Simulations and Image Reconstruction for High Resolution CaLIPSO PET Scanner for Human Brain and Preclinical Studies

Olga Kochebina*[1,2], Sebastien Jan[1], Simon Stute[1], Viatcheslav Sharyy[2], and Dominique Yvon[2]

[1]Service Hospitalier Frédéric Joliot (SHFJ) – CEA – France
[2]Service de Physique des Particules (SPP) – CEA – France

Résumé

The foreseen CaLIPSO (french acronym for Liquid Ionization Calorimeter, Scintillation Position Organometallic) Positron Emission Tomography (PET) scanner is expected to have simultaneously a fine image resolution, about 1mm3, and a high contrast. Such performances are especially relevant in human brain imaging and preclinical researches. The CaLIPSO scanner uses the concept of double detection of the signal created by a photoelectron from the 511-keV photon conversion in liquid trimethyl bismuth (TMBi) filling a cell of this innovative detector. The converted electron emits Cherenkov photons and ionizes the medium. Both light and free electrons are collected simultaneously and used for the reconstruction of the time and 3D position of the interaction as well as deposited energy. Enhancement of image contrast is possible thanks to the Time of Flight techniques with expected coincidence resolving time of 100-200ps. The preliminary results on simulations for a full PET scanner with the GATE platform are presented. New results obtained with a non-standard "cube" geometry of the scanner in terms of image resolution and Noise Equivalent Count rate and are compared to HRRT performance. We discuss the challenges for the reconstruction of data produced by this scanner with a high spatial resolution and present the first simulated brain images for 18F-FDG and 11C-PE2I tracer distributions. CaLIPSO is a promising ongoing project for designing a PET scanner with a high potential dedicated to small animal and brain imaging that could outperform the other detector technologies proposed for PET imaging such as scintillating crystals, high-Z semiconductors and liquid Xenon.

Mots-Clés: brain PET scanner, high image resolution, Monte Carlo simulations, image reconstruction

*Intervenant