Proton- and deuteron-induced reactions on ^{107}Pd and ^{93}Zr at 20–30 MeV/nucleon

M. Dozono,[*1] N. Imai,[*1] S. Michimasa,[*1] T. Sumikama,[*2] N. Chiga,[*2] S. Ota,[*1] O. Beliuskina,[*1] S. Hayakawa,[*1] K. Iribe,[*3] C. Iwamoto,[*1] S. Kawase,[*4] K. Kawata,[*1] N. Kitamura,[*1] S. Masuoka,[*1] K. Nakano,[*4] P. Schrock,[*1] D. Suzuki,[*2] R. Tsunoda,[*1] K. Wimmer,[*5] D. S. Ahn,[*2] N. Fukuda,[*2] E. Ideguchi,[*6] K. Kusaka,[*2] H. Miki,[*7] H. Miyatake,[*8] D. Nagae,[*2] M. Nakano,[*9] S. Ohmika,[*2] M. Ohtake,[*2] H. Otsu,[*2] H. J. Ong,[*6] S. Sato,[*9] H. Shimizu,[*1] Y. Shimizu,[*2] H. Sakurai,[*2] X. Sun,[*2] H. Suzuki,[*2] M. Takaki,[*1] H. Takeda,[*2] S. Takeuchi,[*7] T. Teranishi,[*3] H. Wang,[*2] Y. Watanabe,[*4] Y. X. Watanabe,[*8] H. Yamada,[*7] H. Yamaguchi,[*1] R. Yanagihara,[*6] L. Yang,[*1] Y. Yanagisawa,[*2] K. Yoshida,[*2] and S. Shimoura[*1]

The nuclear transmutation of long-lived fission products (LLFPs), which are produced in nuclear reactors, is one of the candidate techniques for the reduction and/or reuse of LLFPs. To design optimum pathways of the transmutation process, several nuclear reactions have been studied by using LLFPs as secondary beams. The studies indicate that proton- and/or deuteron-induced reactions at intermediate energy (100–200 MeV/nucleon) are sufficiently effective for the LLFP transmutation.[1–3] For a systematic study, we performed an experiment of proton- and deuteron-induced reactions on ^{107}Pd and ^{93}Zr at 20–30 MeV/nucleon by using the OEDO beam line.[4]

Secondary beams were produced by the in-flight fission of a ^{238}U primary beam at 345 MeV/nucleon on a Be target with a thickness of 3 mm. The beams were degraded and purified by using an Al degrader at F1 and further degraded by using another Al degrader at F5. The beam energies were 32 MeV/nucleon in front of the secondary targets. For ^{107}Pd, another setting was used to study the reaction at a lower beam energy of 26 MeV/nucleon. The beam particles were identified by the time-of-flight (TOF) between F3 and F5 measured with diamond detectors. The OEDO system was used to reduce the beam spot size, and the resulting size was 30 mm in FWHM on the secondary target.

A schematic view of the setup around the secondary target is shown in Fig. 1. The secondary targets, H_2 and D_2, were prepared as high-pressure cooled gas targets. The temperature was 40 K, and the pressure was adjusted to 7.5(15) mg/cm^2 for H_2 (D_2). In order to obtain the background contribution, empty-target measurements were also carried out.

Reaction residues were analyzed by the SHARAQ spectrometer and detected by two PPACs and an ionization chamber located at the focal plane. In order to cover a broad range of reaction products, several different $B\rho$ settings were applied in SHARAQ. The particle identification (PID) was performed with the TOF-$B\rho$-ΔE-E method. An example of the PID is shown in Fig. 2. In addition to the ^{107}Pd beam events, Ag isotope events are seen. Further analysis is ongoing.

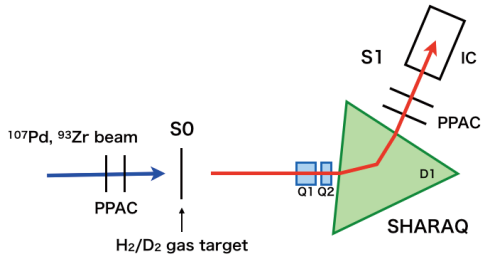

Fig. 1. Schematic view of the experimental setup.

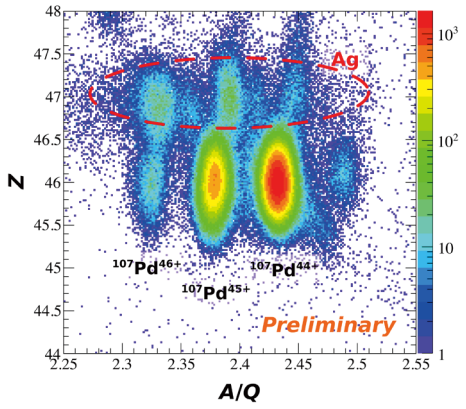

Fig. 2. Correlation of proton number Z and mass-to-charge ratio A/Q of reaction residues produced from a ^{107}Pd beam at 32 MeV/nucleon and a H_2 target.

This work was funded by the ImPACT Program of the Council for Science, Technology and Innovation (Cabinet Office, Government of Japan).

References

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*1 Cener for Nuclear Study, the University of Tokyo
*2 RIKEN Nishina Center
*3 Department of Physics, Kyushu University
*4 Department of Advanced Energy Engineering Science, Kyushu University
*5 Department of Physics, the University of Tokyo
*6 Research Center for Nuclear Physics, Osaka University
*7 Department of Physics, Tokyo Institute of Technology
*8 WNSC, IPNS, KEK
*9 Department of Physics, Rikkyo University