Calibration of Indian National Gamma Array

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Introduction

The Indian National Gamma Array (INGA) was installed in beamhall II at IUAC in January, 2008 and a series of experiments were carried out[1]. The Data Acquisition System (DAS - Candle) was upgraded recently with multi-crate system consisting of three CAMAC crates. Using this DAS, multi fold coincidence data were collected from INGA. Apart from coincidence data, scaled singles data from radioactive sources are also collected for each experiment.

One of the important requirements for establishing the level scheme of a nucleus is to extract the relative angular distributions of the levels populated in the reaction. Typically such an analysis is done using an average efficiency curve for a representative detector in the array. The present excercise is an attempt to show that it is important to take into account the variation in the efficiency curves for individual detectors for a reliable extraction of angular correlation. In order to calibrate the array with respect to data correlation between different detector combinations, we took up the measurement of angular correlation of ^{60}Co γ rays using INGA array.

Experiment and Analysis

At the time of measurement, thirteen Compton suppressed clover Germanium detectors were available. The data were taken both in pre-scaled singles and in doubles mode using ^{152}Eu and ^{60}Co sources. The area under 1173 keV γ peak in coincidence with 1332 keV γ for different detector combinations are plotted in Fig 1a as a function of relative angle θ_{12} between the detectors. There is a large spread in the data points making it difficult to extract the angular correlation.

Careful analysis of singles data showed that although different detectors are expected to have similar efficiency at various energies, actual measurements indicated large variations both in lower and higher energies as shown in Fig 2. It's to be noted that all detectors are mounted at nominally same distance of 24 cm from the source and all four crystals of these detectors are used in add-back mode. The counting rates in photopeak at lower energies are dependent on the absorbers (the target holding rods) coming in front of some detectors. The counting rate varies by as much as 12 % depending on the shadow of source holder on detector. After individual detector efficiency corrections, the normalied coincidence data follows the trend as expected from theory[2] which is shown in solid curve (Fig 1b).

Conclusion

This study shows that it is possible to reliably extract the relative angular distribution of various transitions from INGA data provided the efficiency differences between different detectors are taken into account. This also confirms that the data coming from the three CAMAC crates are treated on equal footing by the data acquisition hardware[3], data collection software CANDLE[4] and the offline analysis code INGASORT.

References

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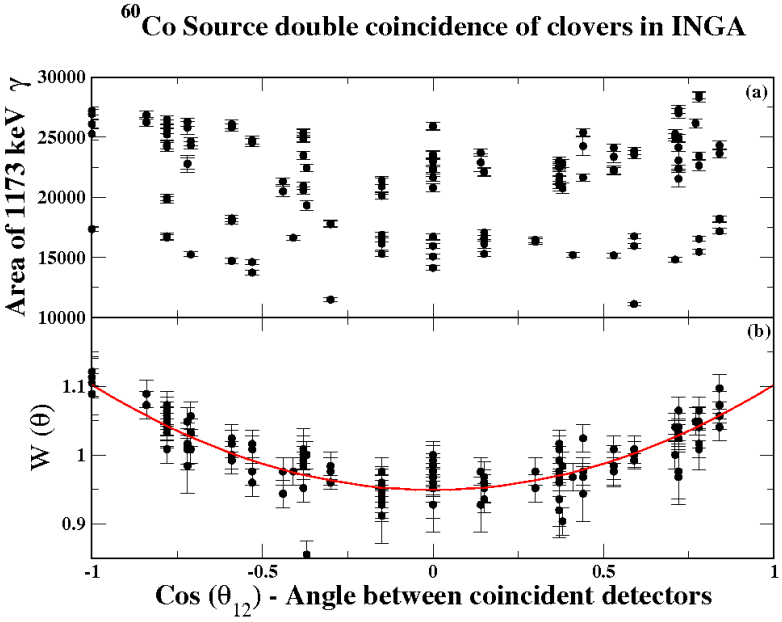

FIG. 1: (a) Area of 1173 keV γ gated by 1332 keV γ, (b) Angular correlation of ^{60}Co γ rays, and W(θ)

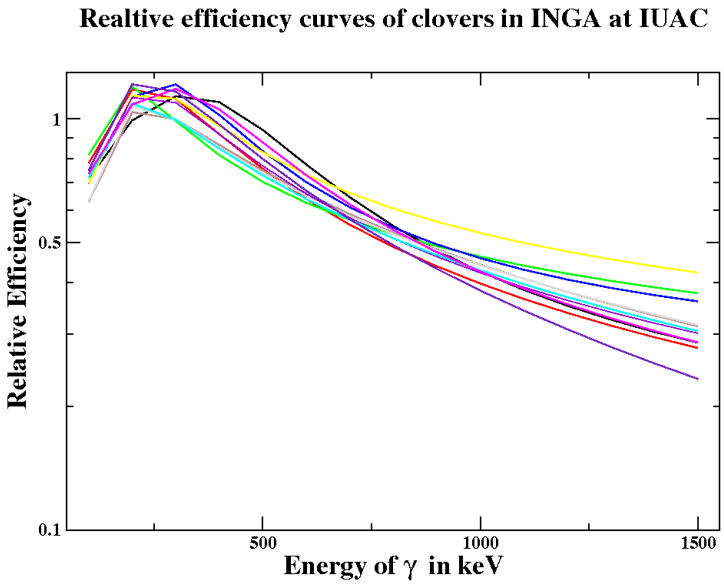

FIG. 2: Relative efficiency curves of clovers in INGA