Measurement of $\vec{p}$–^{6}He elastic scattering at 200 A MeV

S. Sakaguchi, [*1,*2] S. Chebotaryov, [*2,*3] T. Uesaka, [*2] T. Akieda, [*4] Y. Ando, [*3] M. Assie, [*5] D. Beaumel, [*2,*5] N. Chiga, [*2] M. Dozono, [*6] A. Galindo-Uribarri, [*7] B. Heffron, [*7] A. Hirayama, [*8] T. Isobe, [*2] S. Kawase, [*1] W. Kim, [*3] T. Kobayashi, [*4] H. Kon, [*4] Y. Kondo, [*8] Y. Kubota, [*2] S. Leblond, [*9] H. Lee, [*9] T. Lokotko, [*9] Y. Maeda, [10] Y. Matsuda, [11] K. Miki, [*4] E. Milman, [*2,*3] T. Motobayashi, [*2] T. Mukai, [*4] S. Nakai, [*4] T. Nakamura, [*8] A. Ni, [*3] T. Noro, [*1] S. Ota, [*6] H. Otsu, [*2] T. Ozaki, [*8] V. Panin, [*2] S. Park, [*3] A. Saito, [*8] H. Sakaguchi, [*12] H. Sakai, [*2] M. Sasano, [*2] H. Sato, [*2] K. Sekiguchi, [*2,*4] Y. Shimizu, [*2] I. Stefan, [*5] L. Stuhl, [*6] M. Takaki, [*6] K. Taniue, [*10] K. Tateishi, [*2] S. Terashima, [*13] Y. Togano, [*8] T. Tomai, [*8] Y. Wada, [*4] T. Wakasa, [*1] T. Wakui, [*2,*14] A. Watanabe, [*4] H. Yamada, [*8] Z. Yang, [*2] M. Yasuda, [*8] J. Yasuda, [*1] K. Yoneda [*2] and J. Zenihiro [*2]

We measured the vector analyzing power for p–^{6}He elastic scattering at 200 A MeV using a spin-polarized solid proton target and the SAMURAI spectrometer with the aim of investigating spin-orbit interaction between proton and ^{6}He (SAMURAI13 experiment). The experimental setup is described in this article.

A ^{6}He beam was produced from an ^{18}O beam with 230 A MeV using a 15 mm^t Be target and an 8 mm^t F1 degrader. Triton contamination was suppressed to 25% of the total beam intensity with an F2 collimator and was further reduced to 6% by closing the F2 slit to 2 × 2 mm^2. The experimental setup around the target is schematically shown in Fig. 1. Special care was taken to reduce the size of the beam spot at F13. STQ25 was moved 1 m closer to the target for better focusing. A veto scintillator (SBV) with an ϕ18 mm hole was installed in front of the target. The beam intensity was kept at approximately 0.6 MHz. The typical transmission ratio of the beam through SBV was 78%. The beam-spot size on the target was 5 mm in sigma. The polarized proton target was placed 4 m from the SAMURAI magnet center. The target material was naphthalene ($C_{10}H_8$) with a size of ϕ24 mm × 2.5 mm^t (285 mg/cm^2). Two lasers with wavelengths of 556 nm and 545 nm and average powers of 3 W and 0.75 W, respectively, were installed near STQ25. Pulsed laser light with a repetition rate of 3 kHz was delivered to the target. Recoil protons were detected at both the left and right sides of the beamline with ESPRI-RPS[1]. Each system consists of a drift chamber, an energy absorber, one plastic scintillator and seven NaI(Tl) scintillators. For the detection of scattered particles, FDC0 was placed 400 mm away from the target. It is expected to have good high-rate tolerance because of its small cell size of 5 mm. FDC0 was operated with a position resolution of 130 μm in sigma and a tracking efficiency of >98% even for a 1 MHz beam. Two S1-MWDCs from SHARAQ Gr. were placed behind FDC0. Scattered particles were analyzed using the SAMURAI spectrometer with a magnetic field of 2.0 T. The effect of the stray field on the performance of PMTs, polarized target and oxygen monitors was not observed. 95% of the volume of the gap chamber was replaced with helium gas to maximize the acceptance of SAMURAI without severely degrading the $B\rho$ resolution. The FDC1 chamber was slightly over-pressurized (+0.35 kPa) compared to the pressure in the gap chamber to avoid reverse force on its window film. The obtained $B\rho$ resolution was about 1/300, which is one third of the typical value. This is primarily because of the multiple scattering in helium gas and secondarily because of a low magnetic field of 2.0 T. 2.9 T is ideal for ^{6}He at 200 A MeV. The beam propagating through SAMURAI was stopped by a lead block with a size of 10×10×40 cm^3 for protecting FDC2. FDC2 and HODF24 were placed parallel to SAMURAI to cover both ^{6}He and ^{4}He trajectories. Measurements of $\vec{p}$–^{6}He (physics run) and $\vec{p}$–^{4}He scattering (polarization calibration) were performed for 3 days and 1 day, respectively. The polarization axis was reversed once in each run. The carbon target and empty target data were also taken. The current status of the data analysis is described in another article[2].

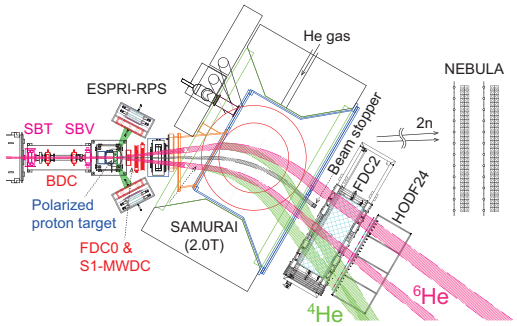

Fig. 1. Setup for SAMURAI13 experiment.

*1 Department of Physics, Kyushu University
*2 RIKEN Nishina Center
*3 Department of Physics, Kyungpook National University
*4 Department of Physics, Tohoku University
*5 IPN Orsay
*6 CNS University of Tokyo
*7 Oak Ridge National Laboratory
*8 Department of Physics, Tokyo Institute of Technology
*9 Department of Physics, University of Hong Kong
*10 Department of Physics, Miyazaki University
*11 CYRIC Tohoku University
*12 RCNP Osaka University
*13 Department of Physics, Beihang University
*14 National Institute of Radiological Sciences

References

1) Y. Matsuda et al., Phys. Rev. C **87**, 034614 (2013).
2) S. Chebotaryov et al., in this report.