Performance and position sensitivity of the first AGATA detectors

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- CEA Saclay –
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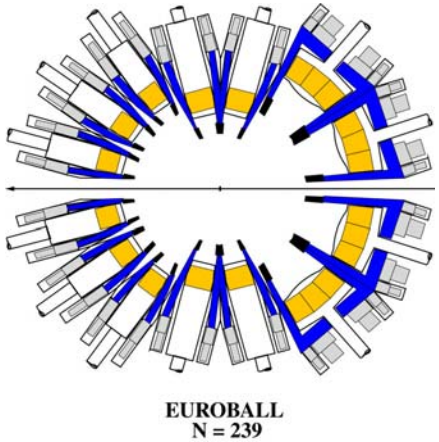
For the AGATA collaboration

- AGATA introduction
- AGATA detector capsule
- Acceptance test – crosstalk model
- Characterization

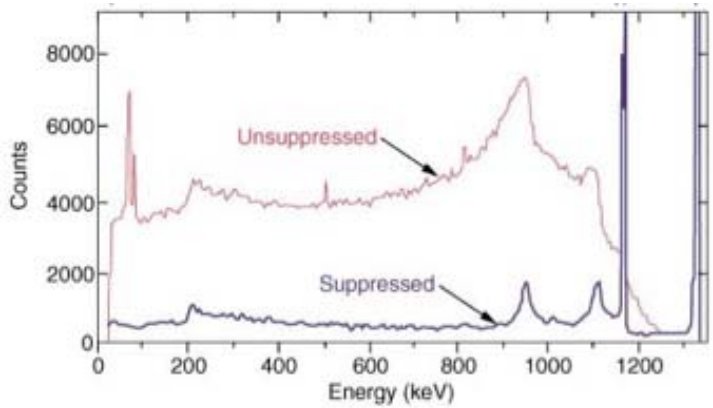
The next generation of spectrometers

Today's spectrometers

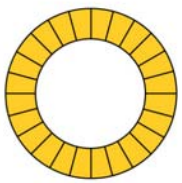


large opening angle means poor energy resolution at high recoil velocity

too many detectors are needed to avoid summing effects

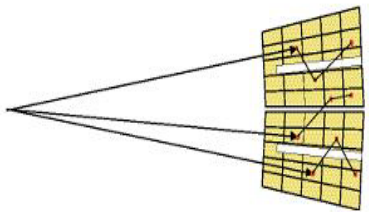


Tomorrows spectrometers



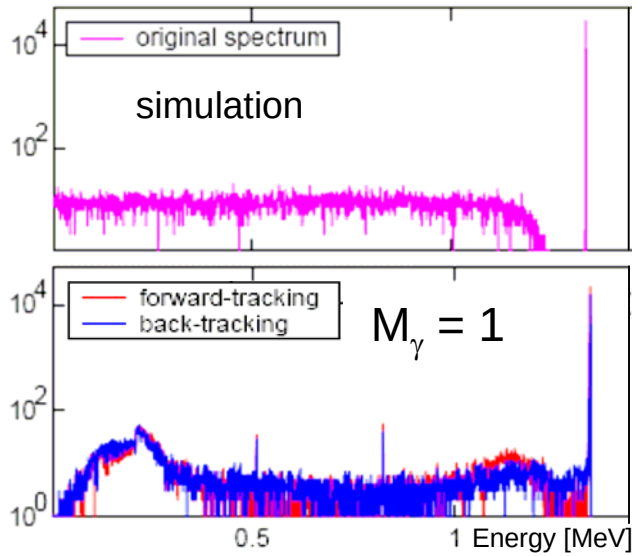
AGATA

N = 180
segmented



Combination of:

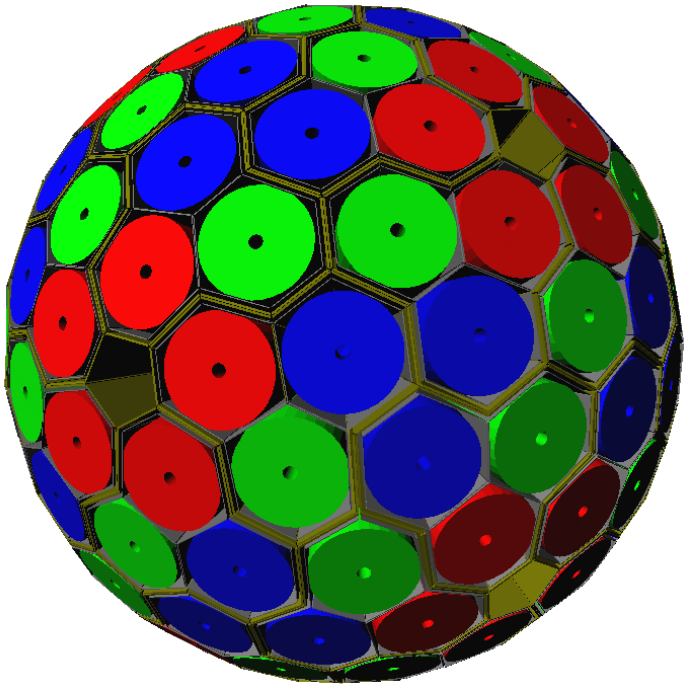
- segmented detectors
- digital electronics
- pulse shape analysis (see talk M. Schlarb)
- tracking the γ-rays



A. Lopez-Martens NIMA 533 (2004) 454–466

AGATA

(Advanced GAmma Tracking Array)
array for Nuclear Physics Experiments at European accelerators providing radioactive and high-intensity stable beams



Main features of AGATA

Efficiency:	43% (M_γ=1)	28% (M_γ=30)
today's arrays	~10% (gain ~4)	5% (gain ~1000)
Peak/Total:	58% (M_γ=1)	49% (M_γ=30)
today	~55%	40%
Angular Resolution:	~1° →	
FWHM (1 MeV, v/c=50%)		~ 6 keV !!!
today		~ 40 keV
Rates:	3 MHz (M_γ=1)	300 kHz (M_γ=30)
today	1 MHz	20 kHz

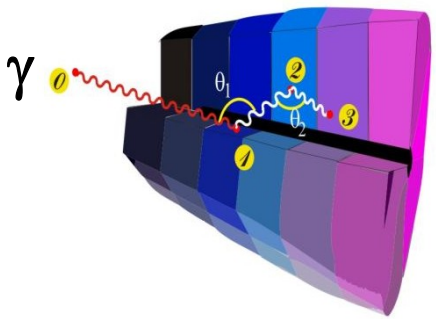
- 180 large volume 36-fold segmented Ge crystals in 60 triple-clusters
- Ultimate spectrometer for: FAIR / GSI , Spiral II / Ganil

http://www-win.gsi.de/agata/

Ingredients of γ-Tracking

1

Highly segmented HPGe detectors



2

Digital electronics to record and process segment signals

3

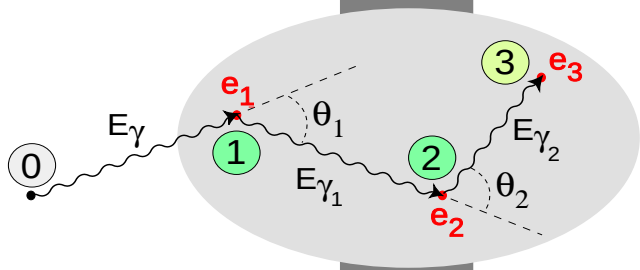
Pulse Shape Analysis to decompose recorded waves

4

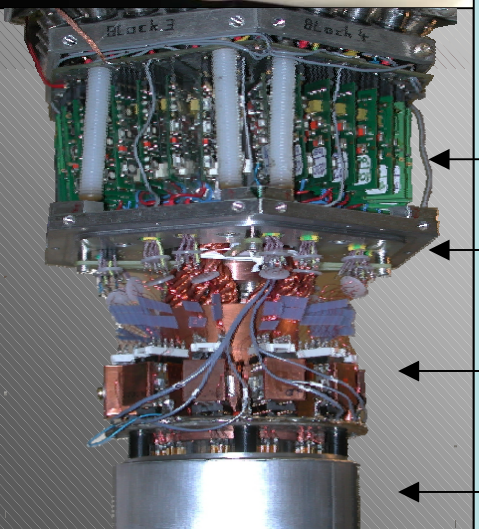
Identified interaction points

$(x,y,z,E,t)_i$

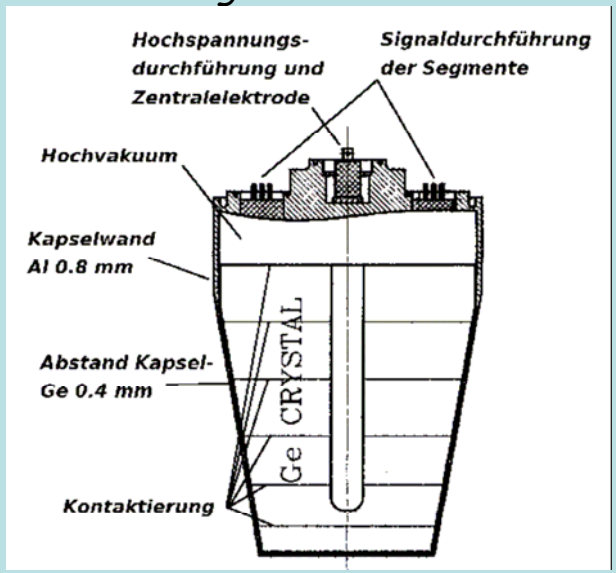
Reconstruction of tracks e.g. by evaluation of permutations of interaction points



reconstructed γ-rays



- ***Encapsulated Ge crystal:***
  36 fold segmented



- ***Fusion with "cold " PCB***
  connection with cold FET

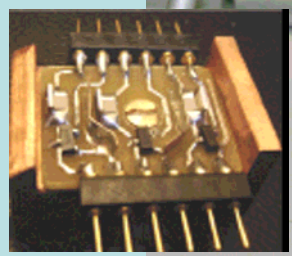
- ***Test cryostat in open condition***

Warm part of preamp

Vacuum feed-throughs

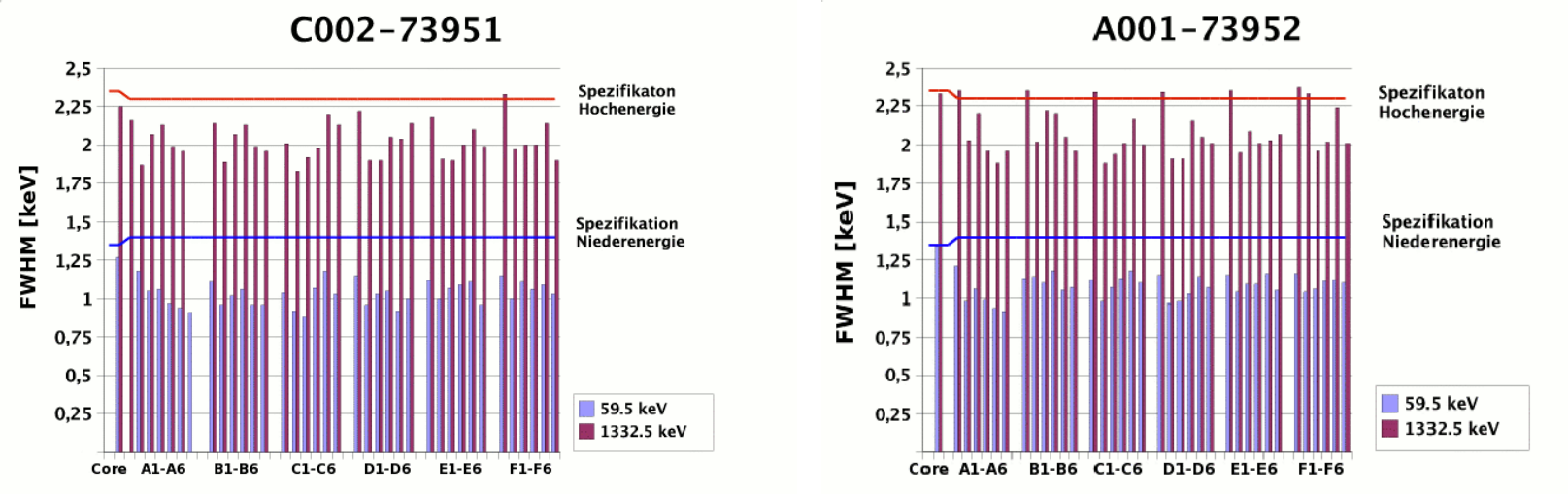
Cold FET's of preamp

Encapsulated detector



Test cryostat closed

4 asymmetric AGATA detectors accepted (11/05 - 11/06)



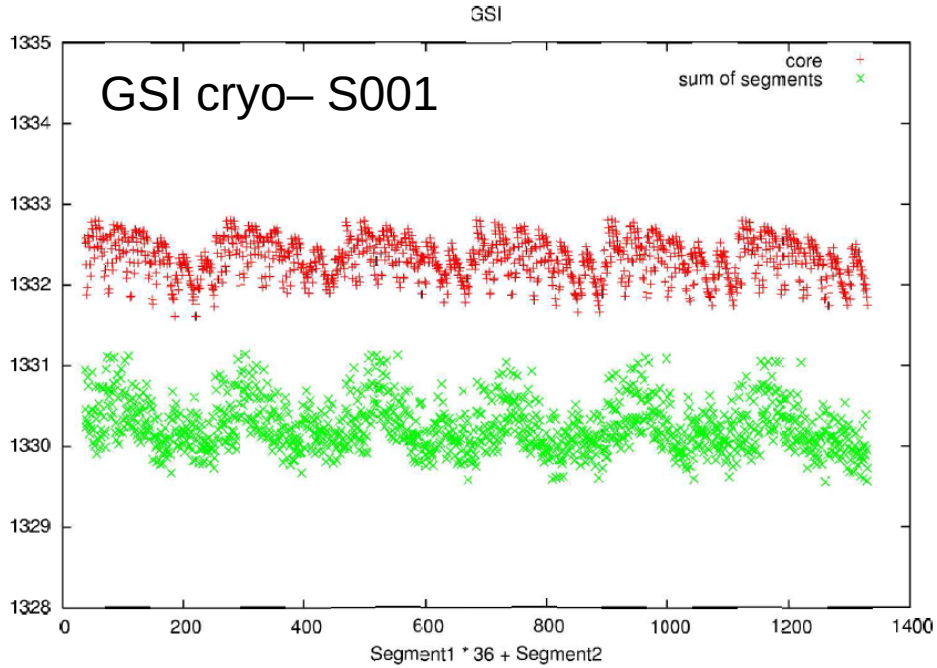
Further specification: **Crosstalk** ≤1‰

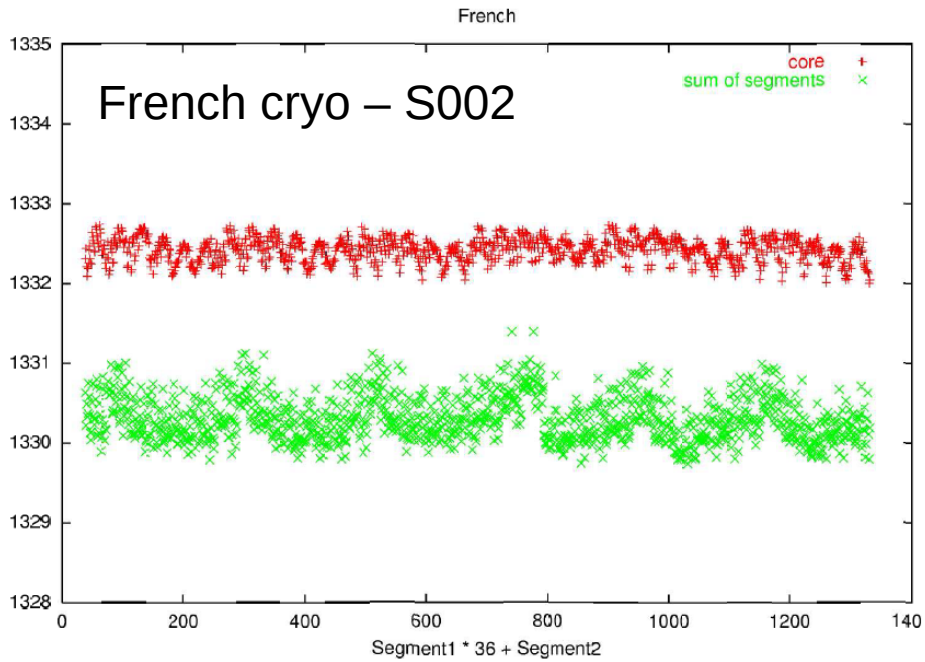
Cross talk results Symmetric detectors

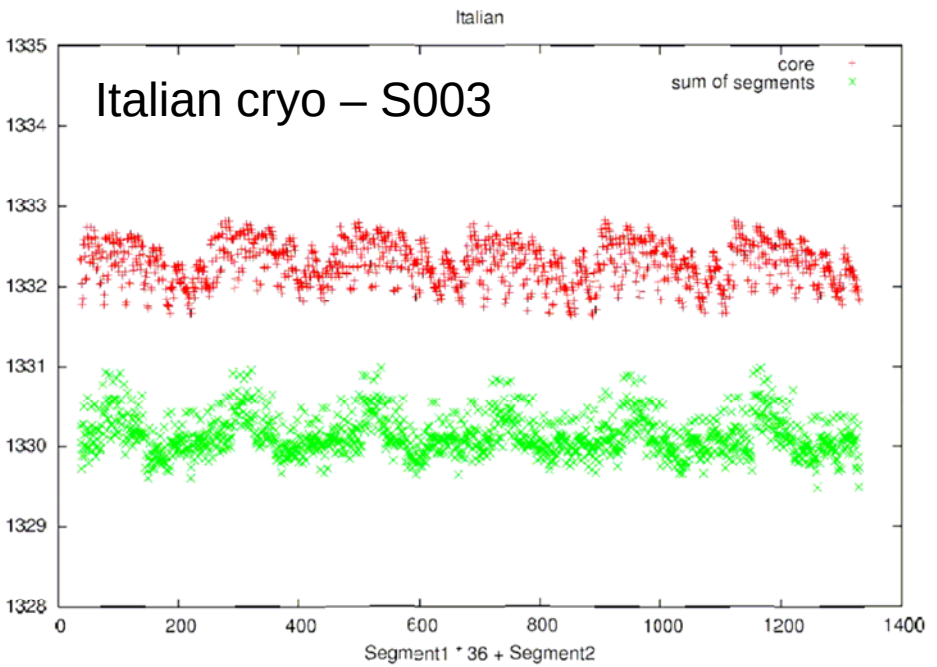
Used to look at 2-folds vs hitpattern:

36 x 36 combinations

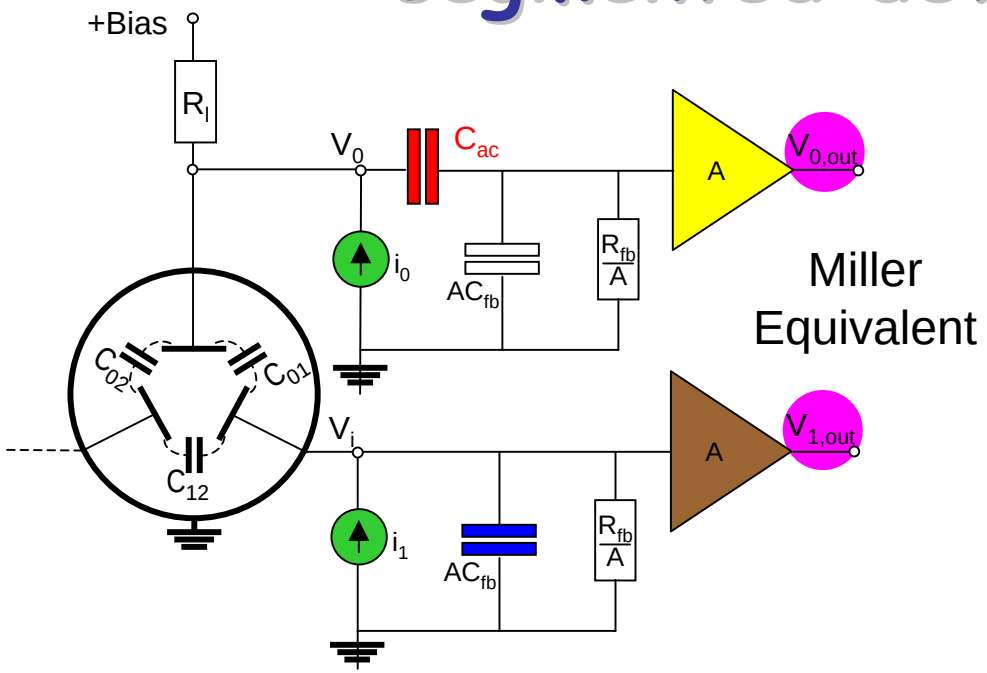
Observable : shift in segment sum and core energy relative to calibration







A model to describe crosstalk in segmented detectors



Miller Equivalent

AGATA:

C_{ac} = 1000pF

C_{fb} = 1.2pF

A (Core) = 80000

A (Seg) = 10000

C_{xy} = ~1pF

Measured quantities

Segment-to-Core

$$\vec{v}_{out} \cong \frac{1}{sC_{fb}} \begin{pmatrix} 1 & -C_{01}/AC_{fb} & -C_{02}/AC_{fb} \\ -C_{01}/C_{ac} & 1 & -C_{12}/AC_{fb} \\ -C_{02}/C_{ac} & -C_{12}/AC_{fb} & 1 \end{pmatrix} \vec{i}$$

Core-to-Seg

~ 1pF/1000pF

Segment-to-Segment

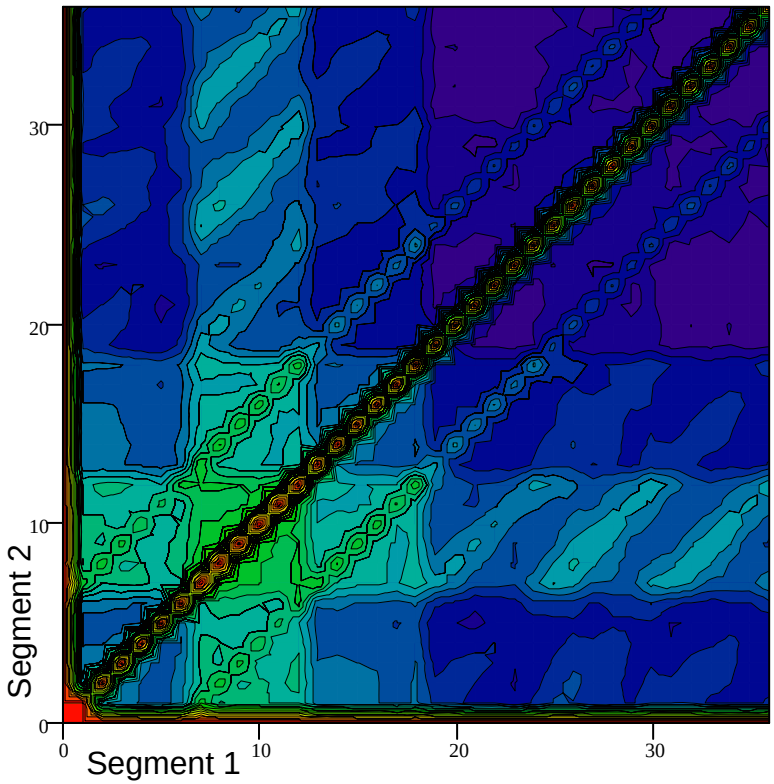
~1pF/(10000 · 1pF)

Crosstalk is intrinsic property of segmented detectors !

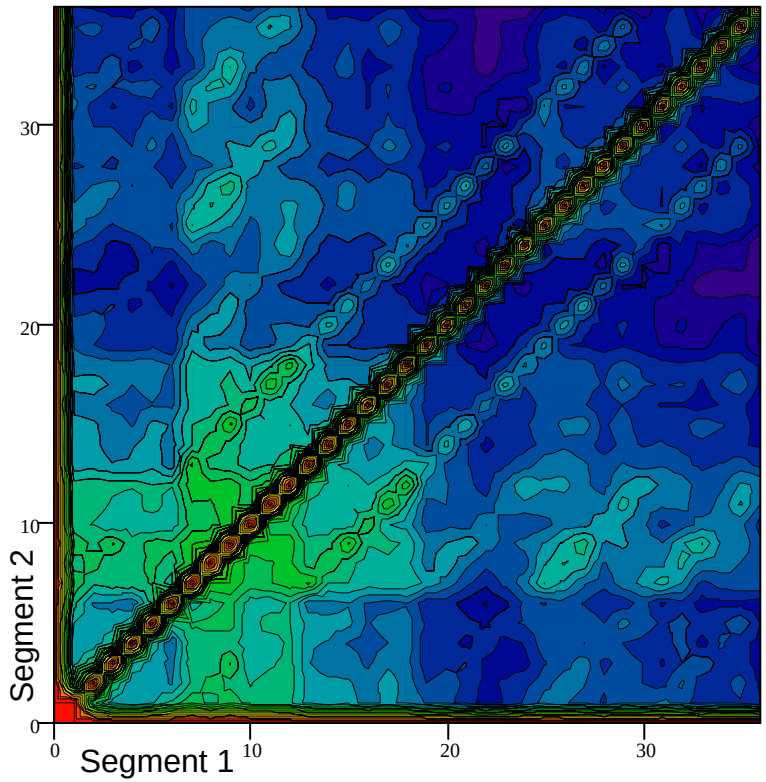
B. Bruyneel et al. in preparation

Core to segment crosstalk in 2folds

Simulation



Measured (S001)



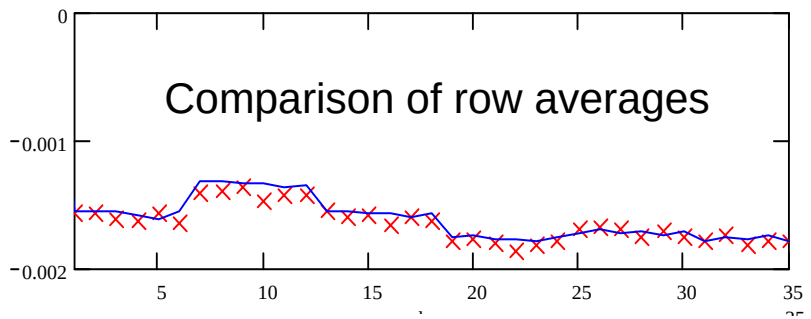
Core to segment crosstalk understood

⇓

Correction possible

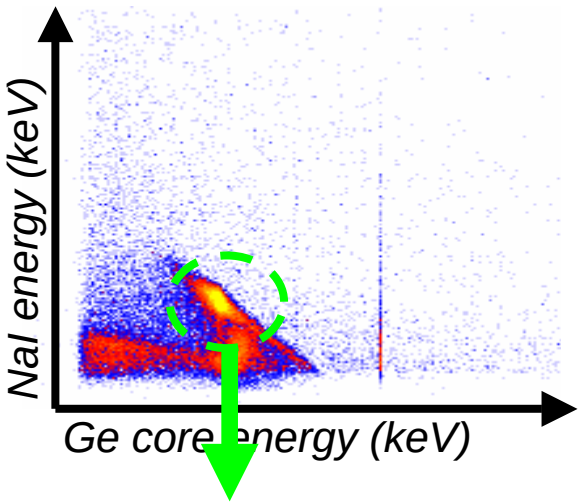
Meas. ×××

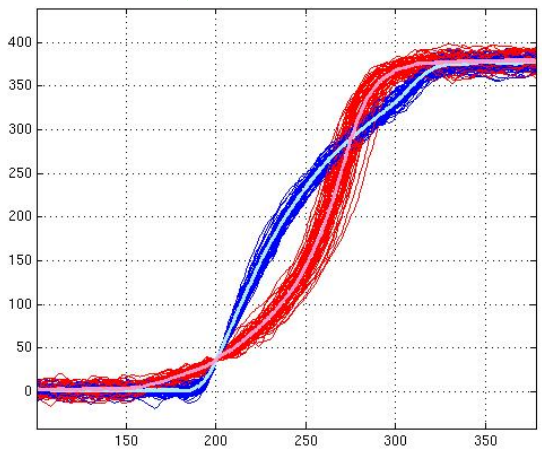
Theory ——

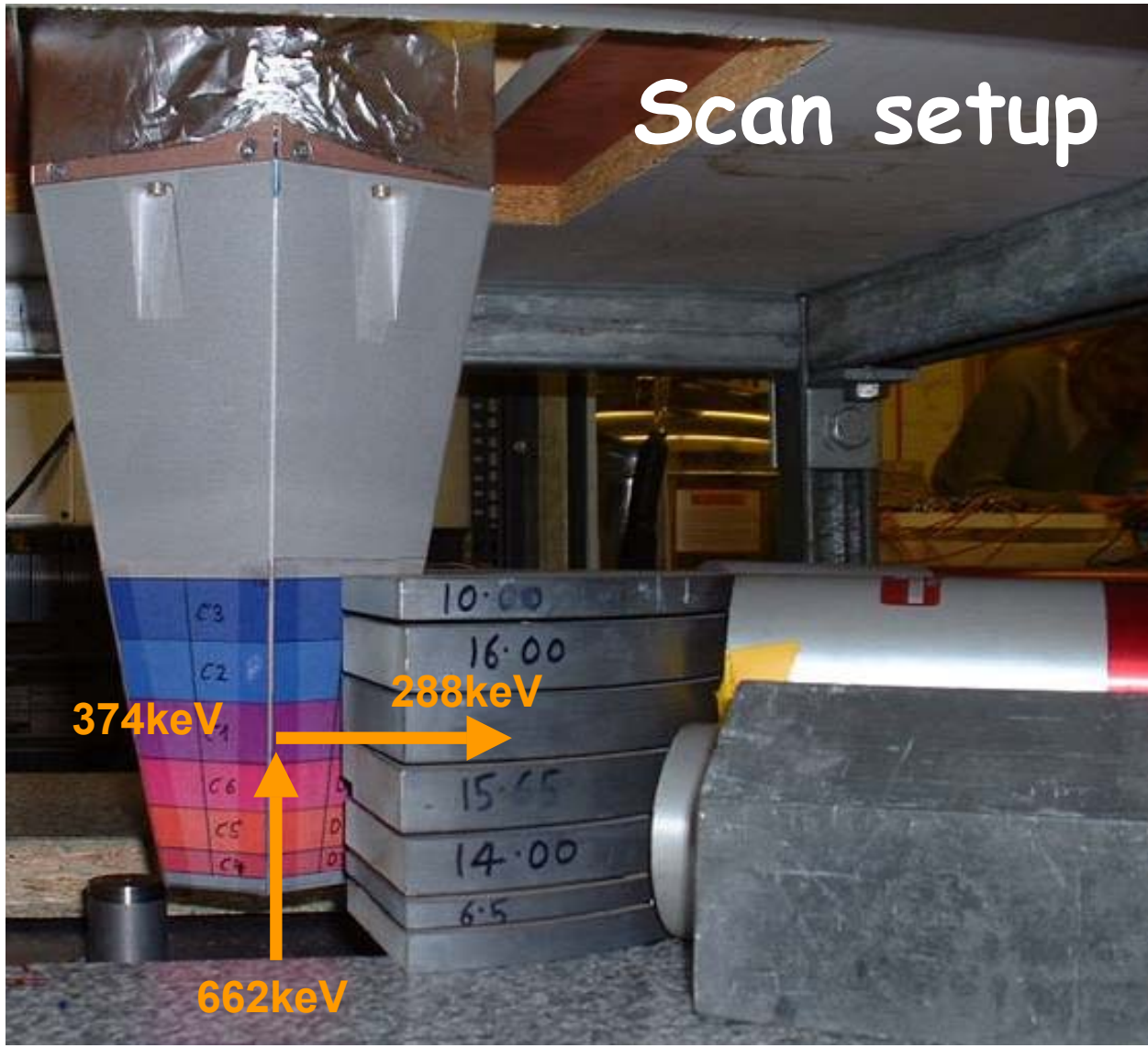


Coincidence measurement = Position selection

THE UNIVERSITY of LIVERPOOL

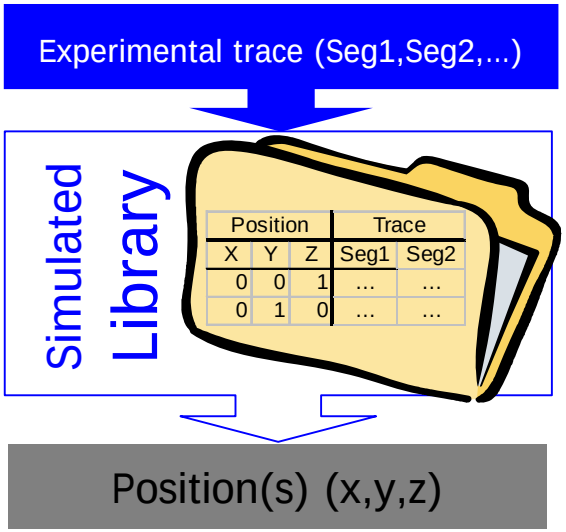


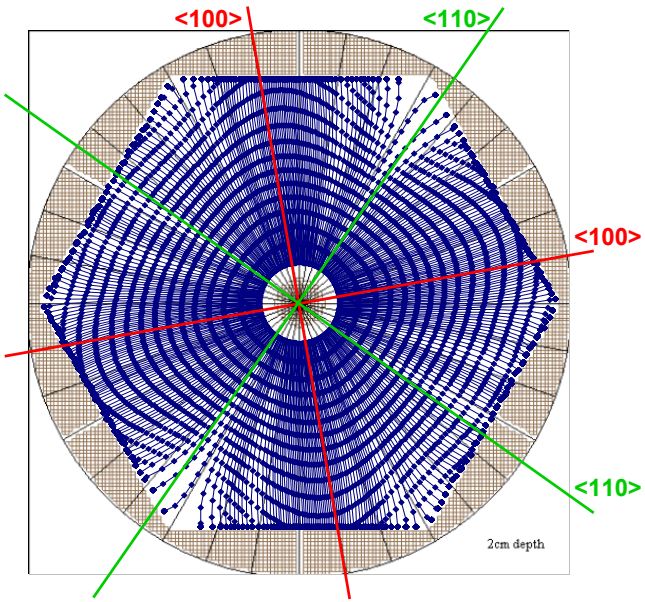




Unfortunately very slow… → Characterization validated simulation

Realistic detector simulations





Quality simulation needs:

Detector properties:

- Fields and potentials
  - Space charge
- Crystal orientation
- Anisotropic Mobility:
  - Electron mobility
  - Hole mobility

B. Bruyneel NIMA 569 (2006) 764-773

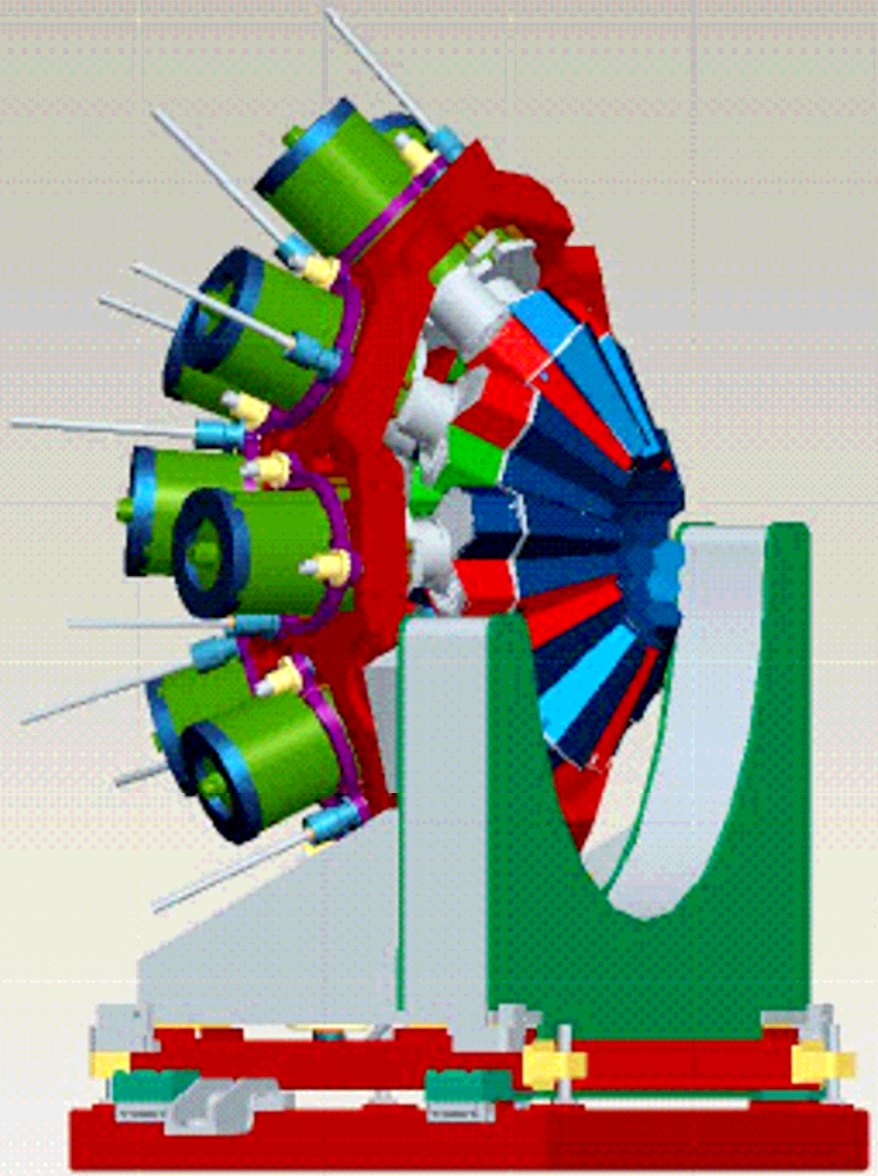
Electronics properties:

- Response functions
- Crosstalk

B. Bruyneel NIMA 569 (2006) 774-789

see also (next) talk by A. Linnemann

Status and outlook

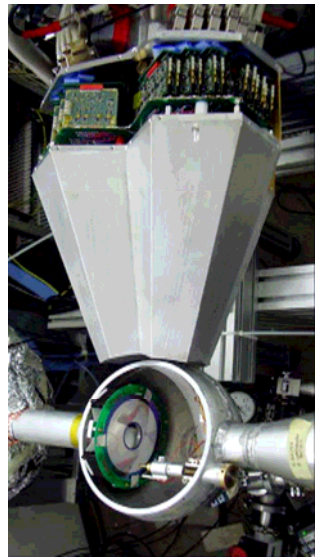


AGATA triple cluster detectors (TC)

•In beam test experiment at Köln tandem with symmetric TC. Position sensitivity < 5mm
... see (next) talk A. Linnemann

•Scanning asymmetric detectors

•First asymmetric TC



•Demonstrator (= 5 TC)...
... First AGATA-like operation

•1π configuration

http://www-win.gsi.de/agata/