

Monte Carlo models for tomotherapy

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The development of helical tomotherapy represents one of the biggest steps toward improved conformal dose distributions and ultimately improved tumor control probability in the history of radiotherapy. Since the technology is under development, there are numerous investigational opportunities, both experimental and theoretical. However, some design problems are not easily solved or even impossible to solve by experimental measure. The computer-based Monte Carlo method is ideally suited to solve many of these types of problems.

Monte Carlo models for tomotherapy were developed to solve key design issues. Models were developed for the Orion benchtop, tomotherapy prototype, and the CT detector used to measure the exit dose. Spectra, fluence, energy fluence, electron contamination, fractional depth dose, isodose distributions, and profiles were computed for both LINAC models. Additionally, the optimized hardening material and thickness for the prototype and tongue and groove/penumbra effect for the Orion were studied. For the tomotherapy prototype, the source properties were calculated for all key components of the LINAC head. Finally, the CT detector model was used to determine the dose "buildup" observed experimentally and calculate the quantum detection efficiency for both in-focus and out-of-focus setups.