

Voxel Imaging PET (VIP): A High Spatial and Energy Resolution (FWHM 1-2%) for Nuclear Imaging Diagnostics

Invention executive summary

IFAE has developed a novel detector module (patented) for Nuclear Medicine Imaging devices, such as **Positron Emission Tomography (PET) detector which provides excellent energy and spatial resolution** when compared to the current state-of-the-art PET detectors.

State-of-the-art

Currently, the detector module used in nuclear medicine imaging devices is made of scintillator crystal, such as LSO, coupled to a photon sensitive device (Avalanche Photo Diode, Silicon Photo Multiplier). With relatively large voxel ($80 \text{ mm}^3 = 2 \text{ mm} \times 2 \text{ mm} \times 20 \text{ mm}$). Such large voxel volume increases the parallax effect, which affects the spatial resolution of the reconstructed image.

Another inherent limitation caused by the scintillator is the indirect conversion. That is the process of converting the original photon energy into electric pulse signal, process that degrades the energy resolution, (estimate $\sim 15\%$ for photon energy of 511 keV).

Invention description

The IFAE's invention is a novel detector module that overcomes the intrinsic limitations of the current state-of-the-art detectors used in nuclear medicine. It is based on innovative conceptual assembly process with pixel CdTe sensors. The photon is captured in a direct conversion process, and thus the energy of the photon is directly converted into electrical signal (100keV generates around 20000 electrons compared to around 500 electrons in scintillator + APD). At the same time the detection position of the photon is measured precisely, with an error of 300 μm .

This technology has several industrial applications:

Application	What can VIP offer
PET- Oncology	3D functional images with less exposure for the patient
PET- Neuroimaging	We can reduce the radiation dose at the same time that the doctor can see different radio-tracers simultaneously
Positron Emission Mammography (PEM)	A modality to detect breast cancer that needs more resolution to see more small tumours and a more localised field of view
Compton Camera	Reduces the exposure time x 50 without having to sacrifice image resolution. By the nature of Compton Camera imaging processing technique one obtains 3D images without having to move the detector

Invention advantages

- Greatly improve the spatial resolution thanks to a extremely minimized voxel module size of 1mm x 1mm x 2mm, that makes negligible the parallax effect.
- Has an excellent energy resolution of 1-2% at an energy of 511 keV, thus reducing the scatter fraction from 40% to 4% and hence the noise of the reconstructed PET image get reduced.
- Both features, small Parallax and small scattered fraction implies the ability to obtain sharp images with excellent contrast allowing the detection of cancerous lesion as small as 2mm, in diameter in a signal to background ratio of 3:1
- Has adequate detection efficiency for 511 keV photons thanks to the high CdTe stopping power and seamless geometry. Thus reducing the over all dose and the duration of the scan

Cooperation Sought

Companies dedicated to the development of nuclear medicine imaging devices and small PET are sought for:

- Research Cooperation via capital venture or H2020 Programme
- Technical cooperation, joint development
- Technology License Agreement

Stage of development

Patent EP09815661.5 "Device for detecting highly energetic photons" - 23 September 2008 (priority date).

Contact:

techservices@ifae.es / www.ifae.es



IFAE is a physics research center located in Barcelona, dedicated to design and develop radiation detectors and high-performance cameras for Medical/ICT sectors and fundamental research (CERN, ESA, ESO).