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Proton dose in heterogeneous lung tissue – A Monte Carlo study

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Abstract:

Purpose: We investigate the effect of mesoscopic structure of lung tissue on the dose distribution of therapeutic proton beams.

Materials and Methods: We develop a simplified computational model for lung tissue consisting of a spatially uniform suspension of air filled spheres in a water matrix, the air filled spheres representing the alveoli (inhomogeneous lung, IL). For comparison purposes, a homogeneous lung tissue model consisting of water, but of the same density as the IP model (homogeneous lung, HL), is developed. HL may be considered representative of lung tissue in Computed Tomography based proton treatment planning. A uniform spread-out Bragg peak (SOBP) is constructed from pristine Bragg peaks, in water. Dose distributions are calculated for IL and HL using the Monte Carlo code MCNPX v.2.5.0.

Results: Proton dose distributions show degradation in the distal fall-off of the SOBP in IL (12 mm) relative to the HL (7 mm). The range of the SOBP, defined as the distal 90% of the SOBP is reduced by 5 mm in the IL relative to HL.

Conclusion: The mesoscopic structure of lung tissue influences the dose distribution of therapeutic proton beams to a clinically significant degree. These influences are not captured by CT based treatment planning systems.