Performance Measurements for the Ge Tracking Array AGATA

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Outline

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3. Method
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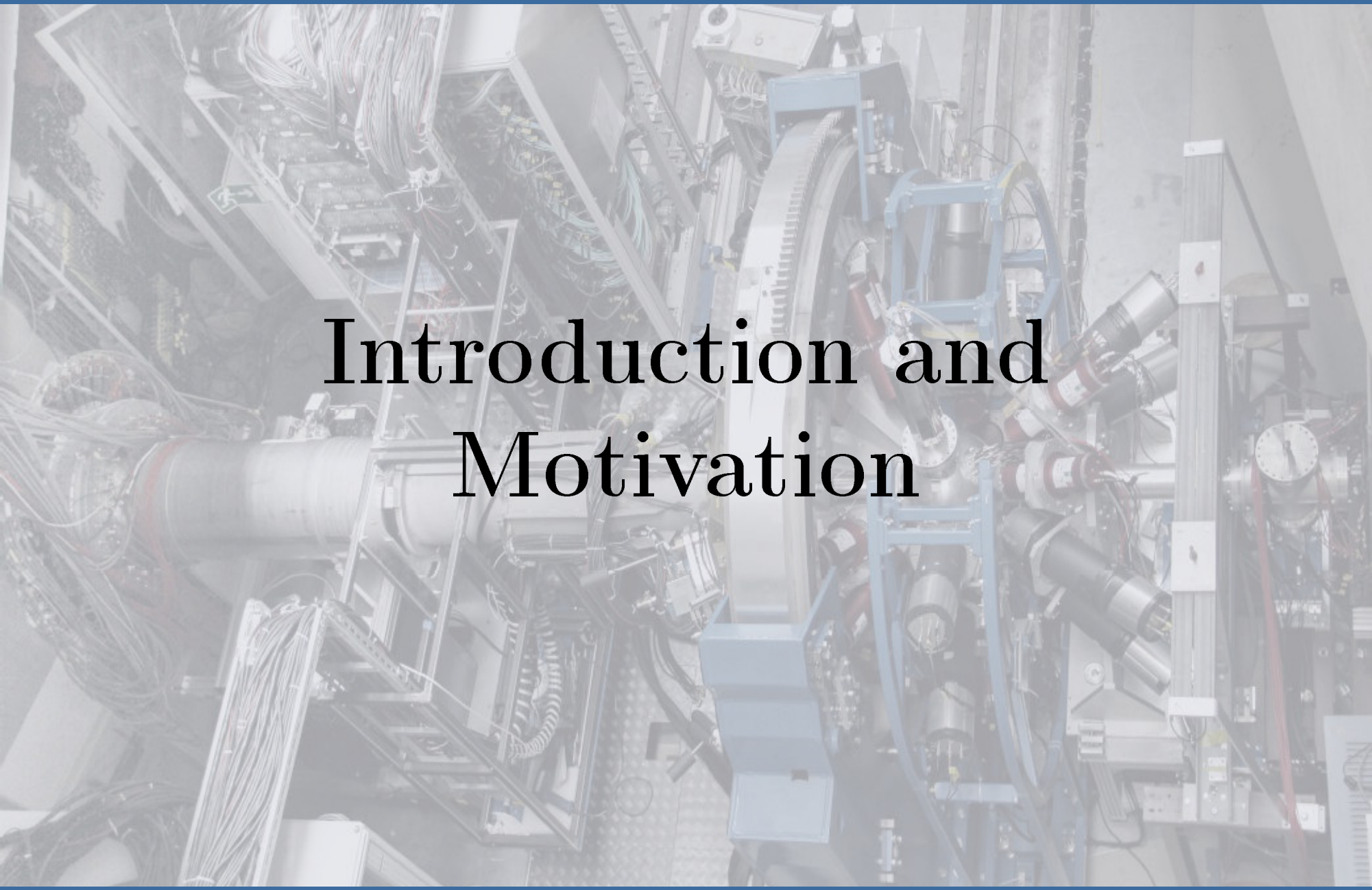
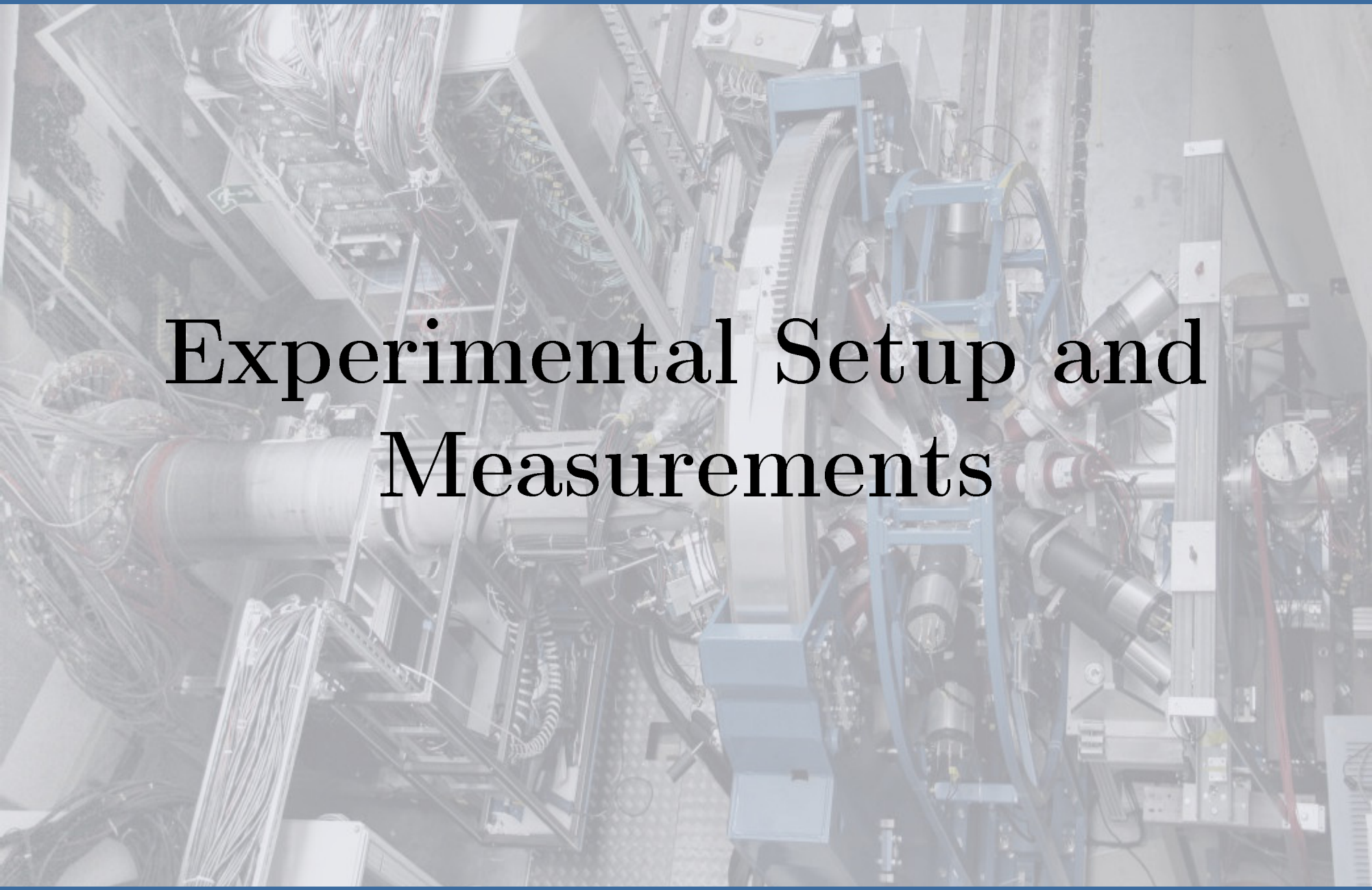


Introduction and Motivation

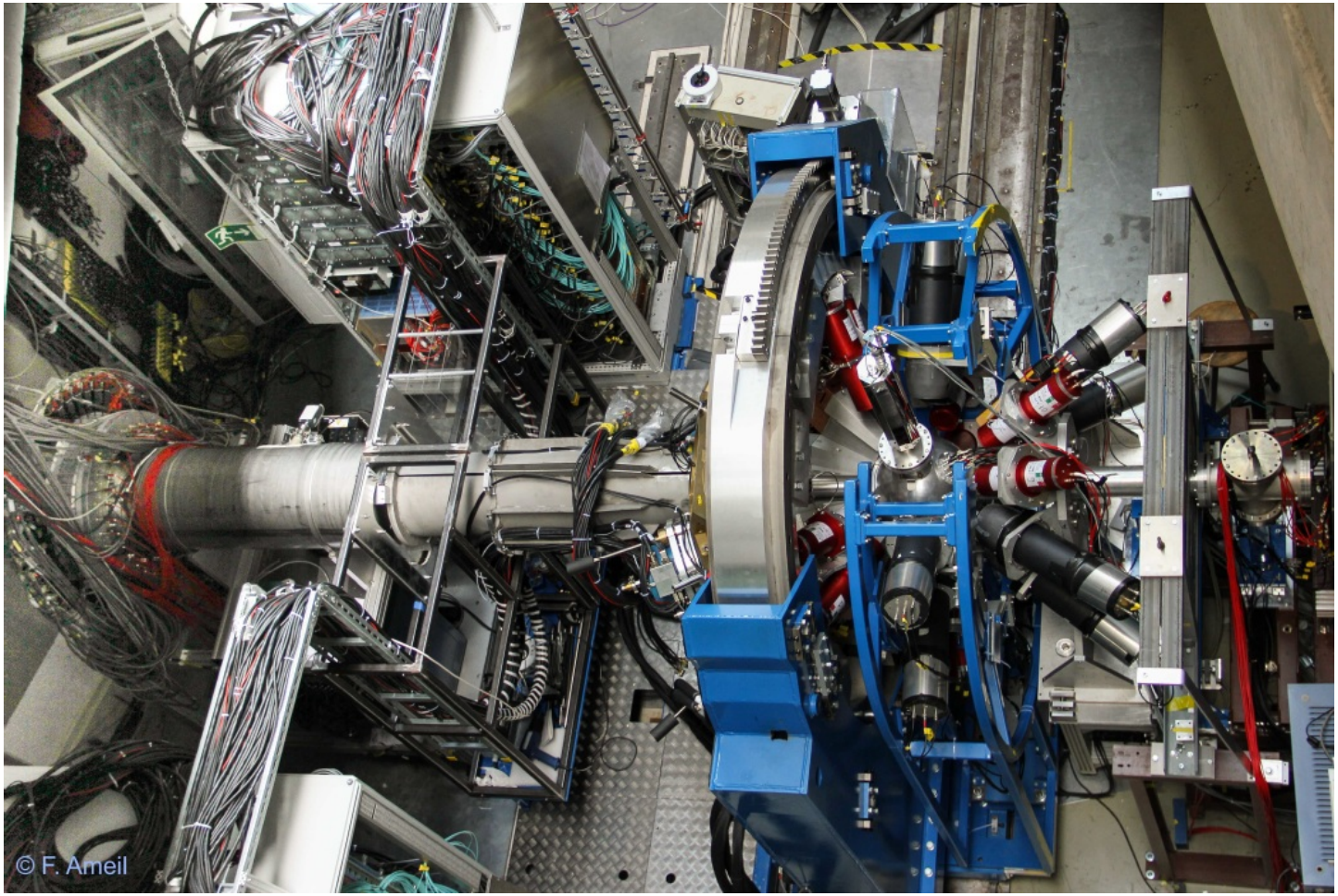
Motivation

- In 2012 and 2014 the PreSPEC-AGATA campaign was conducted at the final focal plane of the Fragment Separator at GSI
- Particle selection and identification in the FRS and a sophisticated γ-ray tracking spectrometer allowed for in-beam γ-ray spectroscopy of radioactive ion beams
- But: Reliable AGATA performance figures are missing!
- A dedicated measurement was done to characterize the setup: *photopeak efficiency*, *peak-to-total* (P/T), *quality of custom AGATA algorithms*



Experimental Setup and Measurements

PreSPEC – AGATA



F. Ameil, Complete PreSPEC-AGATA Setup, GSI Darmstadt, 2014

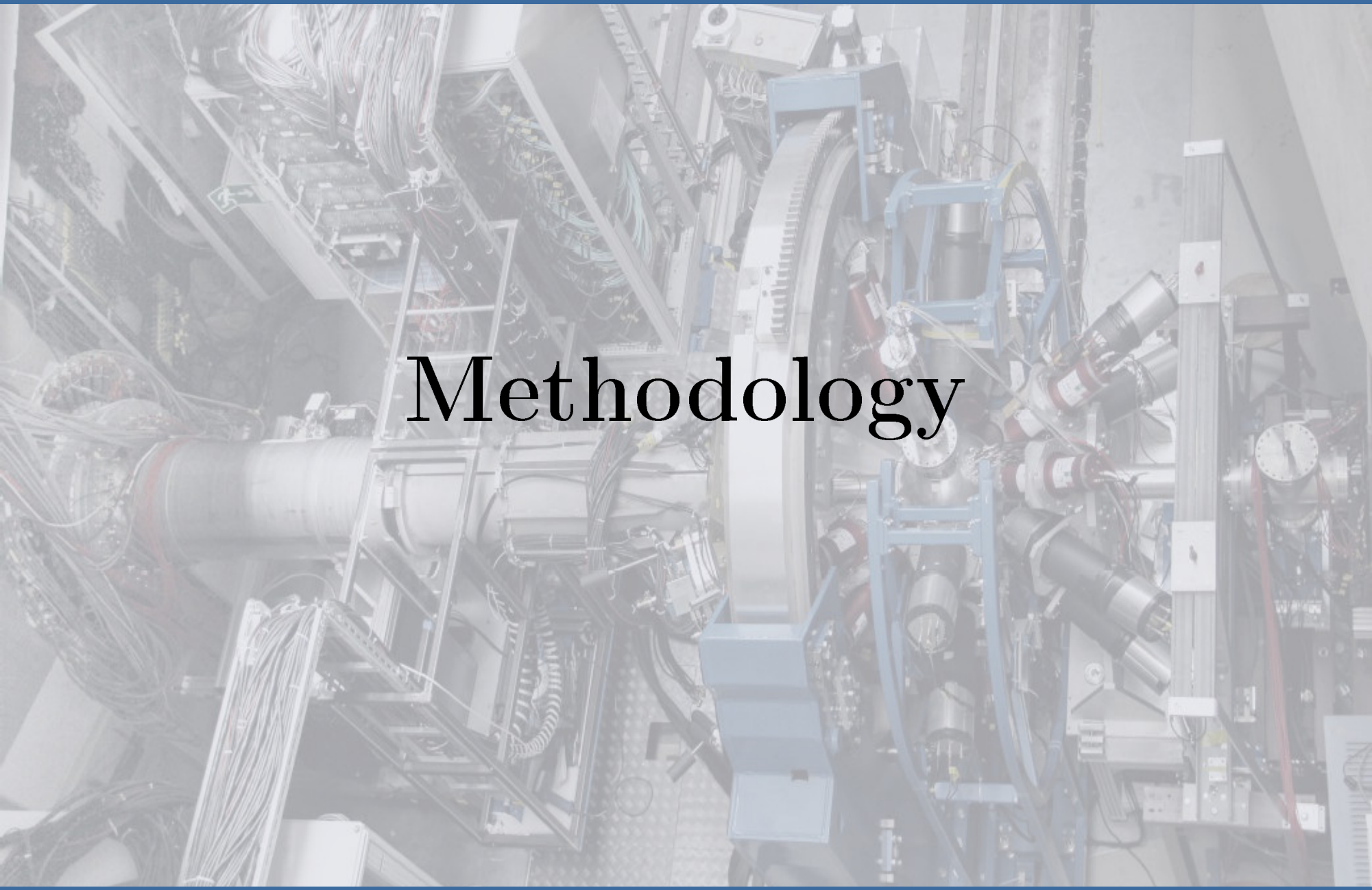
Source Run

- At the beginning of and after the campaign, measurements with different sources were conducted
- ^{60}Co, ^{152}Eu, ^{133}Ba, ^{166m}Ho, ^{56}Co
- Idea: use an external detector as a trigger: *Euroball*
- *Why?*

Experimental Setup

- Twenty-one 36-fold segmented AGATA crystals
- Nominal target-array distance: 23.5 cm
- Calibration sources placed at the target position
- Euroball implemented in the DAQ as if it were one of the AGATA detectors

Position of the reference Euroball detector

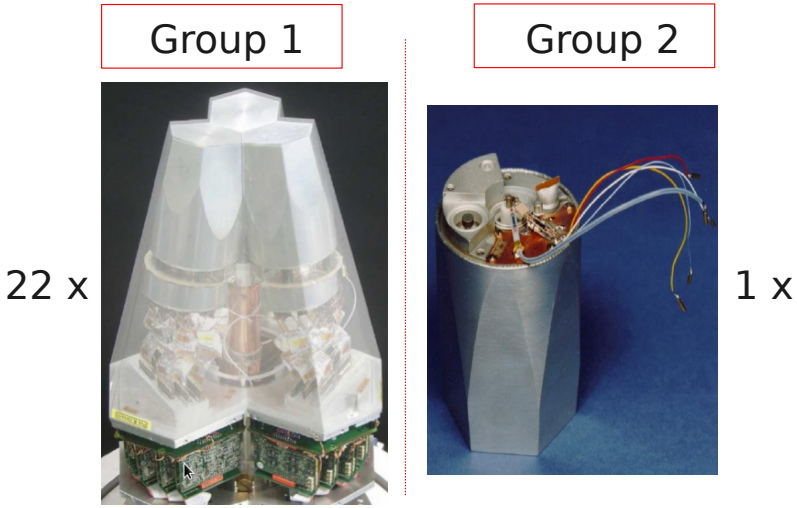


Methodology

1. Coincidence Analysis → Absolute Efficiency

- ^{60}Co data set
- distinguish the reference detector from all AGATA crystals
- Gate on 1.33-MeV line in the spectrum of Euroball
- Total number of *'triggers'* recorded by Euroball defines the number of γ rays emitted in 4π

$$\epsilon = \frac{^{1.17}I_{Agata}}{^{1.33}I_{Euroball}}$$



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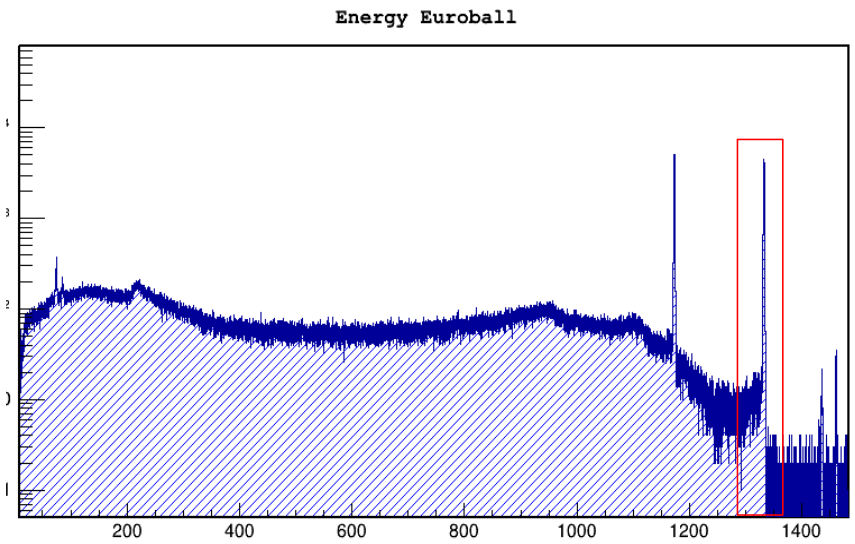


1. Absolute Efficiency

1.a) calorimetric

- Summing up energies recorded by the central contacts of all crystals

1.b) central contact

- Energy from the central contact of only a single crystal

1.c) tracking

- Required: *Pulse Shape Analysis* providing the exact points of interaction and *Tracking Algorithms* finding the right sequence of interaction
- Energy information from reconstructed γ-ray interactions

2. Singles Analysis → Absolute Efficiency

- ^{60}Co data set
- AGATA-only spectra
- *Sum – Peak Method* used to determine the absolute efficiency of the array
- Summing peak at 2.51 MeV

$$\epsilon = \frac{^{2.51}I_{Agata}}{^{1.33}I_{Agata}}$$

- Correction for random coincidences

I. Kim, C. Park and H. Choi, Applied Radiation and Isotopes, 58 (2005), p.199,
J. M. R. Hutchinson, W. B. Mann and P. A. Mullen, Nucl. Instrum. Methods 112, p. 187

3. Singles Analysis → Relative Efficiency

- ^{152}Eu data set
- AGATA-only spectra
- Peak intensities normalized with respect to 1.408-MeV line

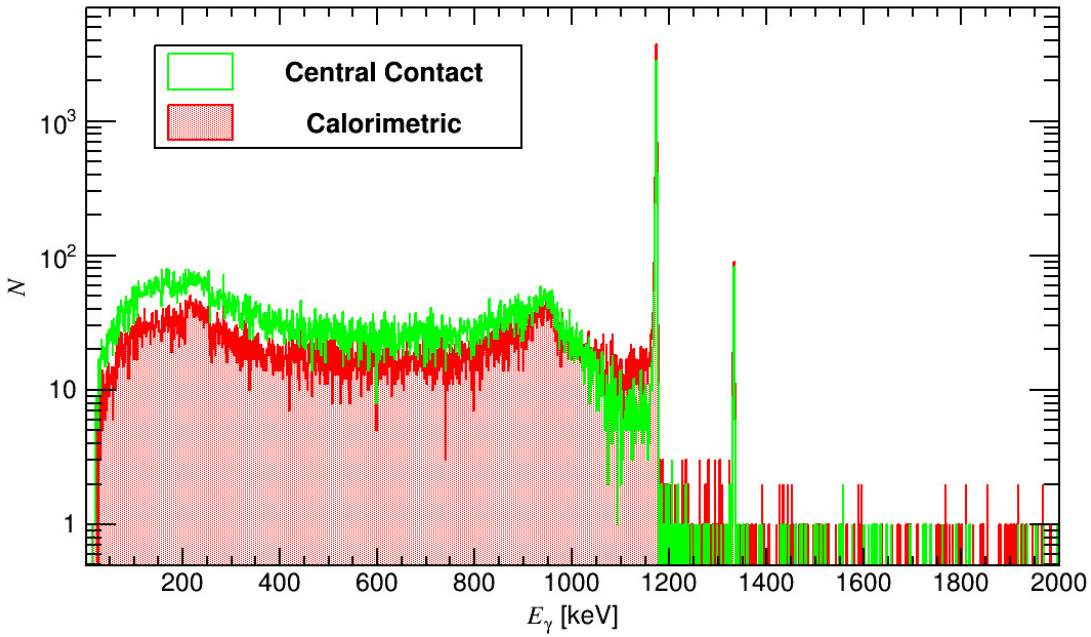
Analysis and First Results

0. Fine tunings

- The final stage of *tracking* requires reliable energy and position information → one of the tasks of offline data-processing
- Corrections performed using the framework **femul**:
  - energy calibration
  - crosstalk
  - time alignment
- Time window for coincidences in all cases: 100 ns

N. Lalović *et al.* for the AGATA collaboration, submitted to EPJ Web of Conferences Journal

1. Coincidence Analysis → Absolute Efficiency



γ-ray spectra of AGATA array obtained by summing all the hit in each detector (central contact) and by summing all the recorded hits (calorimetric)

- 1.a) calorimetric: efficiency 3.3 % P/T 32 %
- 1.b) central contact: efficiency 2.3 % P/T 18.2 %
- 1.c) tracking: efficiency 2.5 % P/T 34 %

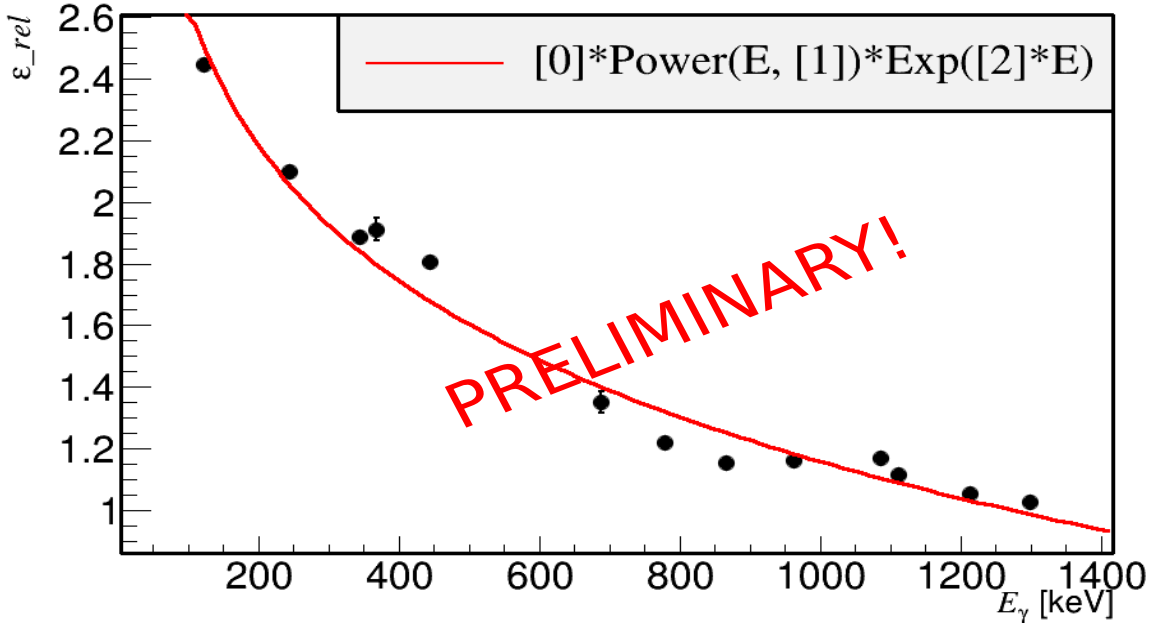
2. Singles Analysis → Absolute Efficiency

- Sum-peak method:

  efficiency 3.3 %

  P/T 30 %

3. Singles Analysis → Relative Efficiency



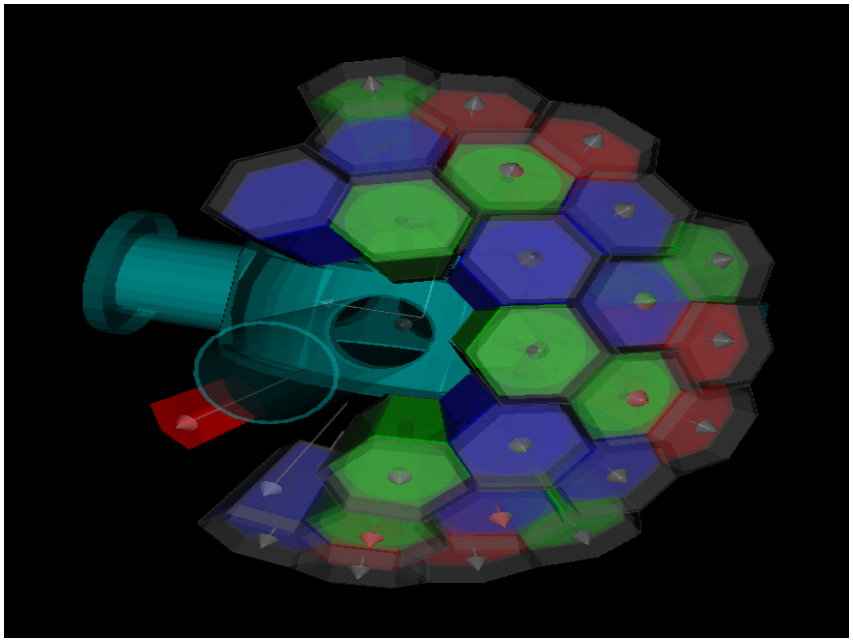
Geant4 Simulation

1. Coincidence Analysis → Absolute Efficiency

calorimetric: efficiency 3.9 %

P/T 50 %

J. Ljungvall for the AGATA Collaboration, CSNSM Orsay, France



Geant4 Simulation

1. Coincidence Analysis → Absolute Efficiency

calorimetric: efficiency 3.9 %

P/T 50 %

J. Ljungvall for the AGATA Collaboration, CSNSM Orsay, France

Experimental: efficiency 3.3 %

P/T 32 %

Summary and Outlook

Summary

- Preliminary values for AGATA absolute efficiency
- Quality-check of the two tracking algorithms available in the community

  OFT – A. Lopez-Martens et al., Nucl. Instr. Meth. A 533, 454 (2004),
  MGT – D. Bazzacco, private communication
- Geant4 simulation suggests somewhat higher values

Outlook

- In-depth analysis currently ongoing: corrections regarding dead-time and potential multiple cascades in case of ^{60}Co
- Extend the relative efficiency curve using the data from ^{56}Co

  N. Lalović *et al.* for the AGATA collaboration to be published
- Final confrontation of our experimental results with the Geant4 simulation

Acknowledgements

N. Lalović[1,2,a], R. M. Perez-Vidal[3], C. Louchart[4], C. Michelagnoli[5], D. Ralet[4,2], T. Arici[6,2], D. Bazzacco[7], E. Clément[5], A. Gadea[3], J. Gerl[2], I. Kojouharov[2], A. Korichi[8], M. Labiche[9], J. Ljungvall[8], A. Lopez-Martens[8], J. Nyberg[10], N. Pietralla[4], S. Pietri[2], D. Rudolph[1], O. Stezowski[11], and the AGATA collaboration

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Thank you for your attention!

Tack så mycket!