AbstractID: 12746 Title: Minimizing Energy Changes in Particle Therapy using Voronoi Partitions

Purpose: To develop a treatment planning algorithm that can reduce the number of energy changes for scanning beam particle therapy.

Materials and Methods:

Changing beam energies in particle therapy requires a considerable amount of time; therefore, a high quality treatment plan with minimum number of energy changes is desired. In this research, we explore using Voronoi diagram to achieve this. A Voronoi diagram of a set of objects partitions a metric space into cells with one cell per object, such that each cell contains the region closest to its object.

Our new planning algorithm mainly uses these steps: (1) Calculating a Voronoi partition of the target for the given beam angles, such that each Voronoi cell contains the portions of tumor “closest” to its beam. Here by “closest”, we mean to be able to hit a target from a beam angle with minimum penetration of normal tissues and no penetration of critical structures. (2) During optimization, each beam only treats the tumor region within its Voronoi cell. The final dose distribution is optimized using a combination of randomization and non-negative least square (NNLS).

The new planning algorithm has been implemented in C. The proton and antiproton kernels used for treatment planning were generated using FLUKA, and contains energy ranges from 75MeV to 175MeV at 1MeV step.

Results: The new algorithm has been applied to a 3D C-shaped tumor phantom for proton and anti-proton therapies. Compared to not using Voronoi partition, we can reduce the number of energy changes by 70%, while maintaining similar treatment qualities.

Conclusion: A particle therapy planning algorithm that can reduce energy changes by 70% has been developed. As part of our ongoing research, we are testing the algorithm for different anatomical sites.