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Calculation of efficiency for a high-resolution gamma-ray spectrometer used for environmental radioactivity measurements

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An accurate procedure for obtaining full energy peak efficiency for high purity germanium detectors using measurements for experimentally calibrated samples geometries is time consuming and often expensive. That is why methods such as Monte Carlo simulations have been proposed and examined by means of results intercomparison. In the case proposed, the geometries used are vials of 45 mm height and 25 mm diameter, made of glass (density: ~2.50 g cm^−3) with a wall thickness of 0.5 mm, as these are the most used geometries for regular monitoring of the environmental radioactivity, on daily/monthly bases, in the area of the institute and nearby. Measured isotopes in environmental samples are 241Am, 137Cs, 60Co, 40K, progenies of 238U and 232Th series. To determine the efficiency of the detector for these geometries quality control sample material from IAEA was used. Six vials have been filled to different heights with soil from one quality control sample, after it has been dried and homogenized. These calibration samples were then measured for long time. The calibration material was modelled as soil with density 1.6 g cm^−3. Detector response was simulated using the MCNPX code, calculating the pulse height tally, that estimates the distribution of the energy deposition which represents an energy spectrum in a physical detector. The results showed an agreement within 5% between simulated and measured efficiencies. The Monte Carlo method has reliable results, can be used for large range of geometries and in a cost effective way.

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