AbstractID: 10923 Title: Exploration of soft-tissue visualization at low dose using flat-panel imagers incorporating thick, segmented scintillators for megavoltage cone-beam CT

**Purpose:** Megavoltage (MV) active matrix, flat-panel imagers (AMFPIs) have become the gold standard in radiotherapy portal imaging by virtue of their many advantages. Nevertheless, conventional MV AMFPIs are very inefficient, detecting only ~2% of the incident radiation at 6 MV. However, recent theoretical and empirical studies have demonstrated that the incorporation of thick, segmented scintillators can significantly improve the DQE of MV AMFPIs, leading to improved image quality at very low dose. This creates the possibility of using megavoltage cone-beam computed tomography (MV CBCT) to provide soft-tissue visualization at clinically practical doses.

**Method and Materials:** Prototype AMFPIs incorporating segmented scintillators based on CsI:Tl or BGO crystals with thicknesses ranging from ~11 to 40 mm have been constructed and are under evaluation for MV CBCT. Each prototype incorporates a detector consisting of a matrix of 120x60 scintillator elements separated by 50 µm-thick, reflective septal walls, with an element-to-element pitch of 1.016 mm. The prototypes are being configured to allow acquisition of tomographic images of low-contrast, soft-tissue-equivalent objects, embedded in a water-equivalent phantom, at the lowest available dose (one beam pulse per image).

**Results:** For projection imaging, all prototypes offer substantial improvement in contrast sensitivity at low dose compared to conventional MV AMFPIs. In particular, the BGO prototype with a zero-frequency DQE of ~20% provides comparable contrast resolution at ~20 times less dose. In view of such good performance, it is anticipated that reconstructed tomographic images of the contrast phantom, obtained at practical doses, will demonstrate soft-tissue delineation.

**Conclusion:** Prototype AMFPIs incorporating thick segmented BGO and CsI:Tl scintillators provide significant improvement in image quality at extremely low dose, facilitating the visualization of soft-tissue at clinically practical doses. It is expected that future, optimized scintillators will lead to highly useful MV AMFPIs for projection and CBCT imaging.