Timing performance of a mirror-type MCP detector use for mass measurements at the Rare RI Ring

Z. Ge,*1,*2,*5 S. Naimi,*1 D. Nagae,*1 Y. Abe,*1 S. Omika,*1,*2 F. Suzuki,*1 H. F. Li,*1,*5 T. Uesaka,*1 Y. Yamaguchi,*1 M. Wakasugi,*1 T. Yamaguchi,*1,*2,*3 N. Tadano,*2 K. Wakayama,*2 A. Ozawa,*1,*3 S. Suzuki,*3 T. Moriguchi,*1,*3 H. Arakawa,*2 K. Inomata,*2 T. Kobayashi,*1 G. Lorusso,*4 Y. Yano*1

High resolution time-of-flight (TOF) measurements are crucial for mass measurements via TOF methods such as in-ring isochronous TOF or beam-line Bp-TOF. To characterize and optimize the timing resolution of a mirror-type micro-channel plate (MCP) detector with a timing anode, an experiment aimed at studying the performance of the detector was conducted at HIMAC (Heavy Ion Medical Accelerator in Chiba). We demonstrate preliminary online results of the timing detector which can be used for the resolution time measurement inside the Rare RI Ring (R3), start TOF of the total TOF for in-ring circulation, beam-line TOF measurement for beam-line mass determination and velocity reconstruction for in-ring mass correction.

To investigate the properties of the detector, a primary beam of 84Kr16+ at the energy of 200 MeV/nucleon is used. The experimental setup is shown in Fig. 1(a). The setup consisted of two parallel plate avalanche chambers (PPACs) for beam tracking, one electrostatic MCP detector, two plastic scintillators for intrinsic timing resolution deduction of the mirror detector. The MCP with a diameter of 40 mm is mounted on a triangular detector structure as shown in Fig. 1(b). The conversion foil is made of mylar (2 μm) coated with aluminium. The accelerating grid consisting of gold-plated tungsten (W+Au) wires (40 μm in diameter) possesses a distance of 8 mm from the conversion foil with a 1 mm pitch, and wires (W+Au) for the inner and outer mirror grids are arranged with a 3 mm pitch. During the experiment, the high voltage (HV) potential of the MCP, accelerating grid and inner mirror were set at 2.5 kV and the accelerating HV of the foil and outer mirror grid were varied. The timing resolution for isochronous and non-isochronous condition has both been studied by the experiment and simulation performed via SIMION as shown in Figs. 1(c) and (d). The distance between the outer mirror and inner mirror is 20 mm for isochronous condition, while it is 8 mm for the non-isochronous condition. As demonstrated from Figs. 1(c) and (d), when the accelerating HV is increased, the timing resolution improves for both configurations with the corresponding settings.

References