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#9-284 Progress report of a long axial FOV PET (IMAS) with TOF and DOI capabilities

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Total-Body Positron Emission Tomography (TB-PET) technology and designs have become very popular in the recent years. These systems are very attractive because of their high sensitivity resulting from their extended axial Field of View (FOV) and potential Time of Flight (TOF) capabilities, allowing for the simultaneous study of the kinetics of multiple organs. Most of TB-PET designs and implementations are based on LYSO crystal pixels without Depth of Interaction (DOI) capabilities.

In this work we present a TB-PET system, named IMAS, based on semi-monolithic crystals to simultaneously enable TOF and DOI capabilities. Our design makes use of a reduction of signals without compromising performance. The system geometry is based on 5 rings of 10 cm in the axial direction each, and gaps of about 5 cm, resulting in a total axial length of 71.4 cm. The system has been constructed and installed (June 2023) at the largest hospital in Valencia named La Fe. Very preliminary experimental tests already predict an almost homogeneous spatial resolution below 4 mm in the whole FOV (as far as at 30 cm off-radial), outperforming any other scanner with a long axial FOV. The system sensitivity is 7.6% with a source at the Center of the FOV (CFOV). The detectors reached a TOF of about 350 ps FWHM. We aim to report a full characterization of the scanner during the conference, including images with first patients taken at the largest hospital in our region (La Fe).

In more detail, we present real data obtained for the IMAS system and report on the extensive work performed on its geometry, detector performance, and image quality, with very preliminary reconstructed images already available. The scintillation slab configuration effectively balances 3D photon impact positioning (x, y, DOI) and timing resolutions due to its monolithic-like and pixel-like structures, respectively. This configuration achieved a Coincidence Time Resolution (CTR) of around 300 ps at the detector level, combined with a spatial FWHM of 3 mm in the monolithic direction. Additional tests yielded a DOI resolution of 4 mm. We arranged 4×4 mini-modules in the super-modules (SM) configuration. Each SM returns 256 channels and is temperature-controlled by water cooling. Each ring comprises 24 SM, totaling 5 rings. The system's energy is calibrated per slab to correct differences in light collection between SiPMs and slab position. Moreover, an energy filter implemented by PETsys filters data based on channels fired and total energy before sending it to the PC, doubling the IMAS dynamic range, with room for improvement by optimizing those parameters.

Preliminary tests with real data have been carried out including DOI information, but still lacking TOF. The spatial resolution remains almost constant and below 3.5 mm FWHM at 20 cm off-radial position when DOI is included. The deterioration for the case without DOI at 30 cm would be almost 6 mm. For comparison purposes, the measured values of other large axial FOV scanners are significantly worse.

The sensitivity profile was determined for the whole scanner, using a bar filled with FDG reporting 4.4%. This increases to 7.6% if using a source at the CFOV. Other tests with phantoms have been also carried out. We tested the Jaszczak phantom with a cold Derenzo-like region. A uniformity of the image in the range of 75% was achieved, together with Contrast to Noise Ratio (CNR) coefficients as good as 60%. Moreover, the cold phantom allowed us to distinguish well the 6.4 mm rods.

Primary authors: GONZALEZ, Antonio J. (Institute for Instrumentation in Molecular Imaging, i3M-CSIC); SANCHEZ, David (Institute for Instrumentation in Molecular Imaging (i3M), CSIC-UPV); Dr JIMENEZ-SERRANO, Santiago

(Institute for Instrumentation in Molecular Imaging (i3M), CSIC-UPV); Mr ANREUS, Alvaro (Institute for Instrumentation in Molecular Imaging (i3M), CSIC-UPV); Dr FREIRE, Marta (Institute for Instrumentation in Molecular Imaging (i3M), CSIC-UPV); GONZALEZ-MONTORO, Andrea (Instituto de Instrumentación para Imagen Molecular (I3M), Centro Mixto CSIC-UPV); Dr TORRES, Irene (La Fe); Dr RIOS, Alfonso (Full Body Insight); BENLLOCH, José María (Instituto de Instrumentación para la Imagen Molecular (i3M))

Presenter: GONZALEZ, Antonio J. (Institute for Instrumentation in Molecular Imaging, i3M-CSIC)

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