

Coulomb Excitation of Radioactive ^{20,21,28,29}Na: First Results from TIGRESS at ISAC

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The TRIUMF-ISAC Gamma-Ray Escape-Suppressed Spectrometer (TIGRESS) is a next generation γ -ray spectrometer designed for use at the Isotope Separator and Accelerator (ISAC) radioactive beam facility at TRIUMF in Vancouver, Canada and, in particular, at its upgrade to higher energies and masses, ISAC-II [1] where first radioactive beams up to 4.5 MeV/u for $A < 30$, became available for experiments in January 2007. TIGRESS will be comprised of 12 clover-type HPGe detectors, each equipped with a composite BGO-CsI Compton Suppression shield. Sensitivity to the location of γ -ray interactions within the HPGe clover is achieved through 32-fold segmentation of the outer electrical contacts, and through pulse shape analysis following 100 MHz digitization of the signal waveforms from each contact [2]. This position sensitivity allows the detectors to be placed close to the target location without sacrificing angular resolution, leading to large gains in γ -ray detection efficiency while retaining the high intrinsic resolution of the HPGe clover detectors.

The full TIGRESS project was funded by the Natural Sciences and Engineering Research Council of Canada over a six-year period (2003-2009). A number of auxiliary detectors are also under development for use with TIGRESS including: a DSSSD barrel for detecting charged particles, an array of neutron detectors, a pixelated gas avalanche counter SuperCHICO and a recoil mass spectrometer EMMA (ElectroMagnetic Mass Analyzer).

The first TIGRESS in-beam experiment, the Coulomb excitation of the mirror nuclei ²¹Ne and ²¹Na, was carried out at ISAC in August 2006. These nuclei are strongly prolate deformed due to the quadrupole-quadrupole interaction among the five valence nucleons outside the ¹⁶O core. The measurements are relevant to our understanding of other 5p states, in particular, the astrophysically important 5p-2h, 3/2⁺ state at 4.033 MeV in ¹⁹Ne. A 1 μ m ^{nat}Ti foil was bombarded with 1.7 MeV/u ²¹Ne and ²¹Na beams at intensities of $\sim 10^7$ /s. Two TIGRESS modules were used to detect prompt γ -rays in coincidence with recoil ions detected in a CD S2 silicon detector. The excellent ISAC beam quality allowed the experiment to be carried out with much higher beam intensities than expected; hence the Coulomb excitation of the proton drip-line nucleus ²⁰Na was also studied. The TIGRESS array is presently being installed on a dedicated beamline in ISAC-II. The first experiment, scheduled for July 2007, will use up to six TIGRESS modules to study the Coulomb excitation of ^{28,29}Na, as part of a program to follow the evolution of shell structure of neutron-rich *sd*-shell nuclei with N near 20. The results from these experiments together with an overview of the project and the scientific opportunities for nuclear structure, nuclear astrophysics, nuclear reactions and fundamental symmetries research at various stages of TIGRESS implementation at TRIUMF-ISAC will be presented.

* The TIGRESS international collaboration is a consortium of researchers from 43 institutions in Canada, USA, Europe, Asia, Australia and Africa.

[1] R. E. Laxdal, Nucl. Instr. and Meth. **B 204** (2003) 400.

[2] C.E. Svensson *et al.*, Nucl. Instr. and Meth. **A 540** (2005) 348.