AbstractID: 5613 Title: A Monte Carlo Model of the Discovery ST PET Scanner

Purpose:
To evaluate the accuracy of a GATE (Geant4 Application for Tomographic Emission) Monte Carlo model of a commercial PET scanner for purposes of simulating the generation, propagation, and detection of annihilation photons in PET scanners, and for evaluating image scatter fractions, resolution, sensitivity, and other scanning parameters.

Methods:
We compare GATE results to experimental data from a GE Discovery ST PET scanner. Our 3D PET simulation model of the GE Discovery ST scanner consists of 10,080 detectors grouped in modules and blocks following the vendor's specifications. NEMA'01 PET commissioning phantoms are also accurately modeled. More than 2 billion positron histories were followed to simulate measured PET scans of the NEMA phantom.

Results:
The simulated GE Discovery ST's radial sensitivity ratios for the NEMA'01 phantoms agree to within 0.6% of measured values ($R_0/R_{10,\text{ measured}}$ [9.118/9.309] = 0.979 versus $R_0/R_{10,\text{ simulated}}$ = [9.145/9.289] = 0.985, sensitivities R are in cps/kBq). The scatter fraction agreement is within 1.6% (the measured and simulated scatter fractions are 45.1% and 45.8% respectively). The model also accurately simulates the behavior of the time curves (measured peak true counts 338 kcps at 32.9 kBq/cc and simulated peak true counts 340 kcps at 32 kBq/cc). In addition, the spatial resolution of the scanner is simulated.

Conclusions:
The validated model accurately predicts scanner response and performance parameters, can be used to evaluate and improve PET resolution, image quality, and quantitative accuracy, and will aid in the determination of optimum scan parameters. In conjunction with CT images, the model can also be used to assess the accuracy of tumor segmentation for radiation therapy treatment planning.

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