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IMAS: a Total-Body PET system with TOF and DOI capabilities

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Total-Body Positron Emission Tomography (TB-PET) systems have become very popular in the recent times, due to their increased sensitivity with respect to Whole-Body (WB) PET systems. This is mainly attributed to their extended axial Field of View (FOV) and, in a few cases, the capability of Time of Flight (TOF) information. This combination enables the simultaneous visualization of the biomarker distribution across multiple organs. The DMIL group from i3M has recently developed and built, with the collaboration of other research groups and companies, a new TB-PET scanner, named IMAS, already installed at Hospital La Fe in Valencia,
The IMAS scanner features five rings with an inner diameter of 82 cm and an axial length of around 10 cm each, separated by 5 cm gaps between rings. This gives a total axial coverage of 70 cm. The IMAS scanner is based on semi-monolithic scintillator crystal with a total of 15,260 LYSO slabs, grouped into mini-modules (MM). Each MM contains an array of 1x8 LYSO slabs of 25×3×20 mm3, wrapped with Enhanced Specular Reflector (ESR) and coupled to an array of 8×8 Silicon Photomultipliers (SiPM) from Hamamatsu Photonics, model S13361-3075AE-08. Our design also uses novel multiplexed read-out electronics that reduce the number of signals from N2 to N. The x-(pixelated) coordinates are directly inferred from the triggered pixel, while y-(monolithic) and DOI (z) coordinates were estimated using two different Multilayer Perceptron's (MLPs). Images were reconstructed using iterative methods. For the entire NEMA protocol, we used the Maximum-Likelihood Expectation-Maximization (MLEM) algorithm. We also carried out the first studies with patients. These images were reconstructed using the Ordered Subset Expectation Maximization (OSEM) algorithm.
A preliminary experimental evaluation of the IMAS system was performed . A system spatial resolution of 3.37 mm was obtained at the center of the scanner. This value remains almost constant along the radial direction due to the DOI capabilities of the system. The system has a peak sensitivity of 7.6% at the center of the scanner.
A significant step forward has been accomplished by acquiring the first patient images with the system. Clinically, image quality of our IMAS system seems to be superior to the conventional WB-PET/CT.

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