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Development of Micro tracking TPC using a Micro Gas Pixel Chamber (mPIC), and Application to time resolved Neutron Imaging Detector

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We have developed a 2-D micro pattern gas detector based on printed board circuit technology (PCB), named Micro Pixel gas Chamber (mPIC). Using the mPIC, a micro Time Projection Chamber (mTPC) and its readout system were developed, which can measure the successive positions of the track of charged particles in a 400 μm pitch like a using only X and Y strips readout method. Then ~ 500 readouts are only needed for 65000 pixels in the 10x10cm mPIC. Its readout system consists of only amplifier and discriminator LSIs and FPGAs, and measures not only the hit strip address but also the both rising and falling times of the pulse, which enables to obtain the relative pulse height of each hit pixel. Thus, this mTPC is quite simple, but it nevertheless gives a fine 3D-track image including dE/dx along the track like a bubble or cloud chamber. Now three size of m-PIC are commercially available; 10x10cm, 20x20cm, and 30x30cm. Already m-TPCs using mPIC with above readout system are being applied in several fields such as a Target chamber catching tracks of the fine fragments from nuclei in the nuclear beam experiment and the radiation monitor in the spacecraft in Japan.

In Kyoto University, using this mTPC technology, following researches are being carried out such as an electron tracking Compton camera (ETCC) for MeV Gamma-ray imaging, a Dark matter wind detector, and time resolved Neutron Imaging detector. In particular, Neutron Imaging detector measures the tracks and Bragg curves of the decay of ^3He absorbing a thermal neutron. Using Bragg curve information, decay products of ^3H and proton are perfectly defined in the m-TPC, and hence the good position resolution of less 200 μm are obtained with a 1 μs second time resolution for each neutron. This detector has already been operated in the J-PARC pulsed neutron source as an time resolved imaging detector with a MHz counting rate.

Here I will mention on the detailed performance of the m-PIC and m-TPC using above application to pulsed neutron imaging.

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