Purpose: Several Monte Carlo (MC) based treatment planning systems are commercially available for electron beams and more users are implementing them in the clinical setting. In the case of MC based treatment planning systems in addition to the dose calculation accuracy one also needs to define the additional calculation parameters, such as the calculation voxel size, the choice between the computation of dose-to-medium or dose-to-water, and the number of histories and/or acceptable level of statistical uncertainty for the voxelized dose distribution.

Methods: We report on the influence of these parameters on both calculation time and on the accuracy of calculated dose distributions for the XiO electron Monte Carlo (XiO eMC) software, a new treatment planning system for electron beams developed and commercialized by CMS incorporated. A comparison of radiochromic film measurements with simulated data using different parameters was performed for a complex heterogeneous phantom.

Results: Dose calculations in a heterogeneous phantom are in very good agreement with film measurements, provided that appropriate simulation parameters are used (1% average statistical uncertainty, voxel size=2x2x2 mm cubed and dose-to-water is computed). The rapid three-dimensional dose gradients exhibited for these data highlight the need for a fully 3D dose comparison tool (currently under development) for electron beams treating complex heterogeneous geometries. Using a clinical XiO Linux workstation (8 processors each 3 GHz, 8.29 GB RAM), high resolution (2.5x2.5x2.5 mm cubed) low noise (<1% MRSU) simulations can be obtained in less than 4 and 8 minutes respectively for 9 and 17 MeV beams with a 10x10 cm squared applicator.

Conclusions: XiO eMC calculated dose distributions agree very well with the experimental ones in both water tank and heterogeneous phantoms. More investigation may be required, however, to determine the optimal trade off between dosimetric accuracy and clinically acceptable computation times.

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