

Mathematical modeling utilizing the MCNP code and determination of response curves of a NaI(Tl) detector

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This report presents a mathematical modeling for NaI(Tl) radiation detector using the MCNP code and the determination of its response curves. A detector that measures a type of radiation with high efficiency can be unsuitable for other types, so the choice of the detector depends on the type of radiation it is operating with, among other parameters [1]. To be able to determine the operating voltage, efficiency and energy resolution several measurements were made utilizing the NaI(Tl) detector and various radiation sources. The operating voltage can be obtained by running several experiments with different voltages and observing the voltage range in which the measurement counts are stabilized. The efficiency can be calculated utilizing those measurements and known values such as the source activity, while the energy resolution of the detector can be obtained from the photopeak full width at one-half of the maximum height (FWHM) [2]. The mathematical model developed was based on a cylinder shaped detector with a 2 cm radius and 5.3 cm length and was utilized to simulate the measurements of a ¹³⁷Cs source so that the results could be compared to the experimental ones. Figure 1 shows the calculated efficiencies for each energy value. The efficiency peak, as shown, was found to be around 200 keV.

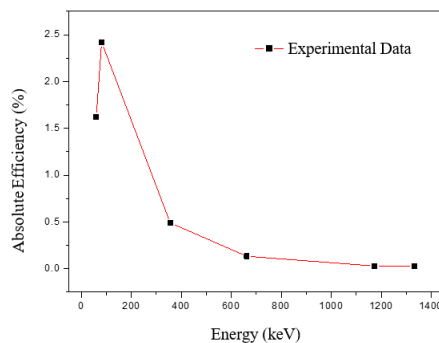


Figure 1. Efficiency curve for the NaI(Tl) detector

Figure 2 shows the calculated energy resolution for each energy. By the results obtained it is possible to observe that the resolution decreases as the energy increases.

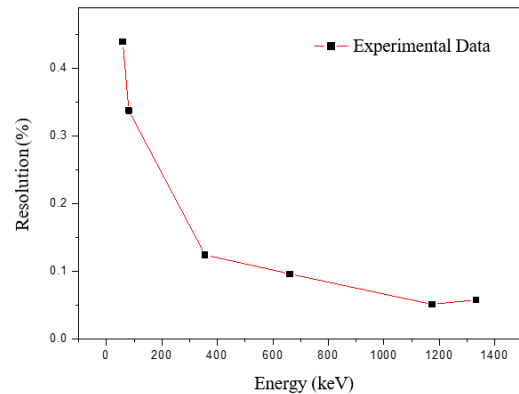


Figure 2. Energy resolution curve for the NaI(Tl) detector

The results obtained from the simulated measurement with the ¹³⁷Cs source were compared with the experimental ones in Figure 3. The photopeak area showed good compatibility while the scattering region shows a considerable discrepancy that may be explained by background radiation.

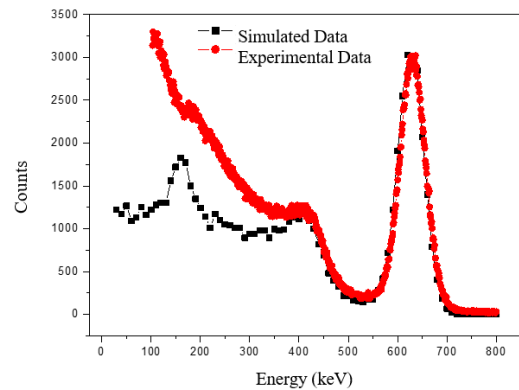


Figure 3. Experimental and simulated measurement comparison

References

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