Contribution ID: **35**	Type: **Poster Presentation**

Neutron Filtering System for Fast Neutron Cross-Section Measurement at ANNRI / ANNRI での高速中性子断面積測定のための中性子フィルターシステムの開発

Thursday, 26 November 2020 17:01 (1h 49m)

The Accurate Neutron-Nucleus Reaction Measurement Instrument (ANNRI) beamline in the Materials and Life Science (MLF) experimental facility of the Japan Proton Accelerator Research Complex (J-PARC) provides the most intense neutron beam available in the world and was carefully designed to precisely measure neutron-induced reactions using the time-of-flight (TOF) method. Currently, the J-PARC accelerator is operated in double-bunch mode in which two 0.1 μs wide proton
bunches are shot into a spallation target with a time difference of 0.6 μs. Because of this, events detected with a specific time-of-flight (TOF) have two different energies as they could have been originated from each of the two different proton pulses. This is particularly important in the continuum
region (keV region) where the cross section can be expressed as a smooth averaged function. In this region, it is impossible to separate the contribution from each proton pulse and, hence, this mode introduces serious ambiguities into the cross-section measurements.

A neutron filtering system has been designed in order to bypass the double-bunched structure of the neutron beam as part of the "Study on accuracy improvement of fast-neutron capture reaction data of long-lived MAs for development of nuclear transmutation systems"project. Filter materials were introduced into the ANNRI beamline in order to produce quasi-monoenergetic neutron filtered beams. The materials suitable to be used as filters present sharp minima in the total cross-section due to the interference between the potential and s-wave resonance scattering. Neutrons having that energy can be transmitted through the filters and, therefore, produce a quasi-monoenergetic beam. Filter assemblies consisting of Fe with a thickness of 20 cm, and Si with thicknesses of 20 cm and 30 cm of Si were used separately to produce filtered neutron peaks with energies of 24 keV (Fe) and of 54 and 144 keV (Si).

In this study, the characteristics and performance of the neutron filtering system at ANNRI using Fe and Si determined from both measurements and simulations are presented. The incident neutron flux was analyzed by means of transmission experiments using Li-glass detectors and capture experiments using a boron sample which was measured with a NaI(Tl) spectrometer. Moreover, simulations using the PHITS code were performed in order to determine the energy distribution of the integrated filtered peaks and assess the reliability of experimental results. Finally, preliminary results of the capture cross section of ^{197}Au are presented using the NaI(Tl) spectrometer alongside the neutron filtering system.

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Session Classification: Poster