Pulse Shape Comparison Scan of HPGe detectors

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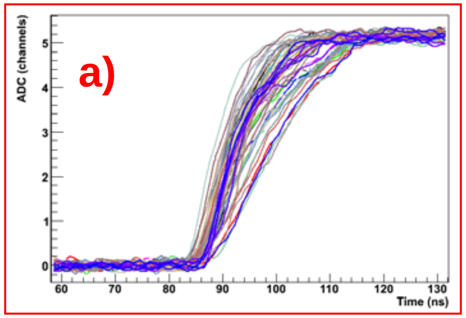
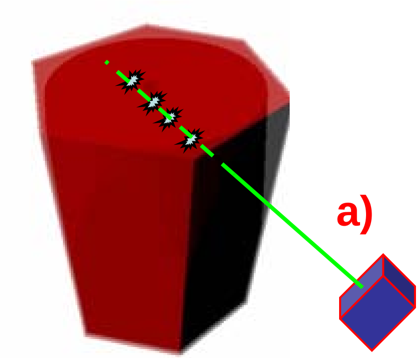
IPHC Strassbourg

HPGe Pulse Shape Comparison Scan method

Based on a collimated γ-ray source

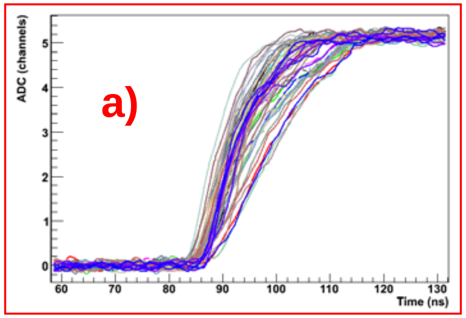


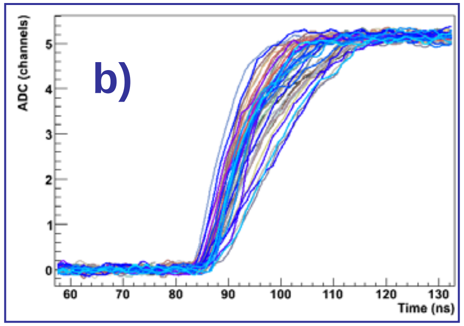


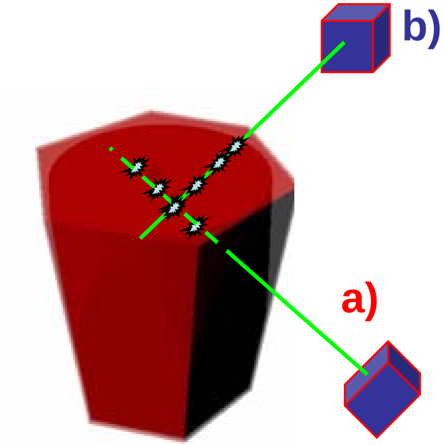
F. Crespi, et al. NIM A (2008)

HPGe Pulse Shape Comparison Scan method

Based on a collimated γ-ray source



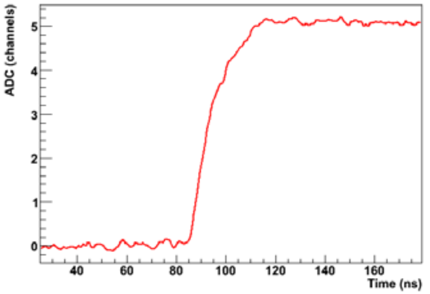




Geometric crossing point: **x,y,z**

Algorithm

χ^2(**a**,**b**)

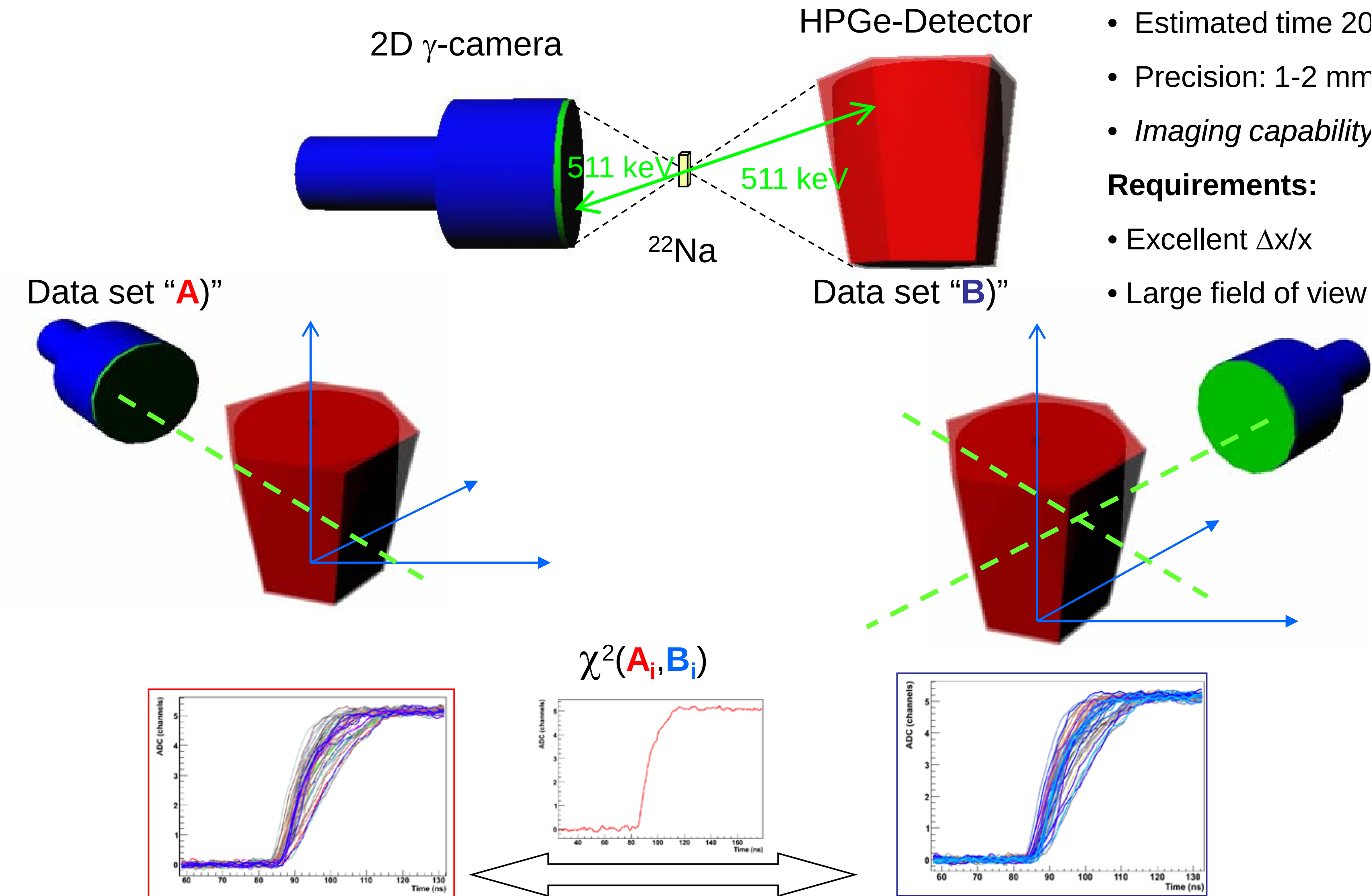


Common pulse out of these two data sets.

F. Crespi, et al. NIMA (2008)

HPGe Pulse Shape Comparison Scan method

Based on a position sensitive detector



Characteristics:

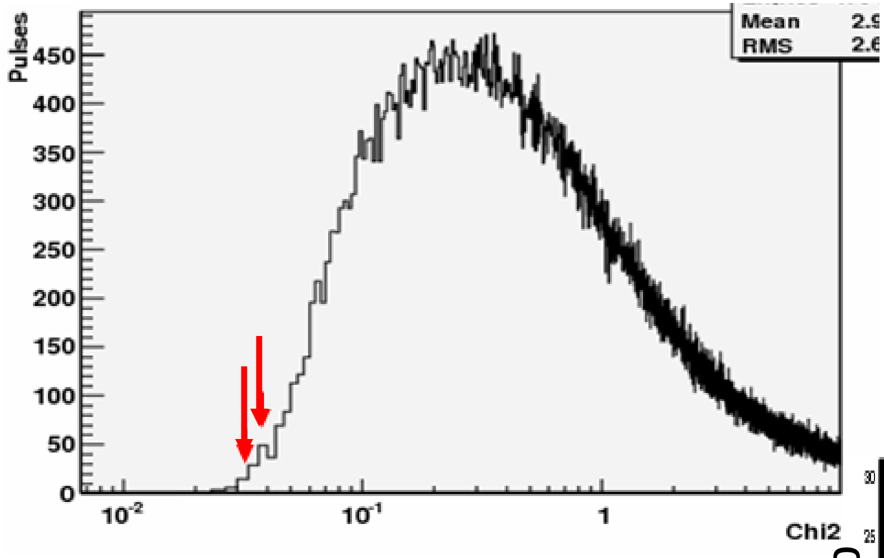
- Estimated time 20^h
- Precision: 1-2 mm
- *Imaging capability*

Requirements:

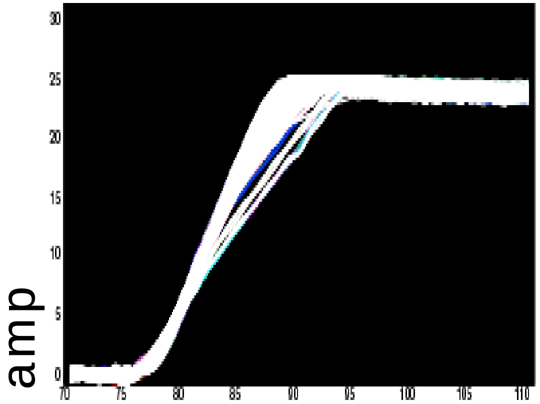
- Excellent $\Delta x/x$
- Large field of view

HPGe Pulse Shape Comparison Scan method

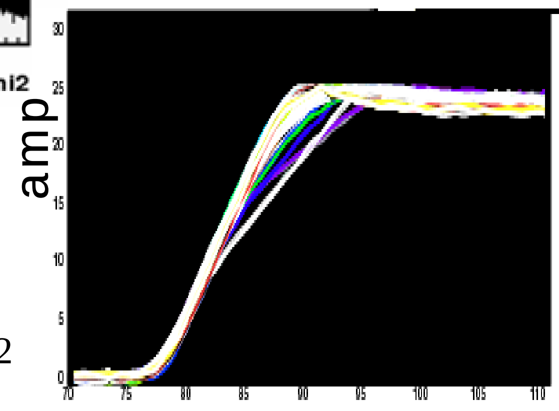
Chi^2 minimisation test



front view



side view

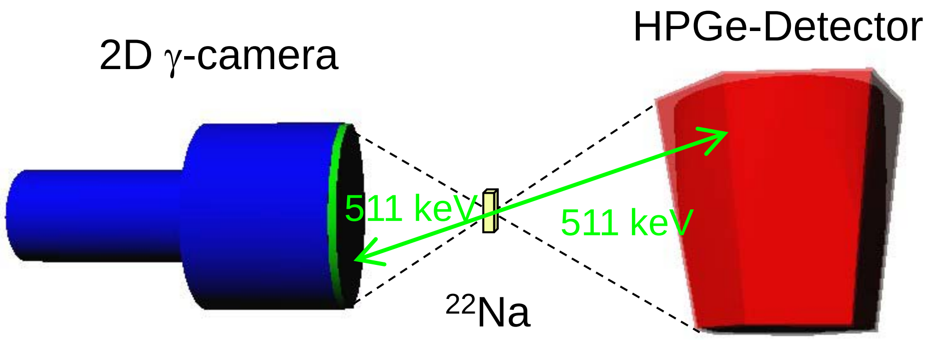


$$\chi^2 = \frac{\sum_{j=1}^{j=n} \left(Amp^{j}_{0\,\deg} - Amp^{j}_{90\,\deg}\right)^2}{n}$$

n = number of bins

HPGe Pulse Shape Comparison Scan method

Based on a position sensitive detector



Characteristics:

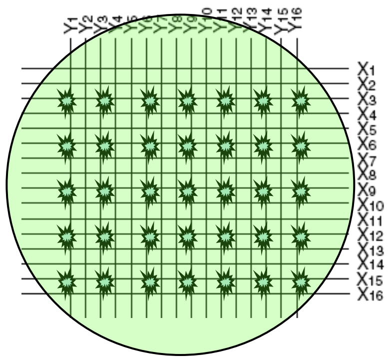
- **Estimated time 20^h**
- **Precision: 1-2 mm**
- ***Imaging capability***

Requirements:

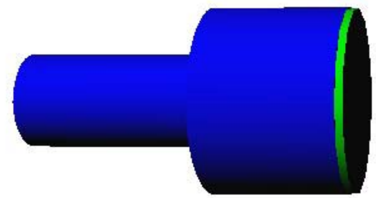
- **Excellent $\Delta x/x$**
- **Large field of view**

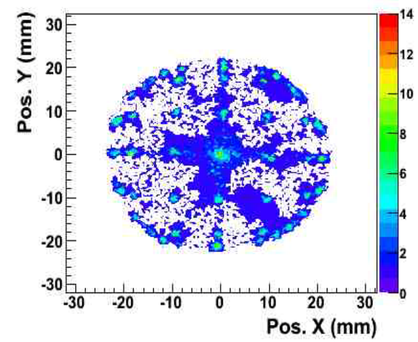
Characterization of the position sensitive detector

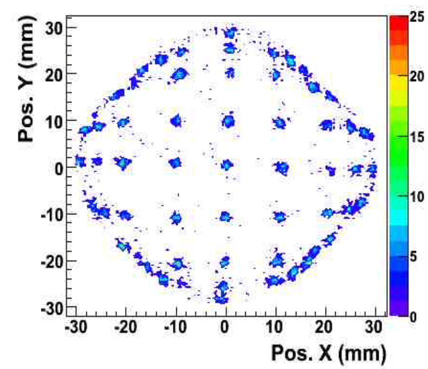
IMAR (Individual Multi Anode Readout) Technique



2D γ-camera







A position sensitive γ-ray scintillator detector with enhanced spatial resolution, linearity and field of view

C. Domingo-Pardo, N. Goel, T. Engert, J. Gerl, M. Isaka, I. Kojouharov, H. Schaffner

Abstract—The performance of a position sensitive γ-ray scintillator detector (PSD) is described. This PSD is based on a LYSO crystal read out by a crossed-wire anode position sensitive photomultiplier tube (PSPMT). The main difference with respect to similar existing devices is the individual multianode readout (IMAR) approach that is followed here. This method allows to exploit better the intrinsic characteristics of the PSPMT, thus yielding better linearity, improved spatial resolution and a larger field of view. The new detector is intended for the characterization of 3D position sensitive germanium detectors.

Index Terms—Gamma detector

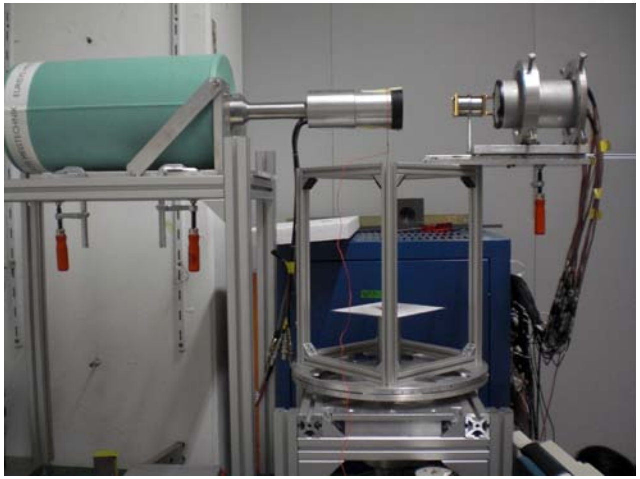
a multi-channel VLSI (very large scale integration) charge sensitive amplifier array the distribution of charge collected along the 18 X-anodes of a Hamamatsu R2487 PSPMT was measured, thus showing that a substantial improvement in the intrinsic position linearity and thus in the useful field of view (FoV) of the detector can be achieved [16].

In the present work we re-investigate the individual multi anode readout method, in the following IMAR method, and we explore its impact on the spatial resolution and on the linearity across the whole photocathode area. There exist similar works

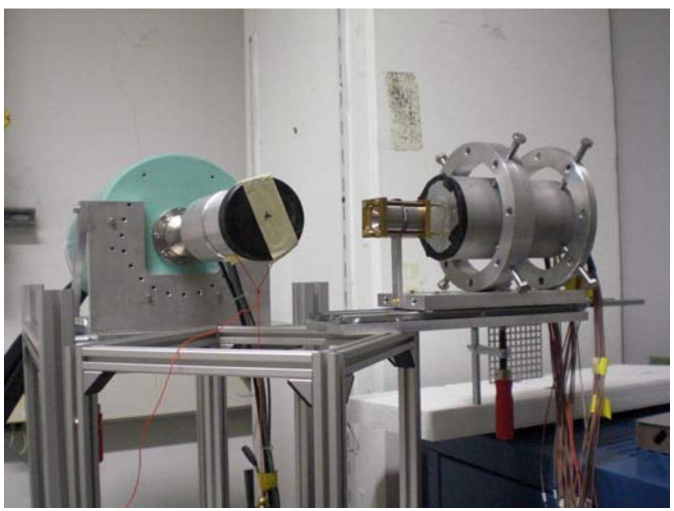
IEEE, **Issue Date:** Dec. 2009 **Volume:** 28 Issue: 12 **On page(s):** 2007 - 2014

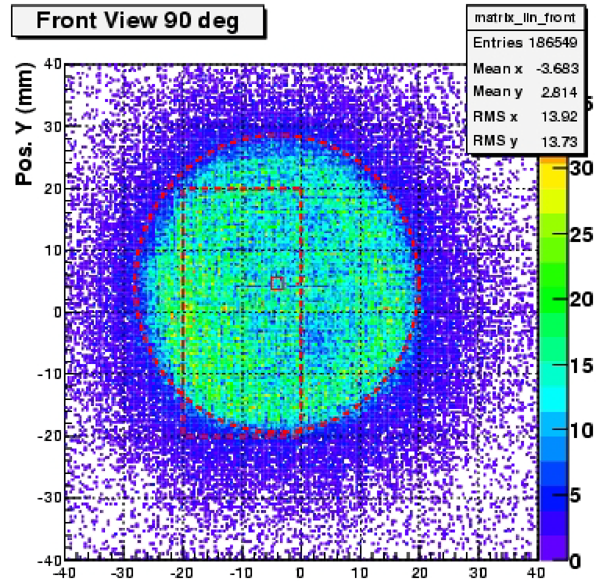
Planar Detector Scan

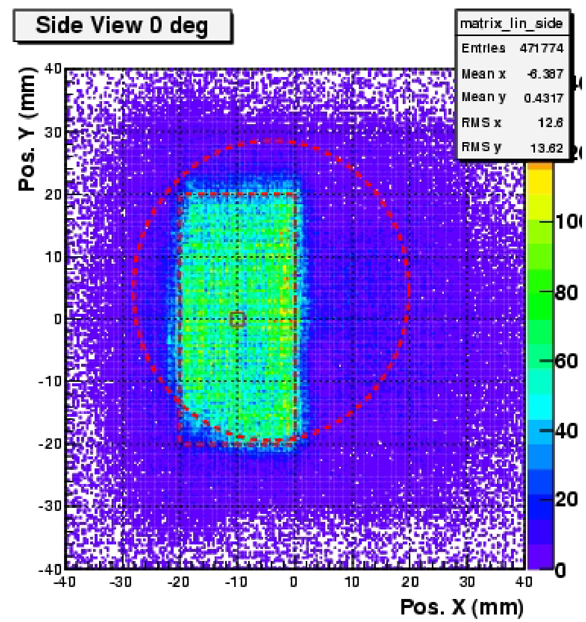
Front view (0 deg):



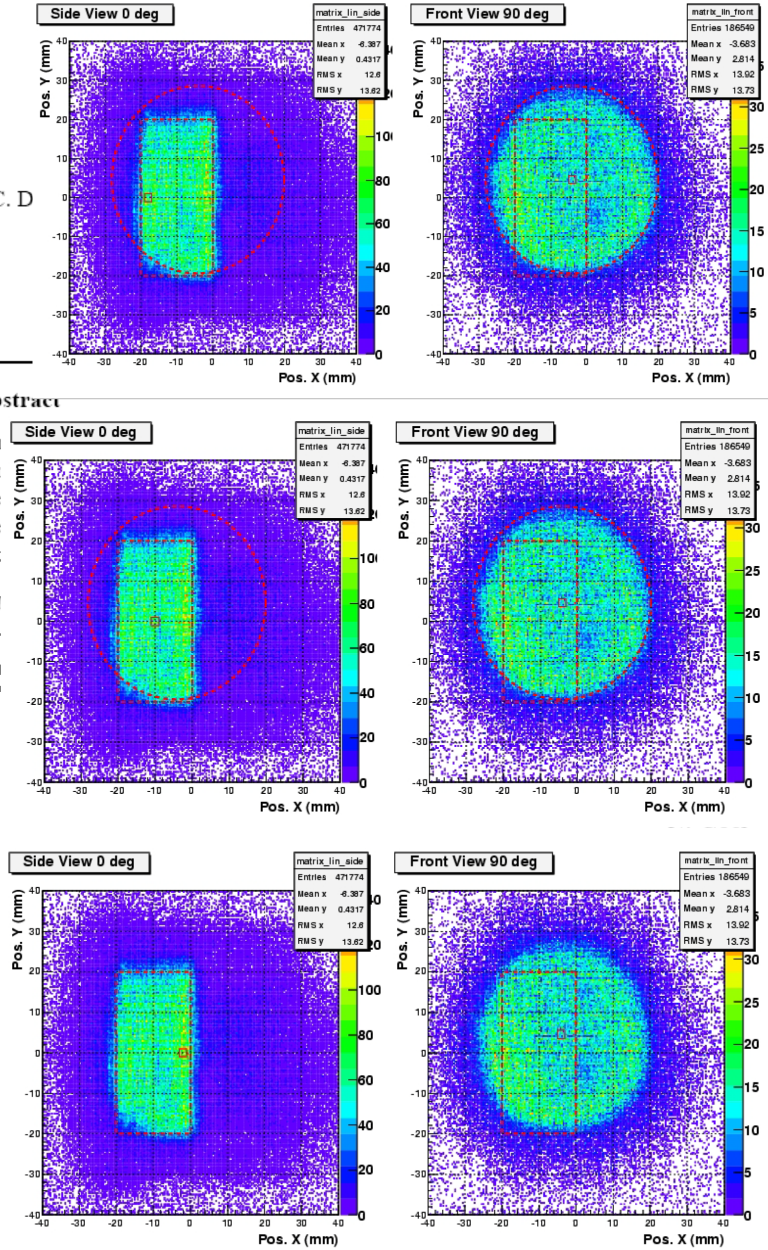
Side view (90 deg):







Planar Detector Scan



...acterization of
...r detectors

C. D... ...F. Didierjean[b], G. Duchêne[b], M.H. Sigward[b]

...4291 Darmst...
...urg Cedex 2,...

Abstract

A ... capabilities of a novel scanning system are reported. This system is primarily intended for the pulse
con... ...on of position sensitive HPGe detectors. The system is based on the pulse shape comparison scan
me... ...is applied to acquire the position response of an n-type planar germanium detector. In this work
me... ...plications of this system such as the details of the inner structure of HPGe detectors and electric
is c... ...hich are provided by means of its imaging ability.

Key... ...germanium, Position sensitive detector (PSD), Pulse shape comparison (PSC), Imaging

...rmanium d...
...echnique.
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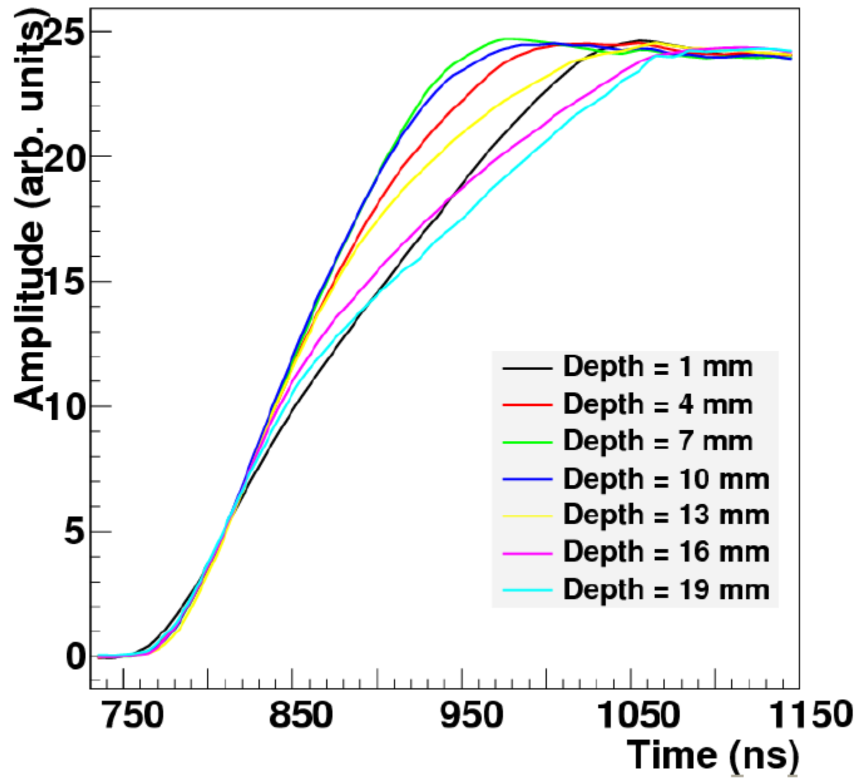
..., C. Dom...

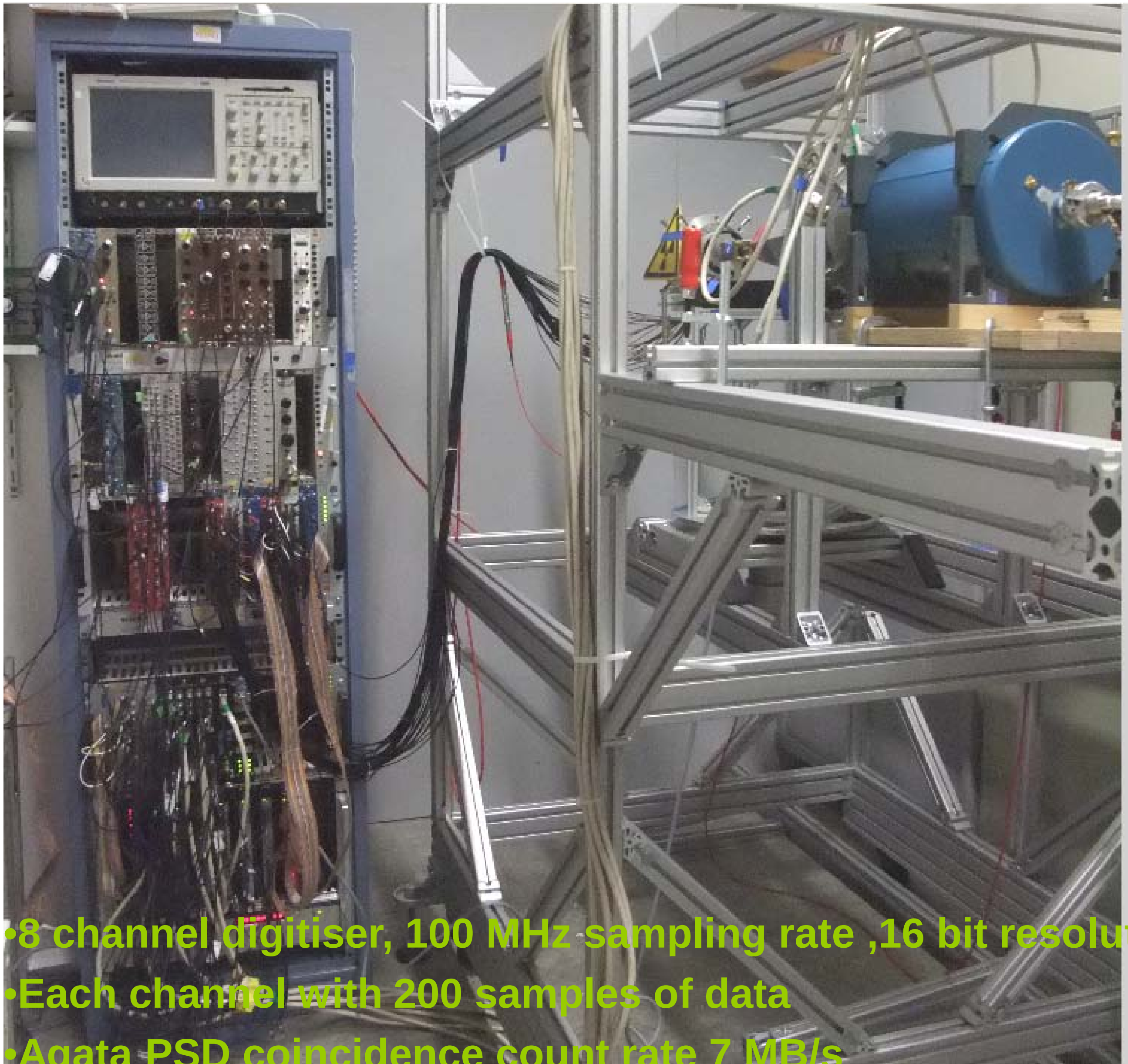
...Helmholtz...
[b] Techn...



In Preparation

Agata S001 Scan: Mechanics

Agata S001 Scan: Electronics



- 8 channel digitiser, 100 MHz sampling rate ,16 bit resolution
- Each channel with 200 samples of data
- Agata PSD coincidence count rate 7 MB/s

Agata detector

↓ 7 MDR cables

Differential to Single end Converter Cologne

↓

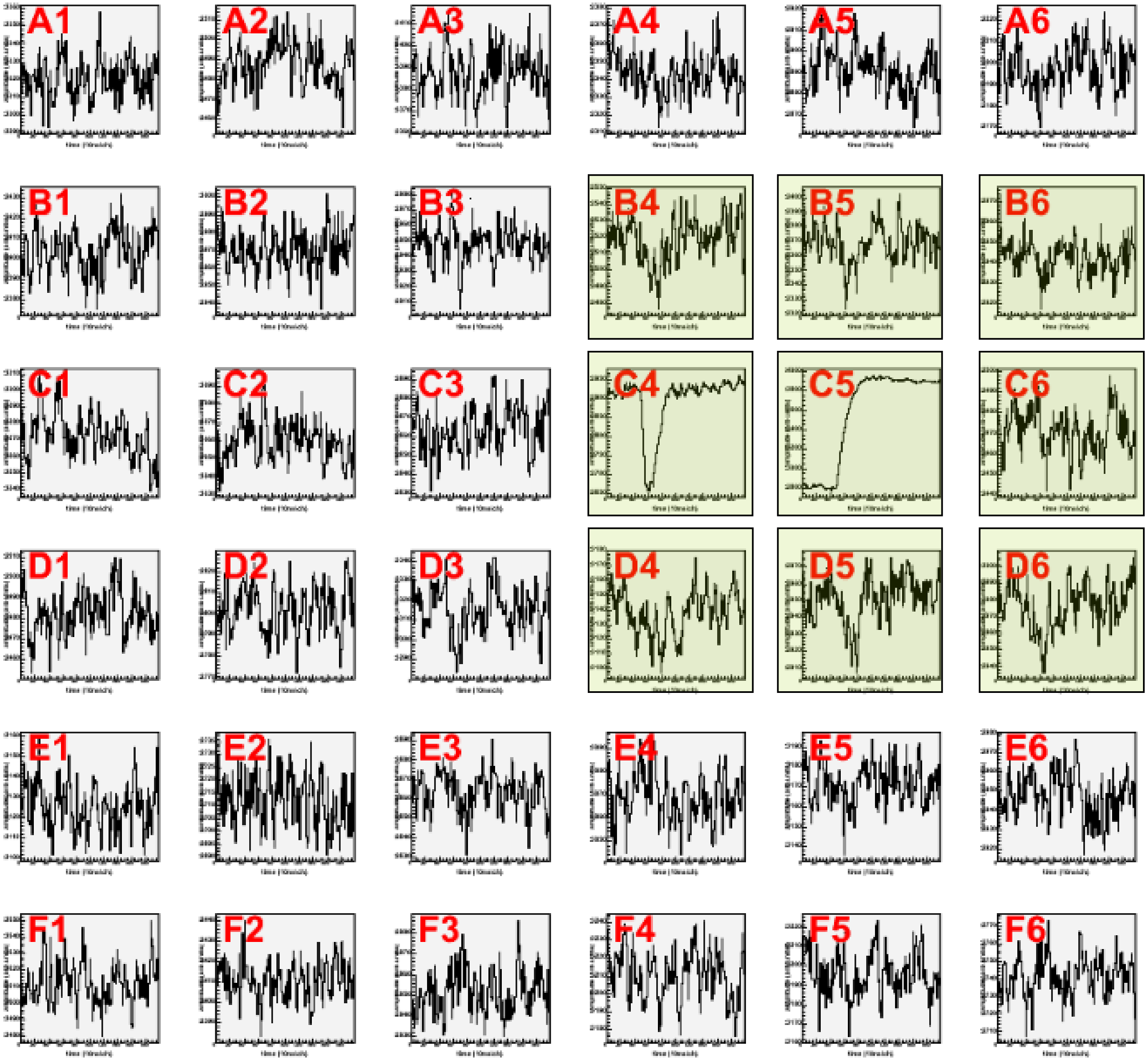
Struck SIS 3302 digitiser

↓

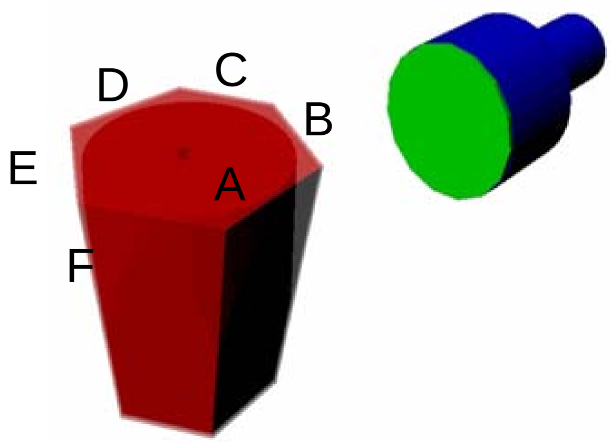
DAQ

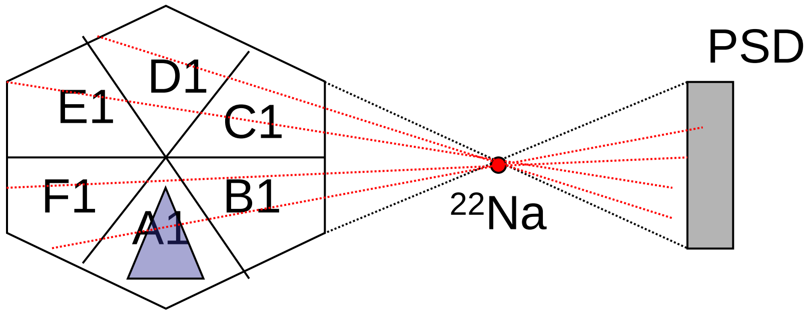
MBS

Agata S001 Scan: Pulses

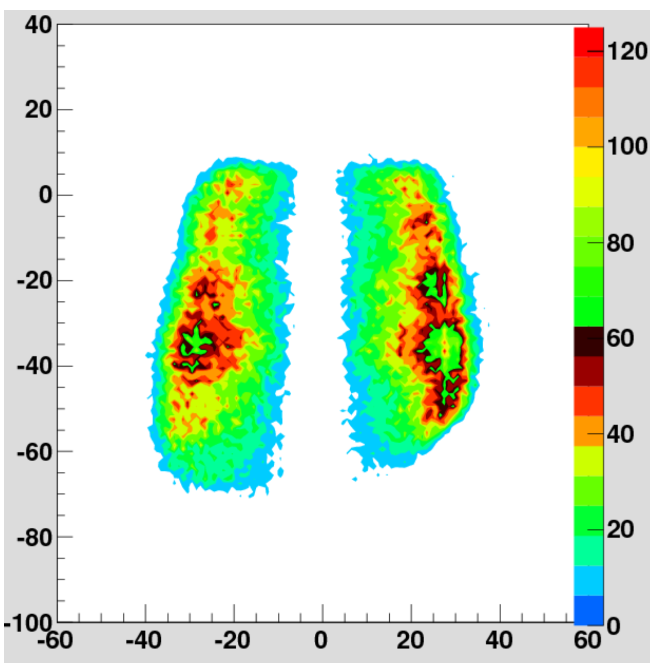


Agata S001 Scan: Imaging

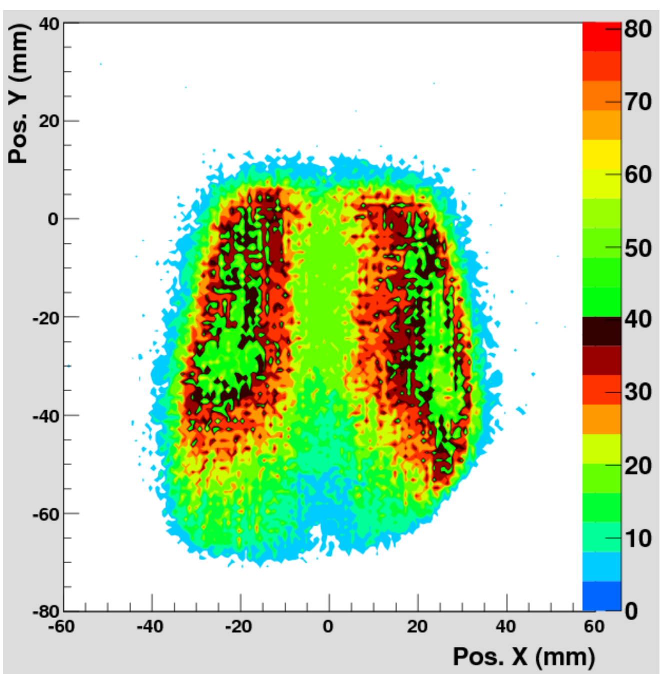




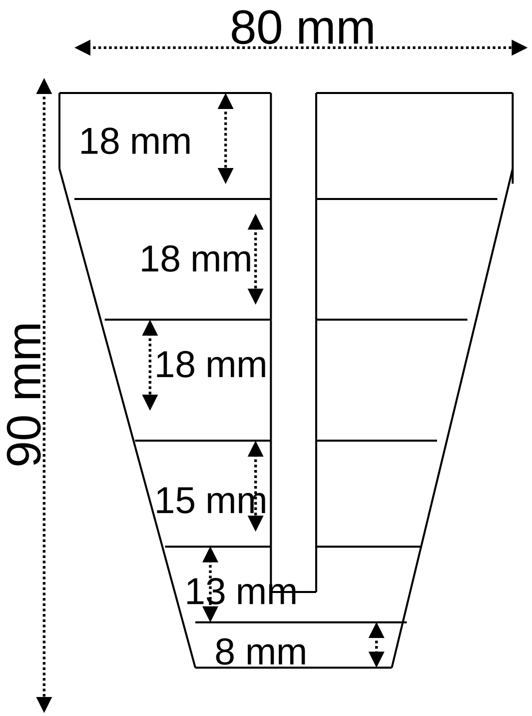
Photopeak events in layers A and D

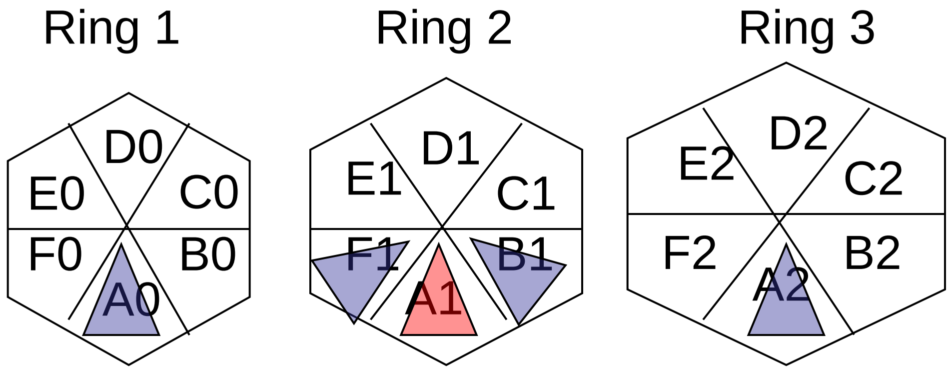


Compton events in layers A and D

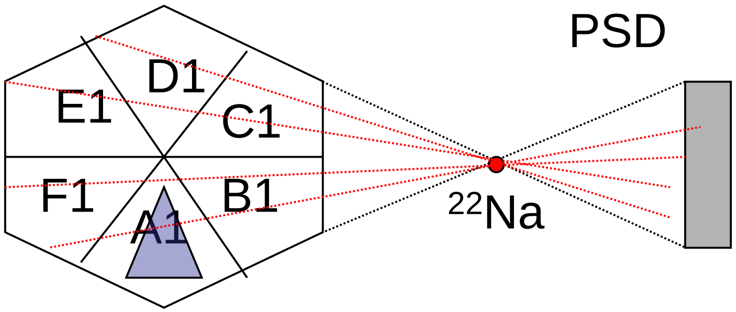


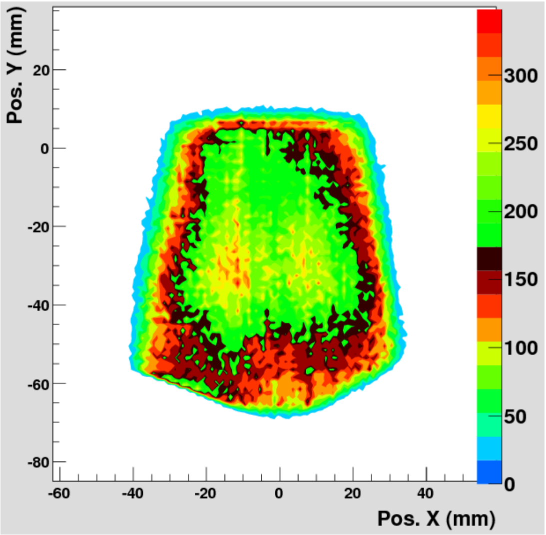
Agata S001 Scan: Geometry

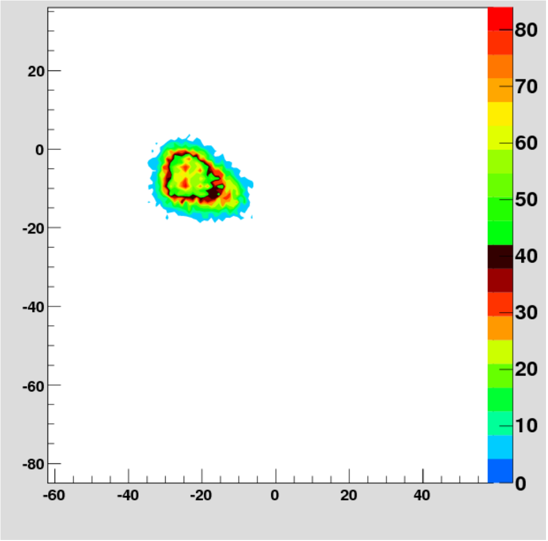


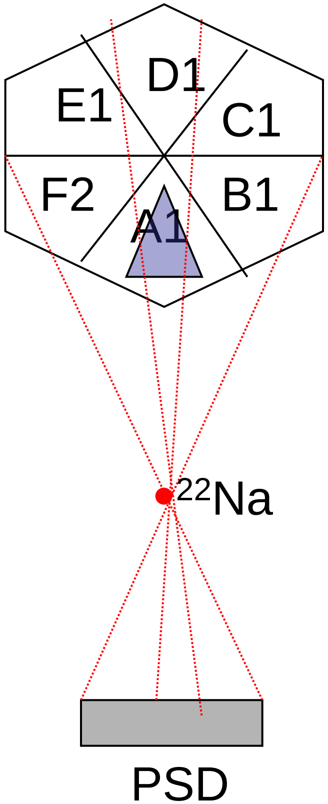


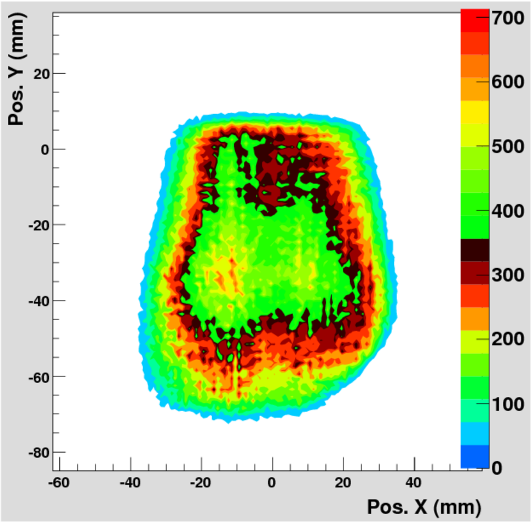
Agata S001 Scan: Imaging

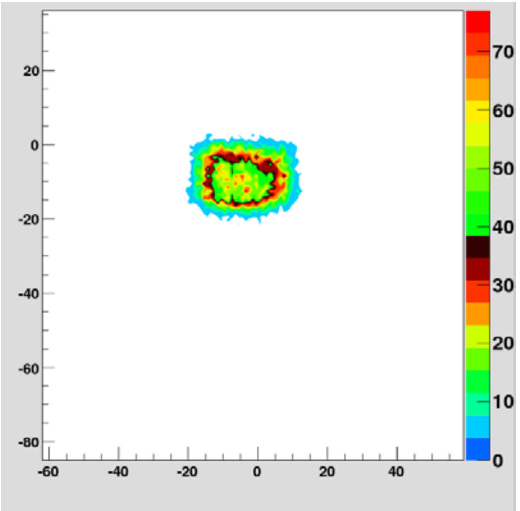




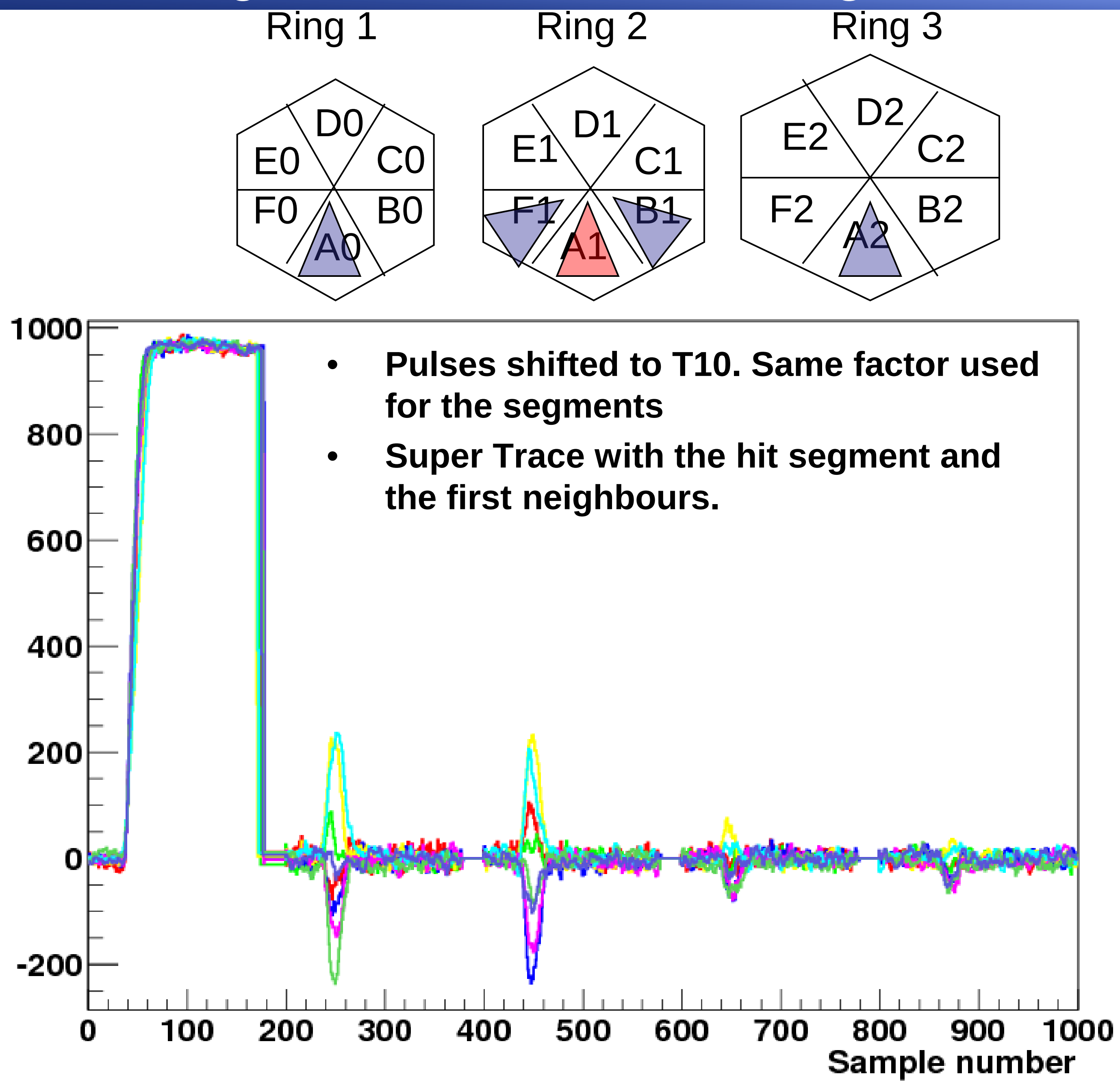








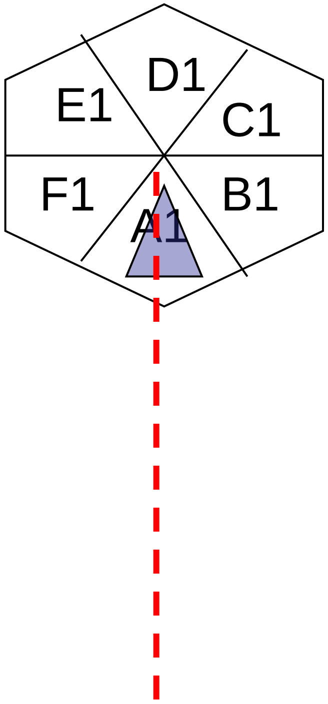
Agata S001 Scan: Time alignment



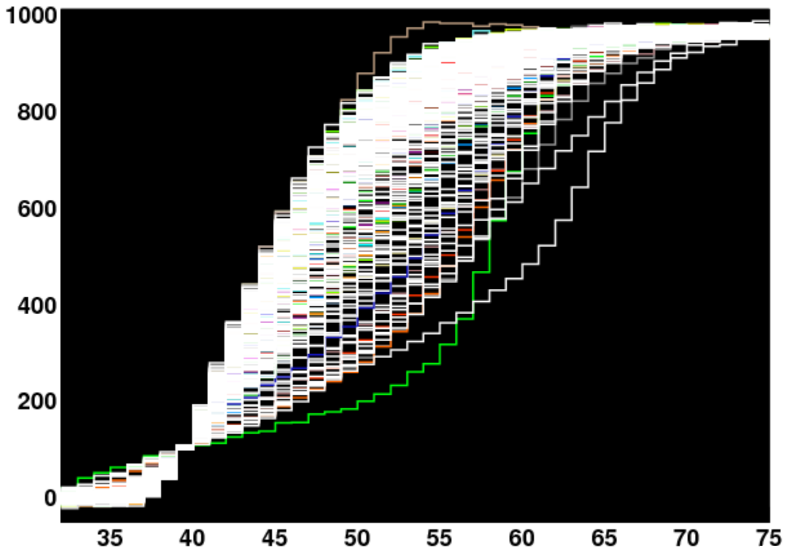
- **Pulses shifted to T10. Same factor used for the segments**
- **Super Trace with the hit segment and the first neighbours.**

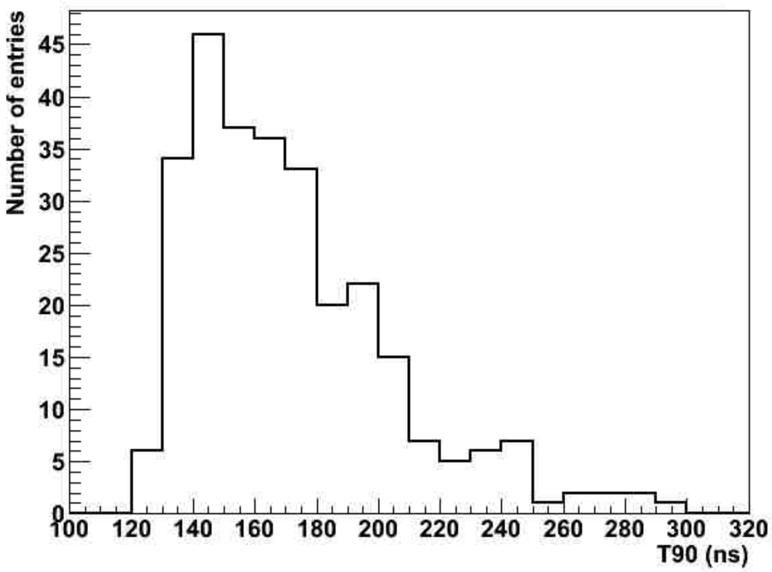
Agata S001 Scan: T90 distribution

Single Trajectory selection



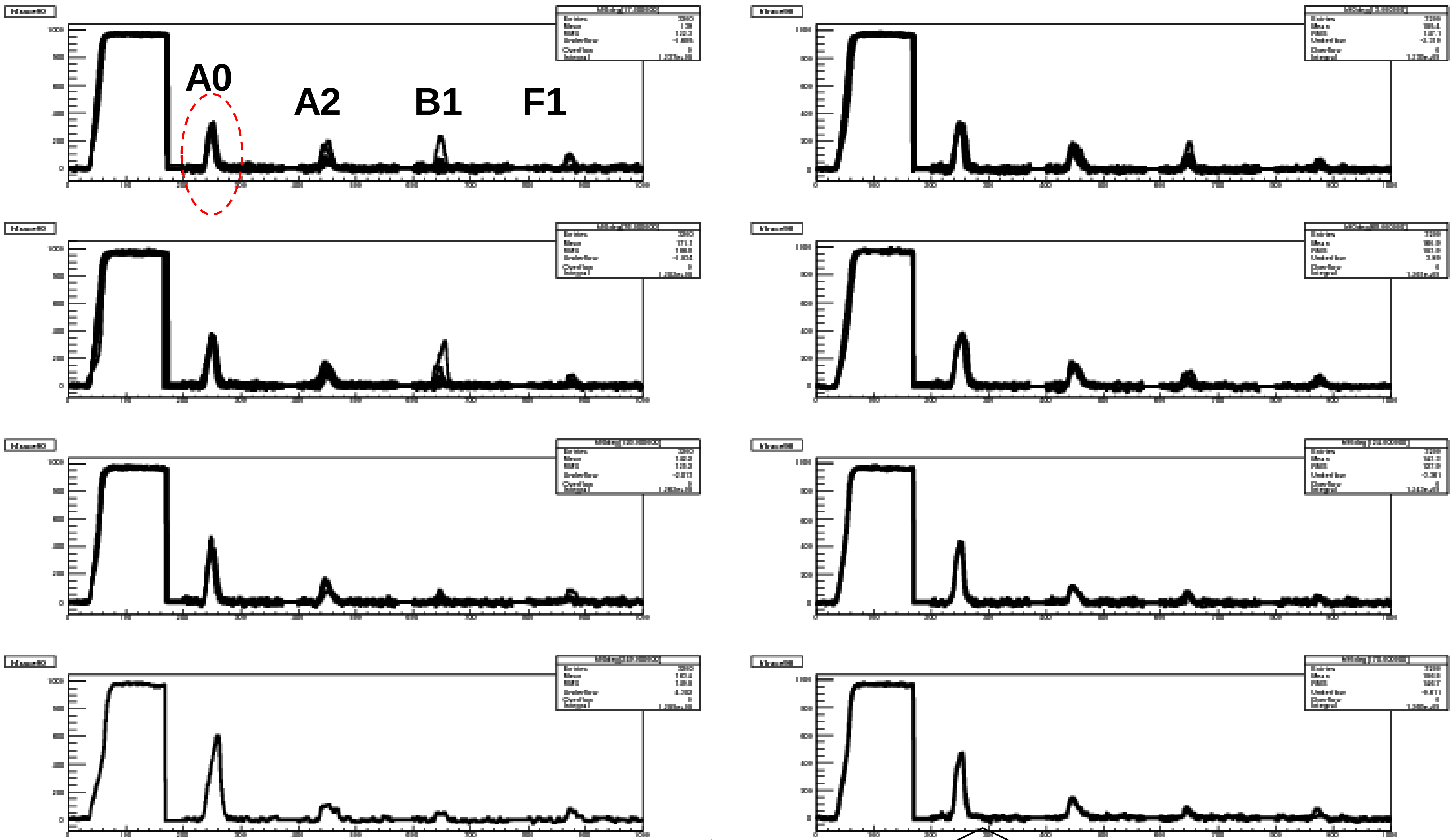
Radial distribution of pulses in the hit segment

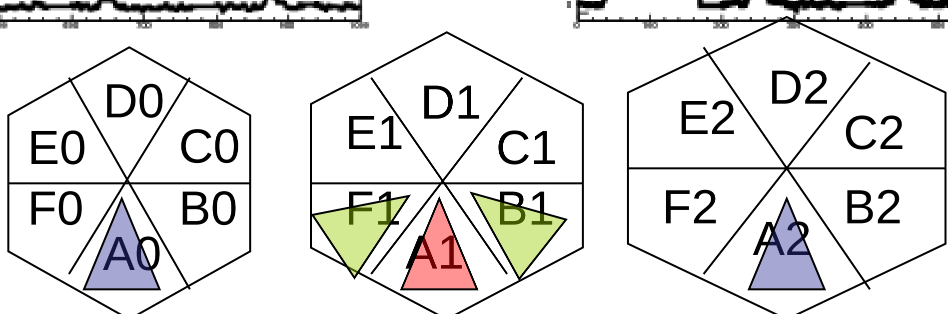




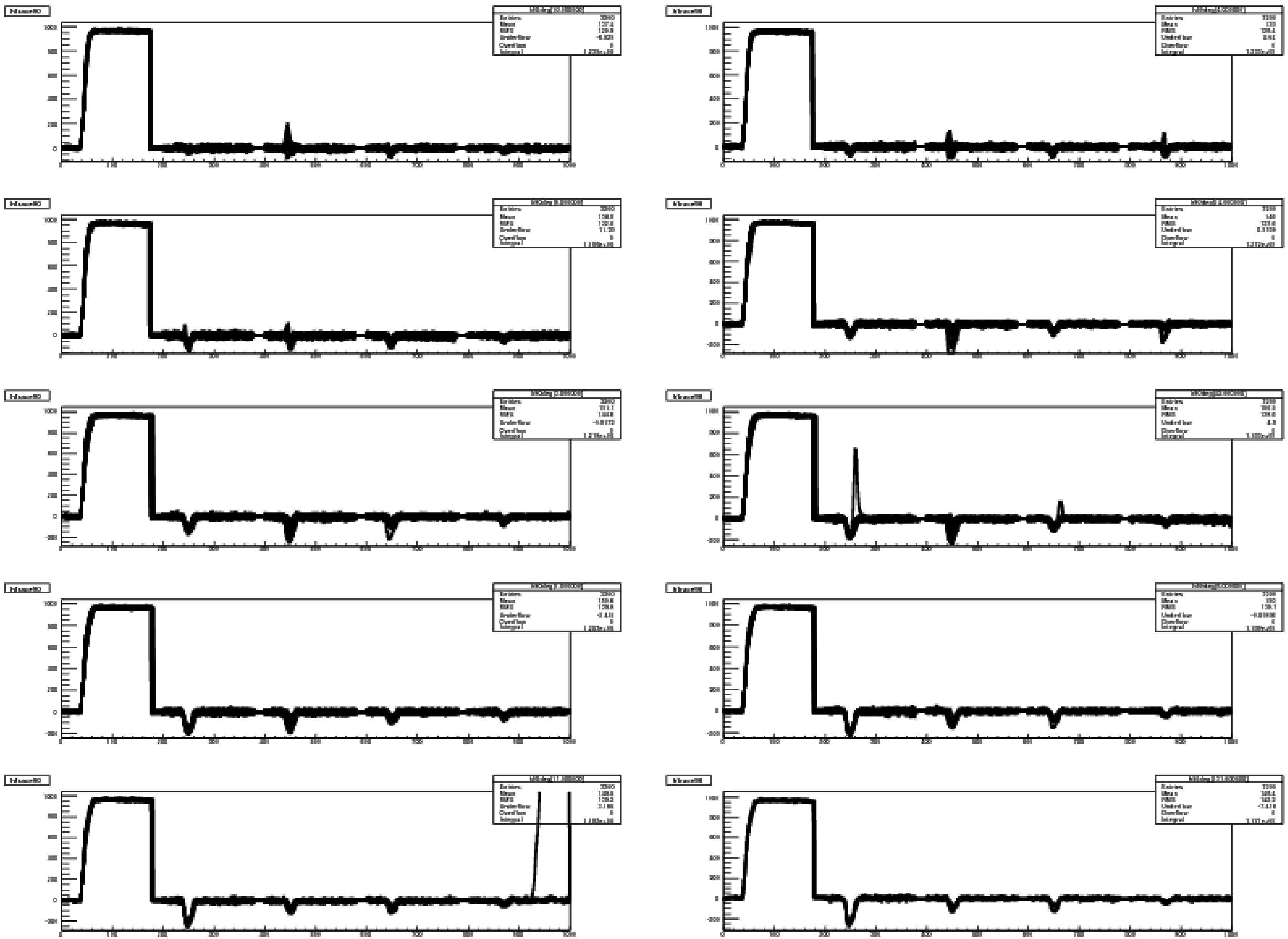
Distribution of T90 values along the radius

Agata S001 Scan: Amplitude selection



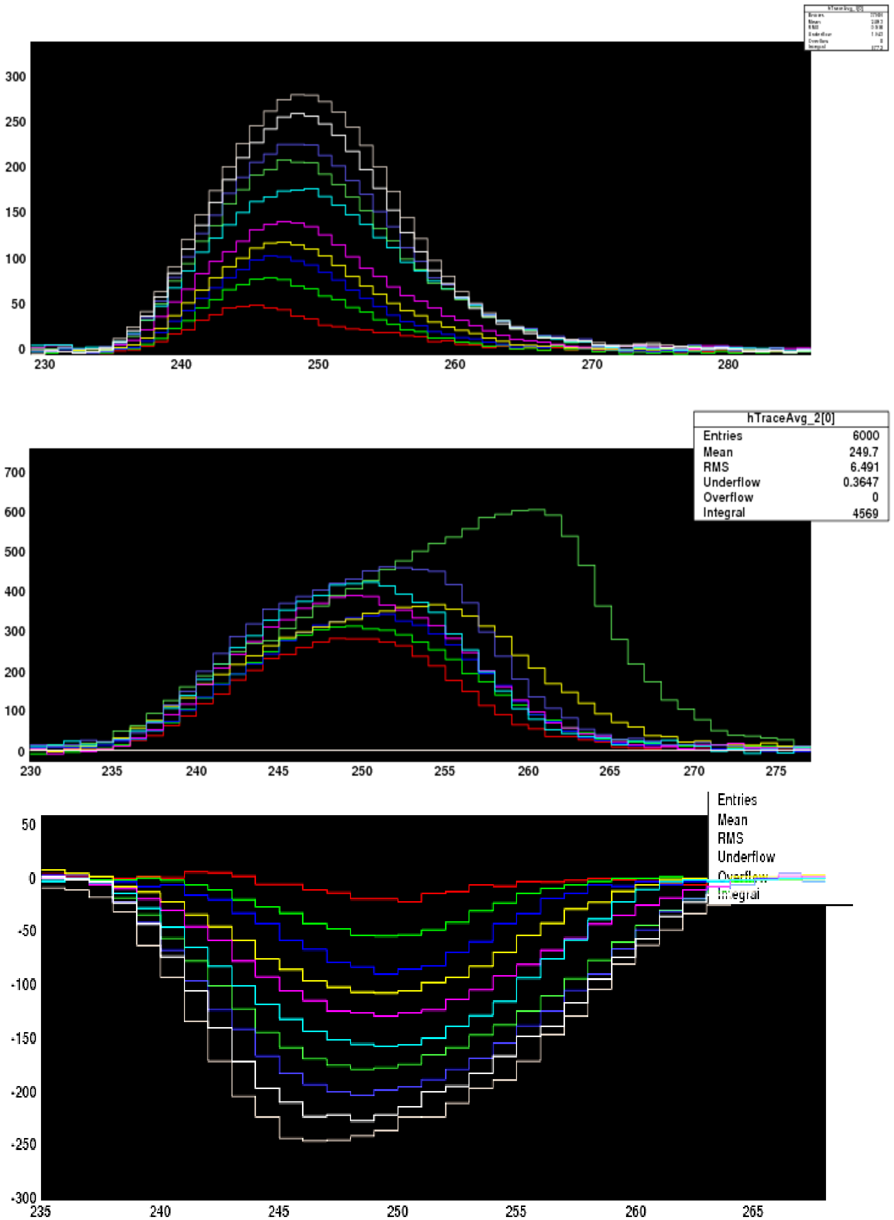


Agata S001 Scan: Amplitude selection

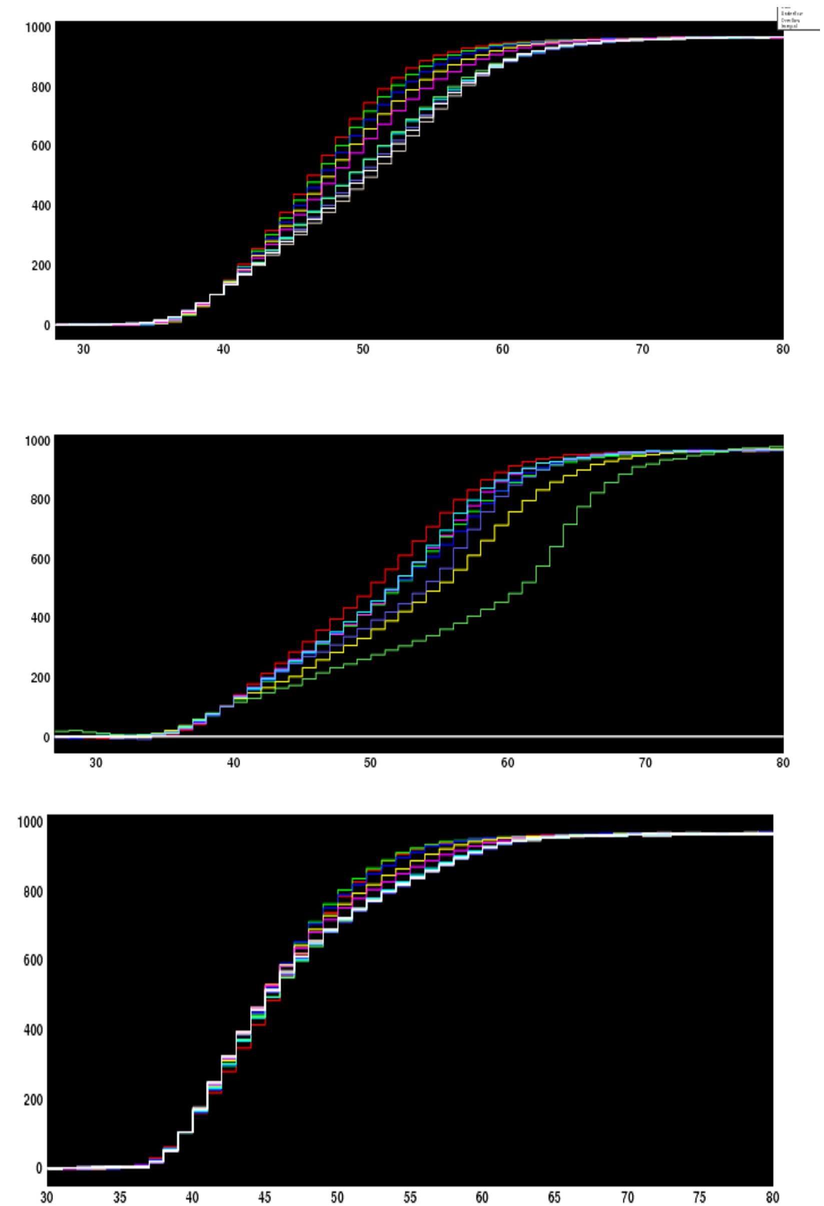


Agata S001 Scan: Radial Variation

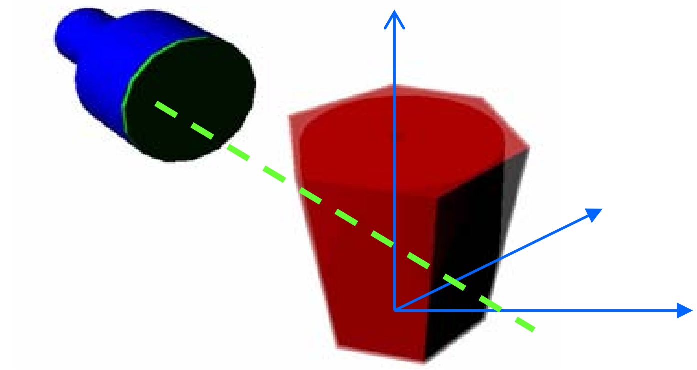
Transient Signal, A0

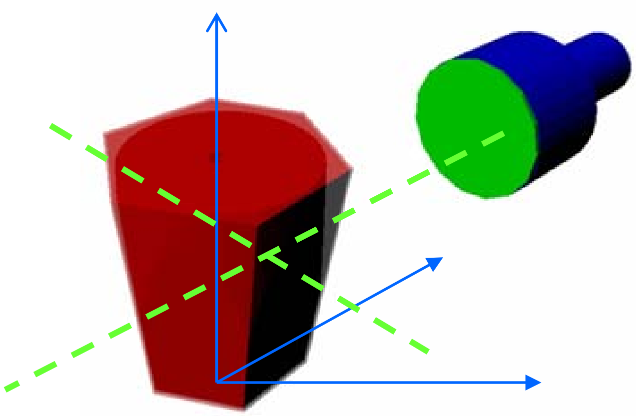


Hit segment A1

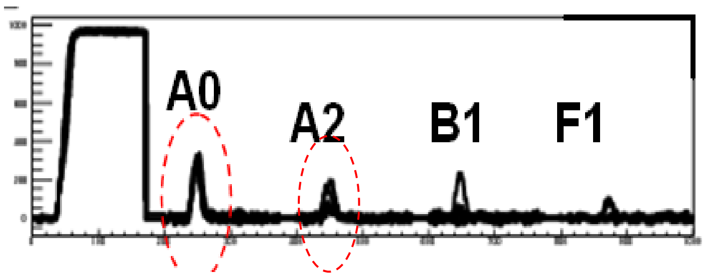


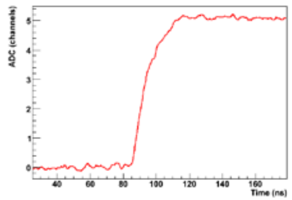
Agata S001 Scan: Pulse Shape Comparison scan

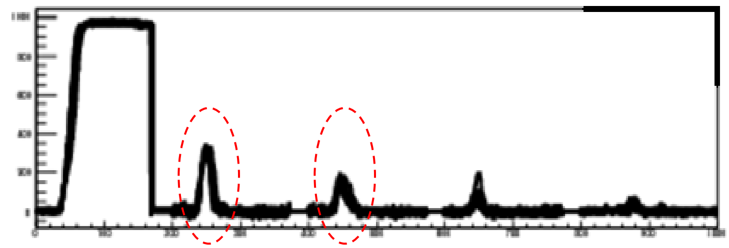




$\chi^2(A_i, B_i)$



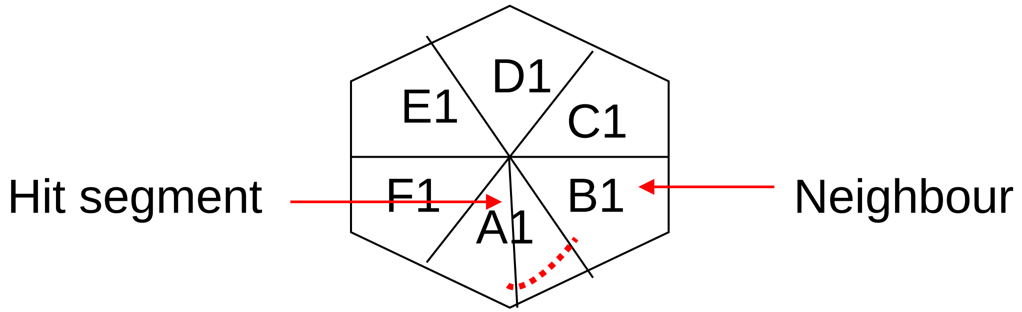


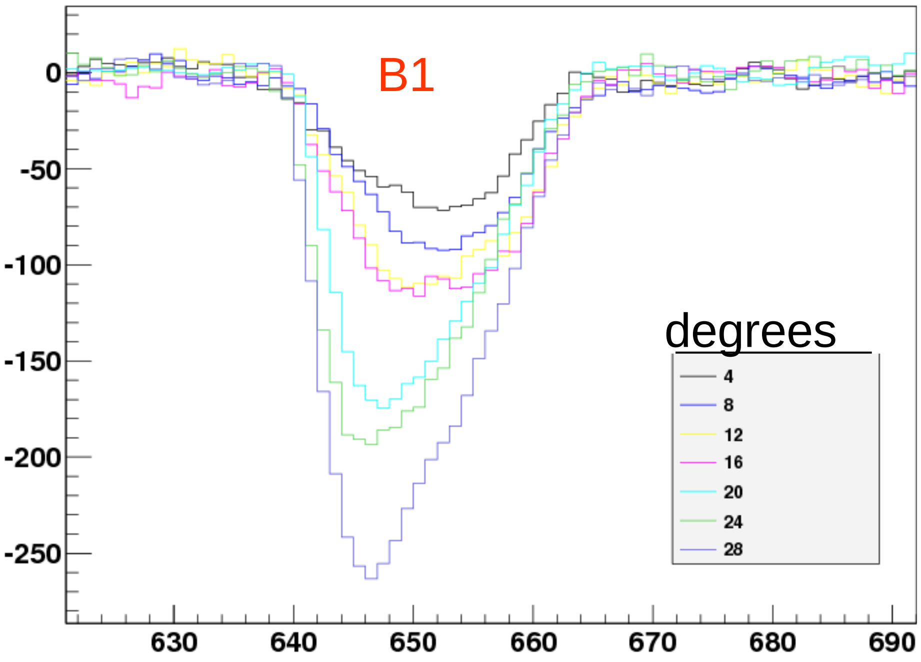


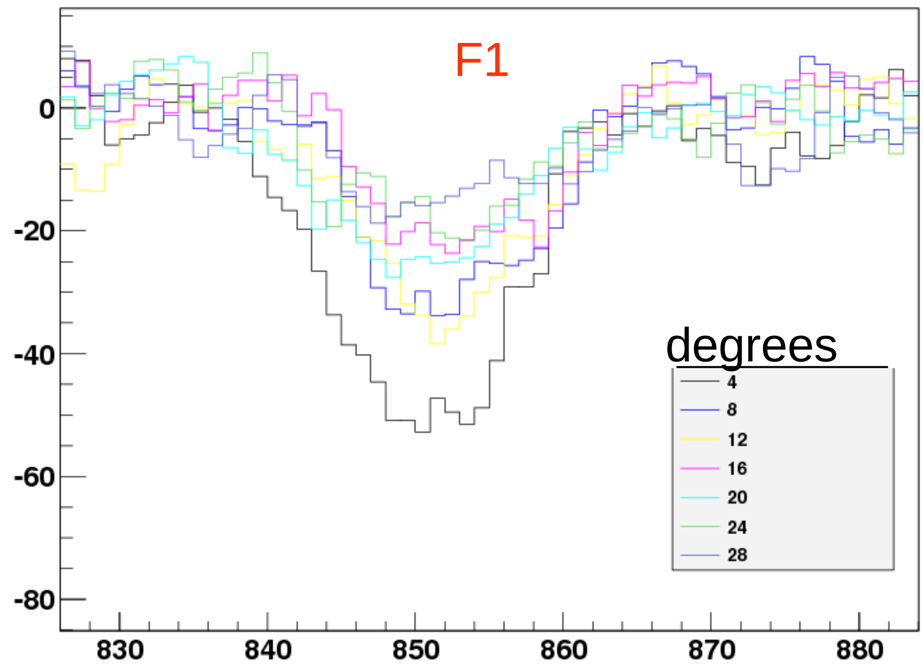
- Only two segments (up and down, A0 and A2) chosen for comparison.
- Hit segment excluded
- "Chi2" definition used:

  Σ(ai-bi)²

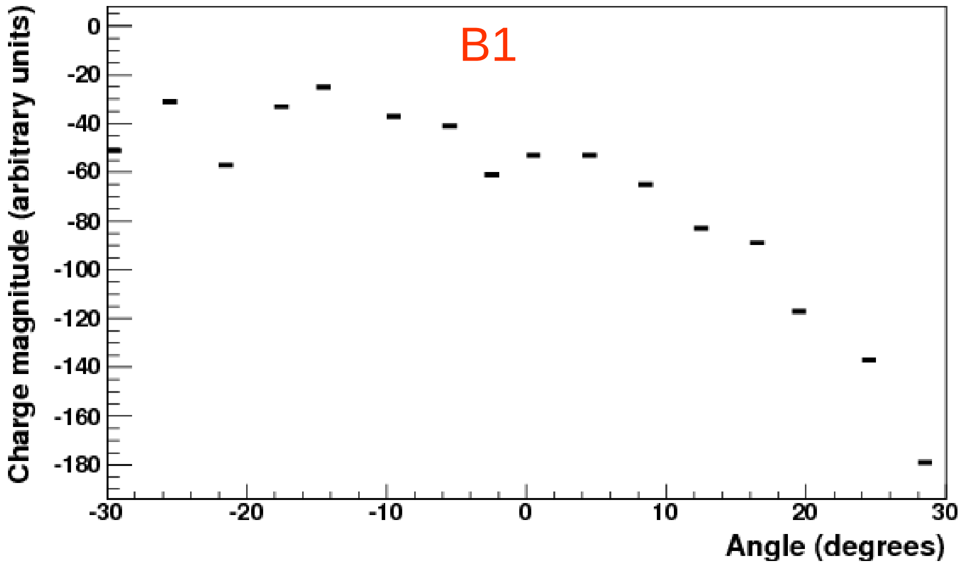
Agata S001 Scan: Azimuthal variation

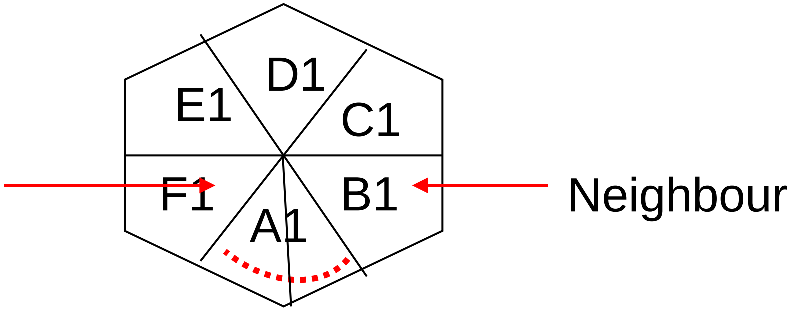


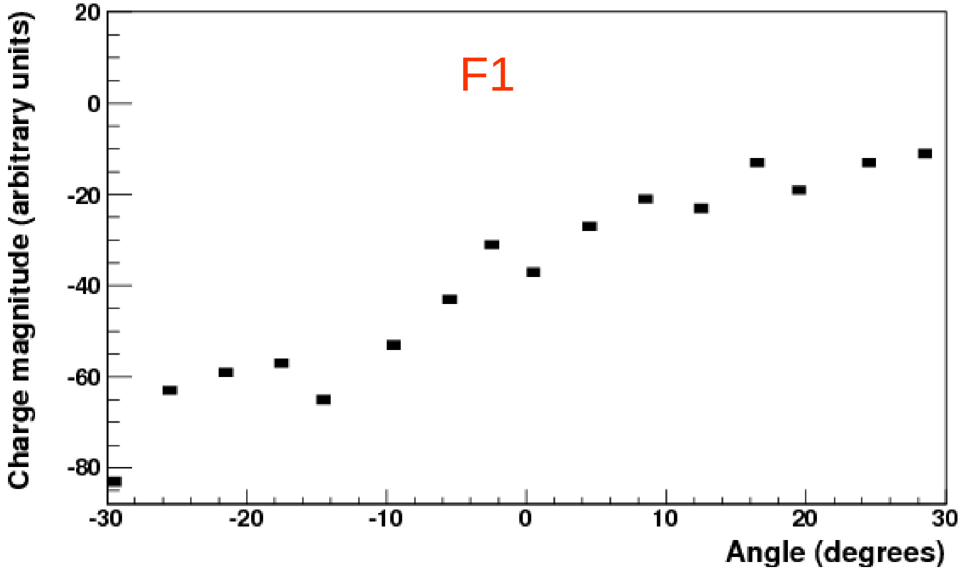




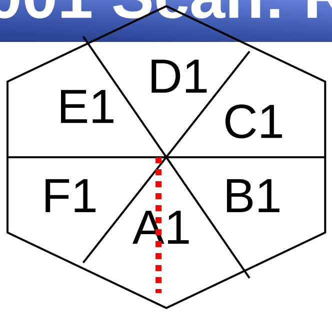
Agata S001 Scan: Azimuthal variation

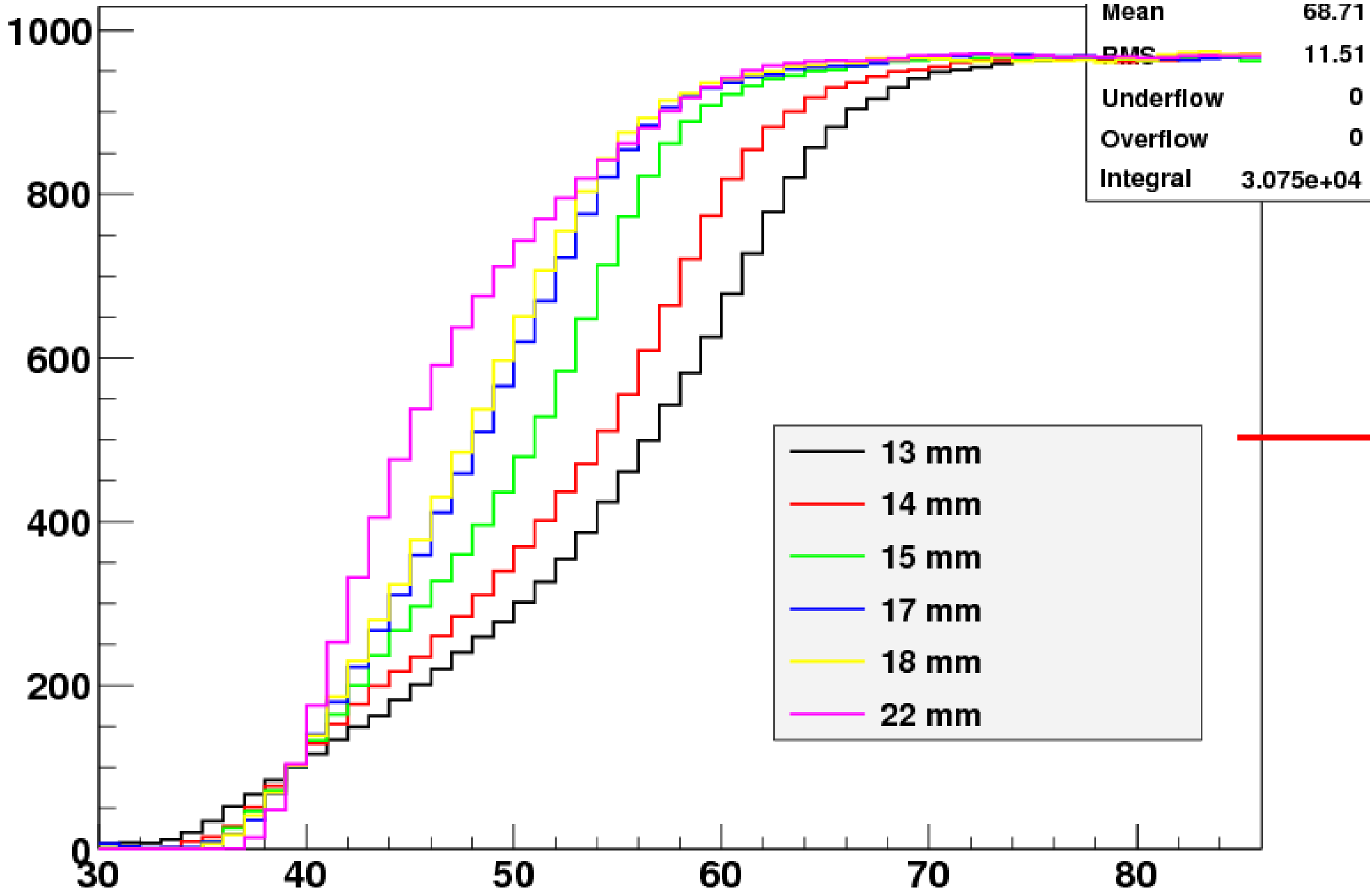


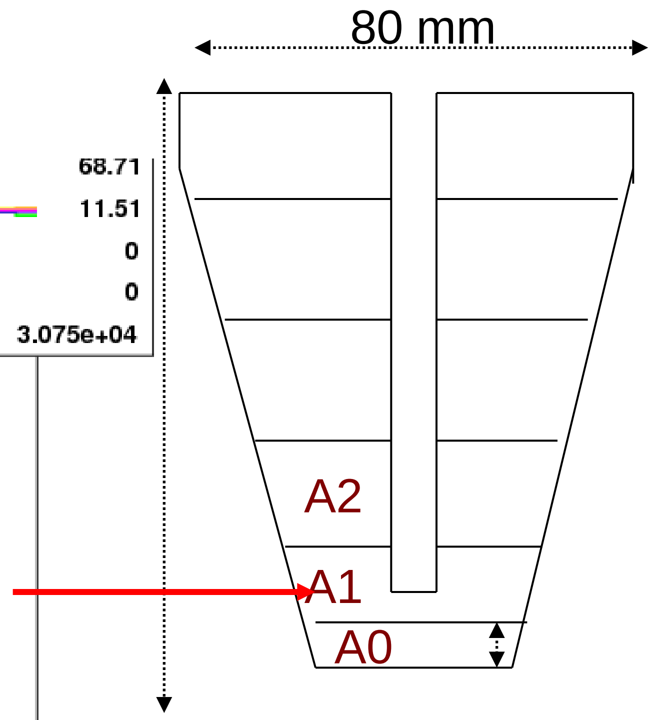




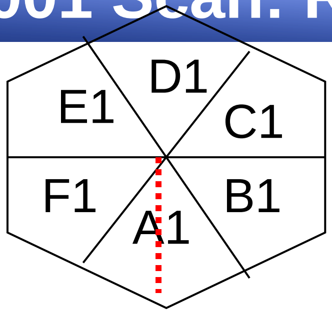
Agata S001 Scan: Radial variation

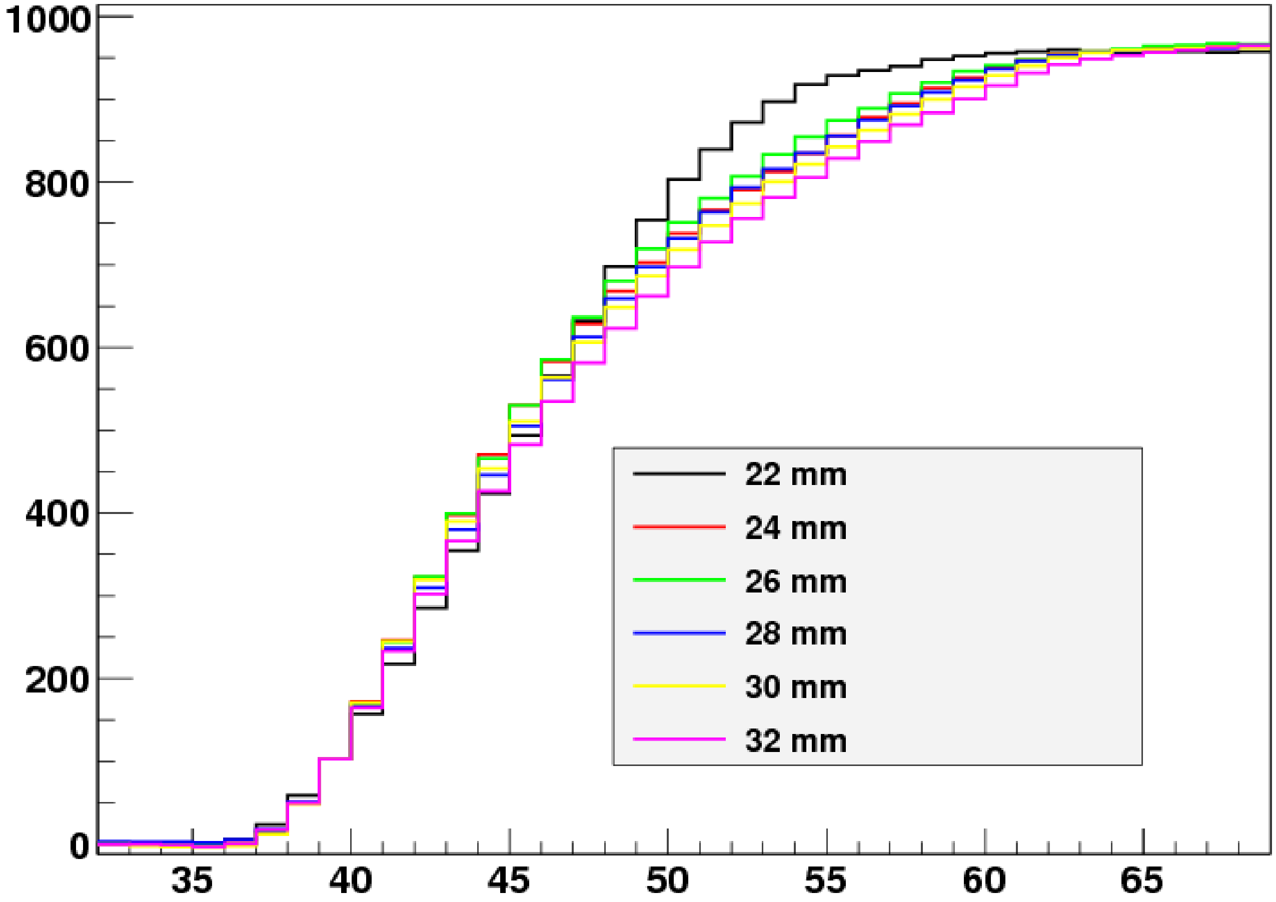


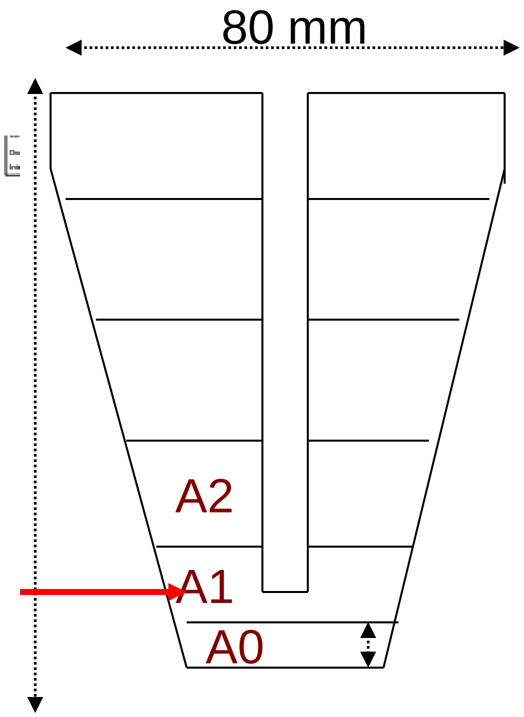




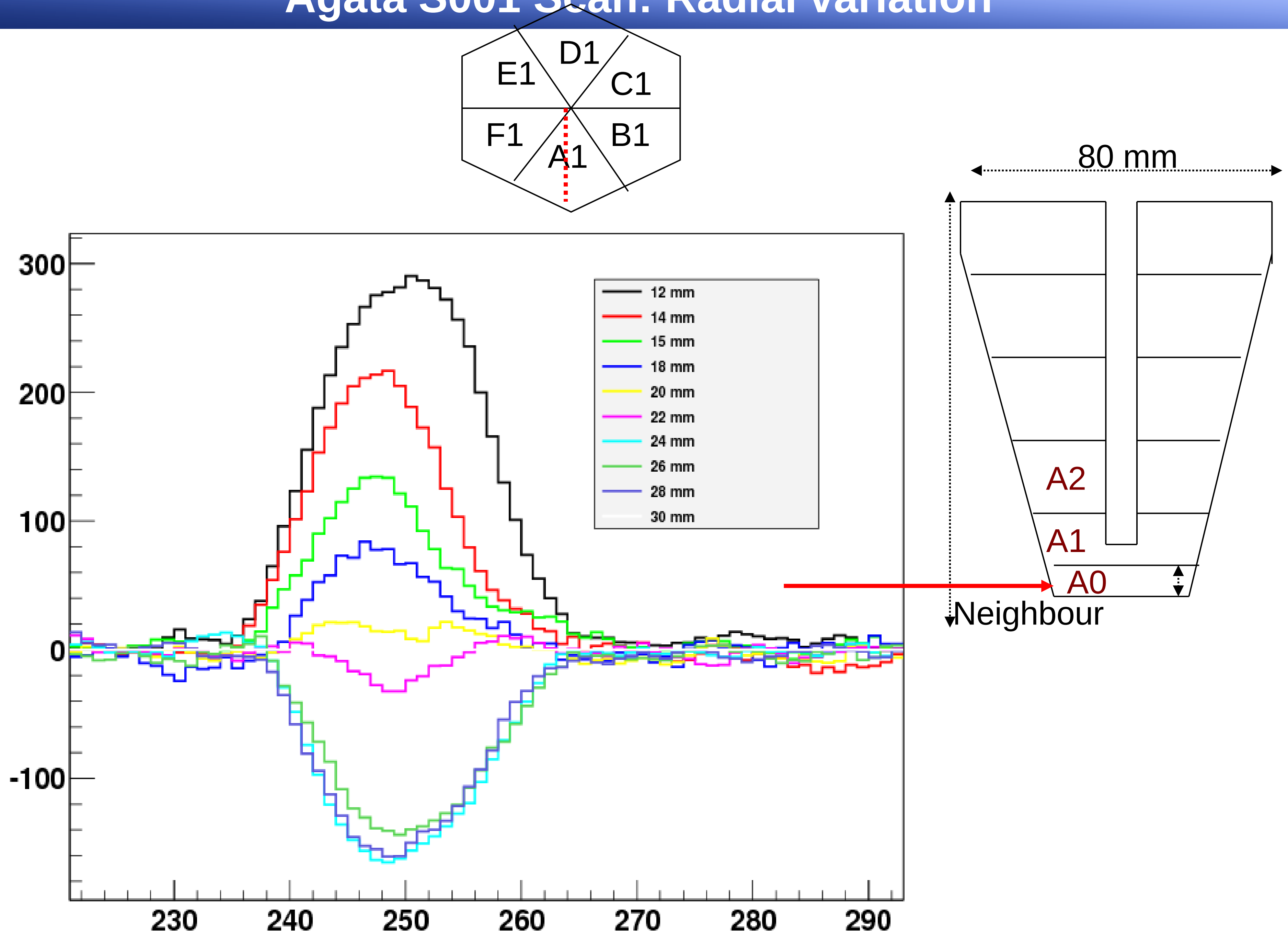
Agata S001 Scan: Radial variation



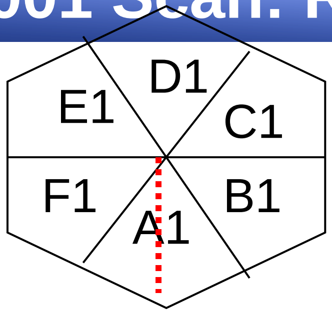


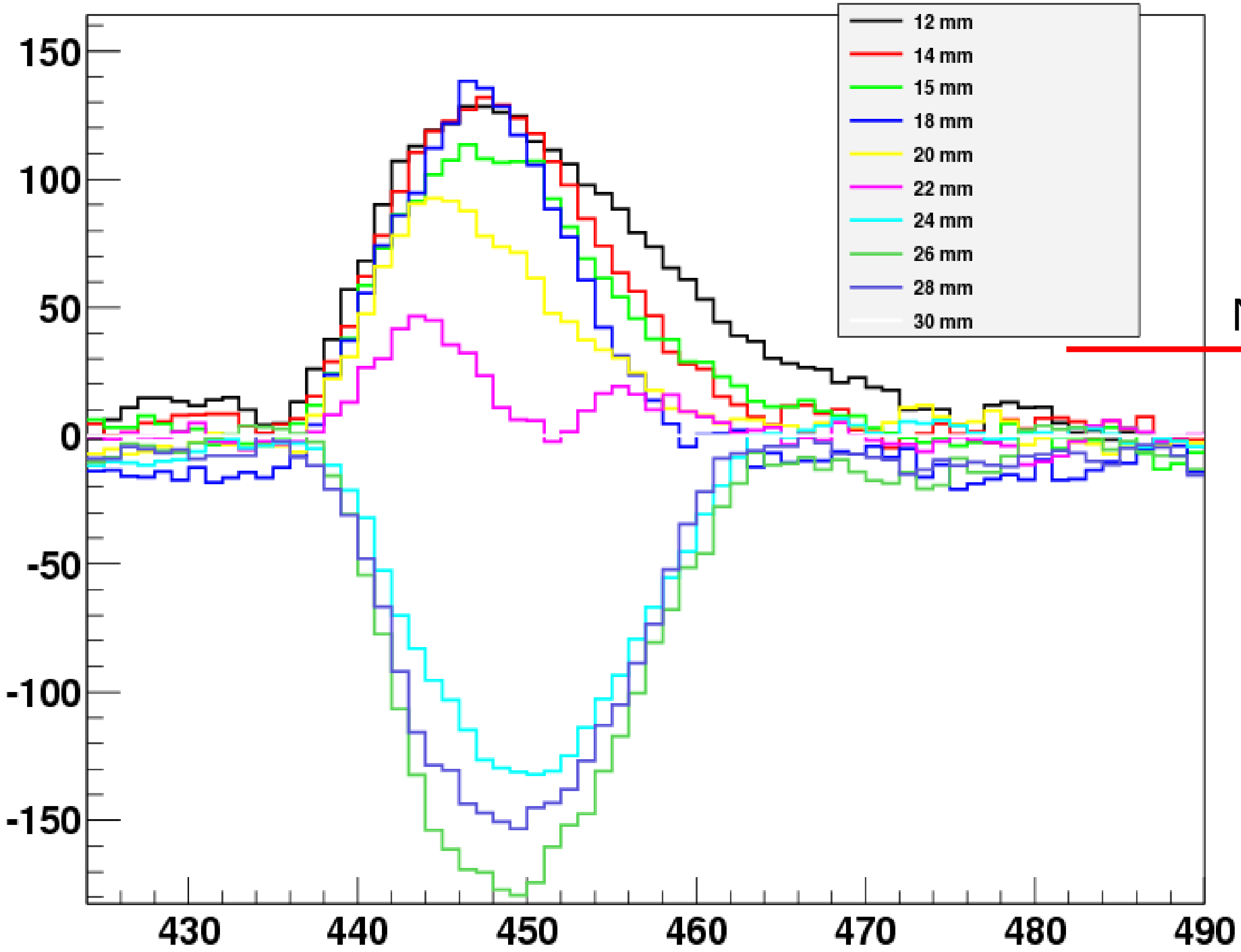


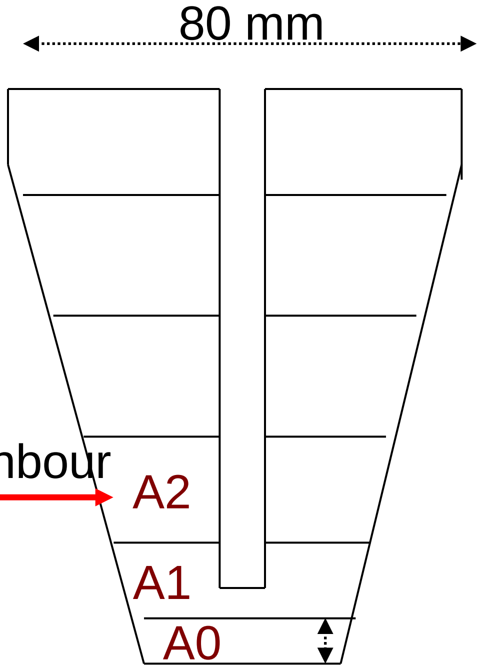
Agata S001 Scan: Radial variation



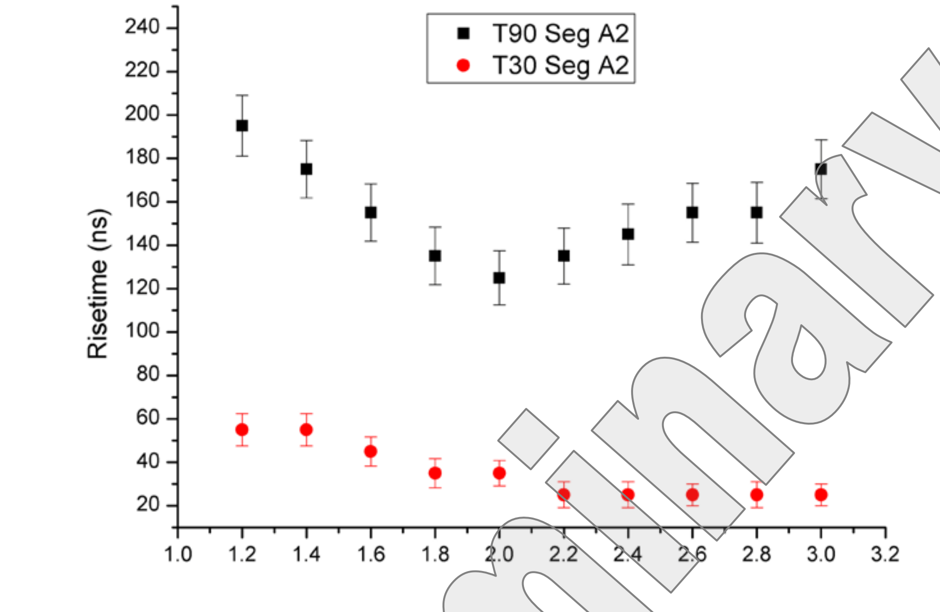
Agata S001 Scan: Radial variation

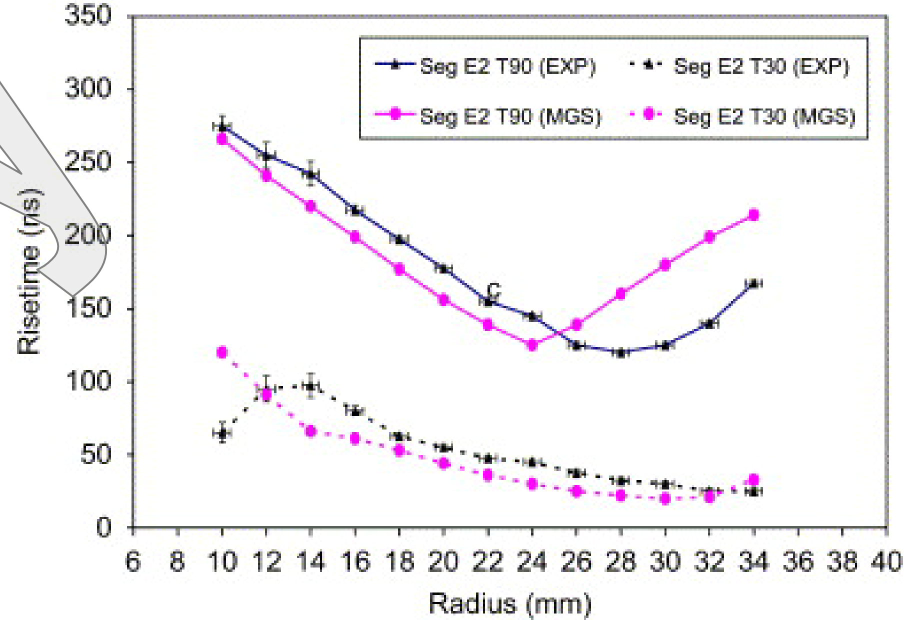


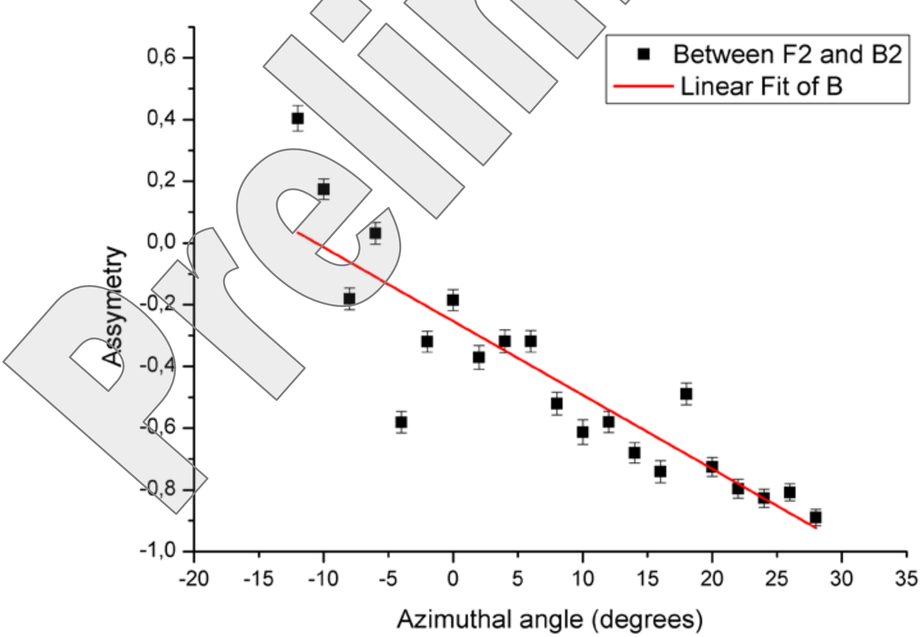


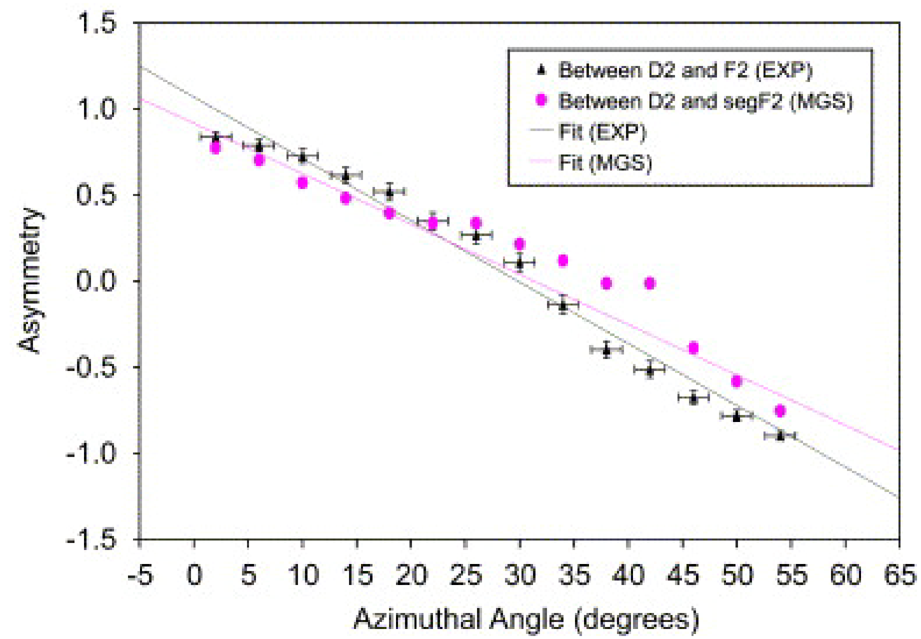


Agata S001 Scan: Pulse Shape Comparison scan



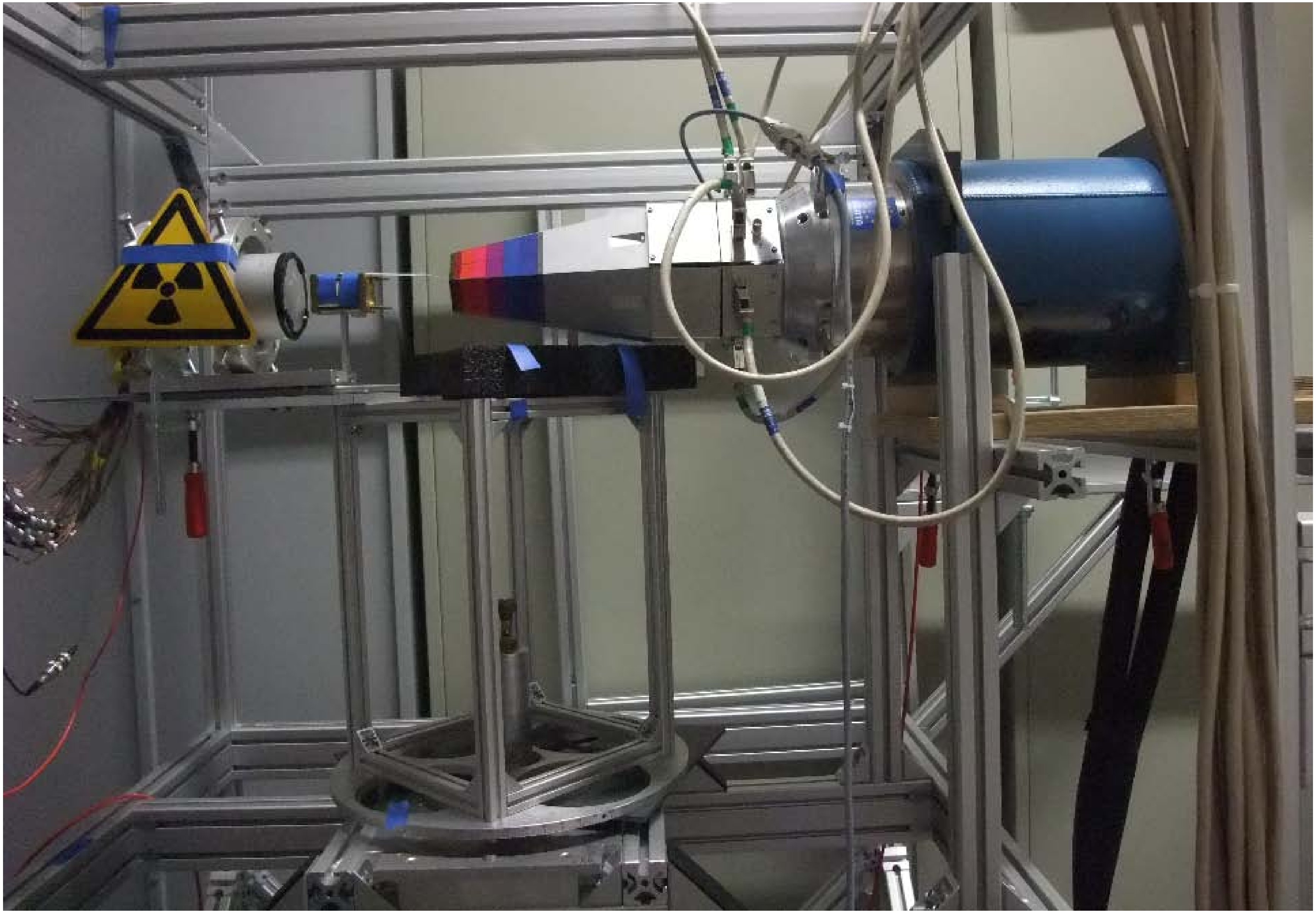




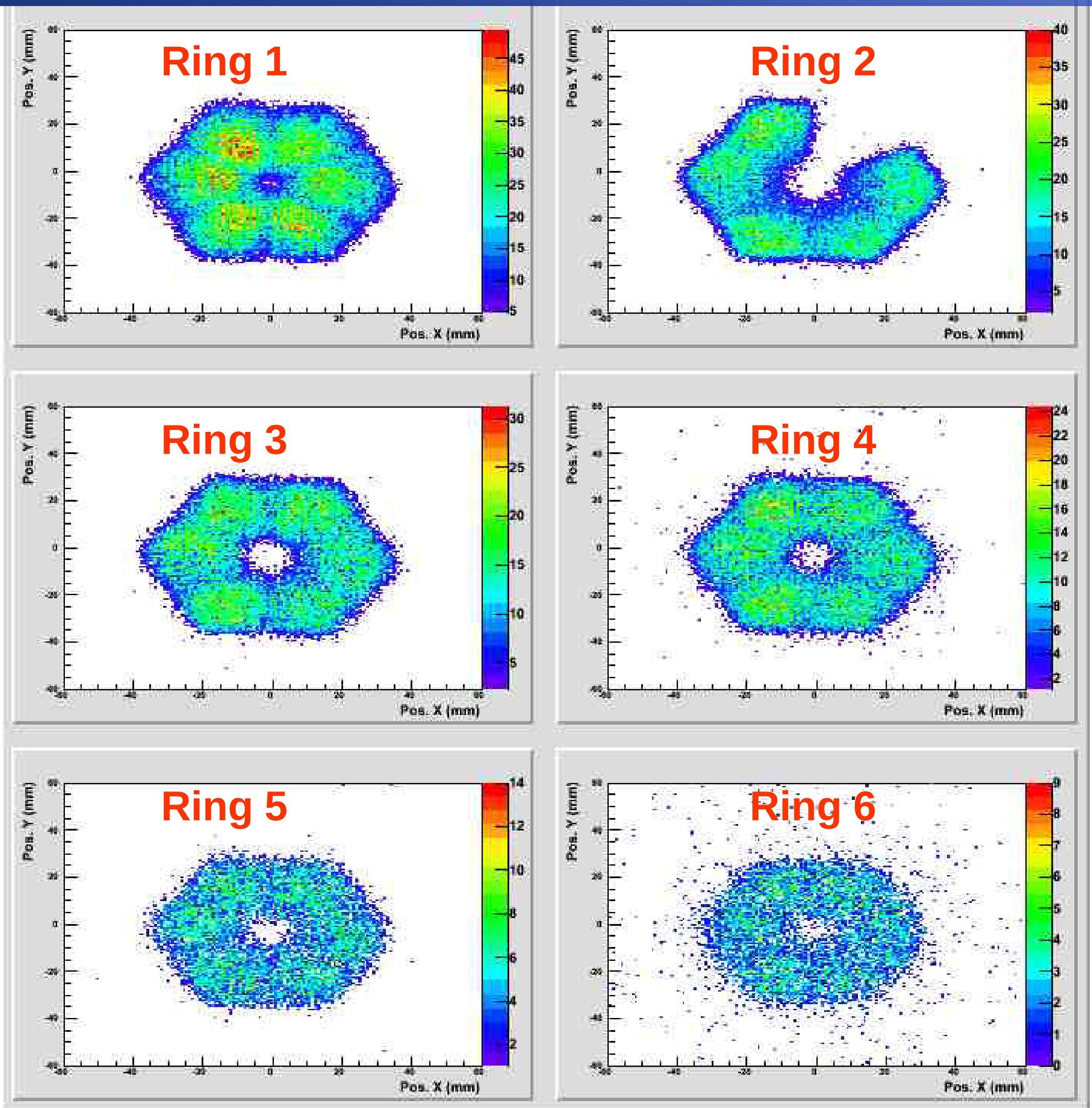


L. Nelson et.al, NIM A 573 (2007)

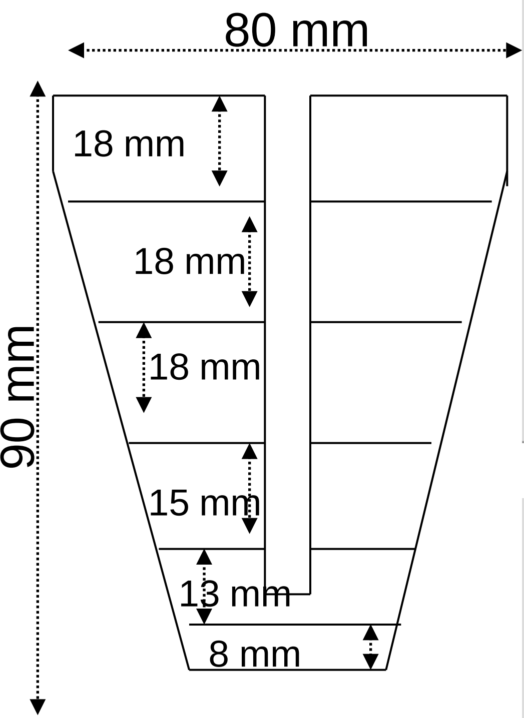
Agata S001 Scan: Horizontal scan



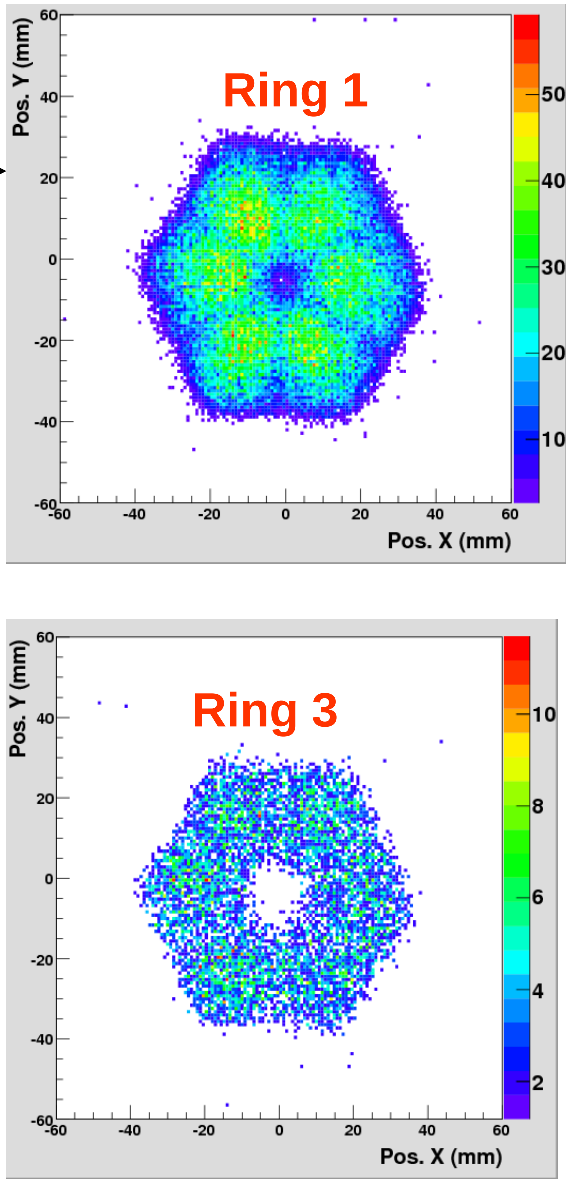
Agata S001 Scan: Intensity maps for 511 kev full energy events



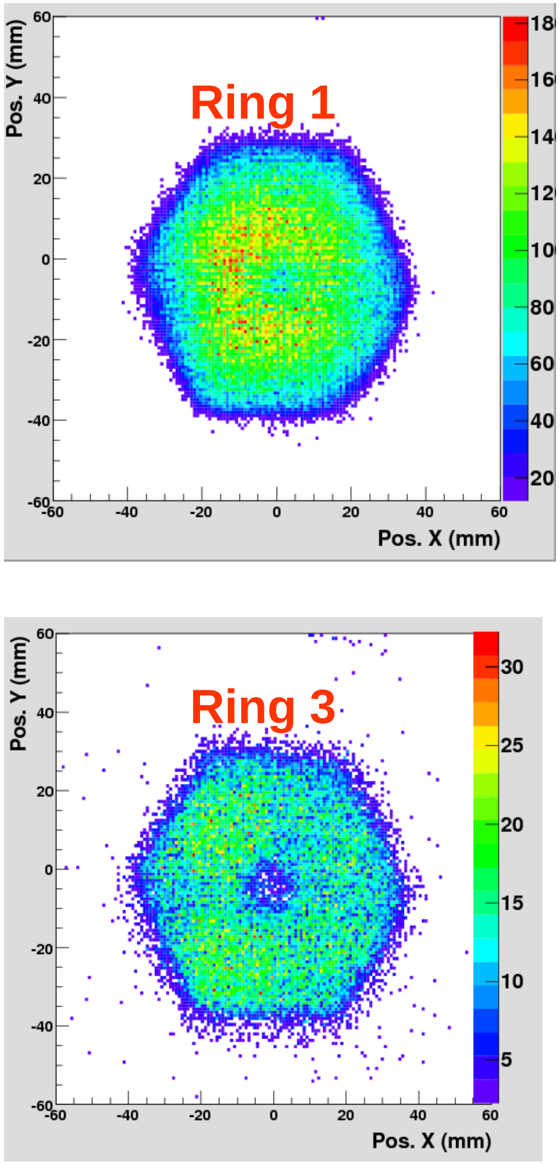
Agata S001 Scan: Intensity maps for 511 kev full energy events and Compton events



Photopeak events



Compton events



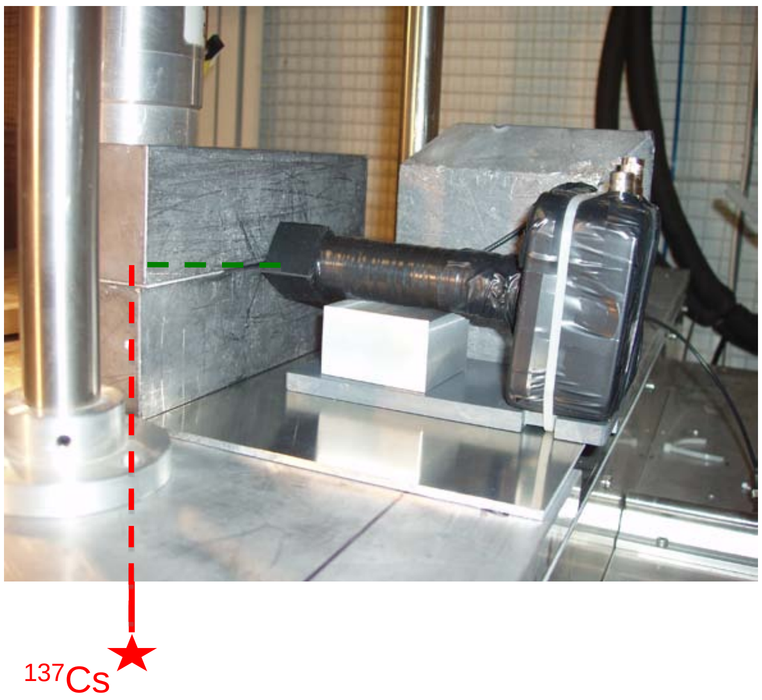
Outlook

1. Measurement for the full scanning of Agata S001 done. Analysis in progress.

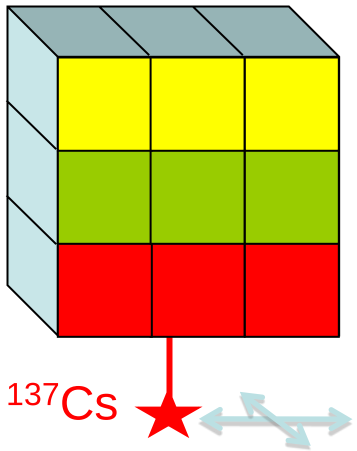
2. Comparison of results with measured/experimental data base.

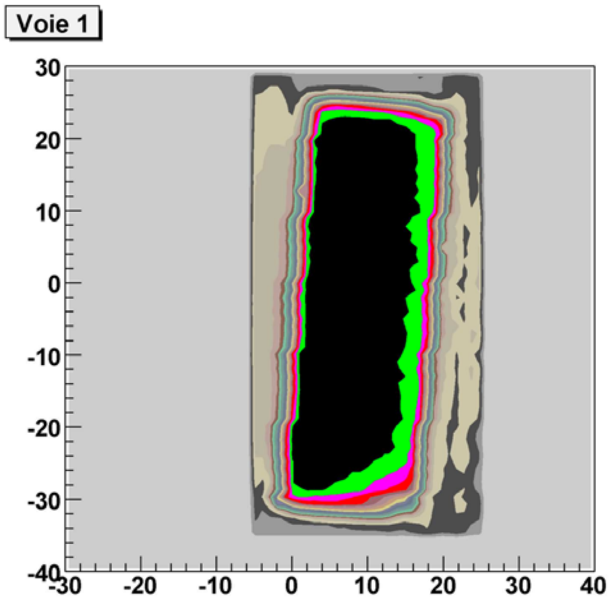
3. Scan a segment Planar detector and compare the results with the conventional scanning system at IPHC , Strassbourg.

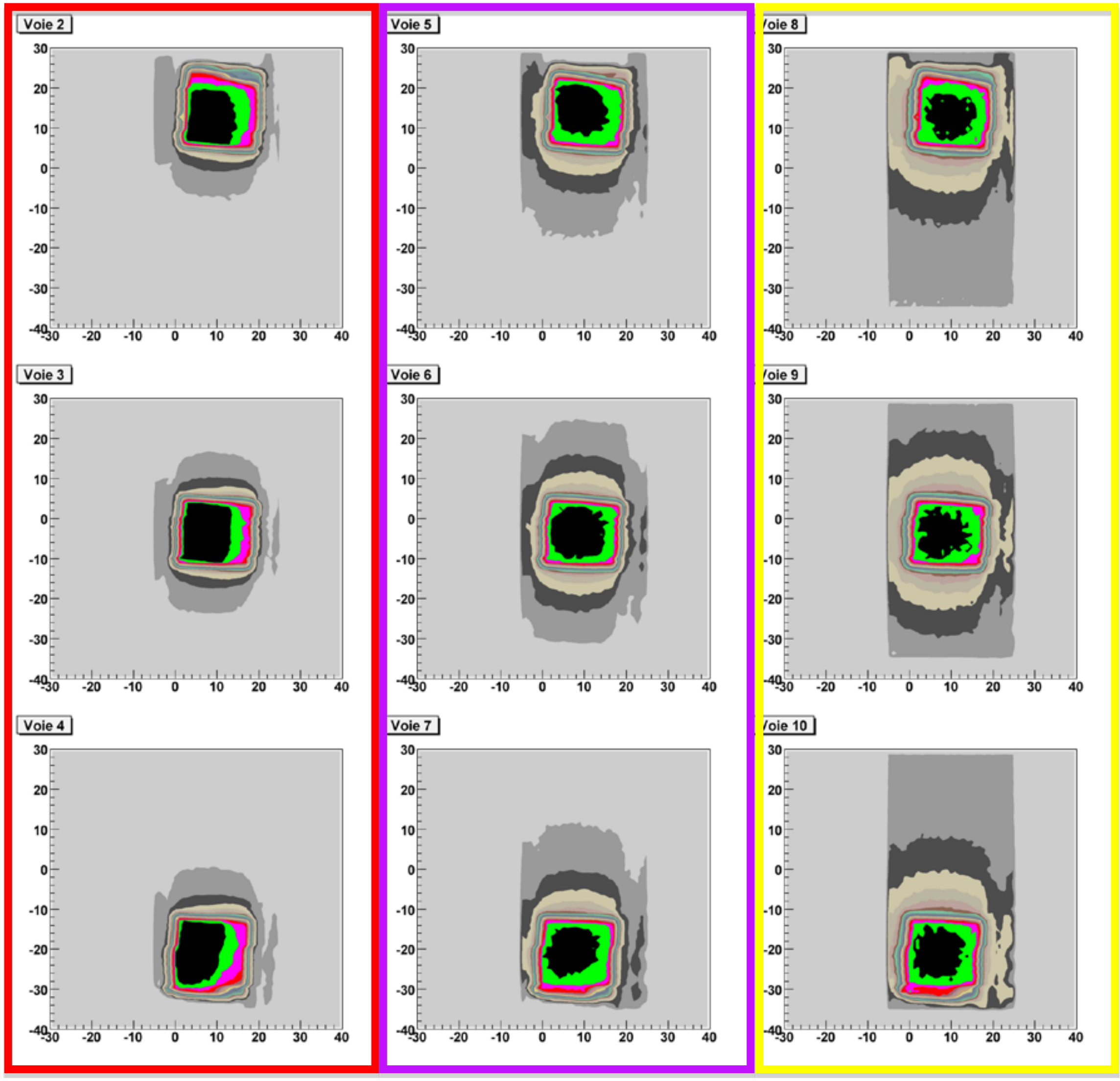
IPHC set up for Cs scan



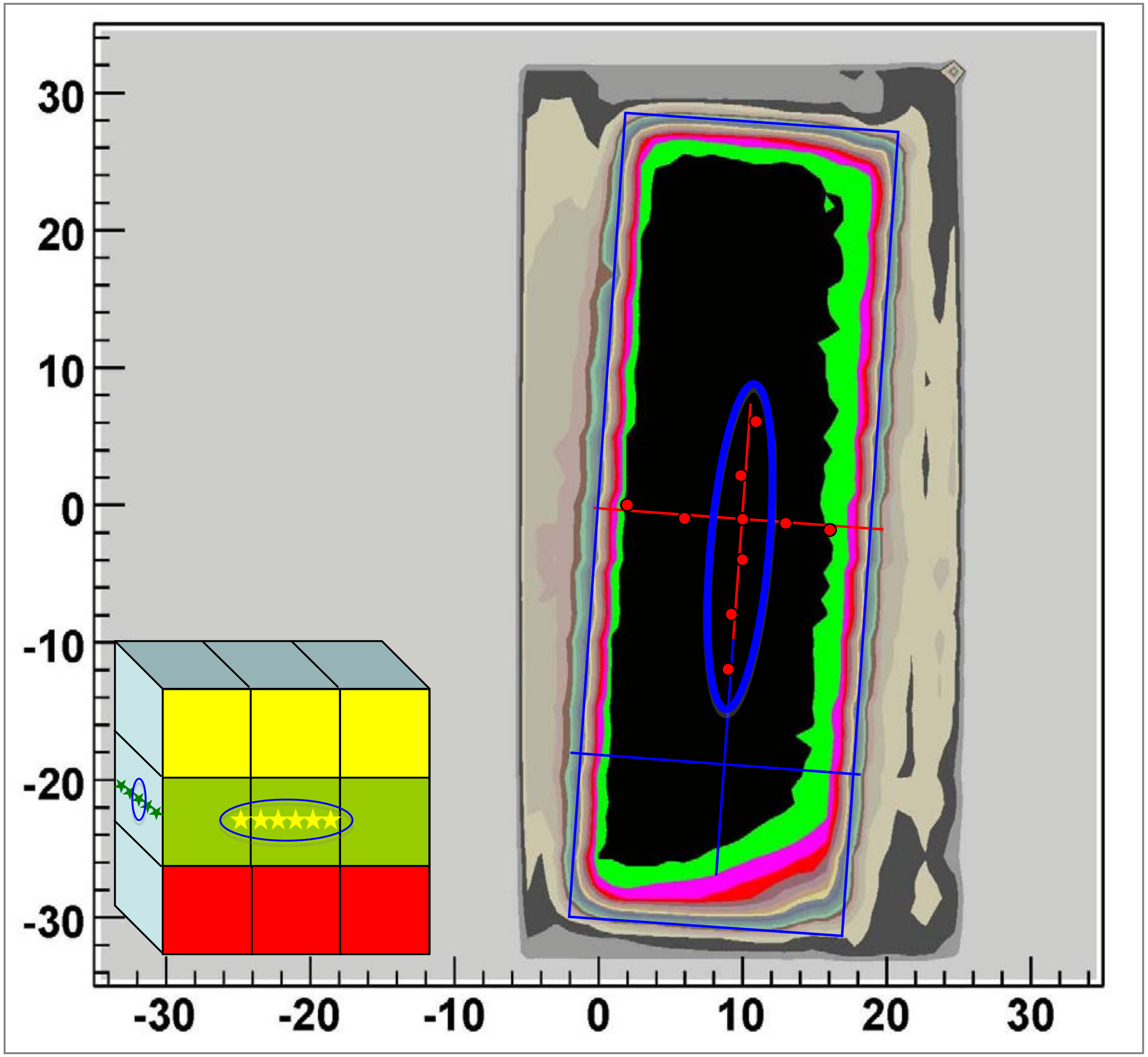
Segmented planar detector 3 x 3

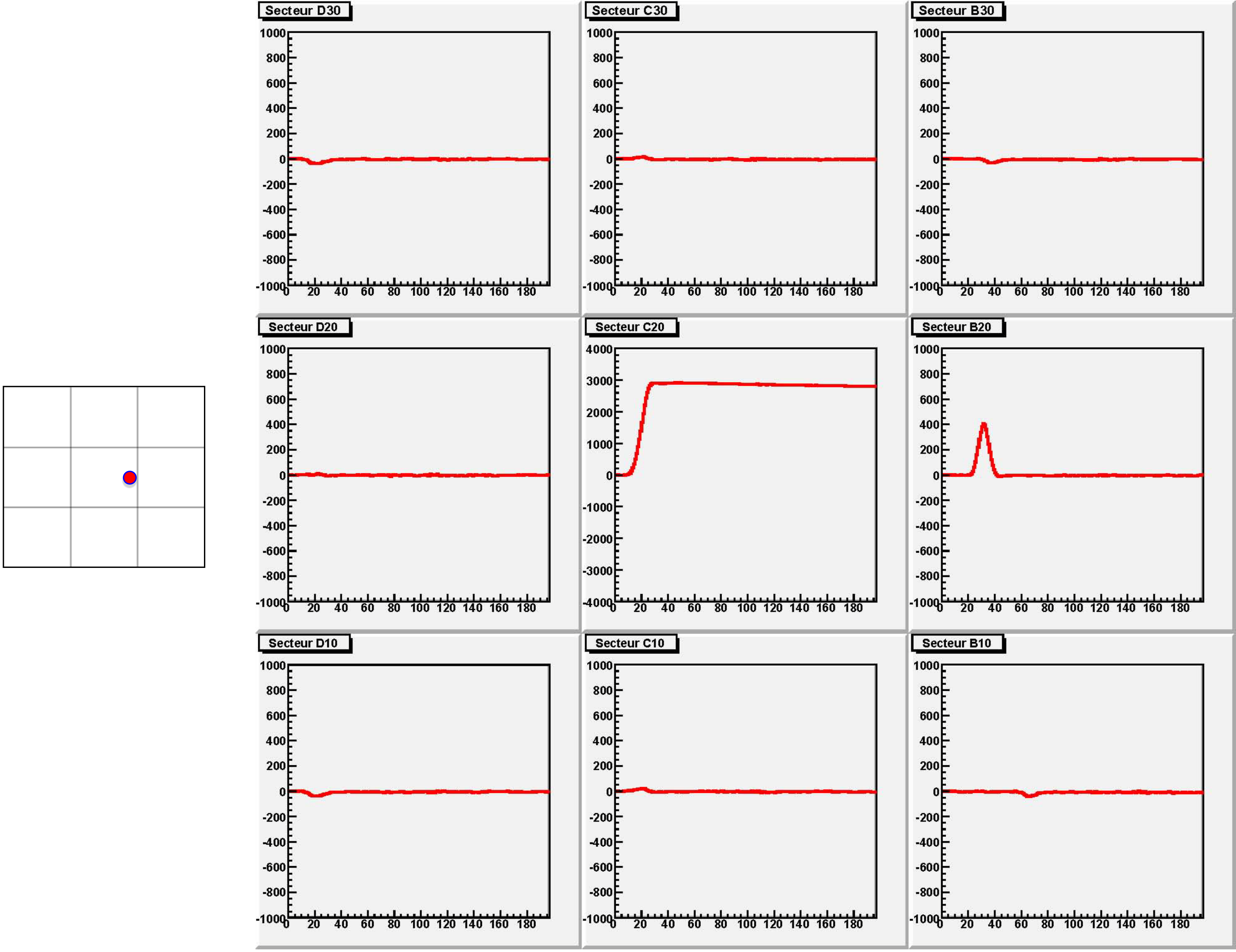






Pulse shapes from IPHC scan (1)

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Secteur C30
Secteur B30
Secteur D20
Secteur C20
Secteur B20
Secteur D10
Secteur C10
Secteur B10
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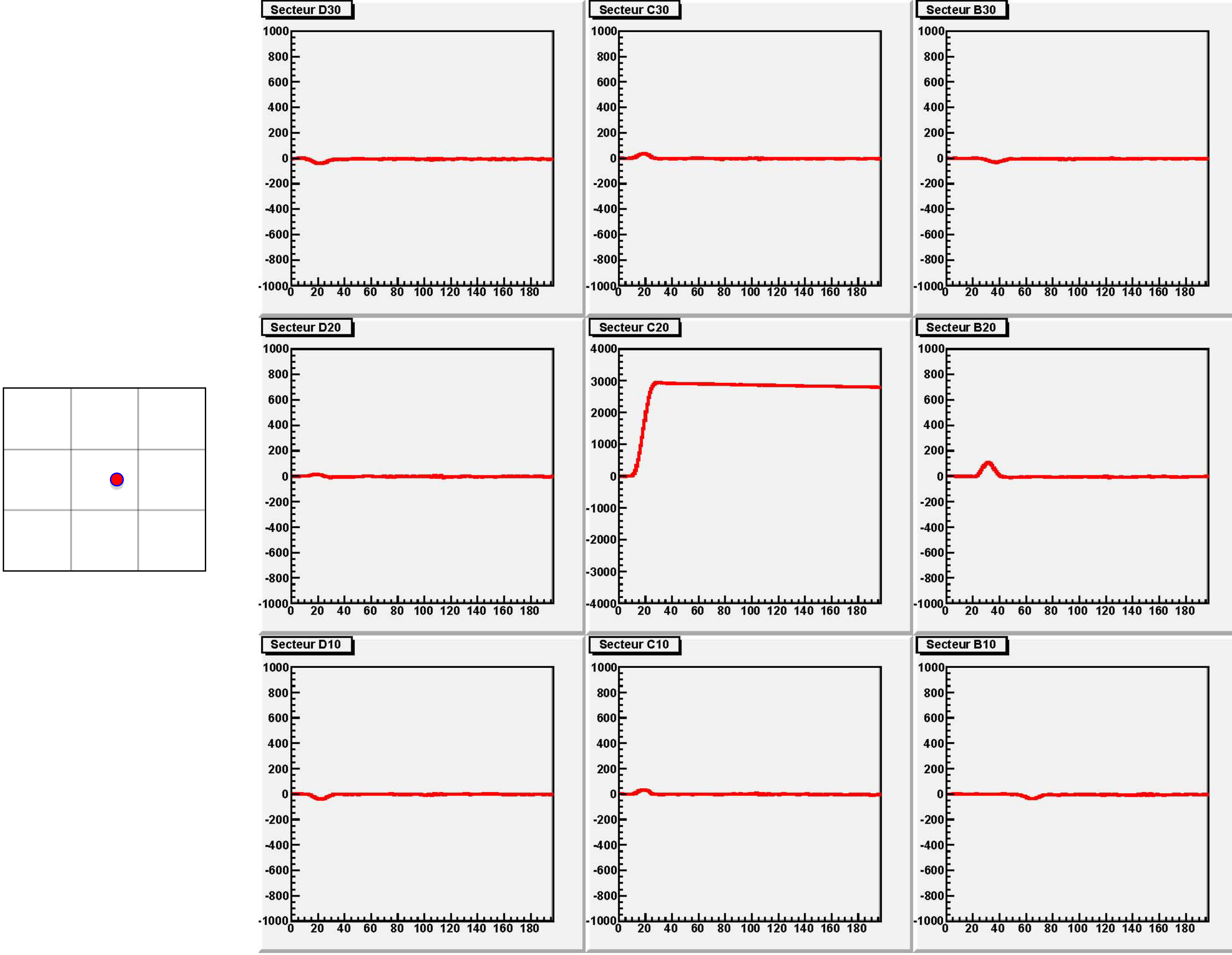
0 20 40 60 80 100 120 140 160 180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Secteur C30
Secteur B30
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Secteur C10
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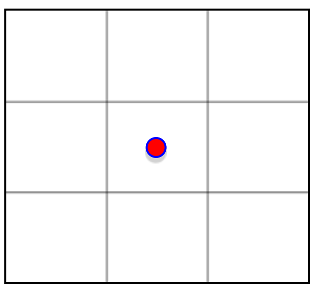

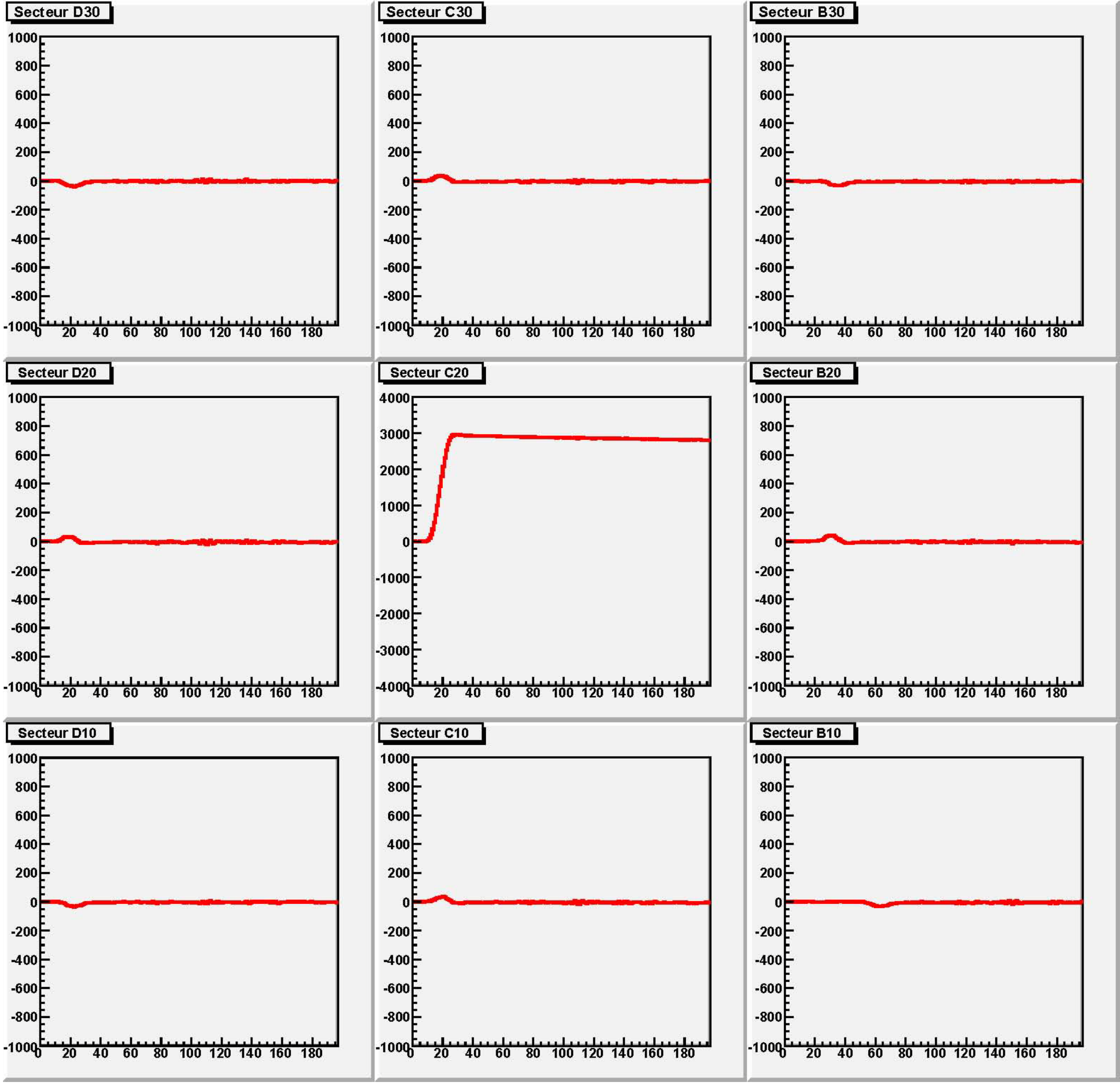
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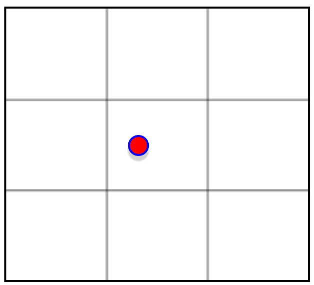
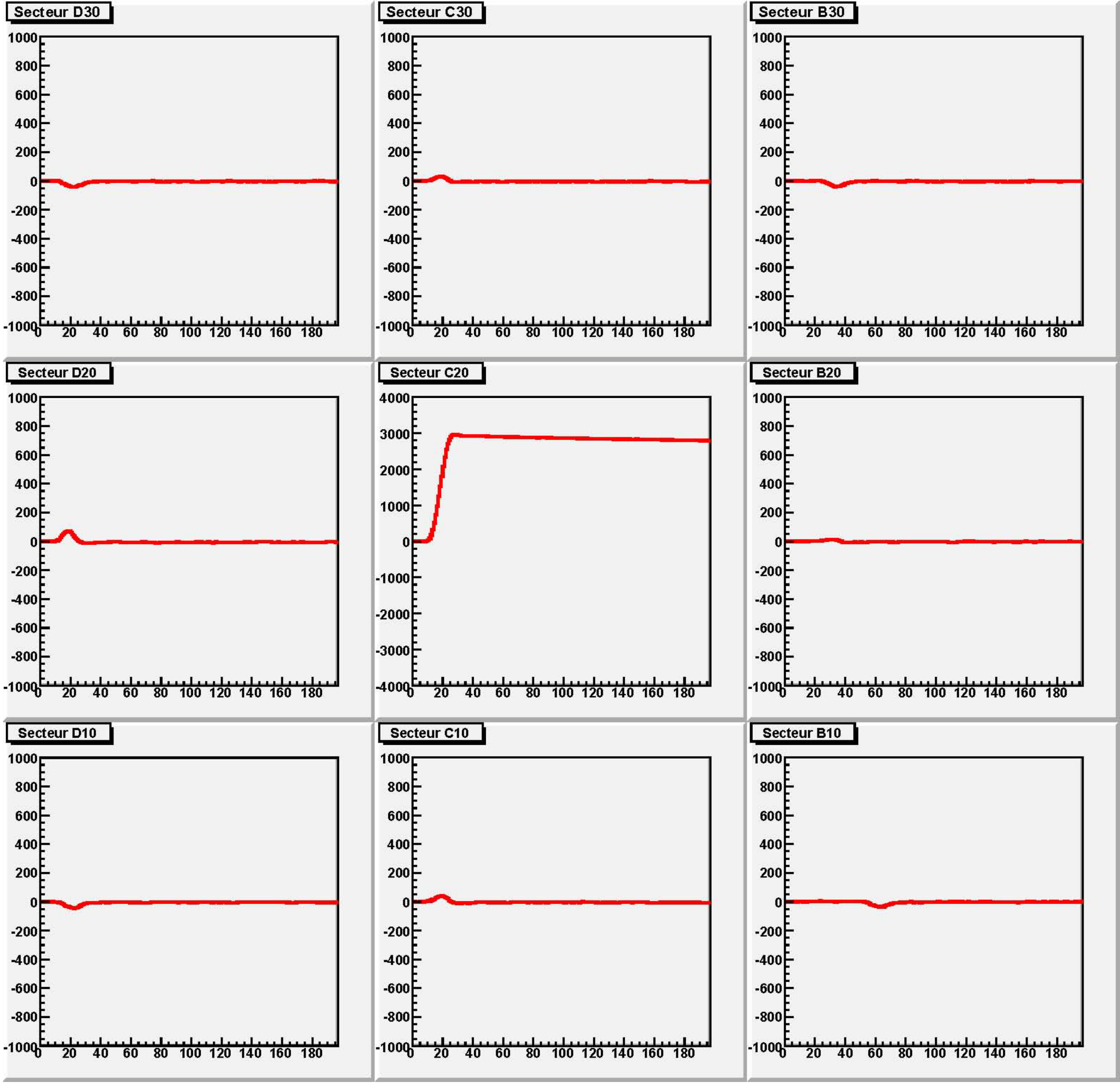
Secteur B20
Secteur D10
Secteur C10
Secteur B10

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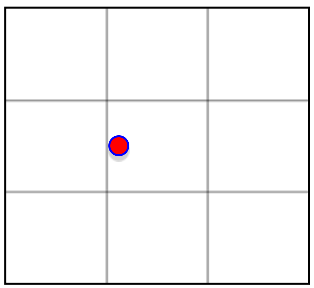

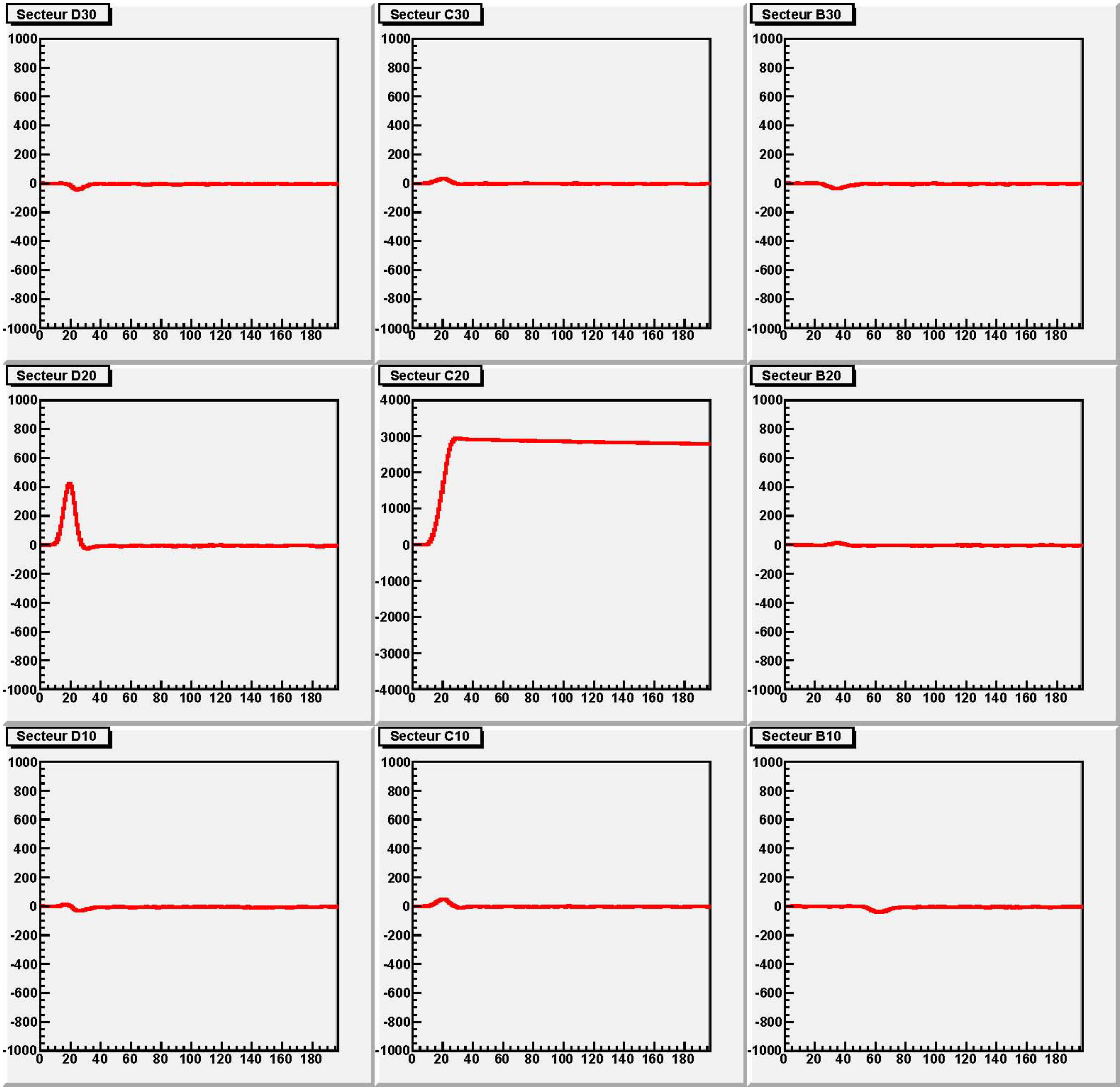
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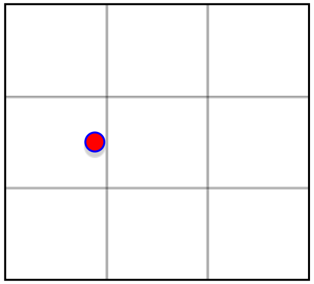

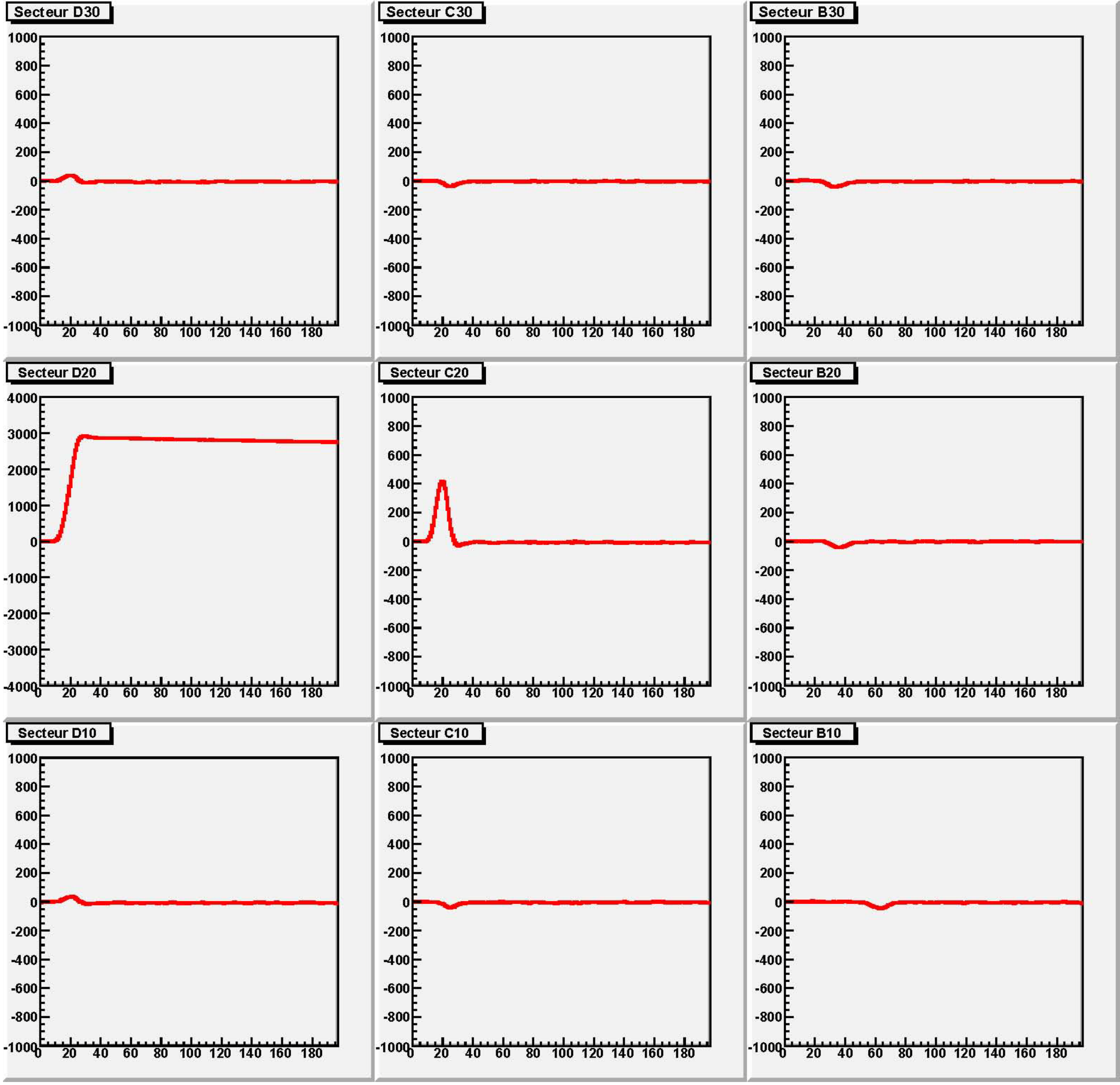

Secteur D30
Secteur C30
Secteur B30
Secteur D20
Secteur C20
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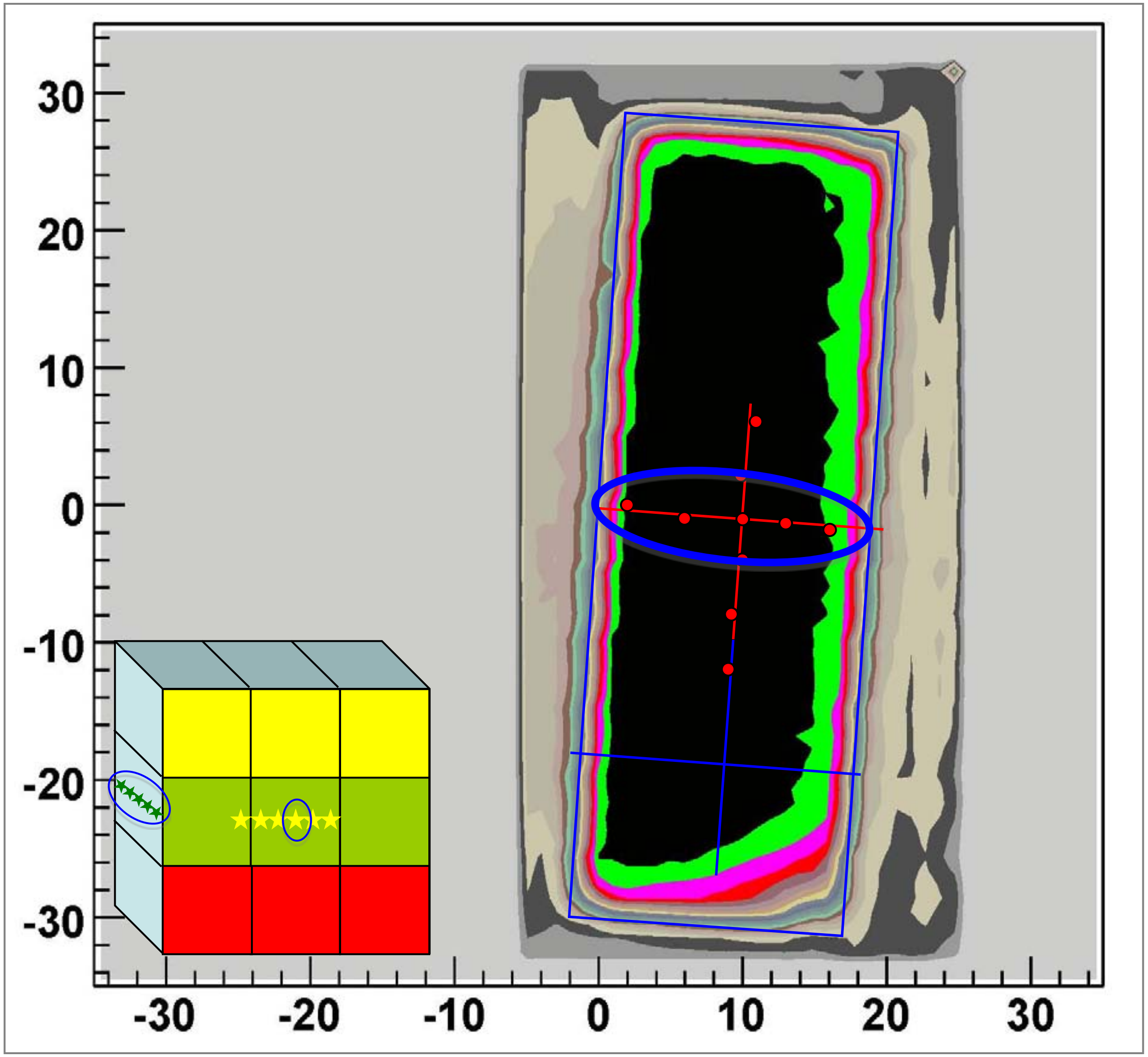
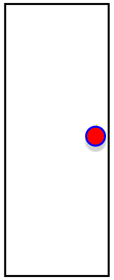
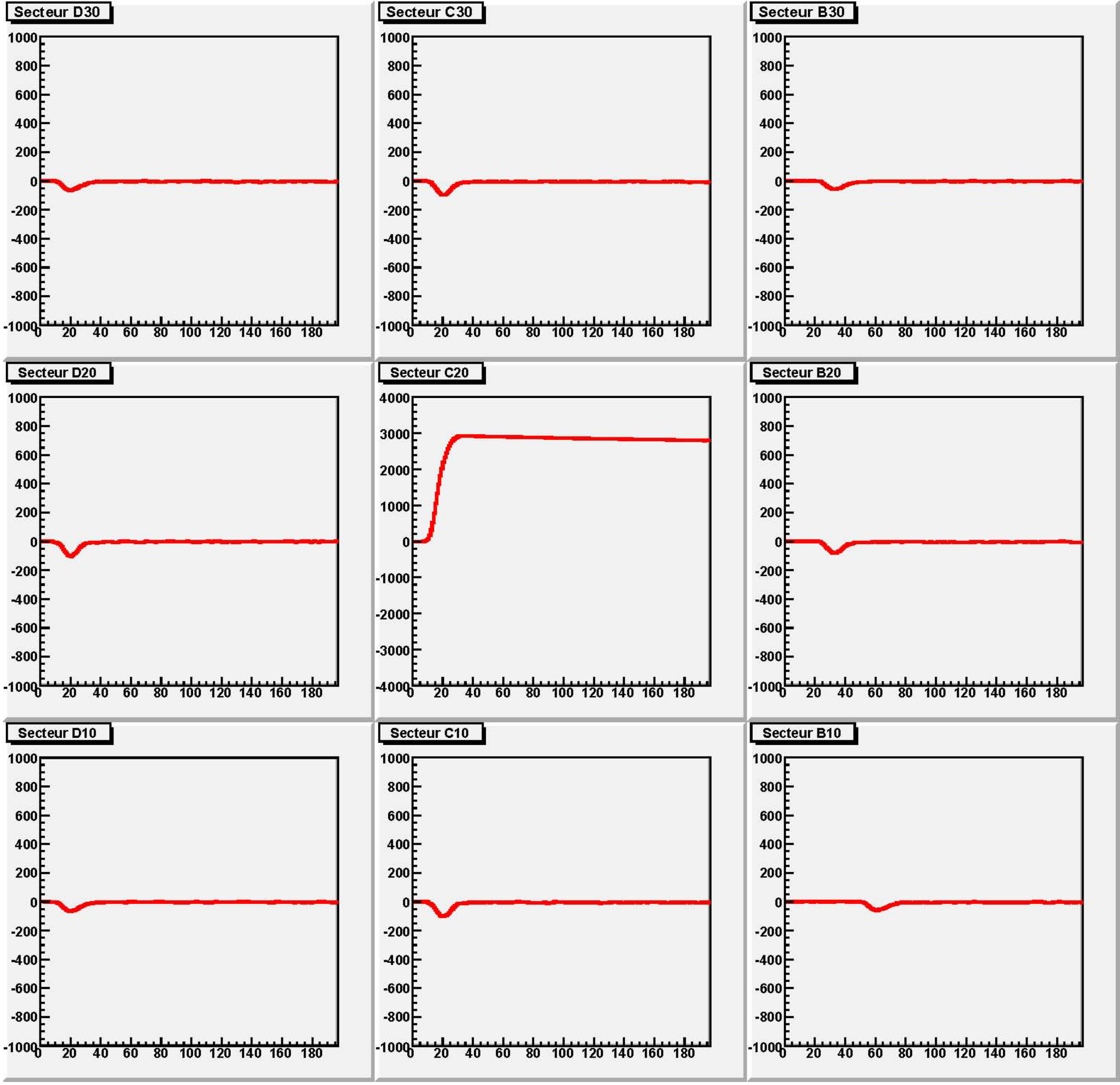
Secteur C10
Secteur B10

Pulse shapes from IPHC scan (2)







Secteur D30
Secteur C30
Secteur B30
Secteur D20
Secteur C20
Secteur B20
Secteur D10
Secteur C10
Secteur B10
1000
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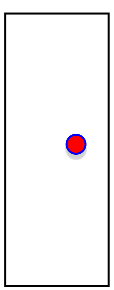

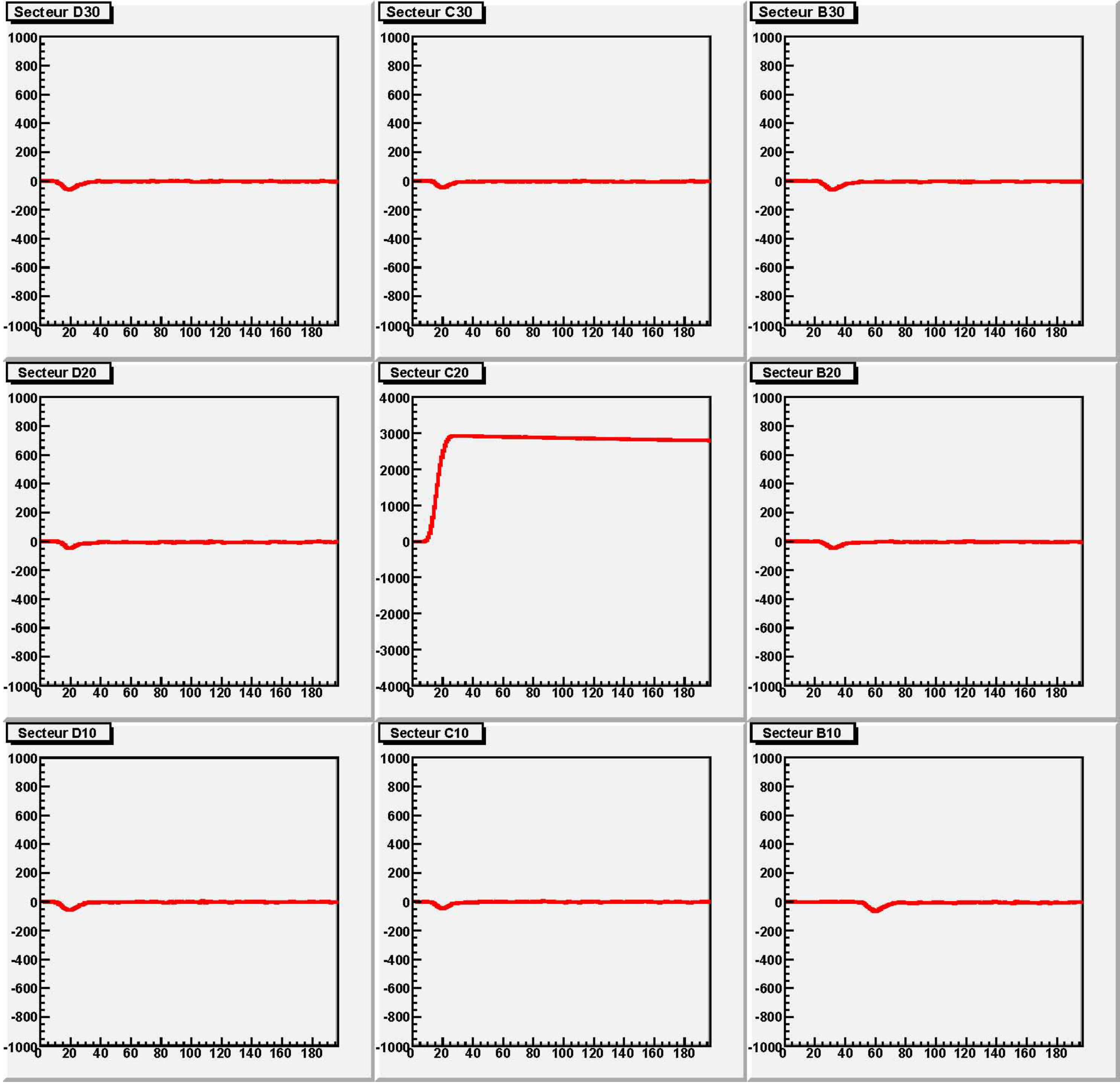

Secteur D30
Secteur C30
Secteur B30
Secteur D20
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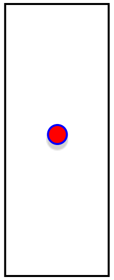
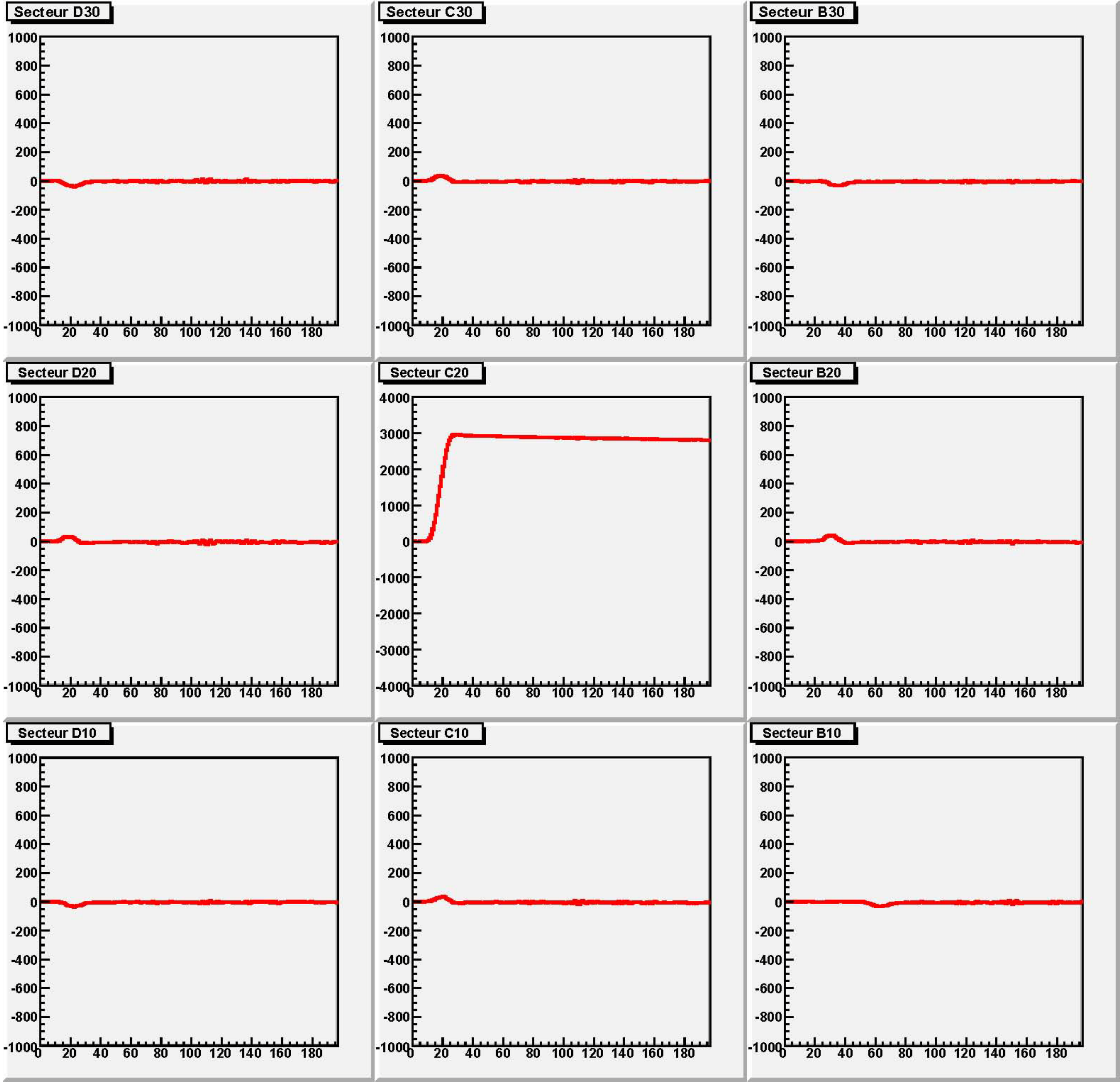
Secteur D10
Secteur C10
Secteur B10




Secteur D30
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Secteur C10
Secteur B10
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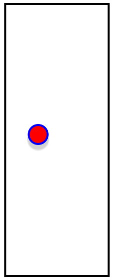

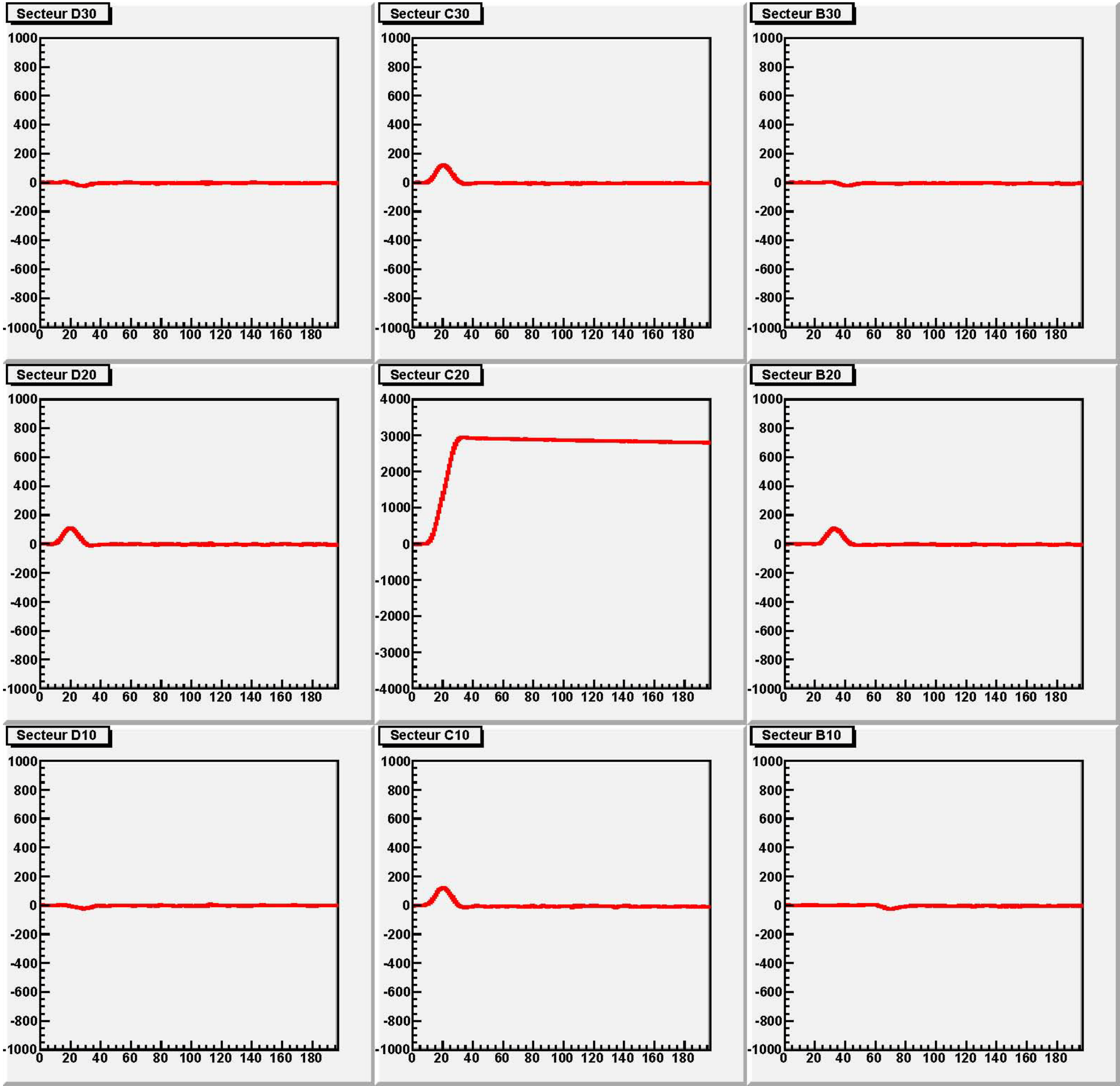
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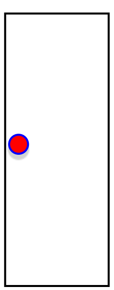

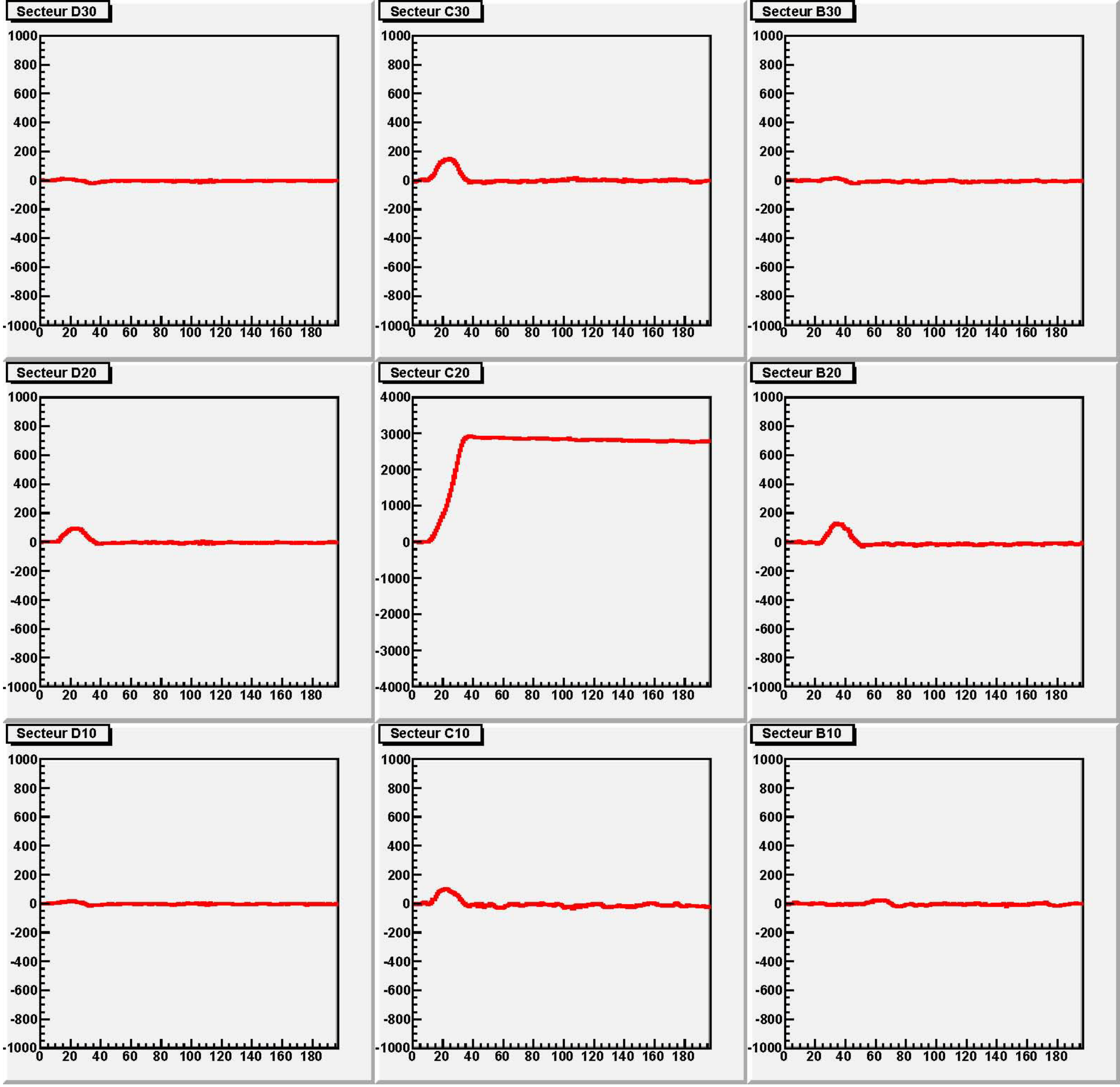
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Secteur B10
1000 800 600 400 200 0 -200 -400 -600 -800 -1000
4000 3000 2000 1000 0 -1000 -2000 -3000 -4000
0 20 40 60 80 100 120 140 160 180

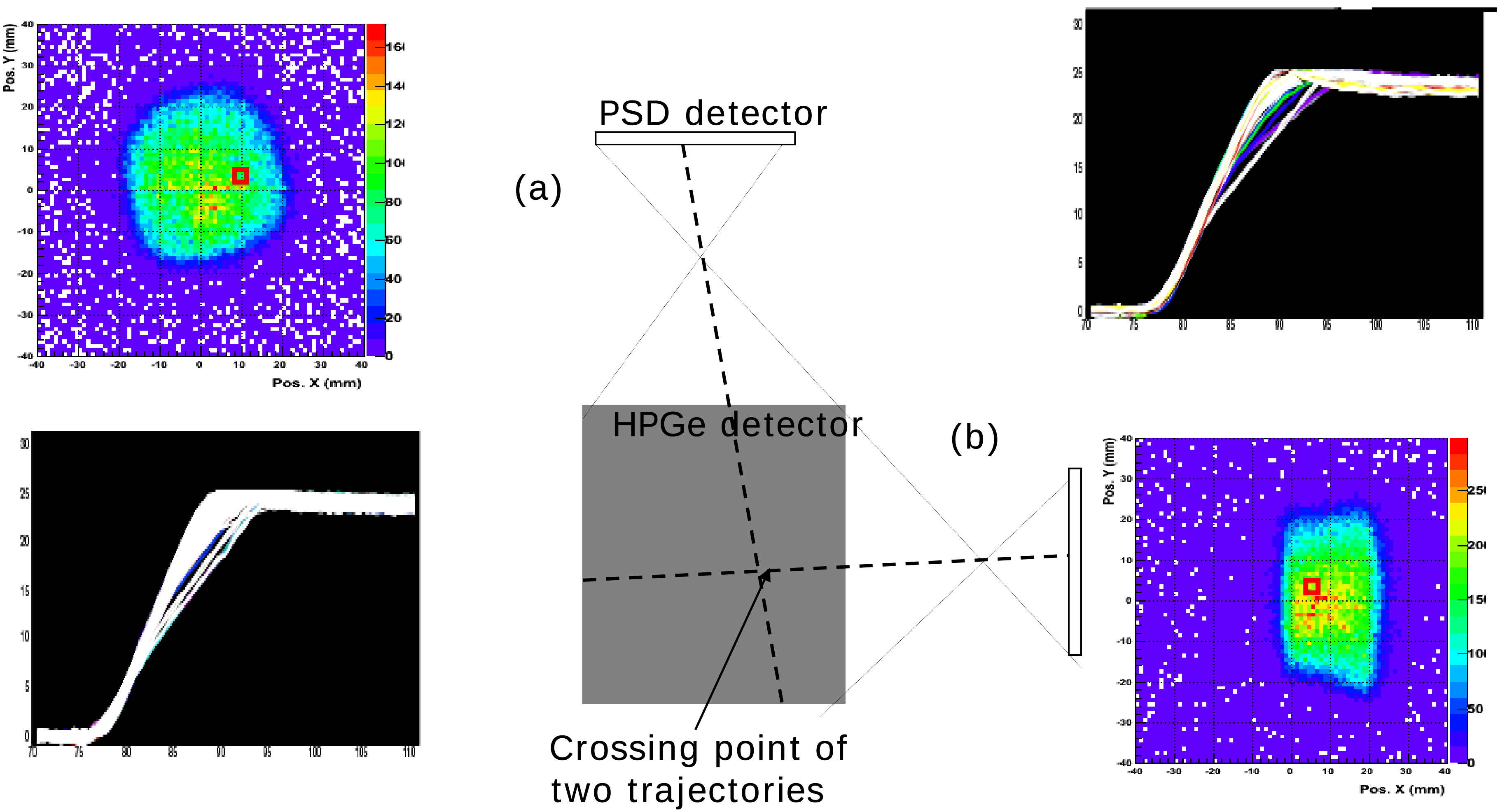
Thank You!

Personal Contact:

n.goel@gsi.de

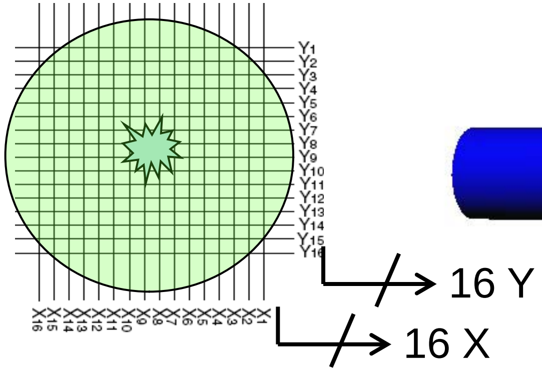
GSI, Darmstadt 64291, Germany
Tel: +49 (0) 6159171/1695

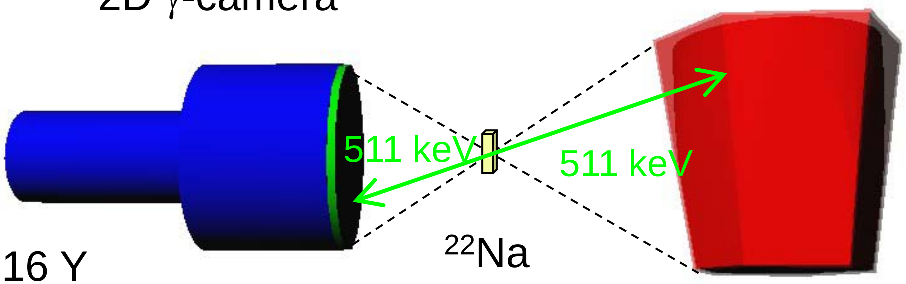
Scanning of Planar Germanium detector



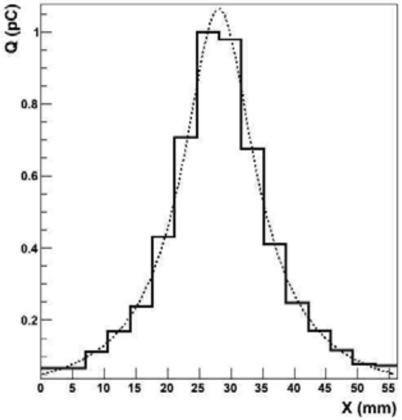
Characterization of the position sensitive detector

IMAR (Individual Multi Anode Readout) Technique

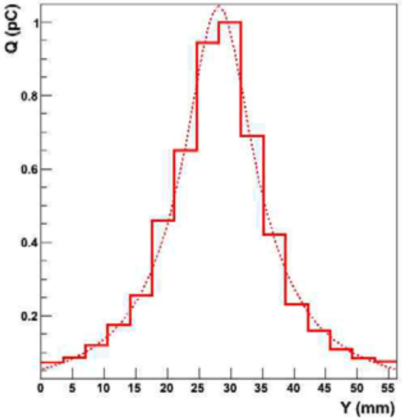


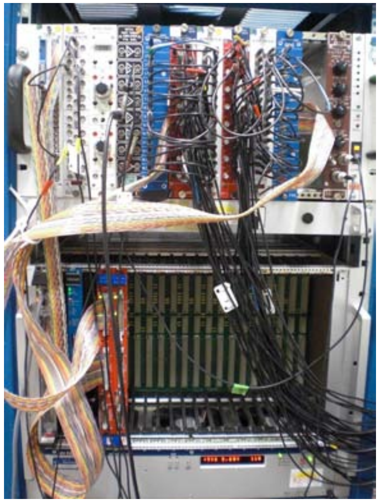


Anodes X



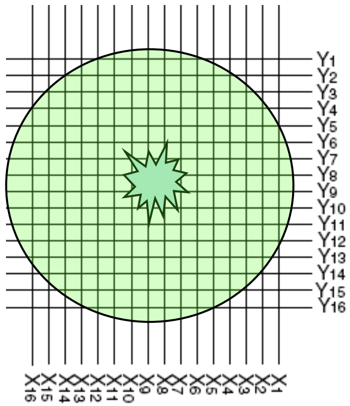
Anodes Y





Characterization of the position sensitive detector

IMAR (Individual Multi Anode Readout) Technique



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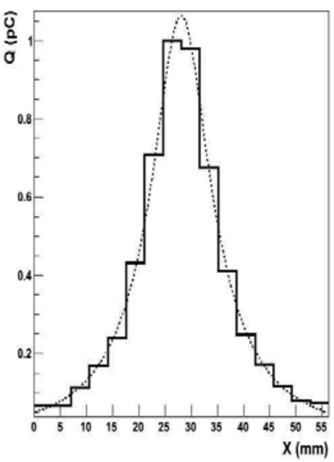

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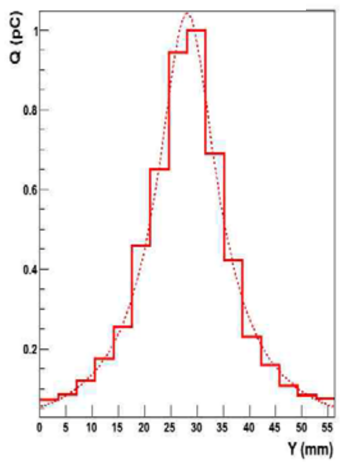
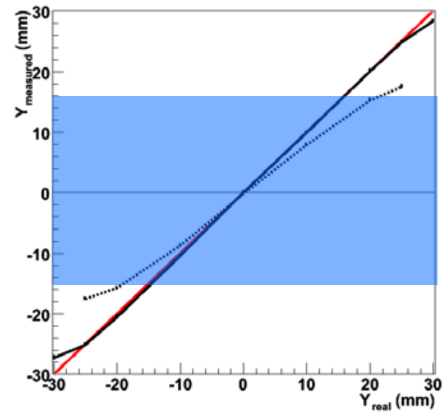
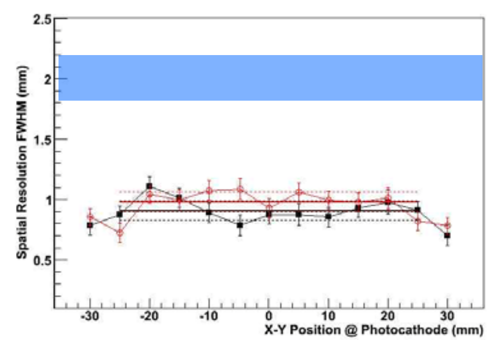


Linearity UFV = 7cm^2 → **20 cm^2**

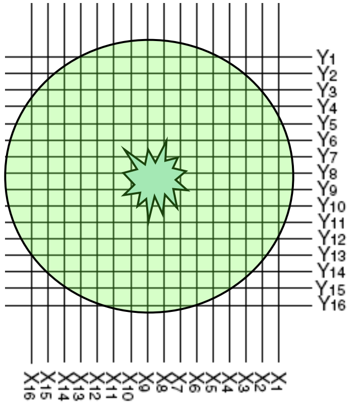


Spatial resolution 2mm → **0.945 +/- 0.08 mm**

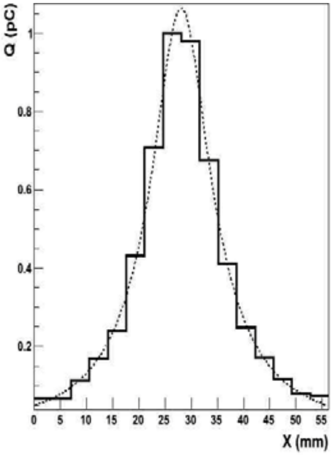


Characterization of the position sensitive detector

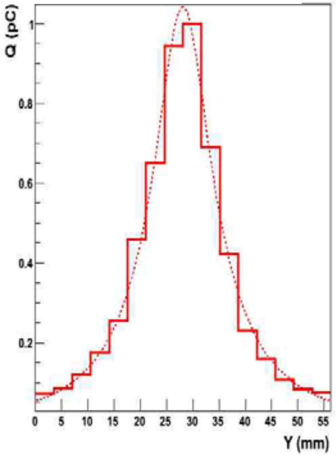
IMAR (Individual Multi Anode Readout) Technique



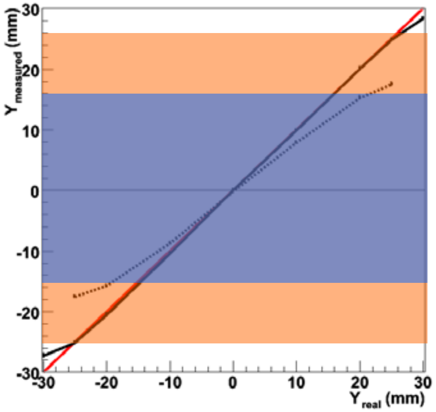
Anodes X



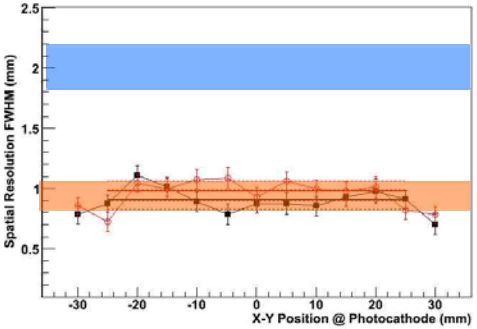
Anodes Y



Linearity UFV = $7cm^2$ → **$20\ cm^2$**

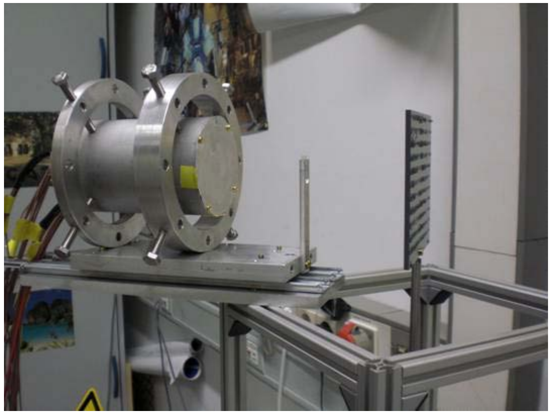


Spatial Resolution 2mm → **0.945 +/- 0.08 mm**

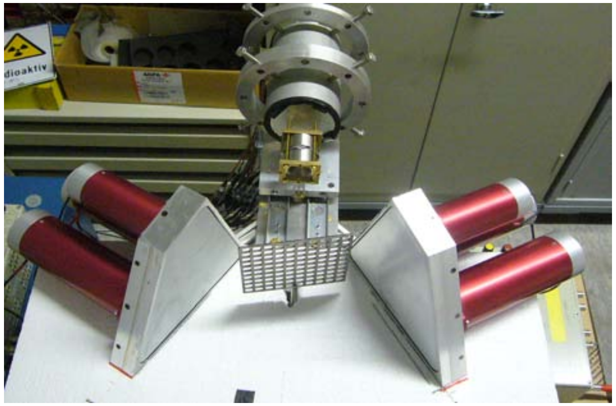


Position calibration using Compton Scattering Imaging

- Determine: $X_r(x_m,y_m)$, $Y_r(x_m,y_m)$



Gamma-ray
scattering technique



Spatial calibration via imaging techniques of a novel scanning system for the pulse shape characterisation of position sensitive HPGe detectors

N.Goel[a], C.Domingo-Pardo[a], T.Engert[a], J.Gerl[a], I.Kojouharov[a], H.Schaffner[a]

[a] GSI Helmholtzzentrum fuer Schwerionenforschung GmbH, Planckstr. 1, 64291 Darmstadt, Germany

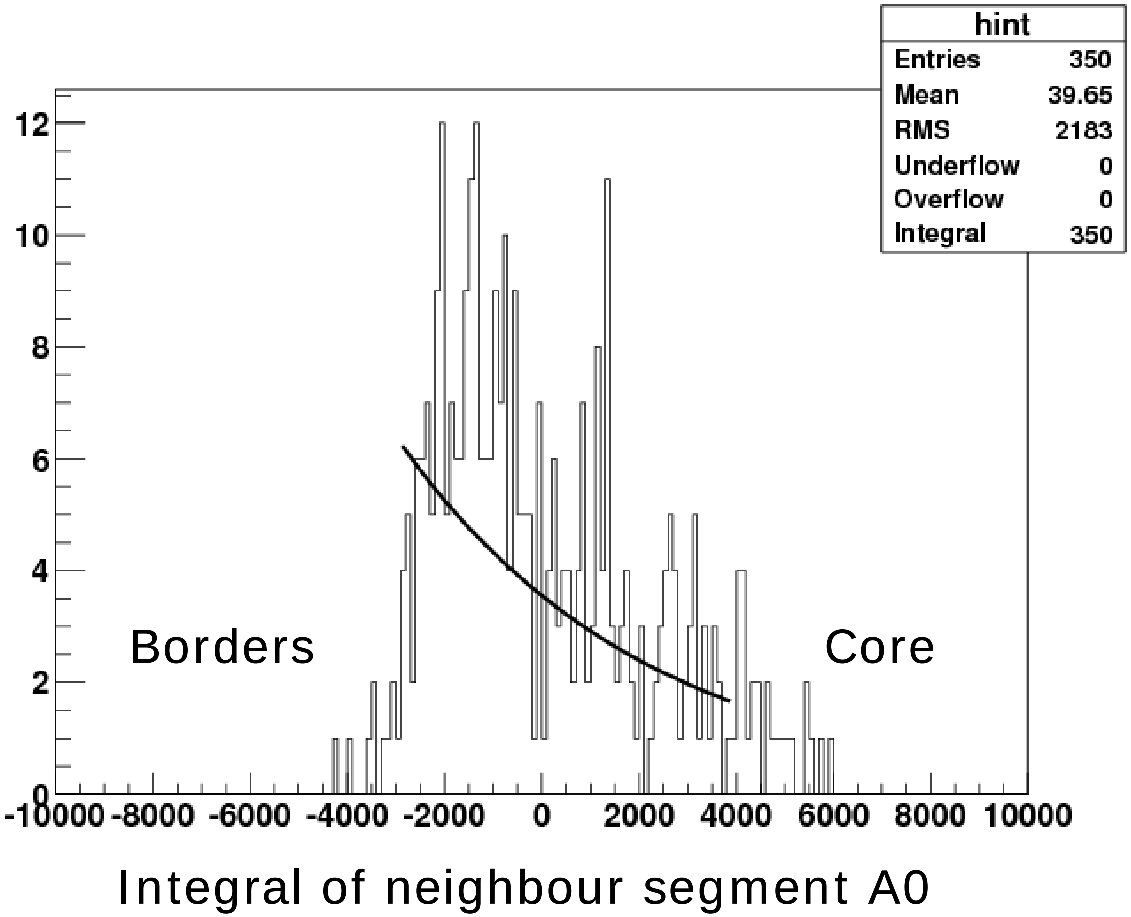
Abstract

In this work, a novel imaging technique for the spatial calibration of a gamma camera is presented. The later is aimed for the characterisation of the charge signals of 3D-position sensitive HPGe detectors. The characterisation method itself is based on pulse shape comparison (PSC) technique. The performance of the device is improved by implementing a gamma camera or position sensitive detector (PSD). This PSD consists of a uniform LYSO scintillating crystal optically glued to a crossed-wire position sensitive photomultiplier tube (PSPMT) from Hamamatsu. The individual multianode readout (IMAR) approach is used to improve its spatial resolution and to enlarge its field of view. A Compton scattering imaging technique is implemented to perform an accurate position calibration of the gamma camera.

Keywords: PSD, Gamma Camera, PSC, Germanium

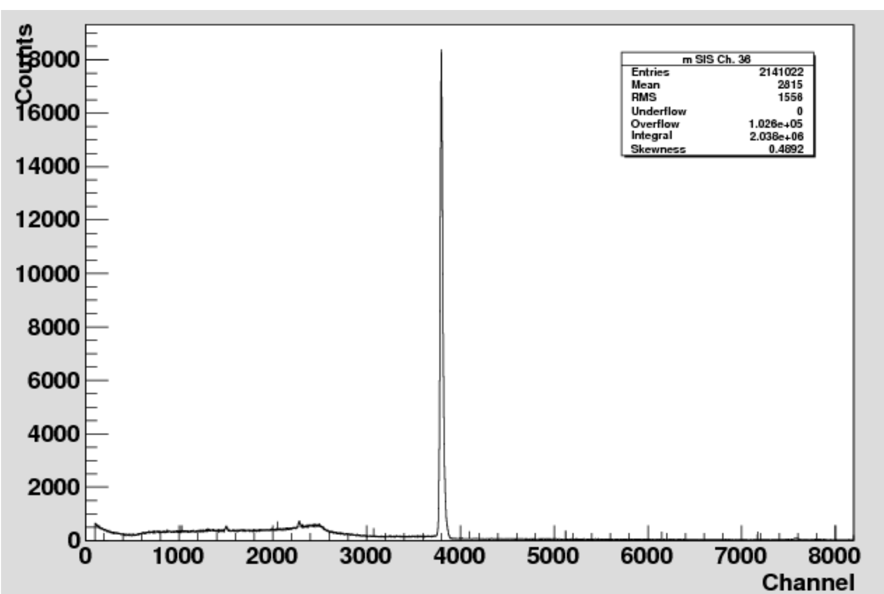
Submitted NIM A

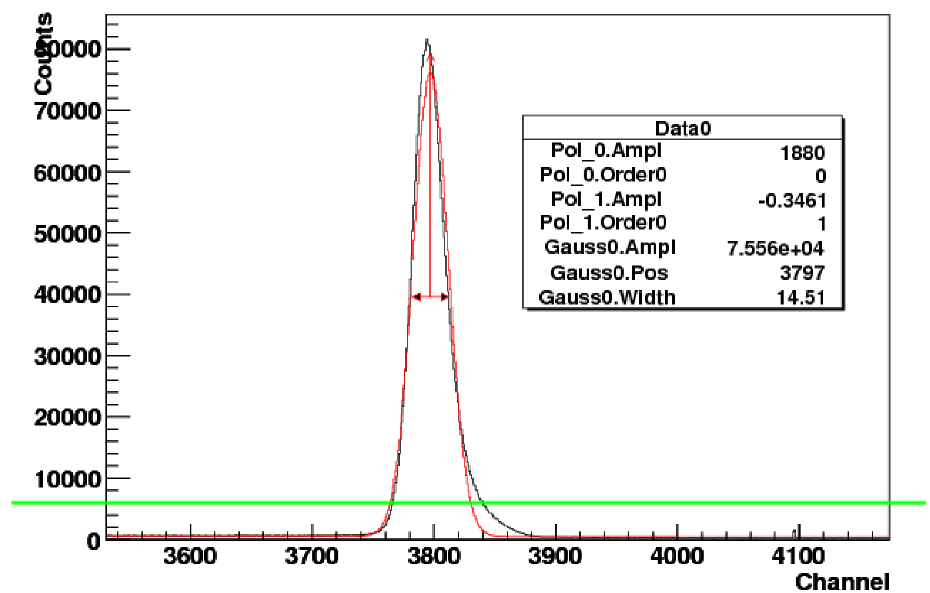
Exponential decay of the number of pulses along the radius



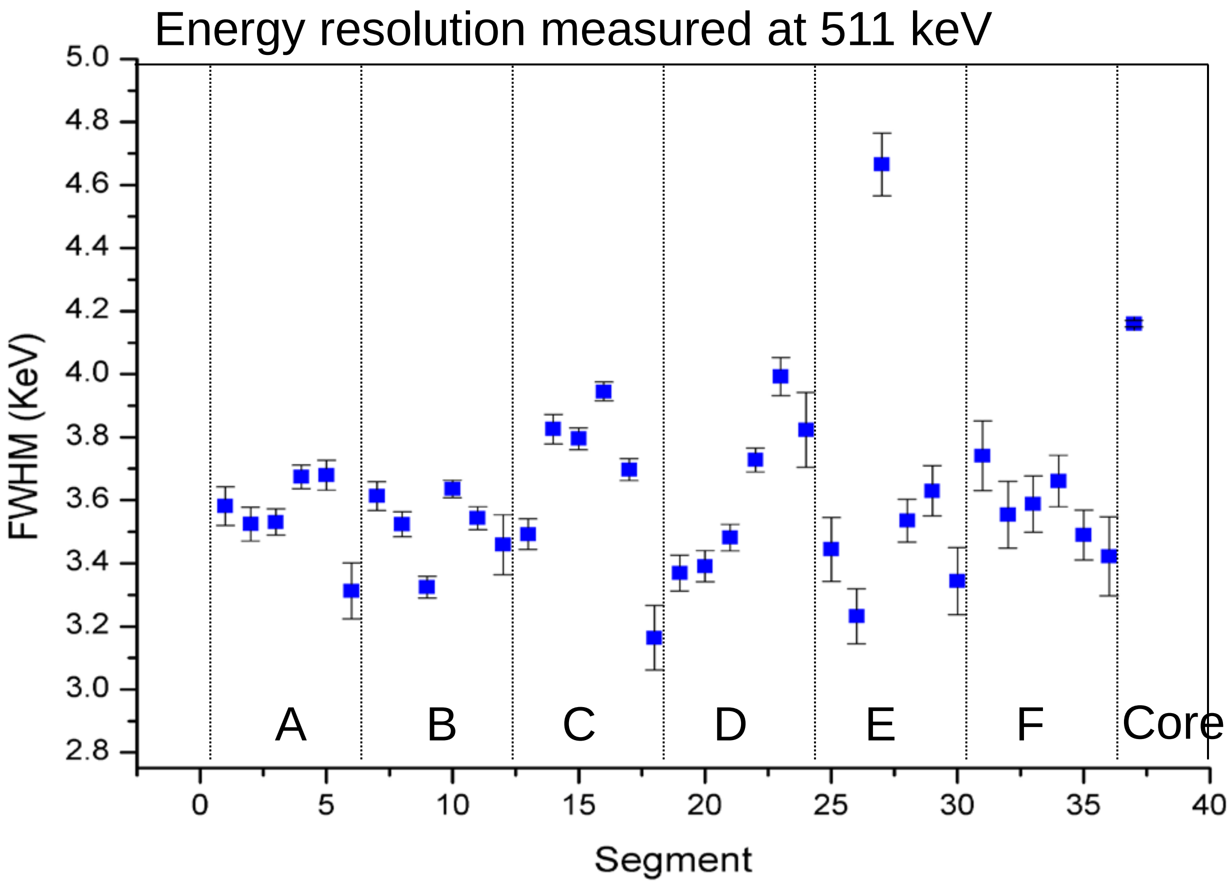
Coincidence pulse height spectra

- Pulse height spectrum core
- Bias voltage = +4000 Volts
- Resolution ~ 4.5 keV





Agata S001 Scan: Energy Resolution



Agata S001 Scan: Pulses