USB-MCA4 software

Instruction Manual

Version 1.2.4. January 2018

Table of Contents

1. Revision history

Data	Edition	Content
October 2015	1.0.0	First public
16 January 2016	1.0.1	Updating description about peak detection
21 January 2016	1.0.2	Addition and modification of description on Information part
26 January 2016	1.0.3	Correction of explanation of external GATE input
4 February 2016	1.0.4	Additions notes on list data file conversion Correction of explanation of two-point calibration calculation method
10 March 2016	1.1.0	Additional notes on MCS function
17 March 2016	1.2.0	Additional notes on Coincidence function
24 March 2016	1.2.1	Correctin of typographical errors, disappearance, layout etc. in this manual
20 May 2016	1.2.2	Correction of explanation of external VETO input function
28 November 2017	1.2.3	Notes on using low power consumption computer, recommendation of USB 3.0 usage
12 January 2018	1.2.4	Add explanation of live time and dead time

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2. Safety precaution and disclaimer

Please read this "Safety Precautions and Disclaimer" before using the USB-MCA4 Model: APG7400A (hereafter this device) and USB-MCA4 software (hereafter this software), Be sure to observe the contents and use correctly.

We are not responsible for any damage caused using this software, including damage to equipment, detectors, connection equipment, applications, damage to failure, and other secondary damage.

🚫

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 strong shock or vibration to this device.
- Do not disassemble or modify this device.
- Do not wet this device with water or condensation. Do not operate this device with wet hands.
- If there is heat generation, deformation, discoloration, odor, etc. in this device, stop using it immediately and contact us.

⚠️

Cautions

- Use this device at room temperature in the operating temperature range and use it so that there is no condensation.
- If there is smoking or abnormal heat generation in this device, turn off the power immediately.
- Be careful of static electricity because this device is a precision electronic device.
- Do not store this device in a dusty place or high temperature / high humidity place.
- Do not place devices that emit strong electromagnetic waves, such as mobile phones and transceivers, close to this device.
- This device may malfunction in environments with high electrical noise.
- The specifications of this device and related documents may be subject to change without prior notice.

* Please be sure to read the notes on red letters and "Caution on use" described in this manual.

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3. Overview

3.1. Overview

USB-MCA4 (USB - Multi Channel Analyzer 4 CH, USB - Multichannel Analyzer 4 CH) manufactured by TechnoAP Co., Ltd.APG7400A (hereinafter referred to as this device) has a high - speed successive approximation ADC for each channel of 4 channels for signal input, It is a lightweight and compact MCA that operates only with USB bus power without using the AC adapter.

The preamplifier signal from the detector is input to a spectroscope amplifier (linear amplifier), and the output signal amplified and waveform-shaped (shaped) by the analog circuit is input to this device. The amplitude (wave height value, peak value) of this signal includes radiation energy information and the like. MCA is a wave height analyzer that detects this signal and digitally converts the maximum crest value to generate a spectrum (histogram).

"Dead time" is an indicator of MCA performance. Dead time is a time zone when MCA can not measure peak value. The radiation causes irregular events. Therefore, while executing from event occurrence to peak detection, wave height value digital conversion, memory rewrite, peak value resetting, a new event can not be measured. The dead time of this device is fixed 1.5 μsec.

Measurement operations are usually in two ways: "histogram mode" and "list mode".
In histogram mode, spectral data is generated with the energy peak value such as keV on the horizontal axis and the count on the vertical axis.
In the list mode, when detecting a valid event (an event where the signal from the amplifier exceeds the threshold and the crest value is between LLD and ULD), the elapsed time from the start of measurement, the crest value and the channel number are displayed, it transfers to the computer as list data of length of 8 bytes and saves it in the file. Both data will be transferred to computer via USB cable.

Optionally, there are "Multi Channel Scaler (MCS) mode" and "coincidence mode".
In MCS mode, spectrum data is generated with the horizontal axis representing time from nanosecond to 1 second and the vertical axis counting. Select the horizontal axis's dwell time (time width per channel) from a minimum of 40 nanoseconds up to 100 seconds in advance. The number of channels can be 16384 and 232 counts per channel. Valid events within the LLD and ULD ranges are detected and the corresponding elapsed time channels are counted and added based on the time information at the timing exceeding the threshold.
Coincidence mode is a mode in which CH1 and CH2 are used to acquire simultaneously detected time and wave height value within a set time. The set time range is from the minimum plus or minus 40 ns to the maximum plus or minus 10 μs. You can save 2 channel simultaneous list data in list mode and create two-dimensional histogram (2048 x 2048 channels) with horizontal axis CH1 PHA and vertical axis CH2 PHA.

The software that comes with this device is driver software and applications that run on Windows.

This manual explains the handling of this device.

3．2． **Specifications**

Applicable models: APG7400A, APG7400A (DM), APG7400A-MCS (DM), APG7400A-COIN (DM)

（1）Analog input

Number of channels	4 channels
Input range	0 (zero) to + 10 V
Input impedance	1 kΩ (ohm)
Input pulse width	Minimum 100 nanoseconds up to 100 microseconds *the threshold is exceeded

（2）ADC

Conversion method	Successive approximation type
Resolution:	16 bits
Conversion time + reset time	1.5 µs
ADC gain	16384, 8192, 4096, 2048, 1024, and 512 channels
Threshold	Full scale 0 (zero) to 50 % (percent), set from computer
LLD	Full scale 0 (zero) to 100 % (percent), set from computer
ULD	Full scale 0 (zero) to 100 % (percent), set from computer

（3）Perfomance

Dead time	1.5 microseconds fixed *Spectroscopy amplifier processing time is not included
Integral nonlinearity	Plus or minus 0.025 % (typ.) or less
Differential nonlinearity	Plus or minus 1 % (typ.) or less

（4）External input

GATE	It functions as time stamp clear (CLR) when measuring in LIST mode.
VETO	It functions as MCS time count clear (CLR) when measuring with MCS mode (option).

（5）Measurement modes

Histogram mode	Maximum 16384 channels, 232 counts per channel
List mode	
MCS mode *optional	40 nanoseconds to 100 seconds per channle, 16384 channel, 232 counts
Coincidence mode *optional	simultaneous measurement by CH1 and CH2. Create two-dimensional histogram
Comunication interface	USB 2.0 *It is recommended to use USB cable length of 2 meters or less, USB 3.0 port. If you have a low power consumption function on a USB port, such as a laptop computer, please cancel it or use it with a USB hub with power supply with the AC adapter.

（6）Application software

USB-MCA4 software	Windows version, driver software and applications

（7） External form

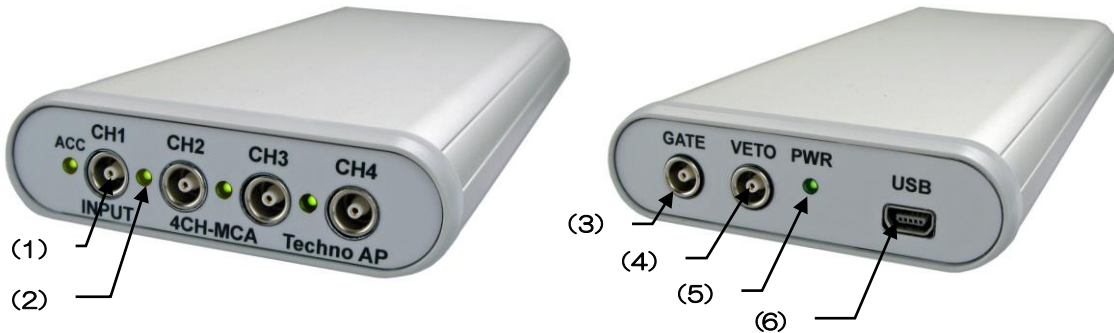| Dimension	70 mm (W) x 160 mm (D) x 20 mm (H)
Weight	230 g

Figure 1: APG7400A

FRONT

(1) INPUT	Amplifier signal input connector (manufactured by LEMO: EPL.00.250.NTN) 1 to 4 channels. *In coincidence mode, CH1 and CH2 are used (option).
(2) ACC	LED lights up when signal is detected. 1 to 4 channels.

BACK

(1) GATE	LEMO connector for external GATE signal input. Input LV - TTL level signal. Data acquisition with input "High", data not acquired with "Low".
(2) VETO	LEMO connector for external VETO signal input. Input LV - TTL level signal. Data not acquired with Input "High" data acquisition with input "Low". LIST mode or MCS mode (option) Time count clear (CLR) is entered during measurement and cleared at input "rising edge (pulse width of 100 nanoseconds or longer)".
(3) PWR	LED turns on when power is on (connected to computer).
(4) USB	USB 2.0 Mini-B receptacle (female)

*Conversion adapter
For the signal input connector to this device, use LEMO EPL.00.250.NTN or a connector of equivalent shape. When using a signal cable with a BNC connector, it is possible to connect to this device by using the following conversion adapter.

Manufacturer	HUBER+SUHNER
Web	https://www.hubersuhner.com/en
Model	33_QLA-BNC-01-1/1--__NE
Specifications	QLA-01 to BNC Connector Gender 1: Interface QLA-01 Connector Gender 2: Interface BNC

（8） Accesorries

Instruction manual	Printed English version
CD-ROM	Driver software, application and PDF version instruction manual included
USB cable	Connector is male (A) and female (Mini-B)

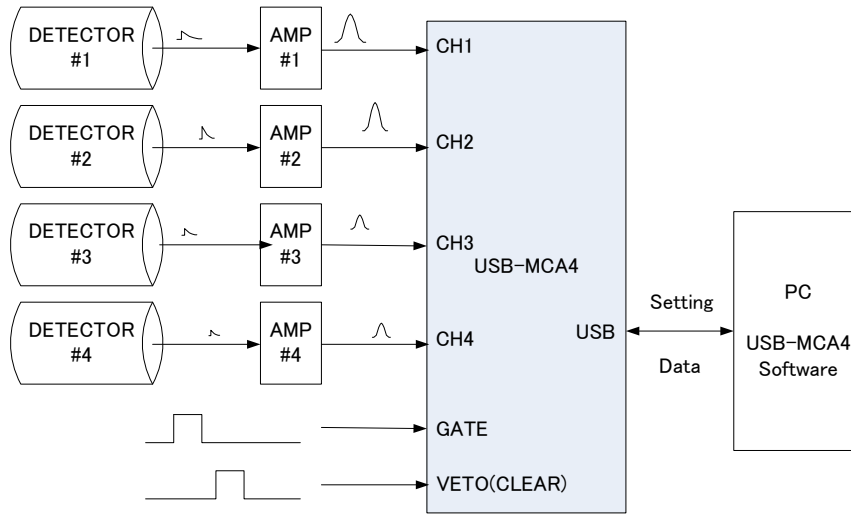TechnoAP Co., Ltd.

4. Preparation
## 4. 1. Connection

Figure 2: Connection when using this device

（1） Connect the USB-MCA 4 and the computer with the included USB cable.

*It is necessary to install the driver software on the computer to be connected for the first time. For the installation method of the driver software, refer to the following.

*Do not connect the signal cable when the power of this equipment is OFF.

（2） Confirm that the "PWR" LED is on.

（3） Connect the preamplifier output signal of the detector (DETECTOR in the above figure) to the linear amplifier (spectroscopic amplifier, AMP in the upper figure).

（4） Connect the waveform-shaped output signal of the linear amplifier to one of "CH1" to "CH4" of this unit.

（5） When control by external signal is required, input the LV - TTL level to the GATE or VETO terminal. When a cable is connected to the GATE terminal, data is acquired when the peak is detected from CH1 to CH4, or when the signal is in the high state. Or when a peak is detected from CH1 to CH4 while the cable is connected to the VETO terminal, data is acquired when the signal is open, or the signal is in the Low state.

（6） VETO pin functions as CLR pin when LIST mode / MCS mode (option) is executed. When the rising edge signal is detected while the cable is connected to the terminal, the LIST time stamp / MCS time counter is cleared.

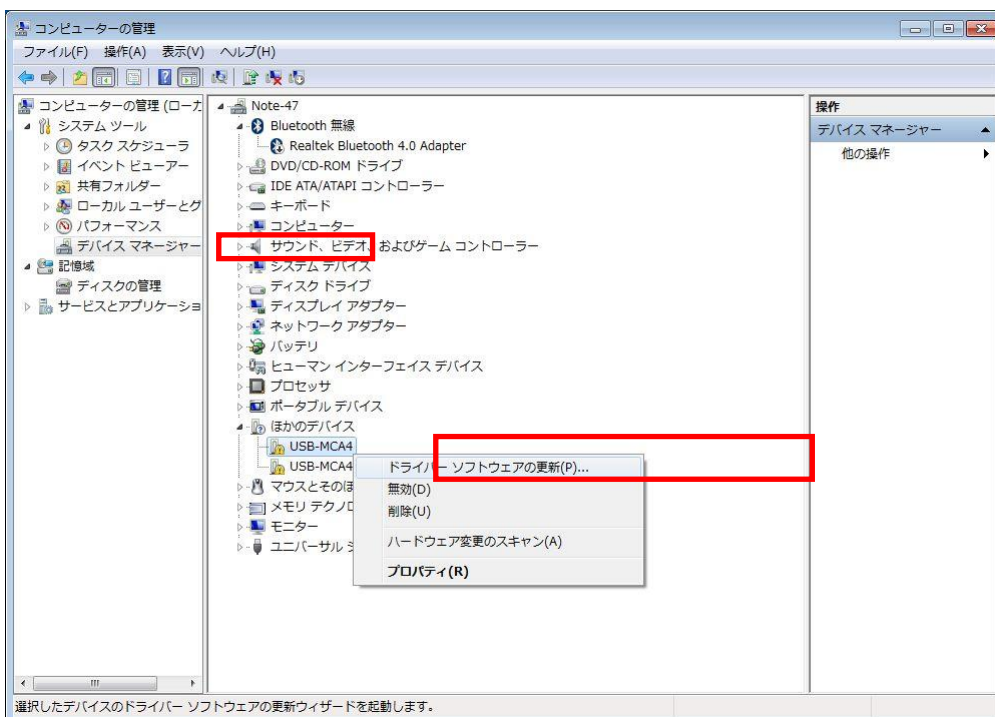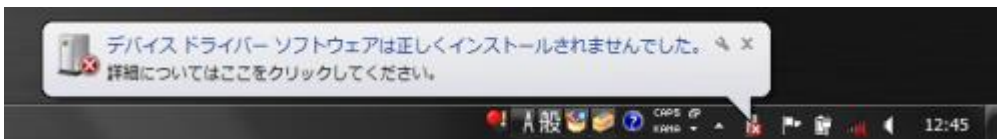## ４．２． **Installation of the driver software**

The first time you connect this unit, you need to install the driver software from the included CD.

For Windows 7

（１） **IMPORTANTE** Log in as Administrator or login with administrator privileges.
（２） Connect the device to the computer with a USB cable.
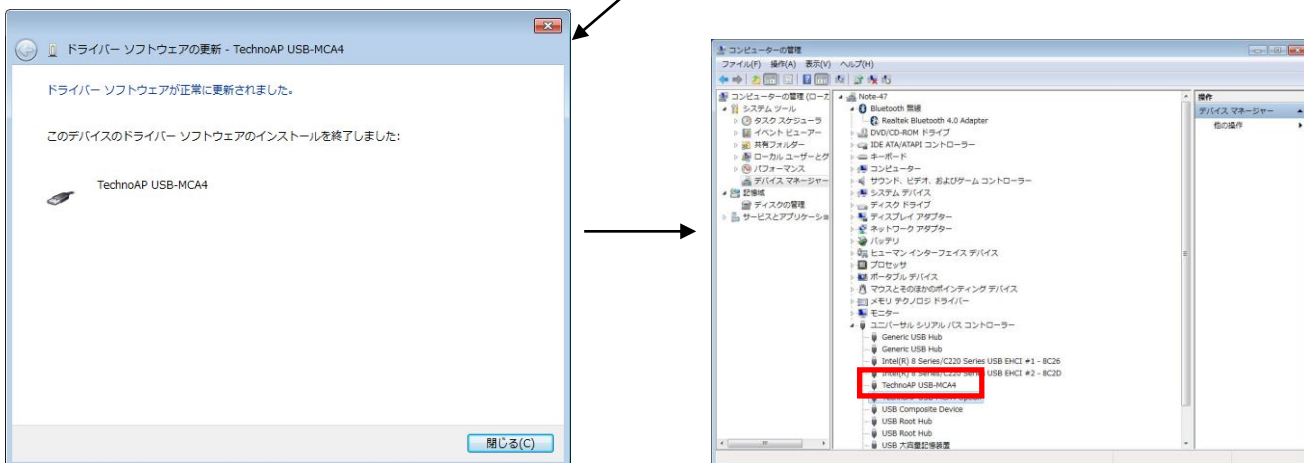（３） "Device driver software is installed" is displayed at the lower right of the desktop.
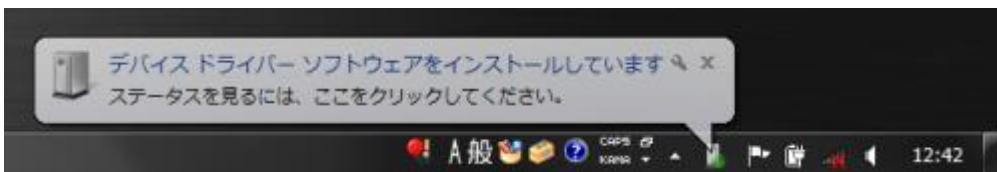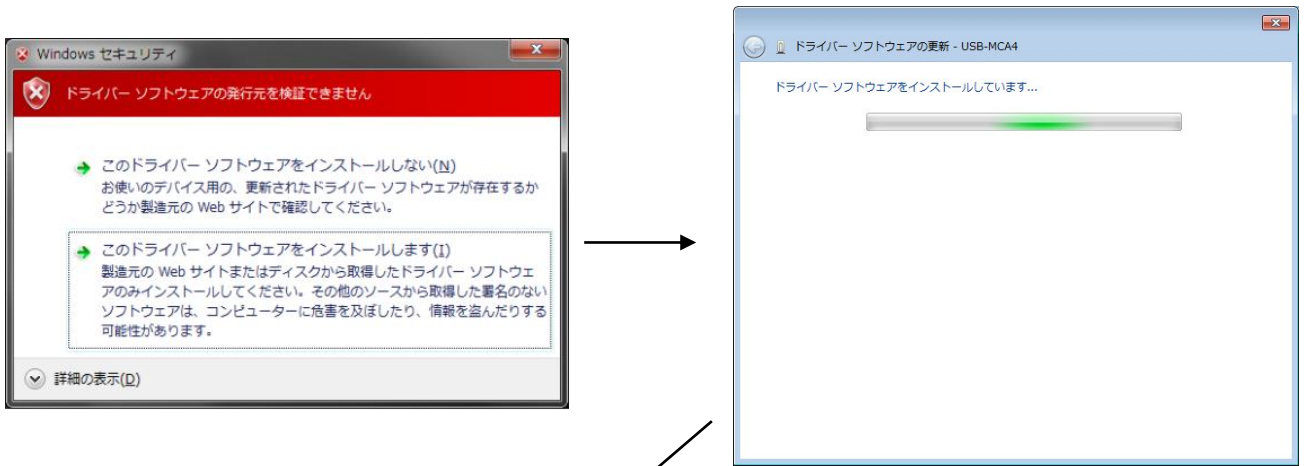

If "Device driver software was not installed correctly" is displayed, open the device manager and check the "USB-MCA 4" icon. Right click on the icon and click "Update Driver Software".

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（1）Advance interactive installation
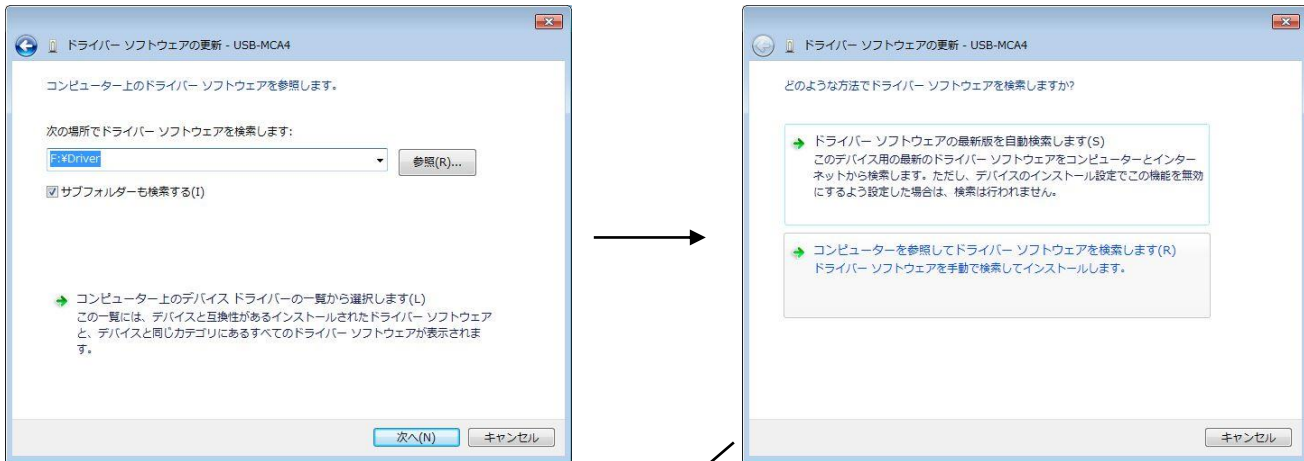
Refer to the "Driver" folder on the attached CD.

Continue to install "TechnoAP USB-MCA4 Option". "TechnoAP USB-MCA4" After installing the driver software, install "TechnoAP USB-MCA4 Option" by the same procedure. Confirm that the two icons "TechnoAP USB - MCA 4" and "TechnoAP USB - MCA 4 Option" are normal in the device manager. After installing the driver software successfully, install the application. The installation procedure is described in the next chapter.

Windows 8 (64 bit)

In Windows 8 (64 bit), to prevent users from accidentally installing driver software, driver software without a digital signature can not install as standard. Since this driver software does not have a digital signature, it is necessary to "disable driver signature enforcement" before installation. The procedure is as follows.
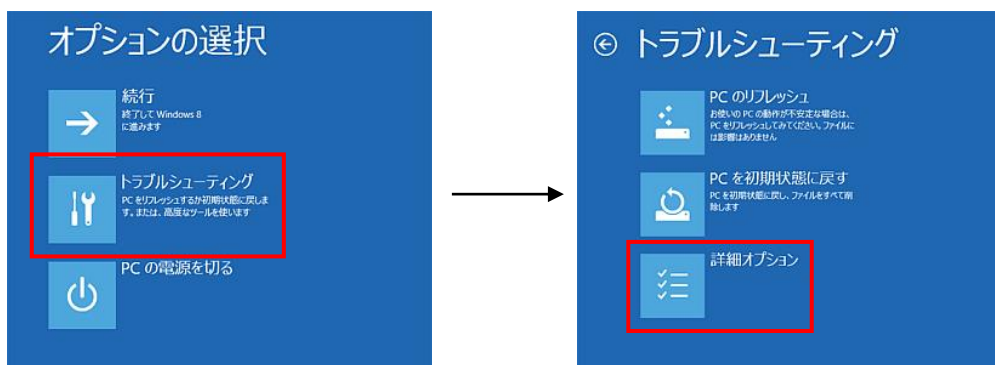
（1）Display the charm on the start screen.
- ・ For mouse operation: Move the mouse to the upper right corner or the lower right corner of the screen.
- ・ Touch operation: Swipe from the right side of the screen toward the center.

（2）Select "Setting" from the charm and select "Change computer setting" from the setting menu.
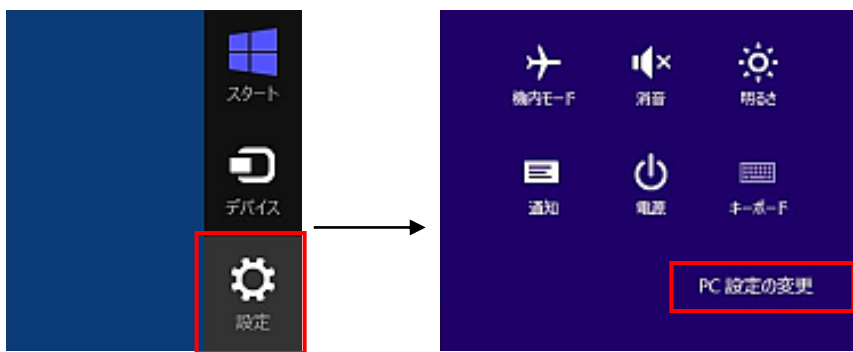
（3）Select "General" from the "Settings" screen of the computer and select "Customize startup of computer" - "Restart now".
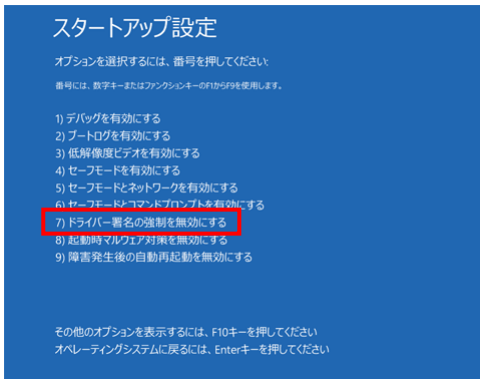

（4）Select "Troubleshooting" from "Select option" screen and select "Advanced option" from "Troubleshooting" screen.

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（5）Select "Startup Settings" from the "Advanced Options" screen and select "Restart" on the "Startup Settings" screen.
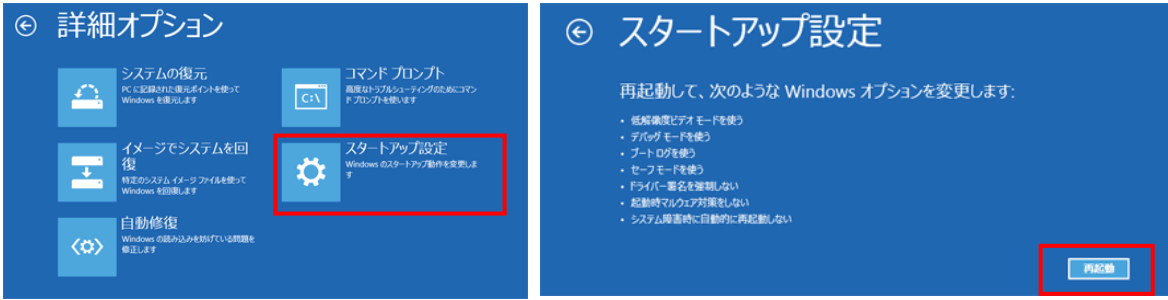
（6）On the "Startup Settings" screen after rebooting, press the "7" key and select "**7) Disable Driver Signature Enforcement**".

（7）**IMPORTANT** After rebooting, log in as administrator or log in with administrator privilege account.

（8）Connect the USB-MCA 4 to the computer with a USB cable.

（9）Right click on the start screen, display "APP / BAR", select "ALL APP", and select "CONTROL PANEL" from APPLICATION view.

（10）　Select "Device Manager" from "Control Panel" and display "Device Manager".

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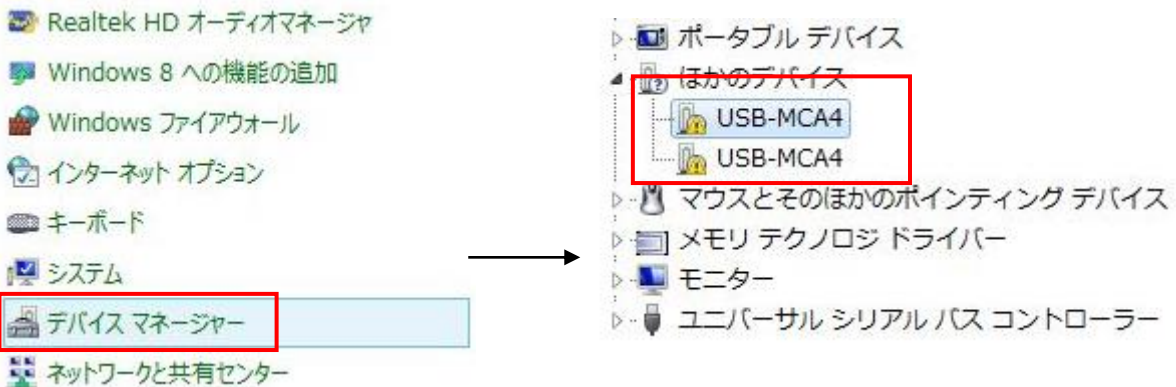
（11）　　Right-click on "USB-MCA4", select "Update driver software (P)" and select "Search for driver software by computer (R)".

（12）　　When "Update Driver Software" screen is displayed, select "Reference (R)", when the "Browse Folder" screen appears, select th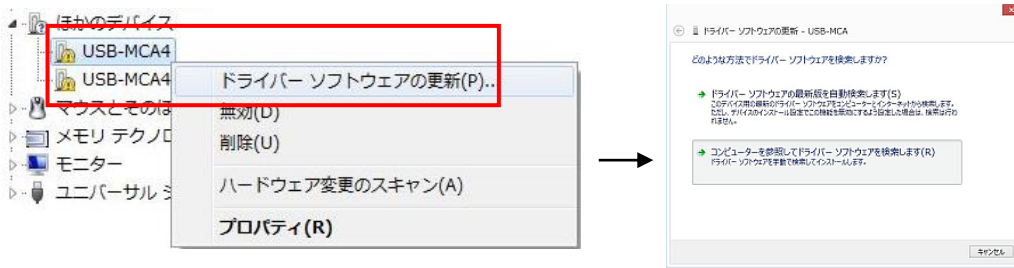e drive where the driver software of "USB-MCA 4" is stored, OK "is selected. When you return to the "Update Driver Software" screen, select "Next (N)".
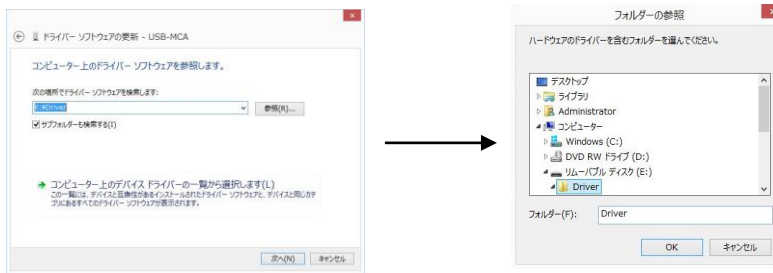
（13）　　When the "Windows Security" screen appears, select "Install this driver software (I)". When "Driver software has been successfully updated" is displayed, select "Close (C)".

（14）　　When "TechnoAP USB-MCA4" is displayed on the "Device Manager" screen, right click on the remaining "USB-MCA4 4" and repeat from (11) to update the remaining driver software.
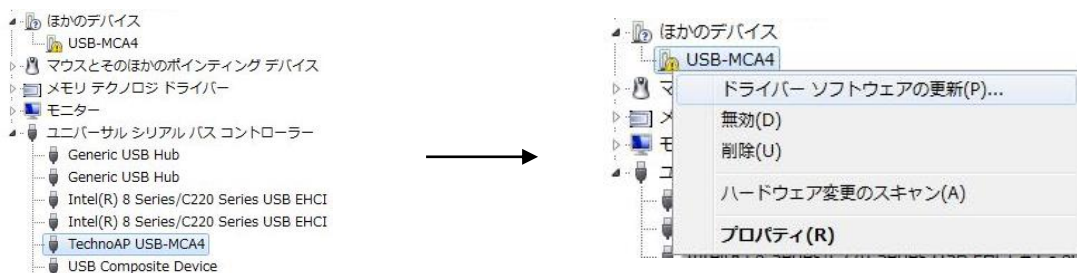
（15）　　"TechnoAP USB-MCA4 Option" is displayed on the "Device Manager" screen, and installation of the driver software is completed.

Windows 10 (64 bit)

In Windows 10 (64 bit), to prevent users from accidentally installing driver software, driver software without a digital signature can not install as standard. Since this driver software does not have a digital signature, it is necessary to "disable driver signature enforcement" before installation. The procedure is as follows.

（1） Click the "Windows" mark 　⊞　 at the lower left of the screen to display "Start menu".

（2） Select "Settings" from the start menu and select "Change and security" from the setting menu.

（3） Select "Recovery" from the "Change and Security" screen and select "Customize computer startup" - "Restart now".

（4） Select "Troubleshooting" from "Select option" screen and select "Advanced option" from "Troubleshooting" screen.

（5） Select "Startup Settings" from the "Advanced Options" screen and select "Restart" on the "Startup Settings" screen.
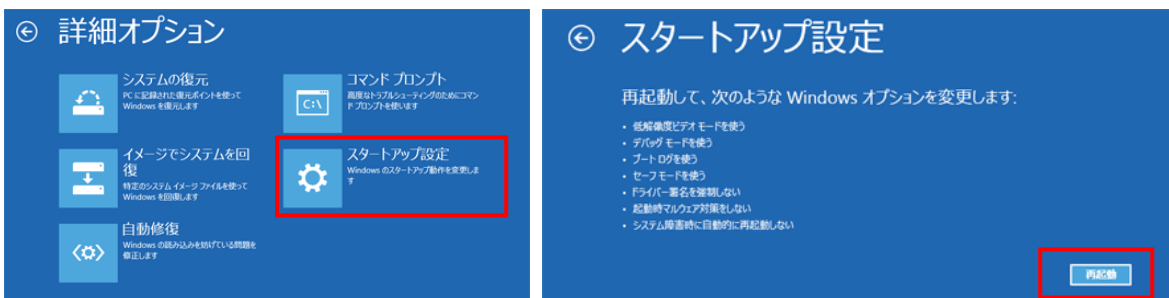
（6） On the "Startup Settings" screen after rebooting, press the "7" key and select "**7) Disable Driver Signature Enforcement**".
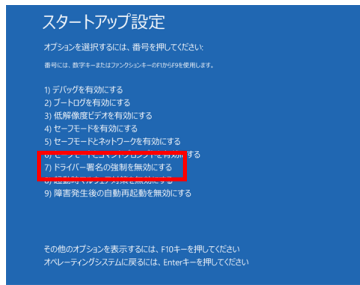
（7） **IMPORTANT** After rebooting, log in as administrator or log in with administrator privilege account.

（8） Connect the USB-MCA 4 to the computer with a USB cable.

（9） Right-click the "Windows" mark on the lower left of the screen, display "Menu", select "Device Manager".
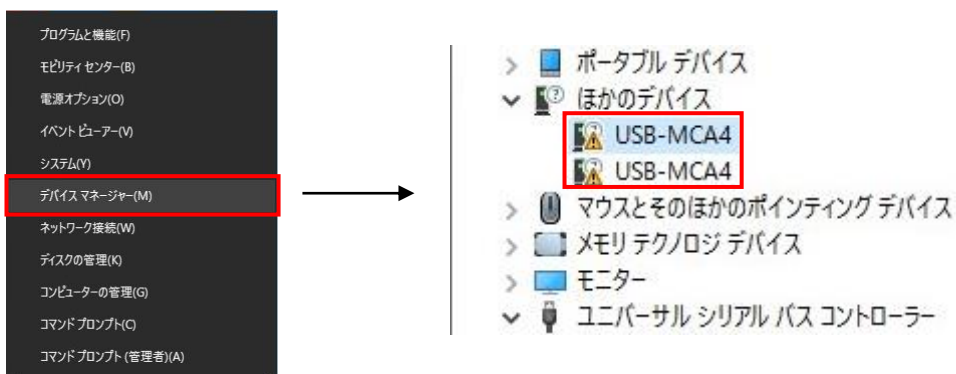
（10） Right-click on "USB-MCA4", select "Update Driver Software (P)" and select "Browse my computer for driver software (R)".
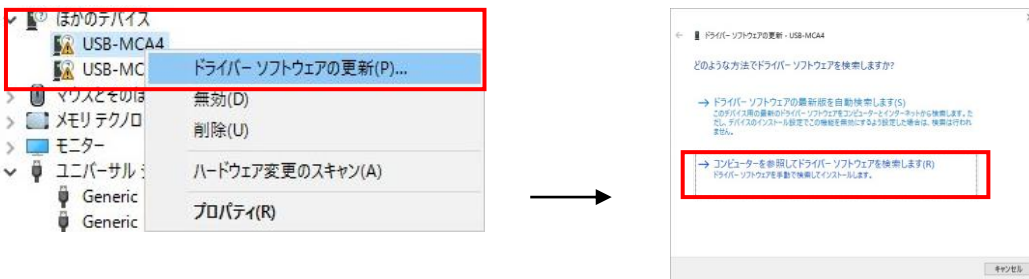
（11） When "Update Driver Software" screen is displayed, select "Reference (R)", when the "Browse Folder" screen appears, select the drive where the driver software of "USB-MCA 4" is stored, OK "is selected. When you return to the "Update Driver Software" screen, select "Next (N)".

（12）　　When "Windows Security" screen appears, select "Install this driver software (I)". When "Driver software has been successfully updated" is displayed, select "Close (C)".

（13）　　When "TechnoAP USB - MCA4" is displayed on the "Device Manager" screen, right click on the remaining "USB - MCA4 4" and repeat from (11) to update the remaining driver software.

（14）　　If "TechnoAP USB-MCA4" is not displayed on the "Device Manager" screen, select "Display non-display device" from "Display" on the device menu.
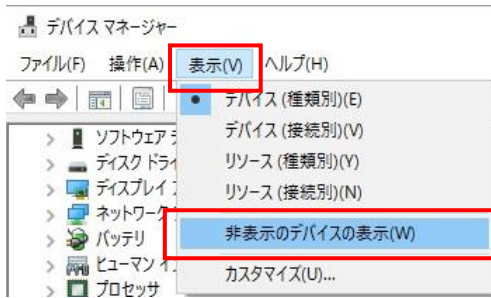
（15）　　"TechnoAP USB - MCA4 Option" is displayed on the "Device Manager" screen and installation of the driver software is completed.

４．３． Installation of the application software

After the driver software is successfully installed according to the procedure in the previous chapter, you need to install the application (executable file) of USB-MCA 4 and the runtime engine of LabVIEW which is the development environment. The installer on the accompanying CD includes USB-MCA 4 application and LabVIEW runtime engine, which can be installed at the same time.

The installation procedure is as follows.

For Windows 7 (the same for Windows 8 as well)

（1）**IMPORTANT** Login as Administrator or login with administrator privilege account.

（2）Execute "Setup.exe" in the "Application" folder in the attached CD. Proceed with installation interactively.
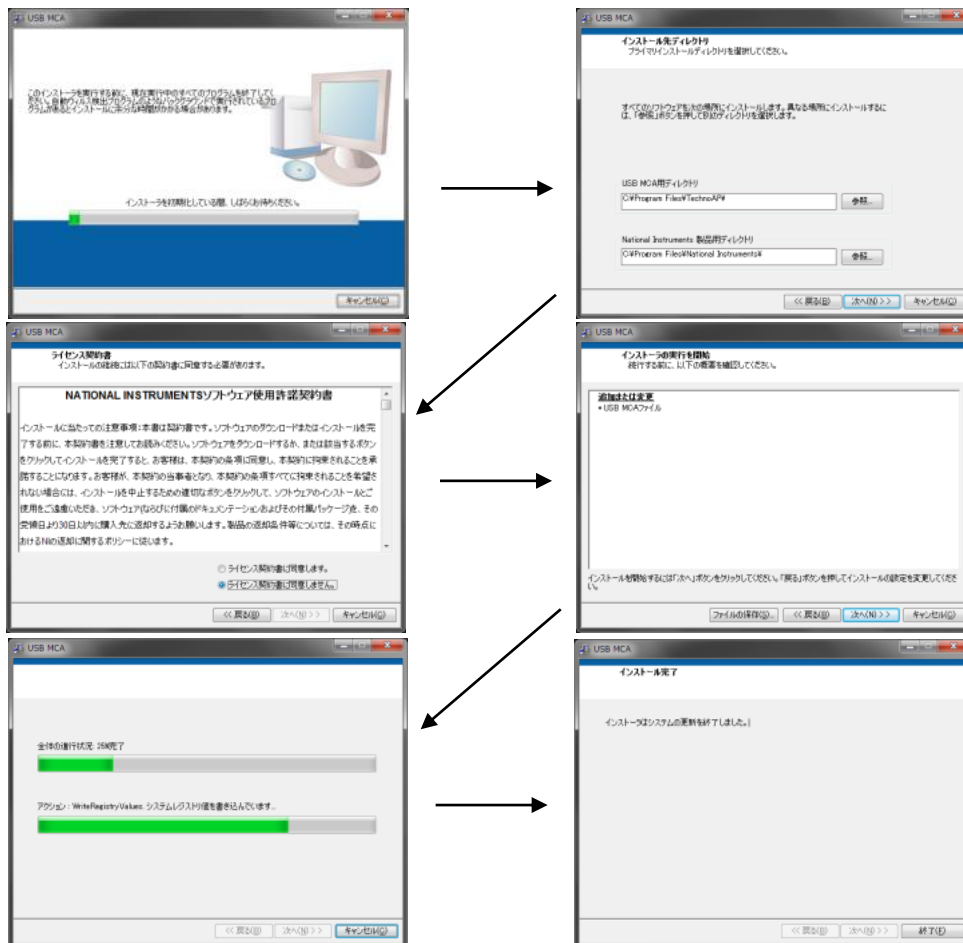
（3）Execute "Start button" - "TechnoAP" - "USB-MCA4".

（4）Application "USB-MCA4" starts up.

If the "connection error" dialog box is displayed immediately after startup, please confirm that this equipment is connected properly with the computer, or whether it is recognized by the device manager.

For Windows 10

（1）Select "Setup.exe" in the "Application" folder in the attached CD. Select "Administration" in the application tool of the menu and select "Run as Administrator"
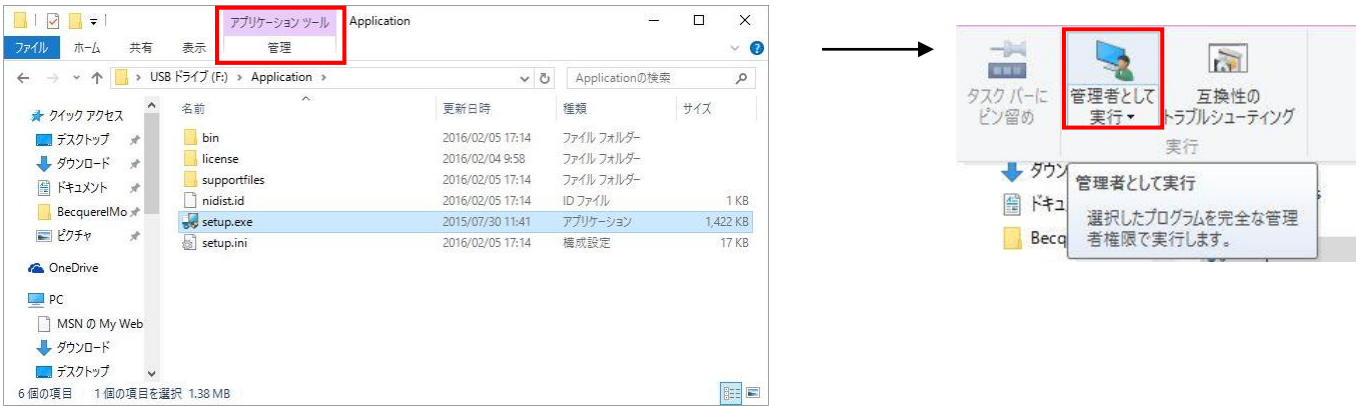
（2）Execute "Setup.exe" in the "Application" folder in the attached CD. Proceed with installation interactively.
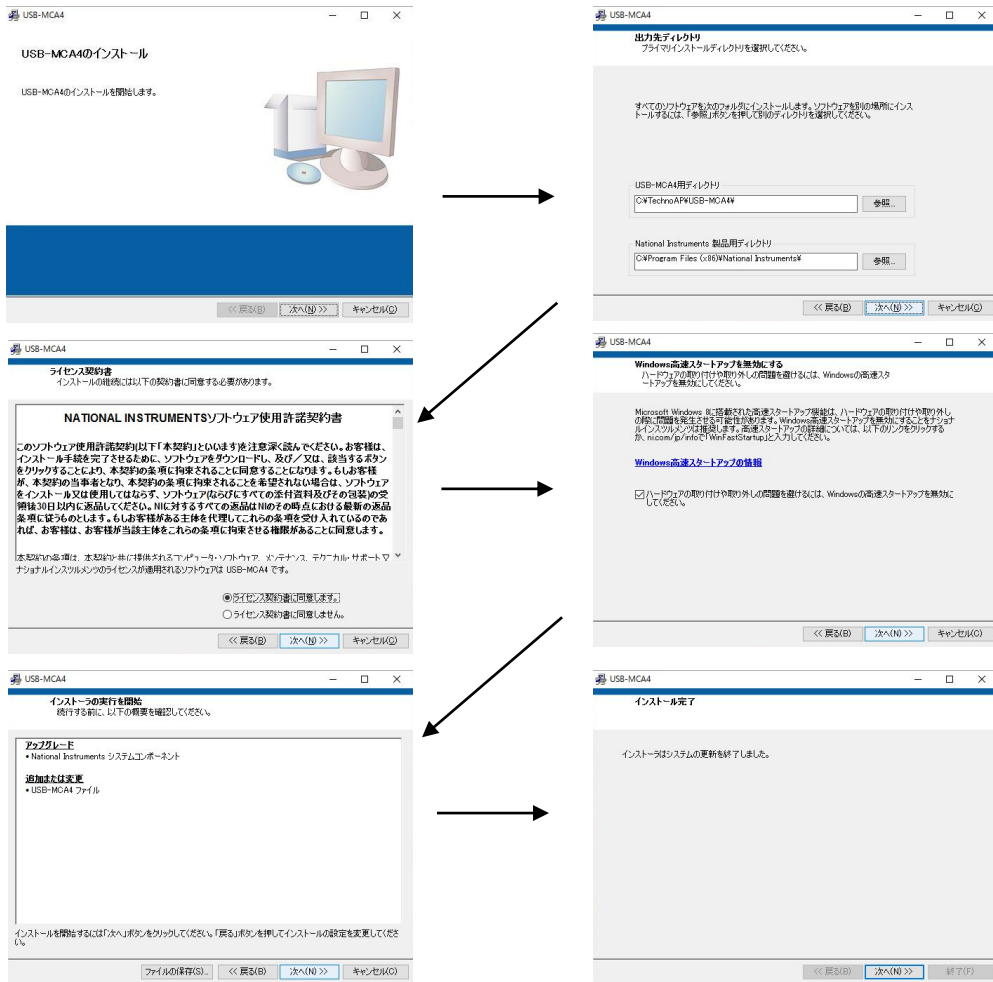
（3）Since it is displayed to restart the computer, click the "Restart" button to reboot.
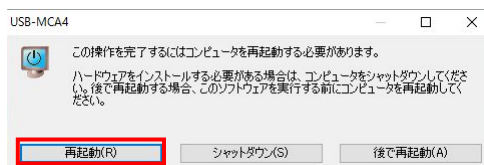
（4） Right-click on the "Windows" mark at the bottom left of the screen, display "Menu" and execute "All Applications" - "TechnoAP" - "USB - MCA 4".
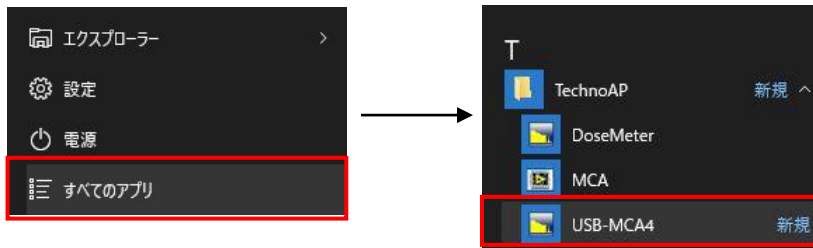
（5） The application "USB-MCA 4" is activated.

If the "connection error" dialog box is displayed immediately after startup, please confirm that this equipment is connected properly with the computer, or whether it is recognized by the device manager.

*Uninstall

To uninstall, select "USB - MCA 4" from "Settings" - "System" - "Applications and Features" and select "Uninstall".

Since "This application and its related information will be briefly stalled" is displayed, select "Uninstall".

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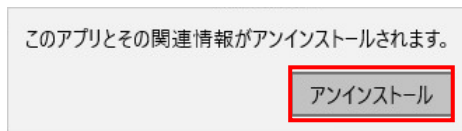
5. Setting

5.1. Startup window

If you run "USB - MCA 4" (Windows 8) in "Start button" - "TechnoAP" - "USB - MCA 4" (Windows 7) or Start screen or "Application view", the following start screen will be displayed .
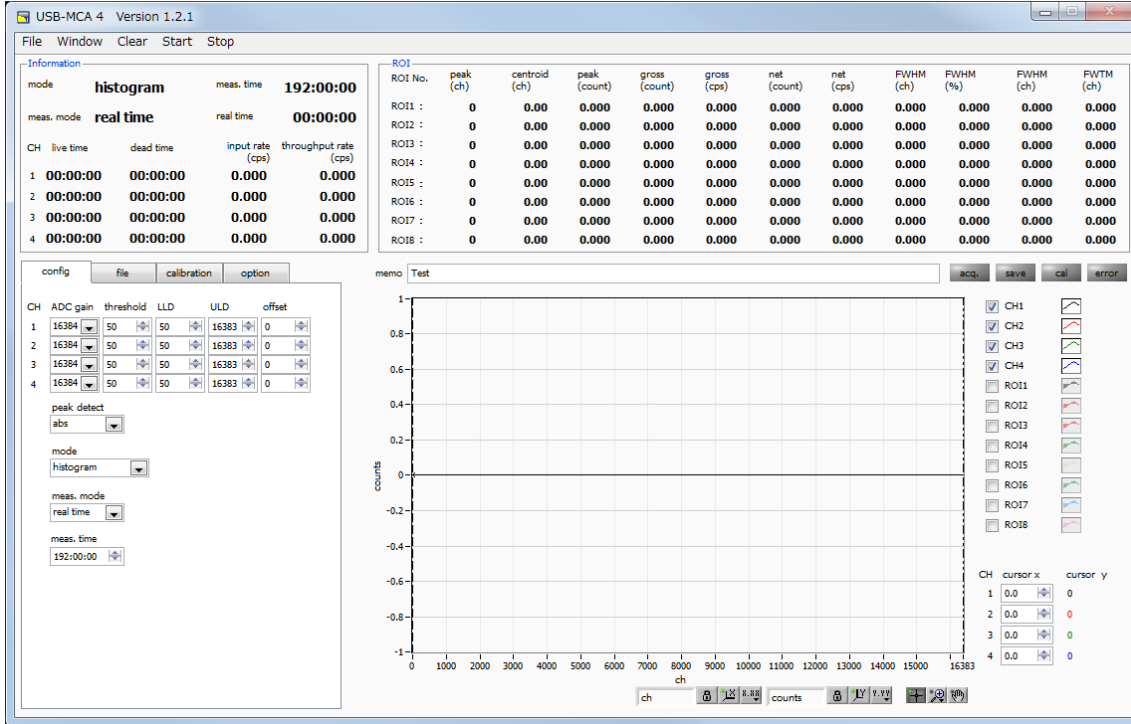
Fig. 3 USB-MCA 4 startup window

Menu section

It is configured "File", "Clear", "Start", and "Stop".

| "File" – "open config"	Reading the configuration file
"File" – "open histogram"	Reading histogram data file
"File" – "open 2D histogram"	Read coincidence 2-dimensional histogram data file ***Option**
"File" – "save config"	Save the current settings to a file
"File" – "save histogram"	Save current histogram data to a file
"File" – "save 2D histogram"	Save the current coincidence two-dimensional histogram data to a file ***Option**
"File" – "save image"	Save this device screen as PNG format image
"File" – "convert to text from binary list data file"	CSV format conversion of binary format list data file
"File" – "quit"	Application termination
"Window" – "histogram"	Display histogram graph ***Option**
"Window" – "2D histogram"	Display 2D histogram graph ***Option**
"Clear"	Initialization of histogram data in this device
"Start"	After sending all settings to this device, send measurement start to this device
"Stop"	Send measurement stop to this device

Tab section

It is configured "config", "file" and "calibration"

"config"	Measurement settings
"file"	File settings
"calibration"	Setting of ROI (Region of Interest) etc. on energy calibration
"option"	Settings for options such as MCS

"Information" section

"mode"	"Histogram", "list", "MCS" (option) displayed
"meas. mode"	Measurement mode. Display "real time" or "live time"
"meas. time"	The set measurement time
"real time"	Real time (actual measurement time)
"live time"	Live time (effective measurement time). real time - dead time (see below)
"deat time"	Dead time (invalid measurement time). real time - live time. When the input signal exceeds "threshold" as described later, peak is detected, and its peak is converted to AD It is dead time until resetting and resetting.
"input rate (cps)"	Number of counts per second when the input signal level exceeds the threshold level
"throughput rate (cps)"	Number of counts per second secured as peak between LLD and ULD

"ROI" section

The calculation result between ROIs is displayed for each channel.

"peak (ch)"	Maximum count channel
"centroid (ch)"	The center value (channel) calculated from the sum of all counts
"peak (count)"	Maximum count
"gross (count)"	Sum of counts between ROI
"gross (cps)"	Sum of counts between ROIs per second
"net (count)"	The sum of the counts obtained by subtracting the background between ROI
"net (cps)"	The sum of the counts obtained by subtracting the background between ROIs per second
"FWHM (ch)"	FWHM (channel)
"FWHM (%)"	FWHM / peak value * 100
"FWHM"	Half width
"FWTM"	1/10 width of peak

acq. LED	Blinking during measurement
save LED	Lit while data is being saved
cal LED	Lit during calculation of data between ROI
error LED	Lit when an error occurs

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5.2. **Quit window**

To exit the application, click the menu "File" - "quit". After execution, the following confirmation screen of termination is displayed.
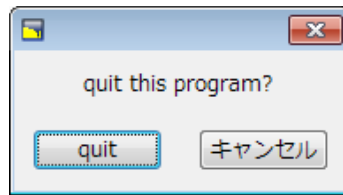
Fig. 4 Quit confirmation screen

To quit, click the "quit" button. After execution the application screen disappears, and it ends.

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5．3． config tab

Fig. 1　config tab

ADC gain	Gain of ADC. Select from 16384, 8192, 4096, 2048, 1024, and 512 channels. The input voltage range of the amplifier output signal of each channel is 0 to 10V. Divide this range by the above channel. For high energy resolution detectors such as germanium semiconductor detectors, data can be acquired with fine resolution by selecting 16384. However, when the count is small, it takes time to acquire the peak. Since energy resolution is somewhat inferior, such as NaI(Tl) scintillation detector, if it can not be divided finely, set 4096 channels and so on.
threshold	Setting of the timing threshold of the waveform acquisition start timing. Unit is digit. The setting range is 0 to 16383. Set to a value less than LLD. It triggers peak detection and AD conversion from the timing when the waveform shaping input signal exceeds the set value of the threshold. If this setting is set too high, peak value of low energy can not be acquired. On the contrary, if the setting is too small, let's pick up the noise. For example, when "ADC gain" is "16384", initially set "threshold" and "LLD" around 100. While looking at the histogram "input rate / throughput rate" little by little, discerns the boundary between noise increase in value and sets the threshold value slightly above it.
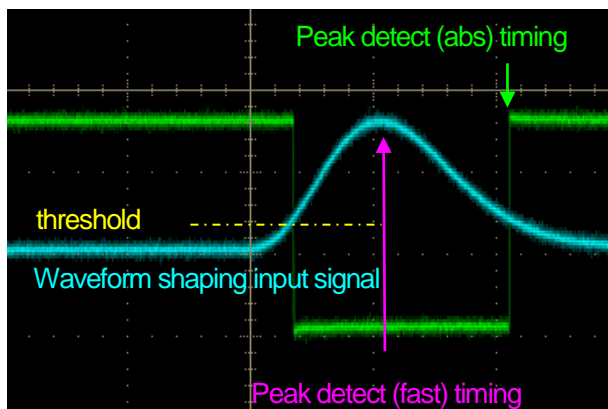
Fig. 6 threshold and peak detection (abs / fast) timing

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LLD	Set up energy Lower Level Discriminator. The unit is ch. Channels below this threshold are not counted. Set it to a value greater than or equal to threshold and less than ULD.
ULD	Set up energy Upper Level Discriminator. The unit is ch. We do not count ch above this threshold. Set it to a value larger than LLD.

Fig. 7 ULD and LLD

| offset	Sets the offset in the positive direction. The unit is ch. By adding the offset setting value, it is possible to shift the spectrum to the right (direction of pulse height). It can be used for peak position adjustment and so on.	
peak detect	*Selection of detection method of peak (maximum pulse height).*	
	abs	Pulse heigh input signal exceeds threshold, after reaching the peak, attenuates and falls below threshold, performs AD conversion. It is possible to acquire the maximum pulse height more definitely.
	fast	When the input signal exceeds threshold, the AD conversion is executed at the timing when it first reaches the peak. It is suitable for measurement and pile-up countermeasure at high count (more than several kcps).
mode	*Selection of operation mode*	
	histogram	The pulse height of the linear amplifier signal is stored in the maximum 16384 channels, and a histogram of the horizontal axis energy and the vertical axis count is created.
	list	The time stamp when the linear amplifier signal exceeds the threshold, the maximum pulse height and the channel number are set as one event data, data is continuously transferred to the personal computer and the file is saved.
	MCS	Generate spectral data with the horizontal axis as time (nano-second to second) and the vertical axis as count. Since the horizontal axis is the time width per channel in advance, the dwell time can be selected from a minimum of 40 nanoseconds to a maximum of 100 seconds, and the number of channels can be 16384, 232 counts per channel. When a valid event within the LLD and ULD range is detected, the count is added to the corresponding elapsed time channel based on the time information at the timing exceeding the threshold at that time.
	Coincidence	Using CH1 and CH2, it acquires simultaneous detected time and wave height value within set time. The set time range is from a minimum of ± 40 ns to a maximum of ± 10 µsec. Save 2-channel simultaneous list data as list mode and create 2-dimensional histogram (2048 × 2048 channels) by PHA on horizontal axis CH 1 and PHA on vertical axis CH 2.

meas. mode	As the measurement mode, select "real time" or "live time".	
	real time	Measure preset time data
	live time	Measure until effective measurement time (difference between real time and dead time) reaches preset time.
meas. time	Measurement time setting. The setting range is 0 to 192 hours (8 days). If it is set to 0, there is no stop by the measurement time, and even if it exceeds 192 hours, measurement will continue until you click the menu "Stop".	

5．4． file tab

Fig. 2　file tab

"histogram" section	Set the method of saving data measured in histogram mode.
"histogram file path"	Sets the absolute path of the histogram data file. Files without extensions are also possible. **!CAUTION!** This file name is not saved. Based on this file name, create the following format. As an example, set "C:￥Data￥histogram.csv" to "histogram file path" and "10" to "histogram file save time (sec)", the date is "2015/12/23" and time is "12:34:00", data storage starts with the file name" C:￥Data￥histogram_20151223 _ 123400.csv ". After 10 seconds, save as "C:￥Datahistogram_20151223_123510.csv" file.
"histogram stop save"	When measurement is completed, histogram data is saved in a file. The file is saved in the same format as described above.
"histogram continuous save"	Sets whether to store histogram data in a file at preset time intervals. **!CAUTION!** Depending on the processing status, the saving interval may be shifted. Please use it for simple backup.
"histo file save time (sec)"	Sets the time interval of consecutive saving of histogram data. The unit is seconds. The setting range is from 5 seconds to 3600 seconds.

"list" section	Set the method of saving measured data in list mode.	
"list save"	After starting the measurement, save the list data sent to the PC to the list data file.	
"update information and spectrum"	During measurement in list mode, data acquisition and display of "Infomation" section will be performed. Also, it creates a histogram from the received event data and displays it. **!CAUTION!** This process takes time. Please be aware that it may not be processed correctly depending on the performance and specifications of your computer, and it may not be able to receive all event data.	
"list file path"	Sets the absolute path of the list data file. Files without extensions are also possible. **!CAUTION!** This file name is not saved. Based on this file name, create the following format. As an example, if "list file path" is set to "C:¥Data¥list.bin" and "list file number" is set to "10", the file "C:¥Data¥list _ 000010.bin" Start saving data by name. "List file number" is updated to "11" when it reaches the preset file size with "list file size (Byte)" and saved as "C:¥Data¥list _ 000011.bin" file.	
"list file number"	It is a number automatically added to the list data file name. Up to "999999" can be used. Next to "999999" is 0.	
"file number"	The list data file name created from "list file path" and "list file number".	
"list file size (Byte)"	Sets the maximum size to save the list data file. Set it as "1 M" "10 M" "100 M" etc. by SI notation. Set it from "1 M" byte to "2 G" byte.	
"file size (Byte)"	Displays the size of the currently saved list data file. "0.789 M", "10.100 M", "1.230 G", etc. are displayed as SI notation.	
"data format"	*Select the file saving format such as binary and text of the list data.*	
	binary (big endian)	Big endian binary file format. You can reduce the file size. The most significant byte occupies the lowest memory address. It is common as network byte order. You can easily check the alignment of the data by eye.
	binary (little endian)	Little endian binary file format. You can reduce the file size. The least significant byte occupies the highest memory address. Used on Windows, Mac OS X, Linux. It is difficult to visually check the sequence of data.
	txt (CSV)	Comma (,) delimited text format. You can easily check the data with Notepad or Excel. **!Caution!** Data such as commas and line feeds are also added, and as the measurement time gets longer, the number of digits of the time data also increases. Therefore, the amount of data per event increases and the file size increases.

5．5． calibration tab
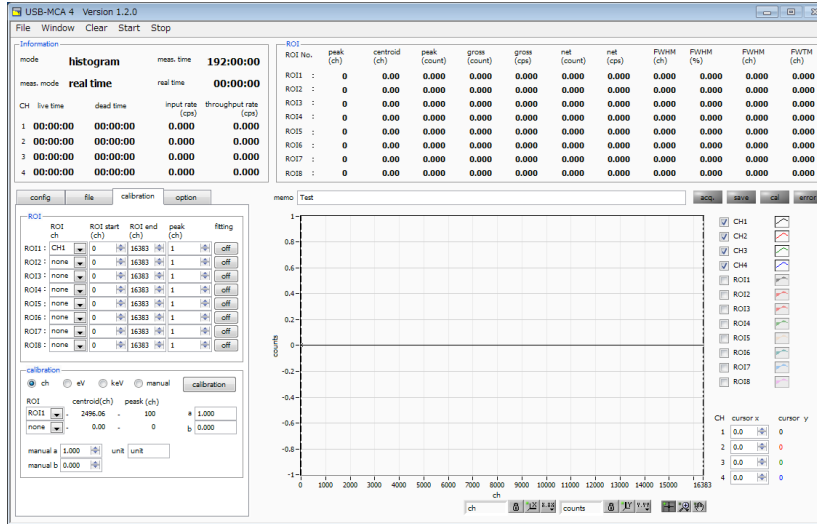
Fig. 3　calibration tab

Setting of ROI (Region of Interest) and energy calibration. Set the ROI to the spectrum peak, calculate the peak count number, full width at half maximum, etc.

"ROI" section

ROI CH	Select the channel number for ROI. A maximum of 8 ROIs can be set for one channel signal
ROI start	Set the start position of the ROI. Unit depends on energy calibration situation.
ROI end	Set the end position of the ROI. Unit depends on energy calibration situation.
peak	The energy value etc. of the peak position (channel) etc are defined. In the case of Co - 60, set it to 1173 or 1332. When "ch" is selected in the next "calibration" part, the peak between the ROI is detected, keV / ch is calculated from the peak position (ch) and the set energy value and applied to the calculation result of the half width .
fitting	Setting whether to apply Gaussian fit to the spectrum between ROI or not. As shown in the figure below, it is possible to calculate the full width at half maximum, even when the count is small, when set to "ON". !Caution! CPU load may be high depending on computer performance and specifications. In that case, please use "OFF".

Fig. 4　fitting execution

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"calibration" section

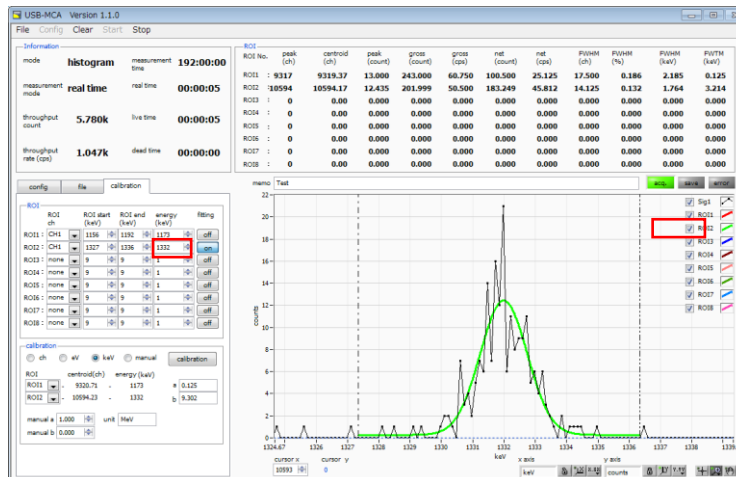|	
Types of calibration	Select the X axis unit from the following. In the case of MCS mode (option), the horizontal axis is time, so select "ns" "us" "ms" "sec". It is not "eV" and "keV".
ch	Display in ch (channel) unit. Units such as "FWHM" of "FWTM" of ROI are optional.
eV	Display in eV unit. Calculate the slope a and intercept b of the linear function y = ax + b so that the channel becomes eV by two-point calibration of two kinds of peaks (center value) and energy value in one spectrum and set it on the X axis . The unit of "FWHM" of ROI "FWTM" is "eV".
keV	Display in keV unit. Calculate the slope a and intercept b of the linear function y = ax + b so that ch becomes keV by two-point calibration of two types of peaks (center value) and energy values in one spectrum and set it on the X axis. The unit such as "FWHM" of ROI "FWTM" is "keV". As an example, if there are 1173.24 keV for Co-60 in channel 5717.9 and 1332.5 keV for Co-60 in 6498.7 channel, a is 0.20397 and b is 6.958297 automatically from two-point calibration.
manual	Energy calibration is performed by arbitrarily setting slope a, intercept b and unit label of the linear function y = ax + b with "manual a", "manual b" and "unit".
ROI	Select the ROI number for energy or time calibration. On the right side "centroid" and "peak", the central value of the ROI being selected, and the energy value being set are displayed. For example, when "ROI 1" and "none" are selected, one-point calibration is performed based on the peak center value of ROI 1 and preset "peak". When "ROI 1" and "ROI 2" are selected, the peak center value of ROI 1 and ROI 2 and the two-point calibration with "peak" set in advance.
Manual a and b	The gradient in the linear function y = ax + b for creating the graph horizontal axis, which is the calculation result of energy calibration, is shown by a and the intercept is displayed in b.
calibration button	Energy calibration is executed according to the type of calibration. After execution, the slope a and intercept b of the linear function y = ax + b applied to the horizontal axis of the graph are calculated and displayed on the lower "a" and "b". For the calculation method, refer to "8.5. Calculation method of two-point calibration" below. For example, if "keV" is selected in the "calibration" part as shown below and the "calibration" button is clicked, each peak is extracted from "centroid" value and "peak" value of "ROI 1" and "ROI 2" Energy calibration is executed so that it becomes the energy value, and the unit of horizontal axis unit of graph, set value of ROI, calculation result of ROI is also "keV".
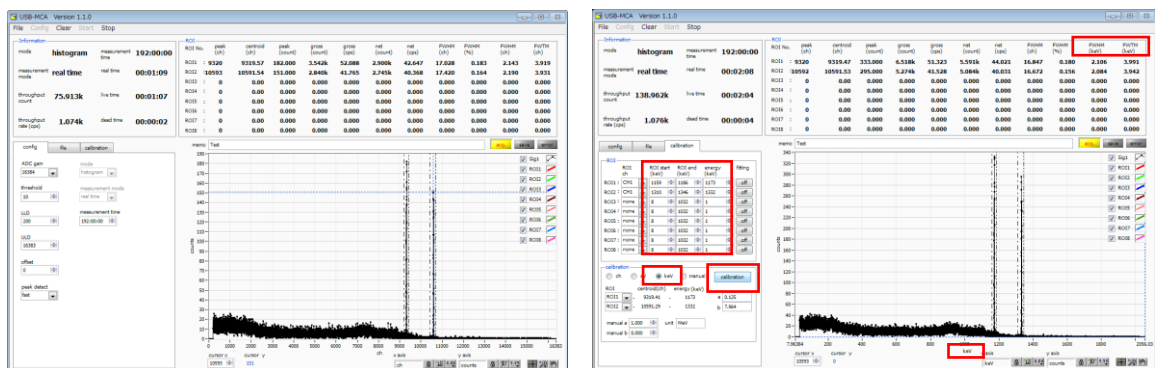
Fig. 11 Select "keV" in calibration section
(Left figure: before energy calibration execution, right figure: after energy calibration execution)

5. 6. option tab

The following settings are valid only for USB-MCA 4 with each option installed. Please note that options can be added after purchasing, so please contact us.

Configure settings such as MCS (Multi Channel Scaler) and coincidence (simultaneous measurement).

Fig. 12 option tab (upper figure: histogram, lower figure: coincidence two-dimensional histogram)

"MCS" section

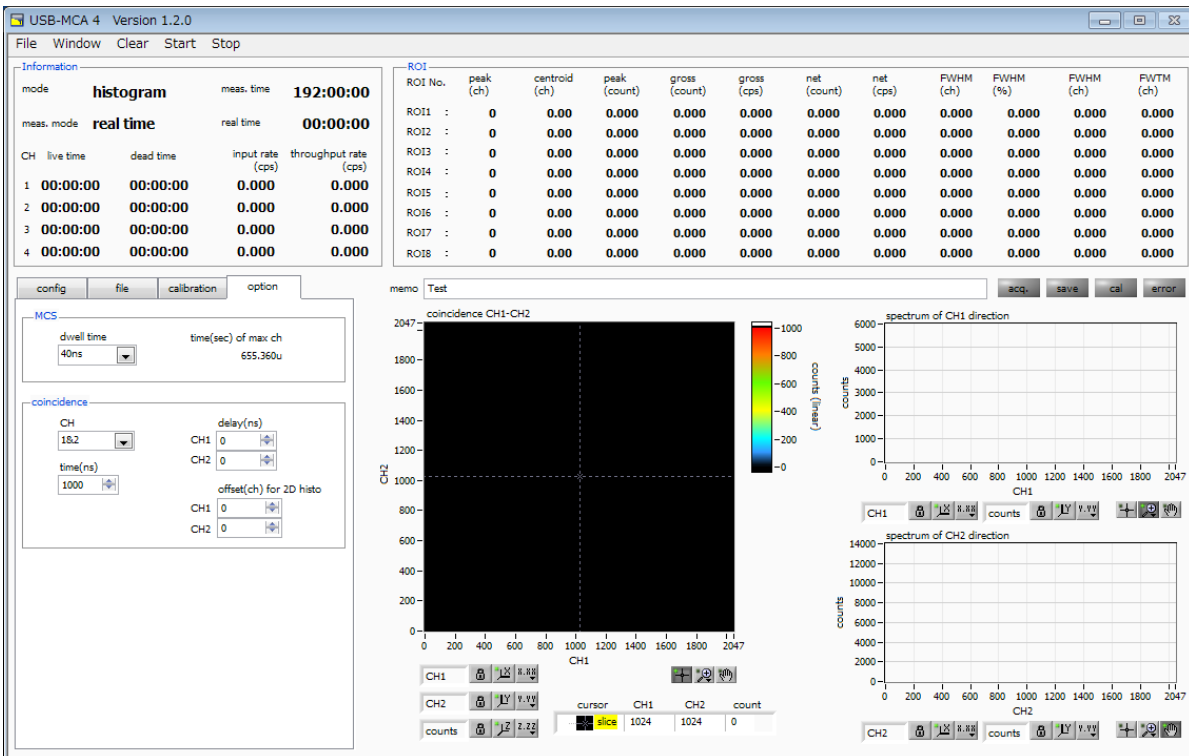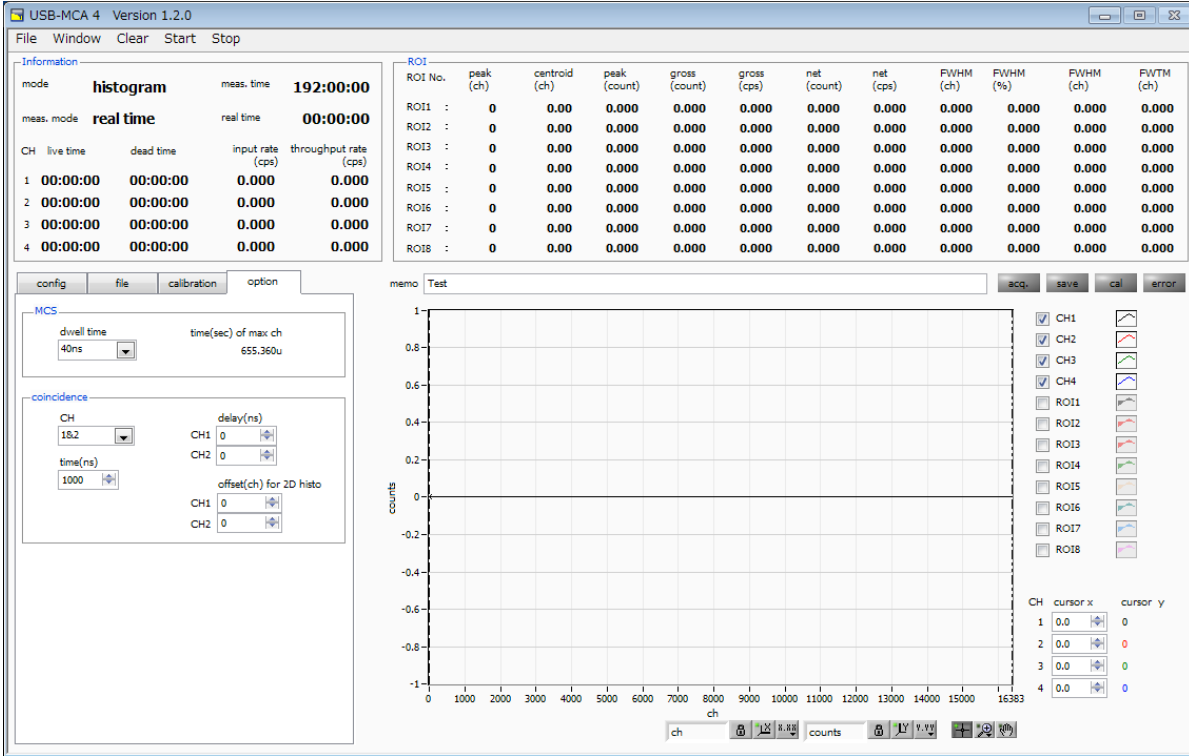| dwell time	Time width per channel. Choose from a minimum of 40 ns to a maximum of 100 s. The selection items are as follows.								
	40 ns	80 ns	120 ns	160 ns	200 ns	240 ns	280 ns	320 ns	360 ns
	400 ns	440 ns	480 ns	520 ns	560 ns	600 ns	640 ns	680 ns	720 ns
	760 ns	800 ns	840 ns	880 ns	920 ns	960 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 time of the maximum channel based on the setting of dwell time. With 16384 channels, the minimum 40 ns is 655.36 µs (655 360 ns) from 40 ns × 16 384 channels.								

"coincidence" section

CH	The target channels. Only channel 1 and channel 2.
time (ns)	Time range for judging the coincidence number. The setting range is 40 ns to 10,000 ns (10 µsec). If the time from exceeding the threshold of one channel to the threshold exceeding the threshold of the other channel falls within this setting range, it becomes the same number of clocks.
delay (ns)	Coincidence number delay time. Adjust the delay of signal transmission between channels. The setting range is 0 to 10,000 ns (10 µsec). Please use it for adjustment such as when there is time lag due to cable length etc.
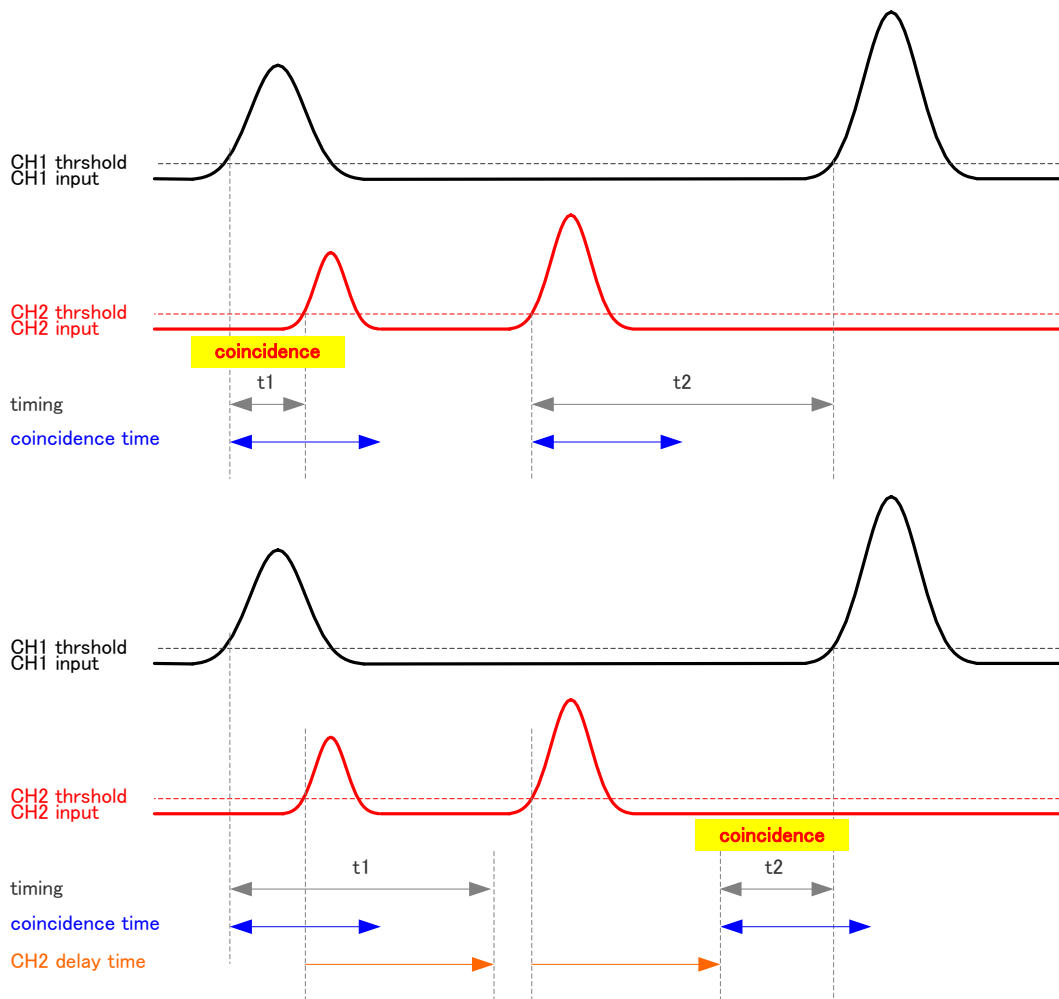
Fig. 13 Example of coincidence timing (upper figure: when delay is not used, lower figure: when CH2 delay time is used)

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offset (CH) for 2D histo	Set offset channel to coincidence 2D histogram. The setting range is 0 to 14336 (16384 - 2048) channels. Since the display range is 2048 × 2048 channels, adjust the offset value so that the peak falls within this range. As an example, if the offset of CH1 is 4096 channels and the offset of CH2 is 8192 ch, the following parts of the whole are subject to histogram creation.
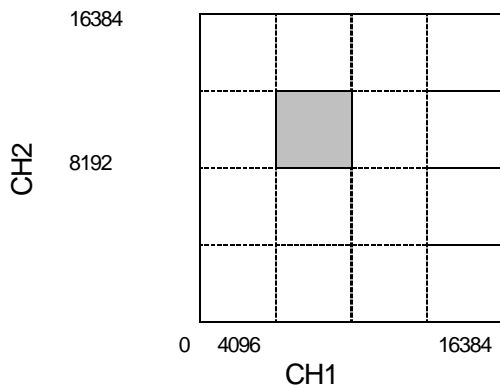
Fig. 14 2D histogram channel offset

graph	Two-dimensional histogram graph. The X axis is the pulse height (ch) of CH1, the Y axis is the pulse height (ch) of CH2, and the Z axis is the count number. The maximum number of channels on the X and Y axes is 2048 channels. The maximum count number on the Z axis is 16383.
spectrum of CH1 derection	One-dimensional channel addition histogram graph viewed from CH 1 side is displayed
spectrum of CH2 derection	One-dimensional channel addition histogram graph viewed from CH 2 side is displayed

5．7． **Graph**

graph	Display spectrum spectrum of CH1 and Gaussian fit spectrum with data between each ROI.
cursor x	There is a dotted line cursor for each channel, and the value of the count on the spectrum in the set channel is displayed in "cursor y" of the corresponding channel.
Plot legend	et the color of the graph and the type of line. You can switch display / non-display in the sub menu on the graph.
X axis range x axis keV	Right click on the X axis and check "AUTO SCALE" to set the automatic scale. When unchecked, it will no longer be automatic scale and the minimum and maximum values of the X axis will be fixed. To change the minimum or maximum value, you can change the mouse pointer by placing it over the numerical value to be changed and clicking or double-clicking it. On the X axis, set auto scalability, precision, mapping (linear / logarithm).
Y axis range y axis counts	Right click on the Y axis and check "AUTO SCALE" to set the automatic scale. If you uncheck it, it will no longer be automatic scale and the minimum and maximum values on the Y axis will be fixed. To change the minimum or maximum value, you can change the mouse pointer by placing it over the numerical value to be changed and clicking or double-clicking it. On the Y axis, set auto scalability, precision, mapping (linear / logarithm).
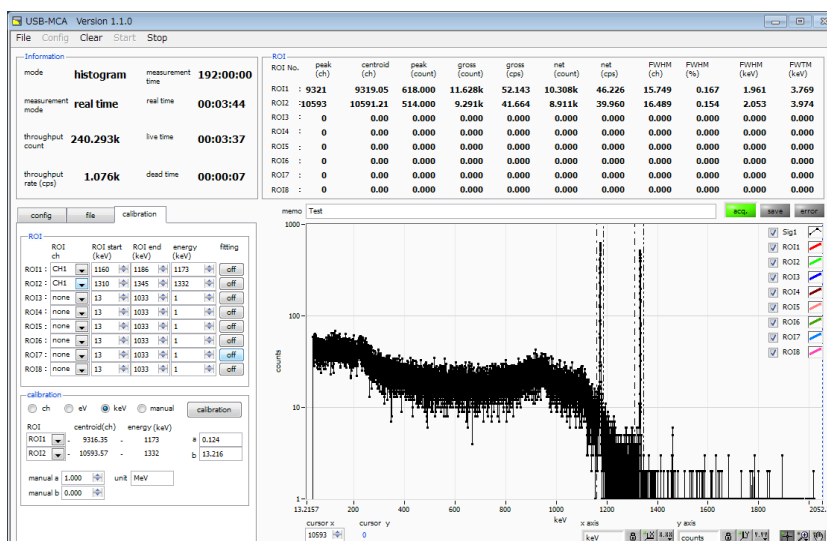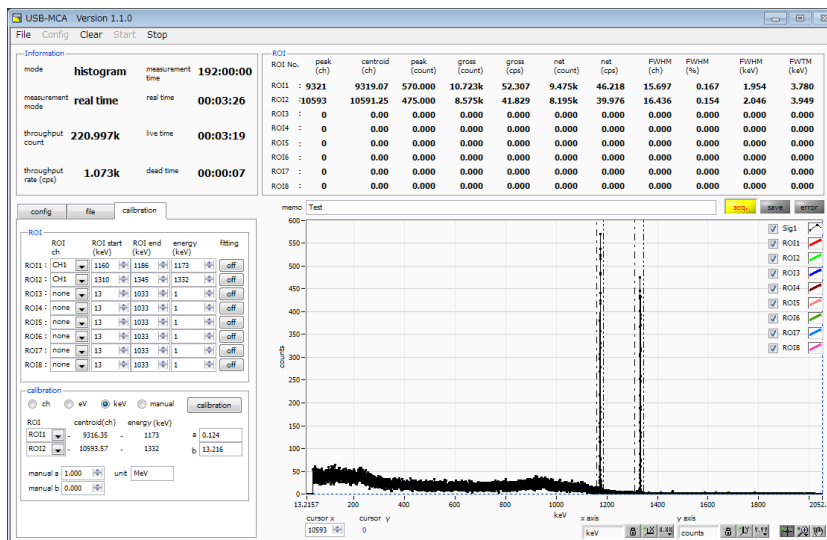
Fig. 15 Select "Line shape drawing" and "Logarithm" (lower figure) in Y axis "Mapping mode"

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✛	Cursor movement tool. The cursor can be moved on the graph when setting the ROI.
🔍	Zoom. You can select and execute the following six zooms in and zoom out by clicking.
🖐	Pan tool. You can grab a plot and move on the graph.

(1)　　(2)　　(3)

(4)　　(5)　　(6)
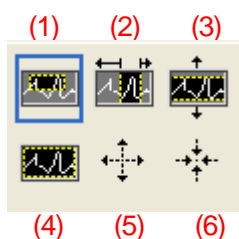
Fig. 16 Zoom in and zoom out tool

(1)	Rectangle zoom	Use this option to click the point on the display that you want to corner in 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	Automatically scale all X and Y scales on the graph.
(5)	Zoom out centering on points.	Click the center point to zoom out.
(6)	Zoom in around a point.	Click the center point to zoom in.

6. Measurement

6. 1. Histogram mode

（1）Select "histogram" in "mode" in "config" tab.

（2）Click "Clear" on the menu. The internal histogram data is initialized. To continue the histogram or measurement result measured last time, start the next measurement without clicking "Clear".

（3）When you click the "Start" menu, measurement is started after all settings are sent to this device.

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

- "Acq" LED flashes.

- The measurement status is displayed in the "Information" section.

- "Histogram" is displayed in "mode".

- Measurement set time is displayed in "meas. Time".

- Real time acquired from this device is displayed in "real time".

- The live time acquired from this device is displayed in "live time" of each channel.

- The dead time acquired from the Switch is displayed in "dead time" of each channel.

- For "ROI", for each "ROI No.", the center value, the gross count (sum within range), the rate, the net count (the total within the range minus the background subtracted from the background) by the ROI range setting in the "calibration" Count) and the calculation result such as rate, half width, 1/10 width etc. are displayed.

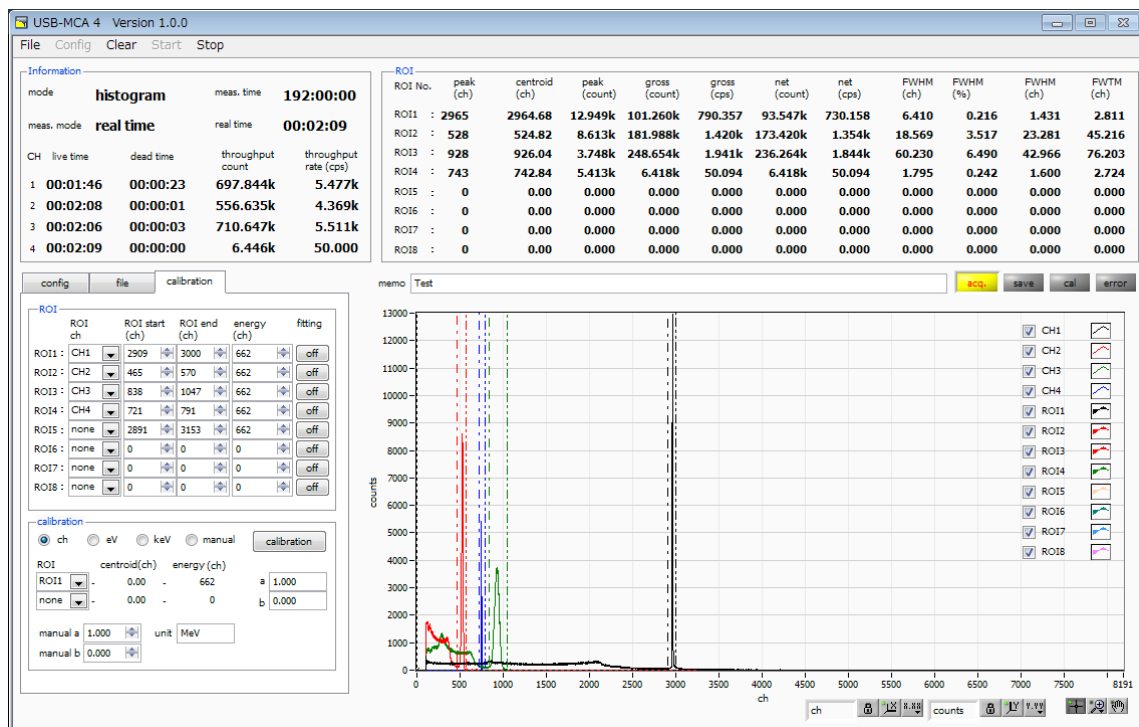- In the graph, a histogram of peak value is displayed on the horizontal axis.

Fig. 17 Window of histogram mode measurement

6．2．　**List mode**

（1）　Measurement is carried out previously in the histogram mode, and the state of the spectrum, the count rate, and the like are confirmed.

（2）　Select "list" in "mode" in "config" tab.

（3）　In the "file" tab, set the data save destination in the "list" block.

（4）　Click the menu "Clear". The in-device list measurement data is initialized.

（5）　When clicking the "Start" menu, measurement is started after all settings are transmitted to this device.

（6）　After the start of measurement, transition to the following state.

> - "Acq" LED flashes.
>
> - "Save" LED flashes.
>
> - The measurement status is displayed in the "Information" section.
>
> - "List" is displayed in "mode".
>
> - Measurement set time is displayed in "meas. Time".
>
> - Real time acquired from this device is displayed in "real time".
>
> - In the "file" tab, the file name being saved in "file name" is displayed, and the file size being saved in "file size" is displayed. When "list file size" is reached, the saved file is closed. "List file number" is incremented by one, "file name" becomes the new file name and the saving process is continued.

If "update information and spectrum" in the "file" tab is checked, "ROI" contains the center value, the gross count (in-range sum total) by ROI range setting in the "calibration" tab for each "ROI No.") And the calculation result such as rate, net count (net count obtained by subtracting background from in-range sum) and rate, half width, 1/10 width, etc. are displayed. A histogram is displayed on the graph.

The time stamp of the list data can be cleared even during measurement by using the VETO (CLR) terminal. When the rising edge of the LV - TTL level (pulse width of 100 ns or more) is detected, the time stamp is cleared.

!Caution!

Since histogram display in list mode is heavy load on the PC, please be careful when measuring high counting etc.
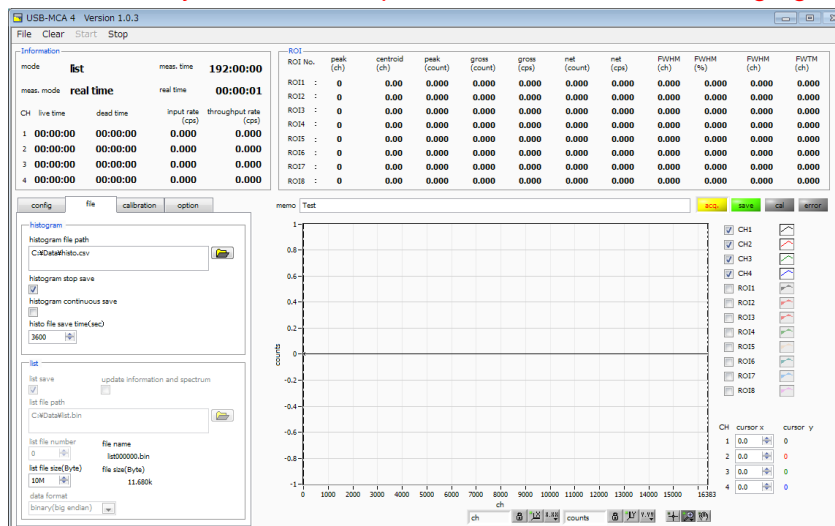
Fig. 18 Window of list mode measurement

6．3． Coincidence mode *option

（1）Connect signals from the linear amplifier to CH1 and CH2. CH3 and CH4 are not used.

（2）Check the spectrum of the current CH1 and CH2 in the histogram mode and check where the center channel of the peak of interest is. In "config" tab "mode" select "histogram".

（3）In "config" tab, set "LLD" and "ULD" widely.

（4）When you click "Clear" and "Start" on the menu, measurement is started after all settings are sent to this machine.

（5）Set the ROI to the read peak of attention of CH1 and CH2 and check the value of "centroid (ch)". In the figure below, CH1 is 5474.35 and CH2 is 5475.80.
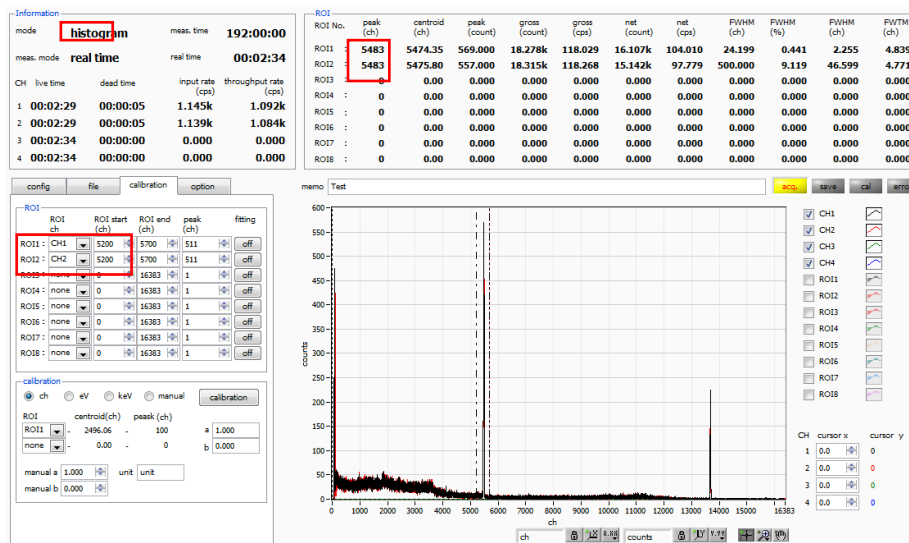
Fig. 19 Check the centroid (ch) of the peak of interest in the histogram mode

（6）After checking the value of "centroid (ch)", click the menu "Stop" to stop the measurement.

（7）Set "LLD" and "ULD", measure again in histogram mode, and confirm that histogram within the range of "LLD" and "ULD" can be obtained.

Fig. 20 Check the setting status of LLD and ULD in histogram mode

（8）Before starting measurement with the coincidence 2D histogram, click "Window" and "2D histo" in the menu to switch to the screen for 2D histogram. In addition, since the data for coincidence 2D historical data is generated on this application based on the list data, for display and saving, use the "list save" and "update information and spectrum" check boxes in the "file" tab .
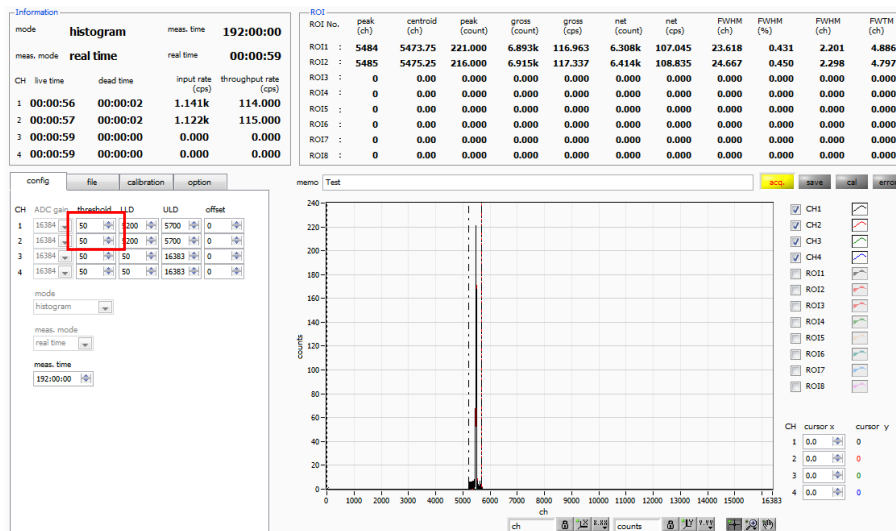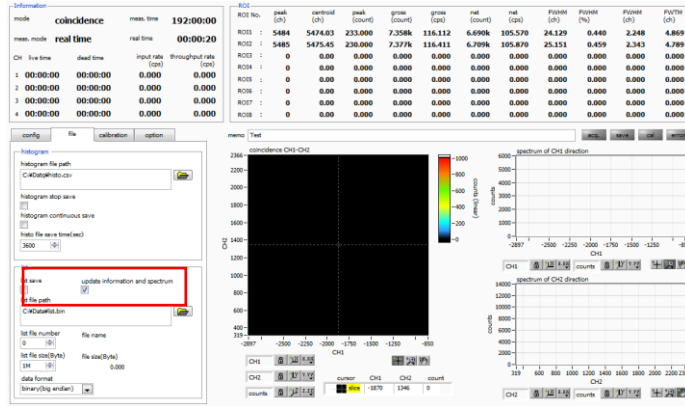

Fig. 21 "file" tab setting

（9）Setting of "coincidence" part in "option" tab. In the case of the above example, since the centroid value of the energy band whose coincidence is desired to see exceeds both the range of the range of two-dimensional histories (CH 1) 2048 × (CH 2) 2048, "offset (ch) for 2 D histo" It is necessary to set. When setting to center 1024 ch, set it from center value-1024 ch to 4451 ch.

（10）In the "config" tab, select "coincidence" in "mode".

（11）Click "Clear" on the menu. The internal buffer list measurement buffer data is initialized.

（12）When you click "Start" on the menu, measurement is started after all settings are sent to this device.

（13）After the start of measurement, it transits to the following state.

- "Acq" LED flashes.

- "Coincidence" is displayed in "mode".

- Measurement set time is displayed in "meas. Time".

- The real time acquired from this equipment is displayed in "real time" in real time acquired from this equipment.

When "update information and spectrum" is checked

- The measurement status is displayed in the "Information" section.

- A map graph is displayed on the coincidence 2D histogram.

- Spectra are displayed in the graph from CH1 direction and graph on CH2 direction side.

Fig. 22 Coincidence 2D histogram * Reference data

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6.4. Multi Channel Scaler (MCS) mode *option

(1) Select "MCS" in "mode" in "config" tab.

(2) Set "LLD" and "ULD" in "config" tab. Use the time when crest value within this range was acquired.

(3) Select the measurement time per channel at "dwell time" in the "Options" tab.

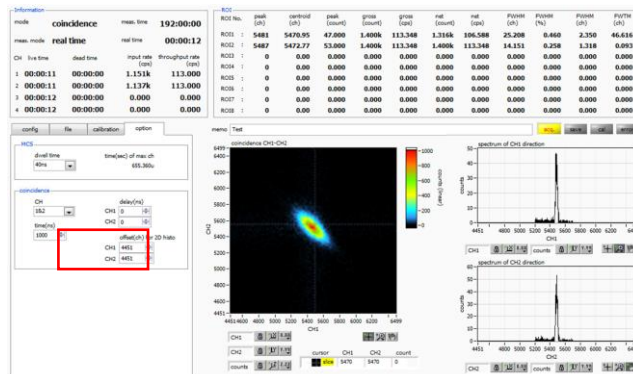(4) In MCS mode, it is possible to measure two patterns depending on whether or not to use the elapsed time reset signal from the outside.

[Reset use]

Connect periodic events that reset the elapsed time to the VETO (CLR) terminal as a reset signal. Generate histogram of elapsed time from reset to event detection. When the rising edge of the LV - TTL level (pulse width of 100 ns or more) is detected at the VETO (CLR) terminal, the elapsed time is reset. When the maximum crest value in the ULD is detected from the LLD after securing the elapsed time until the input signal to the channel exceeds the threshold after the reset, the "dwell time" based on the secured elapsed time 1 is added to the channel corresponding to the elapsed time in the histogram having the interval channel. Adjust the reset signal or "dwell time" so that the reset period is less than "time (sec) of max ch".

[Reset not used]

Based on the elapsed time from measurement start to event detection, 1 is added to the channel corresponding to that elapsed time in the histogram having the channel of "dwell time" interval. Because the elapsed time is not reset, the channel to be added moves to the larger channel as the measuring time passes. It can be used for half life measurement etc.

(5) Click "Clear" on the menu. The MCS histogram data in this device is initialized. To continue the histogram or measurement result measured last time, start the next measurement without clicking "Clear".

(6) When you click "Start" on the menu, measurement is started after all settings are sent to this machine.

(7) After the start of measurement, transition to the following state.

    - "Acq" LED flashes.

    - The measurement status is displayed in the "Information" section.

    - "MCS" is displayed in "mode".

    - Measurement set time is displayed in "meas. Time".

    - Real time acquired from this device is displayed in "real time".

    - The graph shows the MCS histogram with time on the horizontal axis.

    - Events exceeding "time (sec) of max ch" will be added to the last 16383 channels.
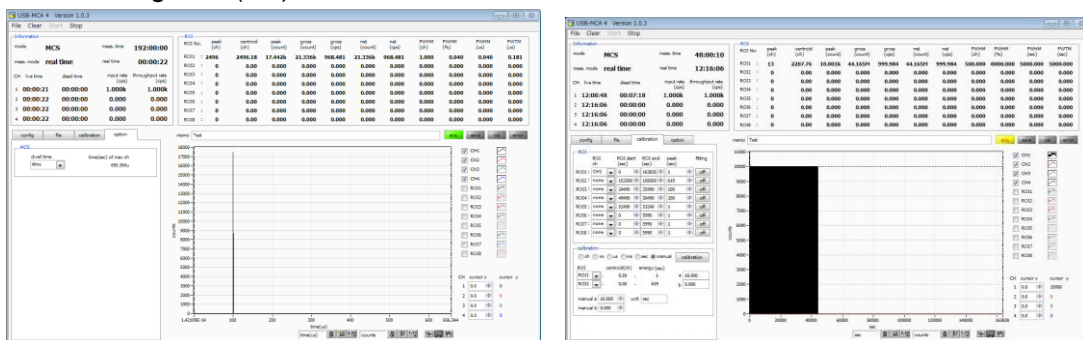
Fig. 23 Window of MCS histogram mode measurement

Left figure: With reset. When the event occurred 100 μsec after reset is repeatedly measured

Right figure: No reset. When the 1 kHz simulation signal is measured with dwell time: 10 sec

6.5. **Measurement stop**

- When "meas. Mode" is "real time", measurement will end when "real time" reaches "meas. Time".

- When "meas. Mode" is "livel time", measurement will end when the latest "live time" reaches "meas. Time".

- To stop during measurement, click "Stop" on the menu. Stop measurement after execution.

7. **Files**

7.1. **Histogram data file**

（1）File format

Comma Separated Values (csv) Text Format

（2）File name

Any

（3）Configuration

[Header] section

Memo	Memo
Measurement mode	Select "Real time" or "Live time" mode
Measurement time	Unit is seconds
Real time	Real time
Live time	Live time per channel. Unit is seconds.
Dead time	Dead time per channel. Unit is seconds.
Start time	Measurement start time
End time	Measurement stop time

*The following items are saved for each channel.

- ADC gain

- Threshold

- LLD

- ULD

- offset

*The following items are **NOT** saved for each channel.

Mode	Mode
meas. mode	Measurement mode
meas. time	Measurement time. Unit is seconds.
CH1 Cursor X	Cursor position for CH1 and count value on CH1 histogram
CH2 Cursor X	Cursor position for CH2 and count value on CH1 histogram
CH3 Cursor X	Cursor position for CH3 and count value on CH1 histogram
CH4 Cursor X	Cursor position for CH4 and count value on CH1 histogram

[Calculation] section

*The following items are saved for each channel.

ROI No.	Input channel number subject to ROI.
ROI start	ROI start position (ch)
ROI end	ROI end position (ch)
peak	Peak energy value between ROI
fitting	Fitting apply
peak (ch)	Peak position between ROI (ch)

centroid (ch)	Center position between ROI (ch)
gross (count)	Sum of counts between ROI
gross (cps)	Gross (count) for 1 second
net (count)	The sum of the counts obtained by subtracting the background between ROI
net (cps)	Net (count) for 1 second
FWHM (ch)	FWHM between ROI (ch)
FWHM (%)	FWHM between ROI (%)
FWHM (keV)	FWHM between ROI (keV etc.)
FWTM (keV)	One-tenth (1/10) width between ROI (keV etc.)

[Status] section

*The following items are saved for each channel.

throughput count	Number of events processed
throughput rate	Number of events processed per second

[Data] section

data	Histogram data for each channel. Maximum 16384 points.

７．２． **List data file**

The format of the data file saved in list mode. The data saved at coincidence mode (option) has the same format.

（1）File format

Binary, big endian / little endian format or text (CSV) format

（2）File name

It becomes the file path set to "list file path" in the "file" tab, adding "file number" 0 plus 6 places.

Example 1: If "list file path" is set to "D:￥data￥123456.bin" and "number" is set to "1"

"D:￥data￥123456＿000001.bin".

Example 2: If "list file path" is set to "D:￥data￥123456" and "number" is set to "100"

"D:￥data￥123456＿000100".

When "list file size" is reached, the file being saved is closed. After that, it automatically advances "list file number" one by one, opens a new file, and continues saving the data file.

（3） Configuration (big endian format)

64-bit per event (8 bytes, 4 WORD)

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

Fig. 24 List data (80 bit) configuration, big endian

Vacant	4-bit. From 63-bit to 60-bit.
ABS	Absolute count (measured elapsed time, Real Time). 44-bit (ABS [43...0]). 40 ns per 1-bit. Maximum measurement time is about 8 days (8 days = 244 * 40 ns). From 59-bit to 48-bit ABS [43…32] From 47-bit to 32-bit ABS [31…16] From 31-bit to 16-bit ABS [15…0]
CH	Channel number. 2-bit (CH [1…0]). 0 is CH 1, 1 is CH 2, 2 is CH 3, 3 is CH 4. From 15-bit to 14-bit CH [1…0]
PHA	Pulse heigh. 14-bit (PHA [13…0]) From 0 to 16383 From 13-bit to 0-bit. PHA [13…0]

（4） Configuration (little endian format)

64-bit per event (8 bytes, 4 WORD)

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

Fig. 25 List data (80 bit) configuration, little endian

| Vacant	4-bit. From 55-bit to 52-bit.
ABS	Absolute count (measured elapsed time, Real Time). 44-bit (ABS [43...0]). 40 ns per 1-bit. Maximum measurement time is about 8 days (8 days = 244 * 40 ns). From 63-bit to 56-bit ABS [39…32] From 51-bit to 48-bit ABS [43…30] From 47-bit to 40-bit ABS [23…16] From 39-bit to 32-bit ABS [31…24] From 31-bit to 24-bit ABS [7…0] From 23-bit to 16-bit ABS [15…8]
CH	Channel number (0 to 3). 2-bit (CH [1…0]). From 7-bit to 6-bit CH [1…0]
PHA	Pulse heigh. 14-bit (PHA [13…0]) From 0 to 16383 From 5-bit to 0-bit. PHA [13…8]

7．3． **List data file conversion**

List mode Convert the binary format list data file saved by measurement to comma-separated text (csv) format. It is saved in the form of "ABS (absolute count), CH number, PHA (crest value)" in one line per event.
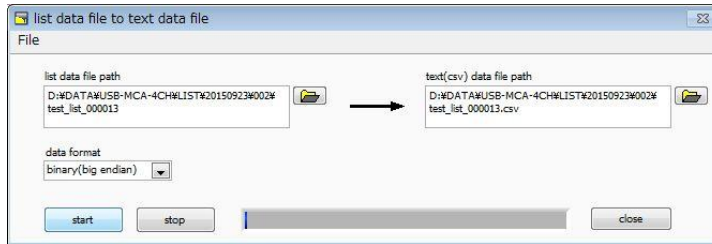
	Binary	**Text**
Absolute count (ABS)	In units of 40 ns	In unit of ns
Number of channel	0 to 3	1 to 4
Pulse heigh (PHA)	0 to 16383	0 to 16383

Use the following procedure to convert the binary format list data file to text (CSV) format.

（1） Click "File" - "convert to text from binary list data file" in the menu.
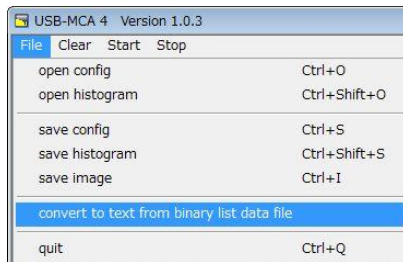
（2） The following "list data file to text data file" window opens.

list data file path	List mode Set binary format list data file before conversion saved by measurement to absolute path.
data format	List mode Set the binary format list data file format saved by measurement. Select from "binary (big endian)" or "binary (little endian)".
text(csv) data file path	Sets the converted list data file in comma-separated text (csv) format as an absolute path and saves it.

（3） Click "start" button to start conversion. Conversion is complete when the status bar becomes full.
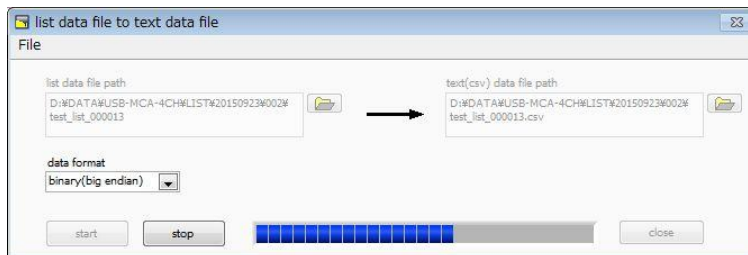
*To stop the conversion, click the "stop" button.

（4） Click the "close" button to finish converting the list data file.

7．4． Coincidence two-dimentional histogram data file *option

After measurement in coincidence mode, you can save coincidence 2D histogram data to a file by clicking "File" - "save 2D histogram" in the menu at an arbitrary timing.

（1） File format

Comma Separated Values (csv) Text Format

（2） File name

Any

（3） Configuration

[Header] section

Memo	Memo
Measurement mode	Select "Real time" or "Live time" mode
Measurement time	Unit is seconds
Real time	Real time
Live time	Live time per channel. Unit is seconds.
Dead time	Dead time per channel. Unit is seconds.
Start time	Measurement start time
End time	Measurement stop time

*The following items are saved for each channel.

- ADC gain

- Threshold

- LLD

- ULD

- offset

*The following items are **NOT** saved for each channel.

Mode	Mode
meas. mode	Measurement mode
meas. time	Measurement time. Unit is seconds.
dwell time	Dwell time. Unit is seconds.
CH1 Cursor X	Cursor position for CH1 and count value on CH1 histogram
CH2 Cursor X	Cursor position for CH2 and count value on CH1 histogram
CH3 Cursor X	Cursor position for CH3 and count value on CH1 histogram
CH4 Cursor X	Cursor position for CH4 and count value on CH1 histogram

[Calculation] section

*The following items are saved for each channel.

ROI No.	Input channel number subject to ROI.
ROI start	ROI start position (ch)
ROI end	ROI end position (ch)

peak	Peak energy value between ROI
fitting	Fitting apply
peak (ch)	Peak position between ROI (ch)
centroid (ch)	Center position between ROI (ch)
gross (count)	Sum of counts between ROI
gross (cps)	Gross (count) for 1 second
net (count)	The sum of the counts obtained by subtracting the background between ROI
net (cps)	Net (count) for 1 second
FWHM (ch)	FWHM between ROI (ch)
FWHM (%)	FWHM between ROI (%)
FWHM (keV)	FWHM between ROI (sec etc.)
FWTM (keV)	One-tenth (1/10) width between ROI (sec etc.)

[Status] section

*The following items are saved for each channel.

throughput count	Number of events processed
throughput rate	Number of events processed per second

[2DHistogram]

CH1 Offset (ch)	Offset channel to coincidence two-dimensional histogram of CH1
CH2 Offset (ch)	Offset channel to coincidence two-dimensional histogram of CH2

[Data] section

data	Histogram data for each channel. Maximum 16384 points. The channel (bin) of CH1, the channel (bin) of CH2, the order of count. The number of lines is variable length.

7．5． **Multi Channel Scaler (MCS) data file *option**

（1）File format

　　Comma Separated Values (csv) Text Format

（2）File name

　　Any

（3）Configuration

[Header] section

Memo	Memo
Measurement mode	Select "Real time" or "Live time" mode
Measurement time	Unit is seconds
Real time	Real time
Live time	Live time per channel. Unit is seconds.
Dead time	Dead time per channel. Unit is seconds.
Start time	Measurement start time
End time	Measurement stop time

*The following items are saved for each channel.

- ADC gain

- Threshold

- LLD

- ULD

- offset

*The following items are **NOT** saved for each channel.

Mode	Mode
meas. mode	Measurement mode
meas. time	Measurement time. Unit is seconds.
dwell time	Dwell time. Unit is seconds.
CH1 Cursor X	Cursor position for CH1 and count value on CH1 histogram
CH2 Cursor X	Cursor position for CH2 and count value on CH1 histogram
CH3 Cursor X	Cursor position for CH3 and count value on CH1 histogram
CH4 Cursor X	Cursor position for CH4 and count value on CH1 histogram

[Calculation] section

*The following items are saved for each channel.

ROI No.	Input channel number subject to ROI.
ROI start	ROI start position (ch)
ROI end	ROI end position (ch)
peak	Peak energy value between ROI
fitting	Fitting apply
peak (ch)	Peak position between ROI (ch)

centroid (ch)	Center position between ROI (ch)
gross (count)	Sum of counts between ROI
gross (cps)	Gross (count) for 1 second
net (count)	The sum of the counts obtained by subtracting the background between ROI
net (cps)	Net (count) for 1 second
FWHM (ch)	FWHM between ROI (ch)
FWHM (%)	FWHM between ROI (%)
FWHM (keV)	FWHM between ROI (sec etc.)
FWTM (keV)	One-tenth (1/10) width between ROI (sec etc.)

[Status] section

*The following items are saved for each channel.

throughput count	Number of events processed
throughput rate	Number of events processed per second

[Data] section

data	Histogram data for each channel. Maximum 16384 points.

8. Functions

8．1． Data acquisition by external GATE input signal timing

To acquire event data at that time according to external conditions when an event occurs, input the LV - TTL level signal to the "GATE" LEMO connector on the front panel. Measurement is performed when it is High, but not when it is Low.

Please input the external GATE input signal in a range sufficient to cover the waveform shaping input signal (see the figure below).

When the waveform shaping input signal exceeds the threshold level Vth from the baseline, the external GATE input signal should be held high. Waveform shaping A / D conversion processing is performed when the input signal falls below the threshold level, and the peak value is determined after 1.2 μs processing time.
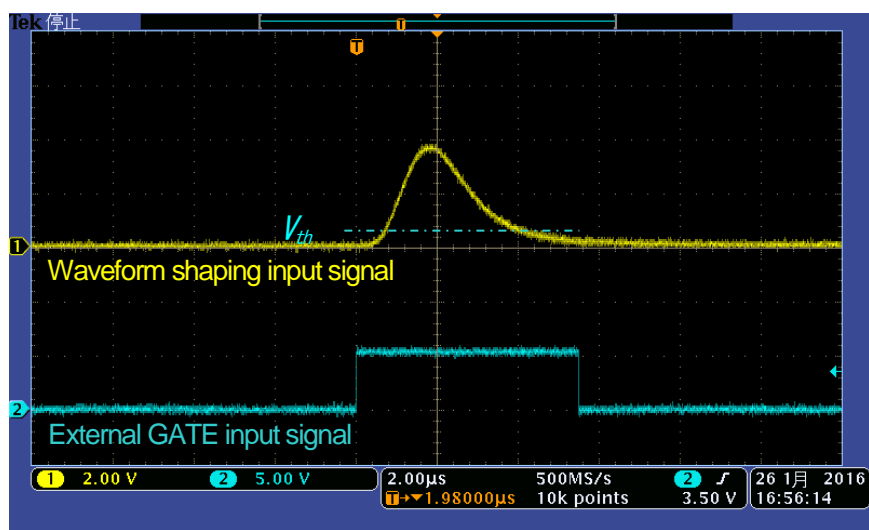
Fig. 26 External GATE Input Signal Timing

*The external GATE input signal is LV - TTL level. Lower level of 0.8 V or less is judged as High level above 2.0 V. The maximum input voltage is 5V.

8．2． Data discard by VETO signal timing

If you want to discard the event data at that time due to external conditions at the occurrence of an event, input the LV - TTL level signal to the front panel LEMO connector "VETO". It is the opposite effect of "GATE". Measurement is performed when it is Low, but not when it is Low. The timing is the same as GATE mentioned above.

8．3． **Caluculation method of full width at half maximum (FWHM)**

The calculation method of Full Width at Half Maximum (FWHM) in "status" tab is as follows.
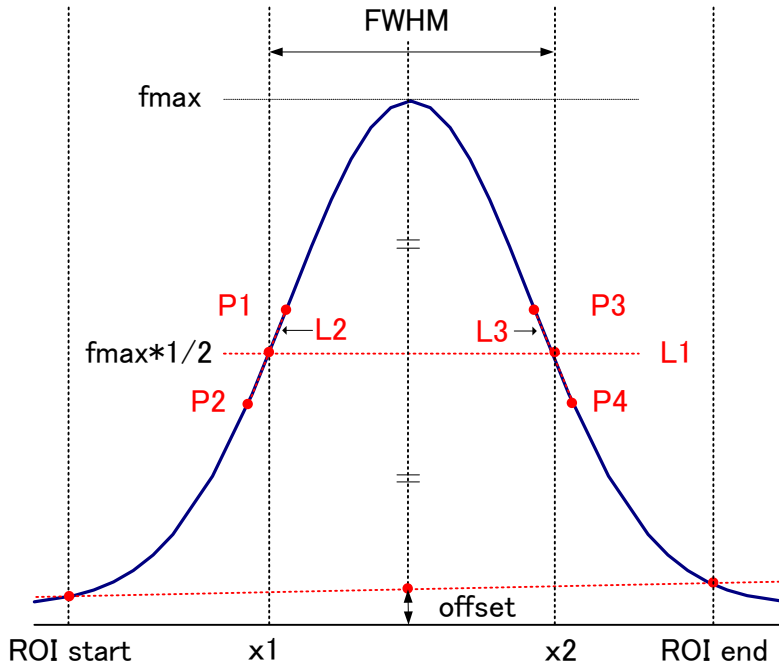

Fig. 27 FWHM calculation

1	Detects the maximum value fmax between ROI Start and ROI end in the histogram.
2	Connect the intersection of the histogram and ROI start with the intersection of the histogram and ROI end with a straight line. Calculate the background offset (offset) by obtaining the intersection of the straight line and the line drawn vertically from the peak value fmax to the x axis.
3	Calculate half (1 / 2) of the part obtained by subtracting offset from fmax and draw a straight line L1 parallel to the X axis.
4	Calculate two points where the histogram and L1 intersect, we detect the intersecting before and after points P1 and P2, and P3 and P4.
5	A straight line L2 connecting P1 and P2 and a straight line L3 connecting P3 and P4 are drawn.
6	Calculate the X coordinate x1 of the intersection of L1 and L2 and the X coordinate x2 of the intersection of L1 and L3.
7	The difference between x2 and x1 is FWHM

8.4. Calculation method of gross count and net count

"Gross" count and "net" count in the "ROI" section are calculated by the Kobel method.
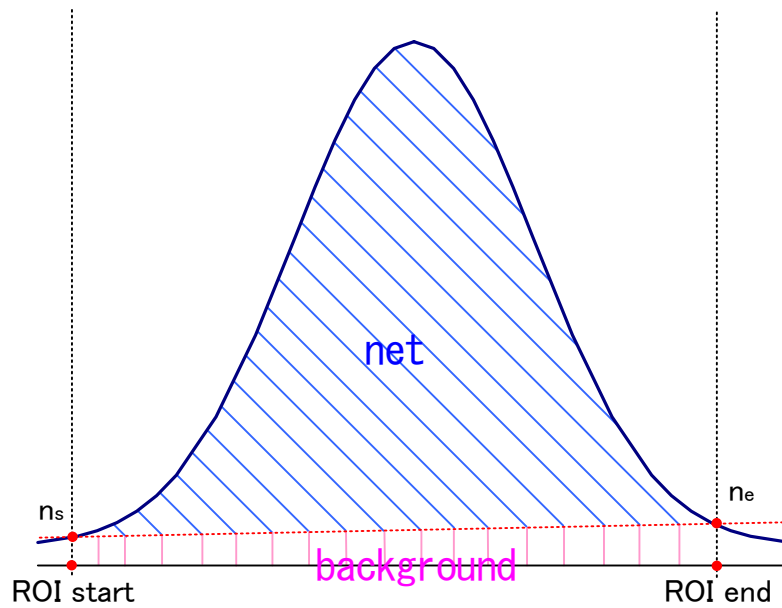

Fig. 28 Gross count and net count calculation

1	The "gross" count is the sum of the counts between ROI Start and ROI end.
2	The "net" count is the net count of the peak minus the background count from the "gross" count (hatched in blue in the above figure).
3	The background count connects the intersection point ns of ROI start and spectrum, and the intersection point ne of the spectrum with ROI end with a straight line. The area of the rectangle surrounding the four points of ROI start, ns, ne, and ROI end (pink line in the above figure).

8. 5.　Calculation method of two-point calibration

（1）　In histogram mode

In energy calibration, to convert X axis unit scale of graph to energy (eg keV), two-point calibration is performed by using 2 energy peak centroid and peak energy value. One-point calibration is also possible.

Refer to the "centroid (ch)" value of ROI 1 / ROI 2 displayed in "ROI" at the top of the graph. Set "ROI start (keV)" and "ROI end (keV)" with "ROI" on the upper side of the "calibration" tab. Or set the range of ROI 1 and ROI 2 by moving the cursor on the graph.

Select the radio button "keV" with "calibration" at the bottom of the "calibration" tab. In "calibration" on the lower side of "calibration" tab, select "ROI 1" and "ROI 2" for ROI.

Set to "peak (keV)" to what keV the energy of each peak of ROI 1 / ROI 2 corresponds.

Clicking on the "calibration" button automatically reflects the inclination a and intercept b of the linear equation y = ax + b calculated by the following formula in the lower "a" and "b".
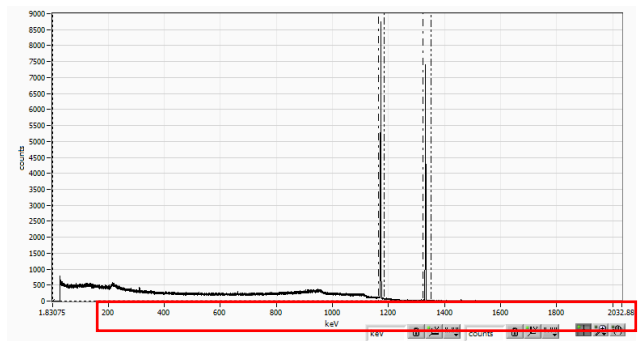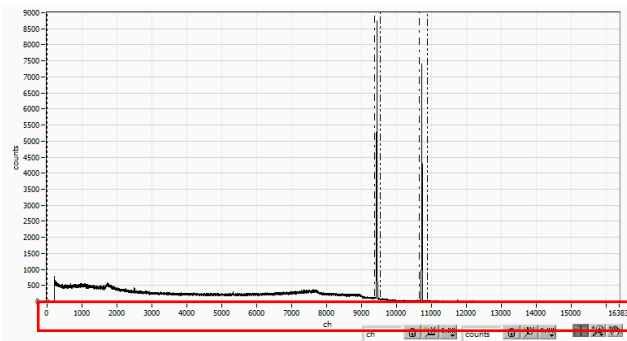
Fig. 29 Before Energy Calibration (Left) After Energy Calibration (Right)

a = (peak1 - peak2) / (centroid1 - centroid2)
b = y – ax

In case of the center grid of Co-60 at 1173 keV is 9446.99 ch and the centrid at 1332 keV is 10729.53 ch,

a = (1332 - 1173) / (10729.53 – 9446.99) = 0.124
b = 1332 – 0.124 * 10729.53 = 1.831

Therefore, it is automatically reflected as "0.124" in "a" and 1.831 in "b", and the unit scale in the X axis is created with the linear expression 0.124 * ch + 1.831.

（2） In Multi Channel Scaler (MCS) mode

Select "manual" in the "calibtaion" tab. Set "dwell time" to "manual a" and "0" to "manual b", execute the time calibration by executing the "calibration" button.

As with the energy calibration described above, in order to set the X axis unit scale of the time calibration graph to time (example: us), two-point calibration is performed using the centroid of two peaks and the peak time value. One-point calibration is also possible.

Set "dwell time" and "caliration" to "ch" and start measurement. Refer to the "centroid (ch)" value of ROI 1 / ROI 2 displayed in "ROI" at the top of the graph. Set "ROI start (ch)" and "ROI end (ch)" with "ROI" on the upper side of the "calibration" tab. Or set the range of ROI 1 and ROI 2 by moving the cursor on the graph.

Select the radio button "us" with "calibration" at the bottom of the "calibration" tab. In "calibration" on the lower side of "calibration" tab, select "ROI 1" and "ROI 2" for ROI.

Set to "peak (us)" how many microseconds each peak time of ROI 1 / ROI 2 corresponds.

Clicking on the "calibration" button automatically reflects the inclination a and intercept b of the linear equation y = ax + b calculated by the following formula in the lower "a" and "b"
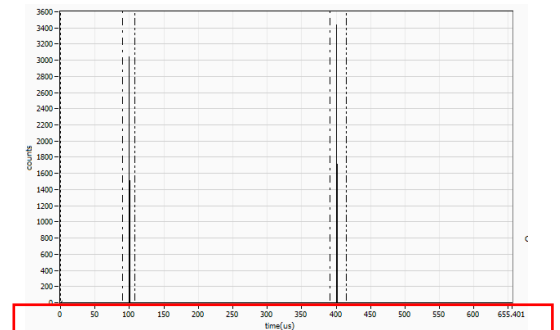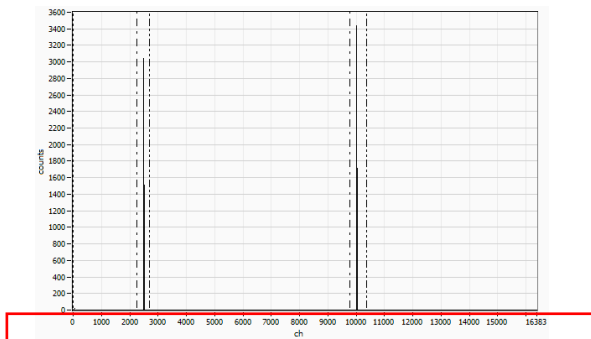
Fig. 30 Before Energy Calibration (Left) After Energy Calibration (Right)

a = (peak1 - peak2) / (centroid1 - centroid2)
b = y – ax

In case of the centrid of the time difference 100 us peak is 2500 ch and the 400 us centrid is 10000 ch,
a = (400 - 100) / (10000 – 2500) = 0.04
b = 400 – 0.004 * 10000 = 0

Therefore, it is automatically reflected in "a" to 0.04, "b" to 0, and the unit scale on the X axis is created with the linear expression 0.04 * ch + 0. In addition, basically "a" is equal to the value set in "dwell time".

9. **Guarantee provision**

The warranty conditions of "our products" 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) Breakdown / damage in harsh environments (high temperature / high humidity, under zero, condensation etc.). (4) Causes other than the above, other than "our products". (5) Consumables. (6) Natural disasters such as fire, earthquake, flood damage, lightning, etc. and breakdown due to theft. (7) When the cause of the malfunction is found to be wet

NOTE: To use our products, you agree to all the above items.

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Distributor or Agency

TechnoAP Co., Ltd.

Warranty

This warranty promises to guarantee the product free under warranty conditions within the warranty period.

Product name	USB-MCA4
Model	APG7400A、 APG7400A(DM)、 APG7400A(DM)-MCS、 APG7400A(DM)-COIN、 APG7400A(DM)-COIN-MCS
S / N	
Warranty period	One year from date of purchase
Purchase date	
Sales store	
Customer Name	
Customer Address	
Customer TEL number	

* Please keep the warranty certificate and documents that can be proved on the purchase date. It is necessary for warranty and repair.

* This product warranty card will not be reissued so please keep it in a safe place.

* Even during the warranty period, costs may be incurred for repair or replacement. Please read the contents of "Safety Instruction and disclaimer" carefully and use it correctly.