# Signal Basis extracted with the PSCS method and tests with RS algorithm.

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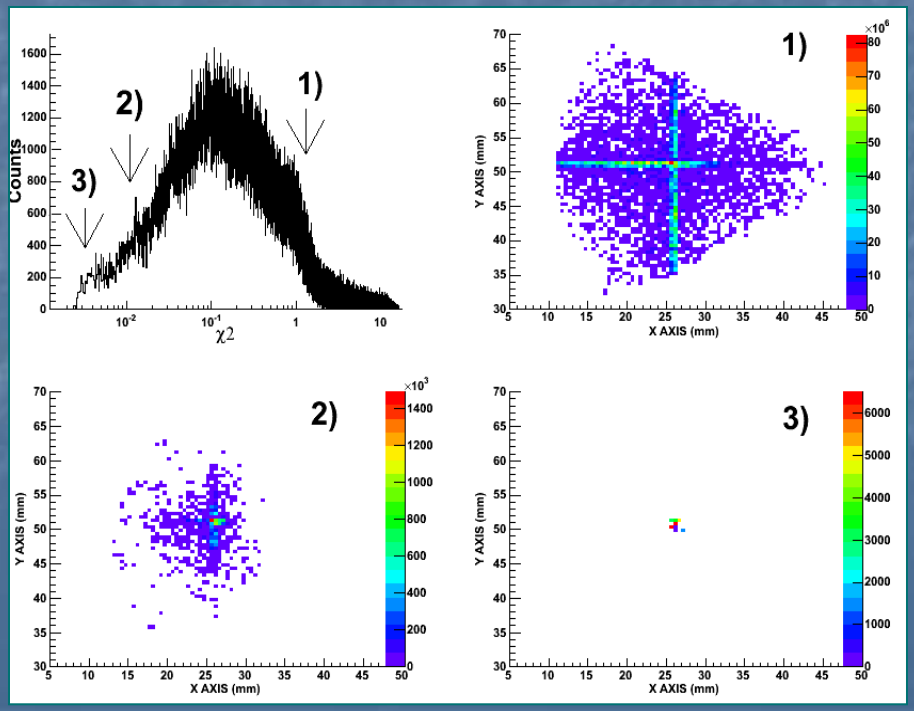
# Pulse Shape Comparison based Scan (PSCS)

- The technique is based on a specific pulse shape comparison procedure.

- PSCS does not require any 'coincidence' between events: this approach allows to enormously decrease the time duration of the measurements.

- 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.

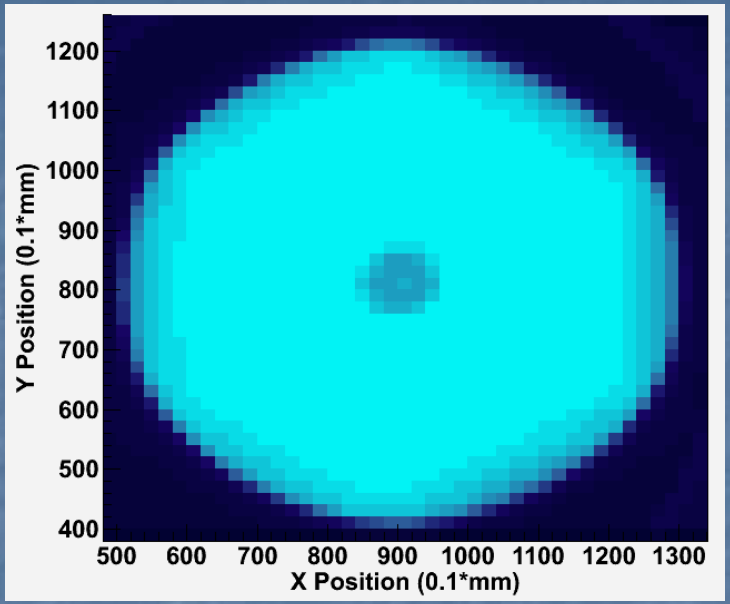
- The case in which a signal of one set is identical to a signal of the other is when the two signals originate at the position corresponding to the crossing point of the two lines defined by the source collimation.



# C001 data taken in Liverpool:

## 1) Front Face Singles Scan

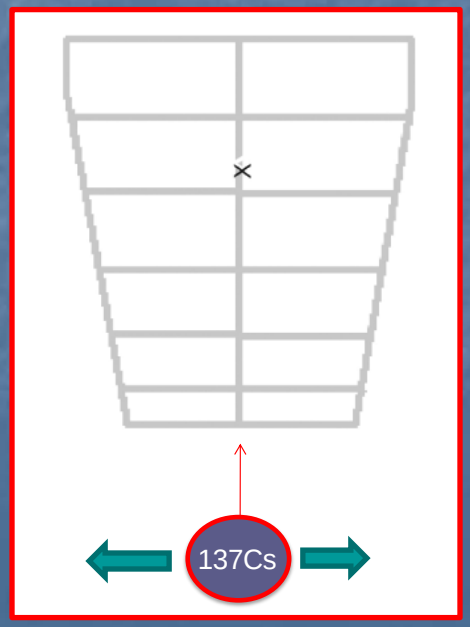
-137Cs source collimated to 1mm swept Across Front face of the detector




Step Lenght = 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

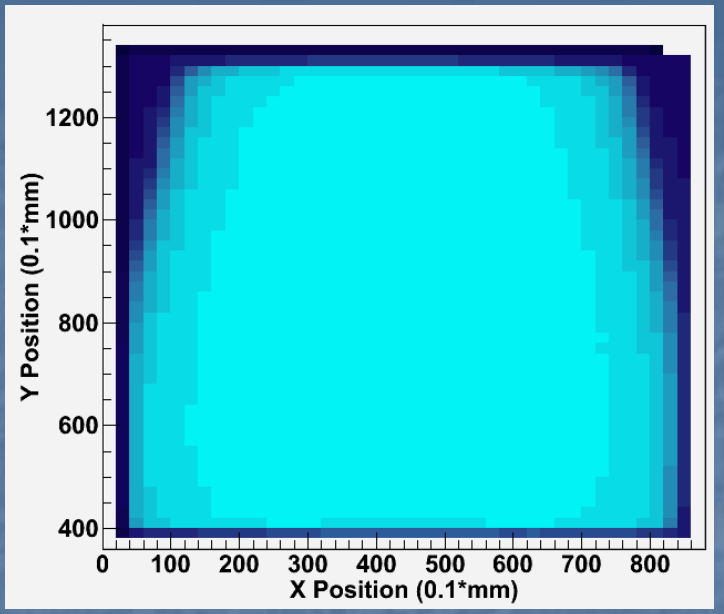


# C001 data taken in Liverpool :

## 2) Side Singles Scan Data

-137Cs source collimated to 1mm swept Across Side face of the detector

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

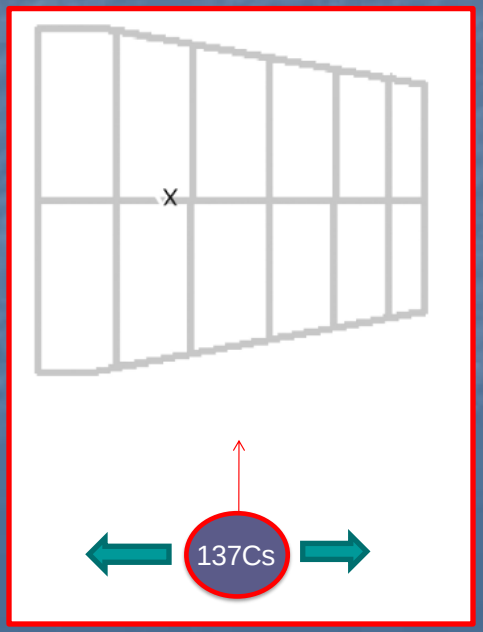



## 3) Higher Statistics Side Singles Scan Data

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

## 4) Planar Singles Scan Data (not yet used)

-137Cs source collimated to 1.5 mm thick plane

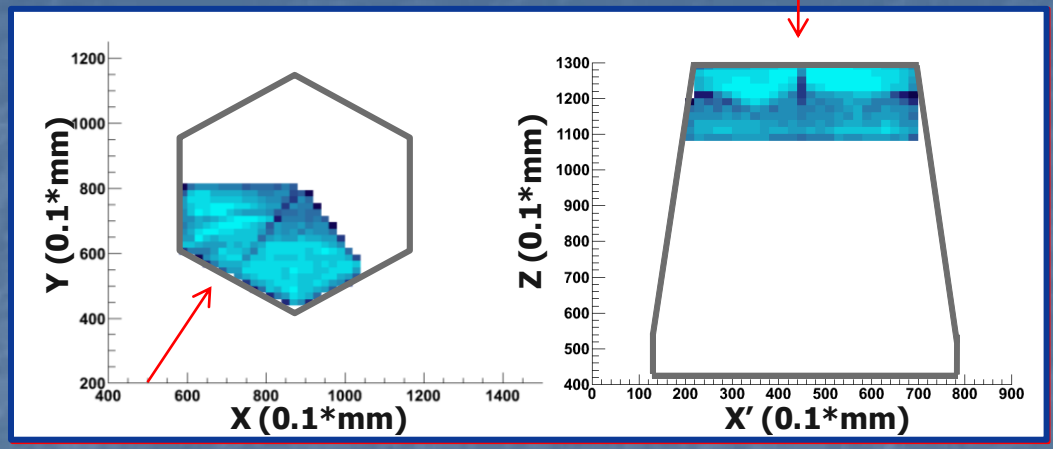


# PSCS Method

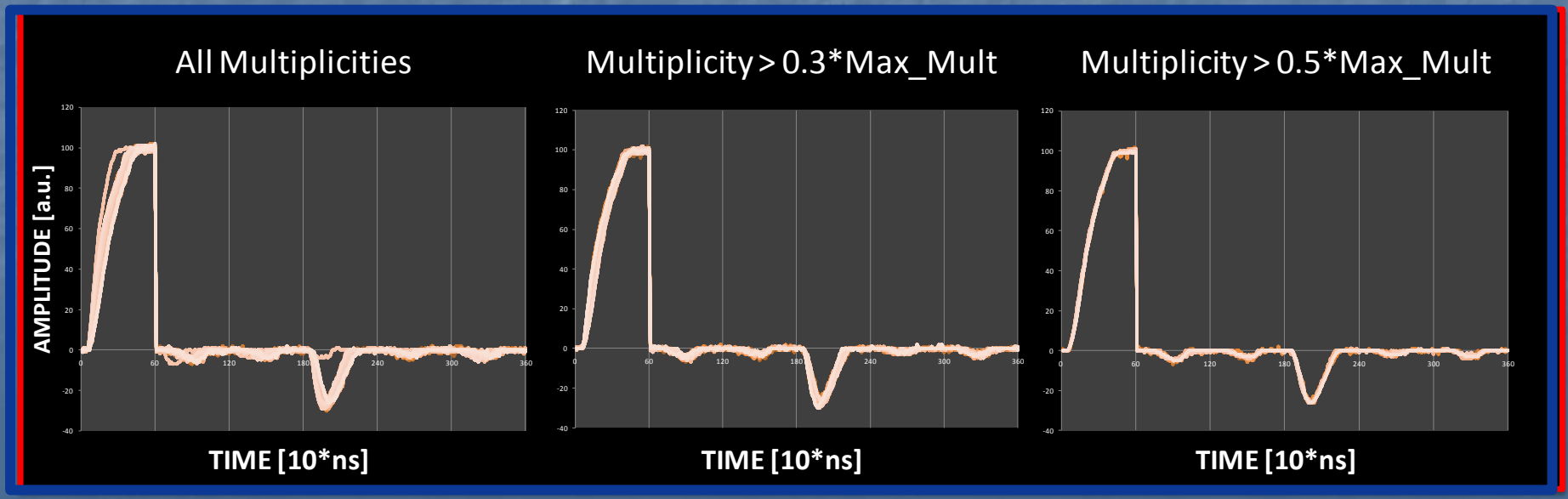
PSCS has been used to extract the position response of 4 detector segments: A1,A2,F1,F2

- "Brute Force" comparison not possible (CPU time)

→Signal Parametrization (used also for RS_3D)



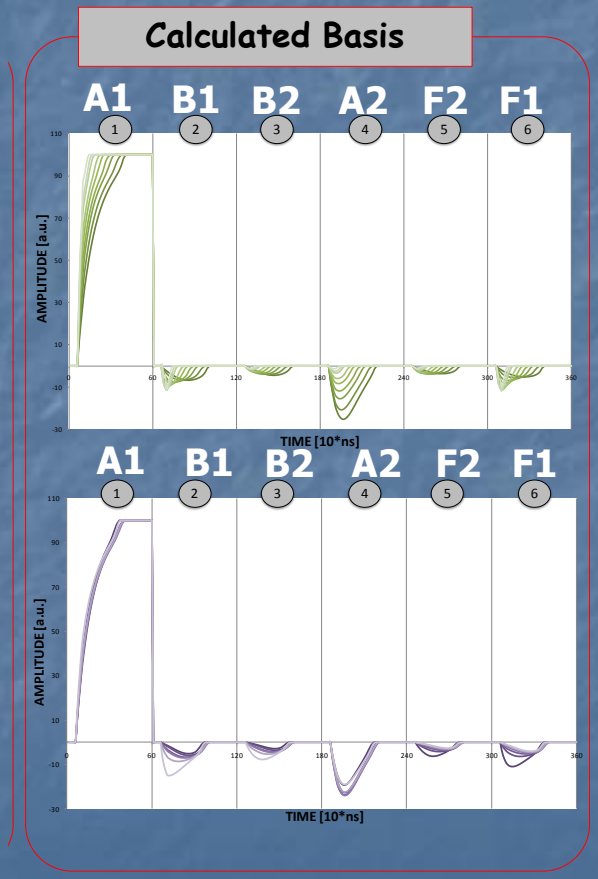

Selecting Shapes with an higher "Multiplicity" value allows to obtain an improved result

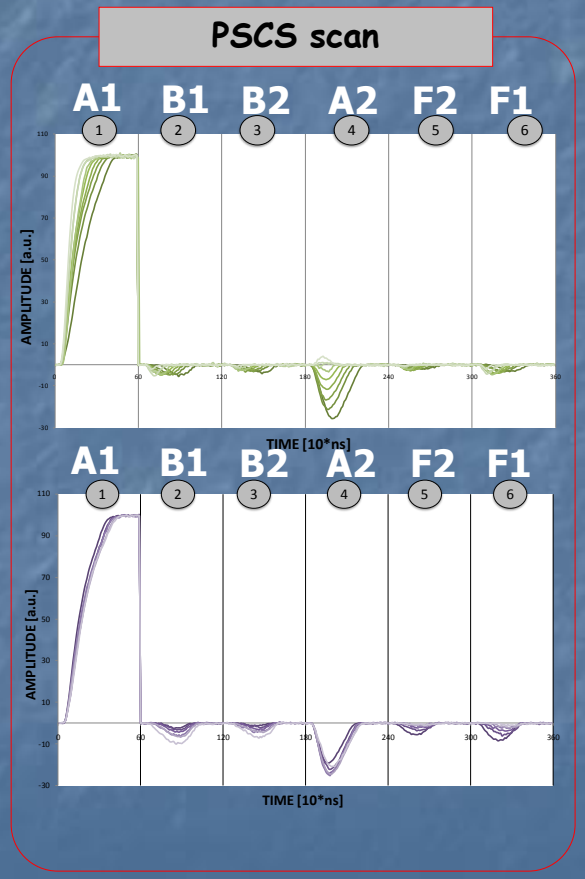


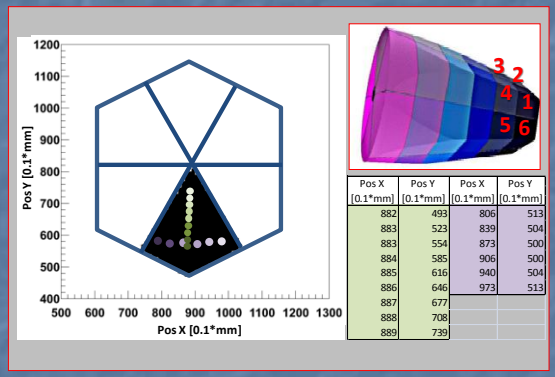
# Signal Basis: Calculated and Experimental

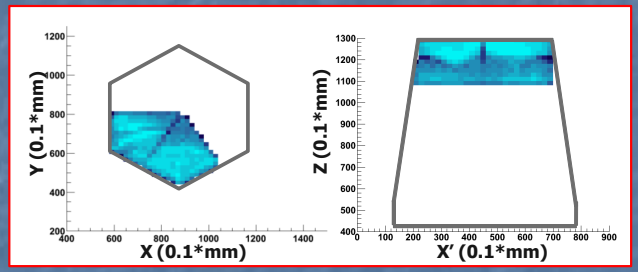
Calculated Basis*: currently implemented and used in AGATA experiments (C001 Asymmmetric Detector, used for experimental data acquisition in Liverpool University***)

Experimental Basis: extracted using PSCS scan*** (4 segments )




→ Signals Shapes that reproduce the same trend have been extracted with the Standard Coincidence Scan → C. Unsworth

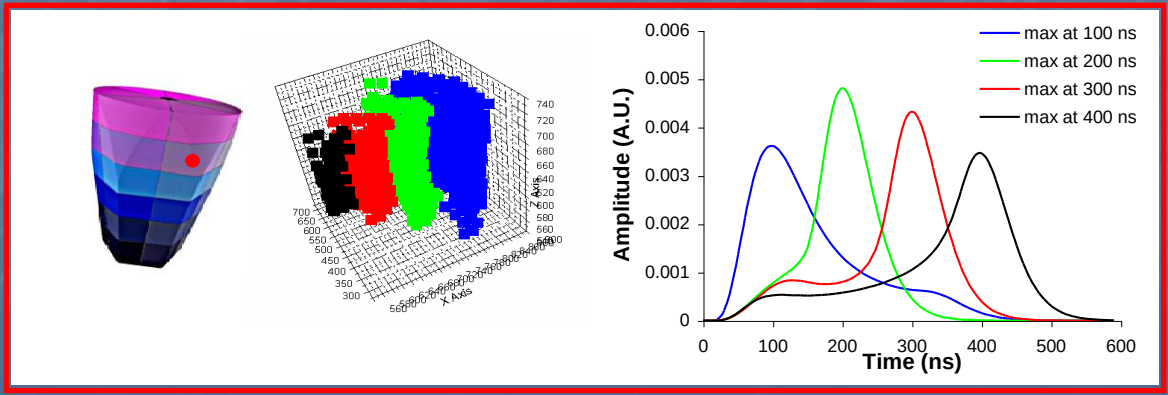
*Bart Bruyneel *et al.*, *NIMA* 599 (2009), p. 196

***A. Boston *et al.*, *Nucl. Instr. and Meth. B* 261 (2007), p. 1098

***F.C.L. Crespi *et al.*, *NIMA* 593 (2008), p.440

# Recursive Subtraction* 3D (RS_3D) Algorithm

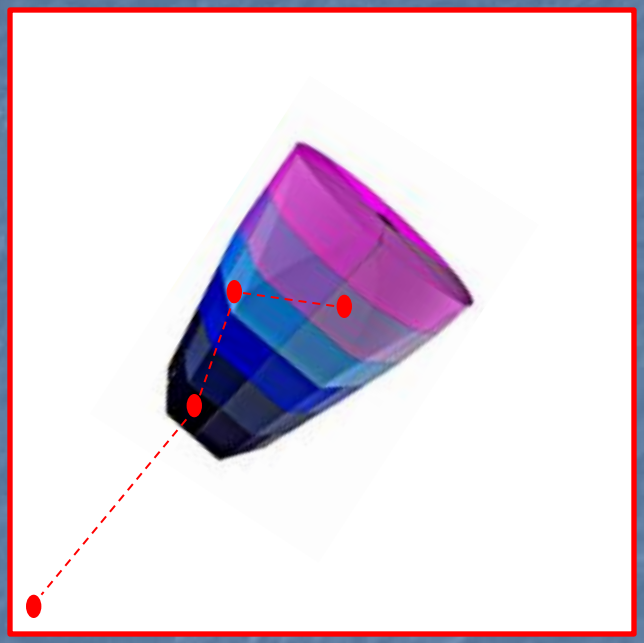
- The XYZ Position of the interactions is extracted comparing the detector signal shape with reference shapes included in a database ("Signal Basis").
- The Signals in the "Basis" are ordered according to specific parameters (e.g. position of the derived net-charge signal maximum) in order to minimize CPU time.
- For each net charge collecting segment the following operations are performed:
  - the Signals (transients or net charge) which are likely to have a shape that depends on only one interaction are selected.
  - these signals are compared with the Basis elements.
  - the element that best matches is subtracted from the detector signal.




* F.C.L. Crespi, *Nucl. Instr. and Meth. A* 570 (2007), p. 459

# Recursive Subtraction 3D (RS_3D) Algorithm

Example: 662 keV* F.E.P. simulated event** ,
Segment multiplicity =3.




*137Cs source, used in tests with experimental data presented in the following.

** Geant 4 AGATA code used

(E. Farnea, D. Bazzacco, LNL-INFN(REP)—202 (2004) 158 )

# Recursive Subtraction 3D (RS_3D) Algorithm

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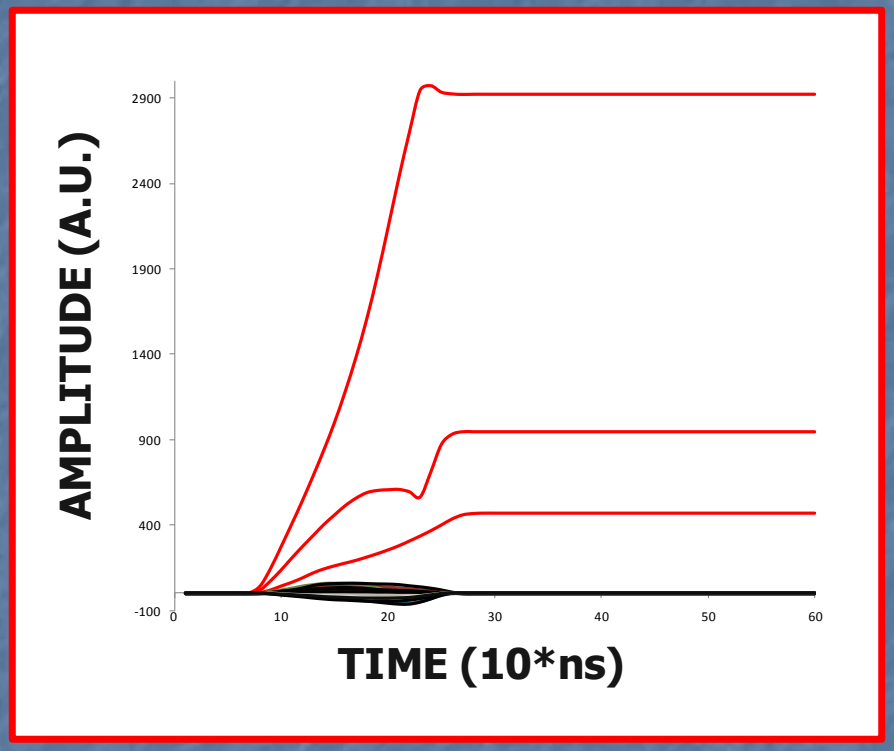
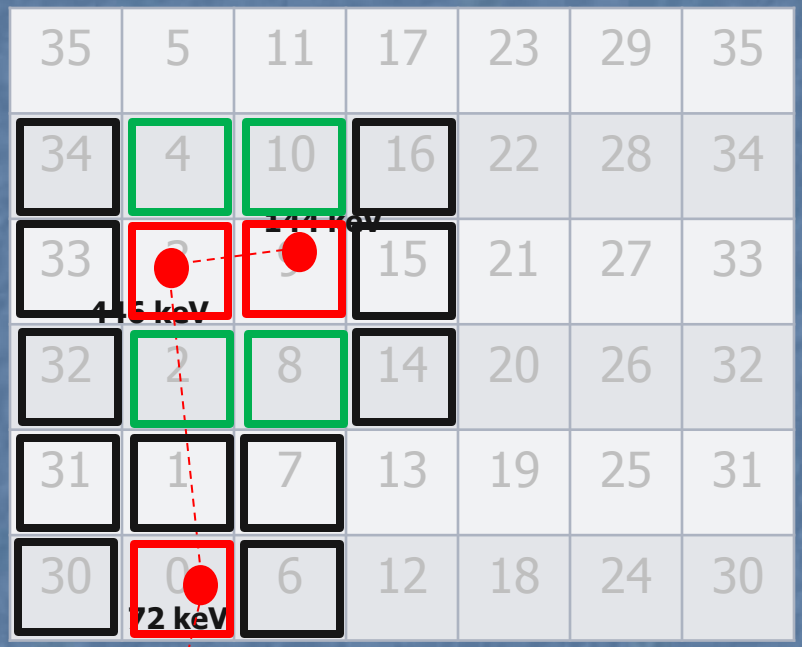



Net Charge Signals

Transient Signals

*(1 N.C. segment neighbor only)*

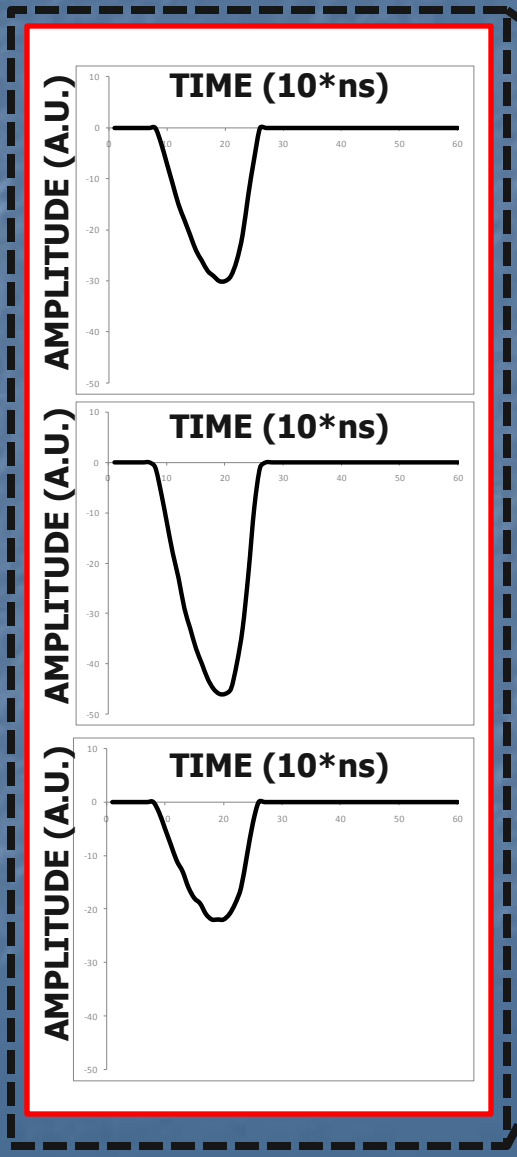
"Superimposed" Transient Signals

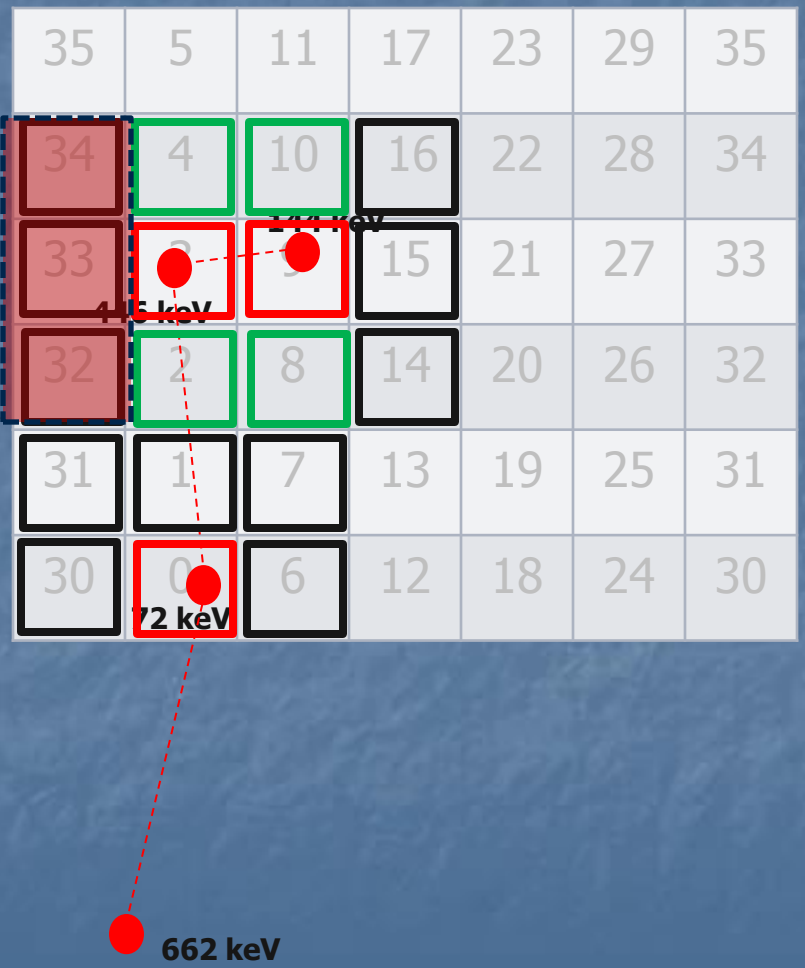
*(influenced by multiple N.C. Segments)*

662 keV

# Recursive Subtraction 3D (RS_3D) Algorithm

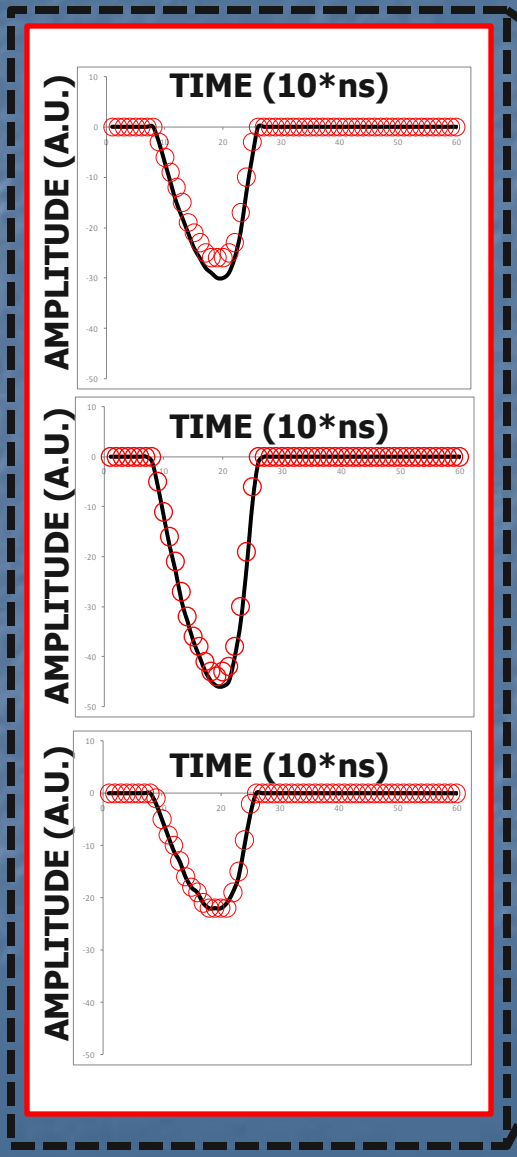
Example: 662 keV F.E.P. simulated event, Segment multiplicity =3

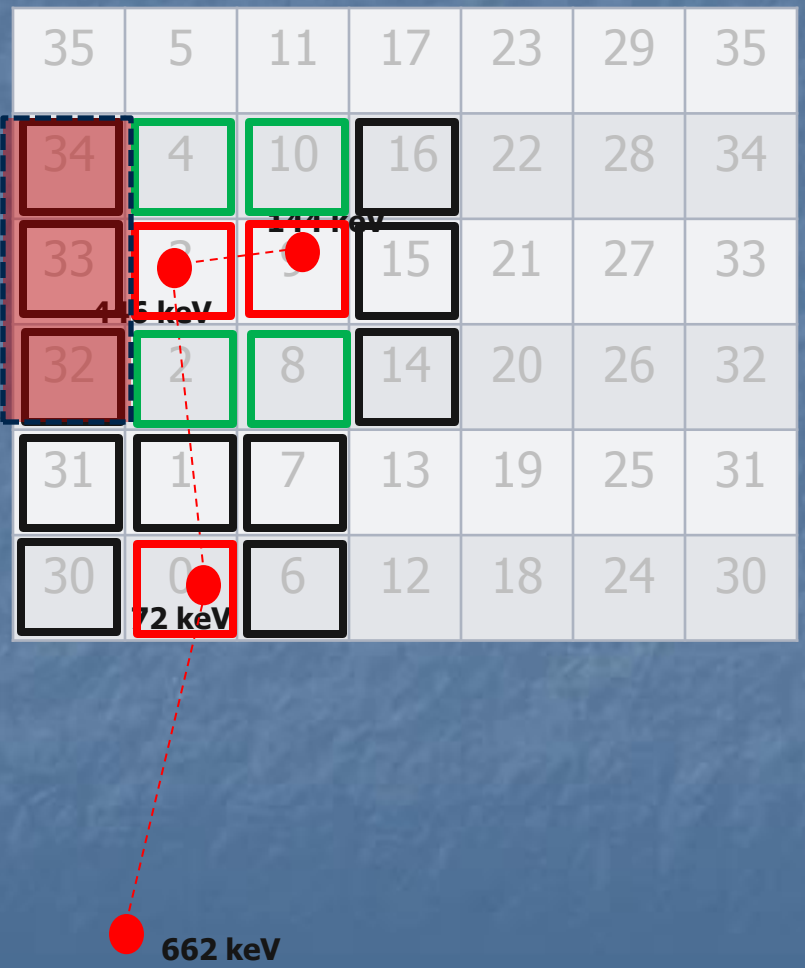


# Recursive Subtraction 3D (RS_3D) Algorithm

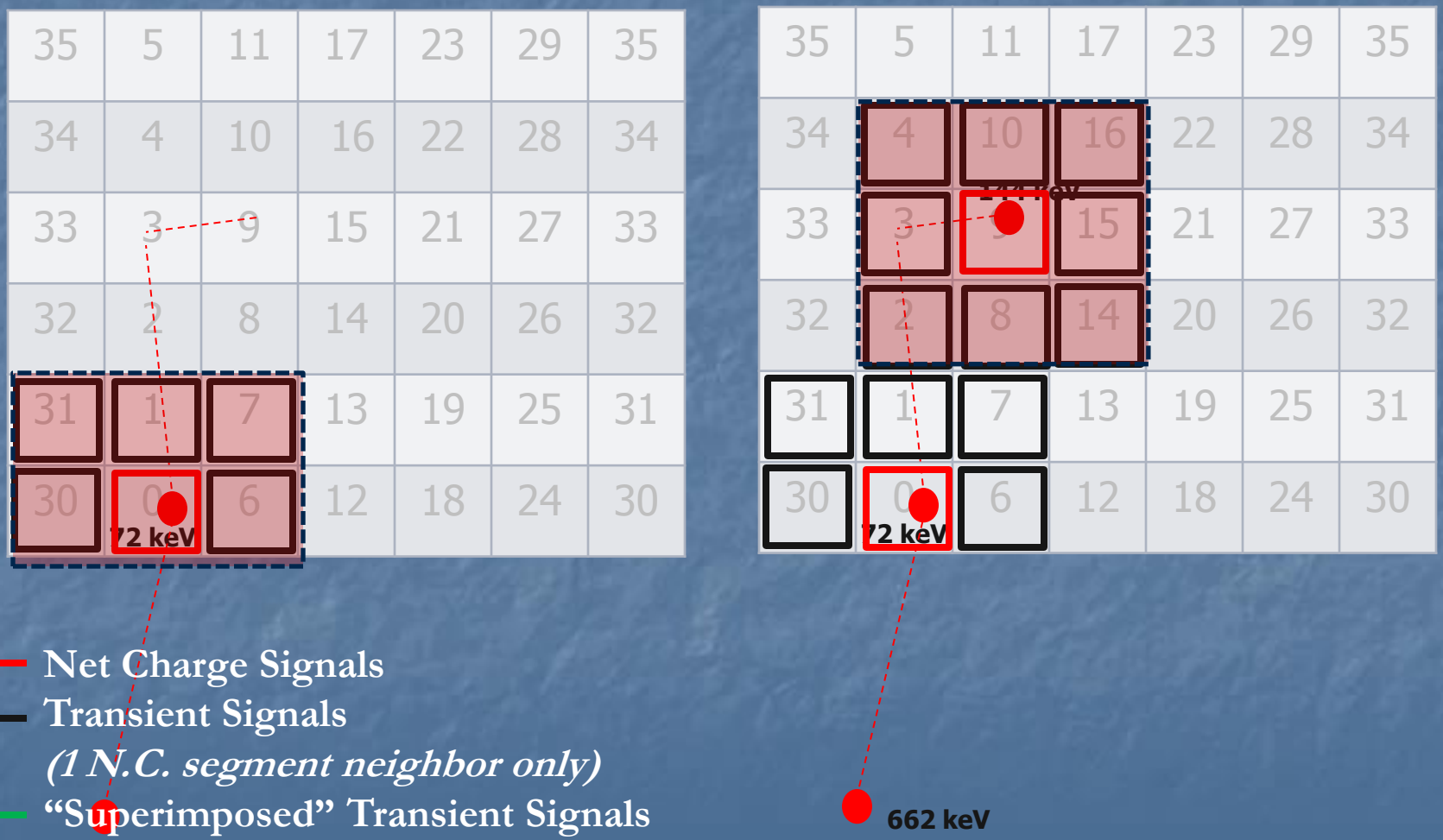
Example: 662 keV F.E.P. simulated event, Segment multiplicity =3



# Recursive Subtraction 3D (RS_3D) Algorithm

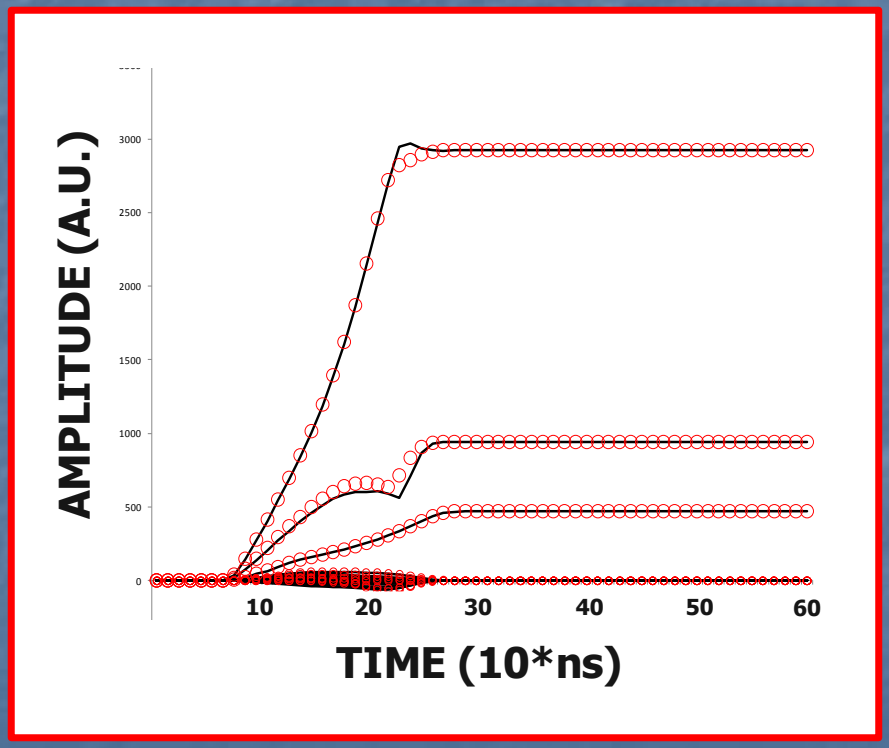
**Example:** 662 keV F.E.P. simulated event, Segment multiplicity =3



# Recursive Subtraction 3D (RS_3D) Algorithm

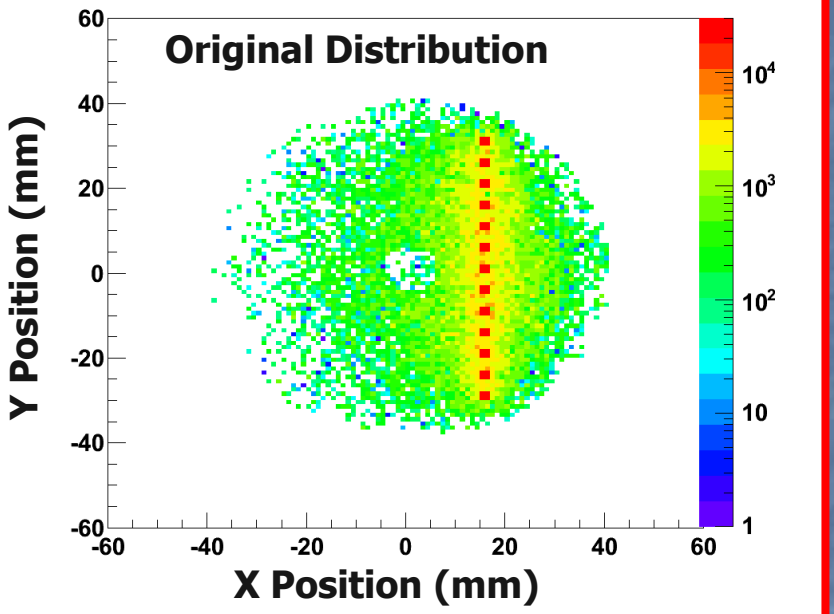
Example: 662 keV F.E.P. simulated event, Segment multiplicity =3

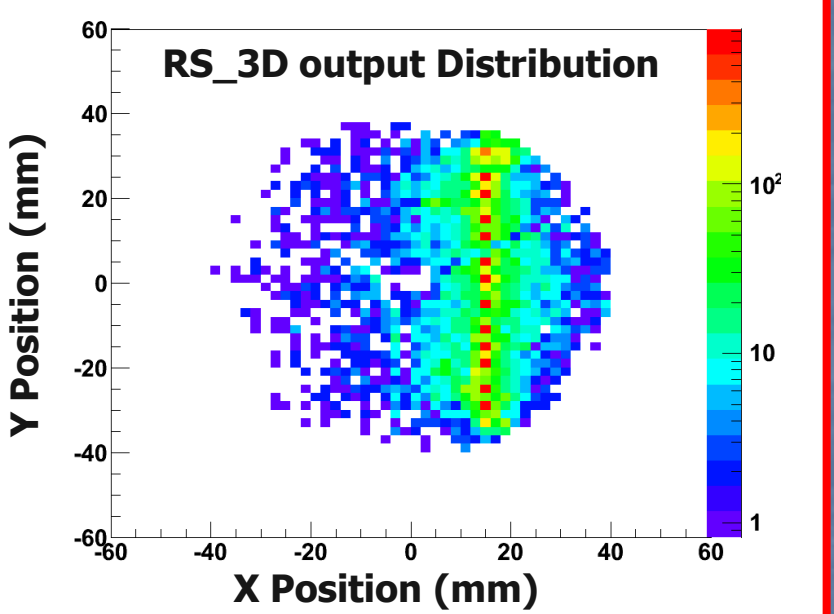
## Reconstructed Signal

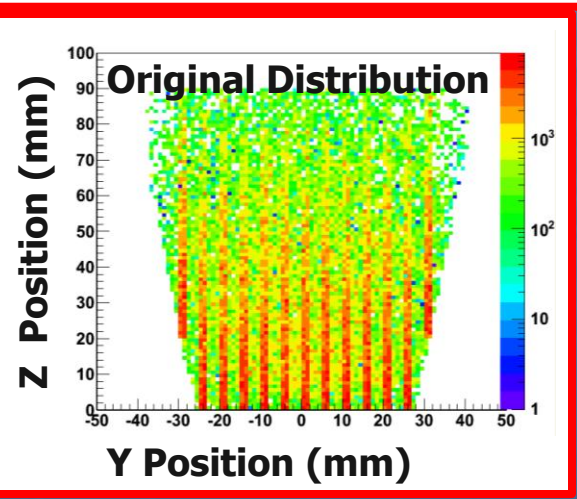


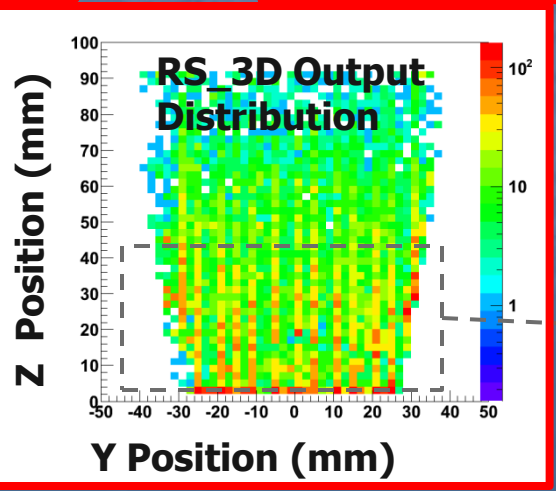

# Tests with Calculated Signal Basis

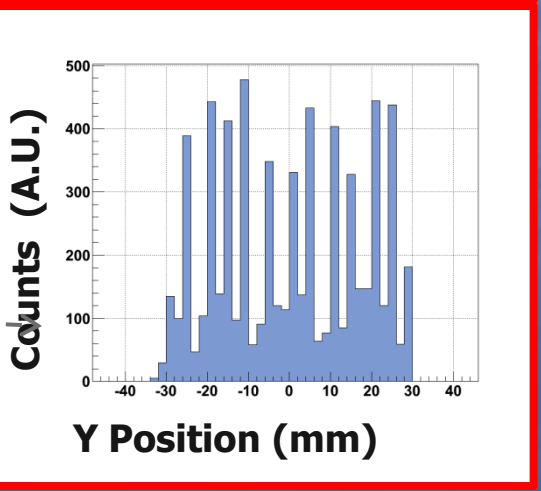
662 keV pencil beam moved along Y direction – 5 mm steps
(Geant4 + Calculated Signals + preamp response + noise)



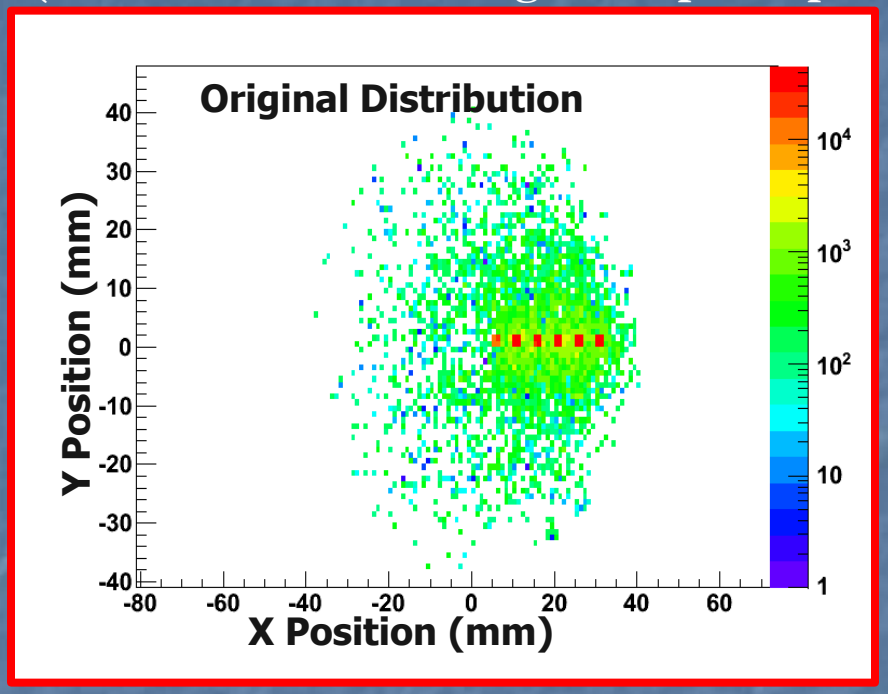



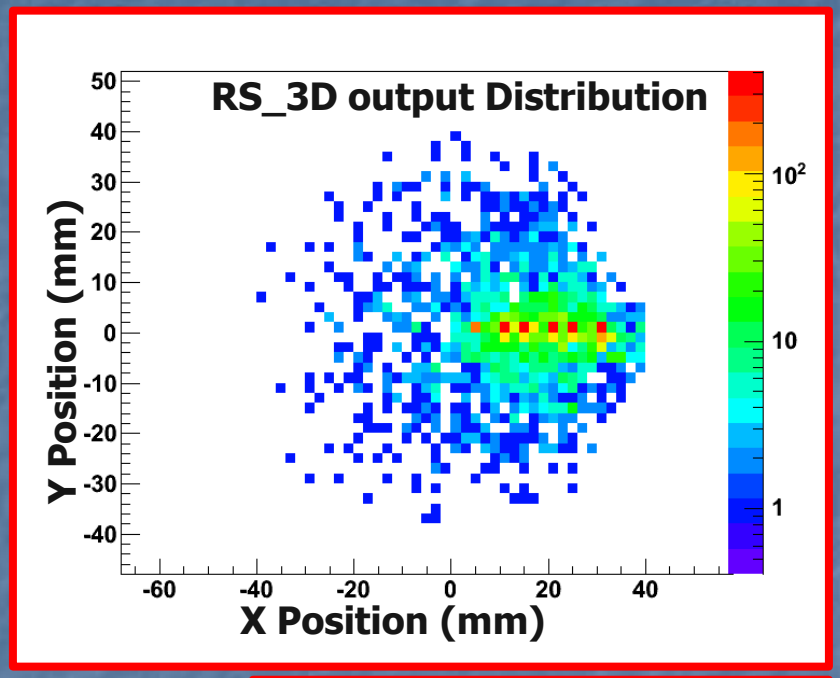



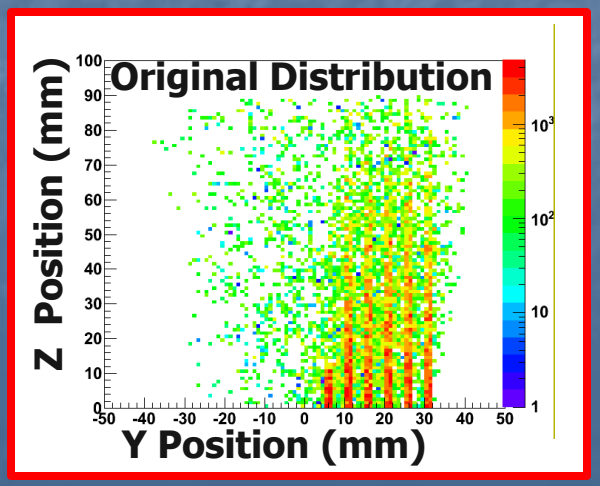



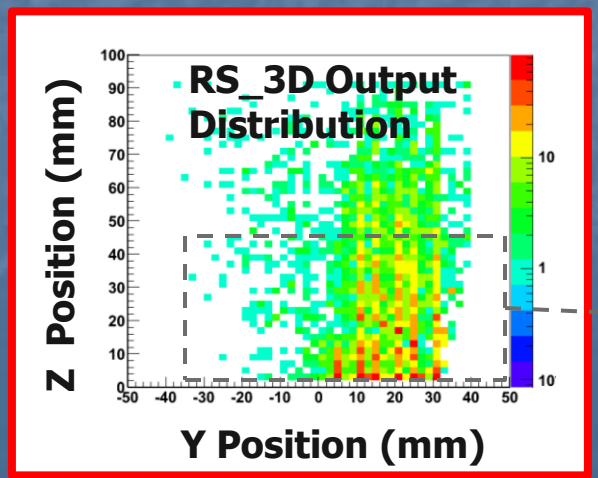
# Tests with Calculated Signal Basis

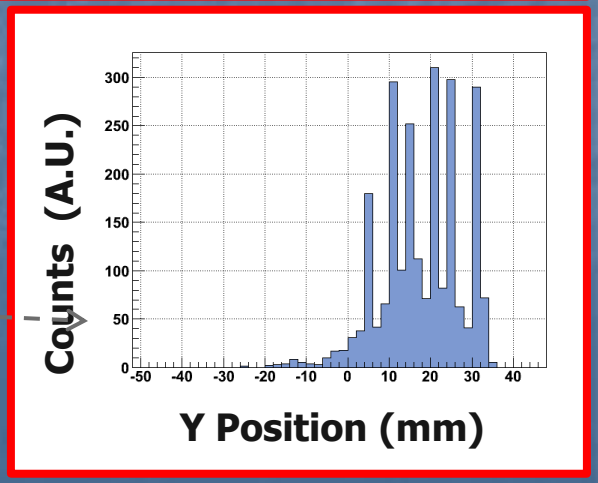
662 keV pencil beam moved along X direction – 5 mm steps
(Geant4 + Calculated Signals + preamp response + noise)



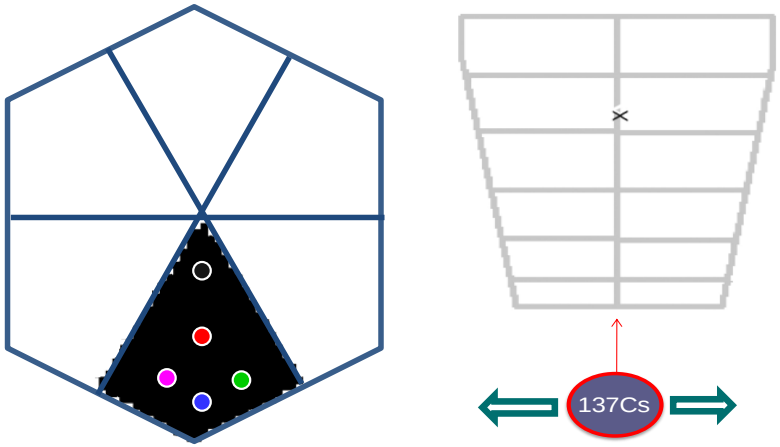



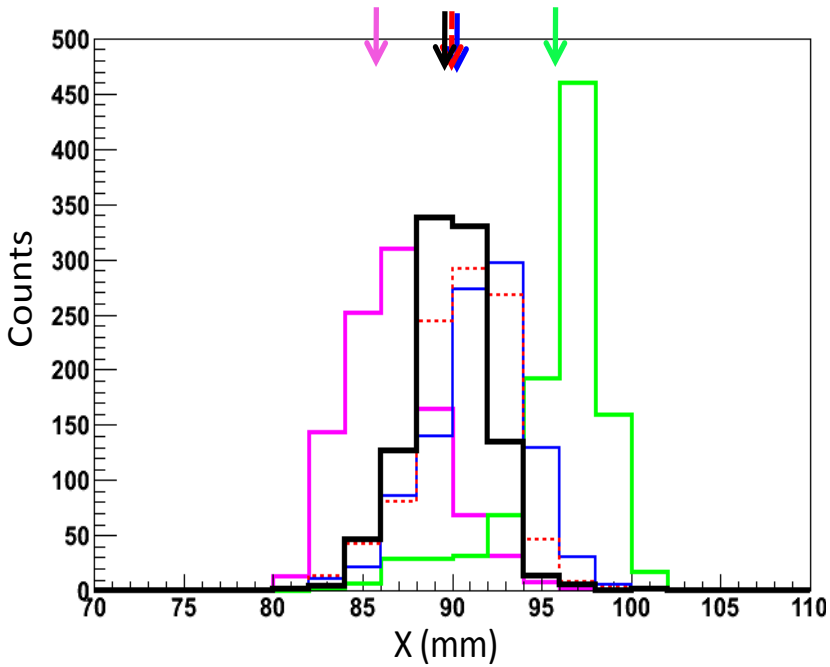
# Tests with Experimental Signal Basis

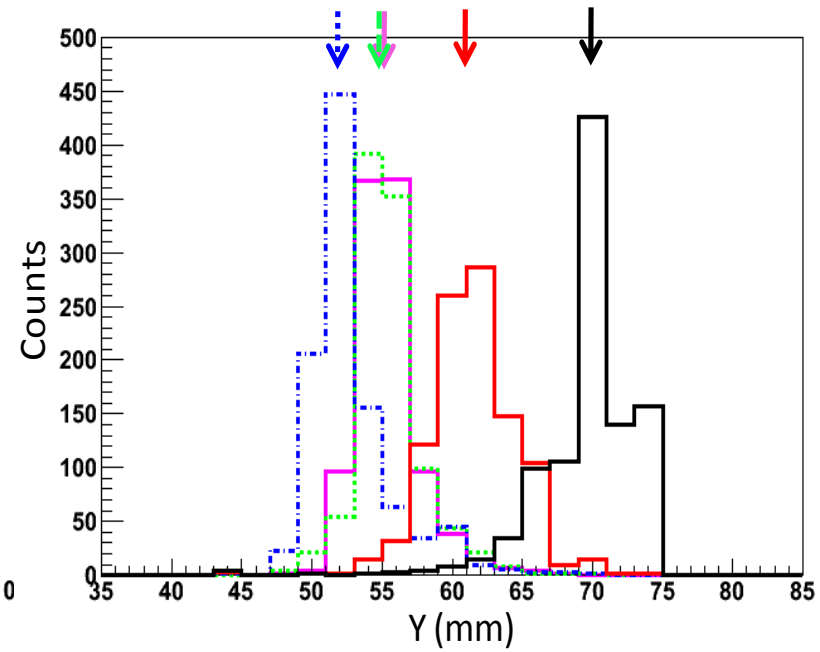
- $^{137}$Cs (662 keV) collimated data*
- Experimental Signal Basis extracted with PSCS technique** for Segment A1.

*A. Boston *et al.*, *Nucl. Instr. and Meth. B* 261 (2007), p. 1098

**F.C.L. Crespi *et al.*, *NIMA* 593 (2008), p.440 and NSS- 2010 (N29-226) Poster Presentation



# Conclusions

- PSCS has been applied to data acquired in Liverpool and an "experimental signal basis" has been extracted for 4 C001 detector segments (A1,A2,F1,F2)

- First comparison of the PSCS with other metods (coincidence scan and calculations shows global agreement of the results

- A new version of RS algorithm (RS_3D) providing 3D localization of gamma interaction points (disentangling also multiple hits in a single segment) has been developed and tested with both calculated and experimental signal basis.
  - 5 mm position resolution is reached BUT time consumption still has to be decreased for allowing the algorithm application on-line

  → **Detector scanning benefits from pulse shape comparison techniques**

# Future work

- Further test the RS_3D algorithm with experimentally extracted PSCS basis, using all the scanned segments. (e.g. looking at the reconstructed energy release distribution along Z axis). This will provide a test also for PSCS technique.
- Complete comparison between PSCS, Coincidence Scan and Calculated signals
- Improving RS_3D algorithm CPU time performances

(→ In-beam Test of AGATA clusters with (up to)15 Mev gamma rays, next week @ LNL )
(→ "Inelastic scattering as a tool to search for highly excited states up to the region of the Giant Quadrupole Resonance", R. Nicolini experiment performed June 2010 @ LNL – Doppler Correction)