Proton elastic scattering with ^{86}Kr beam at 66 MeV/nucleon

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Proton elastic scattering on a nucleus is one of the fundamental nuclear reactions. Experimental data on various stable nuclei with several beam energies have been gathered. Global optical model potentials (OMPs) have been developed and widely used for performing the calculations that describe the proton-induced reactions using these data. The parameters of the global OMPs are usually calculated using the nuclear mass number (A), charge number (Z), and kinetic energy. Global OMPs can also be applied for calculating reactions with unstable nuclei by setting A and Z away from the stability line. However, how much these parameters can be applied to unstable nuclei should be evaluated because these parameters originate from the elastic scattering with stable nuclei. The experimental data on proton elastic scattering with unstable nuclei remain limited. The measurement of elastic scattering anytime anywhere any-beam (MESA) project has started as a part of the Transformative Research Innovation Platform (TRIP) of RIKEN platforms use case.[1)]

Proton elastic scattering is measured using inverse kinematics with an unstable nuclear beam and a proton target. The recoil proton from the target is measured using the DELTA telescopes, as shown in Fig. 1(a).[2)] The telescope is composed of three layers. The first layer is a single-sided strip silicon detector (SSD) with a thickness of 0.1 mm and a strip pitch of 0.1 mm. The second layer is another SSD with a thickness of 0.3 mm and a strip pitch of 5 mm. The last layer is an inorganic scintillator of CsI(Tl) or GAGG:Ce. The scattering angle of the proton is measured using the hit position of the two SSDs. The total kinetic energy is reconstructed through adding the energies measured using the three detectors. The $E-\Delta E$ method is used for identifying the recoil particles.

The first experiment with a heavy ion beam was performed in March 2024 using three DELTA telescopes.

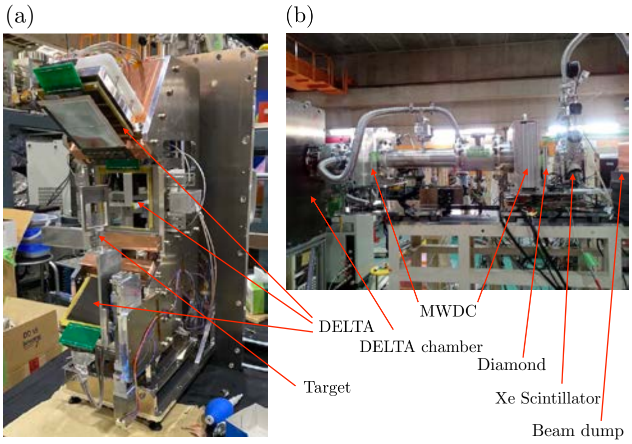

Fig. 1. Photographs of the experimental setup. (a)DELTA telescopes and target, placed in the DELTA chamber. (b) Beam line detectors downstream of the DELTA chamber.

The primary $^{86}Kr^{31+}$ beam at 66 MeV/nucleon from RRC was transported to the RIPS beam line. The slits were used between RRC and RIPS to reduce the beam spot size and the beam intensity. Standard PPAC detectors were installed for tuning the beam at RIPS, which are uninstalled during the main measurement due to the high beam intensity. The beam intensity and spot size at the target were 200–300 kcps and approximately 0.6 mm r.m.s, respectively. The telescopes were placed in the DELTA chamber at the F3 focal plane. A target ladder was also fixed in the chamber. Four targets were prepared: CH_2 (4.7 mg/cm^2) for the main measurement, carbon (5.6 mg/cm^2) for the background measurement, empty for the tuning, and a mask target for the calibration, as shown in Fig. 1(a). The target was changed without breaking the vacuum using a stepping motor.

Some detectors were placed downstream of the target, as shown in Fig. 1(b). Two low-pressure multiwire drift chambers (MWDCs) were used to measure the trajectory of the beam-like particle. A diamond detector was used for determining the beam intensity. A Xe gas scintillator was used for identifying particles. The beam was stopped in the copper beam dump.

The data are in the process of being analyzed.

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References

1) H. Baba *et al.*, RIKEN Accel. Prog. Rep. **57**, 27 (2024).
2) S. Takeshige *et al.*, RIKEN Accel. Prog. Rep. **57**, 116 (2024).