AbstractID: 10075 Title: Dynamic splitting of Gaussian pencil beams in heterogeneity-correction algorithms for radiotherapy with heavy charged particles

Purpose: To develop an algorithm to resolve intrinsic problems with dose calculations using pencil beams when particles involved in each beam are overreaching a lateral density interface or when they are detouring in a laterally heterogeneous medium. **Method and Materials:** A finding on a Gaussian distribution, such that it can be approximately decomposed into multiple narrower, shifted, and scaled ones, was applied to dynamic splitting of pencil beams implemented in a dose calculation algorithm for proton and ion beams. The method was tested in an experiment with a range-compensated carbon-ion beam. Its effectiveness and efficiency were evaluated for carbon-ion and proton beams in a heterogeneous phantom model. **Results:** The splitting dose calculation reproduced the detour effect observed in the experiment, which amounted to about 10% at a maximum or as large as the lateral particle-disequilibrium effect. The proton-beam dose generally showed large scattering effects including the overreach and detour effects. The overall computational times were 9 s and 45 s for non-splitting and splitting carbon-ion beams and 15 s and 66 s for non-splitting and splitting proton beams. **Conclusions:** The beam-splitting method was developed and verified to resolve the intrinsic size limitation of the Gaussian pencil-beam model in dose calculation algorithms. The computational speed slowed down by factor of 5, which would be tolerable for dose accuracy improvement at a maximum of 10%, in our test case.