AbstractID: 5341 Title: X-ray and optical Monte Carlo Study of Thick, Segmented Scintillators for MV Imaging

Purpose: To study the imaging characteristics of thick, segmented, 2-D $CdWO_4$ crystal-photodiode detectors as a function of crystal height, septa material and optical reflectivity, x-ray beam spectrum and beam divergence using a two-step Monte Carlo approach involving both x-ray photon transport at megavoltage (MV) energies and the optical photon transport in scintillator and photodiodes.

Method and Materials: We have studied the spatial frequency dependent detective quantum efficiency (DQE) of thick, segmented, 2-D $CdWO_4$ crystals in contact with silicon photodiode arrays. The energy deposited into the 3-D voxels (1 x 1 x 1 mm^3, septa thickness = 0.15 mm, fill factor = 72%) of the detector for each of the 6 and 3.5 MV x-ray photons in a normally incident pencil beam was calculated using the DOSXYZnrc user code of the EGSnrc Monte Carol system. The isotropically emitted optical photons in each voxel were calculated using the average $CdWO_4$ optical yield and transported to the photodiode array using DETECT2000 optical Monte Carlo code. A 10° beam divergence angle was also simulated. The detector DQE was calculated using the spatial distribution of optical photons.

Results: The DQE increases with the crystal height only if the reflectivity of the septa material is high (0.975). For poor reflectivity (0.65 and 0.8), the increase in the DQE of the taller crystals to MV photons is seriously offset (from 42% to less than 20% for 3 cm tall crystals) by the decreased probability of detecting optical photons. Similarly, the increase in DQE due to the lower energy photons is obtained if the high reflectivity of septa material is maintained for the detector. Beam divergence in thick crystals also reduces the DQE.

Conclusion: High reflectivity of the septa in thick, segmented scintillation detectors is very important to achieve high DQE.

Conflict of Interest (only if applicable): None