AbstractID: 2888 Title: Determining parameters for a multiple-source model of a linear accelerator using optimization techniques

Purpose: To determine the parameters of a multiple-source model for an arbitrary linear accelerator using optimization methods.

Method and Materials: A multiple-source model describing the energy fluence output of a linear accelerator was developed in this study. A point source modeled radiation from the target, a finite-size source all extra-focal radiation, and an electron source contaminant particles. The parameters determined were the mean energy curve (for off-axis softening), intensity profile curve (for non-uniform photon energy fluence), electron source values, extra-focal source size, energy, and intensity. The parameters were optimized by minimizing the gamma error between the dose calculation results and the beam data measurements by applying a non-linear optimization technique not requiring gradient information. The dose was calculated by an algorithm based on superposition/convolution of Monte Carlo determined scatter kernels. The beam data measurements required were depth dose curves, lateral profiles, and diagonal profiles for multiple field sizes. The model requires minimal data about the internal dimensions and construction of the accelerator head.

Results: The method was applied to 231 realistic data sets of varying quality and consistency for Elekta, Siemens and Varian accelerators. The gamma error (1%, 3 mm) for an average optimized model was lower than 1.0 for 98% of the measurement points. Typical duration of the optimization to derive the model parameters was 5–15 minutes. In cases where the measurements contained inconsistencies, the resulting gamma errors were significant, which indicates that the method could be useful in quality assurance of measurement data.

Conclusion: This study demonstrated that the parameters for a multiple-source model can be determined in an efficient and stable manner using optimization methods. The model is applicable to an arbitrary accelerator and has clinically acceptable accuracy and execution time.

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