Evaluating spatial distributions of ^{132}Xe ions extracted from SCRIT

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A SCRIT method is a target-forming technique in an electron storage ring for electron scattering experiments with unstable nuclei.[1] A target ion beam with a charge state of 1+ is injected into a SCRIT device. They are trapped transversely by periodic focusing forces from electron beam bunches and longitudinally by the electrostatic well potential in the SCRIT device. The trapped target ions are focused onto the electron beam axis as their charge state increases primarily through electron impact ionizations. However, increasing the ion charge state enhances space charge effects and spreads the spatial distributions of trapped ions.[1] This depends on various factors (*e.g.*, the emittance of injected ions, electron beam instability, *etc.*) and limits the target density of SCRIT. Evaluating the ion spatial distribution of each charge state in SCRIT is essential to understanding the target formation dynamics and improving the target density of SCRIT.

After the ion-trapping in the SCRIT device, the target ions are extracted and transported to the ion analyzer consisting of movable 4-channel slits, an E × B velocity filter (Model 600-B, Colutron Research Corp.), and a 43-channeltron array (Photonis Scientific, Inc.)[2] (Fig. 1). Most trapped ions are detected as a total trapped charge by the slits, and only a few ions passing through the slit aperture are analyzed for a charge-to-mass ratio by the ExB filter. The spherical surface (SS) deflector can control the ions passing through the slit aperture. In this study, to evaluate the spatial distribution of ions in SCRIT, we measured the response of trapped ions in various charge states while varying the supply voltage of the SS deflector.

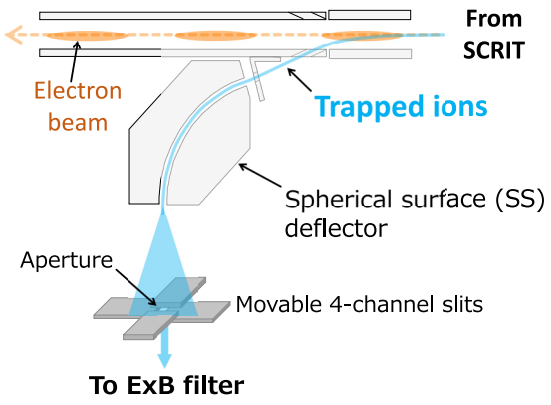

Fig. 1. Shematic of the trapped ion transportation from SCRIT to the ion analyzer.

We observed ^{132}Xe^{1+} ∼ ^{132}Xe^{9+} ions using the ion analyzer with a trapping time of 15 ms in the SCRIT device. The incident energy of ^{132}Xe^{1+} ions to the SCRIT device was approximately 6 keV. The energy and current of the electron beam were 150 MeV and 180–240 mA, respectively. The diameters of the incident ^{132}Xe^{1+} ions and electron beams were roughly 10 and 1 mm, respectively. The supplied voltage of the SS deflector was varied from 1090 to 1160 V. The aperture of the movable 4-channel slits was 0.2 mm × 0.2 mm.

Figure 2 shows the responses of trapped ^{132}Xe ions while varying the supplied voltage of the SS deflector. This provides a rough description of the spatial distribution of ^{132}Xe ions at the plane of the slits. Among the ions observed, only ^{132}Xe^{1+} ions exhibit a large spread, whereas the distributions of highly charged ^{132}Xe ions are narrower. The peak of these distributions was obtained when the supplied voltage to the SS-deflector was approximately 1130 V. Assuming the ions at the peak area are transported from the vicinity of the electron beam axis, this suggests that the dominant contribution to electron scattering comes from highly charged ions. This is the first observation for discussing the ion spread in SCRIT. Currently, simulations of the ion transport from SCRIT to the slits are being undertaken to explain the non-smooth distribution of ^{132}Xe^{1+} ions and assess the ion spatial distributions in SCRIT.

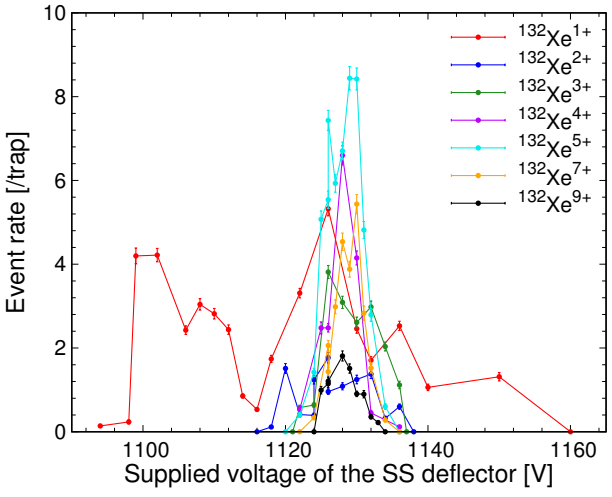

Fig. 2. Responses of trapped ^{132}Xe ions when the supplied voltage of the SS deflector was varied.

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References

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