Translating N-12 imaging to the clinic using Monte Carlo simulations

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Background: The RIVER project at the Particle Therapy Research Center (PARTREC) aims to investigate imaging of the very short-lived positron-emitting nuclide N-12 (half-life of only 11 milliseconds), produced in the patient by the therapeutic beam, for real-time in vivo verification. The project aims to make a major step toward translating N-12 imaging to the clinic. A GATE Monte Carlo simulation framework is being set up to transform the N-12 production image into a calculated N-12 PET image.

Material and Methods: GATE, the Geant4 Application for Emission Tomography, is used in the present study. We simulate the in-house PET scanner, which is 1/6th of a Siemens Biograph mCT scanner. Two panels are arranged facing each other. Each panel is composed of a 4×4 array of block detectors of 56×56×20 mm^3. Each block detector consists of a 13×13 array of 4×4×20 mm^3 LSO scintillator crystals. The distance between the panels ranges from 350 to 450 mm, significantly smaller than the diameter of the full-ring scanner in order to maximize the sensitivity. The framework will apply corrections for attenuation and scatter based on the CT-image of the anthropomorphic head phantom that will be used in irradiation experiments, and will take the geometry of our PET scanner into account.

Preliminary results: A dual panel Biograph PET scanner was modeled and validated with the experimental set up (Fig.1). Using the simulation framework and N-12 production images from RayStation, we will predict the N-12 PET images and compare these to the measurements obtained with the PET scanner. Experiments are planned at PARTREC and the Groningen Proton Therapy Center.

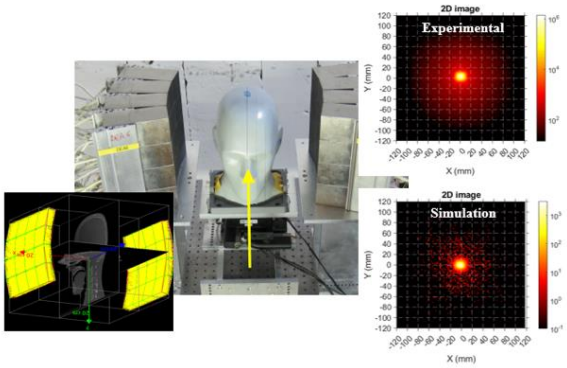

Figure 1: Experimental setup, the GATE implementation and images of a point source .