

AbstractID: 13974 Title: Thin film CdTe photovoltaic detector performance under diagnostic X-ray beams

**Purpose:** Recent development of thin-film cadmium telluride (CdTe) deposition techniques allows manufacturing of low cost large-area devices, having the direct detection design with superior imaging capabilities, and outstanding radiation hardness. We investigate the performance of a thin-film CdTe-based radiation detector operating in a photovoltaic mode under the range of energies relevant to diagnostic imaging applications.

**Methods:** The energy deposition in CdTe layer of varying thickness was evaluated by Monte Carlo simulations under diagnostic X-ray beams, yielding the charge carrier generation profiles across the film thickness. These profiles were used for modeling of current-voltage (I-V) characteristics with device operation modeling software SCAPS, routinely employed for photovoltaic devices. The results for the thinnest devices were compared to those measured under Varian Ximatron simulator in our clinic.

**Results:** Performance of CdTe detector having thickness from 3 to 1000 microns was studied under X-ray beams with 70 to 120kVp energies. Output voltages and currents were extracted from I-V characteristics modeled with SCAPS. The output parameters for thicker devices were found to gradually decrease with thickness. The two major factors responsible for these trends are the limited average photon penetration depth of about 150  $\mu\text{m}$ , and enhanced charge carrier separation near the CdS/CdTe junction region. The X-ray beams of higher input energies produced higher output signals. The measurements on experimental 3 and 10 micron thick CdS/CdTe devices confirmed some of the general trends found through the modeling, though the output signal was lower than modeled.

**Conclusions:** Device operation modeling led to estimates of expected output signals and their dependence on CdTe layer thickness and input X-ray beam energy and intensity, provided important insights into device operation. The experimental results demonstrated that even at the thinnest detector has signal sensitivity and linearity adequate for use in quantitative measurements under diagnostic X-ray beams.