Abstract ID: 16259 Title: Investigation of Novel, Focused, Segmented Scintillator Geometries for High DQE Megavoltage Active Matrix Imagers


Purpose: Megavoltage active matrix, flat-panel imagers (AMFPIs) have become ubiquitous in modern radiotherapy environments. However, their imaging performance is severely constrained by very low DQE (~1%). While significant performance improvements have been demonstrated through introduction of thick, precision-machined matrices of optically-isolated crystalline detector elements, the benefits are constrained by geometric beam divergence. It is therefore of interest to examine the potential performance of focused, segmented scintillator geometries specifically designed to circumvent DQE losses caused by divergence.

Methods: The potential detection efficiency and DQE performance of hypothetical detector geometries was examined by means of Monte Carlo simulation of radiation transport. The choice of geometries examined was governed by considerations including: maximization of DQE through geometrically focused elements; manufacturability of the focused matrix; and feasibility of the underlying active matrix of indirect detection imaging pixels. Calculations were performed for a variety of candidate scintillator materials up to 6 cm thick.

Results: The most promising detector geometries identified in the study consisted of matrices of scintillator elements located along the surface of a plane, as well as along the surface of a spherical cap. For cap detectors, elements arranged in a warped-rectangular matrix, concentric rings, and a geodesic are of interest – and geometries employing a single element shape are particularly favored, although at the cost of fill factor. While focused planar detectors would be compatible with conventional AMFPI arrays, cap detectors would involve active matrix arrays in the shape of an approximately spherically curved surface created through cut and bend techniques. Overall, depending upon detector geometry, scintillator material and scintillator thickness, calculations indicate that DQE improvements of up to a factor of ~50 are conceivable.

Conclusions: This initial theoretical study suggests that the promise of very high DQE performance from thick, segmented scintillators could be realized through novel, focused detector geometries.



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