Commissioning study of SCRIT facility with ^{138}Ba nucleus

K. Tsukada,[*1,*2] Y. Abe,[*2] A. Enokizono,[*2] T. Goke,[*3] Y. Honda,[*2,*3] Y. Ito,[*1] K. Kurita,[*4] Y. Maehara,[*1] T. Ohnishi,[*2] R. Ogawara,[*1,*2] T. Suda,[*2,*3] M. Watanabe,[*2] M. Wakasugi,[*1,*2] and H. Wauke[*2,*3]

The Self-Confining RI Ion Target (SCRIT) electron scattering facility was constructed to realize electron scattering experiments for short-lived unstable nuclei.[1)] SCRIT uses a novel technique to achieve a luminosity of 10^{27} cm^{-2}s^{-1}, which is sufficient to perform elastic electron scattering experiments by trapping a small number of target ions, typically 10^8 particles/pulse, along the electron beam.

In 2021, we performed electron scattering from ^{138}Ba for two electron beam energies, 150 and 300 MeV, as a commissioning experiment. ^{138}Ba is stable, and its charge density distribution is known.[2)] This is the first time experiment with the gas target trapped in the SCRIT since the present SCRIT device was installed in 2020, and a drift chamber of the electron spectrometer was replaced with a new one in 2018. The present SCRIT device has a larger cross-section and less material around the trapping region, and it provides much better uniformity of the electric potential compared to the previous device. The present drift chamber in front of the spectrometer magnet provides both vertical and horizontal information of the trajectories of scattered electrons, whereas the previous one provided only horizontal information.

The data for 150 MeV is analyzed in this report. The beam current was 250 mA at the beginning of the data acquisition and dropped to 150 mA at the end. The achieved luminosity was approximately 1×10^{27} cm^{-2}s^{-1} on average.

Figure 1 shows the reconstructed vertex-point distribution along the beam line after the spectrometer acceptance correction. It is found that the target length in the SCRIT device is about 300 mm and the distribution is almost flat. Compared to the previous data,[3)] the apparent bump structure caused by the distortion of the electric potential disappears, which makes the data easier to analyze and interpret.

Figure 2 shows the yield distribution after the acceptance correction and background subtraction. The solid line represents a calculation using a phase-shift calculation code, DREPHA,[4)] with the charge-density distribution of ^{138}Ba.[2)] The distribution of our data is well reproduced by the calculation, except for the foremost point, which corresponds to the end of the acceptance.

In summary, the target ions are trapped in the present SCRIT device almost uniformly as expected, and the angular distribution is well reproduced by our spectrometer. We are almost ready and will soon start the world's first electron scattering experiment with an unstable nuclear target.

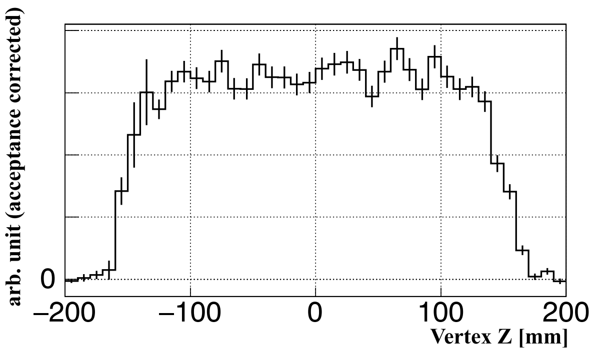

Fig. 1. Reconstructed vertex-point distribution along the beam line after acceptance correction.

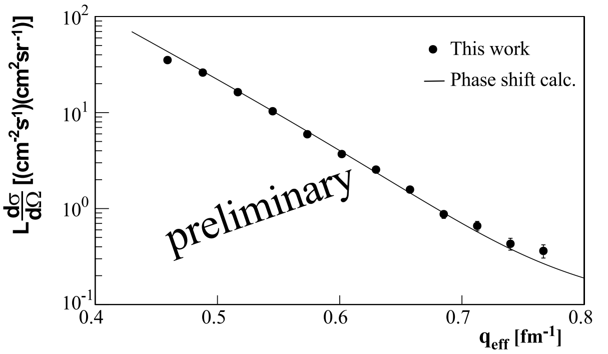

Fig. 2. Yield distribution with varying effective momentum transfer after acceptance corrections. The solid line is a phase-shift calculation obtained using a charge-density distribution of ^{138}Ba.[2)]

References
1) M. Wakasugi *et al.*, Nucl. Instrum. Methods Phys. Res. **317**, 357 (2013).
2) H. de Vries *et al.*, At. Data Nulc. Data Table **36**, 495 (1987).
3) K. Tsukada *et al.*, Phys. Rev. Lett. **118**, 262501 (2017).
4) B. Drepher, A phase-shift calculation code for elastic electron scattering (private communication with J. Friedrich).

*1 Institute for Chemical Research, Kyoto University
*2 RIKEN Nishina Center
*3 Research Center for Electron-Photon Science, Tohoku University
*4 Department of Physics, Rikkyo University