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X-ray interaction characteristic functions in semiconductor detectors

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The Compton scattering (CS) and the photoelectric effect (PE) accompanying fluorescence (FL) in semiconductor detectors can cause confused information about interaction locations. This implies signal spreading and increased correlation noise in resultant images. Escapes and reabsorptions of those secondary photons can further increase image noise. When the detector is operated in a photon-counting mode, those effects can also degrade energy resolution.
Using the Monte Carlo technique, we investigate x-ray interaction-induced signal spreading in cadmium telluride, which is typical sensor material used for photo-counting detectors, for various imaging applications such as mammography, radiography, and computed tomography. History of a single photon can be diverse: for example, PE with the production of FL and termination of FL by PE; remote PE plus FL interaction of a scattered photon and termination of FL by PE, etc. Novelty of this study can be found that we distinguish single-photon histories and determine their corresponding signal spreading characteristic functions, as shown in Fig. 1. We discuss energy-dependent characteristic functions for a wide range of energy. We expect this study will be helpful to the design of photon-counting detectors.

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