Study of efficiency transfer method for NaI(Tl) detector

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The use of NaI(Tl) scintillation detectors for measurements implies the determination of the detection efficiency as a function of the energy of the incident photons. The efficiency curve can be obtained experimentally with the use of several monoenergetic sources calibrated with emission energies that cover the whole range of interest. A theoretical validation using the Efficiency Transfer Method (MTE) was used in three different positions on the axial axis [1]. This method is based on the ratio of effective solid angles to calculate the absolute efficiency of photopeak that correlates the effective solid angle between the source and the detector. Given the efficiency value of a source at a point P_1, it is possible to obtain the efficiency response at a different point P_2, see Figure 1. It is worth noting that the material (air) between the source-detector in the calculation of the effective solid angle was not considered.

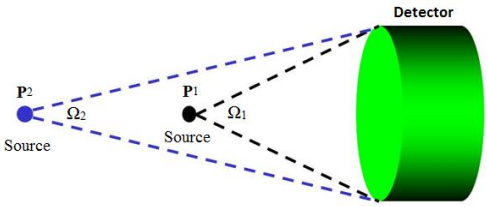

Figura1. Ângulos sólidos

A NaI(TI) detector with dimensions of 3.175 cm in diameter and 1.905 cm in thickness and a radiation source of ^{137}Cesium (662 keV) was used to perform the experiments. The source was supported on a Teflon holder with a diameter close to its size and a concentric through hole to allow source-detector emission without interference. To ensure the vertical alignment between the source-detector system, a plumb bob was used and for the horizontal, a bubble level. The measurement geometry is shown in Figure 2. The efficiency calculation was performed in 3 different detector-source distance (DSD) positions (10.6 cm, 11.3 cm and 12.0 cm). The measurement time was of 30 min to reach the uncertainty of 1% in the counts of the photoelectric region. The program used to obtain the spectra was the GENIE 2000, a spectrum acquisition and analysis tool.

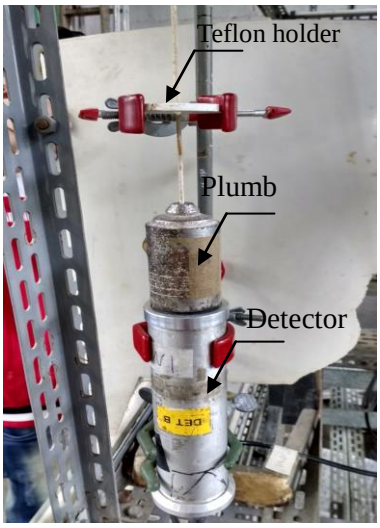

Figure 2. Measurement geometry

The experimental results were compared to the values calculated by the MTE. Table 1 shows the efficiencies obtained by the MTE using the experimental values.

Table 1 - Comparison between the experimental results and the MTE

DFD (cm)	Efficiency		ERROR %
	Experimental	MTE	
10.6	0.0470	0.0434	-7.74
11.3	0.0439	0.0471	7.18
12	0.0396	0.0428	7.01

The experimental validation presented maximum relative errors of 7.74% for the position 10.6 cm. It is possible that with the use of small differences between DSDs (due to limitations of the measurement system) the accuracy has been compromised. The MTE relative error if the distance of the source had an inaccuracy of 1 mm presented a 9% error. In any case, the results indicate the possibility of calculating efficiency using the MTE.

References

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