Purpose: To implement a dynamic, analytical source model for fast and accurate derivation of the beam characteristics on the exit plane of a linear accelerator for modulated electron radiation therapy using a Few Leaf Electron Collimator (FLEC). Methods: An analytical source model (SM) is derived for modulated electron radiation therapy (MERT) by the use of source fluence kernels directly on the linear accelerator's exit plane. The BEAMnrc code was used to identify the most significant radiation sources in MERT. "Virtual" BEAM models were then created, where the different components of the sources were isolated to each other. Monte Carlo simulations of these models were performed to derive the fluence and energy electron distributions on the exit plane. The data were then stored as histograms on a 2D fluence grid (source kernels). Since the source kernels were derived by simulation of a precise accelerator model it is expected that the scattered particles would be accurately predicted. An arbitrary rectangular field can be recreated by superposition of the appropriate source kernels directly on the output plane. Results: Fluence and energy distributions were derived for three field sizes (8 x 8, 2 x 2 and 2 x 8 cm2) and 20 MeV electron beam energy with the SM and compared with the PH-SP data. Scattered particles from the FLEC agreed well in all cases, while moderate discrepancies were encountered for the primary beam and scattered particles from the jaws. The total reconstructed beam deviation between PH-SP and SM was less than 1.5% for all cases. Conclusions: The proposed method has shown to reproduce the fluence and energy distributions of small and/or arbitrary rectangular fields within acceptable tolerance. The model is expected to help significantly improve MERT optimization speed while maintaining accuracy in the dose calculations.

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