INSTITUT MAX VON LAUE - PAUL LANGEVIN

NEUTRONS FOR SCIENCE ®

A Trigerless Acquistion System for Large Detector Arrays

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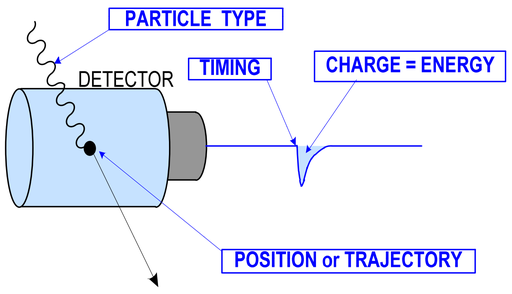
ABSTRACT

State-of-art γ-ray spectroscopy requires nowadays the use of large arrays of high purity Ge detectors (HPGe). The large multiplicity of the detection system requires:

- The capability to process the multitude of signals from many detectors.
- Fast processing → on-line event display.
- Very high throughput of more than 10^6 data words/sec.



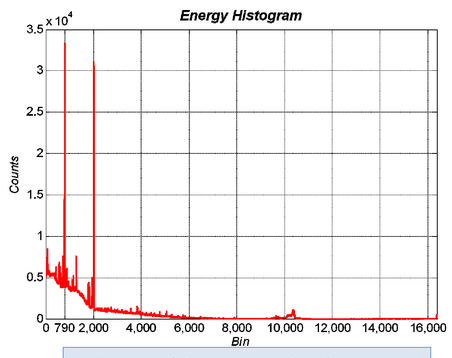
The front-end electronics must provide precise information about amplitude, time, detection position and possibly pulse shape.

System developed

Digitizer	***PowerPC***
8 channels 15 bit 100 MS/s	VME single board computer 256 Mbytes

Implements real time algorithms for:
- Sorting list mode
- Coincidence events

Handles event rates > 1MHz

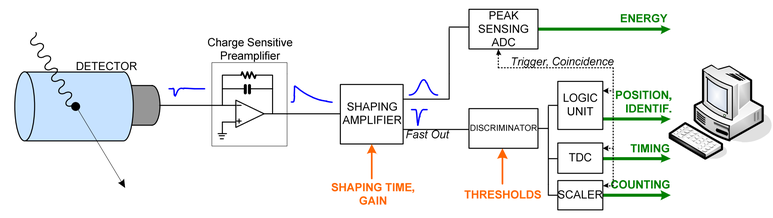


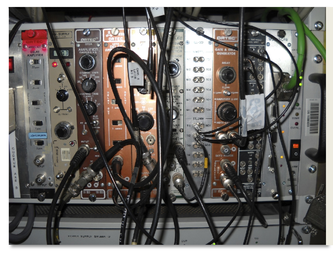
Energy histogram Ge detector

DIGITAL APPROACH

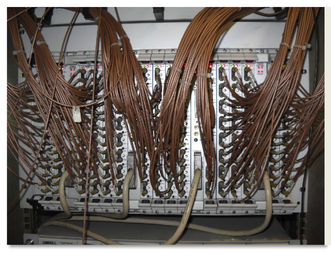
Traditional analogue electronics

- Expensive cost per channel
- Signal degradation
- Complex analogue path



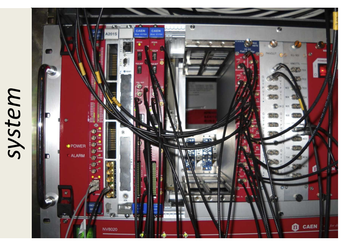


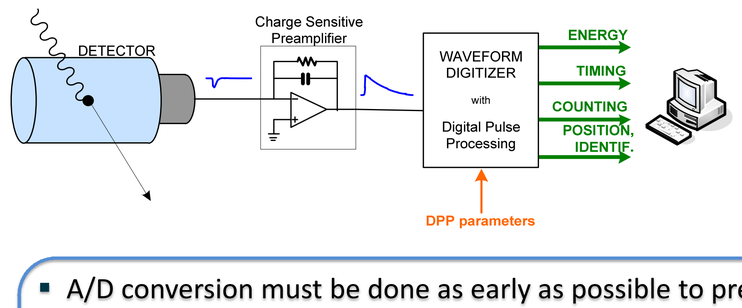
One channel energy-time



256 x 128 pixel

Digital acquisition system





Digital pulse processing systems

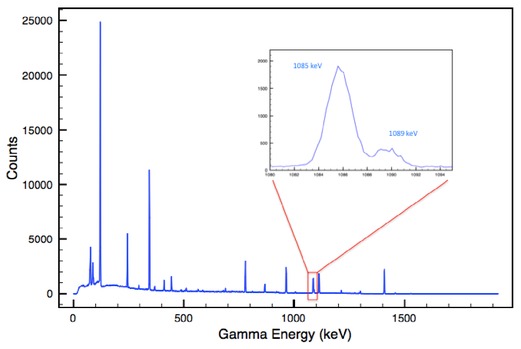
- Better timing and energy resolution
- Linearity and stability
- Low cost per channel and reliability

- A/D conversion must be done as early as possible to preserve the information
- The major problem is the throughput rate (readout bandwidth)
- No possible to read row data and make the analysis on-line
- The FPGA can do on-line digital pulse processing (DPP) to extract and save only the quantities of interest.

RESULTS

Array of eight HPGe detectors for g-spectroscopy studies from (n_{th}, g) reaction

Scientific goal: to verify the beam quality, with respect to background and collimation.

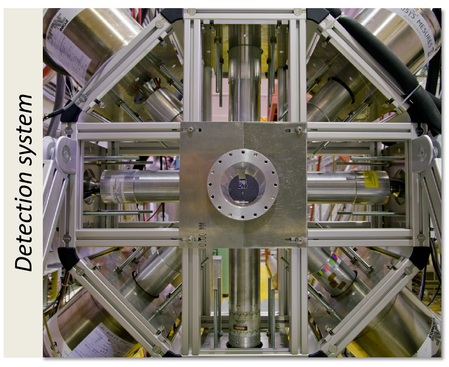


Energy spectrum measured by the HPGe detector from ^{152}Eu radioactive source

Performance target: to test the overall performance of the new acquisition in view of the upcoming EXOGAM campaign of measurements.

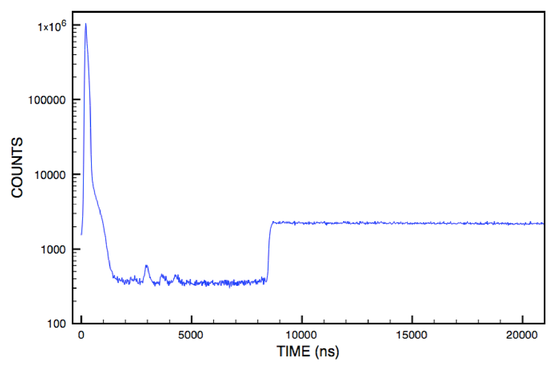
Energy resolution of 2.45(5) keV at the 1408 keV g-line. In the zoom area the doublet at 1085 and 1089 keV is ***clearly resolved!!***

Combination of HPGe and BGO detectors



Detection system

Scientific goal: to measure the e^+e^- pair-production cross-section close to the 1022 keV threshold.



Time between BGO (start) and Ge (stop), measured for ^{22}Na source in pair spectrometer mode

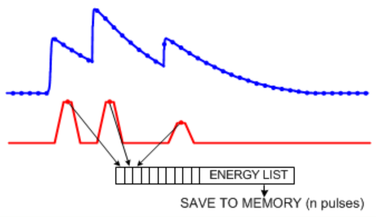
Performance target: to derive the timing properties of the new acquisition with the analysis of the recorded list-mode data acquired using a ^{22}Na radioactive source in pair spectrometer mode.

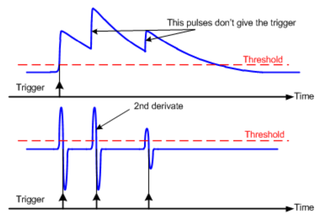
The time difference between g-detection in any of the BGO detectors and the corresponding detection in the Ge detector is plotted versus time. A single, very clean peak is visible at about 200 ns after the g-detection in the BGOs.

DPP ALGORITHMS

The purpose of the DPP is to perform on-line signal processing able to transform the row sequence of samples into a compressed data packet that preserves the relevant information.

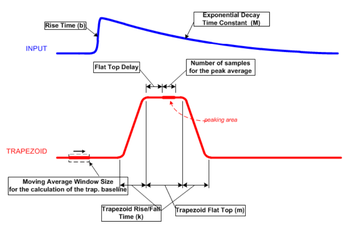
LIST MODE
The digitized signal is processed on-line and the acquisition is continuous.





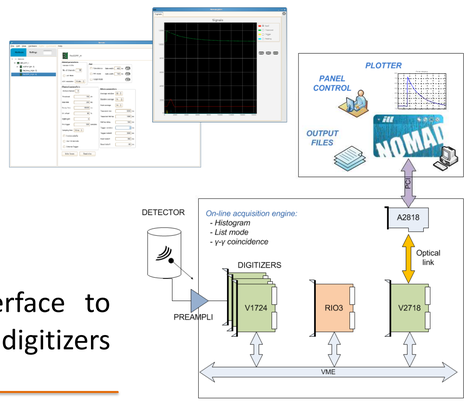
TIMING AND TRIGGER
DPP trigger and the time tag are based on the voltage step. 2nd derivate of the signal (delta2).

ENERGY (TRAPEZOIDAL FILTER)
A trapezoidal filter is applied to the input signal to derive its amplitude, proportional to energy.



ON-LINE ACQUISITION ENGINE

The newly developed acquisition system consist of:



Digitizers: a number of digitizers according to the required number of detectors. Flash ADC CAEN v1724.

Processor card: Power PC based VME board computer equipped with 256 MB of memory.

Instrument control software: full graphical interface to access all parameters related to the configuration of the digitizers as well

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