AbstractID: 3940 Title: Monte Carlo Modeling of the Xoft AXXENT^{TM} X-ray Source

Purpose: Extensive Monte Carlo modeling was performed using MCNP5 to characterize the Xoft AXXENT™ miniature x-ray source for electronic brachytherapy. This study assessed the dose distribution, dosimetry parameters using the AAPM TG-43U1 protocol, and the sensitivity of results to source geometric parameters and choices of computational parameters.

Method and Materials: Monte Carlo simulations of radiation generation and transport utilized the MCNP5 code and EPDL97-based mcplib04 cross-section library. Dosimetry parameters using a modified TG-43U1 2-D dosimetry formalism were determined at 40, 45, and 50 kV operating voltages. While the source was modeled as a point due to small anode size, < 1 mm, the 1-D brachytherapy dosimetry formalism is not appropriate due to significant polar anisotropy. Source output was measured in a water phantom using a PTW 34013 Ion Chamber.

Results: Calculated point-source model radial dose functions at $g_P(5)$ were 0.19, 0.24, and 0.29 for the 40, 45, and 50 kV voltage settings, respectively. Measured point-source model radial dose functions were ± 10% of the calculated results for 1.5 cm $\le r \le$ 7.0 cm. Calculated $F(r,\theta)$ values for all operating voltages were typically 1.1 along the distal end ($\theta = 0°$) and ranged from $F(0.5, 160°) = 0.2$ to $F(10, 160°) = 0.5$ near the catheter proximal end. Default energy substep values, *estep*, for photon generation in the anode film and substrate were found to be adequate. Doubling the default values effected the number of x-rays and brehmsstrahlung photons generated by <1%. Utilizing geometry splitting/rouletting and brehmsstrahlung biasing for variance reduction improved the computational efficiency by >30x.

Conclusion: A miniature x-ray source for electronic brachytherapy has been characterized using MCNP5. The Monte Carlo results agreed with measured results for radial dose function and anisotropy function to within ± 10%.

Conflict of Interest: Research was supported by Xoft, Inc.