AbstractID: 7668 Title: X-ray Pinhole Camera Images and Electron Beam Modeling of the Xoft Axxent® Source

Purpose: To understand the propagation of electrons through the acceleration gradient of the Xoft micro-miniature x-ray source via electrostatic modeling of the fields and x-ray pinhole camera imaging.

Materials and Methods: 1) A 3D model of the source was built using OmniTrak[3], and electron trajectories were traced from the hot cathode to the x-ray producing anode. A finite element model of the filament temperature profile was input to a Richardson-Dushman thermionic emission/extraction model to determine the electron emission density distribution. Assumptions made were that the field was graded linearly along the length, and that electrical connection between conductive and resistive components was ideal. 2) A ShadoCam[4] x-ray sensitive camera was used to acquire images of sources through a 30 μm pinhole mounted 15 mm from the source. The camera was 105 mm from the pinhole, providing a magnification of 7x. The camera was read out through a USB computer interface. Images were typically acquired over ten second integration times.

Results: The actual images showed distinct patterns that were identifiable with model predictions. Structures associated with particular emission locations and launch angles on the filament were clearly observed. Conversely, patterns in the images were explainable in terms of parameters such as the absolute location of the filament. Image patterns which were relatively similar to the nominal had no correlation with measured spatial distribution patterns of the sources, but where there were notable variations in the image patterns it was possible to infer correlations with polar and/or azimuthal measurements.

Conclusions: Electron trajectories within the accelerating structure were explored through pinhole imaging and computer modeling, and sensitivities to mechanical tolerances were established that were valuable in setting manufacturing tolerances.