AbstractID: 11104 Title: Tissue inhomogeneities in Monte Carlo treatment planning for proton therapy

Purpose: To investigate the effect of tissue segmentation and metal streaking artifacts for Monte Carlo (MC) dose calculations in proton therapy. **Method and Materials**: CT images of a phantom with 9 tissue equivalent inserts were segmented into material and mass density maps using the conventional single-energy CT and a more accurate dual-energy (DECT) material extraction. MC dose calculations for a broad 200 MeV proton beam were performed in the exact geometry and in the single-energy and dual-energy CT geometries in the MCNPX code. The dose calculation errors for the two tissue segmentation approaches were quantified. MC dose calculations were performed for a 147 MeV proton beam treatment plan of a patient with metal bilateral hip prostheses based on water-only geometry, on original CT images with severe streaking artifacts and based on artifact corrected images. The effect of the artifacts and their correction on MC dose distribution was evaluated. **Results**: The materials of three inserts were incorrectly assigned using the conventional approach. The conventional tissue segmentation yielded dose calculation errors below 2%. In both the single-energy CT and DECT geometry, there was a 0.7 cm shift in the position of the Bragg peak suggesting that density assignment is more important than correct tissue segmentation in proton beam MC dose calculations. The patient dose calculations using CT images with streaking artifacts showed large statistical errors in the artifact corrupted voxels and differences up to 1.5 cm in the 20% and 30% isodose lines due to the artifacts. **Conclusions**: The shift in the Bragg peak demonstrates the need for careful mass density assignment in proton beam MC dose calculations. The use of DECT tissue segmentation might therefore have only a small added benefit. The patient study shows that a metal artifact correction is necessary for patients with bilateral hip prostheses.