AbstractID: 1453 Title: Analysis of errors due to limited dose-grid resolution in fluence map optimization for IMRT

We examine the issue of dose-grid resolution and plan-evaluation accuracy for intensity modulated radiation therapy optimization. A general Information Theory based Fourier analysis of the accuracy of discrete representations of three dimensional dose distributions is presented. Analytic integrals that predict the worst case aliasing and voxel averaging errors that can occur in beamlet based fluence map optimization irregardless of the location and orientation of the dose grid are derived. Errors associated with the spatial discretization and volume averaging of the dose-grid employed in optimized intensity modulated radiation (IMRT) therapy treatment plans were assessed both empirically and theoretically. The analytic model predicted that an isotropic dose grid with 2 mm spacing or less will prevent dose errors larger than a few percent in the worst possible case. The predictions of this theory are compared to empirical results obtained by solving a linear-programming based optimization model to global optimality for increasing resolution until convergence was observed. Good agreement between worst case estimates and errors observed in the dose volume histogram data of the empirical results was observed. This was attributed to the fact that the optimization takes advantage of aliasing to produce an optimal plan. Finally, an empirical analysis demonstrated that this resolution is needed most in high dose targets. Therefore, a multi-resolution isotropic 2/4/6 mm grid-spacing model was developed where these resolutions are applied to targets/structures/tissue, respectively, to obtain unaliased results with the smallest possible model size.