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Title: Passive Gamma-Ray Imaging of Special Nuclear Materials

Abstract
A handheld dual-particle imager composed of organic and inorganic scintillators coupled to silicon photomultipliers has been designed and built. Gamma-ray imaging is performed by reconstructing double-scatter events between organic and inorganic scintillators to localize gamma-ray emitting sources. The key benefit to performing Compton imaging by reconstructing gamma-ray interactions between the two types of scintillators is being able to assume the sequencing of the interactions with a high degree of certainty. Photoelectric absorption in the energy ranges of interest tends to be negligible in organic scintillators. Reconstructing gamma rays within a summed photopeak then means that the gamma ray must have undergone photoelectric absorption in the inorganic scintillator in the second interaction. The first interaction in the organic scintillator is then most likely a Compton scattering interaction. This Compton imaging methodology was shown to accurately reconstruct gamma-ray sources such as 137Cs and 22Na. To further test this methodology, a mock 10-kg equivalent highly enriched uranium sphere and a 100-g disk of plutonium were measured at Savannah River National Laboratory. The sources were measured independently and in the same field of view. In both cases, the H2DPI was able to accurately reconstruct the two sources by passively imaging the emitted gamma rays.