Implementation of the Electron Pencil-Beam Redefinition Algorithm into a 3D Treatment Planning System

The electron pencil-beam redefinition algorithm (PBRA) has been implemented into COPPER-Plan, M.D. Anderson Cancer Center's 3D treatment planning system. The implementation of the code, previously used for research, included changes in data structures and subroutines, improvements to the transport process from the collimator to the patient, and optimizations to decrease execution time. Minor changes and new routines were made in the PBRA code so that it could interface with existing data structures in COPPER-Plan. Electron transport from the collimators to the proximal patient surface, where the pencil beams are first redefined, has been modified to explicitly account for beam divergence. The PBRA code was modified to decrease execution time by (1) optimizing calculation cutoff values, (2) optimizing energy-loss spread function, and (3) incorporating a small-angle approximation into the electron transport equation. Accuracy of the implementation was verified using the Electron Collaborative Working Group Electron Dose Algorithm Verification Data Set. Results showed the accuracy of the PBRA-calculated dose distributions in the 3D treatment planning system to be similar to those of previous PBRA calculations with a reduction in calculation times of approximately 75%. With successful implementation of the PBRA into COPPER-Plan more rigorous patient tests can be performed to determine the feasibility of using the PBRA for clinical patient treatment planning.

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