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Complete Validation of Biograph mCT PET with Monte Carlo simulation: GATE and STIR.

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The Geant Application for Tomographic Emission (GATE) is a simulation platform based on GEANT4, which is designed to perform numerical simulation in medical imaging and radiotherapy. The purpose of our study is to validate a GATE model of the commercial PET/CT Siemens Biograph placed at the University Hospital of Salamanca (Spain). The geometry of the system was implemented including the detector ring, crystal blocks, PMTs,etc. The GATE simulation results were reconstructed with analytical and iterative algorithms using STIR (Software for Tomographic Image Recostruction), an open source software for 3D PET and SPECT image reconstruction. Simulated data were compared to experimental results obtanied using the NEMA NU-2-2007 standard protocols. It consisted of sensitivity estimation, count rate, NEC curve, scatter fraction, spatial resolution and image quality (hot and cold contrasts, atenuation in the lung and percent background variability).

The reults for 2D and 3D sensitivity, scatter fraction, count rate and parameters referring to the image quality were found to agree with experimental values. The simulated sensitivity obtained is 10.9 cps/kBq in the center of the transaxial field of view and 8.85 cps/kBq at 10cm. Excellent agreement between simulation and experiment can be seen in the spatial resolution results, FWHM being 5.288 mm at 1 cm with GATE and 5.280 mm at 1 cm experimentally. Simulated Scatter dispersion was 35.1% for a concentration of 2.48 kBq/mL, a value was lower than that provided by the manufacturer.

In conclusion, our study showed that our Monte Carlo model can be used to optimize,simplify and reduce the simulation time for the quality control procedure of PET scanners.

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