Beamtime

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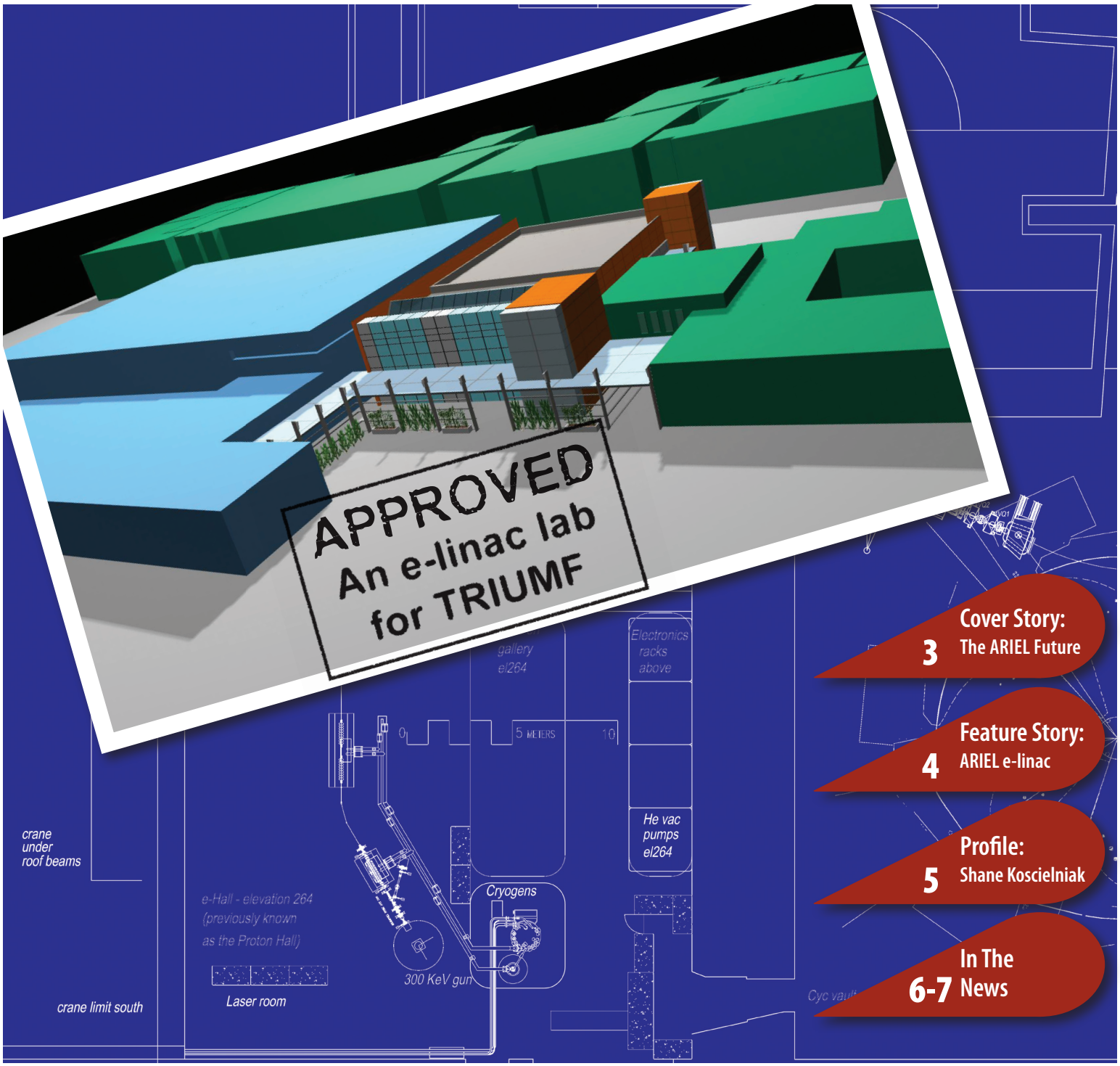
TRIUMF

News from Canada's national laboratory for particle and nuclear physics



Director's Voice

Securing TRIUMF's Rare Isotope Advantage with Electrons

TRIUMF will design, construct, commission, and operate a new electron accelerator for the first time in its history over the next 5 years. This world-class machine, which will begin to push the limits of power density and utilize the latest superconducting RF technology, is aimed at giving Canada a lead position in rare-isotope beam science. Rare isotopes are important for improving our understanding of the nucleus and are now the hot area of research in nuclear physics around the world. This is partly because nuclear medicine is always looking for more and better isotopes for imaging and therapy. However the main reason is that nuclear theorists think they can develop a single complete theory of the nucleus if given enough information from rare-isotope experiments. A challenge indeed to the experimenters!

> "beginning one of the most productive...science periods in TRIUMF's history"

TRIUMF already produces rare isotopes with the main 500 MeV cyclotron. Adding a new source of isotopes from the electron machine, called the e-linac, will make TRIUMF a unique facility. In addition, the commissioning of actinide targets next year will add yet another dimension to our rare-isotope program. The e-linac will eventually allow several experiments to operate with rare-isotope beams at the same time. This is important because TRIUMF over the last decade has developed three state-of-the-art experimental areas consisting of low-energy trapping experiments, medium-energy nuclear astrophysics experiments and higher-energy nuclear-structure experiments. With the new electron machine, and eventually a new proton beam line in the same tunnel, we will send beams to all three areas simultaneously. The e-linac is the beginning of this dream!

In the next few years, I look forward to this challenging technical project and many great rare-isotope beam experiments being completed. When combined with the full breadth of TRIUMF's particle physics, materials science and nuclear medicine programs, we are assuredly beginning one of the most productive and impactful science periods in TRIUMF's history.

Cover Story

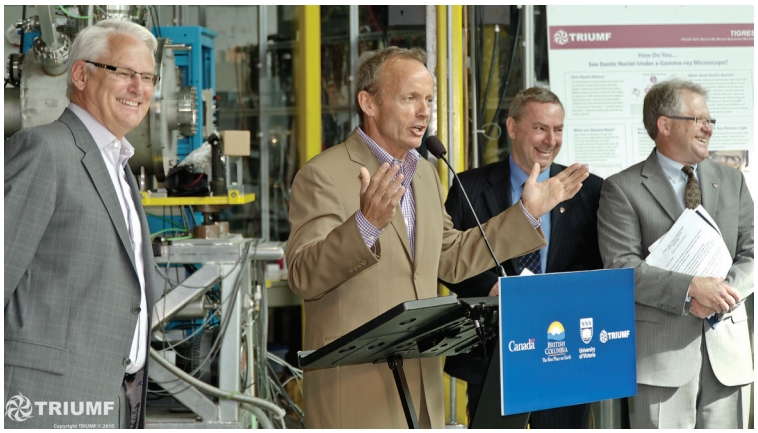
The ARIEL Facility

A Future for TRIUMF

AR • I • EL *n.* a Judeo-Christian archangel | a spirit in Shakespeare's Tempest | title character in Disney's Little Mermaid | the **A**dvanced **R**are-**I**sotop**E** **L**aboratory, a new initiative at TRIUMF designed to research and develop isotopes for physics and medicine.

TRIUMF research and development on isotopes for physics historically has used proton beams from its main cyclotron. Physicists worldwide come to TRIUMF's ISAC-I and ISAC-II facilities to use these isotopes to study the nature and bonding of nuclei, the origin of the elements, and basic properties of the universe ("fundamental symmetries"). Presently, only one experiment can operate at a time. When fully deployed, the ARIEL facility will provide two additional sources of isotopes allowing TRIUMF to triple its scientific activities.

ARIEL will use electron photo-fission technology to: expand the proton-based capabilities of the existing cyclotron, provide isotopes in greater variety and number for research and development, advance substantially TRIUMF's materials-science program by enhancing the β-NMR program, investigate alternative production technologies for contemporary medical isotopes (e.g., Tc-99m) and uncover promising new "medical isotopes of the future" for disease treatment and diagnosis. No other laboratory in the world will have these combined capabilities.



Federal Treasury Board President Stockwell Day addresses guests at ARIEL funding announcement, with BC Premier Gordon Campbell, TRIUMF Director Nigel Lockyer, and UVic Vice President Research Howard Brunt (left to right).

ARIEL exploits TRIUMF's emerging prowess in next-generation superconducting radiofrequency (SRF) accelerator technology for the flagship element, the 500 kW electron linear accelerator (e-linac), developed in Canada by TRIUMF with Italian, Japanese and the U.S. collaborators, and then commercialized locally in partnership with PAVAC Industries. SRF technology lowers the energy demands of power-hungry accelerators and so has become the technology of choice in multiple international projects, e.g. the proposed next-generation International Linear Collider accelerator project.

ARIEL will be realized through a large partnership including: the University of Victoria, leading the e-linac design, assembly and construction effort, with support from the Canada Foundation for Innovation and the Government of Canada (through the National Research Council); the Government of British Columbia, providing a substantial investment in the infrastructure and supporting facilities; and the VECC (India), Jefferson and Fermilab (U.S.A.) and DESY (Germany) laboratories, contributing people, parts and science experiments that will leverage ARIEL's unique capabilities.

ARIEL will thrust British Columbia and Canada to the front of the world stage for isotopes in physics and medicine. We look forward to the completion of ARIEL and "first isotopes" in 2014!

• Tim Meyer

For more: www.triumf.ca/research/future-facilities

Feature Story

TRIUMF's Newest Accelerator

Superconducting electron linac centrepiece of ARIEL facility

The ARIEL facility project features a superconducting electron linear accelerator (e-linac). TRIUMF has operated very successfully with proton beams for 40 years, so "why electrons?" Scientifically, it's about filling a "niche", but also about exploiting the "choice technology" of the early 21st century. Meson physics dominated TRIUMF's early days and was an important scientific niche, and so too will be the electron-produced rare-isotope beam science at ARIEL. When coupled with a second proton beam and advanced production targets in the future, ARIEL will greatly broaden TRIUMF's scientific opportunities.

The e-linac consists of an electron source, an injector cryomodule (ICM) containing one accelerating (RF) cavity, and two accelerator cryomodules (ACMs) each with two RF cavities (see Figure 1). Initially only a single ACM will be built, with the second added after initial commissioning and operation. The modular ICM+ACM+ACM configuration permits a future upgrade path. The e-linac will be housed in TRIUMF's existing proton hall, while the transfer line and the target stations will be located in a new tunnel and hall (see Figure 2).

Figure 1. Elliptical niobium cavities are the "choice technology" to be employed in the ARIEL e-linac

Electrons are 100-1000 x less efficient at isotope production than protons, but electron beams can easily be made far more intense than proton beams, at a small fraction of the cost. As well, rare-isotope beams of scientifically-important neutron-rich isotopes can be produced much "cleaner" with the e-linac than with protons beams, making ARIEL an effective complement to the existing cyclotron.

Due to widespread applications, there has been a huge international investment into optimizing the superconducting radio frequency (SRF) cavity technology enabling electron accelerators. Low temperatures (minimizing waste heat) and high frequency (shorter structure length) are key design considerations, leading to elliptical-shaped niobium cavities bathed in 2 Kelvin liquid helium as the configuration of choice. The ARIEL e-linac capitalizes on that investment: the SRF cavities will provide a 10 MeV/metre energy gain to a 10 mA electron beam, with 100 kW/cavity of beam power provided by 1.3 GHz klystrons. By the end of the next five-year plan, nearly 50 MeV of energy gain will be provided by five such cavities, with the 500 kW electron beam being shared between two target stations and a new mass separator system to filter the isotopes for ISAC experiments. As a side benefit, the in-house expertise developed with the "choice" SRF technology could be deployed to a wide variety of other applications in the future — both widespread and niche. • Shane Koscielniak

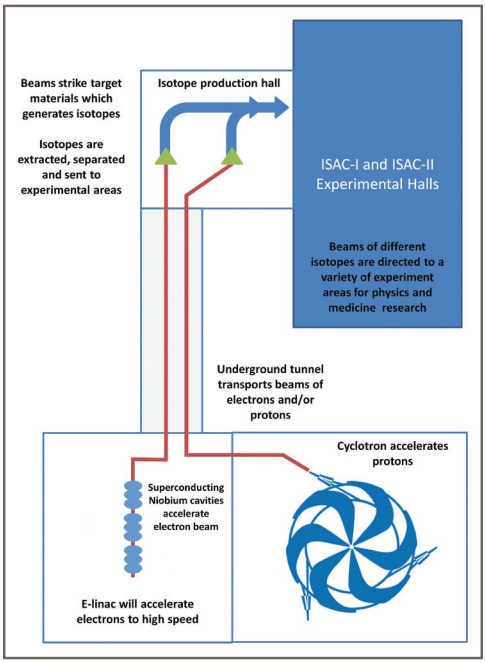


Figure 2. Schematic representation of the new ARIEL facility

For more: www.triumf.ca/research/research-facilities/future-facilities/e-linac

Profile

Shane Koscielniak

Overseeing TRIUMF's first electron accelerator

The most exciting component of TRIUMF's immediate future is the Advanced Rare Isotope Laboratory (ARIEL) facility, featuring the lab's first electron linear accelerator (e-linac). The project is led by a physicist who almost became a chemist – Shane Koscielniak. When ARIEL is completed, TRIUMF's annual scientific productivity will increase by a factor of three. Shane explains, "Presently ISAC , with just the single driver, the 500MeV cyclotron, is oversubscribed – there are more requests for beam time than can be delivered." Consequently he is charged no less than with overseeing the centrepiece of TRIUMF's future, the e-linac.

ARIEL will consist of a second proton beam line from the cyclotron, the e-linac, two high-power isotope-production stations, an isotope mass separator and a new building to house the facility. The e-linac will be used mainly for nuclear physics and materials science research, but will also benchmark new medical isotope techniques and uncover medical isotopes of the future. Koscielniak watches over the project integration, and provides "intellectual quality control" to ensure the e-linac's successful installation and commissioning.

Raised near London, UK, Shane's family and friends always thought he'd become a great chemist. However, after napping through his first-year Chemistry course at the University of Cambridge, Shane switched his major, eventually landing a Bachelor's Degree in Physics. While a Ph.D. candidate in Theoretical Physics at the University of Oxford, destiny intervened when Koscielniak met UBC Professor Michael Craddock at the Rutherford Appleton Laboratory. Being the project leader for the TRIUMF KAON Factory proposal, Craddock invited Koscielniak to join his team for a year. The one year turned into 23 years as Shane's role at TRIUMF evolved.

> *"I learned from physics ...there is no idea that cannot be improved"*

After working on the KAON proposal until 1993, Koscielniak went on to design the ISAC-I RFQ, the first-stage linear accelerator for ISAC-I, and then joined the Beam Dynamics group under Rick Baartman, focusing on radiofrequency systems and beam dynamics. As well, Shane has delivered graduate level accelerator-physics lectures at the University of Victoria, and is lecturing in the accelerator physics lecture series at UBC, initiated by Lia Merminga in 2009.

Shane muses that "A general life lesson that I learned from physics is that there is no idea that cannot be improved." So it is with ARIEL, whose design is continually being refined under his watchful eye. And his parents can be proud that, despite nodding off a life in chemistry, he has become an accomplished physicist achieving great things for science and society.

• Ting Wang

In The News

MoRe Recognition For SFU Grad and TRIUMF Alumnus

On August 4, Dr. Suzanne Lapi was awarded a Marino Nicolini Prize by the TeraChem 2010 Committee (www.terachem2010.com). Her (and collaborators') paper "An alternative route to the production of High Specific Activity 99Mo" is based on the MoRe isotope-separation project, sponsored by Advanced Applied Physics Solutions, Inc., located at TRIUMF. Suzy was a graduate student at Simon Fraser University working at TRIUMF and is now an Assistant Professor at the Washington University, St. Louis. The Nicolini Prize is dedicated to the memory of Professor Marino Nicolini, awarded based on innovation in the proposed work, principal applications foreseen, and beneficial impact on society.

MoRe (Molybdenum-Rhenium) technology aims to purify 99Mo by mass separation of a 98,99Mo source mixture created from a nuclear reaction on stable 98Mo. Radioactive decay of the purified 99Mo leads to 99mTc, the most widely used medical imaging isotope.

The MoRe project is under active development, but once operational, it could have a significant impact on the "isotope crisis" currently facing hospitals and cancer patients.

Main Cyclotron Deemed Historic Engineering Achievement

The world's largest professional association for the advancement of technology (IEEE) has recognized the extraction of the first high-energy proton beams from the TRIUMF main cyclotron on December 15, 1974 as a historic engineering milestone. The IEEE Board of Directors approved the designation following a careful evaluation of the historical significance and global uniqueness of the accomplishment.

Prof. David G. Michelson, chair of IEEE Vancouver Section and a member of the Department of Electrical and Computer Engineering at the University of British Columbia, said, "The quality of the initial design and engineering of the TRIUMF 500 MeV cyclotron is underscored by the cyclotron's longevity. Thirty-five years after the first full energy proton beam was extracted, the cyclotron is still the main engine of TRIUMF's world-leading research program."

A dedication ceremony will be held at TRIUMF on the 36th anniversary of the event in December.

Mikey Enriquez' photo of the TRIUMF 8π detector was the global winner in the 2010 Global Physics photowalk

Smile! TRIUMF Captured on Camera by Local Photographers

In June, photographers from Photo Club Vancouver and the Burnaby Photographic Society, plus a few guests, participated in TRIUMF's first ever science photo walk, an initiative within the Artist in Residence program. After a half a day tour and photoshoot of the lab, the photographers submitted their favourite photos. A jury of TRIUMF staff whittled the contributions down to ten, which were then put on display at TRIUMF until August 10th.

Following up on this successful program, local photographers were invited to a behind-the-scenes photowalk at TRIUMF on August 7, as part of the Global Particle Physics Photowalk taking place that day at TRIUMF, CERN (Switzerland), KEK (Japan), Fermilab (USA) and DESY (Germany). Photographers visited, explored and took photos of people, objects, and locations in four research areas around TRIUMF. The winner of the global competition between the five labs was local photographer Mikey Enriquez for his shot of the 8π detector.The winning photos will be showcased in 2011.

The Future of Nuclear Power Tours TRIUMF

In early May, Canada's Department of Natural Resources hosted the Generation IV International Forum (GIF), whose members met to discuss the future role of nuclear energy. GIF is a cooperative, international organization of governmental representatives whose goal is to carry out the research and development needed to establish the feasibility and performance capabilities of next-generation nuclear energy systems. The goals adopted by GIF provided the basis for identifying and selecting for further development six nuclear energy systems, some which could become commercialized by 2030.

About forty members of the GIF Policy Group visited TRIUMF May 4. TRIUMF research addresses some topics related to advanced nuclear-energy systems, for example, Simon Fraser University professor Paul Percival used muon-spin resonance techniques to image the chemistry and transport of supercritical water, relevant for Canada's research program in Super Critical Water Nuclear Reactors.

The GIF Policy Group invited TRIUMF director Nigel Lockyer to deliver a welcoming address at their Wednesday meeting, where he noted that nuclear power had a role to play in addressing the global energy challenge.

Members of the Generation IV International Forum on the future of nuclear energy gather outside TRIUMF after their tour in May

PET Collaboration Demonstrates Placebo Effect

Individuals with Parkinson's disease were more likely to have a neurochemical response to a placebo medication if they were told they had higher odds of receiving an active drug, according to a report in the August 2010 issue of Archives of General Psychiatry. The expectation of symptom improvement is associated with the release of the neurotransmitter dopamine, and the manipulation of this expectation has been shown to affect the motor performance of patients with the condition.

Scientists at the Pacific Parkinson's Research Centre at Vancouver Coastal Health and the University of British Columbia studied 35 patients with mild to moderate Parkinson's disease undergoing treatment with the medication levodopa. First a baseline positron emission tomographic (PET) scan was performed, then participants were scanned 1 hour later after being given levodopa. On the second day, patients randomly divided into four groups, according to whether they were told they had either a 25, 50, 75, or 100% chance of receiving levodopa, ALL received a placebo regardless before a third scan. TRIUMF provided the medical isotopes used for the PET scans.

Patients who were told they had a 75 percent chance of receiving active medication demonstrated a significant release of dopamine in response to the placebo, whereas those in the other groups did not. While this finding may not generalize to diseases other than Parkinson's disease, it is extremely likely that both probability and prior experience have similarly profound effects in those conditions.

Calendar

Nov. 12, 2010 York University	BOM TRIUMF Board of Management Meeting
Dec. 2-3, 2010 TRIUMF	NSERC Review of T2K
Dec. 5-6, 2010 TRIUMF	NSERC Review of ATLAS
Dec. 8, 2010 TRIUMF	TUG AGM TRIUMF Users Group Annual General Meeting
Dec. 9-10, 2010 TRIUMF http://cawonaps2010.triumf.ca	CAWONAPS2010 Canadian Workshop on the Nuclear and Astro-physics of Stars
Dec. 10-11, 2010 TRIUMF	ACOT Advisory Committee on TRIUMF
Dec. 13-15, 2010 TRIUMF	ATLAS Workshop 2010

Back to School

Andrew Warren (centre) and Laurel Stothers (centre-right) show off their TRIUMF High School Fellowship awards after a six-week work experience, alongside their supervisors Fabrice Retiere (far left, Stothers) and Jess Brewer (far right, Warren) and Director Nigel Lockyer (centre left).

Grade 11 student Hannah Bild-Enkin shows off her award winning science fair work at the public lecture opening the INPC2010 conference in July.

Local high school students participating in the "Go Physics !" hosted by the Perimeter Institute at TRIUMF in May .

National Nuclear Physics Summer School and TRIUMF Summer Institute students pose with school staff after the Institute held at TRIUMF in June .

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Editor: Marcello Pavan
Production: Dana Giasson

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Inquiries or comments to: newsletter@triumf.ca

4004 Wesbrook Mall
Vancouver, BC V6T 2A3
Canada

+1 604 222 1047 telephone
+1 604 222 1074 fax

www.triumf.ca

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