AbstractID: 3596 Title: Application of the Pencil-Beam Redefinition Algorithm to Electron Arc Therapy

Purpose: A dose algorithm suitable for electron arc therapy is not available on existing commercial treatment planning systems. This project investigated the potential for simulating an electron arc therapy beam by summing (1° angular steps) fixed-beam dose distributions calculated using the pencil-beam redefinition algorithm (PBRA).

Method and Materials: Similar to the Hogstrom pencil-beam algorithm (PBA), the PBRA was commissioned for fixed beam geometries typical of electron arc therapy. The PBRA was constrained to calculate dose output for fixed beams as a function of field width and SSD. For arced beams, a small width correction was incorporated to conserve integral dose. Resulting arced beam calculations of dose output and mid-arc depth dose were evaluated by comparing to data measured using cylindrical water phantoms (ρ=12, 15 cm). Calculated 2D relative dose distributions in the plane of rotation were evaluated using film dosimetry in a polystyrene cylindrical phantom (ρ=13.5 cm). A wide range of treatment parameter combinations was investigated — three field sizes, three radii of curvature, and multiple arc angles at 10 and 15 MeV.

Results: For arced beams, the maximum difference between PBRA-calculated and measured dose output at mid-arc was 2%. Along mid arc, the maximum dose difference in low dose-gradient regions was 3.4%, and the maximum distance to agreement (DTA) of dose values in high dose-gradient regions was 2.2 mm. Away from mid-arc, the maximum dose difference was 2%, and the maximum DTA was 1.2 mm.

Conclusion: Results showed that the PBRA summation method can calculate dose in homogeneous phantoms within 3.4%. Since PBRA calculations in patients have been shown to be within 4% by Boyd et al., this method should be suitably accurate for use with electron arc therapy patients. User experience with the PBA and ease of PBRA beam commissioning make the PBRA attractive for this application.