AbstractID: 13268 Title: Non-Voxel-based-Broad-Beam (NVBB) framework for IMRT treatment planning

Purpose
IMRT treatment planning, as implemented in the TomoTherapy TPS, is a very-large-scale-problem (VLSP) and requires a computer cluster. We present a novel framework that enables IMRT planning solvable in a single workstation with improvements in cost, plan quality and planning throughput.

Material and Methods
The current TomoTherapy TPS uses a beamlet-based-optimization that requires pre-calculation and storage of large amount of beamlets. A computer cluster with 7-14 nodes is used for both computation and data parallelization. We invented and developed a Non-Voxel-based-Broad-Beam (NVBB) framework for direct-machine-parameter-optimization (DMPO) in IMRT. Both functions and derivatives are evaluated in the continuous viewpoint without "voxel" and "beamlet" representation. Thus pre-calculation and storage of beamlets are no longer needed. Low-memory, full computation and data parallelization nature of the framework render its efficient implementation on the graphic-procession-unit (GPU).

We implemented the NVBB framework in TomoTherapy TPS (NVBB-TPS). NVBB-TPS runs on a single workstation with a GPU. Significant verification/validation tests were performed in house and via third parties. Benchmarks on dose accuracy, plan quality and throughput were compared with the commercial TomoTherapy TPS (cluster-TPS) using 14 nodes.

Results
Compared with the cluster-TPS, the pre-processing time of NVBB-TPS reduced from 10–200 minutes to about 10 seconds and the time of each iteration is reduced to 25-80%. Plan qualities were indistinguishable for most cases and less dose artifacts were present for a few cases via NVBB-TPS. For the same delivery plan, dose differences between cluster-TPS and NVBB-TPS were within 1%, 1mm for all test cases.

Conclusions
We developed a novel NVBB framework for VLSP IMRT optimization. The DMPO nature of the algorithm eliminates the needs for beamlets and leads to better plan quality. Non-cluster solution significantly saves hardware and service costs. Compared with the cluster-TPS, treatment time can be reduced in many folds with NVBB-TPS.