Ruprecht-Karls-Universität Heidelberg
Medizinische Fakultät Mannheim
Dissertations-Kurzfassung

Monte Carlo source models of a kilo-voltage radiotherapy device

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Dose calculation algorithms are essential for radiation therapy treatment planning. The INTRABEAM device is a low energy x-ray source for intraoperative radiation therapy and brachytherapy. No clinical dose calculation algorithms exist for this radiotherapy source. The aim of this work is to develop a dose calculation algorithm for this device. Three different Monte Carlo (MC) source models were developed. The first source model is based on a phase space file (PSF). This model describes the deduction of the relevant functions that are required to score the position of the photons that reach the scoring plane. Because of the limitations that are associated with the use of PSF for MC dose calculation, a virtual source model (VSM) was derived from the PSF. This source model overcomes some of the disadvantages of the PSF model. A third source model, the integral knowledge virtual source model (IK-VSM) was developed to overcome the limitations of the previously mentioned models. The IK-VSM algorithm is derived by incorporating all available knowledge (geometric data about the construction of the source, experimental data, simulated data and mathematical knowledge) in the source-modelling process. Validation checks with the gamma analysis method show that the model is accuracy to within 3% / 1 mm (≥95% pixel pass rate). These results demonstrate that the model meets the requirements of a clinical dose calculation algorithm.