Measurement of proton elastic scattering from ^{50}Ca with a new telescope DELTA

T. Nakada,[*1,*2] T. Yano,[*1,*2] J. Zenihiro,[*1,*2] H. Baba,[*2] S. Takeshige,[*3,*2] S. Koyama,[*2] Y. Ichinohe,[*2] M. Arai,[*2] M. Yoshimoto,[*2] Y. Hijikata,[*1,*2] R. Tsuji,[*1,*2] R. Yoshida,[*1,*2] G. Ikemizu,[*1,*2] Y. Matsuda,[*4,*2] N. Yamasaki,[*4,*2] K. Yasumura,[*4,*2] S. Terashima,[*5,*2] and N. Kitamura[*6]
for the TRIP-MESA and the ESPRI Collaborations

We have began a new program of Measurement of Elastic Scattering Anytime Anywhere Any-beam (MESA) to construct a elastic scattering database of various unstable nuclei that is essential for both nuclear reaction and structure studies. The MESA program is part of the Transformative Research Innovation Platform (TRIP) project at RIKEN,[1] and is now collaborated with the ESPRI project[2] for measurements of proton elastic scattering and determinations of nuclear density distributions in unstable nuclei. Based on the study of the ESPRI project, we have newly developed telescope arrays, DELTA[3] which have large solid angles. We constructed three DELTA telescopes. Each telescope consists of a micro-strip silicon detector (SSD1) and 5-mm-pitch strip silicon detector (SSD2) and CsI(Tl)/GAGG(Ce) calorimeters. In the TRIP23 and TRIP24 experiments in March, May, and Oct. in 2024, we developed the DELTA system and successfully measured proton elastic scattering in inverse kinematics using several heavy ion beams.[4–6]

In this paper, we report the first MESA measurement from unstable ^{50}Ca at 300 MeV/nucleon performed at the F12 focal plane area of RIBF, in May 2024. The secondary beam including ^{50}Ca was produced from ^{70}Zn beam at 345 MeV/nucleon and was transported to the F12 area. At F12, the ESPRI device with a solid hydrogen target (SHT)[7] and the DELTA telescopes with a CH_2 target were installed in series. The beam trajectories were determined using a N_2 gas scintillator and two multi-wire drift chambers (MWDCs) located before the SHT. Xe gas and $LaBr_3$(Ce) scintillators were also installed after the CH2 target for the particle identification (PID) of the reaction residues. The intensity of the cocktail beam was 130 kcps, and the purity of ^{50}Ca beam was approximately 20%. The total irradiation time on the secondary targets was approximately eight hours.

As shown in Fig. 1, we selected ^{50}Ca from the correlation between the time-of-flight (TOF) at F3 and F7 and the energy loss by the Xe scintillator at F12. Even with the limited beam time, we also identified the clear elastic loci in the correlations between the recoil angles and the energy deposits in the DELTA detectors of scattered protons, as shown in Fig. 2. We preliminarily obtained an r.m.s excitation energy resolution of 0.6 MeV derived from the kinematical correlation, which was consistent with the simulation result.

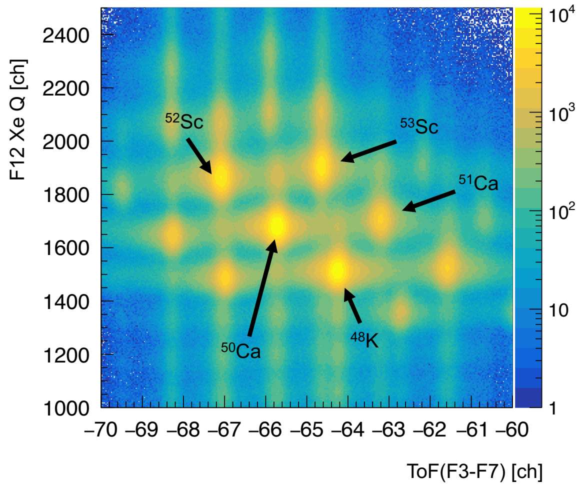

Fig. 1. PID plot of TOF data at F3-F7 and energy loss data at the Xe scintillator at F12.

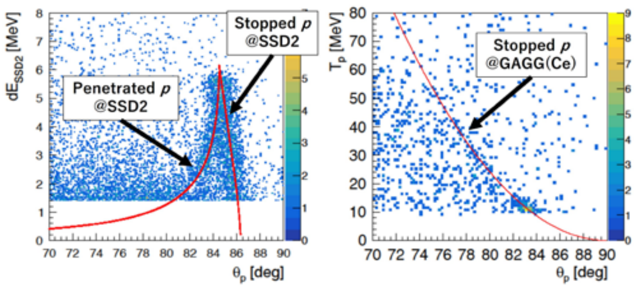

Fig. 2. Correlations between the recoil angle θ_p in the laboratory frame and the energy deposits at SSD2 (left), and at the GAGG(Ce) calorimeter (right) of the scattered protons from ^{50}Ca beam. Two-body kinematical curves of $p-^{50}$Ca elastic reaction are also plotted in red lines.

References
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*1 Department of Physics, Kyoto University
*2 RIKEN Nishina Center
*3 Department of Physics, Rikkyo University
*4 Department of Physics, Konan University
*5 Institute of Modern Physics, Chinese Academy of Sciences
*6 Center for Nuclear Study, University of Tokyo

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