Abstract ID: 15858 Title: Uncertainties in planned dose due to the limited voxel size of the planning CT when treating lung tumors with proton therapy

Purpose: Dose calculation for lung tumors can be challenging due to the low density and the fine structure of the geometry. The latter is not fully considered in the CT image resolution used in treatment planning causing the prediction of a more homogeneous tissue distribution. In proton therapy, this could result in predicting an unrealistically sharp distal dose falloff, i.e. an underestimation of the distal dose falloff degradation. The goal of this work was the quantification of such effects.

Methods: Two computational phantoms, resembling a two-dimensional heterogeneous random lung geometry and a swine lung were considered applying a variety of voxel sizes for dose calculation. Monte Carlo simulations were used to compare the dose distributions predicted with the voxel size typically used for the treatment planning procedure with those expected to be delivered using the finest resolution.

Results: The results show, for example, distal falloff position differences of up to 4 mm between planned and expected dose at the 90% level for the heterogeneous random lung (assuming treatment plan on a 2×2×2.5 mm3 grid). For the swine lung, differences of up to 38 mm were seen when airways are present in the beam path when the treatment plan was done on a 0.8×0.8×2.4 mm3 grid.

Conclusion: The two-dimensional heterogeneous random lung phantom apparently does not describe the impact of the geometry adequately because of the lack of heterogeneities in the axial direction. The differences observed in the swine lung between planned and expected dose are presumably due to the poor axial resolution of the CT images used in clinical routine. In conclusion, when assigning margins for treatment planning for lung cancer, proton range uncertainties due to the heterogeneous lung geometry and CT image resolution need to be considered.