Development of Technology for Unfolding Radiation Energy Spectra using EGS4 Monte Carlo Code

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ABSTRACT

The EGS4 Monte Carlo simulation technique has been developed to obtain the energy spectra of the incident particles at a position where the particles enter the detector from the spectra measured by the same detector. In a preliminary step, feasibility of the simulation code was investigated by comparing the energy spectra measured using a high purity Ge detector with the calculated ones. A collimator consisting of lead disks with 3 mm diameter holes was used to reduce the scattered photons from the surrounding material entering the detector. The measured spectra with the collimator were then compared with the theoretically calculated ones using EGS4 code. The comparison showed excellent agreements for several radioisotopes with negligible difference in the shapes of the absorption energy spectra. In the next step, the measured spectra obtained by changing a source to detector distance from 10cm to 100cm for ^{60}Co and ^{137}Cs sources were unfolded. To unfold the measured spectra, pulse height distributions of the high purity Ge detector were first calculated using EGS4 code and the calculated spectra were normalized to the measured spectra at the peaks of incident beam energies. The strengths of the main peaks in the unfolded spectra appeared to be stronger than the ones in the measured spectra by 3 to 5 times. As the source to detector distance increases, the ratio of the events caused by the scattered photons at the surrounding materials also increased. In the unfolded spectra of ^{60}Co and ^{137}Cs in the open space with the source to detector distance 10 cm, about 9 % of the total events were due to the scattered photons from the surrounding materials, while at 50 cm, about 25 %. The electron contribution to the unfolded energy spectra for the ^{137}Cs source shows the behavior of decreasing as the distance increases and becoming negligible over 50 cm. In the unfolded spectra for the ^{60}Co and ^{137}Cs sources in the actual irradiator, the ratio of two peaks to the total strength is 71.9 % for ^{60}Co and 64.1 % for ^{137}Cs.

Keywords: Computer simulation, EGS4 code, HPGe detector, scattering, energy spectrum, unfolding