First result of elastic electron scattering from ^{132}Xe at the SCRIT facility†

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For the first time, nuclear charge density distribution was extracted from only 10^8 nuclei target (^{132}Xe) at the SCRIT (Self-Confining Radioactive Isotope Target) electron scattering facility,[1,2] which has been constructed at RIKEN to realize electron scattering off unstable nuclei. The data were taken in 2016, and reported in the previous report.[3]

Figures 1(a)–(c) show the reconstructed vertex distributions of scattered electrons along the beam and at vertical positions. The background contributions from residual gases are shown in Figs. 1(a) and (c) as blue histograms. It was found that the target ions were clearly trapped in the SCRIT by the transverse focusing force given by the electron beam itself and the electrostatic potential well provided by both ends of the electrodes.

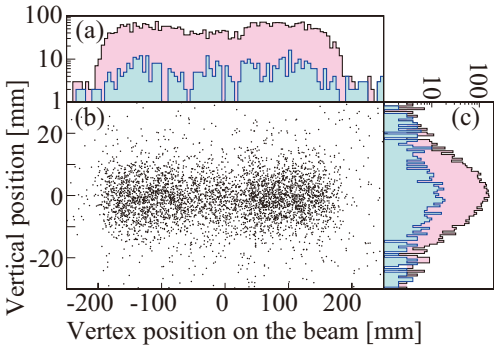

Fig. 1. Reconstructed vertex distributions of scattered electrons. Panels (a) and (c) show the vertex point distributions with and without the target ions. Panel (b) shows the scatter plot of the vertex point distribution with the target ions.

Figure 2 shows the differential cross sections multiplied by luminosity for elastic electron scattering. By changing the electron beam energies, a wide range of momentum transfer can be covered. The lines in Fig. 2 represent the elastic scattering cross sections calculated by a phase shift calculation code DREPHA,[4] assuming nuclear charge density distributions. In the present analysis, a two-parameter Fermi distribution, $\rho(r) = \rho_0/(1 + \exp(4\ln 3(r-c)/t))$, is assumed to extract the nuclear charge distribution. The luminosity is also considered as a fitting parameter, because the study of the luminosity monitor (LMon)[5] to determine the absolute value of luminosity is under way. The achieved luminosity is evaluated to be around 1×10^{27} cm^{-2}s^{-1} on average. From this analysis, the most probable values ($c = 5.42^{+0.11}_{-0.08}$ fm, $t = 2.71^{+0.29}_{-0.38}$ fm, and $\langle r^2\rangle^{1/2} = 4.79^{+0.12}_{-0.10}$ fm) are obtained.

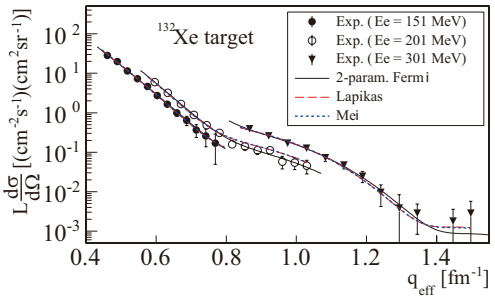

Fig. 2. Differential cross sections multiplied by luminosity, versus effective momentum transfer. The lines represent the results of phase shift calculations assuming nuclear charge density distributions obtained by the two-parameter Fermi distribution (black solid line), the Hartree-Fock + phenomenological calculation (red dashed line),[6] and the beyond-relativistic-mean-field theory (blue dotted line).[7] The parameters of the two-parameter Fermi distribution are the best values evaluated in this analysis.

This work demonstrates that the SCRIT technique enables us to perform electron scattering experiment for unstable nuclear targets. The RI production for experiments on unstable nuclei has already started.[2] Electron scattering off short-lived unstable nuclei will be realized in near future.

References

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