

## The Texas-Edinburgh-Catania Silicon Array (TECSA): a status report

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A memorandum of understanding was signed in June 2008 between three groups from Texas A&M University, the University of Edinburgh and the University of Catania to pool our resources and build TECSA (Texas-Edinburgh-Catania Silicon Array), a multi-detector system for use with radioactive nuclear beams. It is made of an array of up to 16 Micron Semiconductor type YY1-300 annular silicon strip detectors. The detectors are composed of 16 annular rings each, and are about 300  $\mu\text{m}$  thick. Detectors of this type have been employed previously to construct high-efficiency detector arrays with large solid angle coverage at Louvain-la-Neuve [1], TRIUMF [2], and elsewhere. The development of TECSA will improve our capability to study reactions induced by rare isotope beams from MARS or from the new upgraded facility at TAMU, with a focus on those relevant for nuclear astrophysics. For example, TECSA will allow for the measurement of Asymptotic Normalization Coefficients (ANC) [3] for reactions such as  $^2\text{H}(^{14}\text{C}, p)^{15}\text{C}_{\text{g.s.}}$ , and multi-particle breakup reactions such as  $^9\text{C} \rightarrow ^8\text{B} + p$ .

The MSL-YY1 detectors arrived at TAMU from INFN-Catania in August 2008. First, the detectors were tested with a  $^{228}\text{Th}$  source to check their resolution. The resolution for a typical detector was approximately 150 keV (Fig. 1) with 6  $\mu\text{s}$  shaping time. It is expected that the resolution will be improved with the dedicated electronics for these detectors. These electronics include power supplies, pre-amplifiers and shaper-amplifiers from the University of Edinburgh. The electronics have recently arrived from Edinburgh and will be tested with the MSL-YY1 detectors in the near future.

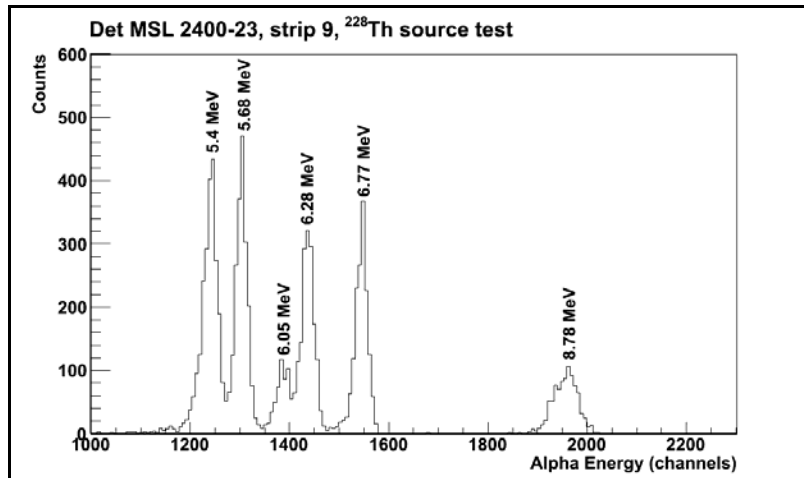


FIG. 1. A Typical  $^{228}\text{Th}$   $\alpha$ -calibration spectrum from the MSL-YY1 detector tests

It was found during the testing of the detectors that some of the detectors had damaged wire bonding connections between the silicon strips and the PC board mount. This resulted in non-functional detector strips in 11 of the 16 detector sectors. To repair the damaged wire bondings, the MSL-YY1 detectors were taken to the National Superconducting Cyclotron Laboratory at Michigan State University (NSCL), where we reconnected the silicon strips to the PC board with a West-Bond wire-bonding machine [4]. After these repairs, 15 of the 16 detector sectors have all 16 silicon strips functional. The 16<sup>th</sup> detector has a damaged PC board in addition to the damaged wire bondings, and will be sent to Micron Semiconductor for further repairs.

Monte-Carlo simulations of envisioned detector array arrangements for TECSA have been carried out with the GEANT4 toolkit [5]. The detector array response for the “flat, annular” ring and “lamp” arrangements as described in Ref. [1] were simulated for the  $^2\text{H}(^{14}\text{C}, \text{p})^{15}\text{C}$  reaction at 12 MeV/u. The detector arrangements used in the GEANT4 simulation are shown in Fig. 2. In inverse kinematics, the cross section is expected to be largest for backward scattering angles. The goal of these simulations was to observe if it was possible to separate the  $^{15}\text{C}$  ground state from the first excited state at 740 keV such that a measurement of the ANC for the  $^{15}\text{C}_{\text{g.s.}}$  can be made. The best energy and angular resolution were obtained with the flat, annular arrangement (Fig. 3). However, as shown in Table IV of Ref. [1], it is possible to cover a larger solid angle with the “lamp” configuration at the cost of both energy and angular resolution. In experiments where the count rate is low and energy and angular resolution are not as critical, the “lamp” configuration may be preferable.

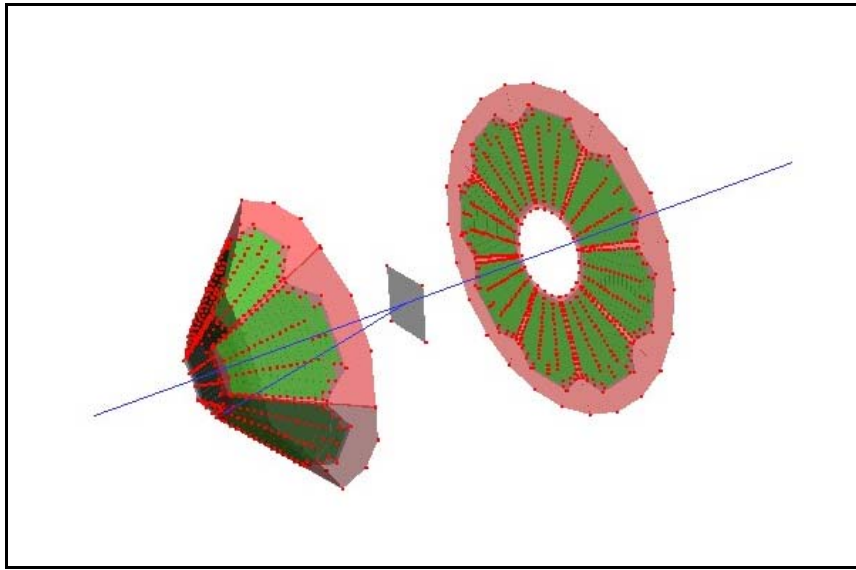


FIG. 2. GEANT4 simulated YY1 detector arrangements for TECSA. The “flat, annular” configuration is shown at forward angles and the “lamp” configuration is shown at backward angles.

The electronics, previously used at LEDA, arrived from Edinburgh in May 2009 and will be tested with the detectors in July 2009 to determine a grounding scheme that minimizes electronic noise in the detector array. The most likely configuration will involve mounting the detector pre-amplifiers

directly to the outer wall of the scattering chamber such that the connectors are covered by the pre-amplifier box. This arrangement will simultaneously create a good ground for the electronics and eliminate RF pick-up noise in the ribbon cables.

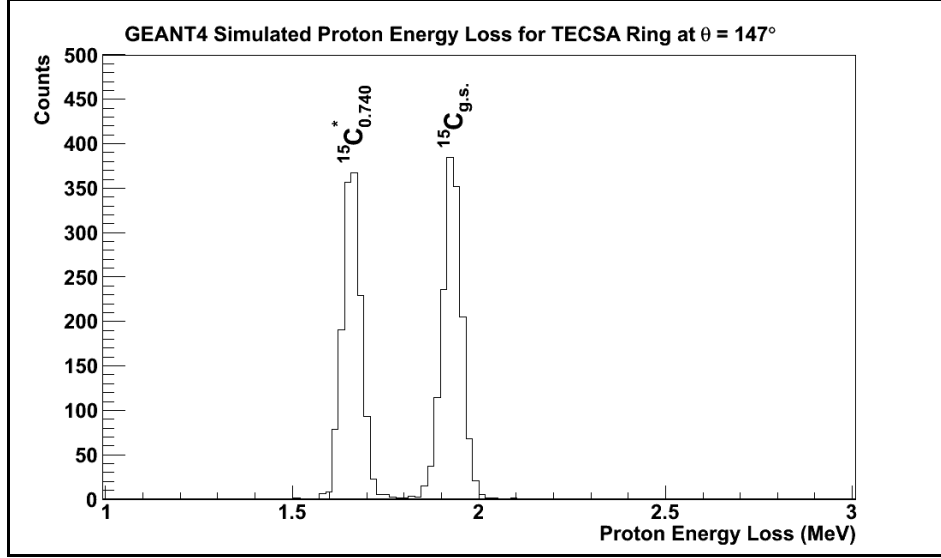


FIG. 3. Spectrum at  $\theta=147^\circ$  for  $^2\text{H}(^{14}\text{C},\text{p})^{15}\text{C}$  at 12 MeV/u obtained from a simulation of the “flat, annular” configuration. The ground state is clearly separated from the first excited state.

The design of the scattering chamber will be completed within the next few months. Upon completion of the chamber, the first experiments with the TECSA array are envisioned for early 2010.

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