AbstractID: 10323 Title: A statistical analysis of lung tumor regression and interfraction geometric variation

Purpose: To evaluate interfraction geometric variation and tumor regression in thoracic cancer using an active breath hold technique.

Method and Materials: Weekly helical CT images were acquired during planning and treatment for six research subjects using an active breath hold technique at end of normal inspiration. A small deformation inverse consistent linear elastic (SICLE) algorithm was used to nonrigidly register each weekly image to the image acquired during planning. The resulting displacement vector fields (DVF) were used to track internal volume points and delineated surface points for the gross tumor volume (GTV) and ipsi- and contralateral lungs throughout the treatment course. The anatomical and pathological variation was analyzed through reduction of the vector field distribution using principal component analysis (PCA). Statistical models were generated independently for each patient using PCA. Principal eigenmodes were analyzed for trends related to volume regression, shifts, or combinations of both.

Results: For all patients, three to five eigenmodes (mean: 4.2) accounted for at least 98% of the variation for the GTV only model. The mean residual error for a model constructed with these principal eigenmodes was 0.35 +/- 0.14 mm (range: 0.00 to 1.1 mm) over all subjects. The dominant eigenmode represented primarily shape change, attributed to volume regression of the GTV. The secondary eigenmodes represented rigid shifts in tumor position (within the lung) week to week and higher order combined effects.

Conclusion: Isotropic tumor volume regression and tumor position shift in the lung were separated into components using PCA. Analysis of the dominant component will enable selection of the appropriate image-guided intervention to account for the variation represented by the model.