Multi Channel Analyzer

USB-MCA2
APG7302

Instruction Manual

Version 1.1.0
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TechnoAP Co., Ltd.

ADD : 2976-15 Mawatari, Hitachinaka-shi, Ibaraki, Japan
ZIP Code: 312-0012
TEL: 029-350-8011
FAX: 029-352-9013
URL: http://www.techno-ap.com
e-mail: order@techno-ap.com

Safety Precautions / Disclaimer

Thank you very much for purchasing this product from TechnoAP Co., Ltd. Before using this product, please read this "Safety Precautions and Disclaimer" and be sure to observe the contents and use the product properly.

We are not responsible for any damage caused by abnormality of device, detector, connected device, application, damage to failure, other secondary damage, even if accident caused by using this device.



Prohibited matter

This device cannot be used for applications requiring special quality and reliability related to human life, accident.
This device cannot be used in places with high temperature, high humidity, and high vibration.
Do not apply a power supply that exceeds the rating.
Do not turn the power on while other metals are in contact with the board surface.



Note

If there is smoking or abnormal heat generation in this device, turn off the power immediately.
This board may not work properly in noisy environments.
Be careful with static electricity.
The specifications of this board and the contents of the related documents are subject to change without notice.

Warranty policy

The warranty conditions of "our product" are as follows.

Warranty period: One year from date of purchase.
Guarantee contents: Repair or replacement will be carried out in case of breakdown even though you have used correctly according to this instruction manual within the warranty period.
Out of warranty: We do not warranty if the cause of the failure falls under any of the following.
1. Failure or damage due to misuse or improper repair or modification or disassembly.
2. Failure and damage due to falling etc.
3. Consumables.

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1 Overview

The USB-MCA2 (USB Multi-Channel Analyzer 2CH) APG7302 manufactured by Techno AP (hereinafter referred to as “this device”) is a lightweight, compact MCA that operates solely on USB bus power without using an AC adapter. It is equipped with high-speed successive approximation ADCs on each of the two signal input channels.
Preamplifier signals from the detector are input to a spectroscopy amplifier (linear amplifier, hereinafter “amplifier”), and the output signals, which have been amplified and shaped by the analog circuit, are fed into this device. The amplitude (peak value) of these signals contains information such as the energy of radiation. The MCA detects these signals, converts the maximum peak height to digital form (AD conversion), and generates a histogram, functioning as a pulse-height analyzer.
A key performance metric of the MCA is dead time. Dead time refers to the period during which the MCA cannot measure pulse heights. For irregularly occurring events such as radiation, from the moment an event occurs until the peak is detected, converted to digital, written to memory, and the pulse height reset, new events cannot be measured. The dead time of this device is fixed at 1 μs.
The device supports four measurement modes: histogram mode, list mode, multi-channel scaler (MCS) mode, and coincidence mode.
In histogram mode, a histogram is generated with the horizontal axis representing energy peak values (e.g., keV) and the vertical axis representing counts.
In list mode, when a signal from the amplifier exceeds the threshold and the pulse height falls between the LLD and ULD, valid events are detected. The elapsed time since the start of measurement, the pulse height, and the channel number are transferred to the PC as 8-byte list data and saved to a file. All data are transferred to the PC via USB cable.
In MCS mode, histogram data are generated with the horizontal axis representing time (from nanoseconds to seconds) and the vertical axis representing counts. The horizontal axis can be set to a dwell time per channel ranging from 40 ns to 100 s, with 232 counts per channel. When a valid event within the LLD and ULD range is detected, the timing information at which the threshold was exceeded is used to increment the count in the corresponding elapsed time channel.
In coincidence mode, CH1 and CH2 are used to acquire the time, channel number, and pulse height of events detected simultaneously within a set time window. The set time range is from ±40 ns to ±10 μs. Two-channel list data can be saved in list mode, or a two-dimensional histogram (2048 × 2048 channels) can be created with CH1 PHA on the horizontal axis and CH2 PHA on the vertical axis.
Accessories include driver software and an application (hereinafter “this application”) that operate on Windows.
This document describes the operation of this device. It is compatible with the included software (APP-MEAS Version 8.0.0 or later).

2 Specifications

Product Name: USB-MCA2 (same name for the included application)

Model: APG7302 (including products with additional notations after the model number)

(1) Analog Input

- Number of Channels: 2CH
- Input Range: 0 to +10 V
- Input Impedance: 1 kΩ
- Acceptable Pulse Width: Minimum 100 ns to maximum 100 µs (duration exceeding the threshold)

(2) ADC

- Conversion Method: Successive approximation
- Resolution: 16-bit
- Conversion Time: 650 ns
- ADC Gain: 16,384; 8,192; 4,096; 2,048; 1,024; 512 channels
- Threshold: Full scale 0–50%, set via PC
- LLD: Full scale 0–100%, set via PC
- ULD: Full scale 0–100%, set via PC

(3) Performance

- Dead Time: Fixed 1 µs (does not include amplifier processing time)
- Integral Nonlinearity: ±0.025% (typical) or less
- Differential Nonlinearity: ±1% (typical) or less

(4) External Input

- External Input: GATE and VETO

  Input Signal Level: LV-TTL

  *VETO acts as CLR (clears time information) in list mode

  *VETO acts as CLR (clears MCS time count) in MCS mode

(5) Functions

• Operating Modes	Histogram Mode (up to 16,384 ch, 232 counts/ch) List Mode (elapsed time per event, channel number, pulse height) MCS Mode (40 ns to 100 s/ch, 16,384 ch, 232 counts) Coincidence Mode (simultaneous measurement with CH1 and CH2, 2D histogram)
• Communication Interface	USB 2.0 *USB cable length should be 2 m or less. Usage with USB 3.0 ports is recommended. If the USB port has low-power settings, disable them if possible, or consider using a USB hub with AC adapter power.
(6) Software	Application: USB-MCA2 software (Windows version) Driver Software *Sample programs for Linux, Visual C++, C# are available on our website support page.
(7) Dimensions	70 (W) × 160 (D) × 20 (H) mm
(8) Weight	Approx. 205 g

(9) Accessories:

User Manual

CD (driver software, application, and user manual)

USB Cable (USB A male to USB Mini-B male)

3 Appearance

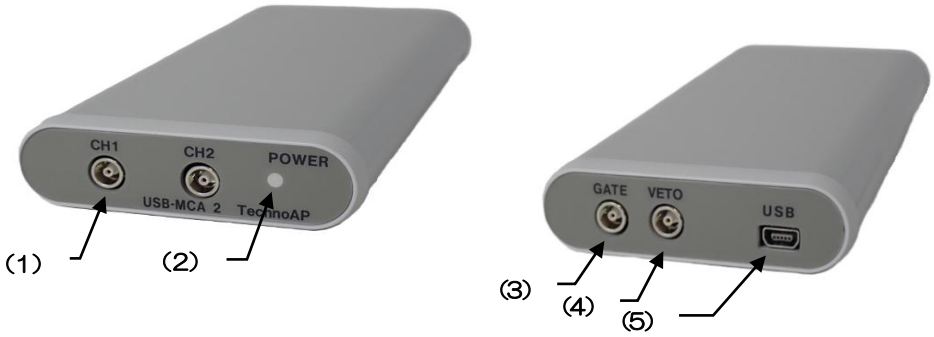


Photo1 APG7302

【Front】

(1) INPUT LEMO connector (EPL.00.250.NTN) for amplifier signal input, available for CH1 and CH2. In coincidence mode, CH1 and CH2 are used.

(2) POWER LED lights up when the power is ON (connected to PC).

【Rear】

(3) GATE LEMO connector for external GATE signal input. Accepts LV-TTL level signals. "High" input: data acquisition active. "Low" input: data acquisition inactive.

(4) VETO LEMO connector for external VETO signal input. Accept LV-TTL level signals. "High" input: data acquisition inactive."Low" input: data acquisition active In list mode or MCS mode, acts as CLR (clears time count). Rising edge of input signal (pulse width ≥100 ns) triggers the clear.

(5) USB USB 2.0 Mini-B receptacle (female)

Note: Conversion Adapters

The signal input connector of this device uses LEMO EPL.00.250.NTN or equivalent.

If using a BNC connector cable, the device can be connected via the following conversion adapter:

Manufacturer: Huber & Suhner

Model: 33_QLA-BNC-01-1/1--_NE

Contents: QLA-01 to BNC

Connector Gender 1 Interface: QLA-01

Connector Gender 2 Interface: BNC



Photo2: 33_QLA-BNC-O1-1/1--NE

However, when using adjacent channels such as CH1 and CH2, interference may occur. In such cases, use a LEMO-to-BNC conversion cable as shown in the photo below.



Photo 3: Example of LEMO–BNC Conversion Cable

4 Setup

4.1 Connection

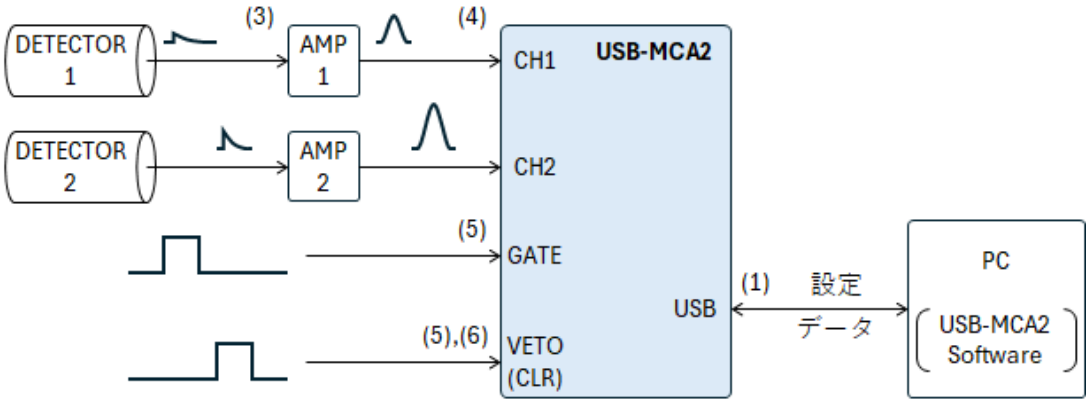


Figure 1: Connections When Using the MCA

(1) Connect the USB-MCA2 to the PC using the included USB cable.
- For a PC connecting for the first time, the driver software must be installed. Refer to the installation instructions below.
- Do not connect signal cables while the device power is OFF.

(2) Confirm that the POWER LED is lit.

(3) Connect the preamplifier output signal from the detector (DETECTOR in the figure above) to the amplifier (AMP in the figure above).

(4) Connect the shaped output signal from the amplifier to either CH1 or CH2 of the device.

(5) If external signal control is required, input an LV-TTL level signal to the GATE or VETO terminal.
- When a cable is connected to the GATE terminal, data is acquired if the peak is detected on CH1 or CH2 while the GATE signal is open or in the High state.
- When a cable is connected to the VETO terminal, data is acquired if the peak is detected on CH1 or CH2 while the VETO signal is open or in the Low state.

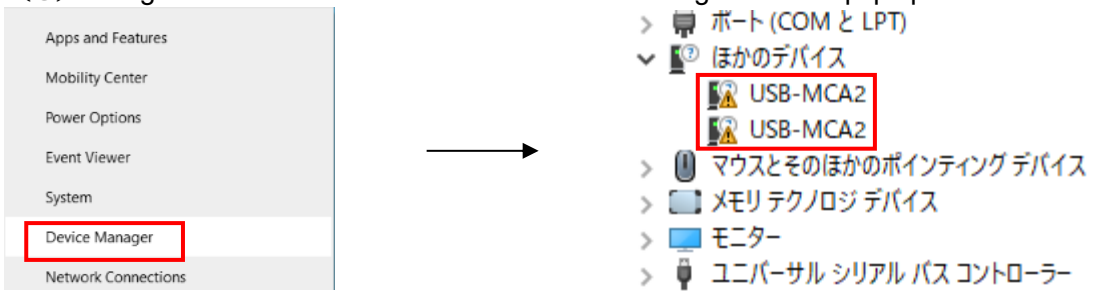
(6) In LIST mode or MCS mode, the VETO terminal functions as a CLR terminal.
- When a rising-edge signal is detected on the VETO terminal, the LIST elapsed time or MCS time counter can be cleared.
- The input pulse width should be at least 100 ns.

4.2　Installing the Driver Software

For a PC connecting to this device for the first time, the driver software must first be installed from the included CD.

For Windows 10 (also applies to Windows 11)

（1）　(Required) Log in as an Administrator or with an account that has administrator privileges.
（2）　Connect the USB-MCA2 to your PC using the USB cable.
（3）　Right-click the Start button and select "Device Manager" from the pop-up menu.



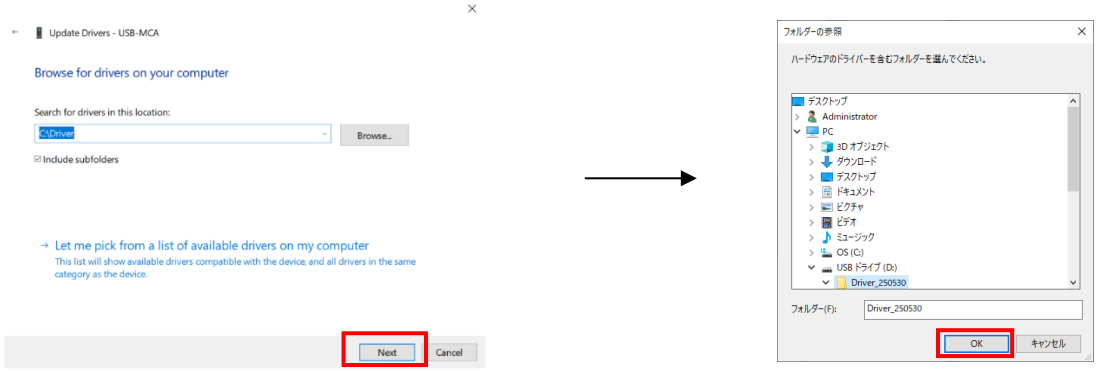
（4）　Right-click one of the "USB-MCA2" entries, select "Update driver", and then select "Browse my computer for drivers".



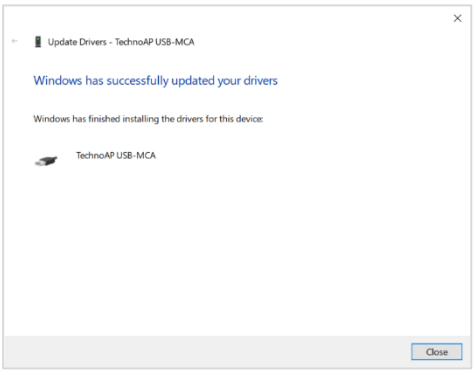
（5）　When the "Update Drivers" window appears, click "Browse...".

When the "Browse For Folder" window appears, select the folder where the USB-MCA2 driver software is saved (Driver¥Windows10-11), and click "OK".

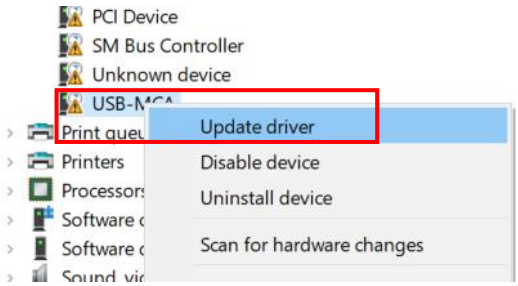
Once you return to the "Update Drivers" window, click "Next".



When the message "Windows has successfully updated your drivers" is displayed, click "Close".



（6）　Right-click the remaining "USB-MCA2" entry and repeat the steps from (5) to update the remaining driver software.



（7）　The driver software installation is complete when "TechnoAP USB-MCA2" and "TechnoAP USB-MCA2 Option" are displayed in the Device Manager window.

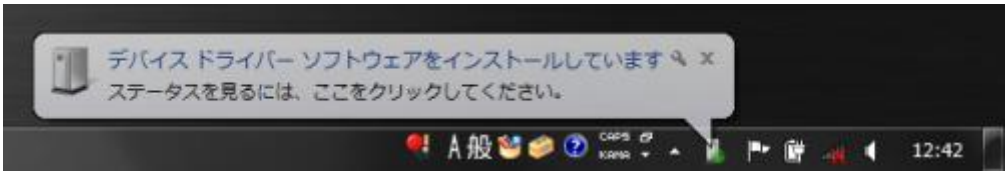


For Windows 7

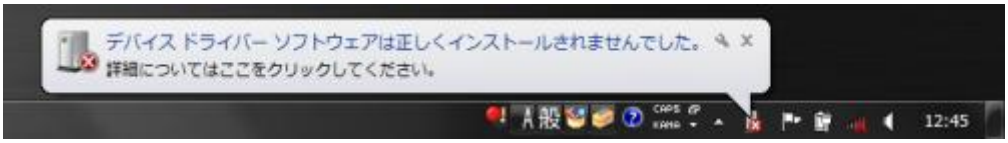
（1） (Required) Log in as Administrator or with an account that has administrator privileges.

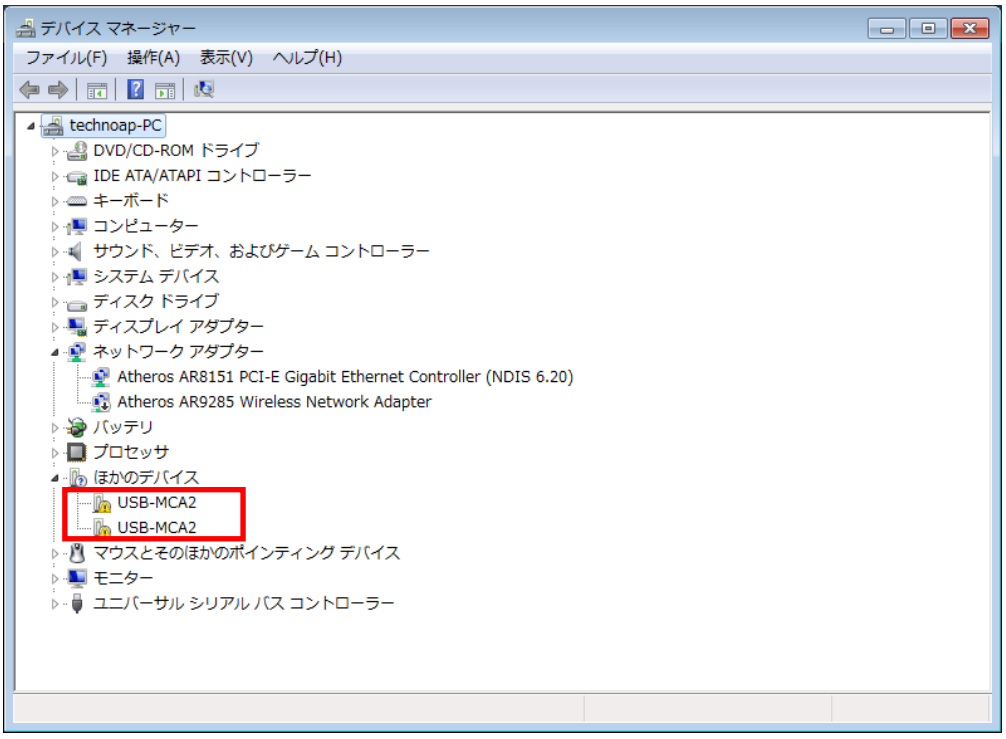
（2） Connect the device to the PC using a USB cable.

（3） A message will appear at the bottom right of the desktop: “Installing device driver software.”

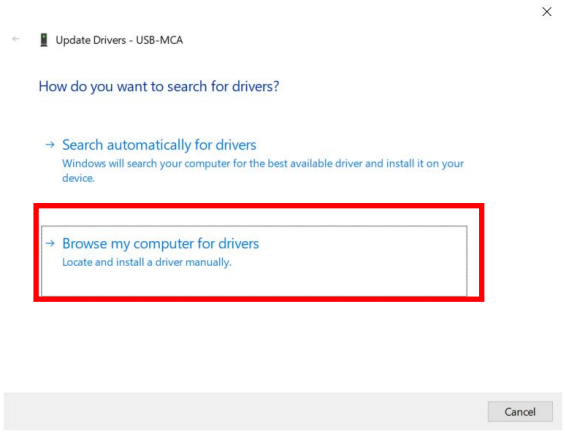


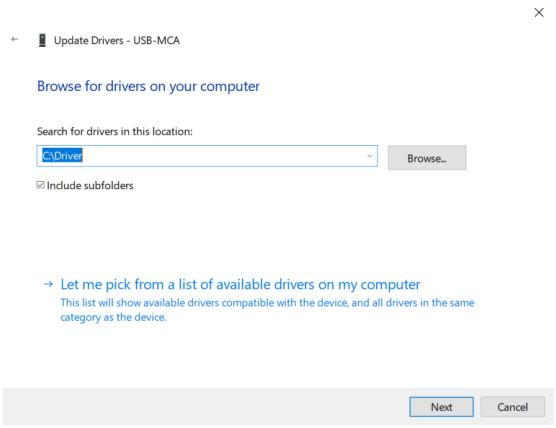
If the message “The device driver software was not installed correctly” appears, open Device Manager and check the icon for “USB-MCA2.” Right-click the icon and select “Update Driver Software.”



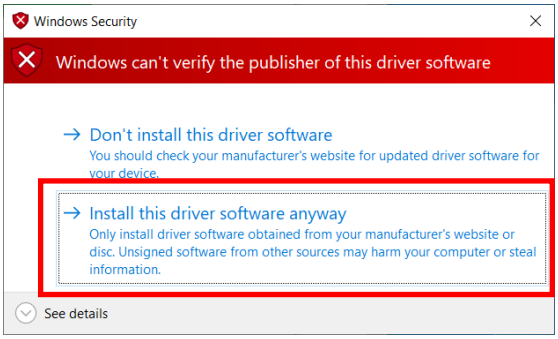


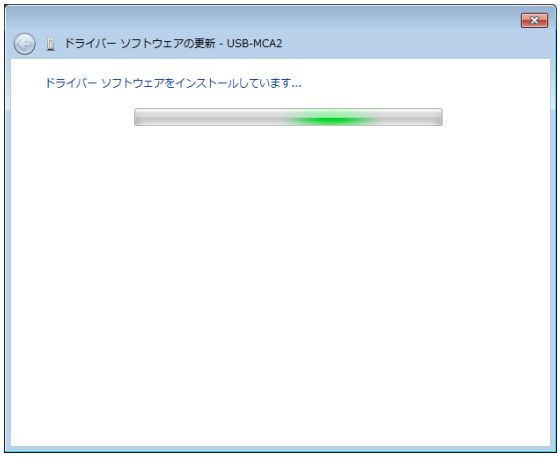
（4） Proceed with the installation using the interactive setup.

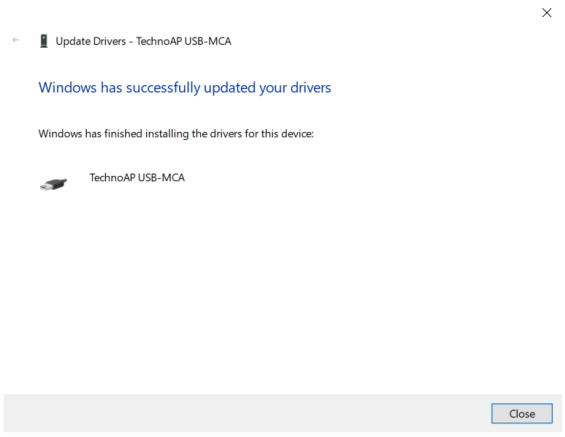


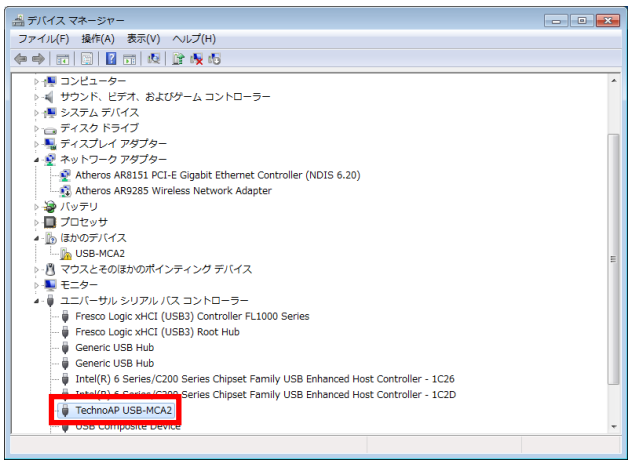


Browse to the "Driver" folder on the included CD.









Next, install the “TechnoAP USB-MCA2 Option.” After installing the “TechnoAP USB-MCA2” driver software, install the “TechnoAP USB-MCA Option2” following the same procedure. Verify in Device Manager that both the “TechnoAP USB-MCA2” and “TechnoAP USB-MCA2 Option” icons are functioning correctly. Once the driver software is installed properly, proceed to install the application. The installation steps are described in the next chapter.

For Windows 8 (64-bit)

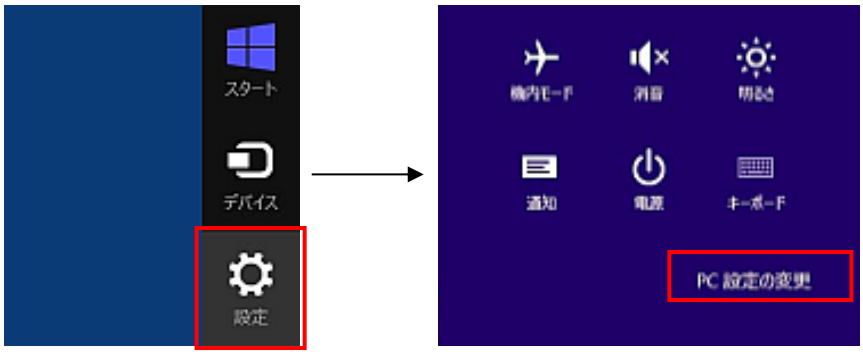
In Windows 8 (64-bit), unsigned driver software cannot be installed by default to prevent users from accidentally installing unverified drivers. Since this driver software is unsigned, you must disable “Driver Signature Enforcement” using the following steps before installation.

（1） Display the Charms bar on the Start screen.

For mouse operation: move the mouse to the upper-right or lower-right corner of the screen.

（2） For touch operation: swipe from the right edge of the screen toward the center.

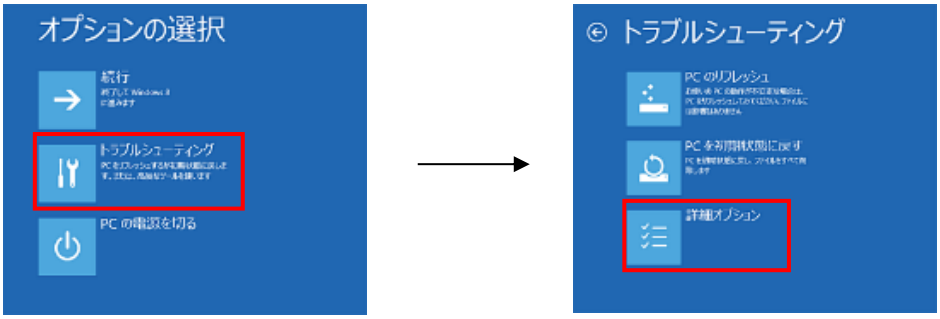
From the Charms bar, select “Settings,” then choose “Change PC settings” from the settings menu.



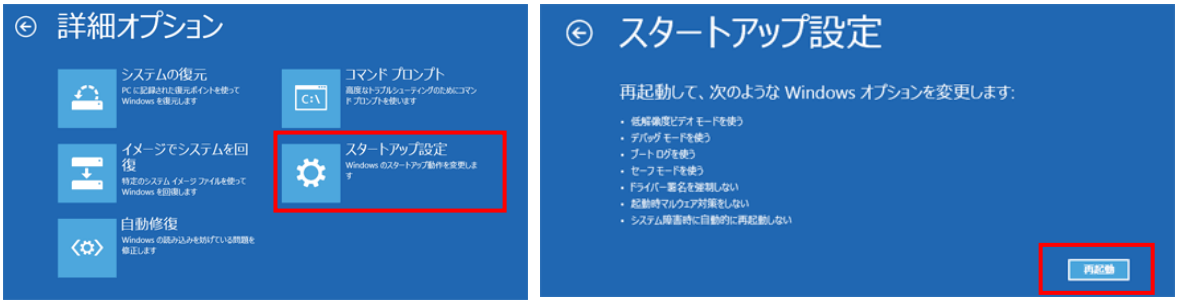
（3） In the “PC Settings” screen, select “General,” then under “Advanced startup,” choose “Restart now.”



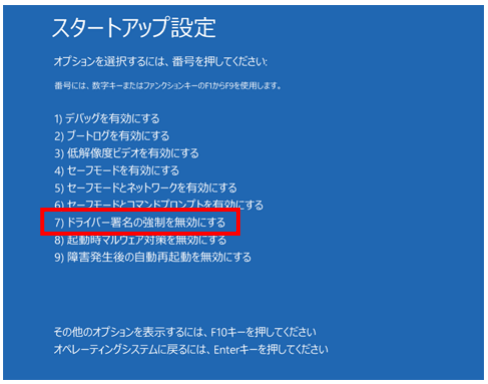
（4） On the “Choose an option” screen, select “Troubleshoot,” then on the “Troubleshoot” screen, select “Advanced options.”



（5） On the “Advanced options” screen, select “Startup Settings,” then on the “Startup Settings” screen, choose “Restart.”



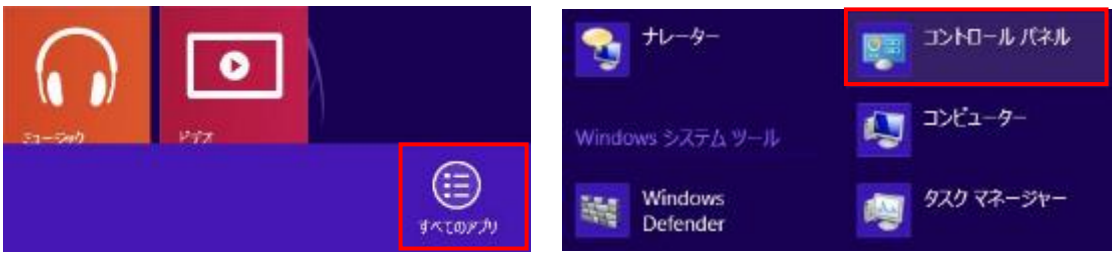
（6） On the “Startup Settings” screen after the restart, press the “7” key to select “7) Disable driver signature enforcement.”



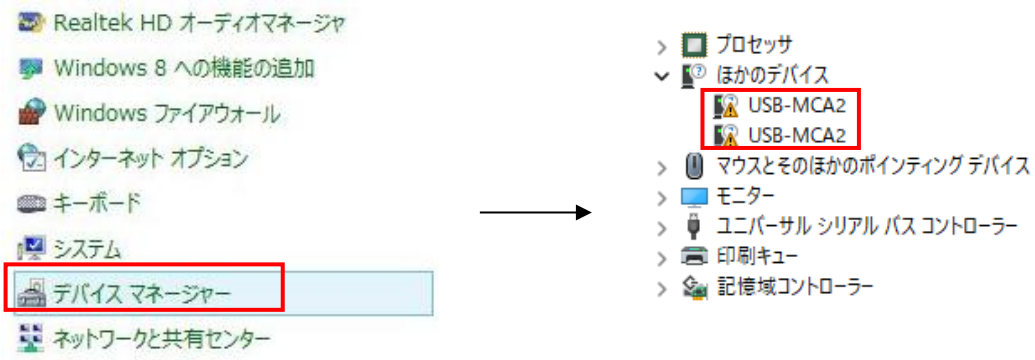
（7） (Required) After restarting, log in as Administrator or with an account that has administrator privileges.

（8） Connect the USB-MCA2 to the PC using a USB cable.

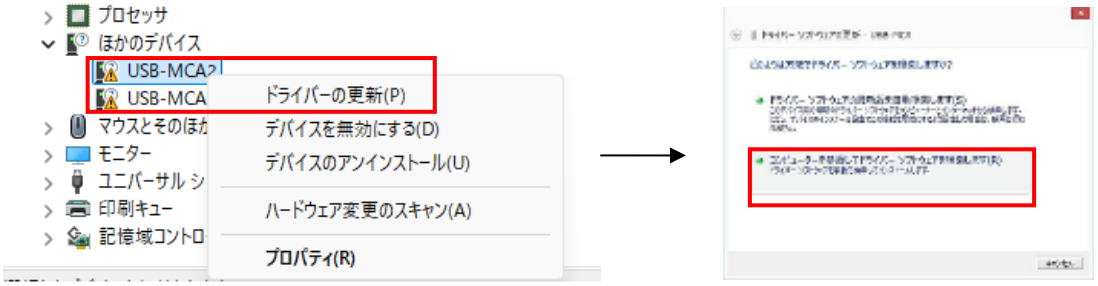
（9） Right-click on the Start screen to display the App Bar, select “All apps,” and then choose “Control Panel” from the Apps view.



（10） From the “Control Panel,” select “Device Manager” to display the Device Manager.



（１１） Right-click “USB-MCA2,” select “Update Driver Software,” and then choose “Browse my computer for driver software.”



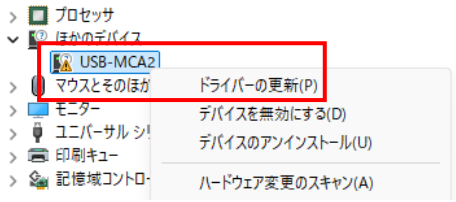
（１２） When the “Update Driver Software” screen appears, select “Browse.” On the “Browse For Folder” screen, choose the drive where the USB-MCA2 driver software is stored, then select “OK.” Back on the “Update Driver Software” screen, select “Next.”



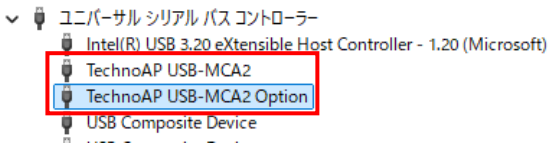
（１３） When the “Windows Security” screen appears, select “Install this driver software.” When the message “The driver software has been successfully updated” appears, select “Close.”



（１４） When “TechnoAP USB-MCA2” appears in the Device Manager, right-click the remaining “USB-MCA2” and repeat the steps from (11) to update the remaining driver software.



（１５） When “TechnoAP USB-MCA Option” appears in the Device Manager, the driver software installation is complete.



4.3 Installing the Application Software

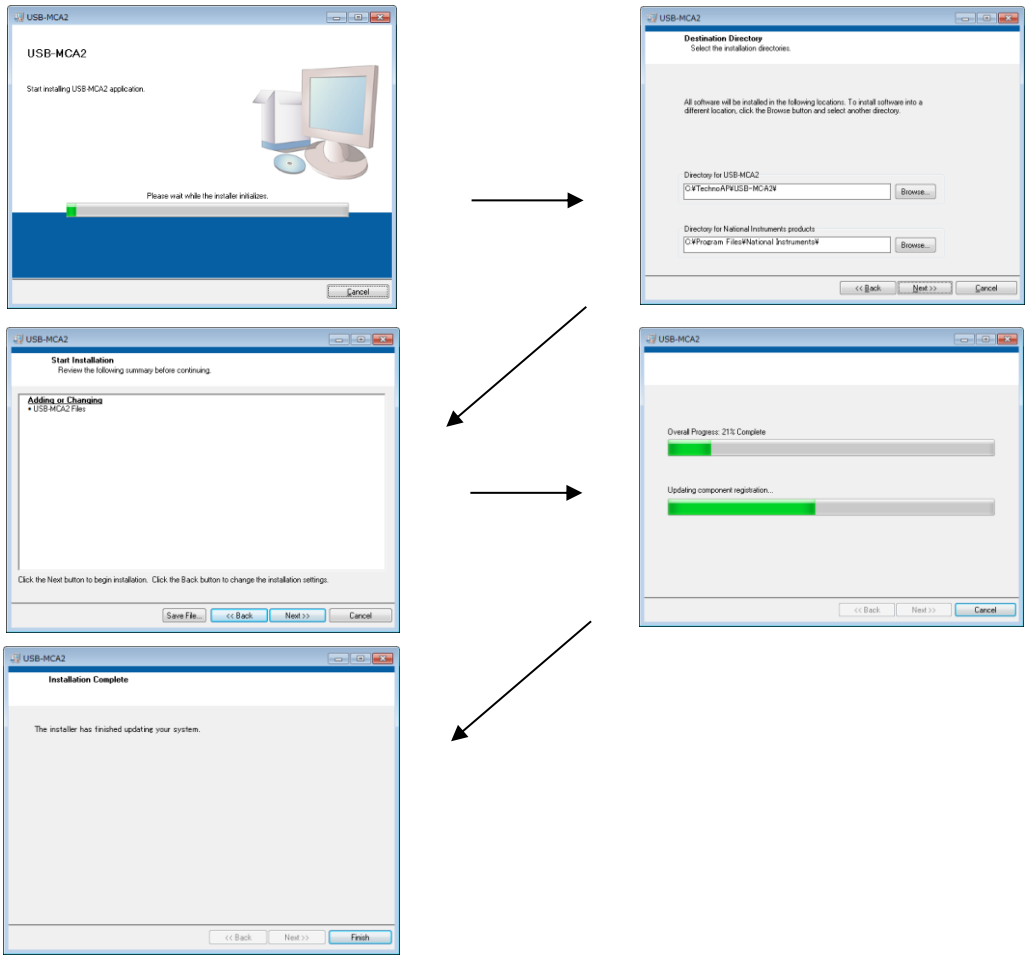
After successfully installing the driver software following the previous chapter, you need to install the USB-MCA2 application (executable file) and the LabVIEW runtime engine, which is required for the development environment. The installer on the included CD contains both the USB-MCA2 application and the LabVIEW runtime engine, allowing simultaneous installation.

Follow the steps below. If installing on a PC that already has other LabVIEW applications, make sure to close all LabVIEW applications before proceeding.

For Windows 7 (also applies to Windows 8):

(1) (Required) Log in as an Administrator or with an account that has administrative privileges.

(2) Run setup.exe located in the Application folder on the included CD. Proceed with the installation using the interactive wizard.



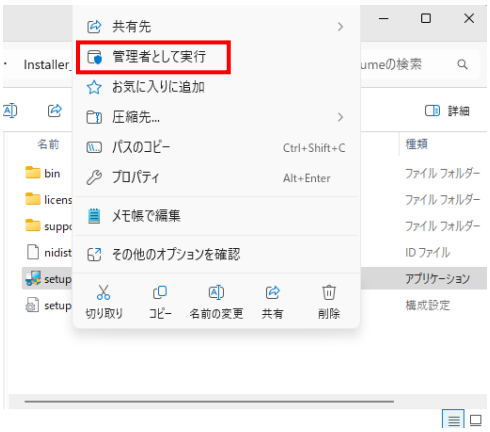
(3) Open Start → TechnoAP → USB-MCA2.

(4) The USB-MCA2 application will launch.

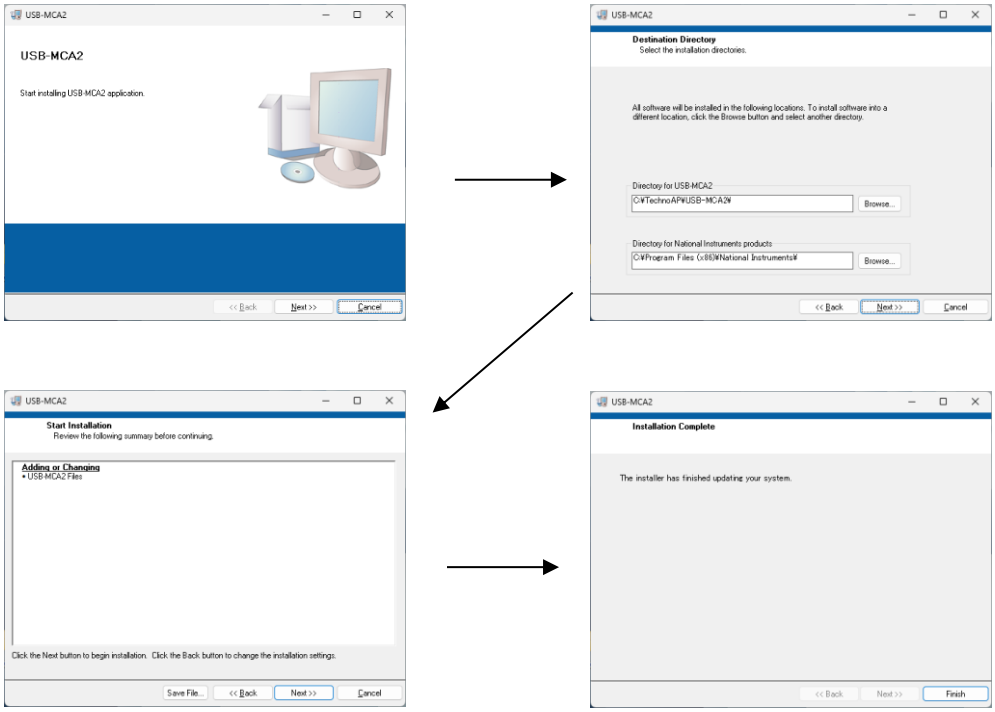
If a “connection error” dialog appears immediately after launch, check whether the device is properly connected to the PC and whether it is recognized in Device Manager.

For Windows 10 (also applies to Windows 11):

(1) Select setup.exe on the included CD, right-click it, and choose Run as administrator.



(2) Run setup.exe on the included CD and follow the interactive prompts to complete the installation.

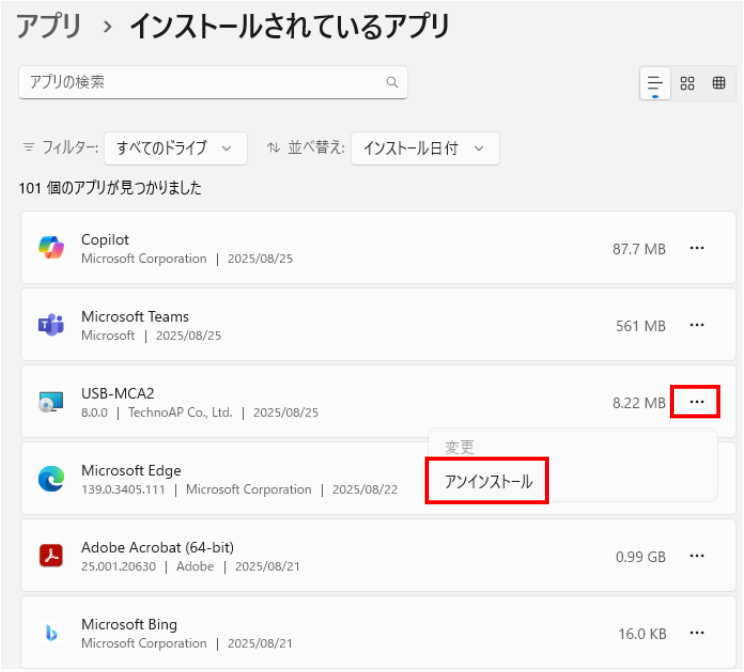


(3) A USB-MCA2 icon will be created on the desktop; double-click it to launch the application.

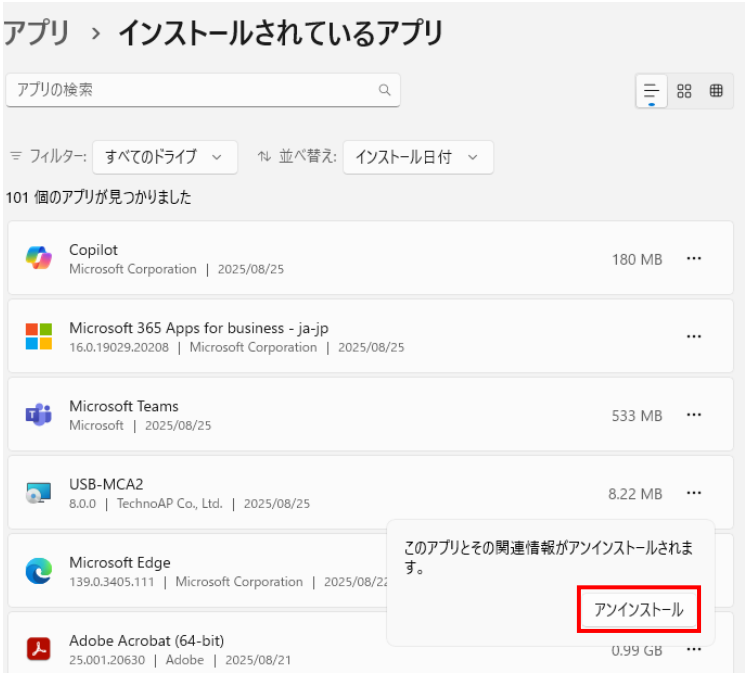
If a “connection error” dialog appears immediately after launching, check whether the device is properly connected to the PC and whether it is recognized in Device Manager.

Uninstallation:

To uninstall, right-click the Start button and select Installed apps (on Windows 10, Apps & features), then locate USB-MCA2, click the … (on Windows 10, select it), and choose Uninstall.



When the message “This app and its related information will be uninstalled.” appears, select Uninstall.



5 Application Screen

5.1 Startup Screen

When you launch USB-MCA2 from Start → TechnoAP → USB-MCA2 or from the Start screen or Apps view (on Windows 11), the following startup screen is displayed.

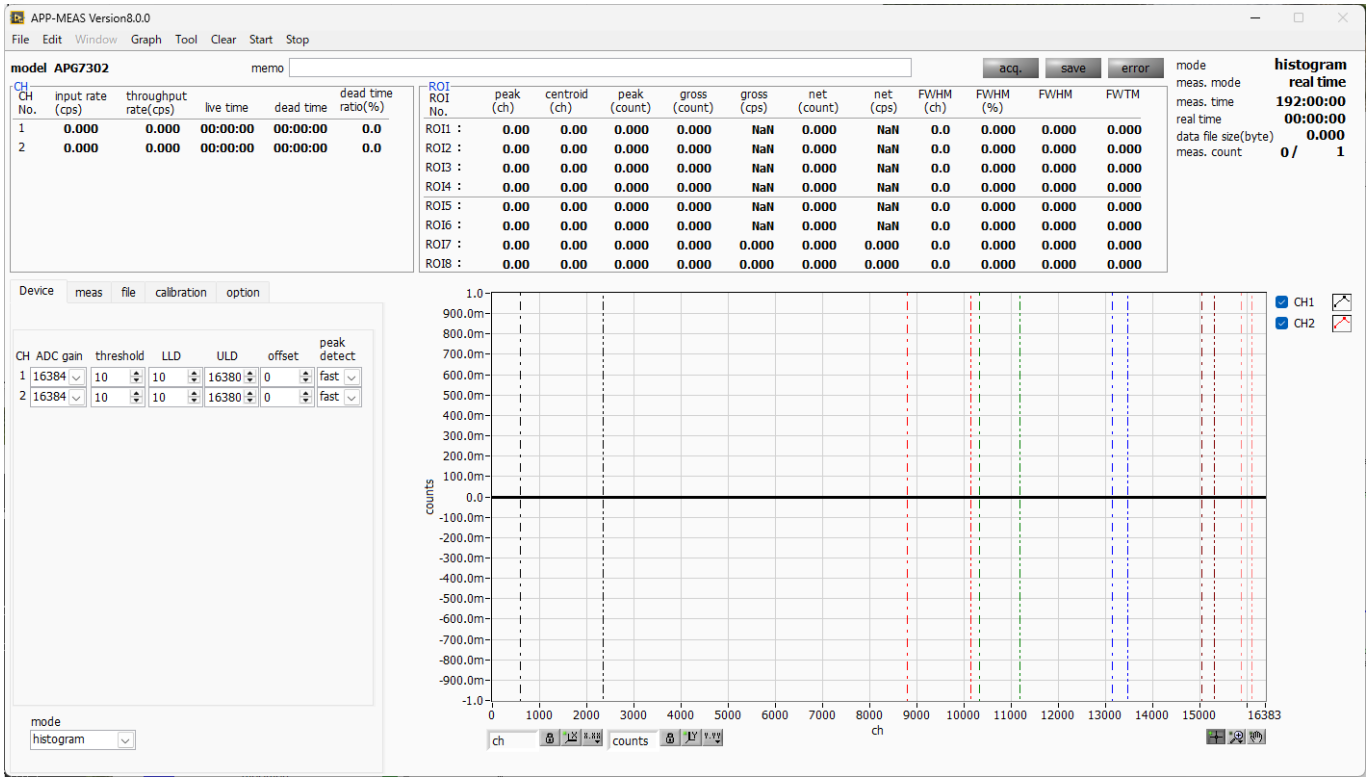


Figure 2: USB-MCA2 Startup Screen

Menu Section

File - open config	Load a configuration file
File - open histogram	Load a histogram data file
File - open 2D histogram	Load a coincidence 2D histogram data file
File - save config	Save the current settings to a file
File - save histogram	Save the current histogram data to a file
File - save 2D histogram	Save the current coincidence 2D histogram data to a file
File - save image	Save the device screen as a PNG image
File - convert to text from binary list data file	Open a window to convert list data files to CSV format
File – reconnect	Reconnect to the device
File – quit	Exit the application
Graph – histogram	Display the histogram graph screen
Graph - 2D histogram	Display the 2D histogram graph screen
Tool – gauss fit analysis	Open the Gaussian fit screen, perform Gaussian fitting on a specified peak, and conduct FWHM analysis
Tool – peak search analysis	Open the peak search screen, detect peaks in histogram data, and perform FWHM analysis
Clear	Initialize the histogram data in the device

Start	Send all settings to the device and start measurement
Stop	Stop measurement on the device
Tab Section	
Device	Settings related to device measurement
meas	Settings for measurement operation and measurement time
file	Settings related to files
calibration	Settings for energy calibration, including ROI (Region Of Interest)
option	Settings for MCS or coincidence mode
Outside Tabs	
model	Displays the device model APG7302
memo	Free text box; can be used for managing measurement data
acq. LED	Blinks during measurement
save LED	Lights up during data saving
error LED	Lights up when an error occurs
mode	Displays the operating mode such as histogram, list, coincidence, or MCS
meas. mode	Measurement mode; displays real time or live time (explained in the meas tab)
meas. time	Measurement time set
real time	Actual elapsed measurement time
data file size (byte)	Size of the saved file
meas. count	Current measurement count / total measurement count; total count is set in the config tab under the DSP section, repeat count
Channel Section	
input rate (cps)	Count per second when the input signal exceeds the threshold
throughput rate (cps)	Number of processed events per second
live time	Effective measurement time; real time – dead time
dead time	Dead time (ineffective measurement time); time from when the signal exceeds threshold until the peak is detected, converted via ADC, and reset
dead time ratio (%)	Dead time percentage per acquisition

ROI Section

Displays calculated results for each ROI

peak (ch)	Channel with maximum count
centroid (ch)	Center value calculated from the total counts
peak (count)	Maximum count
gross (count)	Total counts within the ROI
gross (cps)	Total counts per second within the ROI
net (count)	Total counts within the ROI after subtracting background
net (cps)	Total counts per second within the ROI after subtracting background
FWHM (ch)	Full width at half maximum (in channels)
FWHM (%)	Full width at half maximum / peak × 100
FWHM	Full width at half maximum
FWTM	Full width at one-tenth maximum

5.2 Exit Screen

To close the application, click File - quit from the menu. After doing so, the following confirmation screen will appear.

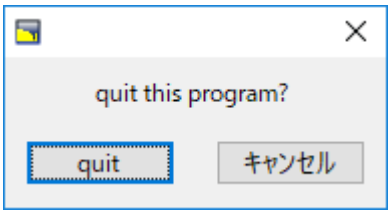


Figure 3: Exit Confirmation Screen

To exit, click the quit button. The application screen will close, and the application will terminate.

5.3 Device Tab

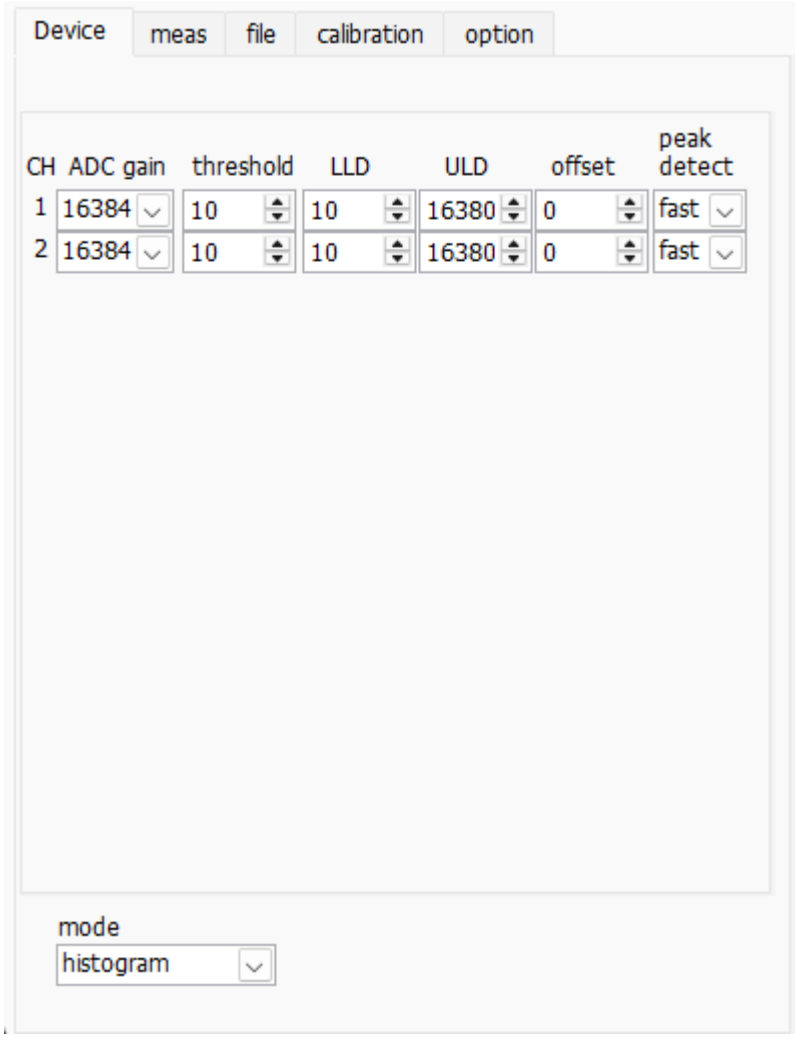


図 1 Device タブ

ADC gain

Select the ADC gain (number of pulse height divisions) from 16384, 8192, 4096, 2048, 1024, or 512 channels (ch). The input voltage range for each channel is 0 to 10 V. This range is divided into the selected number of channels.

Threshold

Set the threshold for the timing to start waveform acquisition. The unit is digit, and the setting range is 0 to 16384. It should be set below the LLD. The trigger for peak detection and ADC conversion occurs when the shaped input signal exceeds this threshold value. If this value is set too high, low-energy pulse heights cannot be acquired. Conversely, if set too low, noise may be captured. Adjust gradually while monitoring the input rate, throughput rate, and histogram to identify the boundary between noise and valid signals, and set the threshold slightly above this point.

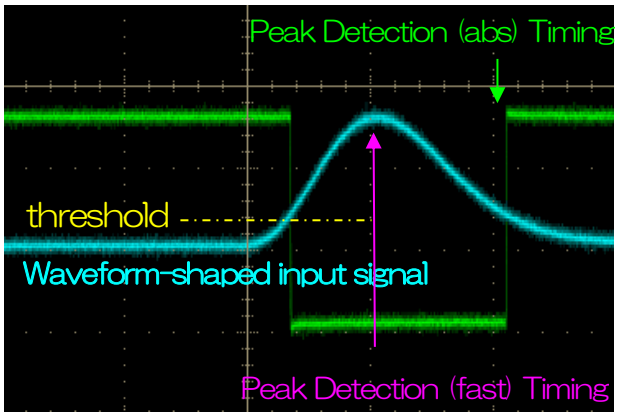


Figure 5: Threshold and Peak Detection (abs/fast) Timing

LLD:	Set the energy LLD (Lower Level Discriminator). The unit is in channels (ch). Channels below this threshold are not counted. Set the value above the threshold and below the ULD.
ULD	Set the energy ULD (Upper Level Discriminator). The unit is in channels (ch). Channels above this threshold are not counted. Set the value above the LLD.
Offset	Set the positive offset in channels (ch). Adding the offset value shifts the histogram to the right (toward higher pulse heights). It can be used for adjusting peak positions.
peak detect	Select the method for detecting the peak (maximum pulse height). See the figure on the previous page.
abs	ADC conversion is performed after the input signal exceeds the threshold, reaches the peak, and then decays below the threshold. This allows more accurate detection of the maximum pulse height.
fast	ADC conversion is executed at the first timing when the input signal exceeds the threshold and reaches the peak. Suitable for high count rates (several kcps or higher) and pile-up situations.
Mode	Select the operating mode.
histogram	Stores the pulse height of the amplifier signal in up to 16384 channels and generates a histogram with energy on the horizontal axis and counts on the vertical axis.
list	When the amplifier signal exceeds the threshold, the time information, maximum pulse height, and CH number are recorded as a single event and continuously transferred to the PC and saved to a file.
coincidence	Using CH1 and CH2, acquires the time and pulse height of events detected simultaneously within a set time window. The set time range is from ±40 ns to ±10 μs. You can save 2-channel simultaneous list data in list mode or create a 2D histogram (2048×2048 channels) with CH1 PHA on the horizontal axis and CH2 PHA on the vertical axis.
MCS	Generates histogram data with time on the horizontal axis (from nanoseconds to seconds) and counts on the vertical axis. The channel width (dwell time) can be selected from 40 ns to 100 s per channel, with 16384 channels and 232 counts per channel. When valid events within the LLD–ULD range are detected, counts are added to the corresponding elapsed-time channels based on the timing when the threshold was exceeded.

5.4 MeasTab

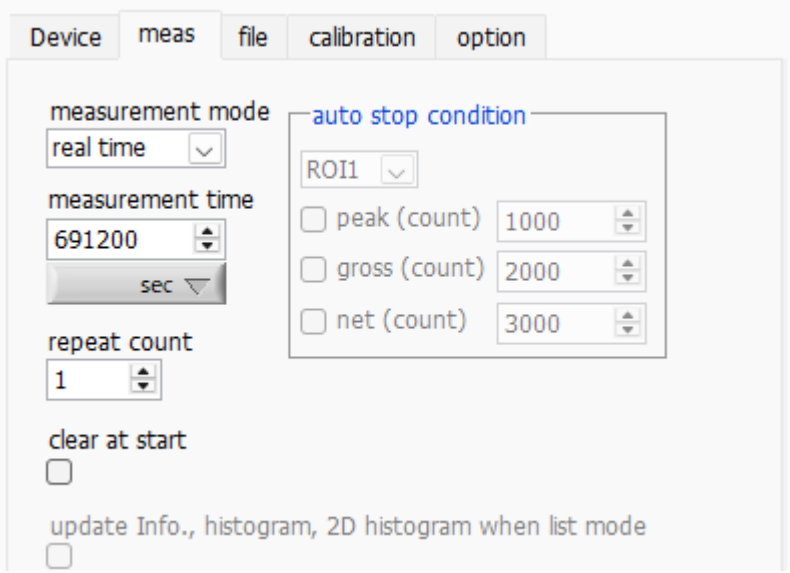


Figure 2 meas Tab

Measurement Section

measurement mode		Select real time, live time, or auto stop.
	real time	Measures data until the real time reaches the set measurement time (described later).
	live time	Measures data until the effective measurement time (real time minus dead time) reaches the preset value.
	auto stop	Measures data until the condition specified in the auto stop condition section (described later) is met. This option is available only when the mode is set to histogram.
measurement time		Sets the measurement duration. The range is from 00:00:00 to 192:00:00. In the case of auto stop, this setting is ignored and automatically set to 192:00:00. If the unit is set to seconds, the range is 0 to 691200 seconds.
repeat count		Specifies the number of measurement repetitions.
clear at start		Determines whether to initialize histogram data at the start of measurement. update Info., histogram, 2D histogram when list mode: During measurement in list mode, retrieves and displays data in the Information section. Additionally, creates and displays histograms from the received event data. This option is available only when the mode is set to list or coincidence. Note: Depending on the PC specifications, it may not be possible to receive all event data if processing cannot keep up.

Auto Stop Condition Section

This section is effective only when auto stop is selected in the measurement mode. It specifies the stop conditions for a single measurement. Measurement will stop when any one of the checked conditions is satisfied.

ROI selection	Selects one ROI to target for the following counts.
peak(count)	Stops the measurement when the peak(count) of the selected ROI reaches or exceeds the specified value.
gross(count)	Stops the measurement when the gross(count) of the selected ROI reaches or exceeds the specified value.
net(count)	Stops the measurement when the net(count) of the selected ROI reaches or exceeds the specified value.

5.5 File Tab

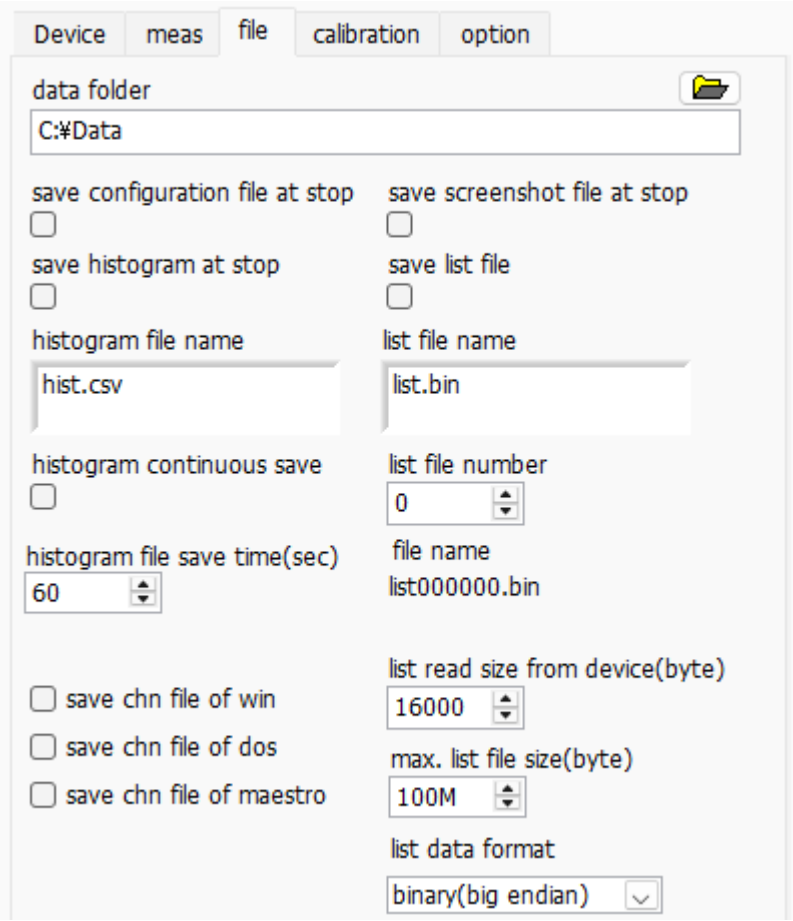


Figure7 file Tab

File Section

data folder	Specifies the common folder for storing data files, using an absolute path.
save configuration file at stop	When checked, the configuration file is automatically saved each time the measurement stops. The file extension is .ini.
save screenshot file at stop	When checked, the entire screen displayed at the time of measurement stop is saved as a file. The file extension is .png.
save histogram at stop	When checked, the histogram data at the time of measurement stop is saved as a file. The file extension is .csv.
histogram file name	Sets the name of the histogram data file. Subfolders can be specified, and file extensions can be omitted. **Note:** The actual saved file name uses this as a base according to a specific format. For example, if the data folder is set to C:¥Data, the histogram file name is histogram.csv, and the date/time is 2025/09/01 12:00:00, the saved file name will be C:¥Data¥histogram_20250901_120000.csv.

histogram continuous save	Determines whether the histogram data is saved at a set time interval. **Note:** Depending on system conditions, the save interval may deviate. This function is intended for simple backup purposes.
histo file save time (sec)	Sets the time interval for continuous histogram saving, in seconds. The range is 5 to 3600 seconds.
save list file	Specifies whether list data is saved to a file. This option is valid only in list mode.
list file name	Sets the name of the list data file. Subfolders can be specified, and extensions can be omitted. **Note:** The actual saved file name uses this as a base according to a specific format. For example, if the data folder is C:¥Data, the list file name is list_.bin, and the list file number is 0, the saved file will be C:¥Data¥list_000000.bin. list file number: Sets the starting number appended to the list data file. The valid range is 0 to 999999. If the number exceeds 999999, it resets to 0.
file name	Displays the actual file name generated from the list file name and list file number when saving.
list read size from device (byte)	Sets the minimum read data length in list mode, in bytes. The default is 10000 bytes. For high count rates, this can be increased to 20000 bytes to allow the PC to receive more events. For low count rates, this can be decreased to reduce the amount of data per read.
max. list file size (byte)	Sets the maximum size for saving list data files. SI notation is used (e.g., 1M, 10M, 100M), with a range from 1 MB to 2 GB.

list data format	Selects the file format for saving list data, either binary or text. binary (big endian) — Big-endian binary format. File size is compact, with the most significant byte at the lowest memory address. Commonly used as network byte order. Data sequence is easy to inspect visually. binary (little endian) — Little-endian binary format. File size is compact, with the least significant byte at the lowest memory address. Used on Windows, Mac OS X, and Linux. Data sequence is difficult to inspect visually. txt (CSV) — Comma-separated text format. Data can be easily viewed in text editors or Excel. **Note:** Commas and line breaks are included, and as measurement time increases, the length of timestamp data grows, increasing the file size per event.
save chn file of win	Outputs a CHN file for Windows version when "save histogram at stop" is checked.
save chn file of dos	Outputs a CHN file for DOS version when "save histogram at stop" is checked.
save chn file of maestro	Outputs a CHN file for Maestro version when "save histogram at stop" is checked. Example: If the data folder is C:¥Data, histogram file name is histogram.csv, and the date/time is 2025/09/01 12:00:00, the saved files will be: C:¥Data¥histogram_20250901_120000_win_CH1.chn C:¥Data¥histogram_20250901_120000_dos_CH1.chn C:¥Data¥histogram_20250901_120000_maestro_CH1.chn

5.6 Calibration Tab

We will set the ROI (Region of Interest) and perform energy calibration. By defining the ROI on the histogram peaks, we can calculate parameters such as the peak counts and full width at half maximum (FWHM).

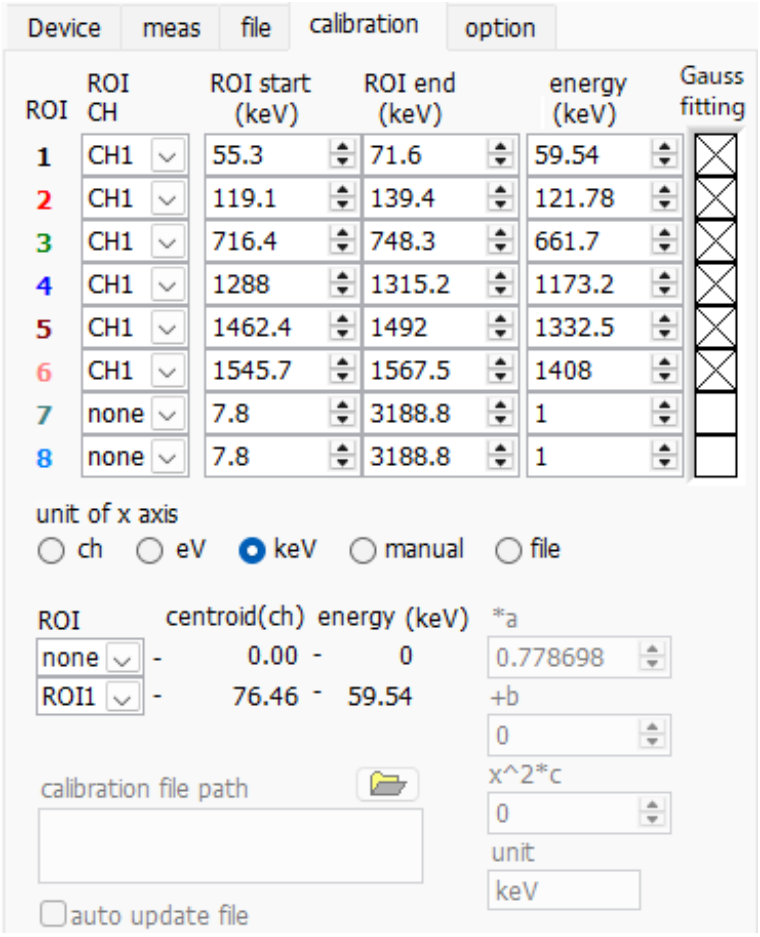


Figure 8: Calibration Tab

ROI Section

ROI CH	Selects the CH number for the ROI target. Up to 8 ROIs can be set.
ROI start	Sets the start position of the ROI. The unit depends on the energy calibration.
ROI end	Sets the end position of the ROI. The unit depends on the energy calibration.
Energy	Defines the energy value of the peak position (in ch). The unit depends on the energy calibration. For example, for ^60Co, set values such as 1173.2 or 1332.5. If "ch" is selected in the "unit of x areas" section, the system detects peaks within the ROI, calculates keV/ch from the peak position (ch) and the set energy value, and applies it to the FWHM calculation results.

unit of x areas Section

Specifies the unit of the X-axis. The X-axis label changes according to this setting.

Ch	Displays the X-axis in channel (ch) units. The units of *peak*, *centroid*, *FWTM*, and *FWHM* in the ROI section are also expressed in ch.
eV	Displays the X-axis in electron volts (eV). Using two peaks (centroid values) and their corresponding energy values within one histogram, a linear calibration function (y = ax + b) is calculated so that the channel (ch) values are converted to eV. The slope (a) and intercept (b) are automatically determined and applied to the X-axis. The units of *peak*, *centroid*, *FWTM*, and *FWHM* in the ROI section become eV.
keV	Displays the X-axis in kilo-electron volts (keV). Similar to the eV mode, two calibration points (centroid and energy values) are used to calculate the linear function (y = ax + b), which converts channels (ch) to keV. The units of *peak*, *centroid*, *FWTM*, and *FWHM* in the ROI section become keV. *Example:* If 5717.9 ch corresponds to 1173.24 keV (from ^60Co) and 6498.7 ch corresponds to 1332.5 keV, the two-point calibration automatically calculates (a = 0.20397) and (b = 6.958297).
Manual	Applies a quadratic function (y = ax + b + cx^2). The unit can be set arbitrarily.
File	Uses an energy calibration file created with Tool → Create Calibration File. The file extension is fixed as ".ec". For details on the energy calibration file, refer to *Tool Section – Create Calibration File*.
ROI	Selects the ROI number used for energy or time calibration. The adjacent *centroid* and *peak* fields display the centroid value and set energy of the selected ROI. For example: Selecting *ROI1* and *none* performs single-point calibration using the centroid and set energy of ROI1.Selecting *ROI1* and *ROI2* performs two-point calibration using the centroid and set energy values of both ROI1 and ROI2.
Gauss fitting	When checked, performs Gaussian function fitting. The calculation results are displayed in the ROI section.
manual a and b	Displays the slope (a) and intercept (b) of the linear function (y = ax + b), which is the result of the energy calibration and defines the horizontal axis of the histogram.
Unit	When *manual* is selected, allows you to freely define the unit name used for the histogram's X-axis label and the unit used in ROI calculations.

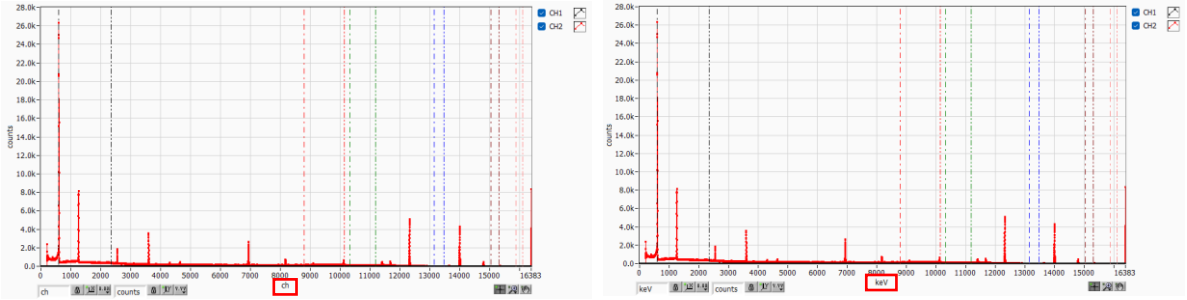


Figure 9 When "keV" is selected in the Calibration section

(Left: Before energy calibration execution Right: After energy calibration execution)

5.7 Option Tab

In the Option tab, you can configure settings for functions such as MCS (Multi Channel Scaler) and coincidence (simultaneous measurement).

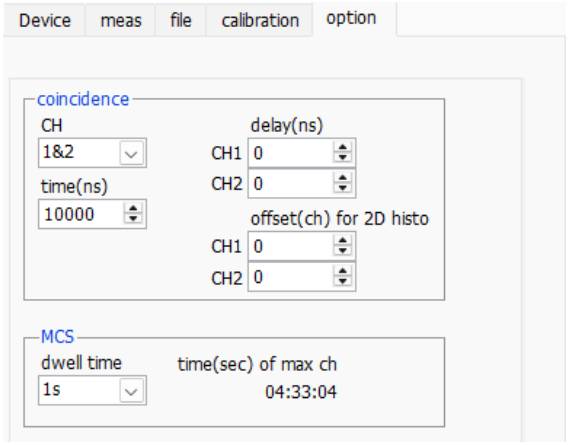


Figure10 Option Tab

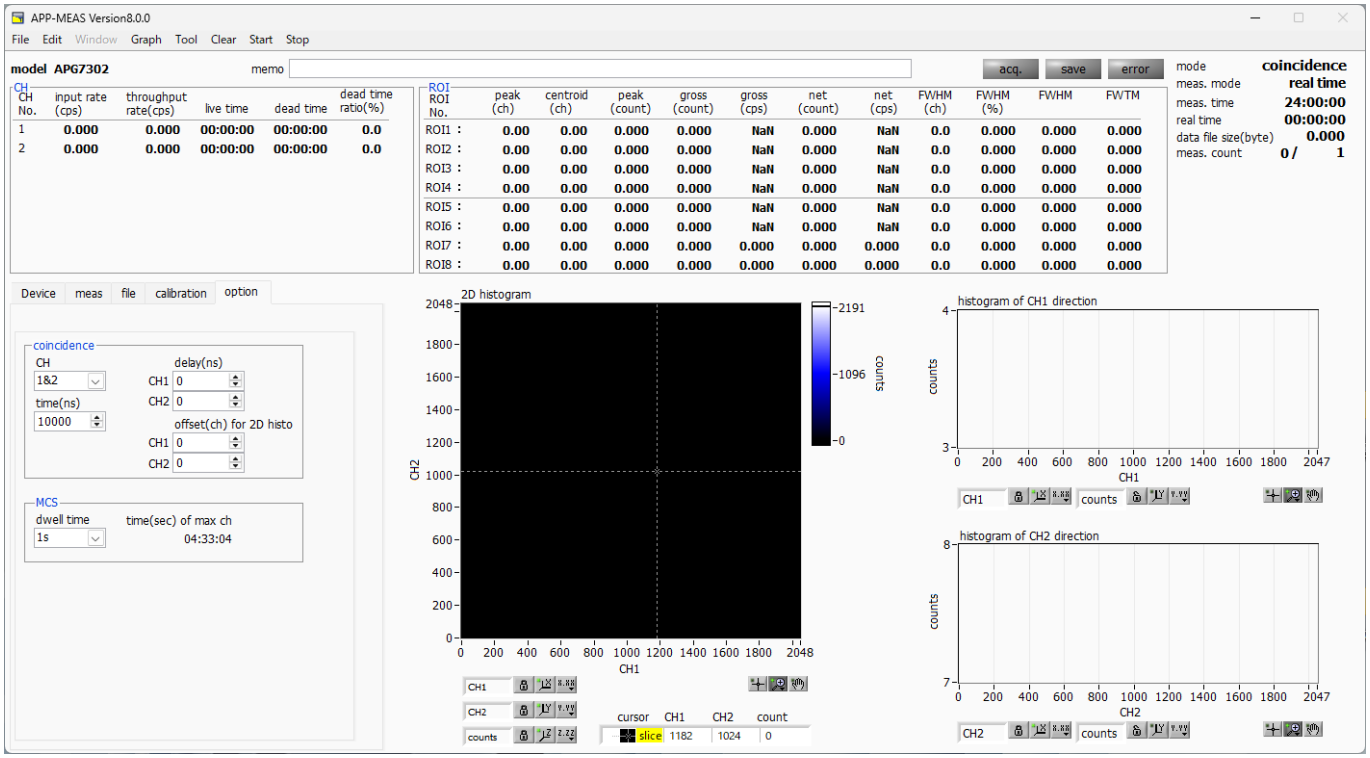


Figure 11: Coincidence 2D Histogram

MCS Section

dwell time

Specifies the time width per channel on the horizontal time histogram. The selectable range is from a minimum of 40 ns to a maximum of 100 s. The available options are as follows:

40 ns,	80 ns,	120 ns,	160 ns,	200 ns,	240 ns,	280 ns,	320 ns,	360 ns,
400 ns,	440 ns,	480 ns,	520 ns,	560 ns,	600 ns,	640 ns,	680 ns,	720 ns,
760 ns,	800 ns,	840 ns,	880 ns,	920 ns,	960 ns,	1 µs,	2 µs,	5 µs,
10 µs,	20 µs,	50 µs,	100 µs,	200 µs,	500 µs,	1 ms,	2 ms,	5 ms,
10 ms,	20 ms,	50 ms,	100 ms,	200 ms,	500 ms,	1 s,	2 s,	5 s,
10 s,	20 s,	50 s,	100 s					

time (sec) of max. ch

Displays the total time corresponding to the maximum channel count based on the dwell time setting. Since there are 16,384 channels, when the dwell time is set to the minimum value of 40 ns, the total time is:

40 ns × 16,384 channels = 655,360 ns (655.36 µs).

Coincidence Section

CH — Specifies the target channels. Only 1 & 2 (CH1 and CH2) can be selected.

time (ns) — Defines the time window for coincidence counting. The range is from 40 ns to 10,000 ns (10 μs). If the time between one channel exceeding its threshold and the other channel exceeding its threshold falls within this range, the events are counted as coincident. The time information, channel number, and pulse height of each channel are read out and saved.

delay (ns) — Sets the coincidence delay time. This allows adjustment for signal transmission delays between channels. The range is from 0 to 10,000 ns (10 μs) and can be used to correct for time differences caused by factors such as cable length.

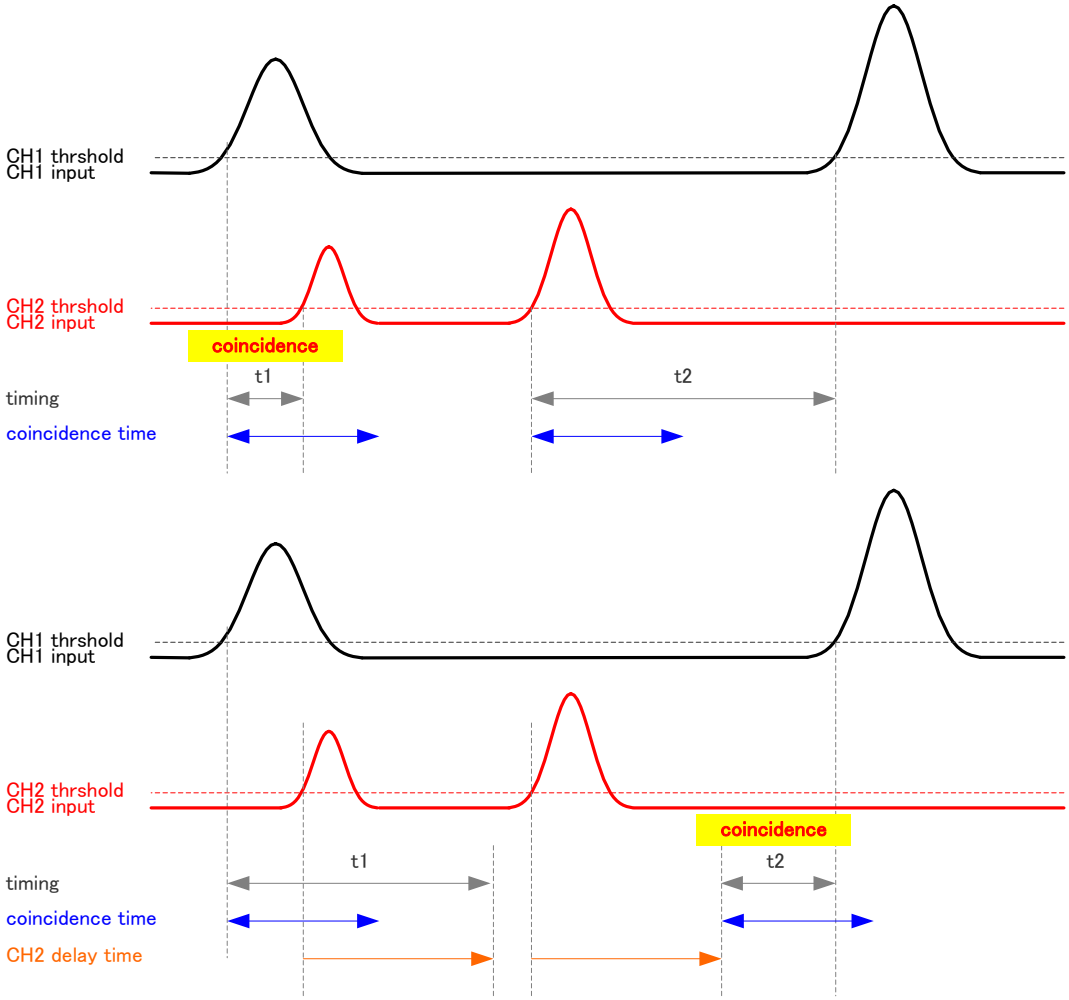


Figure 12: Example of Coincidence Timing (Top: without delay, Bottom: with CH2 delay time)

offset (ch) for 2D histo — Sets the offset channel for the 2D coincidence histogram. The range is 0 to 2048 (4096−2048) channels. Adjust the offset so that the peaks fit within the 2048 × 2048 display range.

Graph — Displays the 2D histogram. The horizontal axis represents the pulse height of CH1 (in channels), the vertical axis represents the pulse height of CH2 (in channels), and the Z-axis represents the counts. The maximum number of channels for both the horizontal and vertical axes is 2048.

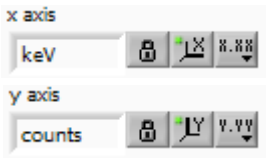
spectrum of CH1 direction — Displays a 1D channel-summed histogram from the CH1 side.

spectrum of CH2 direction — Displays a 1D channel-summed histogram from the CH2 side.

5.8 Graph

Displaying the histogram from CH1 to CH2

spectrum	graphHistogram (spectrum) in histogram mode, with the horizontal axis representing energy and the vertical axis representing counts.
cursor x	Sets the position of the dashed cursor on the graph. The count value at this position is displayed in cursor y.
cursor y	Displays the count value at the intersection of the dashed cursor. The X-axis position of the cursor can be set via cursor x or by drag-and-drop.
plot legend	Sets the color, line style, etc., of the graph. Visibility can be toggled via the sub-menu on the graph.
horizontal axis range	Right-click on the horizontal axis and check “auto-scale” to enable automatic scaling. Uncheck to fix the minimum and maximum values. To change the min or max, hover the mouse over the value, then click or double-click to modify. Options include auto-scale enable/disable, precision, and mapping type (linear/logarithmic).
vertical axis range	Right-click on the vertical axis and check “auto-scale” to enable automatic scaling. Uncheck to fix the minimum and maximum values. To change the min or max, hover the mouse over the value, then click or double-click to modify. Options include auto-scale enable/disable, precision, and mapping type (linear/logarithmic).



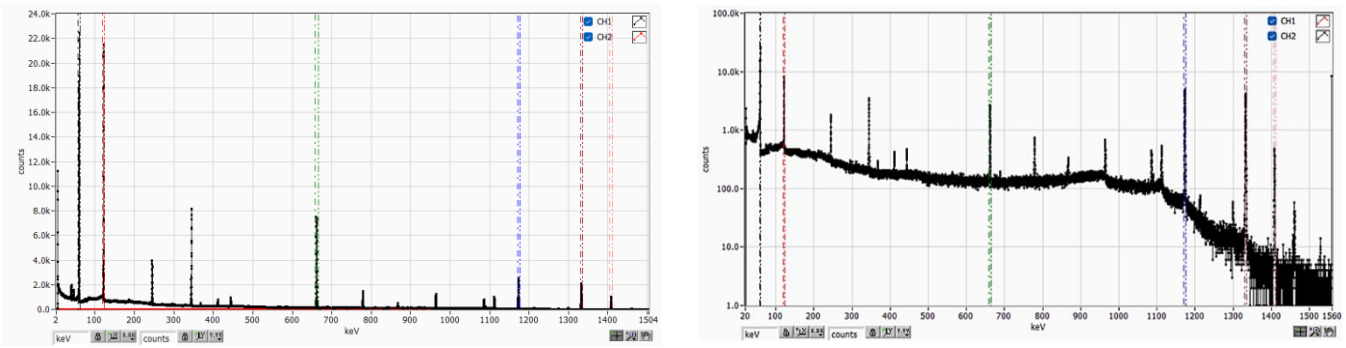


Figure 13 – Histogram Graph (Left: Linear vertical axis mapping, Right: Logarithmic)



Cursor movement tool. The cursor can be moved on the graph when setting ROI.



Zoom. Clicking allows you to choose from six types of zoom-in and zoom-out operations and execute them.

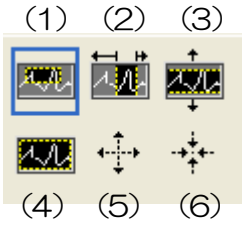


図 3 Graph Zoom In and Zoom Out Tools

(1) Rectangle Zoom	Use this option to click a point on the display as a corner of the zoom area, then drag the tool until the rectangle covers the desired zoom area.
(2) X-Zoom	Zoom in along the X-axis of the graph.
(3) Y-Zoom	Zoom in along the Y-axis of the graph.
(4) Fit Zoom	Automatically scales all X and Y axes on the graph.
(5) Zoom Out Centered on Point	Click the point that will serve as the center for zooming out.
(6) Zoom In Centered on Point	Click the point that will serve as the center for zooming in.
Pan Tool	
	Grab the plot to move it across the graph.

6 Measurement

6.1 Histogram mode

（1） Select "histogram" in "mode" in "config" tab. “histogram” is displayed for “mode” in the "Information" section.

（2） Click "Clear" on the menu bar. The histogram data in this device is initialized.
If you want to continue the previously measured histogram or measurement results, start the next measurement without clicking "Clear".

（3） Click “Start” on the menu bar to start measurement after all settings have been sent to this device.

（4） After starting measurement, transition to the following state.

- "acq" LED blinks.
- The measurement status is displayed in the "Information" section.
- Real time acquired from this device is displayed in "real time".
- The "live time" of each channel will display the live time acquired from this device.
- The dead time obtained from this device is displayed in "dead time" of each channel.
- For “ROI” for each “ROI No.”, center value, gross count (total within range) and rate, net count (total within range total minus background) by setting “ROI range” in “calibration” tab Calculation results such as net count), rate, half width, 1/10 width etc are displayed.
- The graph displays the histogram of the peak value on the horizontal axis.

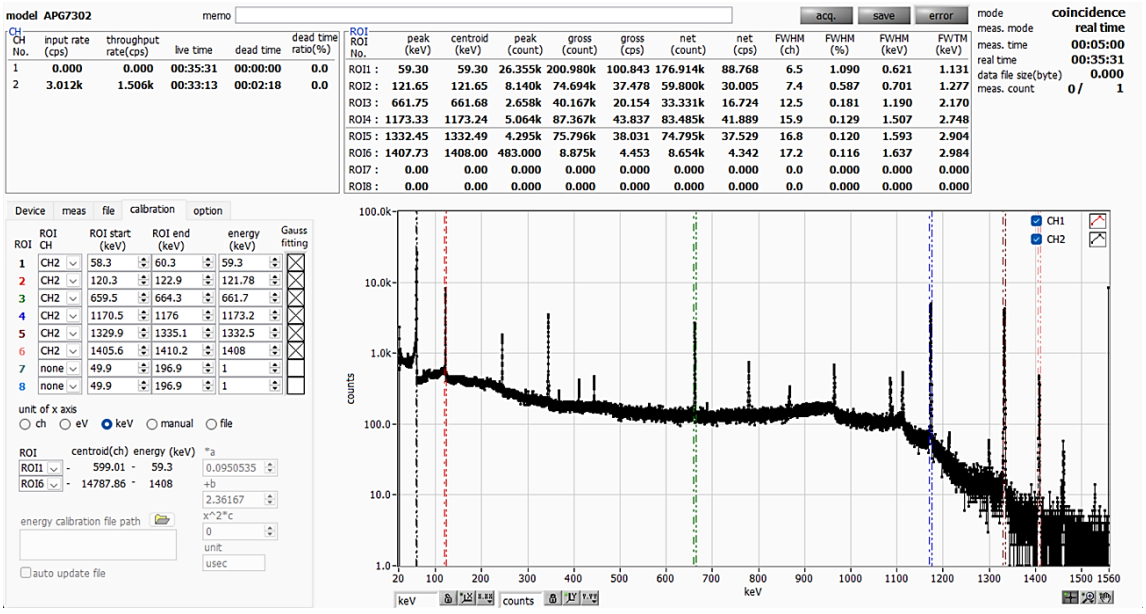


Fig. 15 Histogram mode measurement screen

6.2 List mode

（1） Perform measurements in advance using the aforementioned histogram mode to check the histogram status, count rate, etc.

（2） Select list under mode in the Device tab.

（3） Set the data save location under list file name in the File tab.

（4） Click Clear on the menu bar to initialize the list measurement buffer data inside the device.

（5） Click Start on the menu bar; all settings will be sent to the device, and measurement will begin.

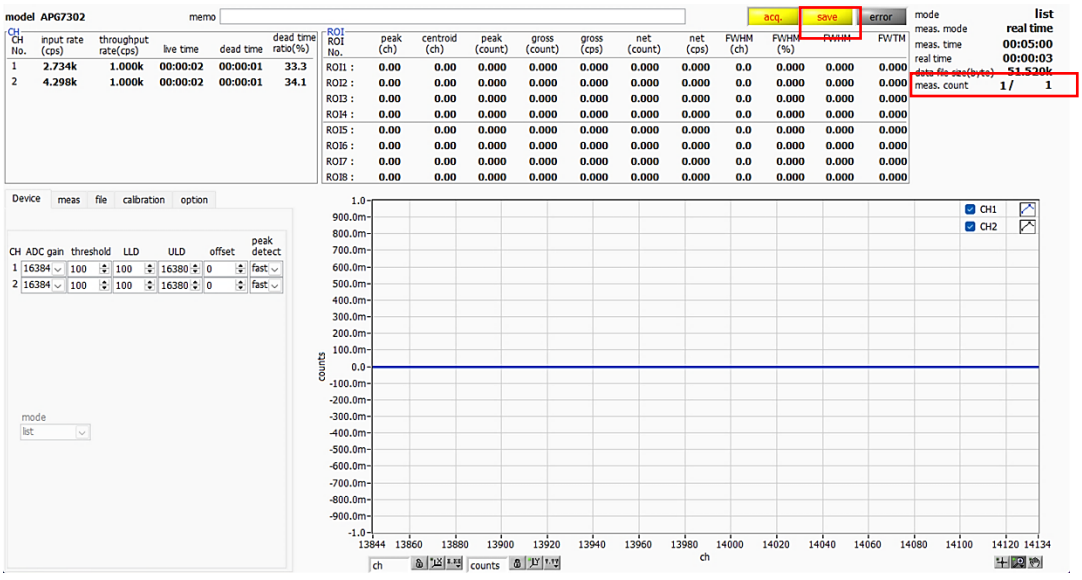
After starting measurement, the system transitions as follows:

- list is displayed in mode at the top right of the screen.
- The save LED blinks, and the currently saving file size is displayed in list file size (byte).
- The saving file name is displayed in file name and the saving file size is displayed in file size in the File tab.
- When max. list file size (byte) is reached, the active file is closed; subsequently, the list file number increments by 1, file name updates to the new file name, and data saving continues.

If update Info., histogram, 2D histogram when list mode in the File tab is checked, ROI calculation results (centroid value, gross count [total sum within range] and rate, net count [net count subtracting background from range total] and rate, FWHM, FWTM, etc., based on the ROI range settings in the Calibration tab) are displayed for each ROI No., and the histogram is displayed on the graph.

Note: Displaying the histogram in list mode incurs a heavy processing load, so please exercise caution during high count rate measurements.

By using the VETO (CLR) terminal, time information in list data can be cleared even during measurement; an LV-TTL level rising edge (pulse width ≧ 100 ns) triggers the clear2.



- **Figure 16:** List mode measurement screen

6.3 Coincidence mode

（1） Connect signals from amplifiers, etc., to CH1 and CH2.

（2） Select histogram under mode in the Device tab.

（3） Check the current CH1 and CH2 histograms in histogram mode to identify the center channel of the peak of interest.

（4） Set LLD and ULD broadly in the Device tab.

（5） Click Clear → Start on the menu bar to send all settings to the device and begin measurement.

（6） Set ROIs on the loaded peaks of interest for CH1 and CH2, and check the centroid(ch) values.

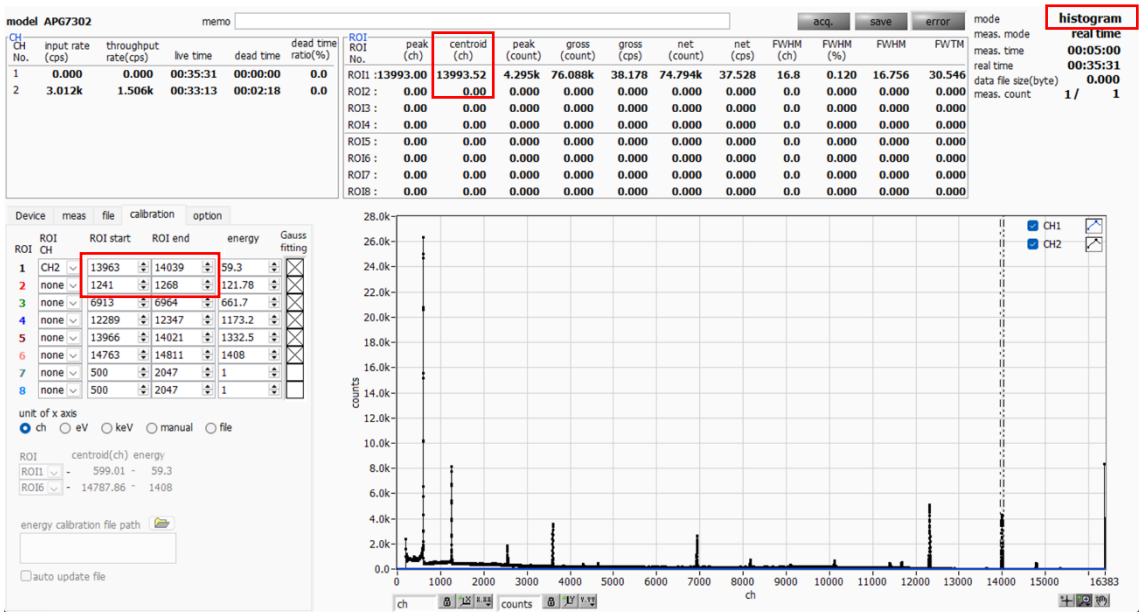


Figure 17: Checking centroid(ch) of the peak of interest in histogram mode

（7） After checking centroid(ch) values, click Stop on the menu bar to stop measurement.

（8） Set LLD and ULD, perform measurement in histogram mode again, and confirm that the histogram within the LLD and ULD range is acquired.

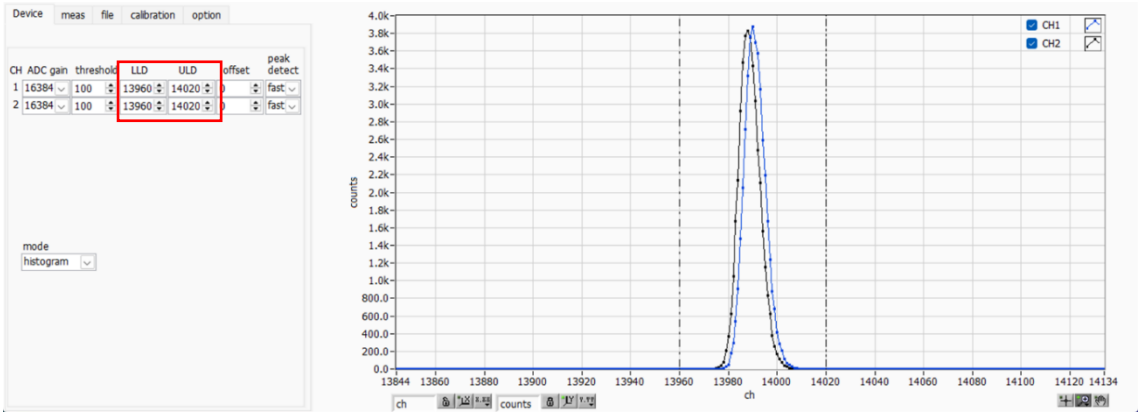


Figure 18: Checking the setup state of LLD and ULD in histogram mode

（9） Select coincidence under mode in the Device tab.

（10） Before starting measurement in coincidence 2D histogram, click Graph - 2D histogram on the menu bar to switch to the 2D histogram screen.

（11） Coincidence 2D histogram data is generated within this application based on list data; for display and saving, use the save list file checkbox in the File tab and the update Info., histogram, 2D histogram when list mode checkbox in the Meas tab.

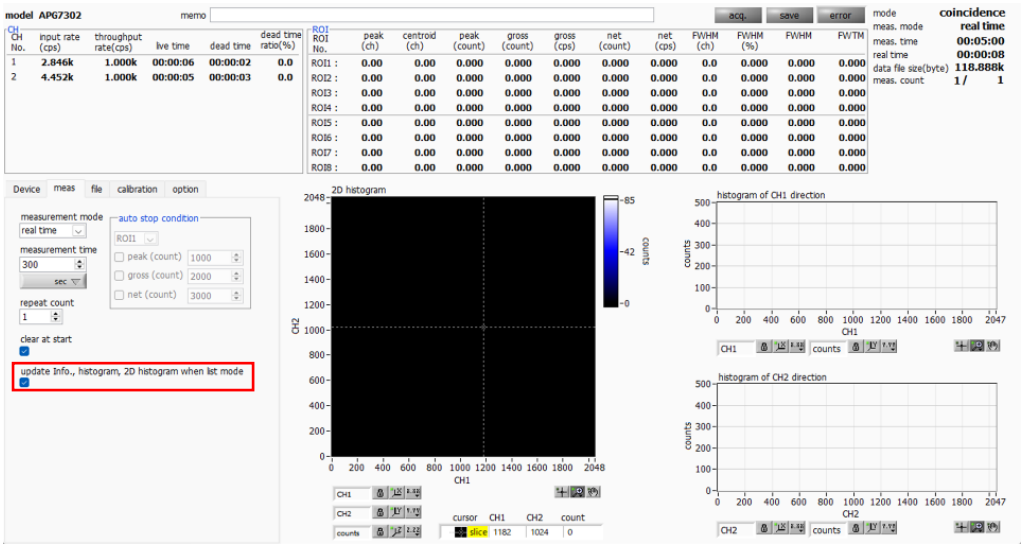


Figure 19: Meas tab settings

（12） Configure settings in the coincidence section of the Option tab4. In this example, because the centroid values of the energy range of interest exceed the 2D histogram range (CH1 2048 × CH2 2048) on both channels, setting offset(ch) for 2D histo is required4. To place each at the center (1024 ch), set 12969 ch calculated from center value (13993 in this example) minus 1024 ch.

（13） Click Clear on the menu bar to initialize the list measurement buffer data inside the device.

（14） Click Start on the menu bar to send all settings to the device and begin measurement.

（15） After starting measurement, the system transitions as follows:

- acq LED blinks
- mode displays coincidence
- set measurement time is displayed in meas. time
- real time acquired from the device is displayed in real time

When **update Info., histogram, 2D histogram when list mode** is checked:

- measurement status is displayed in the Information section
- a map graph is displayed in the coincidence 2D histogram graph
- histograms are displayed from the CH1 direction and CH2 direction

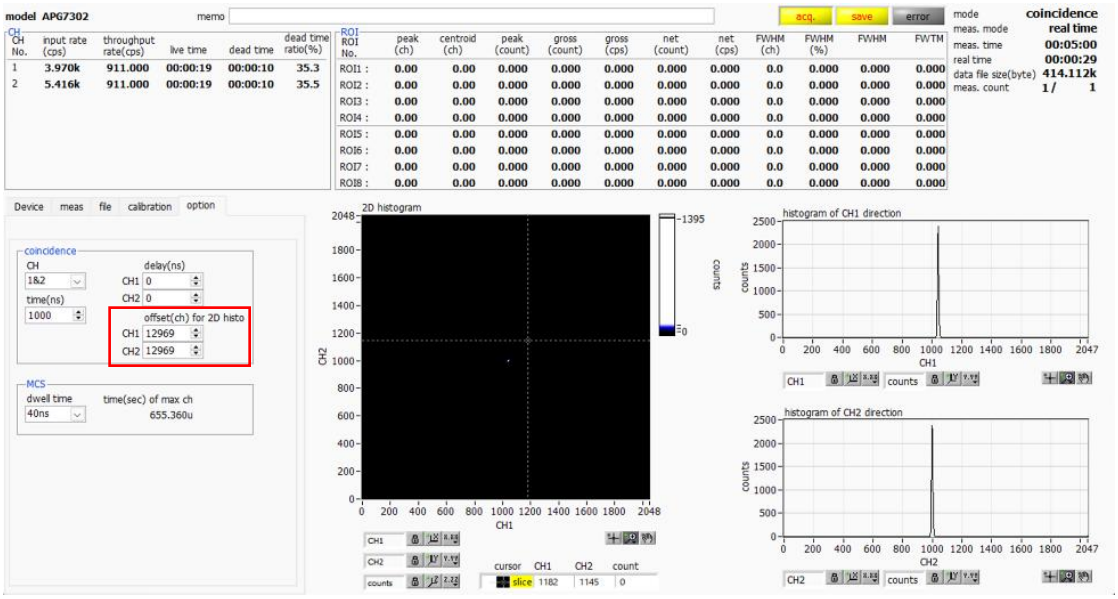


Figure 20: Coincidence 2D histogram (*Reference data)

6.4 MCS mode

（1） Select MCS under mode in the Device tab.

（2） Set LLD and ULD in the Device tab to use the timestamps when pulse heights within this range are acquired.

（3） Select measurement time per channel under dwell time in the Option tab.

（4） For horizontal axis calibration in the Calibration tab: if peak time is known in advance, select from ns, μs, ms, sec, and set that time in peak of ROI; if unknown, check manual, enter the time selected in dwell time into manual a, and enter its unit name into unit.

（5） In MCS mode, two types of measurement are available depending on whether an external elapsed time reset signal is used:

With Reset: Connect a periodic event that resets elapsed time as a reset signal to the VETO (CLR) terminal to generate a histogram of elapsed time from reset to event detection5. An LV-TTL level rising edge (pulse width ≧ 100 ns) at VETO (CLR) resets elapsed time5. The system measures elapsed time from reset until the input signal exceeds threshold; when a valid event within LLD–ULD is detected, 1 is added to the corresponding channel in the dwell-time interval histogram based on that elapsed time5. Adjust the reset signal or dwell time so the reset period is less than time (sec) of max ch.

Without Reset: Adds 1 to the corresponding channel in the dwell-time interval histogram based on elapsed time from measurement start to event detection. Since elapsed time is not reset, the target channel moves to higher values as measurement time progresses (usable for half-life measurements, etc.).

（6） Click Clear on the menu bar to initialize MCS histogram data in the device. (To continue from previous histogram/results, uncheck clear at start in the Meas tab and start measurement without clicking Clear.)

（7） Click Start on the menu bar to send settings to the device and start measurement.

（8） After starting measurement:

- the acq LED blinks
- measurement status appears in the Information section
- mode displays MCS
- set measurement time appears in meas. time
- real time appears in real time
- the MCS histogram appears on the graph
- Events exceeding time (sec) of max ch are added to the final channel

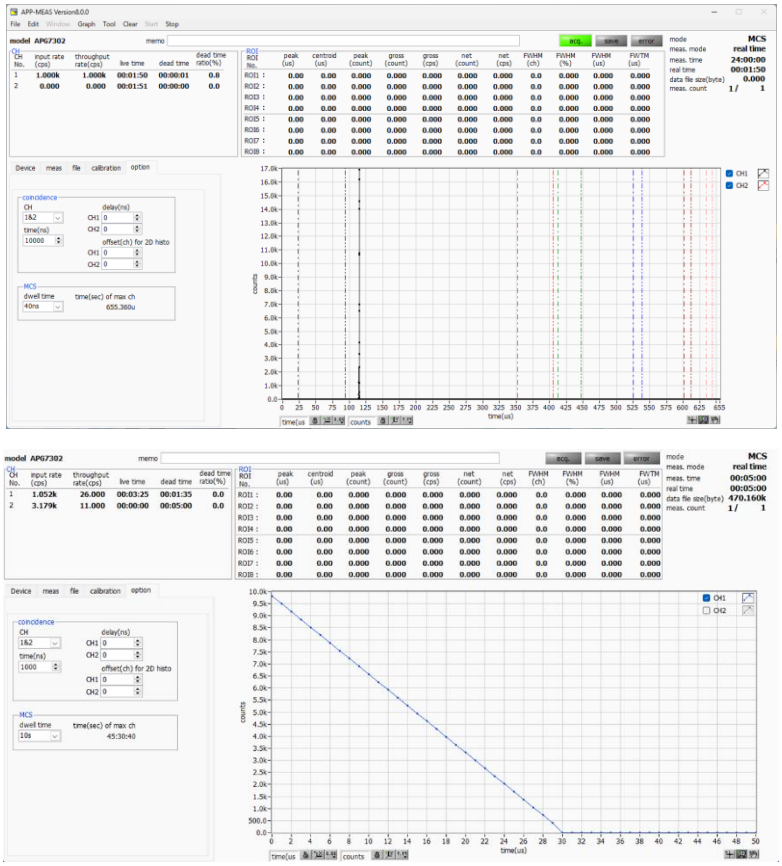


Figure 21: MCS histogram mode measurement screen (Top: with reset; Bottom: without reset)

6.5 Measurement Stop

- When meas. mode is real time, measurement ends when real time reaches meas. time.
- When meas. mode is live time, measurement ends when the slowest live time reaches meas. time.
- To stop during measurement, click Stop on the menu bar.

7 File

7.1 Histogram data file

（1） **File format:** Comma-separated (CSV) text format

（2） **File name:** Optional / arbitrary

（3） **Structure:**

[Header]: Header section

Memo: Memo

mode: Mode (histogram)

meas. mode: Measurement mode (real time or live time)

meas. time(sec): Measurement time in seconds

Real time(sec): Real time

Live time(sec): Live time per CH in seconds

Dead time(sec): Dead time per CH in seconds

Dead time ratio(%): Dead time ratio per CH in percentage

Start Time: Measurement start date and time

Stop Time: Measurement end date and time

[APG7302]: APG7302 specific section (*saved per CH*)

ADC gain: ADC gain

threshold: Threshold

LLD: Energy LLD

ULD: Energy ULD

offset: Offset

[Calculation]: Calculation section (*saved per ROI*)

ROI No.: ROI number

ROI CH.: Target input channel number for ROI

ROI start (optional): ROI start position (keV, etc.)

ROI end (optional): ROI end position (keV, etc.)

Energy (optional): Peak energy value within ROI (keV, etc.)

peak (optional): Peak position within ROI (keV, etc.)

centroid(ch): Centroid position within ROI (ch)

peak(count): Maximum peak count within ROI

gross(count): Sum of counts within ROI

gross(cps): gross(count) per second

net(count): Sum of counts within ROI minus background

net(cps): net(count) per second

FWHM(ch): Full Width at Half Maximum within ROI (ch)

FWHM(%): Full Width at Half Maximum within ROI (%)

FWHM (optional): Full Width at Half Maximum within ROI (keV, etc.)

FWTM (optional): Full Width at Tenth Maximum within ROI (keV, etc.)

[Status]: Status section (*saved per CH*)

input rate(cps): (Fixed at 0)

throughput rate(cps): Processed events per second

[Data]: Data section

calibration a: Slope a

calibration b: Intercept b

X-axis histogram data (channels or eV, keV, optional), up to 16,384 points

7.2 List data file

Format for data files saved in list mode (data saved in coincidence mode uses the same format)

（1） **File format:** Binary (Big Endian / Little Endian format) or Text (CSV) format

（2） **File name:**

The file name set in list file name in the File tab plus file number padded to 6 digits (e.g., C:¥Data¥123456_000001.bin).

When list file size is reached, the active file closes, list file number automatically increments by 1, a new file opens, and data saving continues.

（3） **Structure (Big Endian format):** 64 bits (8 Bytes, 4 WORDS) per event.

63 60	59 48
Unused 3..0]	ABS[43..32]
47 32	
ABS[31..16]	
31 16	
ABS[15..0]	
15 14	13 0
CH[1..0]	PHA[13..0]

Figure 22: List data (80 bit) structure, Big Endian case

- Unused Unused: 4 bits (Bit 63 to Bit 60)
- ABS Absolute count (time info, elapsed time, Real Time), 44 bits (ABS[43..0]), 40 ns per bit, max measurement time approx. 8 days (8 days approx 2^44 × 40 ns)
  - Bit59 to Bit48 ABS[43..32]
  - Bit47 to Bit32 ABS[31..16]
  - Bit31 to Bit16 ABS[15..0]
- CH Channel number, 2 bits (CH[1..0]), 0 is CH1, 1 is CH2 (Bit 15 to Bit 14)
- PHA Pulse height, 14 bits (PHA[13..0]), 0 to 16383 (Bit 15..8: PHA[7..0], Bit 5..0: PHA[13..8])

（4） **Structure (Little Endian format):** 64 bits (8 Bytes, 4 WORDS) per event

63 56	55 52	51 48
ABS[39..32]	Unused[3..0]	ABS[43..40]
47 40	39 32	
ABS[23..16]	ABS[31..24]	
31 24	23 16	
ABS[7..0]	ABS[15..8]	
15 8	7 6	5 0
PHA[7..0]	CH[1..0]	PHA[13..8]

Figure 23: List data (80 bit) structure, Little Endian case

- Unused Unused: 4 bits (Bit 55 to Bit 52)
- ABS Absolute count (time info, elapsed time, Real Time), 44 bits (ABS[43..0]), 40 ns per bit, max measurement time approx. 8 days (8 days approx 2^44 × 40 ns)
  - Bit63 to Bit56 ABS[39..32]
  - Bit51 to Bit48 ABS[43..30]
  - Bit47 to Bit40 ABS[23..16]
  - Bit39 to Bit32 ABS[31..24]
  - Bit31 to Bit24 ABS[7..0]
  - Bit23 to Bit16 ABS[15..8]
- CH Channel number, 2 bits (CH[1..0]), 0 is CH1, 1 is CH2 (Bit 7 to Bit 6)
- PHA Pulse height, 14 bits (PHA[13..0]), 0 to 16383
  - Bit15 to Bit8 PHA[7..0]
  - Bit5 to Bit0 PHA[13..8]

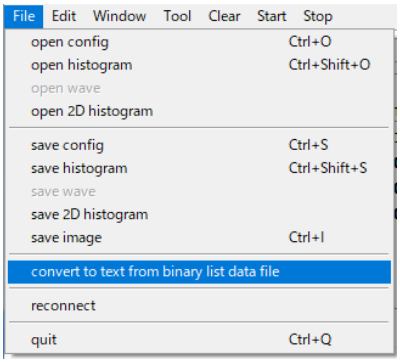
7.3 List data file text format conversion

Binary list data files saved during list mode measurement can be converted into comma-separated text (CSV) format (1 line per event: ABS, CH number, PHA)

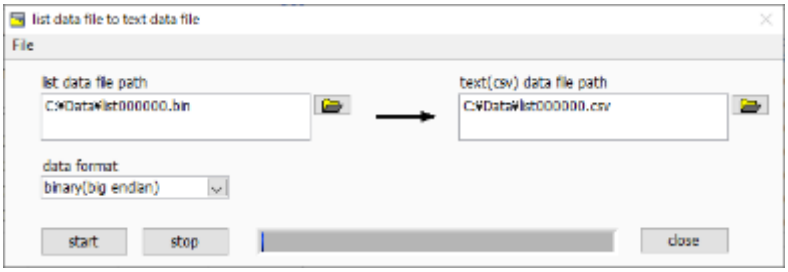
- ABS Count — Binary in 40ns units → Text in ns units
- CH Number — Binary in 0 to 1 → Text 1 to 2
- PHA（Pulse Height） — 0 to 16383 in both binary and text

Procedure:

（1） Click menu File - convert to text from binary list data file.

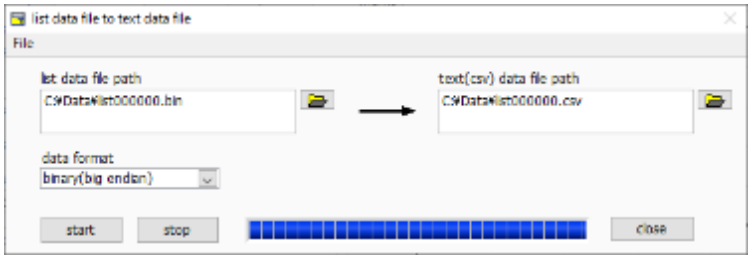


The list data file to text data file window opens



- list data file path — Set the absolute path of the target binary list data file
- data format — Select binary (big endian) or binary (little endian).
- text（csv） data file path — Set the absolute path for the converted CSV file (automatically populated with .csv extension)

（2） Click start to begin conversion; conversion completes when the status bar fills up. Click stop to interrupt.



（3） Click **close** to close this window.

7.4 Coincidence 2D histogram data file

After measurement in coincidence mode, clicking File - save 2D histogram from the menu at any time saves coincidence 2D histogram data to a file.

（1） File Format

Comma-separated (CSV) text format

（2） File Name

Arbitrary

（3） Structure

[Header]	Header section
Memo	Memo
Mode	Mode（coincidence）
meas. Mode	Measurement mode (real time or live time)
meas. time(sec)	Measurement time in seconds
Real time(sec)	Real time
Live time(sec)	Live time per CH in seconds
Dead time(sec)	Dead time per CH in seconds
Dead time ratio(%)	Dead time ratio per CH in percentage
Start Time	Measurement start date and time
Stop Time	Measurement end date and time
[APG7302]	APG7302 specific section
Saved per CH below	
ADC gain	ADC gain
threshold	Threshold
LLD	Energy LLD
ULD	Energy ULD
offset	Offset
[Calculation]	Calculation section
Save per ROI below	
ROI No.	ROI number
ROI CH.	Target input channel number for ROI
ROI start(Optional)	ROI start position (keV, etc.)
ROI end(Optional)	ROI end position (keV, etc.)
Energy(Optional)	Peak energy value within ROI (keV, etc.)
peak(Optional)	Peak position within ROI (keV, etc.)
centroid(ch)	Centroid position within ROI (ch)
peak(count)	Maximum peak count within ROI
gross(count)	Sum of counts within ROI

gross(cps)	gross(count) per second
net(count)	Sum of counts within ROI after subtracting background
net(cps)	net(count) per second
FWHM(ch)	Full Width at Half Maximum within ROI (ch)
FWHM(%)	Full Width at Half Maximum within ROI (%)
FWHM(Optional)	Full Width at Half Maximum within ROI (keV, etc.)
FWTM(Optional)	Full Width at Tenth Maximum within ROI (keV, etc.)

[Status]	Status section
Saved per CH below	
input rate(cps)	Number of detected events per second
throughput rate(cps)	Number of processed events per second

[2DHistogram Header]	
CH1 Offset(ch)	Offset channel for CH1 coincidence 2D histogram
CH2 Offset(ch)	Offset channel for CH2 coincidence 2D histogram

[2DHistogram]

CH1(ch)

CH2(ch)

Counts

[2DHistogramCH1Direction]

CH1

counts

[2DHistogramCH2Direction]

CH2

counts

[Data]	Data section
calibration a	Slope a
calibration b	Intercept b

X-axis data (channels or eV, keV, optional) histogram data

Up to 16,384 points

7.5 MCS data file

（1） File Format

Comma-separated (CSV) text format

（2） File Name

Arbitrary

（3） Structure

[Header]	Header section
Memo	Memo
mode	Mode（MCS）
meas. Mode	Measurement mode (real time or live time)
meas. time(sec)	Measurement time in seconds
Real time(sec)	Real time
Live time(sec)	Live time per CH in seconds
Dead time(sec)	Dead time per CH inseconds
Dead time ratio(%)	Dead time ratio per CH in percentage
Start Time	Measurement start date and time
Stop Time	Measurement end date and time
[APG7302]	APG7302 specific section
Saved per CH below	
ADC gain	ADC gain
threshold	Threshold
LLD	Energy LLD
ULD	Energy ULD
offset	Offset
[Calculation]	Calculation section
Saved per ROI below	
ROI No.	ROI number
ROI CH.	Target input channel number for ROI
ROI start(Optional)	ROI start position(keV, etc.)
ROI end(Optional)	ROI end position(keV, etc.)
Energy(Optional)	Peak energy value within ROI(keV, etc.)
peak(Optional)	Peak position within ROI(keV, etc.)
centroid(ch)	Centroid position within ROI(ch)
peak(count)	Maximum peak count within ROI
gross(count)	Sum of counts within ROI
gross(cps)	gross(count) per second
net(count)	Sum of counts within ROI after subtracting background
net(cps)	net(count) per second

FWHM(ch)	Full Width at Half Maximum within ROI (ch)
FWHM(%)	Full Width at Half Maximum within ROI (%)
FWHM(Optional)	Full Width at Half Maximum within ROI (keV, etc.)
FWTM(Optional)	Full Width at Tenth Maximum within ROI (keV, etc.)

[Status]	Status section
Saved per CH below	
input rate(cps)	Number of detected events per second
throughput rate(cps)	Number of processed events per second

[Data]	Data section
calibration a	Slope a
calibration b	Intercept b

X-axis data (channels or eV, keV, optional) histogram data

Up to 16,384 points

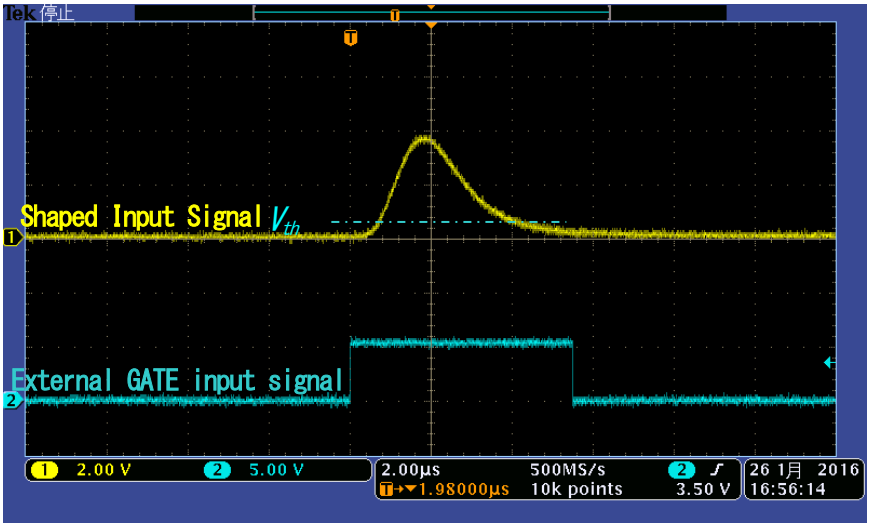
8 Function

8.1 Data acquisition by external GATE input signal timing

To acquire event data under external conditions, input an LV-TTL GATE signal to the rear GATE terminal (High: measure, Low: do not measure).

Input the GATE signal in a range that sufficiently covers the shaped input signal, especially maintaining High where the shaped signal exceeds threshold level $V_{th.}$

A/D conversion occurs when the shaped signal drops below threshold level $V_{th.}$, determining the peak value after 1.2 µs processing time.



- **Figure 24:** External GATE input signal timing

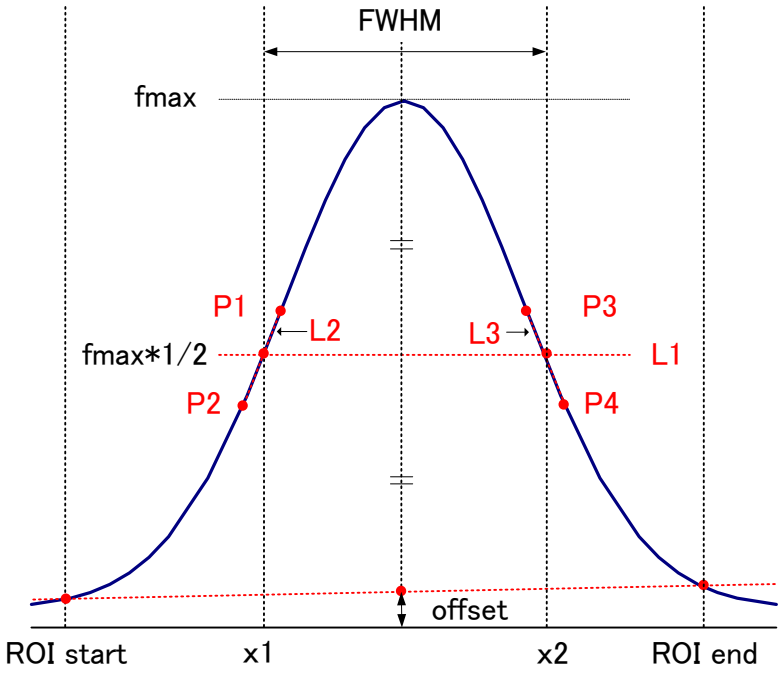
Note: LV-TTL level (≤ 0.8 V is Low, ≥ 2.0 V is High, max input voltage 5 V)

8.2 Data discard by VETO signal timing

To discard event data under external conditions, input an LV-TTL signal to the rear VETO terminal (Low: measure, High: do not measure)

8.3 FWHM calculation method

FWHM on the status tab is calculated as follows:



- **Figure 25: FWHM calculation**

（1） Detect maximum value fmax between ROI start and ROI end in the histogram.

（2） Connect the intersections of histogram with ROI start and ROI end with a straight line, and find its intersection with a line dropped vertically from fmax to calculate background offset.

（3） Calculate half of fmax - offset, and draw horizontal line L1.

（4） Detect points P1, P2 before/after the first intersection, and P3, P4 before/after the second intersection.

（5） Draw line L2 connecting P1–P2, and line L3 connecting P3–P4.

（6） Calculate X-coordinate x1 of L1–L2 intersection, and x2 of L1–L3 intersection.

（7） FWHM = x2 - x1

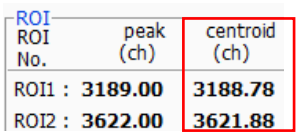
8.4 Gross count and net count calculation

gross(count) and net(count) in the ROI section are calculated using the Covell method (refer to Section 3.4 "ROI calculation by Covell method" in the "Application Tool Edition Instruction Manual")

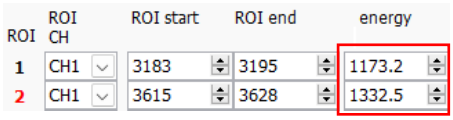
8.5 2-point calibration calculation method

（1） In Histogram Mode:

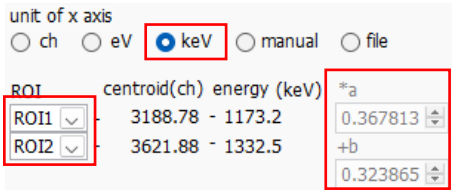
Performs 2-point energy calibration using centroids and peak energy values of two energy peaks (1-point calibration also possible)



Referring to ROI1/ROI2 centroid(ch) values above the graph, set ROI start(keV) and ROI end(keV) in the Calibration tab or set ranges using graph cursors.



Set peak energy in keV in peak(keV).



Select **keV** radio button in **unit of x axis**, select ROI1 and ROI2 in the ROI dropdown, and linear equation y = ax + b slope a and intercept b are automatically calculated:

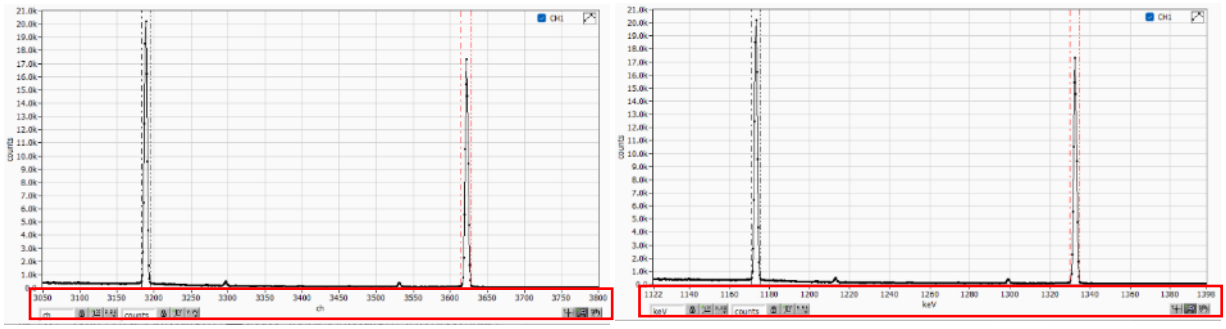


Figure 26: Left: Before energy calibration (ch), Right: After energy calibration (keV)

a = （peak1-peak2） / （centroid1-centroid2）

b = y – ax

Example: (^{60}Co 1173 keV centroid 9446.99 ch, 1332 keV centroid 10729.53 ch):

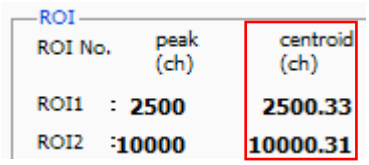
a = 0.124, b = 1.831

As a result, 0.124 is automatically reflected in a and 1.831 in b, and the unit scale on the horizontal axis is created using the linear equation 0.124 * ch + 1.831.

（2） In MCS Mode:

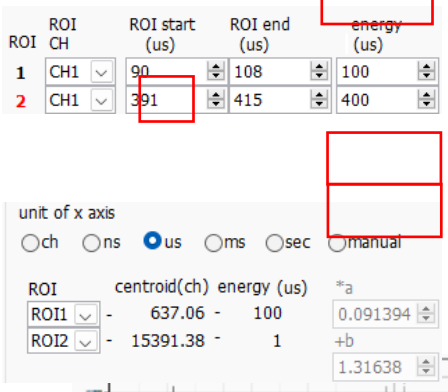
Select **manual** in the Calibration tab, set dwell time in **manual a**, and 0 in **manual b** for time calibration.

2-point time calibration uses centroids and peak time values of two peaks (1-point calibration also possible).

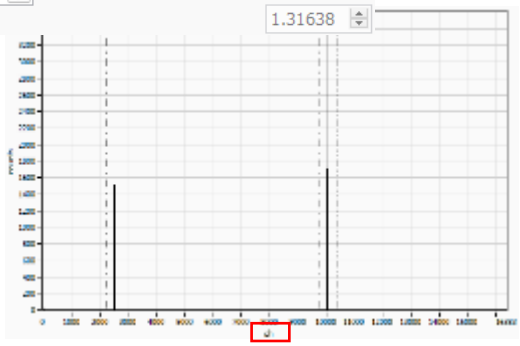


Set dwell time and set calibration to ch, then start measurement. Referring to the centroid(ch) values for ROI1/ROI2 displayed in the ROI section located at the top of the graph, set ROI start(ch) and ROI end(ch) under ROI at the upper section of the **Calibration** tab, or set the ROI1 and ROI2 ranges by moving the cursor on the graph.

Set the corresponding peak time in μsec for ROI1/ROI2 in energy(us).



Under unit of x axis located at the bottom of the **Calibration** tab, select the **us** radio button. When ROI1 and ROI2 are selected for ROI under calibration located at the bottom of the **Calibration** tab, the slope a and intercept b of the linear equation $y = ax + b$, calculated using the formula below, are automatically reflected in a and b at the bottom.



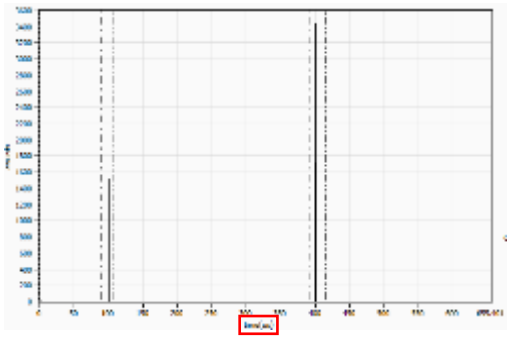


Figure 27: Left: Before energy calibration (ch), Right: After energy calibration (time in μs)

a = （peak1-peak2） / （centroid1 - centroid2）

b = y – ax

As an example, if the centroid of a peak at 100 μs is 2500 ch, and the centroid at 400 μs is 10000 ch:

a = （400 - 100） / （ 10000 – 2500 ） = 0.04
b = 400 – 0.004 * 10000 = 0

As a result, 0.04 is automatically reflected in a and 0 in b, and the unit scale on the horizontal axis is created using the linear equation 0.04 × ch + 0. Note that a is basically equal to the value set in dwell time.

9 Reference Material

This manual mainly describes the hardware of the device and the application parameters.

For detailed explanations of the Tool, which enables advanced analysis, please refer to the separate document:

Detailed Tool Description

“Application Tool Edition User Manual”

10 Troubleshooting

For solutions to various issues related to the application, please also refer to:

"https://www.techno-ap.com/support_app.html"

Techno AP Co., Ltd.
Address: 2976-15 Mawatari, Hitachinaka-shi, Ibaraki 312-0012, Japan
TEL: +81-29-350-8011
FAX: +81-29-352-9013
Website: http://www.techno-ap.com
E-mail: info@techno-ap.com