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Nuclide production cross sections of natLu target irradiated with 0.4-, 1.3-, 2.2-, 3.0-GeV protons

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Reliable assessment of radioactivity in target and structural materials for high-energy accelerator facilities such as accelerator-driven systems and spallation neutron sources requires detailed information on nuclide production cross sections by spallation reactions. To obtain the systematic cross section data for nuclide productions by spallation reactions, we have conducted irradiation experiments at Japan Proton Accelerator Research Complex (J-PARC). So far, we have measured nuclide production cross sections for light to medium-heavy target elements (Z≤47) with proton energies ranging from 0.4 to 3.0 GeV. To investigate heavier target elements, we conducted an experiment for target elements with atomic number around Z=70, including $^{\mathrm{nat}}\mathrm{Lu}$ (Z=71) target.

Four sets of Ho ($90\mathrm{mg/cm^2}$), Lu ($100\mathrm{mg/cm^2}$), and Re ($210\mathrm{mg/cm^2}$) foils were packed in aluminum containers together with 0.1-mm-thick aluminum catchers to avoid recoil contamination. Each set of targets was irradiated with 0.4-, 1.3-, 2.2-, and 3.0-GeV protons accelerated by 3-GeV Rapid Cycling Synchrotron (RCS). The beam current was monitored by a current transformer installed in front of the irradiation position. After the irradiation, gamma-rays emitted from the samples were detected by two high-purity Germanium detectors (relative efficiency 20%, Canberra Co., Ltd.).

The measured cross sections were compared with theoretical predictions by Particle and Heavy Ion Transport code System (PHITS) [1], and INCL++/ABLA[2,3]. The figure shows experimental and calculated $^{\mathrm{nat}}\mathrm{Lu}(p,X)^{\mathrm{nat}}\mathrm{Be}$ reaction cross sections. INCL/GEM model implemented in PHITS underestimated the experimental cross sections by a factor of about 2.

In the presentation, we will report our experimental results for the natLu target, and more detailed discussion on reaction mechanics will be given.

References

[1] T. Sato, et al., J. Nucl. Sci. Technol. 55, pp.684 (2018).

[2] D. Mancusi et al., Phys. Rev. C 91:034602 (2015).

[3] A. Kelic et al., Proceedings of Joint ICTP-IAEA Advanced Workshop on Model Codes for Spallation Reactions, ICTP Trieste, Italy pp.181 (2008).

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