

Digital Spectrometer

APU101

Manual

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Safety Precautions / Disclaimer

Thank you for purchasing the product of Techno AP Co., Ltd. (hereinafter referred to as "our company"). Before using the product, please read this "Safety Precautions / Disclaimer" and be sure to observe the contents to ensure correct use.

Even if an accident occurs due to the use of our products, we will not be liable for any damages including abnormalities of devices, detectors, connected devices and applications, damages caused by failures, and other secondary damages.



Prohibited matter

- It cannot be used for applications that require special quality and reliability related to human life and accidents.
- Please refrain from using the product in places with high temperature, high humidity, and high vibration (excluding countermeasures).
- Do not apply more power than rated.
- Do not turn on the board product with other metals in contact with the board surface.



Notes

- Turn off the power immediately if there is smoke or abnormal heat generation.
- It may not work properly in a noisy environment.
- Be careful of static electricity.
- Product specifications and related documents are subject to change without notice.

Warranty conditions

The warranty conditions for "our products" are as follows.

- Period: One year after purchase.
- Contents: If the product breaks down during use within the warranty period, it will be repaired or replaced.
- Not applicable: We do not guarantee if the cause of failure falls under any of the following.
 1. Use other than the original usage of "our products"
 2. In addition to the above, causes other than "our company" or "our products" (including force majeure such as natural disasters)
 3. Consumables, etc.

1. Overview

Digital spectrometer APU101 (hereinafter referred to as this device) is a digital spectrometer that integrates a high-voltage power supply, preamplifier power supply, and MCA (multi-channel analyzer) into one. Since it is a multi-channel analyzer (MCA) equipped with a real-time digital signal processing function (DSP), waveform shaping processing by an analog circuit is not required, and a very high-speed A / D converter is used to directly digitalize the signal from the preamplifier. It is converted to and processed by the trapezoidal filter in real time by the pipeline architecture by FPGA. This provides excellent energy and time resolution and has outstanding stability even at high count rates (100 kcps and above).

This device can be connected to a personal computer (hereinafter referred to as PC) with a LAN cable, and by using the attached application APP101 (hereinafter referred to as this application), parameters can be set, data can be read, and measured data can be analyzed and imported.

This manual describes the handling of this device and this application.

* This manual describes normal products and may differ from the one you are using depending on the presence or absence of options, special specifications, and specifications of the high-voltage power supply module.

* The contents of this manual are subject to change without notice.

2. Specifications

1. Analog Input

- Number of channels 1 CH
- Input range ± 1 V
- Input impedance 1 k Ω
- Coarse gain $\times 1, \times 4, \times 10, \times 20$ Set the value from the application

2. ADC

- Sampling frequency 100 MHz
- Resolution 14 bit

3. MCA

- ADC gain 8192, 4096, 2048, 1024, 512, 256 channel
- Measurement mode Histogram, Wave and List

4. Digital pulse shaping

- SLOW, Rise time 0.1 μ s - 10 μ s
- SLOW, Flat top time 0.1 μ s – 1 μ s
- Digital Fine gain $\times 0.333 - \times 1$
- Digital Pole zero cancel
- Digital Baseline Restorer
- Digital Pile up Reject
- LLD, Lower-Level Discriminator
- ULD, Upper-Level Discriminator

5. Unit panel, Switch, Button and Connector

FRONT

- Unit power supply, LED for EMO
- Emergency stop button
- LED for High voltage power monitor
- LED for Dead-time monitor
- Clear signal input connector * unused
- Clock signal input connector
- AUX1 and AUX2 signal output connector

BACK

- DC power supply connector
- F.G terminal
- D-Sub 15-pin connector for preamplifier power supply
- BNC connector for filter waveform output

- Connector for preamplifier output signal input
- SHV connector for high voltage power output
- LEMO compatible connector for high voltage power shutdown

6. High-voltage power supply

* If the specifications are changed, the maximum output voltage and current value may differ.

- Output voltage Positive electrode property, negative electrode property,
High-Z switchable, 0 V to 4000 V, $\pm 5\%$, 1 G Ω load
- Output impedance About 200 k Ω
- Output current Max. 1 mA
- Ripple 20 mVp-p (typ.)
- Supports automatic step-down by detecting bias shutdown signal

7. Preamplifier power supply ± 12 V, ± 24 V * NIM standard compliant

8. Communication interface RJ45 connector, Ethernet 1000Base-T, TCP / IP and UDP

9. Outer diameter 210 (W) x 45 (H) x 275 (D) mm * without connectors

10. Weight about 1800 g

11. Current consumption +12 V, 0.8 A
Power supply for Preamplifier, ± 12 V, ± 24 V,
* Depends on the connected preamp

12. PC environment

- OS Windows 7 or later, 32 bit and 64 bit or later
- Screen resolution Recommended above HD 1366 x 768

3. Appearance

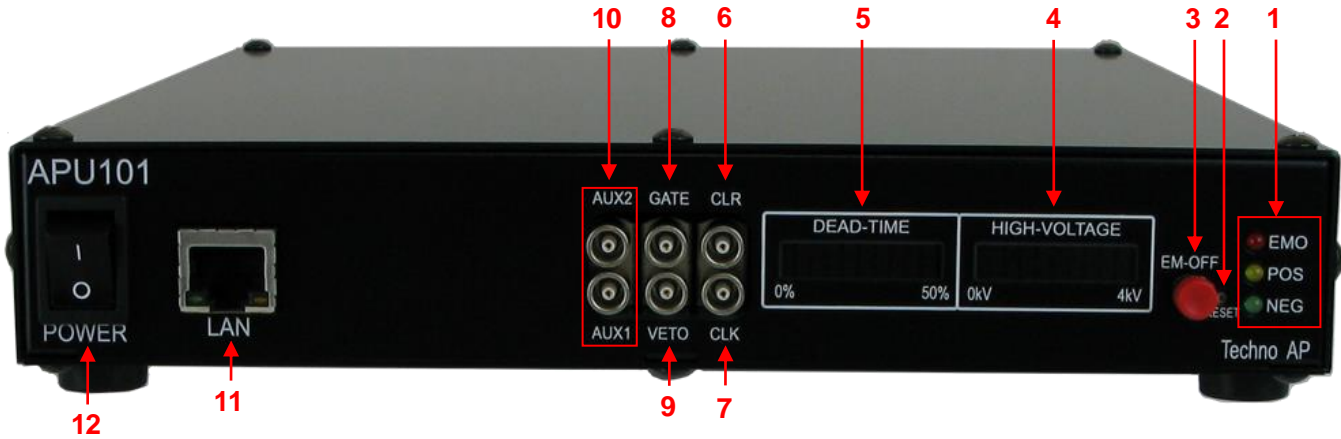


Image 1 APU101 Front

1. LED
EMO (red) Lights during emergency.
POS (orange) Lights when the HV is positive.
NEG (green) Lights when the HV is negative.

If both POS and NEG are off, it is in the high-Z state. It blinks long when stepping up, blinks shortly when stepping down, and lights up when the set voltage is reached.
2. RESET
This button is for restoring the Ethernet connection when communication is lost. Used when Ethernet reconnection (link-up processing) is required in terms of hardware.
3. EMERGENCY
It is an emergency HV stop button. It is provided for emergencies such as when communication with the PC becomes impossible.

If you want to turn off the high voltage in an emergency, press and hold for 3 seconds or longer. The voltage is stepped down according to the sweep voltage rate (V / min.). If all the HV LEDs are turned off, you can confirm that the high voltage has dropped to 400V or less.

If you want to cancel the emergency state, exit the application when the high voltage is sufficiently low → turn off the power of the main unit → wait for 1 minute or more → turn on the power → start the application.
4. HIGH-VOLTAGE
Monitor for high voltage. Ignore the polarity and use 400V / LED. Each LED lights up approximately every 400V.
5. DEAD-TIME
Monitor for dead-time. 5 % / LED
6. CLR
* Unused
LEMO 00.250 compatible connector for external signal (LVTTTL signal) input.
7. CLK
* Unused
8. GATE
LEMO 00.250 compatible connector for external gate signal input. Input an LVTTTL or TTL signal. Enables data acquisition while input is High.
9. VETO
LEMO 00.250 compatible connector for external VETO signal input. Input an LVTTTL or TTL signal. Disables data acquisition during High.
10. AUX1, AUX2
* Unused
External signal for expansion LEMO 00.250 compatible connector

11. LAN RJ45 connector for connecting an Ethernet cable.
The factory IP address is 192.168.10.128.
12. POWER This is the main power switch of this device.
The "O" side is OFF and the "I" side is ON.
*** Do not switch during high voltage power output. It may cause a malfunction of this device and connected devices.**



Image 2 APU101 Back

13. DC-IN It is a power input plug. Connect the included AC adapter. As shown in the figure below, attach the attached connector disconnection prevention device.

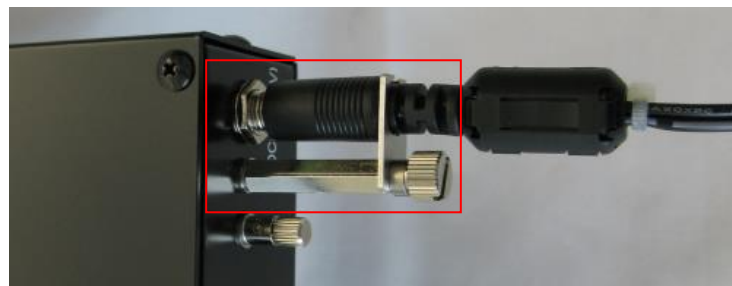


Image 3 Connector dropout prevention device

14. F.G If you cannot use a grounded outlet, or if the ground is weak, connect a ground wire to this terminal.
15. POWER Dsub 9-pin connector for preamplifier power supply.
It supplies ± 12 V and ± 24 V by pin allocation conforming to NIM standard.
16. MONI BNC connector for filtered waveform output.
The voltage range that can be output is ± 1 V at the end of 1 M Ω
17. INPUT BNC connector for preamplifier output signal input.
The voltage range that can be input is ± 1 V.
Input impedance is about 1 k Ω .
18. HV-OUT SHV connector for high voltage output.
Output impedance is about 200k Ω .

*** Never connect or disconnect the cable during high voltage output or when the power is on, as it may damage not only this device but also the detector side.**
19. HV-SHTD LEMO connector for detector bias shutdown signal input.
Input up to ± 24 V is possible.
Input impedance is about 13 k.

Introduction of conversion adapters and conversion cables

LEMO EPL.00.250.NTN and the same shape are used for the signal input connector to this device.

When using a BNC connector cable, it is possible to connect to this device by using the following conversion adapter.

Manufacturer: Huber & Suhner

Manufacturer model: 33_QLA-BNC-01-1/1--_NE

Description: QLA-01 to BNC

Connector Gender 1: QLA-01

Connector Gender 2: BNC



Image 4 33_QLA-BNC-01-1/1--_NE

If it interferes when using adjacent connectors, use the LEMO-BNC conversion cable as shown in the photo below.

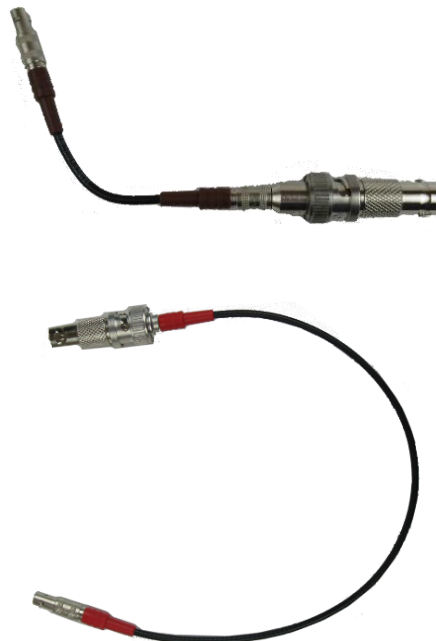


Image 5 LEMO-BNC conversion cables

4. Setup

4. 1. Application installation

This application runs on Windows. To use it, you need to install the execution format ".exe." File of this application and the LabVIEW run-time engine of National Instruments Co., Ltd. on your PC.

Install this application using the installer included in the attached CD. The installer includes an executable ".exe." File and the LabVIEW engine, which can be installed at the same time. The installation procedure is as follows.

1. Log in to Windows with administrator privileges.
2. Execute "setup.exe" in the Application or Installer folder on the attached CD-ROM.
Proceed with the installation interactively.
The default installation destination is "C: \ TechnoAP".
In this folder, the executable file ".exe" of this application and the configuration file ".ini" in which the setting values are saved are installed.
3. Execute Start button → TechnoAP → APP101

To uninstall, select this application from Add / Remove Programs and delete it.

4. 2. High-voltage power supply polarity check and change method

Before using, check the polarity of the high-voltage power supply required for the target detector and the output polarity of the high-voltage power supply of this device.

CAUTION

Never apply high voltage power with polarities that differ from the detector specifications.

It may cause a malfunction of the detector and this device.

1. Check if the polarity of the high voltage power supply supplied to the detector is + (plus) or - (minus).
2. Check the polarity of the current high voltage power supply of this device.
First, with the power turned off, **disconnect all cables except the AC adapter cable.**
3. Turn on the power of this device. Check that the POS or NEG LED on the front panel is lit.
In the case of POS, it indicates that the output is positive, and in the case of NEG, it indicates that the output is negative.
4. If the polarities of the high-voltage power supply of the detector and this device are different, change the polarity

according to the specifications of the detector from this application by the following procedure. For details, refer to the explanation of the HV tab below.

5. In "HV output polarity" in "advanced tab" in "HV tab", select the same polarity as the detector from the pull-down menu "HV output polarity" and press the "set polarity parameter" button.
It will be displayed → Exit this application → Turn off the power of this device → Turn on the power of this device after waiting for 1 minute or more → Start this application → Click "HV output polarity" in the HV tab of this application screen again to the current Check the output polarity.

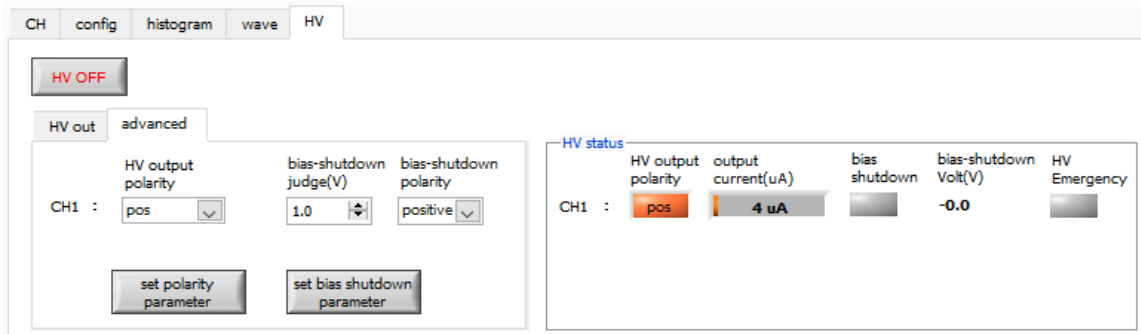


Figure 1 HV tab

4. 3. Cable connection

The basic cable connection diagram required for measurement with this device is shown below.

For this work, connect with the connection diagram and the following procedure with **all power turned off**.

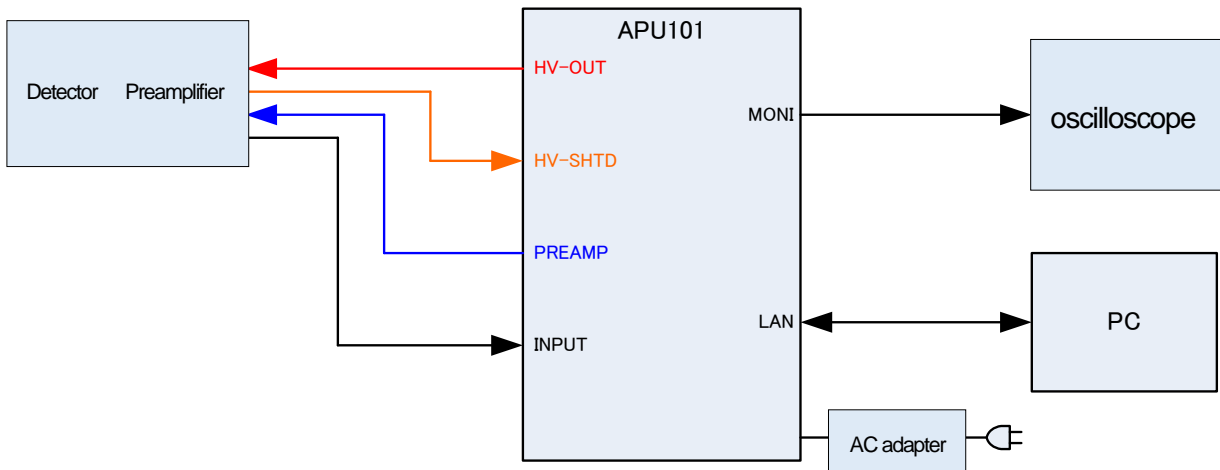


Figure 2 Connection diagram

1. Make sure that the power of this device is turned off.
2. As explained in the previous chapter, after confirming that the polarities of the high-voltage power supply of this device and the detector match, the HV-OUT output terminal (SHV connector) on the back panel and the high-voltage power supply on the detector side are used. Connect the SHV connector with a high voltage power cable.

3. Connect the POWER output terminal (D-sub 9-pin connector) on the back panel and the power connector for the preamplifier on the detector side with a cable.
4. Connect the INPUT input terminal (BNC connector) on the back panel and the preamplifier output signal on the detector side with a cable.
5. Connect the LAN connector on the front panel and the LAN connector on the PC side with a LAN cable.
6. Connect the DC-IN terminal to the rounded connector on the tip of the included AC adapter.

* Please do the following as needed.

1. Connect the MONI output terminal on the back panel and the oscilloscope with a cable.
* The oscilloscope is not essential for every measurement, but it is convenient to have it during adjustment work (necessary to fully demonstrate the performance of this device and the target detector).
2. Connect the HV-SHTD input terminal and the detector bias shutdown connector with a cable.
See the HV tab below for how to set the bias shutdown.

4. 4. Network setup

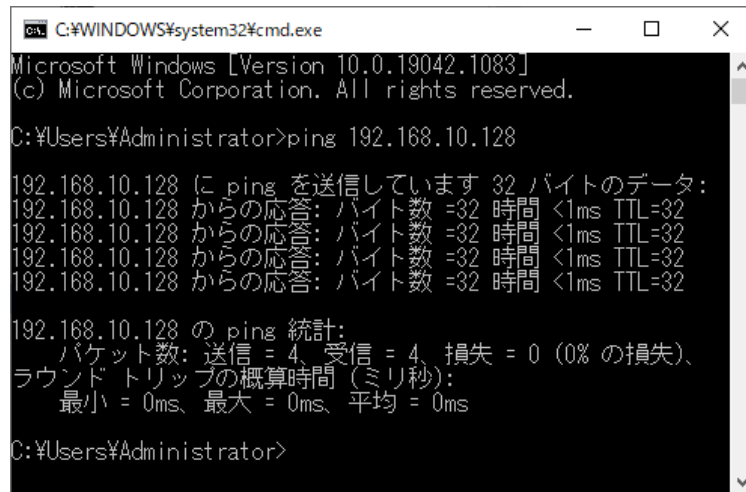
Follow the procedure below to check the communication status between this device and this application.

1. Turn on the power of the PC and change the network information of the PC

IP address	192.168.10.2	* Addresses other than those assigned to this device.
Subnet mask	255.255.255.0	
Default gateway	192.168.10.1	
2. Turn on the power.
Wait about 10 seconds after turning on the power.
3. Check the communication status between the PC and this device.
Execute the ping command at the Windows command prompt to check if the device and the PC can be connected.
The IP address of this device is on the back of the unit.
The network information of this device at the time of shipment from the factory is as follows.

IP address	192.168.10.128
Subnet mask	255.255.255.0
Default gateway	192.168.10.1

> ping 192.168.10.128



```
C:\WINDOWS\system32\cmd.exe
Microsoft Windows [Version 10.0.19042.1083]
(c) Microsoft Corporation. All rights reserved.

C:\Users\Administrator>ping 192.168.10.128

192.168.10.128 に ping を送信しています 32 バイトのデータ:
192.168.10.128 からの応答: バイト数 =32 時間 <1ms TTL=32
192.168.10.128 からの応答: バイト数 =32 時間 <1ms TTL=32
192.168.10.128 からの応答: バイト数 =32 時間 <1ms TTL=32
192.168.10.128 からの応答: バイト数 =32 時間 <1ms TTL=32

192.168.10.128 の ping 統計:
    パケット数: 送信 = 4、受信 = 4、損失 = 0 (0% の損失)、
ラウンド トリップの概算時間 (ミリ秒):
    最小 = 0ms、最大 = 0ms、平均 = 0ms

C:\Users\Administrator>
```

Figure 3 Communication connection confirmation, ping command execution

4. Start this application. Search for and launch APP101 from the shortcut icon APP101 or Windows button on your desktop.
If an error message indicating that the connection to this device failed is displayed when you start this application, refer to the troubleshooting below.

5. Application screen

5. 1. Startup screen

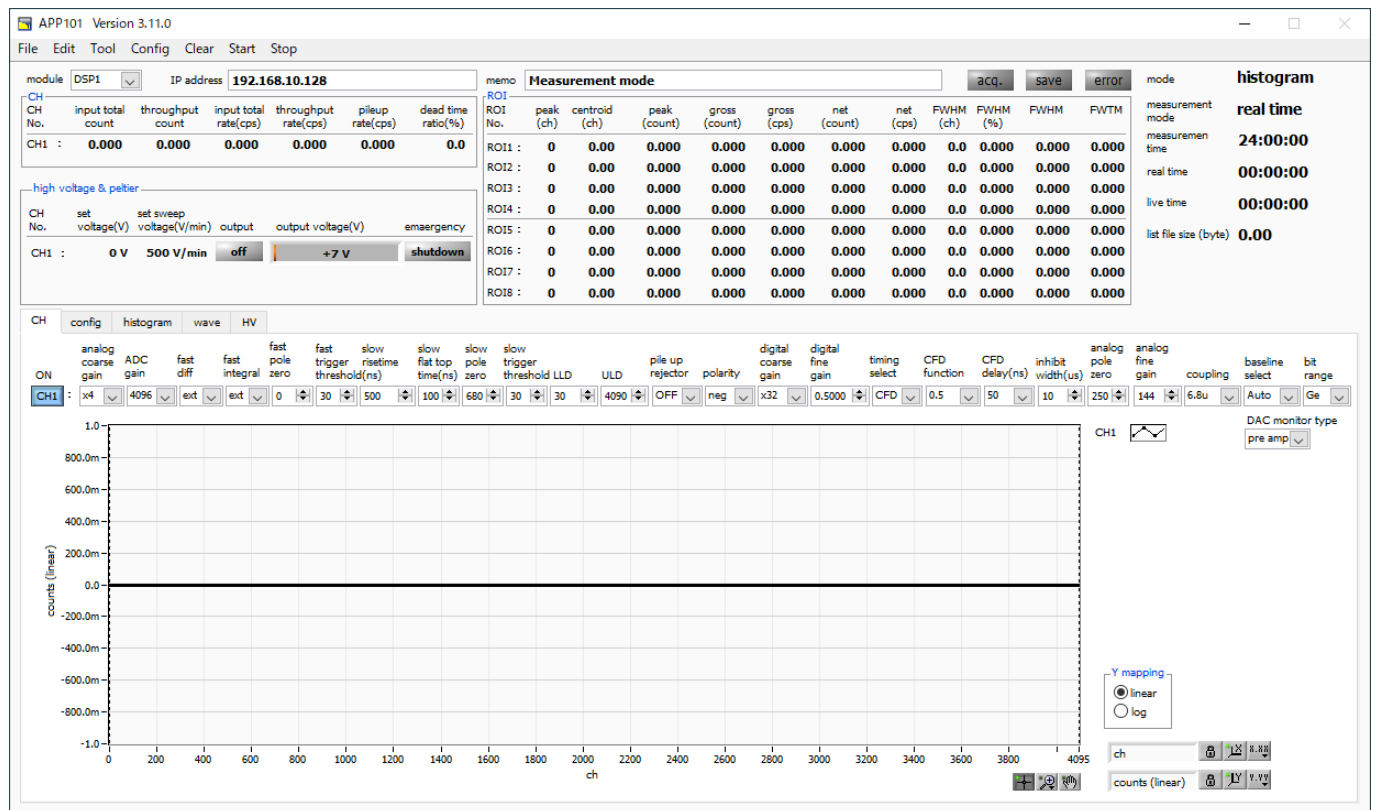


Figure 4 Startup screen

* Images may differ depending on option configuration and updates

Menu

File - open config	Read the configuration file
File - open histogram	Read histogram data file
File - save config	Save the current settings to a file
File - save histogram	Save the current histogram data to a CSV file
File - save image	Save screen capture image to file, PNG format
File - quit	End of this application
Edit - IP configuration	IP address setting
Tool - gauss fit analysis	Gauss fit screen display. Performs Gaussian fitting on the specified peak and performs half-value width analysis.
Tool - peak search analysis	Peak search screen display. Perform peak detection on histogram data and perform half-value width analysis.
Config	Send all settings to this device
Clear	Initialize the histogram data and real time of this device
Start	Send measurement start to this device
Stop	Send measurement stop to this device

Tab

CH	Settings related to CH in the DSP of this device
config	Settings related to the measurement operation and measurement time of this device
histogram	ROI, "Region Of Interest" and energy calibration settings
wave	Waveform display in wave mode, settings related to display
HV	Settings related to high voltage of this device

Other than tab

module	Used to select the device to be controlled when using multiple devices
IP address	IP address of this device
memo	Optional text box. Used for measurement data management.
acq. LED	Blinks during measurement
save LED	Lights when saving data
error LED	Lights when an error occurs
mode	mode. Display the setting status of operation mode such as histogram
measurement mode	Measurement mode. Show real time or live time
measurement time	Set measurement time
real time	Actual measurement time
live time	Effective measurement time
list file size (byte)	The size of the saved list file

CH section

input total count	Total count. Number of input events
throughput count	Throughput count. Number processed for input
input total rate (cps)	Count rate. Number of events entered per second
throughput rate (cps)	Throughput count rate. Number processed for 1 second of input
pileup rate (cps)	Pile up count rate. Pile-up count per second
dead time ratio (%)	Percentage of dead time (%)

high voltage section

set voltage (V)	Output voltage set for this device
set sweep voltage (V / min.)	1-minute output sweep voltage (V / min.) set for this device
output LED	"On" is displayed and lit when the output voltage is 30 V or higher. Displayed and blinks when sweeping. "Off" is displayed and turned off while output is stopped.
output voltage (V)	Shows polarity and voltage monitor value during output. Monitor voltage has an error of \pm about 1 % * Since the output voltage is load-dependent, the set voltage and monitor voltage may not match.
emergency LED	Lights up when there is an abnormality related to the HV, such as when the bias shutdown state or the emergency stop button is pressed.

ROI section

peak (ch)	Maximum count ch
centroid (ch)	Median value (ch) calculated from the sum of counts
peak (count)	Maximum count
gross (count)	Sum of counts between ROIs
gross (cps)	Sum of counts between ROIs per second
net (count)	Sum of counts minus background between ROIs
net (cps)	Sum of counts minus background between ROIs per second
FWHM (ch)	Half width (ch)
FWHM (%)	Half width ÷ ROI set energy x 100 (%)
FWHM (Arbitrary)	Half width. Refer to the calculation method of full width at half maximum (FWHM) described later. The unit depends on the state of energy calibration.
FWTM (Arbitrary)	1/10 width. The width at half maximum is 1/10 (the base of the peak) from the peak, while the half width is half the position of the peak. The unit depends on the state of energy calibration.

5. 2. CH tab

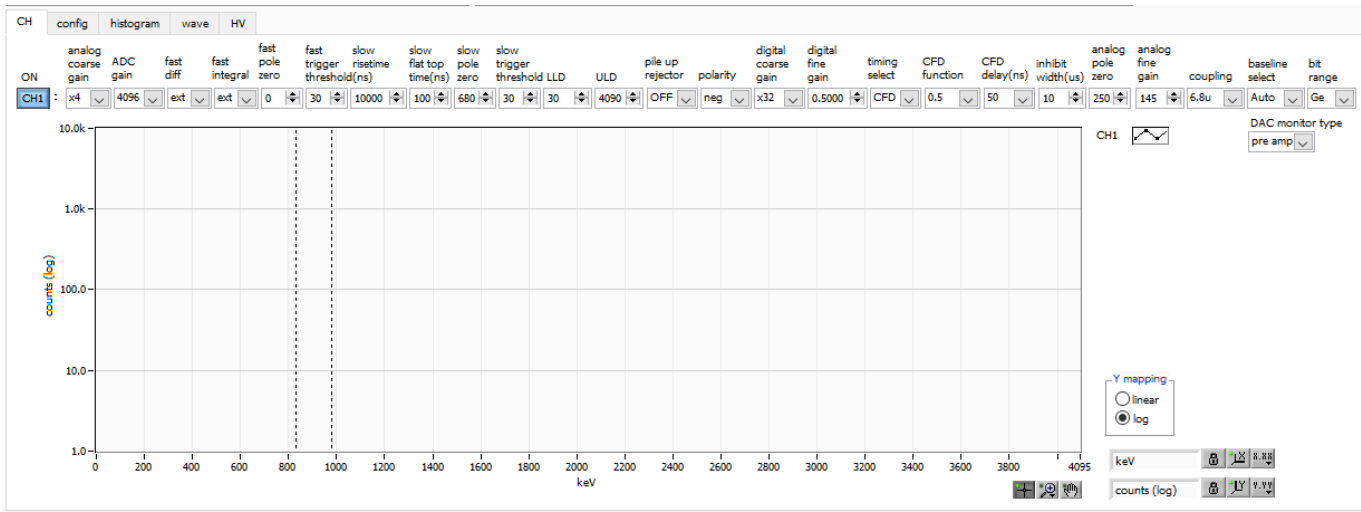


Figure 5 CH tab

ON	CH availability
analog coarse gain	Analog course gain. Select from 1x, 4x, 10x, and 20x. The captured preamplifier output signal is amplified internally.
ADC gain	ADC gain (channel). Select from 8192, 4096, 2048, 1024, 512, 256 channels (ch). The value will be the number of divisions on the horizontal axis of the histogram graph.
fast diff	FAST Differentiator constant. Choose from ext (exclude, no filter), 20, 50, 100, 200. For detectors with a fast rise, select ext or 20. For Ge semiconductor detectors, set 100 or 200.
fast integral	FAST Integrator circuit constants. Choose from ext (exclude, no filter), 20, 50, 100, 200. For detectors with a fast rise, select ext or 20. For Ge semiconductor detectors, set 100 or 200.
fast pole zero	FAST pole zero cancel setting. The setting range is 0 to 8192. 0 is an automatic setting.
fast trigger threshold	Threshold value for the start of waveform acquisition using the FAST filter. The unit is digit.

The setting range is 0 to 8191.

The default setting is 50 digits.

Based on the captured preamplifier output signal, the FAST filter waveform that has been differentiated and integrated in the timing filter amplifier circuit is generated.

When the waveform exceeds this threshold value, the time information acquisition timing at that time and the waveform generation start timing in the spectroscopy amplifier circuit are acquired.

It is mainly related to time acquisition (time stamp).

If this threshold is too small, it will be easier to detect noise and the input total rate (cps) will increase.

While looking at the input total rate (cps), set it several digits higher than the boundary of the noise level where the numerical value increases extremely.

slow risetime (ns)

SLOW filter rise time.

It is the rise time to reach the upper bottom of the SLOW (trapezoidal) filter in the figure below.

Shorter values tend to result in poorer energy resolution but higher throughput, and longer values tend to result in better energy resolution but lower throughput.

Since the peaking time of a linear amplifier is often 2.0 to 2.4 x time constant, the same resolution is shown with a rise time of about twice the time constant of a linear amplifier.

The default setting is 6000 ns.

This corresponds to the shaping time of 3 μ s for a linear amplifier.

slow flat top time (ns)

Flat top time for SLOW filters.

It is the time of the upper bottom part of the SLOW (trapezoidal) filter in the figure below.

The error of the peak value due to the variation of the rising edge (falling edge) of the preamplifier output signal is adjusted by the length of the upper base of the trapezoid.

The set value is 0 to 100 % of the rise (fall) time of the preamplifier output signal, which is twice the slowest time as a guide.

The default setting is 700 ns.

In this case, the slowest rise (fall) time is assumed to be 350 ns.

*** DSP throughput formula: (slow rise time + slow flattoptime) \times 1.25**

slow pole zero

SLOW pole zero cancellation.

The falling undershoot or overshoot of the SLOW filter can be mitigated by setting this value appropriately.

The default setting is 680.

This value varies depending on the detector, so connect the MONI terminal on the front panel and the oscilloscope, select the SLOW filter as the type of DAC monitor, and adjust so that the falling part of the SLOW filter is flat.

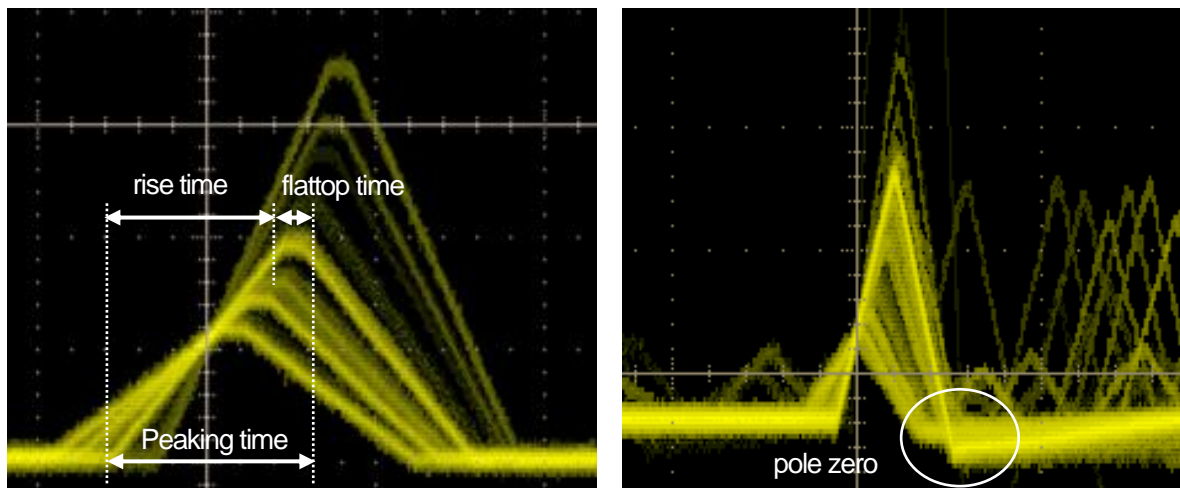


Figure 6 SLOW (trapezoidal) filter

* The figure on the right is an example where the SLOW filter has an undershoot and pole zero is not suitable. In this case, lowering the slow pole zero value below the current setting will raise the undershoot to the top.

slow trigger threshold	<p>Slow Filter waveform acquisition start timing threshold.</p> <p>The unit is digit.</p> <p>The setting range is 0 to 8191.</p> <p>The default setting is 50 digits.</p> <p>Raise or lower this value and set it about 10 digits above the noise level where the throughput rate (cps) is increasing. Set below LLD described later.</p> <p>In the generated SLOW filter waveform, when it exceeds this threshold value, the peak value at the preset time (slow rise time + slow flattop time) is secured.</p>
LLD	<p>Energy LLD, Lower-Level-Discriminator.</p> <p>The unit is ch.</p> <p>ch below this threshold are not counted.</p> <p>Set to a value greater than or equal to the show trigger threshold and less than ULD.</p>
ULD	<p>Energy ULD, Upper-Level-Discriminator.</p> <p>The unit is ch.</p> <p>ch above this threshold are not counted.</p> <p>Set to a value greater than LLD and less than ADC gain.</p>

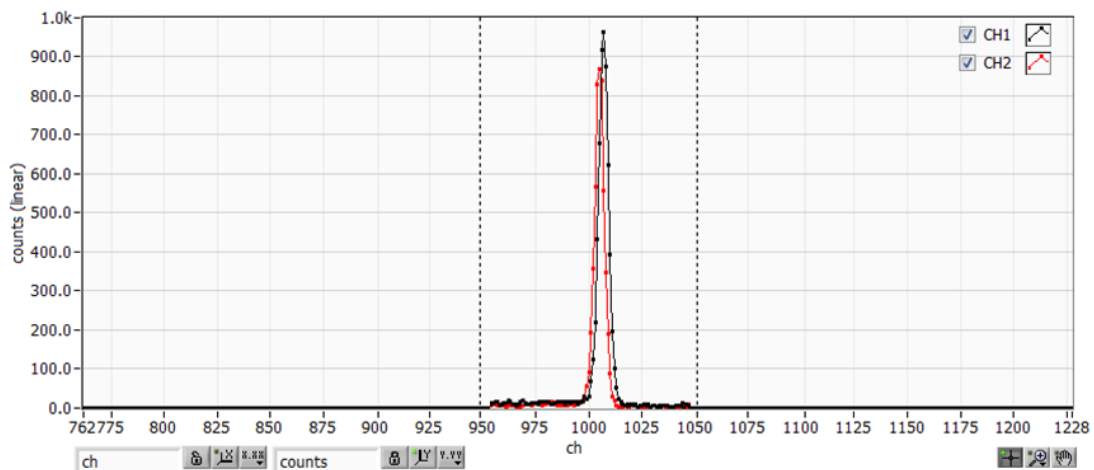


Figure 7 Setting Example of LLD and ULD

* The above figure is an example of setting LLD to 955 and ULD to 1045.

The part smaller than LLD and the part larger than ULD are not measured.

pile up rejector

Whether to use pile up reject.

Valid when ON is selected.

As shown in the figure below, the two pulses generated before the rising time of the waveform-shaped signal will overlap the waveforms and will have different values from the actual peak value.

Under high count, there will be a large amount of background noise.

Pile up rejects to exclude this event by digital signal processing.

The target time is $(\text{risetime} + \text{flattoptime}) \times 1.25$, and if there are two events during this time, it will be rejected.

As the number of pile up rejects increases, the difference becomes larger because the throughput count becomes 0 while there are multiple input counts.

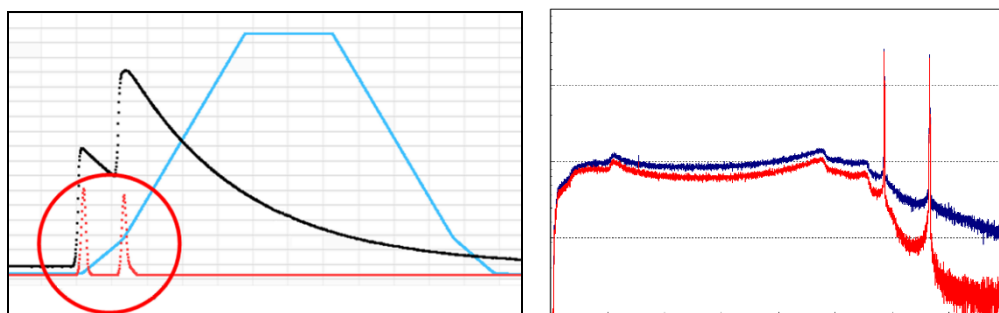


Figure 8 LEFT: pile-up event, RIGHT: Blue is reject invalid, Red is reject valid

polarity	<p>The polarity of the input preamplifier output signal.</p> <p>“pos” is positive, “neg” is negative.</p>
digital coarse gain	<p>Digitally select the gain from 1x, 2x, 4x, 8x, 16x, 32x, 64x, and 128x.</p> <p>For trapezoidal filters, the integrating circuit is calculated by a multiply-accumulate operation.</p> <p>The larger the slow rise time, the greater the number of multiply-accumulate operations and the larger the value, and the smaller the value, the smaller the value.</p> <p>This value becomes the value of the SLOW filter as it is, so it needs to be corrected.</p> <p>Used in conjunction with the slow rise time setting.</p>
digital fine gain	<p>Set the fine gain digitally.</p> <p>The setting range is 0.3333 to 1 time.</p> <p>It is used for correction as well as digital coarse gain.</p> <p>Since the peak value of the SLOW filter changes depending on the settings of digital coarse gain and digital fine gain, it can be used to adjust the peak position of the resulting histogram.</p>
timing select	<p>Select the timing acquisition method from LET (Leading Edge Timing) or CFD (Constant Fraction Discriminator Timing) to determine the time (time stamp) when the event was detected.</p>

LET: Leading-Edge-Timing

It is the timing when a certain trigger level "t" is reached. The trigger acquisition timing will be different if the rising slope changes like **a'** and **b'**.

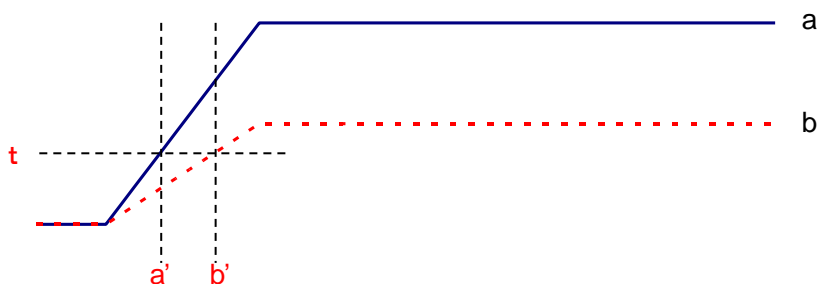


Figure 9 View of Leading-Edge-Timing

CFD, Constant-Fraction-Discriminator Timing

For the different preamp waveforms, a and b in the figure below, the following waveforms c, d and e, f and g, h are generated.

Waveform c, d: Waveforms a and b multiplied by CFD function and inverted

Waveform e, f: Waveforms a and b delayed by CFD delay

Waveform g, h: Waveforms with c and e added and waveforms with d and f added

The CFD, which is the zero-cross timing of the waveforms g and h, is constant even if the wave height changes if the rising start time of the waveform is the same.

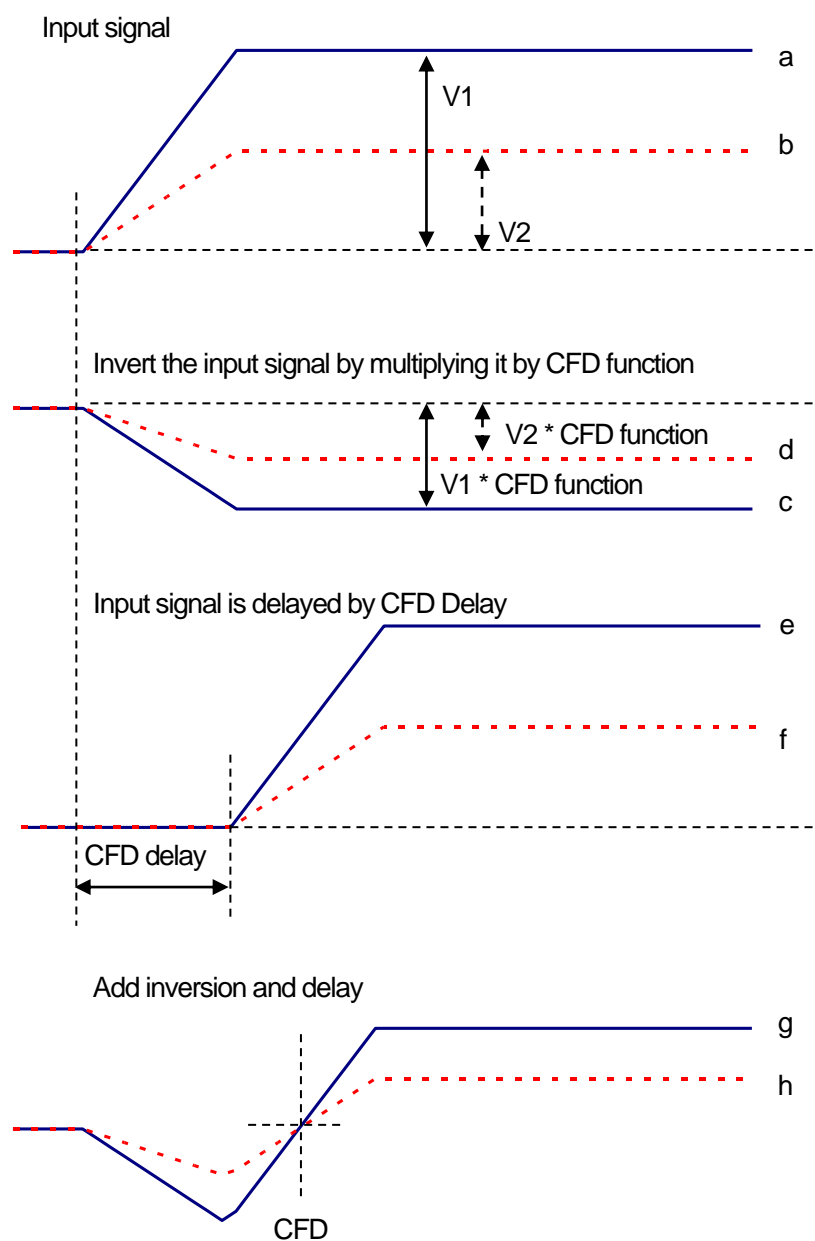


Figure 10 View of Constant-Fraction-Discriminator Timing

CFD function	<p>Magnification for reducing the original waveform for CFD calculation.</p> <p>Choose from 0.125, 0.25, 0.375, 0.5, 0.625, 0.75, 0.875.</p> <p>The default is 0.25 to 0.625 times.</p>
CFD delay	<p>Select the time to delay the original waveform for CFD calculation from 10, 20, 30, 40, 50, 60, 70, 80 ns.</p> <p>The default is 50 - 80 ns</p>
inhibit width (μs)	<p>Dead-time width from reset detection for transistor reset type preamplifier.</p> <p>It processes internally without inputting the inhibit signal from the detector and does not count during this time.</p>
analog pole zero	<p>Analog pole zero.</p> <p>The input preamplifier output signal is internally differentiated, and settings are made to correct the overshoot and undershoot of the falling part of the signal.</p> <p>The setting range is 0 to 255.</p>
analog fine gain	<p>Analog fine gain adjustment.</p> <p>The setting range is 0 to 255.</p> <p>Equivalent to x 0.1 to x 1.5.</p>
coupling	<p>Shaped type.</p> <p>Select from 6.8 us, 2.2 us, DC, 6.8 us (ex RC), 2.2 us (ex RC)</p> <p>6.8 us For resistance feedback type preamplifier, Standard</p> <p>2.2 us For resistance feedback type preamplifier, High counting</p> <p>DC No coupling</p>
baseline select	<p>Baseline processing settings</p> <p>Auto Automatic (default)</p> <p>High Automatic setting for baseline stabilization at high count</p>
bit range	<p>Settings related to arithmetic bit processing of the SLOW filter.</p> <p>Ge For Ge semiconductor detectors, mainly for resistance feedback type preamplifiers.</p> <p>SDD For Si Drift Detectors, mainly for transistor reset type preamplifiers.</p>

DAC monitor type	<p>Select the waveform of the DAC output.</p> <p>The waveform signal of the selected type in the waveform processed inside the DSP is output from the MONI pin.</p> <p>By viewing this signal on an oscilloscope, you can check the processing status inside the DSP.</p>
preamp	<p>A signal obtained by differentiating the preamplifier signal.</p> <p>It is used for checking whether the energy range to be measured is within 1 V and adjusting the analog pole zero when it is taken inside.</p>
fast	<p>FAST filter signal</p>
slow	<p>SLOW filter signal.</p> <p>Used for pole zero adjustment after waveform shaping processing.</p>
CFD	<p>CFD signal.</p> <p>Check the setting status of CFD delay and function when using CFD timing.</p>

5. 3. config tab

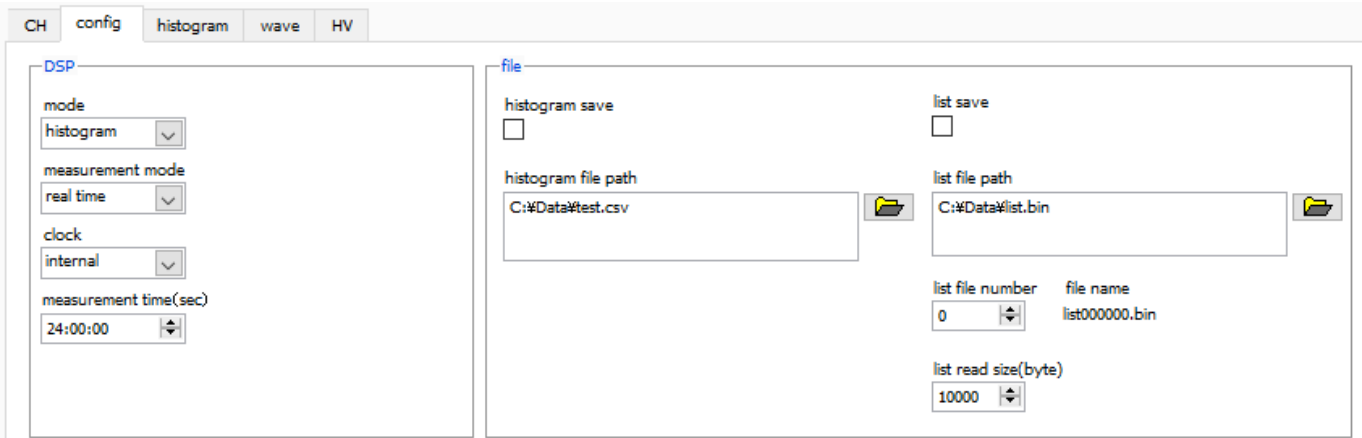


Figure 11 config tab

DSP section

mode	Data processing selection
histogram	Histogram mode stores the peak value of the preamplifier signal in a maximum of 8192ch and creates a histogram.
list	This mode uses the time stamp, peak value, and CH number of the preamplifier signal as one event data, and continuously transfers the data to the PC.
wave	Acquires preamp, fast, slow, and CFD waveforms that have been internally processed based on the preamplifier output signal.
measurement time	Measurement time setting. The setting range is from 00:00:00 to 781:00:00

file section

histogram save	Save the histogram data to a file at the end of measurement.
histogram file path	Set the absolute path of the histogram data file. Can be set without extension.

CAUTION
It will not be saved with this file name.

Based on this file name, it will be in the following format.
Example: Set the histogram file path to C: ¥ Data ¥ histogram.csv,
and if the date and time is September 1, 2014, 12:00:00,
save the data as C: ¥ Data ¥ histogram_20140901_120000.csv.

list save	Set whether to save the list data to a file. Valid only when list mode is selected
list file path	Set the absolute path of the list data file. Can be set without extension.
list file number	Set the starting number of the number that cannot be used in the list data file. The configurable range is from 0 to 999999.
file name	Set the absolute path of the list data file Can be set without extension.

CAUTION

It will not be saved with this file name.

Based on this file name, it will be in the following format.

Example: If the list file path is set to C: ¥ Data ¥ list_.bin

and the list file number described later is 0,

data saving will start with the file name C: ¥ Data ¥ list_000000.bin.

list read size (byte)	Minimum read data length in list mode. The unit is Byte. Normally set to 10000. When the count rate is high, it is set to 20000Byte so that many events can be received on the PC side. Decrease the setting at low count rates to allow a smaller number of events to be received.
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5. 4. histogram tab

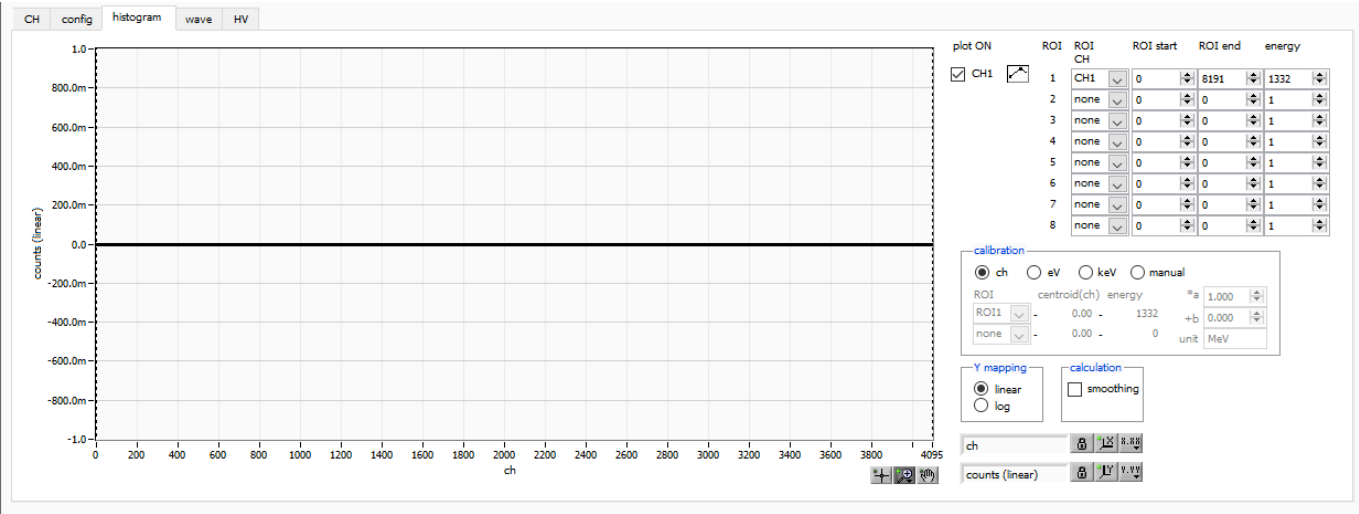


Figure 12 histogram tab

Graph	<p>Histogram graph.</p> <p>When history is selected in mode in the config tab, the energy histogram is displayed during measurement.</p>
Legend checkbox	Select whether to display the histogram for each channel on the graph.
ROI CH	<p>Select the CH number to which the ROI, Region-Of-Interest is applied.</p> <p>Up to 16 ROIs can be set for one histogram.</p>
ROI start	<p>The starting position of the ROI.</p> <p>Input is the unit selected in calibration.</p>
ROI end	<p>The end position of the ROI.</p> <p>Input is the unit selected in calibration.</p>
energy	<p>Definition of the energy value of the peak position (ch).</p> <p>For Co-60, set to 1173 or 1332 (keV).</p> <p>When ch is selected in calibration described later, the peak between ROIs is detected, keV / ch is calculated from the peak position (ch) and the set energy value, and it is applied to the calculation result of half width.</p>
calibration	<p>The unit of the X axis.</p> <p>The X-axis label will change with the settings.</p>
ch	<p>Channel unit display.</p> <p>Units such as FWHM of ROI FWTM are arbitrary.</p>

eV	<p>eV unit display.</p> <p>By two-point calibration of two types of peaks (center value) and energy value in one histogram, the slope a and intercept b of the linear function $y = ax + b$ are calculated and set on the X axis so that ch becomes eV. increase. The unit such as FWHM of FWTM of ROI is eV.</p>
keV	<p>KeV unit display.</p> <p>By two-point calibration of two types of peaks (center value) and energy value in one histogram, the slope "a" and intercept "b" of the linear function "$y = ax + b$" are calculated so that ch becomes keV. Set the value you have set to the X-axis. The unit such as FWHM of FWTM of ROI is keV.</p> <p>Example: If 5717.9 ch has 1173.24 keV of Co-60 and 6498.7 ch has 1332.5 keV of Co-60, "a" is automatically calculated as 0.20397 and "b" is 6.958297 from 2-point calibration.</p>
manual	<p>Arbitrarily set the slope a, intercept b, and unit label of the linear function "$y = ax + b$" and set it on the X-axis.</p> <p>The unit can be set arbitrarily.</p>
Y mapping	<p>Select a mapping for the Y-axis of the graph.</p> <p>The Y-axis label will change with the settings.</p> <p>linear Linear</p> <p>log Logarithm</p>
smoothing	It is a smoothing function to calculate the half width when there are few statistics.
X axis calibration	Select the unit for the X axis.
Y axis calibration	Select the unit of Y-axis.
X-axis range	<p>Right-click on the X-axis and select "Auto Scale" to set it to auto scale.</p> <p>If unchecked, it will no longer be autoscaled and the X-axis minimum and maximum values will be fixed. If you want to change the minimum or maximum value, you can change it by placing the mouse pointer on the number you want to change and then clicking or double-clicking and then entering the value.</p>
Y-axis range	<p>Right-click on the Y-axis and select "Auto Scale" to set it to auto scale.</p> <p>If unchecked, it will no longer be autoscaled and the Y-axis minimum and maximum values will be fixed. If you want to change the minimum or maximum value, you can change it by placing the mouse pointer on the number you want to change and then clicking or double-clicking and then entering the value</p>



Cursor movement tool.
When setting the ROI, you can move the cursor on the graph by dragging it with the mouse.



Zoom.
Click to select and execute the following 6 types of zoom-in and zoom-out.



Phan tool.
Grab the plot and move on the graph

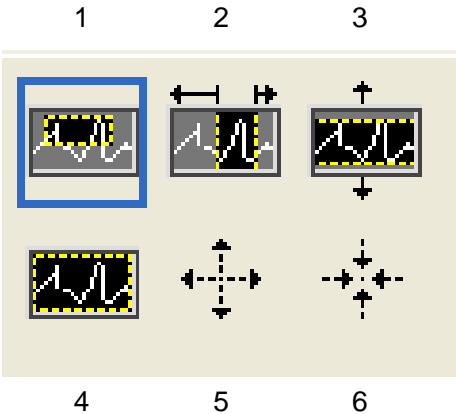


Figure 13 Graph, zoom-in and zoom-out tools

- | | | |
|----|---------------------------|--|
| 1. | Rectangle | Use this feature to click a point on the display that you want to be the corner of the zoom area and drag the tool until the rectangle occupies the zoom area. |
| 2. | X-zoom | Zoom in on the area of the graph along the X axis |
| 3. | Y-zoom | Zoom in on the area of the graph along the Y axis |
| 4. | Fit zoom | Automatic scale of all X and Y scales on the graph |
| 5. | Zoom out around the point | Click the center point you want to zoom out. |
| 6. | Zoom in around the point | Click the center point to zoom in. |

5. 5. wave tab

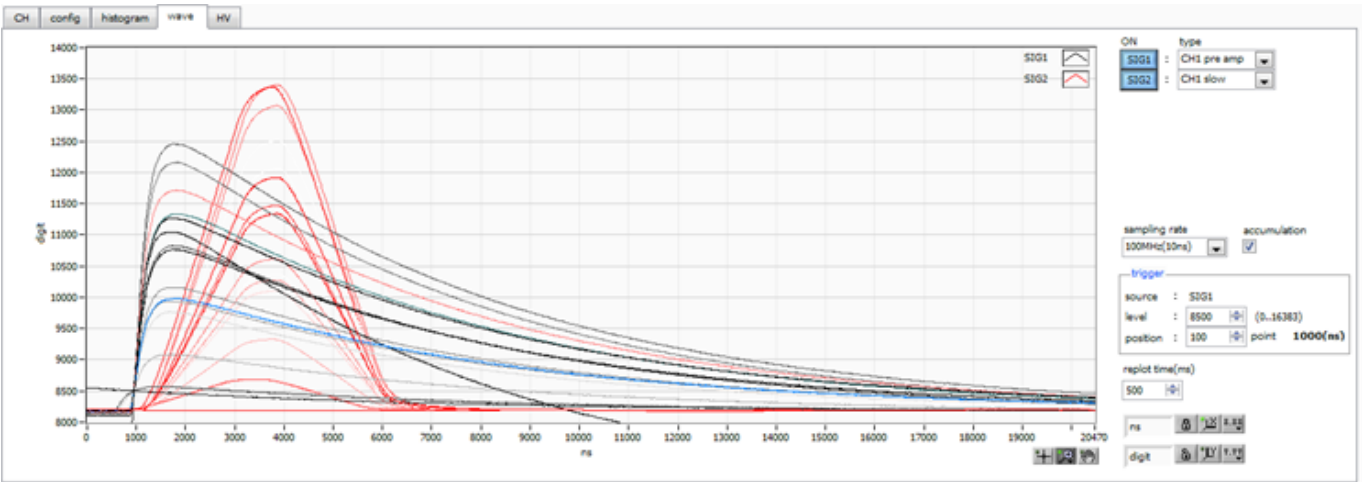


Figure 14 wave tab

Graph	Histogram graph. When histogram is selected in mode in the config tab, the waveform processed by the signal during measurement is displayed.
ON	Set whether to display the waveform.
type	Select the type of waveform to display. preamp Preamplifier signal fast FAST filter signal slow SLOW filter signal CFD CFD signal
accumulation	Enables the superposition processing of the past 16 waveform data. If it is difficult to analyze with a single waveform, turn it ON to make the waveform easier to see.
free run	Gets the waveform regardless of the trigger level.

trigger section

source	Trigger source.
level	Threshold for acquiring trigger waveform. The image is like the rising edge trigger of an oscilloscope. When this threshold is exceeded, a trigger is applied, and waveform data is acquired. When set to 0, a free-run operation (forced data acquisition in a cycle of about 1 second regardless of the threshold value) is performed, which is useful when deciding a guideline for setting the threshold value.

position	Offset score setting to the triggered point.		
	Set this when you need waveform data before the trigger is applied.		
edge	Select the rising edge or falling edge as the trigger acquisition timing.		
	neg	Falling edge	
	pos	Rising edge	

5. 6. HV tab

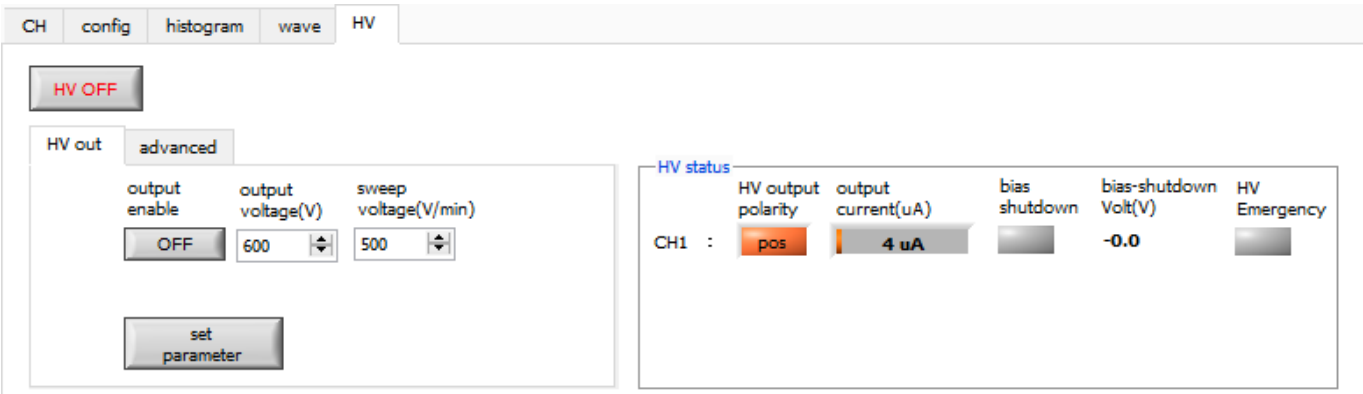


Figure 15 HV tab, HV out tab

HV OFF High voltage output OFF button.
After clicking, the voltage is stepped down at the sweep voltage (V / min.) rate.

HV out tab section

- output enable** High voltage output ON / OFF.
- output volgate (V)** High voltage output value setting.
Input in absolute value regardless of polarity.
The setting range is 0 to 4000 V.
- sweep voltage (V / min.)** The setting range of the step-up / step-down rate (V / min.) of the high-voltage output is 1 to 8000V / min.
- set parameter** The above high voltage related setting values are sent to this device.

HV status section

- HV output polarity** High voltage output polarity.
“pos” is positive and “neg” is negative.
- output current** Output current value (uA)
* Monitor current has an error of ± about 5 %
- Due to load dependence, the expected current value and monitor value may differ significantly when the load is light (equivalent to several tens of uA or less).

bias shutdown LED	Lights when the detector goes into a bias shutdown state. Immediately when lit, the high-voltage output is turned off at the step-down rate.
bias-shutdown volt(V)	The monitor voltage of the signal input to the HV-STHD terminal.
HV emergency LED	Lights when there is an abnormality related to the HV or when the emergency stop button is pressed. Immediately when lit, the high-voltage output is turned off at the step-down rate.

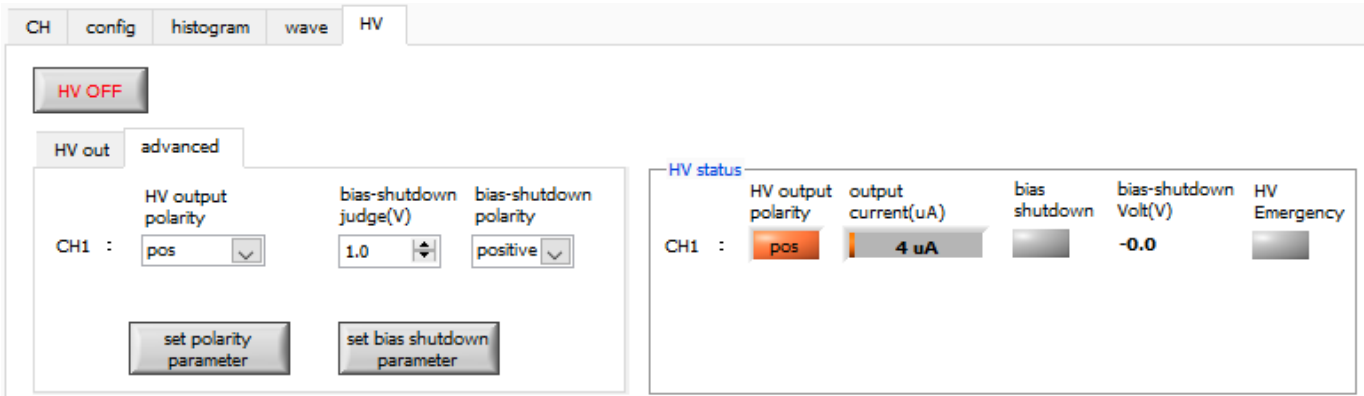


Figure 16 HV tab, advanced tab

advanced tab section

HV output polarity Select from positive, negative and high-Z.

set polarity parameter The above HV output polarity setting value is sent to this device.
 After fully checking the polarity of the HV of the detector, perform the following procedure.

1. Turn off the high voltage that is output when switching.
2. After reaching the output voltage of about several V, send the HV output polarity setting with the set polarity parameter button, and then exit this application.
3. Turn off the power of this device.
4. Then wait at least 1 minute and then turn on the power of the device to switch the polarity after a few seconds.

bias shutdown judge (V) Threshold voltage (V) for bias shutdown.

bias shutdown polarity Polarity to determine bias shutdown

set bias shutdown polarity parameter Send the above bias shutdown polarity setting to this device.
 After carefully checking the status of the normal bias shutdown signal from the detector, perform the following procedure.

1. Turn off the high voltage that is output when switching.
2. After reaching the output voltage until it reaches about several V, send the setting with the set bias shutdown polarity parameter button.

Example: When the bias shutdown signal is normal: -12 V, Shutdown: + 5 V

In this case, the threshold should be set in the range -12 V to + 5 V.

Normally, set a threshold value (for example, about -11.0 V) that is near normal and has a certain margin.

Set to positive if you want to set below the threshold when normal and above the threshold at bias shutdown.

In this example, the bias shutdown judge (V) is set to -11 V and the set bias shutdown polarity parameter is set to positive.

6. Initial setting

6. 1. Preamplifier output signal confirmation

1. Connect the preamplifier output signal to the oscilloscope and check the peak value (mV) and polarity.
In the case of a transistor reset type preamplifier, if it goes up to the right, it is positive, and if it goes down to the right, it is negative.

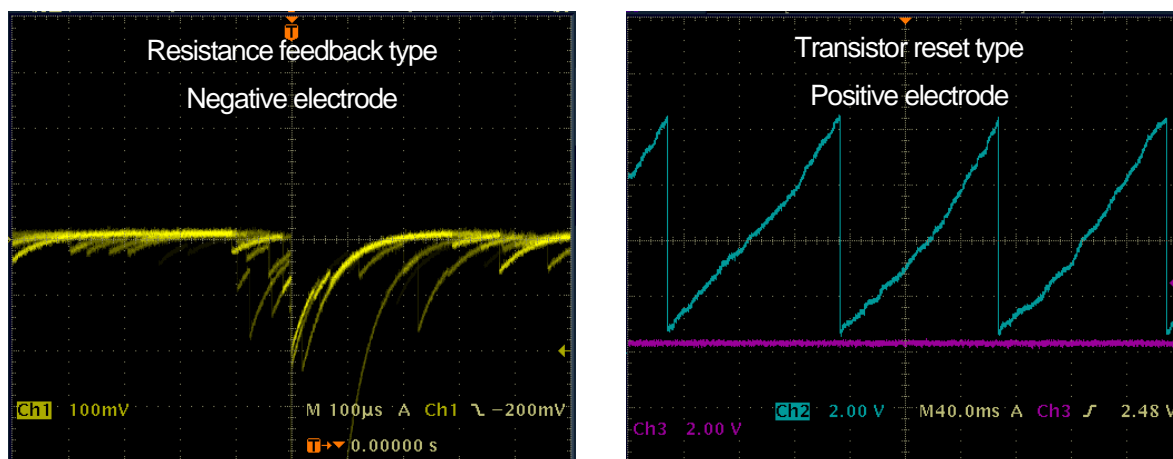


Figure 17 LEFT: Resistance feedback type Negative electrode, RIGHT: Transistor reset type for positive electrode

6. 2. Power and connection

1. Turn off the power of all devices.
2. Connect the LAN connector on the front panel and the PC with a LAN cable.
3. Turn it on when using a switching hub.
4. Turn on the power of this device.
5. Turn on the power of the PC.
6. Connect the CH1 terminal on the front panel to the preamplifier output signal.
7. Connect the MONI terminal on the front panel to the oscilloscope.

6. 3. Setting execution

1. Start this application.
2. Set the CH tab, config tab, option tab if there is an option, etc. First, set the polarity of the signal confirmed above to the polarity in the red frame in the figure so that the preamplifier output signal input to this unit can be processed properly internally.

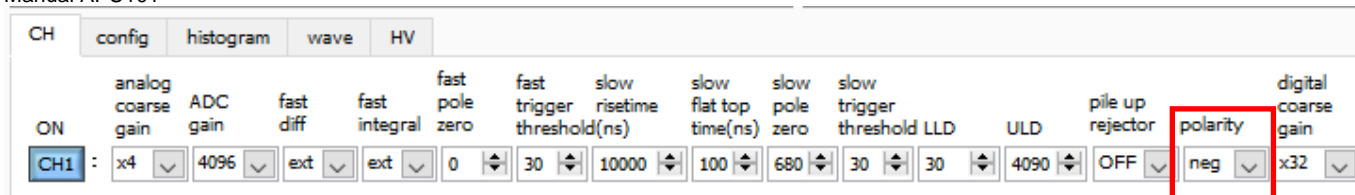


Figure 18 Example of polarity setting in CH tab

- Click the menu “config” and configure all settings.

6. 4. Analog course gain and analog pole zero adjustment of preamplifier output signal

The ultra-low noise, high-speed programmable gain amplifier can amplify the signal from the preamplifier, which requires a fast rise and low noise, with high accuracy. The analog course gain can be set by selecting from 1x, 2x, 5x, and 10x in the analog course gain in the CH tab.

The analog fine gain setting can be adjusted 0.5 to 1.5 times. Apart from the digital fine gain adjustment, the preamp signal itself is adjusted. The signal-to-noise ratio (S / N) may also be improved.

An anti-aliasing low-pass filter is placed in front of the ADC to improve S / N and eliminate aliasing noise. The cutoff frequency is set to 16 MHz.

The setting method differs depending on whether the output signal of the detector preamplifier input to this device a resistance feedback type or a reset type is.

6. 4. 1. For resistance feedback type preamplifier output signal

The preamplifier output signal is usually a signal with a decay (attenuation) of about 50 μ s to 100 μ s. The decay is too long to be processed by this device, so it cannot handle high counts. Therefore, it differentiates into a time constant that is easy to process internally. The undershoot that occurs at that time is as follows, and the overload characteristics of this device deteriorate as with the conventional analog method.

Undershoot (%) = different amplitude / preamp decay time

- Check the preamp signal obtained by differentiating the preamplifier output signal from the MONI terminal on the front panel with an oscilloscope.
- While switching the analog course gain, adjust the wave height including the energy element to be measured in the preamp signal so that it is within 1 V.
For example, when measuring up to 2000 keV of energy, if there is a checking source of Co-60, adjust the part where the overlap of 1332 keV @ Co-60 is strong to 0.666 V (1 V \div 2000 keV \times 1332 keV) or less.

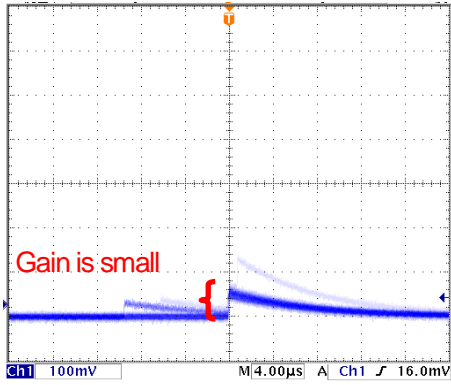


Figure 19 Before adjustment

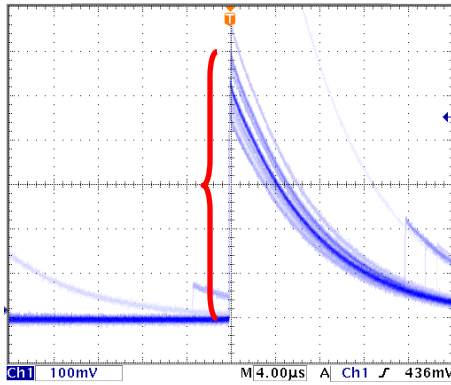


Figure 20 After adjustment

3. Change the setting of analog pole zero and adjust the pole zero so that the falling part is flat while switching the vertical and horizontal ranges of the oscilloscope.

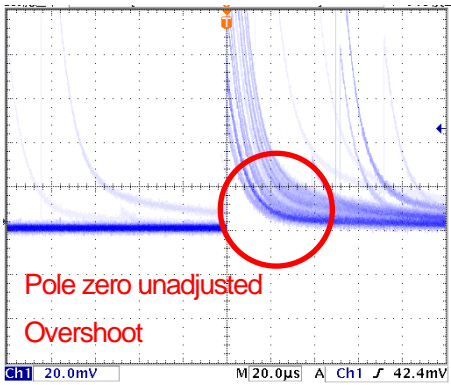


Figure 21 Overshoot , before adjustment

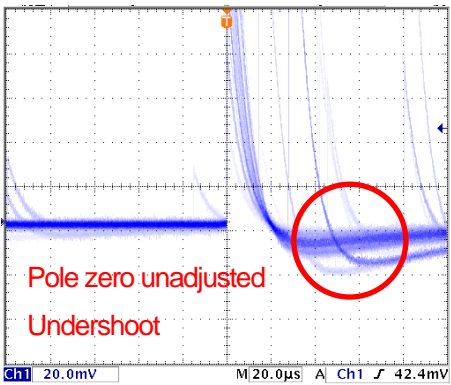


Figure 22 Undershoot, before adjustment

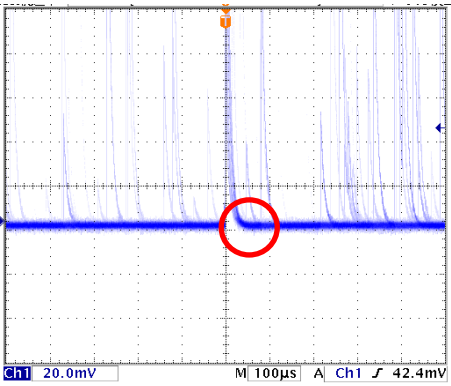


Figure 23 After adjustment

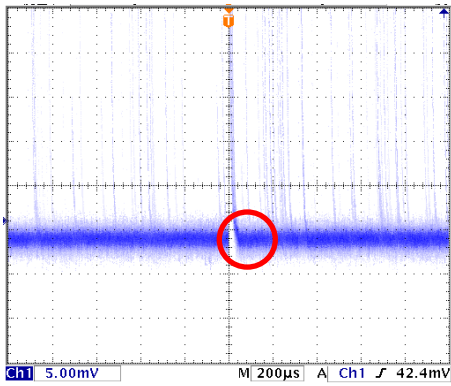


Figure 24 After adjustment, The horizontal axis is widened

6. 4. 2. For transistor reset type preamplifier output signal

1. Set the analog pole zero to 0.
2. Check the preamp signal obtained by differentiating the preamplifier output signal from the MONI output terminal with an oscilloscope.
3. While adjusting the analog course gain and analog fine gain, adjust the wave height including the energy element of the preamp signal to be within 2V as in the resistance feedback type described above.

6. 5. FAST filter settings

This device has a FAST filter for obtaining time information at the time of radiation detection and a SLOW filter for acquiring energy (wave height). First, set the FAST filter-related settings.

The settings have the same characteristics as a typical timing filter amplifier.

1. Connect the MONI terminal to the oscilloscope, select the DAC monitor CH for the corresponding CH, and set the DAC monitor type to fast.

Prepare to see this signal on an oscilloscope

2. Set the constants of the FAST-differentiating circuit with fast diff.

Select from ext (exclude, no filter used), 20, 50, 100, 200.

3. Set the constant of the FAST integrator circuit with fast integral.

Select from ext (exclude, no filter used), 20, 50, 100, 200.

4. Adjust the pole zero with fast pole zero.

The default setting is 0 (automatic setting).

Set the oscilloscope so that it looks like the figure below.

Adjustment is required every time the fast diff or fast integral is changed, but it does not need to be set as strictly as the SLOW pole zero described later.

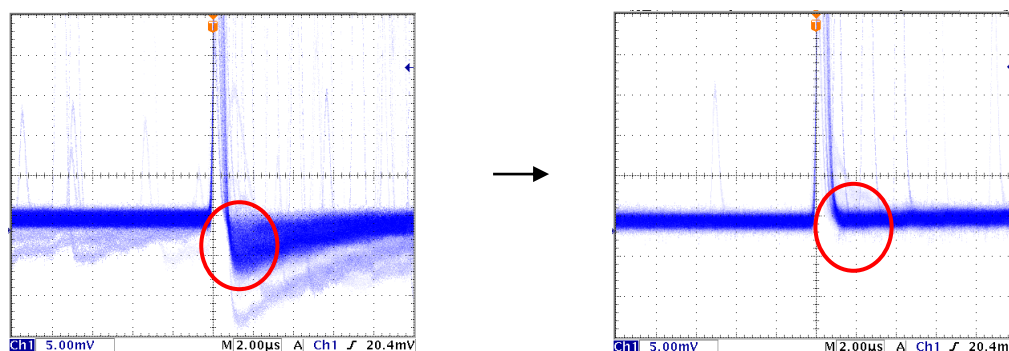


Figure 25 fast pole zero LEFT: Undershoot, before adjustment, RIGHT: After adjustment

The fast diff and fast integral settings depend on the detector and signal status.

The setting example is described below.

Detector	Feature	fast diff	fast integral
LaBr ₃ (Ce) Scintillator	Fast rise	20	ext or 20
Ge semiconductor detector	High energy resolution	100	100

Table 1 Setting example of fast diff and fast integral

1. Set the signal detection threshold of the FAST filter with the fast trigger threshold. The Leading-Edge-Timing (LET) is time-stamped when this threshold is exceeded. It is also used as a threshold for baseline restorer and pileup rejector. Set this value to the lowest possible value that can be discriminated from noise when connected to a detector. The default setting is 25.

POINT

First, input a somewhat large value (about 100) and observe the input total rate (cps).

Find a value that gradually reduces the fast trigger threshold and increases the input total rate (cps).

Since that value is the boundary between the signal and noise, set it to about +3 to +10 from that value.

6. 6. SLOW filter settings

Performs SLOW trapezoidal shaping on the preamplifier output signal. As an algorithm for the trapezoidal filter, the filter block configured in the pipeline architecture calculates the delay, addition, subtraction, and integration values required for the trapezoidal filter in synchronization with the ADC's 100MHz clock.

$$\begin{aligned}
 FIL(n) &= \sum_{i=0}^n \sum_{j=0}^l DIFF^{r,w}(j) + DIFF^{r,w}(i)P \\
 DIFF^{r,w} &= v(j) - v(j-r) - v\{j-(r+f)\} - v\{j-(2r+f)\} \\
 P &= (\exp(CLK / \tau) - 1)^{-1} \\
 r &= risetime \\
 f &= flattoptime \\
 w &= 2r + f = pulsewidth
 \end{aligned}$$

Formula 1 Trapezoidal Filter

1. Connect the MONI terminal to the oscilloscope, set the DAC monitor CH to the corresponding CH, and set the DAC monitor type to slow. Prepare to see the signal on an oscilloscope.
2. To achieve the same conditions as when the linear amplifier shaping time is 3 μ s, set the slow rise time to 6000 ns. This value affects the energy resolution. Setting it shorter enables higher count measurement but lowers the energy resolution. On the contrary, if the setting is too long, it may not be possible to count. The default setting is 6000 ns.
3. Set slow flattop time. For the resistance feedback preamplifier output signal, set a value from 0 to 100 % of the rise time, which is twice the value of the slowest rise. The recommended value is 700 ns. In the case of the transistor reset type, adjust while checking the energy resolution (half width) in increments of ± 100 ns from 700 ns.
4. Set slow pole zero. With this setting, it is possible to reduce overshoot and undershoot at the falling part of the SLOW filter. The default setting is 680. Since it depends on the detector, set it to the optimum value with an oscilloscope.

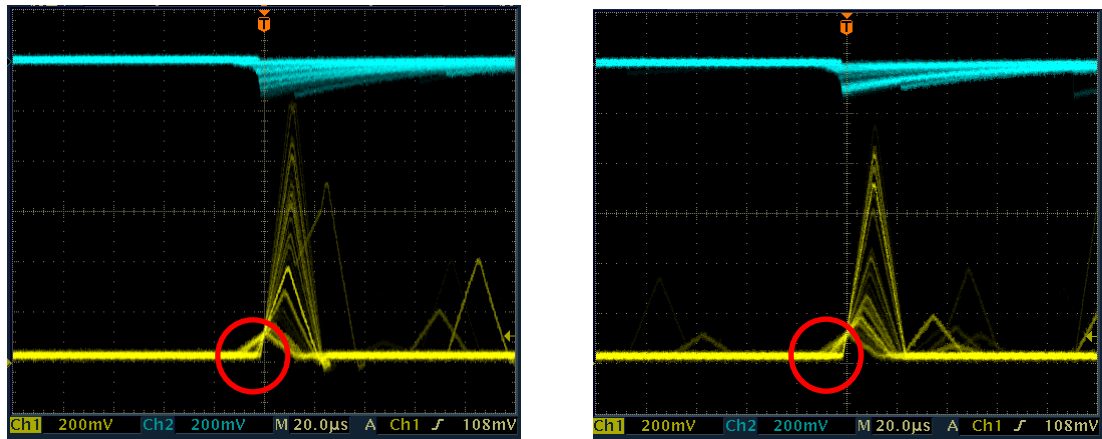


Figure 26 slow pole zero, LEFT: Undershoot, before adjustment, RIGHT: After adjustment

6. 7. SLOW threshold setting

First, input a somewhat large value (about 100) and observe the throughput rate (cps).

Find a value that gradually reduces the slow trigger threshold and increases the throughput rate (cps).

Since that value is the boundary between the signal and noise, set it to about + 3 to + 10 from that value.

The default setting is 30.

6. 8. Signal processing by external input terminal

The following signal processing is possible by using the LEMO connectors GATE, VETO, CLR, and CLK on the front panel. An LVTTTL or TTL level signal is required for use. The allowable High signal level is 2 to 5V, but since it is optimized with a 3.3V signal, it is recommended to use it at 3.3V or less.

* The required signal amplitude (pulse width) depends on the signal processing used.

6. 8. 1. Data acquisition by GATE signal

Use the LEMO connector GATE on the front panel to acquire the event data at that time when a certain event occurs. When it is High, it is measured, and when it is Low, it is not measured.

The setting procedure is as follows.

1. Observe the "slow" of the SLOW filter output from the DAC monitor with an oscilloscope.
2. Create and input a GATE signal (a pulse width that covers the slow signal from rising to falling) within the range that the SLOW filter can determine.

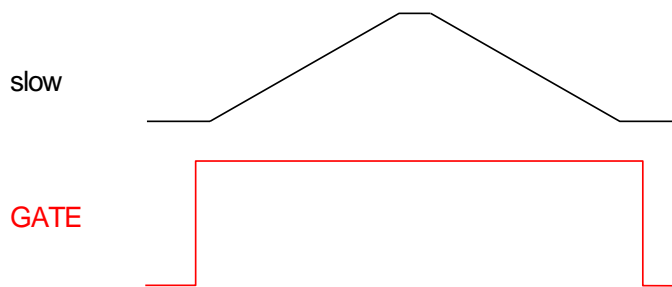


Figure 27 External gate timing

6. 8. 2. Data acquisition by VETO signal

Use the LEMO connector VETO on the front panel to discard the event data at that time when a certain event occurs. When it is Low, it measures, and when it is High, it does not measure. The required pulse width is the same as for GATE processing.

6. 8. 3. Use of external clock

It is unused.

6. 8. 4. Use of external CLR

Use the LEMO connector CLR on the front panel to clear the measurement time to zero with an external timing signal. Clear when High. Input a signal with a pulse width (High level of 50 ns or more) that allows the system to sufficiently discriminate the clear input.

6. 9. Calculation method of half width at half maximum (FWHM) Full Width at Half Maximum

The FWHM (Full Width at Half Maximum) in the ROI section is calculated as follows.

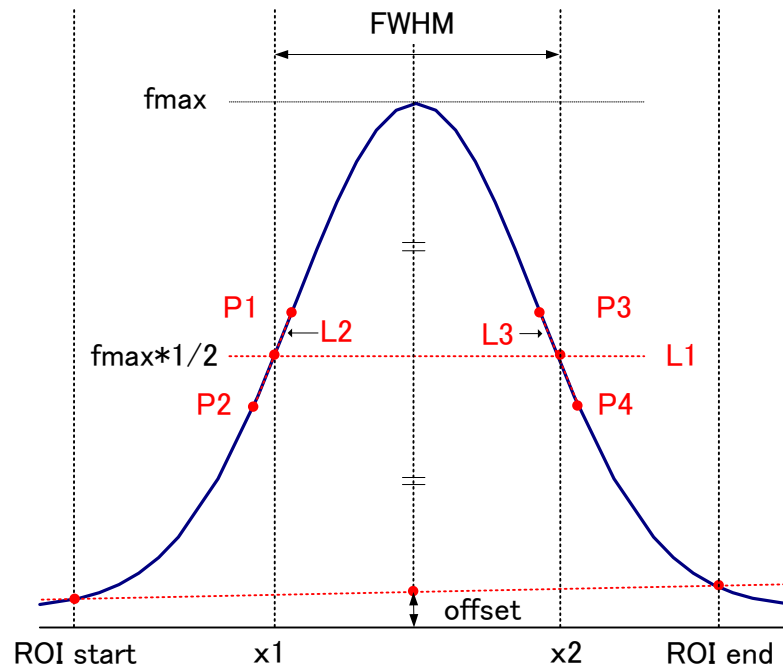


Figure 28 FWHM calculation

1. Find the maximum f_{max} between ROI Start and ROI end in the histogram.
2. Connect the intersection of the histogram and the ROI start with a straight line. Find the intersection of the straight line and the line drawn perpendicular to the x-axis from the peak value f_{max} and calculate the background offset (offset).
3. Calculate $1/2$ of the part obtained by subtracting offset from f_{max} and draw a straight line L1 parallel to the X axis.
4. To find the two points where the histogram and L1 intersect, detect the points P1 and P2 and P3 and P4 before and after the intersection.
5. Draw a straight line L2 connecting P1 and P2 and a straight line L3 connecting P3 and P4.
6. Find the X coordinate x_1 of the intersection of L1 and L2 and the X coordinate x_2 of the intersection of L1 and L3.
7. The difference between x_2 and x_1 is FWHM.

7. Measurement

This chapter is for the purpose of explaining the measurement unit, and the procedure assumes that the power supply, high voltage, etc. have already been applied to the detector and preamplifier, and the signal from the preamplifier is input to the INPUT terminal.

7. 1. Initialization settings

1. Click Config on the menu bar. After execution, all settings in the DSP will be sent to the DSP.
2. Click Clear on the menu bar. After execution, the histogram data in the DSP will be initialized.

To continue the previously measured histogram or measurement result, start the next measurement without clicking Clear.

7. 2. Measurement starts

- Click Start on the menu bar to start measurement.
- The measurement status of CH is displayed in the CH section.
- The acq. LED blinks.
- Measurement time is displayed in measurement time.
- The real time acquired from the DSP is displayed in real time.

histogram mode

- Histogram is displayed in mode.
- Each calculation result is displayed in the ROI section.
- A histogram is displayed on the histogram tab.

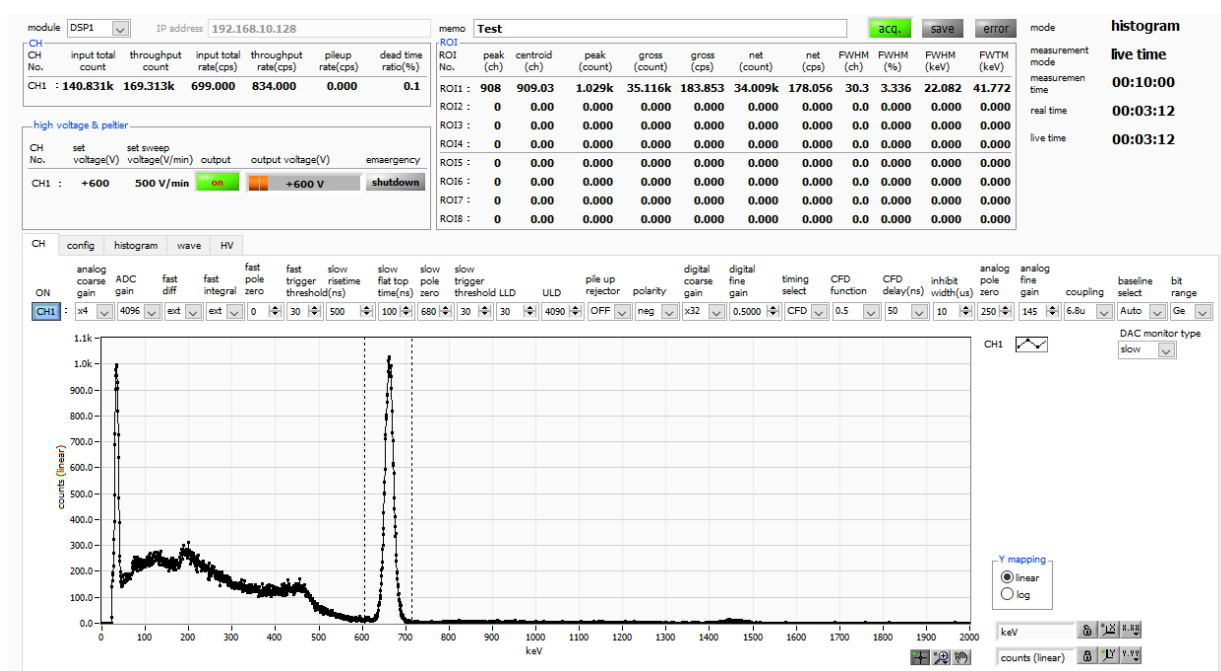


Figure 29 Histogram mode (LaBr₃ (Ce) detector, source Cs-137)

wave mode

- Wave is displayed in mode.
- Waveform information is displayed on the wave tab.

list mode

- Select list in mode in the config tab, and the following will be executed when the measurement starts.
- List is displayed in mode.
- The save LED flashes and the list file size (byte) shows the file size currently being saved.

7. 3. Measurement stops

- Measurement mode: real time \Rightarrow Measurement ends when real time reaches measurement time.
- Measurement mode: live time \Rightarrow Measurement ends when live time reaches measurement time.
- To stop during measurement, click the menu Stop. After execution, the measurement will be stopped.

8. Conclusion

8. 1. High voltage output step-down

Click the HV OFF button to turn off the high voltage output. After execution, the step-down is started at the speed of set sweep voltage.

The output LED blinks during step-down.

The output LED turns off when the output voltage is near 0 V.

8. 2. Application software exit

Click quit in File on the menu bar. Click quit in the confirmation dialog. After execution, this software will be closed.

9. File

9. 1. Histogram data file

File format: CSV text format, comma-separated

File name: any

Composition: It consists of a Header part, a Calculation part, a Status part, and a Data part.

[Header]

Memo	Memo
Measurement mode	Measurement mode. Real Time or Live Time
Measurement time	Measureent time. The unit is seconds
Real time	Real time
Live time	Live time
Dead time	Dead time
Start Time	Measurement start time
End Time	Measurement end time

* Below CH

ACG	Coarse gain
ADG	ADC gain
FFR	FAST rise time
FFP	FAST flat top time
SFR (ns)	SLOW rise time
SFP (ns)	SLOW flat top time
FPZ	FAST pole zero cancel
SPZ	SLOW pole zero cancel
FTH	FAST threshold
LLD	Energy LLD
ULD	Energy ULD
STH	SLOW threshold
PUR	Pile-up reject
POL	Polarity
DCG	Digital coarse gain
TMS	Timing selection
CFF	CFD function
CFD	CFD delay
IHW	Inhibit width
PZD	Analog pole zero
FGD	Baseline count manual
DIF	Cuppling
BRS	Baseline restorer select

BTS	Baseline select
IHT	Unsed
* CH is up to here	
MOD	Operation mode
MMD	Measurement mode
MTM	Measurement time
CLS	Clock select
SCS	WAVE sampling select

[Calculation]

* Saved for each ROI below

ROI_ch	Input channel number subject to ROI
ROI_start	ROI start position (ch)
ROI_end	ROI end position (ch)
Energy	Peak energy value between ROIs
peak (ch)	Peak position between ROIs (ch)
centroid (ch)	Center position between ROIs (ch)
peak (count)	Peak count between ROIs
gross (count)	Sum of counts between ROIs
gross (cps)	$\text{gross (count)} \div \text{elapsed measurement time}$
net (count)	Sum of counts minus background between ROIs
net (cps)	$\text{net (count)} \div \text{elapsed measurement time}$
FWHM (ch)	Half width between ROIs (ch)
FWHM (%)	Half width between ROIs
FWHM	Half width between ROIs
FWTM	1/10 width between ROIs

[Status]

* Saved for each CH below

input total count	Total caount
throughput count	Throughput count
input total rate	Total count rate
throughput rate	Throughput count rate
pileup rate	Pileup rate
dead time ratio	Dead time ratio

[Data]

Histogram data for each channel.

Up to 8192 points

9. 2. List date file

File format: Binary, big endian format

File name: File path set in list file path in the config tab, with file number added to 0 and 6 digits

Example 1: When "D: ¥ data ¥ 123456.bin" is set in the list file path and "1" is set in the number.
"D:¥data¥123456_000001.bin".

Example 2: When "D: ¥ data ¥ 123456" is set in the list file path and "100" is set in the number.
"D:¥data¥123456_000100.bin".

When the list file size is reached, the saved file is closed.
After that, it automatically increments the list file number by one, opens a new file, and continues to save the data as a file.

Composition

80bit per event (10Byte, 5WORD)

79		64			
		ABS [43..28]			
63		48			
		ABS [27..12]			
47		36		35	32
		ABS [11..0]		Vacant [3..0]	
31	29	16			
28					
Vacant [2..0]		PHA [12..0]			
15		6		5	2
		Vacant [9..0]		1	0
				UNIT [3..0]	CH [1..0]

Figure 30 List data 80 bit configuration

- Bit79 to Bit36

ABS, Absolute counts, 44 Bit
10 ns per 1 Bit
Maximum measurement time is about 24 hours (24 hours ≒ 243 * 10ns)
- Bit35 to Bit29

Vacant. 7 Bit
- Bit28 to Bit16

PHA, Pulse Height.
13 Bit for ADC gain up to 8192, 0 to 8191.
- Bit15 to Bit6

Vacant. 10 Bit
- Bit5 to Bit2

Number of unit, 4 Bit
* When using multiple units: 0 for unit 1 and 15 for unit 16.
- Bit1 to Bit0

Number of CH 2 Bit

1 O. Troubleshooting

1 O. 1. Connection error occurs

If you get a connection error at startup or in the menu config, the network may not be connected properly. In this case, check the followings

Check if the settings in the configuration file config.ini before booting meet the following conditions.

1. The IP is set to 192.168.10.128.
2. Each port number in the "System" section is defined as follows.
3. Start this application and check that the IP Address is displayed the same.

[System]

PCConfigPort = 55000

PCStatusPort = 55001

PCDataPort = 55002

DevConfigPort = 4660

DevStatusPort = 5001

DevDataPort = 24

SubnetMask = "255.255.255.0"

Gateway = "192.168.10.1"

Check if the network information of the PC is set so that it can be connected to this device.

The default settings of this device are as follows.

IP address	192.168.10.128
Subnet mask	255.255.255.0
Default gateway	192.168.10.1

- If the arbitrary port number on the PC side for UDP connection conflicts, define another number in Port in the configuration file config.ini before booting.
- Turn on the power while the Ethernet cable is connected.
- Execute the ping command at the command prompt to check if the device and the PC can communicate with each other.
- Turn the power of the device off and then on again, and then execute the ping command again.
- Turn off the virus detection software and firewall software.
- Always turn on power saving functions such as PC sleep.
- If you are using a laptop, disable the wireless LAN function.

1 O. 2. Command error occurs

The combination of the firmware of this device and the application may not match depending on the presence or absence of options. Please contact us.

1 O. 3. Histogram is not displayed

If you see nothing in the graph on the histogram tab when you run Start on the menu bar, check the following:

1. Set CH1 to ON by plot ON in the histogram tab.
2. Check if the input total rate (cps) and throughput rate (cps) are counting.
3. Set the DAC monitor CH to CH1 and the DAC monitor type to preamp and check that the wave height of the preamp is not too small or too large and is within 1V.
4. Set the DAC monitor type to fast and check if the FAST filter signal is output.
5. Set the DAC monitor type to slow and check if the signal of the SLOW filter is output.
6. The values of fast trigger threshold and slow trigger threshold are not too small or too large, and while watching the count of input total rate (cps) and throughput rate (cps), change the setting from 100 to 30. Adjust the two rates so that they are close to each other.
7. Right-click on the X and Y axes of the graph to autoscale.

1 O. 4. Change IP address

Please refer to the attached "Manual: How to change the IP address of the product equipped with APG5107".

If you do not have it attached, please contact us.

1 1. Gauss fit

This software has a peak analysis function by Gauss fitting. By opening the dedicated screen, you can calculate the half-value width, etc. by dividing the peaks with a small number of counts and the peaks that overlap with each other during measurement or for the histogram data in the data file.

1 1. 1. Startup screen

Select Tool from the menu bar and execute gauss fit analysis. After execution, the startup screen shown below will be displayed.

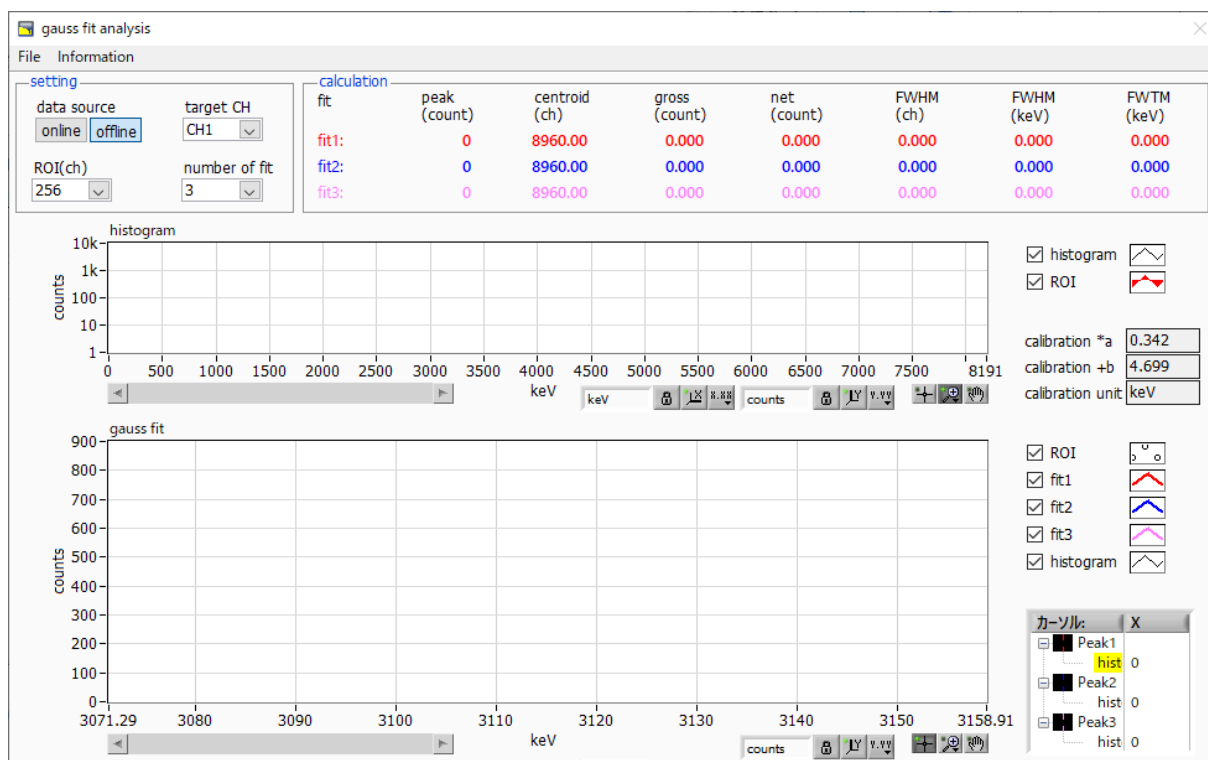


Figure 31 Gauss fit startup screen

Menu section

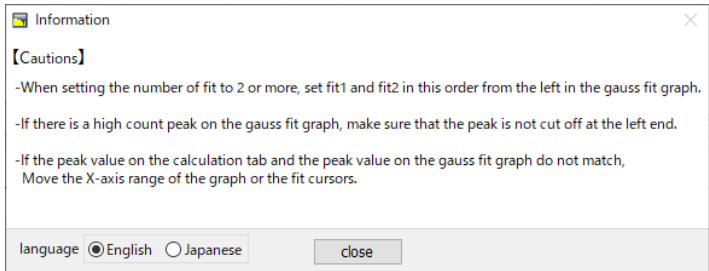
File - open gauss fit file	Read gauss fit file
File - open histogram file	Read histogram data file
File - save gauss fit file	Save Gaussian fit data to a file
File - save image	Save window in png format
File - close	Exit window
Information	<p>Display the information window. Display precautions when using this screen on the dialog screen</p> 

Image 26. Information window

Setting section

data source	Select the data to be analyzed
online	Targets the data being measured on the main screen
offline	Targets the data in the pre-read histogram data file or Gauss fit data file
target CH	Analysis target CH setting
ROI (ch.)	It is the number of data points to be analyzed to be displayed in the graph of gauss fit. Choose from 256 or 512 channels
number of fit	Setting the number of Gaussian fits. Gaussian fit analysis can be performed on up to three peaks for a single histogram

Calculation section

peak (count)	Maximum count
centroid (ch.)	Median value (ch.) calculated from the sum of all counts
gross (count)	Sum of counts
net (count)	Sum of counts minus background
FWHM (ch.)	Half width
FWHM	Half width * The unit is the energy calibration state on the main screen.
FWTM	1/10 width of the peak * The unit is the energy calibration state on the main screen.
calibration *a	The energy calibration factor *a on the main screen is displayed
calibration +b	The energy calibration factor +b on the main screen is displayed.
calibration unit	The unit on the main screen is displayed
histogram graph	The histogram plot in the histogram graphs the histogram data for Gaussian fit. The ROI plot is the part displayed in the gauss fit graph and is displayed in red. You can change the display position while keeping the number of display points constant by moving the horizontal slide bar at the bottom left of the graph to the left or right. If each check box is checked, the plot is displayed, and if it is not checked, the plot is hidden.
gauss fit graph	From the histogram data displayed in the histogram graph, the channel set by ROI (ch) is extracted from the start position of the X axis of the gauss fit graph and displayed. The fit1 to fit3 plots are Gaussian-fitted data for the peaks set by each cursor. Histogram plots are concatenated data of Gaussian fit results. You can change the display position while keeping the number of display points constant by moving the horizontal slide bar at the bottom left of the graph to the left or right. The X of the cursor at the bottom right of the graph is the position of the cursor to be aligned with the Gaussian fit target peak, and you can also move the cursor by directly inputting X. If each check box is checked, the plot is displayed, and if it is not checked, the plot is hidden.

1 1. 2. On-line

For the histogram acquired during measurement, perform Gaussian fit analysis for the specified peak according to the following procedure.

1. Select data source, "online."
2. Start measurement in histogram mode. The histogram during measurement is displayed in the histogram graph.
3. In the gauss fit graph, the histogram of the part of interest in the histogram graph is displayed. To set the horizontal axis range of this graph, first cancel the horizontal axis auto scale and enter the minimum value of the horizontal axis of the gauss fit graph directly or use the X-zoom function of the graph. After setting, the histogram graph will have the range selected in the gauss fit graph red.
4. Set up to three vertical cursors at the approximate peak part of the analysis target. To set the cursor, drag the red, blue, and pink vertical cursor lines while the button in the red frame in the figure below is pressed, and drop them on the peak part. Alternatively, you can move the cursor and set it by entering a numerical value in the X value of the cursor at the bottom right of the screen.
5. Calculation results such as half-value width based on each Gaussian fit data are displayed in the calculation section

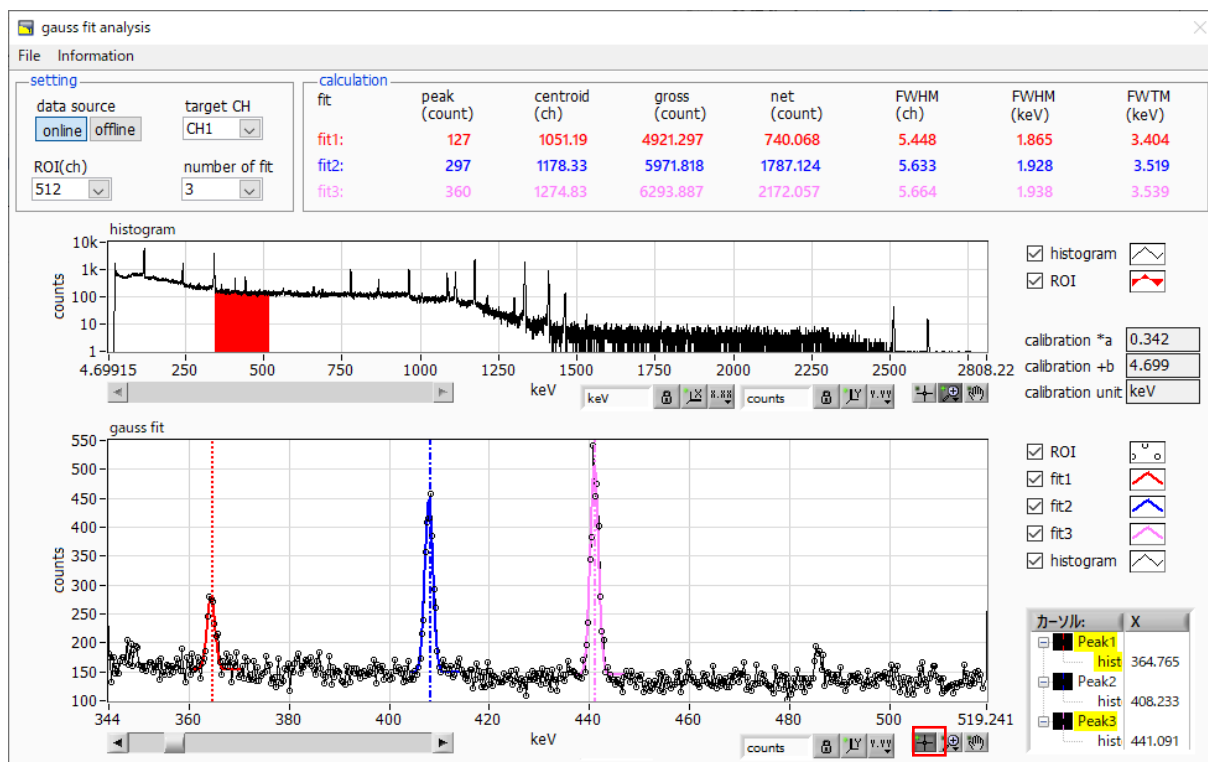


Figure 32 Gauss fit screen, **ON-LINE**

11. 3. Off-line

For the histogram obtained by reading the histogram data file or the Gauss fit data file, perform Gauss fit analysis for the specified peak by the following procedure.

1. Select data source, "offline."
2. Click open gauss fit file or open histogram file from file in the menu. A file selection dialog is displayed. Select the data file to be read and open it. The histogram in the data file is displayed in the histogram graph
3. In the gauss fit graph, the histogram of the part of interest in the histogram graph is displayed. To set the horizontal axis range of this graph, first cancel the horizontal axis auto scale and enter the minimum value of the horizontal axis of the gauss fit graph directly or use the X-zoom function of the graph. After setting, the histogram graph will have the range selected in the gauss fit graph red.
4. Set up to three vertical cursors at the approximate peak part of the analysis target. To set the cursor, drag the red, blue, and pink vertical cursor lines while the button in the red frame in the figure below is pressed, and drop them on the peak part. Alternatively, you can move the cursor and set it by entering a numerical value in the X value of the cursor at the bottom right of the screen.
5. Calculation results such as half-value width based on each Gaussian fit data are displayed in the calculation section.

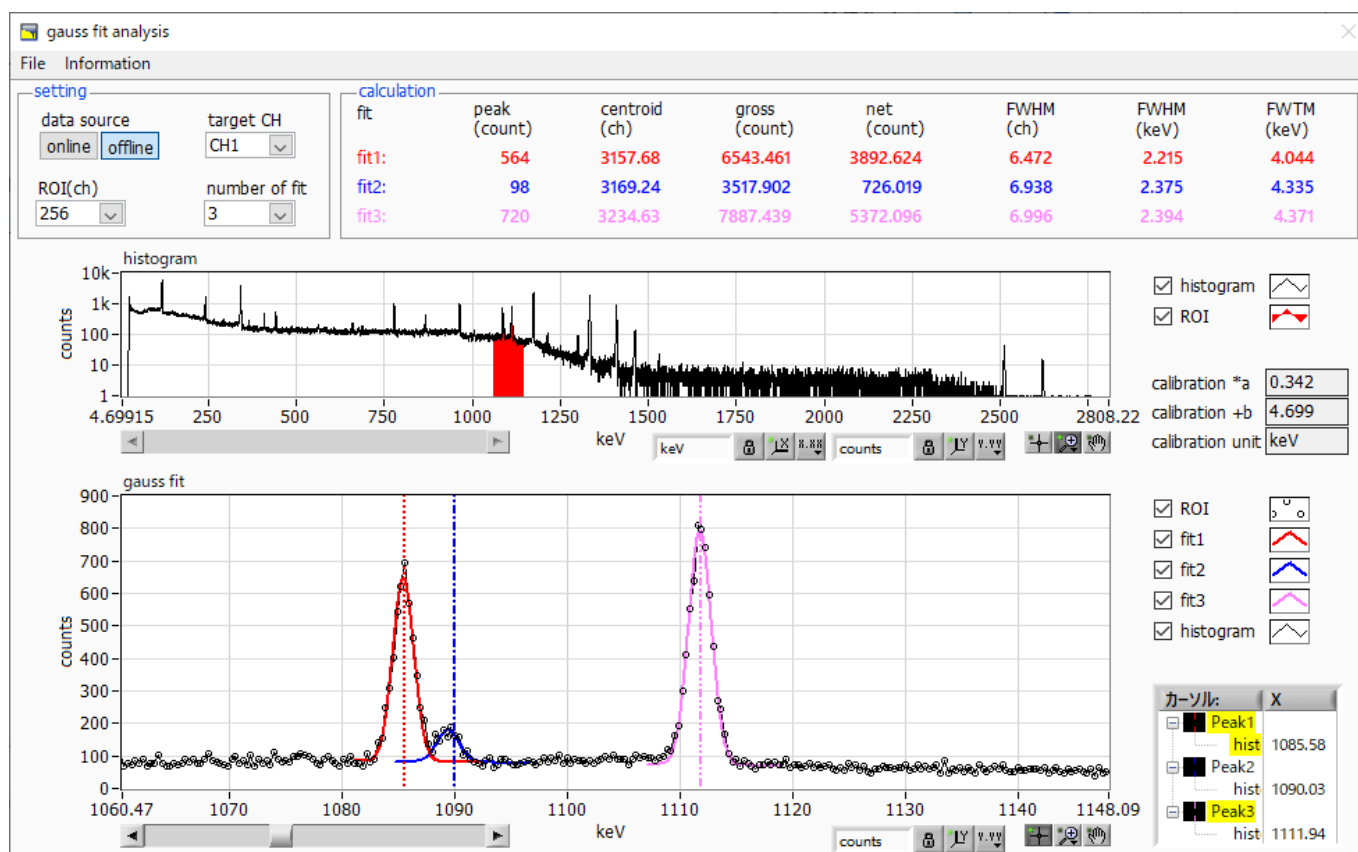


Figure 33 Gauss fit screen, OFF-LINE

1 1. 4. Notes

Please note the following points to operate normally on the Gauss fit screen.

1. When setting the number of fit to two or more, set fit1 and fit2 in this order from the left in the gauss fit graph. If fit1 is not working properly, the following fit2 and fit3 will also be hidden.
2. The peak to be fitted should be displayed without being cut off at both ends of the gauss fit graph.
3. If the peak value on the calculation tab and the peak value on the gauss fit graph do not match, move the horizontal axis range of the graph or the fit cursor.

1 1. 5. End

To close this screen, click close from File on the menu bar.

1 2. Peak search

This software has a function to automatically detect peaks and perform peak analysis. You can open the dedicated screen and automatically detect the peak and calculate the half width etc. for the histogram data of the data file during measurement.

1 2. 1. Startup screen

Execute peak search analysis from Tool on the menu bar. After execution, the startup screen shown below will be displayed.

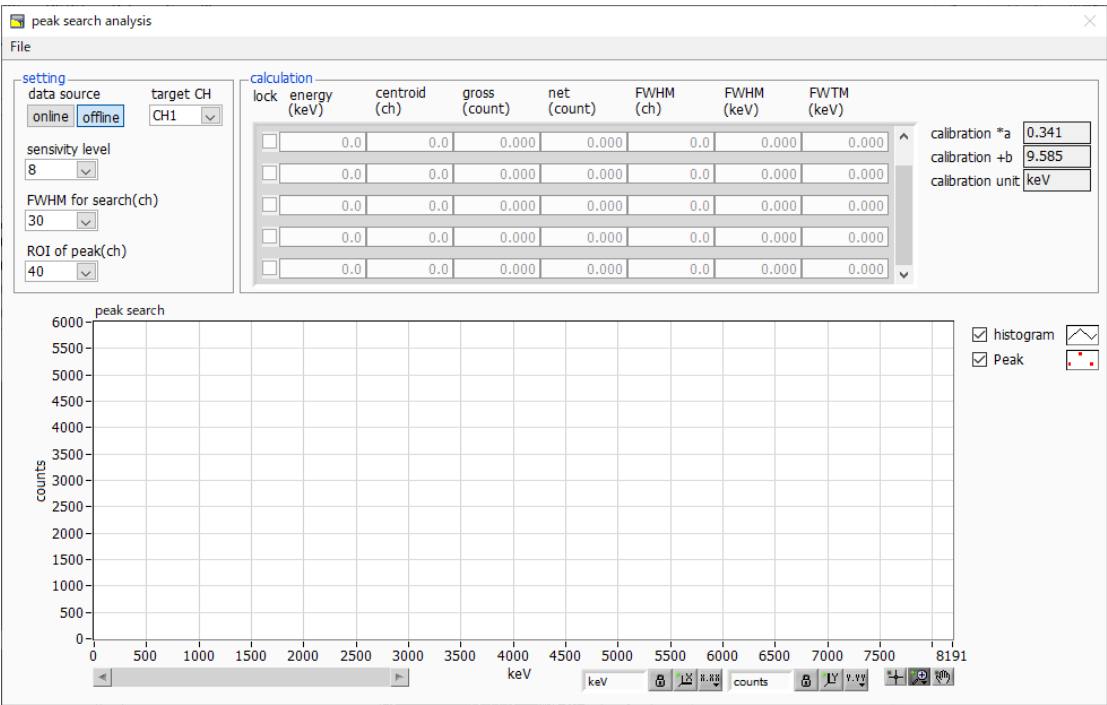


Figure 34 Peak search startup screen

Menu section

File - open peak search file	Read peak search file
File - open histogram file	Read histogram data file
File - save peak search file	Save peak search to a file
File - save image	Save screen in png format
File - close	Exit screen

Setting section

data source	Select the data to be analyzed
online	Targets the data being measured on the main screen
offline	Targets the data in the pre-read histogram data file or Gauss fit data file
target CH	Analysis target CH setting
sensitivity level	Selection of peak detection threshold. If the value is small, even a slight peak will be detected.
FWHM for search (ch.)	Approximate half-value width required for peak search. The unit is channel. Set the approximate half width from the actual peak by channel (point)
ROI of peak (ch.)	Setting the number of ROI plots (CH) for the peak

Calculation section

lock	If you want to display it at the top of the list, turn on the check. If it is OFF, the display position may move up or down each time a peak is detected.
centroid (ch.)	Median value (ch.) calculated from the sum of all counts
gross (count)	Sum of counts
net (count)	Sum of counts minus background
FWHM (ch.)	Half width
FWHM	Half width * The unit is the energy calibration state on the main screen.
FWTM	1/10 width of peak * The unit is the energy calibration state on the main screen.
calibration *a	The energy calibration factor *a on the main screen is displayed.
calibration +b	The energy calibration factor +b on the main screen is displayed
calibration unit	The unit on the main screen is displayed.
peak search graph	The histogram plot in the peak search graph displays the histogram data of the peak search target as a graph. The Peak plot is the part where the peak is detected and is displayed in red with a Gaussian fit. You can change the display position while keeping the number of display points constant by moving the horizontal slide bar at the bottom left of the graph to the left or right. If each check box is checked, the plot is displayed, and if it is not checked, the plot is hidden.

1 2. 2. On-line

Perform peak search analysis using the following procedure for the histogram acquired during measurement.

1. Select data source online
2. Start measurement in histogram mode. The histogram being measured is displayed in the peak search graph.
3. In the peak search graph, the peak part where the peak is detected is gauss-fitted and a red histogram is displayed.
4. In the calculation section, the calculation results such as the half-value width are displayed for each peak detected. If the peak is detected or not detected, the calculation result display may move up and down, making it difficult to see. In this case, if you turn on the lock check, it will always be displayed at the top.

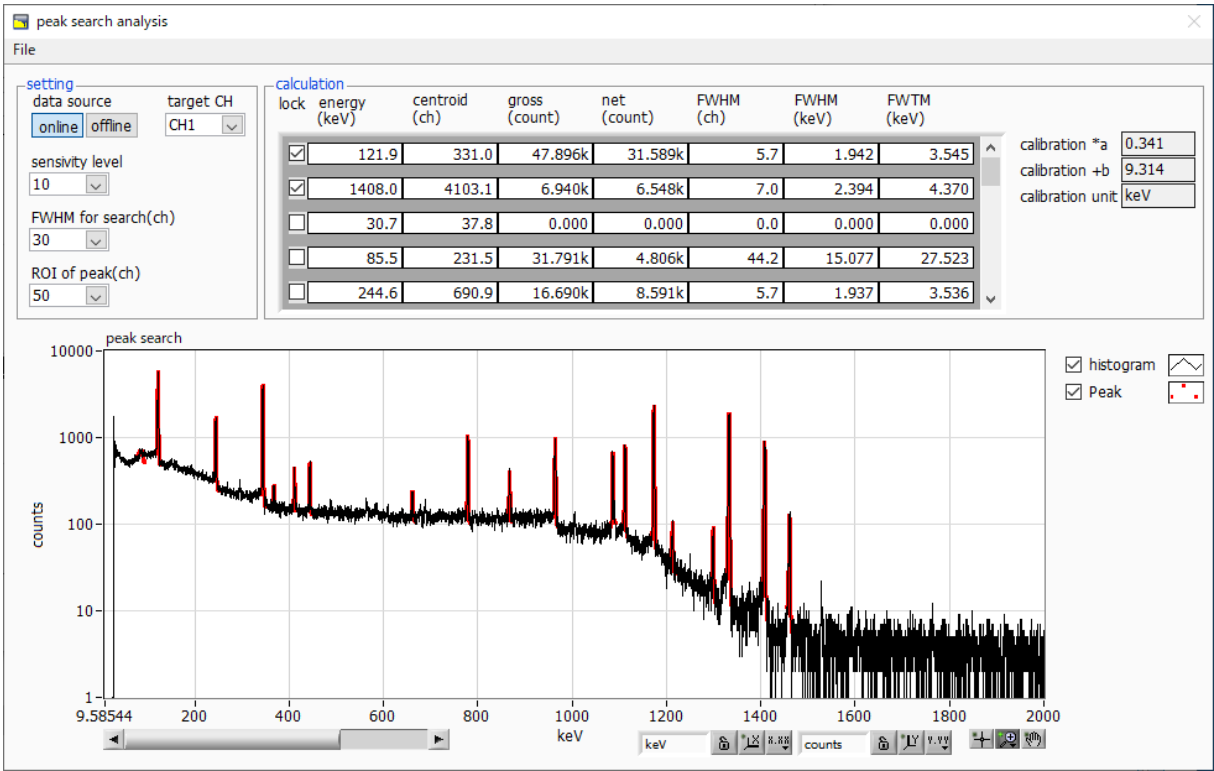


Figure 35 Peak search screens, ON-LINE

1 2. 3. Off-line

Perform peak search analysis according to the following procedure for the histogram obtained by reading the histogram data file or peak search data file.

1. Select data source as offline
2. Click open peak search file or open histogram file from file on the menu bar. A file selection dialog is displayed. Select the data file to be read and open it. The histogram in the data file is displayed in the peak search graph
3. In the peak search graph, the peak part where the peak is detected is gauss-fitted and a red histogram is displayed.
4. In the calculation section, the calculation results such as the half-value width are displayed for each peak detected. If the peak is detected or not detected, the calculation result display may move up and down, making it difficult to see. In this case, if you turn on the lock check, it will always be displayed at the top.

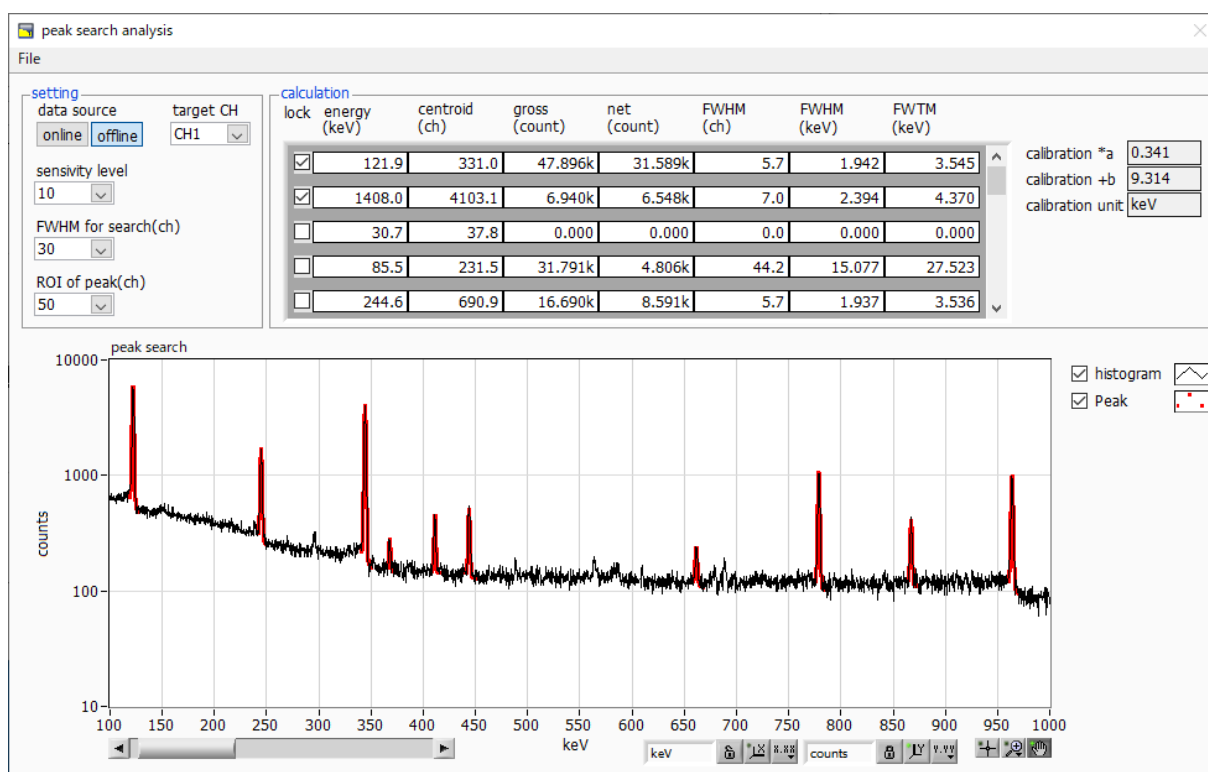


Figure 36 Peak search screens, OFF-LINE

1 2. 4. Notes

Please note the following points to operate normally on the peak search screen.

1. The degree of peak search changes by adjusting the sensitivity level, FWHM for search (ch.), and ROI of peak (ch.). Adjust each setting to the optimum while observing the shape of the red peak detection part.

12. 5. End

To close this screen, click close from File on the menu bar.

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