AbstractID: 6985 Title: Combined effects of respiratory motion and object size on 3-D and 4-D PET/CT images: Dynamic phantom study

**Introduction:** 4-D PET/CT has potential to greatly improve the accuracy of radiotherapy target definition for treatment sites where internal organ motion is significant. While PET has an inherently greater capacity to detect cancer than CT, the best methodology for applying 4-D PET to target definition is not currently well understood. In our study, targets of different sizes in a dynamic phantom were imaged using 3-D and 4-D PET/CT with the goal of better understanding how to best apply these images to radiotherapy target definition.

**Materials and Methods:** Using a PET/CT scanner with 4-D capability, 3-D/4-D image studies were acquired using a dynamic phantom. Hollow spheres filled with $^{18}$F-FDG were inserted into a cavity within the phantom made of material of a density similar to lung. Recovery coefficients (RCs) were determined using 3-D and 4-D PET images acquired with the phantom in static mode and a dynamic mode set to simulate respiratory motion.

**Results:** The activity concentration in the sphere from the 3-D PET images can be underestimated by 40% (23%) in 2 cm (1 cm) motion. The 4-D PET successfully recovers most of the loss of activity concentration resulting from the respiratory motion with 1% (4%) loss in 1 cm (2 cm) motion. We found that the percent recovery slightly varies with minimum 82% (93%) at the middle of expiration and inhalation and maximum 98% (99%) at the end of expiration and inhalation in 2 cm (1 cm) motion in the 4-D PET images.

**Conclusions:** We demonstrate that the speed of respiratory motion at phase–sampling position affects the measured activities of 4-D PET due to spatial mismatch between the 4-D PET and 3-D CT images for attenuation correction. Therefore, RC loss caused by respiratory motion may be minimized using 4-D PET with 4-D CT attenuation correction.