AbstractID: 7752 Title: Monte Carlo Modeling of Variable-Aperture Collimator for Small Animal Radiation Therapy

Purpose:

Monte Carlo simulations have been performed to model the beam profiles produced by a two-stage variable-aperture collimator installed in a 120 kVp microCT scanner. These simulations will be employed as source models for further Monte Carlo calculation of dose deposition in small animals treated with image-guided radiotherapy.

Method and Materials:

The EGS software package (http://www.irs.inms.nrc.ca/EGSnrc/EGSnrc.html) was used as the simulation engine. A standard spectrum for a 120 kV x-ray tube as well as the microCT source-collimator geometry was applied in the calculation. The radiation flux passing through the microCT isocenter plane was compared with experimental data acquired with the collimator set to corresponding aperture sizes.

Results:

A Monte Carlo computation considering 10^8 photons from a 120 kVp x-ray completed in 3 minutes on a 2 GHz computer. A point source model showed that the two stages of 0.97-cm brass collimator blocks create >99% attenuation, suitable for radiotherapy, with the expected dodecagonal beam profile observed at isocenter. These results were confirmed by direct measurement. A point source model however predicts only 1/3 of the penumbra width in the acquired image. A more sophisticated model considering the 0.3-mm focal spot size of the x-ray tube produced beam penumbras that agreed with measurement. In this model for a 1 cm aperture, 0.85% of the total fllux is from scattering, and 70% of the scattering is from the spot area outside the 0.3-mm diameter.

Conclusion:

Monte Carlo simulation using the EGS software package can model a collimated kV x-ray system including the x-ray source and a newly developed two-stage variable-aperture collimator. In a reasonable computation time this model provides an accurate estimate of the output of the system that will be critical in performing dosimetric calculations and further developing the functionality of this small animal radiotherapy system.