AbstractID: 7256 Title: Segmented Crystalline Scintillating Detectors for Radiotherapy Imaging: A Monte Carlo Investigation of Swank Factor

Purpose: A systematic theoretical investigation of Swank factor for thick, segmented crystalline scintillating detectors is reported. The Swank noise, originating from variation in the x-ray-to-photon conversion gain, degrades the detective quantum efficiency (DQE) performance of radiotherapy imagers. Therefore, it is of great interest to examine the Swank factor, in particular the optical Swank factor, as a function of various detector design parameters.

Method and Materials: Swank factor was investigated using a recently implemented Monte Carlo package (MANTIS) that simulates both radiation and optical transport. The radiation and optical Swank factors were examined using a 6 MV photon beam as a function of various parameters, such as the material and thickness of the scintillator, the element-to-element pitch of the detector, as well as the material and thickness of the septal wall separating detector elements. Moreover, the optical Swank factor was examined as a function of the optical properties of the scintillator, top reflector and septal wall.

Results: Radiation Swank factor improved when thicker scintillators or higher density septal walls were employed. The optical Swank factor dropped dramatically when the scintillator surfaces facing the walls were not polished. Moreover, the results indicate that septal walls must be highly reflective, as the optical Swank factor was found to drop sharply with decreasing septal wall reflectivity, even for a relatively clear scintillator. Furthermore, the optical Swank factor was also strongly affected by the thickness, absorption and scattering of the scintillator, and modestly affected by the reflectivity of the top reflector.

Conclusion: Simulation of radiation and optical transport in segmented scintillating detectors provides the means to examine properties that are critically important to performance, such as optical Swank factor. It is strongly anticipated that such studies will greatly assist in the design of detectors exhibiting very high DQE.