Application of the Generic Electronics for Time Projection Chamber (GET) readout system for heavy radioactive isotope collision experiments†

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The SπRIT time projection chamber (TPC) is one of the main devices for the SπRIT project at RIKEN-RIBF.[1)] The SπRIT project aims to study the density-dependent term of the symmetry energy using heavy RI collision through the measurement of charged pions and light nuclei. We have implemented the Generic Electronics for Time Projection Chamber (GET) in SπRIT-TPC readout system. The operation of the GET electronics during the last experiment in 2016 went well at DAQ a rate of 60 Hz.

It was hard to identify Li isotopes clearly due to the limitation of the ADC dynamic range. We have developed a method to measure energy loss by using the slope value of each signal instead of the pulse height. Here, the slope is the gradient of the leading signal shape. A cocktail beam of proton, deuteron, triton, ^{3}He, ^{4}He, ^{6}Li, and ^{7}Li particles with a beam momentum of p/Q ∼1.6 GeV/c is made with the BigRIPS fragment separator. Figure 1 shows the energy loss distribution of each projectile. In the case of the high-gain configuration used for the pion measurement, the deposited energy from the $Z \geq 3$ particles is too high to identify Li isotopes by using signal height information. Due to the saturation of several pads along the Li trajectory, the energy loss resolution of the Li trajectory is worse than that of other light particle trajectories. By using the slope value instead of signal height, it is possible to increase the dynamic range of signal measurement so that the distribution of ^{6}Li and ^{7}Li can be separated by 4 σ.

Figure 2 shows the calibration curves obtained by injecting a long rectangular pulse to the ground wire of TPC: the maximum slope and ADC value as a function of input charge. Although the maximum ADC value is saturated around an input charge of 120 fC, the maximum slope value still shows linearity beyond 120 fC. According to the SPICE simulation, the linearity of the slope value extends up to 200 fC charge input, *i.e.* the dynamic range is increased by 65%.

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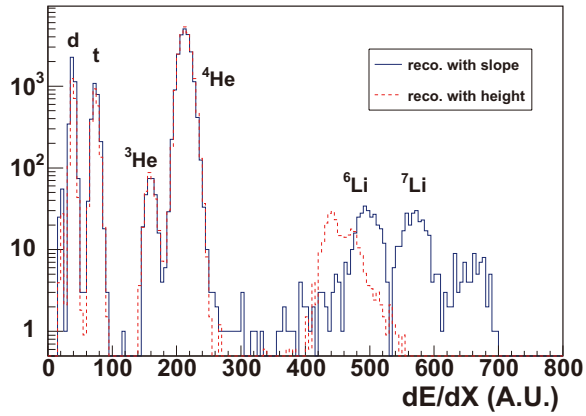

Fig. 1. Energy loss distribution of each particle passing through TPC. Trajectories of $1.6 \leq p/Q \leq 1.7$ GeV/c are selected. The spectrum of energy loss reconstructed with the signal height is shown as a dotted line while the spectrum of energy loss reconstructed with the signal slope is shown as a solid line.

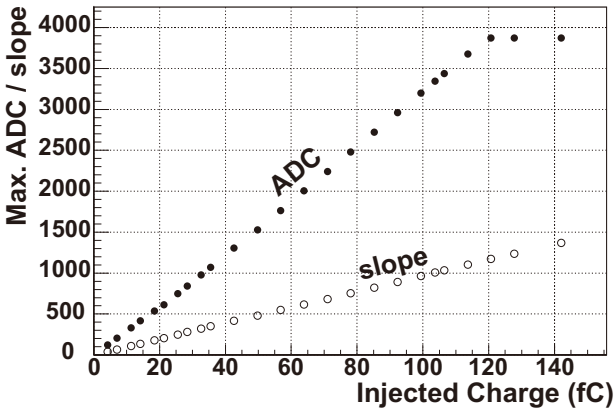

Fig. 2. Pad response induced by a long rectangular pulse injected to the ground plane wire. The induced ADC response is saturated for an injected charge above 120 fC.

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