First Tests of a Six-fold Segmented Ge-Detector for Miniball

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For the measurement of rare γ decays with low γ-ray multiplicities ($M_\gamma \leq 10$) dedicated Ge-detector arrays are presently being developed in Europe. They are optimized with respect to full-energy peak efficiency rather than the resolving power for predominant use at radioactive ion beam facilities. The MINIBALL array is a cube of 6 CLUSTER detectors of the EUROBALL design [1]. Here, each CLUSTER consists of 7 individual encapsulated six-fold segmented Ge-detectors in a common cryostat as illustrated in fig. 1. The high granularity of 252 segments in total is needed to reduce the Doppler-broadening of γ-rays emitted by nuclei with velocities of up to $\beta = 0.1$. While the position of a segment hit by a γ-ray yields information of the location of the primary interaction, a pulse shape analysis of the central current signal can improve the position resolution with a radius information.

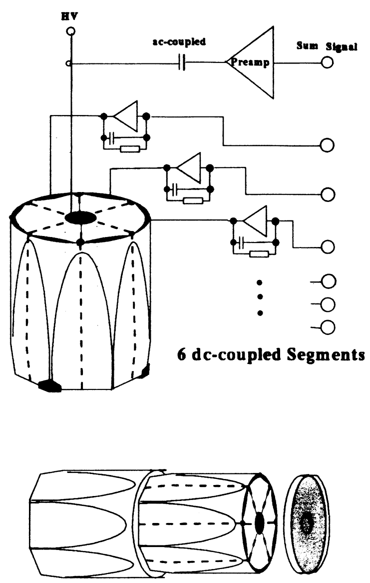

Fig. 1: The six-fold segmented Ge-detector: each crystal is separately encapsulated; the signals of the central contact and of the segments will be processed.

In order to test the first prototype of the six-fold segmented Ge-detector in Munich, a new test stand was set up:
A mounting structure for the detector was developed to allow the experimentalist to precisely move the detector in x- and y-direction. In addition, a Pb-collimator was constructed to project a sharp and small spot of γ-rays from a source with high intensity on the detector. Three γ-sources (^{137}Cs, ^{57}Co, ^{60}Co) with an activity of 100 μCi (to provide enough count rate in the detector after collimation) were purchased to allow the investigation of the detector response at energies from 122 keV to 1332 keV.

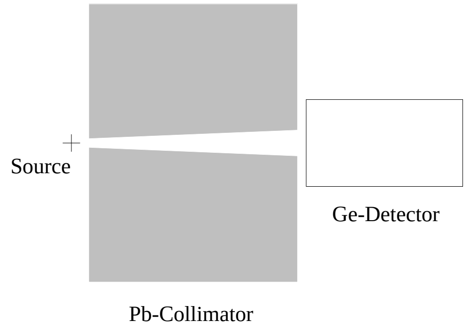

Fig. 2: A funnel-shaped collimator with diameters 1 mm at the side of the source and 3 mm at the side of the detector will be used to map the position dependent response of the Ge-detector. The length is 15 cm.

Finally a new data aquisition system was composed, consisting of 7 Silena ADC's (400 MHz 7420G; for the energy spectra of the central contact and the segments), and 1 Flash ADC (250 MHz STRUCK DL515; for the pulse shape analysis of the central signal used to extract the radius information). Data processing is performed in a VME-based system using 2 VME-CPU's (PowerPC 604, 100 MHz) operated in master/slave mode to minimize the deadtime and maximize the data throughput. The aim is to investigate the energy resolution of the detector (central contact) and its six segments, to look for cross talk, and effects while irradiating the detector near the segmentation lines. Another point is to consolidate the information in the radial direction by analysing the shape of the current pulse [2–6]. The experimental results will be compared to GEANT simulations. Recently, the first two-fold encapsulated segmented detector was delivered to Heidelberg. First tests showed an energy resolution of the central contact of 2.2 keV, and 4.9 keV of the segments [6]. The energy resolution of the six-fold segmented encapsulated prototype which will soon be delivered to Munich was measured very recently by the company EURYSIS. As expected, the resolution of the central contact remained at 2.2 keV, while for the segments an improved resolution was measured, where three segments had 3.0 keV and the three other segments had below 3.5 keV. This confirms the expectation that due to the smaller capacitance of the segments with respect to the central contact, the segments of a six-fold segmented Ge-detector have a better energy resolution than the two-fold segmented detector.

References

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