Monte Carlo analysis of the effects of transverse heterogeneities on the most likely path of protons

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Abstract

The most likely path (MLP) formalism used in proton CT (pCT) reconstruction to predict proton trajectories has improved spatial resolution. However, this formalism assumes a homogeneous medium and a Gaussian distribution of the multiple Coulomb scattering angles . We have investigated the effects of a transverse heterogeneity causing unbalanced scattering on the MLP formalism accuracy. We have compared the trajectories computed with the formalism to paths obtained from Monte Carlo simulations. Our results show transverse heterogeneities induce non Gaussian spatial and angular distributions, causing inaccuracies in the formalism’s predicted trajectories. The difference between the predicted MLP and the simulated MLP reaches 0.5 mm in the worst case, which is only slightly larger than the MLP formalism’s uncertainty in water which is 0.43 mm. Given that we have studied a worst case scenario, we deem the formalism accurate enough even in the presence of transverse heterogeneities.

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