Pulse-shape data taking with double-sided strip silicon detector

D. Suzuki,[*1] Y. Beaujeault-Taudière,[*2] H. Baba,[*1] and T. Isobe[*1]

A new silicon detector array, TiNA, is currently under development for missing mass spectroscopy using radioactive isotope beams provided by the RIBF. The energy and angle of recoiling ions off the target will be obtained from strip silicon detectors that constitute the array and will be used to deduce excitation energies and differential reaction cross sections. The double sided strip silicon detector type TTT of Micron Semiconductor Ltd, which has 10×10 cm^2 active area divided into 128 strips of 0.7 mm in width, is adopted. The array encompasses four TTT detectors, totaling about 1,000 strips. One challenge in realizing TiNA is the readout electronics system. It should ensure signals from this large number of highly condensed strips to be read out efficiently and without losing the resolution. Given the coupling with γ-ray detectors envisioned in future, compactness to save space around the target area is another key quality of electronics. The capability of pulse-shape analysis, which provides various advantages in noise cancellations or particle identification, is also desirable.

In this study, a TTT detector was tested using the GET (General Electronics for TPCs) system. It is a generic, reconfigurable and comprehensive electronics and data acquisition system for nuclear physics instrumentation of up to 33,792 channels.[1)] While developed for large-scale time-projection chambers such as the SπRIT TPC,[2)] the GET system is also an attractive option for other gaseous and semiconductor detectors that require the waveform digitizing capability and efficient data taking. A front-end board AsAd of 23×16 cm^2 alone can pulse-shape and digitize a total of 256 signals. Each AsAd board has four application specific integrated circuit chip AGET with a 512-deep circular capacitor array, which records the time-evolution of the input signal at the maximum writing frequency of 100 MHz.

The test was carried out at the GET test bench of the RIBF, which consisted of one AsAd and one concentration board CoBo. For simplicity, only 32 strips on the junction side surface were read out and all other strips were shorted. The junction side was biased to -40 V, while the Ohmic side was grounded. The selected 32 strips were routed through a 1.6-cm-wide flat cable made by the flexible printed circuit board technology. A biasing board and a diode protection circuit board ZAP were added between the feedthrough and the AsAd board. The charge collected from the Ohmic side was fed to a preamplifier to generate an external trigger. A standard ^{241}Am source was measured. We successfully operated the GET system with different settings in external and internal trigger modes, or in full and partial read out modes, which will help flexibly configure the circuit depending on experiments in future. In the analysis, we realized a common pattern of noise that occured in all connected channels likely due to electromagnetic interferences. This noise was canceled by subtracting the waveform of a strip without a signal (Fig. 1). The energy resolution without any treatment was over 100 keV FWHM, which was improved by this subtraction to about 70 keV FWHM. This resolution is comparable to 50 keV obtained at the same test bench using a NIM-standard spectroscopic amplifier model 671 of ORTEC. The result shows the GET system to be a viable option for silicon detectors.

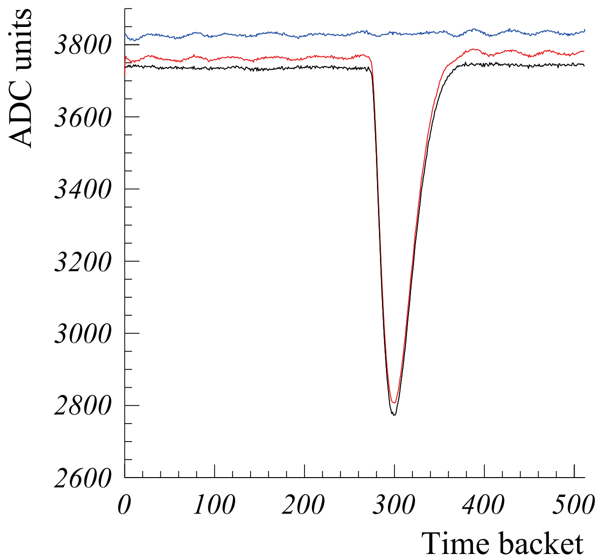

Fig. 1. Example of waveform data with a standard α source using GET electronics. The writing frequency was set to 25 MHz, which corresponds to a full range of 20 μs over 512-deep capacitor array. The pulse shaping was configured with a 1-μs peaking time. The data in red and blue were obtained from two strips with and without a hit of an alpha particle, respectively. A common pattern of noise is seen in both channels. The noise is canceled in the data in black obtained by subtracting the data in blue without a hit.

References
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*1 RIKEN Nishina Center
*2 NPAC, Université Paris-Sud, Université Paris-Saclay