AbstractID: 8835 Title: Theoretical Analysis of a New Generation Portal Imaging Sensor Based on Thin-Film CdTe: A Feasibility Study For Clinical High Energy X-Ray Detection

Purpose: Currently most popular electronic portal imaging devices (EPIDs) are manufactured from hydrogenated amorphous silicon, a material with low atomic number and electron density, exhibiting low quality images and poor radiation hardness when used for megavoltage imaging. We propose a new generation of portal imagers based on thin-film Cadmium Telluride (CdTe), offering device improvement in both imaging and dosimetric properties. In this paper the result of our optimization studies in material/thickness combinations with an estimate of its output signal under typical conditions are presented.

Method and Materials:
Due to very small thickness (~100 microns) the sensor has to be combined with a metal plate facilitating conversion of high-energy photons to charge carriers directly, maximizing the deposited dose in the sensor layer. Monte Carlo (MC) package MCNP5 was utilized to optimize type and thickness of the material used for this purpose. We modeled an ELEKTA SL-25 Linac head matching characteristics of a 6MV X-ray beam. The effect of CdTe layer thickness on frequency-dependent detective quantum efficiency DQE(f) of the device was also analyzed. Based on MC generated profiles we evaluated the voltage output signal of the CdTe detector for different thickness of sensor layers, as well as the effect of front and back exposure, using the software package SCAPS-1D.

Results: Based on calculations of DQE(f) we proved CdTe-based detector system to have higher performance than those using amorphous silicon or selenium. We established the optimal material/thickness combinations for thin-film CdTe/metal plate detector and found that resultant charge carrier generation leads to the voltage output of 0.2 - 0.3 Volts, warranting pulse mode operation without biasing and cooling.

Conclusion: Following a successful mathematical modeling of an optimized detector and measured output voltage, we believe the thin-film CdTe-based detector is well suited for imaging with high energy x-rays used in clinical radiation therapy.