KATANA — A CHARGE-SENSITIVE TRIGGERING/VETO SYSTEM FOR THE SπRIT EXPERIMENT*

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KATANA — the Kraków Array for Triggering with Amplitude discrimiNAtion, has been built and used as a trigger and Veto detector for the SπRIT TPC at RIKEN. Its construction allows for operation in magnetic field and provides a fast response for ionizing particles giving the approximate forward multiplicity and charge information. Depending on this information, trigger and veto signals are generated. The Multi-Pixel Photon Counters were used as light sensors for plastic scintillators. Performance of the detector is presented.

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1. Introduction

A Time Projection Chamber (TPC) called SπRIT (the SAMURAI Pion-Reconstruction and Ion-Tracker) was recently constructed to be applied in the investigation of charged pions and isotopically-resolved light charged particles (LCP) produced in heavy-ion (HI) reactions [1, 2].

To obtain sufficiently large gas amplification for pions and LCPs, a high electric field is required inside the chamber. This brings a risk of damage when a heavier fragment passes through the chamber: the charge produced

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by gas ionization can exceed a safe limit for the pad planes of the TPC. For this reason, a gating grid wire plane was mounted in front of the pad plane [1]. The grid is normally closed, but may be quickly open (in ~ 200 ns) when an interesting collision occurs.

The KATANA array has been designed as a triggering device for the SπRIT TPC. It plays a double role: produces a minimum bias or majority trigger, and provides a veto signal whenever a beam particle or a fragment heavier than $Z \simeq 20$ passes through the chamber. To fulfill the requirements, the wall has been constructed of two parts, a Veto and Trigger arrays. The KATANA-Veto part, consisting of 3 thin (1 mm thick) plastic-scintillator paddles, with the middle one centered on the beam, has been designed to produce a veto signal for heavy fragments. The KATANA-Trigger array, consisting of 12 thicker (10 mm thick) paddles, arranged on both sides of the beam, has been designed to produce a trigger.

The technical details of the detector were presented in [3, 4]. This paper will focus on the performance of the Veto part.

2. Detector description

Three thin KATANA-Veto paddles (size $400 \times 100 \times 1$ mm^3, made of BC404) cover the HI beam area. The light produced in the thin scintillator by the beam or by the charged reaction products is collected along the shorter edges of the plastic with the use of a Wave Length Shifter (WLS) fiber (type BCF92). The WLS propagates the light to the magnetic field insensitive light sensors: the Multi-Pixel Photon Counters (Hamamatsu MPPC, type S12571-010) [5]. Such solution ensures collection of sufficient amount of light from the thin scintillator and minimizes its position dependence. Each MPPC is mounted directly on its preamplifier's PCB to minimize the pickup noise. The front-end electronics of each paddle is completed by an adder, providing an analog sum of signals.

3. Detector efficiency

The efficiency for HI detection and discrimination is a crucial characteristic of each Veto detector. The efficiency of the KATANA-Veto paddles has been tested using the 300 AMeV ^{132}Xe beams at HIMAC (the HI Medical Accelerator in Chiba). The test setup is depicted in Fig. 1 (a). The prototype of the KATANA-Veto module was placed directly in the beam, in air. A KRATTA detector module [6] was mounted behind the Veto paddle. The KRATTA module is a triple telescope allowing to identify the charge of a hitting particle. Especially for the test, the gain of the KRATTA module was lowered to increase its charge identification range. Using it as a reference allowed to profit from its high detection efficiency and its charge resolution. The charge spectrum collected by the KRATTA module is shown in

Fig. 1 (b). The efficiency of the Veto module for the HI discrimination could be determined by correlating the signal amplitude from the Veto paddle with the fragment charge number provided by the KRATTA module. Figure 2 shows the detection efficiency of the Veto paddle as a function of the hitting fragment charge, for various threshold settings on the discriminator. The charge selectivity of the KATANA-Veto paddle is clearly visible.

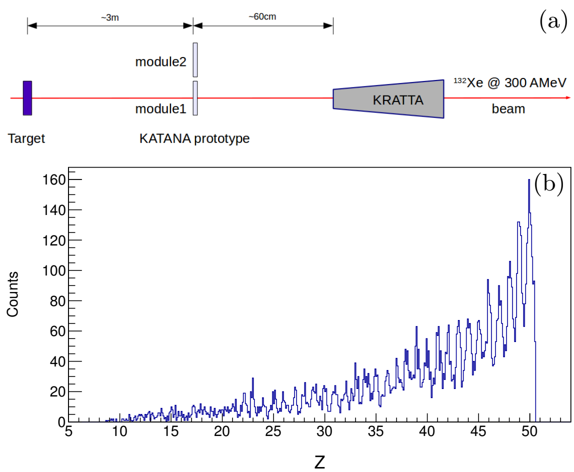

Fig. 1. (a) Test run setup at HIMAC. (b) KRATTA charge resolution.

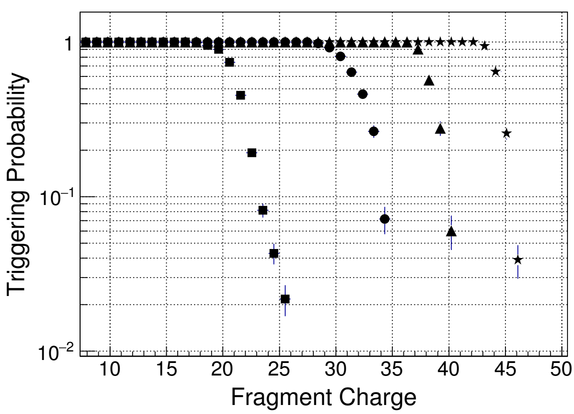

Fig. 2. Experimentally measured triggering probability of a thin Veto paddle. Different symbols correspond to different amplitude discrimination thresholds.

4. Influence of radiation damage

As the Veto paddles are exposed to the beam directly, a significant drop of their efficiency may be expected due to the radiation damage. During the SπRIT experiment, a cocktail of Sn beams of about 10 kHz rate was applied. Even with such a low-beam intensity, a decrease of efficiency can be observed after dozens of hours of exposure. The damage is reflected in decrease of the amplitude measured for the unscattered beam ions. Figure 3 presents this as a function of experimental run number. In terms of time, the amplitude decrease is about 1% per beam day. On the other hand, no significant effect on RMS measured for the beam amplitude was found.

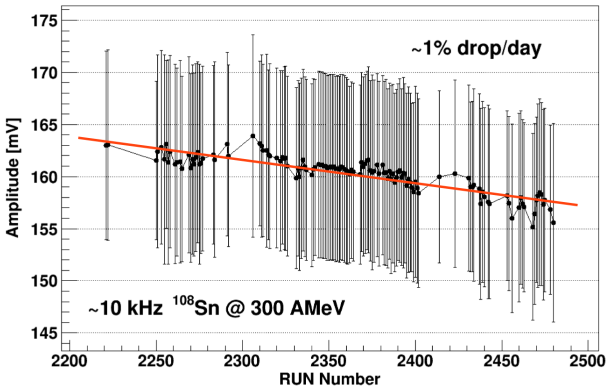

Fig. 3. In-beam aging of a 1 mm thick BC404. Points show the mean amplitudes of the beam peak. The vertical bars represent the RMS of the peak.

5. Summary

In summary, we have shown the performance of the Veto paddles in the KATANA array. The detector was built, tested and used in the recent experiment at RIKEN, playing a significant role in the detection system. Fast response, high veto and trigger efficiency, insensitivity to magnetic field, stability and the possibility of remote control are the main attributes of this array.

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