AbstractID: 13979 Title: Monte Carlo feasibility study of a compact microbeam small animal irradiator

Purpose: Microbeam radiation therapy (MRT) is a promising but poorly understood experimental treatment modality. As an alternative to synchrotron-based facilities, we propose a compact carbon nanotube-based MRT device for small animal research. We report on a Monte Carlo-based feasibility study of the proposed design.

Method and Materials: Monte Carlo calculations were performed using EGSnrc-based codes. The proposed device design includes a carbon nanotube cathode shaped to match the collimator aperture, a reflection anode with filter, and a microbeam collimator. The collimator is sized to deliver a beam width ranging from 30-200 microns at 15 cm SAD. Design parameters studied with Monte Carlo include electron energy, anode angle, filtration, and collimator design.

Results: Increasing the energy from 100 kVp to 150 kVp increased the photon fluence through the collimator by a factor of 1.7. Both energies produced a largely uniform fluence along the microbeam, with 5% decreases in intensity near the edges of the long dimension. The isocentric dose rate for 150 kVp was calculated to be 1200 Gy/min/A in the center of a 3 cm diameter target. Expected cathode currents of 1 A project an isocentric dose rate of 80 Gy/sec for a four-beam system. Scatter contributions resulting from collimator size were found to produce only small (<7%) changes in the dose rate for field widths greater than 50 microns. Dose vs. depth was weakly dependant on filtration material. The peak-to-valley ratio outside the beam was less than 0.5%, indicating the valley dose between adjacent microbeams will be no more than 1% of the peak dose.

Conclusion: Monte Carlo simulations demonstrate that the proposed microbeam device will be capable of delivering a sufficient dose rate and peak-to-valley-ratio to be useful for small-animal MRT studies.

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