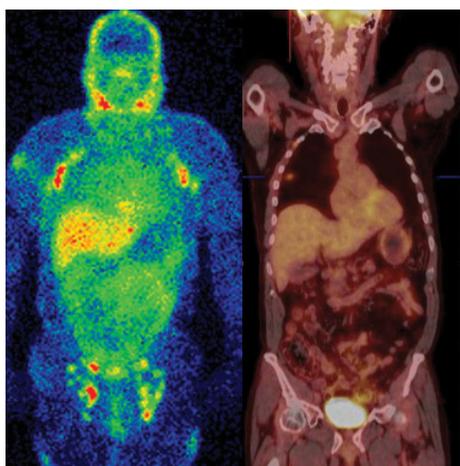


Beamtime

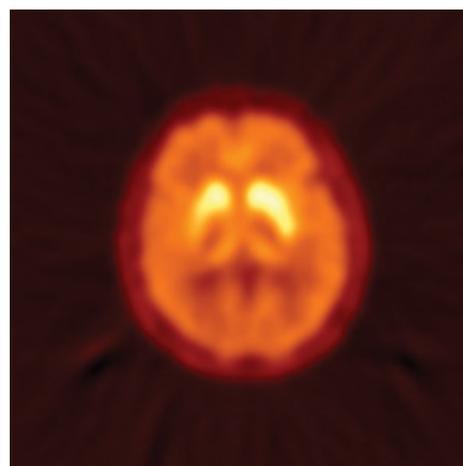
Spring/Summer 2010
Volume 8 Issue 1



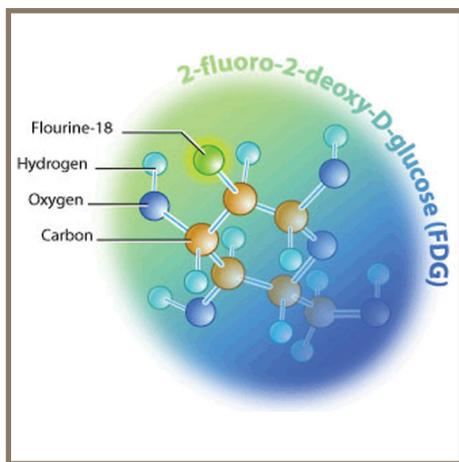
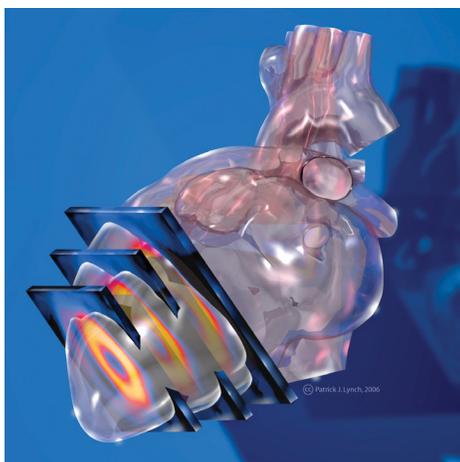
News from Canada's National Laboratory for Particle and Nuclear Physics



Nuclear Medicine at TRIUMF



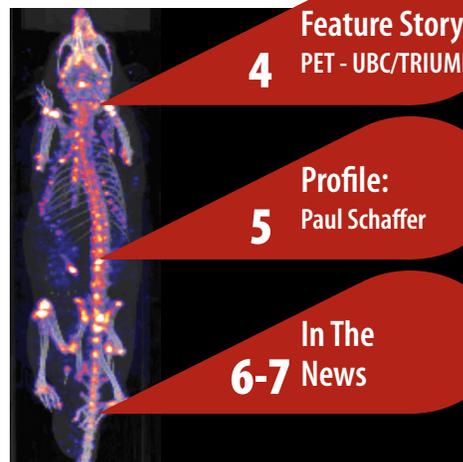
3 Cover Story:
Nuclear Medicine



4 Feature Story:
PET - UBC/TRIUMF

5 Profile:
Paul Schaffer

6-7 In The
News



Director's Voice



TRIUMF and the Nuclear Medicine Renaissance

This issue of “Beamtime” highlights Nuclear Medicine at TRIUMF, a modern branch of medicine that impacts tens of millions of lives around the world every year. Nuclear medicine is a broadly growing field that uses the radioactive decay of a variety of isotopes, often combined with radiopharmaceuticals, to either image or treat disease. Canada is a world leader in nuclear medicine – the research at TRIUMF and its partner institutions across the country is one of the reasons for that.

Why is the field of nuclear medical growing? The answer in short is because of two reasons.... one is that a new imaging technique, Positron Emission Tomography, or PET scanning, has gained increased popularity in the medical community, and the other is the increased availability of new and powerful medical isotopes. Due to the large number of isotopes labelled

PET is highly sensitive and is used to stage cancer; more and more it is the technique of choice to find metastasis. In BC, a PET scan must be used for lung-cancer patients because that cancer readily spreads to other parts of the body.

Combine this story – a growing field of nuclear medicine asking for more and different isotopes (all produced by accelerators, by the way) – with a group of physicists, chemists, engineers, and Canadian businesses all wanting to innovate a new alternative to reactor-produced isotopes, and you have the present situation.... Canada, ready to take the lead by innovation in a global field of economic and medical importance.

“*Canada, ready to take the lead by innovation*”

by the research community, the PET scanner is the fastest growing “camera” technique in nuclear medicine PET is being used as an imaging technique to understand and predict the onset of neurodegenerative diseases, such as Parkinson’s and Alzheimer’s disease, and related side effects such as addiction. Recent breakthroughs in these areas are very promising and have been reported broadly in the international press. The cancer-related, research-arena PET isotopes are able to analyze the details of a given tumour and hence begin to guide therapy.



Cover Story

The Present and Future of Nuclear Medicine

TRIUMF's New Division building on World-Class Status

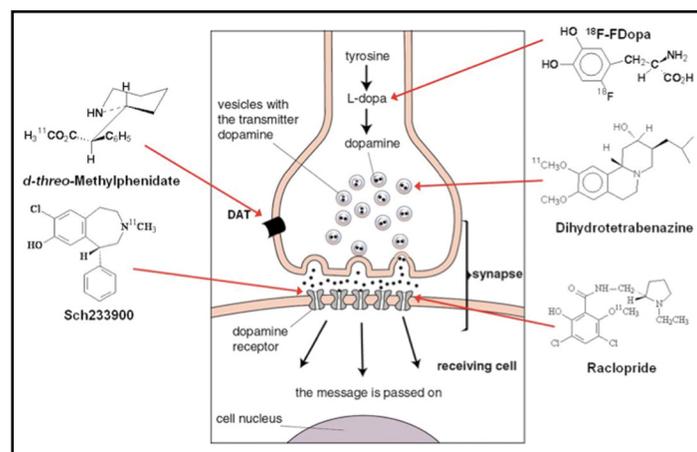
The mission of TRIUMF's Nuclear Medicine Division is to perform research and development for the production of radioisotopes, radiochemicals and radiopharmaceuticals (radiotracers). TRIUMF is involved in many facets of nuclear medicine research, the primary effort is the design of positron-emitting radiopharmaceuticals (PERs) for imaging various biological targets, with new programs driving with fundamental research and development efforts; and core programs geared toward producing almost two dozen PERs routinely for our collaborators.

Our Core Program, founded on a long-standing relationship with the Pacific Parkinson's Research Centre (PPRC), produces Carbon-11 and Fluorine-18 based tracers for pre-clinical research into disorders associated with the dopamine transport system, like Parkinson's disease. This program has yielded many exciting results, including the first clinical demonstration of the placebo affect (Science 2001, 293, 1164-1166), and will benefit from a WED Canada award to upgrade our lab.

For several years the Core Program also has delivered [¹⁸F]FDG to the British Columbia Cancer Agency (BCCA) leading to over 11,000 (and counting) clinical imaging studies. Soon the BCCA will produce their own [¹⁸F]FDG with an in-house cyclotron, nonetheless our exciting research partnership will continue. Together, TRIUMF, the PPRC, and the BCCA are gaining more insight into the onset and treatment for diseases such as Parkinson's disease, Alzheimer's disease and a variety of cancers.

Our New Research Program studies new radiotracers and new technologies for more reliable and efficient radiosynthesis, emerging into an effort focused on large molecular-weight radiotracers and their potential use in neurodegenerative imaging – two previously incongruent topics. Exciting new technology allows researchers to use proteins and peptides to image brain disease; consequently we have initiated an early-stage collaboration with General Electric's (GE) Global Research Center. GE has expressed an interest in a collaboration to develop a novel molecular imaging agent for oxidative stress. We also have applied for a Collaborative Health Research Project grant with SFU, UBC Chemistry, UBC Brain Research Centre and the BCCA to demonstrate the use of microfluidics to synthesize peptidic radiotracers to help elucidate the role of microglial overactivation in neurotoxic response in neurodegenerative disease.

TRIUMF is leveraging its expertise in cyclotrons, targetry and radiochemistry to lead a national effort addressing the medical isotope shortage. ^{99m}Tc, used in over 85% of nuclear medicine scans today, is produced in only a few nuclear reactors worldwide with enough neutron flux to drive the ²³⁵U(n,f)⁹⁹Mo fission reaction yielding ⁹⁹Mo, the parent isotope of ^{99m}Tc.



Example of how radiopharmaceuticals produced at TRIUMF are used to probe the dopamine system

The recent shutdown of two high-capacity reactors has temporarily eliminated 80% of the world's ⁹⁹Mo supply, highlighting a critical vulnerability in the world's medical isotope supply chain. TRIUMF is developing alternative processes through either the ¹⁰⁰Mo(γ,n)⁹⁹Mo or the ¹⁰⁰Mo(p,2n)^{99m}Tc reactions to help avoid future isotope shortages.

TRIUMF continues to actively seek R&D collaborations with other external research partners, which should benefit from membership in the BC Preclinical Research Consortium. This entity has been commissioned to coordinate preclinical research between facilities in British Columbia. TRIUMF is looking to continue its cutting-edge research into molecular imaging enabled by positron emission tomography. With a facility upgrade underway, TRIUMF hopes to attract the best and brightest talent to western Canada, allowing the Nuclear Medicine program to continue building on its world-class status.

• Paul Schaffer

Feature Story

PET at UBC and TRIUMF

Neighbours are Key Partners in Global Network

Positron emission tomography (PET) provides a quantitative in-vivo assessment of biochemical function through imaging of radioactively tagged molecules bound to specific sites. Used in research, PET requires complex, interdisciplinary infrastructure and a research team that exploits the links between disease-related biological target identification, target specific radiochemical development and imaging methodology design, plus linking imaging results to the original biological question.

The PET imaging facility at the UBC Hospital, with its radiotracer production and chemistry partner at TRIUMF, has a 25+ year long history in functional brain imaging, receiving uninterrupted research funding from NSERC, CIHR (MRC), CFI, MSFHR and other agencies since inception. Its vertical integration of radionuclide and radiotracer design and production, expertise in imaging instrumentation and algorithms, and ability to perform pre-clinical studies in rodents, primates and humans makes the facility unique. There is active research in the imaging program working synergistically with end users, mainly the Pacific Parkinson's Research Centre (PPRC). The interdisciplinary group (faculty members in both Science and Medicine, with collaborators in Applied Science) is renowned for its accurate quantitative results and very complex imaging protocols. The program's success is directly coupled with our local, national and international partners, illustrated below:

Radiotracer development. With TRIUMF we have established collaborations with: the University of Alberta on targetry and tracer developments, the University of Montreal

on tracer production and new brain imaging protocols, the Ottawa Heart Institute on implementing new radiochemistry units and with the University of Wisconsin on tracer production techniques. With an NSERC Collaborative Research and Development grant we've established a research partnership with Nordion to develop new imaging platforms based on radiometals.

Imaging Physics and modeling. We have advanced: with the University of Wisconsin, new modeling approaches for our tracers; with Johns Hopkins, new image reconstruction techniques and correction for subject head motion; with the University of California (Irvine), correction algorithms for transmission data scatter; and with Tuebingen University in Germany, modeling, image reconstruction and multi-modality imaging ideas combining PET and MRI.

PPRC Clinical Imaging Program. Our many world-wide collaborations bring the most appropriate subjects for scanning to help unravel the mysteries of movement disorders (viz. Parkinson's disease (PD)) and their genetic and environmental basis: Mayo Clinic, Jacksonville; U. Washington,

Seattle; Norwegian University of Science & Technology, Trondheim, Norway; and Sagamihara National Hospital, Japan.

Collaborations centered on imaging of subjects at increased risk of developing PD due to frequent genetic mutations appearing in their families include University of Alberta (imaging of biomarkers) and Aarhus, Denmark (dopamine and gambling). Subjects are flown to our facility from all over the world, since no other centre is currently capable of performing the complex multi-tracer studies required to investigate pre-clinical aspects of PD.

Animal models. Our program includes animal modeling research with UBC (gambling rat model, multi-modality imaging), the Mayo Clinic (transgenic rodent models) and Aarhus, Denmark (pig models of stimulation therapies).

ADNI study. We are part of a large North-American study (ADNI) to determine the natural history of Alzheimer's disease through neuroimaging. Our centre has been recognized as providing the most reliable HRRT images to the collaboration.

The long history of applying PET imaging to study movement disorders, in particular Parkinson's disease, is completely unique to the PET Imaging group and in Canada, and very rare worldwide. We have obtained unmatched data sets from repeated studies in PD subjects over eight years, providing unique insights into the neurochemistry of disease progression. This would not be possible without careful integration of instrumentation and algorithm development coupled with careful selection of radiotracers developed in conjunction with our research partnerships around the world.

• Tom Ruth & Vesna Sossi



UBC's High Resolution Research Tomograph (PET)Scanner

Profile



Paul Schaffer

Leading the Way to TRIUMF's Nuclear Medicine Future

Jumping into one of the most exciting times for the nuclear medicine program at the lab, deputy head of the nuclear medicine division Paul Schaffer has set some exciting goals for the TRIUMF team and continues to demonstrate the adaptability and excellence of the lab.

Paul grew up in Ontario but moved out to Vancouver early in his academic career to study at UBC where he completed a double major in Chemistry and Biochemistry. After meeting a lovely young woman who later became his wife, Paul moved back to Ontario to complete his PhD in Chemistry at McMaster University. He worked as a researcher for five years at the McMaster University Nuclear Reactor and later took a position in upstate New York as a radiochemist at General Electric.

While working in New York, Paul received a call from Tom Ruth, senior research scientist who invited Paul to visit TRIUMF for a seminar—and discuss a possible position. From living in Vancouver during his undergrad, Paul was familiar with TRIUMF's good reputation. "Taking the position at TRIUMF looked like a good opportunity and a unique challenge". TRIUMF's cutting edge nuclear medicine program caught Paul's interest and so he, his wife, and two children made the move back to Vancouver in 2009.

The nuclear medicine program at TRIUMF entails a broad spectrum of activity. In addition to the Core Program, which supports (pre) clinical research and maintains quality assurance, the New Programs all support and drive research with new isotope production, new tracer synthesis and skills training. As deputy head of the nuclear medicine division, Paul is most excited about three current efforts which will propel TRIUMF to lead in the field of nuclear medicine.

The first goal on Paul's list is to upgrade the existing lab. A \$1M grant is in place to upgrade the laboratory facility, which would add three hot cells, a flow hood and clean room. This upgrade would increase sterility, manufacturing control and have the capability to increase production. The joint MHESA renovation and upgrade remainders drive renewed research efforts with MDS Nordion, effectively to attract and retain world-class talent.

Paul has also set his eyes on labelling tracers for neurodegenerative diseases. "Our longstanding relationship with UBC Neurology can continue to grow with discovery efforts into new tracers." These include C-11 labelled PiB, an exciting new tracer out of Pittsburgh that is capable of detecting Alzheimer's Disease in living patients — something not possible before.

In addition, efforts are underway with novel tracers that use Co-55 and peptides labelled with F-18 to compliment or improve on the foundation laid by PiB. Co-55 is an example of where TRIUMF's unique expertise in producing less-common isotopes can pave the way for the next generation of medical isotopes for disease diagnosis.

The third goal Paul has set for the division and is enthusiastic about is to help TRIUMF complete and develop biomedical tracers for our collaborators, increase efficiency, and ultimately create a molecular toolkit for isotopes production and tracer synthesis. "The efforts of the entire Nuclear Medicine/Radiochemistry community over the past 30-50 years have

come to fruition," said Paul, "and it's time to adopt some of these approaches in our collaborations with others."

On the spectrum between private and academic pursuits, TRIUMF can be identified

as leaning further on the academic side, granting freedom to pursue research ideas. "We're not done yet. There still exists a need to discover radioisotope incorporation methods that are both more agreeable with biological systems and are compatible with some of the emerging isotopes for Nuclear Medicine." Combined with support from the Director, Dr. Nigel Lockyer, and the rest of the laboratory, Paul looks to enable a skilled and resourceful team in realizing their potential.

• Melissa Baluk

“ TRIUMF... a good opportunity and a unique challenge ”

In The News

Go Physics! TRIUMF Day Camp

Thirty enthusiastic local students came to TRIUMF May 28th to take part in the Go Physics! day camp put on by Perimeter Institute for Theoretical Physics (PI). The select grade 11 and 12 students with a keen interest and strong ability in both physics and mathematics engaged in hands-on labs and “minds-on” challenges in thinking like a physicist. They also took part in brainstorming sessions while exploring Einsteinian gravity, relativity and quantum physics. The day camp was presented by Dr. Richard Epp, Manager of Scientific Outreach at PI who has degrees in both engineering and theoretical physics, and Julie Taylor, Outreach Coordinator at PI.

The Go Physics! program is a one-day version of PI’s International Summer School for Young Physicists program and has visited educational and research centres across Canada.

TRIUMF Receives \$222 Million Funding from Government of Canada

The Government of Canada announced March 4 renewed support for TRIUMF, committing \$222 million over the next five years to support core operations in TRIUMF’s next Five-Year Plan 2010-2015. In an extremely challenging fiscal environment, TRIUMF has secured a five-year operating budget and avoided explicit cuts, signaling clear confidence in what TRIUMF can offer Canada.

The federal budget announcement stated: “In addition to fundamental research in subatomic physics, TRIUMF has gained an international reputation as a leader in advanced medical imaging, nuclear medicine, and research in the environmental and material sciences. TRIUMF collaborates with industry partners to commercialize its

scientific breakthroughs, including its successful relationship with MDS Nordion”.

“Budget 2010 provides \$126 million over five years to strengthen the world-leading research taking place at TRIUMF. In combination with \$96 million [from] ... the National Research Council Canada, federal support for TRIUMF’s core operations will total \$222 million over the next five years.”

TRIUMF management has been working diligently to procure other funds for the expansive measures in the Five Year Plan, and announcements can be expected soon.



Rob Mac Donald wins 2008-2009 DNP Thesis Prize

Rob MacDonald of the University of Alberta is the winner of the 2008-2009 Division of Nuclear Physics (DNP) Thesis Prize given in Experimental or Theoretical Nuclear Physics to a student who is obtaining his/her PhD degree from a Canadian University. Rob's thesis "A Precision Measurement of the Muon Decay Parameters Rho and Delta" was based on doctoral research performed at TRIUMF with TWIST, under the supervision of Art Olin.

Rob's thesis reported intermediate results for the TWIST experiment but it was the quality of his analysis that brought attention to his work. The thesis was not only useful for committee members – not all of whom were from his field – but also served as a useful reference document for the TWIST group as the experiment continued.

Rob will receive a cash award of \$1,000 from the DNP and was invited to give a talk at the Winter Nuclear & Particle Physics Conference this February in Banff. He is presently teaching at the University of Alberta as a sessional instructor and is a postdoctoral fellow with the PICASSO particle astrophysics experiment.



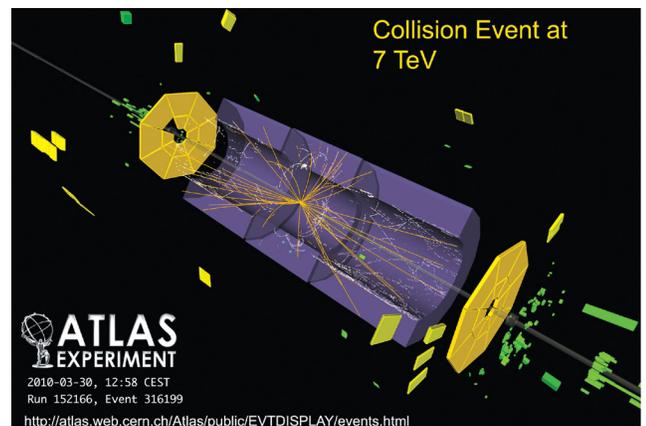
LHC Scientific Program Begins

March 30 at 1:06pm local time, CERN's Large Hadron Collider (LHC) began colliding particle beams at the highest energies ever reached by a man-made accelerator. This milestone marks the beginning of the LHC scientific program that researchers throughout the world have worked towards for over two decades. Some of the loudest cheers were from Canadian scientists who helped design, build and commission the LHC and the massive ATLAS experiment, and their nearly 100 graduate students who await the data.

TRIUMF worked with universities and companies across Canada to contribute key elements to ATLAS and the Large Hadron Collider accelerator itself. TRIUMF also is home to one of the ten supercomputer data centres worldwide processing the enormous volumes of data from ATLAS. In fact, the first collisions "showed up" in the Canadian computer centre within hours, ready for Canadian scientists to start analyzing them. The LHC will now run for the next 18 months and the data collected by ATLAS will allow scientists to probe the origins of matter to an unprecedented precision, to where physics theories predict new phenomena will lie.

Calendar

Sept. 10-18, 2010 TRIUMF http://intds2010.triumf.ca/	INTDS International Nuclear Target Development Society Conference
Sept. 11-12, 2010 Winnipeg	CINP LRP
Sept. 21-23, 2010 TRIUMF www.triumf.info/hosted/cryo-ops	Cryogenic Operations Workshop 2010
Sept. 30, 2010 TRIUMF	CNSC Mid-Term Hearing for Renewal of TRIUMF Operating License
Sept. 27-Oct 1, 2010 TRIUMF http://lap2010.triumf.ca/	LAP2010 Laser Probing Workshop
Oct. 25, 2010 Vancouver	Japan/Canada Accelerator Science Symposium
Nov. 12, 2010 York University	BOM TRIUMF Board of Management Meeting



Looking Back

Forty Years On

June 1970: Excavations Complete and the CRM Cyclotron Taking Shape

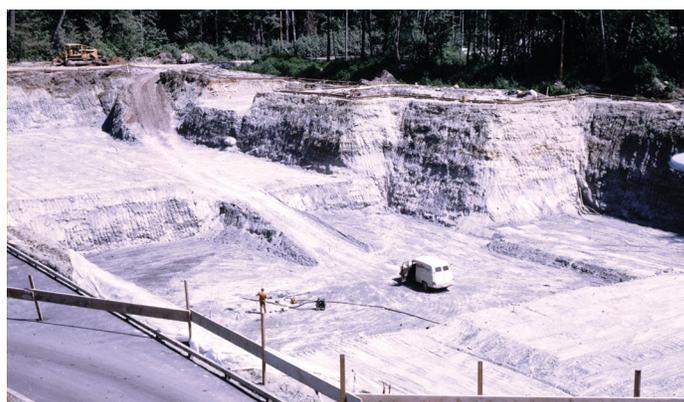
The year following the official dedication and tree-planting ceremony in May 1969 saw tangible progress on a variety of fronts. The skeletal Office & Laboratory Building was completed over the summer and fully occupied by November. At the end of the year the old cafeteria provided the venue for the first-ever TRIUMF Christmas Party, for



which the tickets cost a modest \$2.50 “including exotic food and liquor”. By June 1970 the staff on site had grown to 43, not counting university people, with

another 12 at UVic, 5 at SFU and 6 at UofA. Among the newcomers were many TRIUMF stalwarts: Ewart Blackmore, Bill Bryson, Jack Carey, John Cresswell, Jim Fawley, Dave Gurd, Terry Hodges, Nancy Palmer, Roger Poirier, Paul Reeve, Ian Thorson and Milos Zach.

Outside, the muddy field was transformed in the New Year by the arrival of heavy earth-moving equipment, providing daily lunchtime entertainment. Special enjoyment was provided by the driving of boreholes for the perimeter well-point system, which resulted in great fountains of water shooting into the air. Excavations for the cyclotron and experimental halls were completed in June, by which time 60,000 cubic metres of glacial till had been removed to leave a 120m by 30m hole 13m deep.



Cyclotron and experimental hall excavation



Central Region Model magnet and half the vacuum chamber

Commonwealth Construction were awarded a \$2.2 million contract for the concrete substructure, but were then delayed nearly three months by a strike/lockout in the B.C. construction industry.

Back in the Office & Laboratory Building, an accelerator was already taking shape in the form of the Central Region Model - a 2.5-MeV cyclotron with the same magnetic field and rf parameters as the big machine, together with a 300-kV ion source and injection line. The huge vacuum tank (2m wide and 10m long to accommodate two resonator sections), built by EbCo Industries, arrived in April and was quickly pumped down to the required 5×10^{-7} Torr. The resonator panels, also built by EbCo, arrived soon after.

Altogether, notable progress was being made, both indoors and outside.

• Mike Craddock

Editor: Marcello Pavan
Production: Dana Giasson

Beamtime is available online at:
<http://www.triumf.ca/home/multimedia/newsletter>

Inquiries or comments to: newsletter@triumf.ca

© 2010 TRIUMF Beamtime All Rights Reserved

4004 Wesbrook Mall
Vancouver, BC V6T 2A3
Canada

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

www.triumf.ca



TRIUMF is funded by a contribution through the National Research Council of Canada.

The province of British Columbia provides capital funding for the construction of buildings for the TRIUMF Laboratory