# 20th Real Time Conference

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# Product information

- APV85G4 (4CH, 5GSPS, 10bit-ADC)
- APV6002 (2CH, 2.5GHz, 16bit-DAC)
- APV8508-14 (8CH, 500MSPS, 14bit-ADC)
- APV8104-14 (4CH, 1GSPS, 14bit-ADC)
- APV8516-8 (16CH, 500MSPS, 8bit-ADC)
- APV8702-8 (2CH, 3GSPS, 8bit-ADC)
- APV8016(X) (16CH, 100MSPS, 14bit-ADC)

* Other models can be also available.

* Our products can be customized.

# Time Spectrometer **APV85G4**

5GHz 4CH 10bit ADC Digital Waveform Processing
High-time resolution / High-throughput


- ADC

  4CH, Sampling 5GHz, Resolution 10bit

- Analysis Mode

  Wave height, Time difference, Waveform, Pulse Shape *Option

- Functions

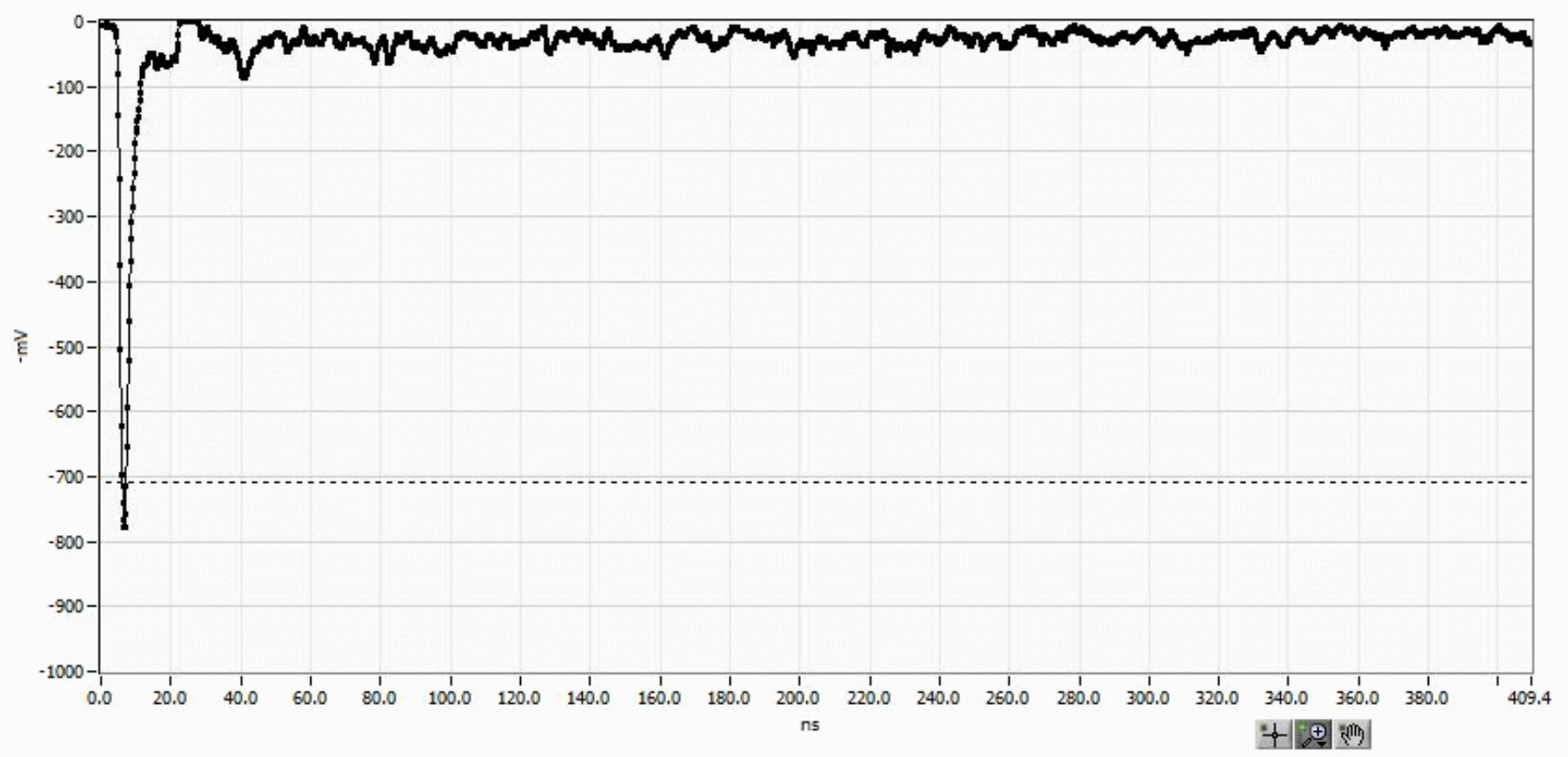
  Digital CFD (WALK, THRESHOLD, LLD, ULD)

- Interface

  Gigabit Ethernet（TCP/IP）

# APV85G4 (4CH, 5GSPS, 10bit-ADC)

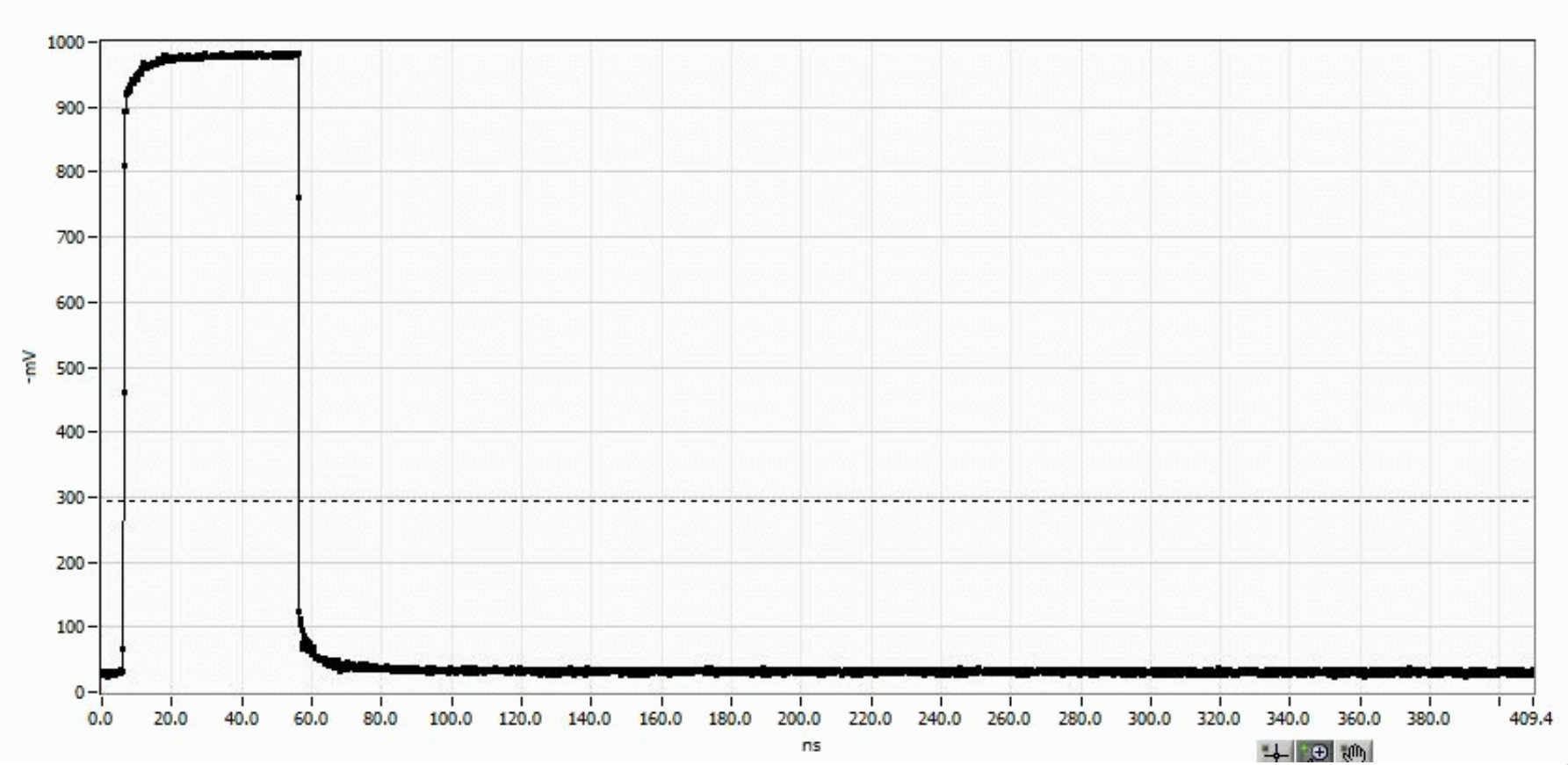
## Analog-to-Digital Converter




$BaF_2$ @ 511 keV ($^{22}Na$), The sampling interval is 0.2 *ns*.

# APV85G4 (4CH, 5GSPS, 10bit-ADC)

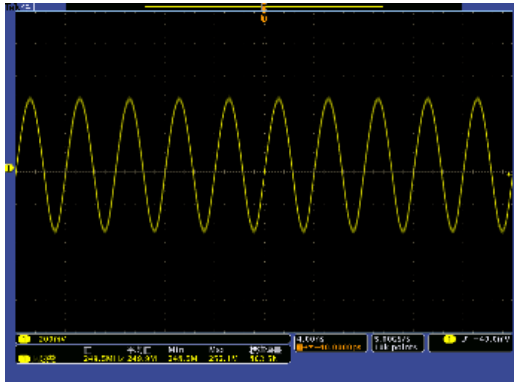
## Analog-to-Digital Converter



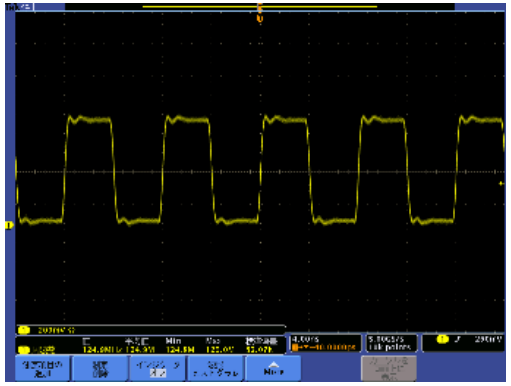

Pulser, Pulse width 50ns

# High-speed Function Generator **APV6002**

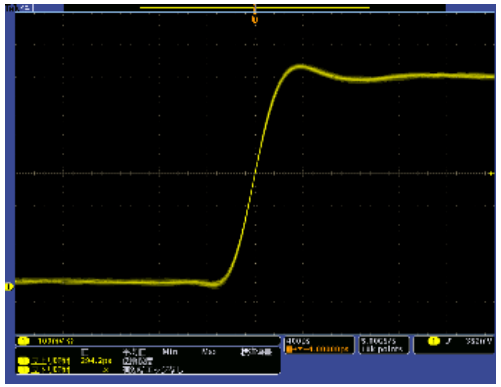
2.5GS/s 2CH 16bit High-speed DAC output,
Arbitrary Function Generator



Sine
250MHz

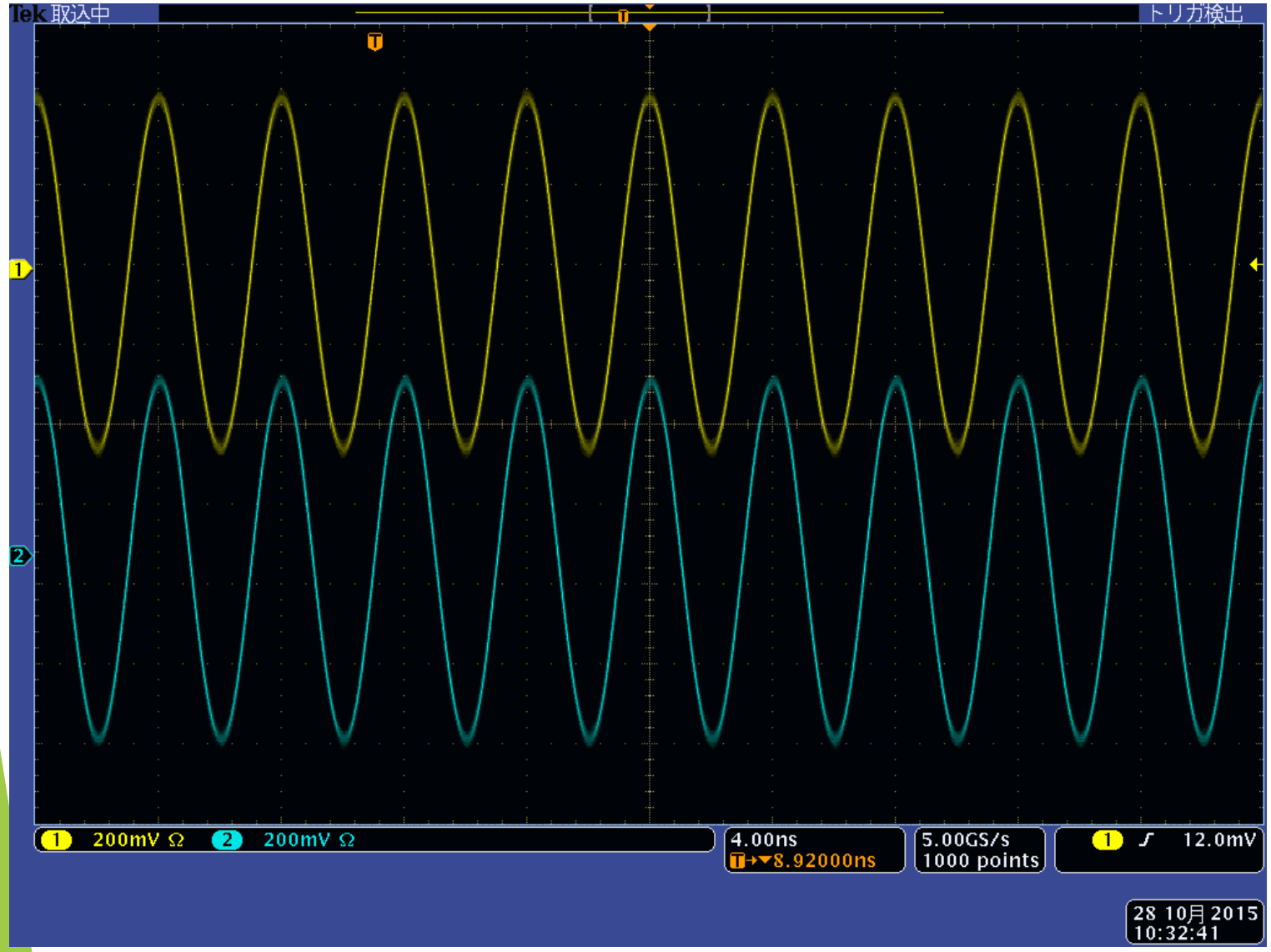


Square
125MHz



Rise time
395ps

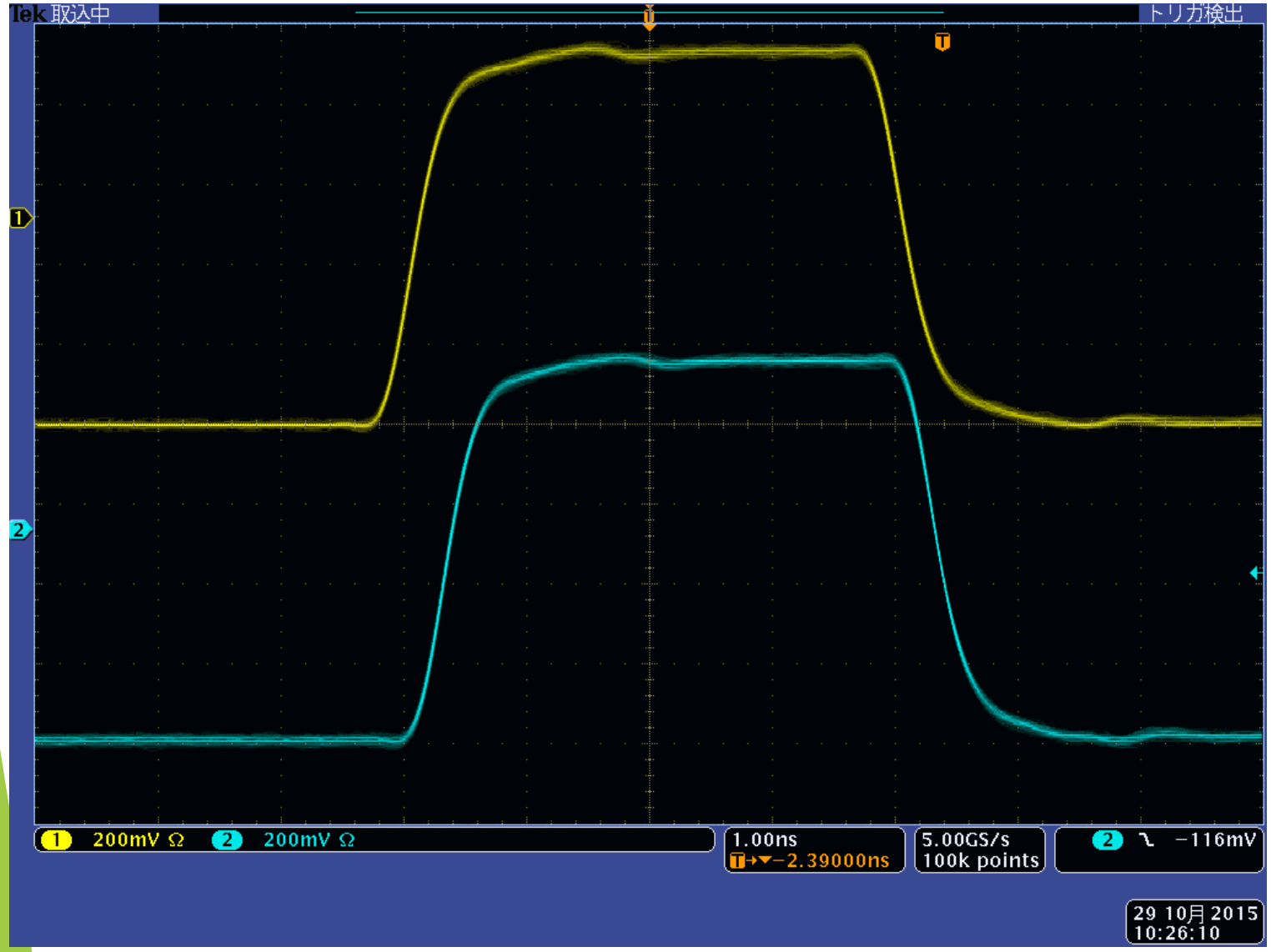
# APV6002 (2CH, 2.5GS/s, 16bit, DAC)





Sine: 250MHz

# APV6002 (2CH, 2.5GS/s, 16bit, DAC)



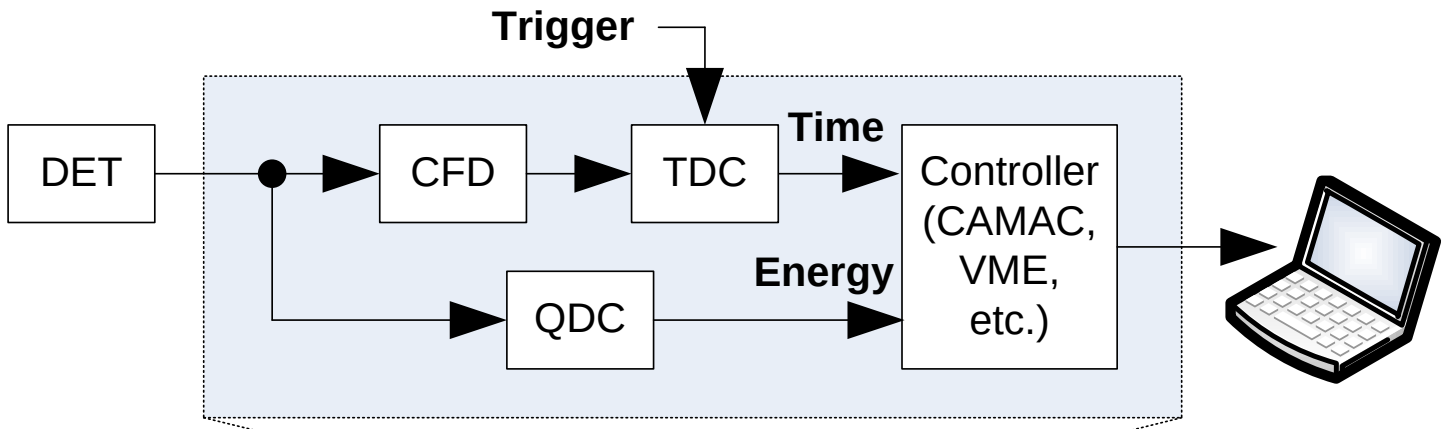


Phase control: min 6.8ps step

# APV8508-14 (8CH, 500MHz, 14bit-ADC)

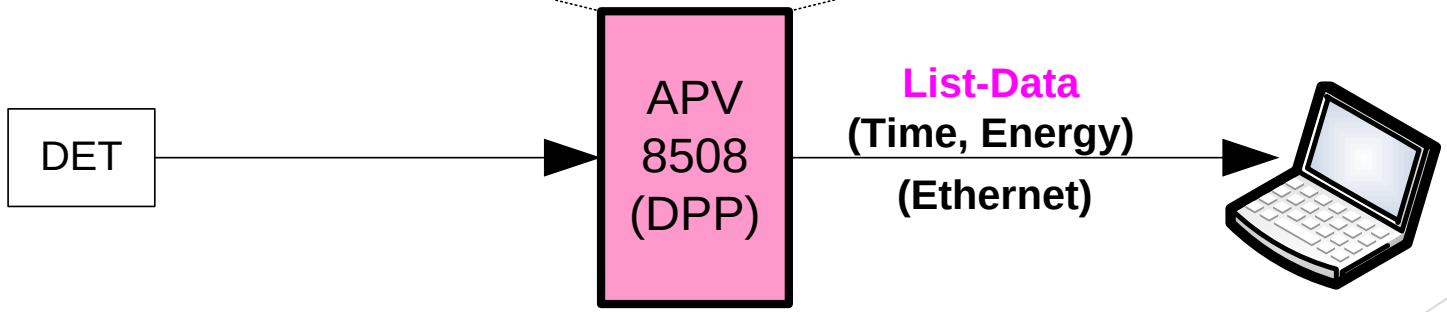
Previous method

The measurement is combination of several modules.



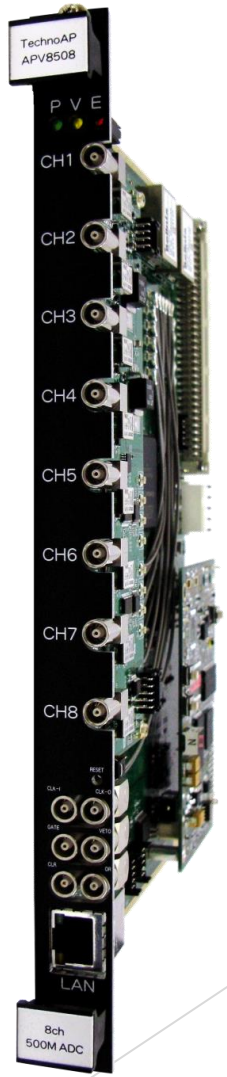

APV8508

Functions of several modules have been unified.



# APV8508-14 (8CH, 500MHz, 14bit-ADC)

Waveform analysis board for scintillation detectors. Each channel is equipped with high-speed and high resolution ADC. This is able to correspond to the high rates of more than 100 kcps per CH in the list mode with using the Gigabit Ethernet connection.




## [Functions]

Digital CFD, TDC, QDC,
Digital PSA*, Digital Coincidence*

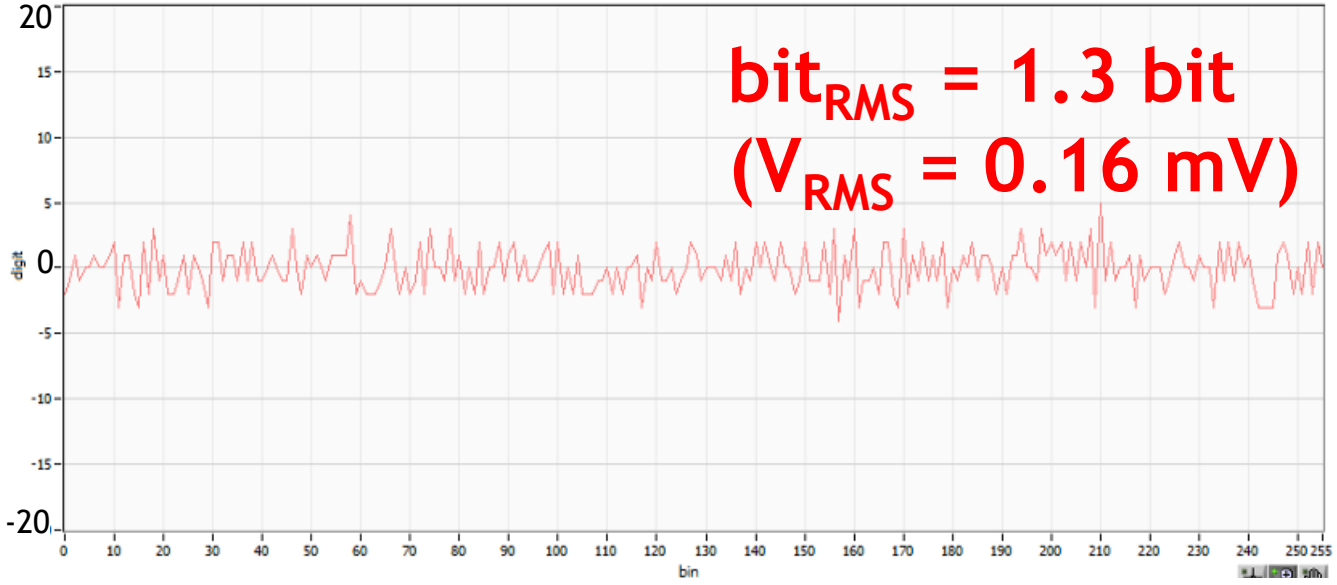
*Optional

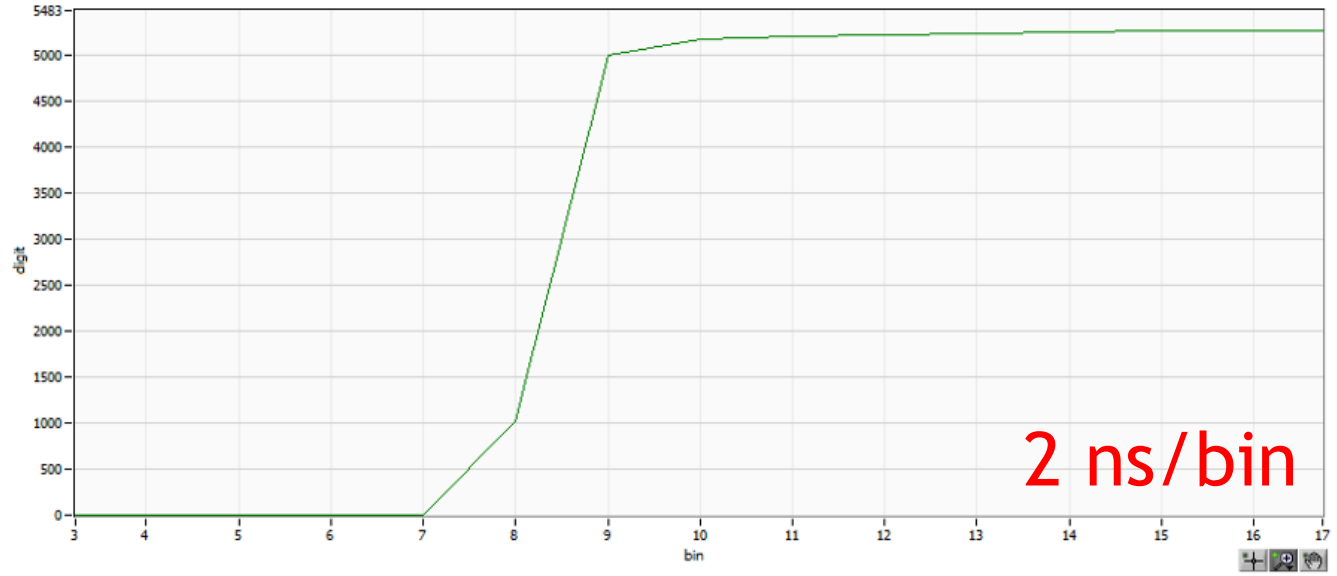
## [Usage Example]

The signal analysis of several high-speed scintillation detectors.

# ADC Performance

## 500 MSPS 14bit (APV8508-14)



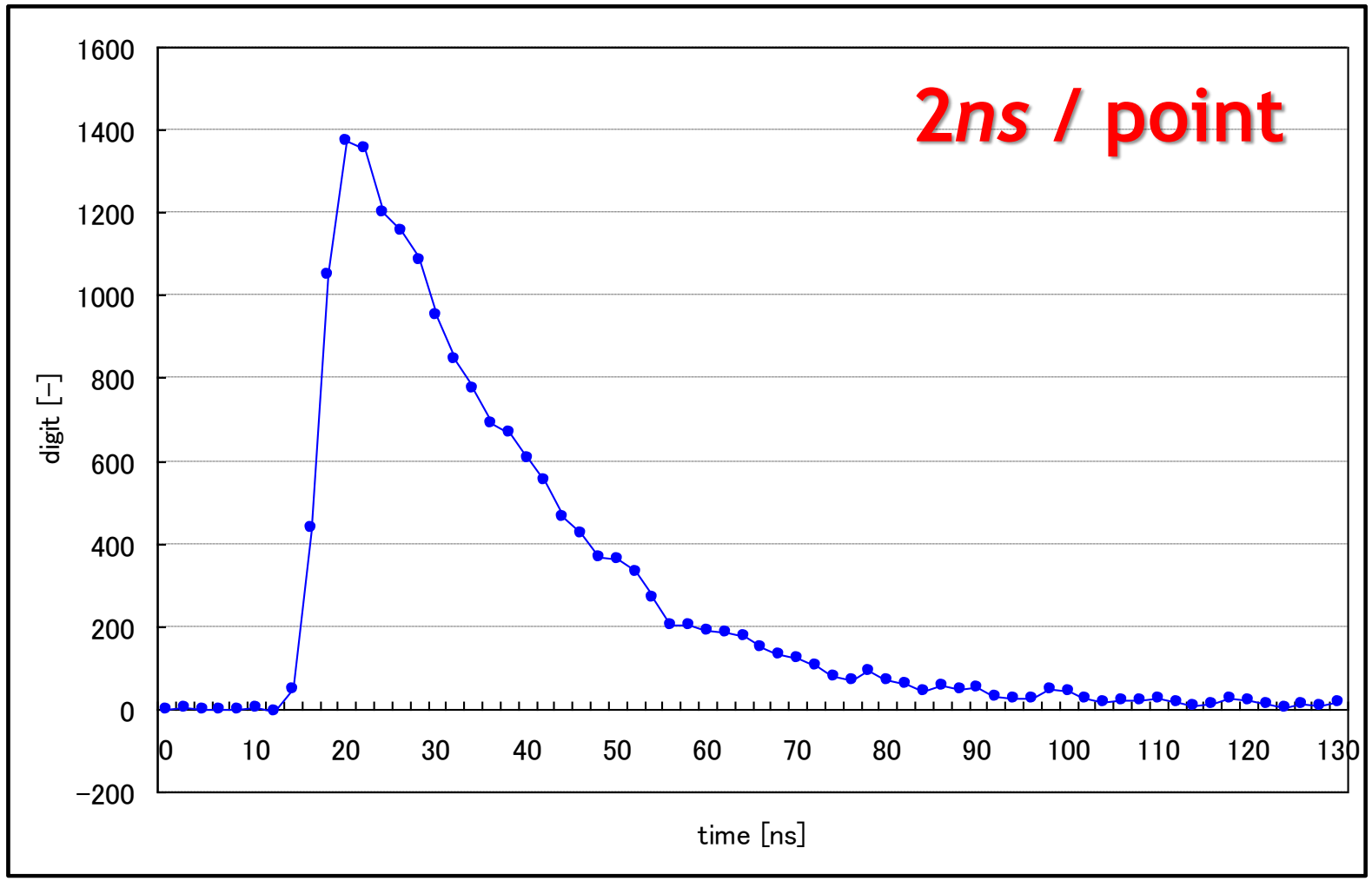

$bit_{RMS} = \sqrt{( (\Sigma(x_i - x)^2 ) / i )}$

$x_i$: Outputted Data

$x$: Average

# APV8508-14 (8CH, 500MHz, 14bit-ADC)

## Analog-to-Digital Converter



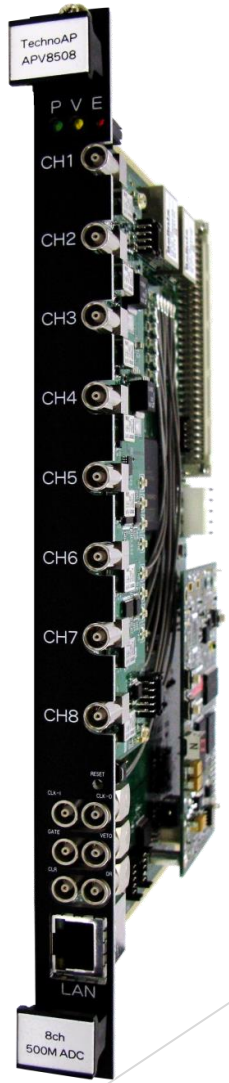

$LaBr_3$ @ 662 keV ($^{137}Cs$), The sampling interval is 2*ns*.

# APV8508-14 (8CH, 500MHz, 14bit-ADC)

## Functions

Digital CFD, TDC, QDC,
Digital PSA*, Digital Coincidence*

*Optional




### Output list data

| |
|---|
| TDC[55..40] |
| TDC[39..24] |
| TDC[23..8] |
| TDC[7..0], TDCFP[7..0] |
| CH[2..0], QDC[12..0] |

These data is transferred to the PC via Ethernet.

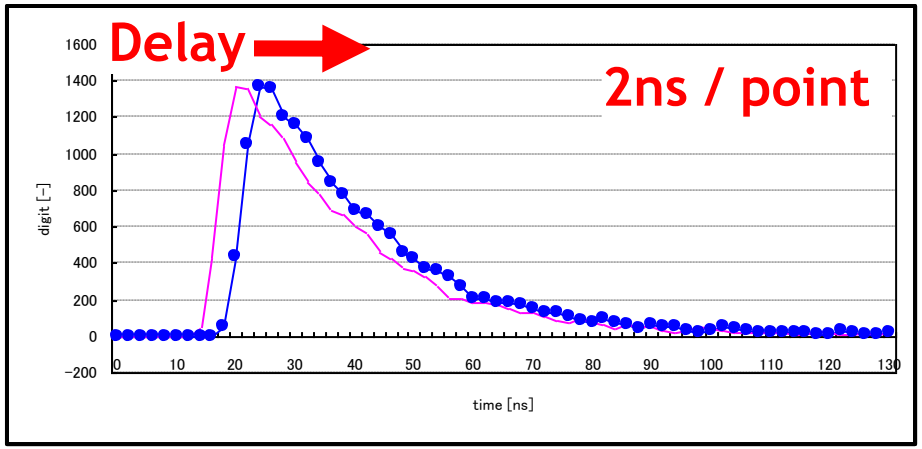
# APV8508-14 (8CH, 500MHz, 14bit-ADC)

## CFD and TDC

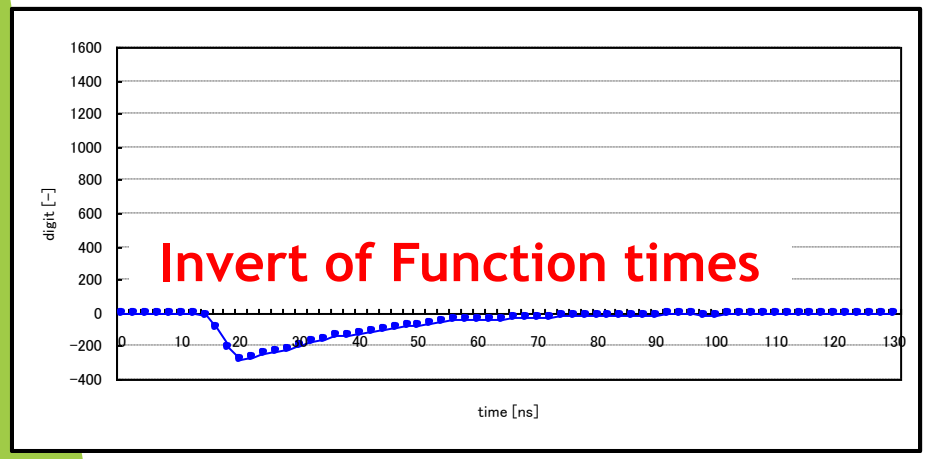
Time stamp timing by CFD waveform

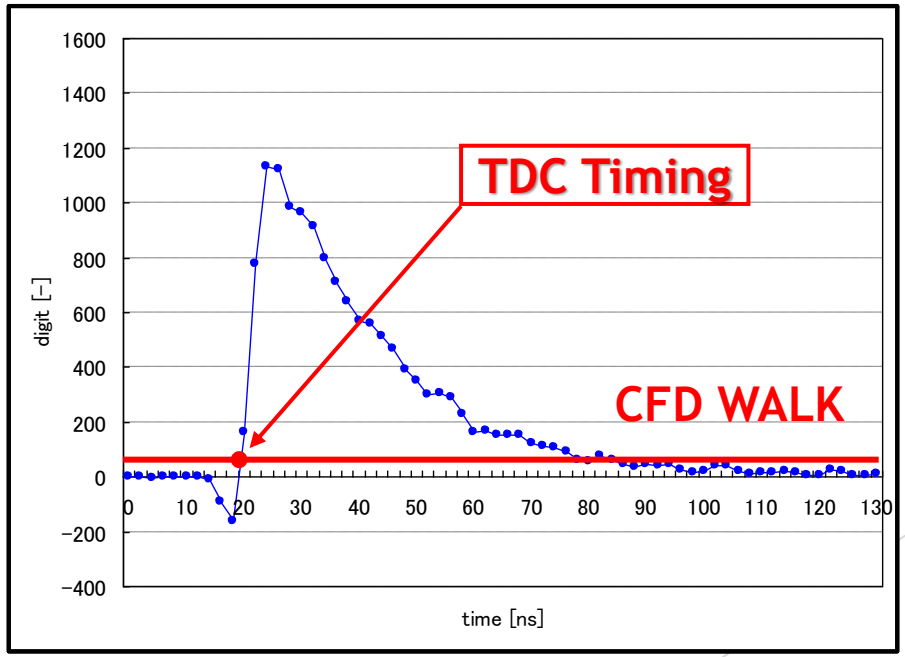
List Format

| | |
|---|---|
| TDC[55..40] | |
| TDC[39..24] | |
| TDC[23..8] | |
| TDC[7..0] | TDCFP[7..0] |
| CH[2..0], QDC[12..0] | |




+



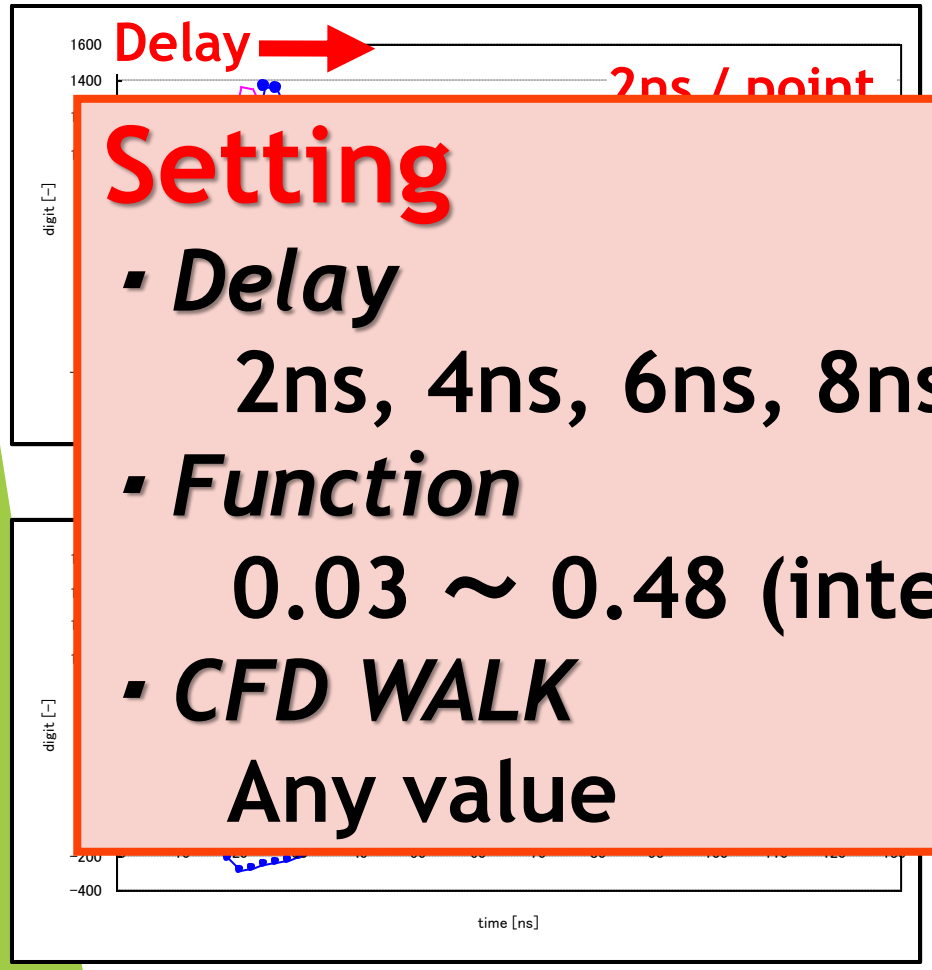



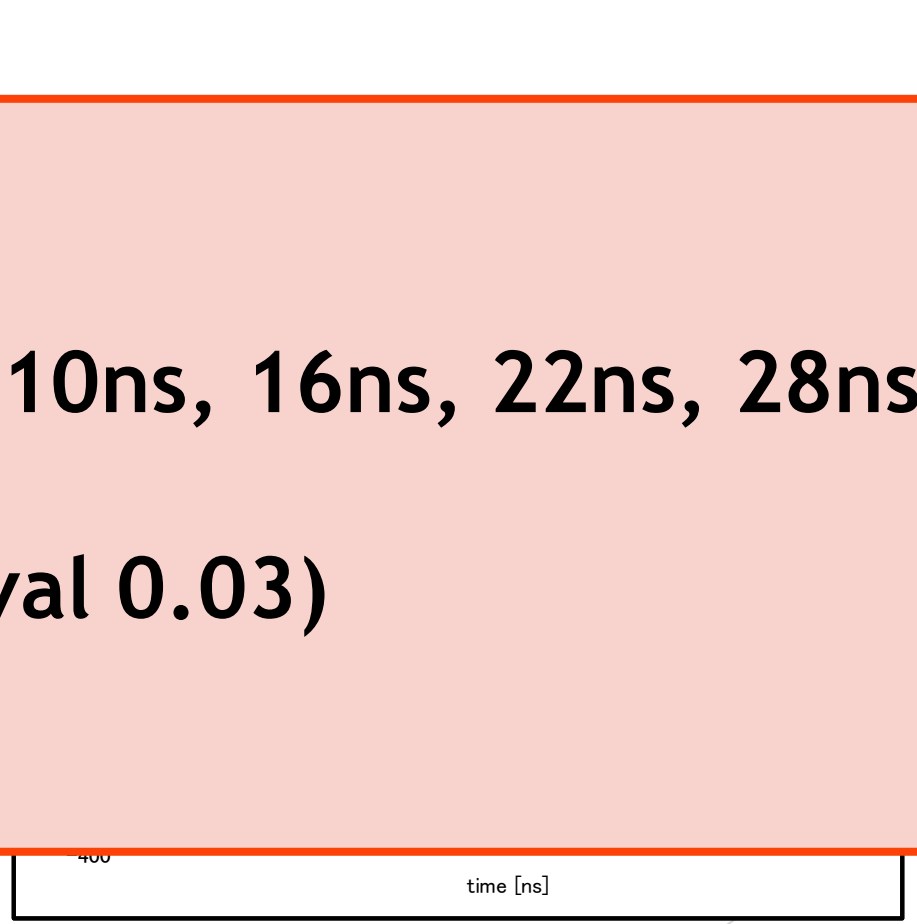

OUT (t) = *ln* (t-delay) + (-*f* ) · *ln* (t)

# APV8508-14 (8CH, 500MHz, 14bit-ADC)

## CFD and TDC

Time stamp timing by CFD waveform




**Setting**

- ***Delay***

  2ns, 4ns, 6ns, 8ns, 10ns, 16ns, 22ns, 28ns

- ***Function***

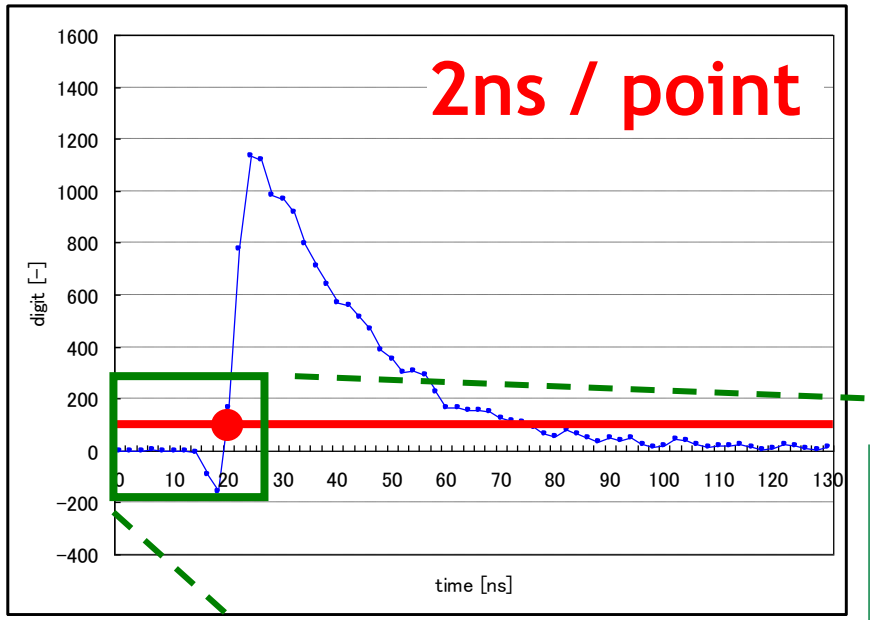
  0.03 ～ 0.48 (interval 0.03)

- ***CFD WALK***

  Any value

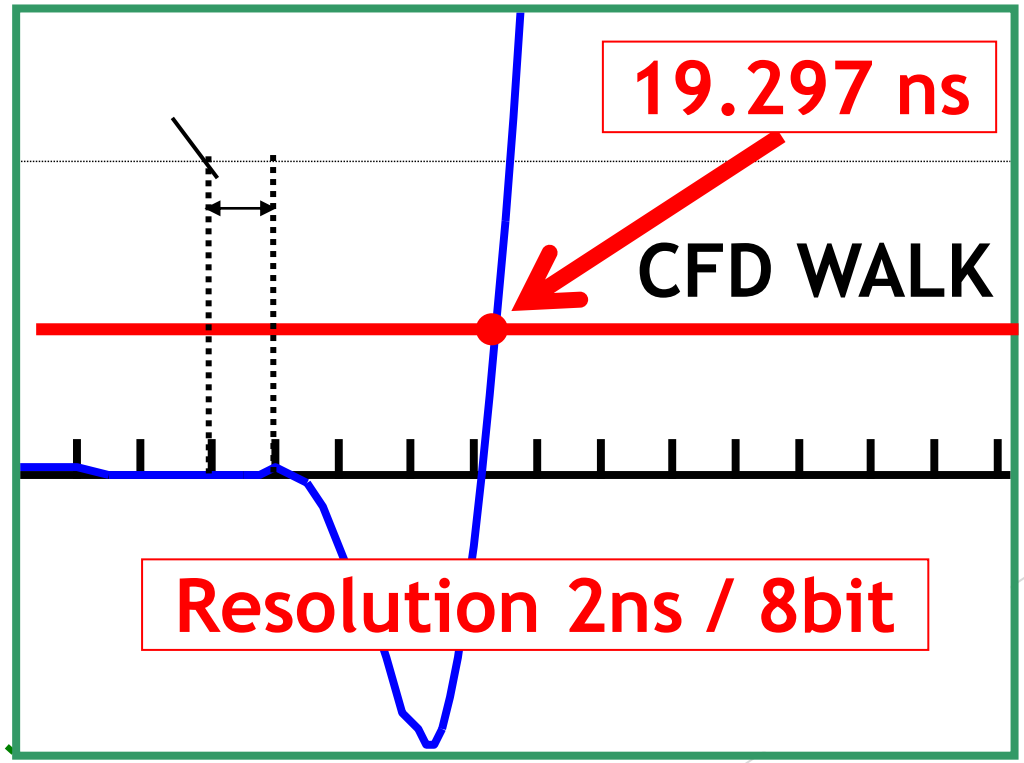
# CFD and TDC

It can calculate the time stamp in less than 2*ns*.



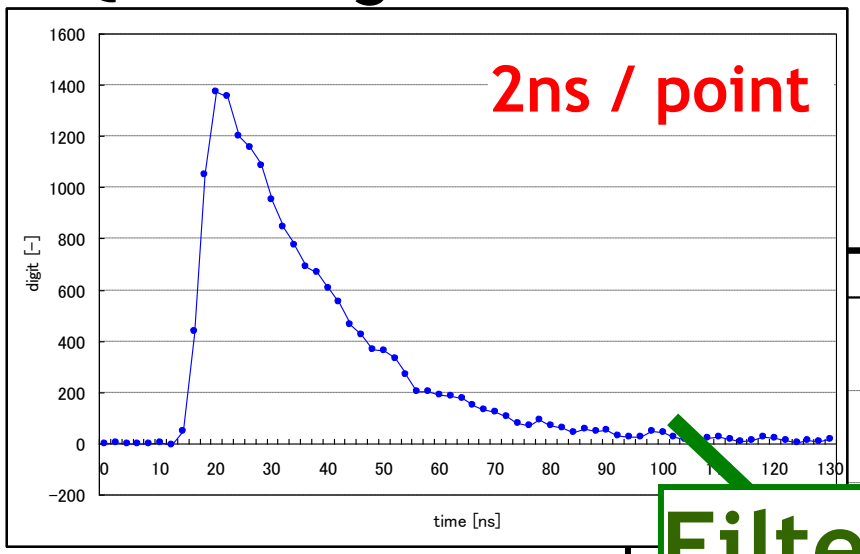

List Format

| |
|---|
| TDC[55..40] |
| TDC[39..24] |
| TDC[23..8] |
| TDC[7..0] TDCFP [7..0] |
| CH[2..0], QDC[12..0] |



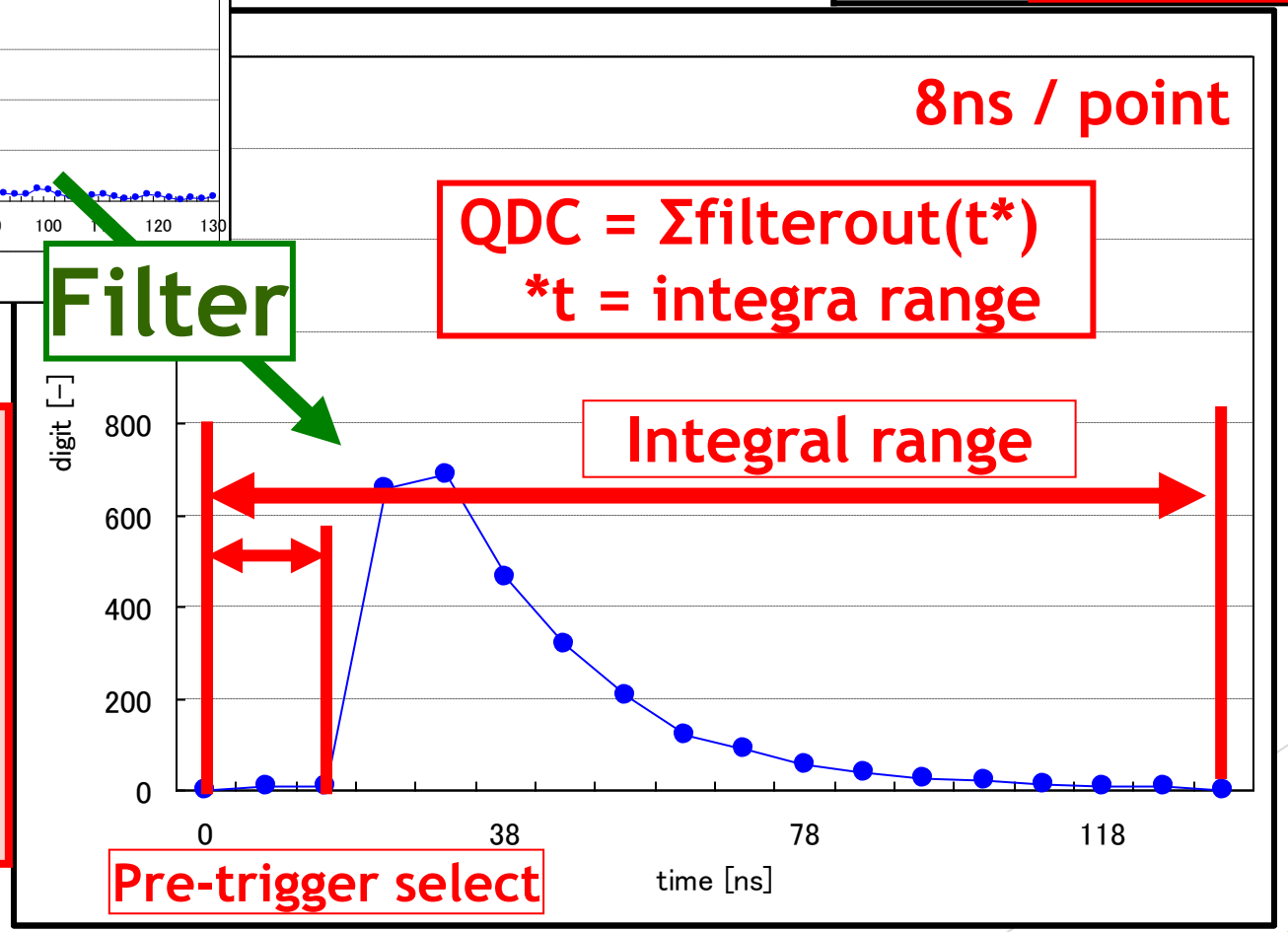
# QDC (Charge to Digital Converter)

## QDC: Integral Mode




**List Format**

| |
|---|
| TDC[55..40] |
| TDC[39..24] |
| TDC[23..8] |
| TDC[7..0], TDCFP[7..0] |
| CH[2..0], QDC[12..0] |




**Setting**

**Pre-trigger sel:**
-8ns, -16ns, -24ns, -32ns, -40ns

**Integral range:**
0ns - 32 μs (8ns interval)

**Filter:**
Ext, 8ns, 16ns, 24ns, 32ns, 48ns, 64ns

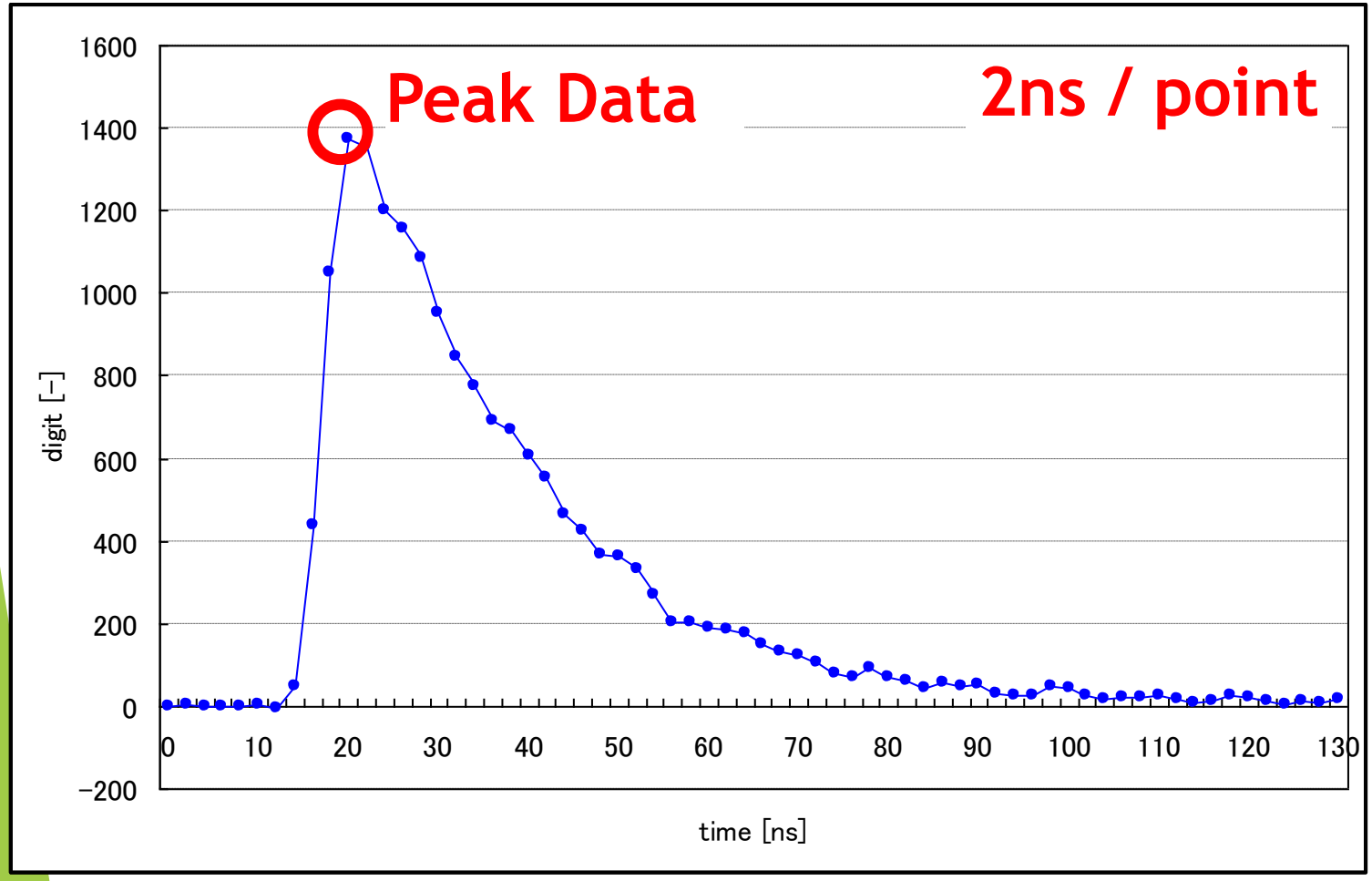
# QDC (Charge to Digital Converter)

## QDC: Peak Mode

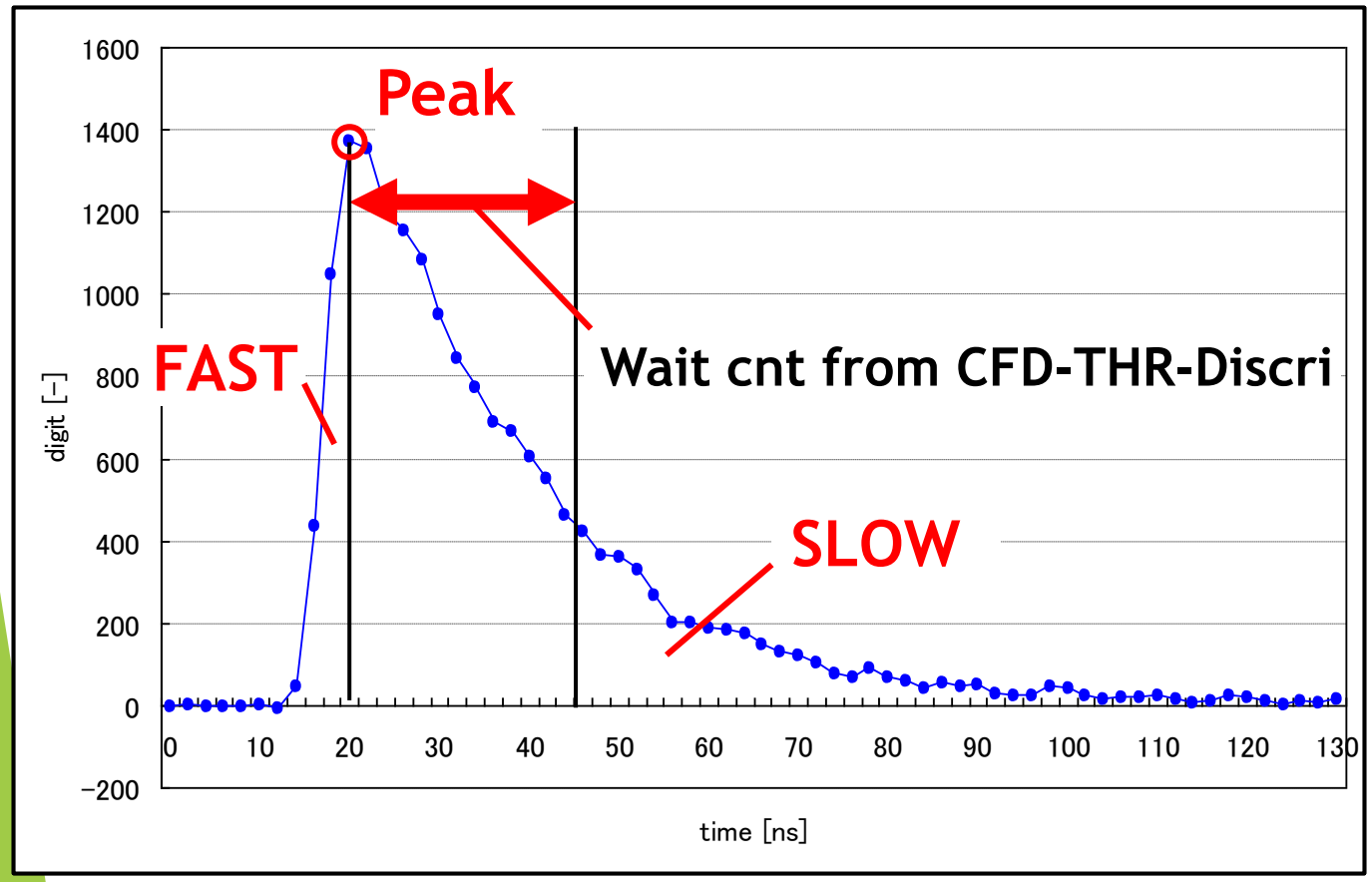
**List Format**

| |
|---|
| TDC[55..40] |
| TDC[39..24] |
| TDC[23..8] |
| TDC[7..0], TDCFP[7..0] |
| CH[2..0], QDC[12..0] |

**QDC = Peak Data**



# PSA (Pulse Shape Analysis)

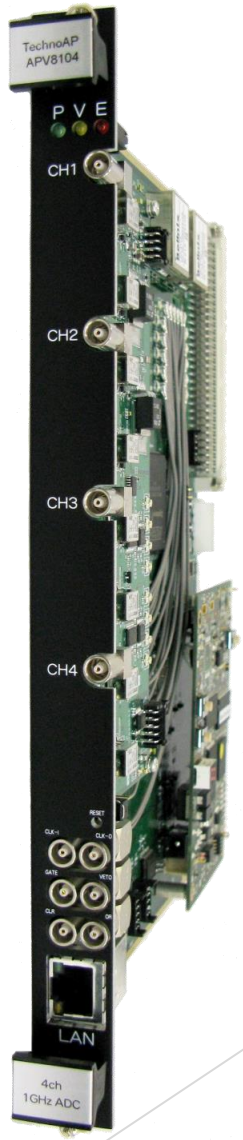



## List Format

| |
|---|
| PSA FAST[12..0] *option |
| PSA SLOW[12..0] *option |
| TDC[55..40] |
| TDC[39..24] |
| TDC[23..8] |
| TDC[7..0], TDCFP[7..0] |
| CH[2..0], QDC[12..0] |

# APV8104-14 (4CH, 1GSPS, 14bit-ADC)

This is a waveform analysis board.
The characteristic of this product is using 1GHz, 14 bit ADC. This is able to correspond to the high rates of more than 100 kcps per CH in the list mode with using the Gigabit Ethernet connection.




## Functions:

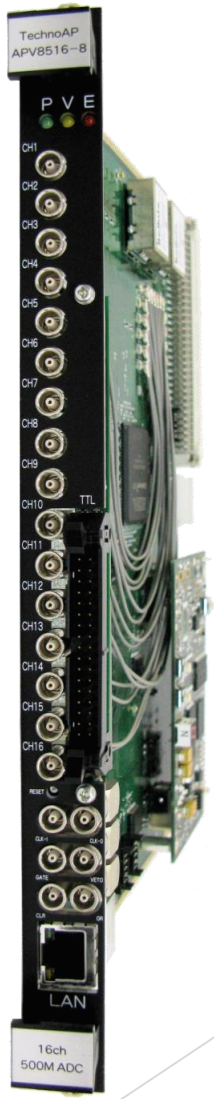
Digital CFD, TDC, QDC,
Digital PSA*, Digital Coincidence*

*Optional

## Usage Example:

The signal analysis of several high-speed scintillation detectors.

# APV8516-8 (16CH, 500MSPS, 8bit-ADC)




This is a waveform analysis board. Each channel is equipped with 500MHz, 8bit ADC. This is able to correspond to the high rates of more than 100 kcps per CH in the list mode with using the Gigabit Ethernet connection.

## Functions:

Digital CFD, TDC, QDC,
Digital PSA*, Digital Coincidence*

*Optional

## Usage Example:

The low cost and the scintillation detectors at a lot of channels.

# APV8702-8 (2CH, 3GSPS, 8bit-ADC)

This is a waveform analysis board. The characteristic of this board is using 3GHz, 8bit ADC. This is able to correspond to the high rates of more than 100 kcps per CH in the list mode with using the Gigabit Ethernet connection.


## Functions:

Digital CFD, TDC, QDC,
Digital PSA*, Digital Coincidence*

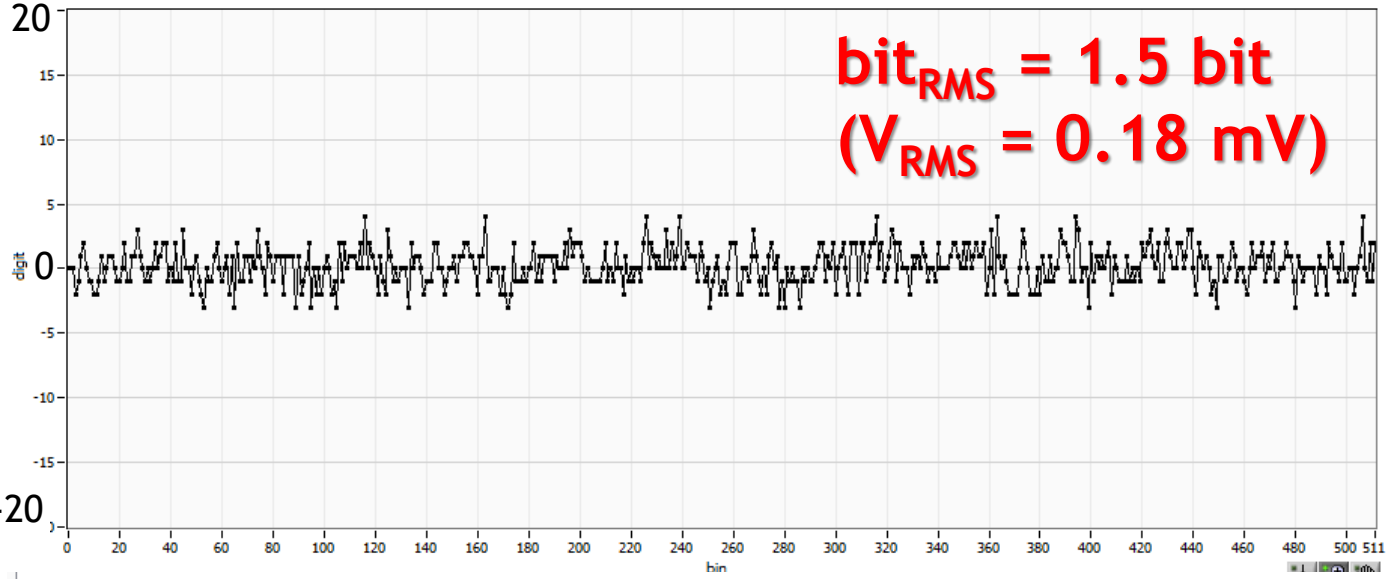
*Optional

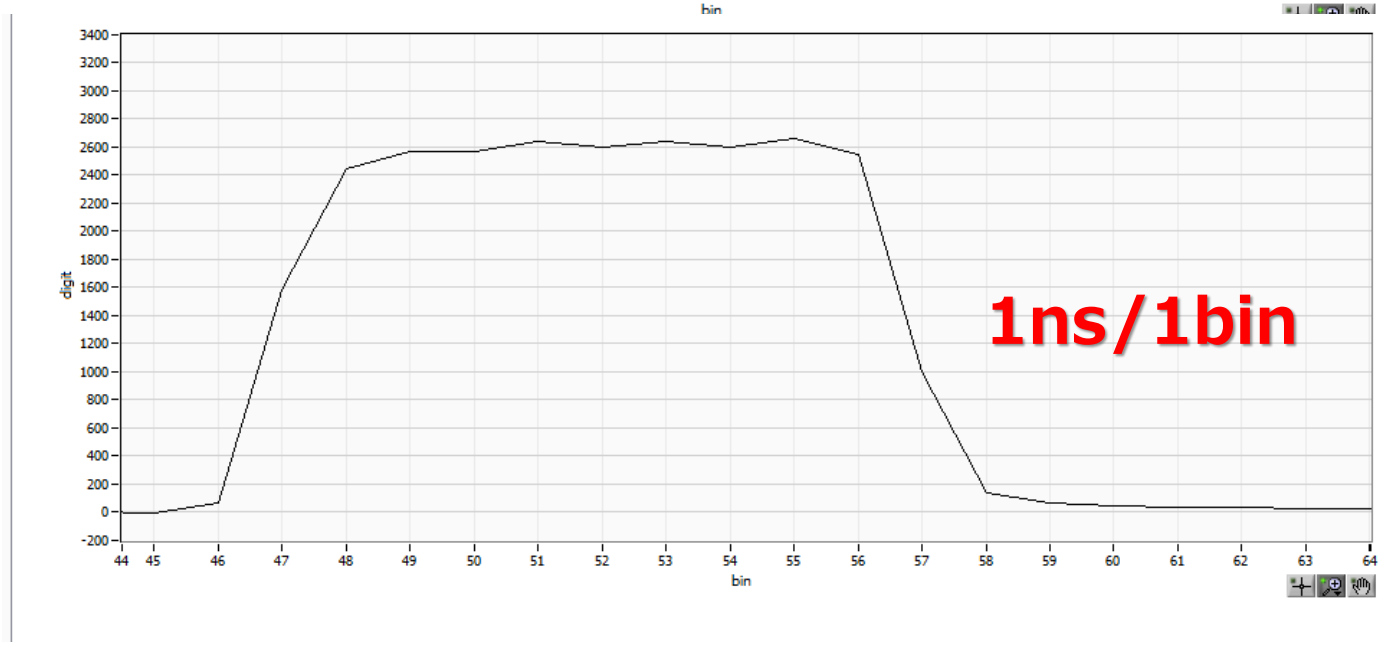
## Usage Example:

The signal analysis of an ultra high-speed scintillation detectors.

# ADC Performance

## APV8104 (1GSPS 14bit)



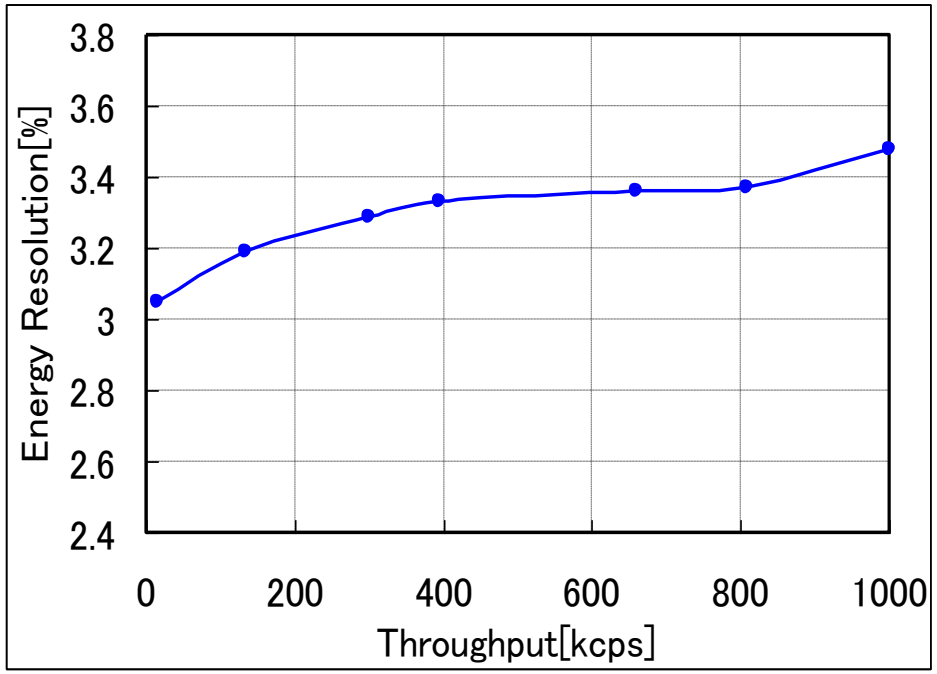




$$bit_{RMS} = \sqrt{\left( \Sigma (x_i - x)^{2} / i \right)}$$

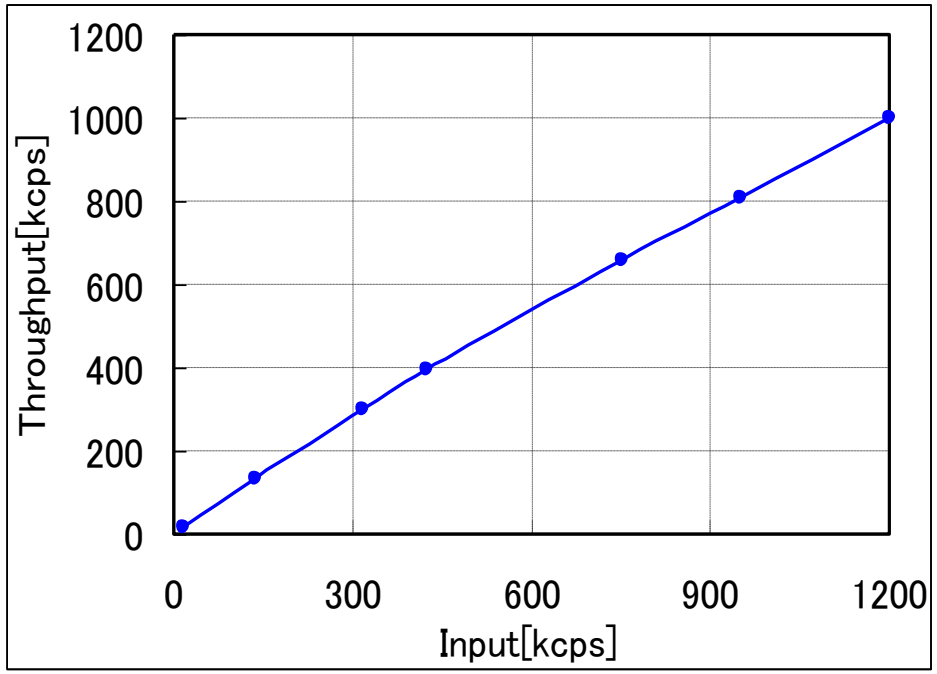
$x_i$ : Outputted Data

x: Average

# Energy Resolution and Throughput (APV8104)



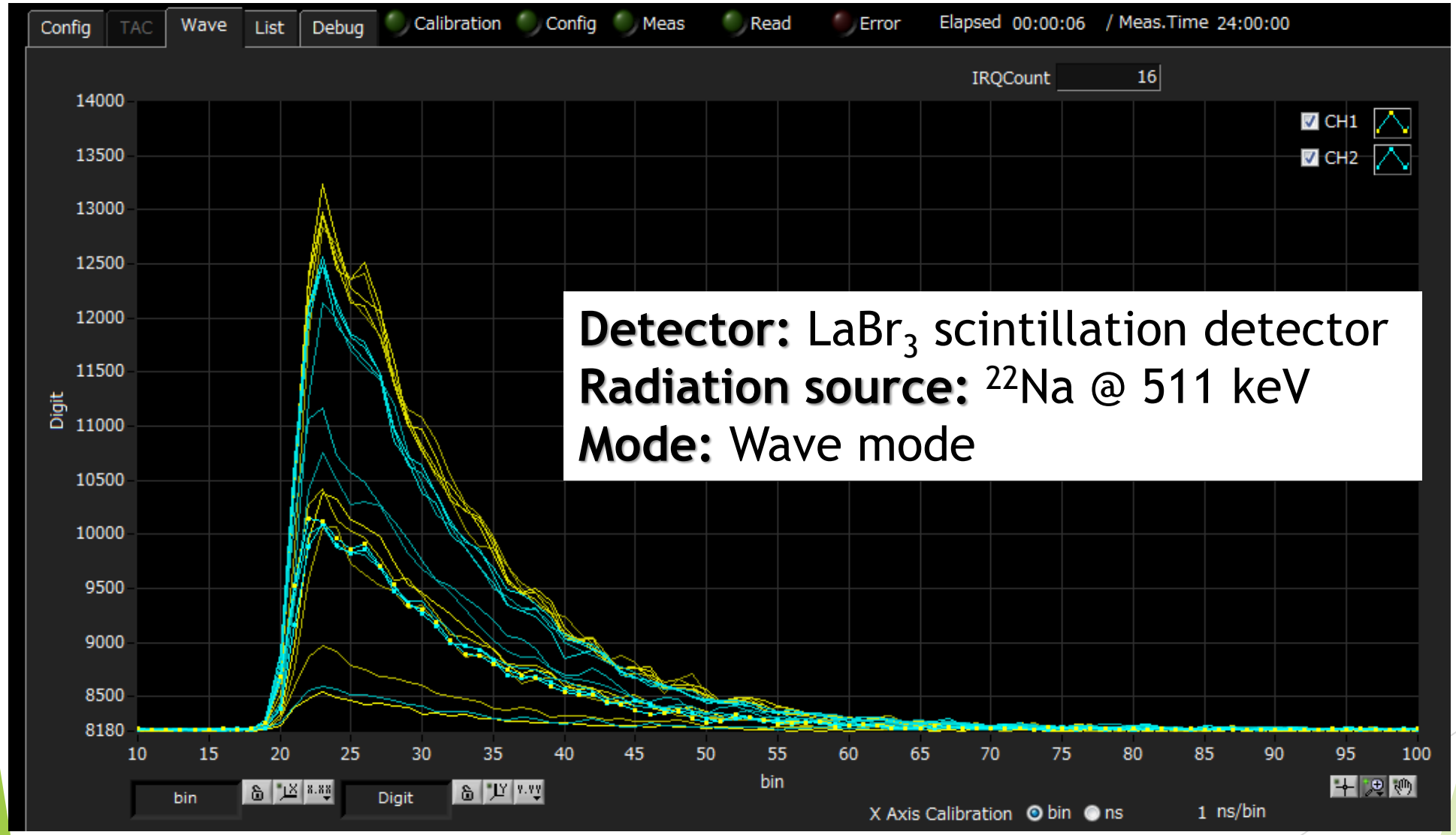

**Throughput** vs **Energy resolution**




**Input** vs **Throughput**

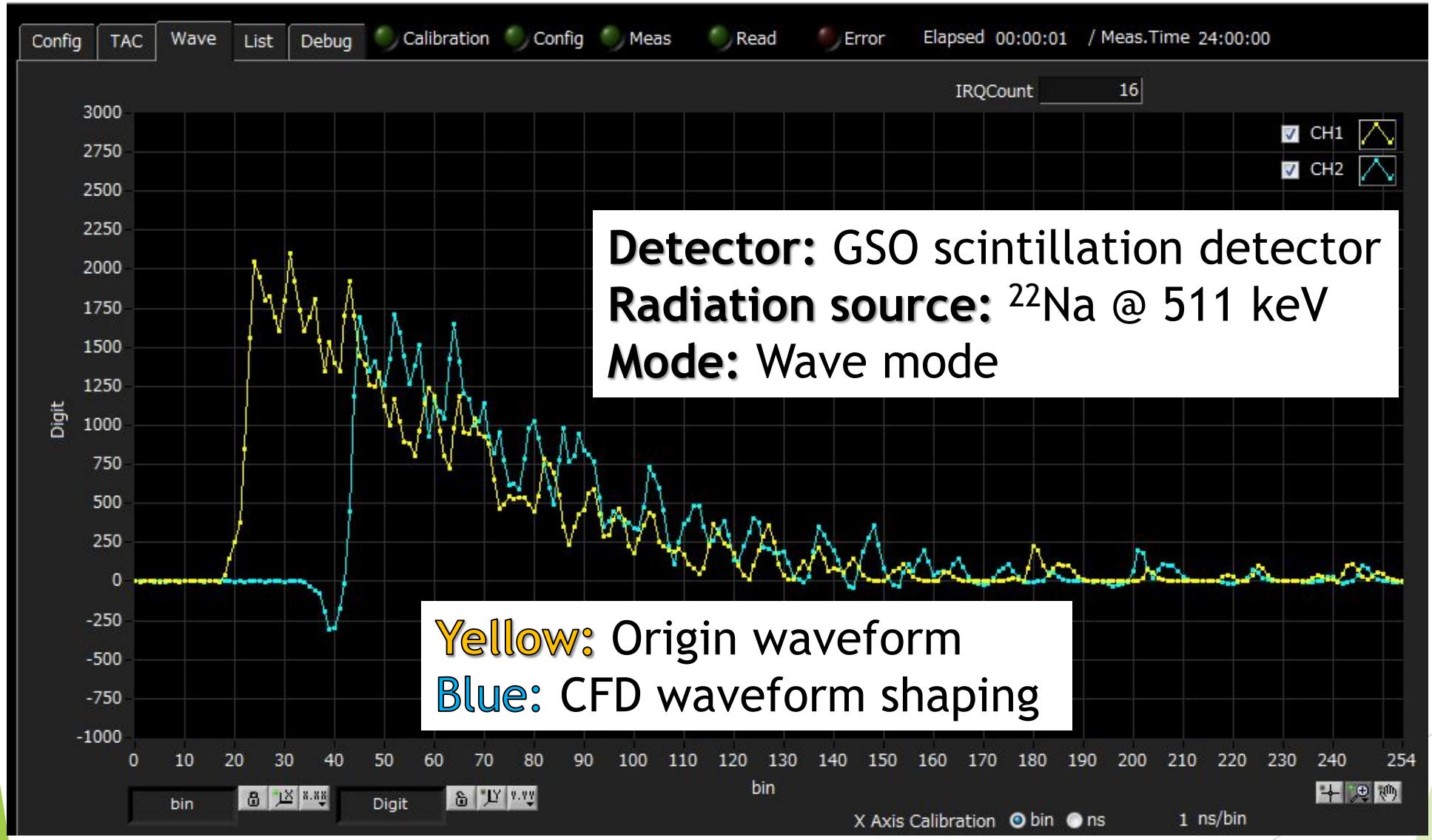
**Detector:** $LaBr_3$ scintillation detector
**Radiation source:** $^{137}Cs$ (10MBq), $^{60}Co$ (2MBq)

# APV8508-14 (8CH, 500MHz, 14bit-ADC)



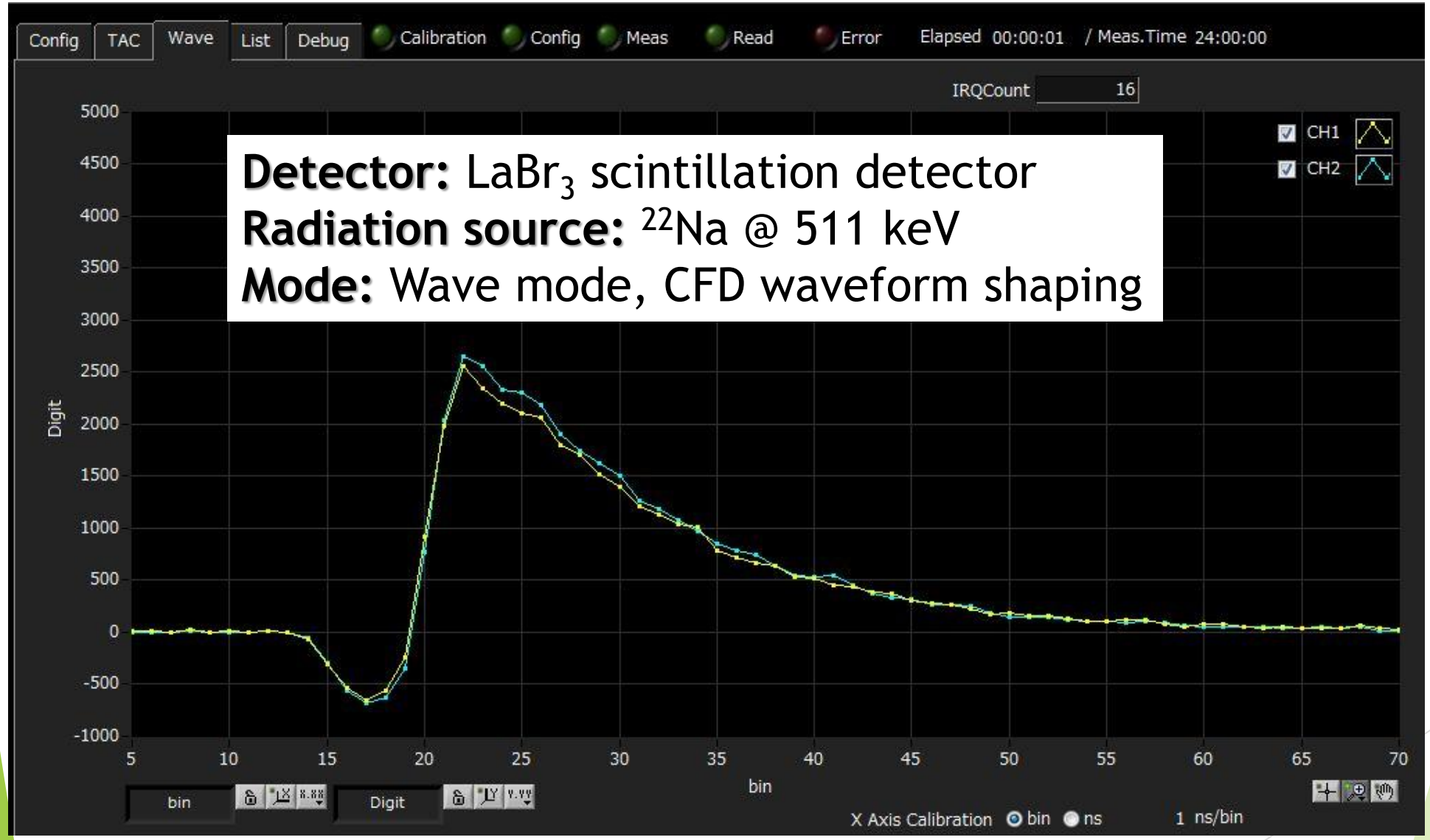

**Inputted waveform confirmable on the PC.**

# APV8508-14 (8CH, 500MHz, 14bit-ADC)




**Measurable early rise time**
**and characteristic fall time such as $LaBr_3$ detector.**

# APV8508-14 (8CH, 500MHz, 14bit-ADC)




**Visualize CFD waveform shaping**

# APV8508-14 (8CH, 500MHz, 14bit-ADC)

## List data

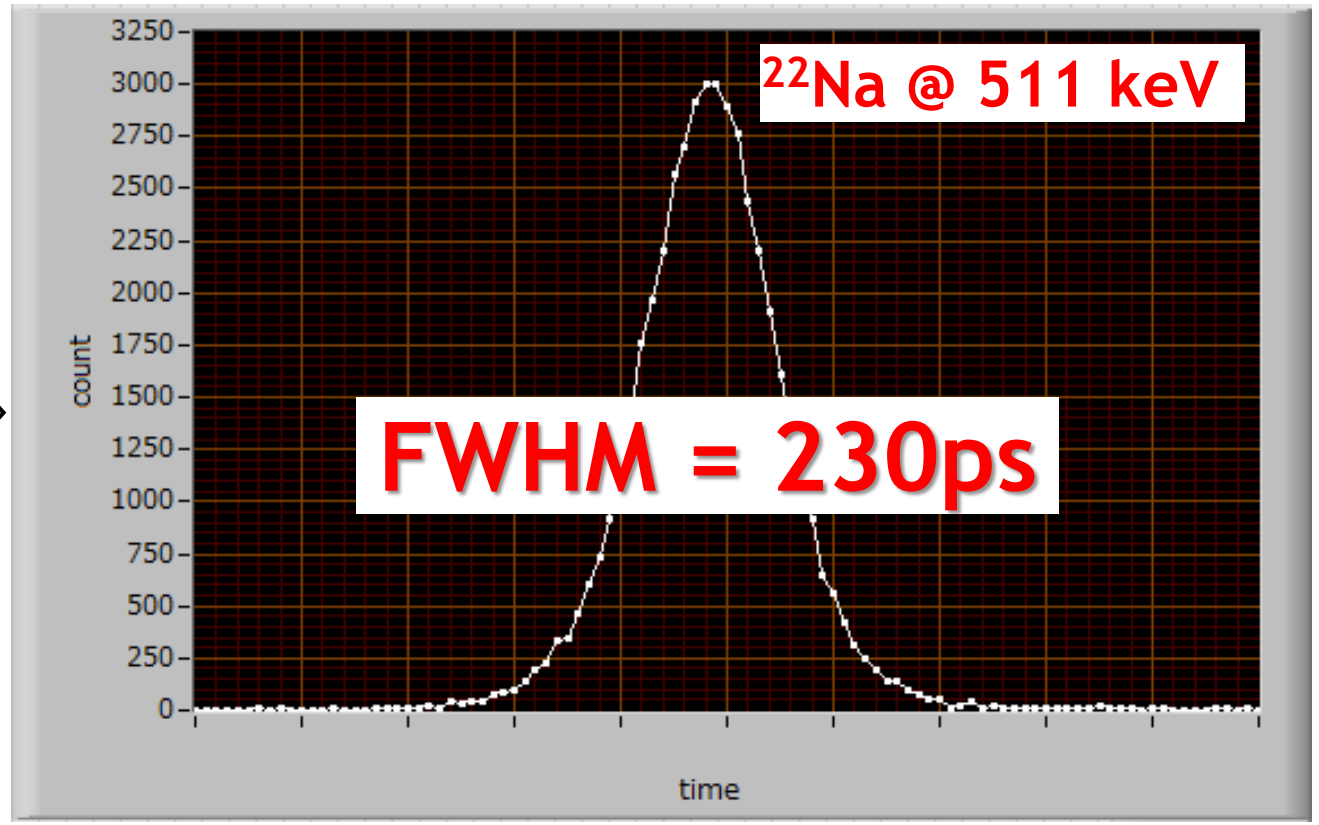
**TDC[55..0]**

| |
|---|
| 5687407143 |
| 5687452095 |
| 5687512849 |
| 5687829373 |
| 5687914953 |
| 5687918551 |
| 5687954008 |

**TDCFP[7..0]**

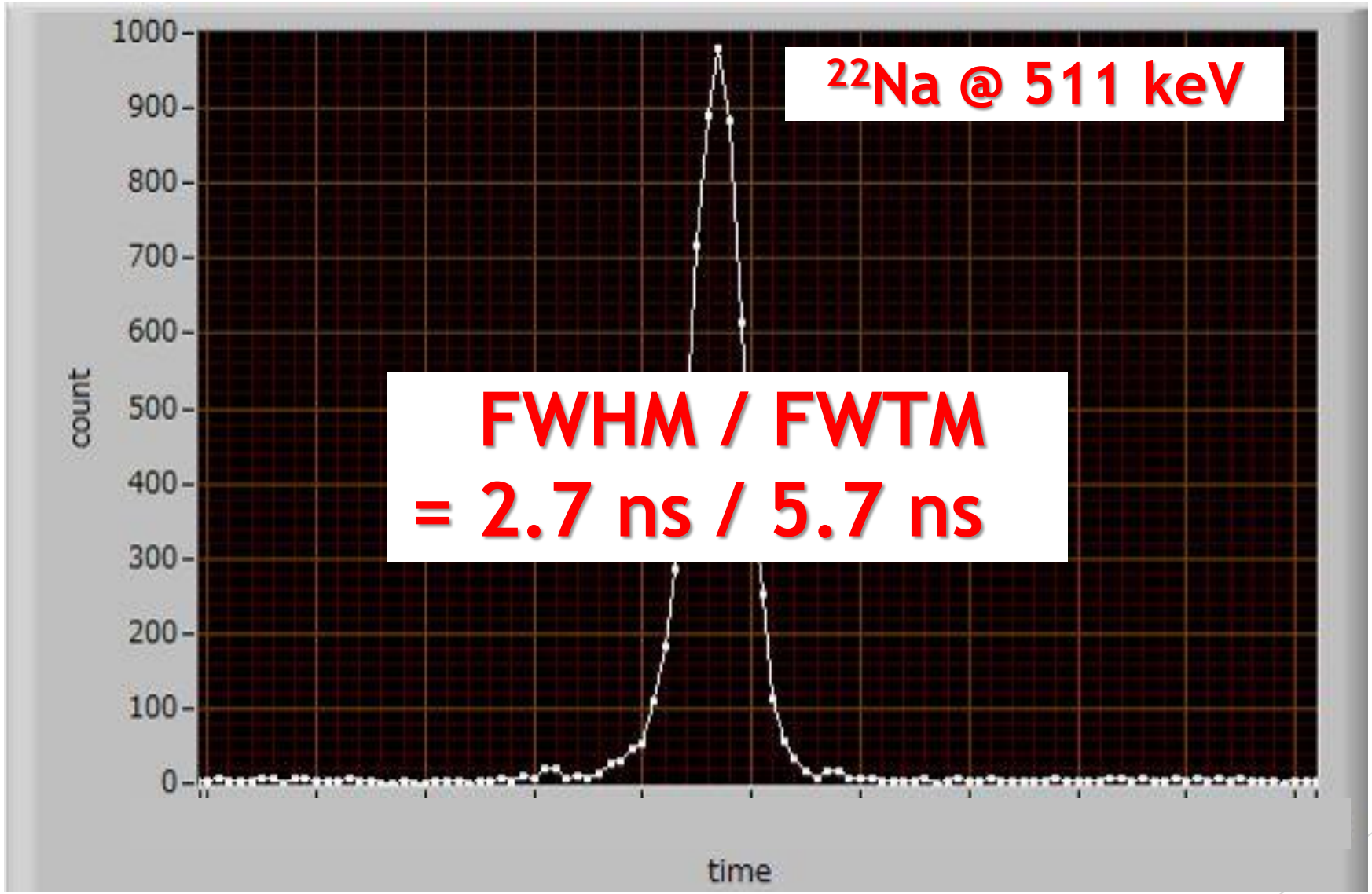
| |
|---|
| 146 |
| 206 |
| 124 |
| 182 |
| 46 |
| 40 |
| 190 |

Inputted TDC of 2 CH is used to the measurement of time resolution.




**$LaBr_3(Ce)$** scintillation detector
vs **$LaBr_3(Ce)$** scintillation detector

# APV8508-14 (8CH, 500MHz, 14bit-ADC)




The time resolution of the GSO scintillation detector

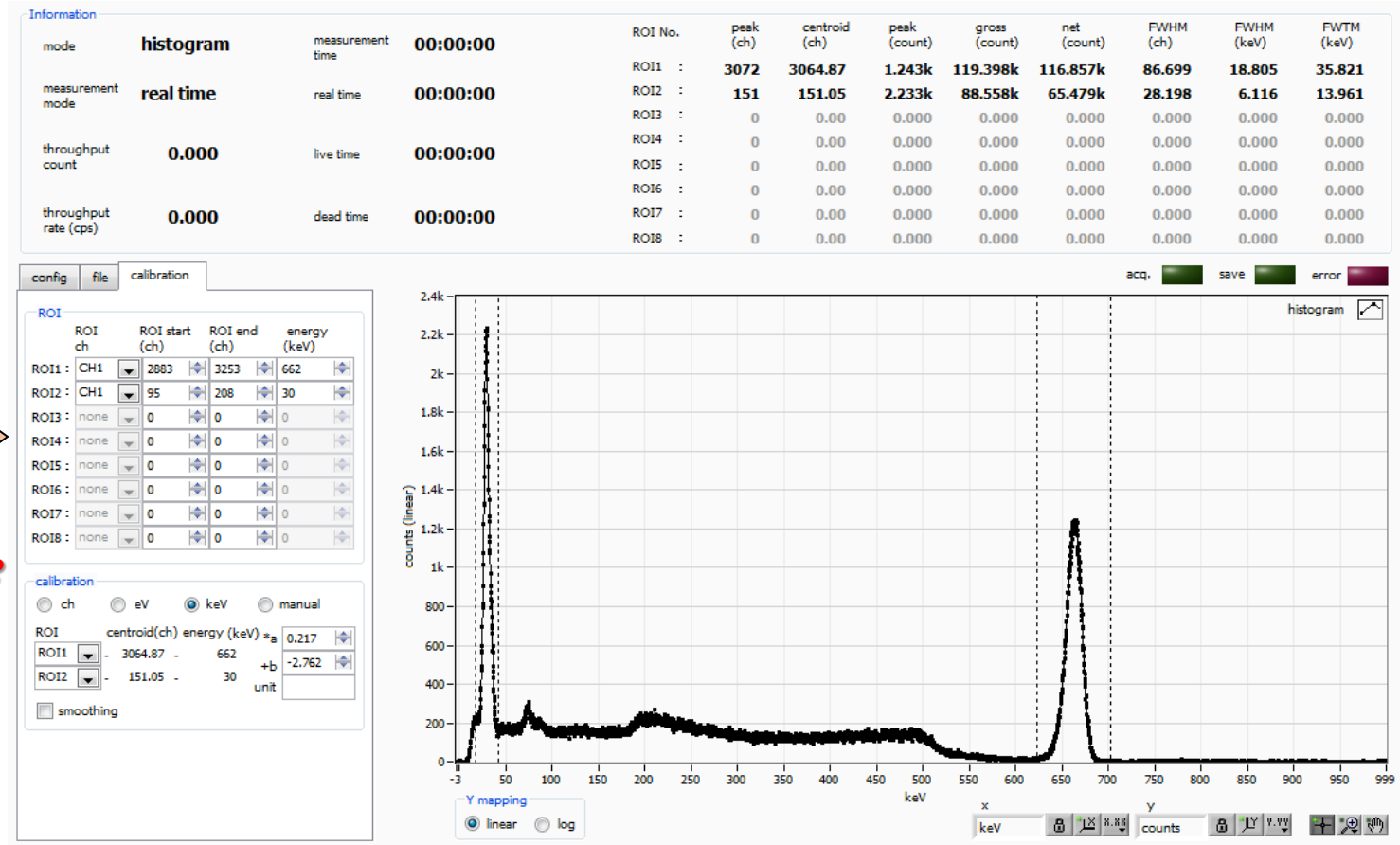
# APV8508-14 (8CH, 500MHz, 14bit-ADC)

Energy spectrum of $LaBr_3(Ce)$ scintillation detector.
The histogram used the QDC (Integral Mode) list data.

**List data**
**QDC[12..0]**

| |
|---|
| 575 |
| 579 |
| 517 |
| 579 |
| 579 |
| 462 |
| 557 |
| 462 |
| 558 |

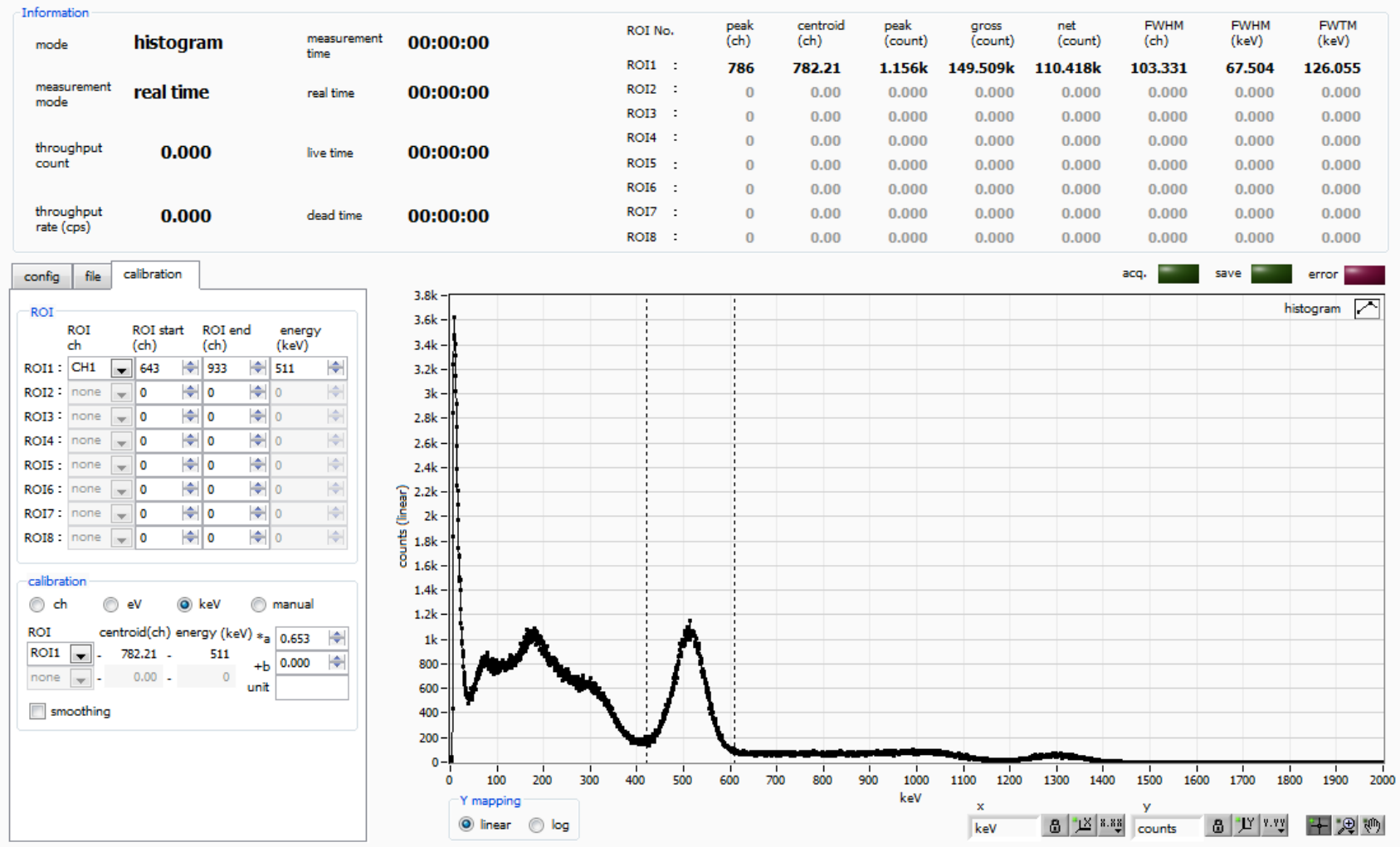
***Real-time***




**$^{137}Cs$ energy resolution: 2.9 % @ 662 keV**

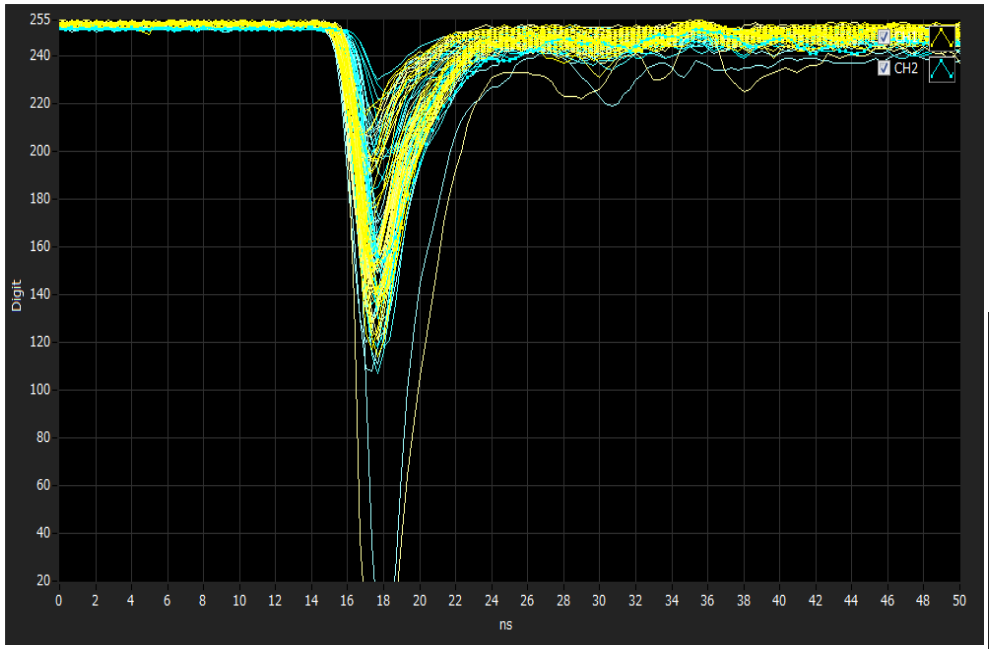
# APV8508-14 (8CH, 500MHz, 14bit-ADC)

## Energy spectrum of GSO scintillation detector

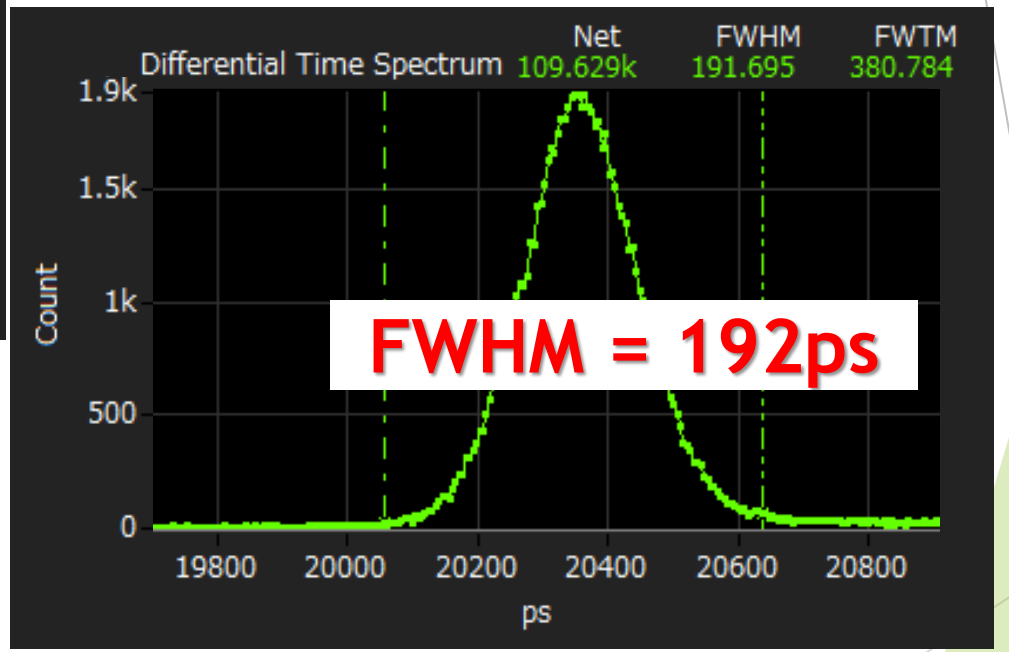



**$^{22}$Na energy resolution: 13 % @ 511 keV**

# APV8702 (2CH, 3GHz, 8bit-ADC)



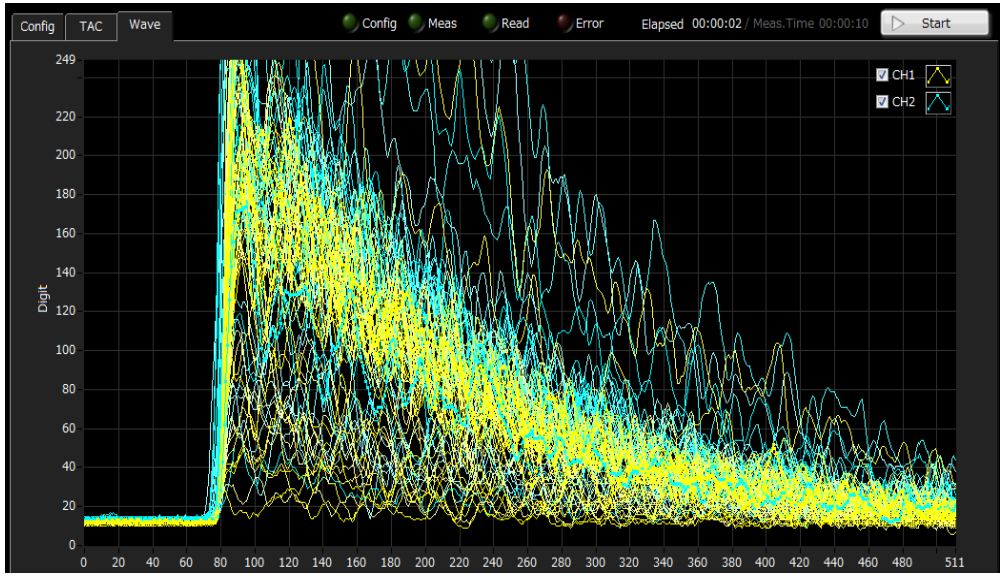

Waveform Mode



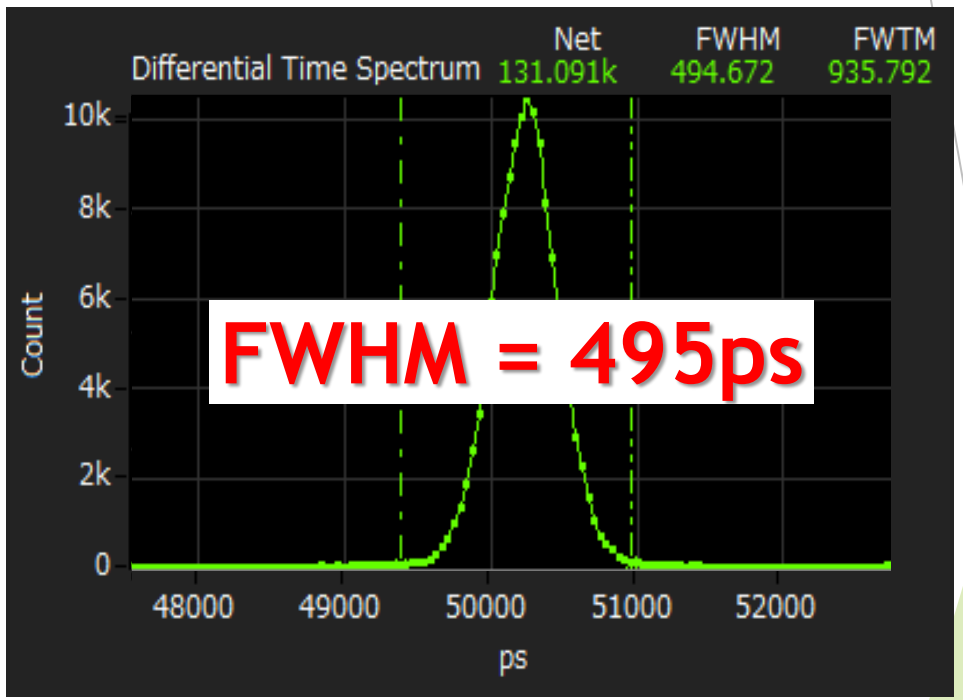

Time resolution Mode

$BaF_2$ scintillation detector, $^{22}Na$ @ 511 keV

# APV8702 (2CH, 3GHz, 8bit-ADC)




Waveform Mode

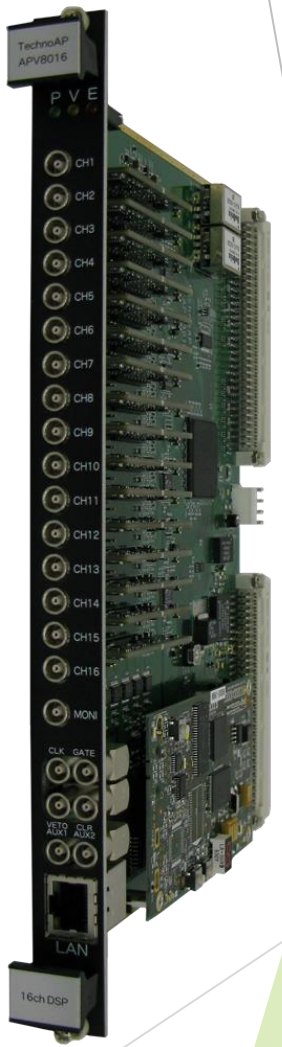



Time resolution Mode

LYSO scintillation detector, $^{22}Na$ @ 511 keV

# **APV8016(X)** (16CH, 100MSPS, 14bit-ADC)

This is a digital signal processor for gamma-ray. Pre-amp signal from the Ge semiconductor detector can be input directly. The inputted signal is converted to digital signal processing by high-speed ADC (100 MHz, 14bit) and highly-integrated FPGA. The measurement data is a histogram, an event and a waveform. The data is transferred to the PC via Ethernet.

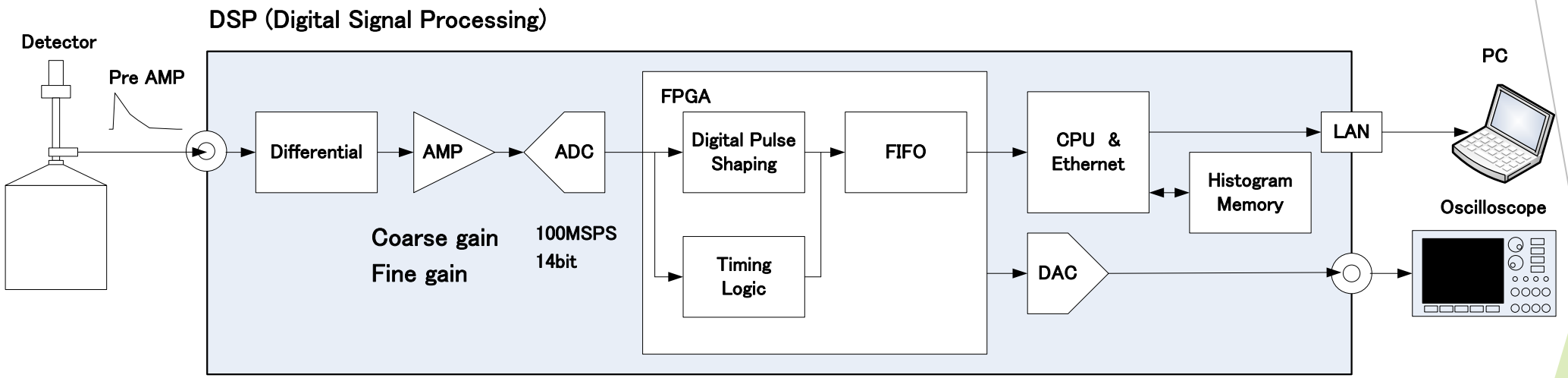



***This module is used for X-ray.**

**Recommendable detectors: SDD, Si(Li), SSD, SiPin etc.**

# DSP (Digital Signal Processor)

Our DSP is a multi-channel analyzer (MCA) equipped with a real-time digital signal processing function.



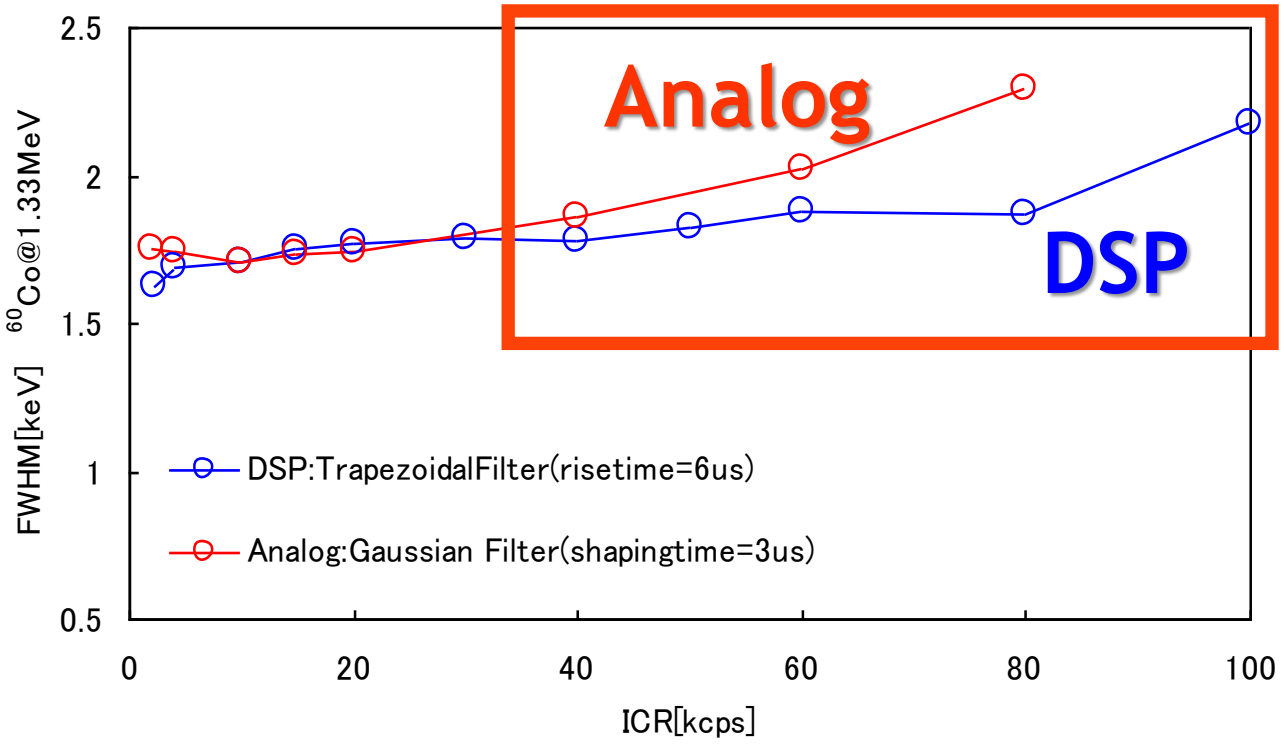

**Block diagram of the DSP circuit board**

**Data collect mode:**

Histogram mode, Event mode, and Wave mode.

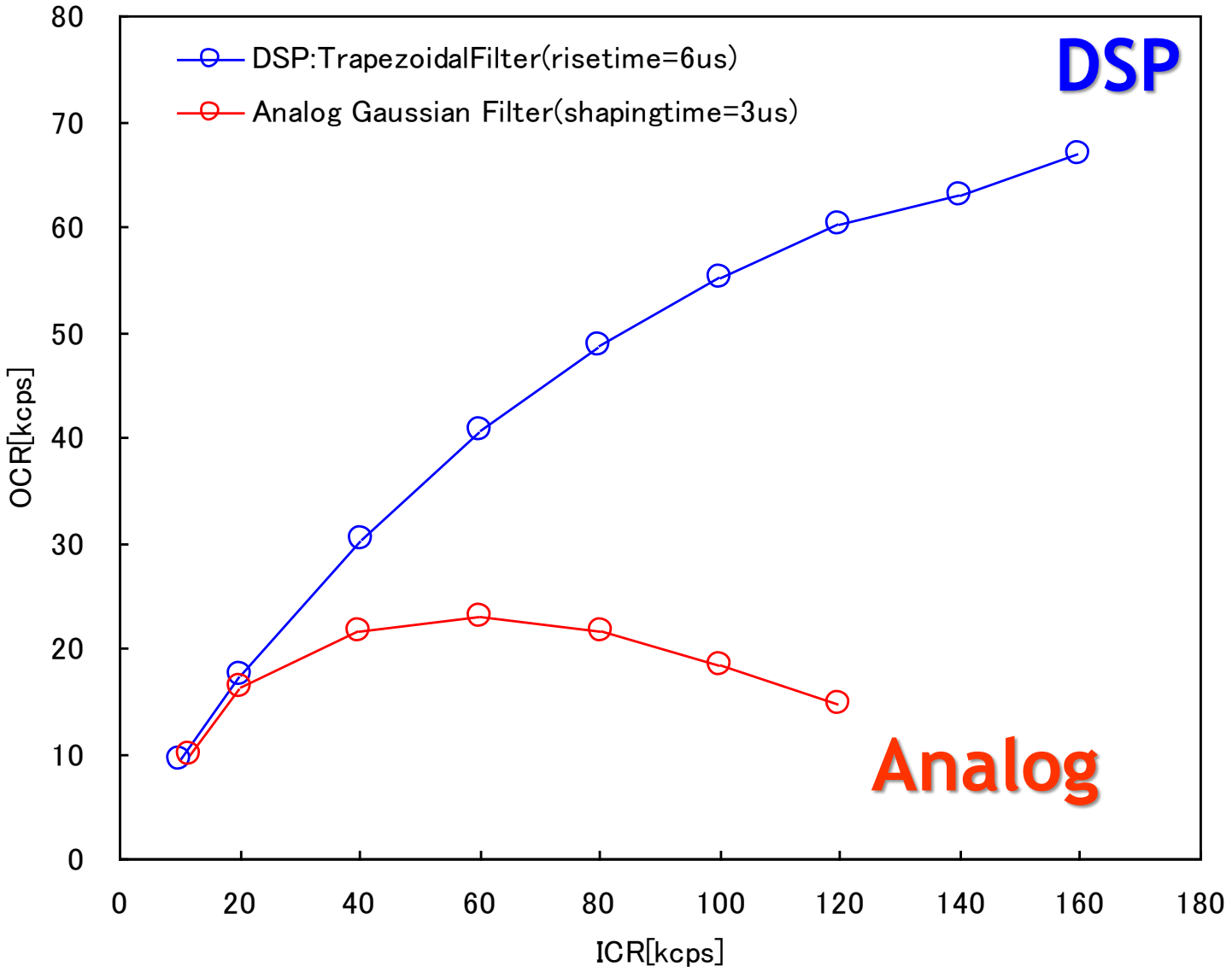
# Characteristic test of DSP using HPGe detector

| | | |
|---|---|---|
| **Detector** | PGT Coaxial P-type HPGe size:10%<br>nominal energy resolution:1.8keV@1.33MeV | |
| **High Voltage** | +2000V | |
| **Source** | $^{60}$Co | |
| **Pulse Shaping** | (1)DSP Trapezoidal Filter | (2)Analog Gaussian Filter |
| **MCA** | APV8016 internal MCA | APV7400 Analog MCA typ. |

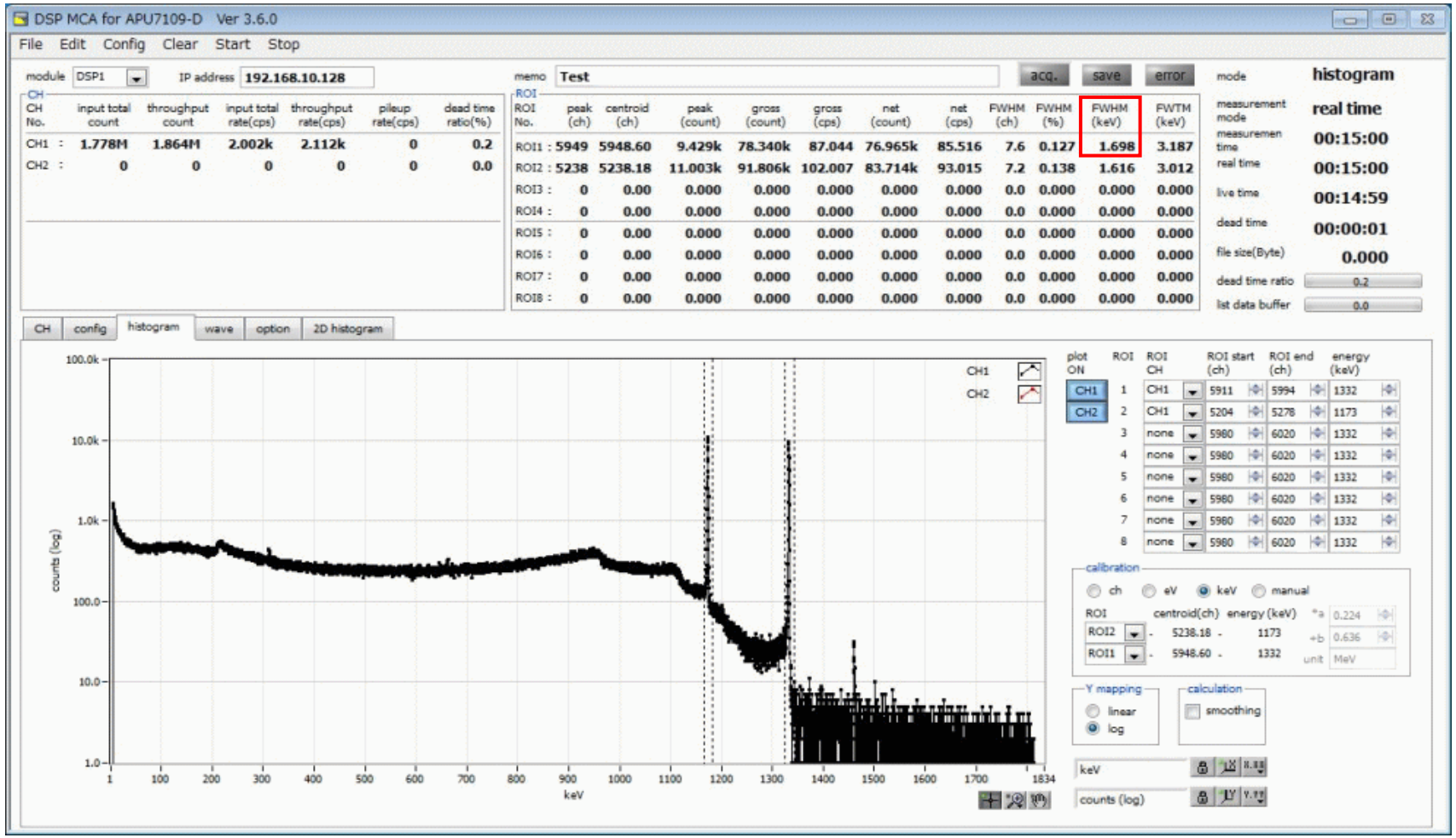



Characteristic of Energy resolution

# Characteristic test of DSP using HPGe detector



# DSP resolution 1.7 keV @ $^{60}$Co, 1.33MeV



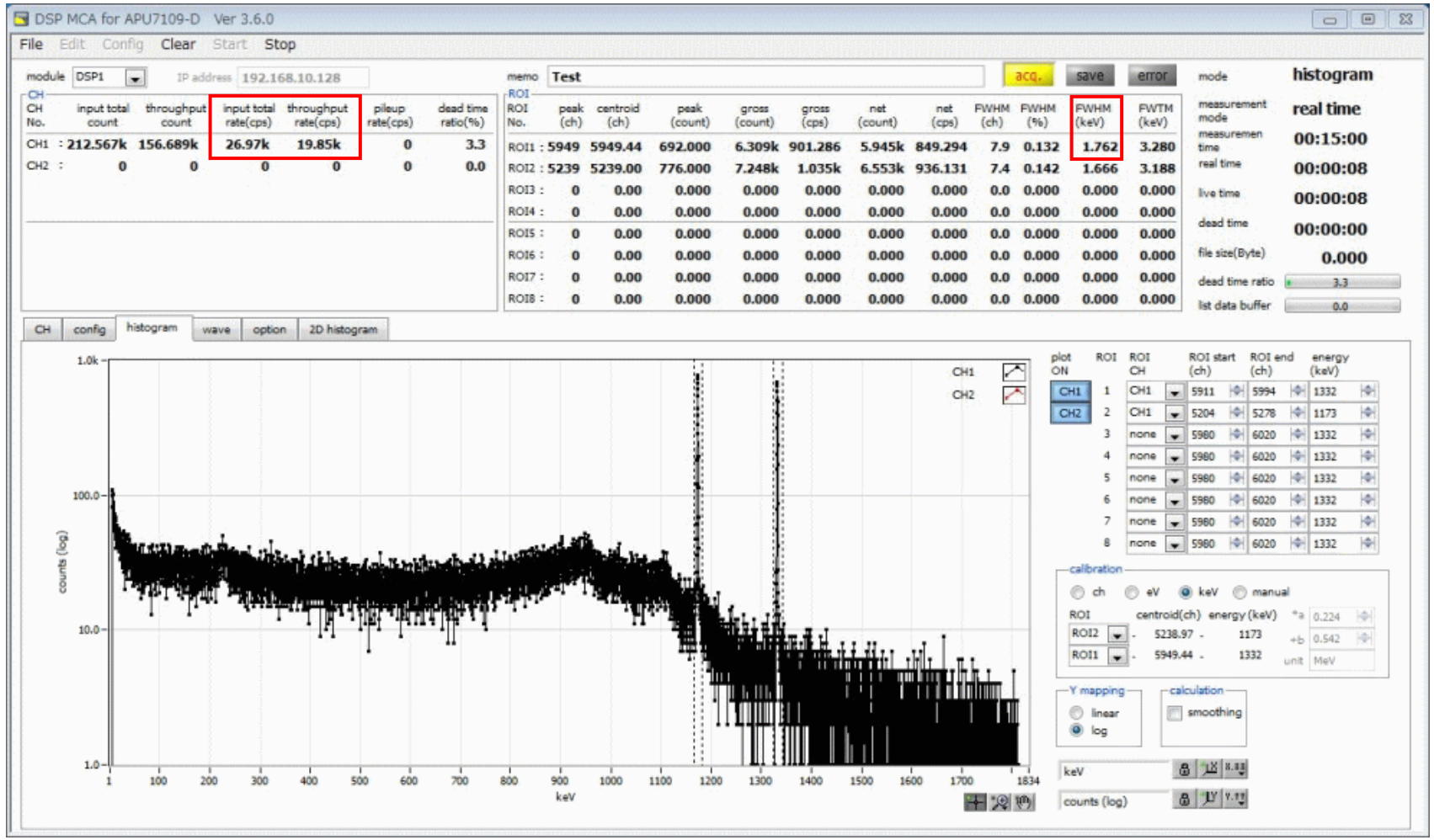

**ENEGY SPECTRUM**

**Detector:** HPGe detector, **Source:** $^{60}$Co,

**Count Rate:** 2 kcps, **Shaping Time:** 6μsec,

**Measurement Time:** 15 min, **Detection Efficiency:** 10%

# Energy resolution with High Count Rate is 1.76 keV

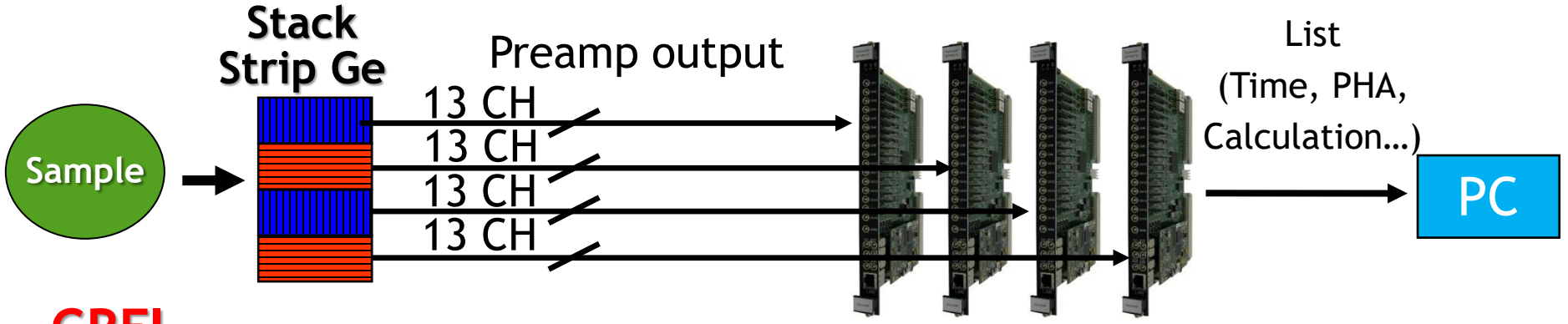



## ENEGY SPECTRUM

**Detector:** HPGe detector, **Source:** $^{60}$Co, **Count Rate:** 20kcps,

**Measurement Time:** 15 min, **Detection Efficiency:** 10%

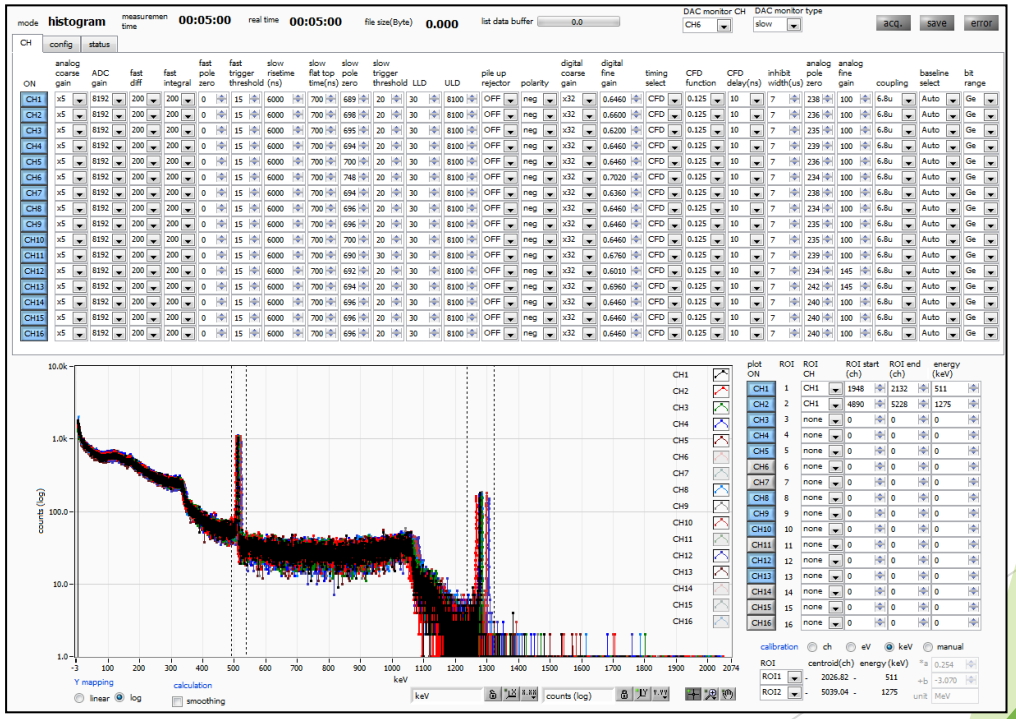
# Usage Example 1: Ge semiconductor Compton camera




## GREI

Gamma-Ray Emission Imaging


External

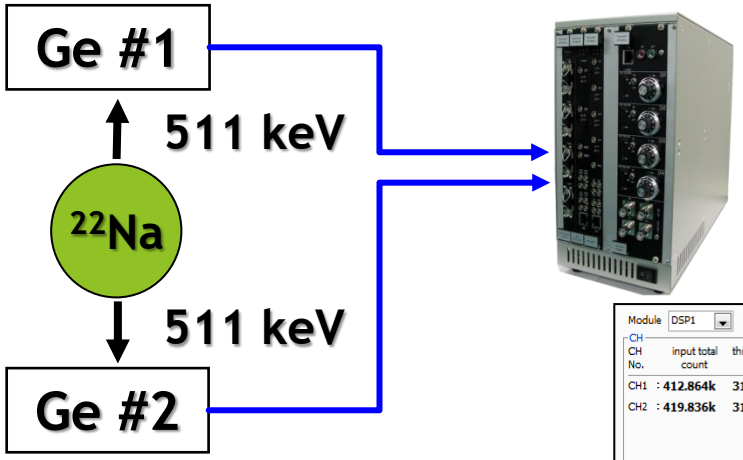


Application for APV8013A

by RIKEN Next-generation Imaging Team

# Usage Example 2: CDB Coincidence Doppler Broadening Positron Lifetime Measurement System

## Composition Example

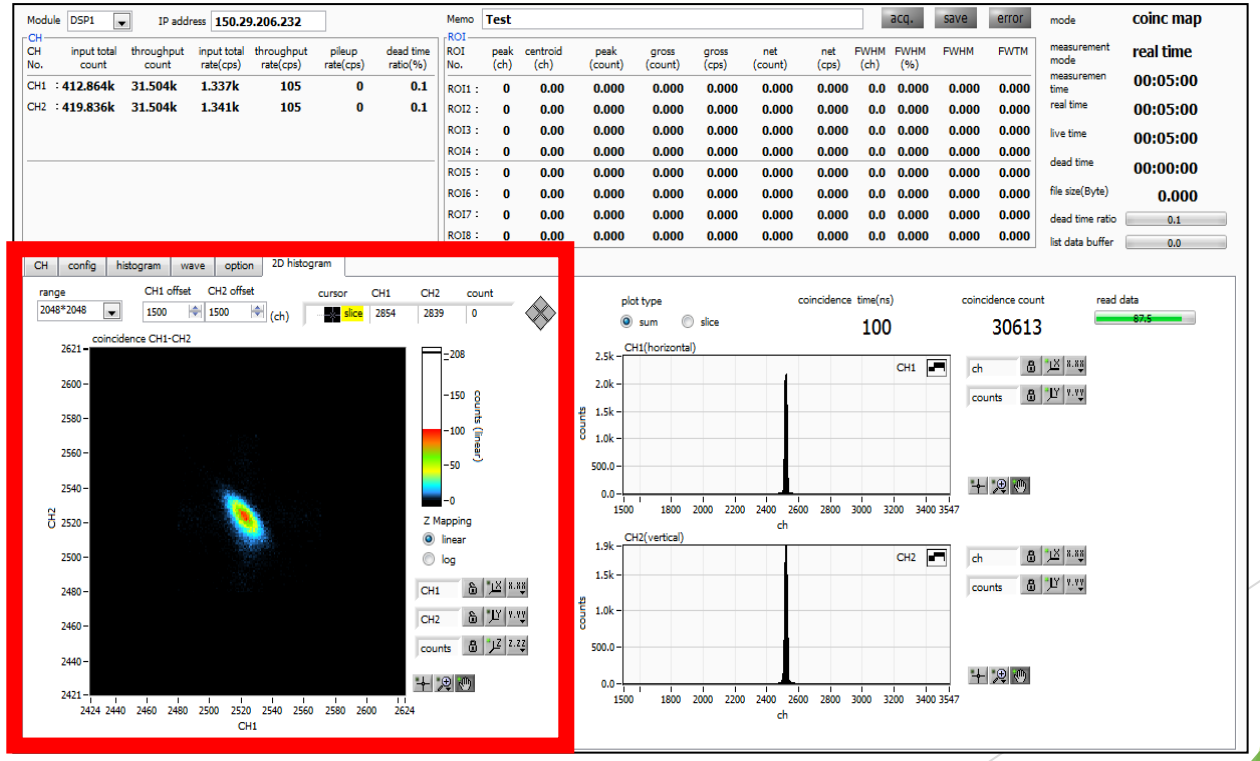





It is able to support the coincidence processing using several detectors.

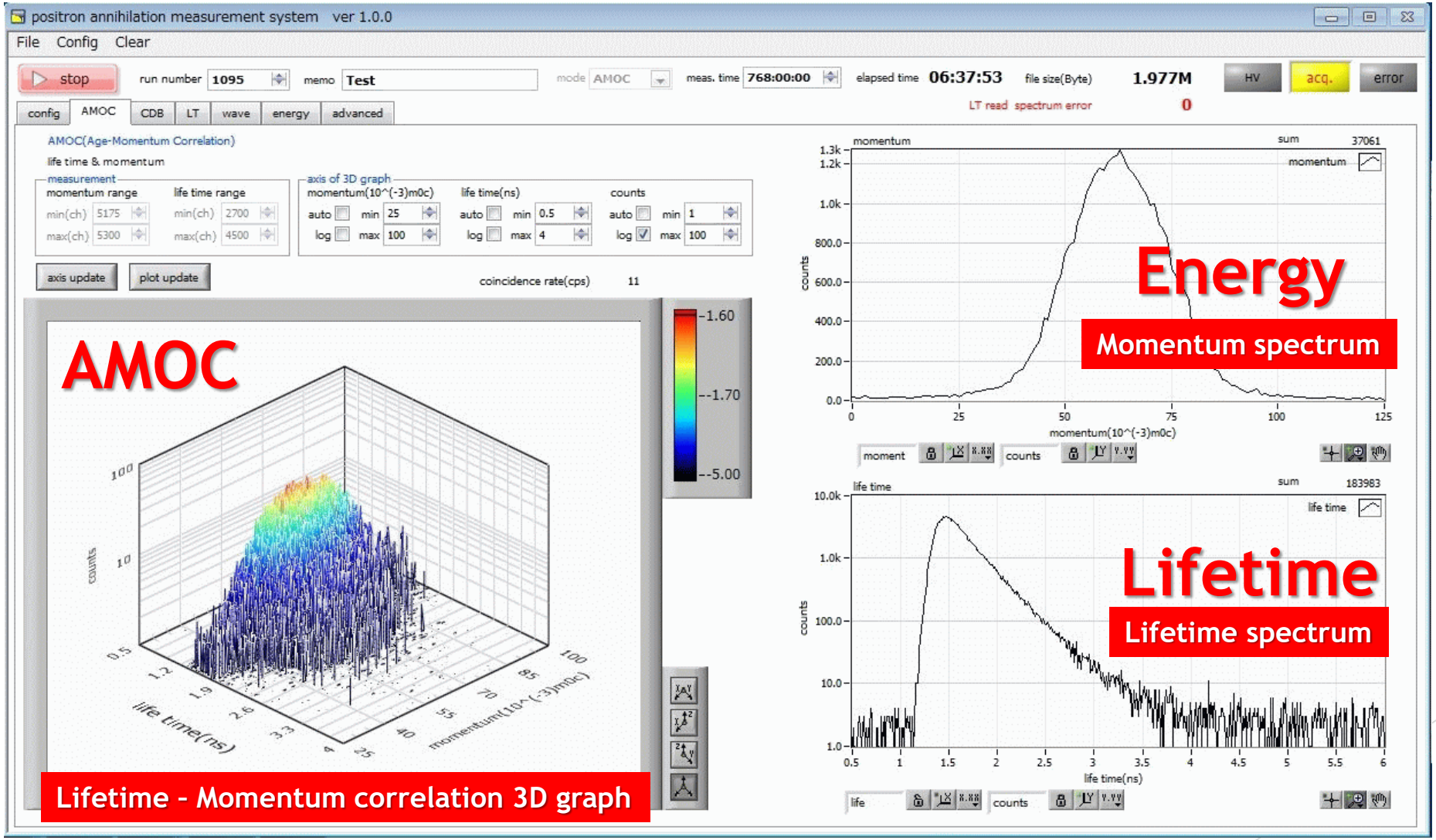
PC

**Coincidence Doppler Broadening** Measurement of Positron Annihilation can be detect a micro-void of the materials, such as semiconductor etc.




Coincidence 2D-Map

# Usage Example 3: AMOC Age-Momentum Correlation Positron Lifetime Measurement System




Sample: Silica

# Our other products:

- Gamma Imaging Module
- Spectrometers
- MCA (Multi Channel Analyzer)
- High-Voltage Power Supply
- Power Supply for Preamp
- Preamps
- Detectors ($LaBr_3$, $BaF_2$, GSO, LFS, etc)
- NIM module

# Please contact us
# if you need further information.

+81-29-350-8011

order@techno-ap.com

# Techno AP

## [Business lineup]

* Sales of radiation measuring instrument and radiation counter.
* Development of radiation measuring device and radiation counter.
* Development of research and development device, measurement controlling system, and inspection apparatus.

## [Contact us]



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