

Versatile acquisition systems for segmented detectors: CAEN case history

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<u>P. Garosi (p.garosi@caen.it)</u>, B. Angelucci, A. Cortopassi, A. Potenza, C. Tintori, M. Venaruzzo





Composite Ge detectors where several crystals are assembled in a common cryostat



Additional detectors for anti-Compton shield, like BGO, LaBr3, Csl, Proportional chambers, etc. to improve: **- peak-to-total ratio**

4-fold segmented detectors to improve:

- Doppler broadening
- Isolated hit probability
- Gamma-ray positioning







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CAEN Product highlights





CAEN Product highlights





CAEN V1782

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Hardware Features

- Octal 32k MCA (16-bit @ 100 MS/s)
- VME 2U wide form factor.
- **BNC** input connectors (1 KOhm input impedeance)
- 4 programmable **gains** (x1, x2, x4, x8, where G=1 corresponds to 1 Vpp dynamic range). An input attenuator (x0.2) is also available by jumper selection; when enabled, the coarse gains are x0.2, x0.4, x0.8, x1.6, where x0.2 corresponds to 5 Vpp dynamic range.
- AC or DC coupling is also selectable by jumper: DC coupling is used for **Charge Sensitive Preamplifiers**, AC for **Transistor Reset Preamplifiers**.

Acquisition

- No spectroscopy amplifiers required (preamp signals feed the digitizer inputs)
- Individual channel self-triggering (fast discriminators)
- Digital shaping: trapezoidal filter with programmable rise time and flat top
- Pile-up rejection
- Acquisition modes: **PHA** or time stamped **list mode**
- Energy spectrum: singles (channel wise), Compton suppressed (channel wise), add-bac (detector wise), coincidences (detector wise)

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Anti-Compton Shield

- Additional detectors, such as LaBr3, NaI, BGO and other scintillators can be read by the V1782, either going through a preamp or directly from the anode signal.
- **Coincidences and anti-coincidences** between channels as well as with the front panels logic I/Os, the V1782 can easily manage <u>Anti Compton Shields</u>, <u>background suppression</u> systems and almost any type of correlation between fast and slow detectors.
- For the applications where a high resolution timing is required (sub ns), the V1782 can be operated in conjunction with faster digitizers such as the V1730 or V1725 (500 and 250 MS/s respectively); the whole system can run synchronously and guarantee the readout of a wide variety of detectors, providing high resolution energy and timing information, as well as pulse shape discrimination.



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• Zero crossing of the RC-CR² trace (double integration and derivative of the input)



• Additional trigger option, combination of **fast and "slow" bipolar triangle**



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- Multiple gain (x1, x2, x4, x8) options software and jumper(x0.2) selectable. The V1724 has three hardware options. DT5781 has four software options
- AC coupling input for TRP



- Integrated **Filter** for high frequency noise
- For older MCAs the filter is available externally (A387 cable)



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COMPASS software

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Data saving: One list file per channel (virtual channel too). Work in progress: build of events, one file per clover. Binary option for a faster write.

Spectrum calibration

ROI fit with linear or step+quadratic background



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Measurement: test laboratory

Canberra clover detector (4 channels)

CAEN system made of a V1782, a V6521P for the HV, V1718 USB controller (FLEXISPEC)

Test with a ⁶⁰CO source, full scale of ~1.6 MeV

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	Crystal 1	Crystal 2	Crystal 3	Crystal 4	Add-back
FWHM @ 1332 keV	1.87 keV	1.81 keV	1.72 keV	1.72 keV	1.91 keV

Add Back Ratio @1332 keV =
$$\frac{Net_{AB}}{\sum_{i=1}^{4} Net_i} = 1.3$$

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Measurement: INCA clover detectors

Indian National Gamma Array (INCA) @ IUAC (India) Up to 24 clover detectors with early 4π geometric coverage Possibility of Compton suppression with CsI detectors

Test with one clover, ¹⁵²Eu source, no Compton shield





CAEN system made of a V1782 and V1718 USB controller Ch0-ch3 were used, Add back in real time as virtual channel



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Measurement: INCA clover detectors (2)



Expected resolution from analog system: ~1.3 keV @ 122 keV, ~2.0 @ 1408 keV

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Measurement: ORTEC clover detector



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Measurement: ESRF synchrotron

CAEN system of a V1782 and V1718 (USB controller) ⁵⁵Fe source



Canberra 6 HPGe with 5 segment each & SDD detector, TRP preamp



- Good performances at low energies
- Good peak resolution
- High rate performances still to be improved



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Conclusions

New Octal CAEN MCA with advanced features:

- Programmable gain
- Versatile input coupling
- Very good resolution with germanium detectors
- Add back and multiple coincidence and acquisition modes that make it suitable for segmented detectors
 - Can be used with scintillator detectors for the anti-Compton shielding and synchronized for multi-board systems





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Thank you for your attention



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- 6 independent HV channels in 1 unit wide VME 6U module
- up to 6 kV and 3 mA output ranges
- Available with positive, negative or mixed polarity
- SHV coaxial output connectors
- Common floating return
- Low Ripple (Typ: from < 3 mVpp to < 15 mVpp)
- up to 1 nA lset/Imon resolution (Optional Imon-Zoom: up to 100 pA)
- Status output
- Channel ON/Status LEDs
- Interlock logic for board enable
- Individual channel enable
- Optional A6580 DC Input Power Equalizer
- Module control via OPC Server



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