

# Characterization of Segmented HPGe Detectors Using Pulse Shape Comparison Methods

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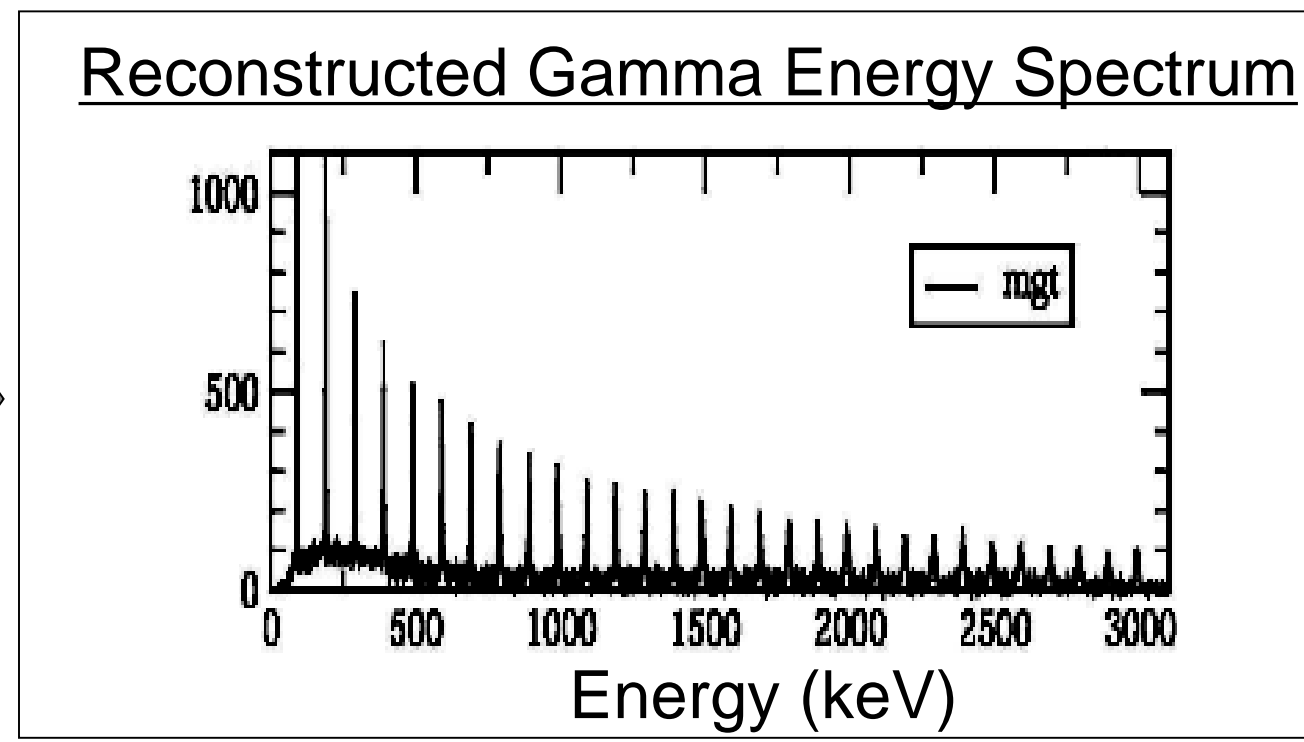
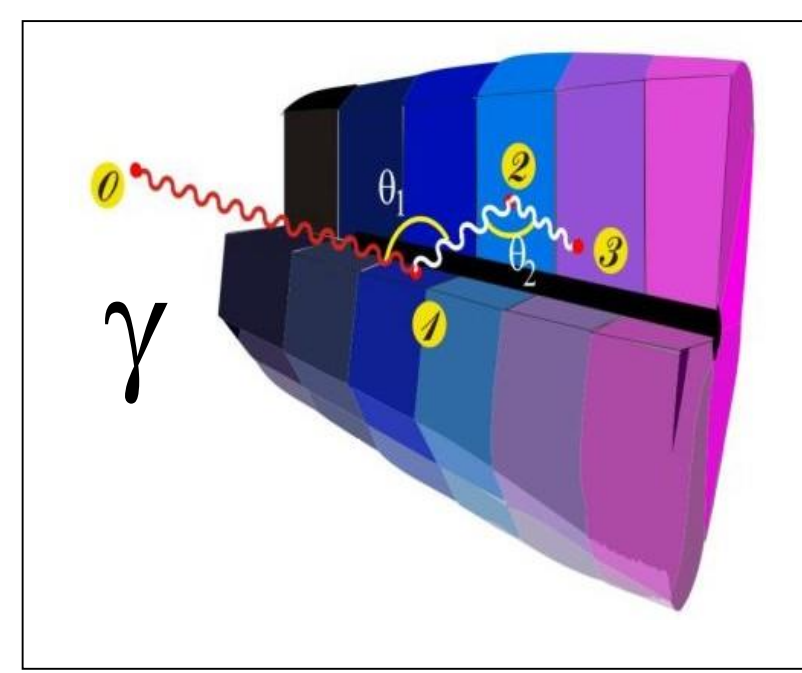
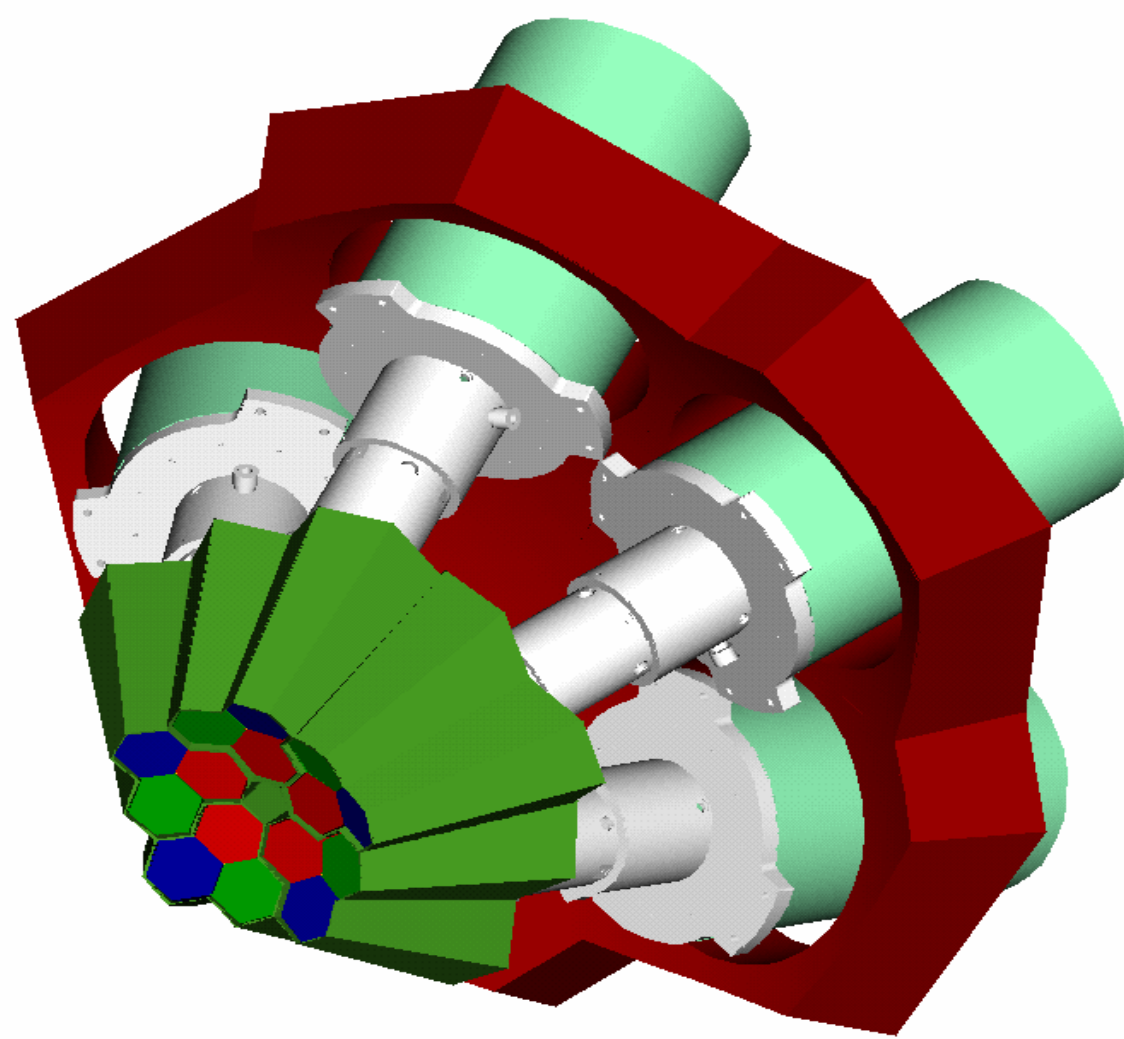
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## $\gamma$ -ray Tracking Detectors

### AGATA Demonstrator

- Large volume (240 cm<sup>3</sup>), Highly segmented HPGe detectors
- Digital electronics to record and process signals from segment
- **Determination of the detector position response**
- **Pulse Shape Analysis (PSA)** to decompose recorded signals
- **Reconstruction of tracks** evaluating permutations of Interaction Points (IPs)

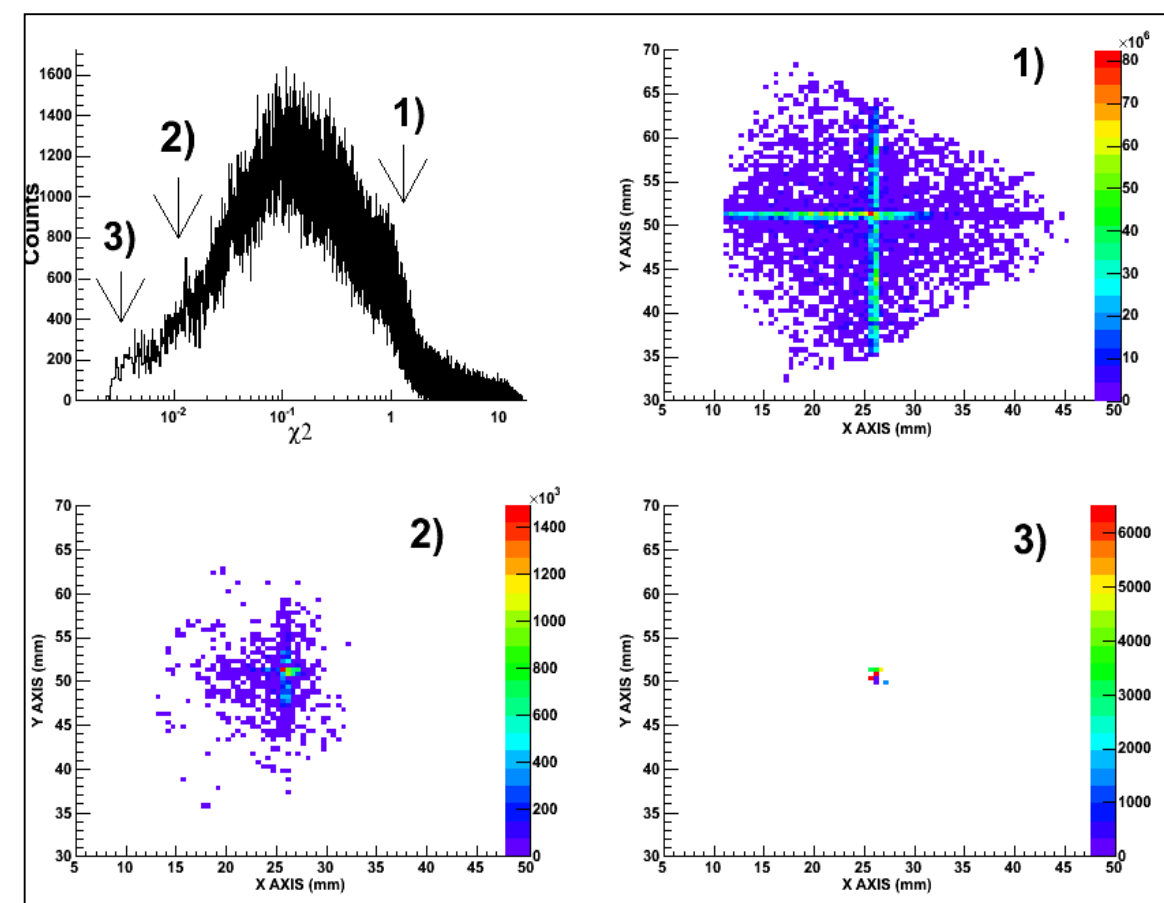


### Abstract

In many in-beam gamma spectroscopy experiments the detection of high-energy gamma rays in the range up to 10-20 MeV is of primary importance. New generation high-resolution gamma-ray spectrometers like AGATA and GRETA are composed of position sensitive segmented HPGe detectors and provide a reconstruction of the gamma-ray tracks. The performance of AGATA detectors in this energy range has, however, never been studied in detail. A measurement of the response to 15.1 MeV gamma rays has therefore been performed using two HPGe triple clusters of the AGATA Demonstrator array, operating at LNL-INFN. This study represents a crucial test of the AGATA detectors for the measurement of high-energy gamma rays, in terms of detection efficiency, energy resolution, tracking and performance of the pulse shape analysis (PSA) algorithms.

### Pulse Shape Comparison Scan (PSCS) – Basic Idea –

The technique is based on a **specific pulse shape comparison procedure** (therefore we named it Pulse Shape Comparison Scan, PSCS). The main difference between the PSCS and standard techniques is that PSCS **does not require any 'coincidence' between events**: this approach allows to enormously decrease the time duration of the measurements. In highly segmented HPGe detectors (e.g. AGATA), two different single-interaction gamma events give rise to clearly distinguishable signal shapes. To identify the **gamma ray interaction point position** 2 data sets are used: each one corresponding to a specific measurement characterized by a defined collimation of the gamma ray source. In fact, the only case in which a signal of one set is identical to a signal of the other is when the two signals originate at the position corresponding to the **crossing point of the two lines defined by the source collimation**.



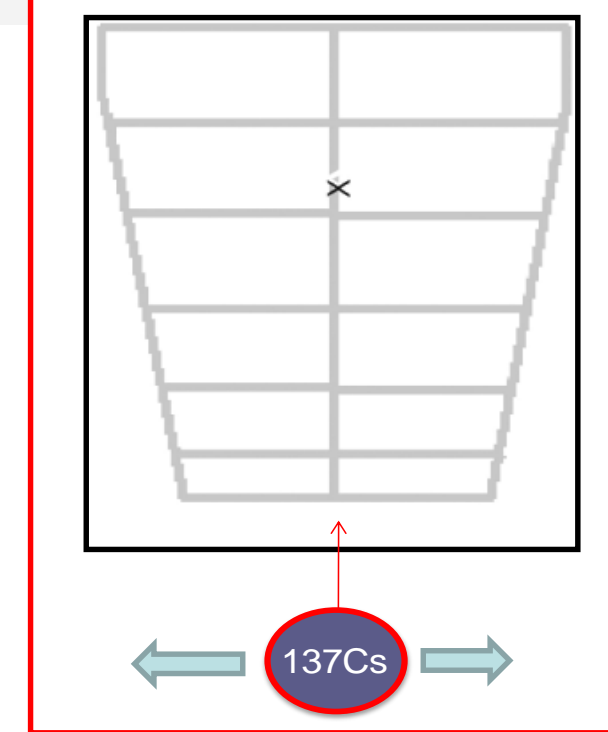
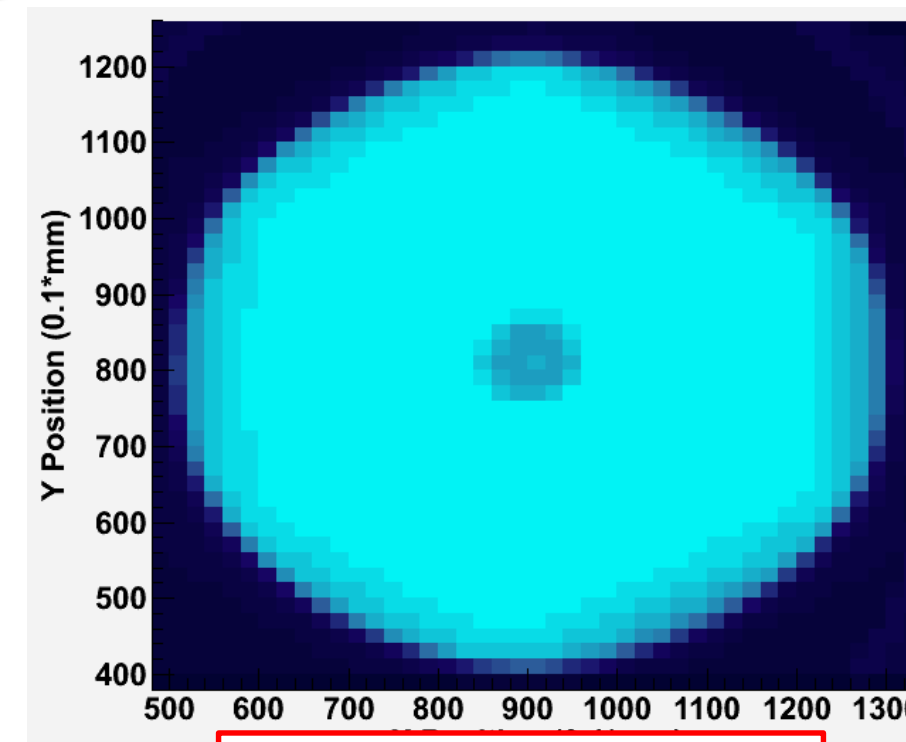
### Data Acquired with the Liverpool University Scanning System to Test the PSCS Method

#### Front Face Singles Scan

<sup>137</sup>Cs source collimated to 1mm swept across Front face of the detector

Step Length = 1 mm  
Step Duration = 60 s  
X-start 48 mm, X-range 86 mm  
Y-start 39 mm, Y-range 86 mm

- Traces of 128 samples digitized at 100 MHz
- The trigger was generated through a CFD on
- the core with a threshold of ~300 keV



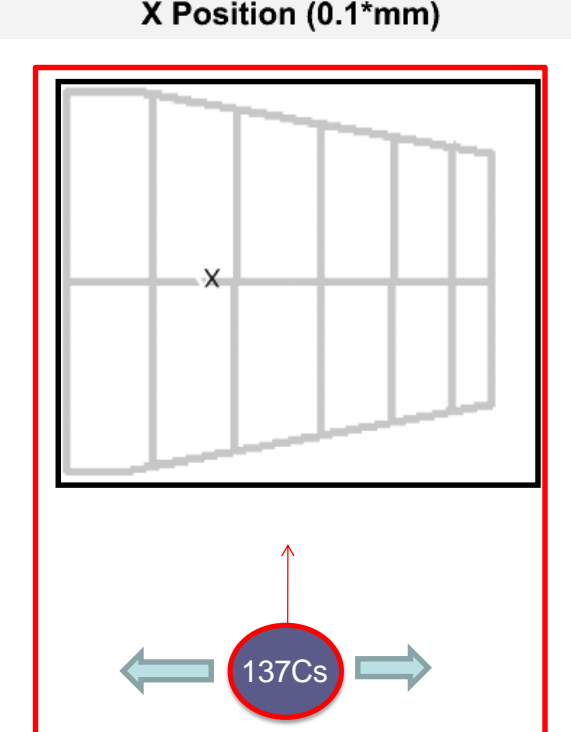
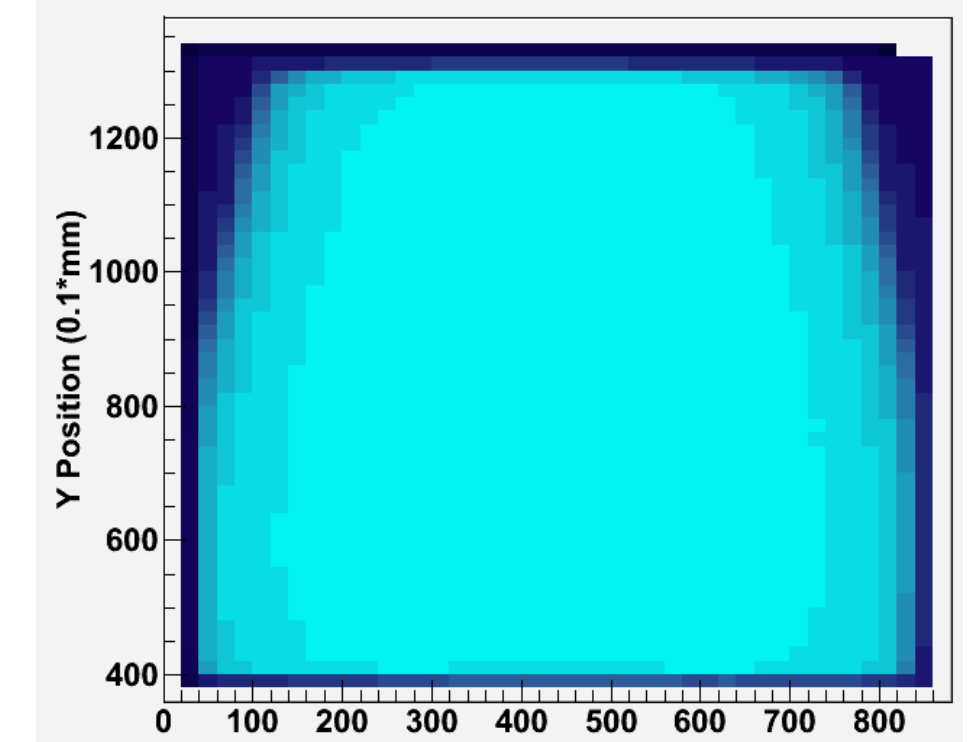
#### Side Singles Scan Data

<sup>137</sup>Cs source collimated to 1mm swept across Side face of the detector

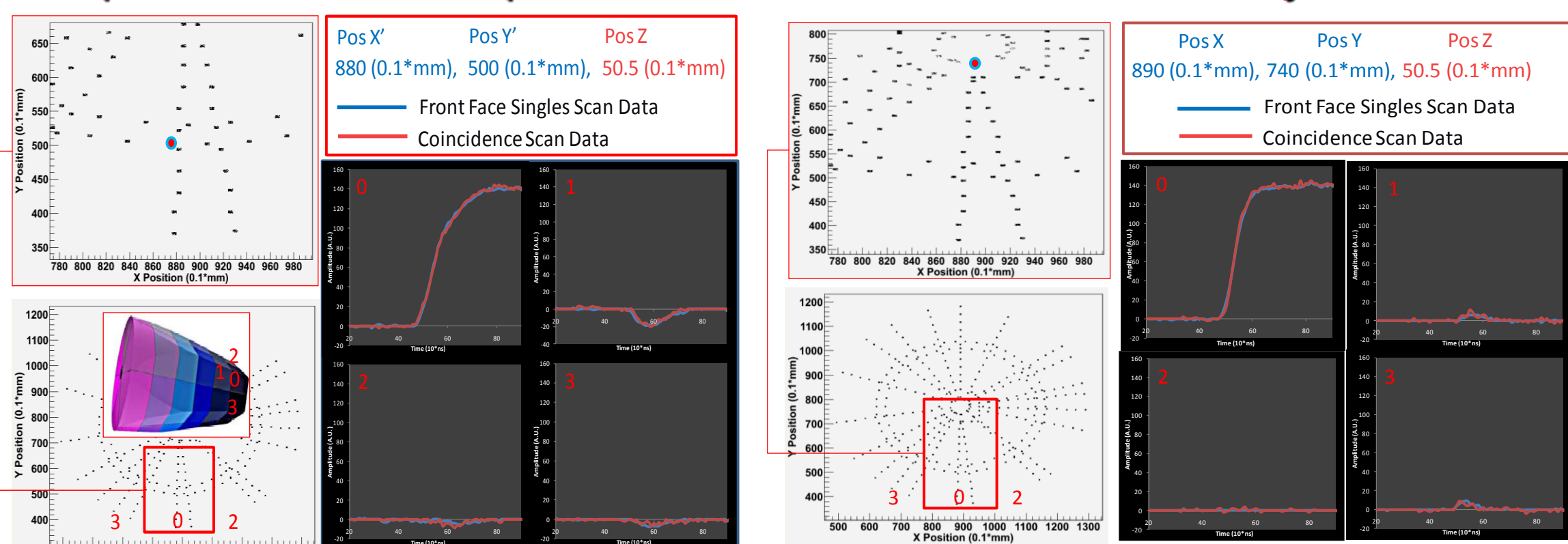
Step Length = 1 mm  
Step Duration = 30 s  
X-start 3 mm, X-range 82 mm  
Y-start 38 mm, Y-range 95 mm

#### Higher Statistics Side Singles Scan Data

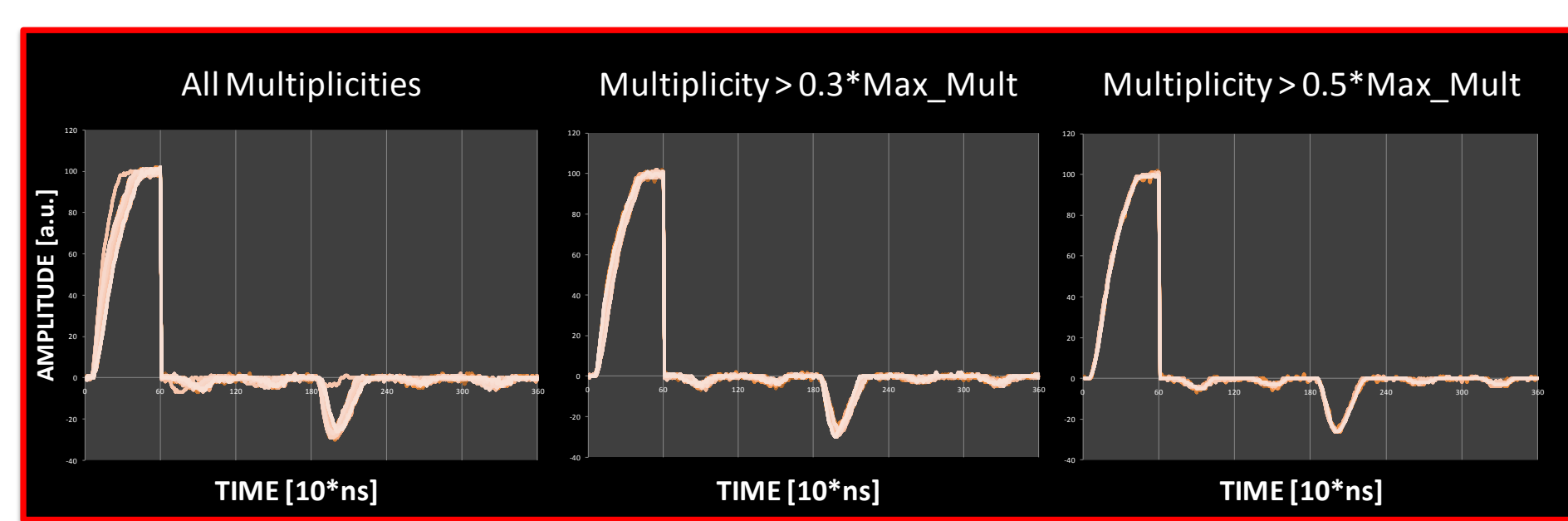
<sup>137</sup>Cs source collimated to 1mm swept across Side face of the detector (Step Dur. = 150s) (performed only for 2 detector rings)



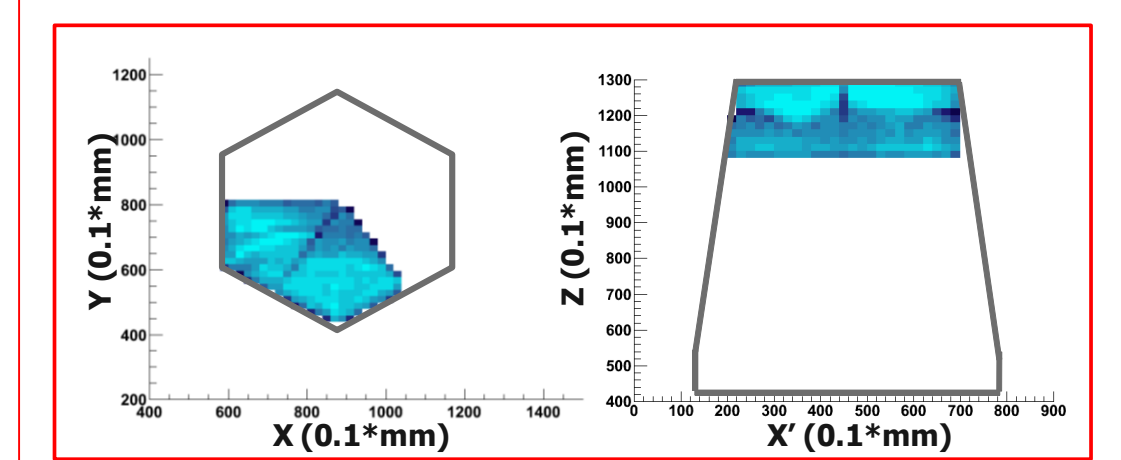
### A simple test has been performed to check the consistency of the data:



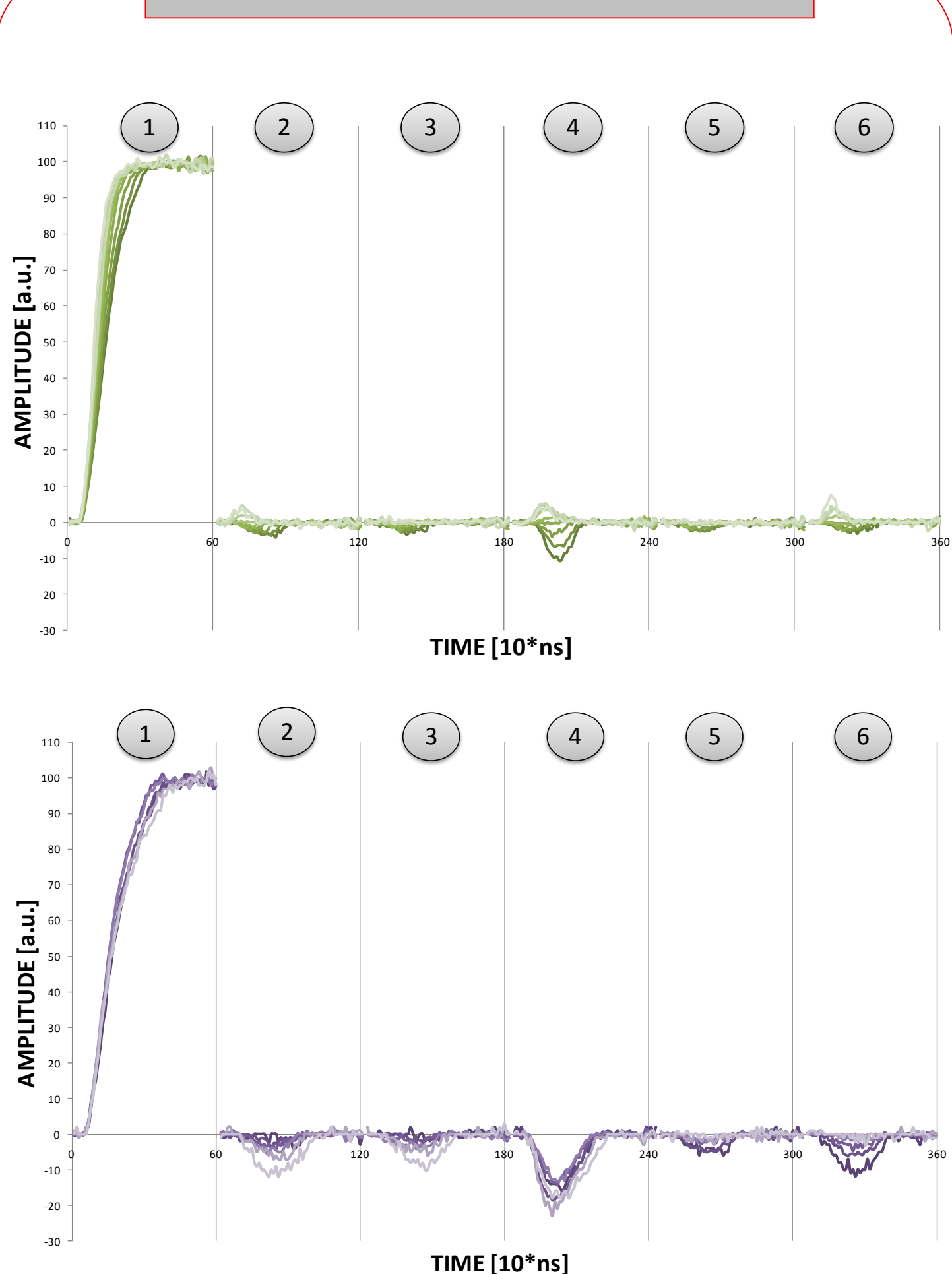
### Selecting Shapes with an higher "Multiplicity" value allows to obtain an improved result



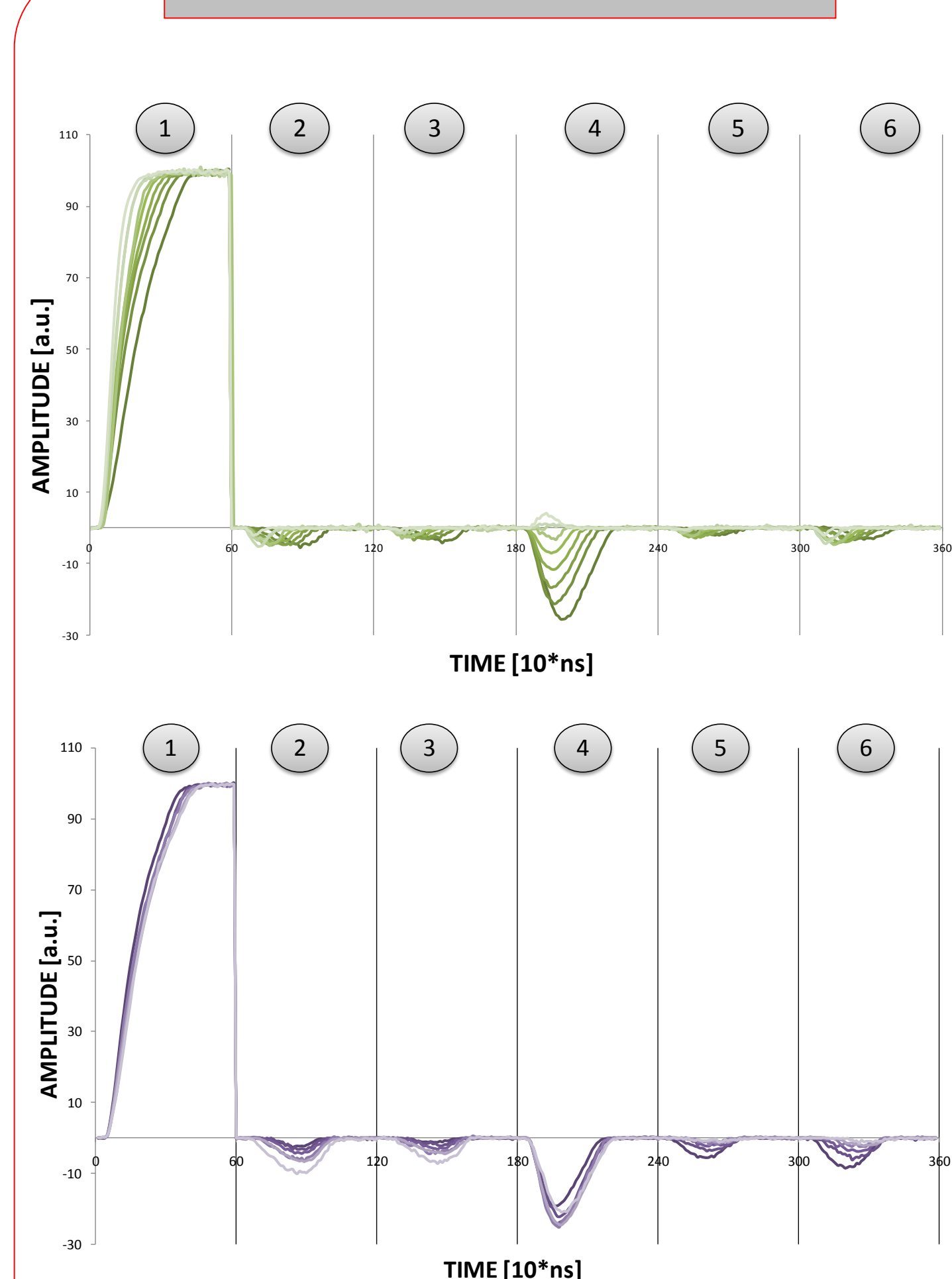
### PSCP has been used to extract the position response of 4 detector segments: A1,A2,F1,F2



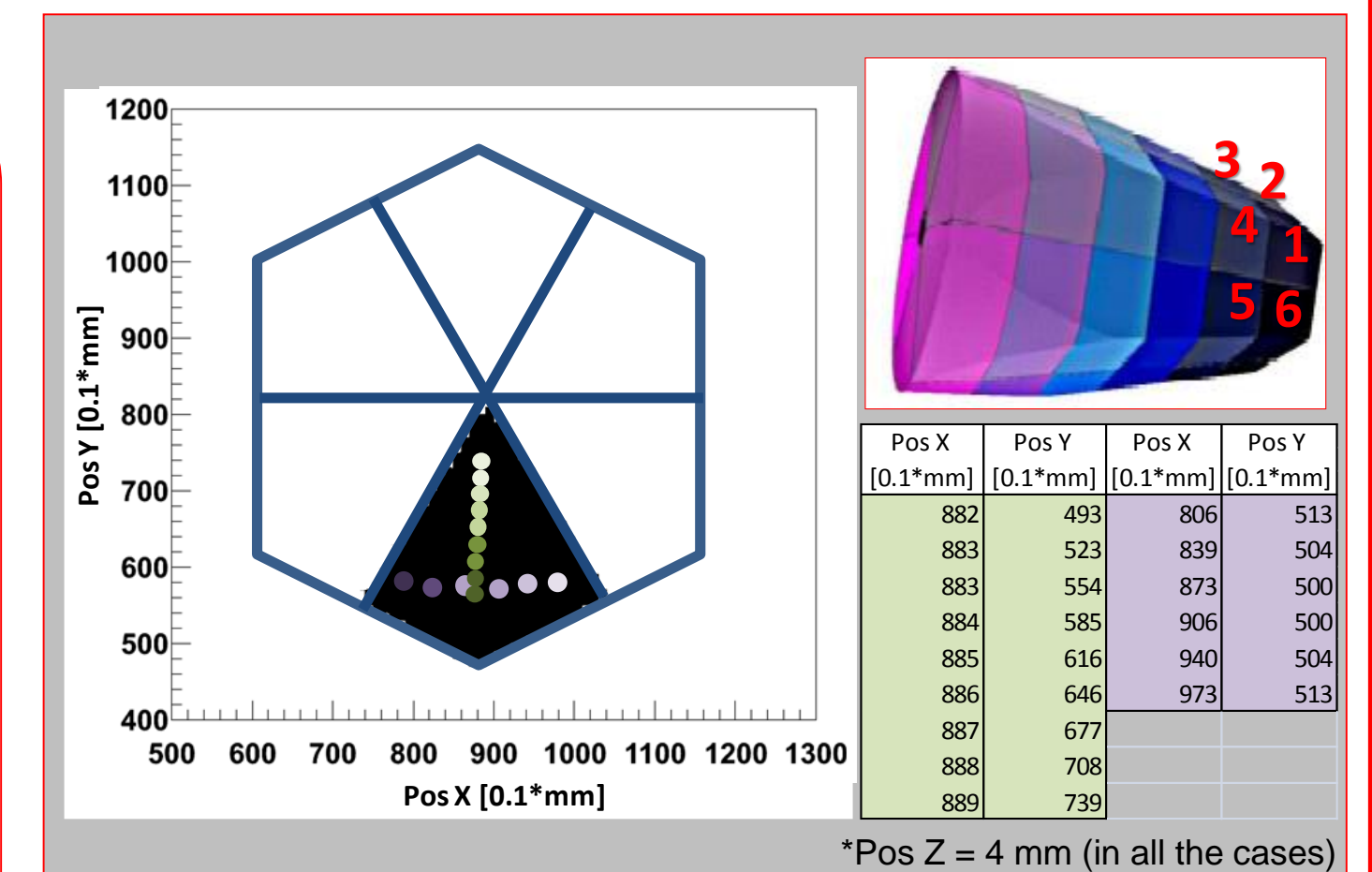
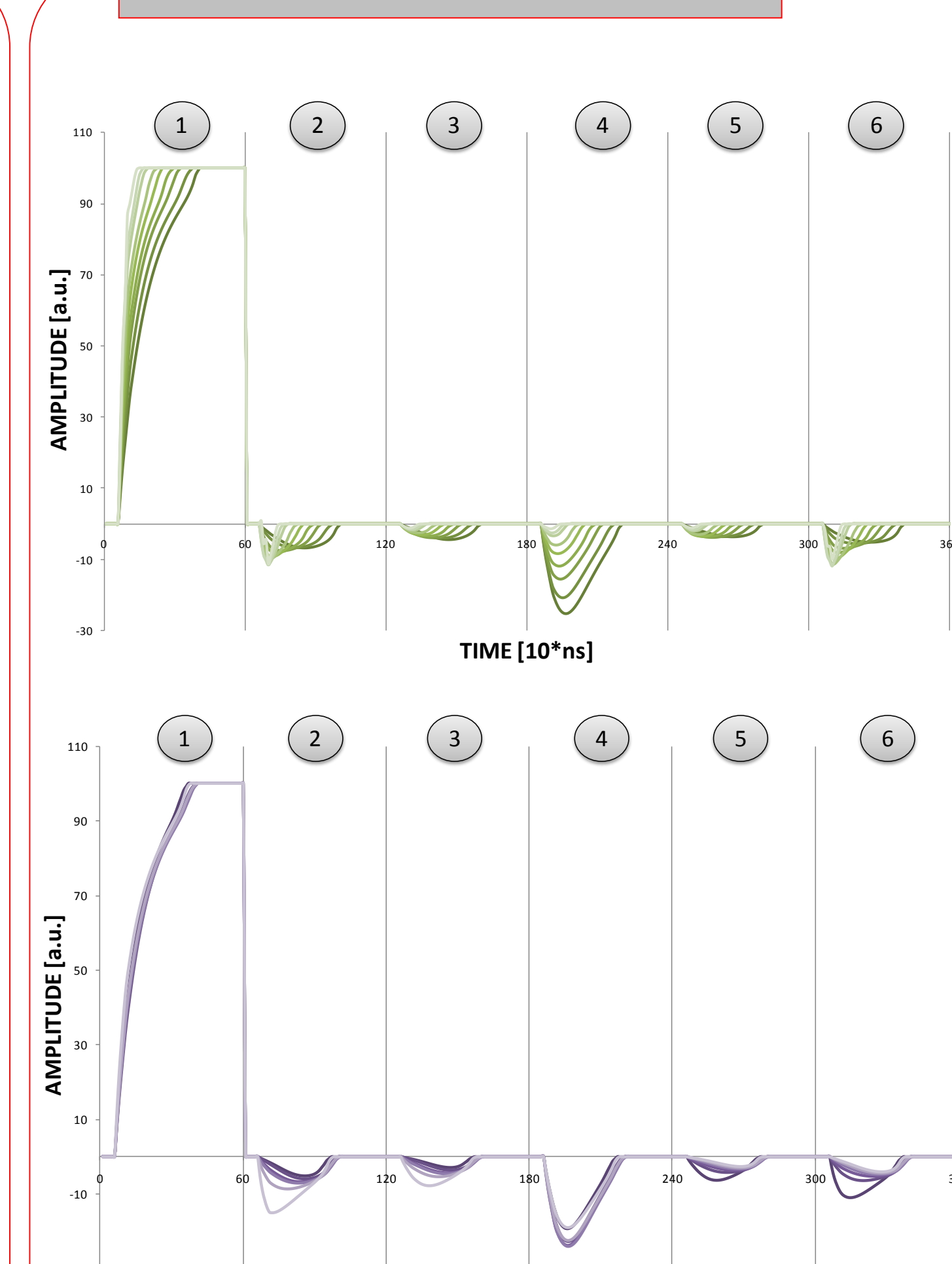
### Coincidence scan



### PSCS scan



### Calculated Basis



### Conclusions

Different sets of collimated data have been acquired with the Liverpool University Scanning system [1]. Front face and lateral single scan data have been used to test the Pulse Shape Comparison based Scan (PSCS) [2] and extract the signal basis for 4 detector segments (A1,A2,F1,F2). The obtained Signal Shapes are compared with those extracted with the standard Coincidence Scan and the calculated basis. Although some discrepancies are present the general trend of the shape variation with position is consistent in all the cases. From the results of these first tests the PSCS showed to be a valuable tool to extract the position response of HPGe segmented detectors.

[1] A. Boston, et al., Nucl. Inst. and Meth. B 261 (2007) 1098-1102  
[2] F.C.L. Crespi, et al, Nucl. Instr. and Meth. A 593 (2008), p. 440.