

AbstractID:8440 Title: Empirical investigation of flat-panel imagers incorporating high-efficiency, segmented BGO and CsI:TI detectors for radiotherapy imaging

Purpose: Megavoltage active matrix flat-panel imagers (AMFPIs) are routinely used for portal imaging in external beam radiotherapy. However, conventional MV AMFPIs are inefficient, utilizing only ~2% of the incident radiation, which leads to a detective quantum efficiency (DQE) of only ~1%. Recent theoretical studies have shown that incorporation of thick, segmented scintillating detectors in MV AMFPI scans significantly increase DQE performance, leading to improved image quality at low dose and the possibility for dose-efficient, cone-beam computed tomography (CBCT). **Method and Materials:** Building upon the findings of our earlier studies, four prototype AMFPIs have recently been constructed, each consisting of a segmented BGO (11.3 mm thick) or CsI:TI (11.4, 25.6 and 40.0 mm thick) detector coupled to an indirect detection flat-panel array. Each detector consists of a matrix of 120 × 60 scintillator elements at 1.016 mm pitch, covered by a black or mirror top reflector. X-rays sensitivity, MTF, NPS, DQE and phantom images were obtained for each prototype using a 6 MV photon beam at extremely low doses (e.g., 1 beam pulse, equivalent to 0.028 MU). **Results:** The BGO prototype shows better MTF (~20% at the Nyquist frequency) than the CsI:TI prototype at similar thickness. The measured DQE(0) at 1 beam pulse for the BGO and the three CsI:TI prototypes were ~19%, 12%, 19% and 23%, respectively. Moreover, the BGO prototype offers higher DQE values compared to the CsI:TI prototypes over most of the spatial frequency range. Images of a contrast detail phantom using the BGO prototype at 2 beam pulses are comparable to that obtained from a conventional AMFPI with 18 times more dose. **Conclusion:** Prototype AMFPIs employing thick, segmented BGO and CsI:TI detectors offer significant improvement in image quality at extremely low doses, leading to the possibility of soft tissue visualization using MV CBCT at clinically practical doses.