Study of nuclear data measurement with covariances and uncertainty quantification

A. Gandhi[1],* Aman Sharma[1], Rebecca Pachuau[1], and A. Kumar†
[1] *Department of Physics, Banaras Hindu University, Varanasi-221005, India*

Many areas of the experimental nuclear science have become highly quantitative in nature and one of such experimental quantitative science is nuclear data, having applications, ranging from the design of fission and fusion reactors to nuclear medicine. Therefore, investigations which, produce such kind of quantitative information, have an obligation to perform the experiments carefully and to report the experimental investigations in detail, including the experimental uncertainties and its covariance matrix [1–11]. This detailed information helps the evaluator to do the evaluation process of the nuclear data precisely and correctly. The covariance analysis is a mathematical tool based on the error estimation which is used to estimate the uncertainty along with the cross-correlations among the observed values, such as reaction cross section.

With this motivation in mind, we have started the nuclear data program at Banaras Hindu University, India in collaboration with Bhabha Atomic Research Center, Mumbai. We

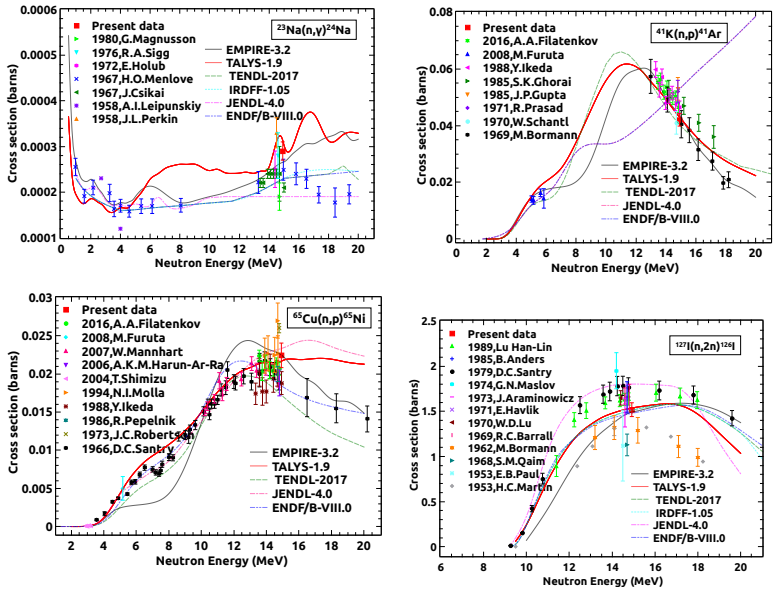

FIG. 1: Experimental results of different reaction cross sections for sodium, potassium, copper and iodine.

*Electronic address: gandhiaman653@gmail.com
†Electronic address: ajaytyagi@bhu.ac.in

TABLE I. Different reactions cross sections measured at neutron energy 14.92 ± 0.02 MeV with their associated uncertainties and inter-reaction correlation matrix between them.

Reaction	Cross section (barns) ($\sigma \pm \triangle\sigma$)	$\triangle\sigma$ (%)	Correlation matrix
^{23}Na(n,γ)^{24}Na	0.00029 ± 0.00002	7.1095	1.0000
^{41}K(n,p)^{41}Ar	0.04204 ± 0.00219	5.2232	0.6118 1.0000
^{65}Cu(n,p)^{65}Ni	0.02244 ± 0.00161	7.1785	0.5317 0.6864 1.0000
^{127}I(n,2n)^{126}I	1.51848 ± 0.07632	5.0266	0.3236 0.4656 0.2877 1.0000

have performed the nuclear data experiments at FOTIA and PURNIMA neutron facilities at Bhabha Atomic Research Center (BARC), Mumbai, India. The neutron source was based on ^{7}Li(p,n)^{7}Be and t(d,n)α reactions. The measurements were done for different reactions channels like (n,γ), (n,p), (n,α) and (n,2n). A large number of reactor structural materials like Sodium, Potassium, Copper, Gallium, Iodine, Tin etc. were used as targets of interest. Fig. 1 represents the results of different reactions cross sections for sodium, potassium, copper and iodine measured at 14.92 ± 0.02 MeV neutron energy. Table. I describes the associated uncertainties with inter-reaction correlation matrix between different reactions measured at 14.92 ± 0.02 MeV neutron energy. More details about the data analysis of cross sections and the uncertainty quantification with covariances will be presented during the conference.

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