AbstractID: 13913 Title: An accurate and efficient finite-size pencil beam based dose calculation engine for online adaptive IMRT replanning

Purpose: To develop an efficient and accurate finite-size pencil beam dose calculation engine for on-line adaptive IMRT re-planning with graphics processing units (GPUs).

Method and Materials: This new GPU-based fast and accurate dose engine was built on our previously published ultrafast finite-size pencil beam (FSPB) model with 3D density corrections. Owing to the commissioning procedure based on Monte Carlo simulations, this model correctly accounts for medium heterogeneities. The new GPU implementation presented here has been designed to maximize the data-parallel strength of GPU and minimize the memory-conflict issues.

Results: Our implementation was tested on two cases: 1) a phantom geometry with a volume of lung density inserted and 2) clinical head neck case. For both, the phantom case and in anthropomorphic geometry, percent depth dose (PDD) curves and cross-profiles for various field sizes were calculated. The results show, that impact of lateral electron disequilibrium and changed beam attenuation affecting the dose distribution, like profile broadening and changed profile amplitude, were correctly modeled. For all tests, calculation acceleration of ~100 times was achieved when using a NVIDIA Tesla C1060 card in comparison with a 2.27GHz Intel Xeon CPU. Eg. for the head neck case, the computation time for a 10x10 cm2 field with the beamlet size of 0.5x0.5 cm2 is less than 1 second.

Conclusion: We have implemented a GPU-accelerated dose calculation engine employing finite-size pencil beam model. The results indicate that accurate dose calculation in real-time is feasible and will enable the on-line adaptive IMRT re-planning.