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#08-89 Efficient System for Small Waste Containers Activity Estimation

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A new system design and a method to estimate and classify small waste containers is presented. A homogenous radioactive waste, placed in these small containers. Each container activity needs to be assessed in order to classify its activity level, e.g. Very Low-Level Waste etc. We propose a measurement system in the shape of a rectangular box made of several plates of scintillator detectors. The waste-container is placed inside the scintillators box to measure the emitted Gamma-photons. This detection configuration is the most efficient due to the full 4π coverage of the radioactive material with detectors. In this configuration the photons count rate is not affected by the 1/R2, since all photons emitted from the radioactive material and not absorbed by the container matrix reach the detectors. These photons are counted with high efficiency if the scintillator is thick enough relative to the emitted photons energies. The total count rate is predominantly affected by the matrix attenuation due to absorption and scattering.

To estimate the activity accurately, one needs to know the matrix attenuation and the spatial distribution of the radioactive material or 'hotspots' position. For known homogenous materials the attenuation can be estimated by weighting the container and calculating its density. Otherwise, we validate the homogeneity by measuring the attenuation along the three container axes using a collimated external source on one side and collimated detector on the other side.

When all the activity is emitted from a single concentrated source, in the center of the container, then the count rate of the detector is minimal due to the maximal attenuation. Any other source with the same activity in a different position or spatial distribution (such as several sources with the same total activity), will give a higher count rate. Thus, for a measured count rate and attenuation, if we assume that all photons were emitted from the center of the container, the estimate of the total container activity is the highest possible activity. In other words, the upper bound of the activity in the container is calculated by assuming a single source in the center of the container. Hence, a better estimation of the source spatial distribution will lower the upper bound of the activity estimation and will make it more accurate.

For a better spatial distribution estimation, we 'break' the box detector into many smaller detectors (pixels). For example, when each side is measured independently, it gives six detectors readings. If each face is divided into several pixels, then the fuller data will provide a better spatial estimation, and hence more accurate activity estimation. However, this leads to a more complex and expensive system. The purpose of this work is to find, using simulations, the relation between the number of pixels in the detection box, to the total activity estimation accuracy, for different attenuations (the medium type, density and energy emitted). The results will be used in the system prototype design in order to meet the requirement for the allowed activity estimation error.

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