Germanium detector activities at IKP Cologne

- MINIBALL
- AGATA
- detector school

P. Reiter
Cologne

Workshop for the European Gamma-ray Spectroscopy Network
Padova, May 10-11, 2007
Composite Ge-detectors

EUROBALL CLUSTER detector encapsulation technique:
• University of Cologne  J. Eberth
• KFA-Jülich / FZ Jülich
• EURISYS / CANBERRA

- cryostat development  H.G. Thomas, D. Weisshaar
- preamp electronics  G. Pascovici
REX-ISOLDE + MINIBALL

- 24 single detectors
- \( \sim 10\% \) efficiency @ 1.3 MeV
- segmented Ge crystals
- pulsed shape analysis
- high granularity
MINIBALL repair, maintenance @ IKP

maintenance and repair of cold preamp:
- FET
- coupling capacitor
- segments shielding
- cold solder joints
- breaking wires

example:
replacement of cold preamplifier set
MINIBALL triple cryostat

Warm preamp motherboards
AGATA
(Advanced GAmmma Tracking Array)

Working group at Cologne:

- AGATA detector
customer acceptance test

- Cryostat development & assembly in collaboration with CTT

- core preamp and precision pulser

- large volume asymmetric shaped 36-fold segmented Ge crystals
- 180 detectors in 60 triple-clusters

http://www-win.gsi.de/agata/
• Encapsulated Ge crystal: 36 fold segmented

- Hochspannungs- und Zentralelektrode
- Signaldurchführung der Segmente
- Hochvakuum
- Kapselwand Al 0.8 mm
- Abstand Kapsel-Ge 0.4 mm
- Kontaktierung

• 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 hit pattern
(in segments: calibrated on 1folds)
36 x 36 combinations
AGATA pre-amplifier

HPGe crystal (36+1 segments)

Core preamplifier + pulser

- Cold part
- Warm part

Segment preamplifier

- Cold part
- Warm part

• higher bandwidth
• fast rise time
• short decay time
• resolution
• stability
AGATA triple cluster detector

3 encapsulated crystals
111 preamplifiers with cold FET
~230 vacuum feedthroughs
LN$_2$ dewar, 3 litre, cooling power ~8 watts

In-beam test
tandem accelerator
University of Cologne
September 2005

d($^{47}$Ti,$^{48}$Ti)p @ 2.3 MeV/u
$^{48}$Ti at b=6%
triple cluster
plus annular
DSSSD detector
A simple model to describe crosstalk in segmented detectors

Core-to-Seg  
\[ \bar{V}_{out} \equiv \frac{1}{sC_{fb}} \begin{pmatrix} 1 & -C_{01}/AC_{fb} & -C_{02}/AC_{fb} \\ -C_{01}/C_{ac} & 1 & -C_{12}/AC_{fb} \\ -C_{02}/C_{ac} & -C_{12}/AC_{fb} & 1 \end{pmatrix} \bar{i} \]

Segment-to-Core  
\[ ~1pF/1000pF \]

Segment-to-Segment  
\[ ~1pF/(10000 \cdot 1pF) \]

Crosstalk is intrinsic property of segmented detectors!

B. Bruyneel et al. in preparation

AGATA:
- \( C_{ac} = 1000pF \)
- \( C_{fb} = 1.2pF \)
- \( A\) (Core) = 80000
- \( A\) (Seg) = 10000
- \( C_{xy} \approx 1pF \)
Core to segment crosstalk understood

Correction possible

Comparison of row averages
MINIBALL detector school @ IKP

Participants

York:
• James Butterworth
• Simon Fox
• Pippa Marley

Manchester:
• Cat Fitzpatrick

Liverpool:
• Andrew Pett

Cologne:
• Christoph Fransen
• Nigel Warr
• Andrey Blazhev
• George Pascovici
• Peter Reiter
### MINIBALL detector school

**Monday, February 5, 2007**

**Introduction (P. Reiter, G. Pascovici)**

<table>
<thead>
<tr>
<th>Time</th>
<th>Subject</th>
</tr>
</thead>
<tbody>
<tr>
<td>10:00 – 12:30</td>
<td><strong>Introduction:</strong></td>
</tr>
<tr>
<td></td>
<td>1. $\gamma$-ray spectroscopy with MINIBALL at REX-ISOLDE</td>
</tr>
<tr>
<td></td>
<td>2. Charge Sensitive Preamplifiers for the MINIBALL Array</td>
</tr>
</tbody>
</table>

**Basics of operation (A. Blazhev, Ch. Fransen, N. Warr)**

<table>
<thead>
<tr>
<th>Time</th>
<th>Subject</th>
</tr>
</thead>
<tbody>
<tr>
<td>13:00 - 16:00</td>
<td><strong>Basics of operating a Miniball detector:</strong></td>
</tr>
<tr>
<td></td>
<td>1. handling</td>
</tr>
<tr>
<td></td>
<td>2. connectors</td>
</tr>
<tr>
<td></td>
<td>3. check of output signals of unbiased detector</td>
</tr>
<tr>
<td></td>
<td>4. biasing of a detector:</td>
</tr>
<tr>
<td></td>
<td>- preamplifier, main amplifier signals, change of signals</td>
</tr>
<tr>
<td></td>
<td>- during the detector is powered up, signals when biased,</td>
</tr>
<tr>
<td></td>
<td>5. check of resolution:</td>
</tr>
<tr>
<td></td>
<td>- required electronics for testing a detector</td>
</tr>
<tr>
<td></td>
<td>- electronics settings to get an information about the detector quality</td>
</tr>
</tbody>
</table>

| 16:30 - 18:00    | **Cooling down of a cluster:**                                         |
|                  | 1. short introduction on pumping station                               |
|                  | 2. removal from pumping station                                         |
|                  | 3. conditions for cooling down:                                        |
|                  | - good vacuum, pumping time                                            |
|                  | 4. cooling down                                                         |
|                  | 5. refilling                                                           |
|                  | 6. cluster on automatic filling system over night                       |

**Tuesday, February 6**

**Repair of a Miniball cluster detector**

<table>
<thead>
<tr>
<th>Time</th>
<th>Subject</th>
</tr>
</thead>
<tbody>
<tr>
<td>9:00 - 11:00</td>
<td><strong>Opening the cluster and removal of encapsulated detectors</strong></td>
</tr>
<tr>
<td></td>
<td>1. venting a cluster with N2 gas</td>
</tr>
<tr>
<td></td>
<td>2. opening the system</td>
</tr>
<tr>
<td></td>
<td>3. removal of capsules from cryostat</td>
</tr>
<tr>
<td></td>
<td>4. test of cold preamplifiers: check jFETs, coupling capacitors, soldering points, especially feedback resistor and capacitor</td>
</tr>
<tr>
<td></td>
<td>5. check of capsules for shortcuts</td>
</tr>
</tbody>
</table>

| 11:15 - 12:00    | **Work on cold preamplifiers**                                         |
|                  | 1. repair of cold preamplifiers                                        |
|                  | 2. mounting of cold preamplifiers                                      |

| 13:00 - 14:00    | **Continuation: work on cold preamplifiers**                           |

| 14:15 - 16:00    | **Mounting capsules in cryostat**                                      |

| 16:15 - 17:30    | **Pumping of a cluster detector:**                                     |
|                  | operation of a pumping station, leak check                             |

**Wednesday, February 7**

**Basics of operation II**

<table>
<thead>
<tr>
<th>Time</th>
<th>Subject</th>
</tr>
</thead>
<tbody>
<tr>
<td>9:00 - 12:30</td>
<td><strong>Hands-on laboratory course</strong></td>
</tr>
<tr>
<td></td>
<td>1. biasing a cluster detector,</td>
</tr>
<tr>
<td></td>
<td>2. tuning of preamplifiers</td>
</tr>
<tr>
<td></td>
<td>3. resolution check</td>
</tr>
</tbody>
</table>
MINIBALL detector school
Existing and future encapsulated, highly segmented Ge-detectors:

- user repair and maintenance
- transition from development phase to technology with standards
- theoretical understanding