Purpose: To develop a comprehensive Monte Carlo (MC) model of an indirect-detection electronic portal imaging device (EPID) that can self-consistently quantify the effect of optical blur on the output signal.

Methods: A model of an indirect-detection EPID was developed using the Geant4 MC toolkit. The EPID was modeled as a series of uniform slabs with thicknesses and material properties obtained from published literature. The model also included a slab of solid water backscatter material directly beyond the EPID rear housing. The standard electromagnetic and optical physics Geant4 modules were incorporated into the model to simultaneously simulate both high energy and optical photon transport relevant for indirect-detection EPIDs. A narrow, monoenergetic beam of 1 MeV photons was used to generate a line of radiation normally incident on the EPID surface. The beam width was equal to the pixel pitch of 0.4 mm used for scoring particle hits and energy deposition in the gadolinium oxysulfide scintillator and amorphous silicon photodiode layers. Optical and gamma photons were scored separately in the photodiode layer to measure their relative effects on the output signal. Line spread functions (LSFs) were generated indicating the distribution of hits and energy deposited across the scintillator and photodiode planes.

Results: The LSFs for optical photon hits in the photodiode array and energy deposition events in the scintillator had a FWHM of approximately 4.7 mm and 0.82 mm, respectively. This indicates a significant increase in image blurring due to optical photon scatter.

Conclusions: Our results indicate that modeling optical photon transport may be important when simulating imager performance for an indirect-detection EPID. Further analysis of calculated LSFs, including determination of the detector modulation transfer function, is required to further quantify imager performance.

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