A Novel technique for the characterization of a HPGe detector position response based on pulse shape comparison

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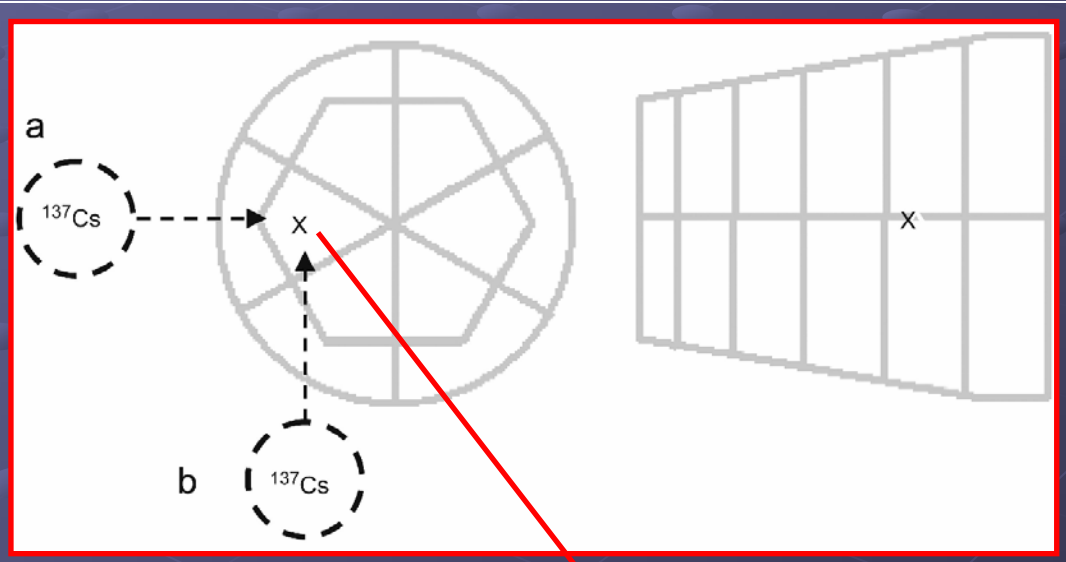
Pulse Shape Comparison based Scan (PSCS): BASIC IDEA

- Only measurements in single mode, characterized by a defined collimation of the gamma ray source (→ significant decrease of time consumption, as compared with the standard coincidence techniques)

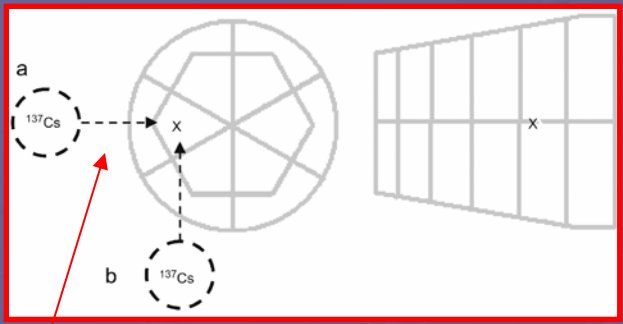
- **Events of Interest** are selected by means of a specific signal shape comparison procedure

Energy release concentrated in a (known a priori) position inside the detector volume



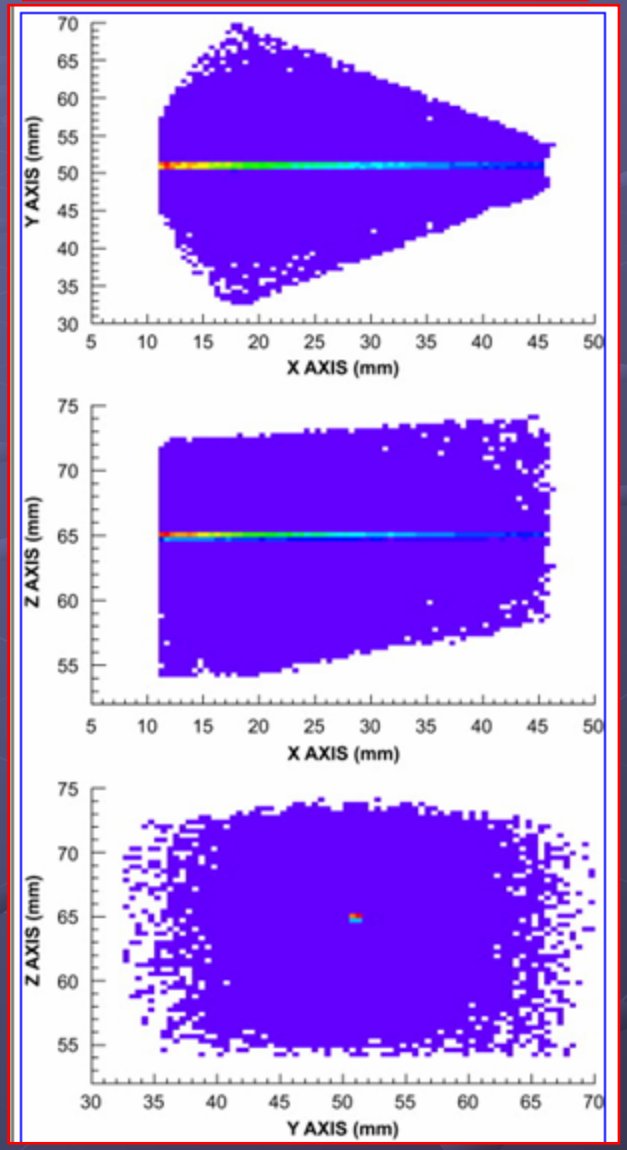
The pairs of signals that have the SAME SHAPE (i.e. that minimize the χ^2) are associated to an energy release concentrated in the point where the 2 collimation lines cross

VALIDATION TEST WITH SIMULATED EVENTS

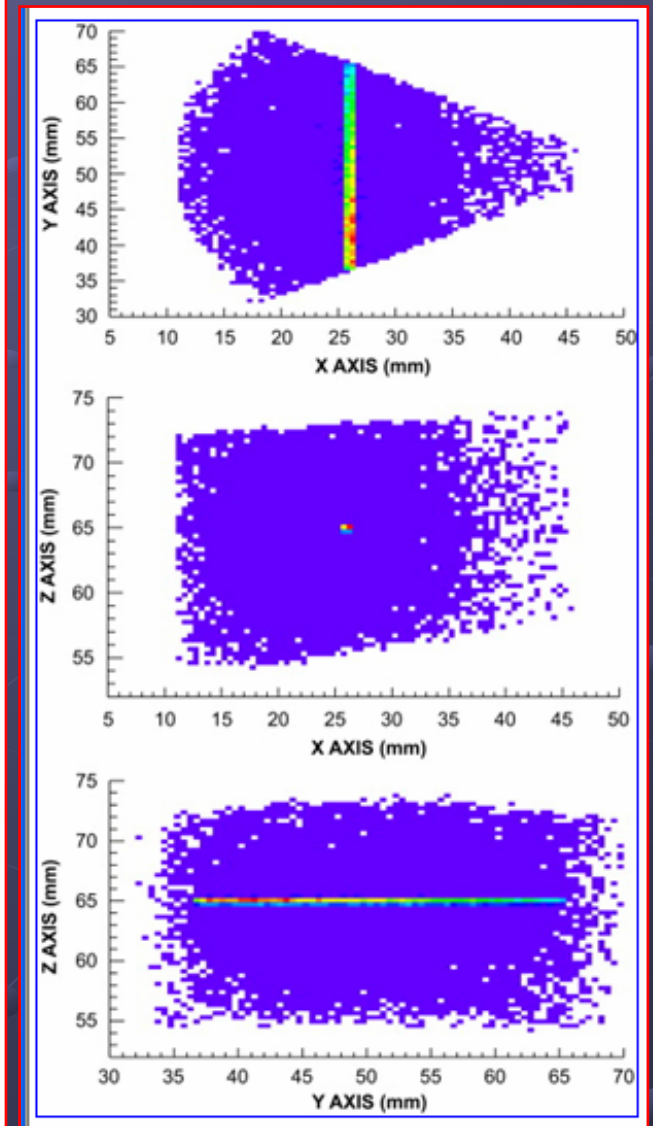


Simulation:**
A 662.7 keV γ-ray pencil beam hits a segment of the AGATA detector, in two perpendicular directions **[a)] [b)]**

energy release – case (a)



energy release – case (b)

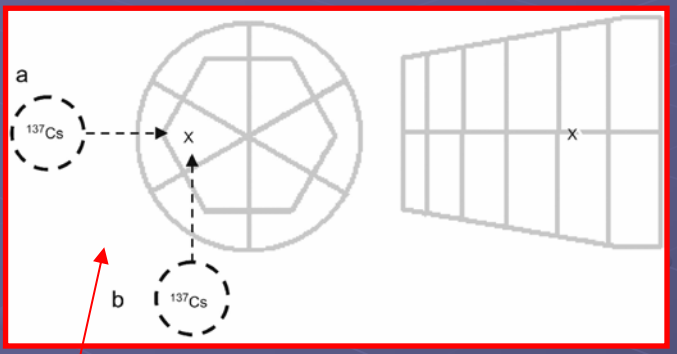


**Simulation performed using Enrico Farnea's "Agata" code

VALIDATION TEST WITH SIMULATED EVENTS

PSCS method applied to a simulated 36-fold segmented HPGe AGATA detector:**
→ calculated pulses are produced using the MGS signal basis. In the simulation the effect of noise and electronic chain response is taken into account.

The more stringent the χ^2 threshold is set
(i.e. the more the signal shapes are similar), the more the energy release is concentrated in the position of interest



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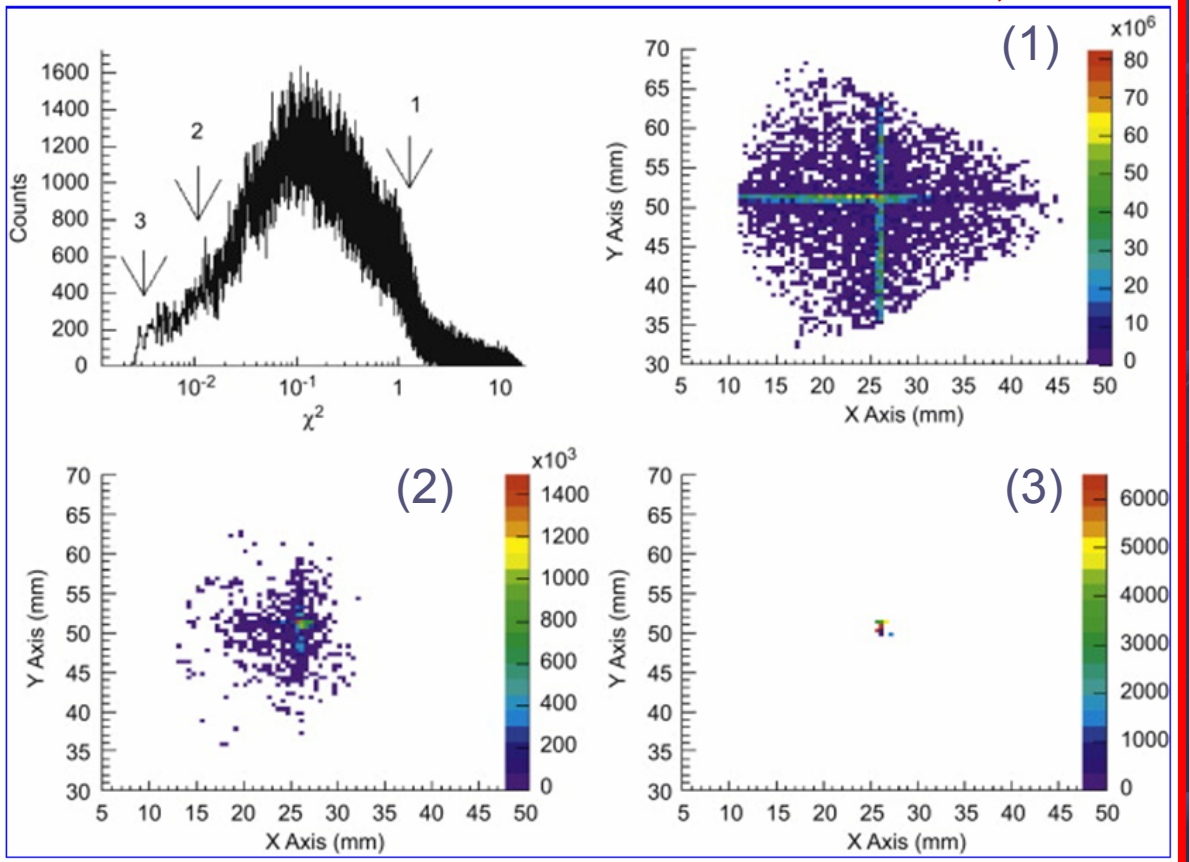
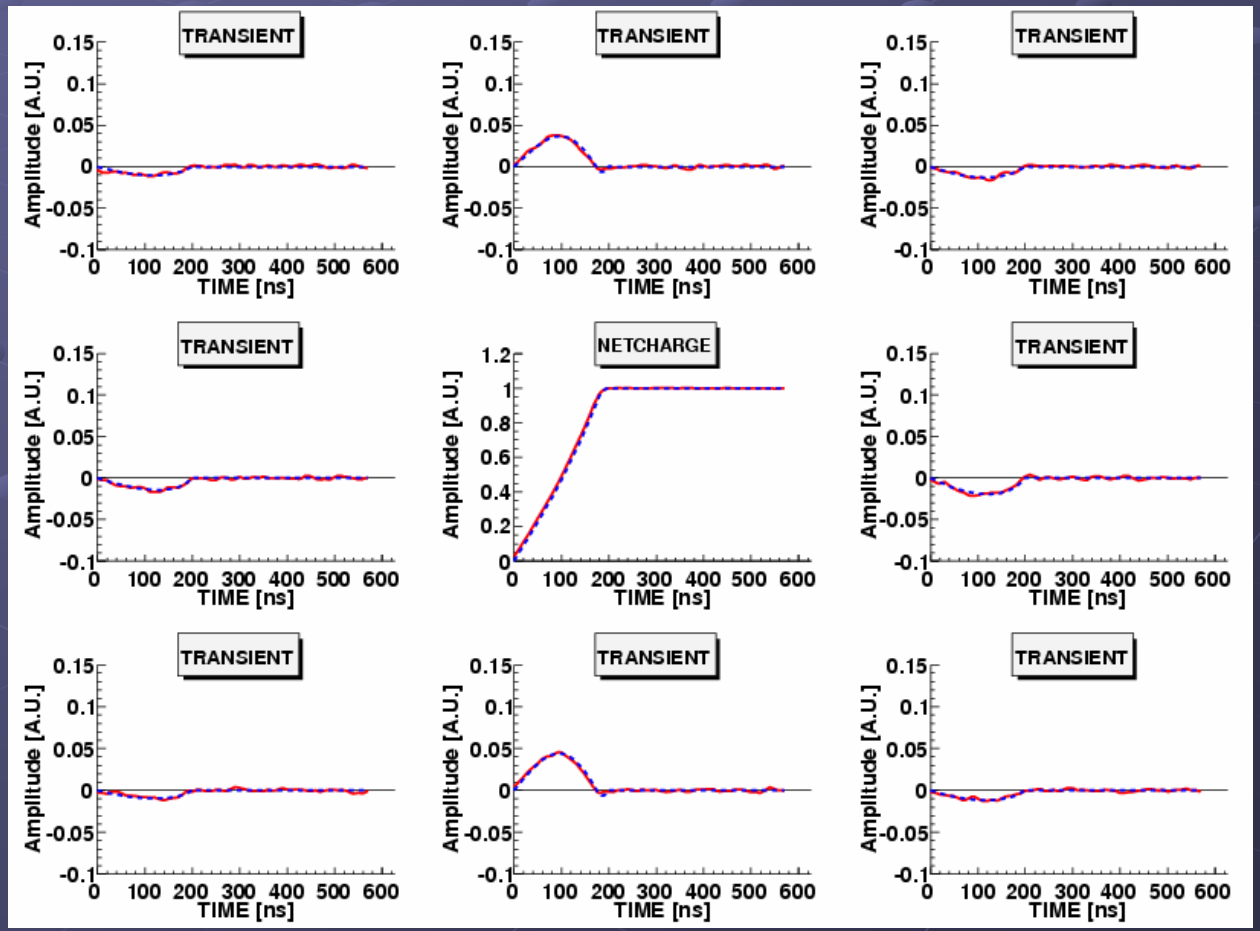


**Simulation performed using Enrico Farnea's "Agata" code

VALIDATION TEST WITH SIMULATED EVENTS

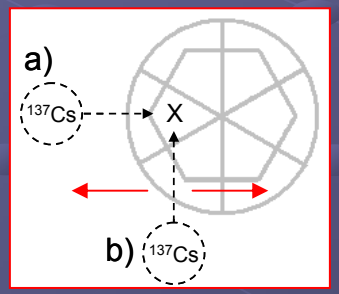
- The signal shape associated to the coordinates of the collimation lines crossing point (**DOTTED BLUE LINE**) is compared with the signal shapes obtained with the scanning procedure (**SOLID RED LINE**)
- The detector position response is extracted by averaging the signal shape associated to all the event pairs below the most stringent χ^2 threshold



VALIDATION TEST WITH SIMULATED EVENTS

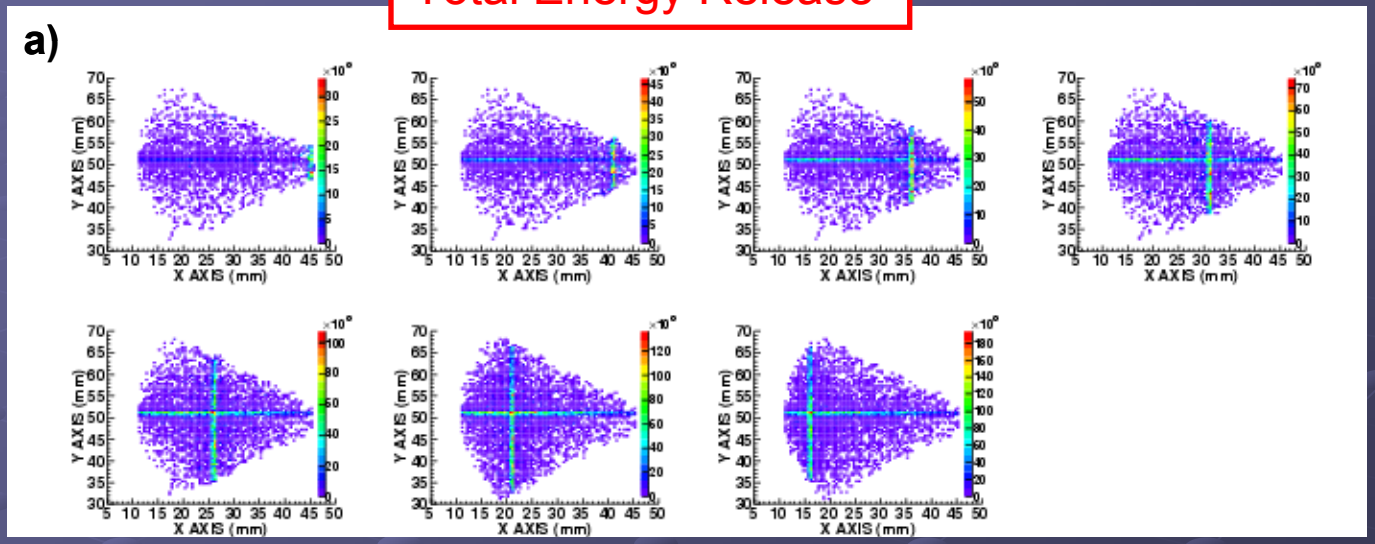
Same technique applied to different positions: the chosen points lie along the radial direction, having a relative distance of 5mm.

position change is made by shifting one collimation line with respect to the other



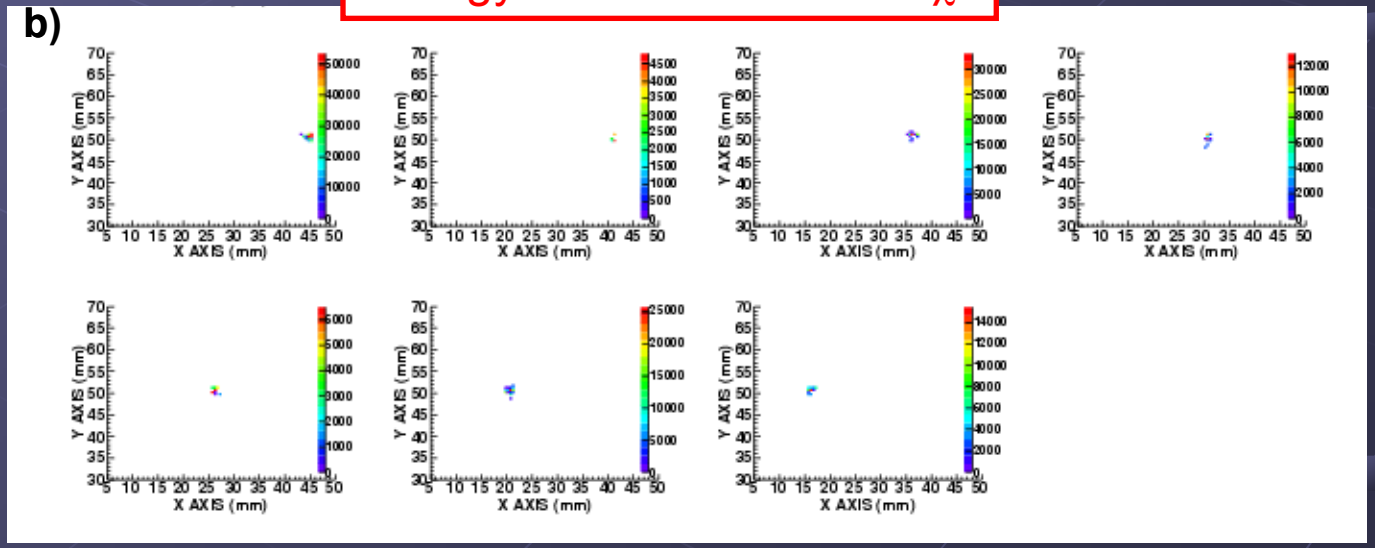
Total Energy Release

a)

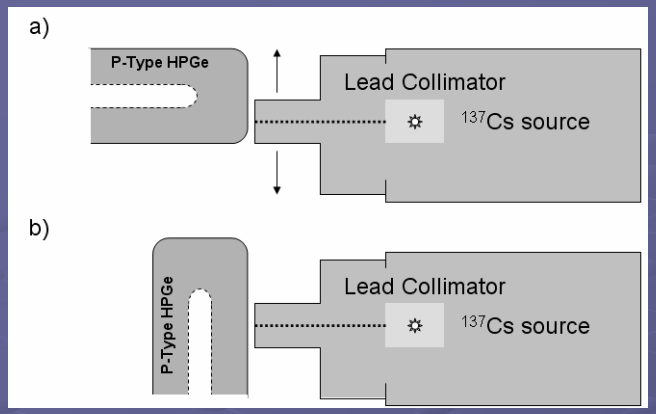


Energy Release Gated on χ^2

b)

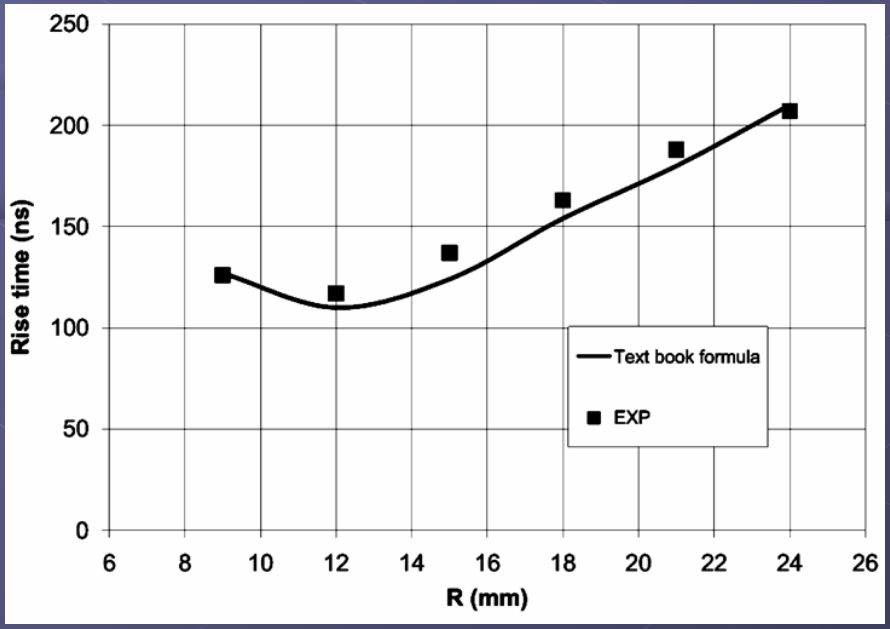


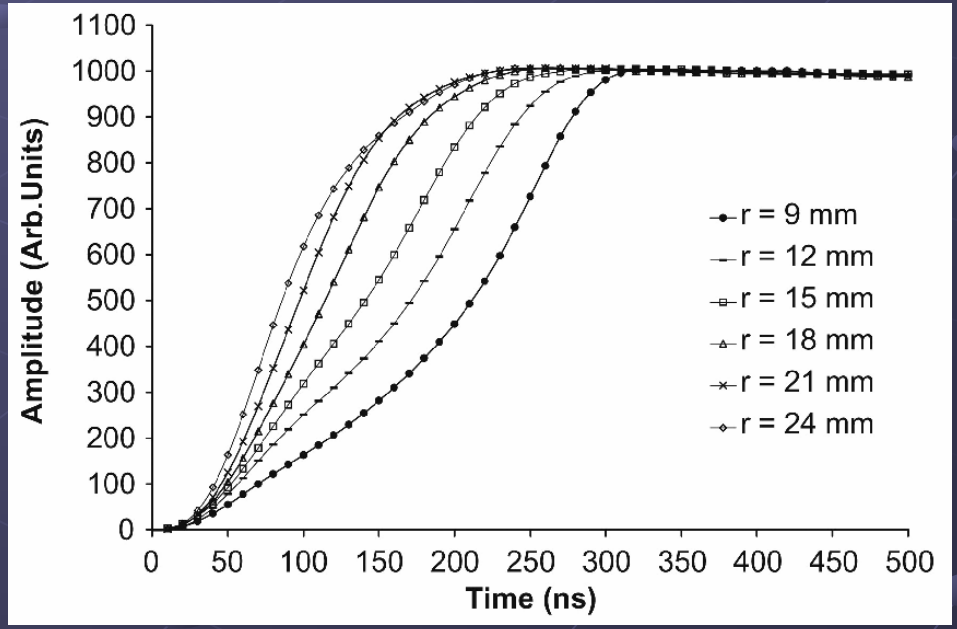
Application of the PSCS technique for the measurement of the position response of a non-segmented coaxial HPGe detector, along the radial direction



- P-Type HPGe
- 438 MBq ^{137}Cs collimated source
- collimation line at a distance of 9,12,15,18,21,24 mm from the detector centre
- signal shapes digitised at 100 M Sample/s at the output of the preamplifier
- 10 pulse shapes / 60 s per point

The Rise Time Values of the Averaged Signals reproduce the ones Obtained with simple calculations





Conclusions:

- A novel technique for measuring a HPGe detector position response has been presented.

- It has been validated on a 36-fold HPGe AGATA detector using **simulated** events

- It has been applied to scan a non-segmented coaxial HPGe detector along the radial direction:

  - ✓ *The rise time of the signals extracted with the scanning procedure were compared with the calculated ones, resulting in a good agreement.*

- Considering the signals collection rate reached during the mentioned measure the estimated time for the full volume scan of a large volume of highly segmented HPGe detector (240cm^3) is of less than a week.