ISAC-II and TIGRESS at TRIUMF

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TRIUMF overview

- **TRIUMF** (Tri-University Meson Facility). 500 MeV cyclotron, continuous beam on ISOL production target.

- **ISAC II** (Isotope Separator and Accelerator)
  Up to 5 MeV/u radioactive beam.

- **TIGRESS** (**TRIUMF-ISAC** Gamma-Ray Escape-Suppressed Spectrometer), and detectors used in conjunction with TIGRESS.
Schematic of the ISAC Facility At TRIUMF
**TIGRESS detectors**

**TIGRESS**: TRIUMF-ISAC Gamma-Ray Escape-Suppressed Spectrometer:

- Array of 8-10 HPGe $\gamma$ detectors (summer 2009).
- 4 crystals with segmented contacts.
- Doppler corrected energies from position measurement.
- Efficiency: 15–20% at 332keV, less at higher energies.

**SHARC** array

**SHARC**: Silicon Highly-segmented Array for Reactions and Coulex:

- Angular coverage: $\approx 2\pi$
- Angular resolution: $\delta \theta = 1.6\ \text{deg}$, $\delta \phi = 3.5\ \text{deg}$.
- Energy ranges: 12MeV, 25MeV.
- Energy resolution: $\approx 40\ \text{keV}$.
- Particle identification from $\delta E-E$ at forward angles.

* The white plastic are dummies substituting real detectors for illustration.
DESCANT (Deuterated Scintillator Array for Neutron Tagging)
Designed to operate in conjunction with TIGRESS.
- Time-of-flight, 1m flight path.
- Pulse height ($\propto E_n^{3/2}$).
- Modular array, $\approx 70$ detectors.
- Angular coverage: $\pi$ sr.
- Paul Garrett, University of Guelph.
- Installation $\approx$ 2010.
EMMA Electromagnetic Mass Analyzer

- Recoil mass spectrometer for ISAC-II.
- EME design: Energy dispersion of electric dipoles canceled out by momentum dispersion of magnetic dipole.
- Energy and angle focusing.
- Angular acceptance: ± 3.6°.
- M/q acceptance: ± 4 %.
- Energy acceptance: ± 20 %.
- M/q resolving power for ± 3°, \( \Delta E/E = \pm 20\%: 368 \text{ FWHM} \).
- Barry Davids, TRIUMF.
- Installation ≈ 2011.
TIGRESS electronics

- Digital shaper and ADC.
- VME and serial readout.
- Readout of waveform and/or value(s) from analyzed waveforms (FPGA).
- Jean-Pierre Martin, University of Montreal.

**TIG-10**
- 10 channels, 14 bit, \(\approx 50\) MHz, 1–4 V full range. In use for Ge and BGO signals.
- (Instrumented)

**TIG-64**
- 64 channels, 14 bit, \(\approx 50\) MHz, 0.5 V full range. Will be used for Si-detector signals (2009).

**TIG-4G**
- 4 channels, 1 GHz. Will be used for neutron-wall timing (\(\approx 2010\)).
The $^{20}\text{Na}(^{6}\text{Li},\alpha)^{22}\text{Mg}\ast$ reaction

Similar to $^{20}\text{Ne}(^{6}\text{Li},\alpha)^{22}\text{Na}$ d-transfer

- Preserves isospin.
- Limited $J^{\pi}$ selectivity.
- Typically $\sigma_{\text{state}} = 0.1-1.5$ mb.

Complete kinematics – coincident measurement of energies and angles of:

- Residual $\alpha$ particle from transfer.
- Secondary proton emission: $^{22}\text{Mg}\ast(,p)^{21}\text{Na}\ast$.
- Subsequent $\gamma$ decay of $^{21}\text{Na}\ast$.

Requires combination of: $\gamma$ spectrometer and highly-segmented charged-particle array with large angular coverage.
Upgrades of ISAC and ISAC-II

Charge State Booster (ISAC):
- Electron cyclotron resonance ion source.
- $30 < A < 150$.
- $A/q \approx 6$.
- Radioactive ion beam $^{80}$Rb has successfully been extracted and accelerated.
- Further commissioning and first experiment 2009.

Actinide target (ISAC):
- First commissioning successful (2008).
- Further tests during 2009.

High-$\beta$ cavities (ISAC-II):
- Upgrade to 10 MeV/u maximum energy.
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