AbstractID: 3547 Title: Preliminary Study of Pixel Pitch and Effect of Divergence on Thick Cadmium Tungstate Detector

Purpose: To theoretically study the effects of pixel pitch and beam divergence on 1 cm thick $CdWO_4$ crystals for use in megavoltage cone beam computed tomography (MVCBCT).
Method and Material: $CdWO_4$ linear array (80-elements, each 0.275 x 0.8 x 1 cm^3 in fan beam) has been proven to be a good candidate for MVCT in our lab. For this study, DOSXYZnrc Monte Carlo code was used to find the point spread function (*PSF*) as the distribution of energy deposited in a theoretical flat detector (30 x 30 x 10 mm^3, 0.01 x 0.01 x 10 mm^3 voxels). A pencil-beam of 6 MV photons was incident at a range of angles (0˚, 5˚, 10˚, 15˚, 20˚) with respect to the normal. In each case, the detector *PSF* (ignoring optical spread) was convolved with a realistic source function to give the system *PSF* in the plane of the object. A realistic object to detector magnification of 1.4 was used in the system *PSF* calculations. The *PSF* at 0.01 mm pitch was re-binned into several pitches (0.5, 0.7, 1.0 mm) and Fourier transformed to obtain the system modulation transfer function (*MTF*).
Results: This analysis suggests an optimum pitch of 0.5 mm which cannot be fabricated using $CdWO_4$ because of the cleavage plane. However, the pre-sampled detector *PSF* is further degraded due to small optical leakage through reflective coating and scintillator-photodiode interface, and the scattered radiation from the object. So, in practice a pitch of 1 mm may be sufficient. The degradation of the system *MTF* with the increasing divergence is significant between 0˚ and 5˚, and becomes large at 10˚.
Conclusions: Practical pitch of 1 mm is not ideal yet maybe sufficient. The use of flat panel photodiode arrays for MVCBCT is precluded due to divergence; instead a focused detector should be used.