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Micro Pixel Chamber Operation with Gas Electron Multiplier

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We are developing a micro-Time Projection Chamber (micro-TPC) based on a micro-pixel chamber (μ-PIC). A Micro-TPC is employed for an electron-tracking Compton camera [1,2].

A μ-PIC is a fine pixel-type two-dimensional imaging detector with a pixel pitch of 400μm and it has a detector area of 10×10cm2. We achieved a maximum gas gain of 15,000 and stable operation over 1,000 hours at a gas gain of 5,000. However, the stable gas gain of 5,000 is not high enough for detecting Compton-recoil electrons, dE/dx of which are the same as that of minimum ionizing particles (MIPs). A required gas gain for MIP detection is 2 –4 times as large as the achieved one.

Therefore, a hybrid detector consisting of a μ-PIC and a gas electron multiplier (GEM) is employed for realizing the required gain. A GEM is installed just above a μ-PIC and operated at a low gas gain (less than 50). We plan to use a GEM temporarily until a gas gain of a μ-PIC reaches the aimed gas gain alone by improvements of the electrode structure and manufacturing process. We used a GEM developed by Center for Nuclear Study, the University of Tokyo. The GEM consist of 50μm a thick kapton foil, and copper clad on each side, 70μm holes arranged with 140μm between centers, with detection area of 10×10cm2.

Operating a μ-PIC at a gas gain of 2.5×103, we achieved a maximum total gas gain of more than 105, and energy resolution of 1.2keV (21%) FWHM at 5.9keV (at a gas gain of 3.3×104). Long-term stability over 170 hours was also confirmed at a total gas gain of 2.0×104 (the μ-PIC was operated at a gas gain of 2.0×103, the GEM at 10). We achieved enough stable gain to detect MIPs and detected cosmic ray muons by micro-TPC. The ion feedback was suppressed to less than 10%, when GEM was operated at a gas gain of 10, which enables us to detect tracks of particles at higher rates.

Now we are developing a larger μ-PIC with a detection area of 30×30cm2 and GEM with that of 28×25cm2. The larger hybrid detector will increase detection efficiency of detecting charged particles, and enable us to measure longer tracks.

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