Abstract

Doctor of Philosophy

INVESTIGATIONS IN NUCLEAR DATA PHYSICS AND COVARIANCES IN NUCLEAR DATA EVALUATIONS

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The relative measurement to determine $^{58}\text{Ni}(n, p)^{58}\text{Co}$ reaction cross-sections have been performed at BARC-TIFR$^2$ Pelletron accelerator facility, Mumbai, India, using activation technique and offline $\gamma$-spectroscopy using High Purity Germanium detector.

There were two targets in each of the three irradiations, corresponding to the proton beam of energy $E_p = 7.8, 12, \text{ and } 18 \text{ MeV}$, a stack of Tantalum-Lithium-Tantalum foils and a stack of Nickel, Thorium and Uranium foils. The stack of Tantalum-Lithium-Tantalum foils is the proton beam facing target, which produces quasi mono-energetic neutron beam of effective neutron energies $E_n = 5.88 \pm 0.12, 10.11 \pm 0.06 \text{ and } 15.86 \pm 0.12 \text{ MeV}$, corresponding to $E_p = 7.8, 12, \text{ and } 18 \text{ MeV}$, respectively, using the $^7\text{Li}(p, n)$ reaction. The neutron beam generated, irradiate the stack of Nickel, Thorium and Uranium foils. Our aim is to determine neutron induced reaction cross-section for the $^{58}\text{Ni}(n, p)^{58}\text{Co}$ reaction, normalized to the standard cross-section: the cross-section for the formation of $^{97}\text{Zr}$ in $^{232}\text{Th}(n, f)$ reaction and the cross-section for the formation of $^{97}\text{Zr}$ in $^{238}\text{U}(n, f)$ reaction.

We discuss, generation of covariance information using the partial uncertainties and the micro-correlations. We present necessary data and step by step simplification, in the following context: Efficiency calibration of HPGe detector with respect to $\gamma$-lines from standard $^{152}\text{Eu}$ source, efficiency of the HPGe detector with respect to characteristic $\gamma$-lines from the reaction products $^{58}\text{Co}^*$ and $^{97}\text{Zr}^*$, reaction rates in the $^{58}\text{Ni}(n, p)^{58}\text{Co}$, $^{232}\text{Th}(n, f)$ and $^{238}\text{U}(n, f)$ reactions, the ratio of reaction rates at three effective neutron energies $E_n = 5.88 \pm 0.12, 10.11 \pm 0.06 \text{ and } 15.86 \pm 0.12 \text{ MeV}$ and normalization.

We further discuss weighted averaging of equivalent data, where, by equivalent data, we mean neutron induced reaction cross-section of $^{58}\text{Ni}(n, p)^{58}\text{Co}$ reaction, normalized to the cross-section for the formation of fission product $^{97}\text{Zr}$ in the $^{232}\text{Th}(n, f)$ and $^{238}\text{U}(n, f)$ reaction, at each of the three effective neutron energies. Additionally, we illustrate $\chi^2$-scaling, when $\chi^2$ value obtained in the weighted averaging of equivalent data is higher than the expected.

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