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Development of a Short Flight-Path Z-Identification System using Fast Plastic Scintillators and an Ionization Chamber for Charge-Changing Cross Section Measurements/荷電変化断面積測定に向けた高速プラスチックシンチレータとイオンチェンバーを用いた短距離用の原子番号識別システムの開発

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Charge-changing cross section (σ_{CC}) measurements play an essential role in advancing our understanding of nuclear structure. In heavy-ion beam experiments, atomic number (Z) identification is performed by combining the measurement of energy loss (ΔE) with that of the particle velocity (β). Under typical conditions, the flight path is long enough to determine β with high precision, and therefore the achievable Z resolution is mainly limited by the ΔE resolution. However, in the σ_{CC} measurements, where Z-identification is required for all particles downstream of the reaction target, the flight path between the target and the downstream magnetic analyzer is too short to measure time-of-flight (TOF). To address this problem, we attempted Z-identification downstream of the target by using the combination of ΔE from an ionization chamber and β measured precisely under a short flight path of approximately 2 m using fast plastic scintillators.
The experiment was carried out at RIKEN RIBF. Secondary beams, such as Sn isotopes, were produced from a primary beam of ^{238}U and irradiated onto a reaction target placed at the F8 focal plane. The Z-identification of the reaction products downstream of the target was performed using the ionization chamber in combination with a newly developed short flight-path TOF measurement system. This system employs fast plastic scintillators together with a processing circuit configured for high-precision time measurement.
In this study, we investigated the timing resolution and its position dependence of the developed plastic detectors, as well as the achieved Z-identification capability when combined with the ionization chamber. The result will be discussed in detail.

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