Measurement of ^{nat}Zr (n,2n) Reaction Cross Section from the Angle Correlated Neutron Spectrum with Pencil-beam DT Neutron Source

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The (n,2n) reaction is a neutron multiplication reaction, the cross-section data of which are crucial information to design a fusion reactor. The ^{nat}Zr(n,2n) reaction cross-section is very important because Li_2ZrO_3 is one of the fusion blanket candidate materials. However, in the previous benchmark studies it was pointed out that agreement between experiment and evaluation was not acceptable.

In the case of ^{nat}Zr(n,2n) reaction cross section measurement, the conventional foil activation method cannot be applied, because suitable radioisotopes cannot be produced by the reaction. In the present study, two neutrons simultaneously emitted by the (n,2n) reaction were detected directly by two detectors. The total cross-section was obtained from measured energy and angular distribution. A pencil-beam DT neutron source of the Fusion Nuetronics Source (FNS) in Japan Atomic Energy Agency (JAEA) was used for the measurement. Two spherical NE213 detectors (4cm in diameter) were located at 18.8cm from a zirconium sample (2.4cm in diameter, 2cm long). Combination of three angles (θ_0, θ and ϕ) defined in Fig. 1 was carefully determined to set up the detectors for measuring circumferential and axial neutron emission distribution.

Measured pulse height spectra were transformed into energy spectra by unfolding process using FORIST code. The necessary detector response matrix was calculated with the SCINFUL code. Measured angle differential cross section (ADX) at 55deg. was shown in Fig.2. Total ^{nat}Zr (n,2n) cross-section was obtained by integrating energy and angular distributions by fitting with Legendre polynomials. From the result, it is suggested that the disagreement in the previous benchmark can be caused by the disagreement of ^{nat}Zr(n,2n) reaction cross section between experiment and evaluation.

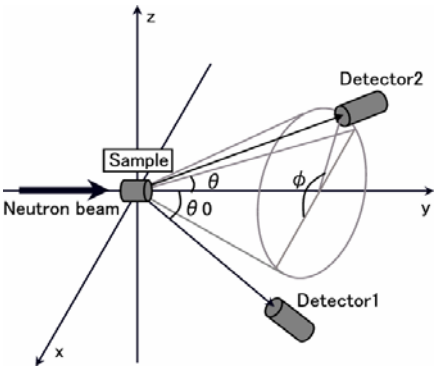

Fig.1 Experimental arrangement around detector.

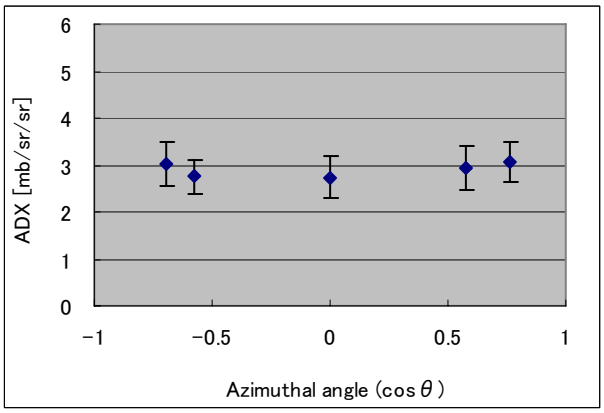

Fig.2 Angular distribution for axial direction.