DEL MAR PHOTONICS

Scanning Autocorrelator

Model: Reef-RTD

Instruction Manual

Rev 1.3

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Please take time to read and understand this Manual and familiarize yourself with the information that we have compiled for you before you use the product. This Manual should stay with the product to provide you and all future users and owners of the product with important operating, safety and other information.

GENERAL SAFETY INSTRUCTIONS

In order to ensure the safe operation and optimal performance of the product, please follow these warnings and cautions in addition to the other information contained elsewhere in this document.

WARNING: Make sure this instrument is properly grounded through the protective conductor of the AC power cable. Any interruption of the protective grounding conductor from the protective earth terminal can result in personal injury.

CAUTION: Before supplying the power to the instrument, make sure that the correct voltage of the AC power source is used. Failure to use the correct voltage could cause damage to the instrument.

WARNING: If this instrument is used in a manner not specified in this document, the protection provided by the instrument may be impaired. This product must be used only in normal condition.

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UNPACKING YOUR AUTOCORRELATOR

Your Reef-RTD autocorrelator was packed with great care and all containers were inspected prior to shipment left Del Mar Photonics in good condition. Upon receiving your autocorrelator, immediately inspect the outside of the shipping containers. If there is any major damage such as holes in box or cracked wooden frame members, insist that a representative of the carrier be present when you unpack the contents.

Carefully inspect your autocorrelator as you unpack it. If you notice any damage, such as dents, scratches or broken knobs immediately notify the carrier and your Del Mar Photonics Sales representative.

ACCESSORIES

Part	Quantity	Note
Optical unit	1	**Opto-mechanical assembly**
Control unit	1	**Electrical control unit**
External aperture	1	**Adjusting aperture**
Connection cable	1	**Cable for connecting the Optical Unit to the Control Unit**
USB cable	1	**USB cable, A to B**
AC adapter 12V with power cable	1	**AC adapter 12V** **Input voltage: 110..240 V AC** **Output voltage: 12 V DC**
Table clamp	3	**Clamps for securing the Optical Unit on optical table**
Manual	1	**This document**

INTRODUCTION

The autocorrelation technique is the most common method used to determine laser pulse width characteristics on a femtosecond time scale.

The basic optical configuration of the autocorrelator is similar to that of an interferometer (Fig.1). An incoming pulse train
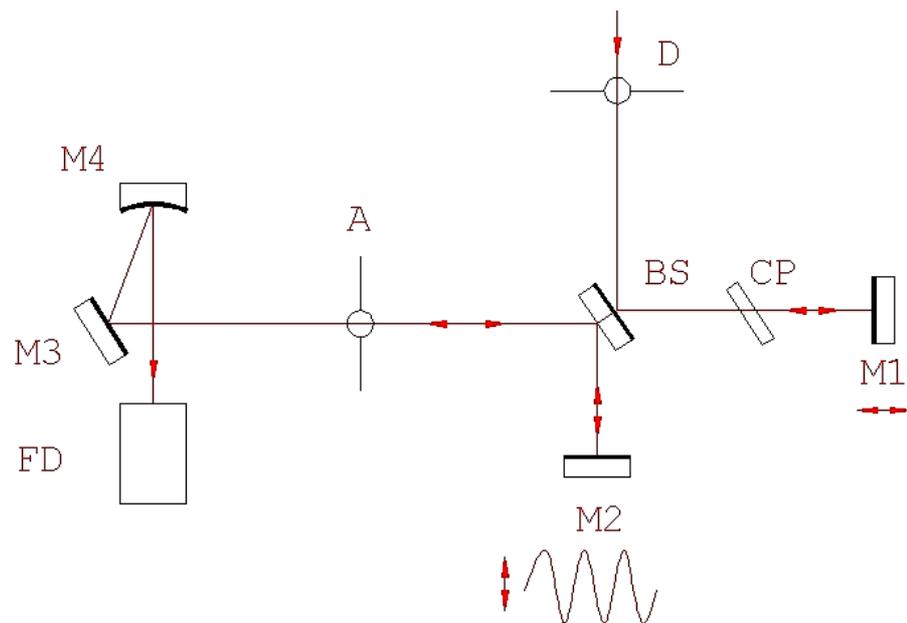
Fig.1

splits into two beams of equal intensity. An adjustable optical delay is placed to one of the arms and then two beams converge within a nonlinear material (semiconductor) for two photon absorption (TPA). The incident pulses directly generate a nonlinear TPA photocurrent in the semiconductor, and the detection of this photocurrent as a function of interferometer optical delay between the interacting pulses yields the pulse autocorrelation function. The TPA process is polarization-independent and non-phasematched, simplifying alignment.

The two beams propagate in a collinear fashion (interferometric configuration). This configuration results in an autocorrelation signal that is on top of a constant background. This

background is produced by TPA photocurrent resulting from the portions of the scan during which the pulses are not overlapped.

The Reef-RTD autocorrelator has been specifically designed to measure the width of pulses from femtosecond lasers. Any PC-compatible computer with Windows OS and USB port will be enough to operate the device. If necessary, an oscilloscope can also be used for conducting stand-alone measurements without a computer.

KEY COMPONENTS

The Reef-RTD autocorrelator consists of an opto-mechanical assembly and electronics:

- Beam Splitter
- Scanning block with measuring converter
- Variable Delay line
- Focusing mirror
- TPA-detector with amplifier
- Delay Sensor
- Control Unit

SPECIFICATIONS

Pulse width	- 10fs to 6ps
Input pulse repetition rate	- 10kHz to CW mode-locked
Scan nonlinearity	- <1%
Sensitivity ($P_{av}P_{peak}$)	- <100 mW^2
Input polarization linear	- horizontal (optional: vertical)
Wavelength range:	- 450 - 700nm,
(depends on the ordered PDs)	- 700 - 1300nm,
	- 1300 - 2000 nm
Scan rate, variable	- 0,1 - 20Hz
Only interferometric autocorrelation	
Detection	- diode with TPA
Electrical power choices	- 110-220 V AC, 50/60 Hz ± 10%
Dimension:	
- optical unit	– 132mmx123mmx118mm
- control unit	– 225mmx190mmx45mm

OUTLINE DRAWING
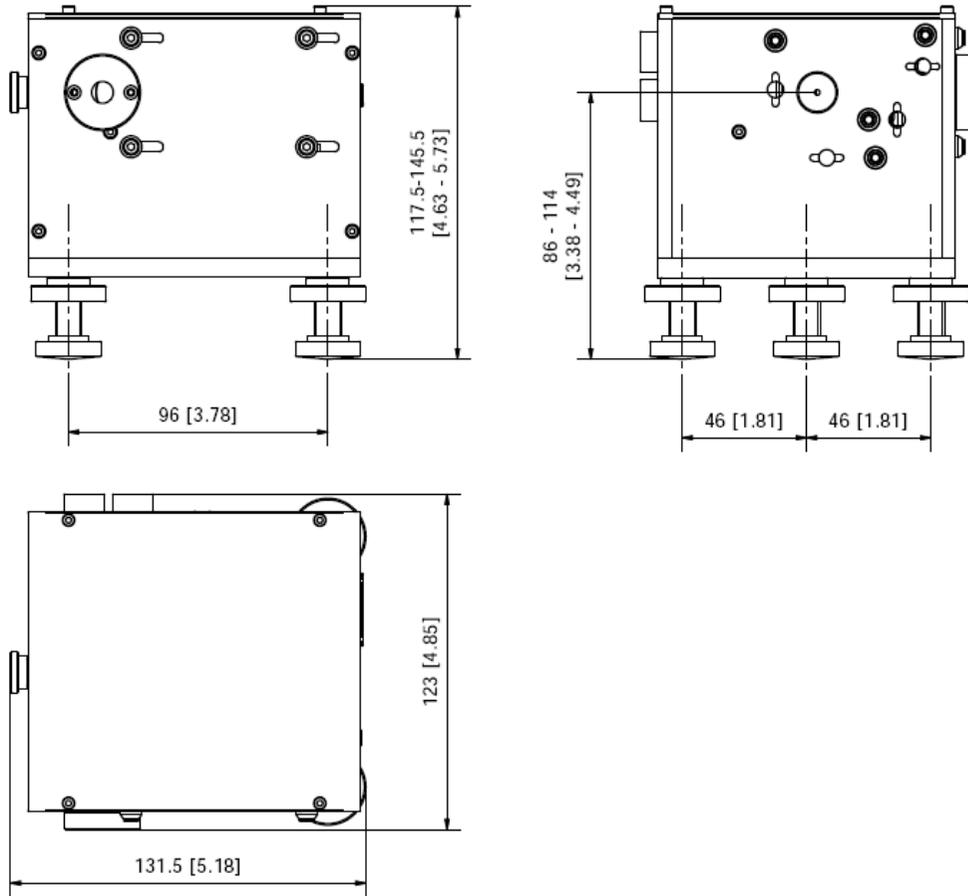
OPTICAL HEAD

Dimensions in millimeters [inches]

CONTROL UNIT

225 [8.86]

SCAN   POSITION   SIGNAL

POWER   CPU-BUS

AA - 10DD

46 [1.81]

189 [7.44]
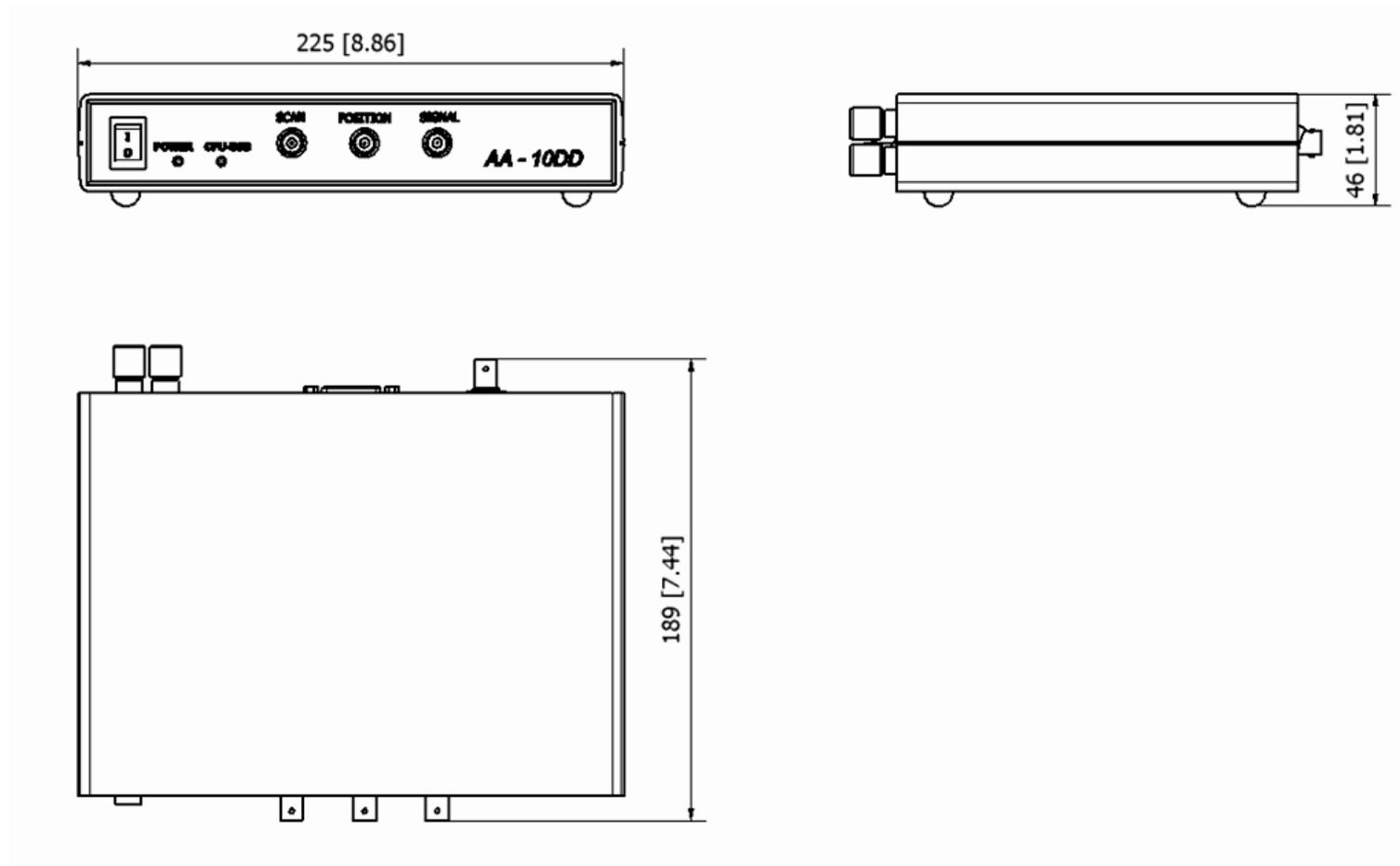
Dimensions in millimeters [inches]

WARNING! LASER SAFETY

For your safety, please read this section of the manual carefully before installing or operation your laser accessory.

The protective housing of this product should always in place during normal operation. Removal of the protective housing may expose the user to unnecessary radiation, and should be done only.

In accordance with specific instructions given in this manual. Be very careful executing any step of alignment. Avoid any exposure to the directed and reflected laser beams. Direct and reflected laser radiation can cause serious eye damage. Remember, that IR radiation is invisible or looks like as red radiation of small intensity. However, it is dangerous even at lowest intensity. Even diffuse reflections are hazardous. Check all reflections and provide enclosures for beam paths whenever possible.

Wear protective goggles whenever possible.

Please use safety instructions of your laser and use their recommendations in your work.

Keep all beams below eye level always. Never look in the plane of propagation of the beams.

When possible, maintain a high ambient light level in the laser operation area.

Provide enclosures for beam paths whenever possible.

CONNECTORS, CONTROL, AND INDICATORS.

OPTICAL UNIT.
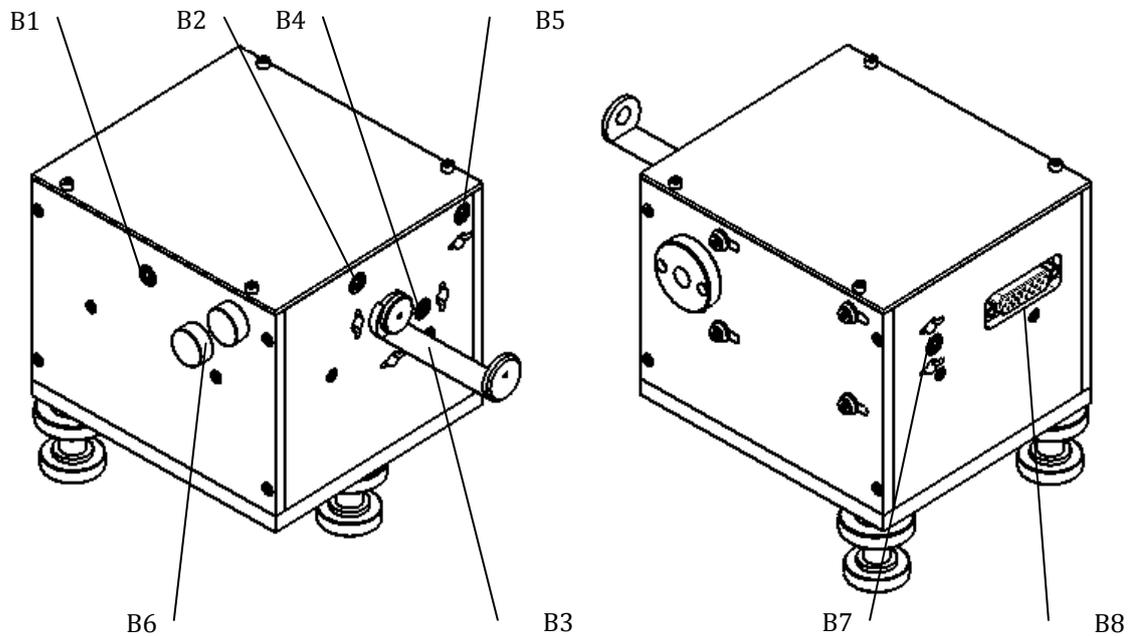
Fig. 2

B1.   Adjustment screw for tuning of interferometer arms (ST).
B2.   Beam-splitter Y-axis adjustment screw.
B3.   Beam-splitter X-axis adjustment screw.
B4.   Focusing mirror X-axis adjustment screw.
B5.   Focusing mirror Y-axis adjustment screw.
B6.   M1 mirror adjustment screw caps.
B7.   Focal strength adjustment screw (SF).
B8.   Control unit connector.
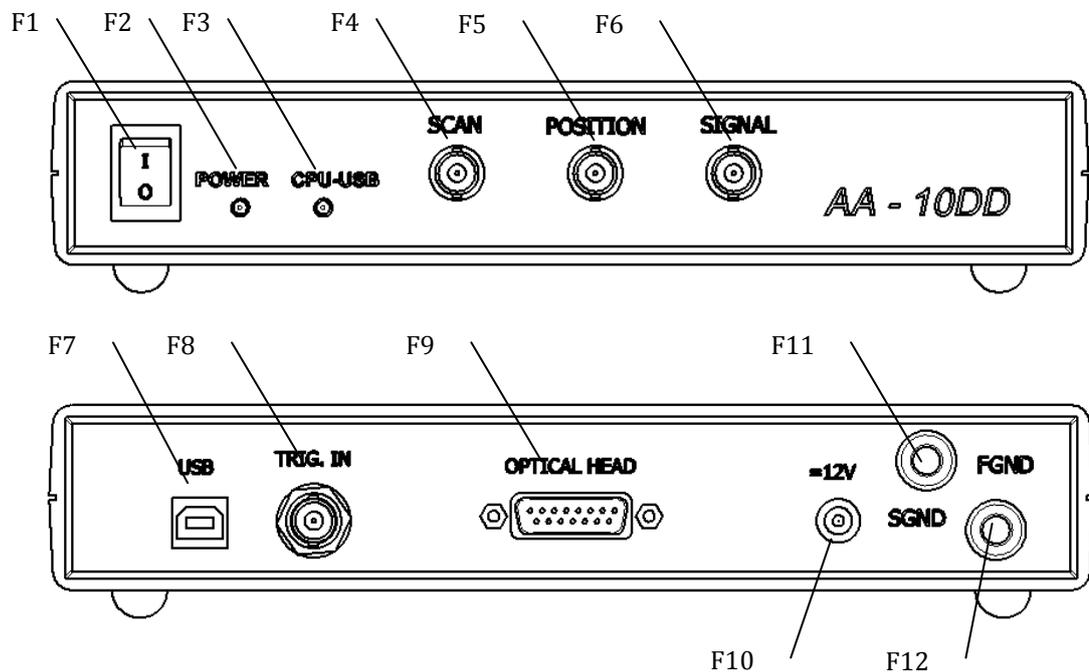
Fig. 3

CONTROL UNIT.

F1. **Power Switch** – Turns the unit On and Off.

F2. **Power On Indicator** – When this LED is lit, power is applied to the unit.

F3. **CPU-USB Indicator** – USB activity indication.

F4. **SCAN BNC Connector** – is used for connecting an oscilloscope to obtain sinusoidal signal that moves the delay line.

F5. **Position BNC Connector** - is used for connecting an oscilloscope to obtain signal that is proportional to delay line mirror position.

F6. **Signal BNC Connector** - is used for connecting an oscilloscope to obtain signal from the photodetector unit.

F7. **USB "A" type Connector** – Use this connector for connecting to a PC via USB.

F8. **TRIG. IN BNC Connector** – Is not used. Reserved for upgrade.

F9. **Optical Head DB15 Connector** – Is used for connecting the optical unit of the autocorrelator.

F10.12V – power connector. Please use the power supply that was shipped together with the device.

F11.SGND - Banana jack, 4mm for chassis grounding. Additional grounding via this jack is required when operating at maximum sensitivity.

F12.FGND - Banana jack, 4mm for chassis grounding. Grounding through this jack is strongly required if the socket lacks the grounding.

INSTALLATION AND ALIGNMENT

For aligning the autocorrelator you will need:

- A PC with USB 2.0 port

- Two mirrors for the wavelength you are working with …

1. Reaching good alignment is easy if you use two external mirrors to direct the laser beam into the autocorrelator.

   Input power should be <20mW!

2. Install optical unit of the autocorrelator on the optical table horizontally at appropriate level. Use bottom screws to adjust level.
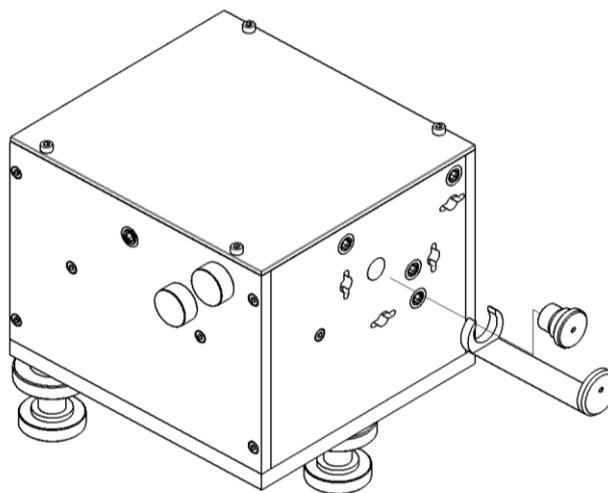
Fig.4

Attach the unit to the table using clamps.
3. The height of the autocorrelator can be changed relative to the optical table.
4. The polarization of the laser input to the autocorrelator must be horizontal. (Vertical –optional).
5. Install the external aperture as depicted Fig.4
6. Pass laser beam through the apertures A1 and A2 (Fig.5).

For visible beams, this alignment can be done visually; for infrared beams, a IR viewer should be used.

7. Move the correlator to direct reflected beam (from M2) nearly back to the center of the aperture A1. (The beam reflected exactly back troubles laser operation.)

Autocorrelator have been aligned at factory. Under careful transportation conditions you can try to continue alignment from instruction step 16.
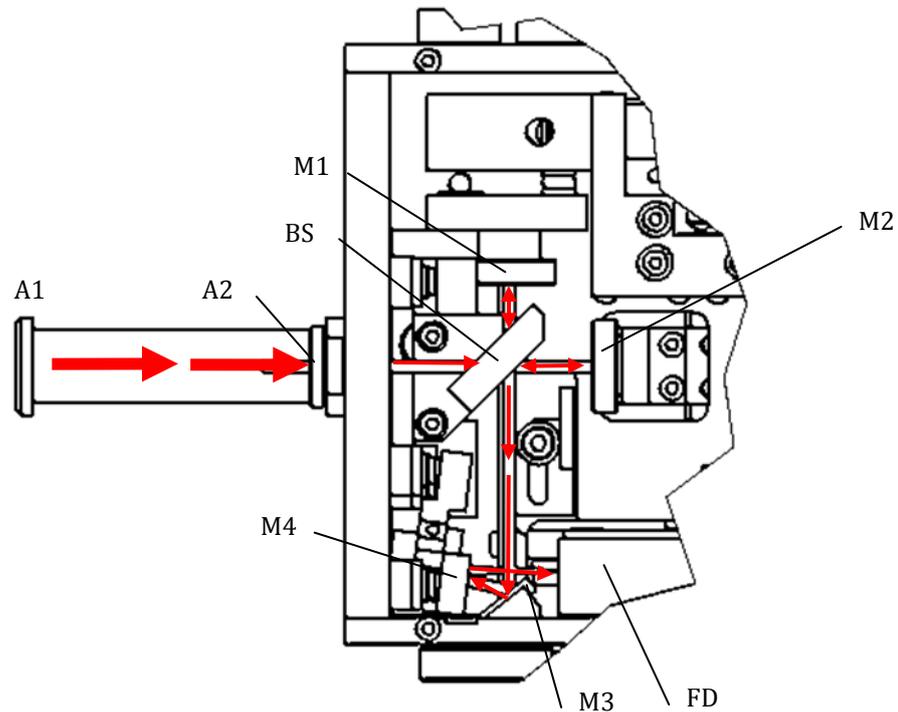
Fig.5

8. *Adjust the beam splitter (BS) to direct beam (reflected from M2 and BS) to the mirror M3 so that the beam is 2-3 mm from the edge of the mirror (see Fig.)*
9. *Direct beam reflected from M1 to the mirror M3 the same way as in the above paragraph.*
10. *Remove M3 with holder.*
11. *Place white screen at 30 - 50 cm distance from the autocorrelator and watch spots of light reflected from M1 and M2.*
12. *Adjust BS and M1 to reach coincidence of spots from two beams on the screen.*

13. *Watch spot moving mirror M1 by smooth step with the micrometric screw. (One step <= 1/16 turn). It is better to use continuous wave radiation to observe fringes.*

14. *Interferometric fringes will appear when arms of the autocorrelator become equal.*
   The picture should have good contrast and no more than one interferometric maximum should be watched.

15. *Place M3 mount into the autocorrelator.*

16. *Adjust M3 to direct beam onto the sensitive area of photodiode (PD).*

17. Connect optical unit to terminal "OPTICAL HEAD" at rear panel of control unit.

18. Connect the PC to the control unit via a USB cable, A to B.

19. Install the driver and software onto your PC, please refer to «Software installation/Driver installation» subsections.

   We strongly recommend reading the whole section «Software» of the current manual at this step.

20. In the menu «Presets» select item «Overview», this will allow you to see several scan periods of the delay line on the screen. Disable «Normalization» and "Y(x) display" in the software.

21. By periodically blocking and unblocking the beam that goes into the device observe the signal level change (axis Y) on the screen. If the level does not change, check if the beam is steered onto the photodetector unit, the power getting to the device is enough, your source is in pulsed mode etc. If the level change is too small then try to increase it by moving the photodetector unit along the focus axis by rotating screw SF.

22. By rotating the screw ST, even out the interferometer arms and obtain results like in the .

23. In the menu «Presets» select item «100 fs» or «1 ps», this will reduce the scanning range of the delay line to the value that corresponds to the chosen pulse duration. It may happen that you will cease to see any autocorrelation trace at this moment. By changing the "Trigger delay" value, place the trace in the middle of the screen.
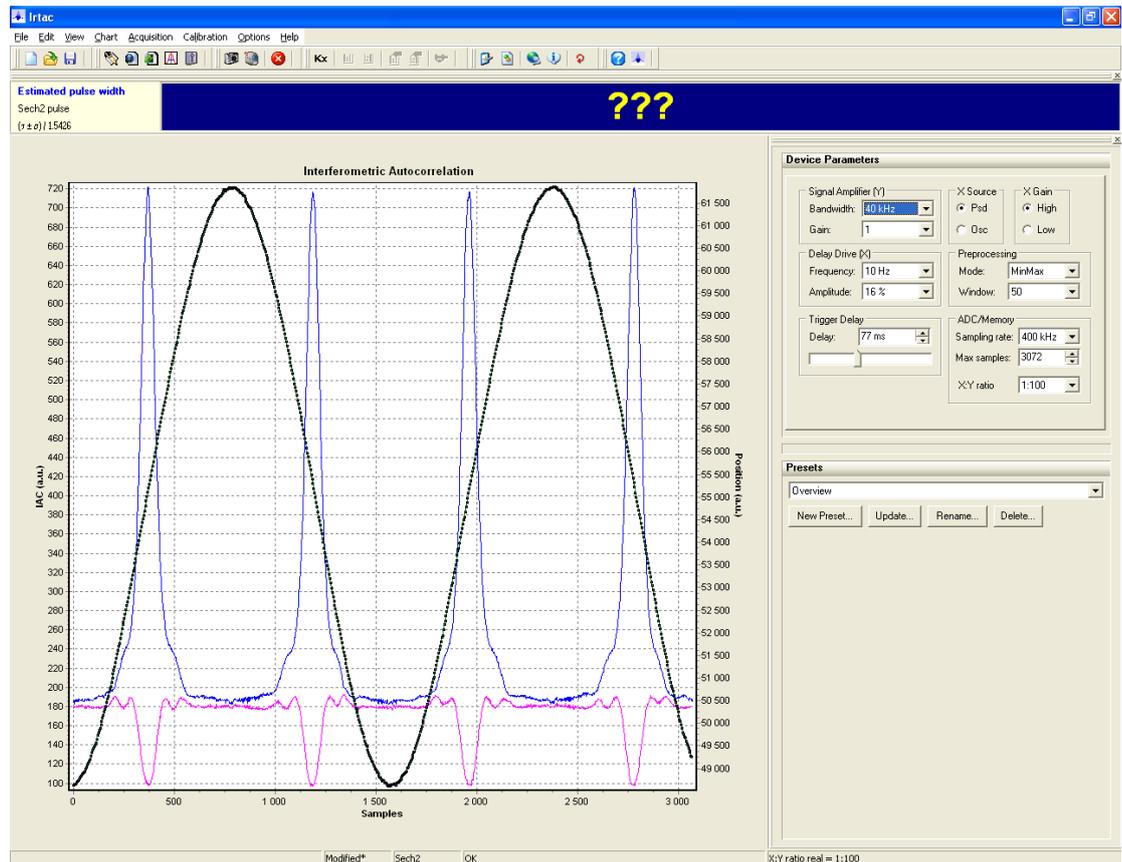
Fig. 6

24. Align the mirror M1 to maximum interferometer contrast.

Device Calibration

The device is shipped to the customer being calibrated at the factory. The calibration coefficients are located on the CD that is supplied with the device in the file *Irtac.ini*. It is copied to the PC during installation process. If the software is re-installed later then calibration setup is set to factory values.

If you require to calibrate the unit then please follow the steps
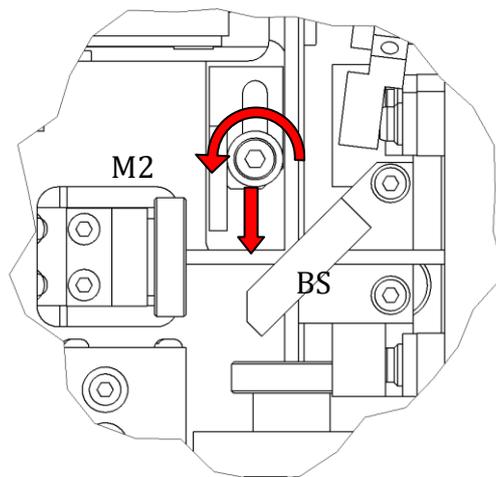
Fig. 7

below.

The calibration procedure should be carried out on the aligned device. Interferometer arms should be even (see manual section "Installation and alignment").

1.   Open the upper cover of the optical unit by removing the four screws.
2.   By using the calibration panel in the software, please set marker #1. Input 0μm.
3.   Loosen the screw that fixes the calibration plate and insert it in the beam between the BS and M2 (see Fig. 7)
4.   By using the calibration panel in the software, set marker #2. Input *47* um.
5.   Choose **Calibration|Calibrate by markers...** menu command. The program automatically calculates the value of Kx for current X channel gain.

6. Remove the calibration plate out of the beam and fix it in the initial position by the screw.

The software has two calibration coefficients, for X Gain High and X Gain Low, for operation with low and high scan amplitude of the delay line respectively. To carry out full calibration repeat the above sequence for the second coefficient, but select the corresponding Gain coefficient in the software (see «Software description»/«Control panel»).

SOFTWARE

SYSTEM REQUIREMENTS

- USB 2.0 port
- CDROM Drive
- CPU: Intel Pentium 800 MHz or above
- Memory: 32MB RAM or above
- Windows XP/2000/ME/98SE

SOFTWARE INSTALLATION

1. Insert the **Driver & Software CD-ROM** into your computer's CD-ROM Drive and click **Yes.**

2. Click **Next**.

3. The InstallShield will install in the following folder. Click **Next**.
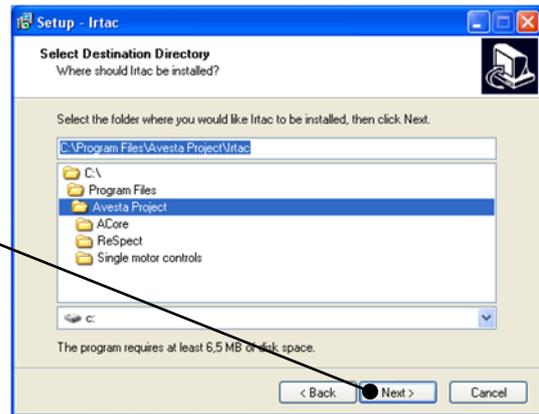
4. Select the Program folder that Setup will add program icons to. You may type a new folder name, or select one from the existing folders list. Click **Next**.
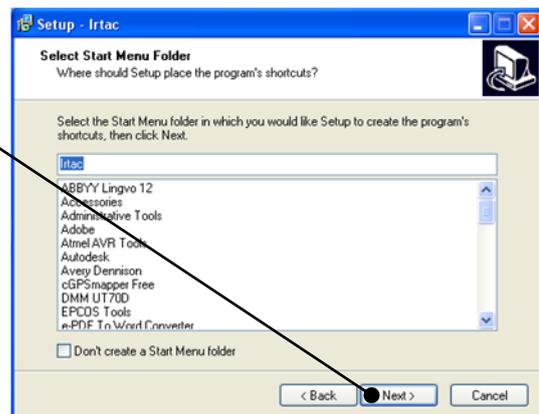
5. Click Install.
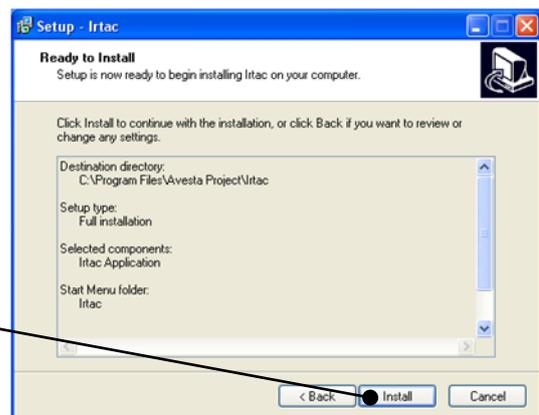
6. Installation is now complete. Click **Finish**.

DRIVER INSTALLATION

Connect the control unit to the PC via USB cable.

1. The **Found New Hardware Wizard** appears. Select **No, not this time** and then click **Next**.

2. Click **Install the software automatically** and then click **Next**.
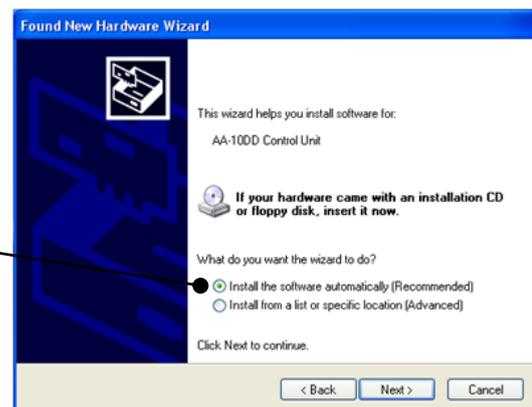
3. Click **Finish**.

4. The **Found New Hardware Wizard** appears. Select **No, not this time** and then click

5. Click **Install the software automatically** and then click **Next**.

6. Click **Finish**.

Your installation is now complete.

SOFTWARE GENERAL DESCRIPTION

MAIN WINDOW

The program's main window is shown in the figure below. The window consists of the main menu, status bar, autocorrelation chart, and a set of toolbar and tool window docks.
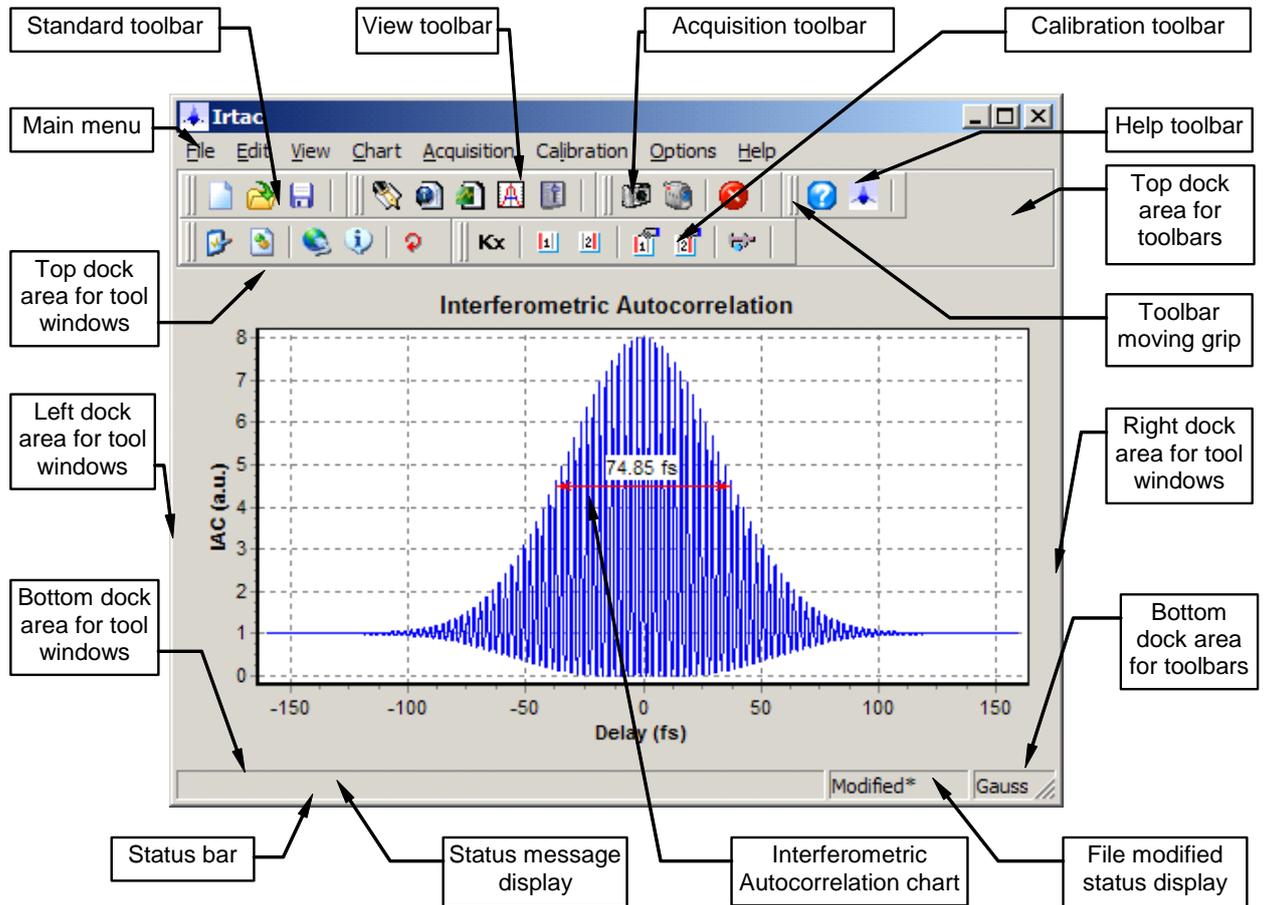
Fig. 8

Interferometric Autocorrelation chart

The chart in the central area of a main window presents the results of IAC data acquisition and processing.

Using chart pop-up menu

Right click in the chart area to open pop-up menu with commands for the chart manipulations.
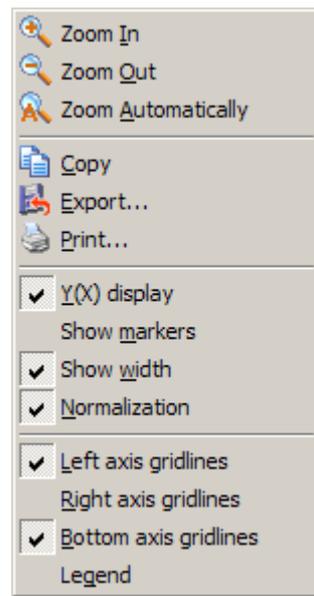
You use Zoom In and Zoom Out menu commands to change the chart display magnification. The command Zoom Automatically restores the chart display magnification to cover the entire data range.

You use Copy menu command in the popup menu (or Edit|Copy command in the main menu) to copy the chart into Windows clipboard. After you've copied the chart to clipboard you may paste it into a document opened in some other application (Microsoft Word for example).

You use Y(X) display option to select the mode of data display. If this option is selected the amplitude of the signal (Y) is drawn versus position (X). If Y(X) display option deselected the Y and X both drawn versus the sample number.

The other options presented here let you customize the chart by displaying or hiding some optional elements.

You can choose to show (or not to show) the Left axis gridlines and Right axis gridlines, the autocorrelation width, and chart Legend. You also may instruct the program to perform Normalization of the autocorrelation curve.

Tips:
1. You may scroll the chart contents by pressing and holding down the SHIFT key then dragging the chart interior with the left mouse button.

2. You may zoom some region in the chart by pressing and holding down the CTRL key then dragging with the left mouse button from top-left to bottom-right to select rectangular area to be zoomed in.

3.You may undo all zooms and scrolls by pressing and holding down the CTRL key then dragging with the left mouse button from bottom-right to top-left (i.e. in the opposite to the previous direction).

4. You may use File|Export... main menu command to save the data drawn in the chart to ASCII file on a disk. The data are saved in two-column tab delimited format with headings specifying the source file name, the chart name (title), the series names and column titles.

5. You may use File|Print main menu command to print the chart to the default printer.

Toolbars

The toolbars in the program provide shortcuts for menu commands. Commands are organized into several toolbars, which can be independently repositioned, or pulled into floating tool windows, or re-docked to alternative docking area by dragging its moving grip with the mouse.

You can display or remove toolbars from the display using View menu.

The toolbars that can appear in the program are

Standard toolbar

The Standard toolbar contains the following buttons: New, Open, and Save.

View toolbar

The View toolbar contains buttons to show or hide the program toolbars and tool windows.

Acquisition toolbar

The Acquisition toolbar contains the following buttons: Run single, Run endless, and Stop.

Calibration toolbar

The Calibration toolbar contains the following buttons: Custom coefficient, Set marker1, Set marker2, Change marker1, Change marker2, and Calibrate by markers.

Options toolbar

The Options toolbar contains buttons for setting the Environment options, Processing options, and data acquisition driver parameters.

Help toolbar

The Help toolbar contains the Help contents button and About button.

Status Bar

The status bar displays information about the application status.

When you browse menu items or move the mouse pointer over toolbar buttons additional information about operations performed by these control elements (a hint) will be displayed in the status message display. When loading or saving files the status message display reflects performing operation.

The status bar displays the state of data acquisition process by showing OK, Running, and Error messages.

When you've modified the file the file modified display will show this fact by displaying text 'Modified' or 'Modified*'. An asterisk means that the autocorrelation data has been changed. The program takes special care for the latter case by querying user to rename the file before saving it. You may disable this feature using the Environment Options dialog box.

Using tool window docks

Docking allows you to make full and efficient use of your screen space as you work on your project. From the View menu, you can bring up any tool window and then dock it directly onto the main window for use while working with program.

There are four docking sites along top, bottom, left, and right sides of the autocorrelation chart. If you want to dock one or more tool windows onto the main window:

1. You choose the View menu and the name of the tool window you want to dock.

2. When the tool window appears on the screen, drag it by clicking on the title bar. When the tool window is over a docking site, its drag outline narrows and changes shape to show how the window would dock.

3. Release the mouse button to dock the window.

To undock a tool window from the main window:

1. Drag the tool window away from the main window by clicking on the title bar. When the window is no longer over a docking site, its drag outline widens.

2. Release the mouse button. The tool window becomes a floating window.

STATISTICS VIEWER

The Statistics Viewer tool window accumulates and displays statistical information about autocorrelation curve width (FWHM) and amplitude. You use the Statistics Viewer tool window in conjunction with *Run endless* command to characterize laser pulse stability. The size of the statistics-accumulating buffer is 100 samples. The Statistics Viewer tool window is shown in the figure below.
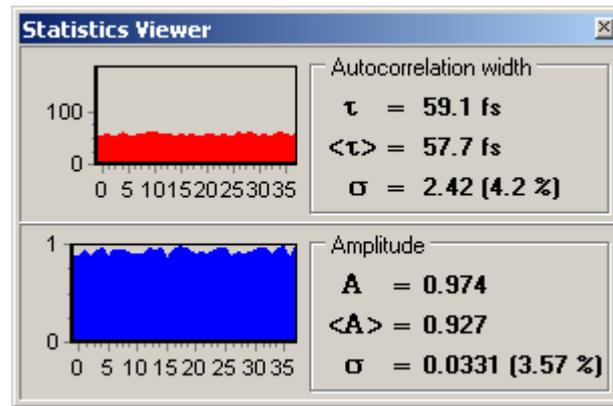
The top pane of the window displays autocorrelation width statistics information. The bottom pane displays amplitude statistics information.

On the left of each pane there is a *history chart* that graphically displays values stored in statistics buffer. The last value, mean value, and standard deviation are shown in the right area.

RESULT VIEWER

The Result Viewer tool window displays the estimated pulse width using current pulse shape assumption and current autocorrelation curve width. Also standard deviation of the optical pulse width computed from statistics information can be displayed. The Result Viewer tool window is shown in the figure below.

Changing the height of Result Viewer window will change the size of font used to display the value of pulse width. So you can adjust it for optimal viewing.

INTENSITY AUTOCORRELATION WINDOW

As it is described in help topic on interferometric autocorrelation to estimate the pulse width one needs to filter out the fringes from input data and obtain intensity autocorrelation. The resulting intensity autocorrelation is displayed in the Intensity Autocorrelation window shown below.
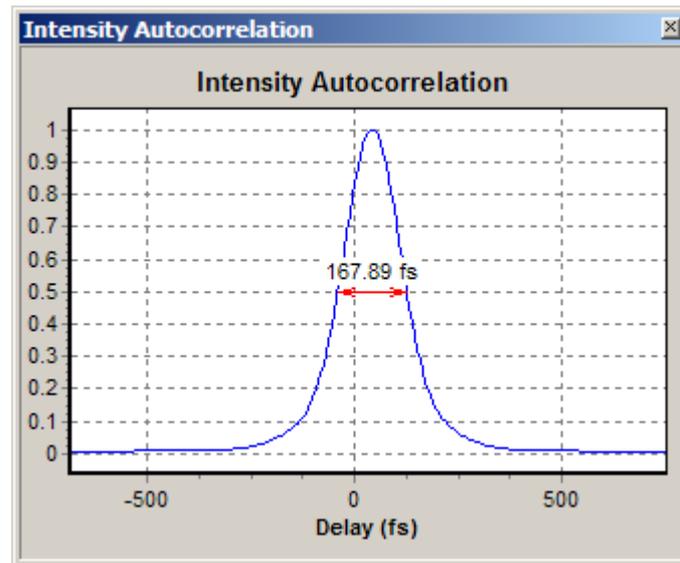
CONTROL PANEL WINDOW

To open the device Control Panel window use *View/Control panel* command from the main menu. You use the Control Panel window to set various parameters of the device operation. The Control Panel window is shown in the figure below.
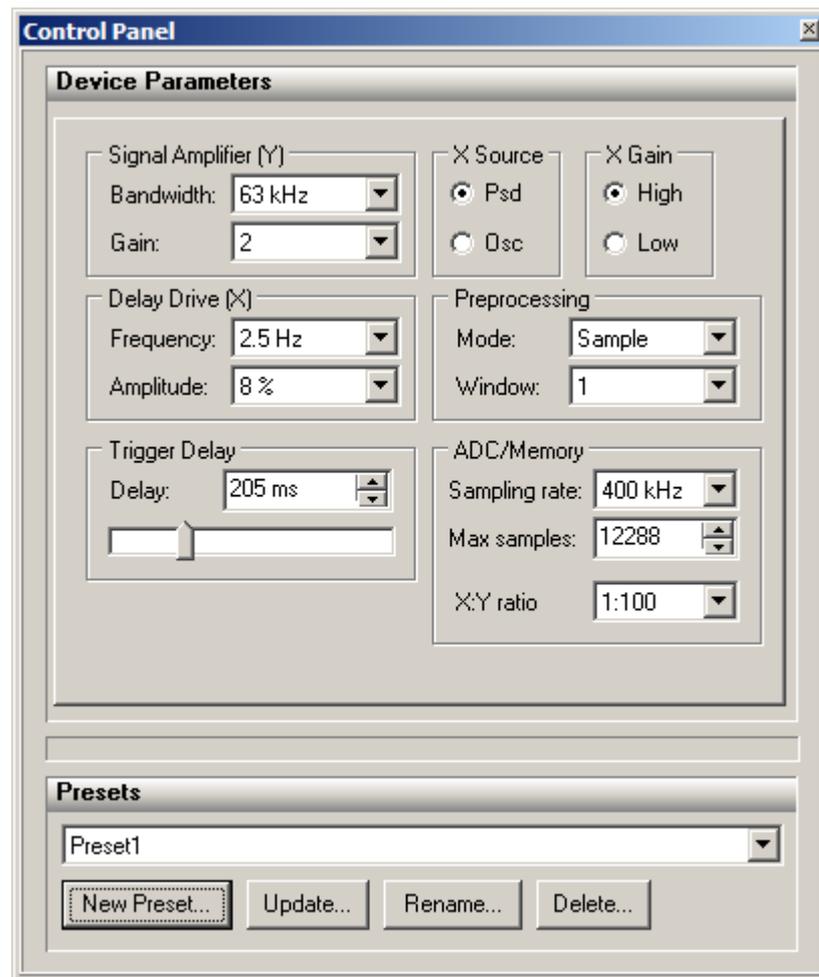
Device Parameters Panel

You use *Signal Amplifier (Y)* group of controls to set the *Bandwidth* and *Gain* of an input amplifier.

You use *Delay Drive(X)* group of controls to set the *Frequency* and *Amplitude* of a delay driver output.

You use *Trigger Delay* group of controls to specify the delay time between the external synchronization pulse and the start of a data acquisition process.

You use *X Source* group of controls to specify from where to take signal for X channel (delay). You have two options: *Psd* (position sensitive diode) located in the optical delay stage, and *Osc* (oscillator) located in the control unit. The former is better for practical operation, and the latter is primarily for the test purposes.

You use *X Gain* to select *Hi* (high) or *Lo* (low) gain of the X channel input amplifier. Selecting *Hi* will increase the gain four times

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with respect to *Lo* setting. Note: you have to make the delay calibration for both of these settings, as the calibration coefficients are different.

You use *Preprocessing* group of controls to specify the data preprocessing performed by the control unit before sending the data to the computer. In *Sample* mode no preprocessing is performed, and the data sent to the computer 'as is'. In *MinMax* mode the control unit will pick up the maximum and minimum values within the specified *Window*, and will send only these two values to the computer. This mode may be convenient for adjustment purposes.

The data digitization parameters are specified by the *ADC/Memory* group of controls. You use *Sampling rate* control to set the Y channel ADC sampling rate. You use *Max samples* control to specify the number of samples (in Y channel) per data acquisition cycle. The X channel ADC runs at reduced rate with respect to the Y channel ADC. You use *X:Y Ratio* control to specify this reduction factor.

Presets Panel

To simplify switching between different operations modes the *preset* concept has been introduced. The preset is a named collection of all of the Control Panel settings. All settings associated with a given preset can be restored by selecting the preset name in the drop down list of available presets. There may be some vendor supplied presets. And you can store your custom setting in the list of presets.

You use *New preset...* button to add current set of parameters to the list of presets.

You use *Update...* button to update parameters in the current preset with the values from the Control Panel controls.

You use *Rename...* button to change the current preset name.

You use *Delete...* button to delete the current preset from the list.

PROCESSING OPTIONS DIALOG BOX

You use the Processing Options dialog box to define how the data is processed by the program.
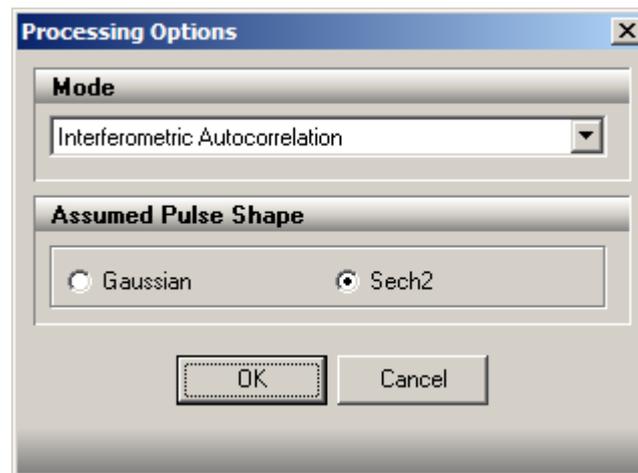
Mode

None – no data processing occurred. This mode could be useful for optical setup adjustment.

Interferometric Autocorrelation – is the main mode. In this mode the intensity autocorrelation is extracted by filtering the interference fringes, and the pulse width is estimated and displayed in the Result Viewer window. Also, the autocorrelation width and amplitude information are accumulated in the Statistics Viewer.

Intensity Autocorrelation – this mode is designated to process fringeless data from non collinear optical setup representing intensity autocorrelation. (*Note: this mode is under development and not fully featured and tested.*)

Assumed Pulse Shape

With this radio buttons you choose assumed pulse shape used in calculation of the estimated pulse width based on autocorrelation function width.

SELECT CONNECTION DIALOG BOX

You use Select Connection dialog box to establish connection with the data acquisition device. The device is connected to PC by means of USB cable. When you open Select Connection dialog box the program scans the attached USB devices to find compatible by description. Then the program displays the serial numbers of the compatible devices in the Select Connection dialog box as it is shown in the figure below.
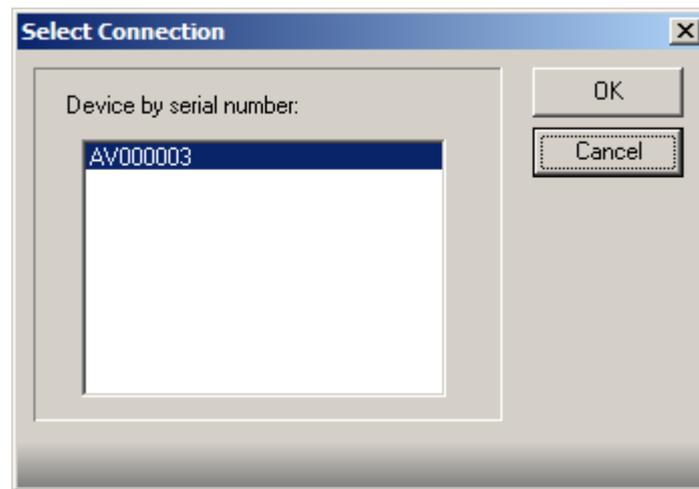
Typically, there is only one autocorrelator device in the system. But if there are more than one, you have to select the device you want to use by its serial number.

APPENDIX A.

WHAT IS THE INTERFEROMETRIC AUTOCORRELATION?

Interferometric autocorrelation measurement is a technique widely used for characterization of the ultrashort optical pulses generated by modern mode-locked lasers. The pulse durations ranges from several femtoseconds to a few picoseconds. The pulses may have phase modulation and thus may be not bandwidth limited. In contrast to *intensity autocorrelation* (also widely used for characterization of the ultrashort optical pulses) the interferometric autocorrelation provides some additional information about this phase modulation. Although this information can not be processed to the full time domain phase dependence it provides a significant advice to experimenter who develops and uses the laser systems.

Typically, interferometric autocorrelation is achieved by splitting the optical pulse in two replicas. Each replica propagates in different optical path, and the paths difference is controlled by a special translation unit with the generator and the position measurement system (the scanning unit). Finally, two replicas of the source pulse with the relative delay varying in the time are combined in the single collinear beam and passed to nonlinear converter. This could be SHG, or two-photon absorption measurement, or something else depending on particular device construction. Thus the signal from photodetector is proportional to the square of the sum of replicas intensities. Combining the signals from scanning unit as time delay (or as X-coordinate), and from photodetector as amplitude (or as Y-coordinate) one obtains the interferometric autocorrelation of an investigated laser pulses.

For a simple Gaussian shaped bandwidth limited pulses the interferometric autocorrelation can be analytically expressed as:

$$IAC(\tau) = 1 + e^{-2\ln 2(\frac{\tau}{w})^2} + 4e^{-\frac{3}{2}\ln 2(\frac{\tau}{w})^2}\cos\omega\tau + 2e^{-2\ln 2(\frac{\tau}{w})^2}\cos^2\omega\tau \quad (1)$$

Where τ is the time delay between the two replicas, w is the width of the underlying pulse (intensity FWHM), and ω is the optical carrier frequency.

PROPERTIES OF THE INTERFEROMETRIC AUTOCORRELATION

The terms in equation (1) have the following meanings. The first one is a constant shift (or bias). The second term is an intensity

autocorrelation. The third and fourth terms are representing the interference beatings which are also have the intensity autocorrelation envelop.

The maximum amplitude of IAC is 8 while the minimum value is near the zero. Outside the range of time delays where the pulses are overlap the IAC has constant the value of 1.

INTERFEROMETRIC AUTOCORRELATION OF THE BANDWIDTH LIMITED OPTICAL PULSES

In the chart below we represent the IAC for the 50 fs Gaussian pulse with no phase modulation at the wavelength of 800 nm. And in the following picture the corresponding intensity autocorrelation chart is displayed.
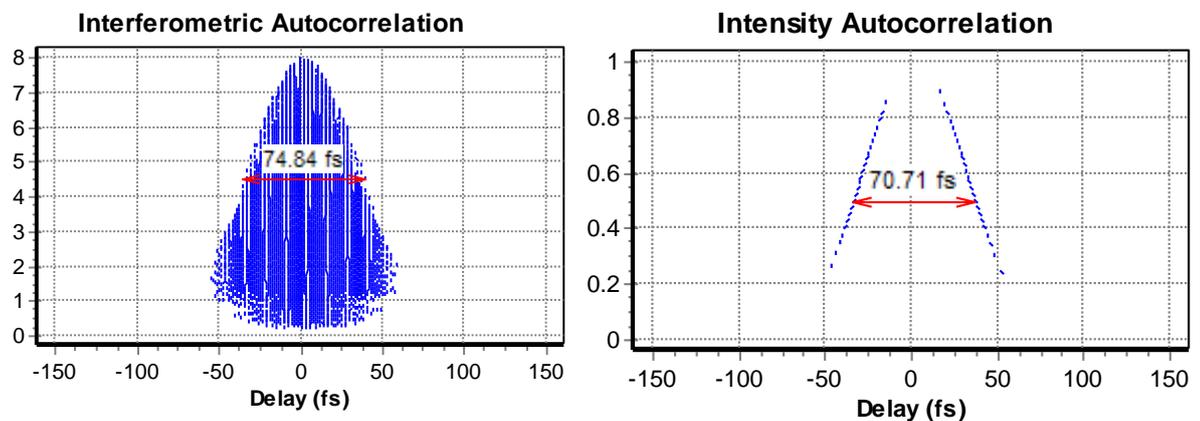
Notice the difference between FWHM of the top envelop of the IAC and FWHM of the intensity autocorrelation curve. If we want to estimate the underlying pulse width from the intensity autocorrelation curve, we will divide its FWHM by 1.4142 and obtain the value of 50.01 fs which is perfectly close to the source pulse width. This is not the case with the interferometric autocorrelation. In this case we need to use the divisor of 1.5331 to obtain estimated pulse width of 48.82 fs (note that the width of IAC in this case is underestimated because one need to calculate envelop of IAC while in the example above the width was measured using IAC fringes).

INTERFEROMETRIC AUTOCORRELATION OF THE PHASE MODULATED OPTICAL PULSES

Now we need to discuss the case of the phase modulated pulses. As noted above IAC is sensitive to phase modulation. Its form changes with the amount and type of the modulation. One may see these changes in the figures below for the pulse with the same width of 50 fs and carrier of 800 nm.
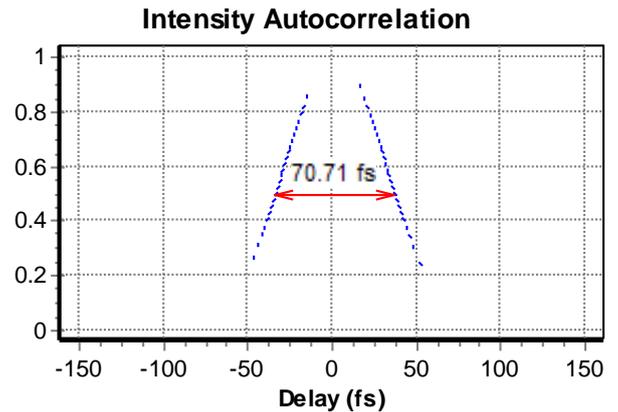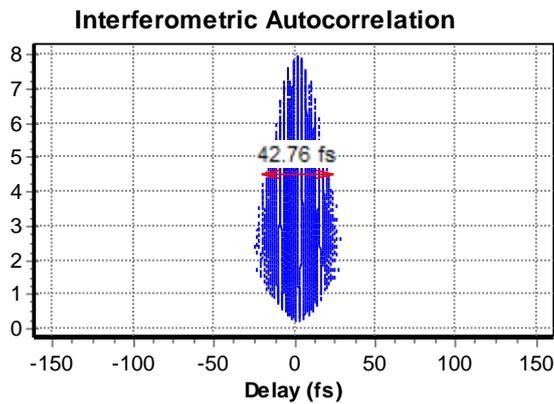
Linear chirp.
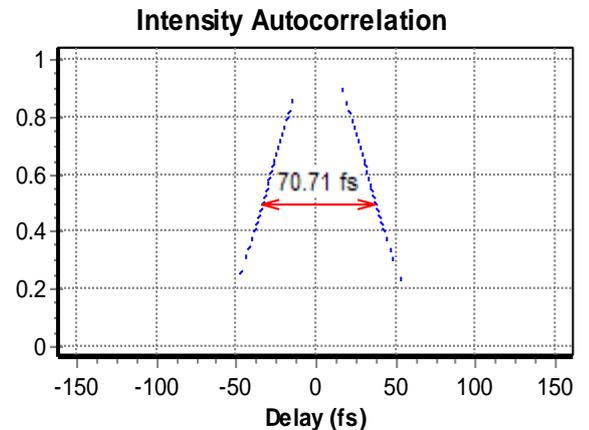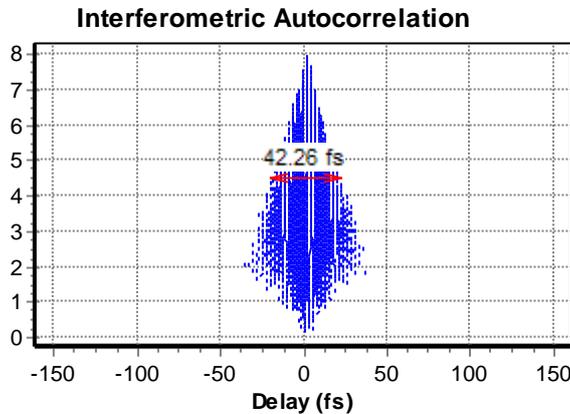
Second order chirp.

Note that intensity autocorrelation width is independent of phase modulation type and amount while width of the top envelop of IAC varying significantly.

CONCLUSION

From these examples it is obvious that the width of the top envelope of IAC cannot be used as a source for the underlying pulse width calculations.

To estimate the pulse width from the interferometric autocorrelation one need to remove terms 1, 3, and 4 from the acquired data to obtain the underlying intensity autocorrelation.

This can be done by some averaging of the IAC data. **Irtac** uses Fourier filtering algorithm to attain this goal. With intensity autocorrelation extracted from IAC data Irtac is able to provide you a valid estimation of the pulse width with any kind of the phase modulations.