The TRIUMF Newsletter

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

DIRECTOR'S NOTES

The arly months of the calendar year are traditionally the time when TRIUMF's facilities undergo extensive programs of maintenance and upgrade. This year the facilities have been in this maintenance shutdown mode for January and February and part of March. However, one major project, i.e., the upgrade of one of the main meson beam lines, will not be complete until the end of April. During this shutdown period, the workload on all staff is particularly high, but nevertheless good progress has been made to complete most of the construction and assembly work associated with the first phase of the ISAC-II accelerator. Actual commissioning of this accelerator will take place this spring.

Development of new intense radioactive beams is a high priority. The development of an intense ^{26g}Al beam by laser ionization and the measurement of ^{26g}Al (p,γ) resonant strengths that are of importance to interpret the galactic concentration of ^{26g}Al are a tribute to the excellent work carried out by the Ion Source Group. Development of FEBIAD and ECR ion sources is a high priority. Users have expressed for some time the importance of developing a high power actinide target for the production of radioisotopes. The laboratory has responded by appointing a group leader to oversee this work.

Most of the laboratory's work associated with the CERN Laboratory - construction of some components for the LHC accelerator and ATLAS detector - has now been completed. In particular, the two massive hadronic endcaps have been constructed and tested and are being installed at the detector pit in CERN. The ATLAS community in Canada is now concentrating efforts to help meet daunting challenges associated with the worldwide distribution, handling and analysis of the vast volumes of data that will flow from the ATLAS detector when it comes on line next year; TRIUMF will play a central role to support the Canadian ATLAS community. In the last few months, TRIUMF joined with other Tier 1 centres to participate successfully in a worldwide data transfer challenge between CERN and Tier 1 centres around the world.

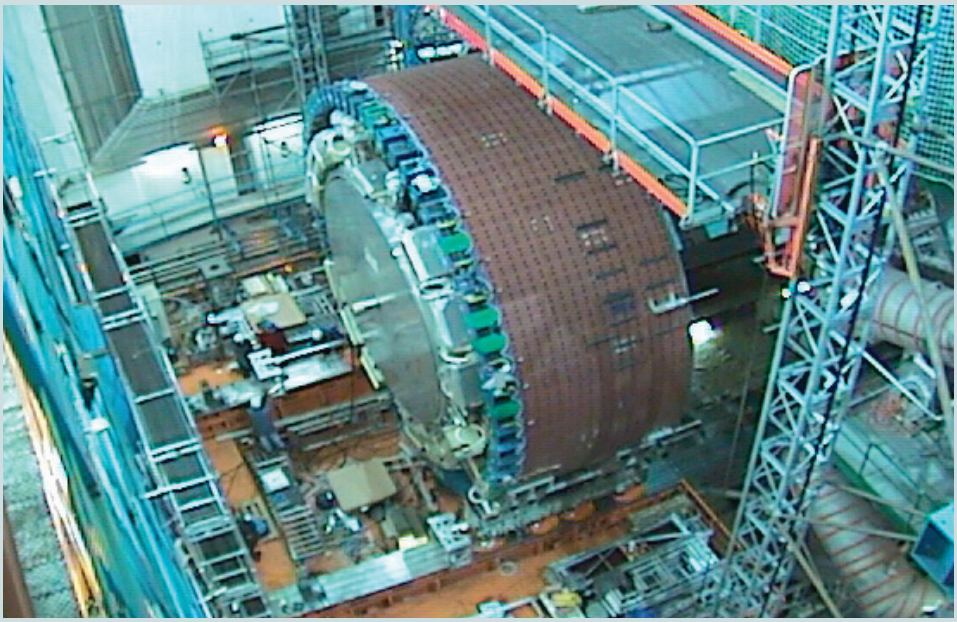
An important part of TRIUMF's mission is technology transfer to the benefit of society. An excellent recent example of this is the collaboration between TRIUMF and the British Columbia Cancer Agency to create a clinical and research functional imaging centre in Vancouver. This centre is still only in the initial development phase, but since it was launched last June at the Cancer Agency hospital over 1000 patients have benefitted.

Finally, but by no means least, TRIUMF passed an important anniversary in January as 40 years ago a report specifying the future TRIUMF facility was published. To members of the study group who wrote the report, we owe a debt of gratitude, but I wonder how many at that time would have believed that 40 years on TRIUMF would still be a vital international laboratory at the centre of scientific discovery?•

Alan Shotter, TRIUMF Director

For more information on TRIUMF Projects, visit the TRIUMF website at: http://www.triumf.info

TRIUMF-built hadronic endcap calorimeters installed in ATLAS detector



The final push to complete the LHC accelerator and big detector experiments is well underway at CERN, in an effort to achieve a winter 2007 startup date. The giant ATLAS detector is starting to take shape, and recently Canada's contribution to the project, the hadronic endcap calorimeters (HEC), was installed into the superstructure. The HEC was built at TRIUMF under the supervision of Chris Oram. ATLAS installation progress can be viewed online at: http://atlaseye-webpub.web.cern.ch/atlaseye-webpub/web-sites/pages/UX15_detector-inst_webcams.htm

WHAT'S INSIDE

Linear Collider Workshop in Vancouver, July 19-22

The July 2006 joint meeting of the American Linear Collider Physics Group (ALCPG) and the International Linear Collider Global Design Effort (GDE) is being organized by TRIUMF and will be held on the University of British Columbia campus from July 19-22, 2006.

The Vancouver ALCPG06 meeting is next in the continuing series of North American workshops on the physics, detector, and accelerator issues of the future International Linear Collider. The Vancouver GDE meeting will review progress with the ILC Reference Design Report (RDR) process. The meeting will open and close with joint plenary sessions, with parallel working sessions held in between.•

For more information, visit: http://vlcw06.triumf.ca

PROTOTYPE TPC MODULE FOR THE T2K EXPERIMENT COMPLETED

TRIUMF, along with several Universities across Canada, is strongly involved in preparations for the T2K long baseline neutrino experiment in Japan, which is scheduled to begin in 2009. The experiment is designed to study the way neutrinos transform from one type to another, oscillating as they travel long distances. The proton beam from the 50 GeV synchrotron under construction at JPARC will be used to produce an intense narrow-band off-axis neutrino beam towards the Super-Kamiokande detector, 295 km away. The Canadian T2K group is working with groups from the US, Europe, and Japan to design a large neutrino detector located near the production target to measure the properties of the neutrinos before they oscillate. A critical component of this detector is the tracker, consisting of two fine grained target planes surrounded by three time projection chambers (TPCs).

The TPC modules are each to be roughly 2.5m x 2.5m x 1m, and will use micro pattern gas detectors for readout, as developed for the Linear Collider TPC project. Charged particles produced from a neutrino interaction in the target planes pass through the TPC and liberate electrons from the gas molecules, which then drift towards the readout endplate. The electrons are amplified and the signals seen on pads give precise information about the path that the original charged particles followed. In essence the TPC takes 3D images of all charged particles that pass through it.

Figure 1. Outer gas box of TPC being glued together inside a heated tent in the large TRIUMF clean room.

Prior to completing the designs for the full scale modules, a smaller prototype was designed, and its construction was completed at the beginning of this year by staff at TRIUMF, University of Victoria, and UBC. Pictures from its construction are shown in figures 1&2.

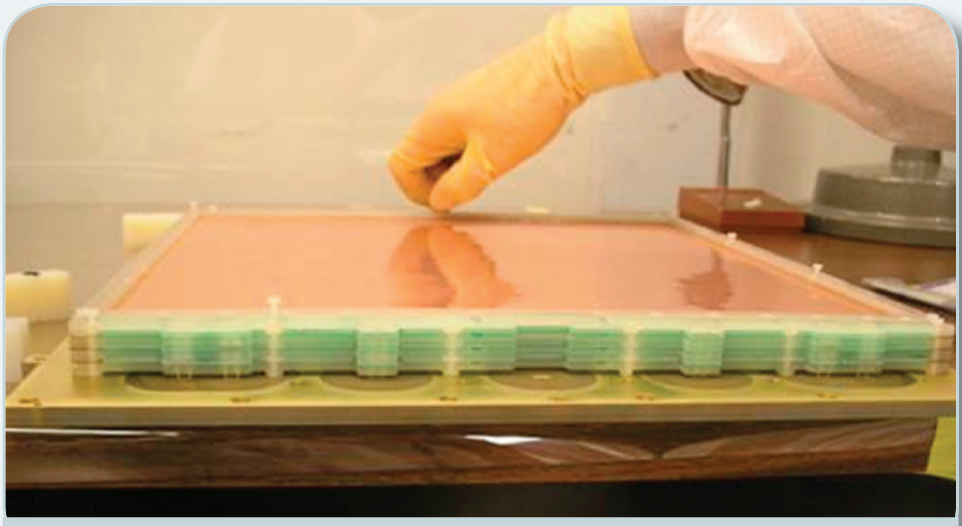


Figure 2. A stack of three gas electron multiplier foils being placed above a readout pad board.

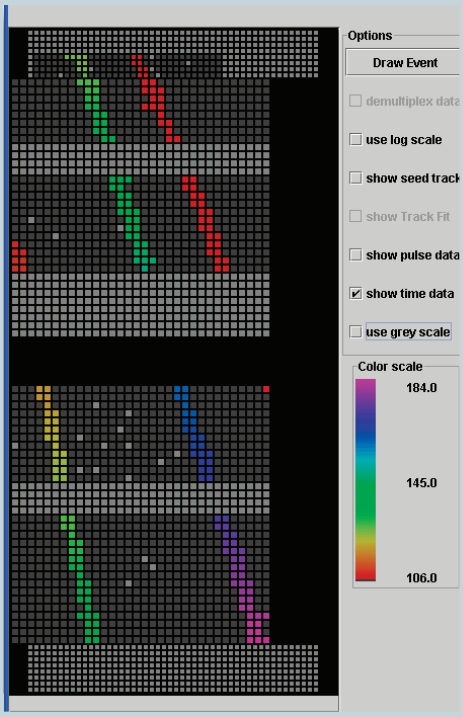


Figure 3. A display of a cosmic ray event containing three charged particles passing through the TPC is shown. The coloured squares show the pads with signals and the colour indicates the arrival time of the signals. The light gray pads are disabled. The larger pads are 8mm x 8mm.

The TPC was operated at the University of Victoria in January, using cosmic ray particles to test its performance. Occasionally, the cosmic ray events involve several particles, such as the event displayed in figure 3.

The preliminary analyses of many thousand cosmic ray events show that the principle design concepts of the TPC are sound, and that the spatial resolution goal for the device (roughly 0.7 mm per row of pads) is obtained.

The Canadian T2K TPC groups will work this year to complete the design and construction of a full scale module, followed by the construction of the 3 production modules in the following two years, to be ready for their installation in Japan in early 2009.•

Dean Karlen

MEASUREMENT OF THE $^{26}Al(p,\gamma)^{27}Si$ REACTION AT DRAGON

The radioactive isotope ^{26}Al has become a hot topic in Astrophysics ever since the first detection of gamma-rays from the isotope in the Milky Way in the early nineteen-eighties,. The signature of ^{26}Al is the 1.809 MeV gamma-ray which is emitted when it decays by positron emission. This gamma-ray can be detected by space-based telescopes, and has already been observed by gamma-ray sensitive instruments on the COMPTEL, RHESSI, and INTEGRAL satellites. The recoil separator facility DRAGON at TRIUMF is able to measure nuclear properties relating to the production of ^{26}Al in the interstellar medium.

The COMPTEL all-sky map (Fig. 1) shows that the ^{26}Al is concentrated in the spiral arms and the core of the galaxy. These are regions of high star birth, and this is one of the reasons astronomers believe that the ^{26}Al probably comes mainly from young massive stars which lose material from stellar winds or in a supernova explosion [Diehl 2006]. However, it is believed that older stars, in particular classical novae, can contribute a small but significant amount of ^{26}Al to the interstellar medium [José 1997].

Of those nuclear reactions that have a dramatic influence on the amount of ^{26}Al made in novae, the most uncertain ones experimentally are $^{25}Al(p,\gamma)^{26}Si$ and $^{26g}Al(p,\gamma)^{27}Si$ (the superscript 'g' is used to distinguish the ground-state of ^{26}Al). The $^{26g}Al(p,\gamma)^{27}Si$ reaction is known to be dominated by a single resonance with a center-of-mass energy of 0.188 MeV. The strength of this particular resonance is a crucial quantity needed to predict with more confidence the amount of ^{26}Al formed in novae. During the course of 2005 the DRAGON group undertook to measure the strength of this resonance at an accuracy required to allow nova models to make significant predictions.

At DRAGON, we measured this resonance strength by accelerating a beam of radioactive ^{26}Al to an energy just above that of the resonance energy, passing it through the DRAGON windowless hydrogen gas target, then detecting the reaction products at the end of DRAGON in coincidence with emitted gamma-rays.

The strength of the 0.188 MeV resonance was thought to be so weak that for every three trillion ^{26}Al particles that passed through the gas target, roughly only one reaction would occur!

We needed a very intense ^{26}Al beam in order for us to have enough reactions to make this measurement with reasonable statistical accuracy. The ^{26}Al beam was generated by impinging 500 MeV protons from the TRIUMF cyclotron onto the ISAC high-powered Silicon Carbide target. The ^{26}Al nuclei created in spallation reactions within the target diffused out into a surface ionization source then were extracted into the ISAC accelerator. The surface ionization was boosted by a factor 8 by the use of the TRIUMF Resonant Ionization Laser Ion Source (TRILIS). After acceleration to 0.201 MeV per nucleon (about 2% the speed of light for ^{26}Al) the beam had up to five billion ions per second of intensity.

During the 180+ hours of data taking, over 100 reaction ^{27}Si reaction products were identified in coincidence with gamma-rays, and subsequently the strength of the resonance was found to be approximately 40% weaker than previously thought. This means that less ^{26}Al would be destroyed in a nova explosion, ie. more would be left over to be distributed into the interstellar medium.

We are currently in the process of publication of these results, including the results of hydrodynamic nova calculations incorporating our resonance strength measurement in order to predict the relative increase in ^{26}Al production from these sources. Preliminary results support the theory that novae are indeed important secondary sources of ^{26}Al in the galaxy. •

Chris Ruiz (TRIUMF)

References

[1] [Diehl 2006] R. Diehl et al. Nature, 439, January 2006

[2] [José 1997] J. José, M. Hernanz and A. Coc, Astrophysical Journal, 479, L55 (1997).

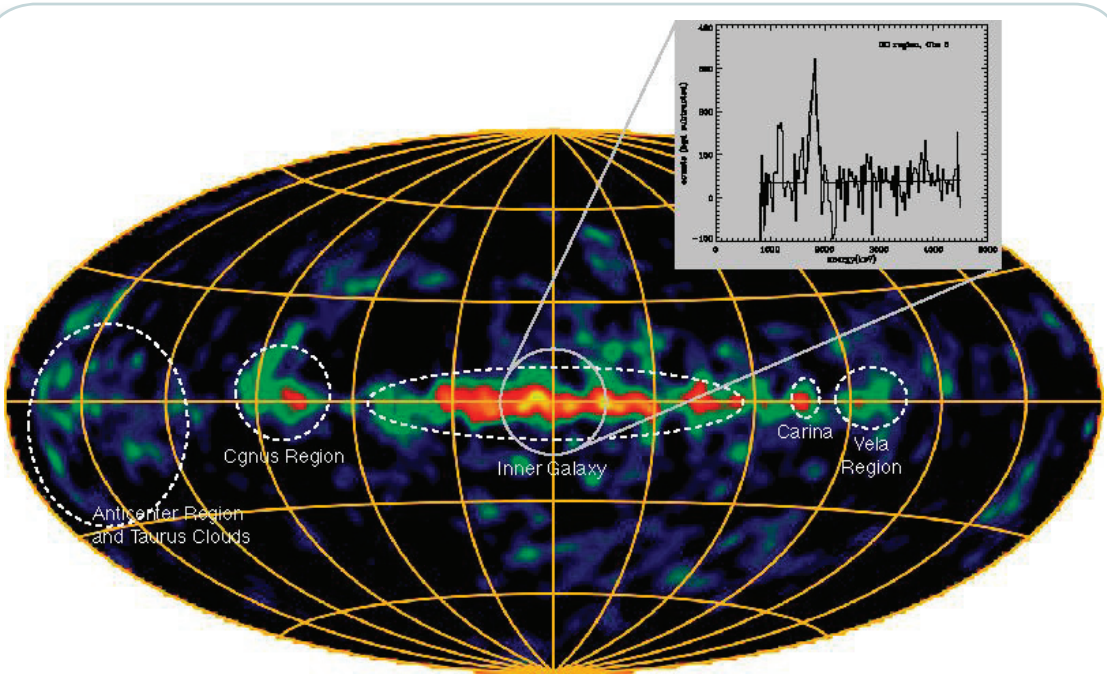


Figure 1: COMPTEL all-sky map of ^{26}Al 1.809 MeV gamma-ray (NASA Goddard Space Flight Center)

THE ISAC-II ERA IS UPON US

On Tuesday morning, April 4, 2006, the ISAC-II era at TRIUMF began.

Three years after the first scientists and technicians moved into the new ISAC-II building (Figure 1), the Canadian Nuclear Safety Commission (CNSC) granted a license to operate the ISAC-II accelerator facility for a one-year commissioning period. After intense efforts by Bob Laxdal and his team, under the overall supervision of ISAC and Cyclotron Division Head Paul Schmor, the first stage of the new ISAC-II facility was ready at the end of March to provide a boost in energy from the 1.5MeV/u currently available at ISAC-I to 4.5 MeV/u. This stage is made up of 20 medium-beta superconducting RF cavities in five cryomodules (figure 3) and associated beam transport components (Figs. 4-5). With the granting of the license the "ISAC-II era" at TRIUMF officially has begun.

Commissioning began using stable ^{40}Ca beams April 5, starting with tests of the solenoids without the RF acceleration cavities turned on. The first successful acceleration through all 20 acceleration cavities to 5.5 MeV/u (starting at 1.5 MeV/u coming from ISAC-I) was achieved only days later (see Figure 6). The average accelerating gradient for the twenty cavities was 5.6MV/m with an average power consumption of 4W/cavity, implying 16MV of voltage gain for only 80W of RF power! Beam commissioning will continue throughout the spring and summer.

The first ISAC-II commissioning experiment with radioactive beam is expected to run in the Fall of 2006. It will study reactions of radioactive ^{11}Li nuclei, with energies of 2 and 4 MeV/u, on a hydrogen gas target to ^{9}Li, ^{10}Li, and ^{12}Li final states. The experiment will use the MAYA detector imported to TRIUMF from GANIL (France) specifically to take advantage of the high intensity ^{11}Li beams available here. The full ISAC-II experimental program is expected to begin in Spring 2007 after full CNSC operating licensing approval.

This milestone achievement is only the first stage of the planned ISAC-II facility, a schematic of which is shown in Figure 2. ISAC-II forms the centrepiece of TRIUMF's 2005-2010 five-year plan, and the final stages of the facility are expected to be built over the next five years boosting the energy of radioactive beams to 6.5MeV/u over a mass range of 1-150.•

Marcello Pavan

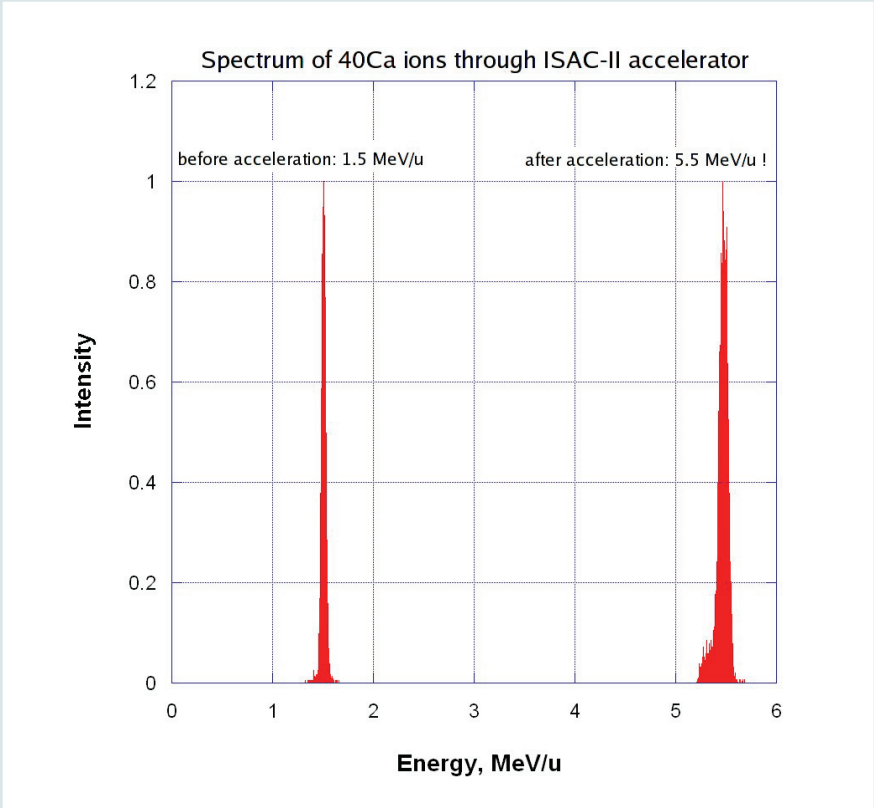


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Figure 5.

View of the ISAC-II accelerator vault looking east, with the final dipole bender in the foreground, followed by the 5 medium-beta accelerator tanks, with the transport quadrupoles off in the distance towards the experimental hall.

Figure 1. View looking south-east of the new ISAC-2 building. The building was officially opened by BC Premier Gordon Campbell June 11, 2003.

Figure 2. Schematic view of the ISAC-II ground-floor layout. The present facility includes the S-bend and the first 5 medium-beta cavities. Future accelerator extensions are outlined with the boxes. Plans for the beamlines in the experimental hall are being finalized.

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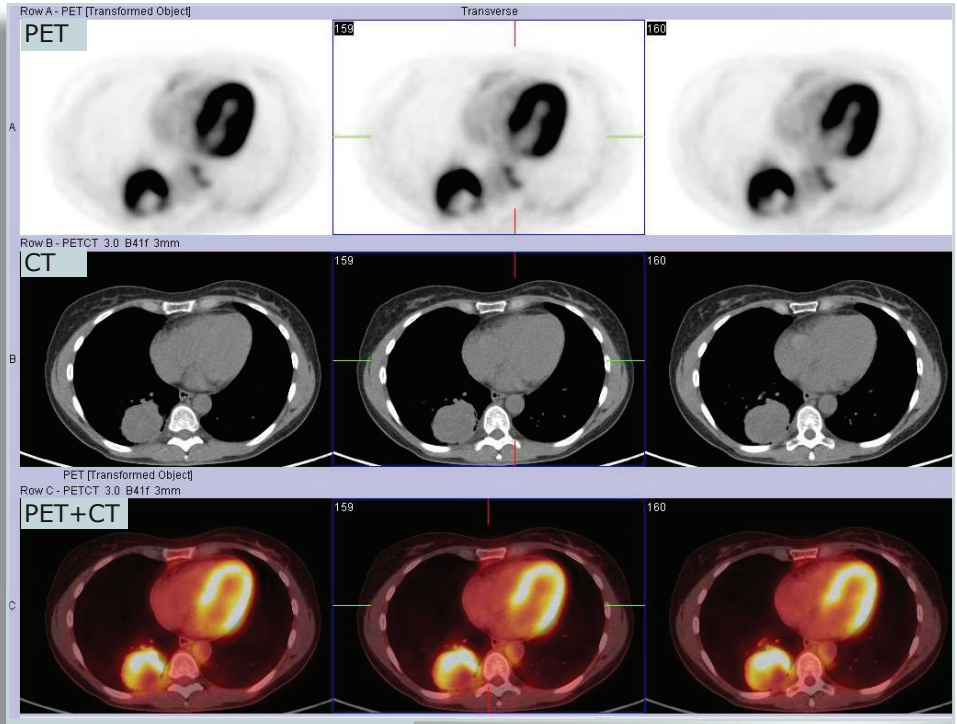
Figure 3. The soul of the new machine - TRIUMF technician Balwinder Waraich in the clean room posing with the superconducting radiofrequency cavities, removed from the accelerator tank.

TRIUMF AND BC CANCER AGENCY TEAM UP TO DELIVER PET/CT SCANS

TRIUMF is benefitting cancer patients in B.C. through a major advance in cancer care and treatment with the opening of the province's first publicly-funded PET/CT scanner at the BC Cancer Agency's (BCCA) Centre near Vancouver General Hospital. PET (positron emission tomography) is a technique utilizing radioactive tracers for whole-body imaging of biological function. When combined with computed tomography (CT or CAT) scans, which use x-rays to image body structure, it allows physicians to diagnose and manage cancer more accurately.TRIUMF's role is to provide the radio-isotopes for the PET scans.

TRIUMF and the BC Cancer Agency (BCCA) have a long history of co-operation and this latest project builds considerably on this successful relationship. The PET/CT system is a significant advance in the ability to track the progress of cancer in the body. An important feature of this new machine is the ability to produce images that show both biological function (PET) and anatomical structure (CT). This provides clinicians with a more comprehensive profile of the imaged tissue, allowing for a more accurate and confident diagnosis. Specifically, the machine has the ability to identify areas of abnormally high metabolic activity and to determine precisely the size and location of these cell groupings. For example, utilizing a CT scan alone, it would be difficult to distinguish between scar tissue and a cancerous tumour (see figure).



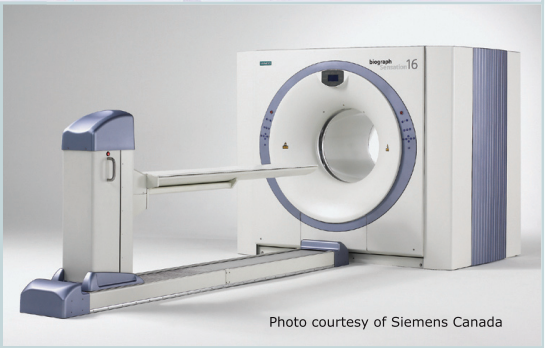


Photo courtesy of Siemens Canada

The Siemens PET/CT scanner (right) has been deployed by the BC Cancer Agency at its centre near Vancouver General Hospital. The specialized unit has adjacent CT and PET scanners which take images of a patient's bodily *structure* and *biochemistry*, respectively. The two images are then superimposed (above) to give a composite picture yielding more information than each separately. TRIUMF is supplying the radioactive 18-F isotope for use in the PET scanner.

PET is a sophisticated imaging technology that requires "radio-tracers", which are biochemicals which have one of their stable atoms replaced by a chemically-similar radioactive atom. The minute radiation from the decay of the radioactive atom is detected and used to trace back to the point in the body where the biochemical originated. For example, glucose sugar can be 'tagged' with radioactive fluorine (Fluorine-18), after which the PET scanner will detect the resulting fluorine radiation to generate an image of the tissue in the body where the sugar is metabolized.

TRIUMF has been creating radio-tracers for PET with its TR-13 cyclotron particle accelerator and associated radio-chemistry facility as a product of extensive research dating back to the early 1980s. Part of TRIUMF's technology transfer mandate includes assisting industry to utilize technologies that will be of benefit to Canadians. Therefore, to assist the BCCA with its immediate scanning requirements, TRIUMF and the BCCA have signed an agreement for TRIUMF to supply the BCCA with Fluorine-18 needed for the PET/CT scanner. The ultimate goal is for the BCCA to acquire and operate its own radioactive atom-producing cyclotron and radio-pharmacy equipment, however setting up a dedicated PET pharmacy is a long and complex task. Since commencing in June 2005, over 1000 scans have been performed, with more than 2000 anticipated in 2006.

This project is funded by the BC Provincial Health Services Authority, and is part of the Centre of Excellence for Functional Cancer Imaging established by the BCCA, the University of British Columbia, BC Children's Hospital, Vancouver Hospital and Health Services Centre, and TRIUMF. • *Marcello Pavan*

For more information, visit the following website:
http://www.bccancer.bc.ca/PPI/PET/

TRIUMF Canada's National Laboratory for Particle & Nuclear Physics
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For more information about Applied Science at TRIUMF, visit the Technology Transfer website at:

http://www.triumf.info/public/tech_transfer/tech_transfer_5.php

TUEC NEWS

The TRIUMF Users Group Annual General Meeting (AGM) was held on Dec. 7, 2005, immediately following the Canadian Subatomic Physics Town Hall meeting in Montreal on Dec. 5 and 6. At the AGM, the results of the TRIUMF Users Executive Committee (TUEC) elections were made public.

For 2006, your TUEC membership is:

Chair	Paul Garrett	U. Guelph
Chair Elect	Uwe Greife	Colorado School of Mines
Past Chair	Jens Dilling	TRIUMF
Gerald Gwinner		U. Manitoba
Mina Nozar		TRIUMF
Fred Sarazin		Colorado School of Mines
Robert McPherson		U. Victoria/IPP
Jo Ressler		Simon Fraser U
Liaison Officer	Martin Comyn	TRIUMF

Highlights of discussion topics at the AGM were reports from Jens Dilling on the Montreal Town Hall meeting, where TRIUMF experimental programs and support for off-shore experiments were emphasized and well represented, and from Paul Schmor on the status of the ISAC-I and ISAC-II accelerators, where possible delays in ISAC-II experimental programmes were alluded to due to licensing issues, and plans towards development of an actinide target for ISAC-I/II beams.

Of great interest to many ISAC users is the actinide target, with many high-priority experiments awaiting its construction. Recent progress towards this is the hiring of a physicist whose prime responsibility will be to coordinate the development of an actinide target. The First Workshop on Actinide Target Development is being planned for April 27-29 at TRIUMF. Topics to be discussed include: the status of existing development efforts, radiation safety, target and ion source handling and storage, and target concepts. As the development of an actinide target has a direct and profound impact on many users, even those whose experimental programme does not include neutron-rich radioactive beams, all ISAC users are encouraged to participate in the workshop.

Since the timing of the December AGM often conflicts with constraints for TUG members at academic institutions, a decision was made to hold a 2 day Users Group meeting in the summer, following the EEC meeting in late July. The dates for this meeting are fixed for July 26 and 27. On the agenda will be a series of invited talks highlighting the variety of TRIUMF programs, and a number of breakout sessions to discuss Users concerns, including TRIUMF computing for ATLAS, ISAC operations, actinide target development, etc. It planned to start discussion concerning the next TRIUMF 5 year program. Further details will be circulated to the TUG as plans solidify. •

Paul Garrett, TUEC Chair

To join TUG or contact TUEC members, please visit the TRIUMF Users' Group website at: http://www.triumf.ca/tug/

OUTREACH NEWS

The World Year of Physics made 2005 an exciting year for the TRIUMF Outreach program (refer to recent Newsletters Vol 3, Issues 1 and 2). While 2006 will lack the frenetic pace of last year, this year promises exciting things with new and expanded initiatives.

The BC Association of Physics Teachers and the BC Science Teachers Association again planned to hold the teach Fall Professional Development Day at TRIUMF. Over 80 teachers had signed up for a full day of lectures, tours, and hands-on activities. Unfortunately, the BC teachers' strike forced its cancellation, but all groups have committed to coming back in fall 2006 to restart this very successful annual event.

The Saturday Morning Lecture (SML) series began anew in November 2005, with monthly lectures arranged until April 2006. The first lecture closed off the World Year of Physics with two lectures celebrating Einstein: one on his philosophy by UBC Distinguished Professor Alan Richardson, and another on a layman's guide to relativity by UBC Physics Professor Mark Van Raamsdonk. Capilano College in Sechelt, B.C. continues to offer SML offshoot lectures on the Sunshine Coast in a series that has proven very popular with local residents. Recently, the SML series is expanding to an even broader audience, with TRIUMF beginning an exciting new intiative with the NRC "Centre of the Universe" at the Dominion Astronomical Observatory (DAO) near Victoria. The TRIUMF lectures will be broadcast simultaneously to the DAO with H.323 videoconferencing technology, allowing participants there to view the presentations and ask questions afterward. The system was tested with good success and we anticipate to broadcast all future talks in this way.

The BC Innovation Council and TRIUMF continue their collaboration on the TRIUMF High School Fellowship program. This year 101 of the most outstanding math and physics students in the province have applied for the Fellowship. New for this year is the sponsorship of a second Fellowship by the Applied Technology Group through a generous contribution by Phil Gardner in the Technology Transfer Office. The two high school students will receive each a $3000 award and will take part in a 6-week work term at TRIUMF in July and August.

The biggest news is that our animated science education video project has received funding for the next three years. Following the success of our pilot video, "Approaching the Speed of Light", an application was made to the NSERC Promoscience program for funding to create three more videos. Thankfully, NSERC granted us $48,000 over three years, and with matching funds from TRIUMF and a contribution from the Vancouver Foundation, one new video per year will be created. Plans are underway with input from local high school teachers and a professional video production company. The first video highlighting the TRIUMF cyclotron should be ready in the fall. •

Marcello Pavan

High School Fellowships: http://www.bcinnovationcouncil.com/programs/scholarships.php
NSERC PromoScience: http://www.nserc.ca/promoscience/index_e.htm

FORTY YEARS ON - TRIUMF'S BEGINNINGS IN 1965

Members of the TRIUMF Study Group celebrate the 40th anniversary of the publication of their report *The TRIUMF Project* in January 1966. From the left: Brian Pate, David Axen, Lorna Warren, Erich Vogt, Gren and Reta Mason, Ralph Korteling, David Walker, Garth Jones, Mike Craddock (holding the report), Karl Erdman, Malcolm McMillan, Dorothy Erdman, and Bruce White.

By the 1960s, the UBC Nuclear Physics Group, under the inspired leadership of John Warren and George Griffiths, had produced more than half the Canadian Ph.D.s in that field. But the 3-MeV van de Graaff, built by John and his students in 1948, no longer provided as exciting research opportunities as the higher energy machines being built at universities across the country. Ottawa was believed to be sympathetic, but cost-conscious, as its rejection of a UBC proposal for a 12-GeV proton synchrotron around 1960 had shown.

John therefore conceived the idea of a joint project with B.C.'s two new universities, Victoria (1963) and Simon Fraser (1965). But was it to be aimed at nuclear structure or particle physics? There was a wide split between low- and high-energy enthusiasts - with John writing in March '65, "I would not settle for less than 3 GeV". As the junior dogsbody, I was then delegated to look at some recent U.S. proposals, when it became clear that such energies were too costly - but that a meson factory might not be, and could satisfy both camps.

To my astonishment this notion was approved unanimously at a meeting of the UBC nuclear physicists in May. The name TRIUMF, standing for Tri-University Meson Facility, was coined soon after, and the TRIUMF Study Group was formed (with UVic and SFU members) to choose a design and write an initial proposal. A fully-fledged meson factory seemed too ambitious, particularly the challenges and expense of shielding, so we aimed at a stripped-down 500-MeV 20-μA "meson workshop". A powerful new arrival in the Fall was Erich Vogt, and with John away on sabbatical, he led the Group in compiling its report, *The TRIUMF Project*.

Of the various designs extant (LASL and Yale linacs, MURA FFAG, Oak Ridge Mc^2 and ETH (PSI) proton cyclotrons, and UCLA H^- cyclotron) I had recommended the H^- machine as potentially the most flexible and least expensive. But was it a safe choice, given that the U.S. had chosen the much more costly linac? Extensive consultations confirmed it was, and we set about persuading Reg Richardson that we were competent to foster his baby – an effort sealed by a visit to UCLA by George Griffiths, Karl Erdman and myself on December 15th, when we negotiated the loan of their 1/20-scale model magnet. Oddly enough, this was nine years to the day prior to achievement of a 500-MeV beam!•

Mike Craddock

Important Upcoming Dates

∗ see insert

WATD*	First Workshop on Actinide Target Development	April 27-29	TRIUMF
BOM	TRIUMF Board of Management Meeting	June 22-23	TRIUMF
MMSEEC*	Molecular and Materials Science Experiments Evaluation Committee meeting	July 6-7	TRIUMF
TSI 06*	TRIUMF Summer Institute	July 10-21	TRIUMF
VLCW06	Vancouver Linear Collider Workshop	July 19-22	UBC
SAPEEC*	Subatomic Experiments Evaluation Committee Meeting	July 24-25	TRIUMF
TUG	TRIUMF Users Group Meeting	July 26-27	TRIUMF
TCP06*	Trapped Charged Particles	Sept 3-8	Parksville

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

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University of British Columbia
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TRIUMF Beam Schedule

The current TRIUMF beam schedule is available on the Web at:

https://admin.triumf.ca/docs/eec/

Users should subscribe to the automated update notification to receive notice of changes which may be required during the period already scheduled.

The TRIUMF Newsletter is published bi-annually, and is available online at: www.triumf.info/public/news/newsletters.php
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