Digital Signal Processing for the Gamma-Ray Tracking Array AGATA

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The European project AGATA aims at the construction of a novel γ-spectrometer for nuclear structure studies [1]. The concept of γ-ray tracking is based on the usage of highly segmented HPGe detectors. The signals from the detectors are digitised at the output of the preamplifiers and all the processing will be done completely on digital electronics. Goal of this electronics is to handle in real-time signals sampled at 100 MHz (14 Bit resolution) even at event rates as high as 50 kHz per detector.

The signal processing is done by digital filters. For the determination of the deposited energy the MWD filter (Moving Window Deconvolution) has been applied [2]. Here, we will focus on the generation of a trigger signal. We evaluated two filters, the SCC (Slope Condition Counter) [3] and the MWDT, a variation of the MWD with parameters optimised for trigger generation [4].

The filters have been programmed in C++ and VDHL. In order to test them under real-time conditions, we implemented them on a Xilinx Virtex-II FPGA sitting on a VME card. With the current chip and compiler optimisation, real-time processing at a rate of about 80 MHz was achieved. Applying a faster and/or larger FPGA will allow to meet the AGATA requirement of 100 MHz.

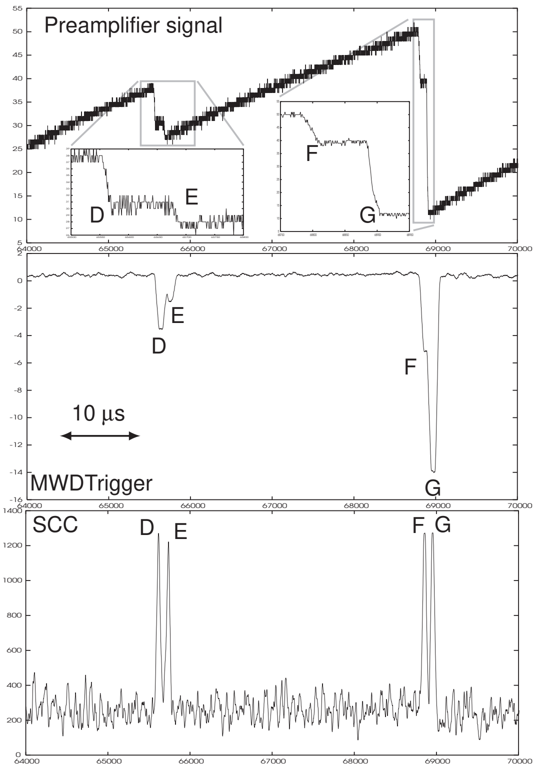

Fig. 1: Signals from the core of the MARS detector (top). Output of the MWDT (middle) and the SCC (bottom) filters.

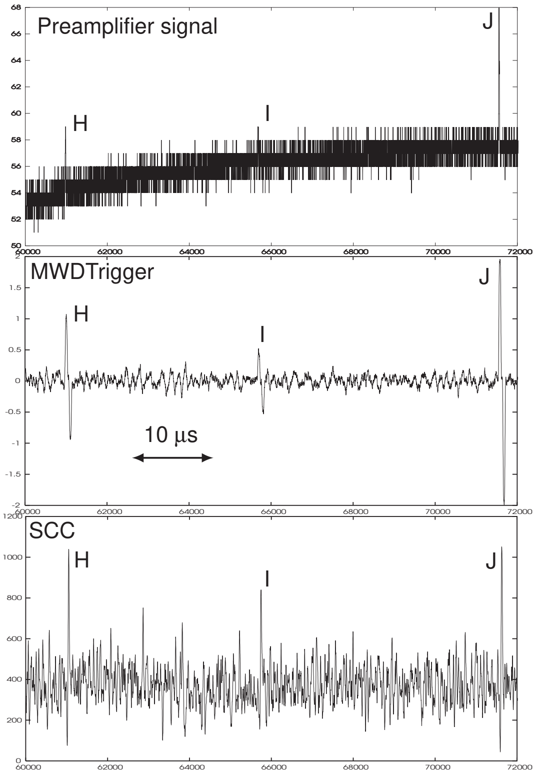

Fig. 2: Signals from segment A1 of the MARS detector (top). Output of the MWDT (middle) and the SCC (bottom) filters.

Experimental pulse shapes have been obtained from the 25-fold segmented MARS detector running at an event rate of 38 KHz on the core contact with the MARS-DAQ (100 MHz, 8 Bit) [5]. These data were stored and later fed offline into the VME card.

Fig. 1 shows that the SCC filter is more powerful to trigger at high rates, e.g. events separated by ≈ 1 μs can be clearly resolved. In particular, the amplitude of the SCC output does not depend on the amplitude of the preamplifier signal. The MWDT filter has advantages in detecting transient signals on the segments, as it can be seen in Fig. 2. Quantitative studies regarding the trigger efficiency at low energies have still to be performed.

Such trigger signals are also needed to adapt the MWD to high rates (adaptive shaping), for zero-suppression, and to select the rising edges of the signals which only will be transferred to the subsequent pulse shape analysis.

References

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