AbstractID: 3903 Title: Sub-Millimeter Three Dimensional Ventilation Imaging of Rodent Lungs

Purpose: To develop a technique capable of generating a high resolution 3D ventilation image in a rat model from a series of CT images. This technique will be invaluable in developing strategies for radiation treatment optimization and characterization of pulmonary disease states.

Method and Materials: A series of three 150gram Fischer 344 rats were euthanized and intubated. The lungs were equilibrated to ambient pressure, then serially inflated and imaged at approximately 1ml increments. A GE flat panel CT scanner capable of 0.15mm resolution was utilized for image acquisition. A deformable image registration algorithm, utilizing 3D optical flow, was applied to each pair of CT images to map, on a voxel by voxel basis, corresponding tissue elements. The difference in average CT number of a nine voxel region surrounding each pair of mapped voxels was then utilized to compute the change in fraction air per voxel (i.e. regional ventilation). This local ventilation measurement was then superimposed onto each voxel of the CT image to generate a 3D ventilation image. The sum of each voxel's ventilation (i.e. total lung ventilation) was then compared to the change in manually segmented lung volumes between each of a series of twenty-two pair of CT images.

Results: Visualization of the 3D ventilation images revealed regional heterogeneity of ventilation throughout the lung fields. The images required smoothing by averaging over a 0.75mm cube surrounding each voxel to minimize artifacts. The calculated total lung ventilation compared favorably with the change in manually segmented lung volumes, with a slope of unity, as expected, and a correlation coefficient of R=0.99.

Conclusion: We have demonstrated a unique method of quantifying regional lung ventilation with sub-millimeter accuracy in a rat model. This model has been developed in order to study lung function and radiation injury.