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PETsys
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PETsys PET Detector Module

The PETsys MPPC based PET detector module is a detector for 511 keV gamma rays for use in Positron Emission Tomography. The detector unit comprising two Hamamatsu S12642-0808PB 8x8 MPPC arrays, two LYSO arrays coupled to the MPPC arrays, and one FEB/A 0808 board with two TOFPET ASICs[1]. See the flyer about the FEB/A 0808 for more information about this board. The PET detector modules, together with the FEB/D and DAQ boards, make a complete solution for a PET scanner that can have many hundreds detector modules. The time resolution between two LYSO crystals facing each other and a positron emitting source in the middle is 132 ps rms when using LYSO crystals 15 mm long, see Fig. 3.

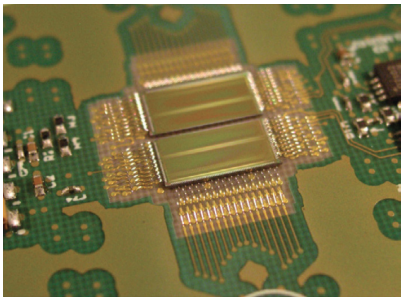

Figure 1
Chip on board assembly; shown here before application of the protective epoxy encapsulation over the ASIC.

The external dimensions of each module are 26.04x52.58 mm, and the modules are four side buttable. The modules can be plugged directly in the TOF FEB/D to form a planar detector unit measuring 105.7x105.7 mm with negligible gaps between the LYSO crystals. It is also possible to have flexible cables between the PET detector modules and the TOF FEB/D board. In this way the detector modules can be arranged in any desired geometry, in particular the modules can be arranged to form a continuous ring with minimal gaps between the modules.

We propose several options for the LYSO scintillating crystal array geometry. The baseline geometry (Fig. 2) is well adapted to applications in whole body PET and is optimised for timing. It uses 8x8 LYSO arrays with crystals measuring 3.13x3.13x20 mm^3, in one-to-one coupling with the MPPC array. The length of the LYSO crystals can be adapted to the preference of the user. In the high resolution modules we use 16x16 LYSO arrays with crystals measuring 1.53x1.53x15 mm^3 in four-to-one coupling with the MPPC pixels. There is a one mm thick glass plate between the LYSO array and the MPPC array. The crystal where the interaction occurred can be identified using light sharing, for example with the flood diagram method (Fig 4).

Our proprietary Depth Of Interaction (DOI) solution can be applied both to the whole body detector modules and to the high-resolution PET detector modules, and provides DOI resolution of a few mm rms when using LYSO crystals 15 mm long. This is illustrated in figure 5.

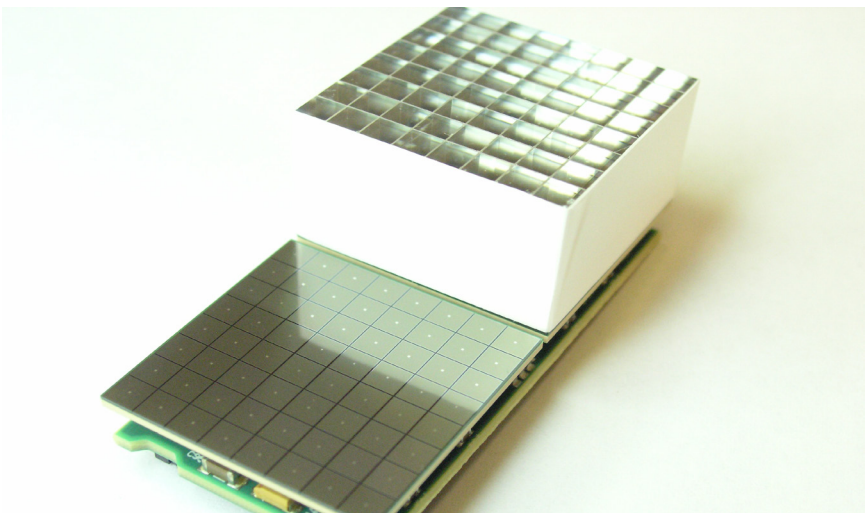

Figure 2.
PET detector module baseline geometry with the outer protection cap and one of the LYSO crystal arrays removed.

[1] M. D. Rolo et al., 2013, JINST 8, C02050

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or contact sales@petsyselectronics.com

Measured detector performance

Coincidence time resolution

Figure 3

Coincidence Time Resolution between two LYSO crystals measuring 3x3x15 mm^3 in one-to-one coupling with the PMMC pixels.

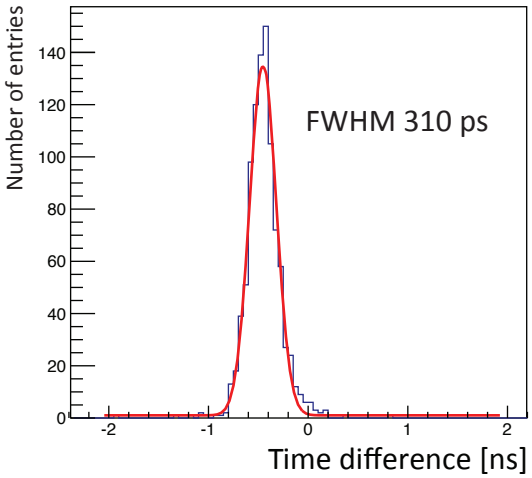


Figure 4

Flood diagram with 8x8 array of LYSO crystals measuring 1.53x1.53x15 mm^3 on a 4x4 MPPC array. The crystals are polished on all sides and separated by Vikuiti ESR foils 70 µm tick.

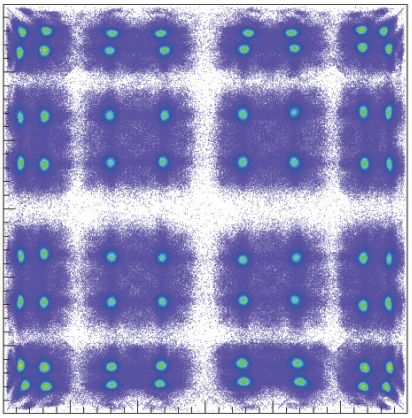
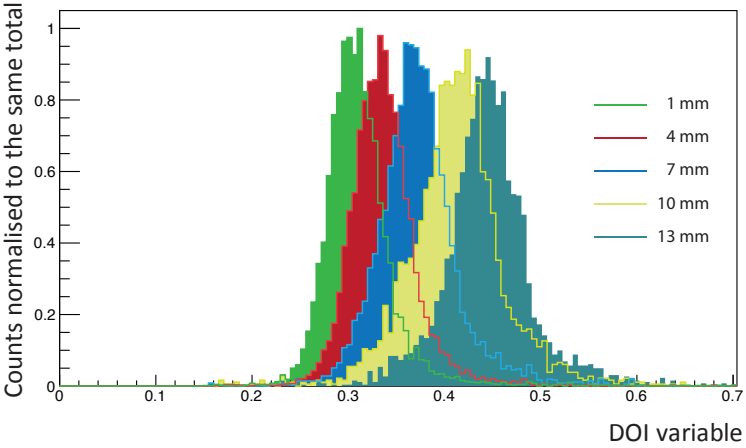


Figure 5

Dept of interaction determination validated here with a collimated beam of 511 keV gamma rays entering sideways into the LYSO crystal array at known dept. Distance is from the front face of the crystal opposite to the MPPC. The LYSO crystals measure 1.53x1.53x15 mm^3.



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