Kyoto Multiplicity Array for the SπRIT experiment

M. Kaneko,[*1,*2] T. Murakami,[*1,*2] T. Isobe,[*2] M. Kurata-Nishimura,[*2] W. G. Lynch,[*3] M. B. Tsang,[*3] J. Barney,[*2,*3] J. Estee,[*2,*3] G. Cerizza,[*2,*3] C. Santamaria,[*2,*3] G. Jhang,[*4] J. W. Lee,[*4,*2] P. Lasko,[*5,*2] J. Łukasik,[*5] P. Pawłowski[*5,*2] and Y. Zhang[*6,*2] for the SπRIT collaboration

The SπRIT experiment aiming to investigate nuclear equation of state at supra-saturation densities was performed in Spring of 2016 at RIKEN-RIBF. The integral or momentum spectrum of π^-/π^+ produced in central heavy-ion (HI) collisions can be a useful probe[1)] and is to be measured in this experiment. In order to identify multi fragments including charged pions generated from HI collision and to reconstruct their momenta, large time projection chamber (SπRIT-TPC[2)]) and ancillary trigger detectors were constructed, which was used in the SAMURAI spectrometer with 0.5 T.

The "Kyoto Multiplicity Array" has a sensitivity to sideward charged particle multiplicity which correlates with collision centrality. This detector consists of 2×30 plastic scintillator bars that are in close contact with both sides of the SπRIT-TPC. The enclosure of the SπRIT-TPC has 1mm thin aluminum window parts allowing light fragments from the reaction to pass through and be detected by the external triggering system. The dimensions of each plastic bar are $450\times50\times10$ mm^3, which are coated with oxidized titanium for light reflection. Each bar has a hole of about 1.5 mmϕ centered along its length for a wave length shifting fiber as a light guide. The light propagated in the fiber of 1 mmϕ will be detected by 1.3 mm^2 Multi Pixel Photon Counter (MPPC) capable of use in magnetic field. Figure 1 shows the geometrical setup of detectors in the SAMURAI magnet.

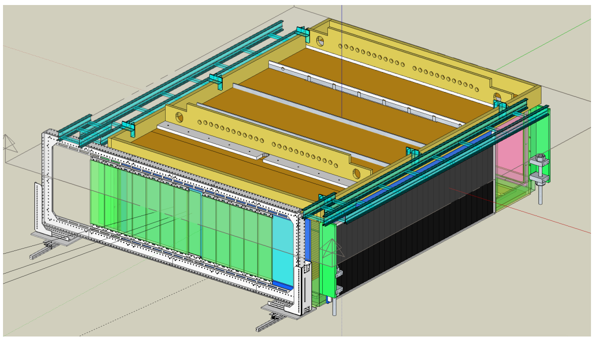

Fig. 1. Schematic drawing of SπRIT-TPC and ancillary detectors from beam-left downstream side. One-sided Kyoto Multiplicity Array is described by black color, and the other side is behind the SπRIT-TPC.

*1 Department of Physics, Kyoto University
*2 RIKEN Nishina Center
*3 NSCL and Dept. of Phys. & Ast., Michigan State University
*4 Department of Physics, Korea University
*5 Institute of Nuclear Physics, PAN, Kraków, Poland
*6 Department of Physics, Tsinghua University

The ASD chip designed to readout photodiode type detectors - EASIROC - is used for shaping MPPC signals. For handling of the EASIROC and its digital outputs from discriminators, FPGA is integrated in one board together with EASIROC (VME-EASIROC[3)]). The number of digital signals, as charged particle multiplicity, is calculated by a combination of ROMs and adder circuits, which is implemented in the FPGA. If calculation result surpass user set threshold, trigger signal will be generated within about 52 ns for the whole electronics. And besides online triggering function, multi-hit TDC with 1 ns time resolution is also implemented in the FPGA for offline analysis. In the SπRIT experiment, triggered event multiplicity was required to be greater than 4.

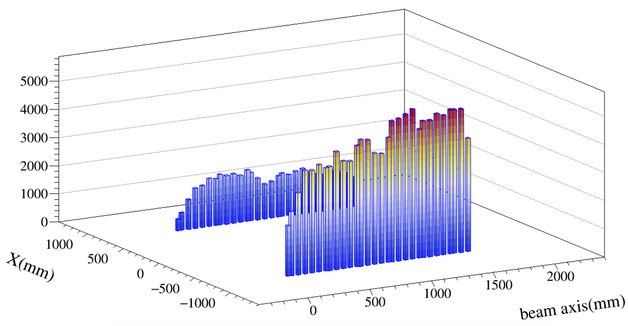

Fig. 2. Number of hits in each plastic bars by offline analysis seen from beam-right upstream side. The coordinates correspond to the position of each bar and target was located at X=0 mm and beam axis=-8.9 mm.

Although it was the first operation in the magnetic field, the data for TPC with ancillary detectors was acquired without a big problem. The hit pattern obtained by the detector is presented in Fig. 2, where the effect of magnetic field on charged particle can be seen. While there are still some fluctuations, detailed analysis is necessary to understand the bias for triggered event and the impact parameter information.

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