CAEN Electronic Instrumentation

Tools for Discovery

Novel acquisition systems and smart FPGA programmability

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2020 ISOLDE WORKSHOP AND USER MEETING

Summary

New hardware developments:

- R5560
- VX2740

Open FPGA concept and SciCompiler

CoMPASS, a comprehensive acquisition control software

-- A talk about flexibility

New hardware

CAEN **always drives to develop** new hardware and to improve its products with new firmware and software tools.

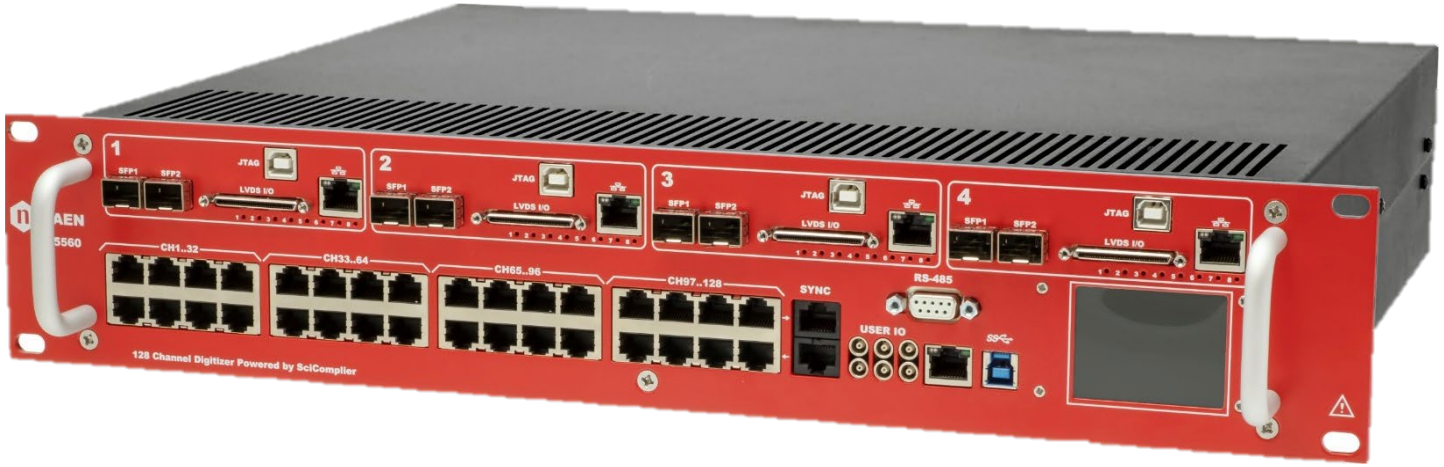
During the last years, a major project was pursued that is going to influence the years ahead: the **new digitizers**.

The new digitizers have better performance across the board:

- more channels for denser systems,
- faster communication links,
- from MB to GB on-board memory,
- improved FPGA with embedded ARM and OpenFPGA.

X5560 family (rack and desktop)

- 128 channels, 14-bit @125 MS/s Digitizer
- Rackmount with differential (CAT5e) or single-ended (MCX) inputs
- Based on powerful Xilinx Zynq-7000 SoC with open FPGA
- **SCI-Compiler for easy FPGA programming**
- Fully customizable data processing firmware , middleware and software
- Readout of large arrays of detector : specifically for position-sensitive 3He tubes.
- Maximum flexibility: **USB3.0, Ethernet**, and Optical Link connectivity
- COMING SOON
  Desktop version - 32-channels single-ended

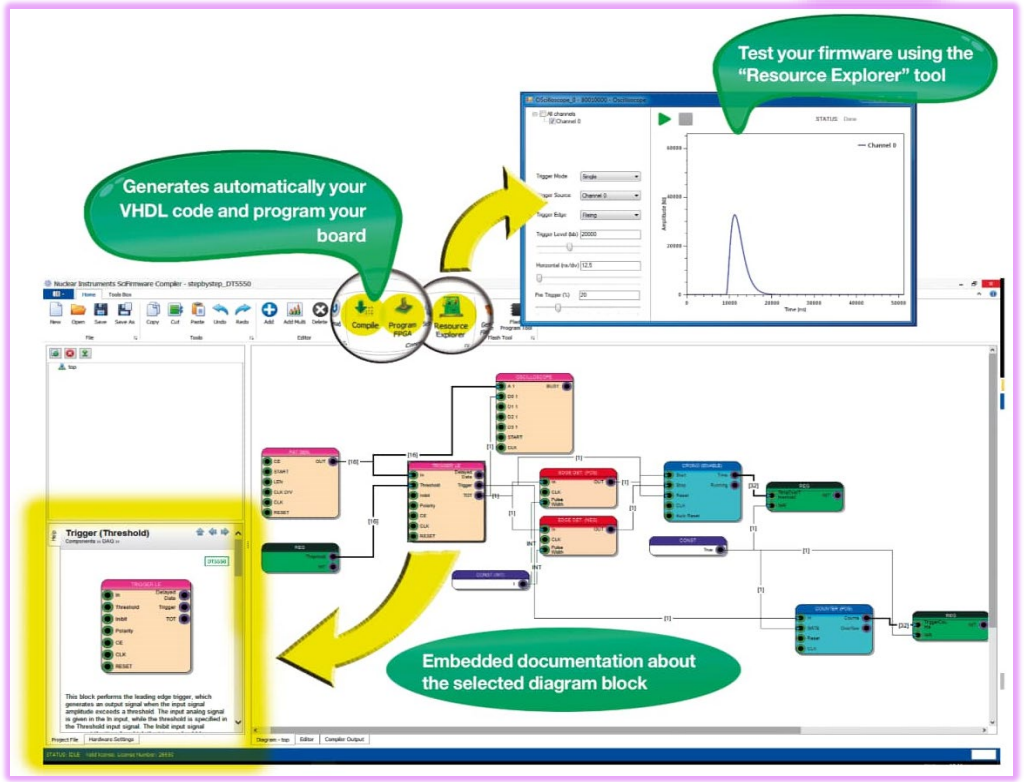


SCI-Compiler: the concept

Blocks implementing advanced signal processing (Trapezoidal filter, Oscilloscope, TDC, MCA, ...)

SCI-COMPILER CAEN

1-year free upgrade license included with CAEN x5560, x5550 families



VHDL code

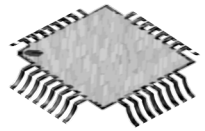
DRIVERS

C/C++/C#/Python libraries

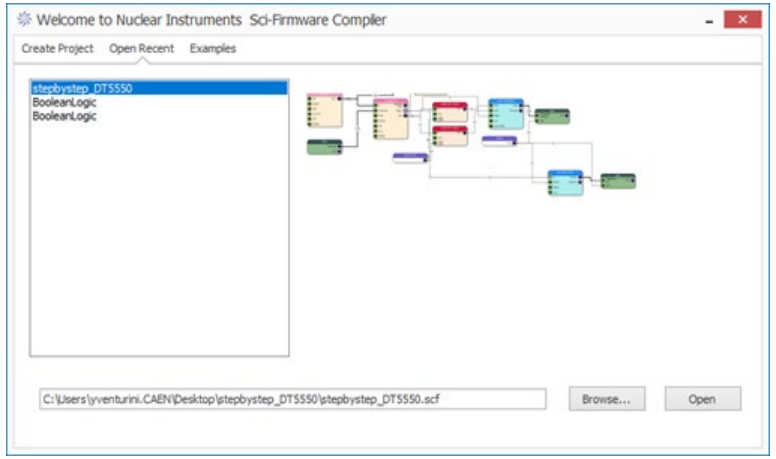
Application example code

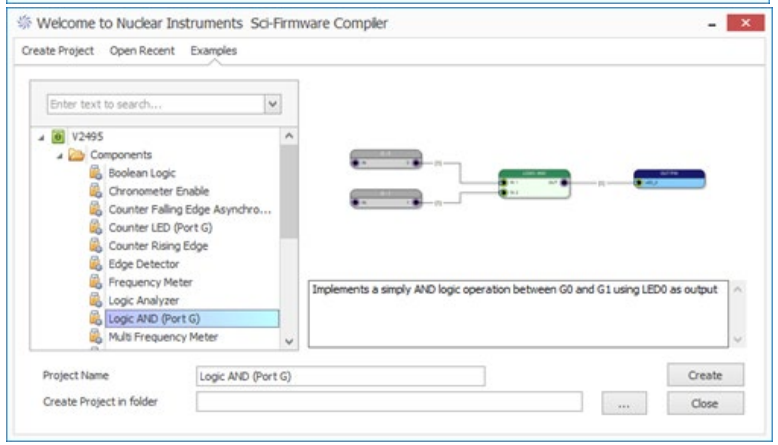
VIVADO

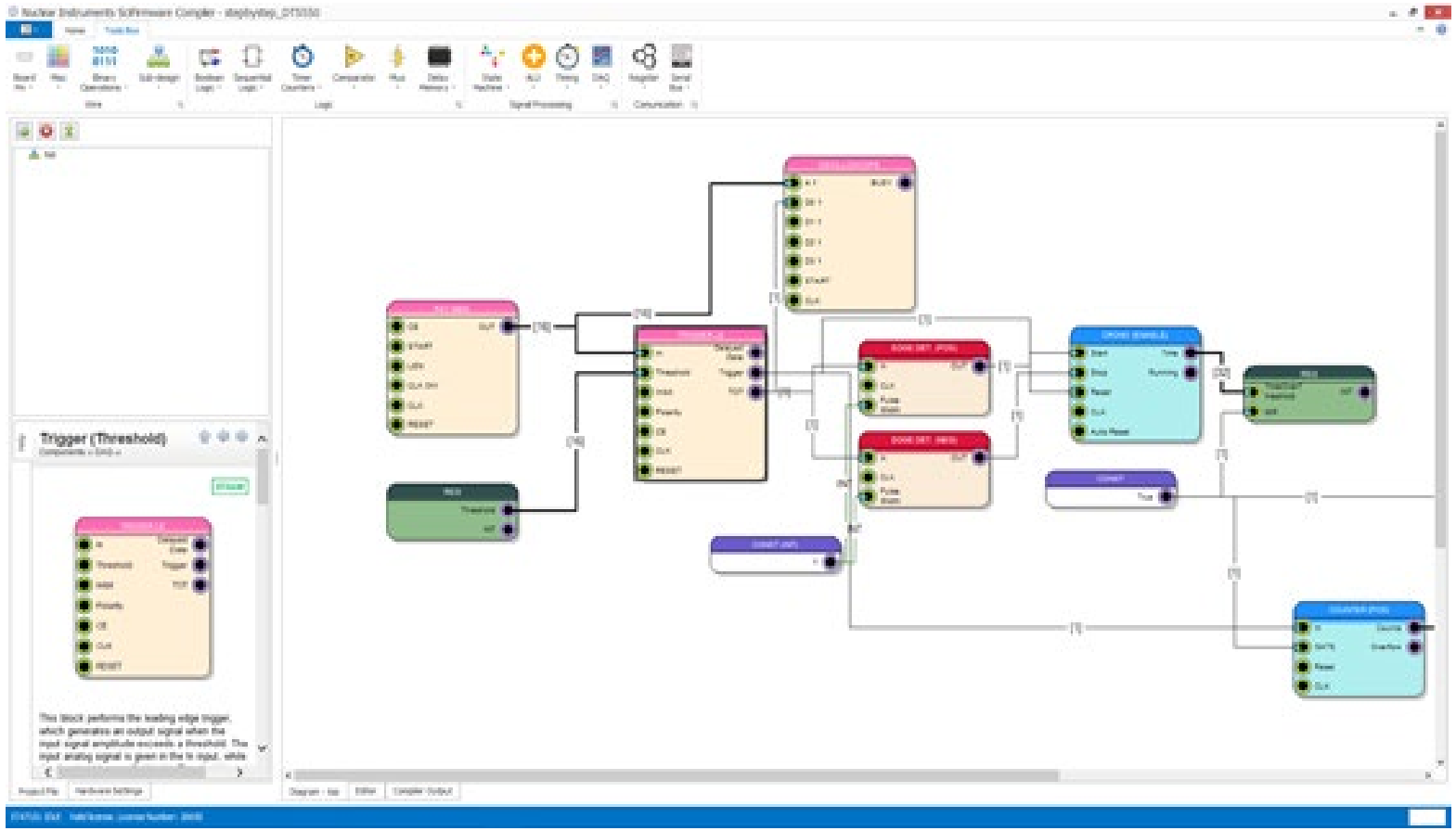
Quartus Prime Design Suite



SciCompiler: how it works







A practical example for neutron detection

3He/ BF3 tube

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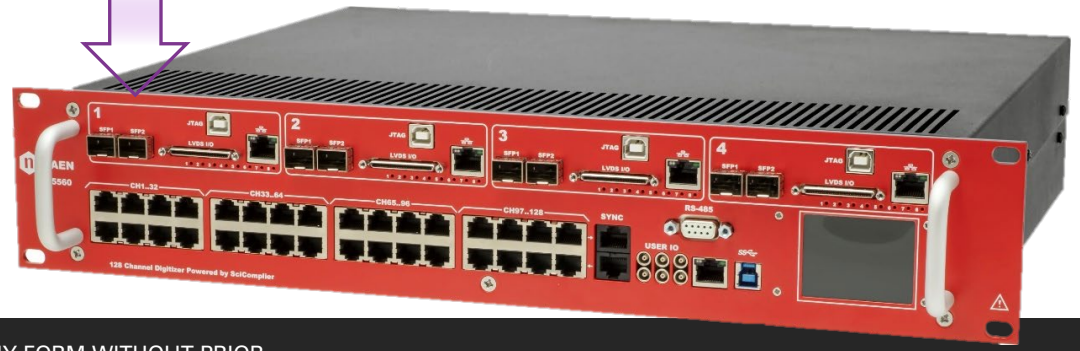
HV: R8033

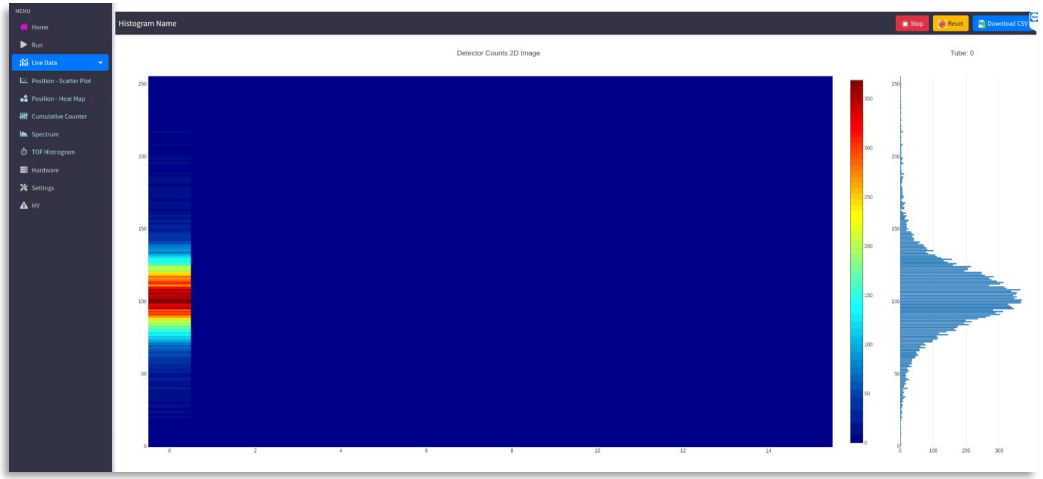
4kV/3mA

R1443 preamp

32/64 channels

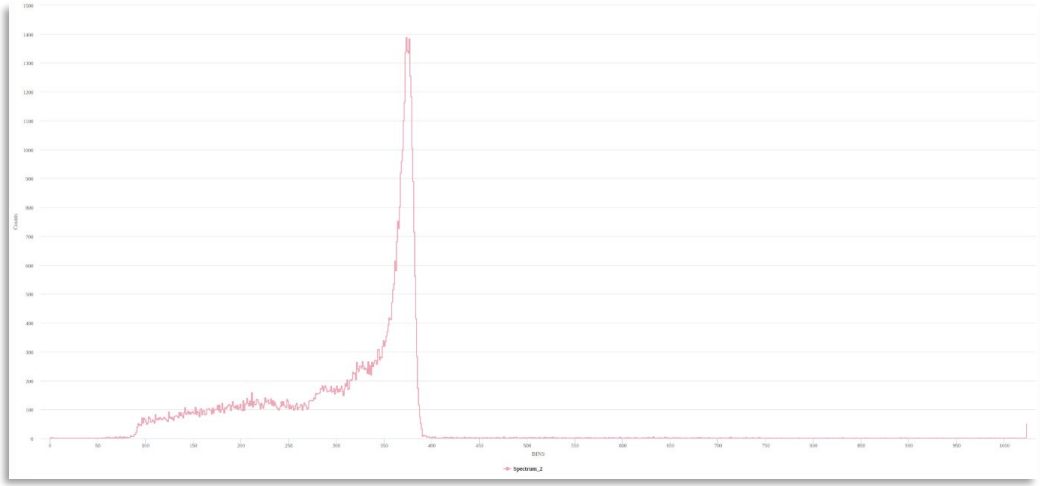
Readout: R5560





Neutron detection: research and security

- **Loki @ ESS**/RAL-ISIS: 3He tubes readout by 30x R5560 synchronized and interfaced with pre-existing systems
- **IRSN** – France: 32 channels readout system for 8 position sensitive 3He tubes – 32 ch preamp R1443 , 16 ch R8033 HV and 32 ch R5560



Thermal neutron position (top) and spectrum (bottom) reconstructions acquired with a 3He tube and R5560

VX2740: the first of a kind

<u>64 channel, 125 MS/s, 16 - bit waveform digitizer</u>

High channel density spectroscopy

Good fit for Neutrino and Dark Matter experiment

Open FPGA: SCI-Compiler tool for beginners or advanced firmware template

Four 40-pin, 2 mm header connectors with DIFF or SE inputs

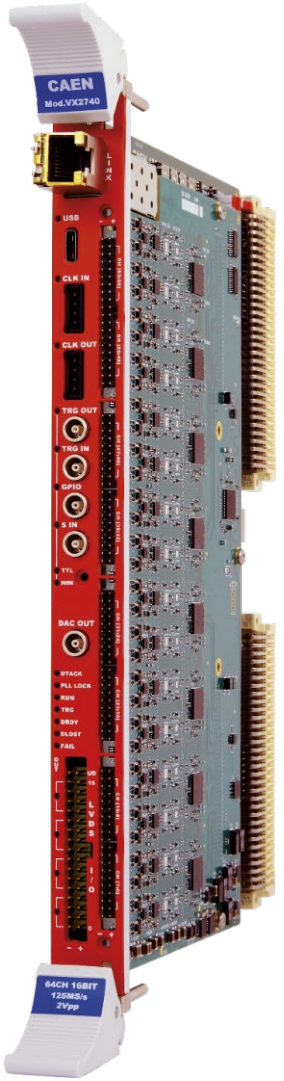
1 GbE, **10 GbE**, **USB 3.0** and CONET 2.0 (optional) connectivity

Common Trigger (waveforms) or Individual Self-trigger modes

DPP options: PHA (soon available), QDC, PSD, CFD

Advanced Waveform Readout modes: ZLE, DAW

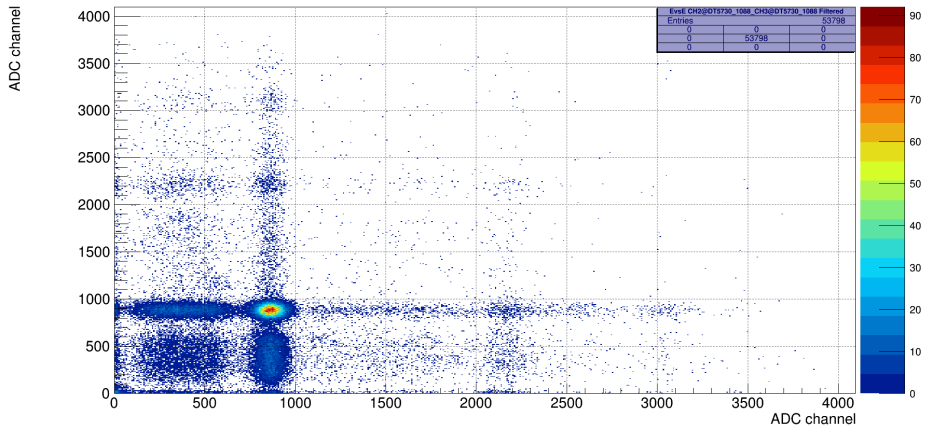
DT2740, 64 channels in Desktop form factor (COMING SOON)



Model	# channels	MS/s	# bit	Applications
x2740	64	125	16	64 MCAs for high channel density spectroscopy Good fit for Neutrino and Dark Matter exp. (candidate for Dark Side)
x2745 Advanced version of x2740	64	125	16	Variable gain input stage Designed for Si detectors readout
x2725/x2730	32	250/500	14	Medium-fast detectors Sub-ns timing combined with high energy resolution Optimal trade off between cost and performances
x2751	16	1000	14	Ultra-fast detectors (diamond, MPCs, SiPMs) with ps timing applications Potential upgrade to 2.5 GS/s
x2724	32	125	16	Spectroscopy & MCA Advanced Front-End (gain, shaping, AC/DC coupling …) Semiconductor detector (HPGe, Clover, SDD ,…) Typically connected to charge Sensitive Preamplifier

Currently available

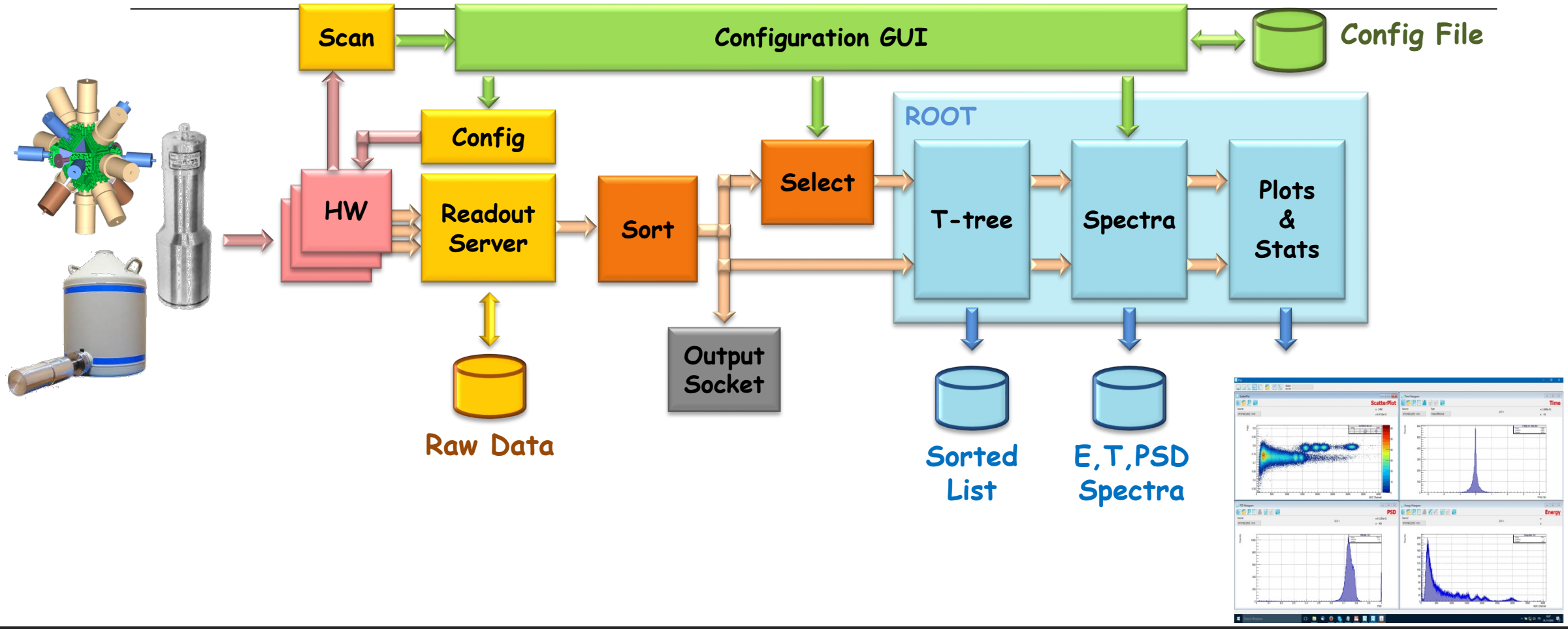
Birdseye view – what's coming



CoMPASS

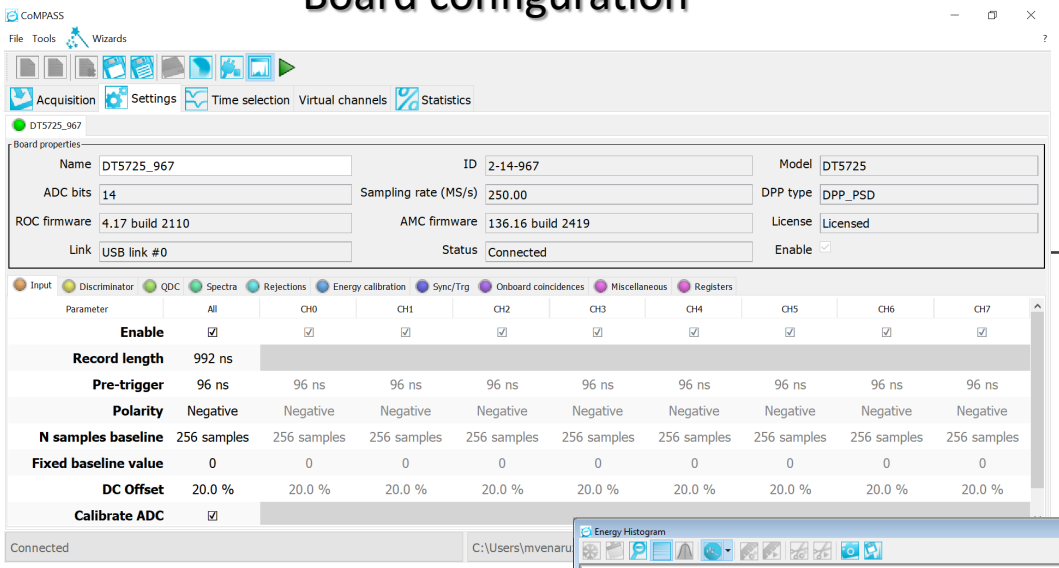
- Support to all the **CAEN Digitizer** running **DPP FW** and MCAs (except Hexagon)
- **Multi-board management**
- **Synchronization** of multiple boards of different type
- Time Correlation between different channels
- Simultaneous plot of waveform, energy, time, PSD, and TOF spectra
- Energy calibration
- Digital Constant Fraction Discrimination for fine time stamp interpolation
- Selectable filters on energy and PSD
- Several options for **data saving**, including **ROOT**, **.csv**, **.bin**, **.n42**, **etc.**

CoMPASS block diagram

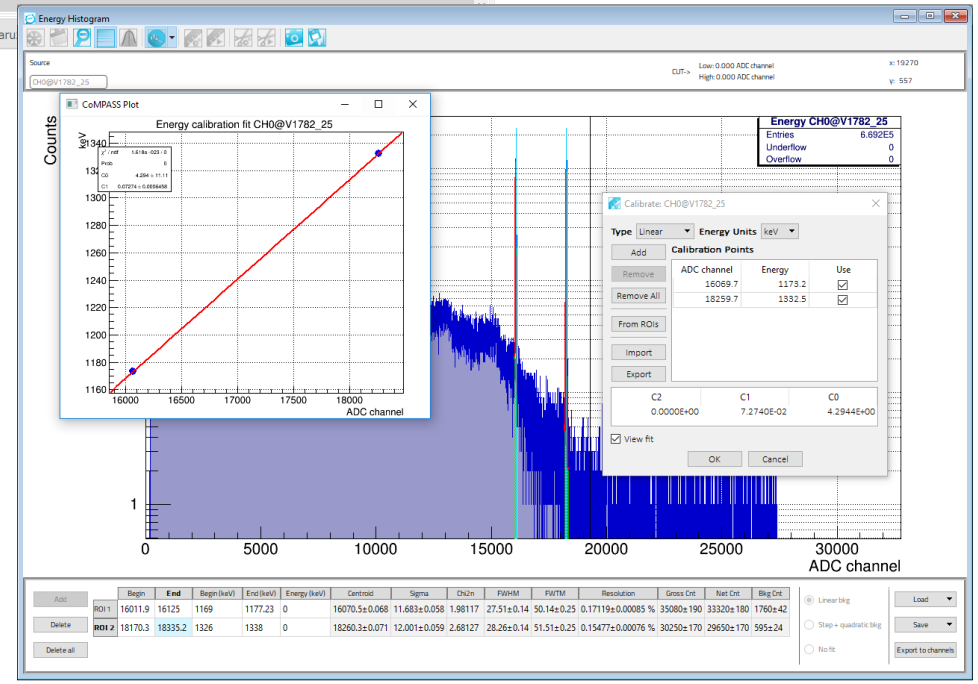


A practical example (1/3)

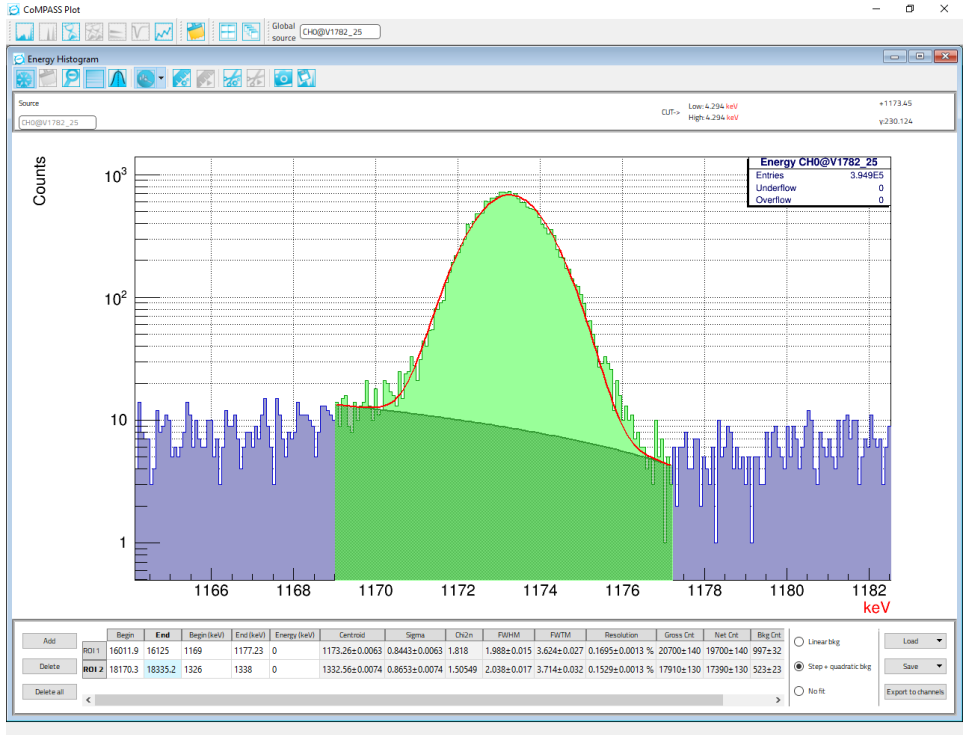
Board configuration



Spectrum calibration

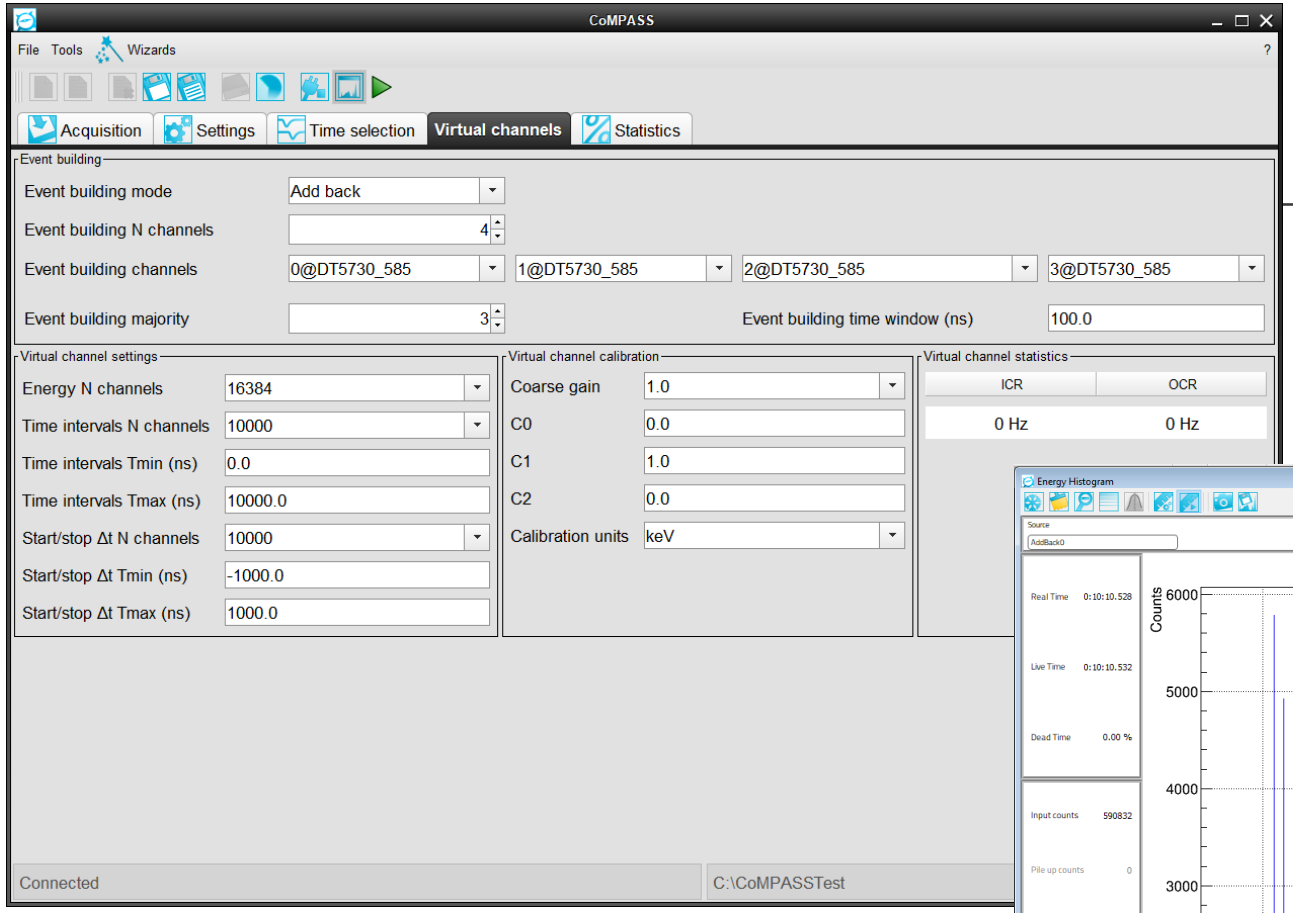


ROI fit with linear or step+quadratic background



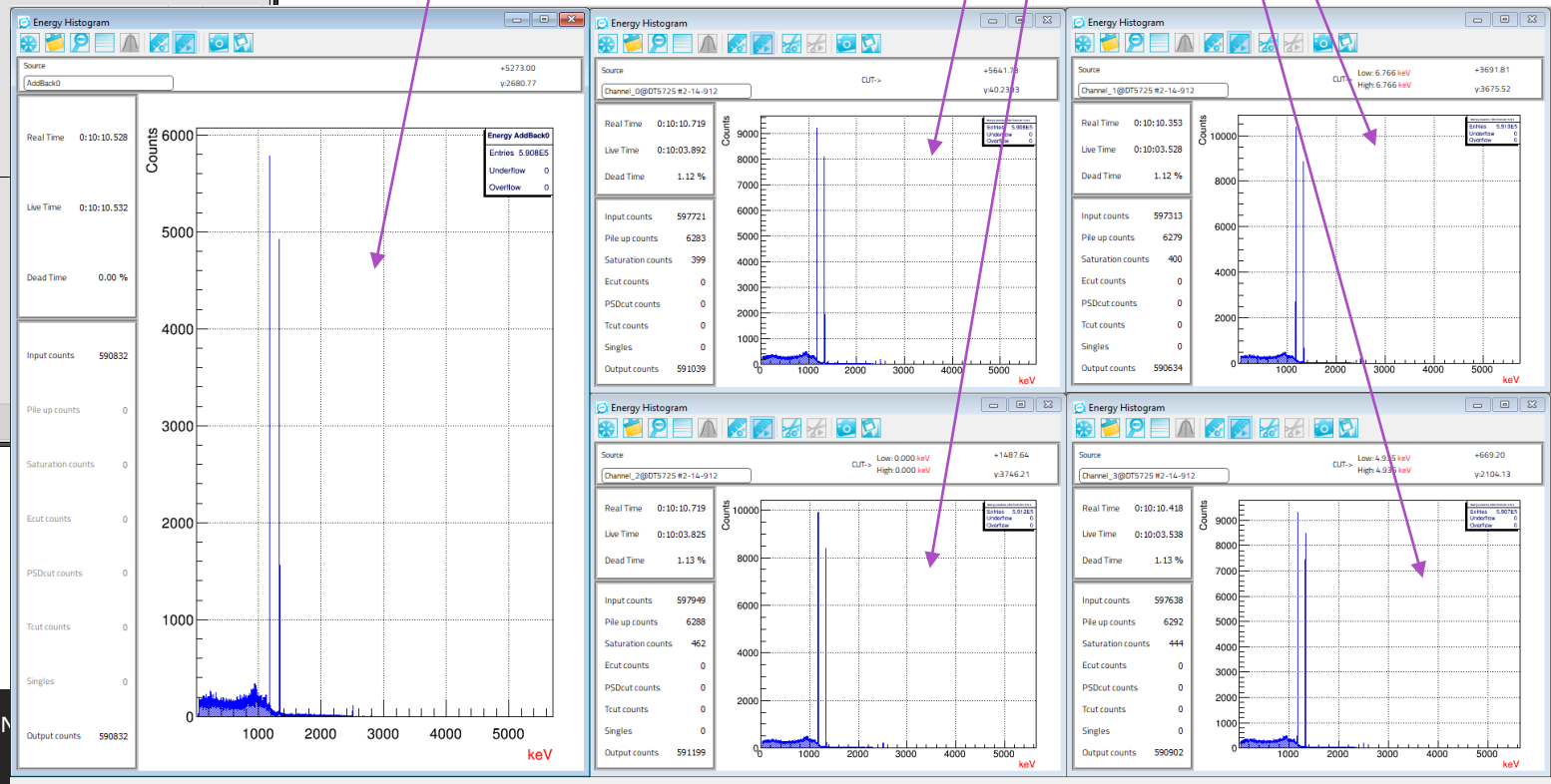
A practical example (2/3)

The Add-Back settings in the GUI



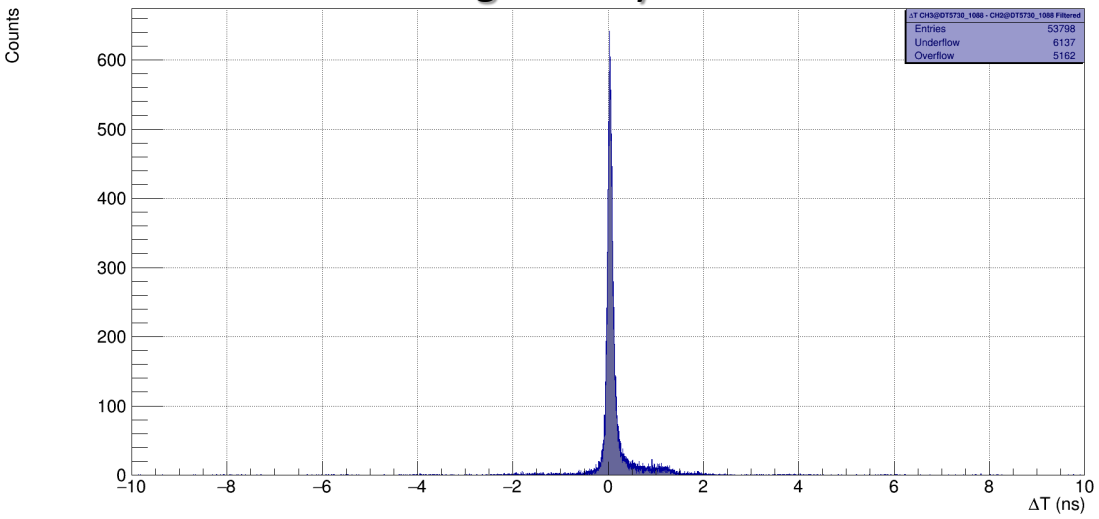
The Add-Back spectrum

Four spectra of the individual channels

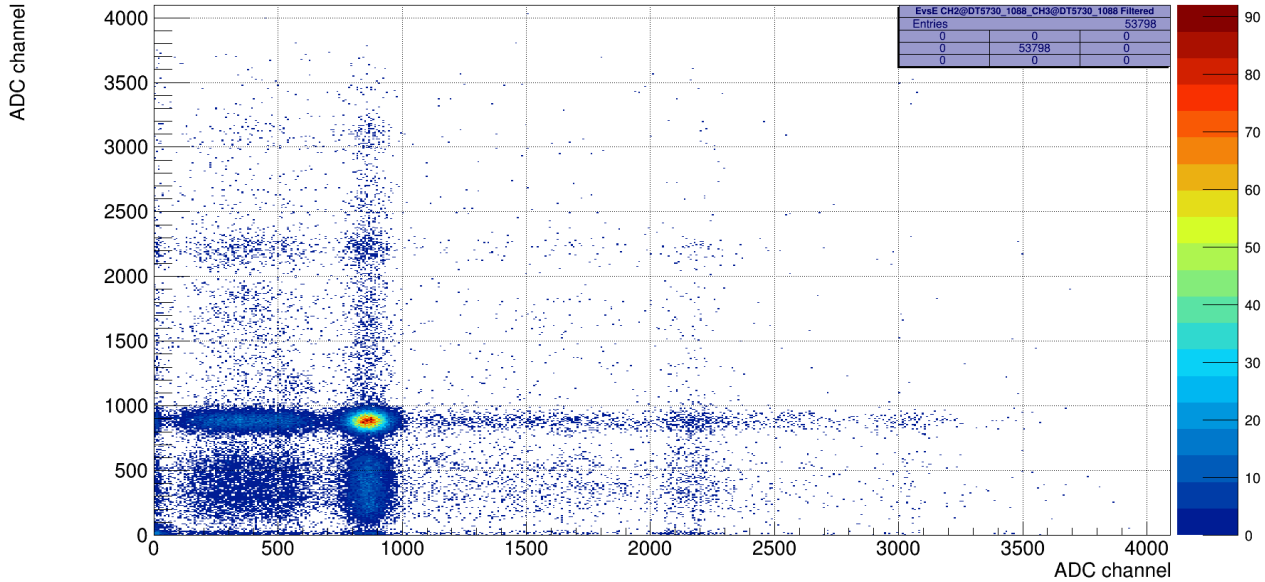


A practical example (3/3)

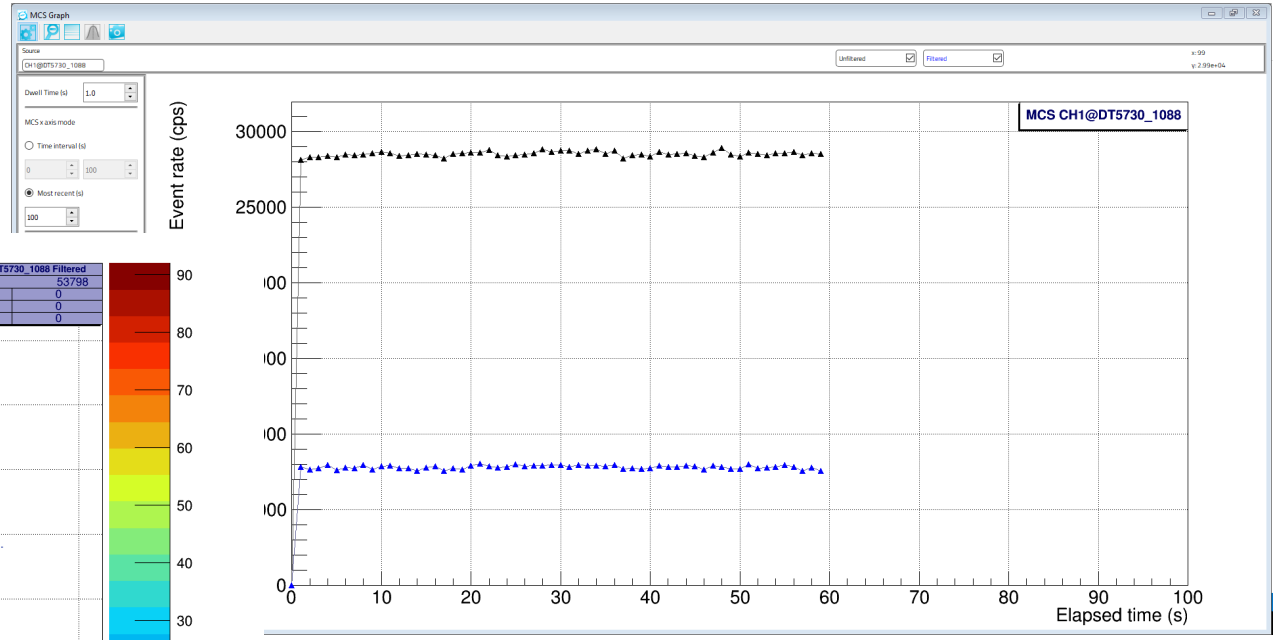
Time of Flight analysis

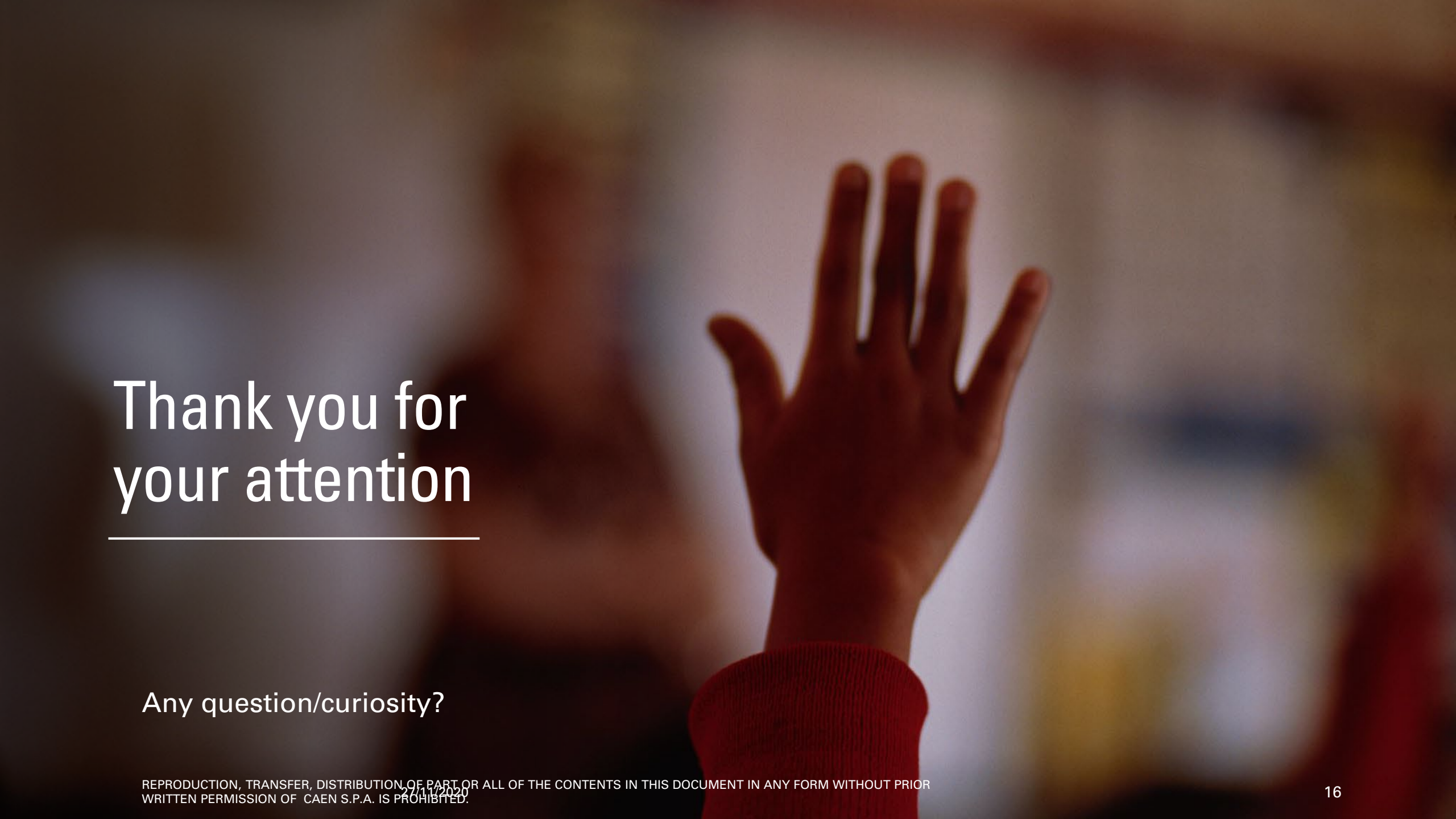


E vs E distribution



Multi Channel Scaler





Thank you for your attention

Any question/curiosity?