TABS – an ASIC-based electronics system at Texas A&M

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A high density electronics readout system has recently been tested in beam at the Texas A&M Cyclotron Institute as part of a broader effort to develop a silicon strip detector array and associated readout system for the SAMURAI spectrometer [1] at RIBF at RIKEN. This project is a collaborative effort amongst groups at Washington University, Louisiana State University, Texas A&M University and RIKEN Nishina Center. For this test a TTT silicon strip detector provided by Micron Semiconductor was used. The design requirements for the SAMURAI-Si detector project require a position sensitive detector able to detect breakup products before they enter the spectrometer. Because the typical breakup products will be a proton in coincidence with a heavy ion, a large dynamic range is needed. In order to achieve sufficient position resolution, a high strip density and thus a large number of channels is required.

The electronic system (**T**exas A&M **A**SIC-**B**ased **S**ystem – TABS) was designed and made by the WU group based on the HINP16C application-specific integrated circuit (ASIC) [2] and can support up to 512 channels on the motherboard. The motherboard has slots for 16 chipboards, and each chipboard supports two HINP16C chips, 16 channels each. Currently the system is half complete, supporting 256 channels. The motherboard is mounted in an aluminum box bolted directly to an ISO200 flange on the vacuum chamber which allows for short cables between the detector and electronic system. It is designed as a prototype for the complete system that will be delivered for RIKEN.

The Micron TTT2-300 detector is one of the designs being considered for the SAMURAI-Si project. It is a 10cm x 10cm x 300μm thick silicon strip detector. It has 128 strips on each side, giving a <0.8 mm strip pitch. Two detectors were provided by Micron Semiconductor Ltd., one N-type and one P-type. Due to large leakage current in the P-type detector, the N-type was used for the in-beam test. The

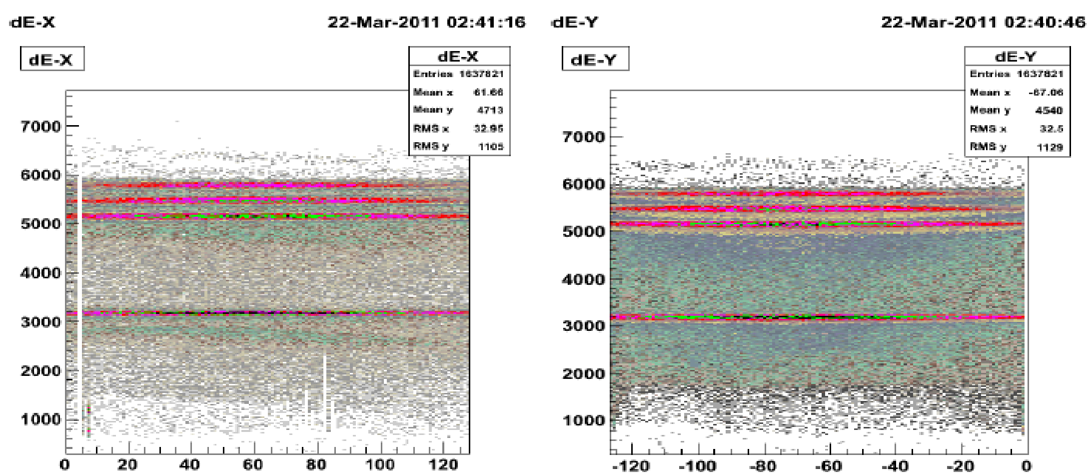

FIG. 1. α source calibration of the TTT detector.

detector is placed in a 5-way NW200 cross. A similar cross was purchased for testing purposes at WU. Prior to being tested in beam, the N-type detector was tested with pulser and sources at WU and the resolution was found to be around 45 keV at the 5.5 MeV alpha line of ^{241}Am, and the threshold at about 400 keV. Calibrations of the X and Y sides of the TTT using a mixed α source are shown in Figures 1 and 2.

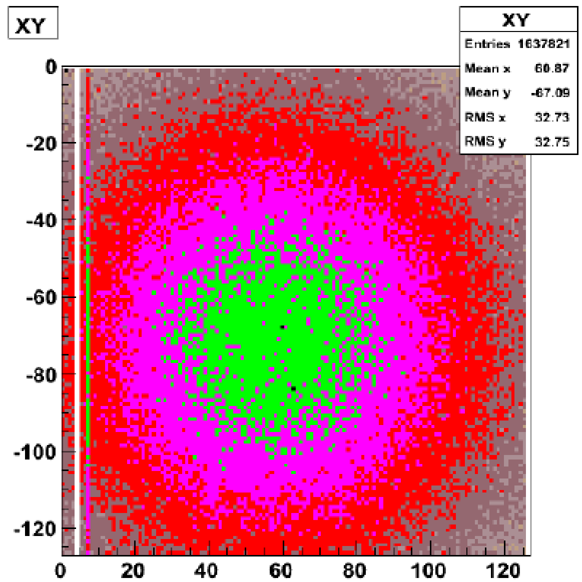

FIG. 2. XY distribution with the α source.

The control of the chips is performed via a Jtec Xilinx logic module (XLM). This unit both handles communication with the chips and also digitizes the analog output. Control of the XLM is by VME-USB using the NSCL Readout program. Online data viewing was done in ROOT.

A 48 MeV/nucleon ^{24}Mg beam was selected for the in-beam test in March 2011. Because the range of the charge-sensitive amplifiers on the ASIC chips is 0-70 MeV for the high gain setting, a fragmentation reaction was used to get a beam that would deposit a suitable amount of energy in the TTT. The fragmentation was done using a 150 μm Be foil at the primary target position of the MARS beamline. Because of the large variety of fragmentation products produced, the entire range of the readout system was able to be tested with the same beam. The vertical dipole D3 was set to place the N=Z line in the center of the detector. A 1 mm thick silicon detector was placed behind the TTT to get E_{res} for particle identification.

The fragmentation beam on the usual MARS target detector is shown in Fig. 3, along with the beam on the TTT detector. ΔE-E_{res} on the TTT is shown in Fig. 4.

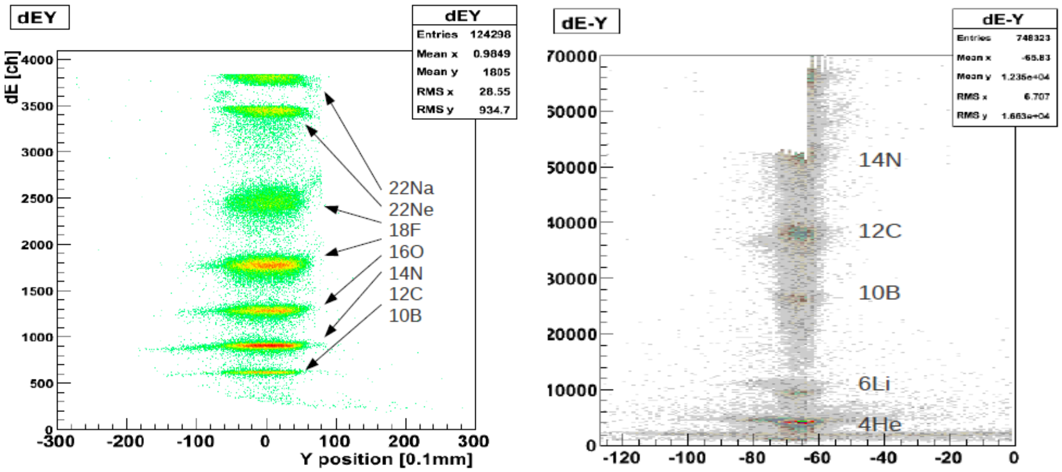

FIG. 3. Beam on the MARS target detector (left) and TTT (right).

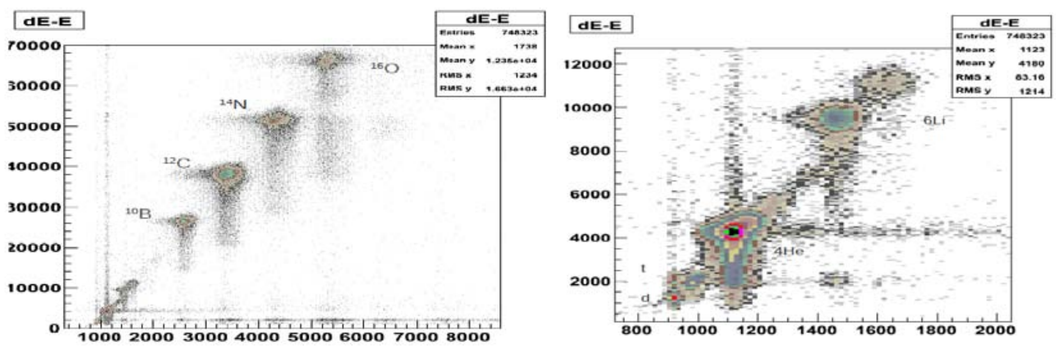

FIG. 4. ΔE-E_{res} in the TTT detector. particles as low as deuterons were identified (~1 MeV deposited in TTT).

During the in beam test a cross talk problem was observed that involved high energy signals (>60 MeV) causing small (~1 MeV) signals in the other chip on the same board. A modification to the chipboards has since been performed at WU to address this problem, raising the threshold where the problem may occur to 120 MeV, and a future beam test will be needed to test this as well as to look to push thresholds lower and to attempt to observe low energy signals from protons in coincidence with large energy signals from heavy ions.

[1] T. Kobayashi *et al.*, *"Large-Acceptance Multi-Particle Spectrometer SAMURAI"* – proposal, RIKEN 2008.

[2] G.L. Engel *et al,* Nucl. Instrum. Methods Phys. Res. **A573** , 418 (2007).