AbstractID: 2981 Title: Implementation of a Fast Incremental Algorithm for Voxel Radiological Path Determination

Purpose: Performing adaptive image-guided IMRT will require rapid computation of dose for frequent IMRT fluence map optimization (FMO). Patients should not have to tolerate waiting more than a few minutes for a new IMRT treatment plan. Most beamlet dose models in IMRT FMO expend considerable time performing voxel based ray-tracing computations. Improvements in voxel based ray-tracing algorithms have not been presented in the radiation therapy literature since the seminal work of Siddon in the 1980s. We present an algorithm that significantly outperforms the voxel ray-tracing algorithm of Siddon when applied to density scaled radiological path length calculations in patient voxel space for beamlet dose computation.

Method and Materials: An incremental voxel ray tracing algorithm that simultaneously computes voxel indices and ray-voxel intersections was developed. The majority of the computational time required by the standard Siddon algorithm was found to be in the concatenation of the intersection parameters (α's) into a single unique set and the conversion of the calculations of the voxel indices from floating point to integer values. This algorithm was compared, as components of our in-house IMRT planning system, to the standard Siddon technique. The test case had 1.7 million total voxels on a 2.5 mm isotropic dose grid and the 1,466 beamlets in the IMRT plan intersected an average of ~15,000 voxels per beamlet.

Results: Use of the new algorithm for the test case demonstrated a 2.7 fold increase in computational speed on average over the Siddon algorithm.

Conclusion: The new algorithm provides a significant improvement in voxel ray-tracing performance over the standard Siddon algorithm. However, parallel computation is still currently required to perform the computation of a typical IMRT treatment planning rapidly enough for adaptive IMRT FMO.