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P2.70: Analysis of absorption signal and noise in thin phosphor detectors for high-energy transmission radiography

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For the application to megavoltage (MV) or mega-electron volt (MeV) imaging, we investigate theoretically and empirically the signal and noise characteristics of thin gadolinium oxysulfide phosphor detectors. For several phosphor detector designs, we perform the Monte Carlo (MC) simulations for various MV x-ray spectra from linear accelerators and gamma-rays (ranging from hundreds of keV to a few MeV) from radioisotopes. Applying the moment analysis to the MC pulse-height measurements, we estimate the energy-absorption signal, its induced noise, and the detective quantum efficiency (DQE). In the analysis, we also take into account the effect of electron-buildup metal layers for possible signal enhancement, which are placed on the top of phosphor detectors, and investigate the role of secondary radiations on the DQE. We construct phosphor-coupled CMOS detectors and report their detection performance for image quality indicators under MV and MeV irradiation environments. This study will be helpful for the development of bendable detectors.

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