AbstractID: 4922 Title: An improved lung model, incorporating realistic random anatomical features, for Monte Carlo-based dosimetry

Purpose: To investigate the effects of incorporating a more physically-realistic lung model, preserving random anatomical features of the lung, on MC-based dose distributions.

Methods: A random lung model was built based on morphological data. The model homogenizes the lung parenchyma with structures of “chunk” sizes less than 0.05 cm, and models all larger chunks (branches of the bronchial and vessel trees, up to ~1.5 cm) as randomly-positioned 2-D cylinders. The MC code PENELOPE was employed to calculate dose distributions in a water phantom containing a lung region, modeled by either a homogenized lung (as used in conventional planning) or the random lung model. Dose calculations used 6 and 18 MV photon beams with four different field sizes.

Results: Depth dose curves in the random lung model illustrate significant perturbations when the structure size is comparable to the field size. For the 1x1 cm field size, large differences (up to 34% of D_{max}) exist in the largest structures due to the loss of CPE with small field size. For large field sizes (10x10 cm or higher), little difference is observed between the random and the homogeneous models. The additional attenuation of the large structures also results in a region of dose reduction behind the lung.

Conclusion: A new random lung model reveals significant dose perturbations from the homogeneous model, and shows that the homogeneous model breaks down when the field size is comparable to the structure size. This work is of importance in IMRT planning, where beamlets are used, or in the treatment of small tumors, where small field sizes are used in the planning. This work suggests that in such cases, a more precise description of the lung geometry, e.g. a high resolution CT-based pixel-by-pixel density map, may be necessary for accurate dosimetry.