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NEWSLETTER

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tascc

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News about Chalk River's Tandem Accelerator Superconducting Cyclotron facility for users and potential users

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New measurement of ^{10}C β-decay branching ratio

A new approach to measuring the carbon-10 beta-decay branching ratio has been demonstrated with the 8π spectrometer. The technique makes use of the spectrometer's high germanium-detector coverage to compare in-beam and out-of-beam γ-ray intensities from proton bombardment of boron-10.

The (p,n) reaction on ^{10}B produces ^{10}C which decays (out-of-beam) to states in ^{10}B. The (p,p') reaction produces the same states in-beam, in coincidence with a characteristic γ-ray. A similar technique, which made use of proton-gamma coincidences, has been used elsewhere but required months of data taking.

Carbon-10 is the lightest nucleus to exhibit a $O^+ \rightarrow O^+$ superallowed β-decay branch and, if its decay can be measured precisely enough, the result should settle once and for all whether there is a missing Z-dependent correction required to extract the vector-coupling constant from nuclear decay. This is the crucial remaining issue in a demanding test of the Standard Model of electroweak interactions.

The new technique was tested in a three-day trial that yielded a result that is a factor of two more precise than all previous measurements combined.

Facility report

Helium-3 has been reestablished as an available Tandem beam following installation of a new gas-recirculating system. Two μamps of beam were on target for a three-day run this month. We also installed a new beam-emittance device on the cyclotron extraction beamline to speed adjustments of beam on target.

Two new beams were developed from the cyclotron this month: 6.7 MeV-per-nucleon bismuth-209 and 5.5 MeV-per-nucleon uranium-208. However, stability problems with the cyclotron magnet power supply prevented delivery of a carbon beam for a scheduled radiolysis experiment.

Beams produced during October were:

Ion	*Energy (MeV)*
Protons	7.8
^{3}He	25-40
^{4}He	7.6
^{14}N	62
^{16}O	64
^{34}S	140
^{35}Cl	140
^{36}S	155
^{197}Au	210
^{209}Bi	1400
^{238}U	714; 1250

ECR ion source developed

An electron cyclotron resonance (ECR) ion source that delivers intense beams of greater than one milliamp for a variety of singly-charged ions has been developed for use at TASCC.

The source is based on a design that originated in CRL's Accelerator Physics Branch. However, the present unit is a simplified version which uses permanent magnets instead of large solenoid coils to generate the required magnetic field.

Intense negative-ion beams have recently been produced from the source coupled to a standard charge-exchange canal. The next development step is to install the source and canal on a TASCC injector deck for transmission tests of high-current beams through the Tandem.

Further developments will include a miniaturized version of the source and direct extraction of negative ions from the source plasma.

Penning-trap mass spectrometer on starting block

A collaboration involving scientists from the University of Manitoba, McGill University and TASCC has completed the conceptual design and preparatory work for a Penning-trap mass spectrometer for unstable isotopes to be installed at TASCC.

The technique used to determine the mass of radioactive isotopes is to measure the cyclotron frequency (ω_C) of the ions stored in the magnetic field of a Penning trap and extract the mass (m) from the relationship $\omega_C = q\,B/m$ with accurate knowledge of the magnetic field B. This method is extremely accurate and requires only a small number of ions to be stored in the trap.

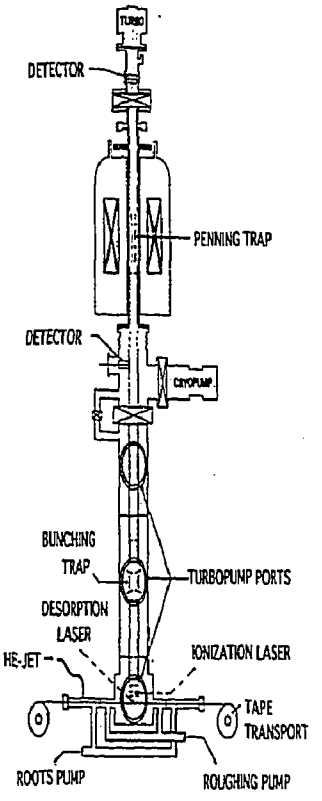
The radioactive ions are injected into the trapping field by a resonant-ionization laser ion source coupled to the existing ISOL He-jet system. Tests performed under "on-line" conditions at McGill University with samples prepared at TASCC have proven the feasibility of this novel approach. This type of injection provides ion bunches very well matched to the phase-space acceptance of the Penning trap. It also has a very high efficiency, is applicable to isotopes of most elements since there is no standard source chemistry necessary, and is extremely selective because of the resonant nature of the ionization process.

The mass resolution of the proposed spectrometer is Fourier-limited by the duration of the r.f.-excitation pulse and is therefore inversely proportional to the mass of the investigated isotope. For unstable isotopes, the expected operation calls for a mass resolution of about one million for mass-100 ions or 10 million for mass-10 ions. Higher mass resolution can, however, be achieved for long-lived or stable isotopes when necessary.

An accuracy of 10^{-8} will be obtained for unstable isotopes with the spectrometer design being proposed. This corresponds to an accuracy of 1 keV for a mass-100 ion. We expect that the 10^{-9} accuracy regime will be reached with this spectrometer for long-lived and stable isotopes.

The proposed mass spectrometer will make maximum use of the wide variety of unstable isotopes that can be produced at TASCC.

In addition, the small number of ions necessary for a mass measurement is especially well suited to our heavy-ion-based facility, from which only modest yields are available but these extend very far from stability.



When installed at TASCC, this spectrometer will provide the most accurate absolute mass values available anywhere in the world for unstable isotopes of most elements, even the most refractory.

In addition to mass measurements, the facility will provide stored radioactive ions at rest, free of outside perturbations, in a well-controlled environment. Such a facility will offer many interesting possibilities for precision experiments such as laser spectroscopy, hyperfine-anomaly studies, β-decay asymmetry measurements and high-precision fundamental studies.

The total cost of the project is about $1.1 million. Roughly half of this amount will be contributed by the three institutions while a major installation grant application has been submitted to the National Sciences and Engineering Research Council (NSERC) for the balance.

Science academy tutor wins $37,000 scholarship

Becki Halko, a tutor working at TASCC with the Deep River Science Academy this past summer, has just won a prestigious NRC scholarship.

The award, worth $37,000, is offered under the National Research Council's "Program for Women in Science and Engineering", and will support Becki for three years at university and during several work terms at the Council's Institute for Environmental Chemistry in Ottawa.

Becki had previously worked with CRL's Environmental Research Branch as a Science Academy student and subsequently as a tutor with TASCC. While here she contributed to the ECR development project, working with project leader John Wills.

"I was happy to congratulate Becki for winning, even though I'm disappointed she won't be returning to TASCC for more work terms," says Wills.

Erratum: September's newsletter mispelled Guy Leblond's name in the list of authors of the new graphics package, OLGA. Sorry Guy!

October experiments

Experiment	Cyclotron development of 6.7 MeV-per-nucleon bismuth-209, 3 MeV- and 5.25 MeV-per-nucleon uranium-238. Bismuth is the 67th beam from the cyclotron and 5.25 MeV/u uranium is the 68th.
Researchers	TASCC Beam Commissioning Team
Beams	6.7 MeV/u ^{209}Bi; 3 MeV/u ^{238}U; 5.25 MeV/u ^{238}U
Duration	5 days

Experiment	Measurements of β-decay branching ratio in carbon-10 with the 8π spectrometer. Gamma-ray intensities following the beta-decay of (p,n)-produced ^{10}C alternating with γ-rays from (p,p') on ^{10}B were compared. Initial results look encouraging.
Researchers	G. Savard, A. Galindo-Uribarri, E. Hagberg, J.C. Hardy, V.T. Koslowsky and D.C. Radford *(TASCC)*
Beam	7.8 MeV protons
Duration	3 days

Experiment	Oxygen analysis of 40 zirconium targets (3 – 10 mins each) with the 7.6 MeV resonance to enhance sensitivity 100-fold over normal Rutherford scattering.
Researchers	J.A. Davies and S.-Y. Tong *(McMaster U.)*; J.S. Forster *(TASCC)*
Beam	7.6 MeV ^{4}He
Duration	1 day

Experiment	Asssessment of beam-induced x-ray production for elemental analysis. X-ray yields measured in thin germanium, tungsten and gold targets were significantly smaller than anticipated for highly-stripped heavy ions. This discrepancy is under study.
Researchers	J.A. Davies, R. Siegele and S.-Y. Tong *(McMaster U.)*; J.S. Forster *(TASCC)*
Beams	140 MeV ^{35}Cl; 64 MeV ^{16}O
Duration	1 day

Experiment	Study of the decay of cobalt-52 with ISOL. Two and one-half days were sufficient to establish the basic decay scheme and the isobaric analogue transition.
Researchers	E. Hagberg, J.C. Hardy, V.T. Koslowsky, G. Savard and A. Renaud *(TASCC)*; S. Sterbenz *(LANL)*
Beam	62 MeV ^{14}N
Duration	3 days

Experiment	Study of forward elastic recoil of gold beams as a means of elemental analysis. Tests of a new ΔE (gas) detector plus a solid-state E detector gave much better mass resolution than a Bragg detector used previously. Recoil masses from hydrogen to zirconium were resolvable simultaneously. Improved beam collimation is required before routine analysis is possible.
Researchers	J.A. Davies and R. Siegele *(McMaster U.)*; J.S. Forster and H.R. Andrews *(TASCC)*
Beam	210 MeV ^{197}Au
Duration	1 day

Experiment	Study of high-spin states in cadmium-106 with the 8π spectrometer and ALF charged-particle detector. A known superdeformed band was observed in palladium-105; high-spin states were identified in silver-108; a dipole band observed in ANU data was placed in silver-106; and a new collective rotational band was observed in cadmium-106 up to spin ≈26.
Researchers	P. Regan and A. Stuchbery *(Australian National University, Canberra);* V.P. Janzen, A. Galindo-Uribarri, G.C. Ball, D. Ward and D.C. Radford *(TASCC);* S. Pilotte *(U. of Ottawa);* J. Degraaf and M. Cromaz *(U. of Toronto)*
Beams	155 MeV ^{36}S; 140 MeV ^{34}S
Duration	5 days

Experiment	Investigation of oxygen-14 production for a precise half-life measurement with ISOL. Further tests are needed to enhance sample purity.
Researchers	V.T. Koslowsky, E. Hagberg, G. Savard, J.C. Hardy and M.J. Watson *(TASCC)*
Beams	25, 30 & 40 MeV ^{3}He
Duration	3 days

One doesn't discover new lands without consenting to lose sight of the shore for a very long time.

ANDRÉ GIDE

Next month . . . . .

- Study of resonant coherent excitation
- Search for intruder bands in indium
- Irradiation to measure gas release from UO_2 and SIMFUEL
- Irradiations of high-T_c superconductors
- Development of heavy ions with the superconducting cyclotron
- DSAM study of intruder bands in tin
- AMS measurements of chlorine-36 content of various samples

Facility operating record

Elapsed Time (Year-to-date)	7296 h
Beam Available	
Tandem Only	4128.9
Tandem + Cyclotron	929.8
Beam Development	999.9
Planned Shutdown	786.5
Forced Shutdown	450.9

Editor: Larrie Thomson
Tandem Accelerator Superconducting Cyclotron Facility
AECL Research, Chalk River Laboratories
Mail Station 49A Chalk River,
Ontario, Canada K0J 1J0
Phone (613) 584-8811, extension 4131.
FAX 613-584-1800
Internet TASCC@CRL.AECL.CA