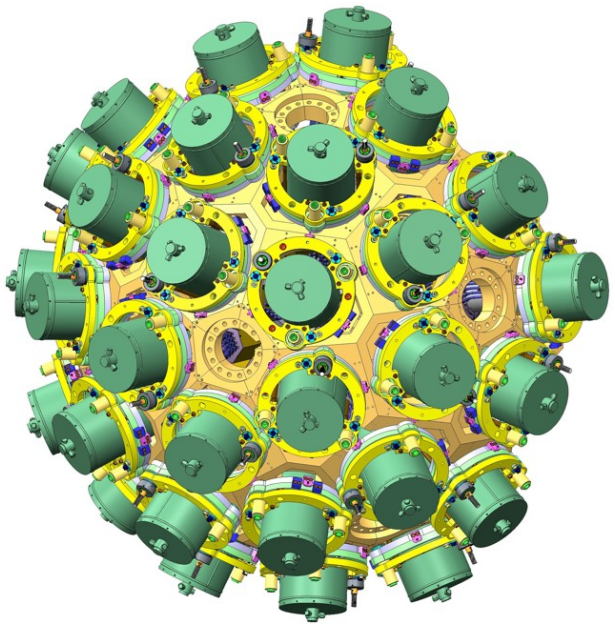
Pulse Shape Analysis

Andy Boston on behalf of AGATA PSA team



AGATA Pulse Shape Analysis

- Key Objectives
- Optimisation of the basis (characterisation JS later)
  - Selection of recent results
- Optimisation of AGS
- Other potential opportunities – Machine Learning etc
- Implementation for AGATA phase 2

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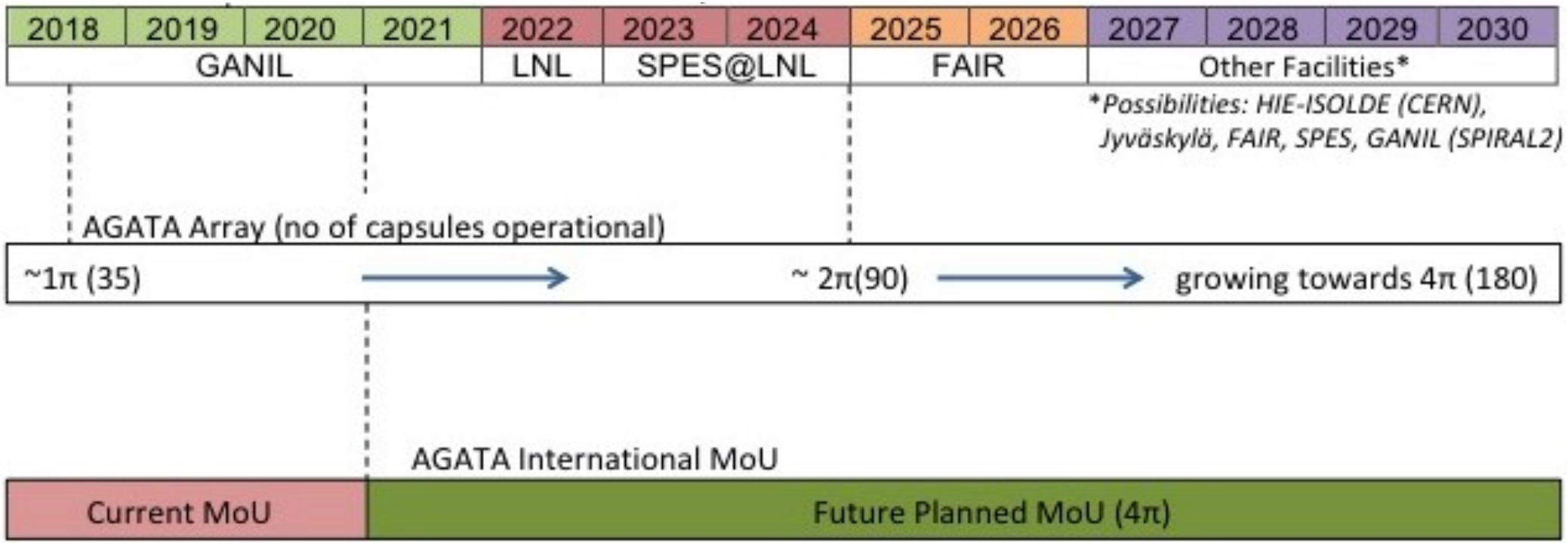

PSA objectives

- The implementation of the existing AGS algorithm will be optimised for performance throughput.
  - Include the addition of the export of PSA position uncertainties from the AGS algorithm to the Gamma-ray tracking algorithm (Marco)
  - This will potentially allow performance improvements in the gamma-ray tracking.
- The PSA algorithm will be upgraded* to include the handling of multiple interactions in a segment. The performance of this algorithm will be evaluated and a decision on implementation during phase 2.
- An exploration into the use of other (non AGS) PSA algorithms for future implementation.
  - The focus is on the possibilities available using machine learning and will build on initial work that has started within the collaboration.

*with AGS/GRETINA SD

Pulse shape analysis: Basis optimisation

- Investigation of the dominant factors limiting the performance of the calculated basis.
  - An evaluation of the impact of the temperature dependence of the mobility parameters
  - The impact of a realistic charge cloud size
  - Crystal dead layer related effects – the dead layer around the core electrode.
  - Neutron damage limitations – how the degree of neutron damage influences the efficacy of the signal basis in addition to the energy resolution correction already implemented.
  - The impact of the electronics signal chain (preamplifier, grounding/configuration)

Pulse shape analysis: Basis optimisation

- Experimental database approach
  - In situ determination of basis J. Ljungvall Eur. Phys. J. A (2018) 52: 198
  - PSCS method M. Ginsz, PhD thesis 2015 and conference proceeding

- ADL basis and optimisation
  - Data from Liverpool coincidence tables(s) (F. Holloway / A. Kus)
  - Data from PSCS at IPHC following recent U/G (B. De Canditiis)
  - Use scan data and full array data (L. Lewandowski)

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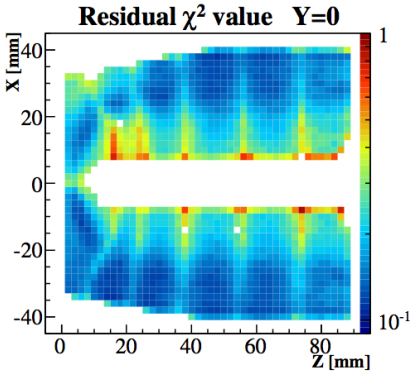
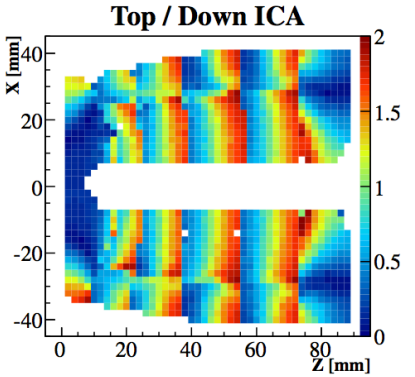
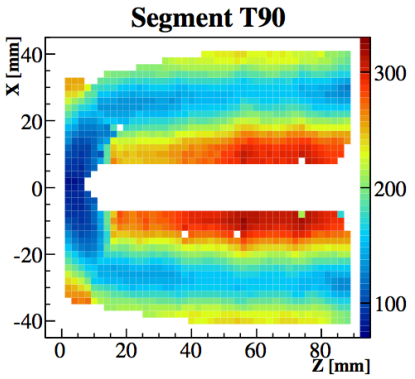
PSCS validation and experimental basis







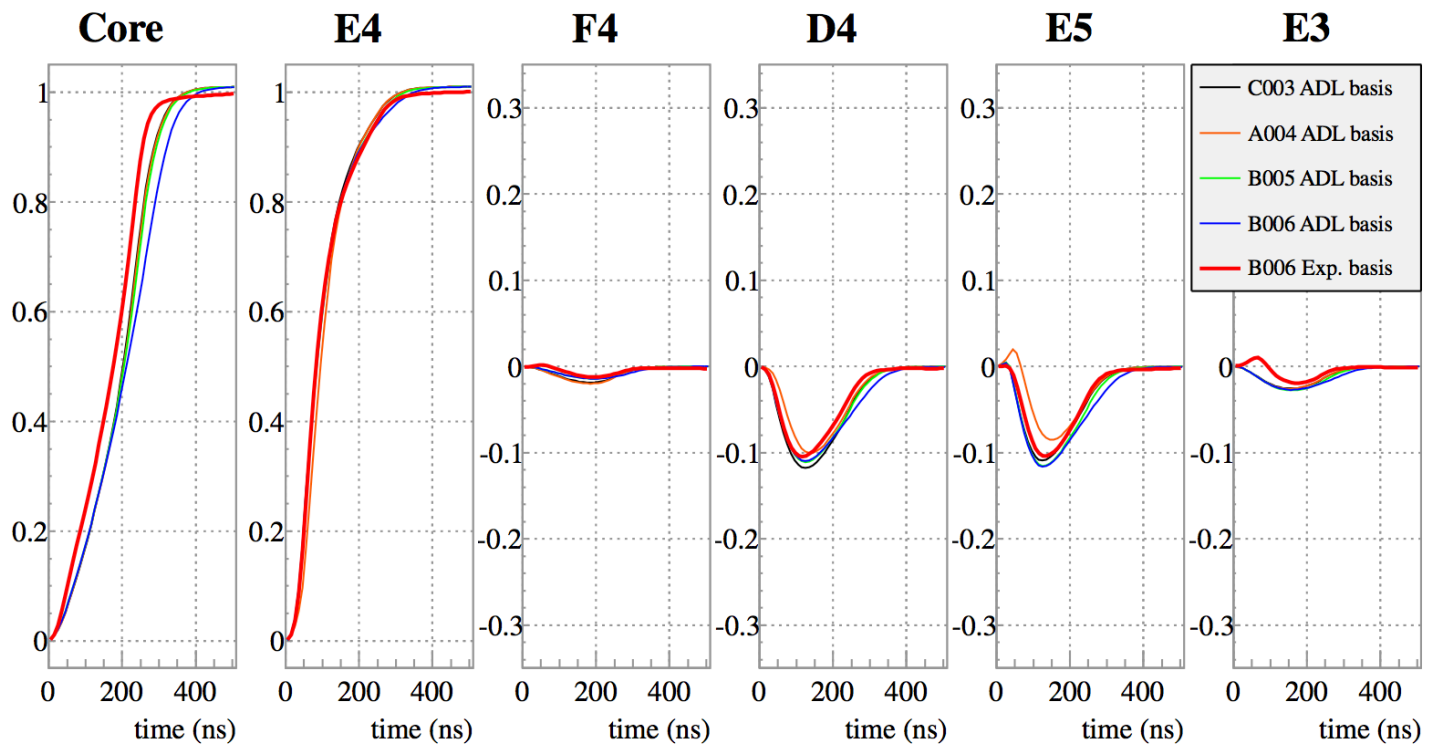
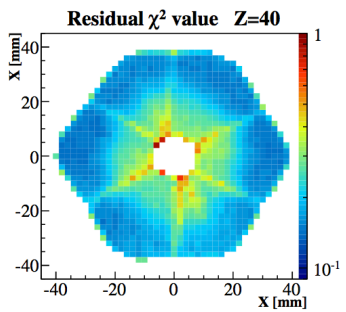
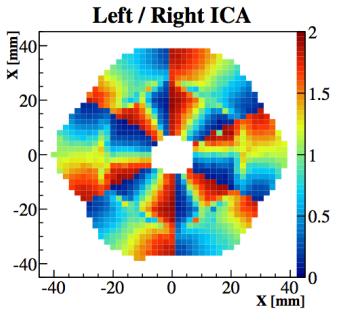
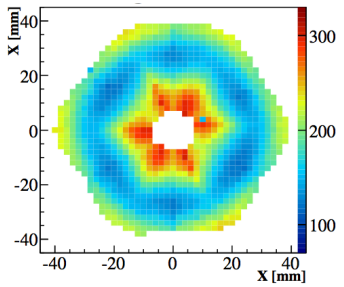


Figure 5.17: Comparison between experimental basis and several ADL basis at position X=30, Y=-4, Z=48 mm







M. Ginsz PhD Thesis (2015)

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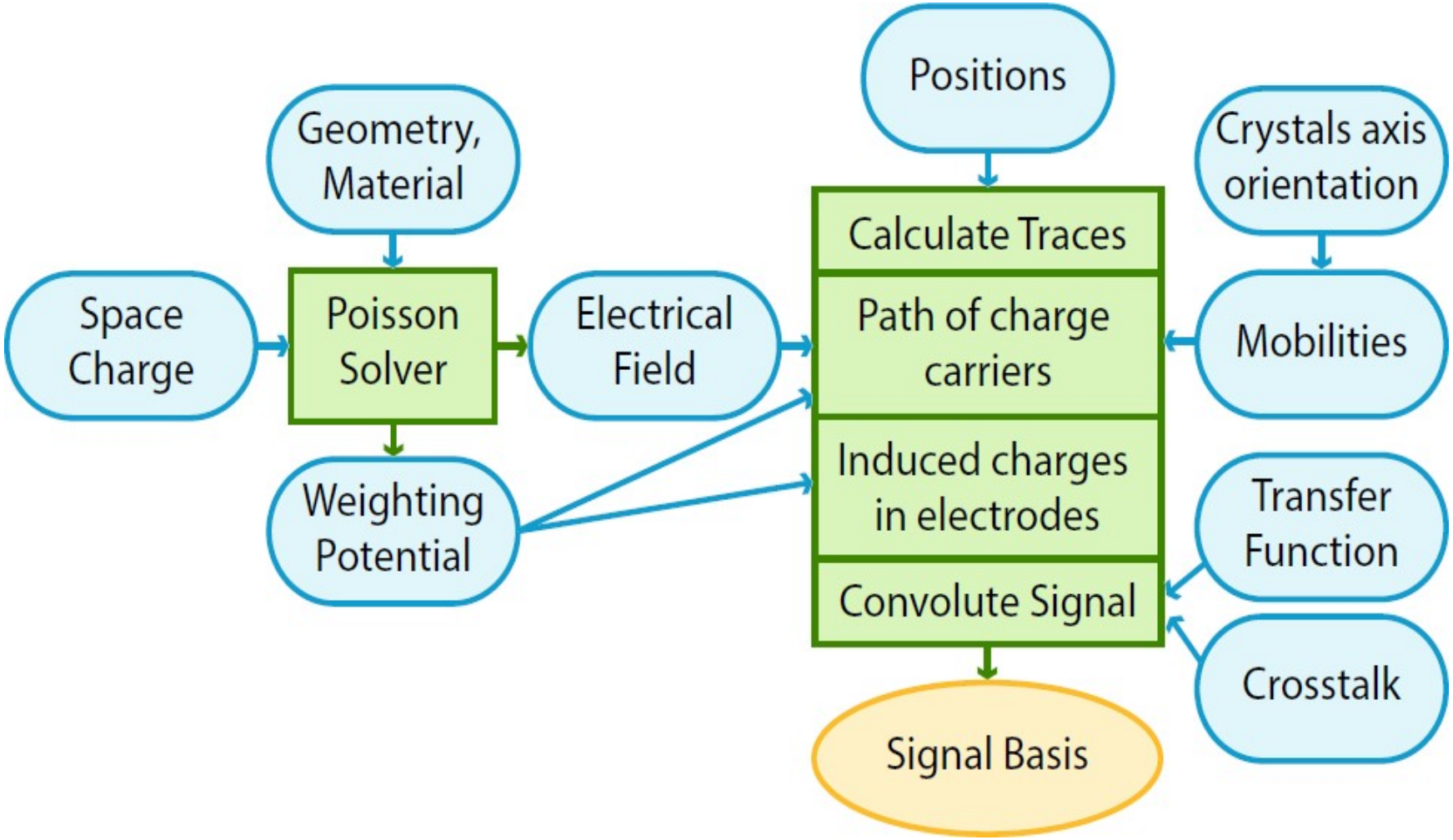
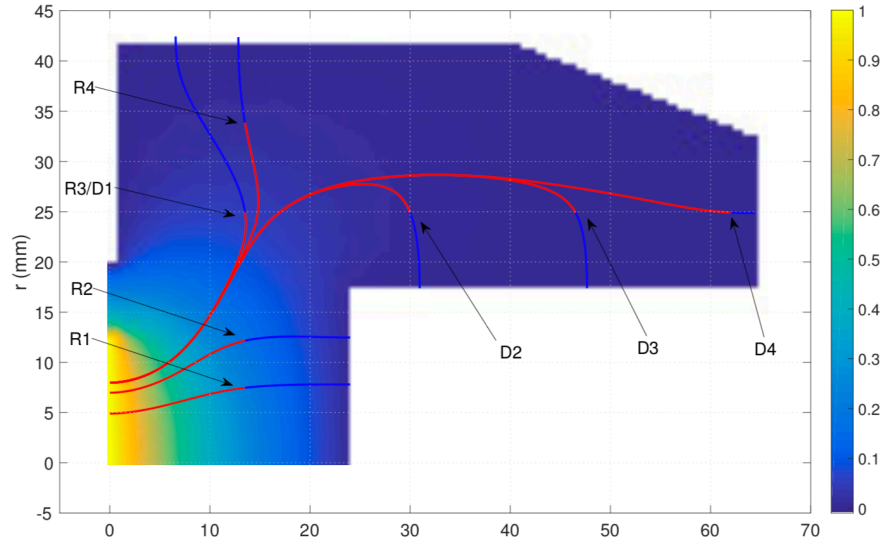
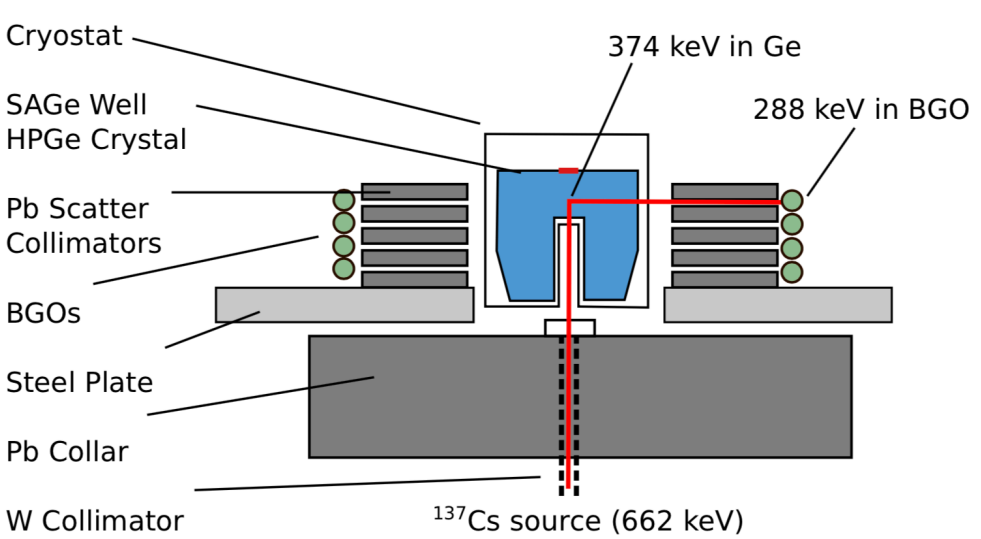
AGATA Data Library

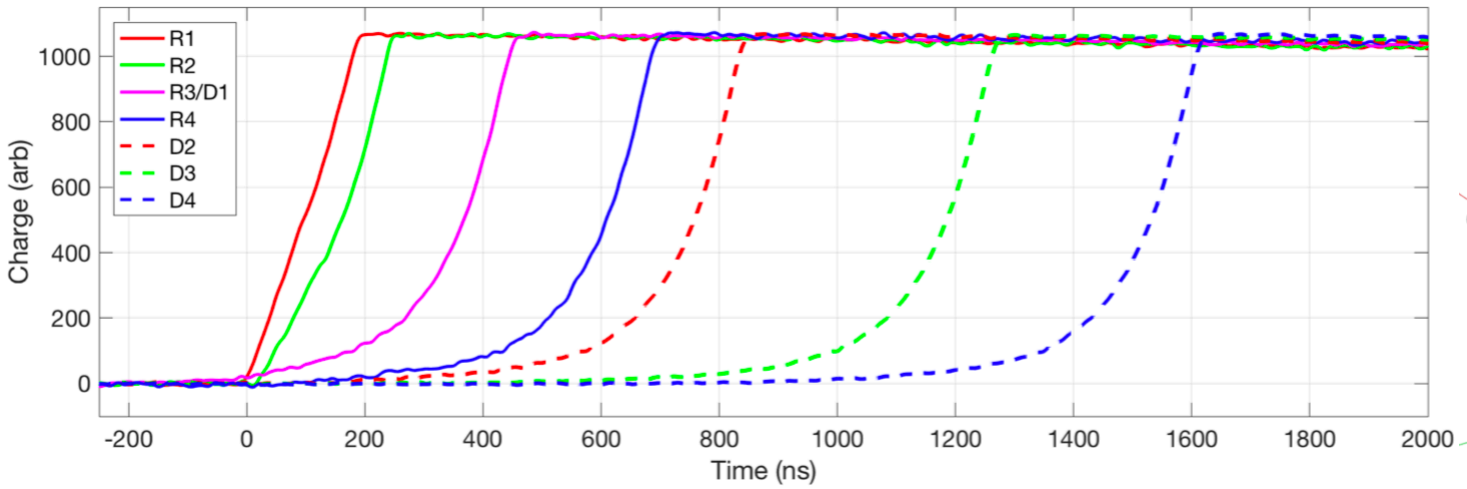


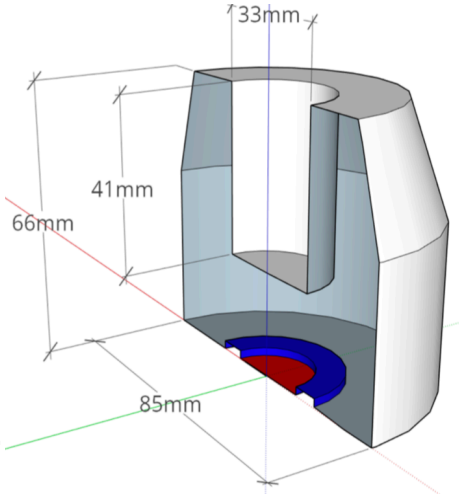
Pulse shape analysis and position determination in segmented HPGe detectors: The AGATA detector library. Bruyneel, B.; Birkenbach, B.; Reiter, P. in *The European Physical Journal A* (2016). **52**(3) 70.

Liverpool TSLM SAGe commissioning



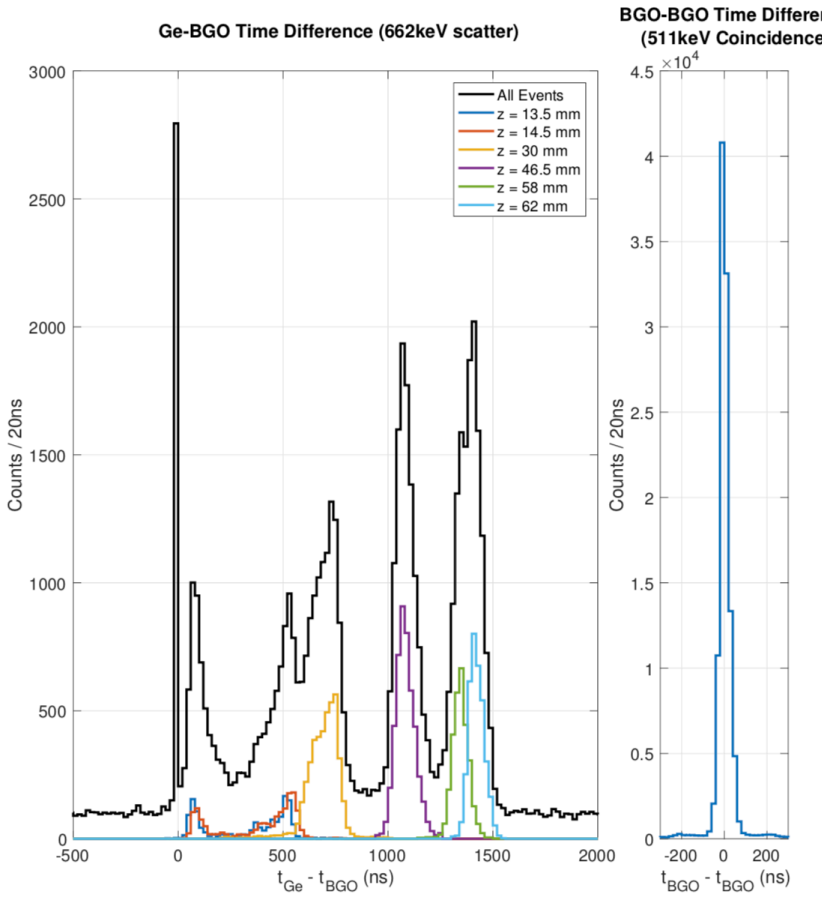


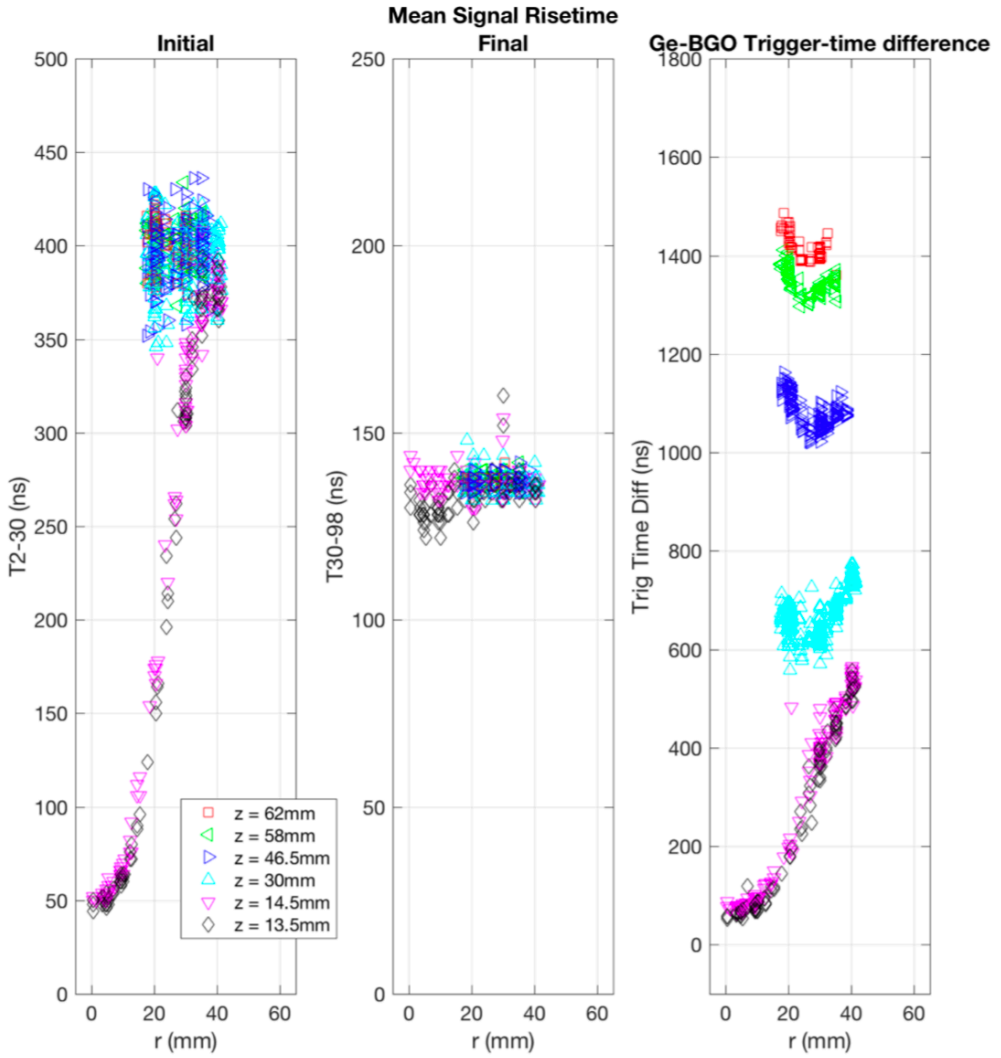




https://doi.org/10.1016/j.nima.2019.02.043C. Unsworth, NIMA 927, 21 May 2019, Pages 293-300

TSLM performance tests





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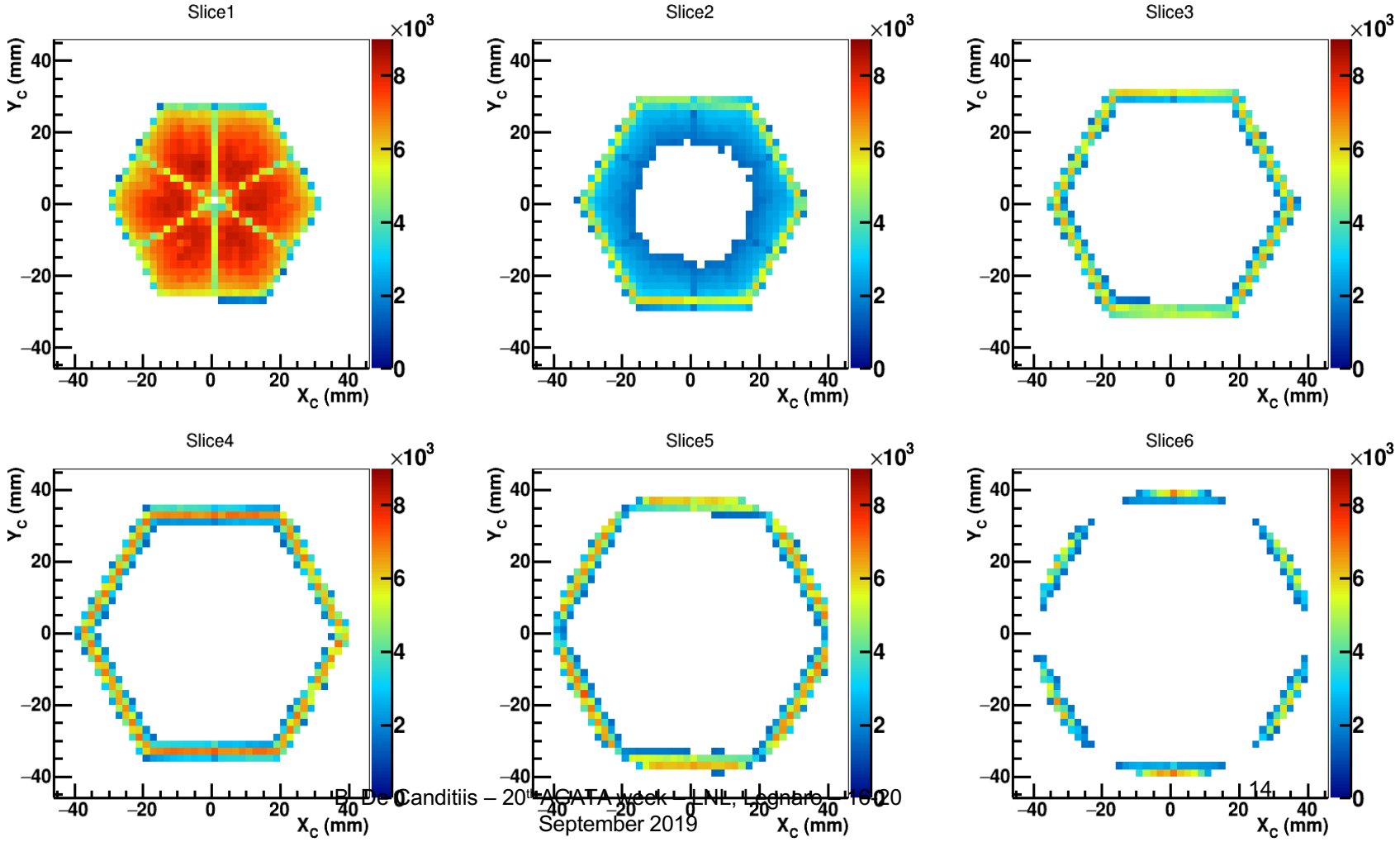
AGATA detector PSCS simulations and first 2D scan with 152Eu

20th AGATA week and 4th PSeGe Workshop
LNL, Legnaro – 16-20 September 2019

B. De Canditiis, G. Duchêne, F. Didierjean, M. Filliger, M.H. Sigward

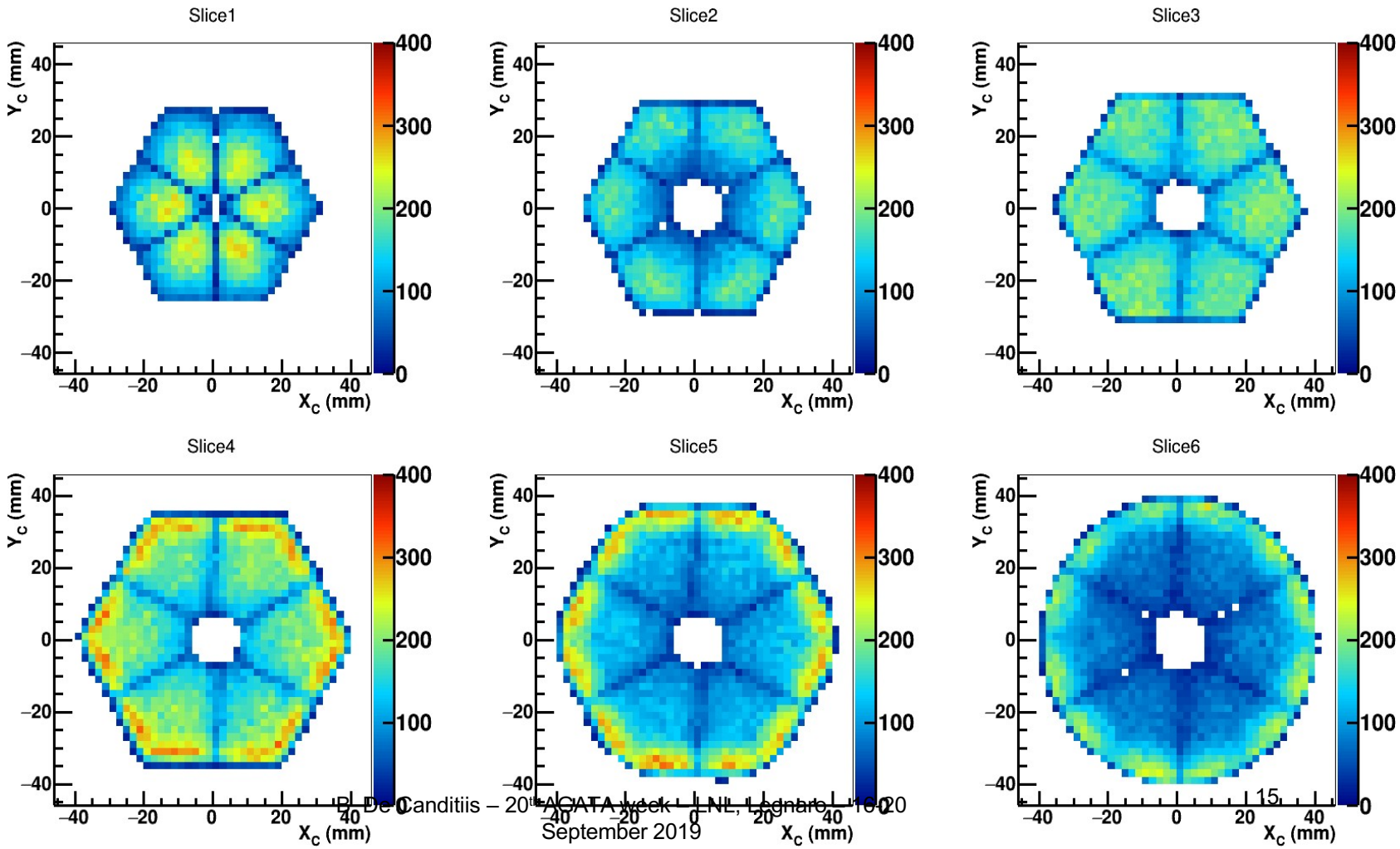
Measurements on S001: 2D scans @ 122keV

Full area scan: 152Eu @ 122keV (BR 29%), diam. 1.0mm, pitch 2x2mm^2



Measurements on S001: 2D scans @ 1408keV

Full area scan: 152Eu @ 1408keV (BR 21%), diam. 1.0mm, pitch 2x2mm^2

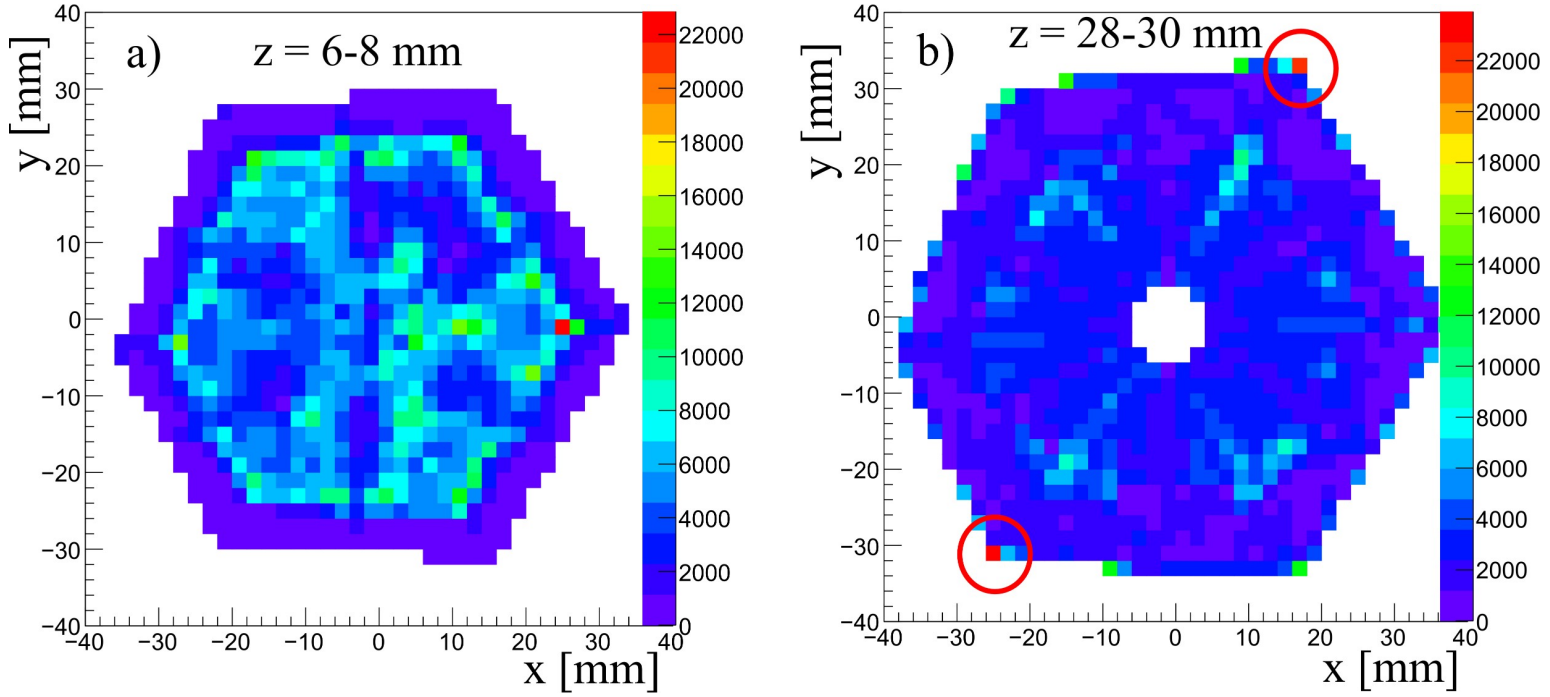


Optimisation of the ADL basis @ IKP

- Investigation and optimization of PSA performance, including:
  - Transfer function
  - Hole mobility
  - Electron mobility
  - Weighting of transient signals
  - Split distance metric for transient signals
- Improved PSA results, but still not ideal

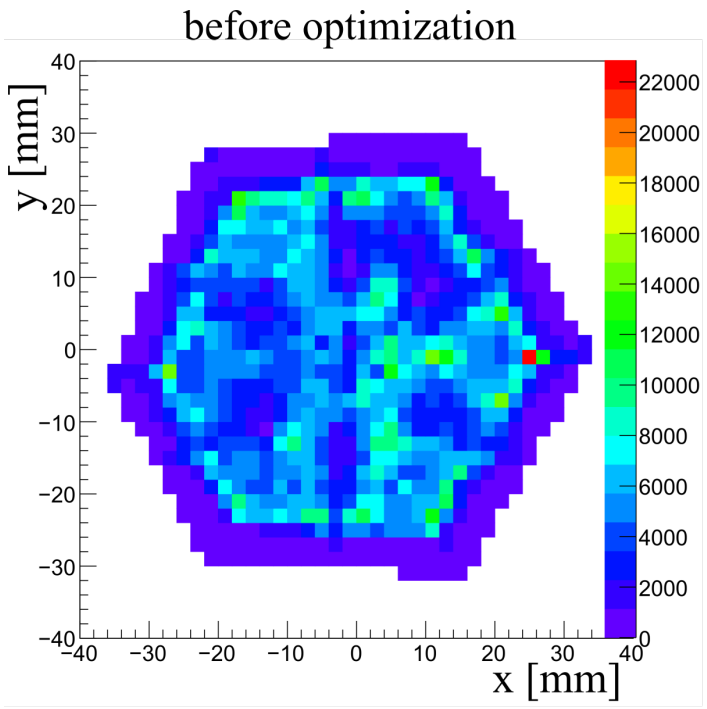
Lars/Peter talk tomorrow

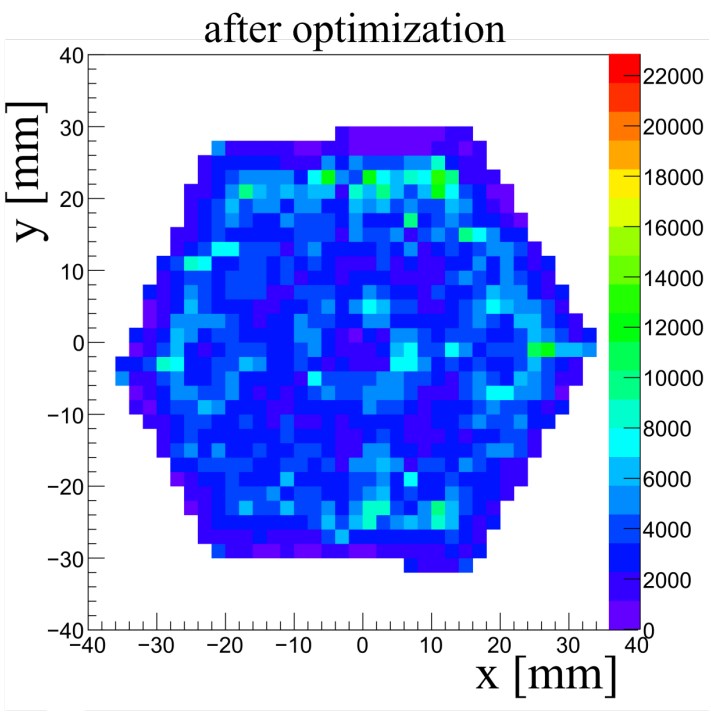
Results of the Pulse Shape Analysis



- Same expectation value for grid points with same *z*
- Example: crystal A001

Results of the Pulse Shape Analysis





- Exemplary hit distributions (crystal A001)
- $z = 6 - 8\,\mathrm{mm}$

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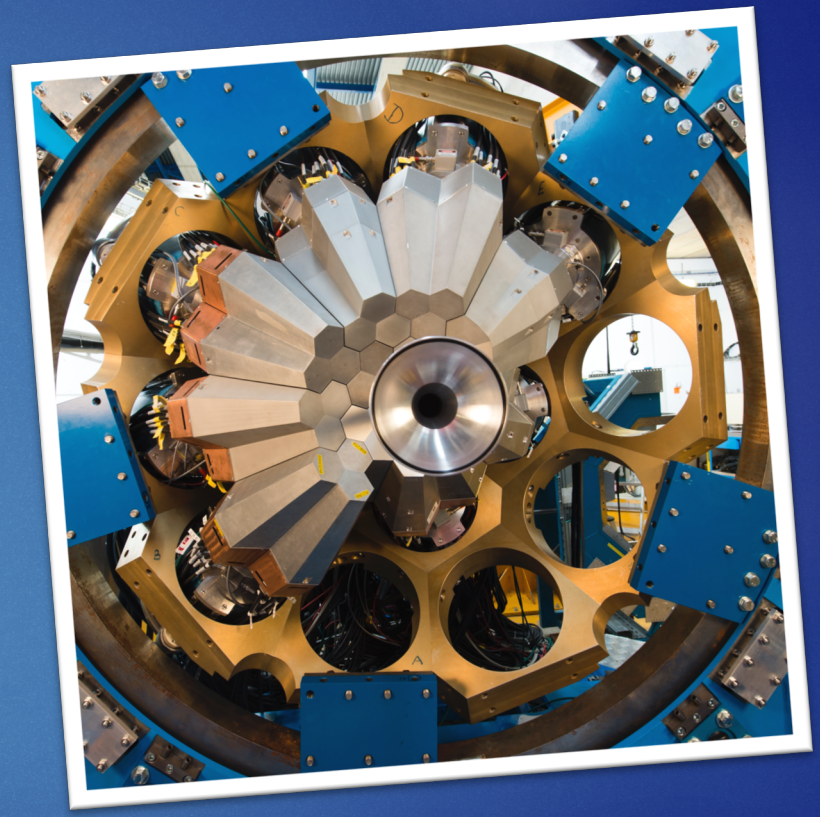
AGATA Week 2019

Machine Learning and Topological Data Analysis for Pulse Shape Analysis

Fraser Holloway



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AGATA ADVANCED GAMMA TRACKING ARRAY

Future PSA Implementation

- Data Flow and PSA Infrastructure upgrades
- The computation performance of the algorithm(s) needs to be optimised to run on highly parallel, multi-core nodes.
- The existing algorithm is limiting the rate capability of AGATA phase 1.
- In AGATA phase 2, the algorithm(s) will be optimised to adapt to the new platforms and to allow flexibility in basis format, PSA outputs, and pre-processing options.
- To take advantage of the performance gains provided by computational advances.

PSA tasks going forward

- Pristine basis generation with irregular basis using SIG-GEN
- Optimised basis with experimental corrections (from ^{60}Co flood data)
- Development of an integrated data set of two interactions/segment using collimated scanning data
- Development of an integrated data set of two interactions/segment using collimated scanning data from AGATA digitisers
- New PSA algorithm development

PSA tasks going forward

- Implementation of multiple interaction algorithm for testing in beam
- Inclusion of positon uncertainties in PSA output
- Including regular/irregular basis and ADL/SIG-GEN
- Multiple interaction algorithm implementation
- Tracking: use of uncertainties propagated from PSA

Perspectives

- Availability of AGATA capsules for characterisation
- Continuity of available personnel to implement PSA algorithms

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