



Direct Detection of Pu-242 with a Metallic Magnetic Calorimeter Gamma-Ray Detector

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Cryogenic high-resolution gamma-ray detectors can improve the accuracy of non-destructive assay (NDA) of nuclear materials in cases where conventional high-purity germanium detectors are limited by line overlap or the Compton background. We have improved the performance of gamma detectors based on metallic magnetic calorimeters (MMCs) by separating the 0.5mm x 2mm x 0.25mm Au absorber from the Au:Er sensor with sixteen 30 μm diameter Au posts. This ensures that the entire gamma-ray energy thermalizes in the absorber before heating the Au:Er sensor, and consequently improves device linearity and energy resolution. Our MMC gamma-ray detectors have achieved an energy resolution of 46 eV FWHM in a dilution refrigerator at 15 mK, and between 90 and 140 eV FWHM in an adiabatic demagnetization refrigerator at 35 mK. The high energy resolution enables the direct detection of gamma-rays from Pu-242, an isotope that cannot be measured by traditional NDA and whose concentration is therefore inferred through correlations with other Pu isotopes. The Pu-242 concentration of 11.11 ± 0.42 % measured by NDA with MMCs agrees with mass spectrometry results and exceeds the accuracy of correlation measurements.