Measurement of photoneutron spectra for 17 MeV linearly polarized photon on Ta, W, and Bi targets.

*Thuong Thi Hong Nguyen[1], Toshiya Sanami[1,2], Hirohito Yamazaki[1,2], Toshiro Itoga[3], Yoichi Kirihara[4], Kenta Sugihara[4], Mohd Faiz Mohd Zin[1], Shuji Miyamoto[5], Satoshi Hashimoto[6], Yoshihiro Asano[2,5].
(1. SOKENDAI, 2. KEK, 3. JASRI, 4. JAEA, 5. Osaka Univ., 6. Hyogo Univ./LASTI)

The neutron spectra of the (γ,xn) reaction were measured for 17 MeV linearly polarized photons on Ta, W, and Bi targets at BL-01, NewSUBARU, Hyogo, Japan. The target mass and angular dependence will be discussed based on experimental data.

Keywords: photonuclear reaction, time-of-flight method, polarized photon, neutron spectrum.

1. Introduction: Cross-section and angular dependence of neutron production in the photonuclear reaction are necessary to estimate the activation and shielding thickness of electron accelerators. Up to now, the neutron spectra of 17 MeV polarized beam on medium-heavy targets were measured [1]. Two components were observed on the spectra, low-energy, and high-energy parts. The high-energy component showed a strong angular dependence. In the 1960s, angular dependence was parametrized as a coefficient for various targets [2]. Referring to this, a significant difference was reported for targets having Z numbers between 70 and 90. The coefficients of Ta and W were smaller about two times than those of Pb and Bi. It is interesting to see what difference will be observed on each spectrum for nuclei showing small and large coefficients. Thus, we measured the neutron spectra on Ta, W, and Bi nuclei at 17 MeV linearly polarized photon beam along with available data of Au and Pb in [1].

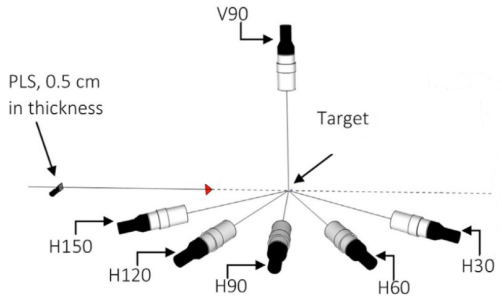

Fig. 1. Schematic diagram of experimental setup.

2. Experimental setup: The experiment was carried out at NewSUBARU BL01 facility, Hyogo, Japan. Figure 1 displays the schematic drawing of the experimental setup which was mentioned in [3]. The mono-energetic, horizontal polarized photon beam was produced by the collision of a polarized laser source and 1 GeV electron at the backscattering angle. The beam was adjusted to inject to the center of the target. Six liquid scintillation detectors (NE213, 5x5 inches) were at 30, 60, 90, 120, and 150 degrees horizontally and 90 degrees vertically to the photon beam direction. Targets were cylinders with 1 cm thicknesses for Ta and W and 2 cm for Bi. A 5-mm-thick plastic scintillator was placed upstream of the target to determine the number of incident photons. The time-of-flight method and pulse shape discrimination technique were used to obtain the spectra.

3. Data analysis: The bias energy for the whole analysis was 0.25 MeVee. The neutron energy histogram was the result of converting the TOF histogram. SCINFUL-QMD simulation was employed to define the efficiency of NE213 detectors. The final spectrum was normalized by the solid angle and the number of photons.

4. Results: Figure 2 shows the neutron spectra from Ta and Bi nuclei for the highest and lowest yield conditions that correspond to horizontal and vertical 90 degrees positions. The spectrum of W is similar to Ta, while Au and Pb are comparable to Bi. The difference in high-energy parts of Bi is larger than that of Ta. They led to the division into two groups, Ta and W group and Au, Pb, and Bi which is similar to the tendency reported in reference [2]. Besides, these results did not include neutron attenuation, so we will revise more in the future.

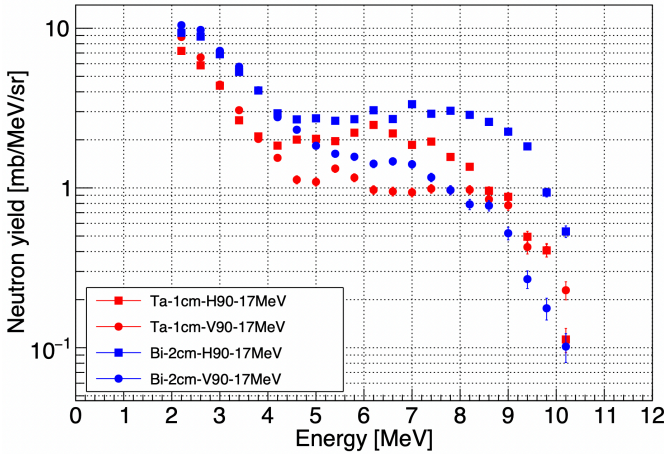

Fig 2. Neutron spectra on Ta and Bi nuclei.

This work was supported by JSPS KAKENHI Grant Number 20K12487.

References

[1] T. K. Tuyet, et al., *Nucl. Instrm. Meth.* **A 989** (2021): 164965.
[2] R. G. Baker, K. G. McNell, *Can. J. Phy.* **39** (1961).
[3] Y. Kirihara, et al., *J. Nucl. Sci. Tech.* **57.4** (2020): 444-456.