AbstractID: 3841 Title: Validation of GATE Monte Carlo Simulations of the Noise Equivalent Count Rate and Image Quailty for the GE Discovery LS PET Scanner

Purpose:
The needs of radiation therapy treatment planning impose higher demands on PET/CT imaging accuracy. The recently developed GATE (Geant4 Application for Tomographic Emission) Monte Carlo package, provides the possibility to model accurately the factors contributing to decreased PET resolution and image degradation. The purpose of this study is to test GATE's ability to predict time curves and image quality (IQ) for the GE Discovery LS/Advance PET scanner.

Method and Materials:
Our 3D PET simulation model of the GE Discovery LS scanner and phantoms follows both the vendor's and NEMA's specifications and was previously validated for the PET scatter fraction and sensitivity tests. Simulations with this model were performed for the count rate and IQ NEMA-2001 tests as a function of activity concentration. The Software for Tomographic Image Reconstruction (STIR) package was used to reconstruct the simulated data which was then compared to experiment.

Results:
Our simulations correctly predict the shape and magnitude of the true, scatter, random, and NEC rates. The simulated peak true and NEC rates are both within 3 kBq/cc of the measured data. Scatter and random rejection in the Monte Carlo data dramatically improved the agreement between measured and simulated contrast ratios. The cold sphere contrast ratio is within 9% of the measured data when the scatter and random coincidences were rejected. Larger discrepancies for the hot sphere contrast are currently observed and investigated.

Conclusions:
Monte Carlo simulation of PET images and the corresponding NEC rates can aid in improving PET image quality. The ability to model the features of PET scanners accurately makes GATE a potentially useful tool in improving PET's performance, which is necessary for its effective use in radiation treatment planning

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