Production cross-section measurement of ^{16}N isomer for proton elastic scattering experiment

R. Yoshida,[*1,*2] M. Dozono,[*1] J. Zenihiro,[*1] Y. Hijikata,[*1,*2] S. Ogio,[*1] R. Tsuji,[*1,*2] K. Yahiro,[*1] T. Yano,[*1] H. Sakaguchi,[*3] J. Tanaka,[*2,*3] S. Ota,[*3] Y. Matsuda,[*4] F. Saito,[*4] S. Umemoto,[*4] D. Nishimura,[*2,*5] M. Amitani,[*2,*5] Y. Nakamura,[*2,*5] C. Fukushima,[*2,*5] S. Terashima,[*6] N. Imai,[*7] K. Yako,[*7] S. Michimasa,[*7] T. Chillery,[*7] R. Kojima,[*7] S. Hanai,[*7] T. Uesaka,[*2] and E. Takada[*8]

Over the past few decades, several neutron-rich nuclei have been discovered to exhibit halo-like properties. The neutron halo is a common phenomenon in nuclei, observed in excited states as well. The isomeric state of ^{16}N ($J^\pi = 0^-$, $E_x = 0.12$ MeV) is a candidate for an excited halo state. A recent experimental study using the $(d, ^3\mathrm{He})$ reaction[1] indicated similarities between the $1s_{1/2}$ neutrons in the ^{16}N isomer and ^{15}C halo ground state, which suggests that the ^{16}N isomer has a halo structure. This is also supported by the result from the asymptotic normalization coefficient approach[2] and neutron removal experiment.[3]

To obtain precise information about the halo structure in the ^{16}N isomer, we plan measurements of the $p + {}^{16}\mathrm{N}(0^-)$ elastic scattering in inverse kinematics. The nucleon density distribution will be extracted from the data, which would provide clear evidence for the ^{16}N excited halo. For an efficient measurement, a secondary ^{16}N beam with high intensity and high isomeric ratio is required. To this end, we have conducted a test experiment for ^{16}N beam production. In this report, we present preliminary results of the experiment.

The experiment was perfomed at HIMAC, QST in Chiba in Feburuary 2023. ^{16}N was produced by the reaction of ^{18}O at 230 and 350 MeV/nucleon impinging on a 10-mm-thick ^{9}Be production target. Secondary beam separation was conducted with two dipole magnets and beam slits, and the settings were changed to investigate the momentum distribution of the isomeric ratio for the beam optimization. The momentum of the beam particles was selected within a central value of ±0.1% by one of these slits. Both the ground and isomeric states of ^{16}N were identified by the ToF-ΔE method with two plastic scintillators. Then, the beam was degraded for implantation to a 10-mm-thick acrylic stopper. The isomeric state of ^{16}N was tagged by γ rays from isomeric decay with $CeBr_3$ scintillator.

Figure 1 shows the production cross-section of ^{16}N including both ground and isomeric states produced with the ^{18}O primary beam at 230 and 350 MeV/nucleon, respectively. A further analysis is ongoing to obtain the isomeric ratio and production cross-section of ^{16}N isomer.

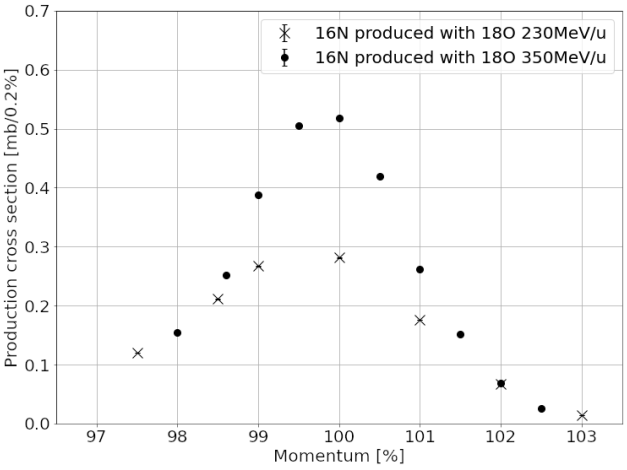

Fig. 1. Production cross-section of ^{16}N produced with the ^{18}O primary beam at 230 and 350 MeV/nucleon, respectively. Momentum 100% corresponds to 10.519 and 13.682 GeV/c. Production cross-section of each momentum was selected within a central value of ±0.1%.

References

1) T. L. Tang *et al.*, Phys. Rev. C **105**, 064307 (2022).
2) E. T. Li *et al.*, Chin. Phys. C **40**, 114104 (2016).
3) M. Fukutome *et al.*, Few-Body Syst. **63**, 37 (2022).

*1 Department of Physics, Kyoto University
*2 RIKEN Nishina Center
*3 Research Center for Nuclear Physics (RCNP), Osaka University
*4 Department of Physics, Konan University
*5 Department of Natural Sciences, Tokyo City University
*6 Institute of Modern Physics, Chinese Academy of Science
*7 Center for Nuclear Study, University of Tokyo
*8 HIMAC, National Institute for Quantum Science and Technology

DOI:10.34448/RIKEN.APR.57-188