AbstractID: 11576 Title: Quantifying the 4D PET/CT volumetric distortions: a 4D dynamic phantom study based on pre-recorded patient data

Introduction 4DPET/CT imaging is a powerful technique to assist clinicians in accurate definition of gross-tumor-volumes (GTV) in the lung and abdomen. We present the results of phantom studies designed to evaluate the accuracy of 4DPET/CT at reconstructing the true GTV when tumor motion and abdominal motion are reproduced based on pre-recorded data from real patients.

Methods Measurements were conducted using a 4D dynamic phantom control system capable of reproducing a time-dependent 3D motion (GTV) and a synchronous, decoupled 1D motion (abdominal surface). The tumor and the abdominal motion trajectories programmed into the phantom are based on pre-recorded patient data (tumor and abdominal motion). A 4ml spherical vial of FDG, representing the tumor, was used within a water-FDG mixture adjusted to produce a target-to-background activity-ratio of 8:1. The image reconstruction was done using 10 phase bins over the respiratory cycle. The patient selection was based on the amplitude of the internal marker motion (> 1cm).

Results and Discussion Based on a 3DPET scan with no target motion, two methodologies were used to determine the activity threshold that recovers the active volume of the target (4ml) relative to: (1) the maximum intensity voxel; (2) the average intensity obtained from the five highest intensity voxels;. The percentage difference between the true and calculated volume was determined for each phase bin of the 4D studies. Errors as large as 45% were observed for specific patients and phases with a statistical bias towards overestimation of the target volume. However, the activity threshold based on the average intensity has shown to reduce the inter-phase volumetric distortions.

Conclusion Our results have quantified volumetric distortions that occur during 4D PET/CT imaging based on previously recorded internal target and abdominal motions in patients. These results are relevant to the accurate application of 4D PET/CT to radiotherapy target definition.