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Measurement of Saturation Depth of 279 keV Gamma Rays in Bronze

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The optimum thickness, known as saturation thickness, at which the number of multiply scattered events saturates, is measured for 279 keV gamma photons in bronze. An inverse matrix approach converts the pulse-height distribution of NaI(Tl) scintillation detector to a photon spectrum.

Key Words: Multiple Compton scattering, Scintillation detector, Response unfolding, Saturation depth.

INTRODUCTION

Multiple scattering of incident photons acts as a noise in Compton profile studies. For correct evaluation of Compton profile, an accurate measurement of the intensity and energy distributions of multiply scattered photons is required to correct the data for multiple contaminations.

Our previous measurement[1] provides a complete survey of experimental, analytical and Monte Carlo simulation approaches to study the multiple scattering. The survey reveals that there are no data available on multiple scattering of 279 keV photons, so the present measurements are undertaken to investigate the multiple scattering of 279 keV photons in bronze (an alloy) target of various thicknesses.

EXPERIMENTAL

The present measurements are performed using a ^{203}Hg (279 keV) radioactive source of strength 25 mCi. Fig. 1 shows the set-up for the present measurements. The angular spread due to the source collimator (radius 6 mm) on the bronze target is $\pm 2.3°$. An intense collimated beam of gamma photons from the radioactive source impinges normally on rectangular targets of bronze of varying thickness. The radiations scattered from the target are detected by a properly shielded and collimated NaI(Tl) scintillation detector having dimensions 51×51 mm placed at 60° to the incident beam. The angular spread about the median ray in direction of the gamma detector is $\pm 3.7°$. The experimental data are accumulated on a plug-in multi-channel analyzer (MCA).

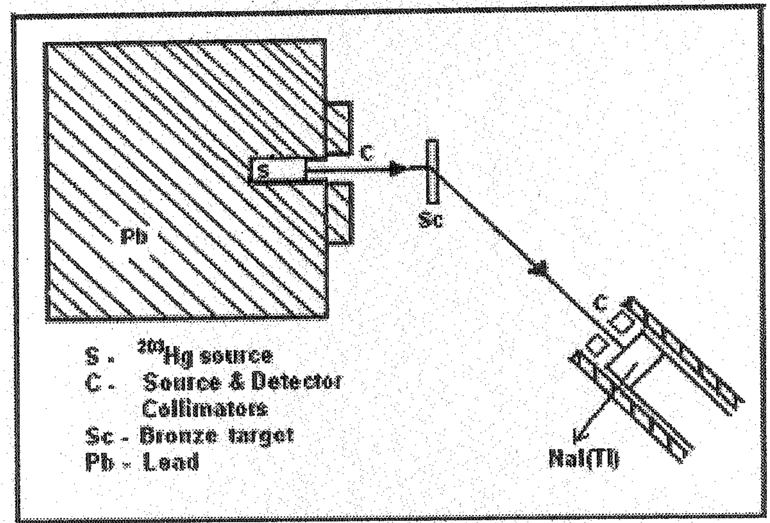

Fig. 1. Experimental Set-up

RESULTS AND DISCUSSION

A typical observed scattered spectrum (curve-a of Fig. 2) corrected for background events, originating from interactions of 279 keV incident photons with the bronze target (10 mm thick) is a composite of singly as well as multiply scattered photons. The singly scattered events under the full energy peak (curve-b) are obtained by reconstructing analytically[1] the singly scattered inelastic peak using the experimentally determined parameters. The experimental pulse-height distribution (curve-a) is converted to a photon energy spectrum with the help of an inverse response matrix[2,3] constructed for 51 × 51 mm NaI(Tl) scintillation detector. The solid curve-c is the resulting calculated histogram of N(E) in units of photons. Low pulse-height counts resulting from partial absorption of higher energy photons are shifted to the photo-peak energy. The events under the histogram in the Compton continuum accounts for photons of reduced energy (less than that of inelastically Compton scattered peak) originating from multiple interactions in the target and finally escaping in direction of the gamma detector. The events under the calculated histogram corresponding to energy range from 160 to 250 keV accounts for singly and multiply scattered radiations having energy equal to that of singly scattered ones. The events under curve-b of Fig. 2 are divided by peak-to-total ratio of the gamma detector and then their subtraction from the events under the calculated histogram (curve-c) in the specified energy range results in events originating from multiple scattering in the bronze target, having the same energy as in singly Compton scattering.

These multiply scattered events are plotted (Fig. 3) as function of thickness of the bronze target. The solid curve provides the best-fitted curve to present experimental data. The observed numbers of multiply scattered events are found to be increasing with increase in the target thickness and saturates at thickness of 6.5 mm of bronze.

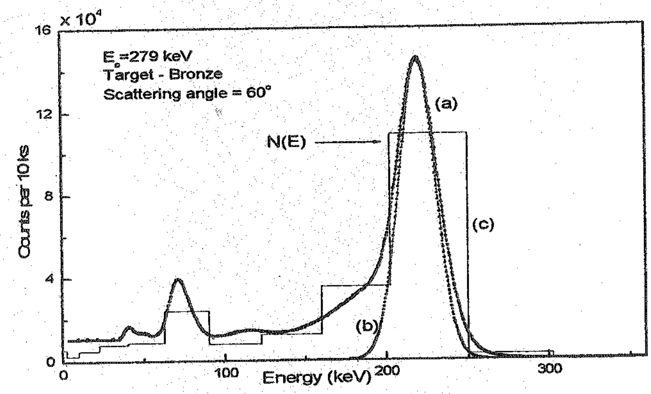

Fig. 2. Observed pulse-height distribution and its conversion to a photon spectrum

The saturation of multiply scattered photons is due the fact that as the thickness of target increases, the number of scattered events also increases but the number of photons coming out of the target decreases. So a stage is reached when the thickness of the target becomes sufficient to compensate the above increase and decrease of the number of photons

A decrease in the intensity of multiply scattered photons emerging from the target at further increasing target thickness is due to absorption and further attenuation of scattered gamma rays in the target before reaching the detector. The work on multiple scattering is further in progress for targets of different atomic numbers and under different geometrical conditions.

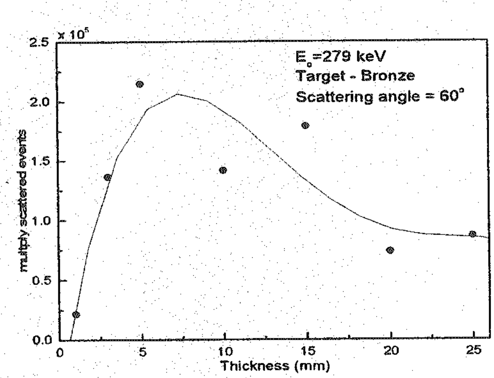

Fig. 3. Variation of observed number of multiply scattered events as function of thickness of the bronze target

REFERENCES

1. M. Singh, G. Singh, B.S. Sandhu and B. Singh, *Appl. Rad. Isotopes,* **64**, 373 (2006).
2. J.H. Hubbell, *Rev. Sci. Instr.*, **29**, 65 (1958).
3. J.H. Hubbell and N.E. Scofield, *IRE Transactions Of The Professional Group Of Nuclear Science* **NS-5**, 156 (1958).