Beam test of the MAIKo active target

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The Mu-PIC based Active target for Inverse Kinematics. (MAIKo) is under development at RCNP to perform missing mass spectroscopy on unstable nuclei. Missing mass spectroscopy could be a powerfull tool to study phenomena above particle decay threholds such as giant resonances or cluster correlation. However, this method has rarely been applied to a measurement at forward angles because energies of the recoil particles are too small (∼1 MeV). Active target systems, where the detector itself works also as the target material, can solve the problem. Since the recoil particles stop inside the detector, the active target can detect even low-energy particles. MAIKo is based on time projection chamber (TPC) which provides three-dimensional track of charged particles. For the amplification and detection of the ionized electrons, Micro-PIxel Chamber (μ-PIC) [1] is utilized to the TPC because it achieves high position resolution (∼200 μm). Detailed design of the detector system is described in Ref. [2].

In 2013, the first test experiment with an accelerated beam was performed at RCNP EN course (E419). The experiment aimed to study the detector performances such as gas gain and angular resolution under high irradiation rate. Scattering events were also acquired to develop an event reconstruction algorithm. The beam was ^{4}He at 12.5 MeV/u. This beam loses the same energy along the TPC as unstable ^{12}Be beam at 62 MeV/u.

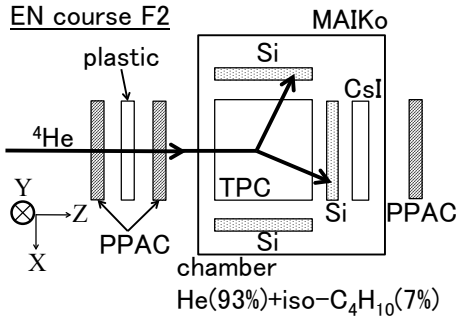
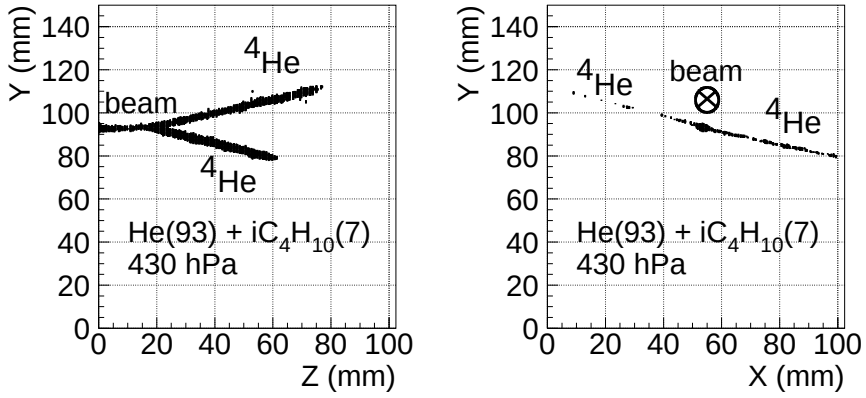


Figure 1: Setup of the experiment.

Fig. 1 shows the setup of the experiment. MAIKo was installed at F2 focal plane. The TPC chamber was filled with He(93%)+iso-C_4H_{10}(7%) with a pressure of 430 hPa to investigate (α, α') scattering with ^{4}He beam. Three PPACs were installed upstream and downstream of the TPC to measure the position of the beam. A plastic scintillator was used to count the beam rate. Si and CsI detectors were installed around the TPC to trigger the data acquisition of the scattering events.

During the experiment, the TPC was stable even under a high beam rate of 1 Mcps. When the beam rate was 110 kcps, angular resolution of 6.76 ± 0.15 mrad for the beam particles was achieved.

In the experiment, hundreds of scattering events were acquired. Typical track of a scattering event is shown in Fig. 2. Anode (Fig. 2(a)) and cathode (Fig. 2(b)) track provide the $z - y$ and $x - y$ projection of the track, respectively. From the scattering angle and recoil energy which was determined by the Si detector, this event was unambigously identified as the ^{4}He + ^{4}He elastic scattering. The scattering angle was determined by fitting the track to three straight lines. Tracking algorithm which can determine the scattering angle and excitation energy is now under development.



(a) anode (b) cathode

Figure 2: Track of a scattering event.

References

[1] A. Ochi *et al.*, Nucl. Inst. and Meth. in Phys. Res. A **471**, 264 (2001).

[2] T. Furuno *et al.*, J. Phys.: Conf. Ser. **569**, 012042 (2014).