Purpose:
The aim of this study is to assess the improvement of image quality on a time-of-flight (TOF) PET/CT scanner using phantom with varying sphere size and sphere-to-background ratio (SBR)

Methods:
A NEMA IEC phantom containing six spheres (1-3.7cm) was scanned on a GE Discovery-690 TOF PET/CT scanner. 8 saline bags (250ml each) were attached to the phantom to simulate an obese patient (BMI=32). The scan was repeated for two SBR, 4:1 and 8:1 with background activity concentration of 0.14 and 0.1uCi/cc respectively. PET data was acquired in 3D for 3 minutes for each SBR, and images were reconstructed with and without TOF information, using 16 subsets and varying 1-10 iterations. ROIs were placed in the central slice on each sphere based on CT images, and the mean value in each ROI was calculated. Background mean and standard deviation were measured from 500 randomly selected voxels across 10 slices. Signal-to-noise ratio (SNR), contrast recovery coefficient (%CRC), and background variability (%noise) were determined and compared across different sphere size, SBR, and iterations.

Results:
Contrary to what is expected, SNR w/o TOF is consistently better than with TOF for all sphere sizes, iteration number, and SBR. The CRC for TOF on the other hand is consistently higher than non-TOF when evaluated at the same noise level for SBR 4:1. This finding however reverses at higher SBRs and iteration number. The CRC gain of TOF vs. non-TOF increased with decreasing sphere diameter.

Conclusions:
TOF imaging improves the resulting CRC but not the SNR of PET images when compared using the same number of iteration. The benefit of TOF is highest for small spheres and SBRs.