AbstractID: 13498 Title: Development of a GPU-based Monte Carlo Dose Calculation Code for Coupled Electron-photon Transport

Purpose: Monte Carlo (MC) simulation is broadly considered as the most accurate method for dose calculations in radiotherapy. However, its efficiency still requires improvement for many routine clinical applications, especially for online adaptive radiotherapy. The goal of this work is to develop a GPU-based MC dose calculation code. **Method and Materials:** We have implemented the Dose Planning Method (DPM) MC dose calculation on GPU architecture under CUDA platform. The MC simulation is performed by treating each computational thread on GPU as independent computing units, responsible for the complete history of a source particle. To test the accuracy of our GPU-based MC dose calculation with respect to the original sequential DPM code on CPU, we have performed MC simulations on phantoms with an electron or a photon beam. **Results:** In all testing cases, the average relative uncertainties $\overline{\sigma_D / D}$ are less than 1%. Results obtained from CPU and GPU are in good agreement with each other (The difference at more than 98% voxels is within 1% of the maximum dose in both cases). These results demonstrate the adequate accuracy of our GPU implementation for both the electron and the photon beams in radiotherapy energy range. A speed up factor of 4.5 and 5.5 times have been observed for electron and photon testing cases, respectively, using an NVIDIA Tesla C1060 GPU card against a 2.27GHz Intel Xeon CPU processor. **Conclusion:** This work demonstrates the possibility to speed up the intensive computation in MC dose calculation. However, due to the inherent conflict between GPU architecture and the randomness in MC simulations, algorithms should be carefully tailored to achieve high efficiency on GPU.