Characterisation of a Novel Composite LEPS

M. Saha Sarkar[1], Sudatta Ray[1], Purba Bhattacharya[1], Moumita Roy Basu[2], Abhijit Bisoi[1]

[1]*Saha Institute of Nuclear Physics, Bidhannagar, Kolkata 700064, INDIA and*
[2]*University of Calcutta, Kolkata 700009, INDIA*

Introduction

The large gamma detector arrays usually have very low detection efficiency of photons less than 50 keV. But this energy range has special importance for identification of fission-fragments using their X-rays, detection of highly converted gammas emitted from low lying states in heavy nuclei, etc. Low energy photon spectrometers (LEPS) having reasonable resolution at this energy range have very low efficiency. So it is desirable to have an improved efficiency for these detectors. Electrically segmented LEPS has been utilised in some of the arrays as a solution to this problem. But the resolution of this detector is not sufficiently good. So it is difficult to resolve the X-rays which are emitted by the fragments of a spontaneous fission source. Fabrication of a composite LEPS with planar HPGe detectors having good energy resolution below 100 keV is an alternative way to get efficient LEPS with necessary resolution.

Experiment and Results

In the present work, a novel composite low energy photon detector (New LEPS) with four small HPGe planar detectors mounted on a common cryostat like a Clover detector has been used. The detector has been fabricated by DSG Detector Systems, Germany. The planar detectors are of p-type. The volume of each crystal is such that each of the crystals has a resolution of around 500 eV for 122 keV and the efficiency of the total system is around 4 times that of a single detector. This is primarily a physically segmented low energy photon detector. The active area is 4 X 80 mm^2. It has a thin Be window. The necessary reverse bias for this composite LEPS for operation is only -300 V. This is very low. Bias always depends on the material and the crystal design. In this case the crystal quality is probably very good and the design is also very interesting. The reason for negative bias is the inner design. It depends on which side of the crystal the high voltage has been applied. The noise level is quite low even without bias. Fig. 1 shows the preamplifier output from one of the crystals without bias, Fig. 2 shows the same preamplifier output with 300 V detector bias.

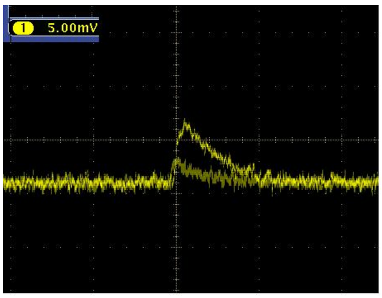

FIG. 1: Preamplifier output without bias.

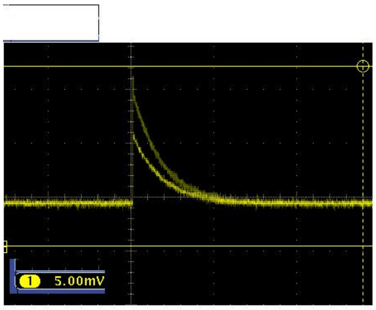

FIG. 2: Preamplifier output with bias.

Correlated total spectrum of the four crystals (similar to addback spectrum of a Clover) has been generated. In this work, the relative efficiency and the resolution of the composite detector in added and correlated modes have been compared with a normal single crys-

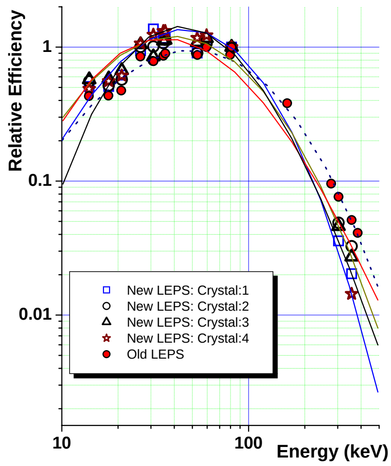

FIG. 3: Relative efficiency curves.

tal LEPS (Old LEPS). It has been found that although the single crystals of the composite LEPS (Fig.3) (New LEPS) show similar efficiencies at low energies ($\leq$ 100 keV), at higher energies the efficiency of the single crystal LEPS (Old LEPS) improves gradually.

Discussion

The comparison of the add, addback, single fold and two fold spectra clarify this behaviour. The addback spectrum of the composite LEPS contains a relatively low intensity shadow peak corresponding to each higher energy gamma peak (Fig. 4). These peaks are solely generated by the two fold events as evident from Fig. 4. Such characteristic of a segmented planar detector has also been discussed by R.J. Cooper *et al.*. [1]. They assigned the origin of these peaks on the image charges formed in the neighbouring segments.

To identify the origin more accurately, two fold spectra generated from neighbouring crystals (12,23,34 and 14) as well as diagonally opposite crystals (13 and 24) have been compared in Fig.5. It is clearly seen the the diagonally opposite crytals are contributing only half of that contributed by the neighbouring ones. To bring back these counts from the shadow peaks to the full energy peaks has been attempted to improve the characteristics of these detectors at relatively higher energies (> 200 keV).

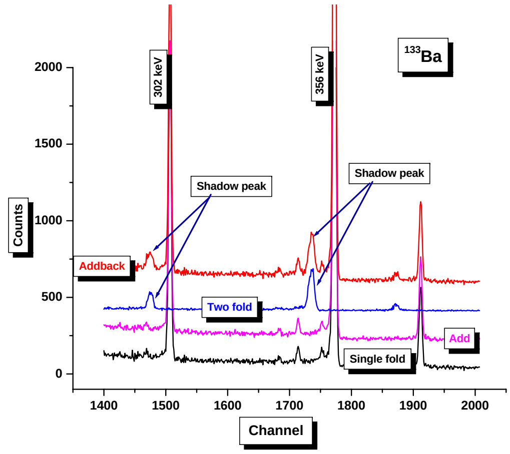

FIG. 4: The add, addback, single and two fold spectra.

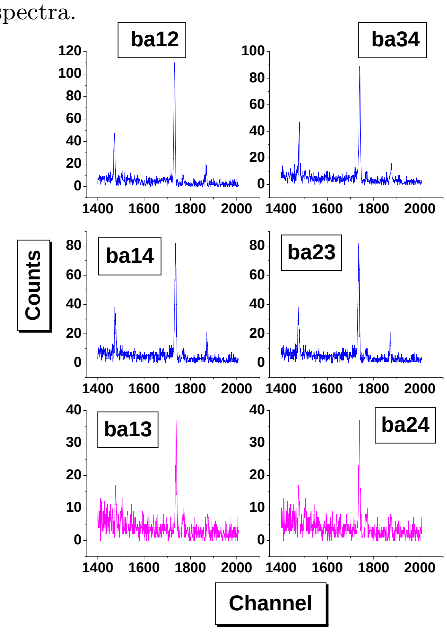

FIG. 5: The comparisons of different two-fold spectra.

Acknowledgments

The authors sincerely thank Ms. Jonaki Panja for technical help during the experiment.

References

[1] R.J. Cooper *et al.*, Nuclear Instruments and Methods in Physics Research A **595**, 401 (2008).