

Purpose:For preclinical research using small animals, a dedicated image-guided irradiation system has been developed with CBCT imaging and conformal radiation delivery capabilities. A special collimator for a rat model of radiation induced heart disease is desirable. This study aims to design a new primary and secondary collimator system using a Monte Carlo based code.

Methods:At an SSD of 32.5 cm, the required maximum field size (FWHM) at 1.0 cm depth in water was 2.0 cm, which is comparable to the size of a normal rat's heart. For simulations, we installed the BEAMnrc (GUI version, revision 2.0) and Dosxyznrc (GUI version, revision 1.1) Monte Carlo based codes on a 64 bit Intel quad-core processor 8×2.0 GHz running the Linux operating system. The simulation model included the X-ray tube (225kVp), with a Be inherent filter, an external Cu filter (0.5 mm thick), brass primary and secondary collimators and a 10×10×10 cm³ solid water phantom. 1) We began with a simple geometrical design, 2) we expanded the aperture of the primary collimator for the desired FWHM of the beam, and 3) we trimmed the beam by reducing the aperture size of the bottom part of the secondary collimator to eliminate low energy photons and sharpen the penumbra.

Results:Monte Carlo simulations successfully accomplished a beam 2.0 cm (FWHM) in diameter at 1.0 cm depth with a sharp penumbra. A new collimator will be constructed based on the final simulated design. We will then verify the Monte Carlo generated depth dose distribution and dose profiles.

Conclusions:Monte Carlo based modeling is an effective tool to create new designs for small animal conformal radiotherapy systems. The Beamnrc and Dosxyznrc codes will also be utilized further as the treatment planning engine for the localized heart irradiation project.