Development of gating grid driver for SPiRIT TPC

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The symmetry energy part of the nuclear equation of state (EOS) influences various phenomena in nuclear astrophysics, nuclear structure, and nuclear reactions. The behavior of nuclear symmetry energy can be probed through a measurement of the π^-/π^+ ratio in heavy ion collisions. For this purpose, experiments using the Time Projection Chamber (TPC) installed in SAMURAI magnet[1)] have been proposed.[2)] The TPC is necessary to measure charged particles such as pions, protons, and light ions in high multiplicity environment produced by heavy ion collisions. When we perform the experiments at SAMURAI, heavy ions pass through TPC as well as light charged particles, resulting in gain reduction due to the production of a large amount of ions from the avalanche process around anode wires. To avoid such a gain reduction, gating grid wires are located prior to the avalanche region. Techniques to protect the avalanche region have been well established.[3)] In the open gate mode, all the gating grid wires are held at the same potential V_G, admitting electrons from the drift volume to enter the avalanche region. In the closed gate mode, the gating grid is biased with a bipolar field (positive side:$V_G + \Delta V$, negative side:$V_G - \Delta V$), which prevents electrons from the drift volume to reach the avalanche region. The closed gate prevents ions created in the avalanche processes of previous events from drifting back into the drift volume. A gating grid driver (GGD) was developed to realize such protection of the TPC. Figure 1 shows a prototype of the GGD. The design is based on the E907 TPC GGD.[4)]

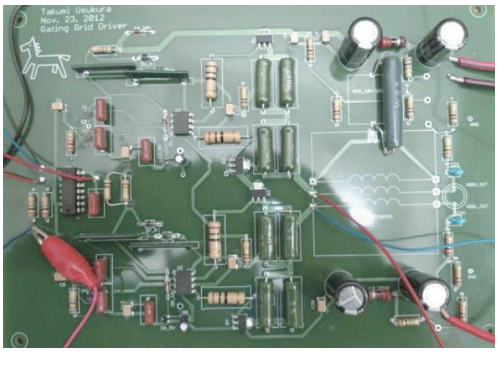

Fig. 1. Prototype of gating grid driver.

The GGD performance was studied by using a Xe beam at HIMAC. Since we could not use the TPC for SAMURAI, we used the BRAHMS TPC[5)] to check the GGD performance. A CsI target was located in front of the TPC so that light charged particles can be measured as well as the Xe beam. T2K-TPC electronics were used to read out 256 (4 ×64) pads. Without switching the gating grid wire using the GGD, we observe a gain attenuation at the beam rate of 10kpps. On the other hand, such a gain attenuation can be suppressed by switching the gating grid wire. The switching potential (V_G) is the same as that for the BRAHMS experiment.[5)] Though we can suppress the gain attenuation, the base line is fluctuated every time by the gate operation, which generates a large noise on the pad readouts with respect to the signal from the MIP particles. One of the main reasons of the noises from the GGD is the different rise times in the positive and negative sides although the sum of the positive and negative side voltages ($2V_G$) should be controlled to be constant. Since the noise shape caused by the GGD is similar among different events, we calibrate the baseline shape with a pedestal run and reconstruct the hit position after the subtraction of the baseline. Figure 2 shows the position resolution along the wire axis of the TPC after the calibrated baseline is subtracted. The position resolution under the bad noise condition created by the GGD is similar to the resolution with GGD. This implies that the noise created by the GGD can be made insignificant by subtracting the baseline as far as the position resolution is the same.

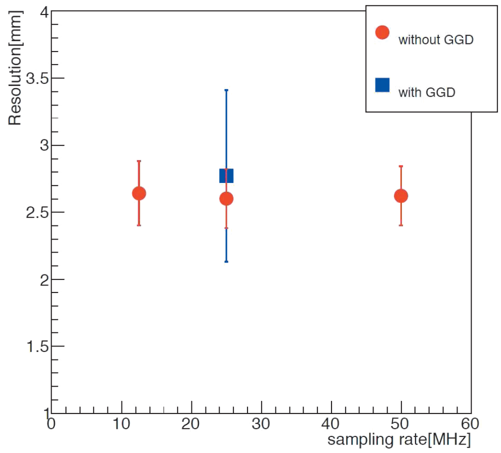

Fig. 2. Position resolution along wire axis as a function of flash ADC sampling frequency for each case, with and without GGD.

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