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P1.61: X-ray and Gamma-Ray Photon Spectroscopy with Continuous Sampling Readout

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We present results from a new x-ray and gamma-ray spectrometer with continuous sampling of detector signals. The system was designed for Compton scatter collimation with up to 4 detector crystals of cadmium zinc telluride (CZT of 20mm x 20mm x 10mm). Here, we report on the capability to sample positive and negative polarity charges from detector electrodes at programmable sampling frequency. This feature is important for the use with other room-temperature semiconductor detectors like germanium, TlBr3, and CsPbBr3 (CPB). Using Cs-137 gamma-rays and a CZT with 121 pixelated anodes at room-temperature, we measure energy resolution of 4keV FWHM, i.e., 0.60% FWHM at 661.7keV for 121 pixels (100%). The system allows one to measure positive and negative charge polarity in the range from -700fC to +700fC. With CZT, we find that 50-MHz sampling speed is well suited, and we demonstrate sampling at 25MHz, 12.5MHz, and 6.25MHz which would suit “slower”detector materials, like TlBr3 and CPB. The sampling readout of signals from anodes and cathodes allows one to measure the exact location of Compton-scatter interactions in the detector crystal which enables Compton scatter collimation. Possible applications are high-resolution energy spectroscopy and imaging of radiation from a distance.

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