Abstract ID: 16521 Title: Robotic linac adaptation (RLA) with a novel electron gun design for the in-line MRI-linac configuration

Purpose: The emergence of MRI based guidance systems in radiation therapy has the potential for real-time volumetric imaging and targeting. This work investigates a continuous delivery technique for an in-line MRI-linac system with a non-MR-shielded linac. Similar to the CyberKnife(TM) system the linac tracks the tumor motion and adapts its orientation in the fringe field of the magnet.

Methods: An electron gun model resembling a plane capacitor is proposed to function with an unmodified Varian 600C linac. Space charge and electron transport simulations were used to characterize the electron gun-linac system in the fringe field of a 0.5T open bore MRI scanner (GE Signa SP) at 0.18T. The assembly was displaced off the axis of symmetry and moved along the magnetic field lines to account for tumor motion and the beam characteristics of the systems were determined.

Results: The minimum transverse rms emittance of the beam is ~6.4 pi-mm-mrad 4.4mm away from the electron gun cathode with a current of 360mA. This compares favorably with the performance of a standard Pierce-type gun placed at the same location in the magnet, which demonstrates significant reduction of current and/or emittance as high as 25 pi-mm-mrad. We show that the linac can be displaced off axis with minimal reduction in capture efficiency while maintaining low emittance if the linac is aligned with the field lines. The linac capture efficiency, the beam current at the gun exit, and the beam current at the linac exit were computed within the domain of linac motion.

Conclusions: A specially designed electron gun-linac assembly can function in the fringe field of a MRI magnet for various relative orientations of the linac with respect to the MR scanner. This technique allows the linac to simultaneously deliver dose and continuously track and adapt its position based on tumor motion.