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X-ray interaction-induced signal and noise characteristics of edge-on silicon microstrip detectors for digital mammography

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It has been greatly paid attention in the development of novel x-ray imaging technologies based on single-photon energy measurements for superior image quality with a reduced patient dose. While the promise of this research is exciting, we are at an early stage in the design of energy-resolving detectors. To be successful, it is critical that we fully understand what detector designs have the best chance of success and what designs will never be successful due to fundamental physical or engineering limitations. In the contemporary designs, microstrip silicon detectors having edge-on geometry to the x-ray incidence have been used especially for digital mammography. Using Monte Carlo techniques, we investigate the fundamental signal and noise performances induced by x-ray interactions in the edge-on microstrip detector designs. The response functions are determined and used to determine quantum efficiency, average energy absorption, Swank factor, and detective quantum efficiency based on energy-moment theory. In addition, relative energy accuracy and imprecision in photon-energy measurements are estimated. The results are analyzed with x-ray interaction physics. The spreading of signal and noise through pixel strips due to the Compton scatter is also analyzed. Analyzing approach in this study will be very useful to the better and optimal designs of photon-counting x-ray detectors, such as the optimal tilting angle that may provide the best signal-to-noise performance.

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