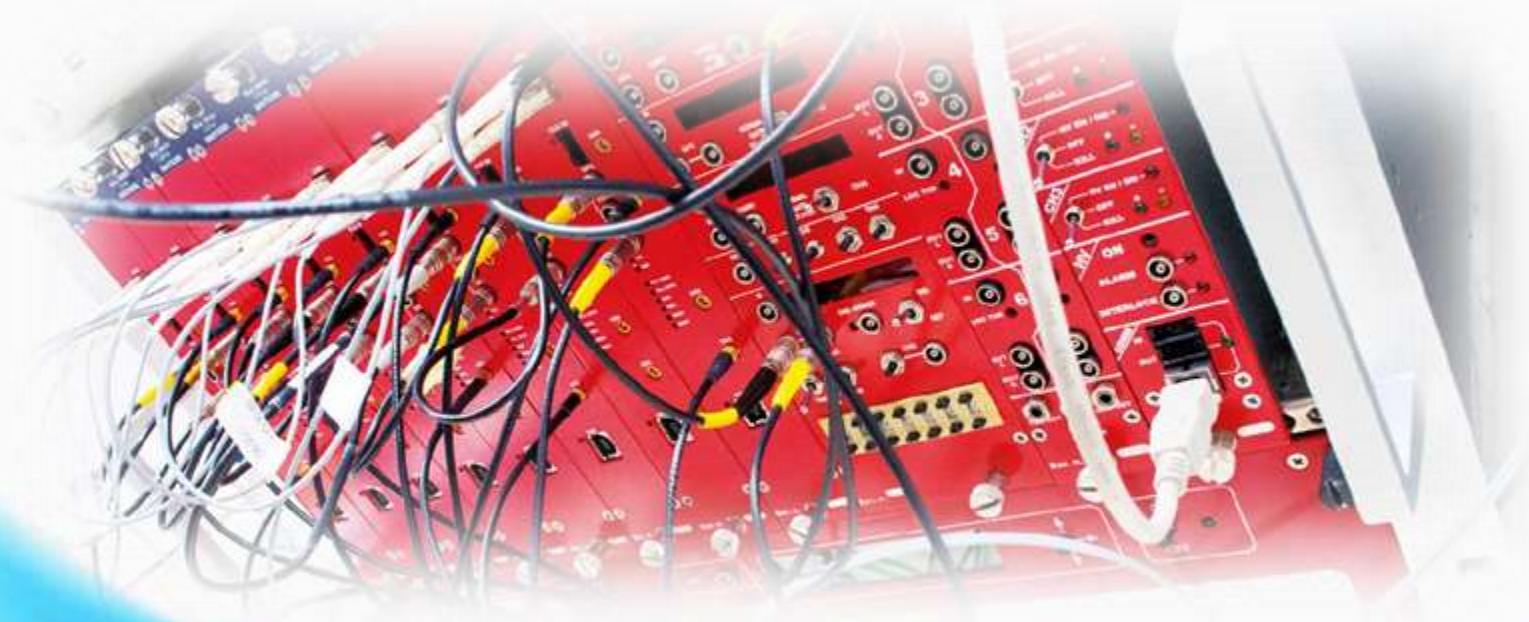
GAMMATECH

Digital systems for Multi-Parametric analysis in Physics Applications




CAEN SyS
gt
CAEN
Tools for Discovery
CAENels
Gear for Science
СПЕКТР

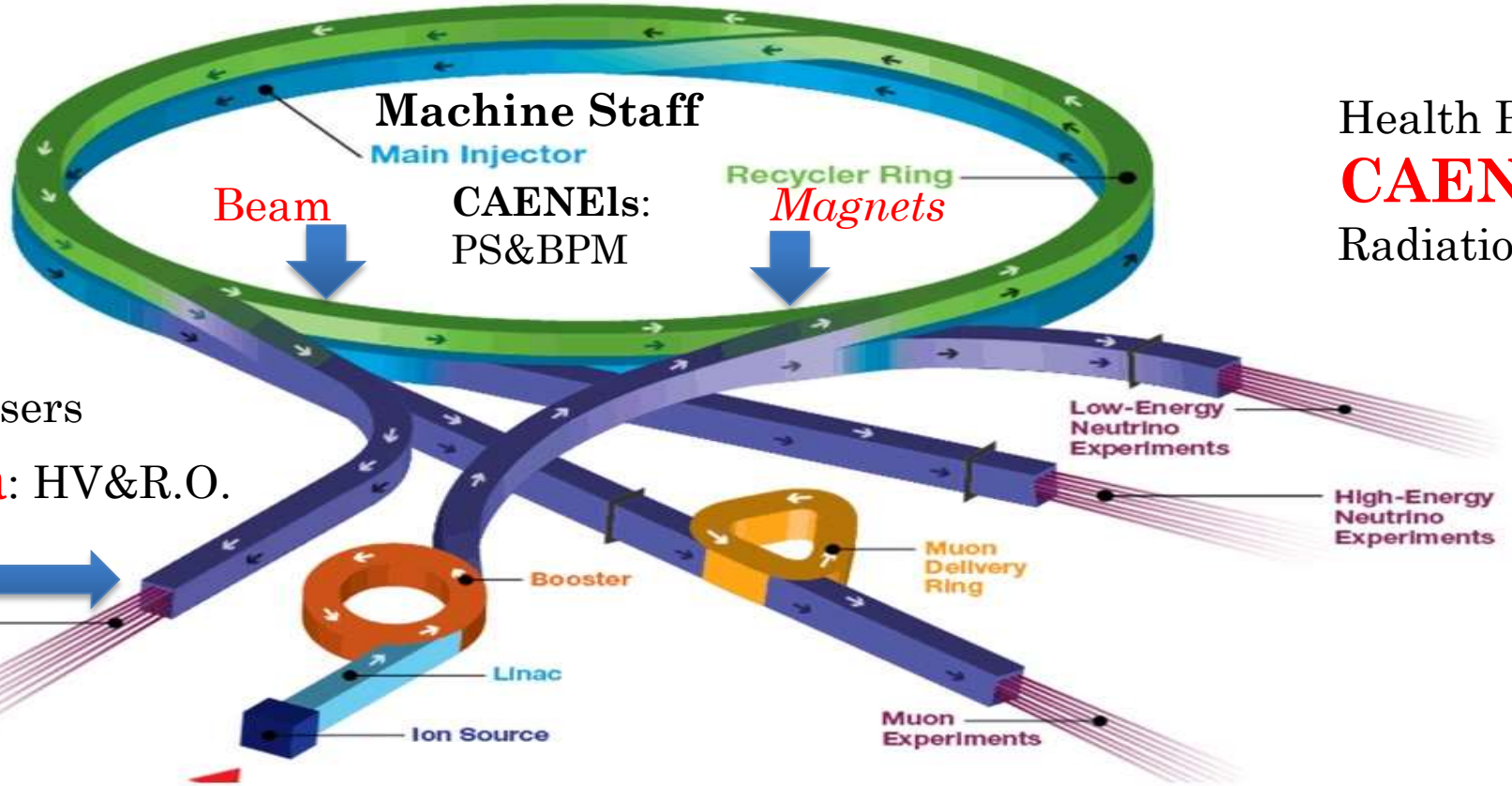
CAEN in particle physics

CAEN SpA (Costruzioni Apparecchiature Elettroniche Nucleari) was founded in 1979 as an important industrial spin-off of the INFN.

Core business&Primary Market: Electronic Instrumentation for particle accelerator physics experiments (world leader)

CAEN for the Synchrotrons Labs

Core business&Primary Market: Bipolar Power Supplies and Beam Profile Monitors for synchrotron accelerators



Health Physics

CAEN SyS:

Radiation Monitors

Beam Line Users

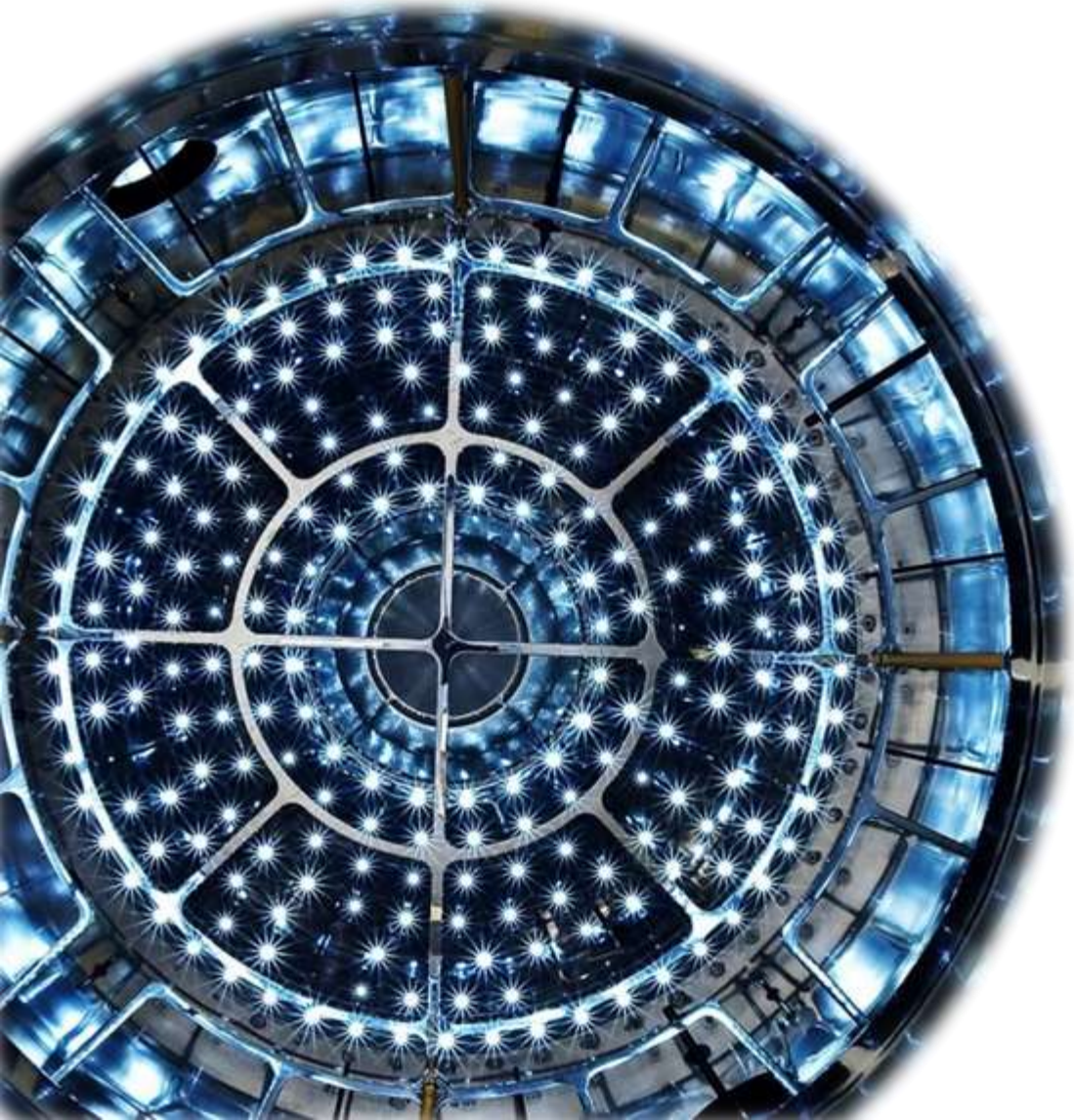
CAEN Spa: HV&R.O.

Detectors

CAEN
Tools for Discovery

35 years of innovation

For more than 35 years CAEN has been providing Scientists and Engineers with the most advanced electronic instrumentation for any particle or radiation detectors



CAEN is proud to produce the best tools for:

- **High Energy Physics**
- **Astrophysics**
- **Neutrino Physics**
- **Dark Matter Investigation**
- **Nuclear Physics**
- **Material Science**
- **Medical Applications**
- **Homeland Security**
- **Industrial Applications**

Digital systems by CAEN Spa

✓High Voltage & Low Voltage Power Supplies

- Multi-Channel CAEN Systems
- Multi-Channel NIM and VME Modules
- Stand-alone Power Supplies
- PCB mountable HV DC-DC converters

✓Signal Conditioning, Read-out Electronics & Emulation

- Waveform Digitizers & Digital Pulse Processing
- Digital MCA and instrumented PMT bases
- Digital Detector Emulators
- NIM and VME traditional electronics
- Preamplifiers

✓Powered Crates and Chassis

- Low Ripple Linear NIM powered Crates
- New Hi-End VME64/VME64x Crates

✓Signal Generator

✓Educational Line

1st Product Line : High Voltage& Low Voltage Power Supplies

- HV : 100 V – 15 KV range (detector bias)
  Small currents (mA &microAmp outputs & few nA resolution
  LV: for electronics
- Channels : from 1 to 768 in 1 mainframe
- GeCo 2020 Software interface for all.
- NIM, VME, Desktop, Mainframe architectures

Modular VME power supplies

V6519, V6533, V6534, V6521, V6521H

- 6 channels in 1 VME Unit
- From 500 to 6 kV, from 20 μA to 3 mA
- Common Floating Return
- SHV connectors
- Voltage ripple < 3 mVpp
- Internal Hardware protections
- Available with positive, negative or mixed polarity

Thanks to the GECO2020 control software and the multimaster capabiity of CAEN VME Bridges, CAEN VME HV power supplies become a System:

DAQ and HV in the same VME crate independently controlled!

NIM-NDT HV

CAEN OPC Server | CAEN HV Wrapper | CAEN LabVIEW | GECO 2020

N1419, N1470, N1471, N1471H, N14xxET

- 4/2/1 channles in 1 NIM Unit
- From 500 to 8 kV, from 20 μA to 3 mA
- SHV connectors
- **Voltage ripple < 5 mVpp**
- Internal Hardware protections
- Independently selectable channel polarity
- Local and Remote control
- **Now also with Ethernet connection!**

Desktop HV Power Supplies

DT55xxE, DT14xxET

- 4 channels in desktop module
- **from 500 V to 6 kV, from 20 µA to 3 mA (DT55xxE)**
- **from 500 V to 8 kV, from 20 µA to 3 mA (DT14xxET)**
- Common Floating Return
- SHV connectors
- Available with positive, negative or mixed polarity
- **Local and Remote control (USB/Ethernet)**
- Individual channel enable
- 2.8” color touch screen display (DT14xxET)
- 110-220 Vac plug for desktop operation (DT14xxET)
- Independently selectable channel polarity (DT14xxET)

HV/LV Mainframe boards

SY4527

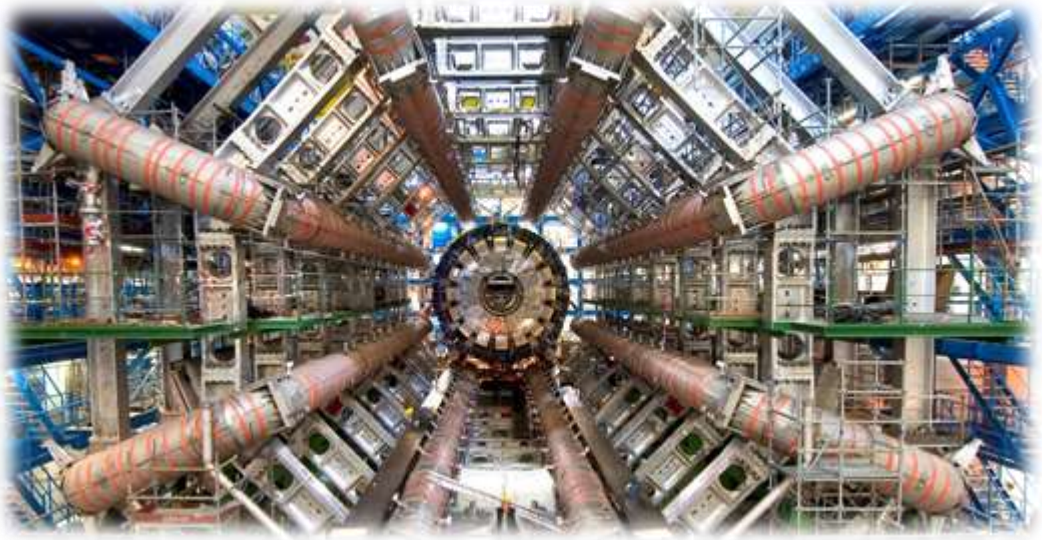
- Fully equipped experimental vertion
- 19" wide, 8U-high; depth: 747 mm
- 16 slots for all card types
- Modular power supply up to the 4 kWt

SY5527

- Small scale experiment and laboratory
- 19" wide, 4U-high; depth: 747 mm
- 6 slots for all card types
- Modular power supply up to the 1m8 kWt

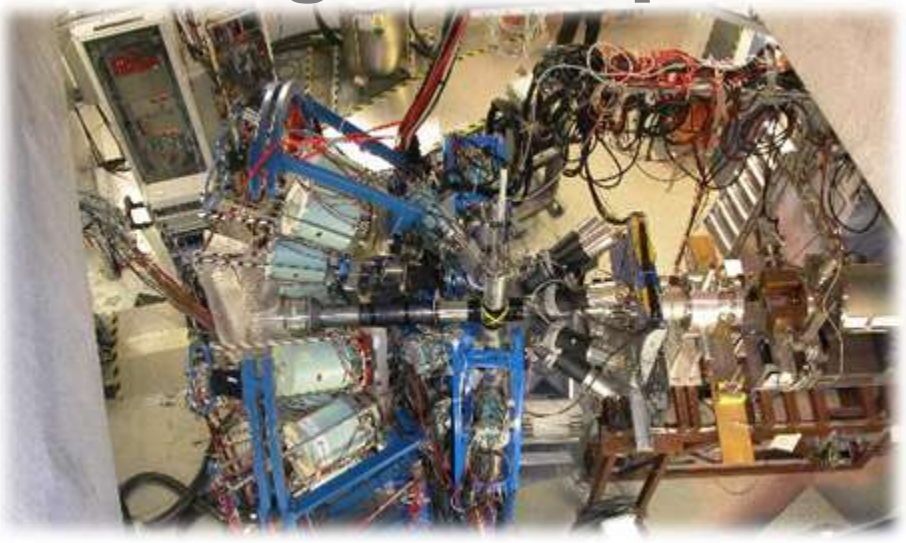
The idea behind Multichannel System

BIG Experiments



- Each subdetector has a big number of channels
- They don't need just HV/LV channels…. They need a HV/LV infrastructure!
- Modularity is a strong need (spare parts management, maintenability, …)
- Simple integration in the DCS of the experiment

Medium/Big Lab experiments



- The number of channel for each detector can sweep from one to many
- The possibility to have different channels in the same box is a plus
- A unique power supply system simplifies the software development and the management of the setup

Universal Multichannel Systems - New Multichannel Boards

A new categorization of CAEN Multichannel Power Supply Boards introduced to guide the users in finding the best solution for their applications

The Boards have been divided by:

✓ Maximum Output Voltage
- Low Voltage
- Up to 500 V Family
- Up to 4 kV
- Up to 8 kV
- Up to 15 kV

✓ Channel Grounding
- Common Ground
- Common Floating Return
- Individual Floating Channel

✓ Channel Architecture
- Independent Channel
- Independent Dual Range Channel
- Board for Specific Application

ALMA experiment: Extreme Environmental Condition

- Low Voltage Power Supply for ALMA (Chile Atacama desert at 5,000 m altitude) largest existing astronomical project (ESO: European Southern Observatory)
- 86 Complex Systems produced
- Very low ripple/noise performance
- High reliability; simplified maintenance
- Requirements for vibration, shocks, transportation, earthquake, air pressure, dust protection

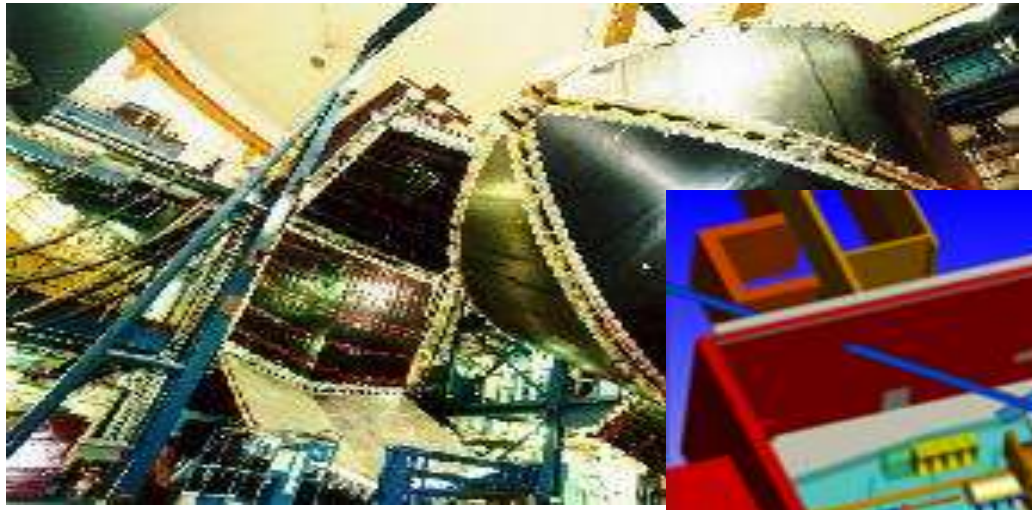
XENON

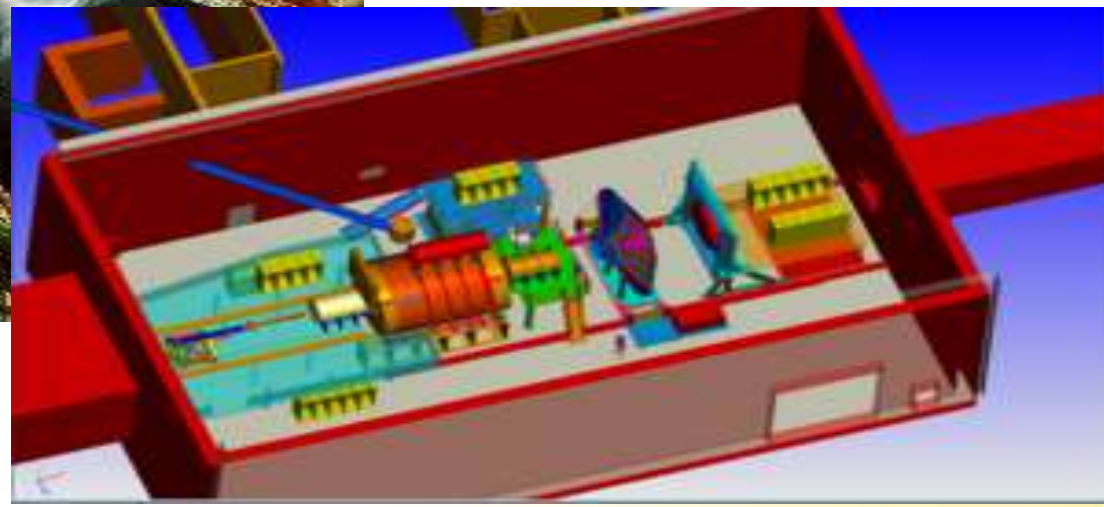
- **Nr. 35 V1724**
- **Nr. 15 A1535**
- **Nr. 2 A1526**
- **Nr. 2 Sy1527**
- **Nr. 2 VME8100/00**
- **Nr.2 V2718kit**

XENON Dark Matter Search Experiment aims to construct a next-generation dark matter detector, which will use liquid xenon as the target material for finding Weakly Interacting Massive Particles (WIMPs). The collaboration is led by Elena Aprile, an astrophysics professor at Columbia University.

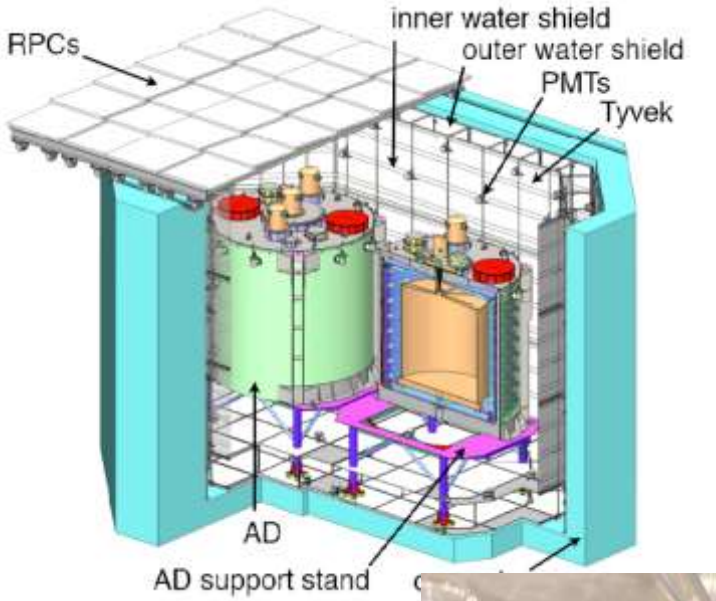
JLAB recently purchased a large number of HV modules for the several experiments of the lab. CLAS12, HALL A, HALL C, Hall D and GLUEX (HALL B) are all using CAEN systems for powering the detectors and for the accelerator radiation monitoring.

- **Nr. 6 SY1527LC**
- **Nr. 5 SY4527Basic**
- **Nr. 18 A1535SN**
- **Nr. 9 A1535P**
- **Nr. 3 A1535N**
- **Nr.12 A1550P**
- **Nr. 82 A1535N**
- **Nr. 5 A1550P**





DAYA BAY Neutrino Reactor Experiment



The Daya Bay Neutrino Experiment is a neutrino-oscillation experiment designed to measure the mixing angle q13 using anti-neutrinos produced by the reactors of the Daya Bay Nuclear Power Plant (NPP) and the Ling Ao NPP

On March 13,2012 **Electron anti-neutrino disappearance is observed at Daya Bay, together with a spectral distortion A new type of neutrino oscillation is thus discovered**

- **Nr. 8 SY1527LC**
- **Nr. 55 A1932P**

CMS-Compact Muon Solenoid-APD

ECAL APDs Power Supply System:
Design and manufacturing of the power supplies for the Avalanche Photodiodes of the Electromagnetic Calorimeter (ECAL). Such modules (A1520) are double width SY1527/SY2527/SY3527 System boards, housing nine +500V / 15mA floating channels each. The board offers an outstanding stability, load regulation and excellent ripple performances.

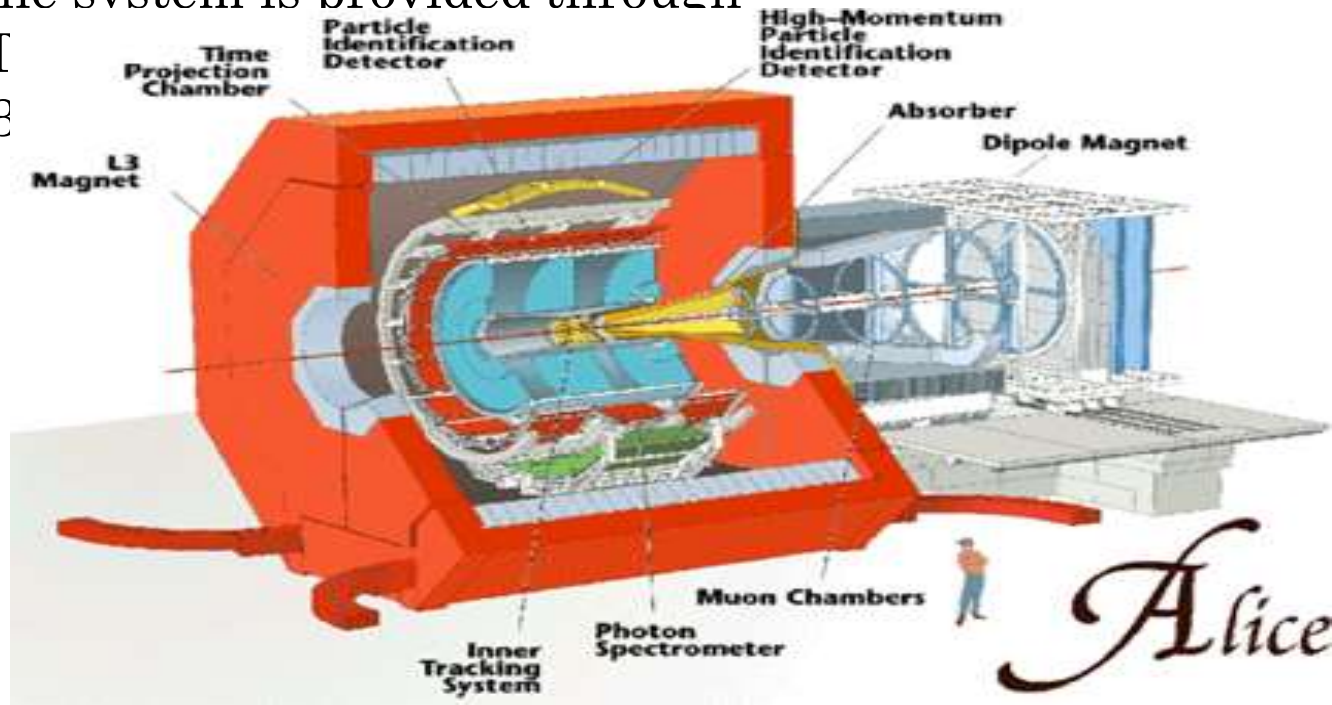
- **Nr. 18 SY1527 crates**
- **Nr. 144 A1520 HV Modules**

ALICE
Time of Flight

Microstrip Detector Power Supply System
Design and manufacturing of the LV and HV Power Supplies for the ALICE Microstrip detector. The system is based on a 12 channels High Voltage module (A3501) and a 3 channels Low Voltage module (A3602). The A3501 and A3502 modules are housed in a specific crate called EASY3000. EASY3000, A3501 and A3602 are designed to be magnetic and radiation tolerant. The remote control of the system is provided through the SY1527LC crate and the A1676A boards. T
the modules (48 Volt DC) is provided by the A3

- **Nr. 18 EASY3000 crates**
- **Nr. 24 A3501 HV modules**
- **Nr. 144 A3602 LV modules**
- **Nr. 4 A1676A boards**
- **Nr. 1 SY1527LC crate**

- **Nr. 9 A3486P PS modules**



CAEN
Tools for Discovery

2nd Product line: Signal Acquisition & Processing

Signal Conditioning, Read-out Electronics - interface between the experiment and the scientist: from detector signals to visualization of data!

- Modular IEEE-Standards NIM&VME
- Programmable Trigger modules
- Preamplifiers
- ADC,QDC,TDC

CAEN
Tools for Discovery

Preamplifiers

For most application in Particle and Nuclear Physics industrial monitor

Charge Sensitive Preamplifiers

- A422A (1 Channel with Timing)
- A1422 (1,4,8 Channel)
- A1422H (Hybrids)
-A1424 (Scintillation Preamplifier)

-Different input options to match Detector requirements

Fast Charge Amplifier

- A1425 (1 Channel, fast rise time)

Suitable for Diamond Neutron Detectors

Cardarelli Long Distance Matched Amplifier

- A1426 (INFN Design)

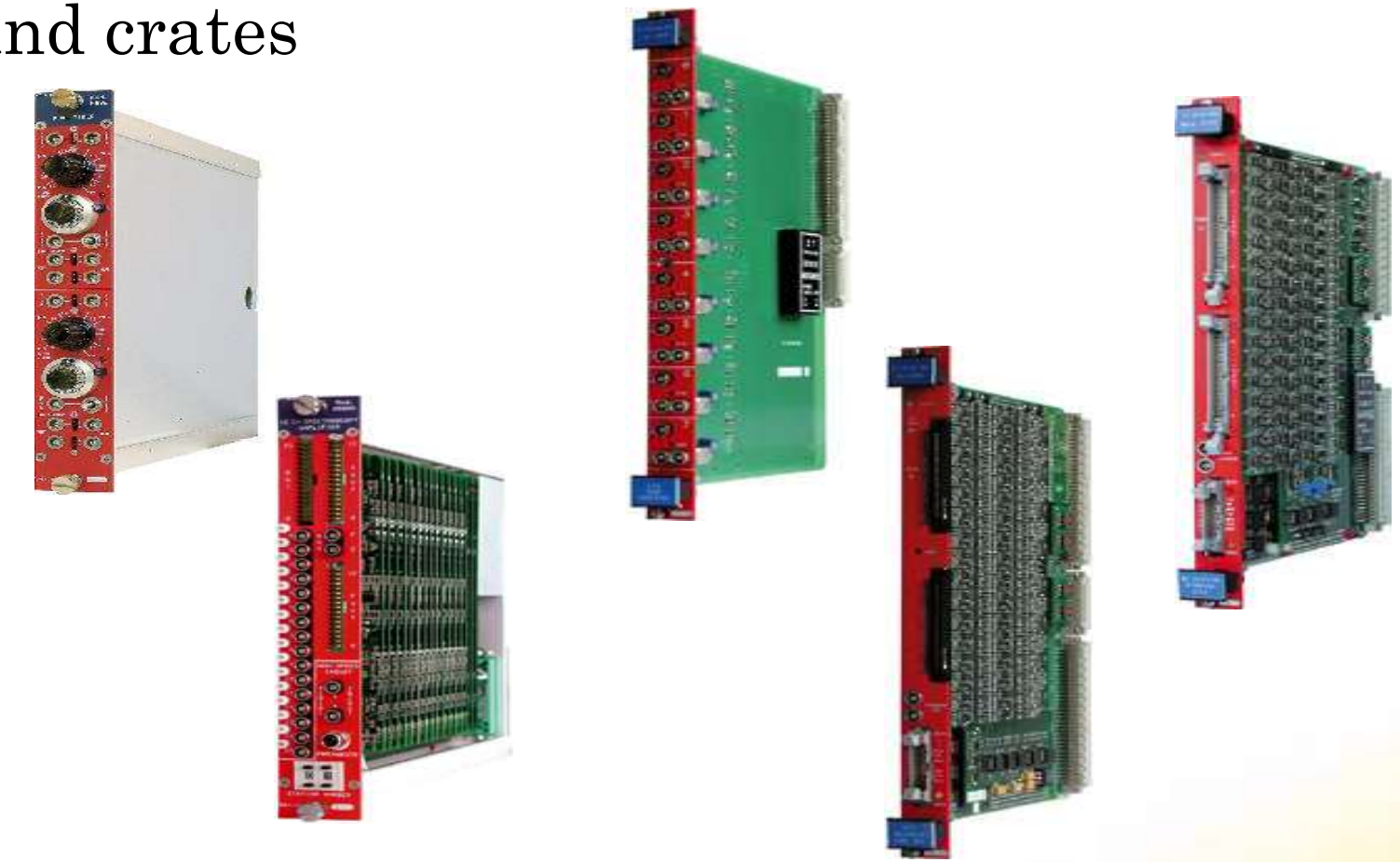
“Préamplificateur à collecte de courant”

- A1428 (CEA/LIST Design for operation in nuclear radiation research labs)

Traditional Electronics

CAEN offers a wide selection of Traditional Electronics in NIM and VME form factors and crates

- Discriminators
- Amplifiers
- Logic units
- Fan-in/Fan-out
- Scalers
- Peak Sensing ADC
- QDC
- TDC
- VME bridges

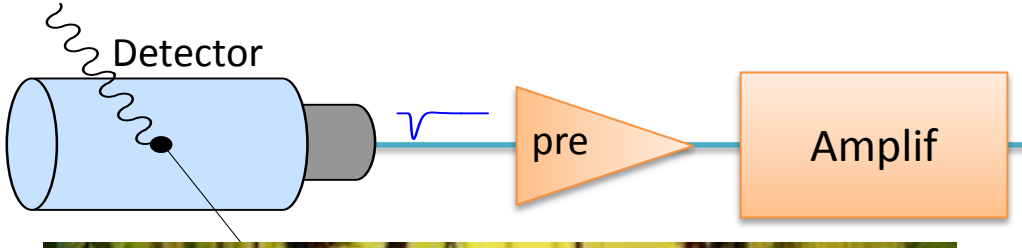


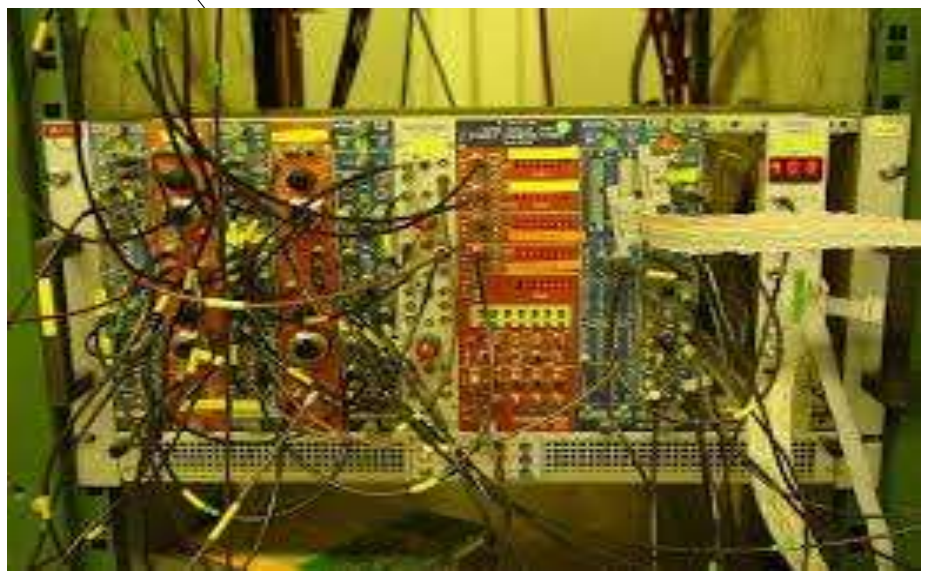
Traditional acquisition chain

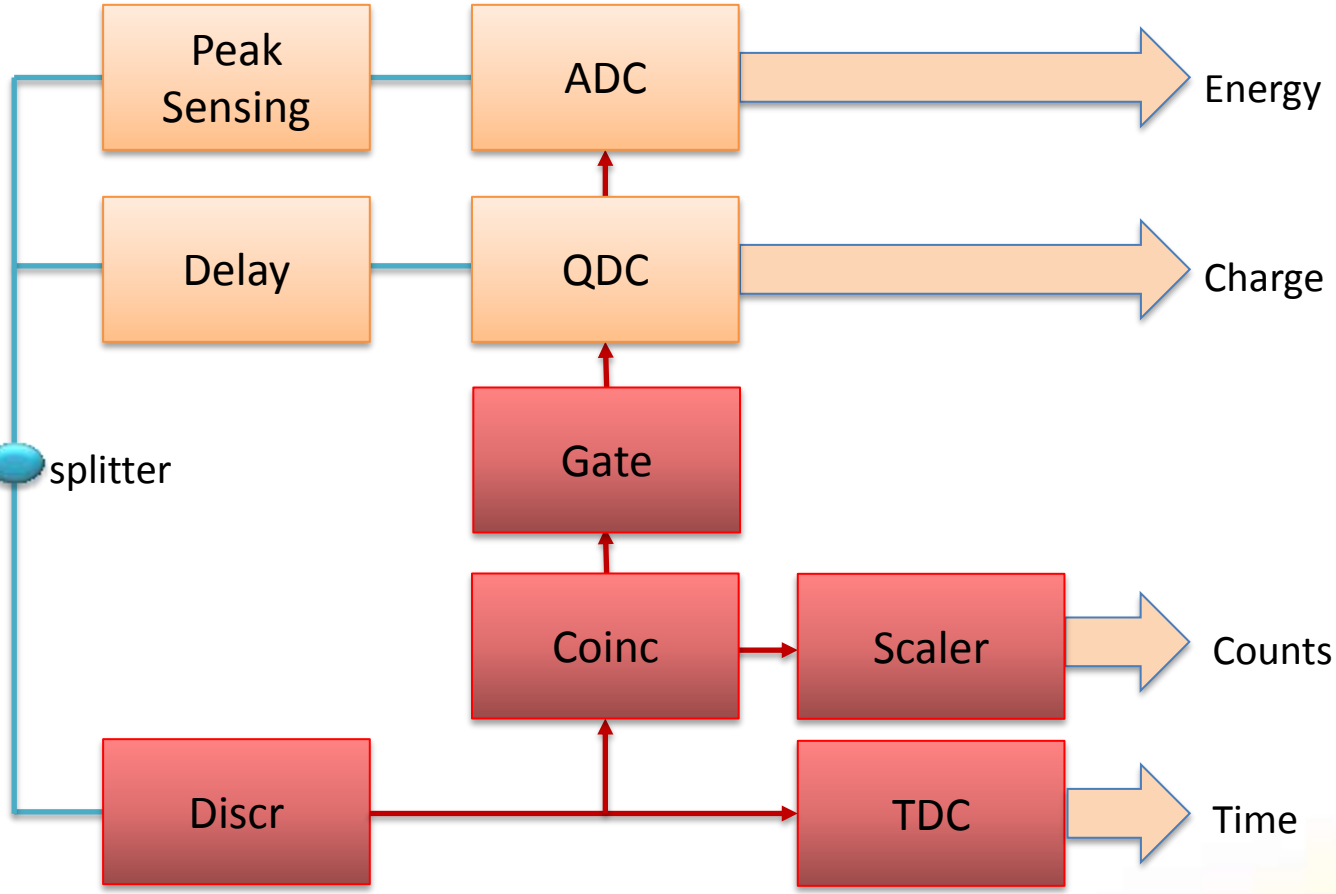
Tools for Discovery

A/D conversion at the end of the chain

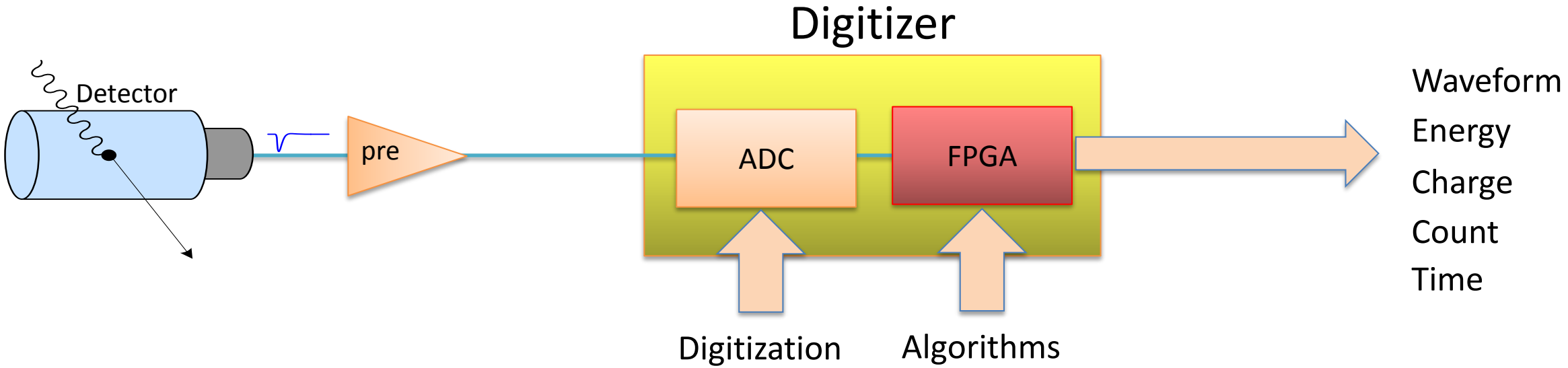
Traditional acquisition chains are made of a number of analog modules interconnected with cables







Fully digital acquisition chain



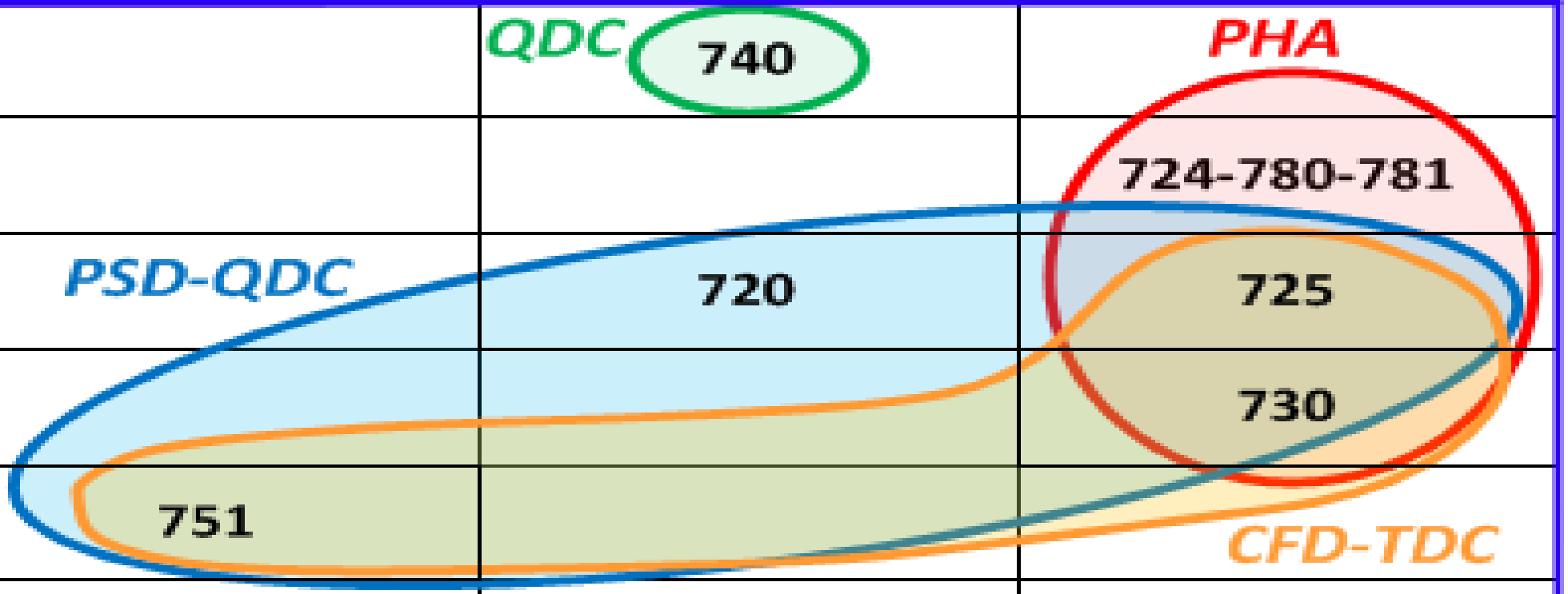
The aim of the Digital Pulse Processing is to make a “all in digital” version of analog modules such as Shaping Amplifiers, Discriminators, QDCs, Peak Sensing ADCs, TDCs, Scalers, Coincidence Units, etc.

Digitizers

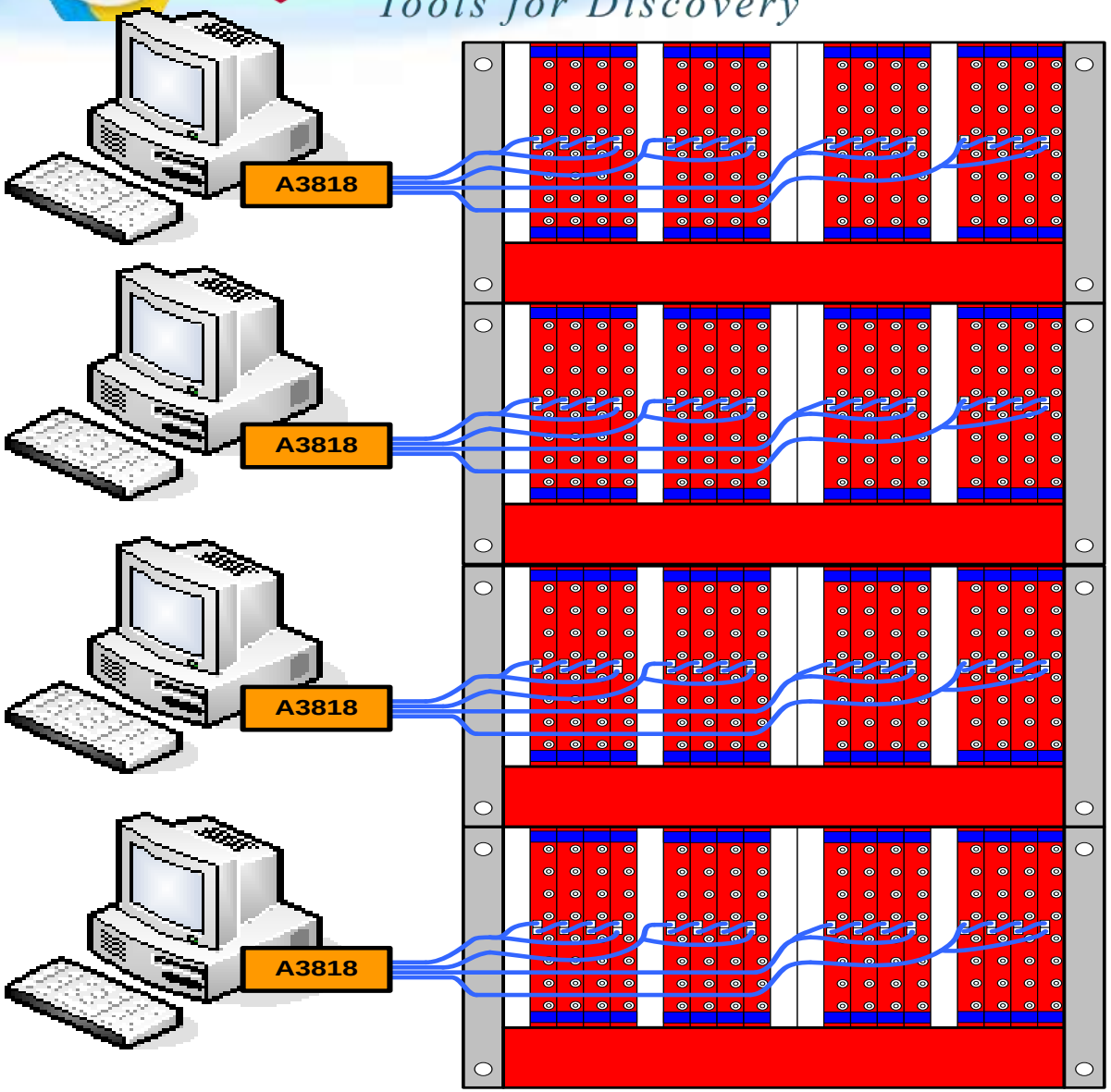
- VME, NIM, Desktop form factors:
  - **12, 14** bit flash ADC up to **500 MS/s**
  - **10** bit flash ADC up to **4 GS/s**
  - **12** bit switched capacitor ADC up to **5 GS/s**
  - Up to 64 channels in a VME board
- On-line Digital Pulse Processing (DPP):
  - PHA: Pulse Height Analysis (MCA)
  - PSD: Dual Gated integrator (QDC), Pulse Shape Discrimination, CFD + Timing interpolator (TDC)
  - QDC/CI: Gated integrator (QDC)
  - ZLE: Waveform Mode with Zero Suppression
- Multi-board synchronization and scalability
- Readout: VME, USB, Optical Link + PCIe (80 MB/s)

Application Map

	10 bit	12 bit	14 bit
62.5 MS/s		740	
100 MS/s			724-780-781
250 MS/s		720	725
500 MS/s			730
1 GS/s	751		
>= 2 GS/s	751 / 761	742 / 743	

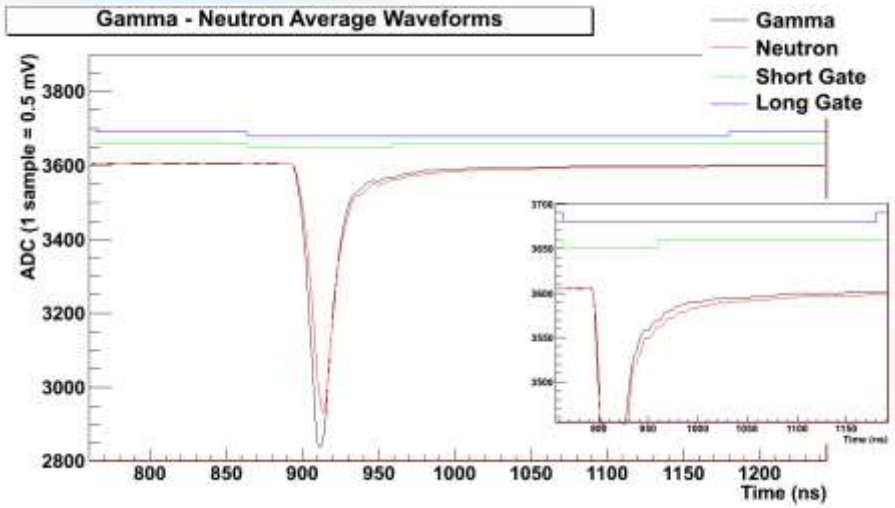


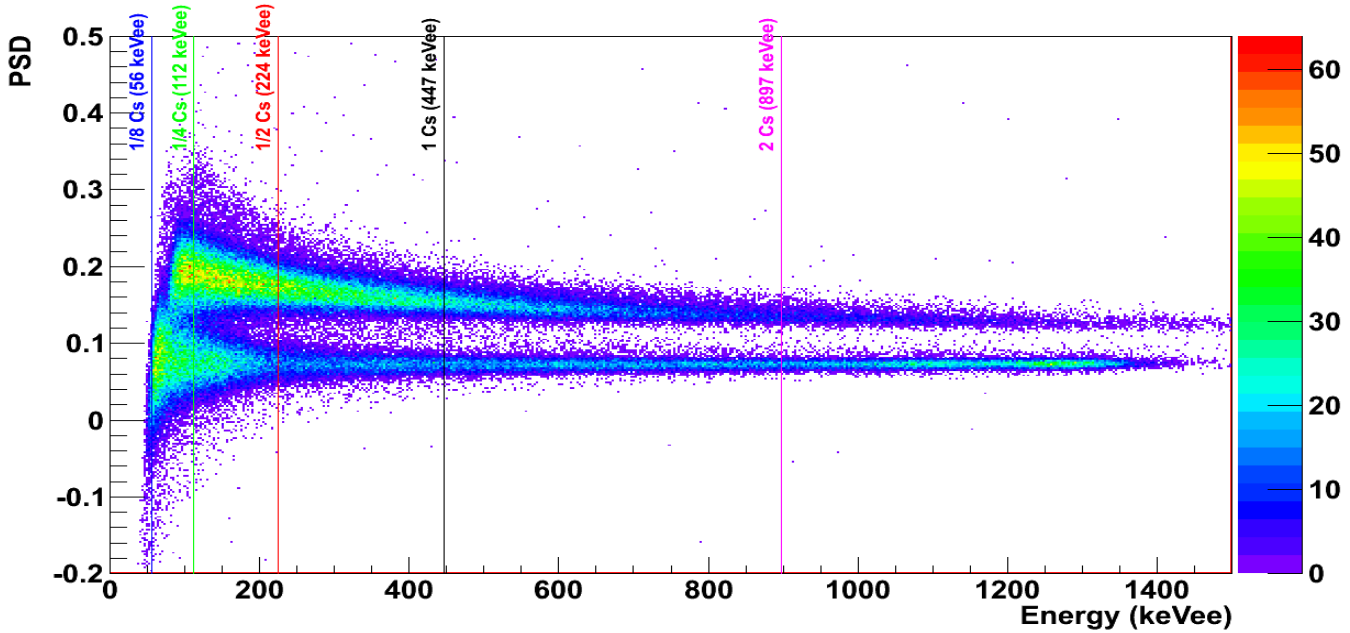
CONET example: XMASS experiment



64 V1751 modules in 4 VME crates
512 channels (10 bit @ 1GHz)
4 A3818 4 link PCIe cards
16 parallel CONET links
4 digitizers daisy chained
Readout Bandwidth = ~2 MB/s/ch
Total Bandwidth = ~ 1GB/s

γ-n Discrimination





Detector: BC501A 5x2 inches,

PMT: Hamamatsu R1250

Board: DT5720 with DPP-PSD

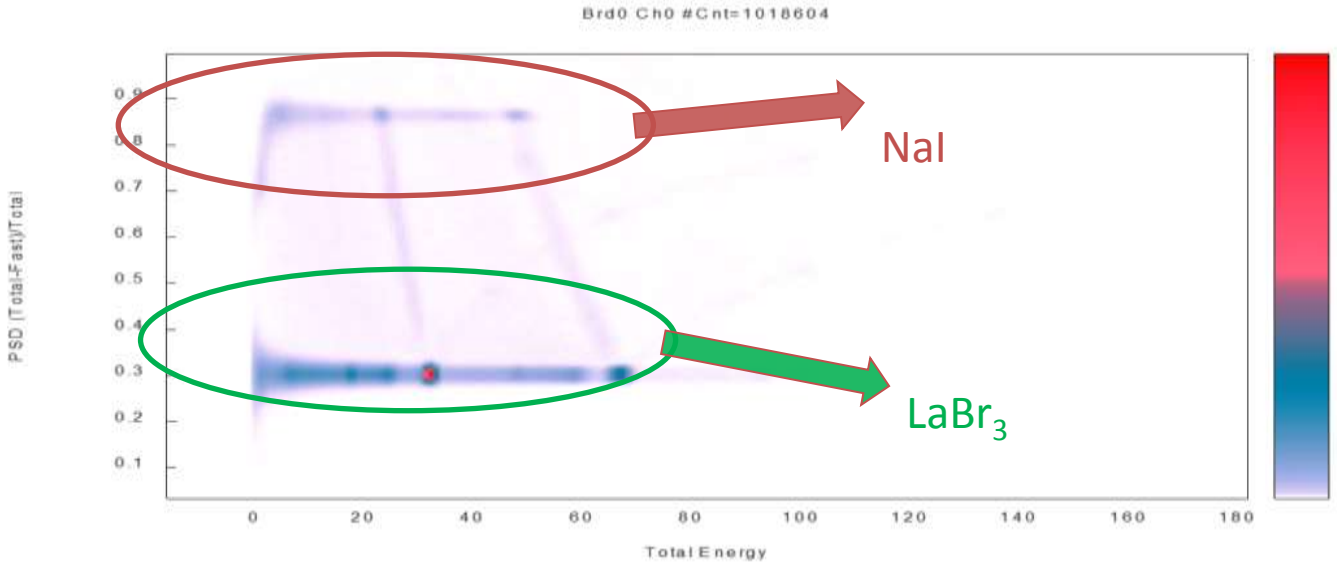
"Pulse shape discrimination with fast digitizers"
L. Stevanato et al, NIMA 748 (2014) 33–38

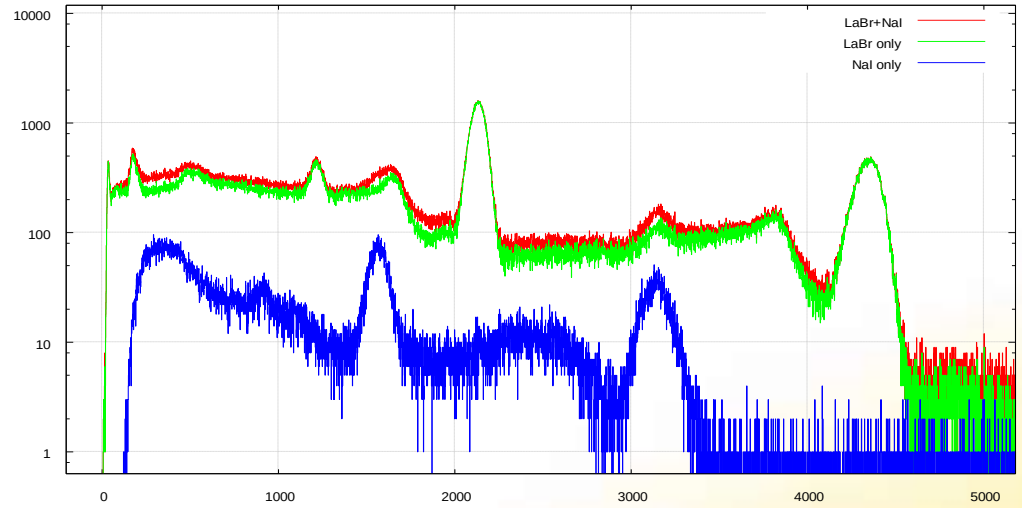
PSD with Phoswich detectors

DAQ to readout an array of Phoswich detectors made of $LaBr_3$ and NaI

- ✓ Pulse Shape Discrimination needed to separate the energy released in each scintillator and apply the proper calibration separately
- ✓ Fine Timing needed to exploit the excellent timing capabilities of $LaBr_3$

Test made with DT5730 (14 bit, 500 MS/s) running Pulse Shape Discrimination w/ dual charge integration gate





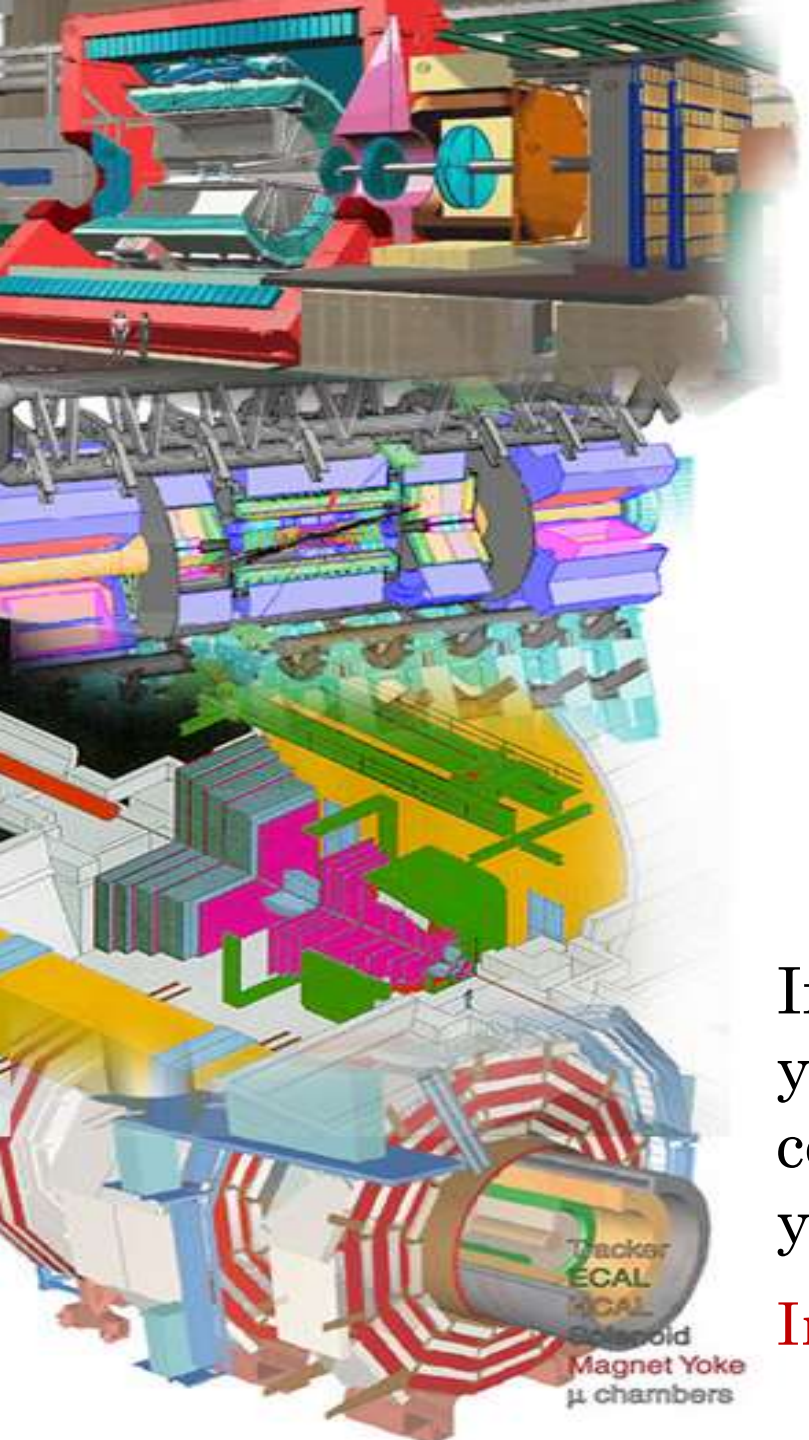
CAEN
Tools for Discovery

Modern Digital MCA line

Digital Detector Emulator

- Emulator/Pulser/Function Generator operating mode
- Energy spectrum emulation (pre-defined or measured in real setup)
- Time distribution emulation
- Pile-up emulation
- Noise (Gaussian, 1/f, random walk) and periodic interference emulation
- Baseline drift
- Custom signal shape emulation (predefined or measured in real setup)
- 12 ps/step programmable analog delay generator
- Correlated events generation on the two output channels
- Multiple shape on the same channel for testing the pulse shape discrimination

Open to Custom Projects



If you don't find the Product you need in our Catalog, or if you are starting a new experiment and require a completely new design, CAEN will help you at any stage of your project.

Important share of CAEN turnover from custom developments!

Thank you for attention!