

Purpose: To develop a Monte Carlo model of the treatment beam of a small animal stereotactic irradiator.

Method and Materials: A Monte Carlo source model has been created for a custom small animal stereotactic irradiation device. X-ray generation is performed by an XRAD-320 x-ray tube (Precision X-Ray Inc., North Branford, CT) operated at a potential of 250 kVp. Determination of the un-collimated energy spectrum from the XRAD-320 at 250 kVp was calculated using the "SpekCalc" GUI program by Poludniowski and Evans. These calculation results were used to form the photon source probability distribution in MCNPX (Los Alamos National Laboratories, Los Alamos, NM). A custom, in-house field collimation system is used in conjunction with the x-ray source to collimate the source into 1.0, 3.5, 5.0, 7.5, and 10.0 mm stereotactic beams. This collimation system has been incorporated into the MCNPX beam model. Percent Depth Dose (PDD) curves from the irradiator were measured using radiochromic film (Gafchromic EBT, International Specialty Products, Wayne, NJ) with all collimator apertures and two treatment SSDs of approximately 20 and 25 cm.

Results: PDD curves created with film measurements and Monte Carlo simulation results were compared for agreement. Simulated PDD curves were found to agree with measured data for all collimator sizes and source-to-surface distances (SSDs) for 2%/2 mm normalization criteria.

Conclusion: The agreement between simulated data and repeatedly measured PDD data suggests accuracy in this application of the SpekCalc GUI program. An accurate beam model of this small animal irradiator in conjunction with ongoing micro CT-based "patient" modeling will provide a system for Monte Carlo-based clinical and investigational research of small animal stereotactic radiotherapy.