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Imaging with glass GEM and dynamic time-over-threshold pulse processing method

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We report on pulse counting imaging with glass GEM (G-GEM) combined with a newly developed electronic readout based on the dynamic time-over-threshold (dynamic ToT) pulse processing method.

The ToT is a pulse processing method to convert an analog pulse to a digital pulse whose width is proportional to the original analog pulse height, measuring the time while the analog pulse is over the preset threshold. The ToT system is composed of simple circuit and hence promising for front-end circuits of multi-channel data acquisition system. The dynamic ToT is a modified method of ToT; The threshold is dynamically changed over time and the linearity between analog pulse height and digital pulse width is greatly improved.

We newly developed a dedicated preamp-shaper-dToT circuit for G-GEM and demonstrated preliminary charge-division imaging of Fe-55 5.9 keV X-ray. The G-GEM was made of crystalized glass which has 100 mm x 100 mm sensitive area, 170 um of hole diameter, 280 um of hole pitch, and 680 um of glass thickness. A G-GEM was operated under Ar/CH4 gas mixture and biased at high gain of about 1.0E+4. A two-dimensional resistive charge-division board was placed under the G-GEM. The amplified charges divided by the board were processed by the 4 channels preamp-shaper-dToT circuit. The digital pulse widths of dToT were measured by an FPGA with the clock frequency of 8 ns, and were effectively stored in a high-speed 16 bits SRAM memory. The approximate position of Fe-55 source was successfully detected by charge-division calculation using pulse height information from the 4 channels. The maximum energy resolution from a dToT channel was 31.8 % at 5.9 keV peak.

We are also developing an individual-strip readout system with dToT to improve the spatial resolution. The imaging system will be applied for future neutron imaging of nuclear materials.

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