

Pulse Shape Discrimination for INTEGRAL's Spectrometer Instrument

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NASA is providing a Pulse Shape Discrimination (PSD) system for the Ge detectors of the Imaging Spectrometer (SPI) on ESA's INTEGRAL mission. This will reduce the background and improve the sensitivity between approximately 400 keV and 2 MeV. The dominant background contributor for the detectors in this energy range will be beta-minus decays from Ge isotopes activated by cosmic rays. This induced activity has mostly single-site energy losses, while photons in this energy range usually deposit energy in multiple sites. The differences in these types of events' pulse shapes can be exploited to reject single-site events. The effectiveness of this technique is enhanced by using Ge detectors with small central bores and a high-bandpass preamplifier output (separate from the spectroscopy output); pulses from single-site events are strongly peaked, and pulse duration is around 400 ns. This signal is sampled at 100 MHz, digitized to 9 bits, and analyzed on the basis of its resemblance to a single-site event versus a linear combination. Recent progress includes an analysis algorithm that runs fast enough in the flight processor yet still approaches the theoretical increase in sensitivity, rejecting more than 95% of the single-site events while accepting about 60% of the multiple-site events. For the background expected in the interplanetary INTEGRAL orbit, sensitivity should be improved by a factor of 2.1 at 845 keV. The Pulse Shape Discriminator's electronic systems and analysis algorithm are described, and results on discrimination between single-site and multiple-site events are presented.