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Author

Dylan Silveira

Organization

McMaster University – Hamilton, ON

Title

Development of the spectral decomposition algorithm for the analysis of HPGe gamma spectra collected from low-level waste samples

Abstract

Gamma-ray spectrometry is the gold standard for the identification and quantification of radionuclides in low-level waste (LLW) samples. Owing to their excellent energy resolution, high-purity germanium (HPGe) detectors are the most widely used. Conventional gamma spectral analysis typically focuses on the peak regions of the spectrum. However, for weak gamma emitters, counting statistics are often poor and therefore, analyzing the full detector response function is highly beneficial, given the Compton continuum of the response function takes a significant fraction of the total counts from each radionuclide. Unlike the conventional method, the spectral decomposition method extracts the total counts from each radionuclide, including features such as the Compton continuum, by applying a linear decomposition algorithm using the response functions (i.e. model spectra) of the radionuclides of interest and background radiation. Founded on our original spectral decomposition code developed for NaI(Tl) detectors, a new decomposition code was implemented in MATLAB for the low-level analysis of HPGe gamma spectra. Three model spectra were acquired using an HPGe detector for Cs-137, Co-60, and background. A comprehensive performance evaluation was conducted using both synthetic and real MCA spectra with various total counts and count ratios between Cs-137 and Co-60. The results demonstrate higher stability and reduced uncertainty in count rate compared with the conventional method for low-count spectra.