Performance and position sensitivity of the first AGATA detectors

B. Bruyneel

J. Eberth, H. Hess, L. Heuser, A. Linnemann, G. Pascovici, P. Reiter, N. Warr, A. Wiens
- Uni zu Köln –
A. Boston, M. Dimmock, L. Nelson, P. Nolan
- Uni Liverpool –
A. Goergen, W. Korten, J. Ljungvall, J. Pancin, C. Theisen, C. Veyssiere
- CEA Saclay –
A. Pullia – uni Milano, B. Cahan - Ganil, M. Petcu - Bucharest, R. Baumann - Strasbourg

For the AGATA collaboration

• AGATA introduction
• AGATA detector capsule
• Acceptance test – crosstalk model
• Characterization
Today’s spectrometers

- too many detectors are needed to avoid summing effects
- large opening angle means poor energy resolution at high recoil velocity

Tomorrows spectrometers

Combination of:
- segmented detectors
- digital electronics
- pulse shape analysis (see talk M. Schlarb)
- tracking the $\gamma$-rays

AGATA

$N = 180$

segmented

$M_\gamma = 1$


The next generation of spectrometers
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% ($M_\gamma = 1$) today's arrays
- 28% ($M_\gamma = 30$)
- 10% (gain ~4) 5% (gain ~1000)

Peak/Total:
- 58% ($M_\gamma = 1$) today
- 49% ($M_\gamma = 30$)
- 55% 40%

Angular Resolution:
- ~1° FWHM (1 MeV, v/c=50%) ~ 6 keV !!! today
- ~ 40 keV

Rates:
- 3 MHz ($M_\gamma = 1$) today
- 300 kHz ($M_\gamma = 30$)
- 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 $\gamma$-Tracking

1. Highly segmented HPGe detectors

2. Digital electronics to record and process segment signals

3. Pulse Shape Analysis to decompose recorded waves

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

Identified interaction points $(x, y, z, E, t)_i$
**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 FETs 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

AGATA:
- \( C_{ac} = 1000 \text{pF} \)
- \( C_{fb} = 1.2 \text{pF} \)
- \( A \text{ (Core)} = 80000 \)
- \( A \text{ (Seg)} = 10000 \)
- \( C_{xy} = \sim 1 \text{pF} \)

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

Comparison of row averages
Coincidence measurement = Position selection

Unfortunately very slow... → Characterization validated simulation
Quality simulation needs:

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

Electronics properties:
- Response functions
- Crosstalk

B. Bruyneel NIMA 569 (2006) 764-773
see also (next) talk by A. Linnemann
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

- $1\pi$ configuration

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