AbstractID: 10705 Title: Comparison of dose volume histograms from selected proton therapy treatments between Geant4.5.0 and Geant4.9.0 Monte Carlo simulations with and without dynamic densities

Introduction: In order to reduce computation time for proton Monte Carlo dose calculations, our group has introduced a method to improve the voxel navigation algorithm in Geant4.5.0 and to dynamically assign material density in a given voxel element during particle transport. In the meantime, we have developed a new fast voxel navigation technique tailored to Geant4.9.0. Furthermore, Geant4.9.0 shows differences in the physics setup and tracking algorithm compared to the Geant4.5.0. Thus, the aim of this study was to assess whether defining all material densities corresponding to a given HU from the CT scan, i.e. without applying dynamic densities, would significantly impact the runtime for the new Geant4 version. In this study we compare dose-volume histograms as well as runtime from selected proton therapy treatments between Geant4 Monte Carlo calculations using Geant4.5.0 with the dynamic density method and Geant4.9.0 without the dynamic density method.

Methods and Materials: The two plans considered in this study were a spinal cord astrocytoma treatment and a prostate treatment. The differences between the Monte Carlo simulations with and without dynamic densities for each treatment were evaluated by plotting the dose-volume histograms of the PTV and several other organs-at-risk considered in the treatment plan. In addition, the dose contours for each treatment and the contour differences were evaluated.

Results: There are small discrepancies between dose calculations with and without dynamic densities, particularly in the GTV of both treatments. These discrepancies may suggest problems with the dynamic density method or problems with the CT conversion process used for generating the patient geometry.

Conclusion: A comparison of dose calculations using Geant4.5.0 (including improved voxel navigation and dynamic density algorithm) and using Geant4.9.0 (including our new voxel navigation algorithm and no dynamic density algorithm) yields slight but not clinically significant differences with comparable run time.