APD-based High Packing-Fraction LYSO:Ce Matrix for PET Applications

Detection Sensitivity and Light Collection Studies

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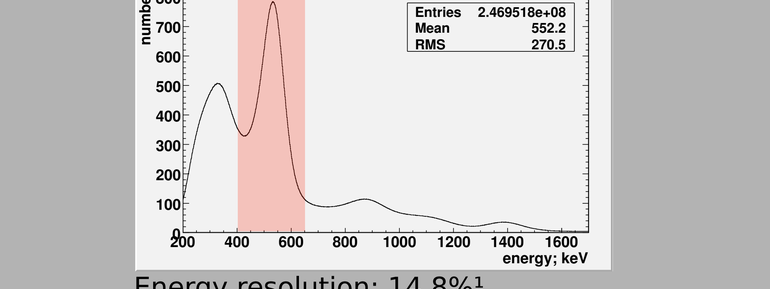
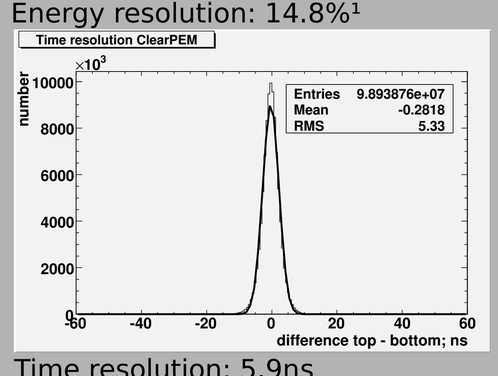
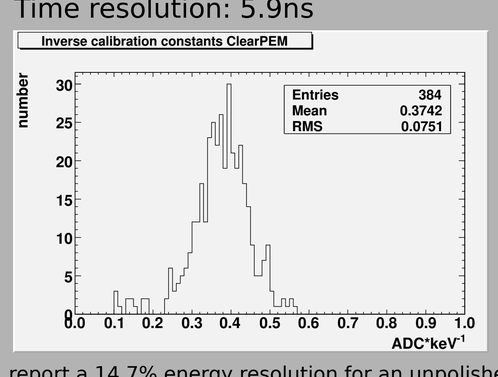
The previous ClearPEM matrix with less packing fraction



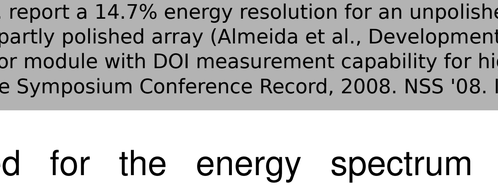
Encapsulation, reflective walls, gaps to accomodate APDs give rise to only **46% active area**



Energy resolution: 14.8%[1]



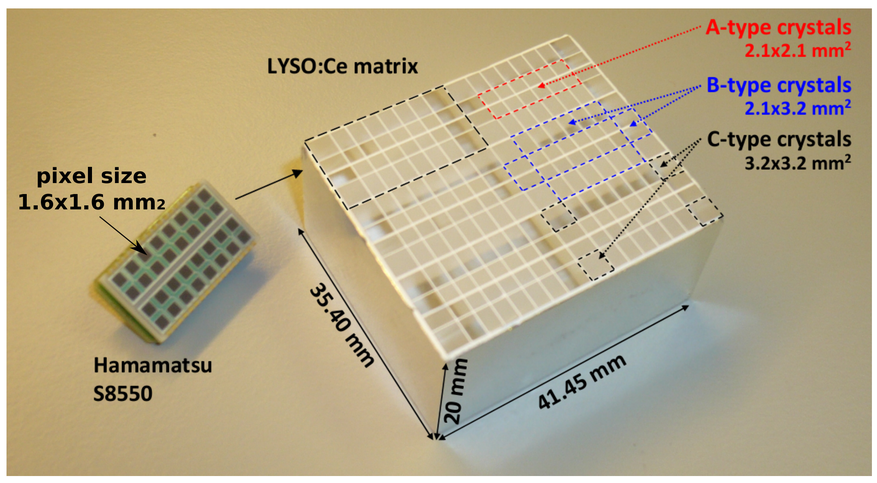
Time resolution: 5.9ns

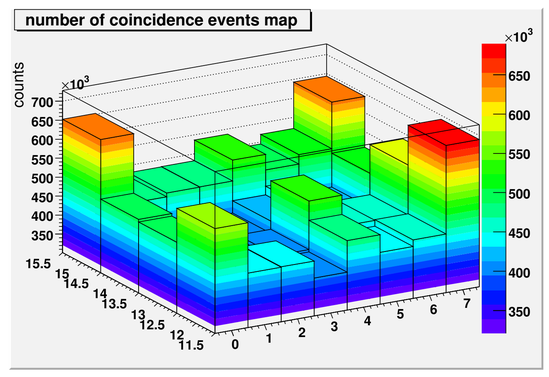


[1] Almeida et al. report a 14.7% energy resolution for an unpolished ClearPEM array and 16% for a partly polished array (Almeida et al., Development of a high packing fraction detector module with DOI measurement capability for high-resolution PET, Nuclear Science Symposium Conference Record, 2008. NSS '08. IEEE)

The new high-packing fraction matrix CCM

The **active area is 76%**. Elimination of inactive area gives rise to different pixel sizes A, B and C:

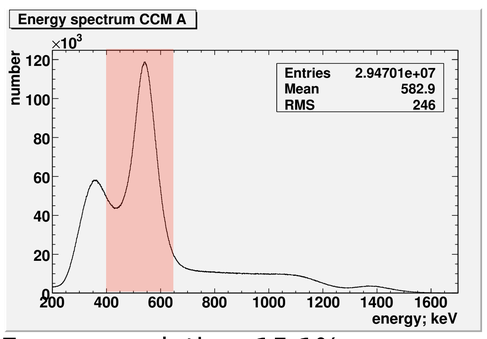




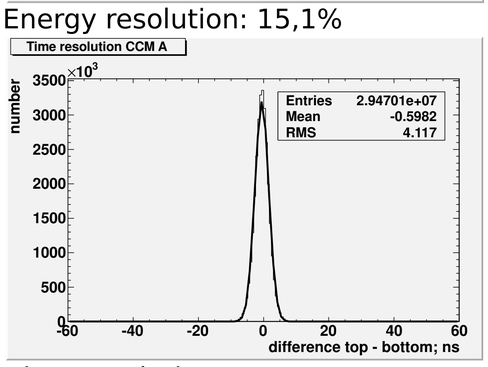
With event rate proportional to crystal volume the larger crystals receive more events

PERFORMANCE RESULTS:

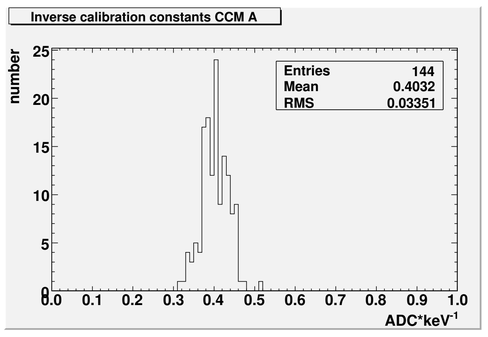
A smallest 2.1x2.1 mm²



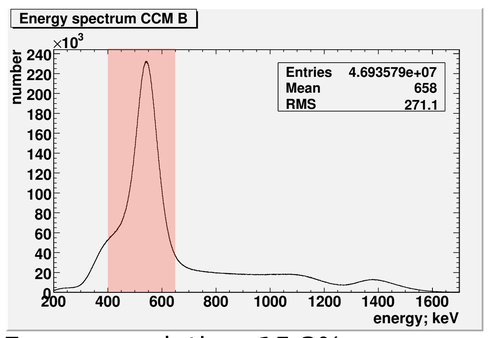
Energy resolution: 15,1%



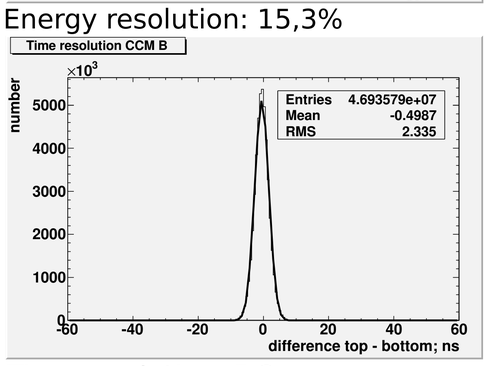
Time resolution: 5.1ns



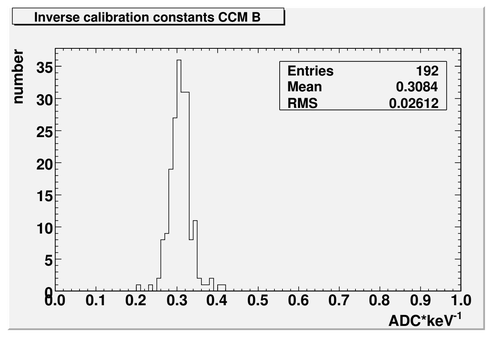
B medium 2.1x3.2 mm²



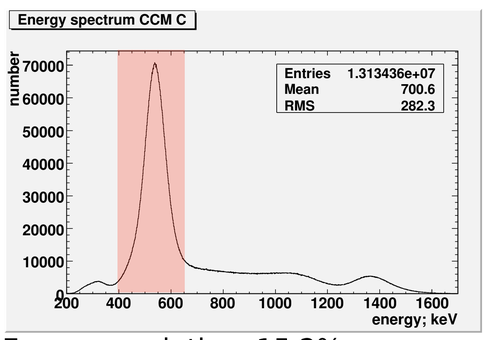
Energy resolution: 15,3%



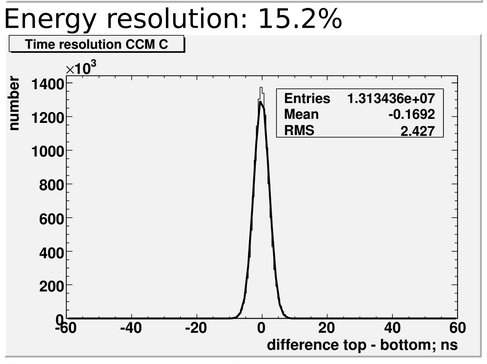
Time resolution: 5.2ns



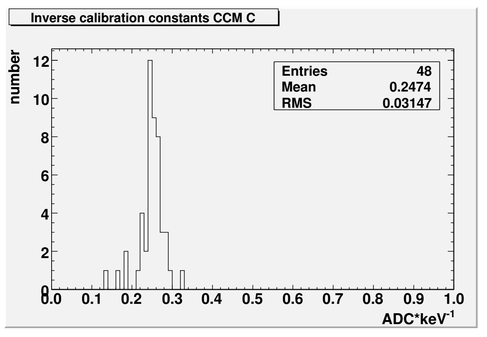
C largest 3.2x3.2 mm²



Energy resolution: 15.2%

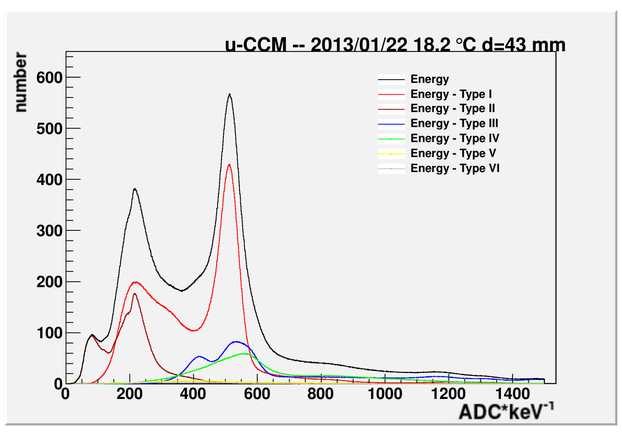


Time resolution: 5.6ns

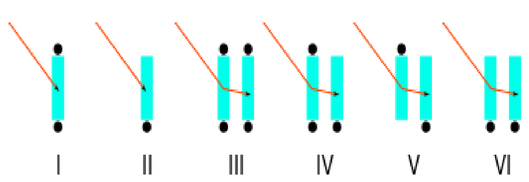


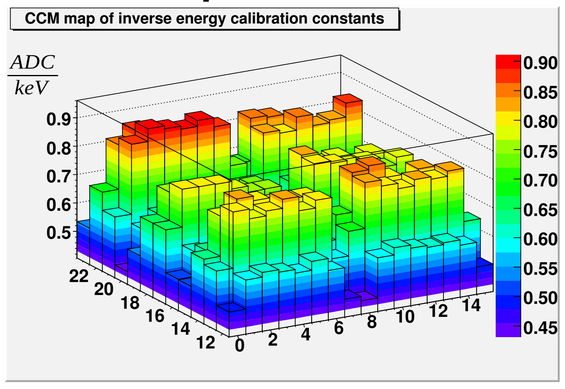
Energy resolution (~15%) and time resolution (~5 ns) is independent of crystal pixel size.
Signal yield relative to the smaller A-type crystals: 78% for B-type crystals; 63% for C-type crystals.
Lower signal yield in larger pixels does not affect the energy and time resolution performance.

We looked for the energy spectrum of photoelectric and Compton events varying the source intensity by altering the distance **d** between the source and the matrix

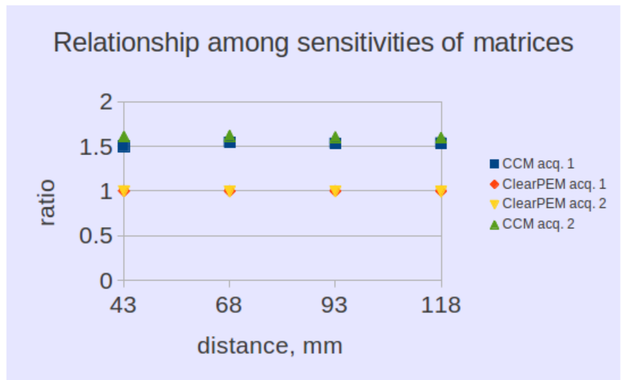


Various types of events we analysed:

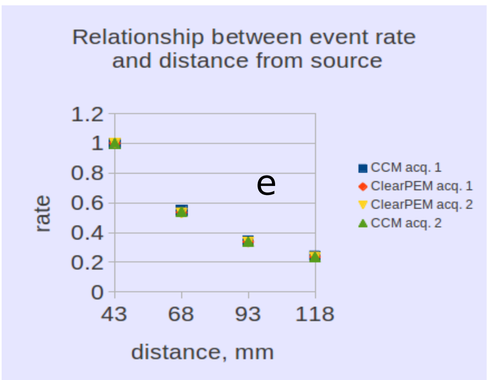




The crystal map of inverse calibration constants reveals the pattern of different crystal sizes well



The new high - packing matrix showed a 57±4% increase in sensitivity, which agrees well with expectations



There is an inverse square relationship between distance from source and event rate, this relationship remains stable between various acquisitions

The new high-packing matrix showed ***a 57% increase in sensitivity. A gain of 2.5 in PET sensitivity*** *is expected.*

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