SAEU3H AE System

Quick Start Operation Guide

SWAE Software version: 4.6.25.67

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Table of Content

1. System Installation and Connection

The system hardware connection diagrams are shown in Fig. 1-1 and Fig. 1-2.
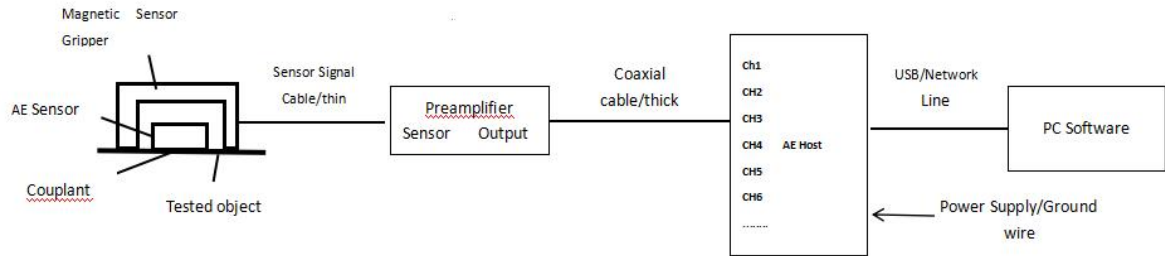
Fig. 1-1 Connection Diagram of generic sensor and external preamplifier
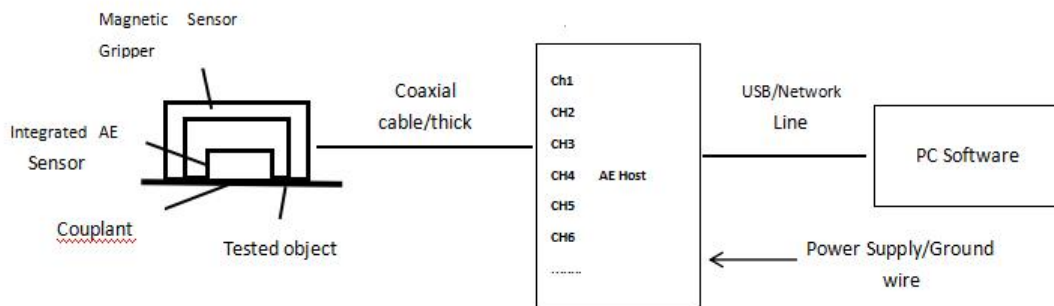
Fig. 1-2 Connection Diagram Of Integrated Sensor

1.1. Hardware connection

1.1.1. Instrument Connection

Figure 1-1 and Figure 1-2 are the schematic diagrams of hardware connection of the acoustic emission detection system. The difference is that the selected sensors are different. The former is that the sensor and preamplifier are independent products, while the latter is of integrated structure.

A. When the sensor and preamplifier are two separated independent products, please refer to the connection method in Fig. 1-1:

a1. Connect one end (M5 or SMA or other types) of the matching signal cable to the connector port of the sensor;

a2. Connect the other end of the signal cable (from Step a1.) to the input port of the preamplifier. There are two types of the input ports on the preamplifier, single-end port and

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differential type port respectively. The **[DIFF]** input port is only for the differential type sensors. For all other types of sensor, connect to the single-end input port **[SINGLE]** of the preamplifier. Also make sure the input type switch of the preamplifier is switched to the correct type and connected port direction (i.e switch down for the single-end input);

a3. Connect the BNC end of the coaxial cable with the output end **[POWER/OUTPUT]** of the preamplifier;

a4. The other end (OOS type) of the coaxial cable is connected to the desired channel port of the SAEU3H acoustic emission board;

Fig. 1-3 Connection picture of generic sensor and external preamplifier

B. When the AE sensor is an integrated sensor with a built-in preamplifier, refer to the connection method in Fig. 1-2;

b1. Connect the BNC (or SMA) end of the coaxial cable with the output end of the sensor, and make sure that the connection is good;

b2. The other end (OOS type) of the coaxial cable is connected to the desired channel port of the SAEU3H acoustic emission board;

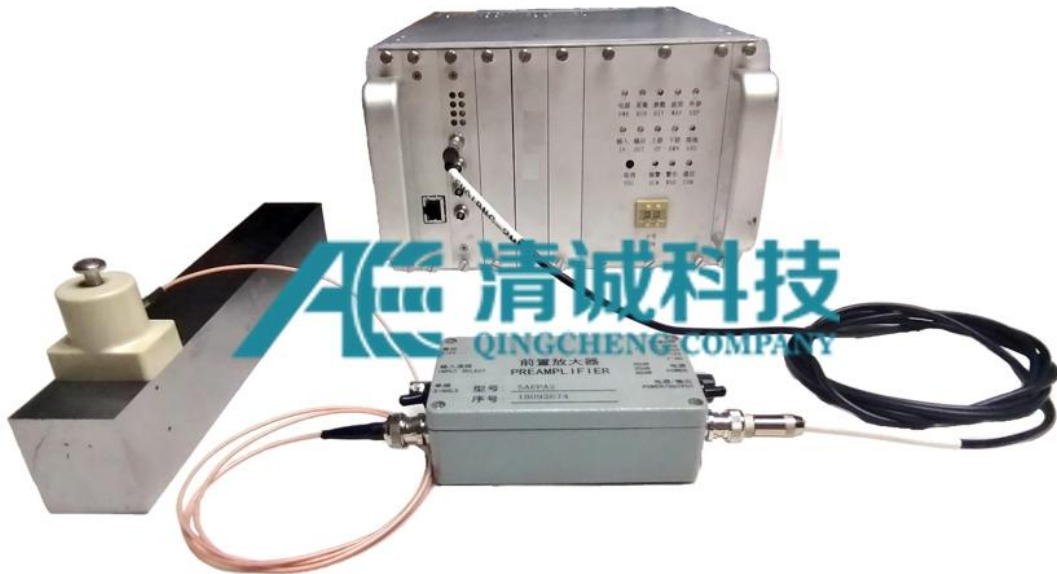## 1.1.2. AE Host Power Supply

SAEU3H AE host requires AC 220V / 50Hz power supply and reliable grounding; when there is no grounding wire connected to the power supply, it can be externally grounded through the grounding terminal on the chassis panel.

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1.1.3. PC Communication

The standard configuration of the connection between the computer and the acoustic emission host is USB 3.0 data line. When the user requires other types, the network cable or WiFi mode can be selected. When USB or network cable is selected for transmission, the computer can be connected to the acoustic emission host through the configured data line. When WiFi is selected for connection, the communication plug-in program shall be installed after the upper computer driver is installed.

1.2. Installation of PC Software

The acquisition of acoustic emission data is based on a correct communication between the acoustic emission acquisition instrument and the computer, which needs the support of the PC software and a driver software; the analysis only needs PC software.

Note: the computer must be a 64-bit operating system of Windows system, and the 32-bit system will cause software installation failure.

1.2.1. PC Software Installation

For the first time use, double click the **[setup_x64_v4.x.x.x.exe]** execution program to install the "SWAE" software package. The installation dialog box will pop up.

First select the language, either **[Chinese] or [English]**, and then click **[Confirm] - [Next]**. Then enter the user name and company name and click **[Next]**. Choose **[Complete]** (the default and recommended installation package) and click **[Next] - [Install] - [Finish]**.

The default installation path is **[C:\Program Files\SWAE]**. During the installation process, you can input English letters or Chinese characters in the input box. If you encounter the prompt or block of the security software, please select **[Release] / [Allow]**. The hardware driver files will be generated automatically in the installation folder after the PC software is installed. The software application shortcut will be created on the desktop after the successful installation.

If you have installed our SWAE software before, please uninstall it completely using the uninstalling process on the computer before a new installation. Sometime a system restart may be needed.

1.2.2. Driver Installation

The correct connection between the acoustic emission acquisition instrument and the computer is the premise of installing the driver

① Connect the USB cable to the computer;

② Open the SWAE software;

③ Turn on the power supply of the acoustic emission acquisition instrument host;

④ The system will prompt to install the driver;

⑤ Install the driver for each AE board of the chassis, plus another one bus board to be installed for the communication between the AE instrument and the PC.

The number of AE boards ＝ （total channel number）／4

The following describes the installation drivers of Win7 and Win10 operating systems covering most computers:

1.2.2.1. Installation Hardware Driver Under Win7 Operating System

a.   **Enter the Device Manager**

The general method is to right-click "Computer" and select **[Device Manager]** in "Management" or "Attributes". Generally, the newly added acoustic emission hardware is under the **[Other Device]**, as shown in the Figure 1-4. For example, it shows a 20-channel acoustic emission instrument hardware drivers, i.e. five AE boards in the SAEU3H chassis and one bus board ["Soundwell FX2 Oioi"], with the yellow "!" Indicates that the driver is not installed or installed incorrectly.
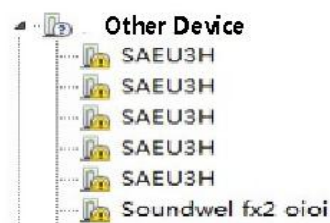
Fig. 1-4 Hardware Identification Status And Location of Driver Uninstalled

b.   **Driver software selection**

Right click on the "SAEU3H" and select **[Update driver software]** in the drop-down menu. Due to the differences of the computer system environment, it is recommended to select **[Browse computer to find driver software]** in the pop-up dialog box, and then find the folder where the driver is located. The default path of the hardware driver in Win7

64-bit operating system is **[C: \ program files \ SWAE \ driver \ win7 \ x64]**.

c. Driver installation

Click **[Next]** until the installation of the hardware is completed. If you are prompted or blocked by the security software, please select **[Release] / [Allow]**. For the first time installation, it is necessary to install drivers for each AE board, as shown above, until all acoustic emission board drivers are installed. After successful installation, the AE boards will be displayed under the "Universal serial bus controller" section, as shown below.
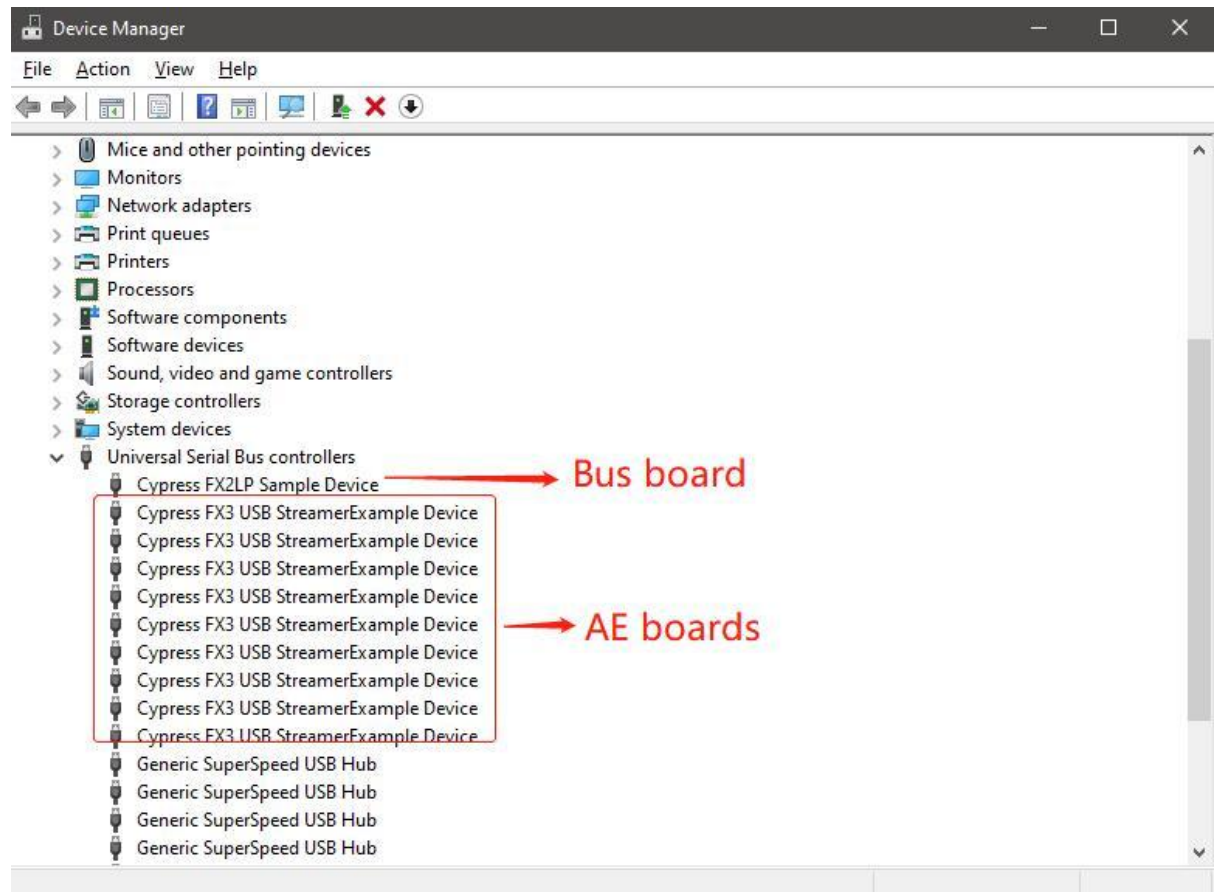
Fig. 1-5 Hardware Identification Status and Location Under Right Installation of Drivers

1.2.2.2. Hardware Driver Installation Under Win10 Operation System

The driver installation process is similar to that of Win7 in Section 1.2.2.1. The default path of the driver is **[C: \ program files \ SWAE \ driver \ win10 \ x64]**.

Under Win10 (Win8) operating system, users need to turn off the "Digital signature authentication" before installing the drivers. The general process of "Turning off the digital signature authentication" is: search [Settings] >> [Update and Security] >> [Recovery] >> [Advanced Starting-up] >> [Restart now] >> [Restart the computer] >> [Advanced] >>

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[Troubleshooting] >> [Advanced Options] >> [Starting-up Settings] >> [Restart] >> press [7 / F7] to disable the driver forced signature after the restarting. For detailed methods, users can search "Win10 turn off digital signature" on the Internet.

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2. Quick Operation of software

2.1. Starting Sequence

(1) Turn on the computer and enter the windows system desktop. Connect the USB cable from the AE instrument to the computer;

(2) Double click the **[SWAE]** icon on the desktop to start the AE application, and then the software will load the default configuration. Refer to Fig. 2-1 for the partition of the software main interface.
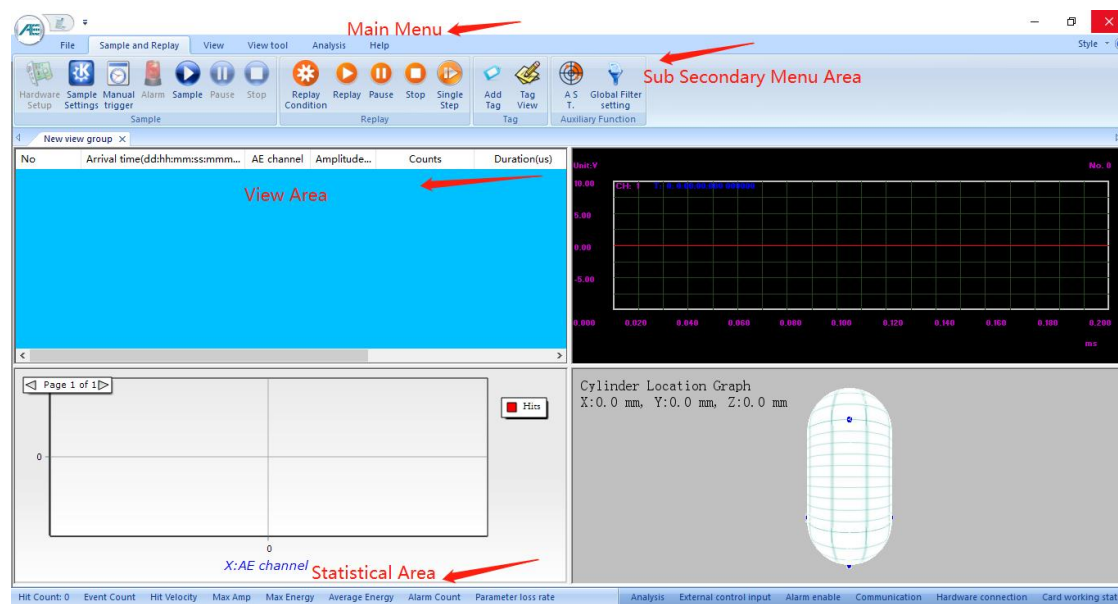
(3) Turn on the U3H instrument.

Fig. 2-1 Main Interface View Of Software

2.2. View Settings

Software supported devices include SAEU3H and RAEM1. During acquisition, the current software supported devices must correspond to the connected acoustic emission devices. Data replay, data analysis and other operations are consistent of both two modes.

You can click the "AE" icon in the upper left corner to view the current supported devices. To switch, click the "AE" icon in the upper left corner, then click the "Yes" button in the popup window, and wait for the software to start.

Note:

The interface and function introduction of the software in this paper is the description of the support device for SAEU3H.
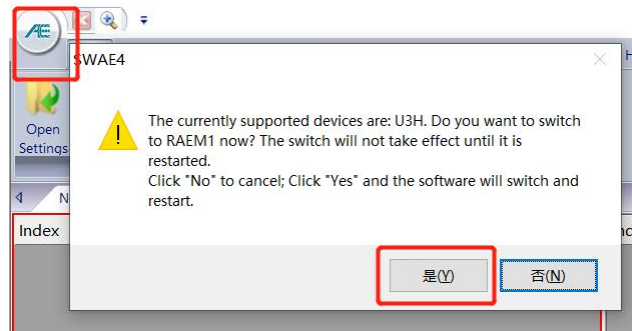
Fig. 2-2 AE software supported device interface

2.3. View Settings

Default view already exists in view area: it can be used after modifying the view settings directly.

If there is no appropriate view setting after starting-up, you can try to load the previous setting file by clicking **[File] >> [Open Settings]**. In the pop-up dialog box, adjust the path and select the corresponding name with the suffix of ".AEC" file, and then click **[Open]**.

Fig. 2-3 Selecting and Calling Profile

The commonly used views in the acoustic emission test process include:

- Data Table

- Waveform Graph

- Correlation Graph

- Location View

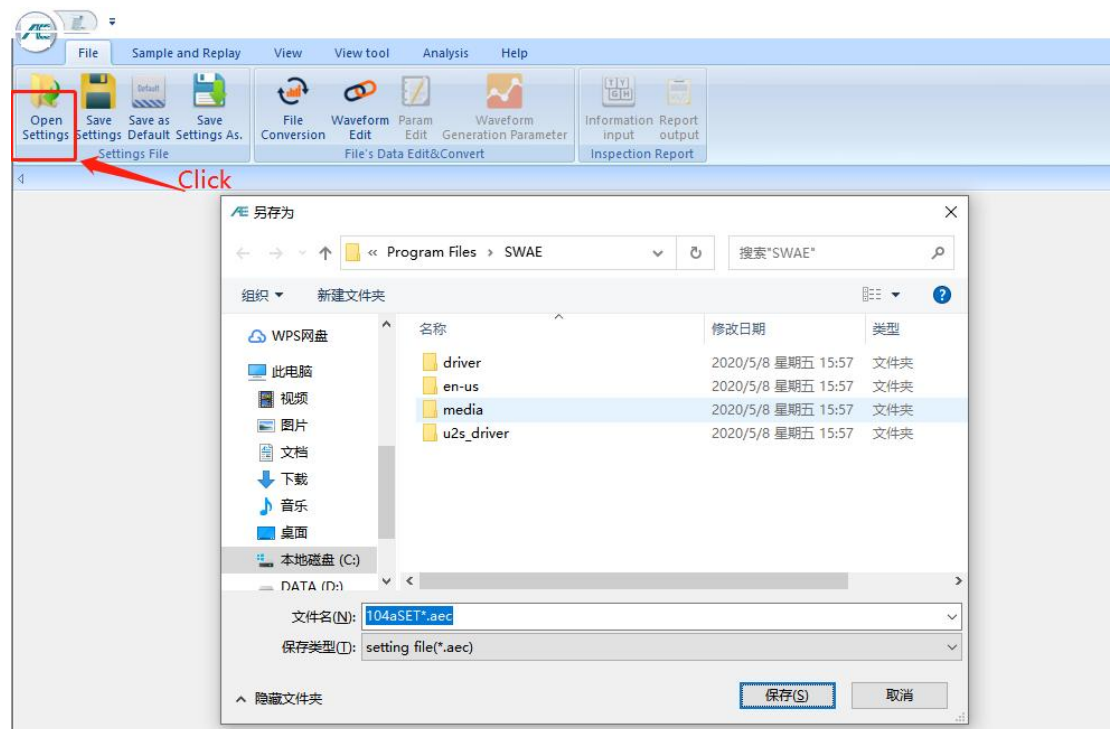There are many types of **[Correlation Graph]** used in general scientific research direction, but not **[Location Graph]**. There are many types of **[Location Graph]** used in inspection and detection direction, and users can adjust the view types according to actual needs.

(1) <u>View Group Establishment</u>

Click **[View]** in the main menu bar to switch to the view setting interface, and select new view group to open a complete gray area named **[New View Group]**.

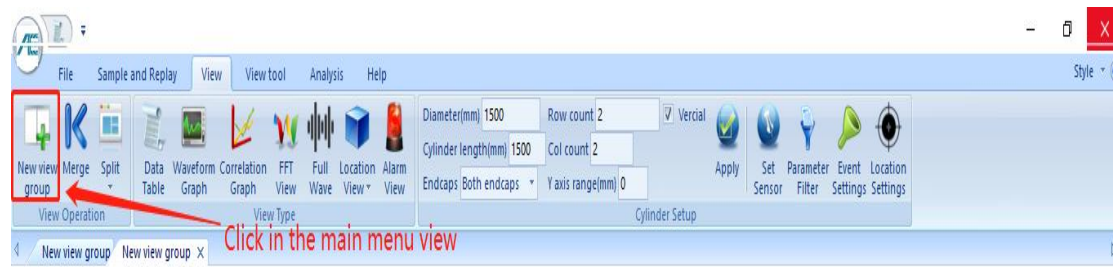Fig. 2-4 Newly Built View Group

(2) <u>View Segmentation</u>

Select the "view area" of the new view group (when the selected frame turns red), click **[Split]**, and select the view array (such as 2 rows and X 2 columns) according to the needs. Click the left button, the view group split is completed, and multiple view windows are generated; the same method can also be used to split any view twice.
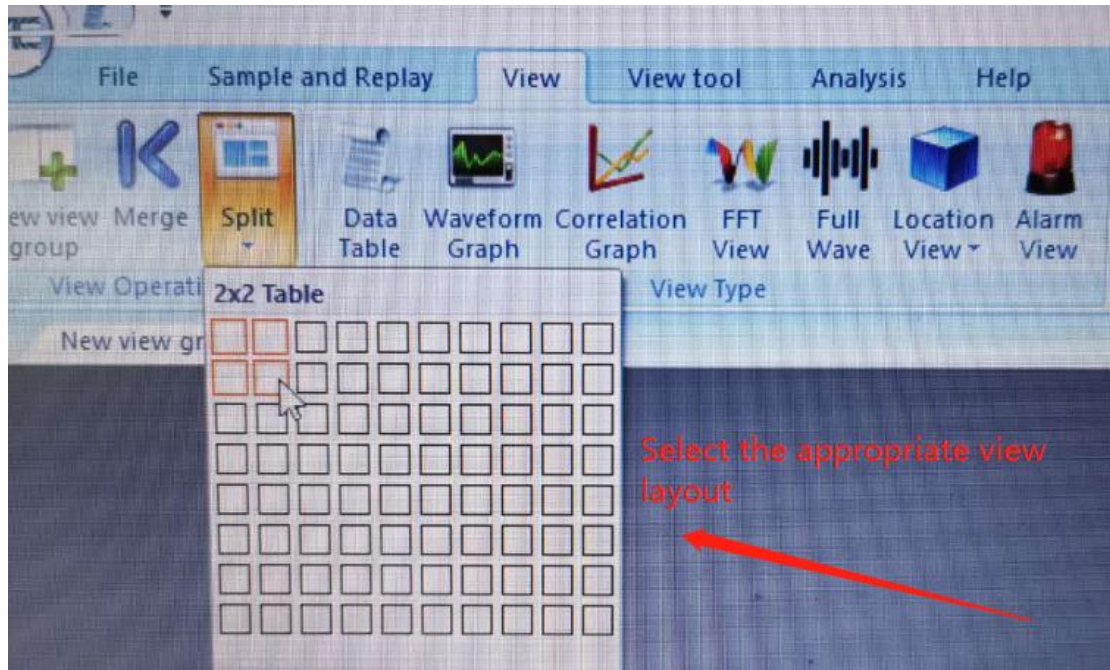
Fig. 2-5 View Segmentation

(3) View Selection

You can customize the view type for each window area, and each view type has different settings. The view types include: [Data Table], [Waveform Graph], [Correlation Graph], [FFT View], [Full Wave], [Location View], [Alarm View], and [Intensity Activity Analysis] etc.
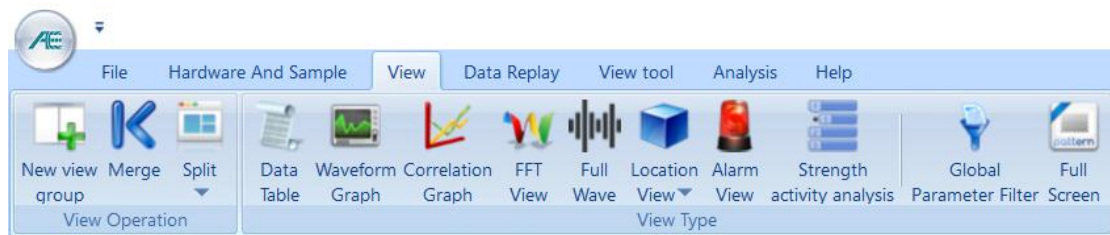
Fig. 2-6 View Type

2.3.1. Establishment of Data Table

a. **Create**: select a blank view and click **[Data Table]** in view menu to complete the creation of data table view. If you need to add or delete parameters, click the **[More Data]** on the right to adjust in the selected view;
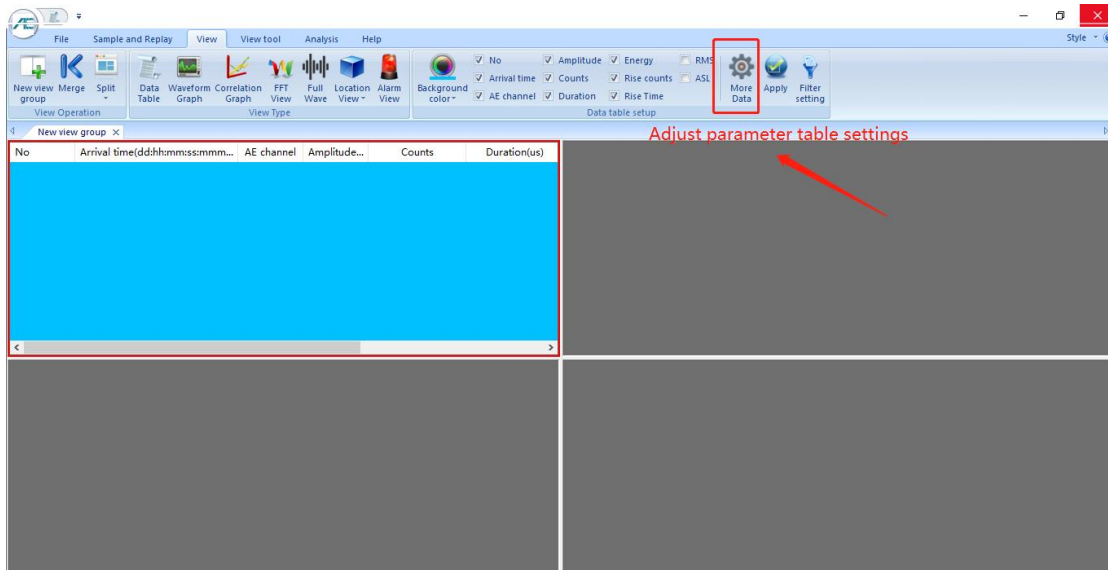
Fig. 2-7 establishment of parameter table

b.   **Filter retrieval:** the **[Parameter Filter]** of this interface is view specific, only effective for the display data of this data table view, and will not affect the data acquisition and storage of the instrument. When the **[Data Table]** view is selected, click **[Parameter Filter]** to open the interface.
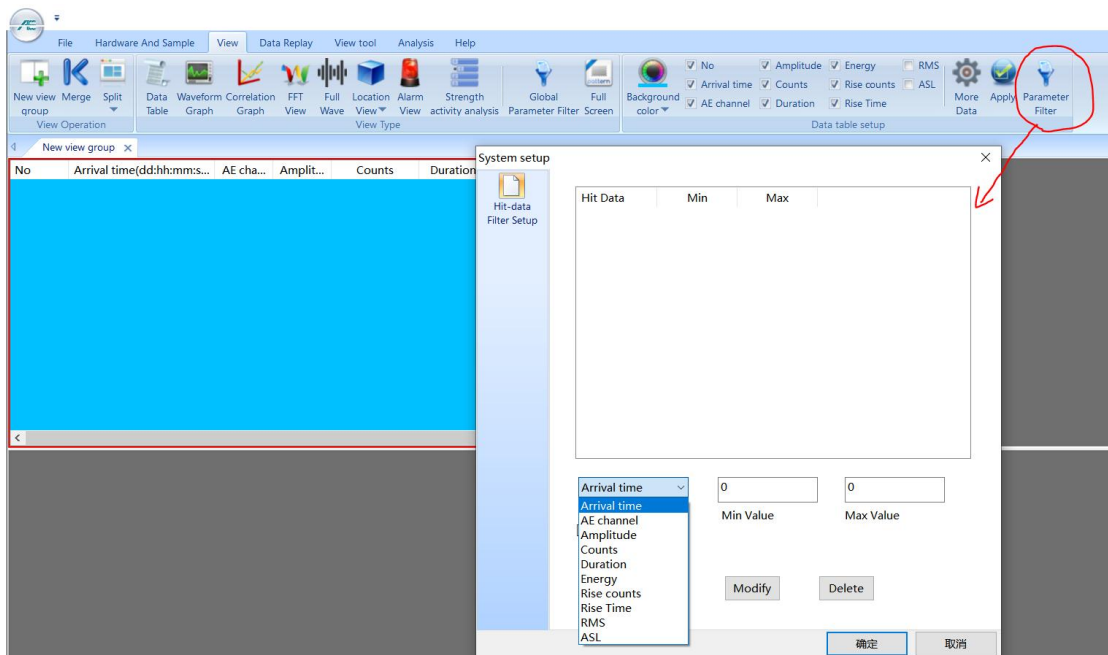
Fig. 2-8 Special filter for calling parameter table

2.3.2. Establishment of Waveform Graph

Select another blank view, and click **[Waveform graph]** in "view type" in the View menu. If it is necessary to change the number of channels and the color of channels displayed on the same interface, in the selected view state, modify it directly.

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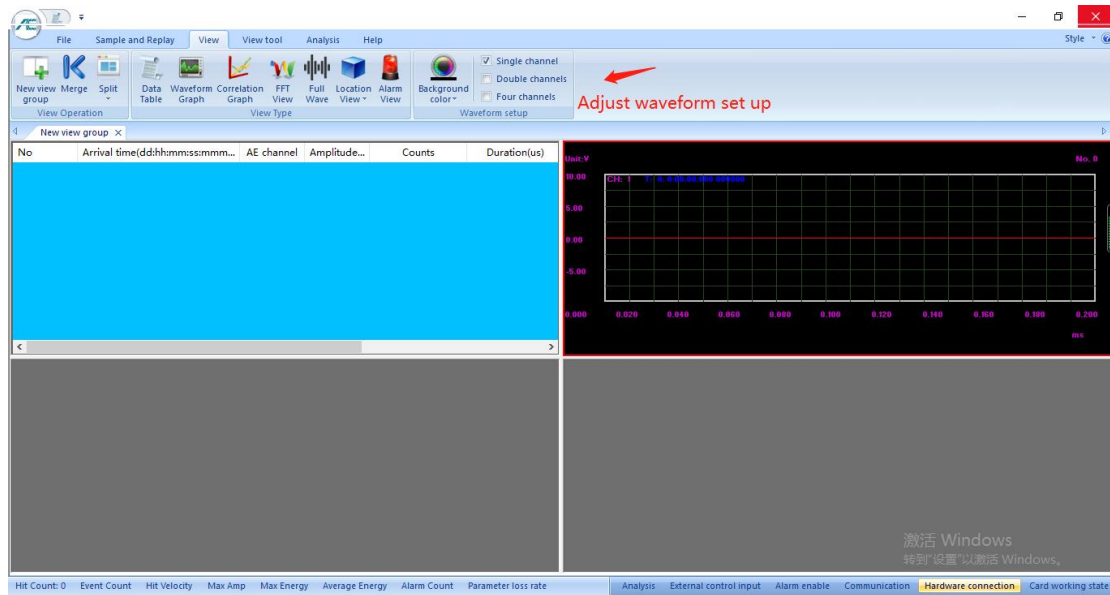
Fig. 2-9 Waveform Establishment

2.3.3. Establishment of Correlation Graph

a.   **Create**: select another blank view, and click correlation graph in view type in view menu to complete the default view creation of correlation graph;

b.   **Modification**: If you need to adjust the parameter settings of x-axis and y-axis, you can adjust the corresponding menu position on the right side in the selected view state. Correlation graphs support multiple Y-axis mode, i.e. under the same X-axis setting condition, you can set different Y-axis parameters in the same graph. After completing the current Y-axis parameter settings, you can directly click the [y add] button. When you click [y delete], it has been added to the relevant menu The y-axis setting in the figure will be deleted layer by layer.

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Fig. 2-10 Establishment Of Default Correlation Graph

For example, take "arrival time v.s. (energy + counts + amplitude)" correlation chart as an example:

1) Select the default correlation graph.

2) Modify "X-axis": first, click the setup menu bar **[X axis]** drop-down menu, and scroll the list to select "arrival time"; then in the **[Step Size]** select the desired value in the drop-down menu, such as 100ms;
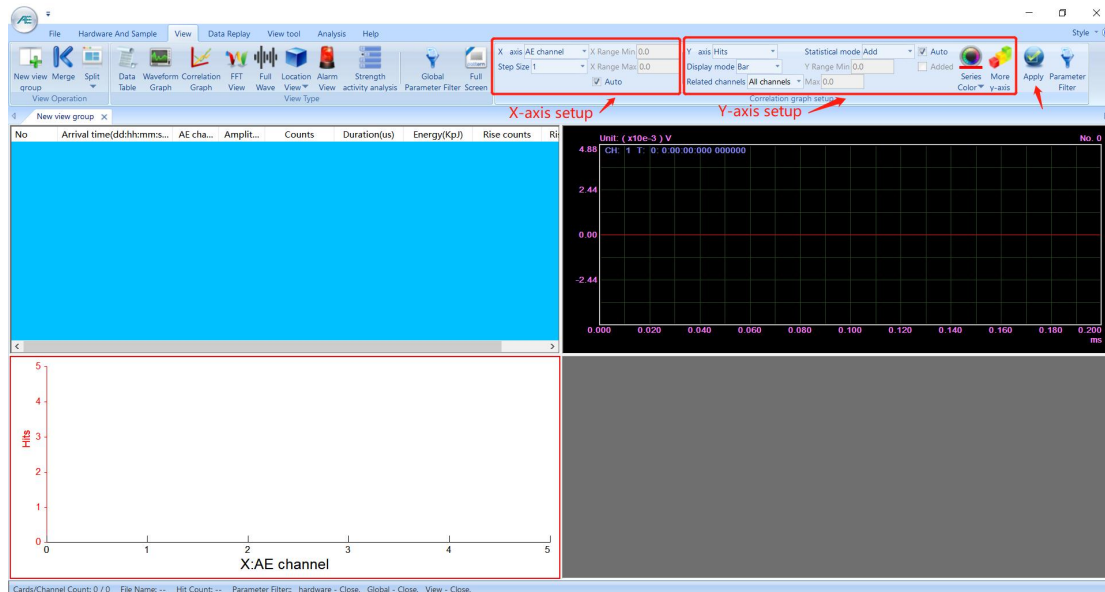
3) Modify "Y-axis":

a.   First, click the setup menu bar **[Y axis]** drop-down menu, and scroll the list to select "energy"; then in the **[Display mode]**, select "line", and then in the **[Related channels]**, select "all channels";

b.   In the **[Statistical mode]** select "Maximum/ average/ add". If "Add" is selected, the energy value is accumulated and counted every 100ms;

c.   Click **[Apply]** button on the right to implement Step a & b.

d.   Click the **[More Y-axis]** button to open the pop-up window. There are up to three more Y axis to add to the graph. Check the [Enable Y2 Axis] and select the "counts" as Y2 axis. Then select the [Display mode], [Related (channels)], [Color], [Statistics (mode)] etc according to the needs. The same steps apply to Y3 and/or Y4 axis. Click [OK] button to finish settings.

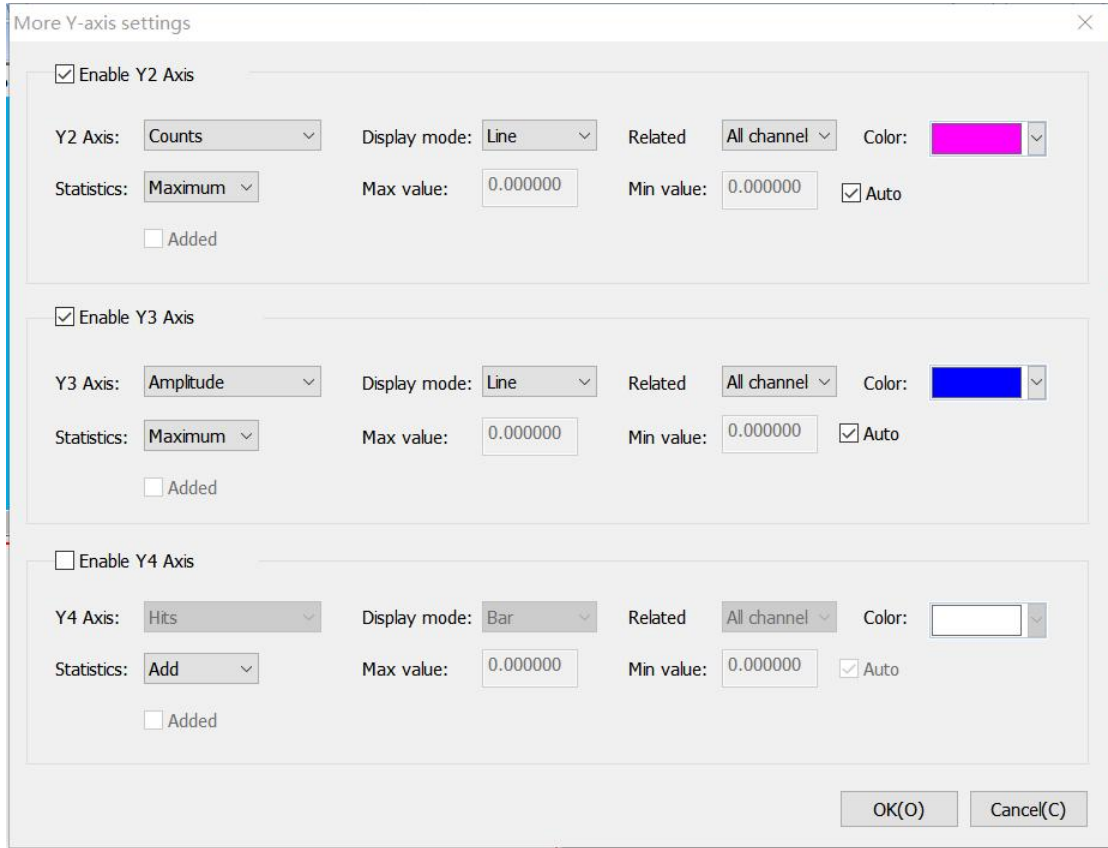e.   Click **[Apply]** button again to implement Step d.

Fig. 2-11 More Y-axis window

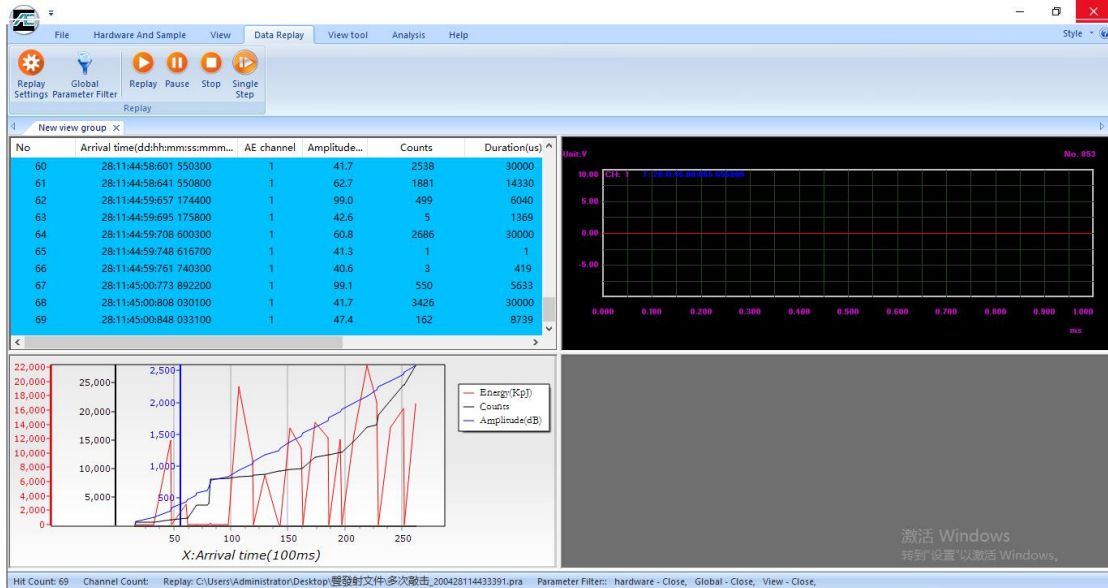Fig. 2-12 Data Display Of Multi Y-axis Correlation Diagram

2.3.4. Establishment of Location View

Location view is one of the most important view in acoustic emission engineering detection, and the evaluation of the whole detection results is also based on the location

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results. Therefore, it is very important to build a relatively accurate model according to the arrangement of sensors, to visually display the location results of acoustic emission signal arrival time difference, and to get the approximate location results.

Location view includes: linear location graph, planner location graph, tank bottom plate (circular surface) location graph, cylinder location graph, sphere location graph, cube location graph, and solid cylinder location graph, etc.

The setting methods of various location graphs are similar. The following is an example of cylinder location view:

1) First, select the area to create the location view, by clicking on one of the view areas. The selected view area should have a red frame around.

2) Select **[View] > [Location View] > [Cylinder Location Graph]**. Then a default cylinder will display in the view.

Fig. 2-13 location map creation

2.3.4.1. Modify Basic Information

When the location map is selected, modify the corresponding data in the basic information window.

1) Diameter(mm): refers to the actual outer diameter, i.e. "1500";

2) Cylinder Length(mm)：refers to the distance between the two circular seams, not including the end caps if there is any, enter "5000";

3) Endcaps: the end caps shall be selected according to the actual situation, and the

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sample container shall select "Both endcaps";

4) Row count: refers to the number of rows. Each row of the sensors are in the circular direction on the cylinder body. The row number is decided by the body length and the sensor spacing, not including the sensors on the end caps. The sample container should be set to 3;

5) Col count: refers to the number of columns, where is the number of sensors in each row. It is determined by the cylinder diameter and the sensor spacing. It is 3 in the example;

6) Y-axis range(mm): not less than the cylinder length and 1.6 times of the diameter, which is set as 8000 in the case;

7) Endcaps Arc Length(mm): the actual distance from the circular seam to the end cap center, enter "1000" in this case;

8) Vertical: display of the vessel modeling in 3D location graph vertically or horizontally, and it will take effect after selection;

9) After all settings are completed, click the **[Apply]** button, and the sensor position will be automatically arranged according to the principle of equal division.

Note:

1) The sensors on the end caps are not included in the [Row count] and [Col count]. The end caps sensors are automatically created if [Both endcaps] and [Only xxx endcap] is selected. Because triangle locating algorithm is applied, if the [Row count] is less than 3, 2 sensors will be applied on each end cap so that the location is more accurate.

2) Right click on the location view and select "Planner" view to view the location map in the planer graph. The numbers are the sensors location. If the number background is orange, it means this number of sensor position is repeated in order to round up the 3D dimension spaces between the last sensor and the first in a row.

Fig. 2-14 basic information modification
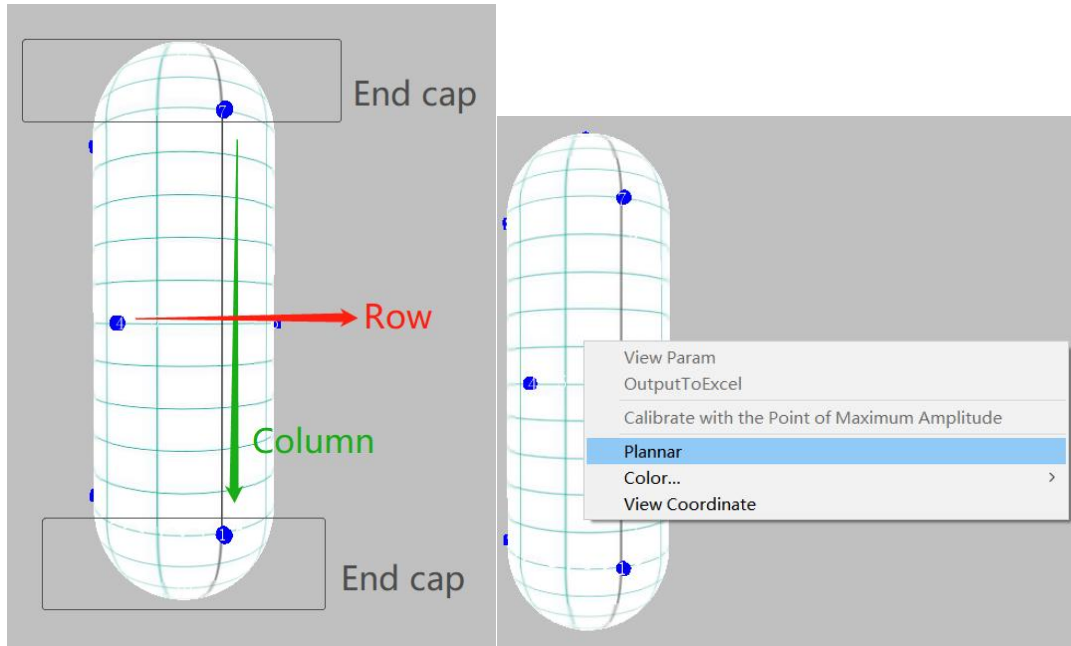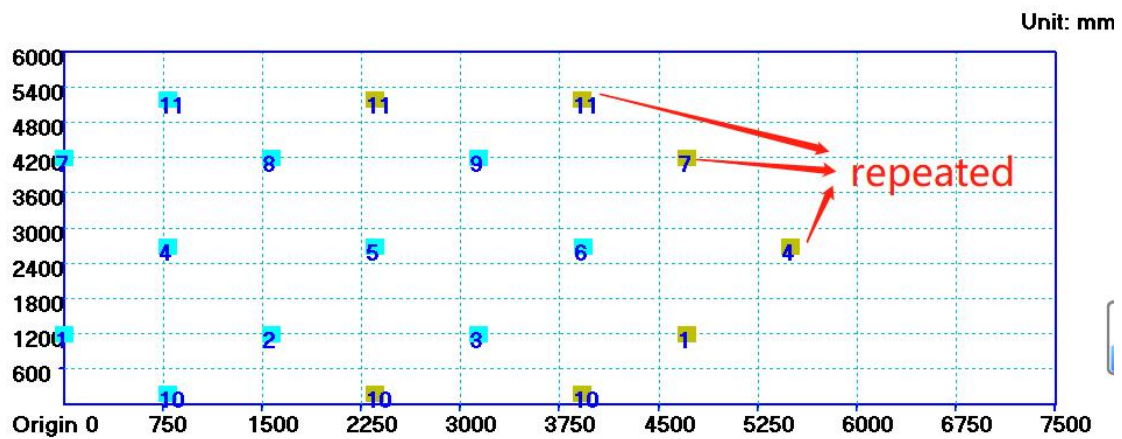
Fig. 2-15 basic information modification

Fig. 2-16 basic information modification

2.3.4.2. Sensor Coordinate Modification

When the sensor coordinates arranged in the principle of equal division are not consistent with the actual installation, you can manually change the coordinates, click **[Set Sensor]** on the right, and directly modify the sensor coordinates in the pop-up window.

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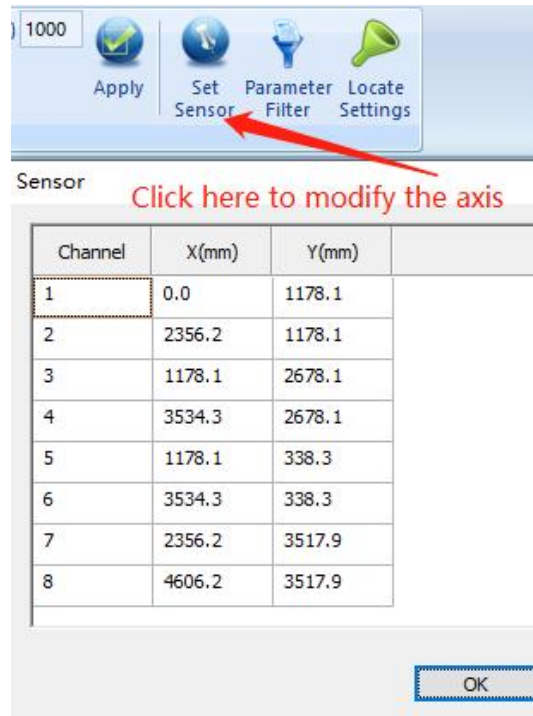
Fig. 2-17 Modification of Sensor Coordinate

Note: the number of sensors required for acoustic emission testing of components depends on the size of the pressure vessel and the selected sensor spacing. The distance between sensors depends on the attenuation of wave propagation, and the attenuation value comes from the distance attenuation curve measured by pencil lead break analog source. In metal containers, the commonly used sensor spacing is about 1-5m.

2.3.4.3. Locate Settings

The location settings mainly include the event setting and sound speed setting. The actual sound speed determines some parameter settings in the event settings. Therefore, before the positioning test, it is necessary to obtain a reasonable sound speed value.

When the location map is selected, click **[Location Settings]** to open the interface:

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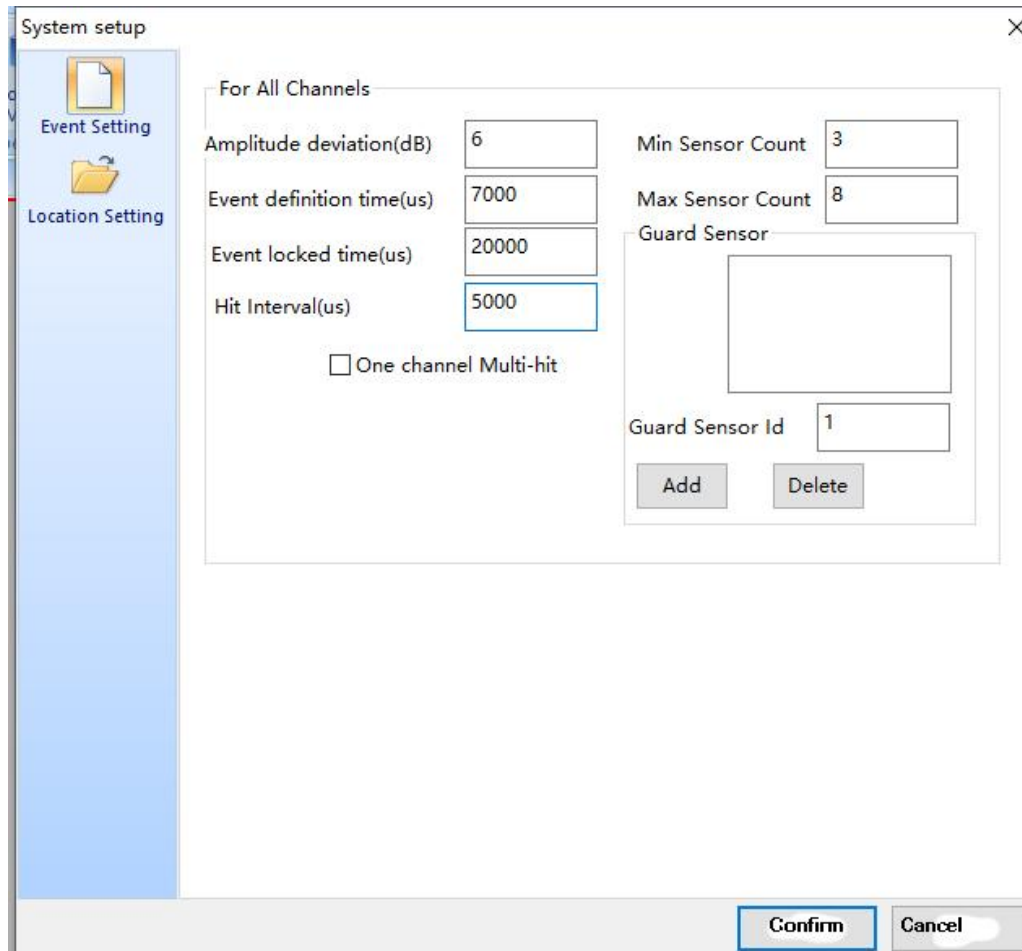
Fig. 2-18 Event Setting Interface

1) Event Setting

For the convenience of understanding, we give an example of rectangular sensor array to illustrate: S1-S4 are sensors, a, b, d are distance values, the proposed sound speed is C, and four sensors are used to participate in the positioning calculation;

Fig. 2-19 Schematic diagram of sensor arrangement array

Amplitude Deviation(dB): it should be greater than the maximum sensitivity difference between any two of all the sensors, i.e. S1-S4 in the current array. For the components with high attenuation or complex shapes, it can be set higher.

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Event definition time(us): the maximum distance between any two sensors in the same array divide by the sound velocity times 1.2. For example, the diagonal length [d] of rectangular array, the value is 1.2*[d/c];

Event locked time(us): generally is equivalent to "Hit definition time (HDT)" in hardware settings;

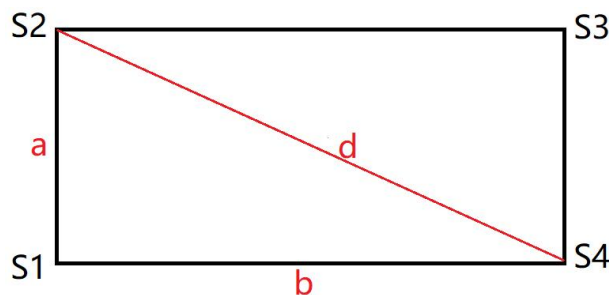**Hit interval(us):** the maximum distance between two adjacent sensors in the same array. If the rectangular array maximum side length is [b], the value to be input is 1.2*[b/c];

Min sensor count: at least the number of sensors needed to participate in positioning calculation. For example, 3 is needed for the triangle positioning array. The generation of positioning points should meet the relationship between the time difference and the sound speed of 3 sensors in the array;

Max sensor count: the maximum number of sensors required to participate in the positioning calculation. For example, when 10 sensor parameters in the array meet the positioning conditions, the first 8 calculations are directly selected;

Guard sensor: The guard sensors are the sensors to prevent mistake hit counts from the remote noises in the locating calculation. When the guard sensor first receives the hit signal, no locating point will be generated within the time specified in "event definition time"; if it needs to be used, input the channel number, and click the [add] button; select the channel number in the added window, and click the [delete] button to remove the channel.

2) **Location Setting**

Sound velocity (Km/s): generally, sound speed should be measured in practice before the test. Reasonable sound speed is very important for positioning accuracy. Take Figure 2-18 rectangle sensor array as an example. Take a pencil lead break signal along but outside the [d] direction. Record the arrival time difference [t] between S2 and S4. The sound velocity should be [d/t]. The default sound speed is common metal surface wave sound speed, which is suitable for the arrangement of sensor spacing of 1-5m;

Arrival time select: the default is "threshold", i.e. the time difference is calculated by the arrival time when the signal exceeds the threshold when calculating the positioning point; "peak arrival time" is the time when the peak is located.

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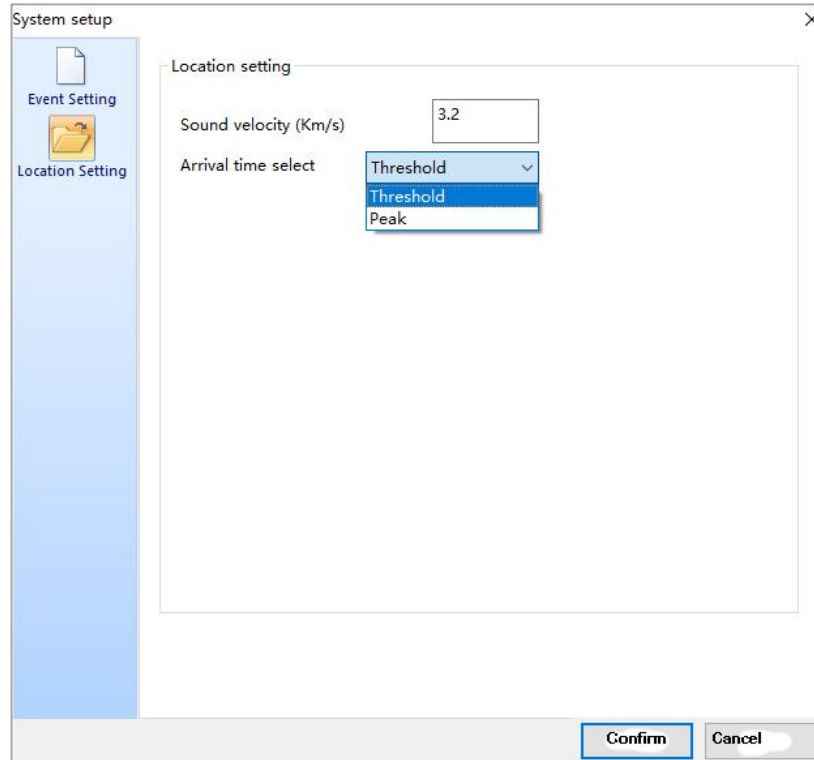**Phone**: +86-20-32290092   **Email:** sales2@ae-ndt.com   **Website**: www.aendt.com

Fig. 2-20 location Settings

2.4. Acquisition Settings

In the acquisition setting, only the basic function parameter setting is introduced to ensure that the user can extract and save the original data, including the hardware parameters, timing parameters, sampling rules and data storage. With the basic display view, the acoustic emission data can be obtained, so as to carry out subsequent research and analysis. The basic acoustic emission software sampling settings includes **[Hardware Setup], [Hit Feature], [Waveform] and [Saving]**.

2.4.1. Hardware Communication

To establish the communication between the host computer and the host computer of the acoustic emission acquisition instrument, the steps are as follows:

①   Click **[Hardware and Sample] > [Sample Settings]** in turn to open the following window, and click **[Refresh]** button at the bottom right corner to recognize all the AE boards connected.

②   After clicking **[Refresh],** if the AE boards driver are installed and well connected, it should display "**Channel count: XX**" below the table.

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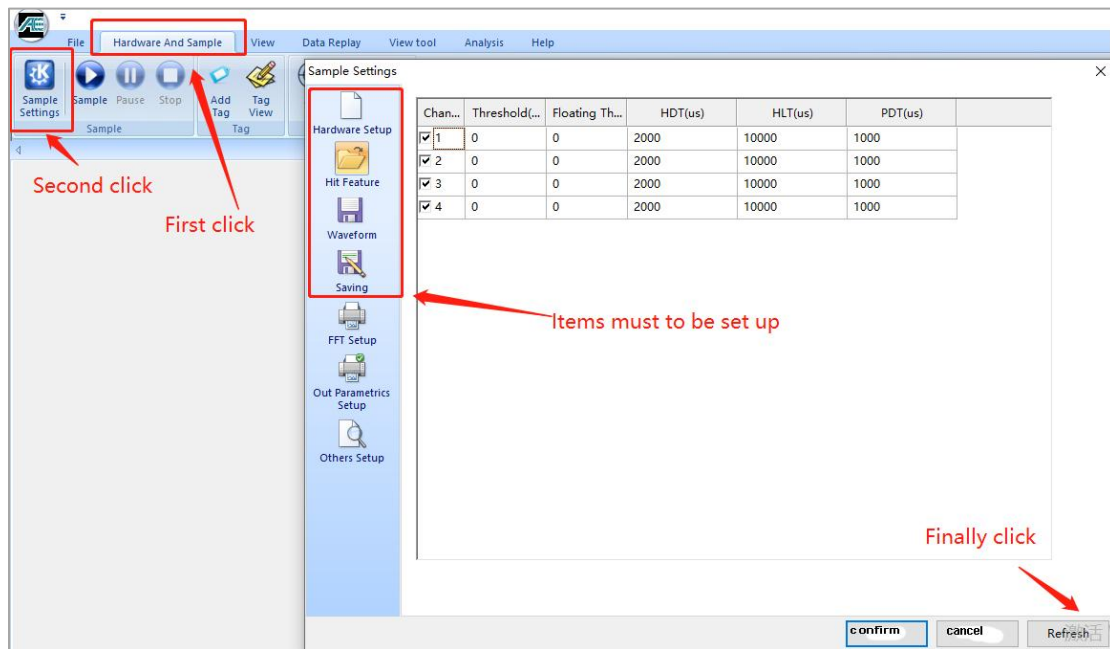**Phone**: +86-20-32290092   **Email:** sales2@ae-ndt.com   **Website**: www.aendt.com

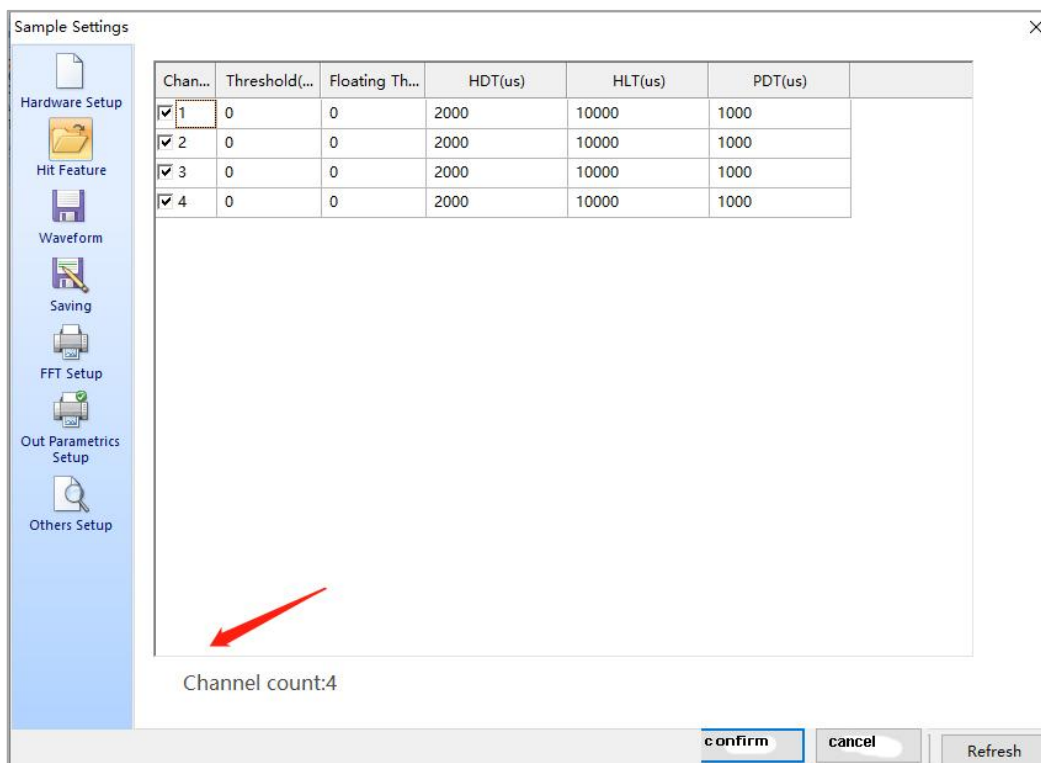Fig. 2-21 Before Hardware Identification of AE Host

Fig. 2-22 Correct Identification of Acoustic Emission Hardware

2.4.2. Hardware Setup

Setting the correct hardware is very important to the waveform data and parameter data extracted and saved. Generally, the setting of this interface should be combined with the actual hardware parameters;

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Click **[Hardware Setup]** in the left menu bar, and refer to the following instructions for adjustment;

1) **Preamplifier gain**: refer to the actual preamplifier settings, double click the mouse and input the number directly. There are four types of preamplifier gains available: 20 / 26 / 40 / 60dB;

2) **Input range**: it depends on the maximum output voltage of the preamplifier. Double click the mouse and select from the pull-down menu. The common options are 10Vp and 5Vp;

3) **Analog filter**: the filter device solidified on the circuit board is composed of three high passes and three low passes filters. You can select the appropriate combination in the pull-down menu according to the actual needs. "High pass" represents to pass the frequency higher than the value, "low pass" represents the frequency passing when lower than the value; for example, to detect the damage of metal materials, the high pass is 100kHz, and the low pass is 400kHz, which represents the band-pass filter from 100kHz to 400kHz;

4) **Digital filter:** it is the secondary filter after the signal is digitized. You can choose whether to enable it according to the actual situation. The setting method is to input the value directly after double clicking. If the digital filter is not enabled, the minimum setting in the column of [low pass] is 1200;

5) **Preamplifier power:** generally 28V by default. 5V is selected when LG and PG series low-voltage sensors are used. Please double check the preamplifier supply voltage. To change the preamplifier voltage,

① please click on the "Preamplifier power" column name to show "Allow to modify Preamplifier power". Click "confirm" to allow the change.

② Then double click on the channel preamp power to select the voltage;

③ After you change the preamp power or just to click "Confirm" in the "Sample Settings" window, it will pop up a notice warning window to remind you that what the current preamp voltage is. Please make sure the connected preamp can handle the set voltage. Otherwise the too high voltage will burn the preamp/integrated sensors.

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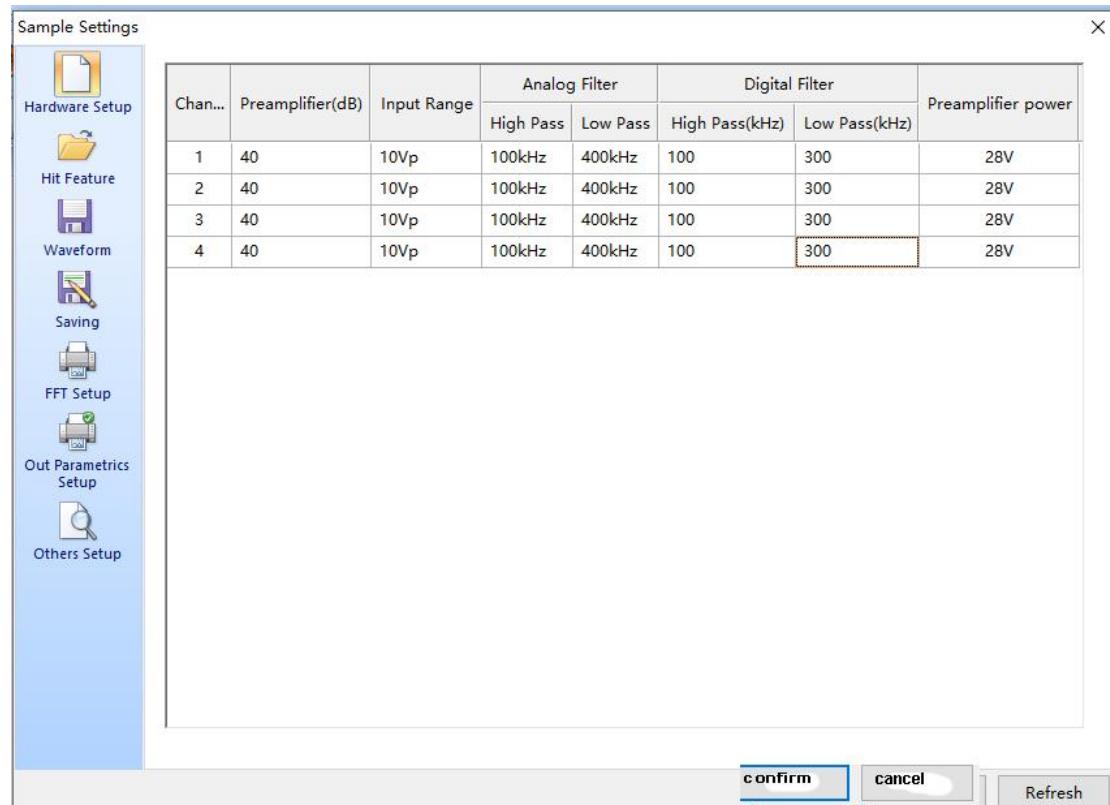**Phone**: +86-20-32290092 **Email:** sales2@ae-ndt.com **Website**: www.aendt.com

Fig. 2-23 Hardware Setting Interface
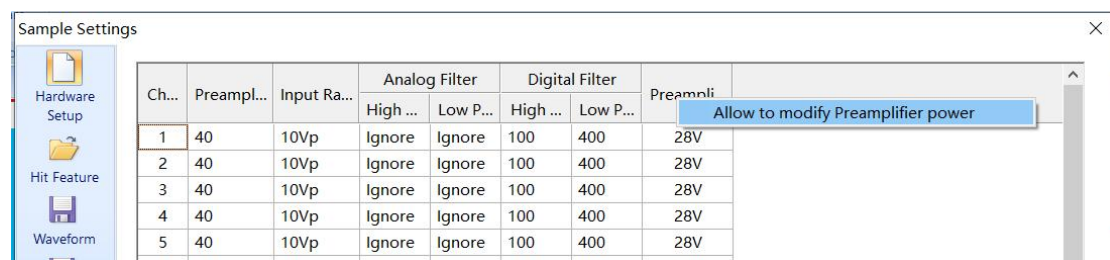
Fig. 2-24 Allow to change preamp power

Fig. 2-25 Select preamp power

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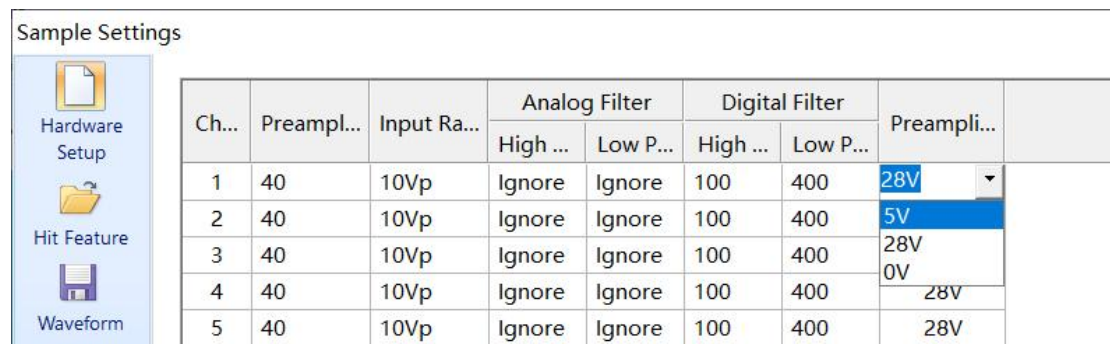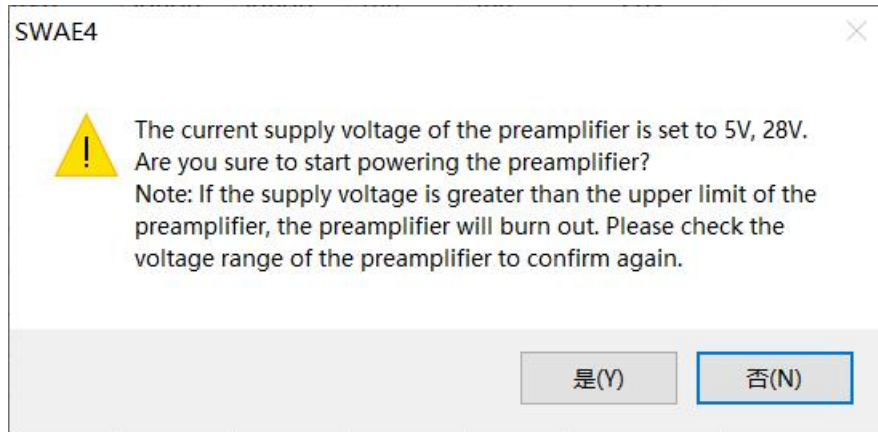
Fig. 2-26 Preamp power notice

Note: Quick table modification tips

1) . when you need to modify the settings of a column, you can click the first row name position of the current column after modifying channel 1, and then click [set current column];

2) When you need to modify the settings of all channels, you can click channel in the upper left corner after modifying all parameters of channel 1, and then click [set all columns].

Fig. 2-27 set current / all columns

2.4.3. Hit Feature

The numerical setting of this interface determines whether the extracted feature parameters are accurate or not, which is very important for the subsequent analysis based on feature parameters, such as parameter table data, correlation graph statistics, location graph calculation, etc.

Modify HIT parameters: click **[Hit Feature]** tab in the left menu bar, and adjust it with reference to the following instructions;

1) Channel: after the hardware is refreshed to correctly identify the channels, the check in the checkbox means the selected channels parameter data will display;

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2) Threshold: generally, it should be set to be 6dB higher than background noise, which can be directly typed in, and 35-55dB is the common value;

3) Floating threshold: compared with the parameter threshold, adjust the current threshold value, which is 0 by default, and generally 3-6dB can be set if the background noise is not consistent;

4) HDT (Hit Definition Time): unit: us, abbreviated as HDT, setting range is 1 ~ + ∞ (positive integer), which can be directly input in the text box. It refers to the waiting time interval of an hit signal setting to correctly determine the end point of an hit signal. When the HDT setting value is greater than the time interval T of two adjacent wave packets passing the threshold, the two wave packets will be classified as one acoustic emission hit signal; if the HDT setting value is less than the time interval T of two wave packets passing the threshold, the two wave packets will be divided into two acoustic emission hit signals. For the same signal, the larger HDT setting is, the less AE parameters are extracted, and the smaller setting is, the more AE parameters are extracted.
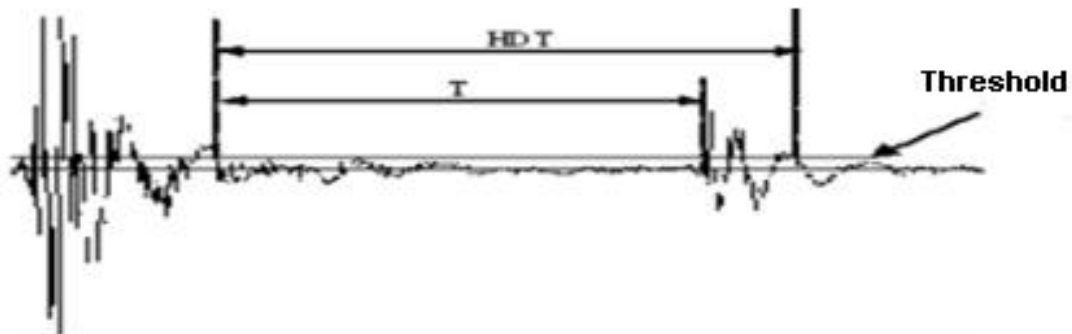

Fig. 2-28 Hit definition time

5) **Hit lock time (HLT)** : unit: us, abbreviation: HLT, setting range: 1 ~ + ∞ (positive integer), which can be directly input in the text box. In order to avoid receiving reflected wave or post wave, a time window is set to turn off the measuring circuit. There is a period of time (HLT) when the signal is ignored after a HDT time after the end of a current acoustic emission event. This period of window is called hit lock time, and the setting value is affected by signal attenuation, structure size, etc. If the setting value is too large, the subsequent acoustic emission signal will be missed. As shown in the figure below, the next acoustic emission signal T period has passed the threshold, but the HLT has not ended, and the signal in t period will not be collected.
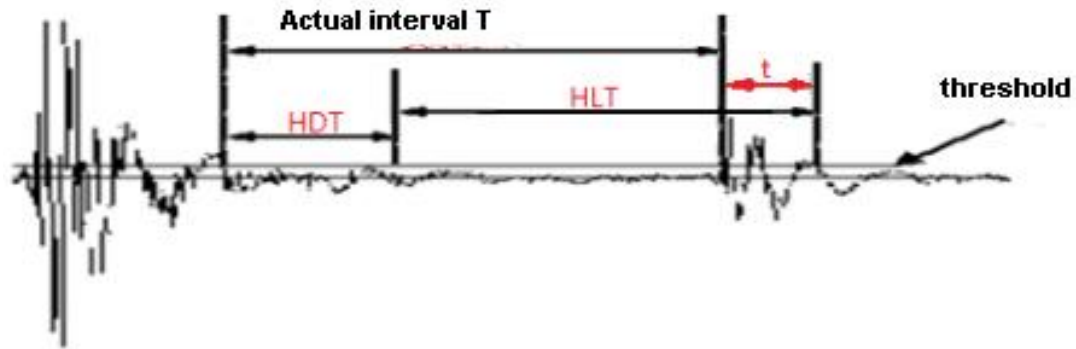
Fig. 2-29 Hit lock time

6) **Peak definition time (PDT)** : unit of us, setting range is 1 ~ + ∞ (positive integer), which can be directly input in the text box. The new maximum peak waiting time interval is set to correctly determine the rising time of the hit signal. If it is selected too short, the high-speed and low amplitude precursor wave will be treated as the main wave by mistake, which is generally taken as 20-50% of the hit definition time (HDT);

Fig. 2-30 HIT Feature setting interface

Materials and Specimen	PDT (μs)	HDT (μs)	HLT (μs)
Composites	20 ~ 50	100 ~ 200	300
Metal small specimen	300	600	1000
High attenuation metal components	300	600	1000
Low attenuation metal components	1000	2000	20000

Table 1 Time parameter setting reference

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2.4.4. Waveform

The value setting of this interface determines whether the extracted waveform data is useful. It is very important for the subsequent waveform analysis methods, such as FFT, wavelet, waveform generation parameters and other functions.

Modify waveform sampling settings: click **[Waveform]** in the left menu bar, and adjust it with reference to the following instructions;

1) Channel: the check in the checkbox means the selected channels waveform will display;

2）Trigger: double-click the "Threshold" box in the [Trigger] column. The drop-down window appears and contains multiple triggering methods. Each channel can be set independently. When collecting burst signals, the default "threshold trigger" is usually used;

3) **Synchronization:** double click the "channel independent" box in the synchronization method column, and the drop-down window appears, which contains three synchronization methods. Each channel can be set independently. When collecting burst signals, the default "channel independence" is usually used;

4) Waveform Threshold: determine the voltage level at which the acoustic emission waveform data starts to be recorded. The setting range is 1-100 (integer). Generally, it is 6dB higher than the noise level. It can be directly input. 35-55dB is the common value, the same as "parameter threshold". When full waveform acquisition is adopted, the "waveform threshold" of acquisition can be set to 1.

5) Sample rate: an integer in the range of 1000-10,000, in kHz. The value represents the maximum number of points that can be collected per second during the acquisition of acoustic emission signals by the current channel. The larger the setting value is, the higher the accuracy of the acquisition signal is, and the larger the amount of data is. It is generally recommended to set it to about 10 times of the upper limit of the frequency domain concerned. For example, when the metal crack signal is set to 3000;

6) Sample length: the unit is the number of points, which refers to the length that a single frame waveform can record and store. If 4000 is set, only the first 4000 points are stored in each frame. This setting is only valid for generating waveform and does not affect parameter generation;

7) Sample mode: double click any "normal sampling" cell under the [Sampling mode] column, and a drop-down window will appear, including three sampling modes. Generally, the default "Normal sampling" is used, that is over threshold acquisition,the data starts at

the time when the acoustic emission signal passes the threshold and ends at the sampling length;

8) Pre-sampling length: unit: number of points, which only affects "pre-sampling "and "post sampling". For example, setting the combination of "pre-sampling" mode and the pre-sampling length "512" means there are 512 pre-sampling data points. When the sampling mode uses "Normal" sampling, the setting does not take effect;

9) Streaming Sampling: when it is selected, it takes effect. The original threshold is triggered. The threshold is only effective when triggered for the first time. After the channel is triggered for the first time, the waveform data will be collected continuously. It can be understood as the full waveform mode, which is affected by the sampling rate, waveform threshold and synchronization mode. It is suitable for the situation where the ultra long wave needs to be collected. It is generally used in combination with the function of spectrum research or waveform re- generation parameters.
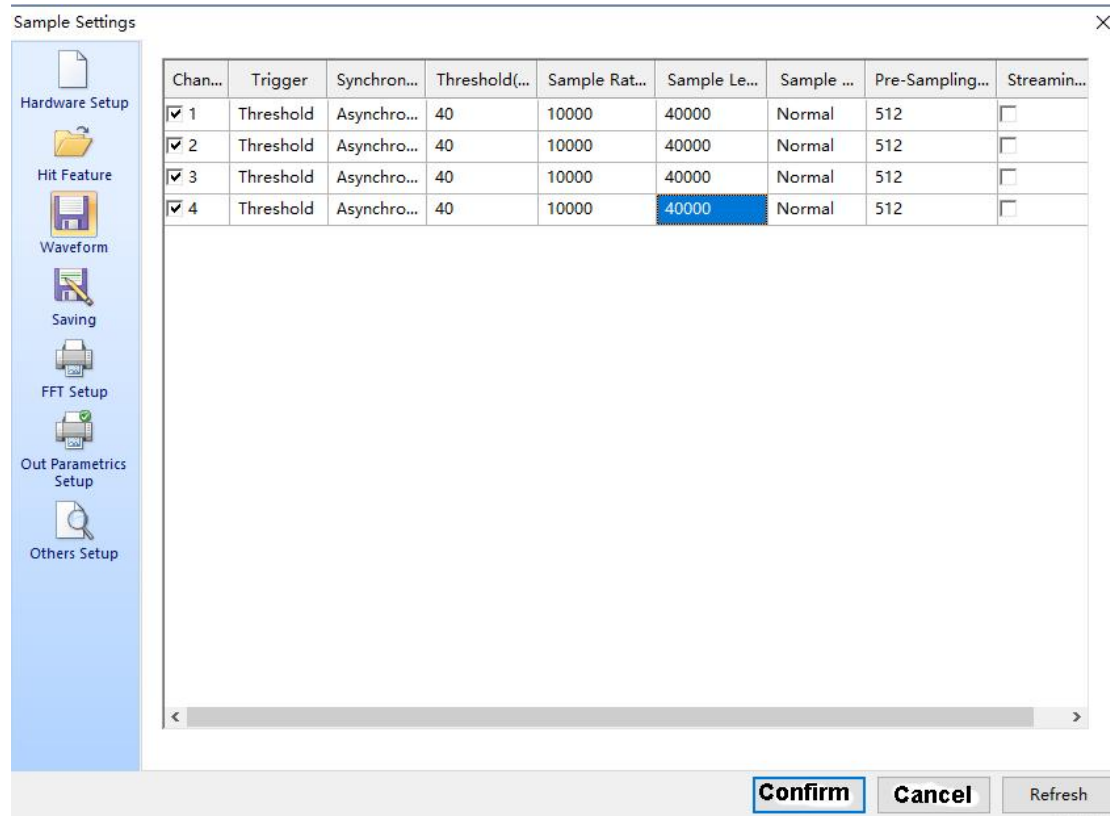

Fig. 2-31 Waveform Sampling Settings

2.4.5. Saving

The data file stored here is the collected data file, including the waveform file with suffix of ".aed", the parameter file with suffix of ".pra", but no setting (configuration) files.

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Click **[Saving]** in the left menu bar, and refer to the following instructions for adjustment;

Data file path: click **[Browse...]** button to locate to the target folder for the files to be saved;

Data file name: letters, numbers and characters can be input directly in the text box, but special characters such as _ \ / : * ? " < > | etc. cannot be included;

Tag Label: the time mark of the data generation time, in the form of "YYMMDDHHMMSS". For example, "200426143359" means that the file generation time is "14:33:59, April 26, 2020". This time is from the computer system time and is not recommended to be changed;

Save Acquired Data: if it is selected, the data file will be saved, and the corresponding .aed and/or .pra files will be generated in the target folder. Otherwise the collected data will not be saved;

Notice Before Acquisition: only used to prompt whether to save data or not. If it is selected, you will be prompted "save/not save data" before each acquisition starts.

Maximum File Size (MB): when the data size is larger than this set file size, it will created another new file to keep on saving the coming data until the acquisition stops. The setting range is 1-4000 integer, in MB, which can be directly input in the text box;

Maximum File Number: the maximum number of files (including both the .AED and .PRA files) after reaching this value, no longer save the data (stop in the collection state) or continue to store data by overwriting the previously stored data. The combination of this value and the setting value of "maximum file size" shall not exceed half of the available capacity of the hard disk. The setting range is 1-1000 (positive integer), which can be directly in the text box;

Autosave Setup: check the box to allow files overwriting, when the maximum file number is reached.
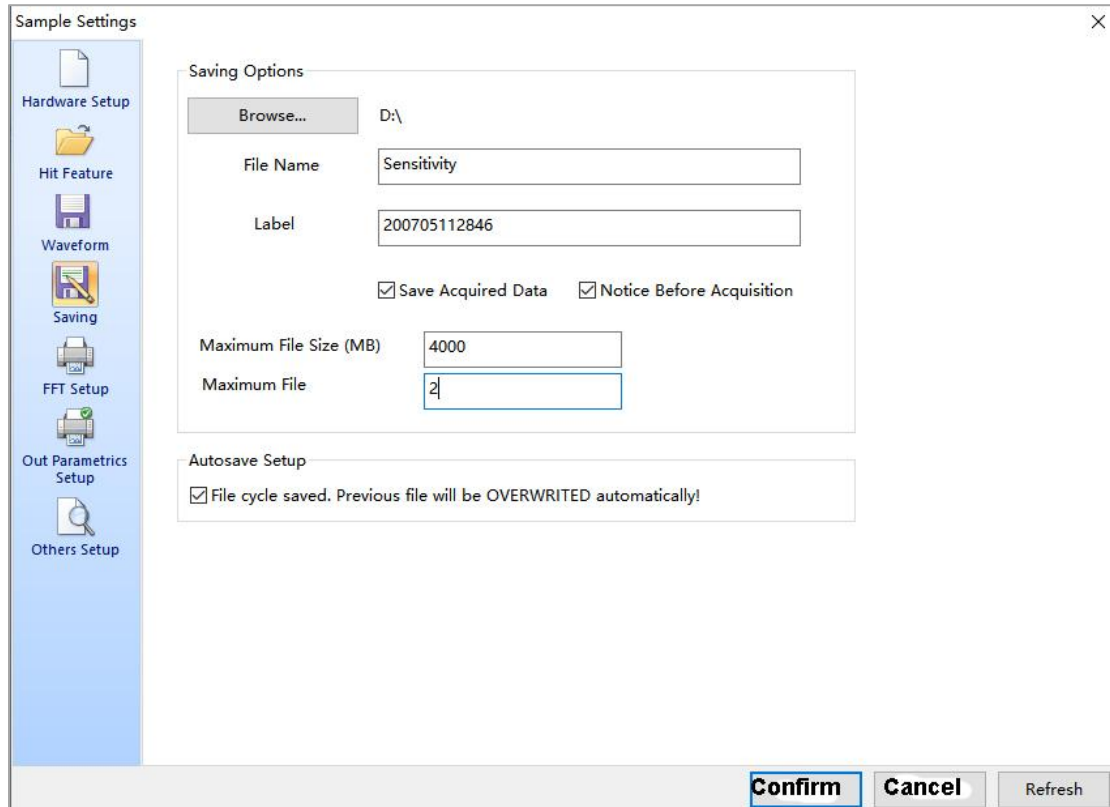
Fig. 2-32 File storage settings

2.4.6. Configuration File

After the above setting operations, the configuration file including hardware and sampling settings and view settings have been completed. In order to simplify the similar test operations or restore the current test settings in the future data analysis process, the whole configuration settings and environment can be stored in a file with the suffix of ".aec". Its function menu is in the main menu file.
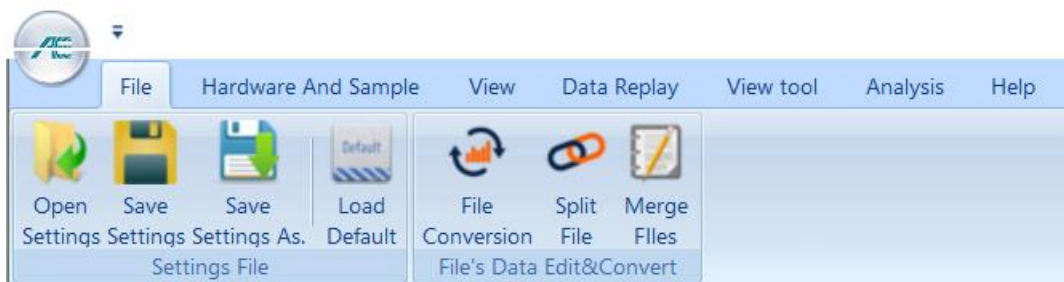

Fig. 2-33 File storage settings

Open Settings: open and load one of the saved setting (configuration) files.

Save Settings: save the current configurations including the hardware and sample settings, views and view settings. This setting file will be opened and loaded automatically when the software starts in the future. It is generally used for continuous testing under the

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same conditions, which is convenient for debugging. But it will be overwritten by the most current configuration settings when pressing the button again.

Save Settings As.: save the current completed configurations as an independent file, and it can be retried and loaded without being overwritten; click **[Save Settings As.]** to set the storage path and file name; when typing the file name, the "*" needs to be removed, but the suffix ".aec" must be reserved.

Load Default: click **[Load Default]** to automatically load the default ".aec" file in the default storage of the software.

3. System Calibration

After the software is set up, the acoustic emission system connecting with hardware needs to be tested and calibrated. Generally, it includes the sensitivity test, background noise test, attenuation test, sound velocity measurement, and positioning calibration tests. A stimulated acoustic source can be applied on the tested object as the signal source stimulation. The pencil lead breaking signal is more commonly used as the AE source stimulation. The pencil lead core can be 0.5 (HB pencil) or 0.3 (2B pencil).

3.1. Start Acquisition

The function area of data acquisition control button is under the main menu **[Hardware and Sample]** interface, and each button is provided with identification description, which will not be described in detail.

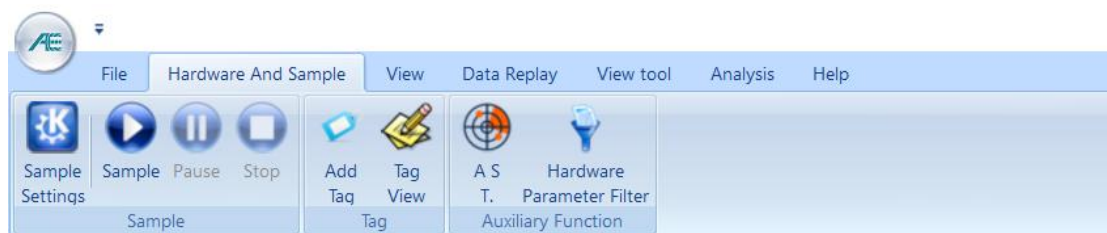Fig. 3-1 Data Acquisition Functions

3.2. Background Noise Test

The background noise test is conducted for all channels. The purpose is to determine the acquisition threshold, i.e. "waveform threshold" and "parameter threshold" in the hardware settings. Generally, the threshold should be 6dB higher than the average background noise level. Before the test, the "waveform threshold" and "parameter

threshold" can be set to low to allow most noise collection (e.g. 26dB) for acquisition. At this time, the environmental background should be close to the real testing conditions for accurate measurements. After 3-5 minutes, observe and record the maximum amplitude frequently appearing in the Data Table as the background noise value.

Then set the threshold to be 6dB higher than the measured noise value for the actual and coming tests to avoid all unwanted noise. When the result threshold value is higher than 55dB, try to eliminate the noise in the actual environment or take necessary setting parameter adjustments, and then repeat this test.

3.3. Sensitivity Test

The sensitivity determines the accuracy of positioning and the reception of small signals. The purpose of sensitivity calibration is to test the sensor quality and to confirm the coupling quality of the sensor.

The sensitivity of each channel is calibrated by breaking the pencil lead for three times at at the same position by a certain distance from the sensor (for example, the pressure vessel is specified as 100 mm from the sensor). Record the highest amplitudes of the channel from each of those three pencil breaking events separately. The average value of the maximum amplitude of the three breaking signals is the sensitivity of the channel.

For example, sand the coating of the pressure vessel to expose the metal surface, at both the sensor position and at 100mm testing position from the sensor. It can set the "waveform threshold" and "parameter threshold" to be higher, like 70dB, for acquisition to eliminate the post waves and to easier to find the maximum amplitudes. When testing the Sensor#1 sensitivity, break the pencil leads at 100mm away from Sensor#1. Record the highest amplitude of channel #1 (Sensor #1). Repeat twice. Average these three amplitudes to obtain the sensitivity of Sensor #1.

After all the sensors sensitivity tests are completed, average the sensitivity of all sensors. Make sure the difference between the average sensitivity and each sensor sensitivity is less than ± 3dB. For example, the detection of most metal pressure vessels requires that the deviation between the sensitivity of each channel and the average sensitivity of all channels is ± 3dB or ± 4dB, while that of fiberglass components is ± 6dB.

If the sensor sensitivity difference is larger than expected, reposition or couple the sensor again or replace the sensor, then repeat the sensitivity test. Sometimes, after the

official AE tests, the post sensitivity test is required to check if the sensors sensitivity are in good condition through the whole process.

3.4. Attenuation Test

The AE signals attenuate during the signal propagation inside the material before it is received by the sensor. The attenuation is affected by the material and the propagation path and length. It is necessary to obtain the attenuation curve in order to determine the most reasonable sensor spacing on the specific material. The attenuation test is generally carried out when large components, low-density sensors are arranged or there is no reference attenuation basis. If necessary, it needs to be carried out before determining the sensor arrangement scheme to ensure the reliable reception of signals.

Only one sensor is needed for attenuation test. Only one channel is used for data acquisition and other channels can be temporarily turned off in "Hardware and Sample" settings to simplify the result analysis. Here, set the "(parameter) threshold" in the "Hit Feature" as the threshold value obtained in step 3.2. Decide a linear path for the pencil breaking points location, usually the direct connecting line from the tested sensor to the other sensor with the largest distance in the array. Break the pencil leads at different distance from the tested sensor along the connecting lines, for example 10cm, 30cm, 60cm, 80cm and the largest distance should not be less than the maximum sensor spacing. At each distance point, break the pencil lead for three times respectively. Record the maximum amplitude of each break and calculate the average value at each distance position, to obtain the distance v.s. amplitude attenuation characteristics curve.

3.5. Sound Speed Test

Two channels are used to calculate the sound speed. First, determine the two sensors to be used and measure the physical distance between the sensors. Break off the pencil lead on the extension line of the two sensors connection. Find the two hits in the Data Table with the maximum amplitude of each channel. Record the arrival times of the two hits and calculate the arrival time difference between the two sensors. Divide the sensor distance by the arrival time difference, that is, the sound speed C. The installation position of the sensor will cause the anisotropy of the sound speed.

As shown in Figure 3-2, the meaning of arrival time in sequence 46 is: 12 o'clock, 45 minutes, 37 seconds, 631 millisecond, 882 microsecond, and 600 nanoseconds, on the 23rd of the current month.

No	Arrival time dd:hh:mm:ss:mmm:uuunnn)	Channel No
46	23:12:45:37:631 882600	3
47	23:12:45:37:632 143800	6

Fig. 3-2 Arrival time

3.6. Location Calibration

Reasonable sound speed is very important for positioning accuracy. It is necessary to measure the sound speed before location calibration.

The source location calibration of field acoustic emission system is to calibrate the analog source signal from the test system on site. Its purpose is to determine the uniqueness and accuracy of the measured source position and source severity compared with the simulated AE source. The final result of positioning calibration is that the simulated analog source acoustic wave is received by a network of the positioning sensor array, and the corresponding number and positions of the measured source locations are displayed in the location view.

The parameter setting of positioning calibration is the same as that used in the actual detection process. If the desired calibration results are not obtained, a compromise should be made by combining the acoustic anisotropy and event timing parameters.

4. Data Collection and Storage

Determine the type of data to be saved based on personal and experimental needs. In general, both waveform data (.AED) and parameter data (.PRA) need to be stored for laboratory research purpose, and the parameter data (.PRA) need to be stored for engineering detection. The tests involved in saving data include: sensitivity test, attenuation test, positioning and calibration, and also in various test stages, such as stretching stage, fracturing stage, loading and hold stages, etc.

According to the standard requirements, during the data collection, the data results shall be observed at all times. In case of unexplained data phenomenon, the test shall be stopped and the data source shall be found out, such as the centralized area where the location event increases rapidly on the location map.

5. Data Replay

After the completion of data collection, the main work is data analysis. Here, only the data replay function is introduced, so that users can see the original data.

5.1. Select data file

In the main menu interface **[Data Replay]**, click **[Replay Settings]**, select the data file to be played back in the pop-up file selection window. The suffix is (.AED) for waveform file, and the suffix is (.PRA) for parameter file. Click **[Open]** after selection.
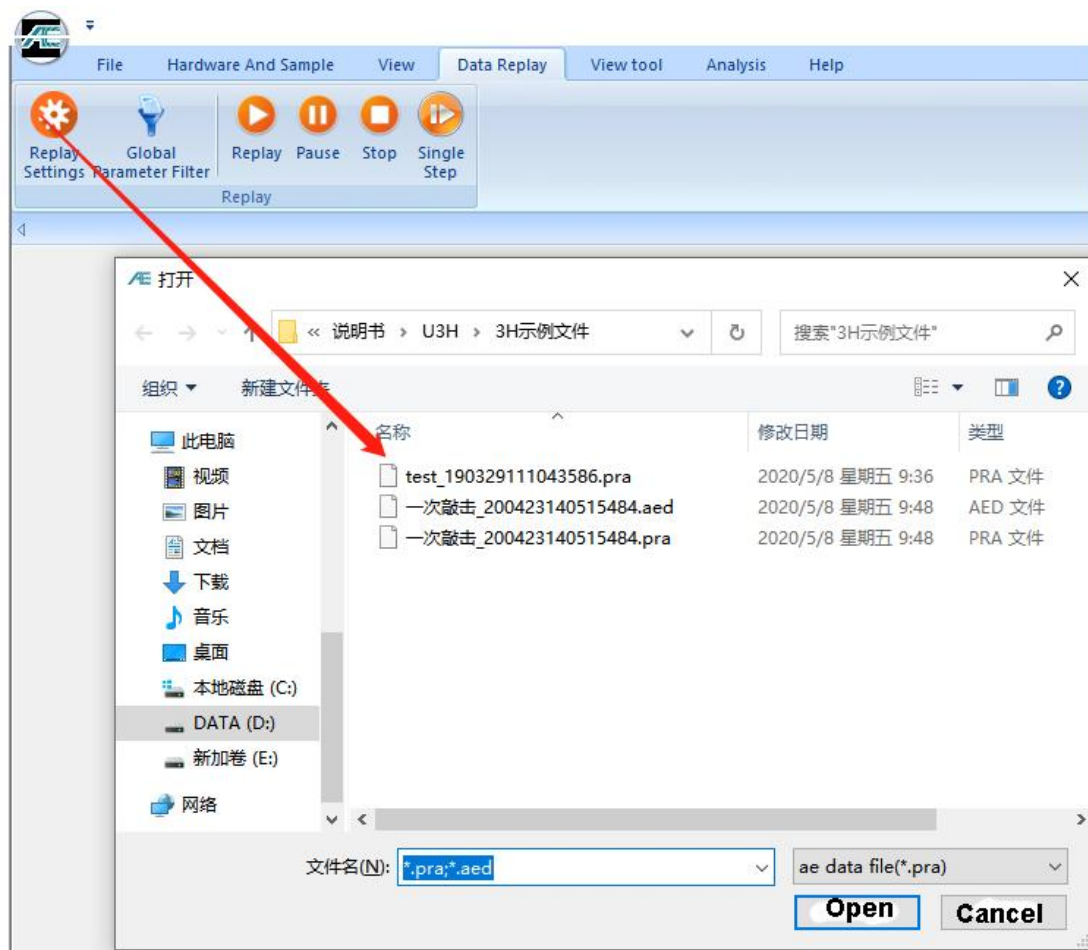

Fig. 5-1 Selection Of replay Data

5.2. Replay settings

After selecting the data to be played back, the interface as shown in Figure 5-2 will pop up. This interface only needs to select the data type and replay rate to be played back.

Replay parameter / replay waveform: when selected, it takes effect. If it is necessary to play back waveform and parameter file synchronously, it needs to be checked at the same time;

Replay speed: the number of hits replaying per second. The maximum speed is 100,000.
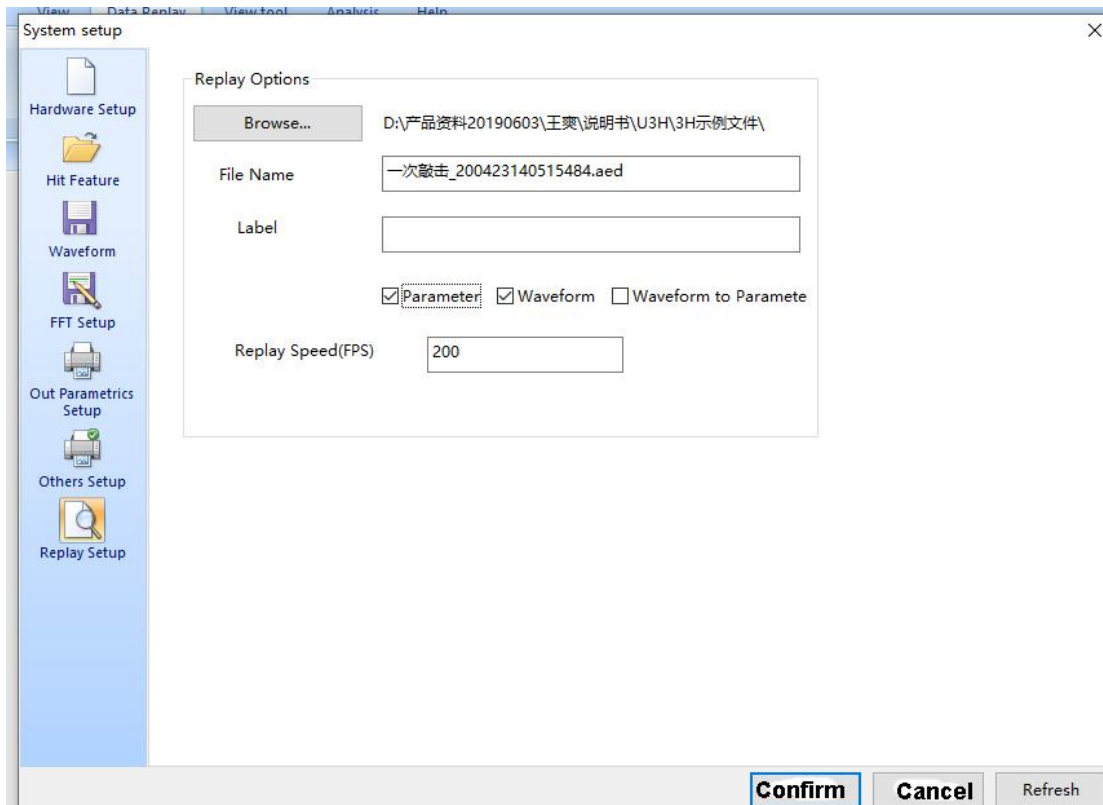

Fig. 5-2 Selection of replay Data Type

5.3. Replay Operation

The function area of data replay control button is in the main menu **[Data Replay]** interface, and each button is provided with an identification description, which will not be repeated.

Fig. 5-3 Data replay Function

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Keyboard and mouse operation

1) In the replay process, the "space" and "enter" keys can be used to switch between continuous, fast and gradual replay;

2) When selecting "waveform graph" with the mouse, the waveform can be enlarged and reduced longitudinally by pressing "↑" and "↓" keys on the keyboard; click the left mouse button to drag from the upper left corner to the lower right corner and release in the waveform graph to realize the horizontal stretching of the waveform; click the left mouse button to drag from the lower right corner to the upper left corner and release in the waveform graph to restore the waveform.