

AbstractID: 3562 Title: A Bench-top Megavoltage CT (MVCT) Scanner with Cadmium Tungstate-Photodiode Detectors

Purpose: To design, fabricate and test the data acquisition timing control, precision rotary stage control, and an analog data multiplexer unit for a prototype megavoltage computed tomography (MVCT) detector. To measure the basic detector characteristics such as linearity with dose rate, the pre-sampled modulation transfer function (*MTF*), the noise power spectrum (*NPS*) and the detective quantum efficiency (*DQE*).

Method and Materials: The 80-element prototype detector array is made with $CdWO_4$ (element size $0.275 \times 0.8 \times 1 \text{ cm}^3$) scintillators and photodiodes placed on an arc with a radius of 110 cm. In addition to designing and fabricating an in-house data acquisition system (front-end integrators, data multiplexer unit, and timing control), a precision rotary stage and its control are added to create a third generation MVCT scanner. The data acquisition is synchronized with radiation pulses from a linear accelerator. The response of the detector as a function of dose rate was studied by varying the source to detector distance. A narrow slit beam, at five locations, was used to measure the pre-sampled *MTF*. The detector signal in open beam was measured for a number of radiation pulses to use the periodogram method for *NPS* estimation. Using the measured *MTF*, *NPS*, and the photon fluence impinging on the detector, the *DQE* was calculated.

Results: Detector response is linear as a function of dose rate, however, shows a non-linear component while measuring the attenuation by solid water due to the poly-energetic spectrum. Therefore, beam-hardening correction is necessary before MVCT image reconstruction. The *MTF* at the Nyquist frequency (0.16 mm^{-1}) is approximately 0.48. The zero-frequency *DQE* in 6 MV beam at 21% is higher than any experimental MVCT detector.

Conclusions: The basic performance of the prototype detector was found to be satisfactory for producing reasonable low contrast resolution in MVCT images with low dose.