AbstractID: 8839 Title: Patient Scatter Analysis for A New Generation of Portal Imaging Sensors Based on Thin-Film Cadmium Telluride

Purpose: An X-ray detector using a layer of polycrystalline Cadmium Telluride (CdTe) in combination with metal plate, serving as a converter of incoming x-rays into electrons, is investigated for therapeutic radiation oncology imaging. Using Monte Carlo simulation, we performed a theoretical analysis of the spatial frequency dependent detective quantum efficiency (DQE) for this detector system. A range of optimal parameters were obtained for this new generation of megavoltage detectors using thin film one of which is the consideration of the influence of patient scatter, a significant component of the realistic detector input on the image quality.
Method and Materials: We examined several choices of metal plate for the thin-film CdTe detector under 6 MV x-ray beam of Elekta Precise Linac by Monte Carlo simulations, using MCNP5 software package. Introduction of scatter degrades the image quality by adding noise to both the signal and its variance. We evaluated the effect of patient scatter in terms of loss in the image contrast (C), corresponding to signal reduction component, and loss in differential signal-to-noise ratio (DSNR), reflecting increase in signal variance.
Results: The contrast and differential signal-to-noise ratio losses have been modeled for a range of thin film CdTe thicknesses, as well as several combinations of metal plate materials of varying thickness. We found that the thicker metal plate of denser material, such as tungsten, helps reducing the effect of patient scatter, decreasing losses in both parameters. Additionally, increase in CdTe sensor thickness also improves the image quality.
Conclusion: Relatively small targeted thickness of polycrystalline CdTe sensor layer, in the range of 10 to 600 microns, makes it more susceptible to the influence of patient scatter. Addition of metal plate to the detector not only enhances its DQE due to energy absorption, but also facilitates reduction of noise due to patient scatter.