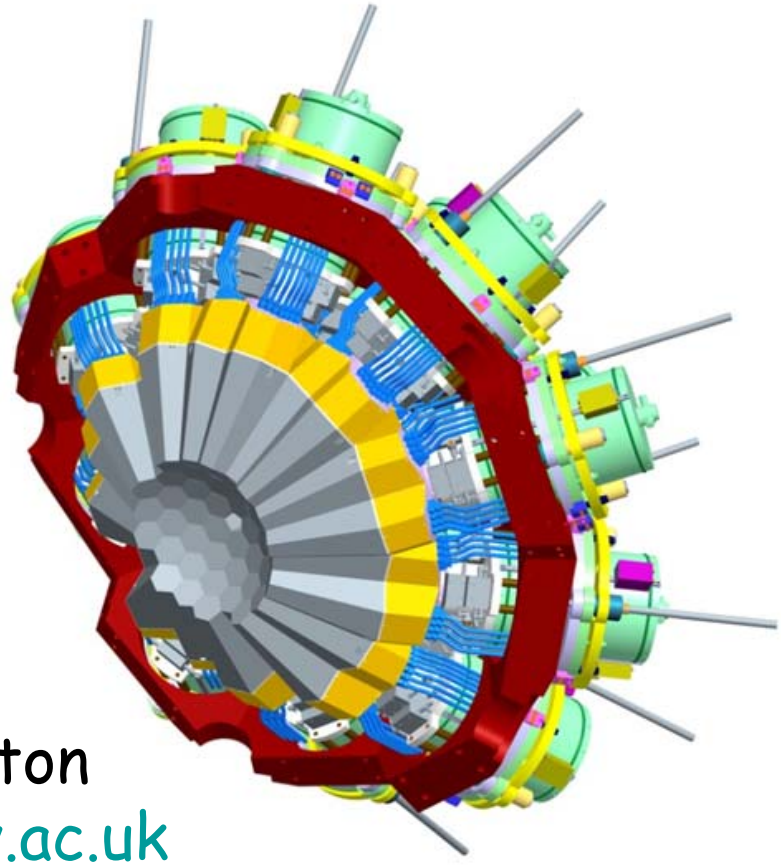
The Advanced Gamma Tracking Array detector characterisation



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

Andy Boston
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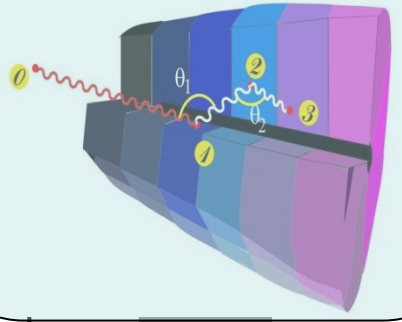
Ingredients of γ-Tracking

1

Highly segmented HPGe detectors



2

Digital electronics to record and process segment signals

3

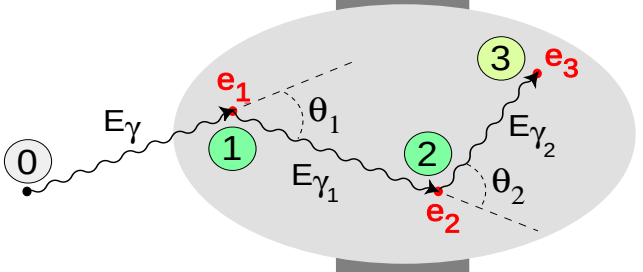
Pulse Shape Analysis to decompose recorded waves

Identified interaction

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

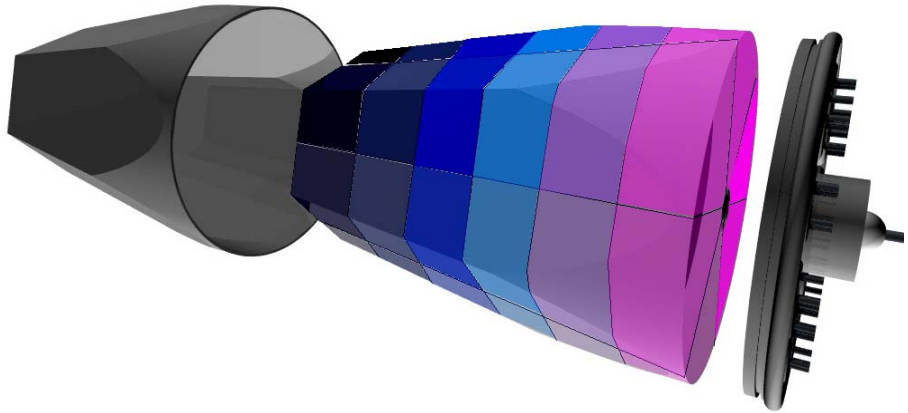
4

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

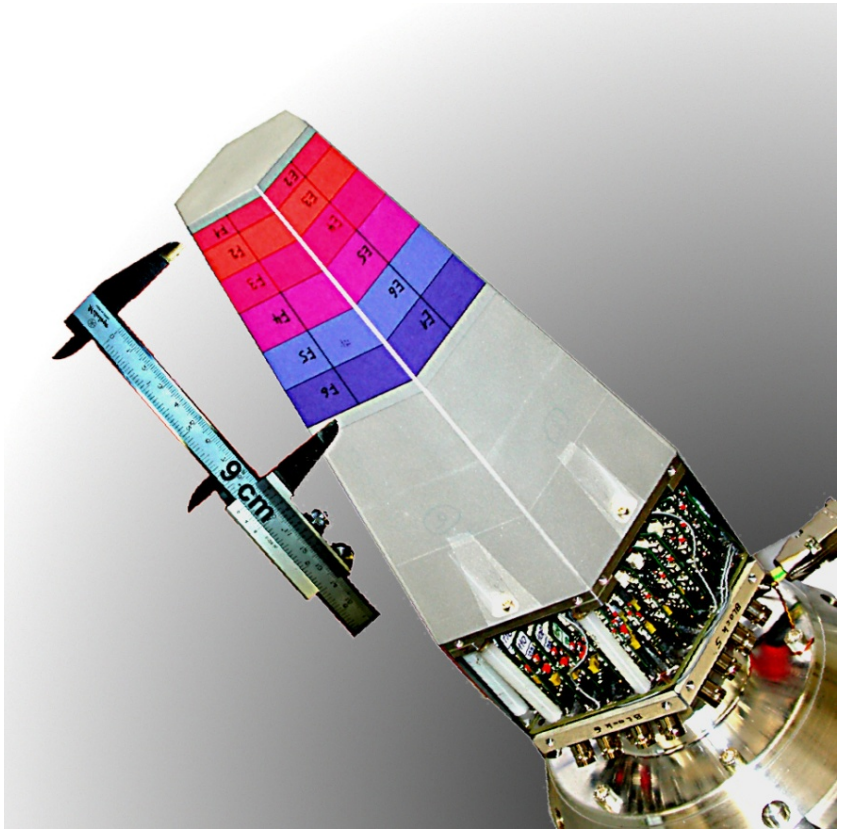


reconstructed γ-rays

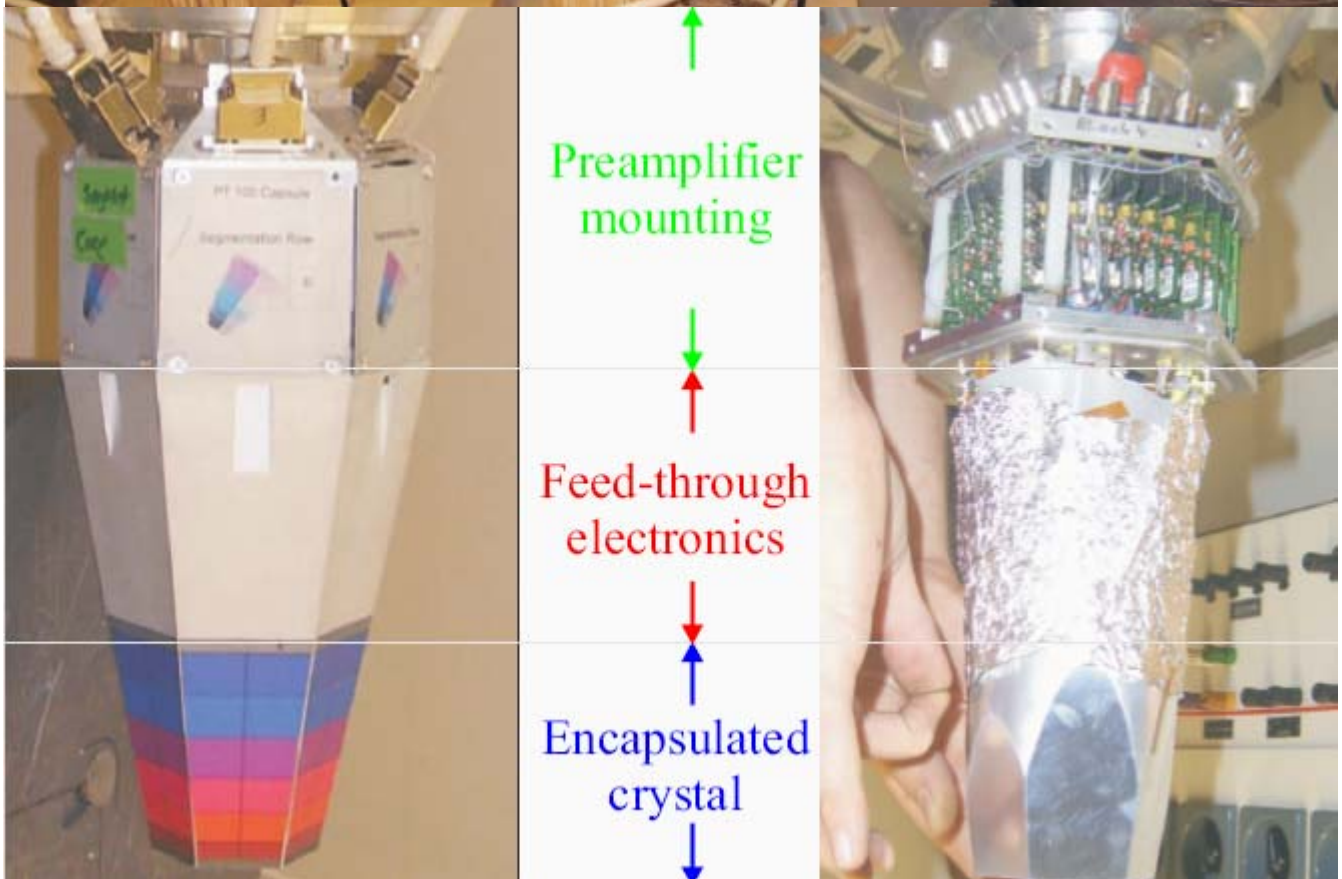
AGATA 1st symmetric capsule

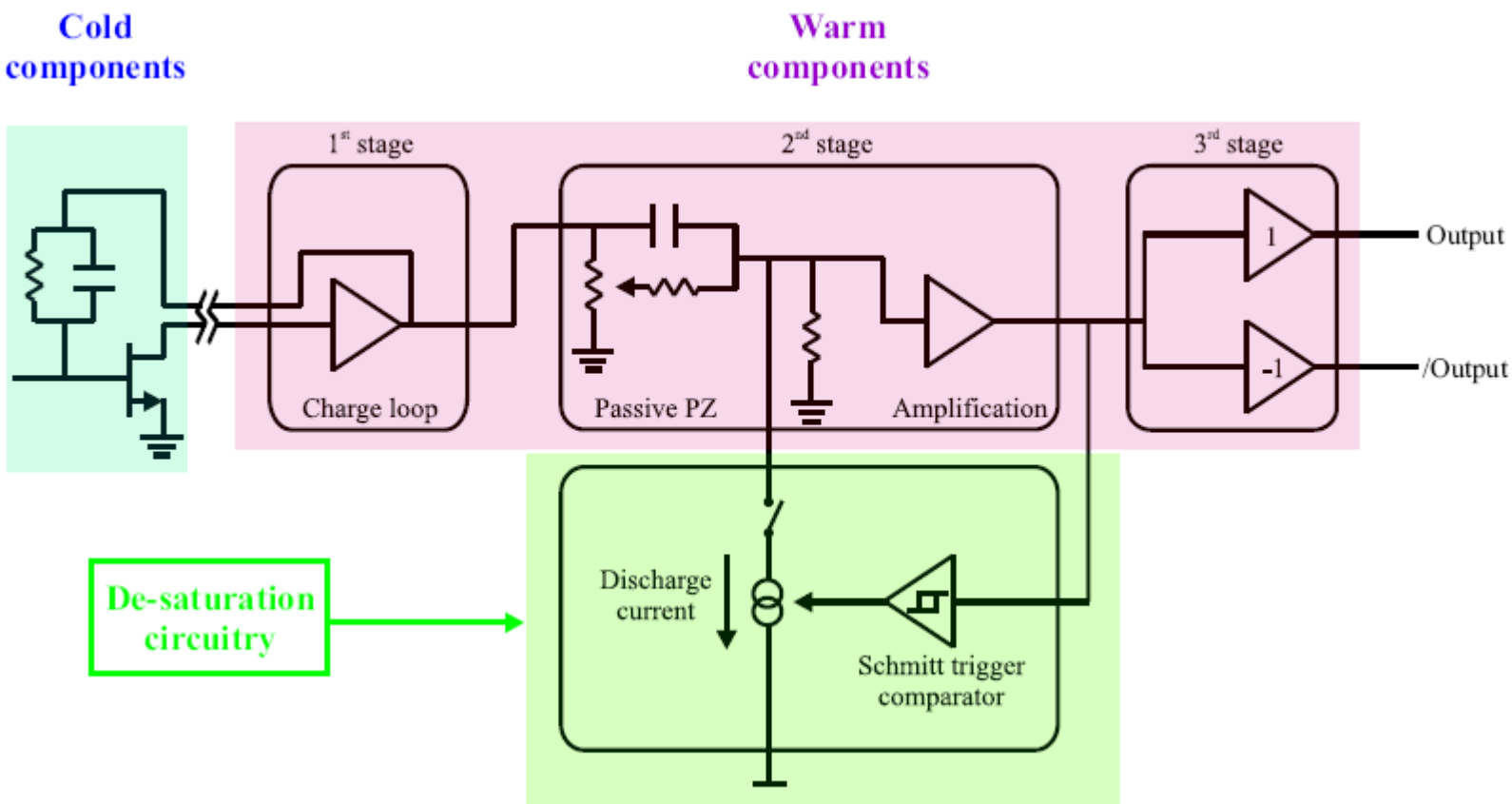


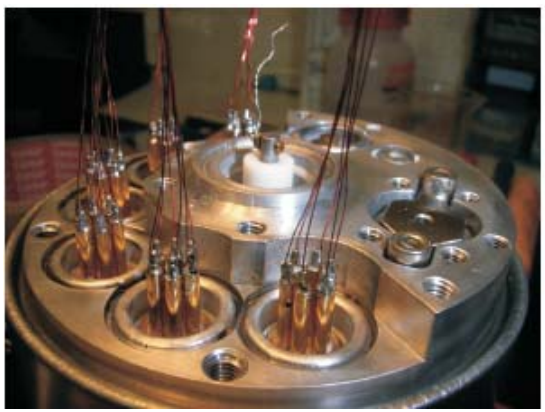
Hexaconical Ge crystals
90 mm long
80 mm max diameter
36 segments
Al encapsulation
    0.6 mm spacing
    0.8 mm thickness
37 vacuum feedthroughs

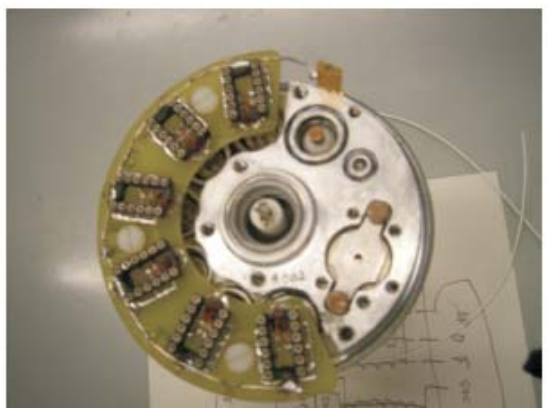


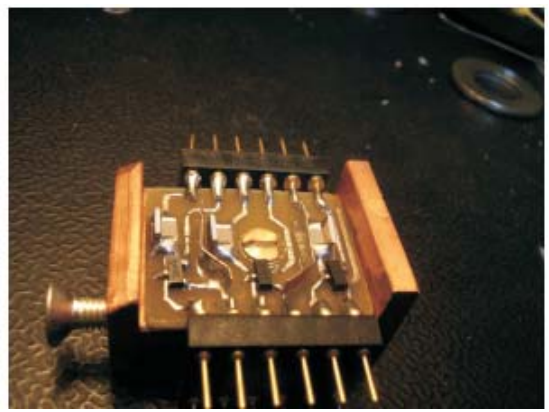
Detector assembly




Cold components
Warm components
1st stage
2nd stage
3rd stage
Charge loop
Passive PZ
Amplification
1
-1
Output
/Output
De-saturation circuitry
Discharge current
Schmitt trigger comparator

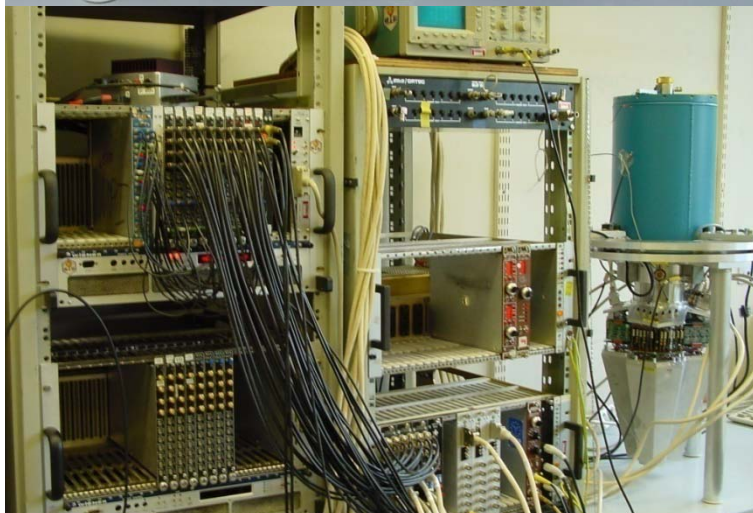






AGATA detector status

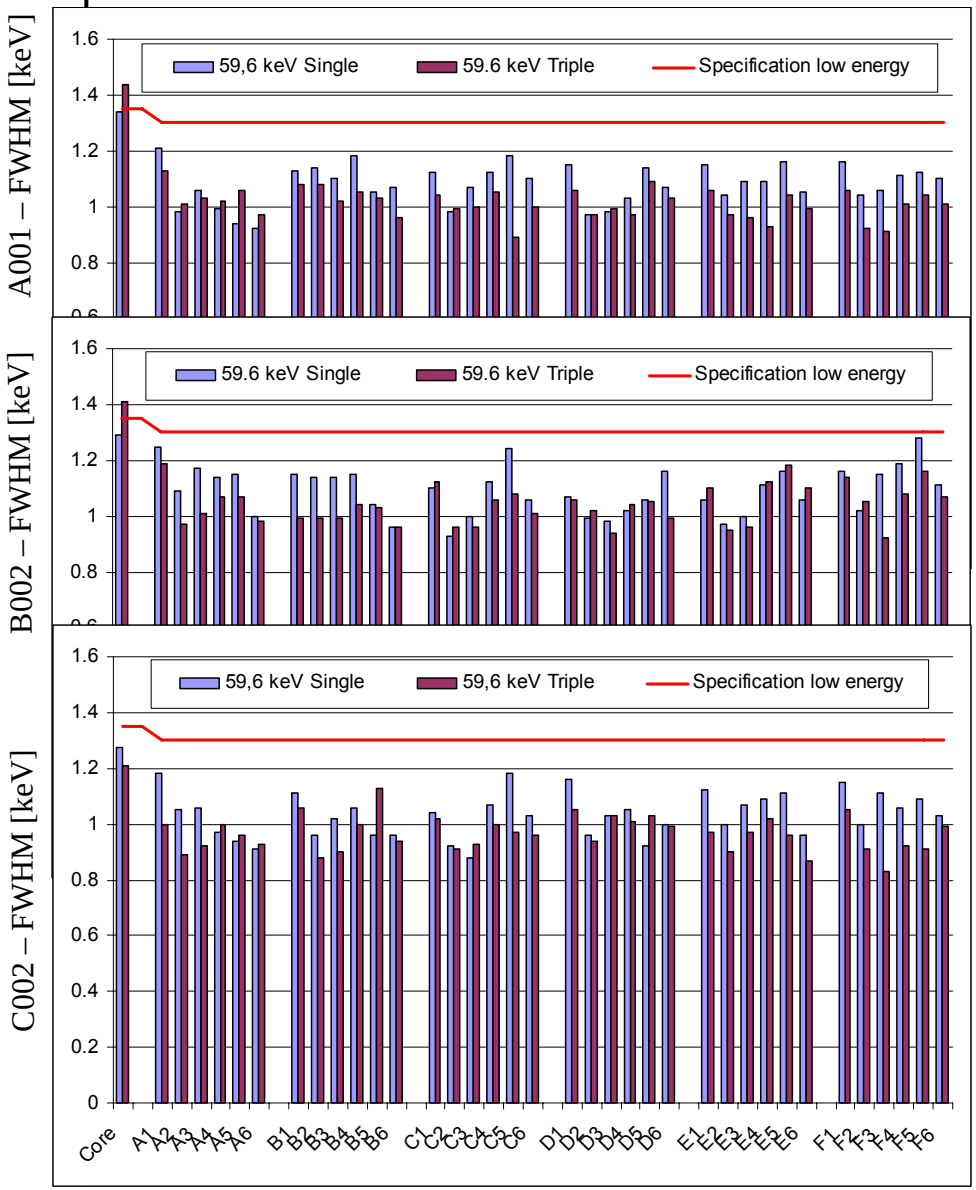
- Symmetric detectors
  - 3 delivered
- Asymmetric detectors
  - 19 ordered (9 accepted, 4 in test, 2 not accepted, 4 to be delivered)
- Preamplifiers available
  - Core (Cologne);
  - Segment (Ganil & Milano)
- Test cryostats for characterisation
  - 5 delivered
- Triple cryostats
  - 5 ordered
  - 1 complete, 2 being assembled, 2 ordered

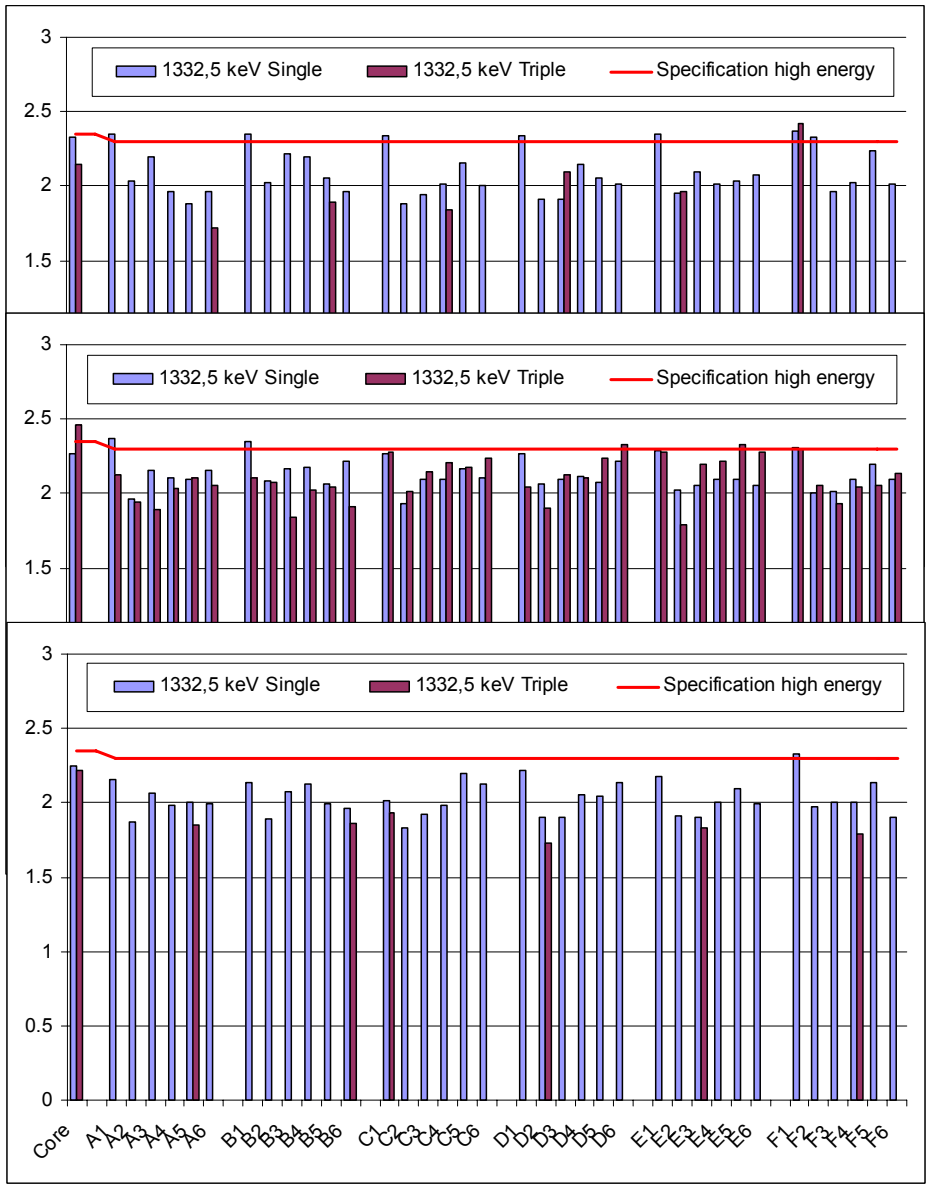


Triple Cluster Energies: Single vs Triple

Resolution 60keV line

Resolution 1.33MeV line



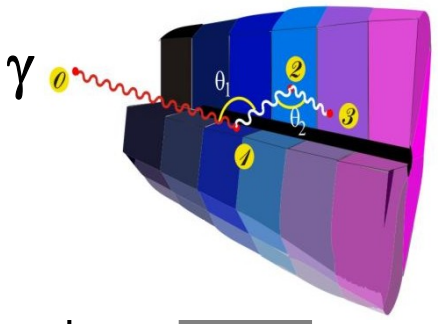


Ingredients of γ-Tracking

AGATA det erisation

1

Highly segmented HPGe detectors



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Pulse Shape Analysis to decompose recorded waves

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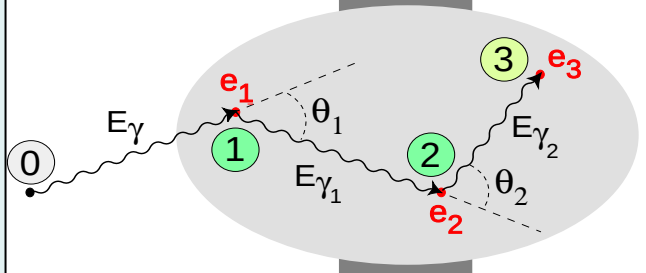
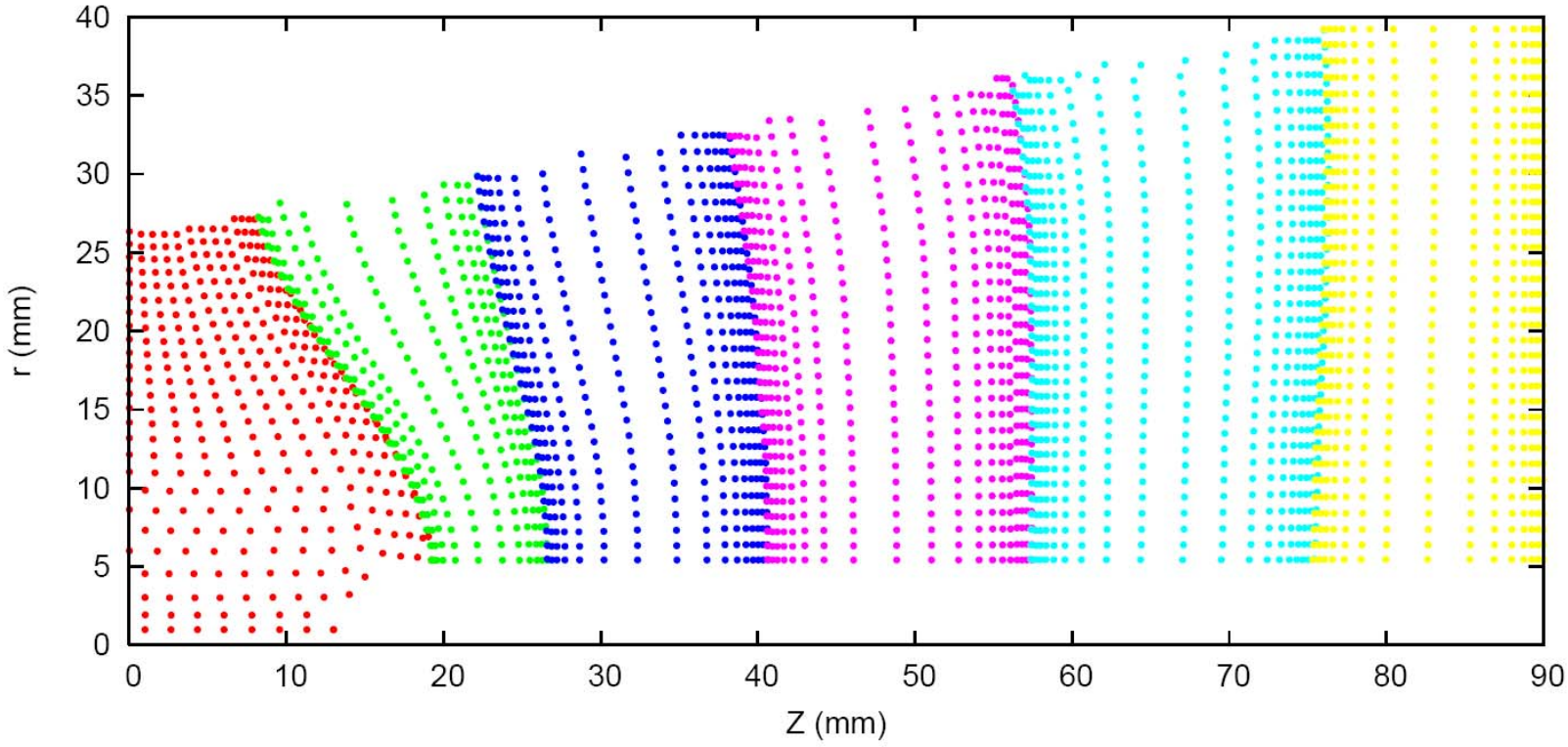
Reconstruction of tracks e.g. by evaluation of permutations of interaction points



reconstructed γ-rays

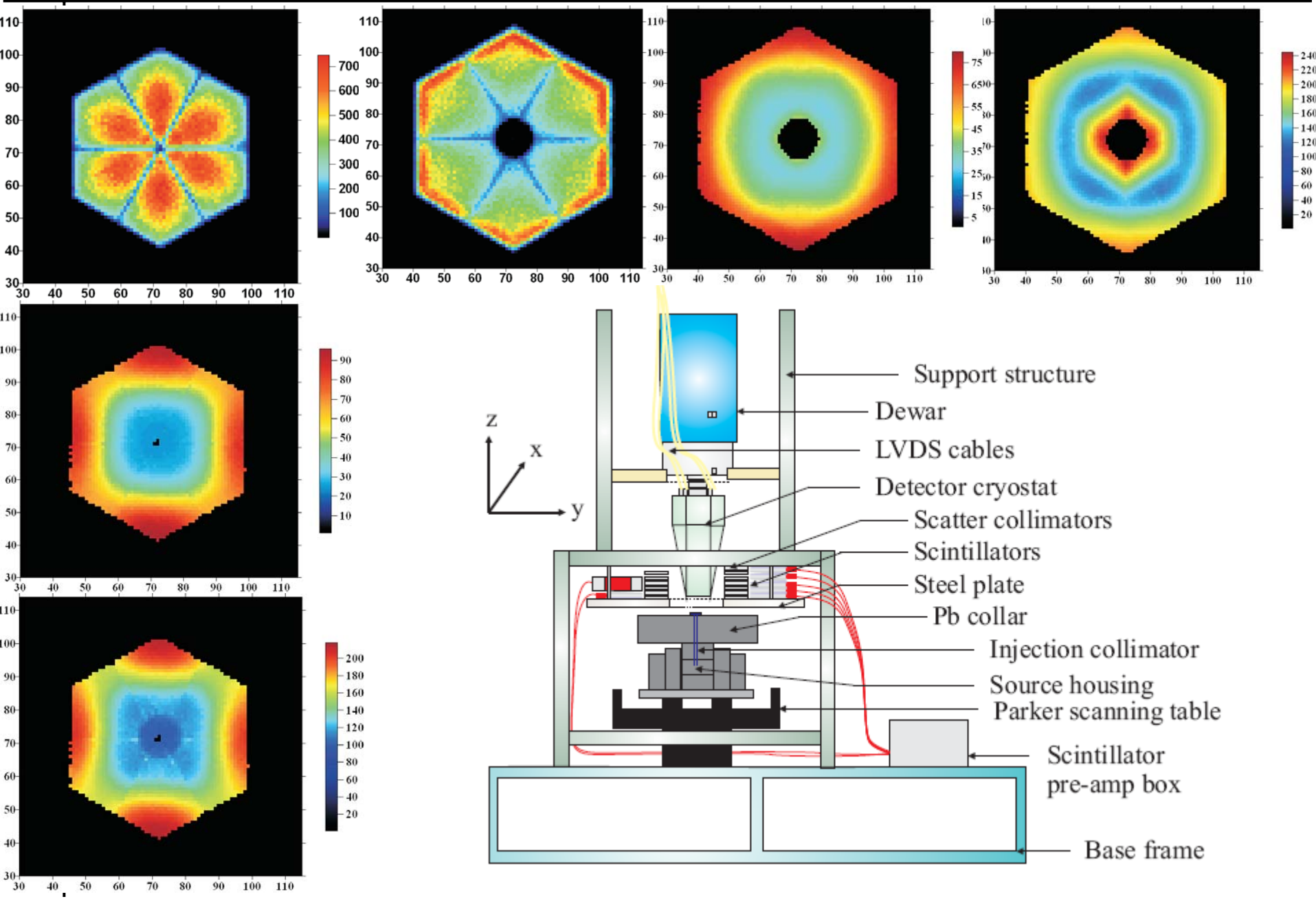
Detector Characterisation and PSA

- Calibrate detector response function
- Comparison of real and calculated pulse shapes
- Coincidence scan for 3D position determination
- Validate codes



“How well your basis fits your real data”

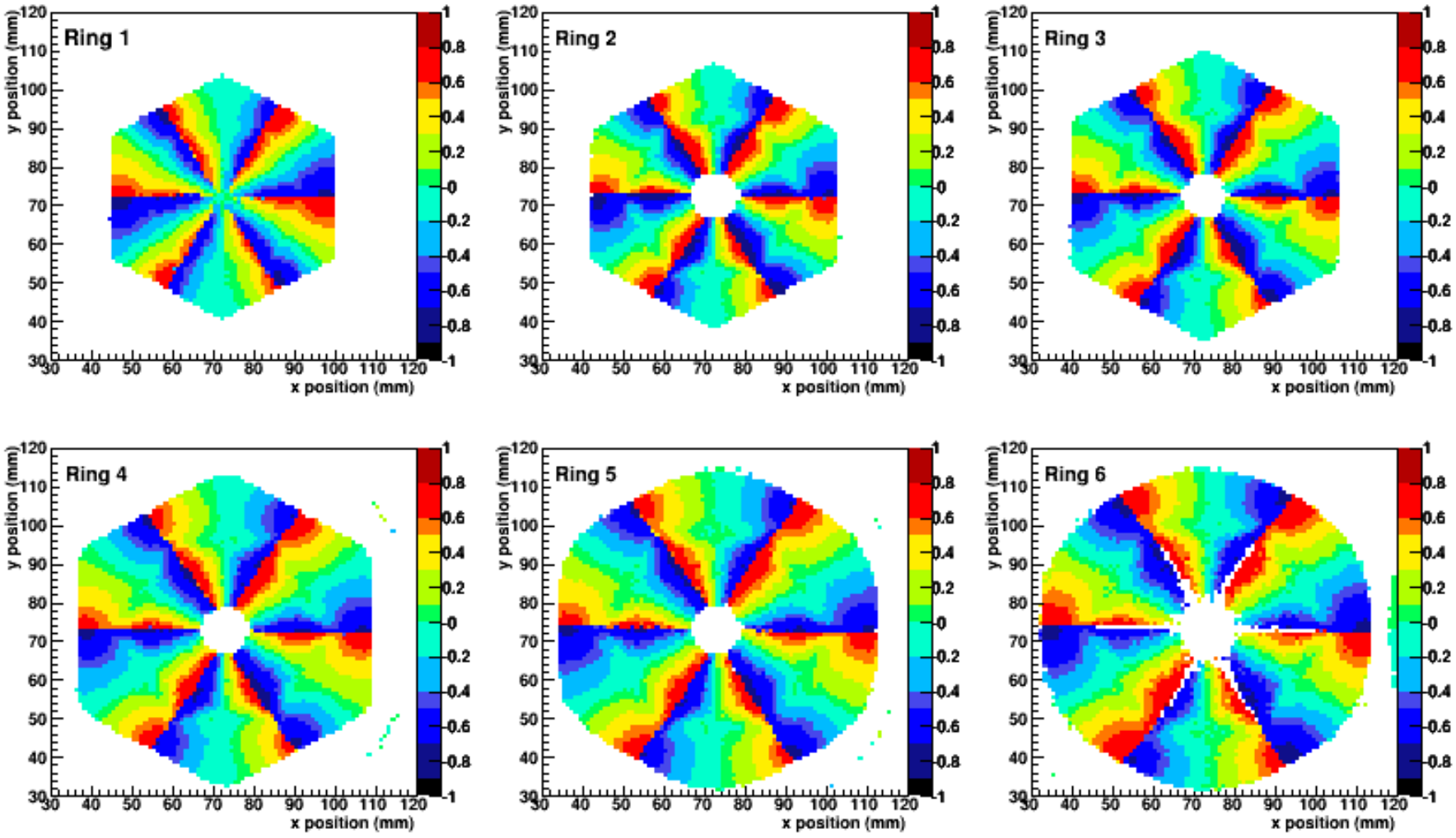
AGATA detector scanning



Azimuthal Position Information

- Image Charge Asymmetry (ICA)

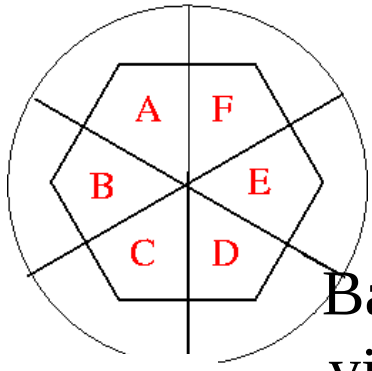
$$ICA = \frac{\left|A_{\text{anticlockwise}}\right| - \left|A_{\text{clockwise}}\right|}{\left|A_{\text{anticlockwise}}\right| + \left|A_{\text{clockwise}}\right|}$$



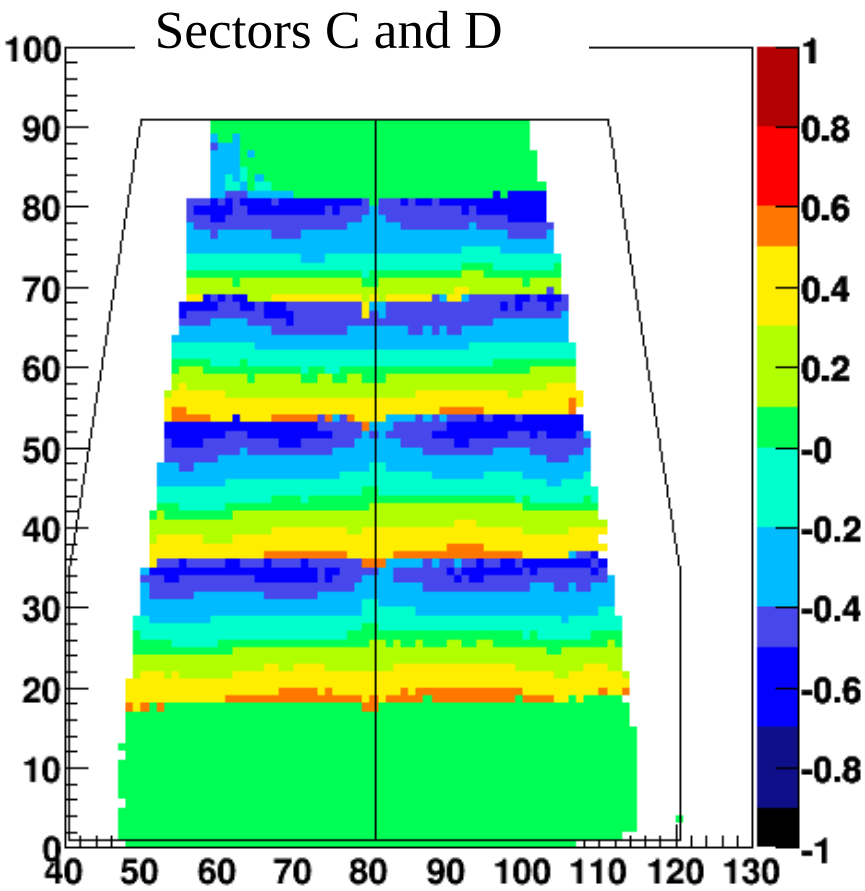
Depth Information

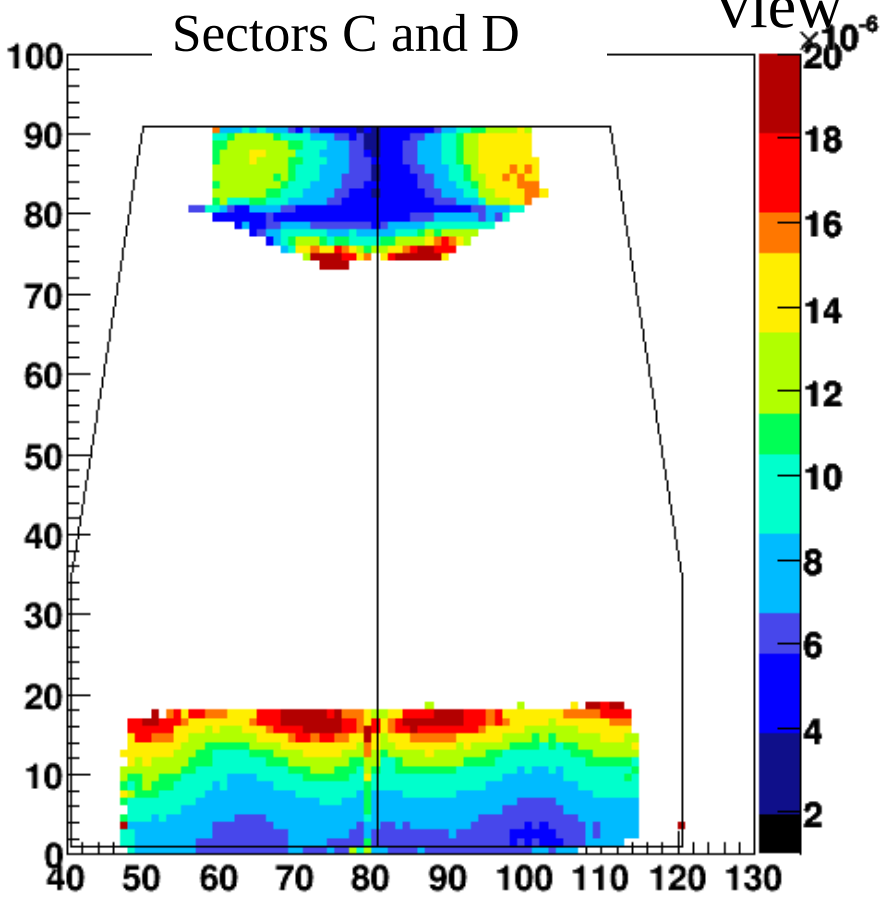
- Vertical Image Charge Asymmetry

$$ICA = \frac{|A_{above}| - |A_{below}|}{|A_{above}| + |A_{below}|}$$

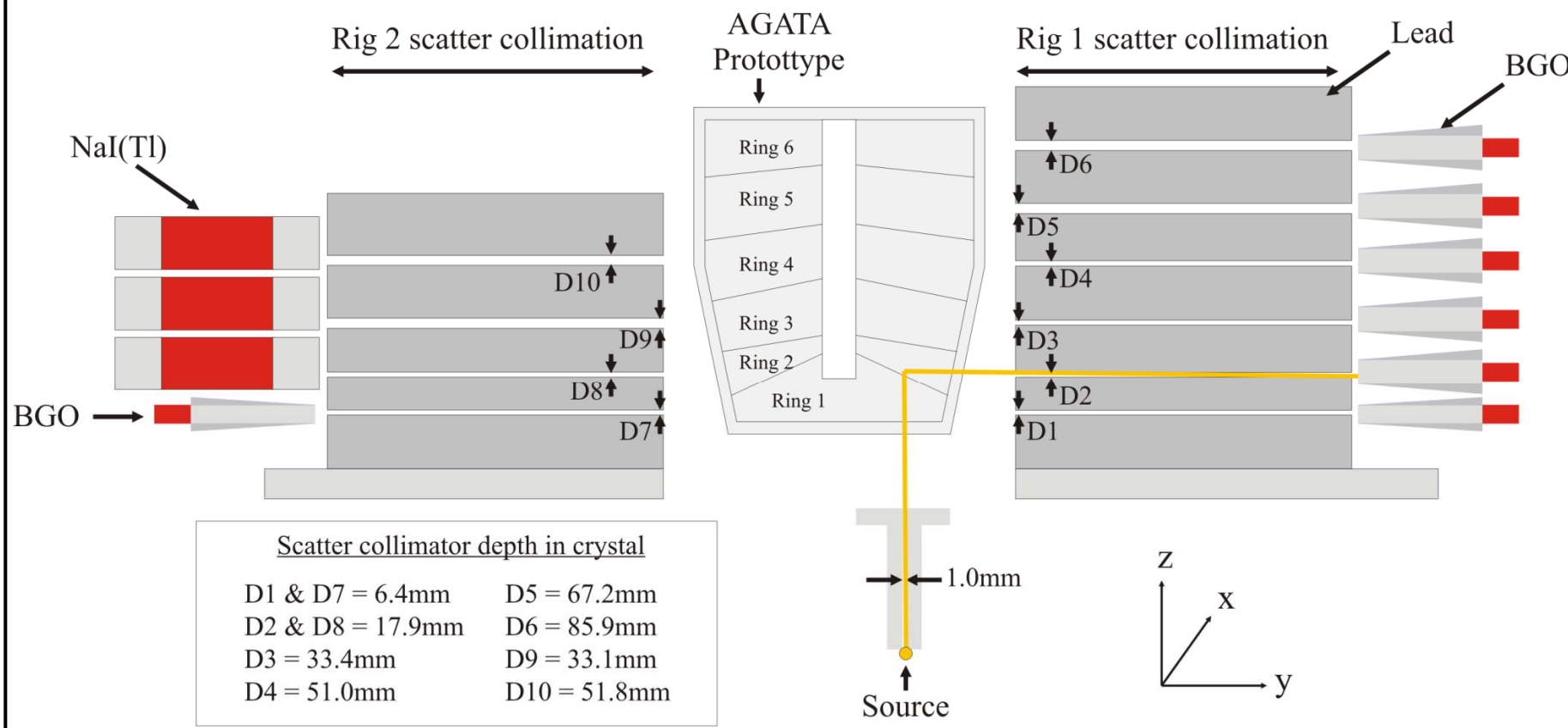


Back view





AGATA Coincidence scanning

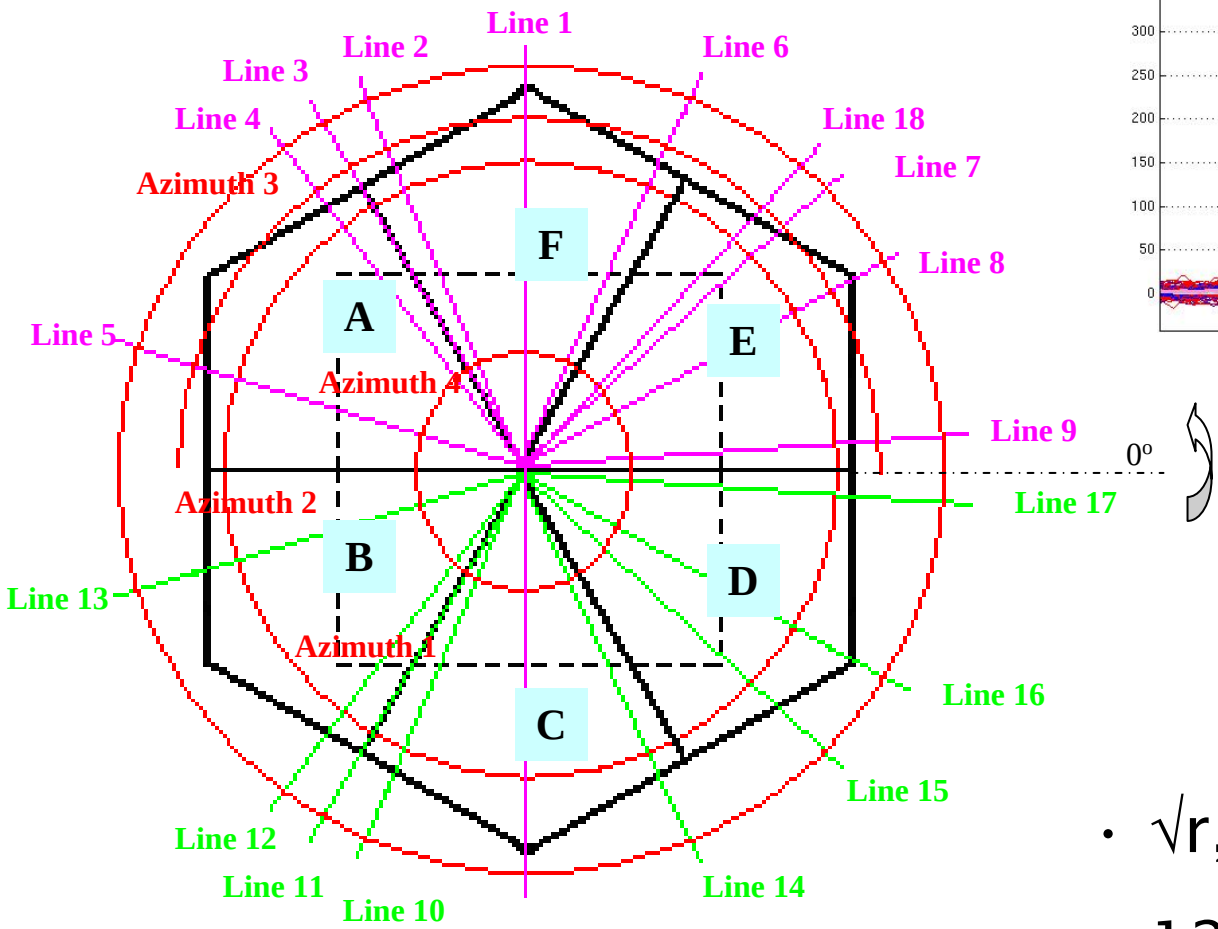


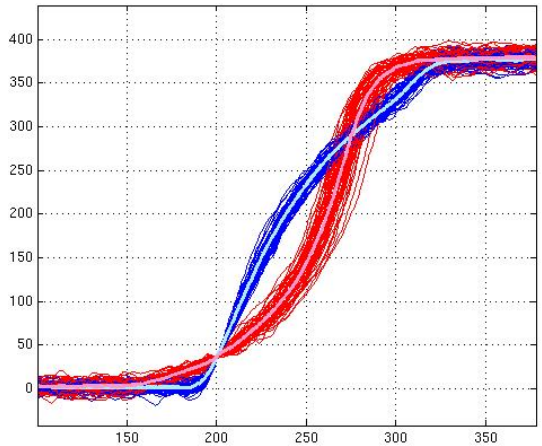
Scatter collimator depth in crystal

D1 & D7 = 6.4mm	D5 = 67.2mm
D2 & D8 = 17.9mm	D6 = 85.9mm
D3 = 33.4mm	D9 = 33.1mm
D4 = 51.0mm	D10 = 51.8mm

AGATA Coincidence scanning

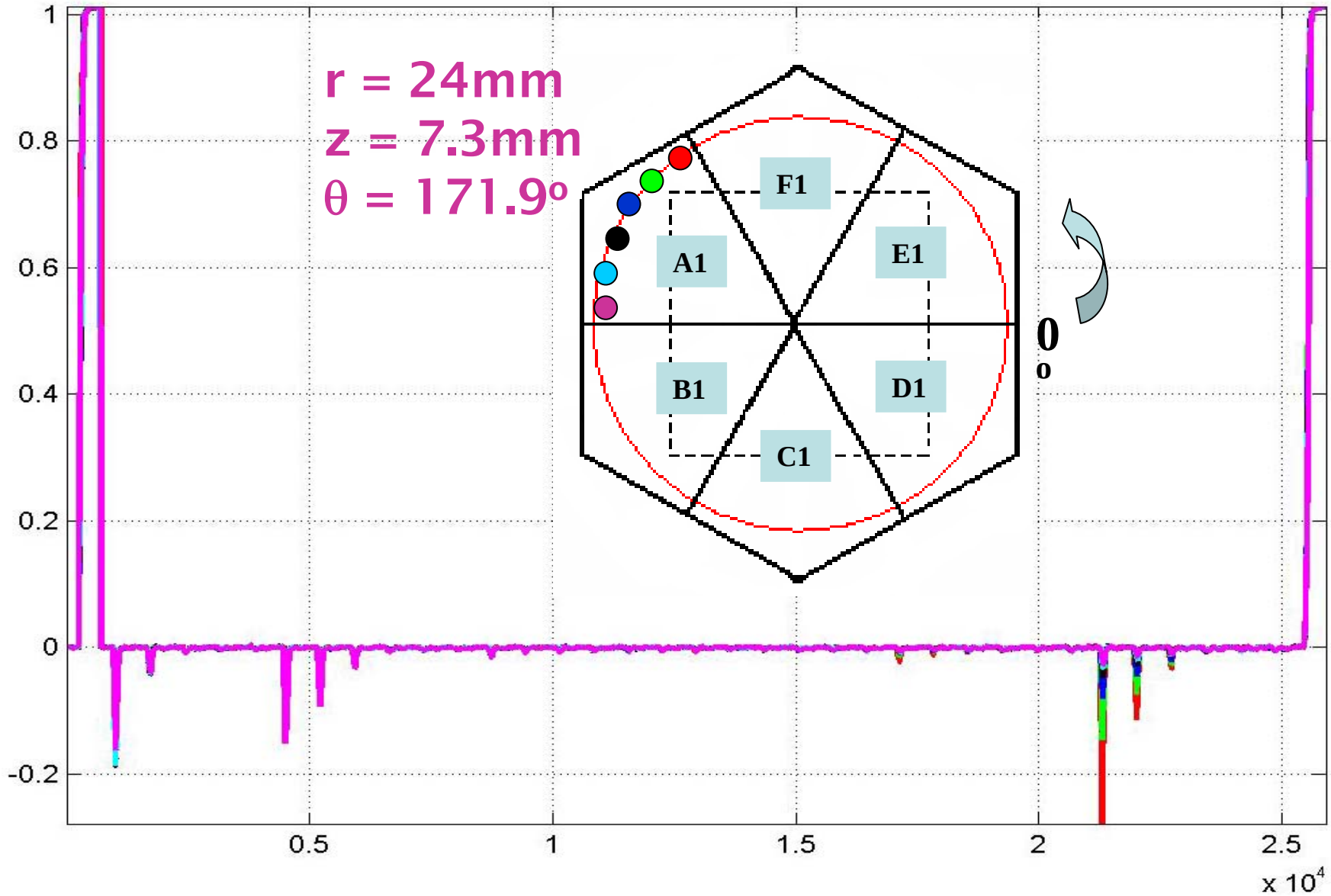
- 16 radial scans + 4 azimuthal scans



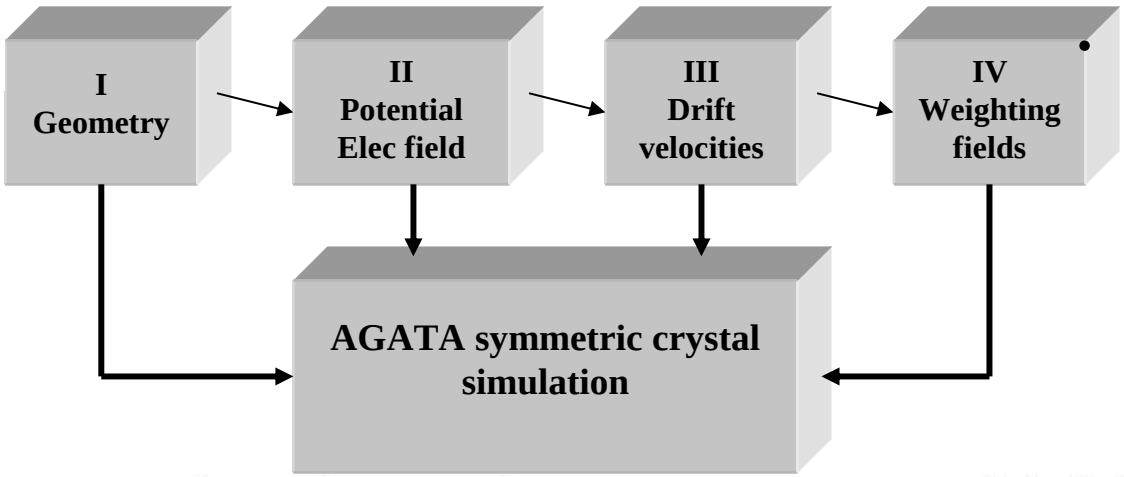


- $\sqrt{r}$,θ grid adopted
- 1200 positions

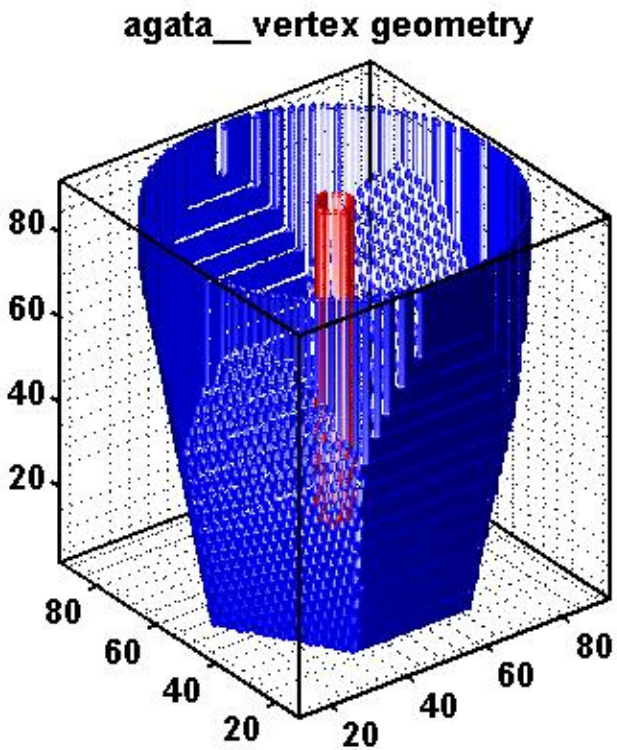
Azimuthal detector sensitivity

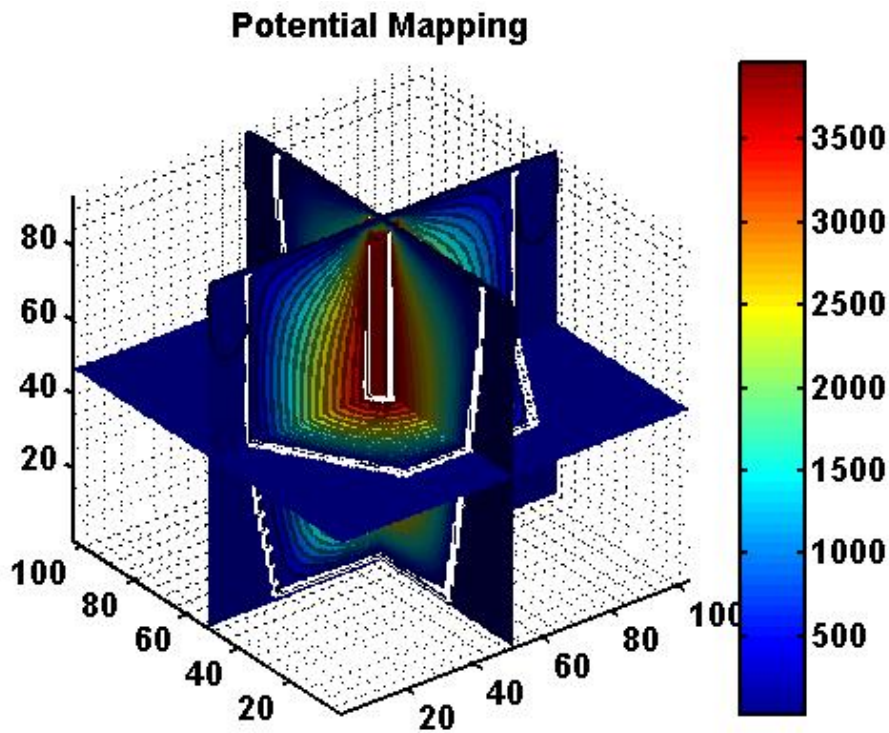


Electric Field Simulations : MGS

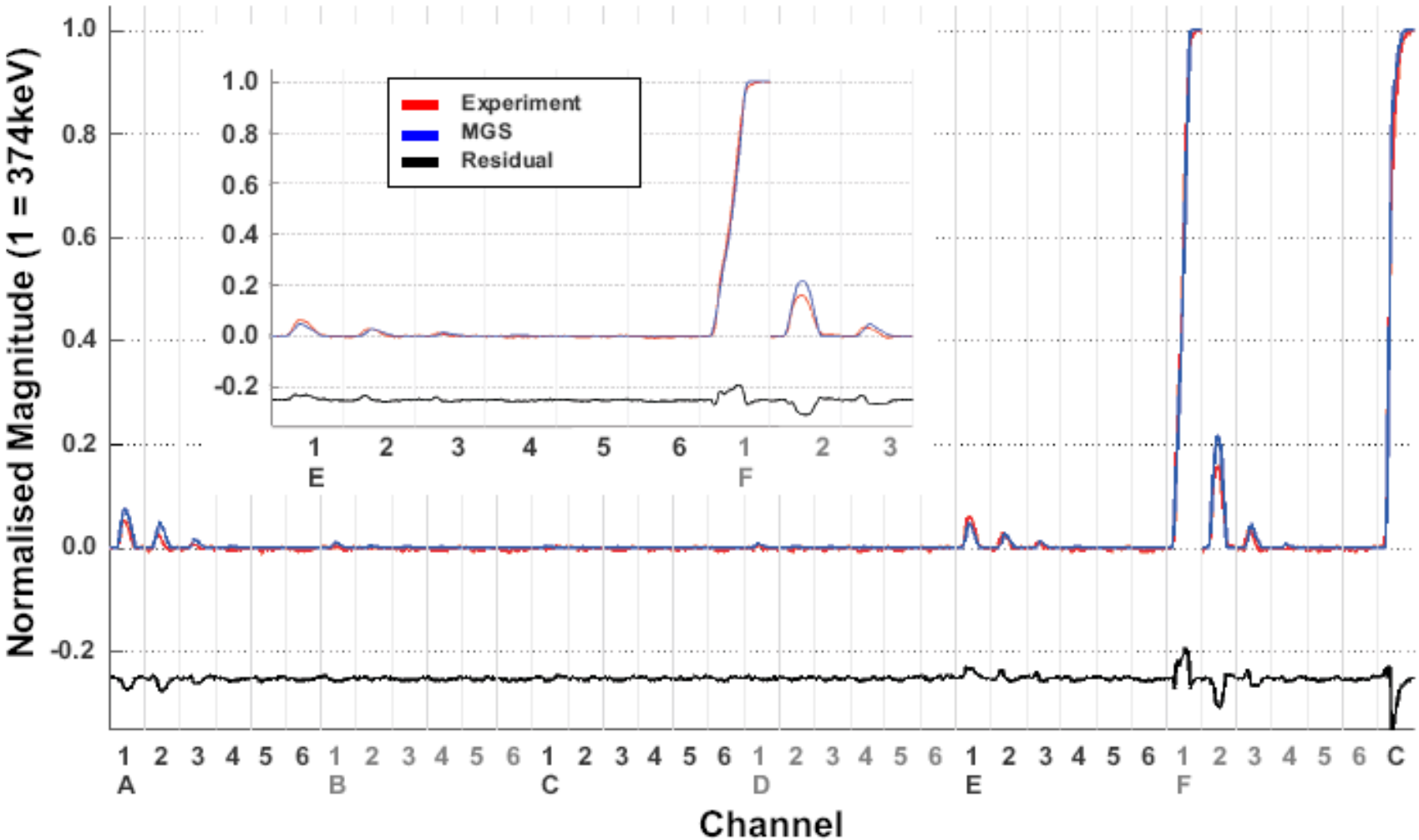


Electric field simulations have been performed and detailed comparisons have been made with experimental pulse shape data.



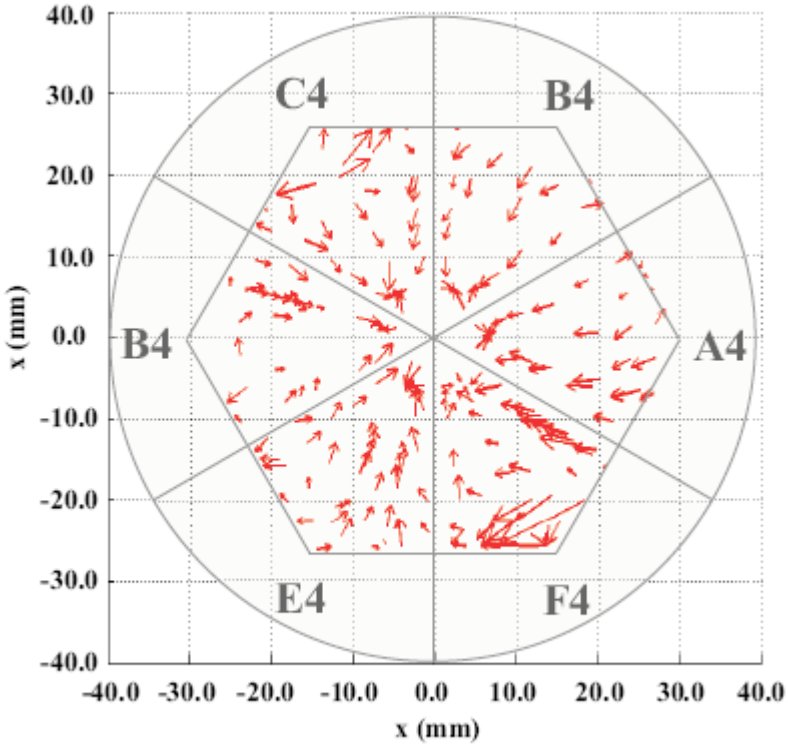


“Superpulse generation”

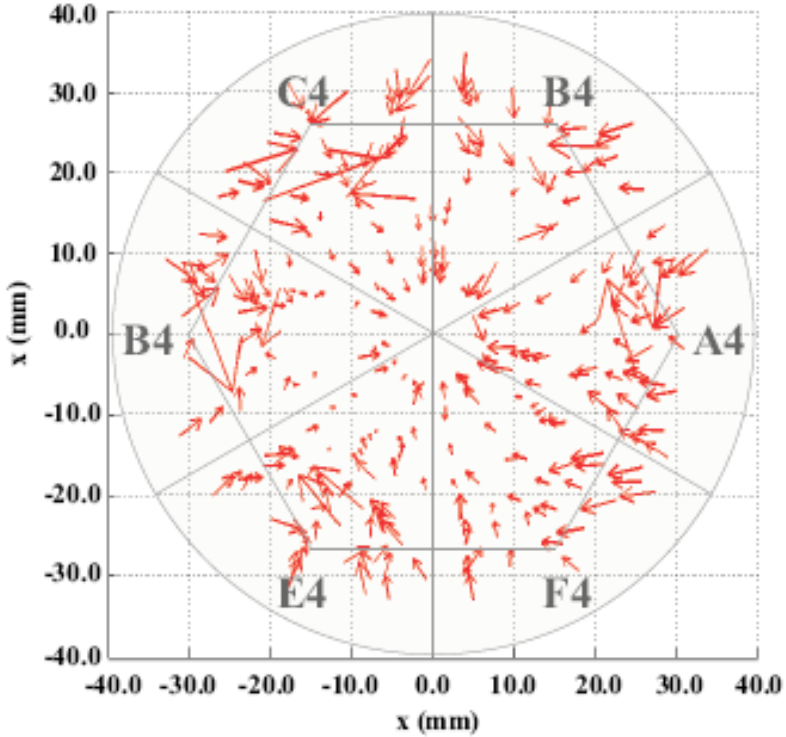


Zone 2, x = 5.7±0.7mm, y = -9.4±0.7mm, z = 15.7±0.3mm.

Experiment vs Theory Performance



a) Displacement vectors, z = 4.8±0.3mm



a) Displacement vectors, z = 48.8±0.9mm

Depth (mm)	Ring	Min Displacement (mm)	Max Displacement (mm)	<Displacement (mm)>
4.2±0.3	1	0.1±0.4	11.9±0.4	2.2±0.4
15.7±0.3	1	0.2±0.6	17.3±0.6	2.7±0.6
48.8±0.3	4	0.1±0.7	17.0±0.7	2.6±0.7

Status of the PSA

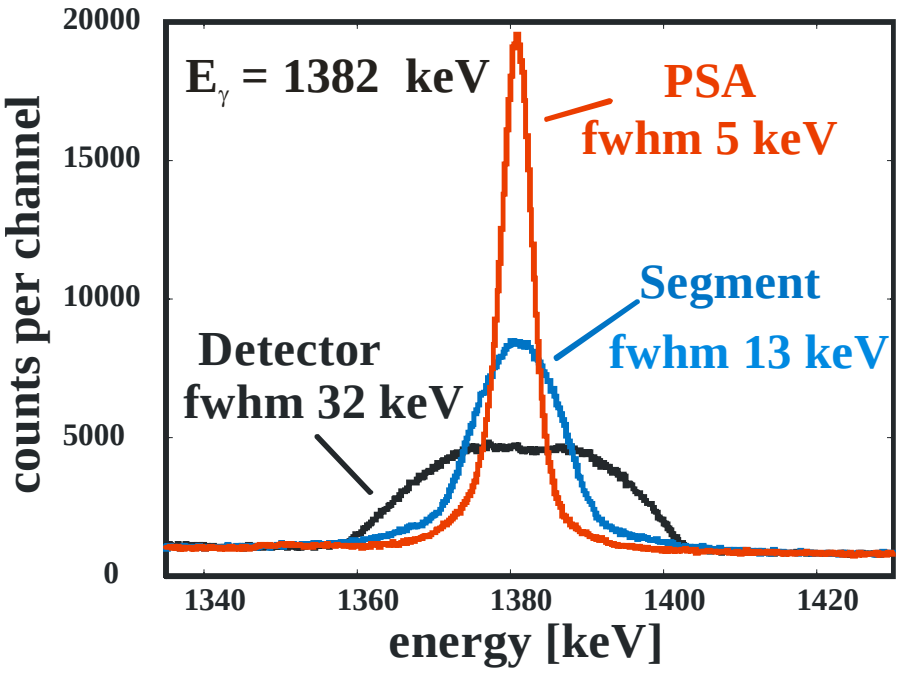
3 types of codes:

- Whole crystal with multi-hits per segment
  - Genetic algo. (Padova, Munich)
  - Swarm algo. (Munich)
  - Adaptative grid search (Padova)
  - Matrix method (Orsay)
- Single-hit in one segment
  - Binary search (Darmstadt)
  - Neural network (Munich, Orsay)
- Determination of the number of hits
  - Recursive subtraction (Milan)
  - Matrix method (Orsay)

Pulse-Shape Analysis: current status

Results from the analysis of an in-beam test with the first triple module, e.g. Doppler correction of gamma-rays using PSA results

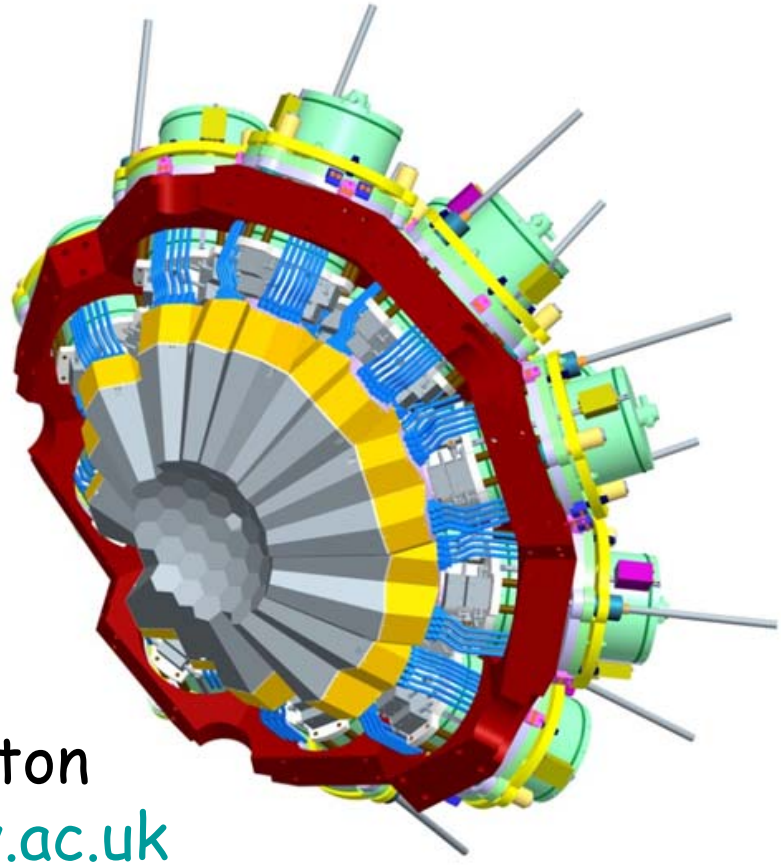
$d(^{48}Ti,p)^{49}Ti$, v/c ~6.5%



Results obtained with *Grid Search* PSA algorithm (R.Venturelli et al.)

Position resolution ~4.4mm

The Advanced Gamma Tracking Array detector characterisation



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