Neutron-Production Double-Differential Cross Sections for 150 MeV Neutron-Incidence on Fe

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High-energy neutron production double-differential cross sections are important for realization of accelerator driven system (ADS) and radiotherapy. Proton-induced neutron-production double-differential cross sections have been measured up to 3 GeV. However data of neutron-induced neutron-production double-differential cross sections above 100 MeV are insufficient because of neutron measurement difficulties and a few quasi-monochromatic neutron sources. Utilization of a continuous energy neutron source by spallation reaction enables us to measure cross section for various incident energies at a time. The purpose of this study is to measure the neutron-production double-differential cross-sections at 150 MeV on Fe with a continuous energy neutron source.

Experiments were performed at the Weapons Neutron Research (WNR) facility in Los Alamos Neutron Science Center (LANSCE) which has a 800 MeV proton linear accelerator. Neutrons generated by spallation reaction were used as incident particles. The neutron energies cover a wide energy range up to 750 MeV. A fission ionization chamber was set to know the incident-neutron flux. Six NE213 liquid organic scintillators 12.7 cm in diameter and 12.7 cm thick were employed to detect neutrons emitted from an Fe sample and placed at 15˚, 30˚, 60˚, 90˚, 120˚ and 150˚. Incident neutron energies were obtained by neutron flight times between the spallation target and NE213 scintillators. Because the distance between the spallation target and the sample were much longer than those between the sample and the detectors, the flight time of the latter was neglectable. The time-of-flight method was not used to determine the energies of emitted neutrons as it was unable to know the time when an incident neutron reached the sample. The energy spectra of emitted neutrons were derived from unfolding their deposition-energy spectra with the responses of the detectors. These response functions were also measured by using the spallation neutrons. In the process of unfolding these deposition-energy spectra, neutron-induced neutron-production double-differential cross sections were parameterized for moving source model by a least mean square approximation method. The experimental results were compared with the PHITS calculation data.