Real-Time Digital Signal Processing for HPGe Detectors

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It is well known that the leading edge of signals from solid state detectors displays details that arise from the particulars of the interaction of the incident gamma-ray (amount of energy deposited and locations of deposition) and the properties of the detector (electric field, charge carrier traps, etc.). If the detector response is understood, which is the case for high purity germanium detectors (HPGe), these signal details can be used to correct individual signals, thus improving the measured spectrum. We have already established the proof-of-principle that signals from conventional coaxial HPGe detectors can be unfolded with sufficient accuracy to determine the radial locations where energy is deposited with good resolution (less than 1 mm). Our algorithms utilize this location information to perform Compton suppression without anticoincidence detectors. Monte Carlo predictions show that it should be possible to choose algorithm parameters that would actually allow nuclear assays to be performed in less time. To test this hypothesis, we are currently applying our algorithm to measurements of gamma-rays from nuclear material samples of interest to materials control and nonproliferation. We are currently testing the effectiveness of the algorithm and optimizing the algorithm parameters. We will implement our algorithm with a digital signal processor in order to perform the Compton suppression in real time. If successful, this work could lead to improved techniques for materials assay. When used with cryo-cooled HPGe detectors, our signal processing system and algorithm would enhance capabilities for remote assays.