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Energy-Resolved Neutron Imaging with Glass Gas Electron Multiplier and Dynamic Time-over-Threshold Signal Processing

Recent micro pattern gaseous detectors (MPGDs) have many readout channels for high-resolution imaging and large-area sensitivity. Reducing the circuit complexity while maintaining its performance is important for the readouts of large-scaled and high-resolution detectors.

The time-over-threshold (ToT) is a pulse processing technique which converts an analogue pulse height into a digital pulse width. Its advantages over ADC-based pulse-height measurement are less circuit complexity, lower power consumption, and pin-saving digital output interface. However, the conventional ToT suffers from the non-linearity between input pulse height and output time width. To overcome this problem, the dynamic time-over-threshold (dToT) has been proposed[1]. In dToT, the threshold is dynamically changed over time to improve the conversion linearity. We have demonstrated X-ray imaging with a glass gas electron multiplier (G-GEM) and a dToT-based readout system [2].

In this research, we demonstrated energy-resolved neutron imaging with a G-GEM and a dToT-based readout system. The measurement was conducted in J-PARC MLF beam line 10. The experimental setup of detector and readout is shown in Figure.1. We demonstrated energy-resolved neutron imaging by performing charge-division imaging simultaneously with neutron time-of-flight (TOF) measurement. The result is shown in Figure. 2. We obtained different images for different neutron energy regions. In conclusion, we have successfully performed energy resolved neutron imaging with a G-GEM and a dToT-based readout system.

[1] T. Orita, K. Shimazoe and H. Takahashi, The dynamic time-over-threshold method for multi-channel APD based gamma-ray detectors, Nucl. Instrum. Meth. A 775 (2015) 154
[2] Y. Mitsuya, T. Fujiwara, H. Takahashi, M. Uesaka, "X-ray imaging demonstration of glass GEM detector with dynamic time-over-threshold-based readout,"Journal of Instrumentation, 13, P12023 (2018)

Author: MITSUYA, Yuki (The University of Tokyo)

Co-authors: Dr SHIMAZOE, Kenji (The University of Tokyo); Dr FUJIWARA, Takeshi (AIST); Prof. TAKAHASHI, Hiroyuki (The University of Tokyo)

Presenter: MITSUYA, Yuki (The University of Tokyo)

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