Excitation function of ^{115}In(n,γ)^{116}In^{m} reaction cross section in the neutron energy range 0.5-3.1 MeV

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Introduction

The neutron capture cross sections find widespread use in nuclear engineering and basic science. Literature [1] shows that several experiments had been carried out to measure the neutron capture cross sections of most of the stable nuclides. However, new measurements with improved experimental techniques, latest decay data and detail analysis are still important to improve the quality of the data. ^{115}In is a stable end product of an isobaric mass chain of symmetric fission products with mass number 115. In the EXFOR database [1] only few measurements of the ^{115}In(n,γ)^{116}In^{m} reaction cross section are available. Also, complete experimental information and detail uncertainty quantification are missing in most of the reported data. Therefore, the purpose of the present work is to measure the ^{115}In(n,γ)^{116}In^{m} reaction cross section using the activation technique and to report the data with detail uncertainty propagation and covariance analysis.

Experimental details

The experiment was performed using FOTIA Facility at BARC, Mumbai. ^{7}Li(p,n)^{7}Be reaction is used as neutron source. The proton beam of energies 2.50 ± 0.02, 3.28 ± 0.02, 3.50 ± 0.02, 3.60 ± 0.02, 4.30 ± 0.02 and 5.00 ± 0.02 MeV were accelerated and bombarded on a freshly prepared thin lithium metallic foil of thickness 2.5 mg/cm^2. During the entire irradiation period, the average proton beam current ranges from 80-100 nA. EPEN code [2] was used to obtain the spectrum averaged neutron energies at each proton energy. Fig. 1 shows the neutron flux energy spectrum calculated using EPEN at proton energy 3.28 ± 0.02 MeV. The ^{197}Au(n,γ)^{198}Au reaction was used as a standard monitor. The average neutron flux during the whole irradiation ranges from 7x10^5 to 4x10^6 n/cm^2/s. The irradiation was followed by offline γ-ray counting of activated samples using HPGe detector having 50% relative efficiency. The detector dead time was negligible. The CAMAC-based LAMPS software was used for the data acquisition and data analysis of γ spectra. The γ-ray spectra obtained from

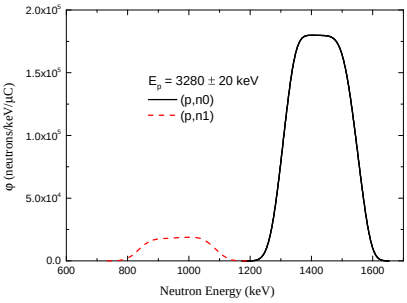

FIG. 1: Neutron flux energy spectra obtained at proton energy 3280 ± 20 keV using EPEN [2]

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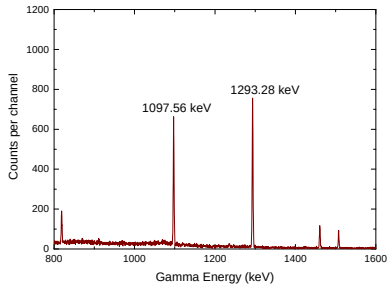

FIG. 2: Gamma-ray spectra obtained from ^{115}In(n,γ)^{116}In^{m} reaction at neutron energy 1.43 $\pm$ 0.13 MeV for t$_{irra}$ = 29220 sec, t$_{cool}$ = 780 sec & t$_{count}$ = 902 sec.

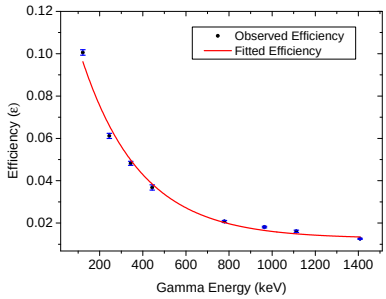

FIG. 3: Experimentally measured efficiency of HPGe Detector with its fitted curve.

the sample residue product is shown in Fig. 2 and the experimentally measured efficiency with their uncertainty for γ-ray peaks of ^{152}Eu source is presented in Fig. 3 along with the fitting curve. The neutron flux energy spectra obtained at all proton energies and the γ-ray spectra of the irradiated In samples and Au monitors will be displayed during the conference.

TABLE I: Decay data along with their uncertainties.

Nuclide	Half-Life	Eγ (keV)	Iγ (%)
^{116}In^{m}	54.29 $\pm$ 0.17 min	1293.56	84.8 $\pm$ 1.2
		1097.28	58.5 $\pm$ 0.8
^{198}Au	2.6941 $\pm$ 0.0002 days	411.80	95.62 $\pm$ 0.06

Result

The measured values of ^{115}In(n,γ)^{116}In^{m} reaction cross section at neutron energies 0.59 $\pm$ 0.15, 1.43 $\pm$ 0.13, 1.64 $\pm$ 0.10, 1.74 $\pm$ 0.10, 2.47 $\pm$ 0.10 and 3.14 $\pm$ 0.10 MeV are plotted in Fig. 4 along with JENDL-AD/2017 and reported data from EXFOR. Detail result will be discussed during the conference.

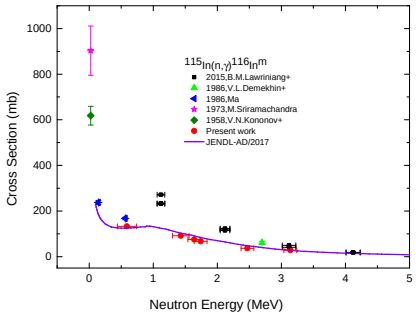

FIG. 4: Excitation function of ^{115}In(n,γ)^{116}In^{m} cross sections measured by us in comparison with the literature data and JENDL evaluated data [3]

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