A new Germanium-spectrometer for material screening

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- Collaboration meeting

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## Ge-detectors at MPI for Nuclear Physics

(see also GeMPI at LNGS)

<table>
<thead>
<tr>
<th>Detector</th>
<th>Bruno</th>
<th>Dario</th>
<th>Corrado</th>
<th>Adam</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type</td>
<td>Coax p</td>
<td>Coax p</td>
<td>Coax p</td>
<td>Coax well</td>
</tr>
<tr>
<td>Crystal size</td>
<td>54.5 x 55.7</td>
<td>59.7 x 61</td>
<td>61.5 x 62</td>
<td>47 x 47</td>
</tr>
<tr>
<td>[diam x lenght] [mm^2]</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Active volume [ccm]</td>
<td>120</td>
<td>158</td>
<td>177</td>
<td>90</td>
</tr>
<tr>
<td>Active mass [kg]</td>
<td>0.63</td>
<td>0.83</td>
<td>0.93</td>
<td>0.47</td>
</tr>
<tr>
<td>Relative efficiency</td>
<td>22%</td>
<td>31%</td>
<td>37%</td>
<td>17</td>
</tr>
<tr>
<td>FHWM @ 1.332 MeV</td>
<td>3.1</td>
<td>2.6</td>
<td>2.3 (old estim.)</td>
<td>1.9 (old estim.)</td>
</tr>
<tr>
<td>[keV]</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Max. sample-volume [dm^3]</td>
<td>0.85 (max. 1.16 without lead-brick)</td>
<td>11.05 (e.g. steel: up to 80kg)</td>
<td>13.46 (e.g steel: up to 100kg)</td>
<td>0.0034</td>
</tr>
<tr>
<td>Possible configuration of sample</td>
<td>Cylindrical box („Standard-box“)</td>
<td>„Standardbox“; Marinelli-beaker</td>
<td>„Standardbox“; Marinelli-beaker</td>
<td>Only small samples</td>
</tr>
<tr>
<td>Operating status</td>
<td>Operational</td>
<td>Operational</td>
<td>Ready in few weeks</td>
<td>2007</td>
</tr>
<tr>
<td>Manufacturing year</td>
<td>Canberra/91</td>
<td>PGT/85</td>
<td>PGT/90 Canberra</td>
<td>DSG/96</td>
</tr>
</tbody>
</table>
Improvement of sensitivity: background-reduction

Detector sensitivity: strictly connected with background reduction
Background reduction implies special requirements to the set-up/construction of the shielding systems

LLL at MPIK: mean shielding depth of about 15 m w.e. (soil, rock and concrete)

Main contributions to the background spectrum of Ge-detectors
1. Environmental gamma radiation and radioactivity inside construction materials
2. Cosmic rays (shallow depths)
3. Airborne contamination
Building up the detector-chamber

 Passive shield:
 - 4 tons of lead
 - 300 kg of ultrapure copper

 $N_2$ flushing system:
 permanent flushing of the detector chamber at slight overpressure (boil-off $N_2$)
Background-reduction through muon vetoing

Muon-vetos:
- Multiwire-proportional chambers:
  Potential applied to the anode wires: ca. +2.5kV; cathode planes grounded
- Anode wires: tungsten-gold; diameter: 50 μm
- Prop.gas used: P10 (90% Argon, 10% Methane)

Electronics assembly for the muon-veto system
Background spectrum: With and without top-chamber

Without Top-ch.*: ICR [(40-2700) keV] = 45115 cpd

-55%

With Top-ch.*: ICR [(40-2700) keV] = 19929 cpd

Expected reduction for full operational system: -90%

* Energy-range and unit according to CELLAR-proposal
MC-Simulation of Corrado
Tools for the exact estimation of the geometry
X-ray imaging: advantages and typical cases

- Voltages used for x-ray imaging: 40-230 kV

- Comparison of the sizes provided by the manufacturer with real sizes;
  NOTE: x-ray images are only complementary to producer’s drafts
  REASON: x-ray images -representing the “shadow” of the detector-
  contains distortions; reconstruction to real sizes: error up to \( \Delta q_i = \pm 1 \text{mm} \)

- Reporting some cases:
  #1: - missing parts: front vespel, FET
    - determination of used materials (high or low densities)
  #2: - displacement of the crystal with respect to the detector
    housing; example: coax-well detector
- Steel-structure and passive shielding (lead and copper) integrating a N₂-flushing system: **done**

- Building of 5 muon-chambers (Multi-Wire-chambers): **completed**

- Testing of the muon chambers (tightness, estimation of thresholds and ideal operational voltage): almost done

- Mounting of muon chambers: will be finished **next week**

- Providing of the complete electronics for all chambers: **ready in 1 month**

- Characterisation of the detector (background spectrum...) already started

- Detector operational: **beginning of 2007**
Summary & Outlook

- Beside Dario a second new detector with comparable chamber-volume will be operational at the beginning of 2007
  ➞ Doubling our screening capacity

- Spring 2007: renovation of our LLL; screening will be interrupted for a short period

- I. Validation of the MC-code: for the first time the geometry of the detector is well known; x-ray imaging as inspection-tool

- II. Validation of the MC-code with standards of higher density; a copper-standard in „standard-geometry“ with a relative density of 4 g/ccm is now available.

- GeMPI III at LNGS: under construction