Target mass dependence of photo-neutron production with 17 MeV linearly polarized photons

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Double differential cross section of photo-neutron production was measured for 17 MeV polarized photon on Ti, Fe, Cu, Au and Pb target at NewSUBARU-BL01 facility. Target mass dependence of the neutron spectrum was observed for evaporation and direct component.
Keywords: photo-neutron, polarized photon, time-of-flight, neutron spectrum, double differential cross section.

1. Introduction: Neutron production of photo-nuclear reaction is an essential process for studying dosimetry and shielding design of an electron accelerator. Until now, neutron spectra of 17 MeV polarized photon on Au target were measured and then angular dependency of evaporation and direct component were observed [1]. To reveal atomic mass dependence of the neutron production, we took experimental data of neutron spectrum for various atomic mass targets at giant dipole resonance energy that provides the highest yield of neutrons.

2. Experiment: The experiment was done at NewSUBARU-BL01, Hyogo-Japan. The procedure is almost identical with the previous study [1]. Figure 1 shows a schematic drawing of experimental setup. The 17 MeV linearly polarized photons were produced by the collision of the polarized laser (Nd:YVO4 laser at 1.064 μm, 20 W) and electron beam with 982.4 MeV of energy. A plastic scintillator, 5 mm in thickness, was used to estimate the number of incident photons at upstream of the target. The photon beam was collimated into the center of the target. The targets, Ti, Fe, Cu, Au, and Pb, were prepared as cylindrical pills with the same diameter of 1 cm and different thickness 4 cm, 2 cm, 2 cm, 1 cm and 1 cm, respectively. An NE213 organic liquid scintillator (12.7 cm ϕ × 12.7 cm L) was set at 90 degrees horizontally with respected to the photon beam axis. In this report, we present the results of NE213 scintillator at 90^0 horizontal. The energy of photo-neutron was measured by a time-of-flight (TOF) method. The pulse shape discrimination (PSD) method was realized to separate photo-neutron and gamma.

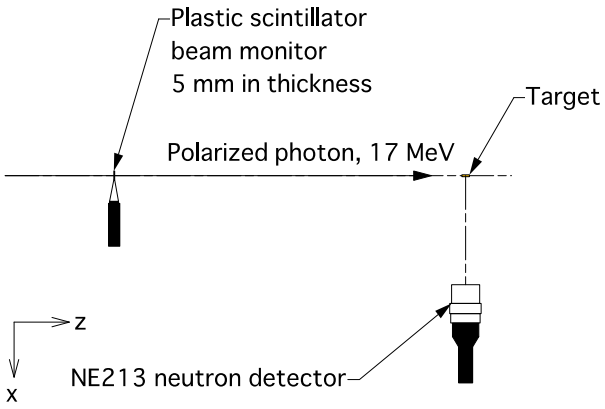

Figure 1 Schematic drawing of experimental setup

3. Data analysis : The energy threshold employed for analysis was 0.25 MeVee. The time walk effect was corrected with the fitting function as the correlation of TDC and QDC [2]. The neutron energy histogram was obtained by converting TOF histogram. The efficiency of neutron detector was estimated by SCINFUL-QMD simulation. The energy spectrum was normalized by the solid angle and the number of incident photons.

4. Result : Figure 2 shows the photo-neutron production double differential cross section for different targets. The shapes are different due to the difference in disintegration energy of neutron and the number of nuclei in each target. The cross-section of the Pb target is highest, while the cross-section of the Ti target is lowest. Similar energy dependences of the cross-section were seen for pairs of Pb and Au targets, and Fe and Cu targets. For these targets, direct component was observed.

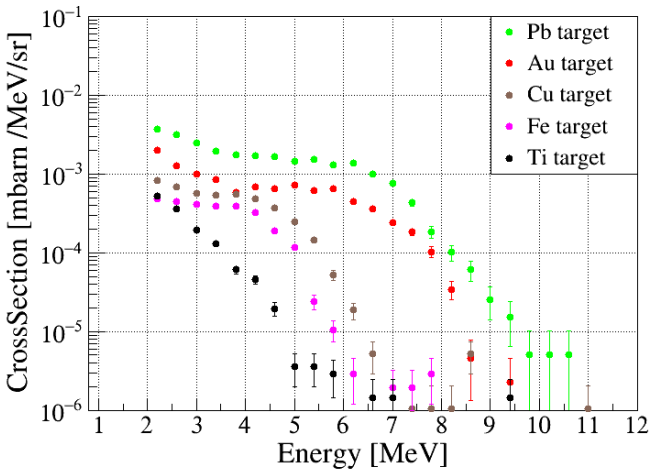

Figure 2. Double differential cross section of neutron production for targets

References

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