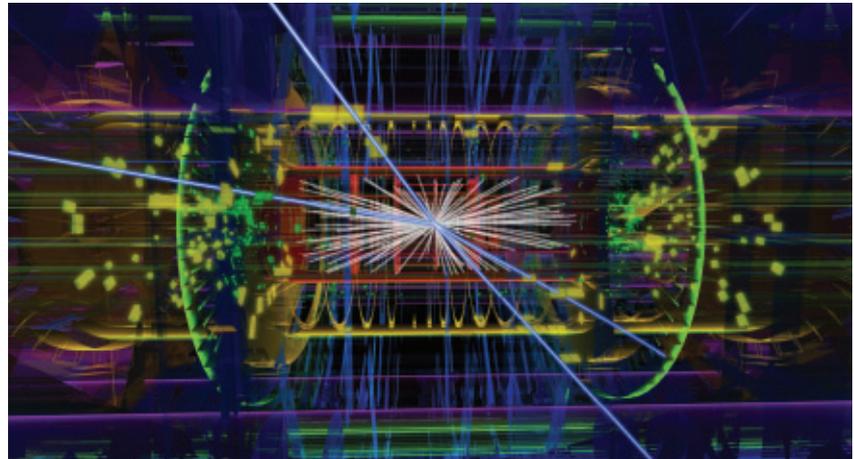
Everyone knows that science is good for you. Just ask your granddaughter or your neighbour. They will confirm that science not only fires the imagination and inspires the human spirit, but it also provides new technologies that create jobs and develop new products and markets. Indeed, OECD tracks dozens of indicators that monitor public and private investment in research and development, and the leaders of the US, Germany, the UK and other countries have made public declarations about elevated targets for public support of scientific research.

Behind all this, however, is an expectation of a new level of performance and results. Research groups and institutes and universities and laboratories around the world are dealing with the challenge of increasing 'excellence' while expanding their 'impact'. This challenge can be viewed as an opportunity – an opportunity for scientific efforts to expand, to enhance and to exceed. As a publicly funded enterprise, science actually flourishes in that difficult realm between survival and luxury – that region public policy-makers often call 'adversity'.

In Canada, the situation is no different. As the national laboratory for particle and nuclear physics, TRIUMF seeks to achieve 'excellence with impact'. Over the past five years, the laboratory has moved forward in leaps and bounds in this direction and with a new cycle of strategic planning about to commence, the laboratory will align itself even more precisely with these objectives. Let's take a look at what this means in practice.

Vision

The vision for TRIUMF is articulated quite simply by its board of management, composed of private-sector representatives and vice presidents



Simulated view of a Higgs particle decay inside the ATLAS particle-physics detector at CERN's Large Hadron Collider

Courtesy ATLAS

of research, deans of science, and heads of physics departments drawn from its 17 member Canadian universities. By declaration when the vision is fulfilled, TRIUMF will:

- Lead in science: the world will see TRIUMF as Canada's leader in probing the structure and origins of matter and in advancing isotopes for science and medicine;
- Leverage university research: the Canadian university research community will view TRIUMF as a way to strengthen and expand their research programmes;
- Connect Canada to the world: international subatomic physics laboratories will look to TRIUMF when partnering with Canada and its research community;



Courtesy J Gazzari

- Create social and economic growth: the global scientific community will see TRIUMF as a bridge between academia and the private sector and as a model for commercialisation and social impact.

TRIUMF seeks to stay closely connected with its 'core constituency', the university research community while simultaneously transcending it to offer a type of facilitation and matchmaking service, granting Canadian researchers ready and reliable access to offshore opportunities. To do so, the laboratory must itself pursue excellence 'on site'; other than the classic tale of Cinderella, no handmaidens have ever attracted the nation's best and brightest by simply doing their bidding. Put more directly, the laboratory seeks to employ and retain a portion of the nation's top talent. Looking around the world, one sees the best laboratories following the same model – to best serve (ie empower and enable) the national scientific community, a laboratory must also have some of the top talent on staff. Take a look at CERN, DESY, KEK, or SLAC and Fermilab in the US.

Although TRIUMF's international reputation as an accelerator laboratory with leading-edge technology has been established for some time now, the vision for TRIUMF asks for more as it strives to blend science, technology and societal impact. Indeed, a very modern laboratory must not only excel in science, it must also have relevance.

Scientific excellence

A good business focuses on a few core competencies while remaining poised and flexible to adopt new practices or product lines. As a publicly funded national research laboratory, TRIUMF follows suit to create and develop excellence.

The research programme is driven by two core themes:

- Probing the structure and origin of matter; and
- Advancing isotopes for science and medicine.

These thrusts build on core strengths in accelerator-based science and the development and exploitation of modern detector systems for experiments in subatomic physics.

TRIUMF strives for excellence in these areas while keeping its eye on important and new opportunities. Understanding the origin of the chemical elements that make up our bodies and the world around us is a major thrust for TRIUMF. It is still not fully understood how the elements are produced in the various stages of stellar burning and explosion. Often rare isotopes that are intermittently produced are involved in these processes, and the study of the properties of these nuclei and their contribution to the astrophysical reactions promises to reveal how nuclear physics governed the origins of the atoms and molecules in our world. Another direction in nuclear physics aims at developing a unified theoretical framework with predictive power for the description of nuclear and nuclear matter based on fundamental forces. With some of the highest production rates in the world at



Courtesy TRIUMF

New laboratory facilities for radiochemistry with isotopes give the TRIUMF nuclear-medicine team new capabilities

TRIUMF's Isotope Separator and Accelerator (ISAC) facility and Advanced Rare Isotope Laboratory (ARIEL) in the future, also in combination with its world-class experimental facilities, TRIUMF is poised to take a leading position in this fundamental investigation.

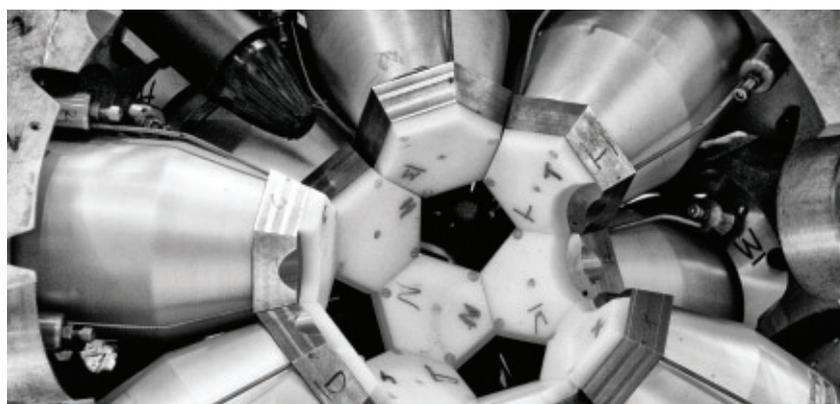
TRIUMF also has unique tools at hand to characterise chemical reactions, molecular binding, and new materials in particular with respect to their magnetic properties. The Centre for Molecular and Materials Science at TRIUMF serves a wide international science and technology community with different stations providing several different kinds of particle probes. The research topics are relevant to a broad spectrum of applications in other areas of science and industry including high temperature superconductivity, chemical reactions relevant for next generation reactors and next-generation lithium batteries.

In addition to subatomic physics, TRIUMF also specialises in nuclear

medicine through the research and development of medical isotopes to advance the diagnosis and treatment of disease. The basic research programme made possible by TRIUMF is tightly coupled with efforts to create social and

economic growth through invention, innovation, and commercialisation with a network of partners. As a standalone division at TRIUMF, the nuclear-medicine team is a national centre of excellence for isotope production, separation, and radiochemistry technologies. The group works closely with the Pacific Parkinson's Research Centre and the British Columbia Cancer Agency.

Another major thrust in TRIUMF's scientific programme aims at identifying and understanding the nature and origin of the elementary particles – the fundamental building blocks of our world – and the forces between them. Substantial evidence now indicates that the current standard model of particle physics may be incomplete, that new particles may exist, and that our comprehension of the fundamental forces may be limited. TRIUMF is ideally positioned to make major contributions in this quest to understand these forces through the portfolio of local and external experiments being carried out by TRIUMF scientists.



Precision detectors built for nuclear physics drive the development of technologies with broader application

Courtesy M. Enriquez



Working with the next generation of leaders is an important element of TRIUMF's strategy for impact

One example is the Large Hadron Collider (LHC) at CERN that is expected to produce the elusive Higgs particle as well as new particles not predicted by the standard model. It is possible that one of these unknown particles actually comprises the stuff of dark matter for which we have astronomical evidence based on large-scale gravitational observations. With its participation in the ATLAS experiment at the LHC and with the Tier-1 Data Centre at TRIUMF (one of 10 around the world connected to CERN's Tier-0 Centre), the Canadian particle-physics community is making substantial contributions to this global pursuit. At the same time the DEAP experiment located deep underground at SNOLAB, Sudbury, Ontario, will be searching for primordial dark matter particles traversing the earth with help from TRIUMF.

High-precision measurements are an ideal tool to search for deviations from Standard Model predictions and for the discovery of effects forbidden in the standard model. TRIUMF is carrying out or is involved in a number of experiments that fall into this category. The T2K experiment in Japan aims at establishing one of the last remaining properties of neutrinos responsible for neutrino oscillations and their potential contributions to the evolution of the universe. The ALPHA experiment at CERN has recently produced and stored antihydrogen for more than 15 minutes, an essential step towards precision spectroscopy of the properties of

antihydrogen to test if antimatter and matter really do behave the same.

Perhaps the most exciting element of TRIUMF's science programme is the recently launched ARIEL project. This new facility will focus on the production and development of isotopes for science and medicine and will give Canada a globally competitive advantage in research and innovation. Employing next-generation superconducting radio frequency technology, the heart of ARIEL will be a new electron accelerator that dramatically enhances TRIUMF's capability – and capacity – to produce isotopes. When fully realised, ARIEL will allow TRIUMF to deliver isotopes to three experiments simultaneously.

Partnerships for innovation and impact

As a national laboratory, TRIUMF must also bring together the talents and resources of Canada to advance the country's innovation objectives. With a solid connection to Canada's world-class university research system and deep experience in delivering complex programmes and projects on time and on budget, TRIUMF provides a unique platform for innovation, collaboration, and commercialisation. Although breakthroughs and inventions are not individually predictable, a firm commitment to innovation from the leadership and staff of a laboratory makes a critical difference.

A core element of TRIUMF's strategy is generating industrial partnerships that bring the business and market acumen of the real world to identify truly innovative science and technology that may be ripe for development. In many instances, TRIUMF's commercialisation partner AAPS Inc is the right vehicle to pull together the teams to spin-out new companies, license intellectual property, and/or develop products. In other cases, TRIUMF works directly with industrial and research partners to provide solutions and services.

TRIUMF's industrial partnership and business development activities are

organised around four main business lines. In each of the areas, TRIUMF has specialised expertise and equipment that attract industrial partners.

Irradiation services

TRIUMF's accelerators provide beams of particles that can be used to probe materials to reveal their structure or bombard systems to examine their performance in elevated radiation environments. The space industry and segments of the high-performance electronics sector are steady customers.

Isotope production and chemistry

TRIUMF's research programme in nuclear medicine has developed core competencies in the production of isotopes using a variety of cyclotron and target technologies. TRIUMF also has expertise in the purification, processing and chemical synthesis that attaches the isotopes to biologically relevant molecules for medical imaging or treatment. These capabilities are regularly in demand by the private sector.

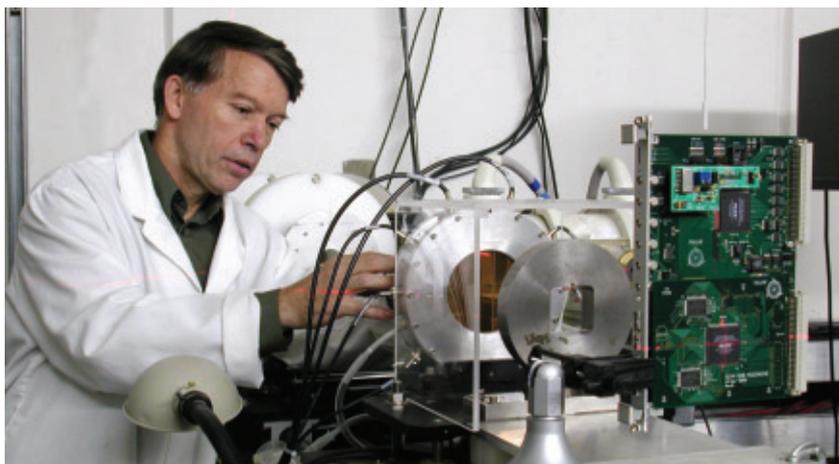
Technical consulting

TRIUMF's capabilities in physics, engineering and design are often tapped in the form of short-term technical consulting arrangements. TRIUMF staff might contribute to troubleshooting a private company's product line or provide advice in developing needed hi-tech infrastructure. TRIUMF's contributions to the success of AAPS Inc projects fall into this category.

Professional training

Finally, TRIUMF provides training experiences for highly skilled workers ranging from apprentices and journeyman in the technical trades to professional development of scientists and engineers through courses, workshops, and conferences.

With each industrial partnership, TRIUMF develops Canadian business in several ways. TRIUMF might provide direct technical assistance to the company on a product line or a platform for product development. Or TRIUMF might be involved with a vendor to enhance an existing



Courtesy TRIUMF

TRIUMF provides irradiation services to industry for qualification and testing of aerospace components

product to meet an application needed for TRIUMF's research programme. Finally, TRIUMF might also collaborate with a company to investigate and develop a new technology, market, or service offering.

The business partnership between TRIUMF and Nordion Inc is well-known as a successful example in technology transfer involving isotope-production technologies, and it certainly is the lab's largest model of success. The mixing of the laboratory academic culture (TRIUMF is, after all, owned by universities), and the business culture has taken time and effort to develop but it is by all measures a smooth and profitable partnership. During a period when federal and provincial governments are seeking to enhance Canada competitiveness with the best economies in the world, it is certainly the time to develop new success stories.

Another element of TRIUMF's strategy for impact is working with students and teachers to provide unique and valuable training experience, either attracting students to long-term careers in science or familiarising them with how research progresses and what it offers.

Much of TRIUMF's focus in the last few years has been through its Centre for Commercialisation and Research (CECR) funded by the federal Networks of Centres of Excellence agency. This non-profit company, AAPS Inc, has a primary mission to

develop the most commercially viable technologies arising from TRIUMF but also to exploit new ideas that arise through interactions with TRIUMF's university owners and corporate partners. AAPS has its own independent board of directors. This governing body has been crucial to its success. A strong business-oriented board brings needed expertise to a small company. To keep costs down, the board members all serve pro bono. Thus far, AAPS has created two 'hi-tech' for profit companies. Both 'newcos' have significant potential for success. Initially, one aim of AAPS is to have four to six exciting prospects in the pipeline that could lead to a successful company. And the threshold to create a new company is high.

When promising inventions and innovations arise at TRIUMF, AAPS is ready to assemble a collaborative team to evaluate and develop the commercialisation potential and then spin-off a new company with the intellectual property. Not only has AAPS supplied direct expertise on projects where TRIUMF is developing new technology for industrial use (such as the production of the medical isotope technetium-99m using existing commercial cyclotrons), but AAPS has also challenged TRIUMF's leadership and its staff to recognise and bring forward potentially relevant technologies for commercialisation (such as geotomography using cosmic rays).

Outlook

Public policy everywhere is becoming a more quantitative and sophisticated endeavour. While most laboratories are well structured to achieve excellence with impact, the new challenge is to establish metrics for measuring, monitoring and maximising performance. In response, TRIUMF is experimenting with metrics for excellence and impact, including publication-citation analyses, tracking invitations and requests for personnel or technical participation in scientific projects outside Canada, longitudinal analyses of student achievements, and economic-impact assessments.

As TRIUMF moves forward with its strategic plan, it will continue to share the technology it develops, to use it to create and study exotic nuclei and materials, to address far-reaching questions concerning the nature of matter, and to advance nuclear-medicine research. By doing so, the lab will remain fully integrated into a fast-paced, discovery-driven, global science agenda. And ultimately, it will fulfil on the vision of connecting the sharpest entrepreneurs with the brightest science and engineers in an environment to let them perform their magic and achieve 'excellence with impact'.



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