Purpose:
Positron emission tomography (PET) of lung tumors suffers due to breathing-motion induced blurring. Gated PET ameliorates motion blurring, but the concomitant reduction in coincidence-event statistics per gated image leads to increased image noise, decreasing the utility of the images. In this work we demonstrate a method of reducing motion-induced blurring from PET images without decreasing coincidence-event statistics.

Methods:
The method works by deforming and stacking gated PET images using lung tissue motion vectors derived from deformable image registration performed between the phases of respiratory-correlated computed tomography (4DCT) images. A duration of 12 minutes of respiratory-correlated FDG-PET data in list-mode format and two 4DCT scans were acquired from 3 patients with a total of 4 small (4-18cc) lung tumors. A motion-corrected image was produced using the first 2 minutes of list-mode data. The motion-corrected image was compared to a high-statistics gated end-exhale PET image created from the remaining 10 minutes of PET list-mode data, which was used as a gold-standard approximating a truly motion-free image. The images were also compared against an un-gated PET image produced using the first two minutes of list-mode data, to quantify the improvement provided by the motion-correction process.

Results:
Tumor SUVmax was on average 44% higher for motion-reduced images relative to un-gated images, but still on average 14% lower than the gold-standard high-statistics gated images. Volumes of tumors segmented at 40% of SUVmax were on average 32% lower relative to un-gated images, but still 22% higher than the high-statistics gated images.

Conclusions:
A process for reducing motion blurring in PET images without increasing image noise was demonstrated. The motion-corrected images are quantitatively and qualitatively improved relative to un-gated images, however further improvement is needed in order to match the quality of high-statistics gated images.