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[P06] Design of a new shadow bar to improve the accuracy of benchmark experiments of large-angle elastic scattering reaction cross sections by 14MeV neutrons

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The elastic scattering reaction cross section data commonly show smaller in backward angles compared to those of forward angles when the energy of incident neutron is high. However, in a high neutron flux field, such as fusion reactor, the effect of back-scattering reaction cross section is becoming not negligible on the calculation result. Until now, there were differences reported between experimental and calculated values of neutron benchmark experiments using a DT neutron source, which focused on back-scattering phenomena like a gap streaming experiment [1]. For this problem, the author's group developed a benchmark method for large-angle scattering cross sections using two types of shadow bars with different thicknesses (thin and thick ones) [2] and has carried out experiments with an iron sample for the last few years [3]. The benchmark method was successfully established based on the activation of Nb foil having a large activation cross section at around 14 MeV. In the experiment, we used a disk-shaped tritium target that was locally irradiated with a D+ beam to generate neutrons as many as possible. In the calculation, we considered it as a point source, however in reality it is a surface source having an intensity distribution on the target. If the position and shape of the surface source varies in each experimental system, the correct results cannot be obtained. Therefore, we decided to irradiate the D+ beam to the tritium target uniformly rather than locally. But it was found, since the current thin shadow bars is too thin (3 cm) compared to the target diameter (2.5 cm), it could allow neutrons to enter directly into Nb foil due to a small error in the installation during the preparation of the experiment. This may lead to an overestimation of the reaction rate. In order to solve this problem, we have designed a new thin shadow bar that does not allow neutrons to enter the Nb foil directly. The design was carried out using MCNP5, changing only the thickness of the thin shadow bar from the present experimental system, i.e., that of the thick shadow bar was not changed. The thickness of the shadow bars was determined so that the number of "neutrons scattered only from the target", which we wanted to see, would be large and that the Nb foil activity would be sufficient with an appropriate irradiation time. As a result of the design calculation, the lower bottom of the thin shadow bar was changed from 3 cm to 4 cm. In the future, we will conduct the experiment again using the newly designed shadow bar.

reference

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