Local Level Processing for the Gamma-Ray Tracking Array AGATA

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AGATA - the **A**dvanced **GA**mma-Ray **T**racking **A**rray - is the European effort to build a novel instrument for nuclear structure studies with γ-ray spectroscopy at future RIB facilities [1]. In contrast to existing arrays, recent technological advances have opened the possibility to construct an array like AGATA solely out of highly segmented HPGe detectors (Fig. 1). The major goal of such an array is the combination of both high photopeak efficiency ($\epsilon_{\rm Ph} > 40\%$) and peak-to-total ratio (P/T $> 60\%$).

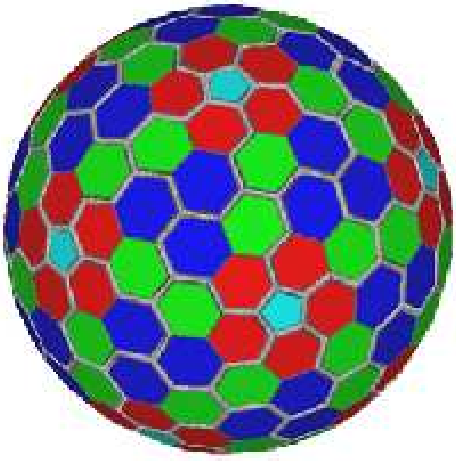

Fig. 1: AGATA - 180 hexaconical and 12 pentaconical detectors

The concept of γ-ray tracking is to identify the individual γ-rays by reconstructing their scattering paths through the array from the points of interaction. Therefore, the HPGe detectors have to be operated in a position sensitive mode. The characterisation of the interaction points of the γ-rays is achieved by pulse shape analysis of the signals from the segments. In principle, the feasibility has been demonstrated recently in an experiment [2]. However, the task of the "Local Level Processing Group" within AGATA is the development of algorithms as well as hardware to perform the pulse shape analysis on-line.

The AGATA will consist of encapsulated detectors with a 6×6 segmentation (Fig. 2, left). In order to obtain optimal position resolution, the layout of the segments for the AGATA detectors is under investigation. Therefore, the electric field and the resulting pulse shapes are simulated for different segment layouts applying a computer code [3]. The charge carriers follow the electric field which is, in particular in the front part of the detector, not parallel to the lines of segmentation. Most striking effect is the emerging difference between geometrical and effective segmentation: the hit segment, i.e. the geometrical segment which accommodates the point of interaction, does not necessarily also collect the generated charge (Fig. 2, right).

Major challenge for the pulse shape analysis is to disentangle multiple interaction events. The existing approaches, e.g. based on the application of techniques from Artificial Intelligence like a Genetic Algorithm [2], are promising, but still need too much computing time. Gaining performance in both software and hardware is the aim of ongoing efforts.

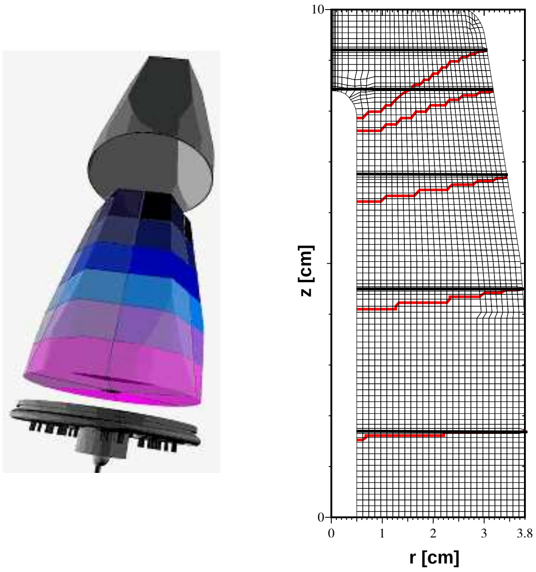

Fig. 2: Encapsulated AGATA detector (left). The geometrical (black lines) and the effective segmentation (red lines), shown for longitudinal segments with different sizes (right).

In AGATA the signals from the preamplifiers will be sampled by fast FADCs and processed by digital electronics. Goal is an improved performance concerning resolution and maximal counting rate compared to analogue electronics. A preliminary result applying the "Moving Window Deconvolution" (MWD) [4], an algorithm to determine the energy from the digitised signals, is shown in Fig. 3. The signals were measured with the MARS detector [2]. The development and implementation of algorithms for timing and triggering is in progress [5,6].

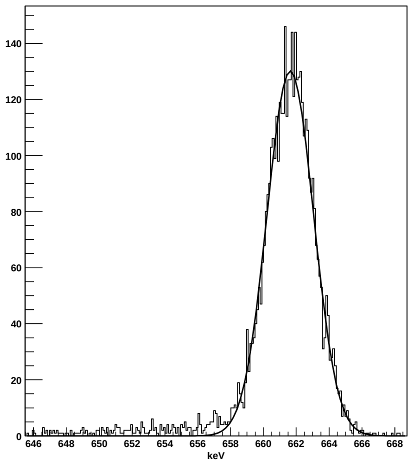

Fig. 3: Preliminary result for the ^{137}Cs peak (661.6 keV) reconstructed by the MWD. The resolution is about 3 keV (FWHM) which can be improved by optimising the parameters of the algorithm [6].

References

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