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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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