

# Development of Mirror-type MCP Detectors for Mass Measurements at the Rare-RI Ring

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Electrostatic Mirror-type foil detectors for detecting secondary electrons (SEs) are being developed for high precision mass measurements and beam monitoring at the cyclotron-like storage ring, Rare-RI Ring at the RI beam factory (RIBF) in RIKEN. An isochronous condition for SEs is chosen to optimize the performance of the time-of-flight (TOF) detector. The resolution dependence of the high voltage applied to the potential plates has been studied experimentally and via simulation. The performance of the mirror-type TOF micro-channel plates (MCPs) detector with a timing anode has been investigated using heavy ions at the Heavy Ion Medical Accelerator in Chiba (HIMAC). The best timing resolution achieved was  $\sigma \sim 40$  ps and detection efficiency of  $\sim 96\%$  for heavy ion beams.

**KEYWORDS:** foil detector, mass measurements, micro-channel-plates, time-of-flight, storage ring

## 1. Introduction

As a fundamental property of atomic nuclei, mass plays an essential role in the study of the nuclear structure and provides important inputs for modeling nucleosynthesis processes in astrophysics. To measure the masses of very exotic nuclei approaching half-lives  $\sim 1$  ms at a precision of  $10^{-6}$ , a very efficient and fast experimental apparatus, a cyclotron-like storage-ring, the Rare-RI Ring [1] in RIKEN Nishina Center has been constructed.

High-resolution TOF detection is crucial for mass measurements via TOF methods, such as isochronous TOF in the Rare-RI Ring or  $B\rho$ -TOF. To design TOF detectors for mass measurements with high precision and accuracy, several conditions need to be considered such as: (a) excellent temporal resolution is essential (less than 100 ps); (b) low energy loss and small angular scattering of the heavy ions; (c) large active area to cover the large beam size when located at a dispersive focal plane or inside the ring; (d) large detection efficiency; (e) no magnetic fields that may disturb the