AbstractID: 3824 Title: Towards low-dose soft-tissue visualization in megavoltage imaging: Initial evaluation of a prototype high quantum efficiency segmented crystal-based portal imager

Purpose: To demonstrate the potential for low-dose soft-tissue visualization at megavoltage x-ray energies using a novel, high-QE segmented CsI(Tl) detector incorporated in an active matrix flat panel imager (AMFPI).

Materials and Methods:
A prototype AMFPI EPID was developed, incorporating a 40 mm thick, non-optimized, segmented detector comprised of 160×160 optically-isolated, crystalline CsI(Tl) elements spaced at 1016 µm pitch. The detector was coupled to an indirect detection-based active matrix array (508 µm pitch) - each detector element registered to 2×2 array pixels. Detailed quantitative characterization of the prototype imager was performed under radiotherapy conditions (6MV) to determine x-ray sensitivity, MTF, NPS and DQE. Images of a contrast-detail phantom and step wedges of low-contrast tissue equivalent materials were acquired at a dose corresponding to a single beam pulse. Monte Carlo simulations were performed to estimate the upper limits of the frequency-dependent DQE for this prototype EPID as well as for a variety of hypothetical segmented detector configurations.

Results:
The prototype imager exhibited over an order of magnitude higher DQE at zero spatial frequency compared to conventional AMFPI systems, with gradual fall-off at higher frequencies. Contrast differences between 1, 2 and 3 cm thick lung tissue phantom (density ~0.3 g/cm^3) overlying an ~1 cm thick acrylic slab were observed in projection images acquired at a single 6MV beam pulse. Finally, theoretical calculations suggest that DQE up to 50%, along with further improvements in MTF, may be achievable through further optimization of the segmented detector design.

Conclusions:
The high DQE values and good contrast resolution exhibited by the prototype imager, as well as prospects for further significant improvements in DQE, open up the enticing possibility of obtaining soft-tissue contrast at clinically practical doses in megavoltage tomographic and perhaps, even projection imaging. This work was supported by NIH grant R01-CA51397