Abstract ID: 15741 Title: A GPU-based finite-size pencil beam (FSPB) algorithm with 3D-density correction for radiotherapy dose calculation

Purpose:To develop an accurate and efficient finite size pencil beam (FSPB) dose calculation engine for online adaptive radiotherapy.

Methods:The new GPU-based 3D-density correction FSPB dose calculation engine (g-DC-FSPB) is built on our previously published ultrafast FSPB (g-FSPB) computational framework. The new dose engine correctly accounts for medium heterogeneities by providing both lateral and longitudinal density corrections and its GPU implementation is designed to maximize the data-parallel strength of GPU and minimize the memory-conflict issues.

Results:Dosimetric evaluations of the g-DC-FSPB dose calculation algorithm against MCSIM Monte Carlo dose calculation algorithm are conducted on 10 IMRT treatment plans with heterogeneous treatment regions (5 head-and-neck cases and 5 lung cases). For head and neck cases, when cavities exist near the target, the improvement with the 3D-density correction is significant. However, when there are high-density dental filling materials in beam paths, the improvement is small and the accuracy of the new algorithm is still unsatisfactory. On the other hand, significant improvement of dose calculation accuracy is observed in all lung cases. Especially when the target is in the middle of the lung, the accuracy improvement with the 3D-density correction is dramatic. Regarding the efficiency, because of the appropriate arrangement of memory access and the usage of GPU intrinsic functions, the dose calculation with the g-DC-FSPB algorithm for an IMRT plan on can be accomplished well within 1 second (except for one case) a NVIDIA Tesla C1060 card.

Conclusions:We have implemented a GPU-accelerated 3D-density correction FSPB dose calculation engine and systematically evaluated its dosimetric accuracy and computational efficiency. Compared to the original g-FSPB algorithm, the new g-DC-FSPB algorithm significantly improve accuracy with slightly scarification of the computation efficiency (about 5-15% slower in terms of the total computation time), indicating that this algorithm is more suitable for online IMRT replanning.