

**«DIMRUS»**

Acoustic Partial Discharge Analyzer and Locator  
**«AR700»**

User Manual



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# 1. AR700 Description

## 1.1.General

AR700 is a portable battery powered instrument that aims measurements and analysis of acoustic signals in HV electrical equipment. It also locates a spatial zone of insulation defects producing partial discharge sparks. All information is stored in the instrument flash memory that allows downloading data into personal computer and performing post-test analysis using specialized software supplied with the instrument.

AR700 has USB communication interface for a connectivity to PC. LCD display with the resolution 480x272 pixels allows for in-field data observation and express analysis.

The device is equipped with four acoustic sensors and two high-frequency sensors RFCT-4 and RFCT-5. The device has a standard headphone jack for listening to acoustic signals in slow motion. When registering signals, the device can be synchronized with a special radio transceiver "PFR-1" or can be manually started measuring without synchronization.

Also, the set includes a special ultrasonic transducer "UST" to check the acoustic sensors, the connection cables and acoustic channels of device.

It operates either from internal battery or from 120/220 VAC stationary power.

## 1.2.Technical characteristics.

Operation temperature range -20 to +50 °C.

Relative humidity up to 98% (non-condensing).

**Table 1**

**AR700 Specification**

Acoustic channels (BNC)	4
Acoustic frequency band	30 kHz – 300 kHz
Electrical PD input (BNC)	1
HF channel frequency	0,5-10 MHz
<b>Flash Memory.</b>	
Allocation	Dynamic
Amount	64 or 256 MB
Storage time	Unlimited

<b>Data presentation</b>	
LCD Display with backlight	480x272
<b>Communication ports</b>	
Interface	USB
<b>Power</b>	
Battery	Up to 8 hours
120/220VAC	Unlimited
<b>Dimensions</b>	
Dimensions, no more than (mm):	220x168x37
Weight, no more than (kg):	12.5

### **1.3.Special conditions**

- AR700 requires specially trained operator, familiar with the user manual and specific hazards during tests on life high voltage equipment.
- AR700 must be protected from falls, impacts and so on that may damage the instrument enclosure. **It should not ever be used if the enclosure has damage.**
- The battery cannot be replaced with non-original type. Battery should be replaced at manufacturer service center.
- Repair must be performed at the manufacturer facility.

## 1.4.Scope of supply

AR700 Instrument	1pc.
Acoustic sensor	4pc.
PD sensor (RFCT-4)	1pc.
PD sensor (RFCT-5)	1pc.
Device Case	1pc.
USB cable	1pc.
PFR-1	1pc.
Coaxial cable	5pc.
Ultrasonic transducer UST	1pc.
Charger	1pc.
User Manual	1pc.
INVA software installer and manual	1pc.

*Note: Actual contents are determined at the time of PO.*



## 1.5.Connectors

All connectors are located at the front and the back panel of the instrument.  
Connectors include:

- \*1 Power connector;
- \*4 BNC connectors for acoustic sensors;
- \*1 BNC connector for PD sensor;
- \*1 HeadPhone connector;
- \*1 Radio connector;
- \*1 USB(at the back panel);



## 1.6.Keypad

Keypad has 15 keys:

Control keys: **Esc**, **Enter**, **Left**, **Right**, **Top** and **Bottom arrows**, and five functional soft buttons **F1-F5**.

Auxiliary keys **Mod**, **Mem**, **Help**.

If a key is pressed continuously, it will repeat its action every 0.5 seconds.

Key's description:

- «**On/Off**»– turns the instrument ON and OFF. AR700 may turn off automatically in specified idle time, if set in the instrument setup.
- «**Esc**» - cancels action, returns to previous menu.
- «**Enter**» - selects menu or table option, enters a symbol confirms action.
- «**Mod**» - functional soft key. Changes function depending upon mode of operation.
- «**Mem**» - primarily used for operation with the device memory.
- «**F1**»... «**F5**» - soft functional keys. Current function is indicated in the bottom part of the display.
- «**Arrows**» - move cursor between menu options.



## 2. AR700 operation

### 2.1. Getting ready

- Unpack the instrument.
- Prior to using AR700 for the first time charge the battery for 8-12 hours.
- Connect the charger to the instrument and then to a stationary power (when possible).
- Connect signal cables to the instrument.
- Turn the instrument ON.

### 2.2. Turning ON

Press power button for a second. You should see the message “**Loading**” for a short time during self-test. Then you will see welcome display that shows the current device date, time and the firmware version.



In a few seconds or by pressing “**Enter**” brings to the display “**Main Menu**”.






### 2.3.Main Menu



All functions of the instrument are selected from main Menu as follows in the table 2.

**Table 2**

Functions from the left to the right.

	« <b>F1 START</b> » – all signals are recorded in this mode. A set of signals can be analyzed to determine a source location.
	« <b>F2 SETUP</b> » – setting date, time and power saving options.
	« <b>F3 ARCHIVE</b> » – observation of the data stored and deletion of unnecessary data.
	« <b>F4 DELETE</b> » – to delete all data from archive.
	« <b>F5 UPDATE</b> » – firmware update.

## 2.4.Submenu "Analysis".

Pressing F1 will bring the following display:

Tank dims .			Sensors coordinates ,cm		
X=	100	cm	#1	X	Z
Y=	100	cm	#2	Y	
Z=	100	cm	#3		
			#4		
			Synchronisation		
			OFF		

F5 NEXT

The top left area determines the spatial zone for defect calculating dimensions. The right area allows setting the sensors' position coordinates. Select parameter to be changed by pressing arrows and then press Enter, then use Up/Down arrows to change the digit under cursor. Left/right arrows can move cursor to another digit. Press Enter to confirm change.

Press F5 "Next" key to move to next page or "Esc" to return to previous menu. Pressing "F5" brings the following page:

Acquisition		Stop set.	
Ch1	ON	Ch1	OFF 0.50V
Ch2	ON	Ch2	OFF 0.50V
Ch3	ON	Ch3	OFF 0.50V
Ch4	ON	Ch4	OFF 0.50V
Ch5PD	ON		
Aver. A	1	Noise set.	
Accum. PD	30	Ch1	0.01V
Periods	8	Ch2	0.01V
V, m/s	343.0	Ch3	0.01V
Thresh.	70%	Ch4	0.01V
Gain PD ch.	x1	Mode	Hand

F4 BACK      F5 NEXT

*The top left quadrant*

Allows to activate/deactivate channels. Keep in mind that for locating you need all four acoustic channels enabled. Move cursor to a channel and press “Enter” to switch it on/off.

***The bottom left quadrant***

- Set the number of averages for acoustic channels. Maximum – 30;
- Set the number of accumulation for PD channel. Maximum – 30;
- Set the number of periods - length of measurement. Maximum – 8;
- Set the sound velocity in the object media in m/sec;
- Signal threshold in % of maximum detected magnitude. Only signals exceeding this threshold will be used for analysis;
- Set gain of PD channel. Range: x1, x2, x4;

***The top right quadrant***

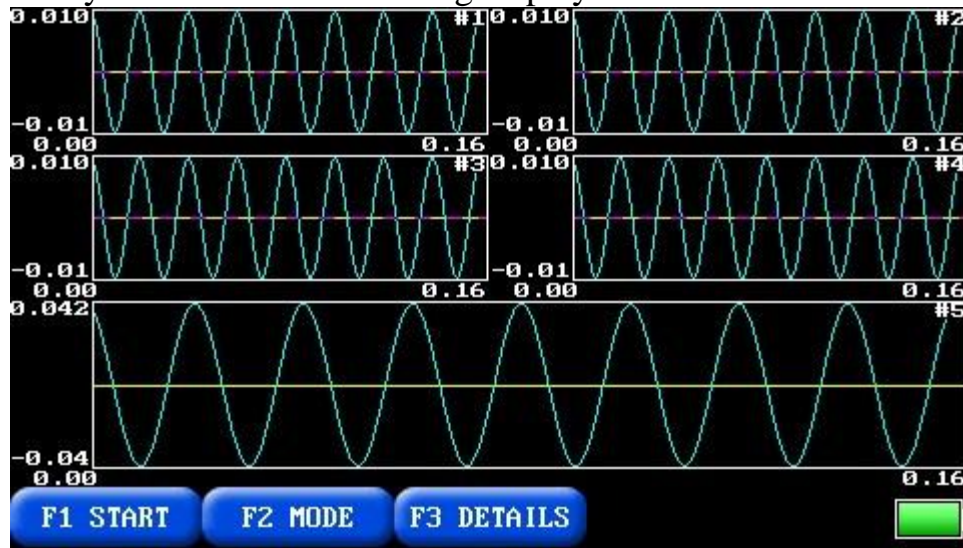
Set magnitude thresholds to automatically stop acquisition in the “Review” mode. If a signal on any channel exceeds the threshold of this channel, acquisition will automatically stop allowing user to observe this signals.

***The bottom right quadrant***

Controls the rejection of noise signal. Signals below the set noise threshold will be treated as noise. There are two modes: Manual “Hand” and Automatic “Auto”. In manual mode each channel’s noise threshold will be the set value. In automatic mode the instrument will determine noise automatically. Manual and Auto modes are selected by highlighting the option using arrows and pressing “Enter”.

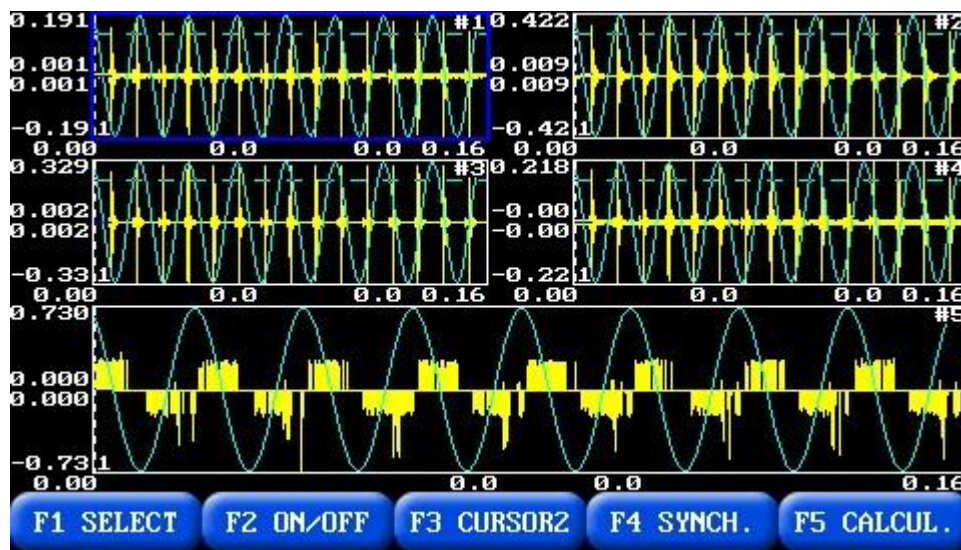
Press “F4” “Back” to return to previous menu or “F5” “Next” to further procedure.

On F5 you will see the following display:



- F1 “START” – starts data acquisition. It will run continuously until F1 is pressed again to “STOP” data acquisition.
- F2 “MODE” – changes view between “GRAPH”, "PRPD" and "3-D view" of an object with defect displayed as a dot.
- F3 “DETAILS.” – allows for detailed review of the data.
- F4 “SAVE” – this option appears when you stop acquisition. It allows saving the current data in the flash memory.

Pressing F3 “Details” will allow to observe more detailed information about the selected record using cursors and zoom options.



Each graph has two cursors and their time coordinates will be displayed underneath. Amplitude coordinates are displayed to the left of a graph. Cursors are moved by the left and right arrows, time scale is zoomed by the up and down arrows.

Zooming of the vertical scale can be done by pressing a combination of buttons: “Mem” + “Up” or “Mem” + “Down” arrows.

Soft menu by F1 – F4 as follows:

- F1 “SELECT” – Selects graph. Selected graph has blue bold frame.
- F2 “ON/OFF” – exclude the selected graph from the detailed view mode. Turns off cursors and zoom options for the selected graph.
- F3 “CURSOR 1/2” – change selected cursor.
- F4 “SYNCH.” – synchronizes cursors on all graphs to the cursor on the selected graph. Applies to the currently active cursors 1 or 2.
- F5 “CALCUL” - the instrument will calculate coordinates and display them.

Using “Enter” key will play the currently selected graph to the phone.

“Mod”+”Up” – to increase volume.

“Mod”+”Down” – to decrease volume.

“Mod”+”Left” – to decrease divider.

“Mod”+”Right” – to increase divider.

Using “Mod” key will expand the currently selected graph to the whole display.

Using “Enter” key will play the currently selected graph to the phone.

“Mod”+”Up” – to increase volume.

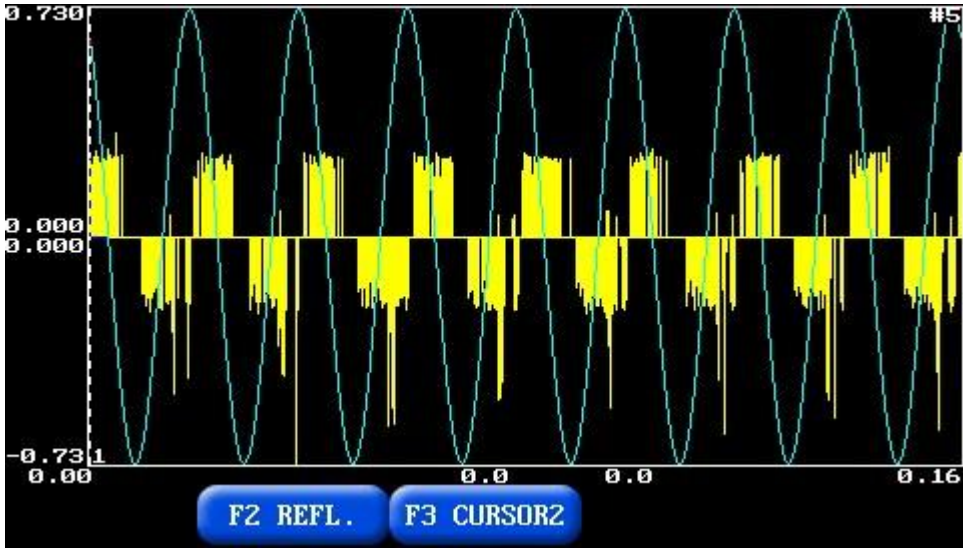
“Mod”+”Down” – to decrease volume.

“Mod”+”Left” – to decrease divider.

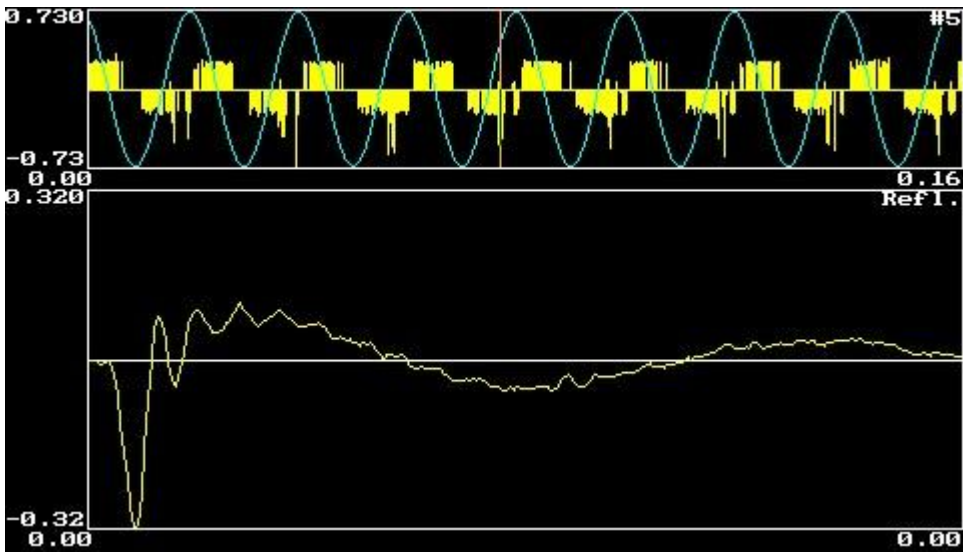
“Mod”+”Right” – to increase divider.

To return back press “Esc”.

If you use Mod button for PD channel, you will see an additional option to view reflectogram.

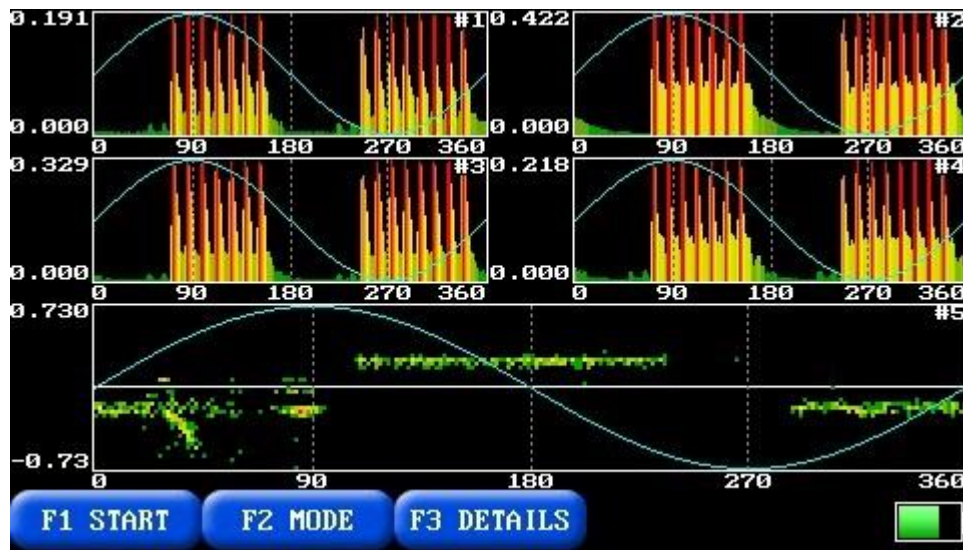


Pressing F2 “REFL.” will allow to observe shape of each pulses. “Left” and “Right” arrows – to select pulses. “Esc” – return back;

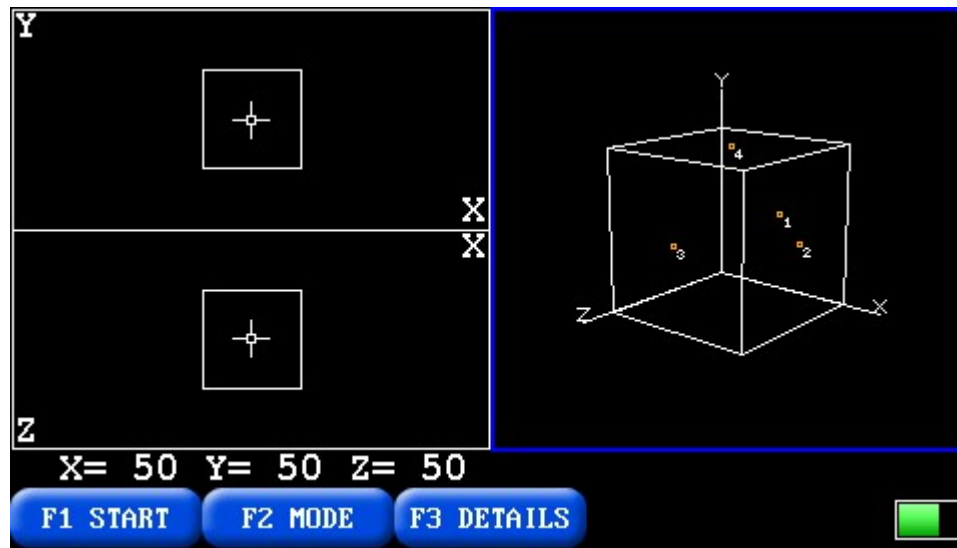




In “PRPD” mode you can see the following display:



In “3-D view” mode the following 3-D with two 2-D views object presentation will appear.



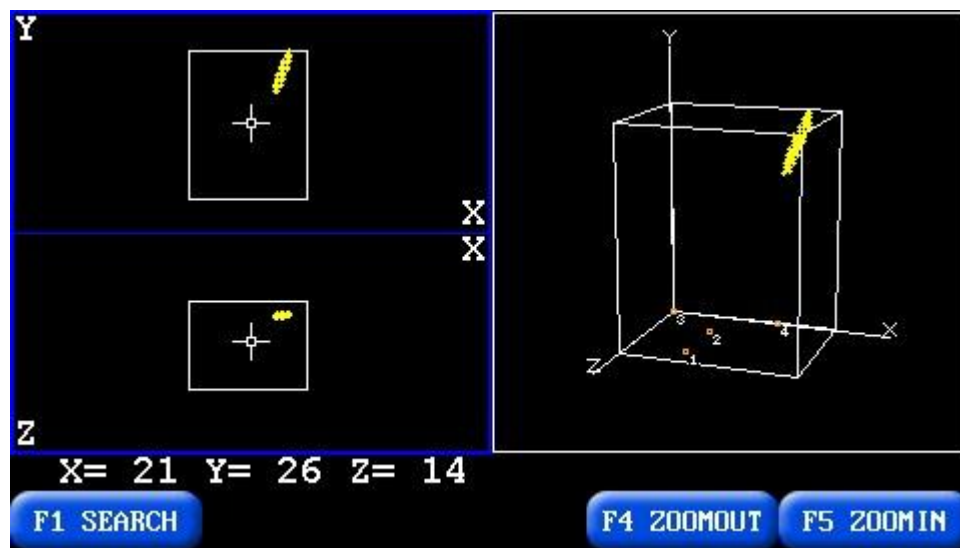
The right part is 3-D view of the zone where a defect will be located and the left part are two projections to XY and XZ planes.

Arrows rotate 3-D view. “Mod” and “Mem” zoom in/out the graph.



Soft function menu:

- F1 “START” – starts continuous data acquisition and F1 changes to “STOP” option. AR700 will continue acquisition until F1 is pressed again. It also will automatically detect PD source location and display each successful detection as a dot on 3-D and 2-D views. Note that for a locating the instrument requires all four channels ON.
- F2 “MODE” – allows to switch mode to view without stopping acquisition and analysis.
- When acquisition is stopped F4 “SAVE” allows saving in the flash memory 3-D picture (if you are in “3-D view” mode) or oscillograms (if you are in “GRAPH” or “PRPD” mode).
- F3 “DETAILS” – allows for detailed analysis of detected locations. New soft menu options will appear: F1 – “SEARCH”, F4 – “ZOOMOUT”, F5 – “ZOOMIN”.

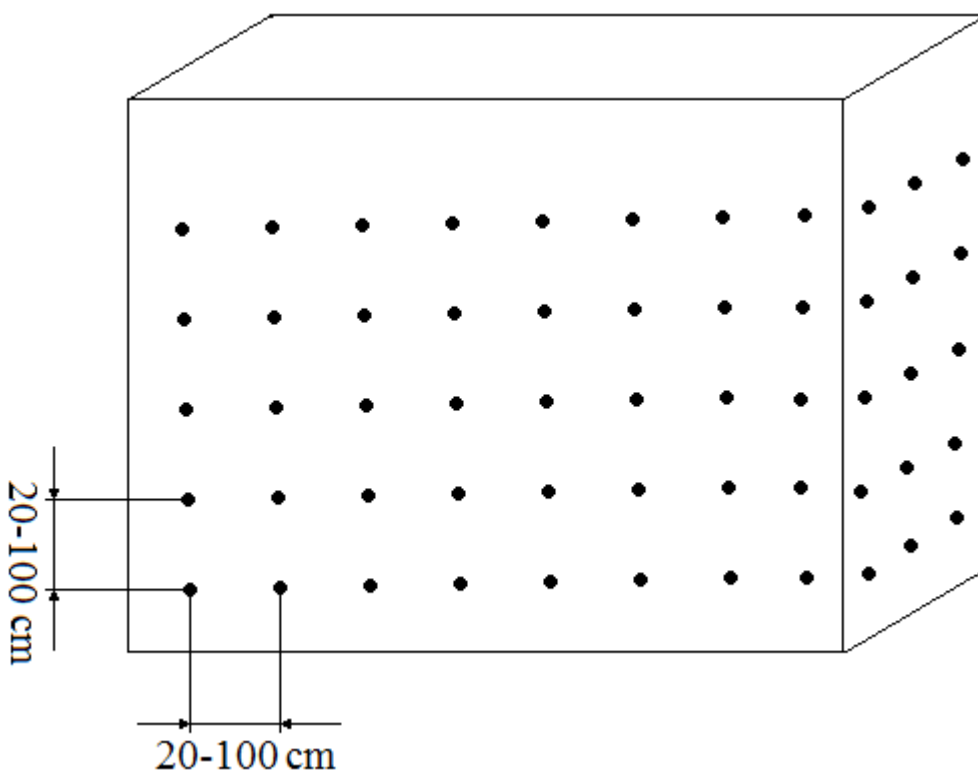


- “SEARCH” – places cursor to the nearest PD location and displays its coordinates beneath 2-D graphs.
- “ZOOMOUT” – zooming out 3-D graph.
- “ZOOMIN” – zooming in 3-D graph.

Arrows and “Mod” and “Mem” move 2-D graphs.  
Press “Esc” to exit detailed analysis.

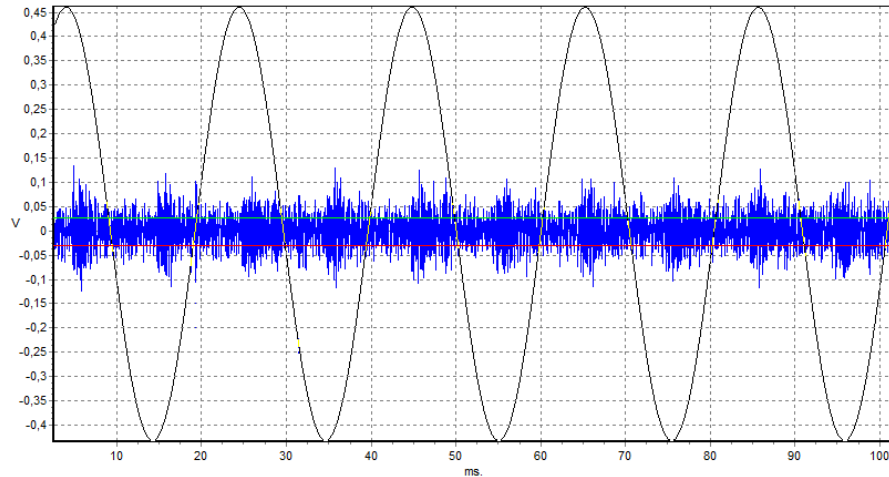
## 2.5. Recommendation on locating defect

As the first step on an object we recommend to use “Review” mode with one acoustic sensor (Ch1=ON; Other channels = OFF; Over.A=1; Periods=4). Walk around an object under test and detect zones with the elevated acoustic activity due to internal partial discharges. Depending upon object your net of placing sensor for initial evaluation may be different. As for example in power transformers 20-100 centimeters appears to be a good number.

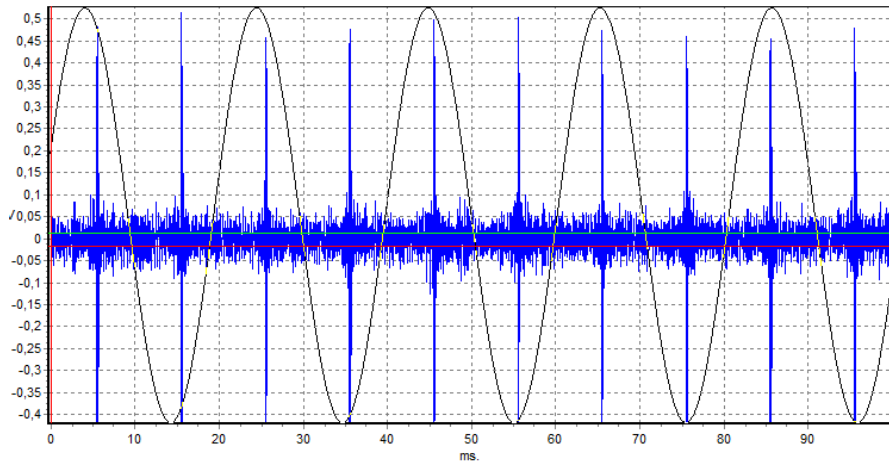


Example of the scheme of acoustic sensors installation.

***Attention!*** You have to lubricate the acoustic sensors special grease before installation on object.

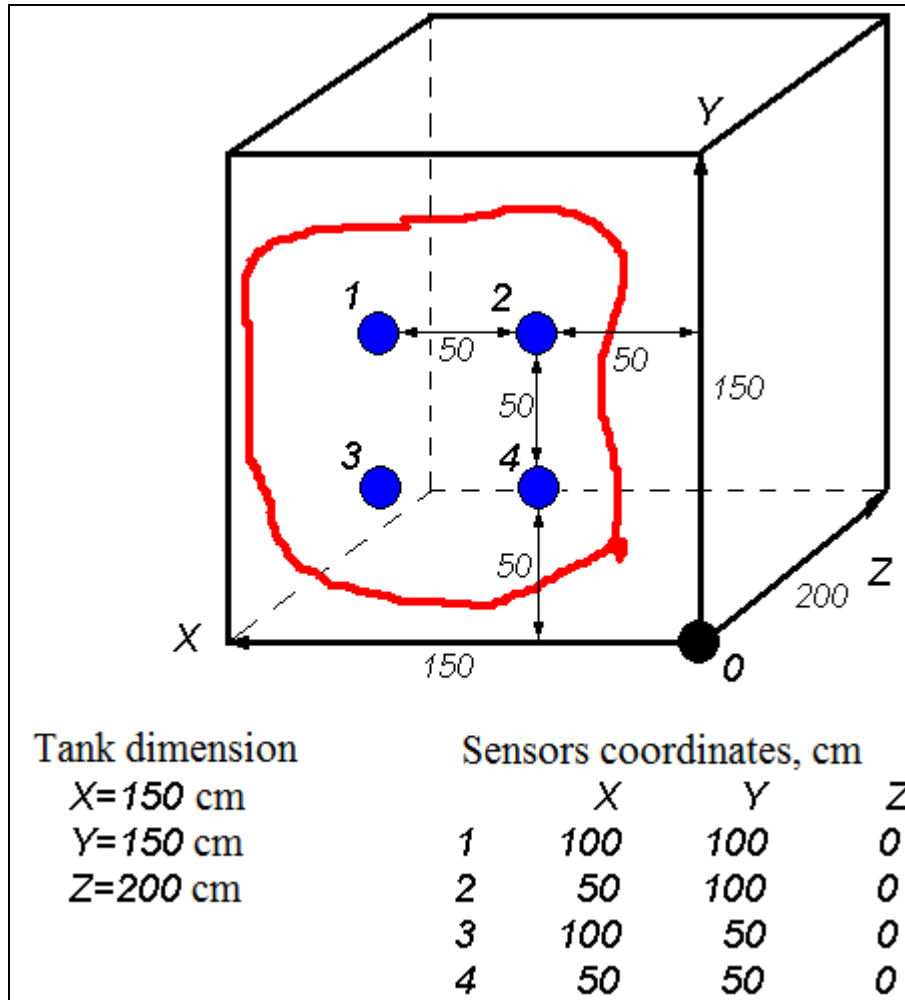


Example signal of transformer noise.



Example signal from zone with the elevated acoustic activity.

If a zone or zones with elevated acoustic activity are detected you may proceed to next step of PD source locating. Install all four acoustic sensors in the way to cover the zone. The recommended distance between sensors is from 0.2m to 1m. Set in the instrument dimensions of the zone of interest and sensors coordinates relatively to the zero point of the selected coordinates system. Set velocity of sound in the media of the tested object. Take one record for four sensors and set the threshold for data analysis. Select “3-D view” mode and start data acquisition.

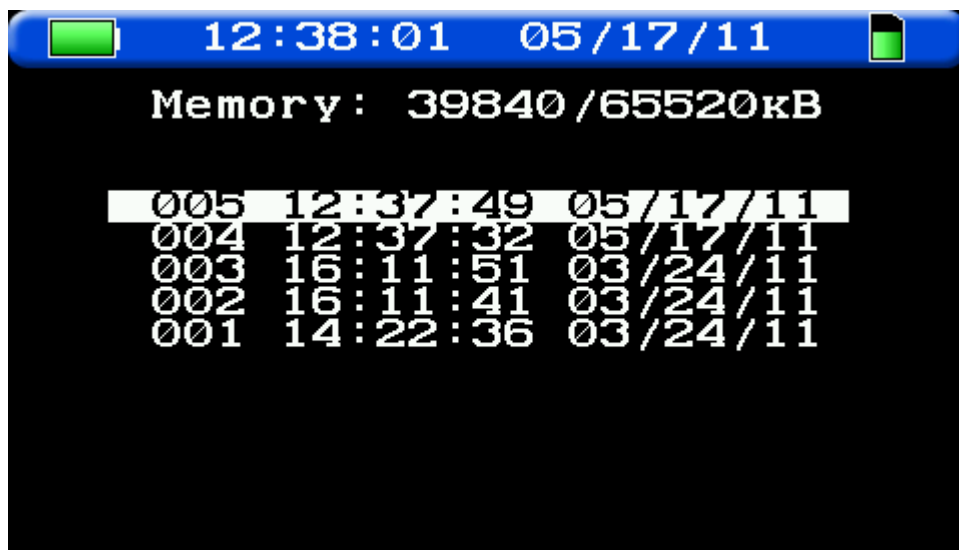


Example for 4 acoustic sensors installation

Another option is to manually select signals for defect coordinates calculation. Take one record in “GRAPH” mode. Select “DETAILS” mode and set cursor 1 on each of four oscillograms onto the beginning of acoustic pulse that you believe corresponds to the same event. Select a single channel with F1. Using “Mod” expands this record and set cursor 1 to the desired peak. By “Esc” return to four graph view and select another channel. Repeat this procedure for all channels. When cursor 1 is set for all channels press F5 “CALCUL”. The instrument will calculate coordinates and display them.

## 2.6. Archive Menu

This menu allows for two options: “View” data and “Delete” data. The following page will be displayed.



Record is selected by top and bottom arrow.

- “Enter” – view and analyze data;
- “Mem” – deletes the selected record. Will require additional confirmation to take action.

**Attention!** Deleted information cannot be restored.

## 2.7. Delete Archive

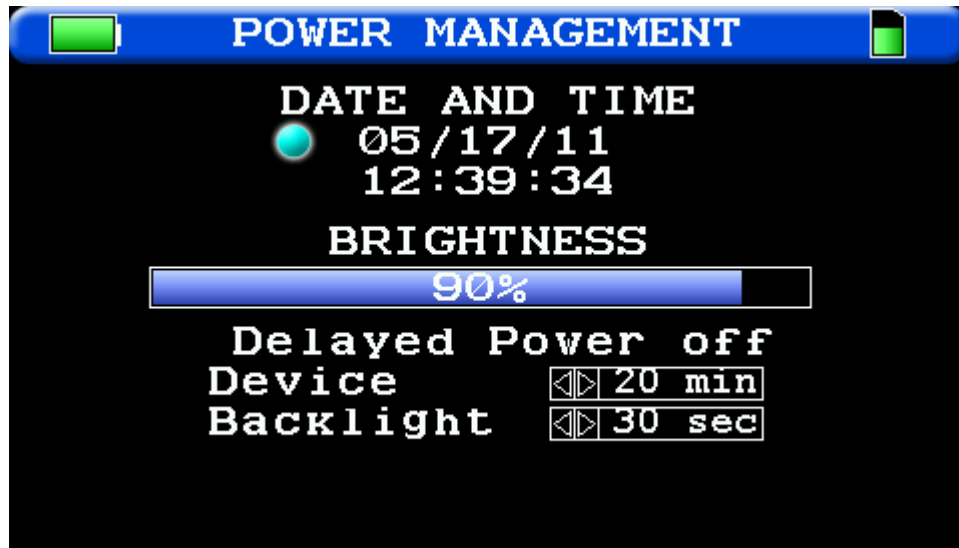
Selecting this function will clear all data memory. It will require confirmation on deletion by pressing “Ent”.



## 2.8. Setup menu

This option sets date and time and power saving options.

Place cursor with arrows to the option to change and press Enter. Select desired numeral and with top and bottom arrows change its value. Press Enter to confirm the change or Esc to exit without confirming.



## 2.9. Update menu

This option allows to update firmware of device.

## Information



Press any button to start  
updating process. Exit - Esc

Cancel (Esc)

### **3. INVA Portable Software.**

#### **3.1. Introduction**

AR700 can transmit data into the software INVA Portable. INVA Portable software is designed for data processing, analysis, storage and viewing of data from "Dimrus" devices.

INVA Portable Software includes two components:

1. INVA Portable – database and application for data processing, analysis, storage and viewing of data.
2. USB driver.

#### **3.2. System requirements**

For comfortable work with INVA Portable software you need a PC (or laptop) has the following characteristics:

- Intel Core i3 processor or better;
- 2GB RAM or more;
- 14" display or more;
- 250 GB storage or more;
- Windows 7, Windows 8, Windows 8.1, Windows 10.

#### **3.3. Software installation**

Run InvaPortable.msi file from a CD or from the site "Dimrus.com" and follow the instructions of the installer. To work correctly INVA Portable application requires Microsoft .Net Framework version 4.5.2 or later.

To install the USB device driver, run InstallDriver.exe as an administrator and follow the instructions of the installer.

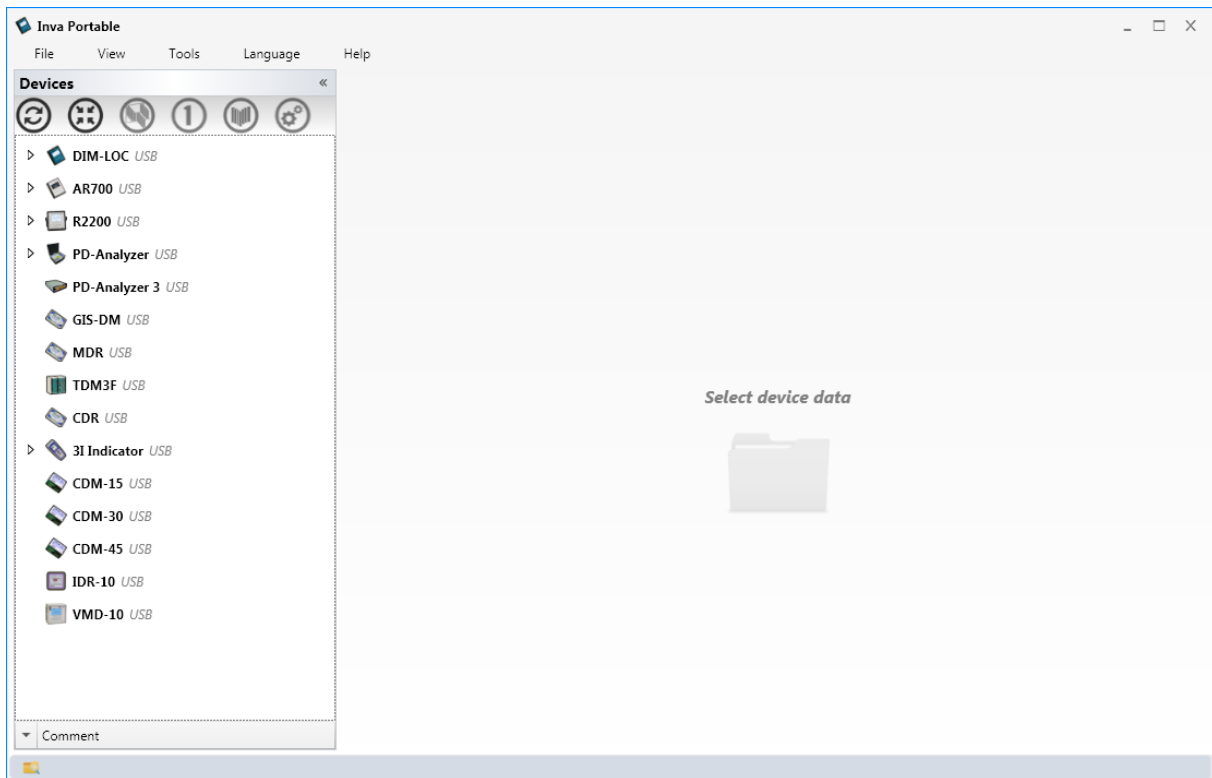
#### **3.4. Run application**

Run the "Start \ Programs \ Dimrus \ Inva (Portable).» Also, the launch of the software by double-clicking the shortcut «Inva (Portable)» on the desktop.





The program window after run is shown in the following figure:



### 3.5. INVA Portable description

Program window includes 4 areas:

- Menu (top);
- Status (bottom);
- Database (left);
- Area for data viewing (right).

The Menu contains the following items:

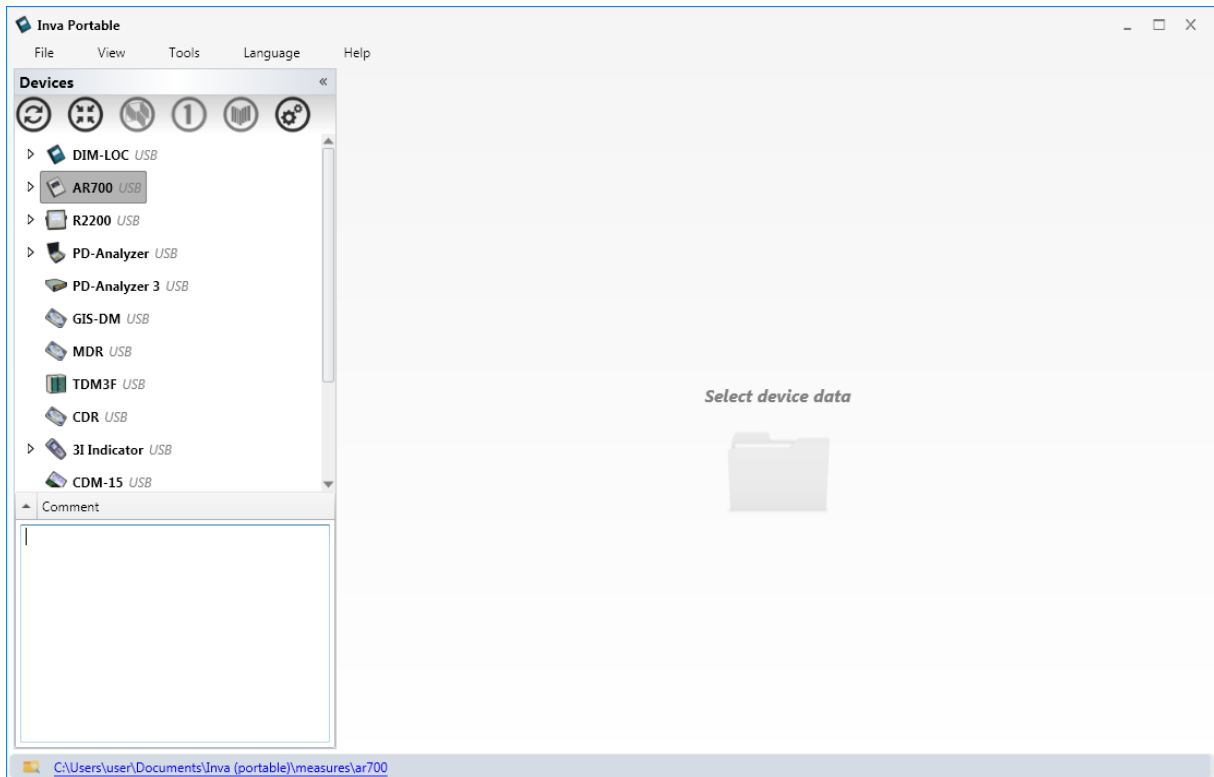
- «File» - to exit from the program and create or download archives;
- «View» - view settings;
- «Tools» - to select the storage folder and edit the list of available devices;
- «Language» - to select interface language;
- «Help» - information about the manufacturer and update program.

Working with the program is to select the elements in the database window. To perform operations on them using the pop-up menu that appears when you click the right mouse button.

DB structure - the tree, and can contain elements of various types:

- Each device Dimrus is the main root - the data directory;
- Folder - item for stored measurements, is used to organize data;
- Measurement - includes resulting data;
- Configuration File - contains the settings of measurement.

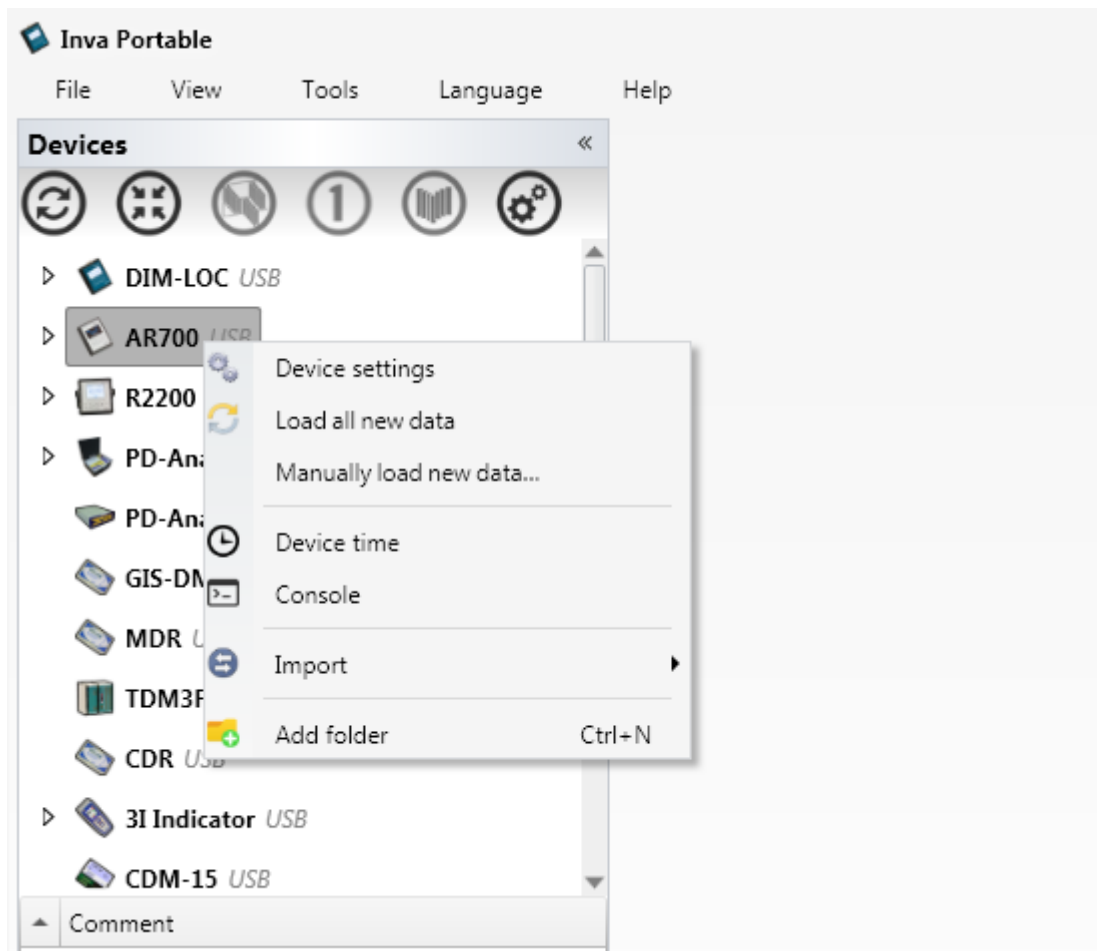
Each element can be assigned a text comment, which is located under the window of the database:



The comment will be displayed in the comment window when you select an item or in the tooltip when you hover the mouse over the element. Items containing comment denoted by the symbol «i».

### 3.5.1. AR700 menu

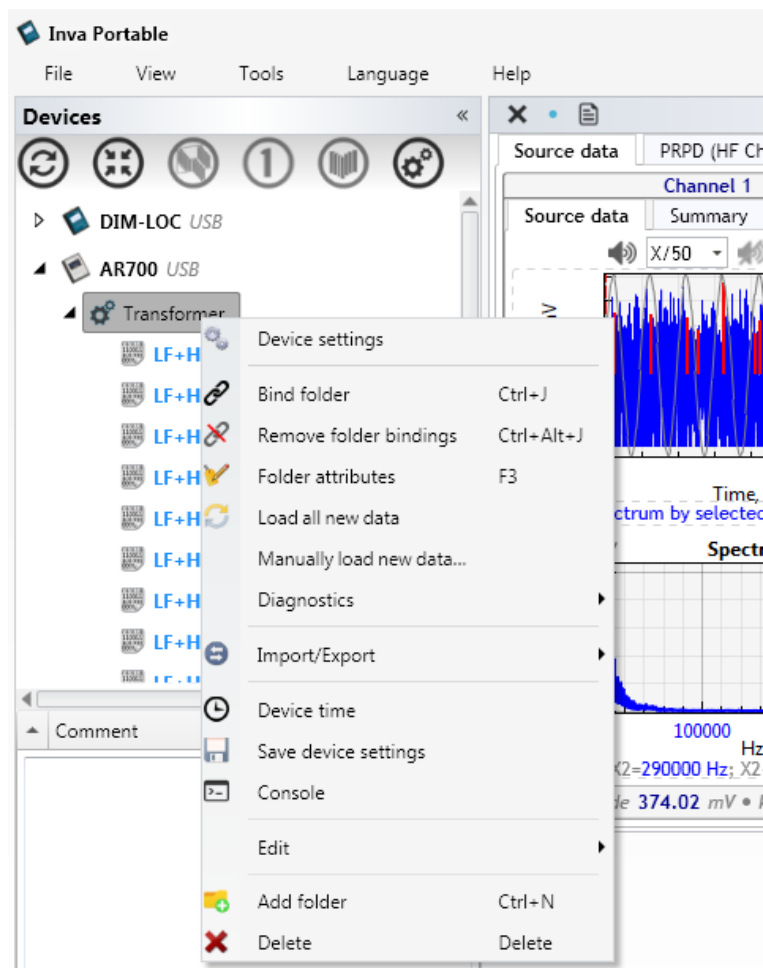
«AR700» menu includes the following items:



- «Device settings» - to get the settings of the device, for viewing or editing;
- «Load all new data» - the program loads the data of all the measurements saved later than the last measurement stored in the database. These are added to the folder "All data";
- «Manually load new data...» - the program loads the data of all the measurements performed later than the last measurement stored in the database. Each measurement can be "drag and drop" into the destination folder;
- «Device time» - to edit the current date and time in the instrument;
- «Console» - used by the manufacturer for testing instrument;
- «Import» - import data from INVA to INVA Portable.
- «Add folder» - to add new folder.

### 3.5.2. Folder menu

Folder menu contains all items of the «AR700» menu and supplemented with the following items:



- «Bind folder» – it is not available for AR700, designed for other devices.
- «Remove folder bindings» – it is not available for AR700, designed for other devices.
- «Folder attributes» - to customize the folder appearance (icon) and the name of measurement channels.
- «Diagnostics» - it is not available for AR700, designed for other devices.
- «Save device settings» - to save the settings of the device to the selected folder. Saving will not be performed if there is no USB connection or settings are identical to the last one which is already stored in this folder;

- «Edit» - to edit folder:
  - *Highlight;*
  - *Rename;*
  - *Sort;*
  - *Split;*
  - *Add attachment;*
  - *Copy, Paste, Cut and etc.*
- «Add folder» - to add a new folder;
- «Delete» - to delete folder and contents.

### **3.5.3. Measurement menu**

Measurement menu contains the following items:

- «Diagnostics» - it is not available for AR700, designed for other devices.
- «Highlight» - to highlight measurement. All parent folders will be highlighted too.
- «Open» - to show measurement;
- «Delete» - to delete selected measurement.

Measurement data and settings files, you can "drag and drop" with the mouse to the other folders.

### **3.5.4. Device settings folder**

Device settings menu contains the following items:

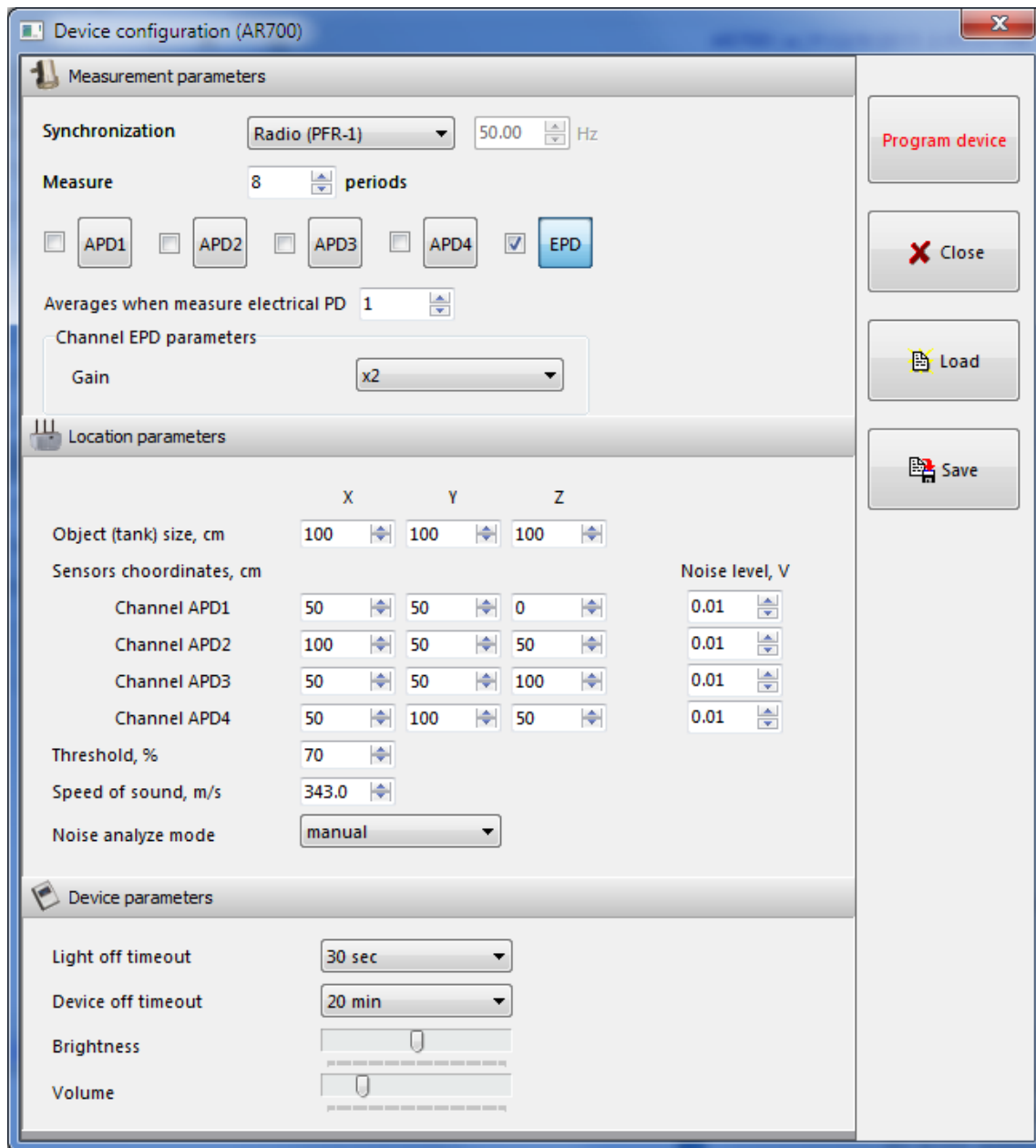
- «Highlight» - to highlight measurement. All parent folders will be highlighted too.
- «Open» - to show to device settings;
- «Delete» - to delete selected device settings.

## **3.6. Device settings**

All instrument parameters can be set from a computer. For this:

1. Make a connection between the computer and the device via USB.


- Right-click on the folder and select the "Device settings". The program will load the configuration of the instrument and start the editing window.

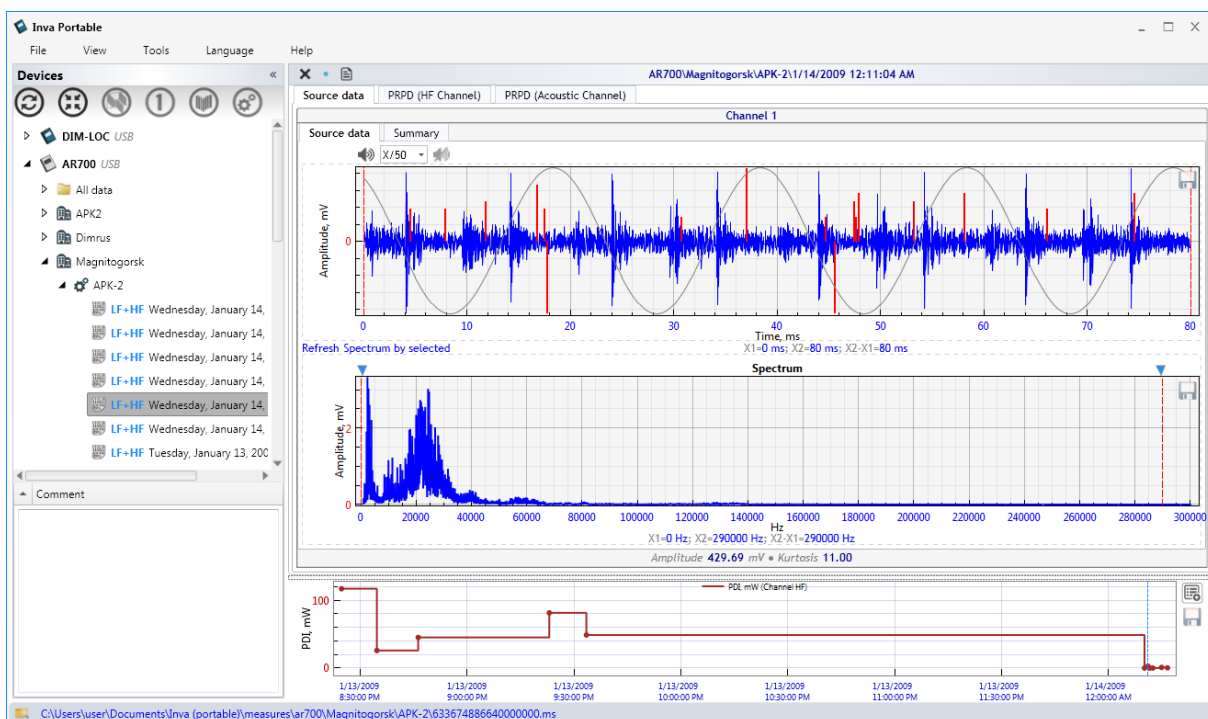


### 3.7. View data

Select the data file in the Database window. data on the measurement of the selected are displayed in the right part of the window. To view a channel on

the full screen, double-click the left mouse button on the channel name. To return to the previous mode, again double-click the left mouse button on the channel name.

At the bottom of the window displays a graph of amplitudes of measurements taken from folder. Click «  » to configure. To select the measurement you can left-click on the point of the graph.



There are 4 modes view graphs:

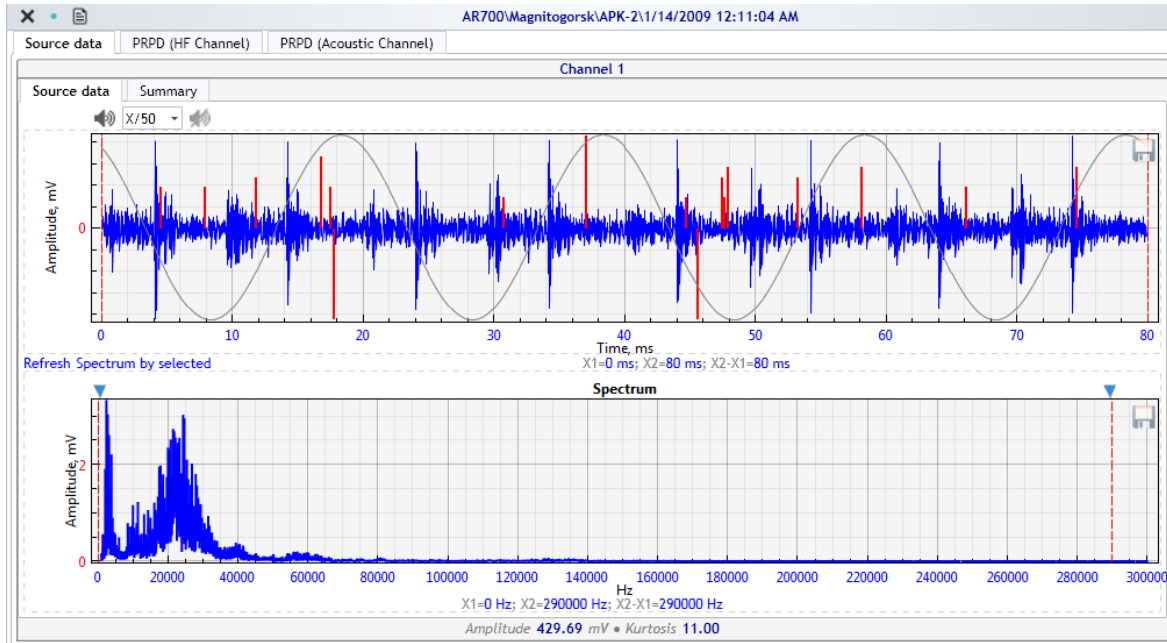
- Source data;
- PRPD (HF Channel);
- PRPD (Acoustic channel);
- PD Location.

To select the view mode you need to select the tab with the same name:

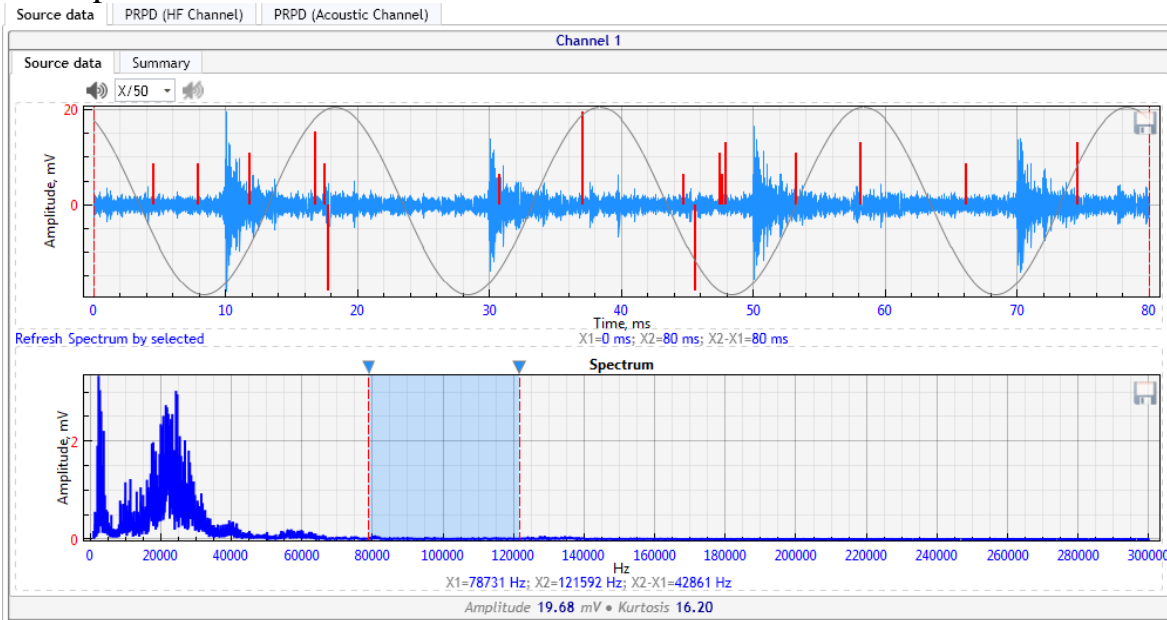


### 3.7.1. Source data

In this view mode, the acoustic signals is displayed on the screen. The red color shows the data from the "E PD" channel.

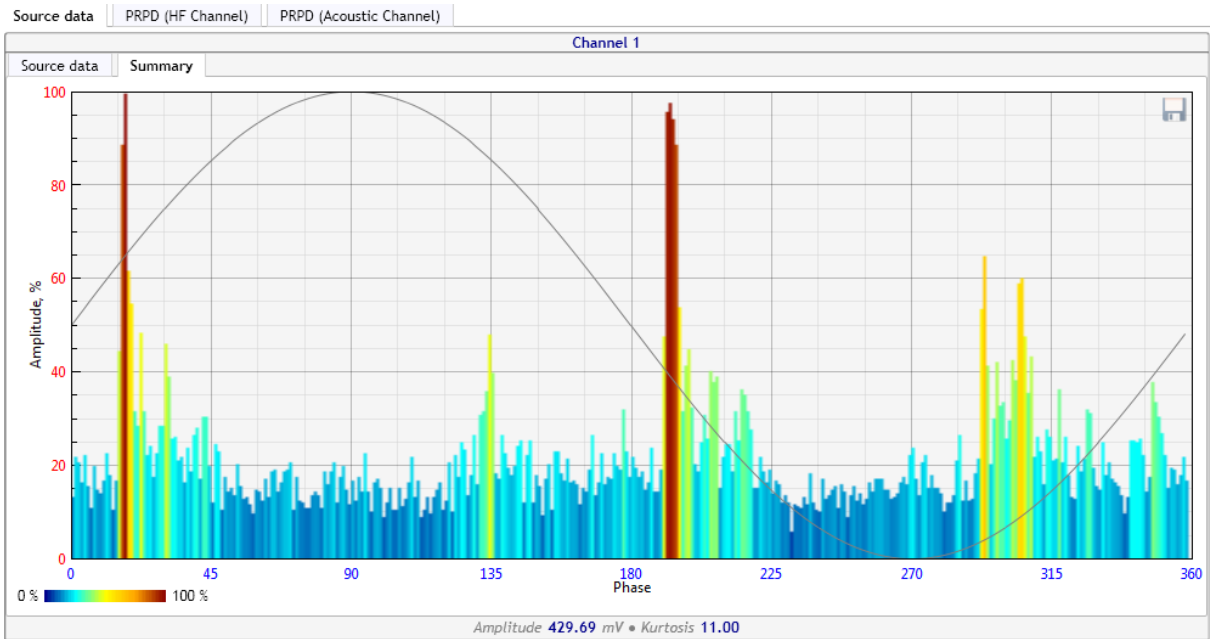


Under each acoustic signal displays its spectrum. Double-click the left mouse button to select the zone. The screen displays a signal obtained by inverse Fourier transform using the selected zone of the spectrum. The figure below shows the same signal as that of the previous figure, but selected only part of the spectrum.



In this view mode, you can select the tab "Summary":

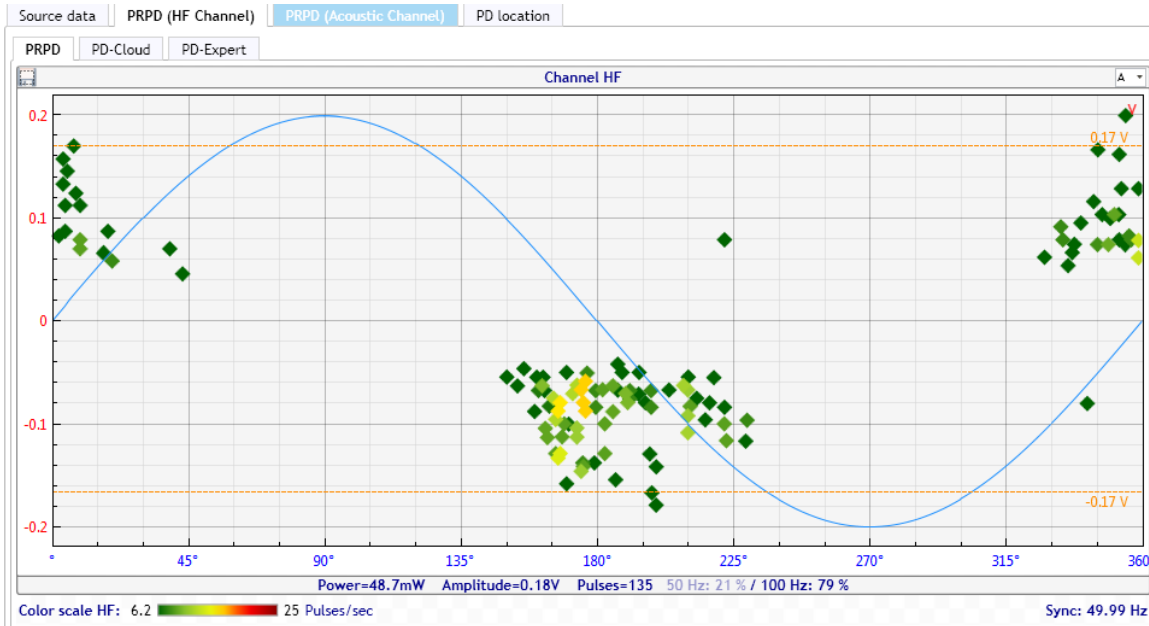




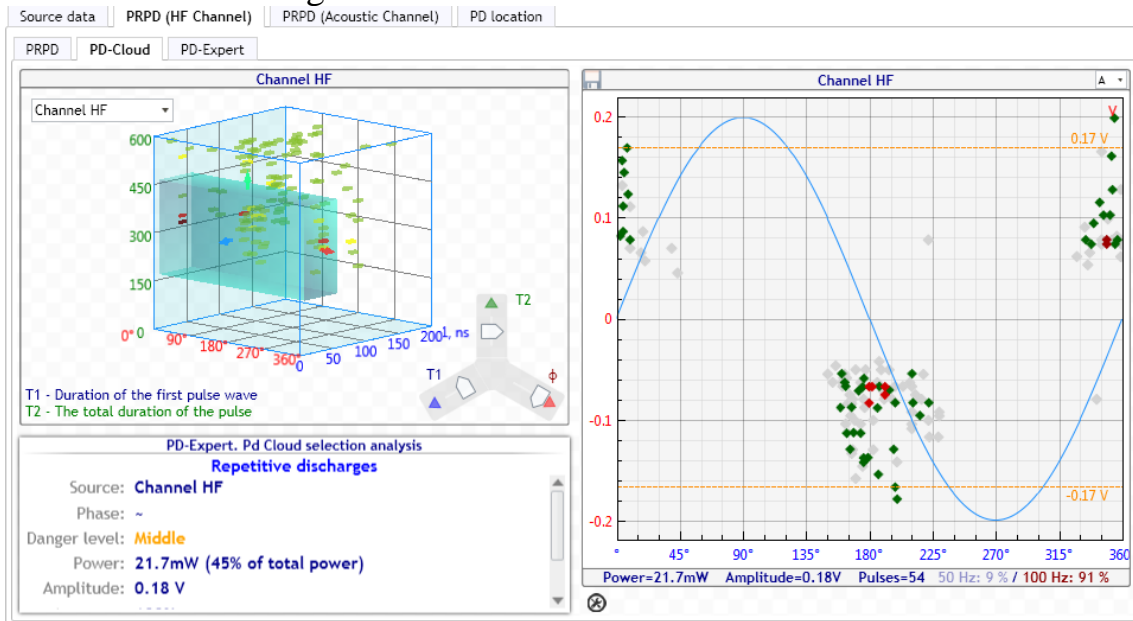
Vertical axis - the amplitude of the pulse, the horizontal axis – phase/degree. The higher the amplitude of the pulse, the more intense the color of the pulse. The color scale is shown below the graph. In this view mode, all periods are superimposed on each other.

### 3.7.2. PRPD (HF Channel)

«PRPD» - Phase Resolved Partial Discharge. This distribution shows the relationship inception time of PD and phase of AC voltage. Vertical axis - the amplitude of the pulse, the horizontal axis – phase/degree. If several pulses falls into one point of the graph per second, this point becomes more intense color. The color scale is shown below the graph.



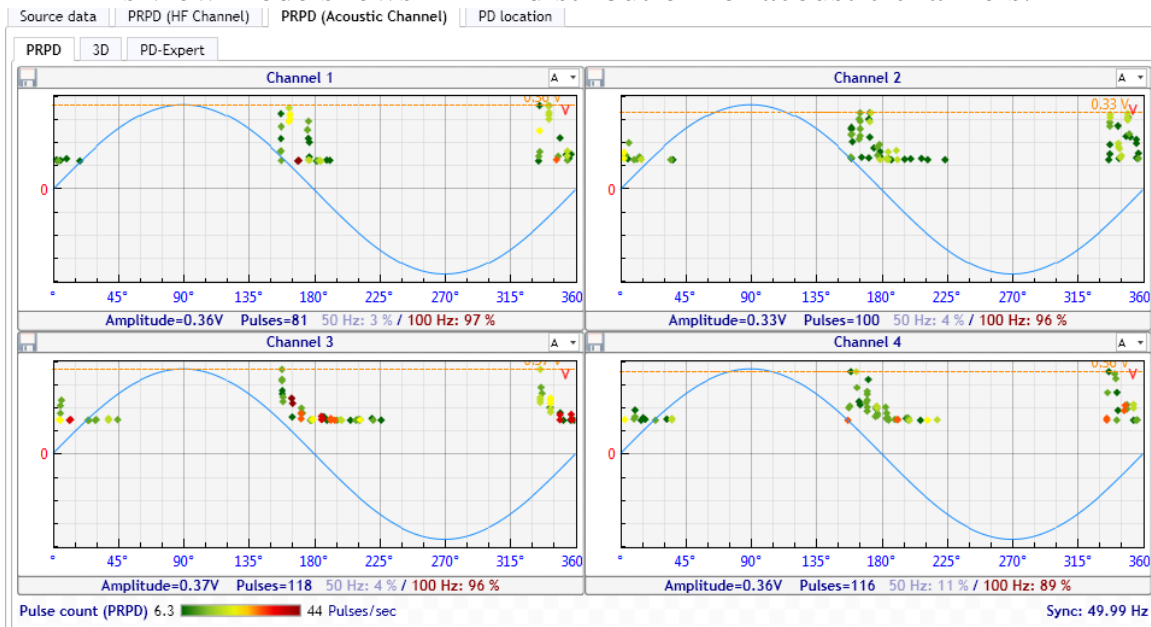
### The next viewing mode - "PD-Cloud":



Tab «PD-Cloud» is used to view the data in the TTI-distribution. The abscissa - phase/degree, the ordinate axis - the total pulse duration (T2), and the Z-axis - the duration of the first half-wave pulse (T1). To rotate a three-dimensional field, press the right mouse button in the graph area, and move it to make the rotation. To move a selected zone, press the left mouse button in the zone, and holding it, to move the mouse. Tab "PD-Expert" is an automatic diagnosis.

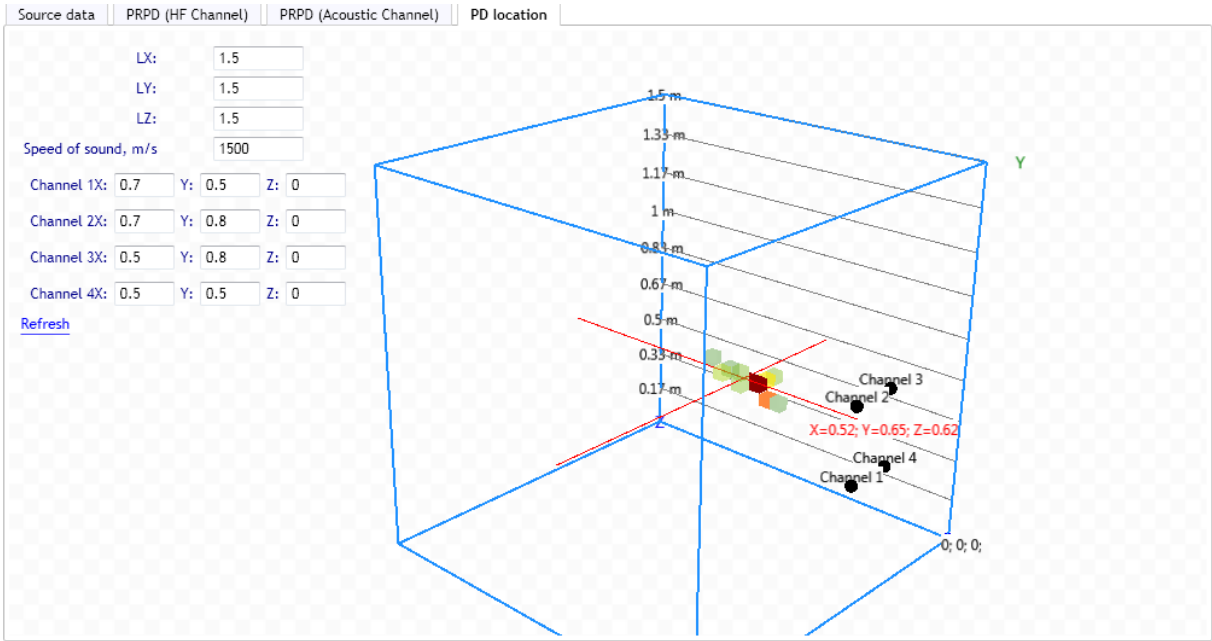
### 3.7.3. PRPD (Acoustic range)

This view mode shows PRPD distribution for acoustic channels.



### 3.7.4. PD Location

This mode is designed to automatically locate. For correct calculation requires measurement of containing the data from all four acoustic sensors. The coordinates of the sensors and the size of the search area can be edited in this window. To start the re-calculation is necessary to click on "Refresh".





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