AbstractID: 10852 Title: Monte Carlo based evaluation of 3D PET quantification inaccuracy for the lung

Purpose: Our goal is to investigate the effect on PET accuracy of the various physical and instrumental phenomena using realistic Monte Carlo (MC) models of patient activity distributions and PET scanners.

Methods and materials: Data from a lung PET/CT scan is used to create numerical voxelized phantom for realistic MC simulations using the GATE MC code. We compared the activity reconstructed from the simulations to the input (”true”) values. We investigated the effects of random coincidences, photon scatter and positional shift between transmission and emission scans on the degradation of 3D PET quantification accuracy.

Results: When exact attenuation, scatter and random corrections are applied, the activity from the simulated scans deviated from the input by more than 50% for 25% of the voxels. Inaccuracy of the random and scatter corrections of 20% will add additional quantification errors of about 20% and 40% respectively. The attenuation correction (AC) adds random and scatter events to the high tissue density regions. AC based on misaligned transmission data causes pronounced changes in the activity distribution in regions that have a high density gradient such as at junctions between soft tissue, bone and lung. AC misalignment causes errors of the activity levels, which may exceed a factor of five around the ribs for 1.5 cm shift between the PET data and the AC image.

Conclusions: MC methods are a useful tool in investigating PET scanner response to realistic distributions of the activity and the attenuation properties and in establishing the uncertainty in PET quantification in patient studies. The potential quantification errors due to possible misregistration and inaccurate scatter and random corrections have been determined as indicated above for the lung.

Supported in part by NCI grant CA-059017 and performed in part on the Physon cluster, funded by Bulgarian NSF contract DO-1-872.