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A High Energy Photon Detector Simulation System

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Abstract. A high energy photon detector simulation software based on detailed Monte Carlo method starting from first principles is under development. The current status of this endeavour and some of the results obtained recently from this program are presented.

Keywords : High energy photons – simulation.

1. Introduction

The response matrix of a detector is required to deconvolve a recorded pulse height spectrum into an incident photon energy spectrum. Detailed Monte Carlo simulations are necessary to calculate the response matrix of the detector.

2. Method of Calculation and Results

The photo-electric absorption and incoherent scattering are simulated using respectively the Einstein Photo-electric equation and the Klein-Nishina formula (Knoll 2000). Photons and charged particles are propagated from their points of incidence or production through the detection medium along straight lines until the next interaction occurs. Particles and photons that escape from the boundary of the detection medium are not followed. Fluctuations in the deposited energy due to the escape of fluorescent and compton scattered photons and also the fluctuations in the secondary emission process at the photo-multiplier dynodes are considered. The detector is a 76 mm diameter CsI crystal scintillator having a thickness of 12.7 mm. A total of 6000 incident high energy photons are considered for each photon energy. The calculated efficiency of the detector is 0.996 at 102 keV. The theoretical value is 1.0.

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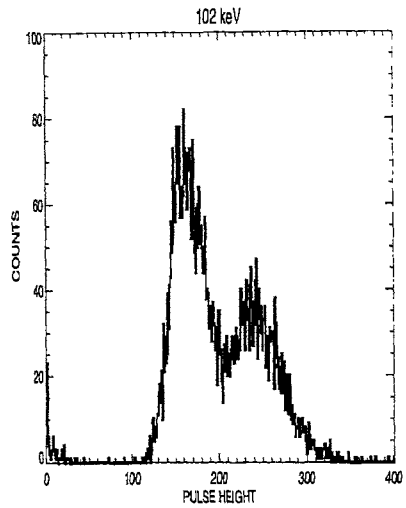

Figure 1. Simulated pulse height distribution for an incident photon energy of 102 keV. The peak at the right is an overlap of the photo-peak and the L X-ray escape peaks of Cs & I. The peak at the left is an overlap of the K X-ray escape peaks due to Cs & I. The energy resolutions of the peaks are nearly 26%. The measured value for a similar detector is 24 ± 2% at 88 keV. The photo-peak is less and the escape peak is more intense because the cross-sections at the absorption edges are under-estimates and the L-shell fluorescent probability is an over-estimate.

3. Discussion and Conclusion

It should be possible to incorporate any detector geometry in this system and calculate the detector response. This software certainly does not have the sophistication like other packages, e.g. GEANT but it is much simpler to use and it attempts to derive directly the pulse height distribution. Efforts are on to further improve this code by incorporating finer details.

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References

Knoll, G. F., 2000 *Radiation Detection and Measurement 3rd ed (John Wiley and Sons, Inc.)*, 51