AbstractID: 7035 Title: Characterization of a novel, fast, in-house, CCD-based optical-CT scanner for 3D dosimetry in radiochromic dosimeters

Purpose: Practical tools for comprehensive three-dimensional (3D) dosimetry are urgently needed. Here we evaluate a novel, in-house, second-generation optical-computed tomography (optical-CT) scanner for 3D-dosimetry in PRESAGE^{TM} dosimeters. Primary advantages over laser-based, first-generation scanners include much faster scanning times and potential for high resolution.

Methods: The optical-CT scanner performance was evaluated by comparing dose readout with that from the 'gold-standard' first-generation (MGS) scanner for three irradiation schemes of progressive complexity (a single rectangular-beam, a 3D-conformal and an IMRT treatment). The scanner incorporates a red-filtered (633 nm) uniform area-backlight, but is distinguished by incorporation of a customized tertiary telecentric lens-system, which enables image formation with parallel light-ray geometry. 2D projection images were acquired on a CCD camera of an irradiated PRESAGE^{TM} cylinder (5 cm diameter). Multiple 2D projections over a 360^{O}-scan were used to reconstruct a 3D map of attenuation coefficients.

Results: A complete set of high-resolution (1392x1040 pixels, 50μm) projection images was acquired in ~5 minutes with the new (CCD) scanner. This represents an improvement in speed of >2 orders of magnitude and potential for high-resolution dosimetry compared to the first-generation MGS scanner. The speed advantage for CCD-scanner arises because, unlike the MGS scanner, an entire 2D-projection is acquired in a single acquisition. Line profiles showed that 3D dose readout from the CCD scanner was in good agreement with independent readout from the MGS scanner as well as the calculated treatment plan for all three irradiation schemes. Gamma comparison indicated agreement with MGS readout within 4% dose-difference and 4mm distance-to-agreement. While the signal-to-noise ratio for MGS scanner is better by a factor of 3, the attributes of faster speed and higher resolution are highly desirable for practical 3D-dosimetry.

Conclusion: This work demonstrates the feasibility of accurate 3D dosimetry with the new optical-CT scanner used in combination with radiochromic (non-scattering) dosimeters.