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CERT. N. 9105.CAEN

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Tools for Discovery

Digital Pulse Processing

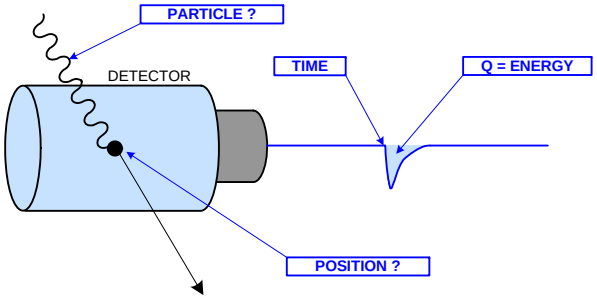
November 2008

Motivation

- The experimental Physicist's dream

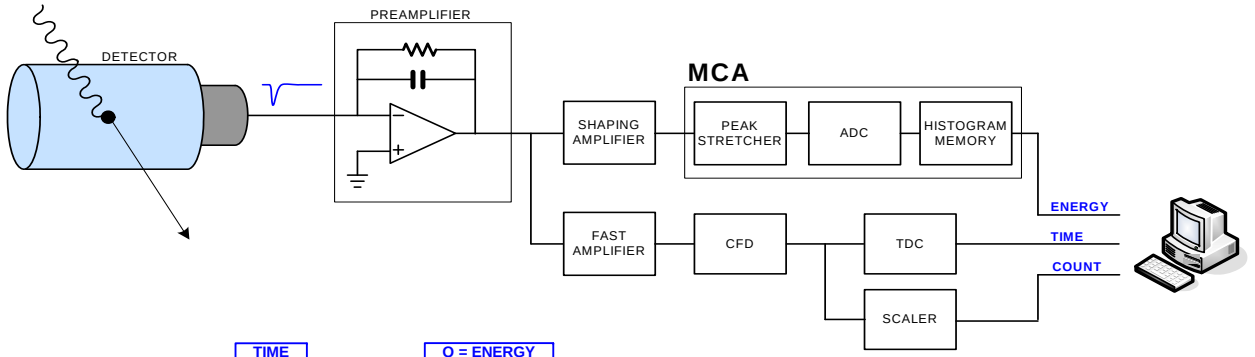
  There is a particle, I want to know:

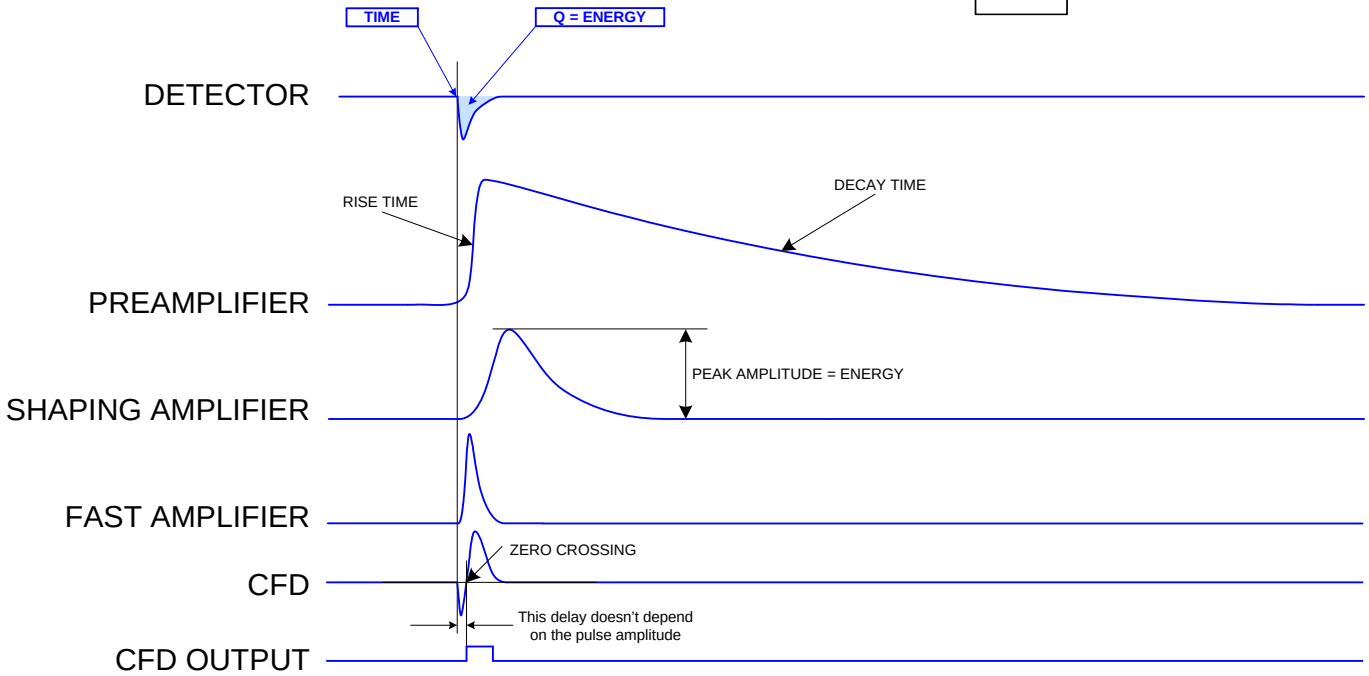
  - ***Type***
  - ***Energy***
  - ***Time***
  - ***Position***



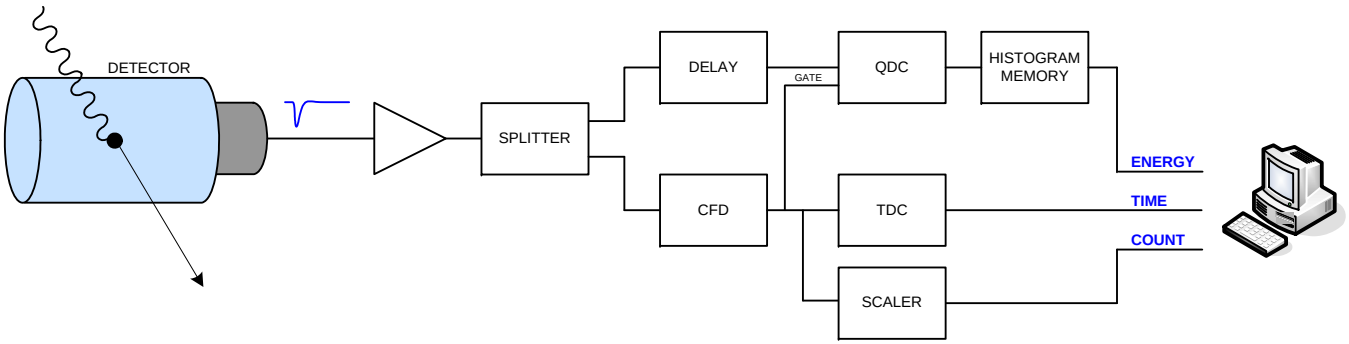
- I can play with:
  - Detectors (different detectors for different information, increased segmentation)
  - Electronics (to treat and extract the signal)
  - Software (reconstruction algorithms)

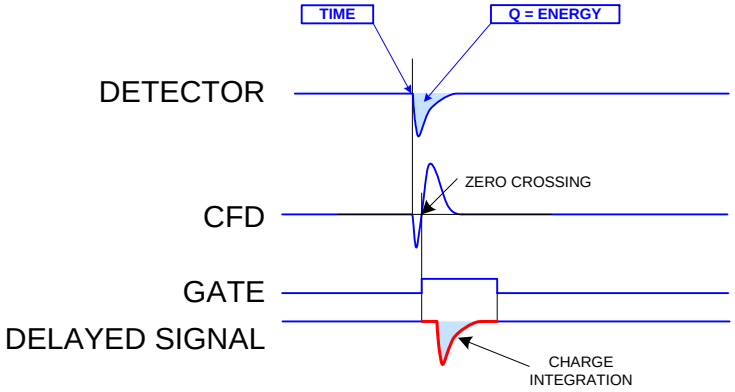
Traditional analogue chain (1)
using charge sensitive preamplifiers





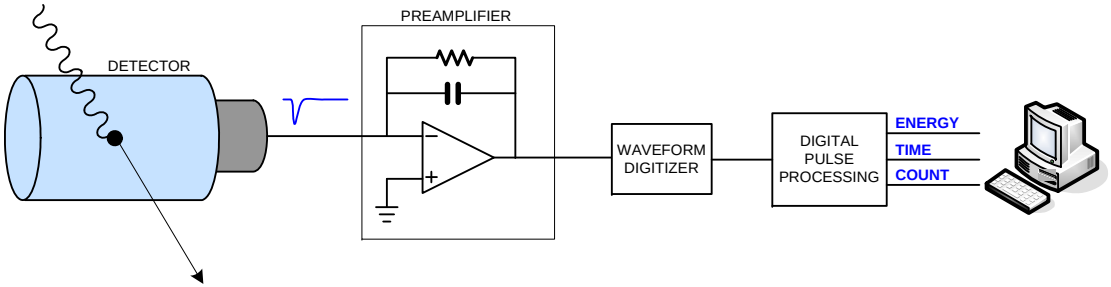
Traditional analogue chain (2)
using linear fast amplifiers (or nothing)





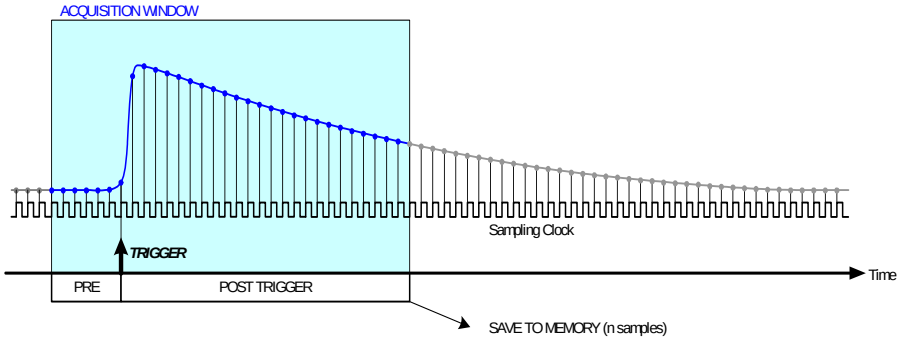
- The QDC is not self-triggering; you need a gate generator
- You need delay lines to compensate the delay of the gate logic (long cables!)

Digital acquisition



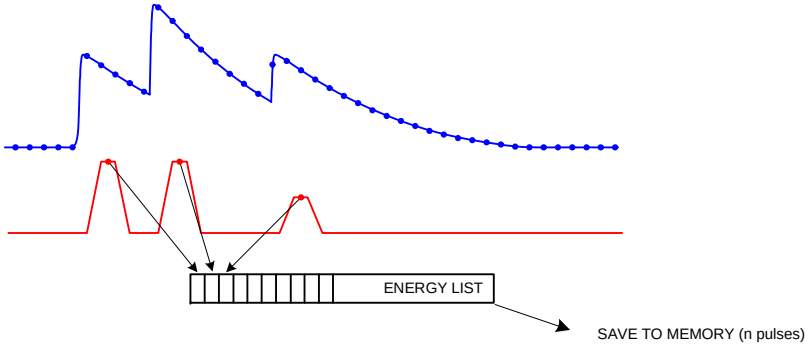
OSCILLOSCOPE MODE

- there is a circular buffer of programmable size
- when a channel is triggered, the current buffer is saved (acquisition window)
- the acquisition can continue without dead-time in a new buffer



MCA/LIST MODE

- the digitized signal is processed on-line and the acquisition is continuous
- the quantities of interest are calculated and saved in the memory buffer
- the amount of data to readout is very small respect to the oscilloscope mode



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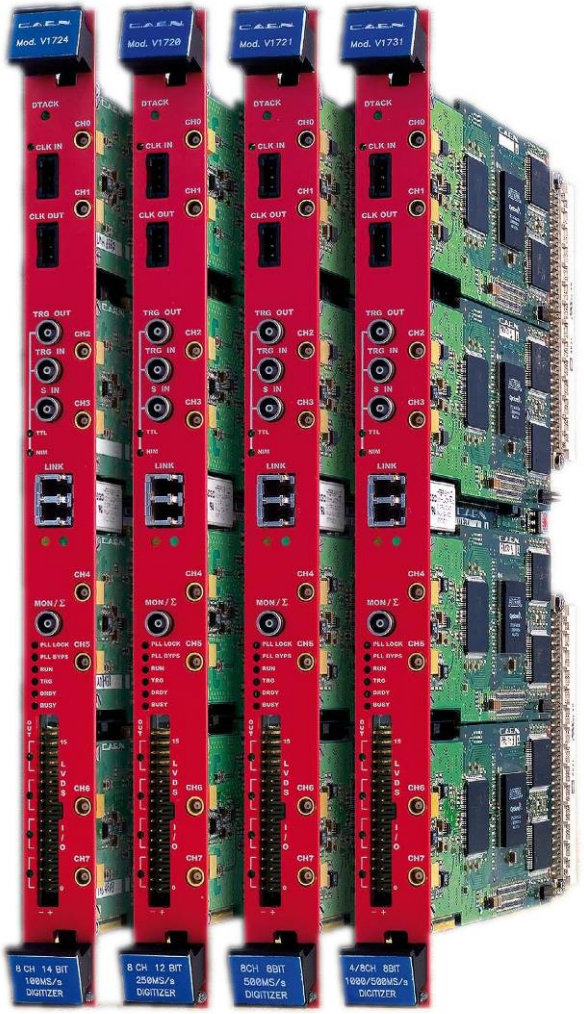
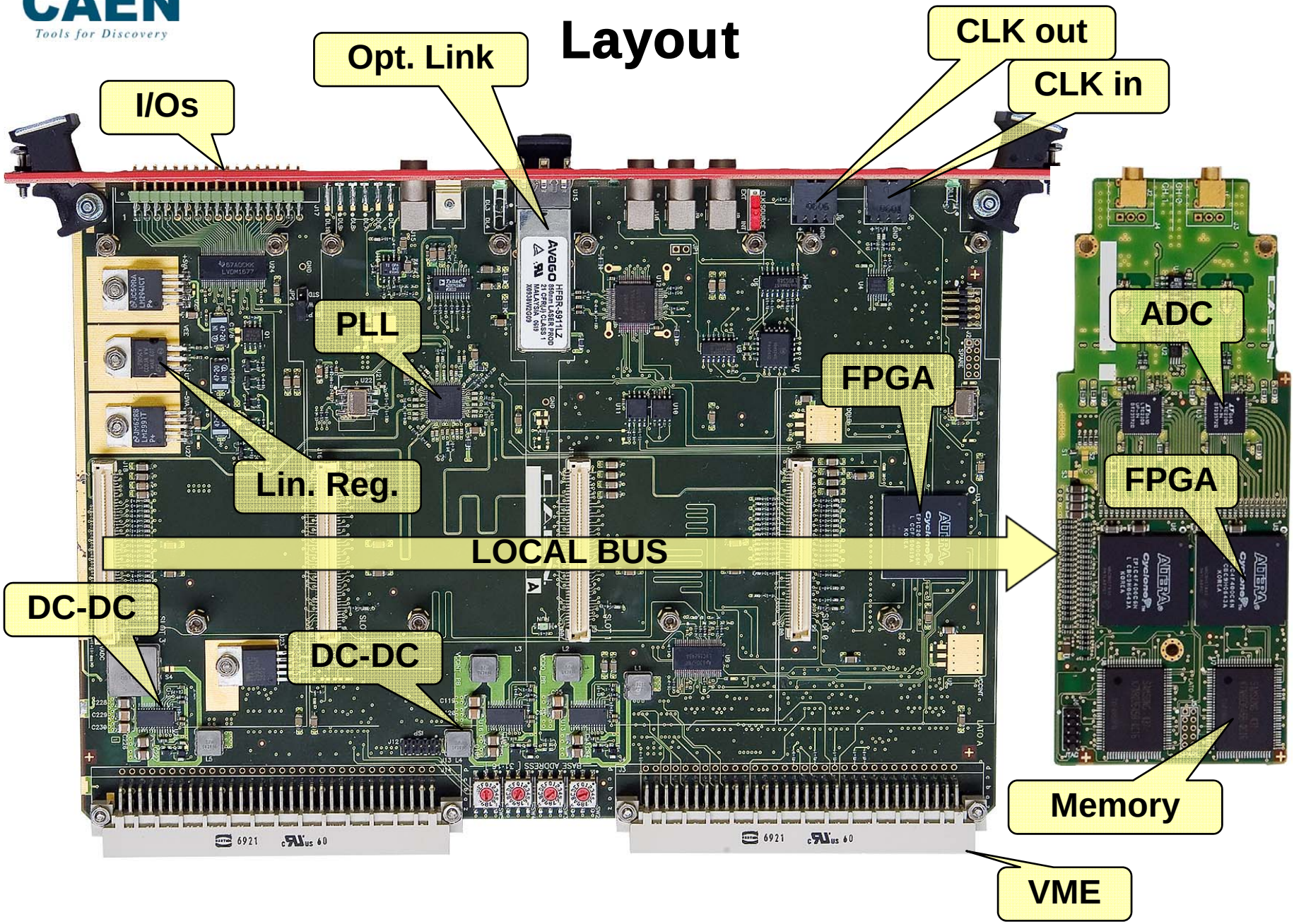
Highlights

A continuously growing family of VME digitizers:

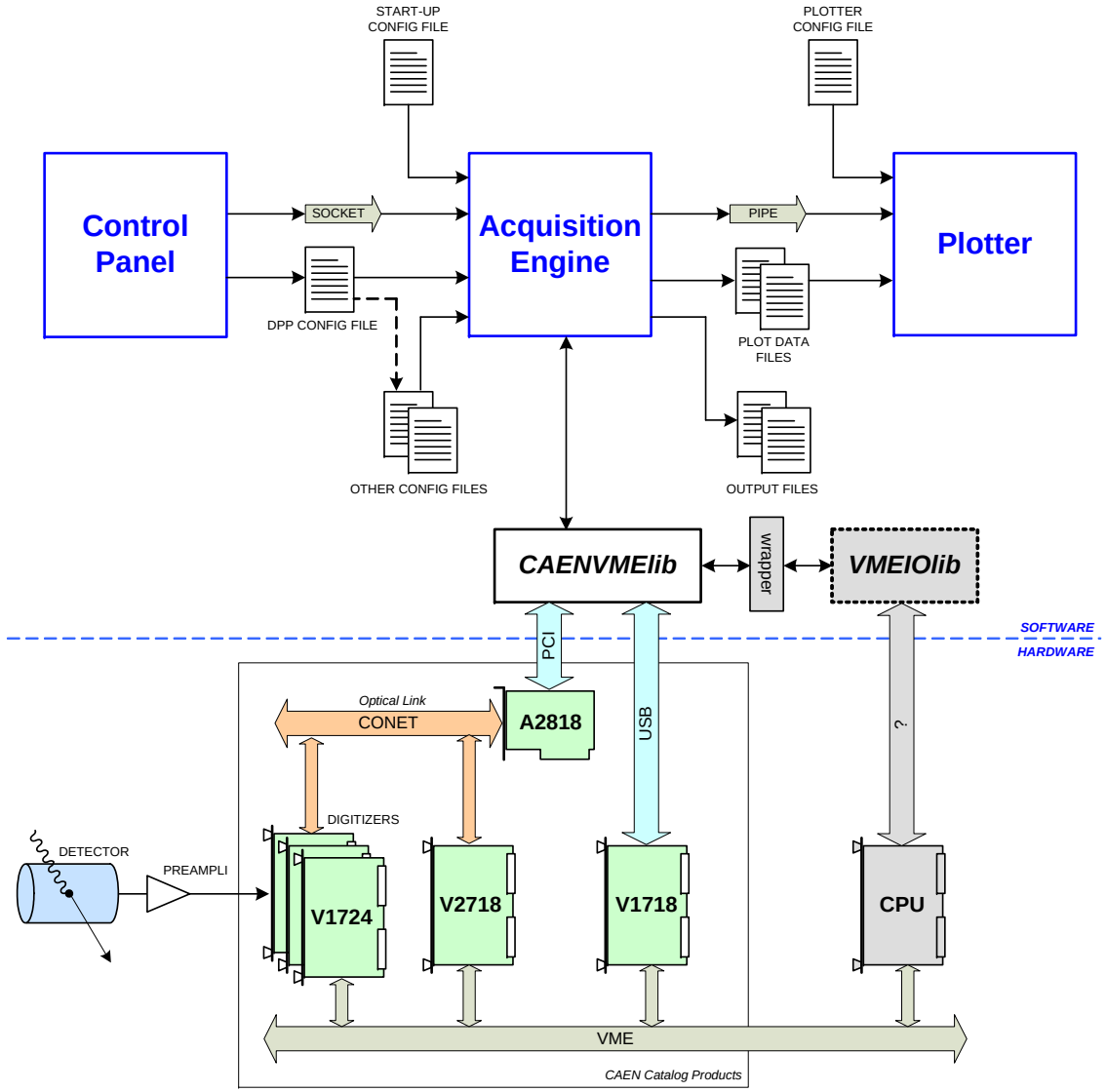
- 8/12/14 bit sampling ADC, up to 2 (5) GS/s
- Memory buffer: up to 10MB/ch (max. 1024 events)
- Multi-board synchronization and trigger distribution
- Programmable PLL for clock synthesis
- 16 programmable digital I/Os
- Analog output with majority or linear sum
- FPGA based design: possibility of customization
- Zero Suppression and Data Reduction Algorithms
- VME64X and Optical Link Interfaces
- Up to ~150MB/s throughput rate (2eSST)



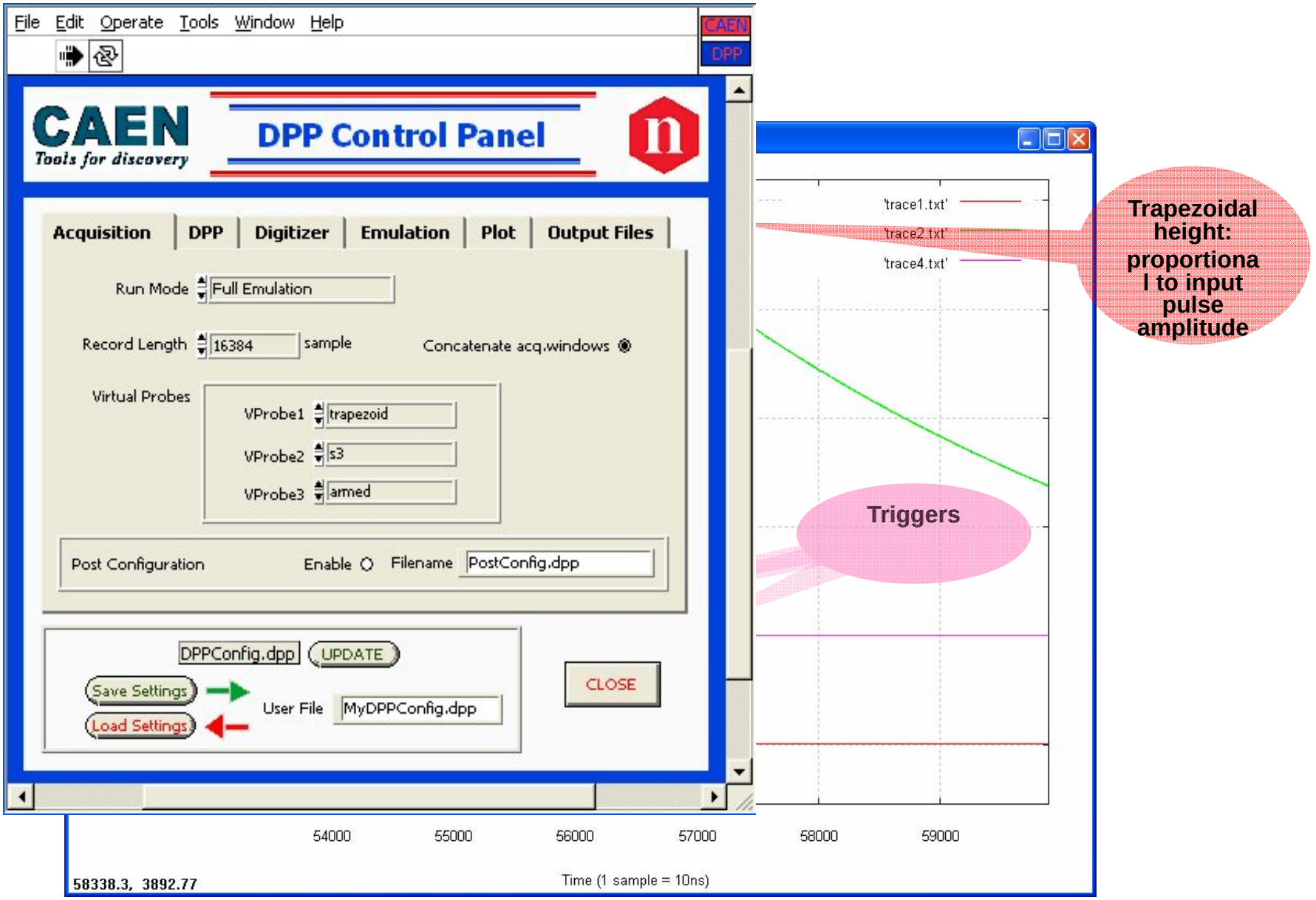
Layout



DPPrunner block diagram



Screenshots

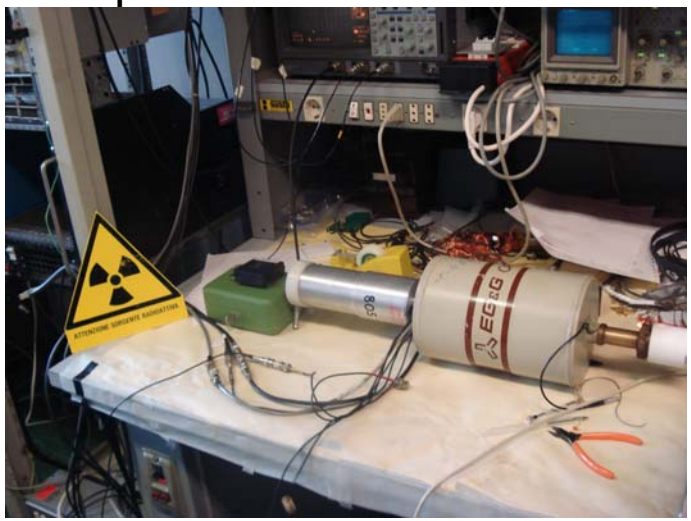


Experimental tests *(GAMMA-X Germanium)*

5-6 Nov 2008, Laboratori Nazionali di Legnaro (Padova)

- Detector: GAMMA-X Germanium (Model ORTEC GMX 20200-S) End cap Beryllium
- Detector Resolution: 1.90 KeV fwhm (@1.33 MeV)
- Sources Co-60 1u curie (Mod. CKR1122 Isotrak)
- Measured and comparison of energy resolution @ 1.33MeV using
  - Digital Pulse Processing (using CAEN V1724 with DPP)
  - Analog chain (using CAEN N968 Shaping Amplifier and N957 8k Multi-Channel Analyzer)
- Acquisition rate: 1 KHz (Typ), 3KHz (Max) Pile-up < 1%
- Preamplifier features:
  - 0.1mV/Kev
  - Decay time: 50 us
  - Rise time: 100 ns

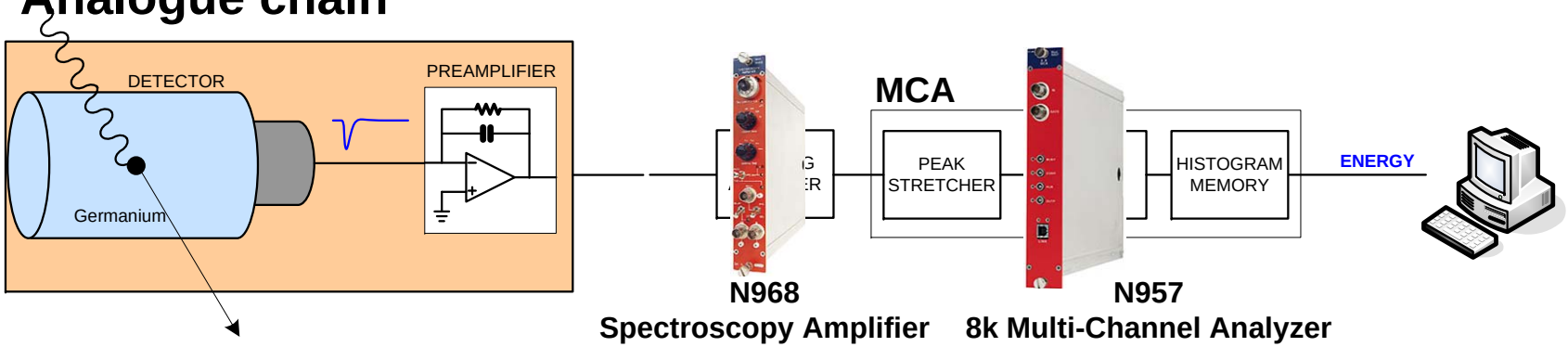
Acknowledgements
Enrico Fioretto
Gianfranco Prete,
Davide Rosso



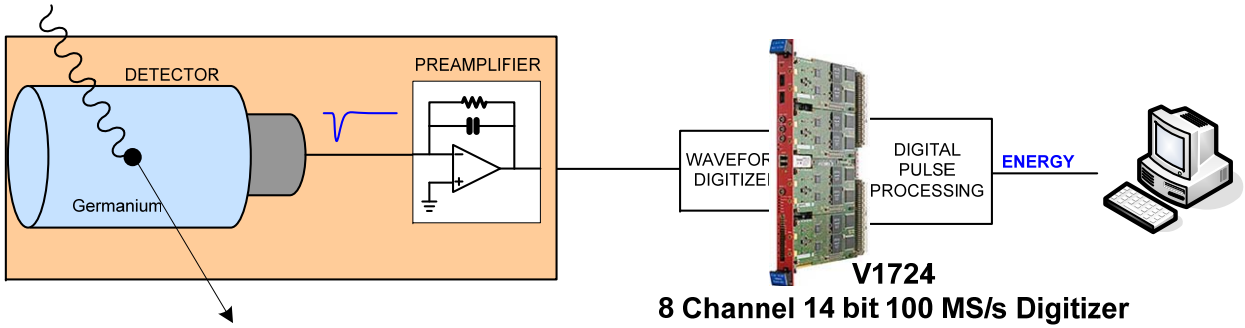
Test setup

5-6 Nov 2008, Laboratori Nazionali di Legnaro (Padova)

Analogue chain

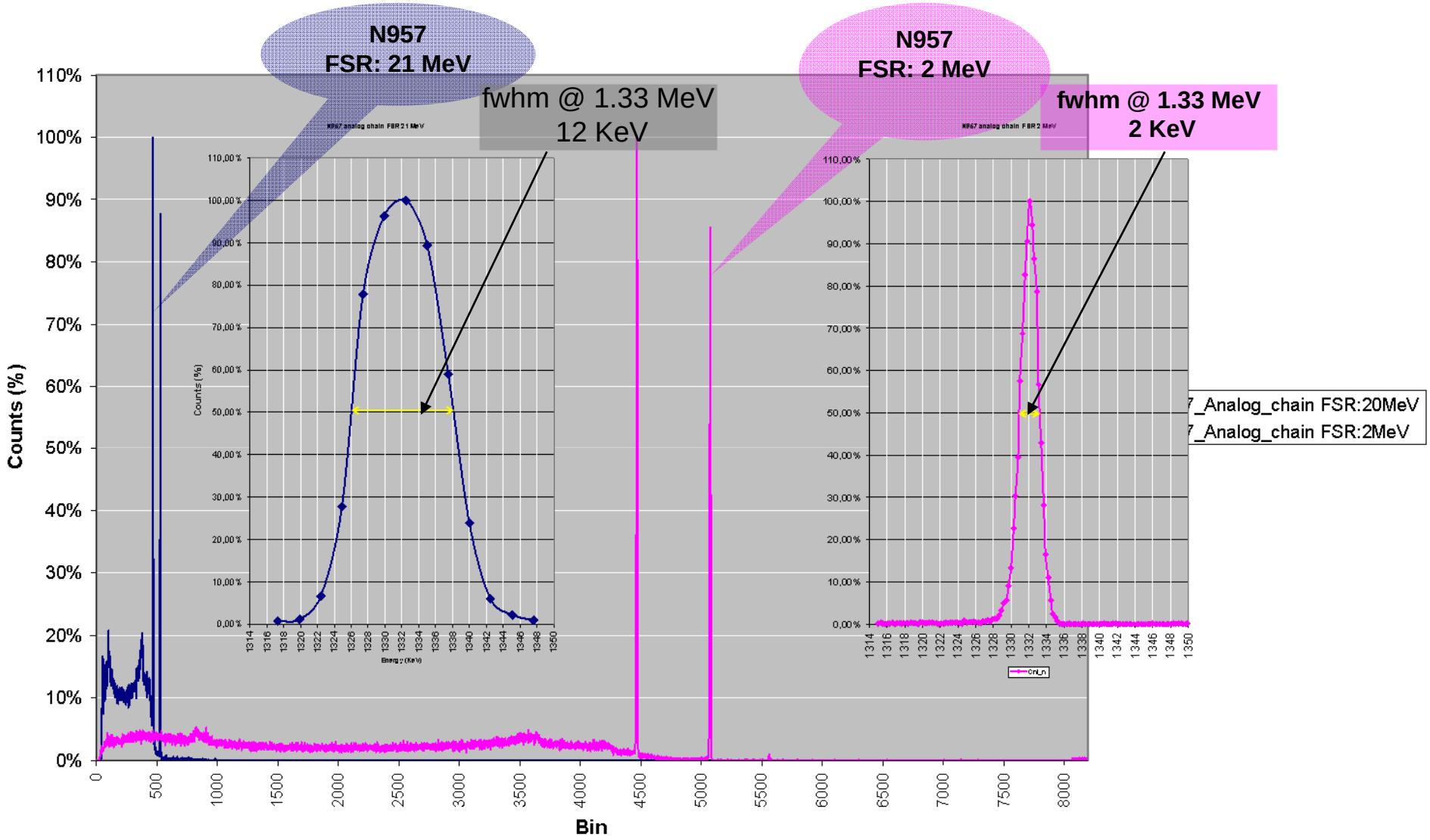


DPP

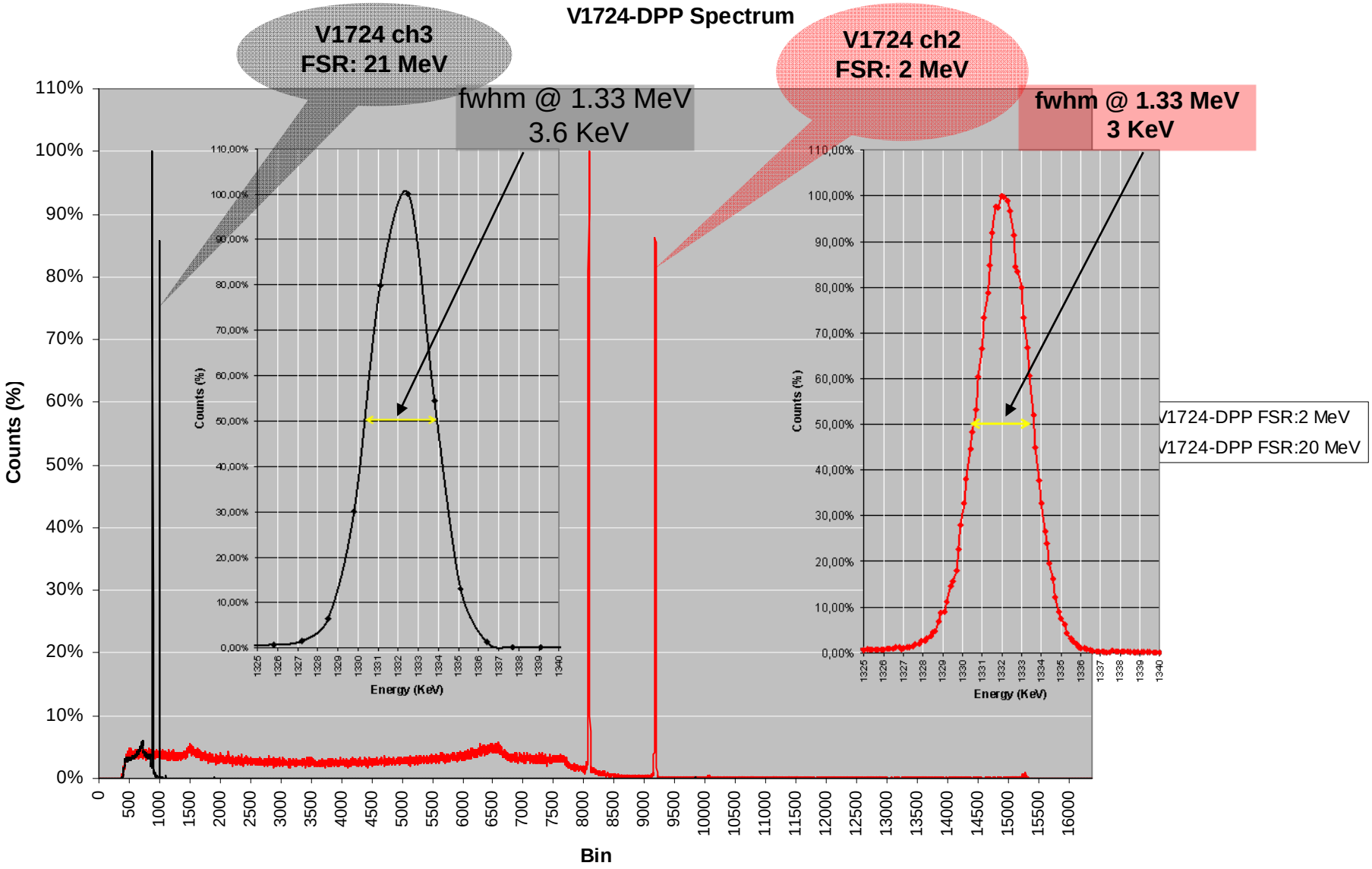


V1724 ADC ch # 2 modified gain ~ 10 (Standard gain = 1)

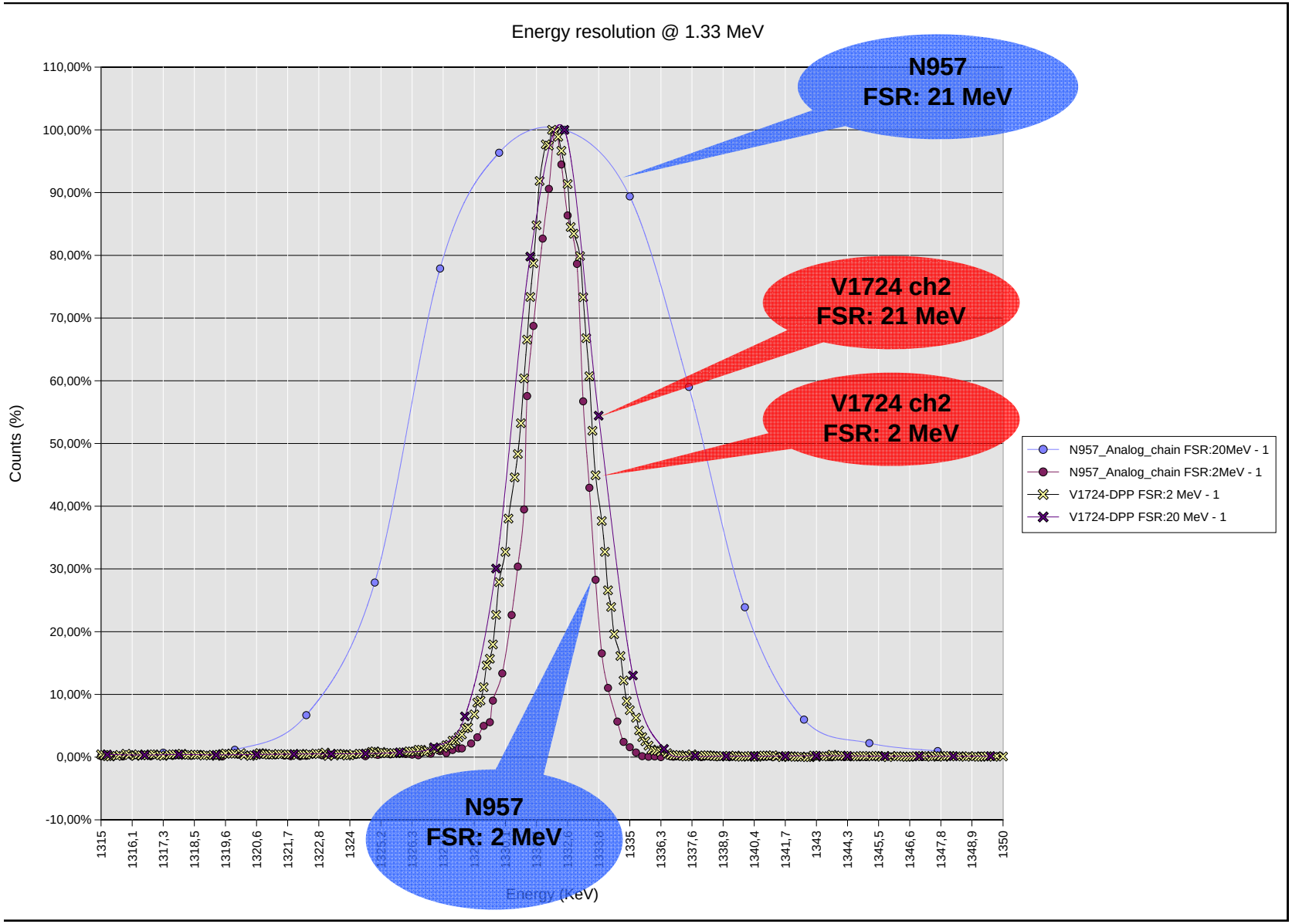
N957 Spectrum *(Analog chain)*



V1724-DPP Spectrum



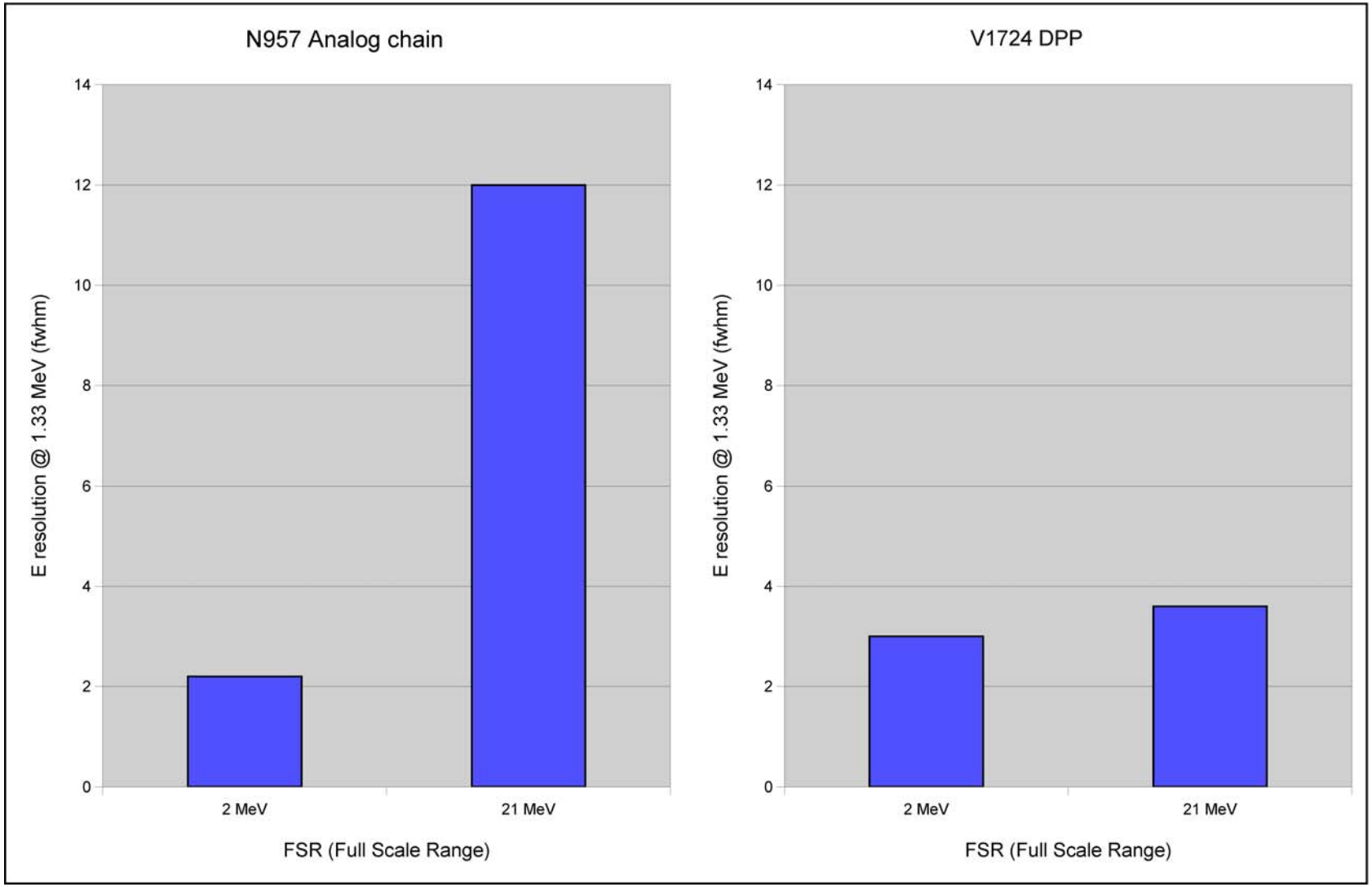
Results



Results

- V1724 standard channel (G=1)
  - FSR: 21 MeV
  - E resolution @ 1.33MeV: 3.6 KeV fwhm
- V1724 channel 2 (G ~ 10)
  - FSR: 2.38 MeV
  - E resolution @ 1.33MeV: 3 KeV fwhm
- N957 (gain N968: 20)
  - FSR: 20.59 MeV
  - E resolution @ 1.33MeV: 12 KeV fwhm
- N957 (gain N968: 200)
  - FSR: 2.15 MeV
  - E resolution @ 1.33MeV: 2 KeV fwhm

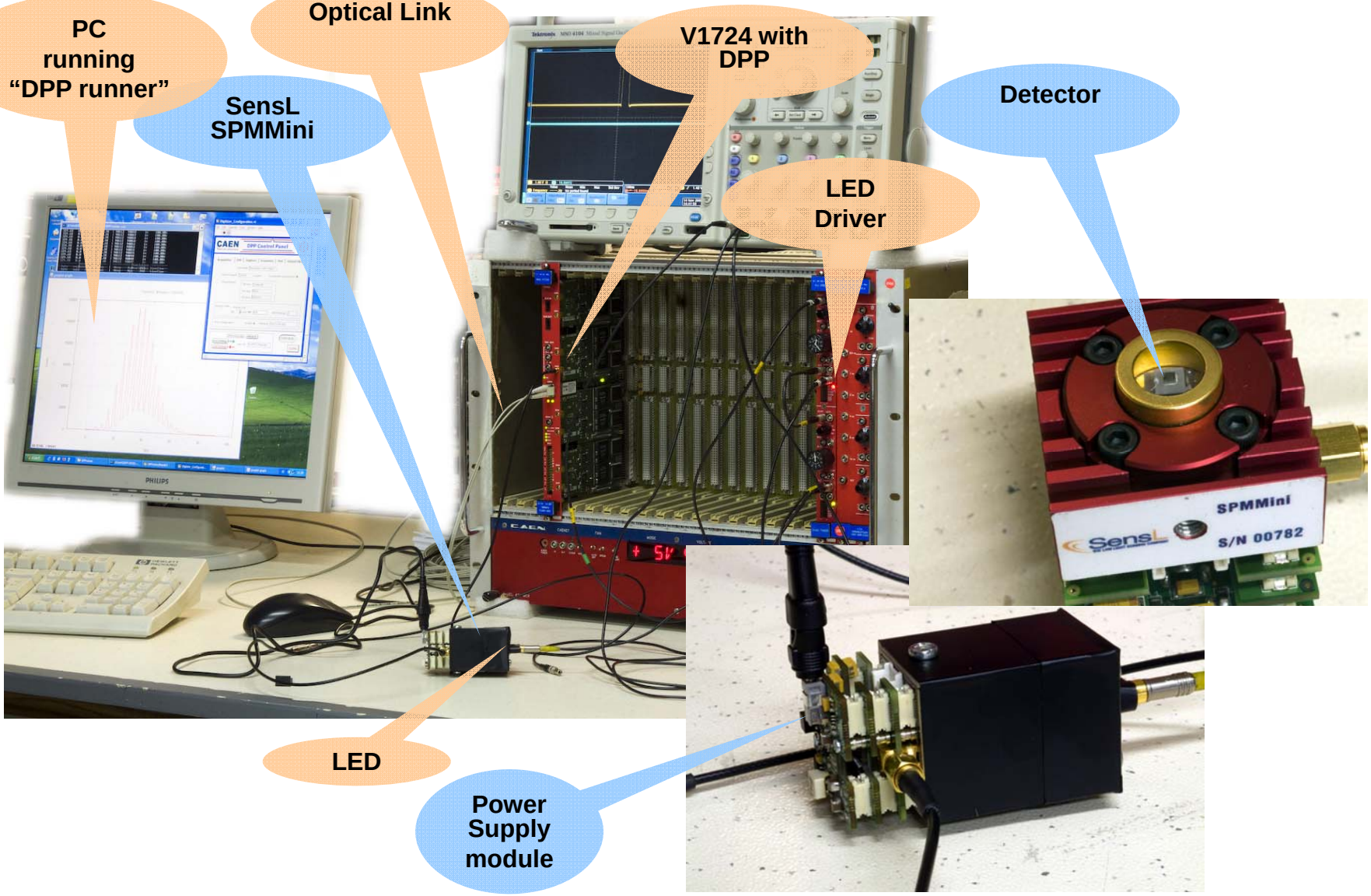
Results



Experimental test *(Silicon Photomultiplier)*

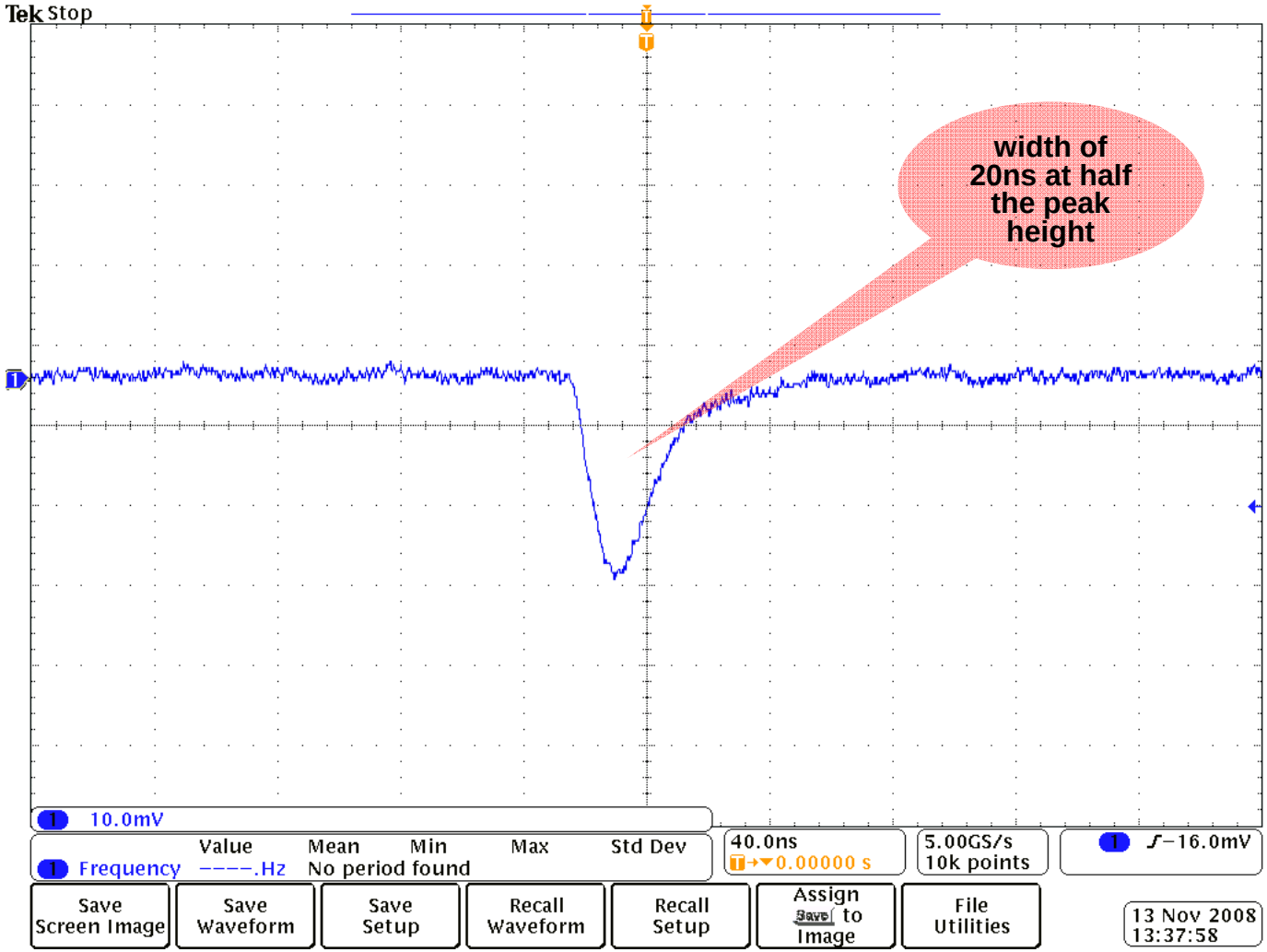
- Detector: SPM Silicon Photomultiplier
- Model SensL SPMMini - High Performance High Gain APD
- Part Number: 1020x08 (1mm diameter, 848 microcells)
- Spectral range 400÷1100 nm (Peak λ = 520nm)
- The SPMMini includes transimpedance preamplification, a Peltier cooler driver circuit to enable cooling to -20C
- SPM output signal features
  - Rise time : 5 ns
  - Falling time: 25 ns
- Photon Spectrum measurement using DPP
  - Measurement of repeated fast pulses of light incident on SPM

Test setup



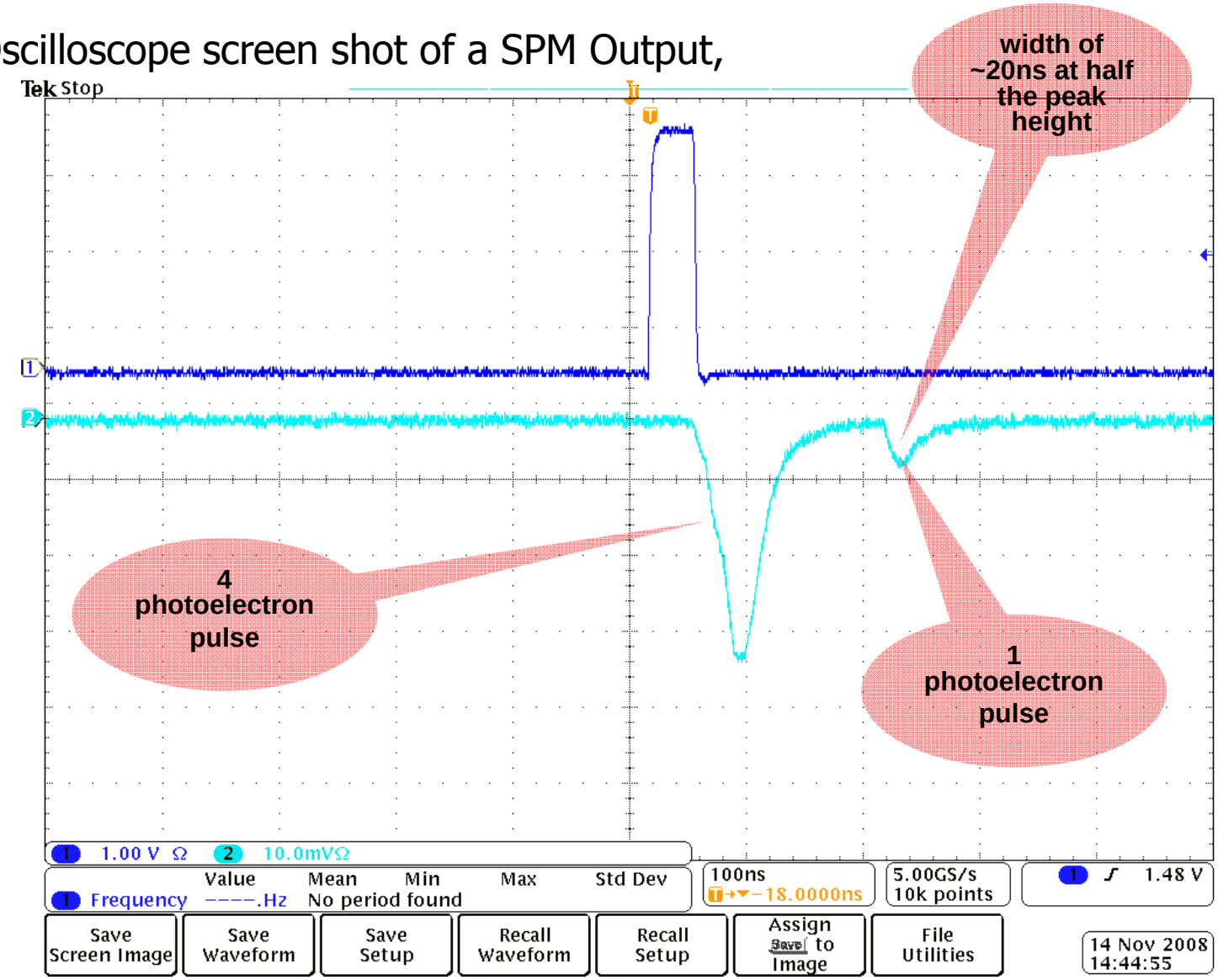
Experimental test

Oscilloscope screen shot of a SPM Output,



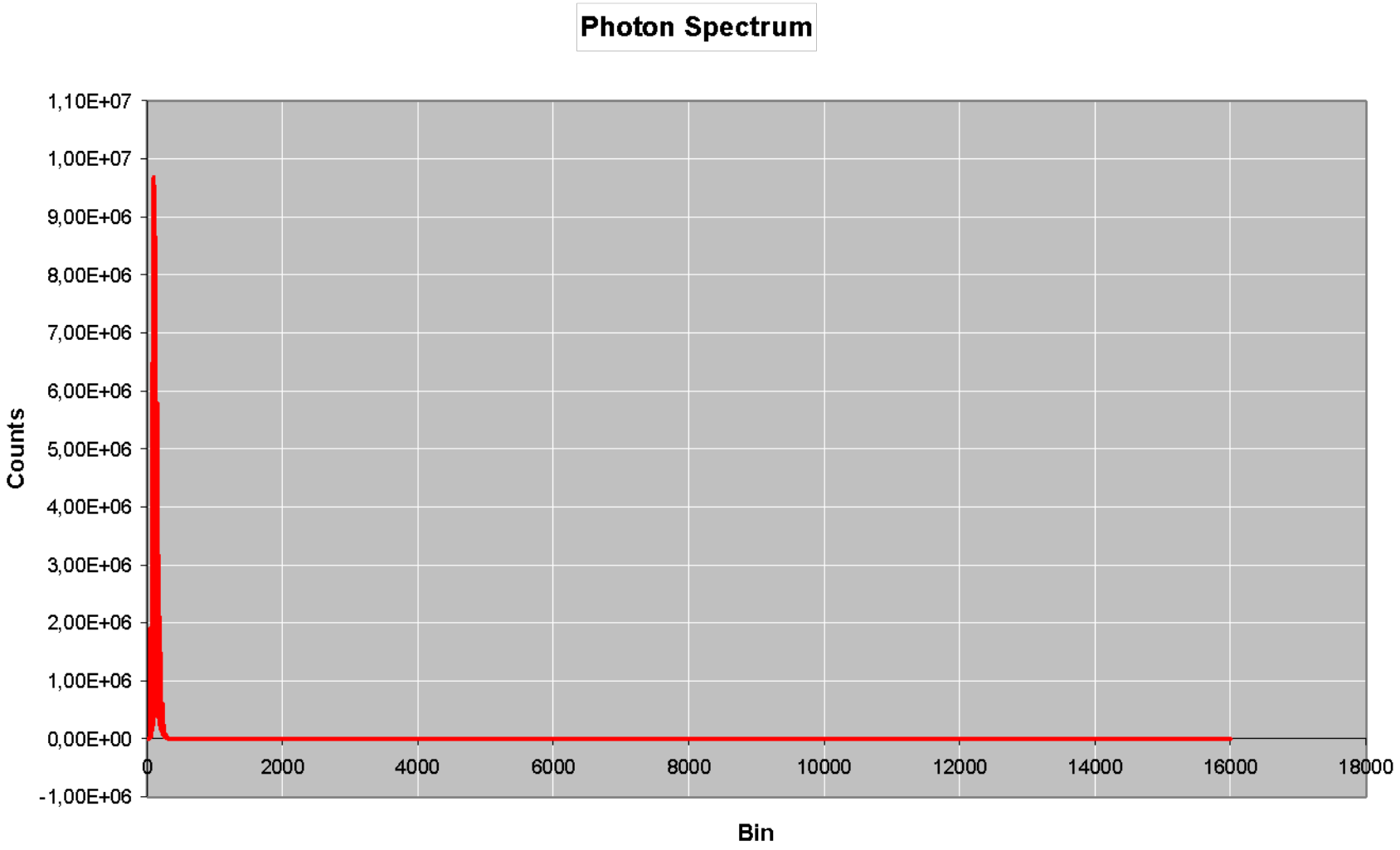
Experimental test

Oscilloscope screen shot of a SPM Output,

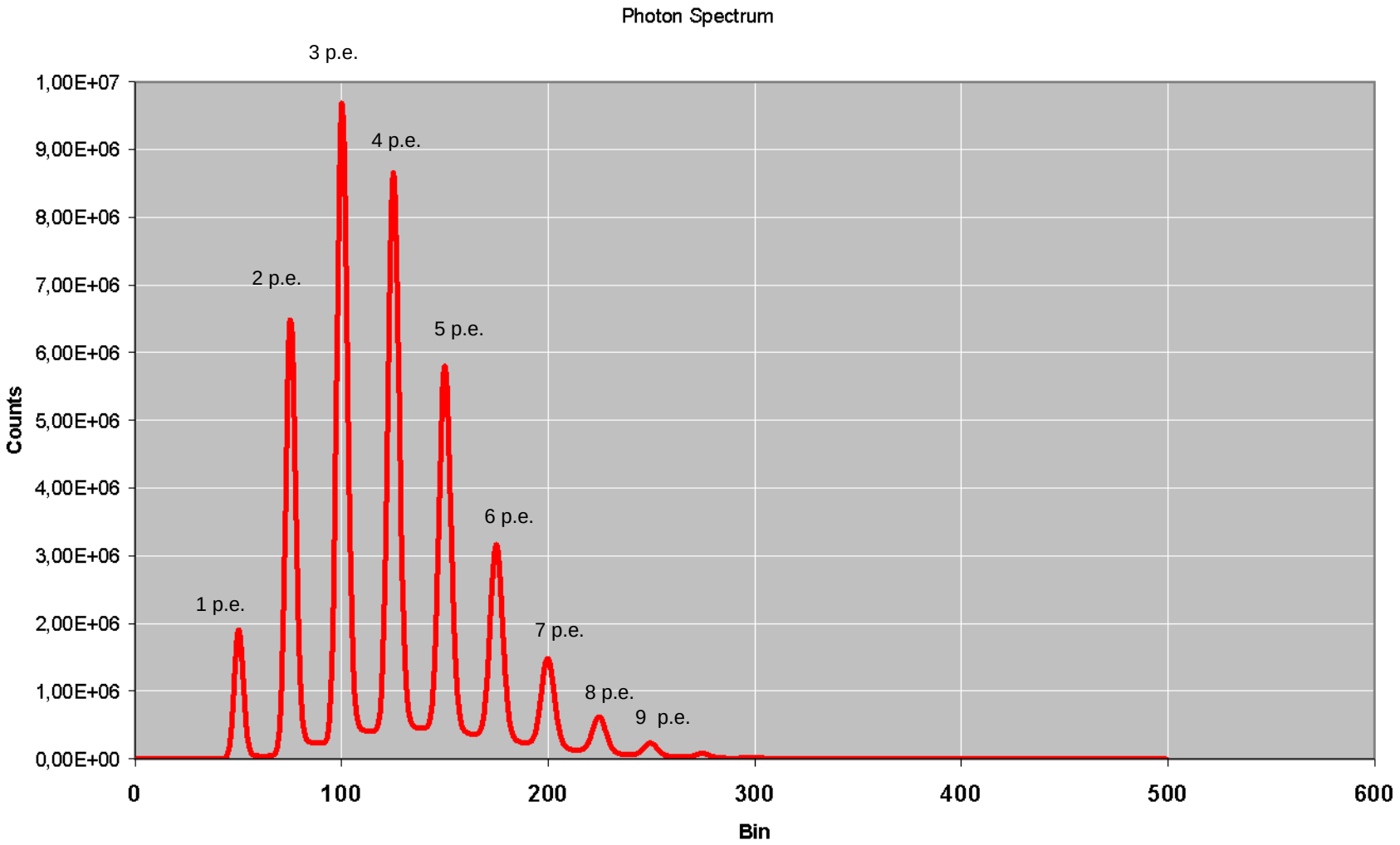


Experimental test

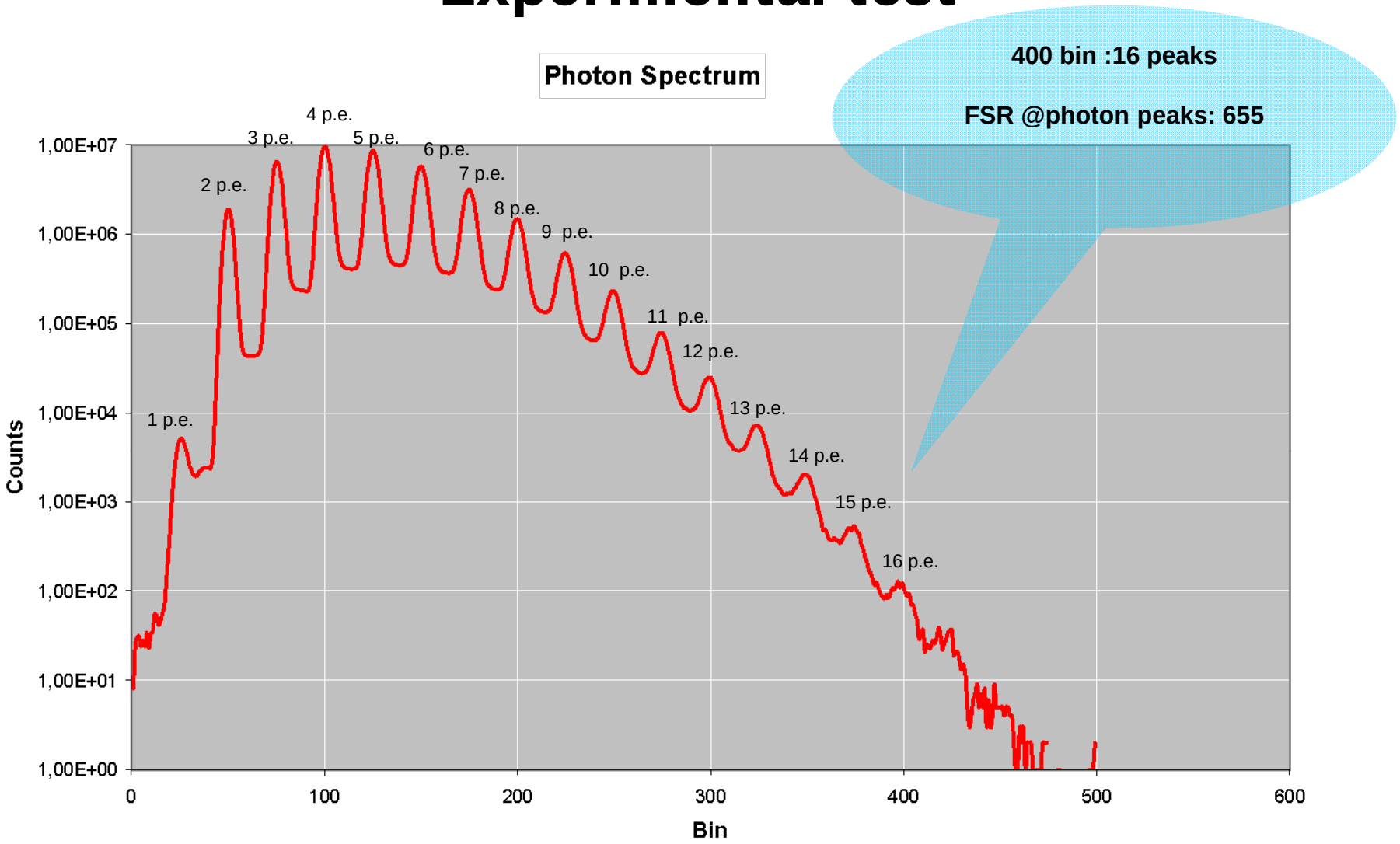
Full scale range (FSR)



Experimental test



Experimental test



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THANKS A LOT !!

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