Development of Gas Electron Multiplier (GEM) Detector

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We plan to measure Coherent Pion Production (CPP) with $^{12}C(p, n\pi^+)^{12}C(Ground\ State)$ reaction. To achive enough resolution for our experiment, there are several critical requirements for pion detector. First, in order to determine the pion energy with sufficient accuracy, the high resolution position detector is required for the tracking in the swinger magnet. Second, because the detector is placed close to reaction point, it must be able to be operated under the harsh radiation environments. Third, since the inner space of swinger magnet is very limited, the size of the detector and its readout system must be compact. In order to satisfy these requirements, we develop tracking detector with Gas Electron Multiplier (GEM) [1] newly.

The GEM detector consists of cathode electrode, GEM electrode, readout board, and readout electronics. The high gain can be achieved by the multilayer of GEM electrodes. GEM electrode consists of a thin polymer foil (50μm thickness) which is metal(copper)-coated on both sides with the thickness 5μm. Small holes of a diameter 70μm are made with the pitch of 140μm. Fig.1 shows a picture of GEM and magnified its electrode.

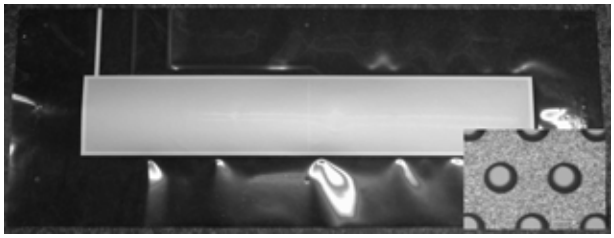

Figure 1: Picture of GEM electrode.

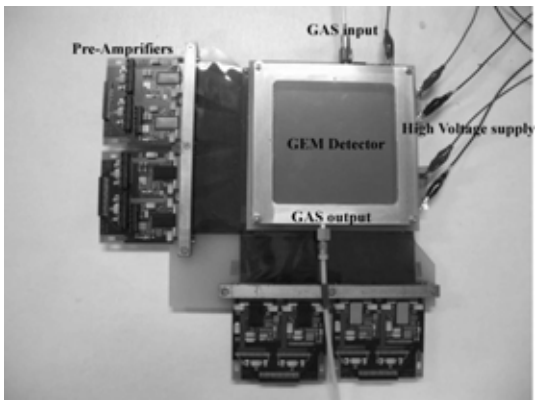

Figure 2: Overview of the prototype detector.

The two-dimensional readout is achieved by the printed circuit board consisting of double layers of perpendicular copper strips with 400μm pitch. The position resolution less than 100μm will be achieved for each coordinate by measuring the center of gravity of charge distribution appeared in the strips.

The prototype of the detector is fabricated as shown in the Fig.2. The gain was measured as a function of the applied voltage, with various gasses mixture using the X-ray from ^{55}Fe (X-ray, 5.9keV) source. Figure 3 and 4 show a typical plot of charge spectrum and the measured gain as a function of biased voltage to GEM (V_{gem}).

The measured gains which show the exponential slopes are consistent with those of measured at CERN[2, 3]. With the triple GEM, a gain of 10^4 was achieved when the V_{gem}=390 V for argon-CO_2 and V_{gem}=380 V for argon-isobutane, respectively. It was checked that the developed GEM detector can be operated with the expected performance. From the Monte Carlo study it is checked that GEM detector has sufficient specification for our experiment.

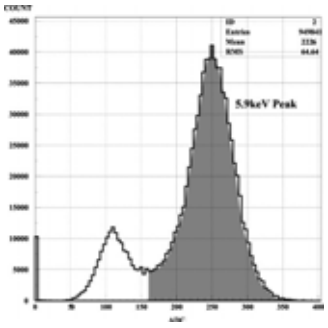

Figure 3: Pulse height distribution for 5.9keV obtained with triple GEM detector.

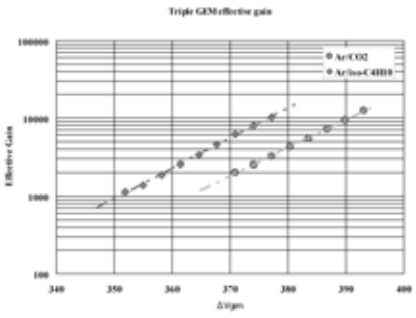

Figure 4: The measured amplification factor in each gas.

References

[1] F. Sauli, Nucl. Instr. and Meth. A386 (1997) 531.
[2] A. Bressan et al., Nucl. Instr. and Meth. A425 (1999) 262.
[3] C. Altunbas et al., Nucl. Instr. and Meth. A490 (2002) 177.