TRIUMF

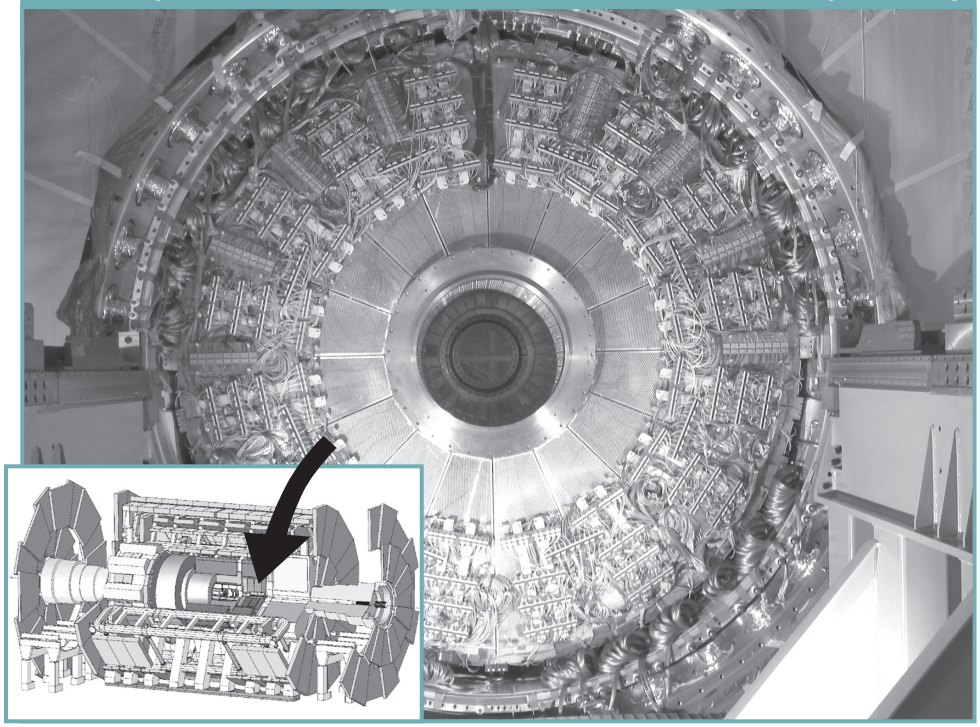
The TRIUMF Newsletter

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

www.triumf.info/public/news/newsletters.php

Installation of ATLAS Endcaps

TRIUMF's contribution to the ATLAS experiment, half the Hadronic Endcap Calorimeters, are presently in the installation stage at CERN. Taken in December, this photo shows a rear view of the first Endcap Cryostat showing HEC2 and plug. The second EndCap is scheduled for assembly in 2004. • ***Chris Oram*** ***For more information, visit www.atlasexperiment.org***



What's inside:

Director's Notes: TRIUMF Five-Year Plan

TRIUMF is funded on a five-year cycle, the current one running from 2000 to 2005. Over the past year, people at TRIUMF and its associated universities have been discussing the plan that will be forwarded to the Canadian government for consideration for funding in the period 2005-2010. This plan now has been peer reviewed by two international committees in the latter part of 2003 and has been presented to the National Research Council in February 2004. Recommendations from the Council will be transmitted to the higher levels of government for funding decisions later in the year.

The underlying theme of the plan is to provide Canadian scientists access to world-class subatomic facilities at TRIUMF and to provide scientific and engineering support to enable Canadian particle physics groups to lead or significantly contribute to various experiments worldwide. For facilities at TRIUMF, which are freely open to the international community, the plan includes completion of ISAC-II, a new radioactive beam development line, improvement in the muon beam lines for material science and chemistry research, and greater throughput of radioisotopes for research in the life sciences. For support of external experiments at TRIUMF, the plan includes development of a data hub for ATLAS data analysis, contributions to the T2K neutrino experiment in Japan, contributions to the KOPIO rare kaon decay experiment in the USA, and research and development for the next linear collider – a world project for the future. In addition, the plan identifies the importance of transferring technical knowledge developed at TRIUMF to the commercial sector and the importance of outreach to the general public. The proposed five-year plan is ambitious but it is a realistic plan which builds on TRIUMF's past and present record of achievements. The plan will deliver first-rate science in a timely and efficient manner and ensure TRIUMF is competitive at the highest international levels. ● *Alan Shotter, TRIUMF Director*

For more information on TRIUMF projects, visit the TRIUMF Web site, at www.triumf.info

TUEC News

The TRIUMF Users' Group (TUG) AGM was held on December 10, 2003, and the 2004 TRIUMF Users' Executive Committee (TUEC) was announced. The Chair is Jeff Sonier (SFU) and the Chair Elect is Jens Dilling (TRIUMF); Past Chair, Des Ramsay (Manitoba); Members, Alan Chen (McMaster) (2003-2004), Tracy Porcelli (Northern BC) (2003-2004), Pierre Bricault (TRIUMF) (2004-2005), and Alison Laird (York, UK) (2004-2005). In addition, TUEC nominates two members to the TRIUMF Operating Committee (OPCOM) to represent the views of the Users. Presently, they are: Graeme Luke (McMaster), alternate Jeff Sonier (SFU); and, Stan Yen (TRIUMF), alternate Larry Lee (Manitoba).

One of the main concerns raised during the AGM Open Forum session was the changing priorities of the TRIUMF experimental program and its Users, mainly due to the new ISAC facility. At the January 2004 TUEC meeting it was noted that many of these concerns could be addressed by revitalizing the link between TUEC and the user community at large. All interested parties are invited to become TUG members in order to obtain the agenda for future meetings, which will be circulated in advance, and to review the minutes posted on the TUG Web site.

An ad hoc TUEC committee was struck which met with the Head of the ISAC division, Paul Schmor, to discuss a variety of Users' concerns. Moreover, TRIUMF has established an ISAC Beam Strategy Committee to foster and advise on the development of radioactive beams for ISAC. Developments and first off-line tests of the negative ion, laser ion, and

... continued on back page

A New Probe for Condensed Matter Research

Radioactive ion beams from ISAC have applications in condensed matter in addition to nuclear physics and nuclear astrophysics. We have recently polarized a beam of $^8Li^+$ to use as a magnetic probe of ultra thin films and interfaces. This application is based on the technique of beta detected nuclear magnetic resonance (β-NMR) which requires about 10 orders of magnitude fewer nuclear spins than conventional NMR. The unparalleled sensitivity of β-NMR comes from the fact that the signal is detected through the beta decay of a polarized radioactive nucleus. The polarized beam line and spectrometers at ISAC are being developed to probe the magnetic and electrical properties of interfaces, nano-structures, and ultra-thin films. The scientific applications arise from the fact that it is virtually impossible to get equivalent NMR information on the host nuclear spins.

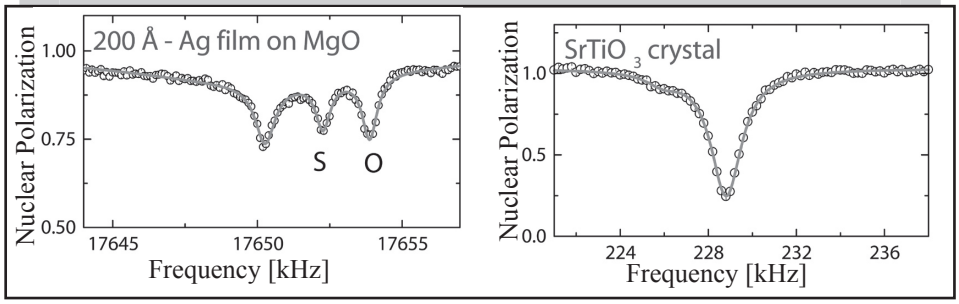
Depth profiling with β-NMR was demonstrated by implanting the beam into a 19 nm thick silver (Ag) film grown on a single crystal of magnesium oxide (MgO). Fig. 1a shows the resulting β-NMR frequency spectrum of ^8Li at a beam energy of 1 keV where the beam stops in the Ag film. The lower line is attributed to the MgO substrate and dominates at higher implantation energies. The two higher frequency lines are attributed to ^8Li at two different crystalline sites in the Ag film. All the lines are remarkably sharp confirming that the implanted Li resides in sites that are well away from any radiation damage. Since Ag is relatively inert and can be easily evaporated onto any surface, one could use the β-NMR resonance to measure the magnetic field distribution near the surface of a material with a resolution of about 0.5 G. In this way the polarized low energy beam can be used as a kind of local magnetometer. For example, one could use this method to characterize the vortex lattice near the surface of a superconductor.

Recently we have observed the β-detected nuclear quadrupole resonance (β-NQR) in a single crystal of $SrTiO_3$ (see Fig. 1b) in zero external static magnetic field. The ability to perform magnetic resonance in zero applied field has important applications for studies on exotic magnetism and superconductivity. ● *Rob Kiefl*

For more information and links to recently published material, please visit the β-NMR Web site at http://bnmr.triumf.ca

Fig. 1a: β-NMR spectra on 19 nm of epitaxially grown Ag film on an MgO substrate taken in a magnetic field of 3T. The sample was provided by T. Hibma at the University of Groningen.

Fig. 1b: The β-NQR spectrum obtained for a $SrTiO_3$ single crystal at T~293 K, B_{EXT}=0. The resonance occurs when the frequency of H_1 equals $3\nu_q$ corresponding to the m=2 to m=1 quadrupolar transition frequency.



The TRIUMF-Seattle $^7Be(p,\gamma)^8B$ Experiment

While the $^7Be(p,\gamma)^8B$ reaction is a very small branch in the solar *pp*-chain, the β-decay of ^8B produces the only high energy solar neutrinos that can be detected by water based neutrino detectors. For a long time, both chemical and water based neutrino detectors have seen a deficit in electron neutrinos compared to the numbers predicted by models. Recently a collaboration using the heavy-water based Canadian SNO detector has shown that the apparent electron neutrino deficit is caused by oscillations of the solar electron neutrinos into at least one other flavor.

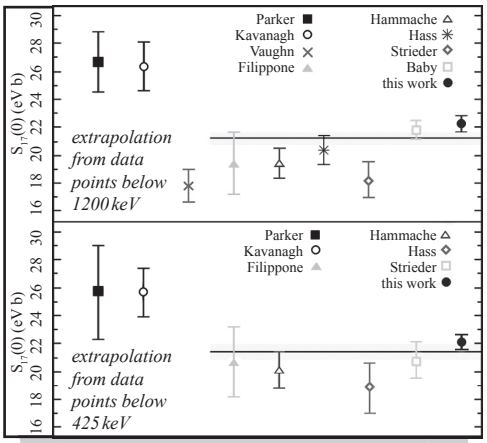


Fig. 1: $S_{17}(0)$ values from direct experiments.

To better understand the parameters of neutrino oscillations and to improve on the solar models, the nuclear reactions of the *pp*-chain have to be well understood at the energies where they happen in the sun. In particular, the $^7Be(p,\gamma)^8B$ reaction has an inherently small cross section and requires the use of a radioactive ^7Be ($T_{1/2}$ =53.29 d) target or beam to measure the cross section.

At TRIUMF we have produced a ^7Be target with unprecedented purity to avoid some of the problems encountered in previous measurements. The ^7Be on the target backing was concentrated into a small spot of about 3 mm diameter, while the proton beam was swept over this target. This ensured in first order that only the total number, and not the distribution, of ^7Be atoms is important in the cross section evaluation.

All measurements using proton and α beams were done at the Center for Nuclear Physics and Astrophysics at the University of Washington (Seattle) covering centre-of-mass energies from 116 to 2485 keV for protons. Possible systematic errors were checked in separate measurements, among them a ^8B backscattering set-up that measured the loss of ^8B at the ^7Be target activation. Such a measurement has never been attempted by any other group. Three different targets were used to obtain the final result. Typical S-factors for zero energies are quoted in the literature. Fig. 1 shows a comparison of $S_{17}(0)$ with other previous measurements using a direct determination of the $^7Be(p,\gamma)^8B$ reaction cross section.

Clearly, the data point obtained in the TRIUMF-Seattle experiment has the smallest error bars. The TRIUMF-Seattle data also shows an energy dependence which is consistent with other direct measurements but not consistent with indirect Coulomb dissociation experiments. The averaged $S_{17}(0)$ for data below 425 keV is 21.4±0.5(exp.) ±0.6(extrap) keV• b. This is slightly higher than previously recommended and allows in principle for some sterile neutrino admixture. ● *Lothar Buchmann*

For more information, please refer to A. Junghans, et al., PRC 68 (2003) 065803

EMMA: ElectroMagnetic Mass Analyzer

On December 11-12 2003, a workshop was held to discuss the physics opportunities that would be afforded by a recoil mass spectrometer at ISAC-II, dubbed EMMA (ElectroMagnetic Mass Analyzer). The main goals of the workshop were identifying the important physics questions to be studied with a recoil mass spectrometer and specifying the essential characteristics it would require to meet the needs of the experimental community.

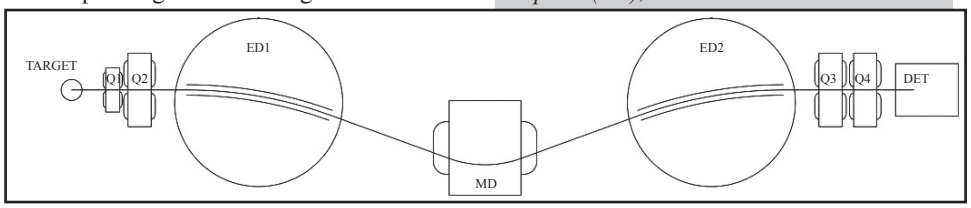
Among the 30 participants in the workshop were experimenters from Canada, France, Italy, the UK, and the USA. Attendees included mainly Canadian, British, and American prospective users of EMMA, as well as several scientists involved in the design and operation of comparable spectrometers around the world.

Following an introduction describing the beams that will be provided by ISAC-II, the talks concentrated on three topics: the properties, limitations, and figures of merit of recoil mass spectrometers in general; classes and specific examples of reactions of interest; and the design parameters of a recoil separator that would allow experimenters to study these reactions most efficiently. The main classes of devices currently in use or under construction were discussed: large acceptance magnetic spectrometers, recoil mass spectrometers that contain both electric and magnetic bending elements, and hybrid devices that seek to combine the features of these classes in a single design where elements can be turned on or off according to the needs of a specific experiment.

Issues discussed were the unavoidable trade-off between mass resolving power and large energy or angular acceptance, due to geometric and chromatic aberrations, and the fact that purely magnetic devices do not produce any physical separation between different masses, a serious limitation of such spectrometers. In both magnetic spectrometers and hybrid devices, measurements of the recoil time of flight through the device are required to achieve even the modest mass resolution of which they are capable. Presentations from those operating and building such devices indicated that the mass resolving power of these spectrometers is inadequate for many if not most of the experiments envisioned by those expressing interest in using a recoil spectrometer at ISAC-II.

As a result, the ongoing design effort focuses on improving the designs of combined electric and magnetic recoil mass spectrometers built throughout the world in the 1980s and 1990s by increasing their angular and energy acceptances without unacceptable sacrifices in mass resolution, mass acceptance, or beam suppression. Considerable success along these lines has already been achieved in design studies following the workshop (see figure). The current plan calls for a funding proposal based on these design studies to be submitted to NSERC in September 2004. ● *Barry Davids*

Schematic view of the current EMMA design, showing the quadrupole (Q) and dipole (MD) magnets, the electrostatic dipoles (ED), and the detector box.



TIGRESS

Descriptions of nuclear structure deduced from the long-lived isotopes of day-to-day existence are not appropriate for nuclei far from stability whose structure is relevant to, for example, stellar nucleosynthesis environments. Breakdown of shell structure, emergence of new "magic" numbers, and formation of neutron-proton pair condensates are all predicted modes of nuclear behaviour that can be probed with ISAC-II exotic heavy-ion beams that should be available in 2005. The energy of these beams should be above the Coulomb barrier of many projectile-target combinations of interest. Population of excited states with these projectiles will produce gamma rays which could be Doppler energy shifted by up to 10% of their energy. Much of the information of the predicted modes of nuclear behaviour is contained within the intrinsic properties of these gamma rays. It is therefore essential to correct for those Doppler shifts while preserving high efficiency, as is done with Exogam and Miniball.

The TRIUMF-ISAC Gamma-Ray Escape Suppressed Spectrometer (TIGRESS) combines the proven technologies of multi-crystal high-purity germanium (HPGe) "clover" detectors and scintillator-based escape suppression, with high outer-contact electrical segmentation and digital signal processing, to measure gamma ray production in ISAC-II experiments. The clover technology provides high absolute efficiency, while the escape suppressors reduce continuum background from gamma rays that are not fully absorbed in the HPGe. Analysis of the pulse shapes of the highly segmented outer contacts is expected to determine the angle of gamma ray emission in the lab frame to ~3°, compared with the ~20° subtended by each crystal. This will bring the emission-angle Doppler-broadening component of an 800 keV gamma ray from a source moving at 5% the speed of light (typical of ISAC-II experiments) to 2.1 keV, comparing favouably to 1.8 keV intrinsic HPGe resolution and 13 keV broadening one would obtain with unsegmented crystals in the same array.

A prototype of the TIGRESS HPGe detector on a test assembly.

A prototype HPGe module was funded by the Canadian Foundation for Innovation, Ontario Innovation Trust, the University of Guelph, and TRIUMF, and is shown in the photo to the left. This test determined that the detector was capable of <2 mm lateral position resolution for single interactions, well within the limits needed to obtain the afore-mentioned angular resolution. Following a technical review of the prototype detector in July 2003, the Natural Science and Engineering Research Council (NSERC) released funds to begin construction of a 12-detector array to be completed in 2009. A subarray is expected to be ready for the first ISAC-II beams. The TIGRESS collaboration comprises researchers from University of Guelph, McMaster University, Université de Montréal, University of Toronto, Université Laval, Simon Fraser University, and TRIUMF. ● *Greg Hackman*

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 any changes which may be required during the period already scheduled.

TUEC News

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FEBIAD-type ion sources, plus the on-going tests of the on-line ECR ion source, were discussed at the inaugural February 27th meeting. Tests and the status of high-power targets were also reported. Priorities and financial resources for the various developments will depend on approved experiments and User demand for relevant beams. One consequence of the meeting was the reactivation of the actinide target task force (ATTF), now led by John Behr (TRIUMF). It is planning safety tests of alpha-emitting species with the goal to obtain the licence to produce and run the uranium and thorium targets which are crucial for the production of radioactive beams for already approved high priority experiments. The interim report of the ATTF can be found on the TUG Web site. Each member of TUEC is to be regarded as a member-at-large, and TRIUMF Users are strongly encouraged to provide frequent input to any members so that action can be taken on their behalf. ●

Martin Comyn and Jens Dilling

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

Important Upcoming Dates

OPCOM	Operating Committee meeting	May 7	TRIUMF
ACOT	Advisory Committee on TRIUMF meeting	May 14-15	TRIUMF
SAPEEC*	Subatomic Experiments Evaluation Committee meeting	June 10-11	TRIUMF
IPP	Institute of Particle Physics AGM	June 12	Winnipeg
CAP '04	Canadian Association of Physicists Congress	June 13-15	Winnipeg
BOM	TRIUMF Board of Management meeting	June 18	TRIUMF
TSI '04*	TRIUMF Summer Institute	July 5-16	TRIUMF
MMSEEC*	Molecular and Materials Science Experiment Evaluation Committee meeting	July 5-6	TRIUMF
NIC-8*	Nuclei in the Cosmos Conference	July 19-23	Vancouver
NSERC	Form 180 - Intention to apply for grants	< August 15	Ottawa
5ISR	Fifth International Symposium on Radiohalogens	September 11-15	Whistler
NSERC	Major grant applications due to TRIUMF Science office	September 22	TRIUMF
BOM	TRIUMF Board of Management meeting	September 26	TRIUMF
NSERC	Major grant applications due (RT3, >500k$ ...)	October 1	Ottawa

* see insert

Outreach Program Turns One

The TRIUMF Outreach Program (TOP) began one year ago to coordinate all aspects of science education and public outreach at TRIUMF. Working with external outreach-related groups, TOP has made good progress towards building comprehensive and coherent educational opportunities for the public, students, teachers, through to undergraduate and graduate students. To date, the successful Teacher Internship Program (see Newsletter Vol.1, No.2) has hosted seven teachers from across BC on local experiments, with 12 more on the waiting list, and discussions are underway with a Vancouver college to provide interns academic credit. A new Web site and a much revamped tour brochure are in progress. TOP has partnered with BC Science World in the Scientists in the Schools program, and with the ISCBC on a new High School Fellowship. Participation in the NALTA cosmic-ray on schools project will begin this summer.

Funding is provided by the Vancouver Foundation and the TRIUMF Tech Transfer office, before being incorporated into the next five-year plan in 2005. ● *Marcello Pavan*

For more information on Outreach Program initiatives, contact outreach@triumf.ca

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TRIUMF is Canada's national laboratory for particle and nuclear physics and related sciences. TRIUMF is operated through a contribution from the National Research Council of Canada.

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Send any Newsletter queries or comments to: newsletter@triumf.ca

Proposal Submissions
to the Experiments Evaluation Committees

We are inviting users to submit new proposals related to research at ISAC, or other TRIUMF Beam facilities.

All proposals should include:

- **A concise summary of the scientific problem under investigation, with appropriate literature references**
- **A clear justification for the proposed experiment**
- **A description of the experimental techniques to be used and naming the facilities to be used**
- **An analysis of beam time requirements**
- **An indication of how the personnel effort is to be devoted to this experiment**

Proposals are requested and received from individuals and groups around the world and are judged solely on the basis of scientific merit and feasibility by the Experiments Evaluation Committees (EEC), peer review boards constituted of distinguished scientists from all over the globe. Proposal forms are available online at:
http://admin.triumf.ca/docs/forms/eec_blank.pdf.

There are three independent Committees (EEC) for the TRIUMF cyclotron and/or ISAC:

- Subatomic physics experiments (SAPEEC)
- Molecular and materials science experiments (MMSEEC)
- Life sciences experiments (LSPEC)

Each of these committees advises TRIUMF's Director of its recommended priorities in the allocation of beam time and major facilities. The Director is not bound by the EEC's recommendations, but has never ignored them.

During the review, proposals are assigned a priority rating that assists in the scheduling of the experiment. The EEC convenes to hear formal proposals once or twice a year. The next meetings are scheduled as follows:

SAPEEC: 10-11 June, 2004. Submit proposals by May 7.
MMSEEC: 5-6 July, 2004. Submit proposals by June 4.

Next Deadlines: Subatomic Physics: May 7, 2004
Molecular and Materials Science: June 4, 2004

The Eighth International Symposium on
Nuclei in the Cosmos

July 19-23, 2004
Vancouver, BC, Canada

The 8th International Symposium on Nuclei in the Cosmos is the foremost bi-annual get together of theoretical and observational astrophysicists, nuclear physicists, cosmochemists, and others interested in the creation of energy and elements in the universe. It features a wide interdisciplinary scope with ample discussions among the participants. Topics include, among others:

- Cosmology and Big Bang Nucleosynthesis
- Stellar Evolution
- Experimental and Theoretical Nuclear Astrophysics
- Dynamics of Stellar Explosions
- Isotopic Anomalies in Meteorites
- Observational Evidence of Nucleosynthesis
- High Energy Astronomy
- Stars as Laboratories

Registration now open!

Important deadlines:

April 2, 2004: Submission of abstracts
April 18, 2004: Early registration fee ends
April 18, 2004: Early booking fees at hotel end
June 17, 2004: Guest room block released at hotel
July 19, 2004: Beginning of conference and deadline for submissions to proceedings

For more details, visit:
www.triumf.ca/nic8

For information on exhibitors and exhibiting, please contact Phil Gardner at *gardner@triumf.ca*

For information regarding registration, accommodation and NIC logistics, please contact:

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2004 TRIUMF Summer Institute

The 16th Annual Nuclear Physics Institute at TRIUMF

Lectures in Nuclear Astrophysics: Experiment, Theory and Observations

July 5-16, 2004
Vancouver, BC, Canada

The TRIUMF Summer Institute (TSI) is designed to give graduate students and young researchers an improved understanding of topics surrounding their research areas by providing short courses in subatomic physics. This year's Institute will focus on selected nuclear astrophysics research topics both from a theoretical as well as an experimental point of view. Related topics in astronomy and nuclear physics will be presented as well. Lectures will take place in the mornings, while afternoons are reserved for problem sessions. University credit can be arranged. TSI 2004 will give an excellent introduction to the eighth symposium on Nuclei in the Cosmos which will take place the week after in Vancouver, B.C. Both experimental and theoretical physics students are urged to attend. Participation is normally limited to 40 students.

For more details, visit:
www.triumf.ca/tsi

For information regarding registration, accommodation and TSI logistics, please contact:

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