AbstractID: 14307 Title: Quantitative PET imaging of heterogeneous tumors: The dosimetric effect of patient set-up on image-based dose painting plans.

Purpose:
PET imaging provides surrogate markers of molecular activity within sub-tumor volumes. However, systematic variations in contrast-recovery occur with relative position of small objects. This work investigates the impact, of patient set-up during imaging, on characterization of dose-painting targets within tumors, and quantifies dosimetric uncertainty within image-based dose-painting plans.

Methods and Materials:
PET/CT images were generated that simulate random set-up errors of head-and-neck patients. Reproducibility to reference PET image was quantified by r, correlation coefficient between co-registered tumor voxels. Dose-painting plans were generated with base-dose of 60Gy for whole tumor, and 5Gy boost-dose redistributed within molecularly active sub-regions. Boost-dose redistributions were: (1) continuous – based on linear scaling of relative molecular activity, (2) threshold – with equal boost-dose throughout $ROI_{25\%}$, (voxels where $SUV \geq 25\% * SUV_{max}$). Relative molecular activity was determined from SUV in PET images. Tumor contours and integral boost-dose were kept consistent for both dose-painting schemes. Dose prescriptions within tumor voxels ranged from 60Gy to ~100Gy.

Results:
Correlation between PET images remained above r=0.8 within most tumor contours, but was r=0.6 for one heterogeneous tumor. For PET images with high reproducibility (r>0.8), dose errors were negligible for the continuous dose-painting method, and the dose in all tumor voxels was within ±1Gy of the dose in reference plans. Due to position-dependent changes in SUV, $ROI_{25\%}$ volumes differed from reference, and some tumor voxels were boosted above reference threshold plans while others were not boosted at all. However, even after considerable loss of image reproducibility (r=0.6), the maximum dose difference in any tumor voxel was under 5Gy.

Conclusion:
Patient set-up uncertainty contributes to reduced reproducibility of PET imaging, and limits voxel-based quantification of tumor heterogeneities. This study has shown that systematic uncertainty in PET results in dosimetric errors in image-based dose-painting. However, magnitude of errors depends on methods used to define targets, and prescribe boost-dose.