

# ***FireWire BeamPro***

## ***Laser Beam Profiler***



## Installation and Operation Manual

Model # \_\_\_\_\_

Serial # \_\_\_\_\_

Date \_\_\_\_\_

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## Appendix

# **1.** *INTRODUCTION*

## **1.1. System Overview**

### **1.1.1. FireWire BeamPro Models 2512, 2518 and 2523**

The FireWire BeamPro Models 2512, 2518 and 2523 are PC based optical beam profiling systems offering a unique combination of performance and ease of use. Highly accurate NIST traceable measurements can be made on both pulsed and CW lasers, over a wide range of wavelengths, beam diameters, and power/energy levels. Sophisticated, yet simple, Microsoft Windows-based software allows these results to be displayed, analyzed and/or archived in real time at video rates.

The FireWire BeamPro Model 2512 includes a ½" format CCD camera with 8.3µm pixels, the Model 2518 includes a ⅓" format CCD camera with 4.4µm pixels, and Model 2523 includes a ⅔" format CCD camera with 6.45µm pixels. All Models also include the FireWire BeamPro Acquisition and Analysis Software.

### **1.1.2. FireWire BeamPro Acquisition and Analysis Software**

The FireWire BeamPro Software was written for Microsoft Windows Vista, Microsoft Windows XP Professional and Microsoft Windows 2000 Professional 32 bit systems, taking full advantage of the menu driven, multi-windowing environment. The software provides quantitative measurement of numerous beam spatial parameters in accordance with the ISO 13694, ISO 11145, and ISO 11146 standards.

Windows available for data display include:

- |                                   |                                    |
|-----------------------------------|------------------------------------|
| ◆ Video window                    | Displays live video images;        |
| ◆ Dual Aperture<br>Profile window | Displays pinhole or slit profiles; |

◆ Beam Statistics window	Displays computed beam parameter values and statistics;
◆ 3D Profile View windows	Displays 3-dimensional representations of the beam intensity;
◆ 2D Contour View windows	Displays 2-dimensional contours of the beam intensity;
◆ Time Statistics windows (up to 15)	Displays strip chart graphs of selected beam parameters;
◆ Pointing window	Displays a target screen for observing beam pointing and divergence;
◆ K-Factor ( $M^2$ ) window	An interactive K-Factor Wizard program for measuring K-factor ( $M^2$ ) by the Rayleigh Method;
◆ Notes window	A simple text editor for entering user annotations;
◆ Measurement window	Displays the Beam Propagation Caustic. Available only for the ModeScan Model 1780.

The software also performs rigorous data analysis over specific regions-of-interest (ROIs) in accordance with the ISO standards. The ROIs can be either system or user defined. Quantitative measurement of numerous beam spatial characteristics is possible. Pass/Fail limit analysis for each of these parameters can be also applied.

Parameters measured include:

- ◆ Beam width
- ◆ Centroid and peak location
- ◆ Major and minor axes
- ◆ Beam orientation
- ◆ Ellipticity, eccentricity
- ◆ Gaussian fit
- ◆ Beam uniformity
- ◆ Beam divergence
- ◆ Pointing stability
- ◆  $M^2$ , K-factor

For data display and visualization, the user can arrange and size multiple windows as required. These may contain, for example, live video, 2D Topographic and 3D views, calculated beam parameters and summary statistics in tabular form with Pass/Fail limit analysis, and graphical strip chart time displays with summary statistics and overlays. Custom configured

instrument screens with multiple views can be saved as configuration files for repeated use.

Data can be saved as program files, or exported to spreadsheets, math and statistical analysis programs and process/instrumentation control programs by logging to files or COM ports, or by sharing using ActiveX Automation.

Live video of both pulsed and CW laser beams can be viewed in false color or gray scale. False color options include rainbow and four monochrome colors. This allows the user to choose a display color that can be seen clearly while wearing laser goggles. Beam profiles through the centroid, the peak or user defined points can be displayed. Profile orientation can be either in the horizontal and vertical axes or along the major and minor axes of elliptical beams.

Hardware and software installation instructions, the features of the software, operating hints and answers to frequently asked questions are presented in this operating manual.

Finally, to take full advantage of the features of the software, it is assumed that users have a working knowledge of the Windows operating systems and are familiar with basic Windows features such as opening, closing and saving files, making menu selections, opening, arranging, and resizing windows, etc. If these procedures are not familiar, see the Windows online **Help**, accessed by clicking on the **Start** button and selecting **Help and Support**, or refer to numerous available Microsoft Windows manuals and tutorials.

## 1.2. Model 2512 Camera Specifications

Specification	Model 2512
Sensor:	Si CCD 1/2" Format
Wavelength:	360 nm – 1100nm (Standard configuration with OD 2.8 filter) 190nm – 1100nm (Sensor only)
Pixel Array:	780 (H) × 580 (V)
Pixel Size:	8.3μm × 8.3μm
Array Dimension:	6.49mm × 4.83mm
Scanning Mode:	Progressive
A / D Conversion:	12 Bit
Signal to Noise Ratio:	58.4dB (maximum)
Maximum Frame Rate:	35.8fps (full frame @ full resolution)
Exposure range:	20μs – 27.64ms (Software selectable)
Gain:	0 – 12dB (Software selectable)
Image Plane:	17.526mm from the C-mount front surface
Trigger:	Internal or External (Software selectable)
External Trigger Specifications:	5V ± V @ 10mA ± 5mA (Positive transition)
Trigger Connector:	10 pin RJ-45 Jack
Trigger Cable:	10 pin RJ-45 to BNC
Interface:	IEEE 1394a (FireWire)
Cable Length:	1.8m (standard)
Supply Voltage:	+8V – +36V DC (+12V DC nominal), <1% ripple (supplied via IEEE 1394 cable)
Supply Power:	3.5W max @ 12V DC (typical)
Filter/Lens Mount:	C-mount (1" - 32 tpi) – 2.8 ND
Dimensions:	49mm × 62mm × 62mm
Weight:	~210g
Cover Glass:	Removed to eliminate interference fringes caused by coherent laser sources
Operating temp:	0° – +50°C (+32°–112°F)
Humidity:	20% – 80%, relative, non-condensing
Conformity:	CE, FCC; RoHS and WEEE
Mounting:	1/4"-20, M6 optional

### 1.3. Model 2518 Camera Specifications

Specification	Model 2518
Sensor:	Si CCD 1/1.8" Format
Wavelength:	360nm – 1100nm (Standard configuration with OD 2.8 filter) 190nm – 1100nm (Sensor only)
Pixel Array:	1624 (H) × 1236 (V)
Pixel Size:	4.4µm × 4.4µm
Array Dimension:	7.15mm × 5.44mm
Scanning Mode:	Progressive
A / D Conversion:	12 Bit
Signal to Noise Ratio:	39dB (maximum)
Maximum Frame Rate:	8.1fps (full frame @ full resolution)
Exposure range:	20µs – 81.90ms (Software selectable)
Gain:	0 – 7dB (Software selectable)
Image Plane:	17.526mm from the C-mount front surface
Trigger:	Internal or External (Software selectable)
External Trigger Specifications:	5V ± 1V @ 10mA ± 5mA (Positive transition)
Trigger Connector:	10 pin RJ-45 Jack
Trigger Cable:	10 pin RJ-45 to BNC
Interface:	IEEE 1394a (FireWire)
Cable Length:	1.8m (standard)
Supply Voltage:	+8V – +36V DC (+12V DC nominal), <1% ripple (supplied via IEEE 1394 cable)
Supply Power:	3.2W max @ 12V DC (typical)
Filter/Lens Mount:	C-mount (1"-32 tpi) – 2.8 ND
Dimensions:	75mm × 44mm × 29mm
Weight:	~110g
Cover Glass:	Removed to eliminate interference fringes caused by coherent laser sources
Operating temp:	0° – +50°C (+32°–112°F)
Humidity:	20%–80%, relative, non-condensing
Conformity:	CE, FCC; RoHS and WEEE
Mounting:	1/4"-20, M6 optional

## 1.4. Model 2523 Camera Specifications

Specification	Model 2523
Sensor:	Si CCD 2/3" Format
Wavelength:	360nm – 1100nm (Standard configuration with OD 2.8 filter) 190nm – 1100nm (Sensor only)
Pixel Array:	71392 (H) × 1040 (V)
Pixel Size:	6.45µm × 6.45µm
Array Dimension:	8.98mm × 6.7mm
Scanning Mode:	Progressive
A / D Conversion:	12 Bit
Signal to Noise Ratio:	65.6dB (maximum)
Maximum Frame Rate:	11.3fps (full frame @ full resolution)
Exposure range:	20µs – 81.9ms (Software selectable)
Gain:	0 – 12dB (Software selectable)
Image Plane:	17.526mm from the C-mount front surface
Trigger:	Internal or External (Software selectable)
External Trigger Specifications:	5V ± 1V @ 10mA ± 5mA (Positive transition)
Trigger Connector:	10 pin RJ-45 Jack
Trigger Cable:	10 pin RJ-45 to BNC
Interface:	IEEE 1394a (FireWire)
Cable Length:	1.8m (standard)
Supply Voltage:	+8V – +36V DC (+12V DC nominal), <1% ripple (supplied via IEEE 1394 cable)
Supply Power:	3.5W max @ 12V DC (typical)
Filter/Lens Mount:	C-mount (1"-32 tpi) – 2.8 ND
Dimensions:	49mm × 62mm × 62mm
Weight:	~240g
Cover Glass:	Removed to eliminate interference fringes caused by coherent laser sources
Operating temp:	0° – +50°C (+32° – 112°F)
Humidity:	20% – 80%, relative, non-condensing
Conformity:	CE, FCC; RoHS and WEEE
Mounting:	1/4"-20, M6 optional



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Photon's products are covered by limited warranty on parts and labor for 12 months from shipment date and 13 months if shipped to an authorized representative except as noted below. This warranty covers parts and labor to repair the equipment that fails to perform due to problems that are innate to the units and its components, but not due to neglect or misuse. Photon cannot be held liable for any damages beyond the original equipment cost.

Photon does not warrant incorrect use of instruments, such as but not limited to:

- ◆ Connecting or disconnecting a plug-in card with the computer powered on.
- ◆ Plugging your computer into a wall outlet without a surge protection strip.

**Photon reserves the right to determine if the problem has been caused by improper use.**

Warranty is not transferable except through resale of products by authorized agents of Photon inc. Unauthorized transfer of equipment and/or modifications to the equipment are grounds for voiding warranty coverage.

Photon reserves the right to void the warranty if the Buyer fails to meet the terms of purchase such as, but not limited to, a payment after the stated agreed invoice payment date or failure to pay for shipping charges.

This is Photon's sole warranty with respect to its products. No statement, agreement or understanding, oral or written, made by an agent, distributor, representative or employee of Photon, which is not contained in this warranty will be binding upon Photon, unless made in writing and executed by an officer. Photon makes no other warranty of any kind, whatsoever, expressed or implied. All implied warranties of merchantability and fitness for particular use, which exceed the aforementioned obligation, are hereby disclaimed by Photon and excluded from this agreement. Under no circumstances shall Photon be liable to Buyer in contract or in tort, for any special, indirect, incidental or consequential damages, expenses, losses or delays however caused.

Photon must be notified of the defect or nonconformity within the warranty period and the affected product returned to Photon's factory or an authorized service center within 30 days after the discovery of such defect or nonconformity. Shipment to Photon shall be made with an RMA# and prior authorization by Photon. Warranty repairs will be returned pre-paid lowest cost shipping method: for example, ground shipment if within the USA. If a faster return is desired, the Buyer must pay the shipping charges.



## **2. System Inspection**

### **2.1. Inspection**

***If you did not inspect the shipping container prior to unpacking, please do so now before going any further.***

Your FireWire BeamPro Beam Profiling system has been carefully tested, inspected and packaged prior to shipment. Photon performs extensive testing to ensure that the unit is in proper working order. Upon receipt, please inspect your FireWire BeamPro system for the following:

- ◆ Note any damage to the shipping container. Please report any damage found immediately to the shipping company. Photon does not warrant damage that occurs as a result of shipment.
- ◆ Check the contents of your shipment against the packing slip attached to the shipping box. Please note any discrepancy.
- ◆ A warranty form is included with all new units. Please complete this form and return it to Photon to activate your warranty.

### **2.2. FireWire BeamPro System Packing List**

The following items are shipped as part of the FireWire BeamPro System:

- ◆ Model 2512 ½" CCD Camera or Model 2518 ⅙" CDD Camera or Model 2523 ⅔" CCD Camera
- ◆ FireWire BeamPro Acquisition and Analysis Software CD for Windows Vista, Windows XP Professional or Windows 2000 Professional 32 bit systems
- ◆ FireWire (IEEE 1394a) cable
- ◆ External trigger cable: RJ-45 10-pin to BNC
- ◆ Operating Manual



# **3.** *SYSTEM SETUP*

## **3.1. Personal Computer Requirements**

To ensure the successful installation and operation of the FireWire BeamPro system, verify that your PC has the following minimal requirements:

- ◆ 1.8GHz or faster Pentium IV Processor (32-bit architecture)
- ◆ Microsoft Windows XP Professional SP1 (32-bit version), Microsoft Windows 2000 Professional SP3 Operating System, or Vista Professional (32-bit version)
- ◆ OHCI Compliant IEEE-1394a (FireWire) Adapter
- ◆ 512 MB of RAM
- ◆ CD-ROM Drive
- ◆ 30MB free space on hard disk
- ◆ 64MB Color SVGA Graphics Card
- ◆ SVGA Display Monitor
- ◆ Mouse or other Pointing Device
- ◆ Keyboard

## **3.2. Camera Installation**

Proper operation of the FireWire BeamPro cameras requires a standard 6-pin IEEE-1394 connector. These 6-pin connectors can usually be found on desktop PCs or on PCI IEEE-1394 adapter cards.

To install the camera connect one end of the 6-pin IEEE1394 cable provided with the system to the camera connector and the other end to the 6-pin port at the PC.

Some laptop PCs provide a built-in 4-pin IEEE-1394 connector that does not provide power to the camera. In this case you will need to have an IEEE-1394 powered hub inline (like the SIIG 1394 hub, PN: NH-H6012).

If you have a laptop that does not have a built-in IEEE 1394 port you will need an IEEE 1394-powered PC-Card and the corresponding external power supply.

### 3.3. Software Setup

In order to properly install and configure the software you will need Administrator Rights. (Please contact your system administrator for details regarding the Administrator Rights).

#### 3.3.1. Installation

1. Insert the **FireWireBeamPro CD** into the CD Drive. Open Windows Explorer and browse to **FireWireBeamPro CD** and double click the **setup.exe**.
2. Follow the instructions and, if it is possible, accept the default (suggested) settings.

##### 3.3.1.1. Microsoft Windows Vista only

1. Click **Allow** when prompted by the UAC (User Account Control); there will be two prompts during the installation.

#### 3.3.2. Uninstallation

##### 3.3.2.1. Microsoft Windows Vista

1. Open the **Control Panel** by clicking **Start** then selecting **Control Panel**.
2. Click on the word **Uninstall a program** under the programs heading.
3. Select **FireWire BeamPro** and then click the **Change** button. Click **Next**, select **Remove** and then click **Next** to confirm your selection. Click **Remove** to start uninstalling the software. Click **Allow** when prompted by the UAC. Click **Finish**.
4. Select **Basler Pylon Viewer 2.0.0.566** and then click the **Uninstall** button. When prompted click **yes** to start removing the software. Click **Allow** when prompted by the UAC.
5. This completes the uninstall procedure for the software.

##### 3.3.2.2. Microsoft Windows XP Professional

1. Open the **Control Panel** by clicking **Start** then selecting **Control Panel**.
2. Click the **Add or Remove Programs** icon

3. Select **FireWire BeamPro** and then click the **Change** button. Click **Next**, select **Remove** and then click **Next** to confirm your selection. Click **Remove** to start uninstalling the software. Click **Finish**.
4. Select **Basler Pylon Viewer 2.0.0.566** and then click the **Uninstall** button. When prompted click **yes** to start removing the software.
5. This completes the uninstall procedure for the software.

#### 3.3.2.3. Microsoft Windows 2000 Professional

1. Open the **Control Panel** by clicking **Start** then selecting **Settings** and then **Control Panel**.
2. Double-click the **Add/Remove Programs** icon
3. Select **FireWire BeamPro** and then click the **Change** button. Click **Next**, select **Remove** and then click **Next** to confirm your selection. Click **Remove** to start uninstalling the software. Click **Finish**.
4. Select **Basler Pylon Viewer 2.0.0.566** and then click the **Uninstall** button. When prompted click **yes** to start removing the software.
5. This completes the uninstall procedure for the software.





# 4. *ACQUISITION AND ANALYSIS SOFTWARE*

## 4.1. Quick Start

### 4.1.1. Starting the Program

To run the FireWire BeamPro Acquisition and Analysis Software program:

From the Windows **Start** menu, select **Programs**, then **Photon**, and then **FireWire BeamPro** or select the **FireWire BeamPro** icon from your desktop.

After installation when the program is first started, the Video window will appear. At this point the program GUI can be configured as desired with the multiple windows available. Alternatively, a **sample** startup GUI configuration screen is available that can be opened from the File menu. The sample configuration file name is “Example.fwc” and can be found in the directory where the software was installed, (default directory is “C:\Program Files\Photon\FireWire BeamPro”). There are 6 windows on this sample screen, including:

- ◆ **Video** window
- ◆ **Profile** window
- ◆ **Beam Statistics** window
- ◆ **3D Profile** window
- ◆ **Pointing** window
- ◆ **Notes** window

Figure 4.1 below shows the Example.fwc configuration screen and the arrangement of these 6 windows.

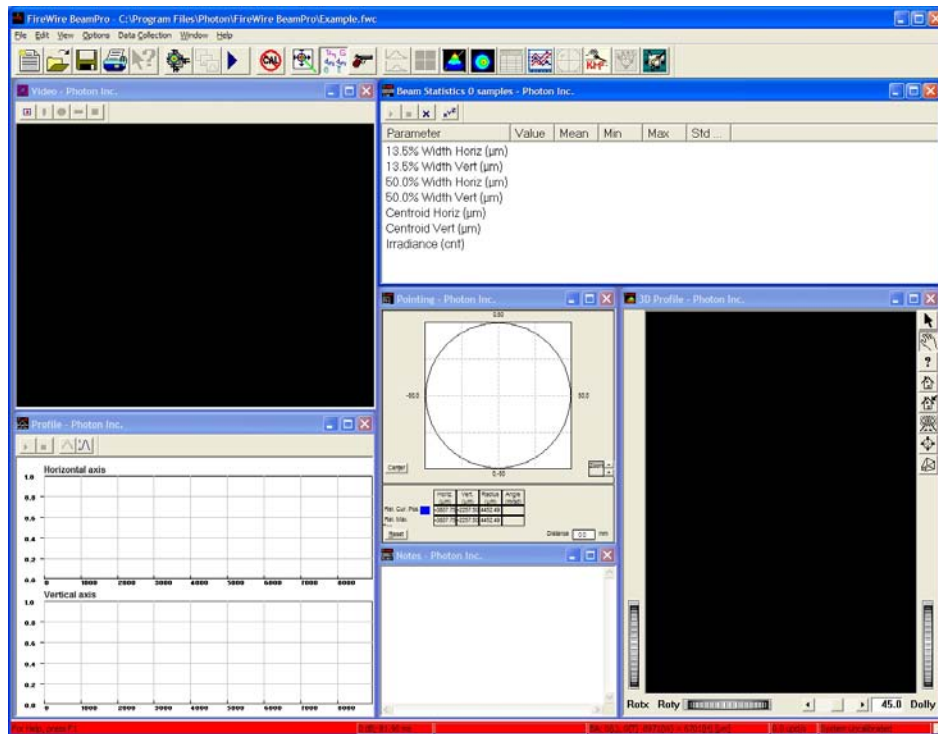





Figure 4.1. "Example.fwc" Configuration Screen.

The software has **3 Acquisition Modes** for image acquisition and processing. These are accessed under the **Data Collection** menu or through the icons from the main toolbar:

- ◆ **Laser Positioning**  Used for positioning the laser beam in the sensor aperture as shown in the **Video** window.
- ◆ **Analysis**  Used to obtain Beam Parameters on a continuous basis.
- ◆ **Single Shot**  Used to obtain Beam Parameters one shot at a time.


At first startup, the system is in **Laser Positioning Acquisition Mode**.

The software has **3 Trigger Modes**, accessed under the **Data Collection** menu:

- ◆ **CW** **for CW lasers;**
- ◆ **Pulsed** **for Pulsed lasers where an external sync trigger is NOT available;**
- ◆ **External** **for Pulsed lasers where an external sync trigger is available.**

At first startup, the system is in **CW Trigger Mode**.

### 4.1.2. Position the Laser Beam in the Aperture

To begin collecting data, select **Global Data Collection** from the **Data Collection** menu, or alternatively, use the  icon on the toolbar, or depress the Ctrl+G 'Hot Key'. The **Video** window will now be displaying data. The other windows will remain blank because data processing is inhibited in Laser Positioning mode to provide the fastest video update.

Adjust the laser beam steering or the camera position until the beam image is centered in the aperture as viewed in the **Video** window. The **Video** window uses false color schemes to code the beam intensity. The default scheme is the 'rainbow' spectrum, with low intensity toward the violet and high intensity toward the red. **White** indicates a **saturation** condition. If the beam is too intense and saturation is observed, attenuation will be needed. To fully utilize the system dynamic range and achieve the specified accuracy in beam measurements, adjust the laser intensity to a level just below the saturation level.

### 4.1.3. Trigger Mode for Pulsed Lasers

If your laser is CW, skip this step.

To measure pulsed laser beams, use either the **External** Trigger Mode or the **Pulsed** Trigger Mode. These trigger modes are discussed below.

If you can provide an external trigger, the best way to measure pulsed laser beams is using the **External** Trigger Mode. **External** triggering requires a TTL signal, with the trigger occurring on the positive-going (leading) edge. The external trigger cable provided with the system connects to the camera with a Hirose connector and has a BNC connector for the TTL signal input.

The External Trigger acts like an Asynchronous Reset for the camera integration or exposure period. It is therefore necessary to apply the trigger before the occurrence of the laser pulse, or in other words it requires a PRETRIGGER signal. The trigger occurs on the positive-going (leading) edge of the signal, and this must occur at least 32 $\mu$ s for model 2512 and at least 63.5 $\mu$ s for model 2523 before the laser pulse.

If you cannot provide an external trigger, use the **Pulsed** Trigger Mode. When this mode is selected, the software will automatically determine the presence of the beam based on minimum signal amplitude of 32 counts out of 4096. In this mode, the update rate will, in general, be reduced from that obtainable using the **External** Trigger Mode. The Trigger Mode can be changed through the **Data Collection** menu using the mouse. Open the **Trigger Mode** menu and select either **Pulsed** or **External**.



#### 4.1.4. Calibrate the System

It is necessary to perform a calibration prior to making beam measurements to obtain the specified accuracy. To calibrate, select **Calibration** from the **Data Collection** menu. The **Camera Calibration** dialog box will appear.

There are 2 visual indicators in the GUI, which change depending on the system calibration status. These indicators are the Calibration icon on the main toolbar and the status bar. The icons change to indicate the status of calibration, as follows:



System Uncalibrated



System Settings Changed since last calibration






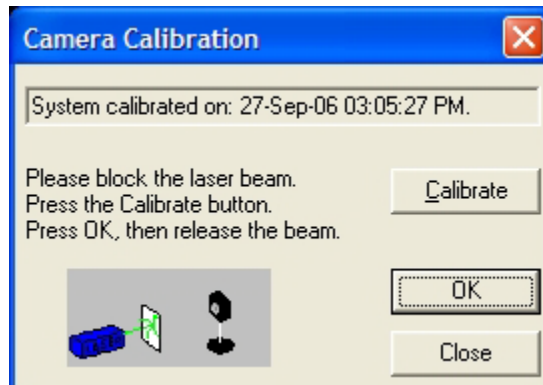
System Calibrated under current system settings

System settings include camera gain and exposure, trigger mode, and unit serial number.

The status bar changes color to indicate the status of calibration. **RED** indicates an uncalibrated system, **YELLOW** indicates that the system has been calibrated, but that something about the measurement configuration has changed; either the exposure or gain, the trigger mode, or the unit serial number. In this case it is recommended to recalibrate. If the status bar has the default color, the system is calibrated under the current measurement configuration.



To calibrate, use the displayed Calibrate icon,    on the main toolbar or select **Calibration** from the **Data Collection** menu. The **Camera Calibration** dialog box will appear.



Simply follow the directions. Block the beam (as far from the camera aperture as possible) and click the **Calibrate** button. Then click on the **OK** button. This completes the calibration procedure.

#### 4.1.5. Switch to Analysis Mode

To start measuring Beam Parameters, the system must be set to Analysis Mode. The Analysis Mode can be set by selecting **Acquisition Mode** from the **Data Collection** menu and clicking on **Analysis**.



Alternatively, use the icon on the toolbar.

#### 4.1.6. Beam Parameters – Computation and Display

##### 4.1.6.1. Computation of Parameters

Beam parameters are computed when the system is operating in the **Analysis** Acquisition Mode. The computations that are performed are determined by selections made in the **Data Analysis** dialog. To optimize the data update rate, all computations are done on a *subset* of the entire video image called the **Beam Area**. The computations also use the effective pixel dimensions and the **Magnification Factor**.

##### 4.1.6.2. Beam Area

If the system is set for **Auto Track**, the Beam Area is automatically determined to include the entire laser beam image but to be of minimal size. (This is to minimize the computation time by keeping the Beam Area as small as possible.) If the system is not set for **Auto Track**, a Beam Area must be set manually so that computations are performed. To set the Beam Area manually, either use the **Set Beam Area** selection under the **Video** window **Options** menu, or use the **Set Beam Area** drawing tool on the **Video** window toolbar. The **Beam Area-Position/Size** dialog box can also be used to define the top, left, width and height coordinates.

##### 4.1.6.3. Magnification Factor

This item under the **Data Collection** menu opens a dialog box for entering an optical magnification factor. This is necessary to obtain accurate beam width values whenever optical components such as lenses or mirrors with magnification are used to image a laser beam. This factor is used to scale the linear pixel dimension of the camera selected for measurements. The default magnification factor is 1. (If you do not know the magnification factor

of your optical system, it can be determined by mechanically translating an object a known distance horizontally through the image. The measured translation of the object in the image divided by the known mechanical translation is the magnification factor.)

#### 4.1.6.4. Displaying Parameters

Computed parameters can be displayed in the **Beam Statistics** window or in the **Time Statistics** windows. The selection of parameters for display is accomplished through the **Parameters** entry under the **Options** menus for these windows. Selecting the **Parameters** entry opens a dialog box for specifying which parameters will be displayed.

## 4.2. Advanced Use

The previous Quick-Start procedure utilizes only the very basic features of the FireWire BeamPro Acquisition and Analysis Software program. The program is very powerful and flexible, allowing users to configure the image data acquisition, the analyses, and the information display windows to suit their individual needs.

The **Data Collection** menu includes selections that determine or affect the collection of data. Through the **Data Analysis** dialog, users select the types of data analyses that will be performed, all in accordance with the ISO Standards.

Numerous parameters can be computed and displayed, determined in the **Beam Statistics Parameters** dialog. Parameters measured include:

- ◆ Beam width
- ◆ Centroid and peak location
- ◆ Major and minor axes
- ◆ Beam orientation
- ◆ Ellipticity, eccentricity
- ◆ Gaussian fit
- ◆ Beam uniformity
- ◆ Beam divergence
- ◆ Pointing stability
- ◆  $M^2$ , K-factor
- ◆ ISO 11146  $M^2$  parameters (Available only with the ModeScan Model 1780)

Three methods for computing beam widths:  $D_{\text{slit}}$ ,  $D_{\text{energy}}$ , or  $D_{4\sigma}$ , are available in either **XY** or **Elliptical** analysis modes.

**Energy/Power Uniformity** or **Flat Top** analyses can be performed on selected regions of interest.

There are also three methods of computing **Beam Divergence**.

Windows available for display include the:

- ◆ Video window;
- ◆ Profile window;
- ◆ 2D Contour window;
- ◆ 3D Profile window;
- ◆ Beam Statistics window;
- ◆ Time Statistics window;
- ◆ Pointing window;
- ◆ K-Factor window;
- ◆ Measurement window (available only with the ModeScan Model 1780).

Each window has an **Options** menu that offers many choices in how data will be displayed. There is also a **Notes** window for entering text. Users can arrange and size multiple windows as required, and these screens can be saved as files for future use. **Limit Analyses** can be performed on selected beam parameters. Also, data can be exported to spreadsheets, math and statistical analysis programs, and process/ instrumentation programs by logging data to files or COM ports, or shared using ActiveX Automation.

A complete description of the various features of the program is given in this section. Users are encouraged to learn the software features in detail and to experiment with the program. A little time spent in advance learning the features of the system will go a long way in making the FireWire BeamPro Acquisition and Analysis System an invaluable resource for laser beam characterization.

### 4.3. Operating Hints

1. Use the manual to completely familiarize yourself with all the features of the FireWire BeamPro Acquisition and Analysis Software.
2. Use **Laser Positioning** mode for positioning the laser beam in the aperture, and also for course tuning of the laser beam. Only use **Analysis** mode when you need parameter values.
3. Configure the **Data Analysis** and **Beam Statistics Parameters** only for values that are needed. For example, do not use **Elliptical Analysis** if the laser beam is nearly circular. Additional computations require more time and reduce the

system performance in terms of data update rate and the cross hairs will be very unstable, constantly jumping around to find the “ellipse”.

4. **Calibrate** the system periodically. Array sensors are very sensitive and can sense changes in background light intensity due to such things as reflections from a white shirt or light from a computer monitor. For accurate and repeatable measurements, the consistency of the experimental setup is important. Therefore, calibrate the system whenever there is a change in setup or background lighting. This will ensure the most consistent and accurate results.
5. Open only those windows that are required by your application. Additional windows reduce the data update rate. This is particularly true for the **Video**, **2D Contour**, and **3D Profile** windows. If all you need is beam width values, and you require the fastest data update rate, close unnecessary windows, including the **Video** window, and use only the **Beam Statistics** and/or **Time Statistics** windows.
6. Every window has a display update rate that is configured under the **Options** menu for each window. You may want to change the default **Timing** settings in order to improve the performance of your system.
7. Use Autotracking if your beam is stable. If your beam is unstable, the Beam Area as defined by the Autotracking algorithm will also be unstable. This will adversely affect the **Profile** and **3D Profile** windows, in that the displays will tend to change or pop with each change in the Beam Area. In this case, set a manual Beam Area to eliminate these effects.
8. Use **Frame Background Subtraction** to eliminate any stray light that is not due to the incident laser beam.
9. If data is being collected over long periods of time, use the Automatic backup feature to prevent total loss of data in the event of a failure.

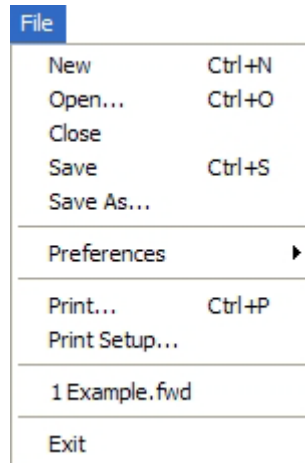


## 4.4. Program Menus

### 4.4.1. File Menu

As in any other Windows compliant program, the **File** menu is used for file manipulation and printing.

When **File** on the Menu Bar is clicked, the pull-down menu below appears.



#### **New**

Closes all open windows, and then creates a new **Video** window.

#### **Open...**

Opens the **File Open** dialog box. It lists Data Files from the current working directory.

To open a data file, select one from the list and then select the **Open** button. All windows will be closed and the new file will be loaded. The data, windows and computed statistics from the file will be displayed.

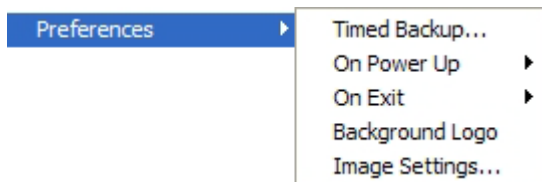
To open a configuration file, repeat the above steps except select **Configuration Files** from the **Files of Type** combo box. The list will show all configuration files in the current working directory. Configuration files contain everything that a data file does, except for the raw data and beam statistics. Use this to save a particular screen layout and set of data acquisition parameters without the raw and computed data.

#### **Close**

Closes all open windows and halts data collection.

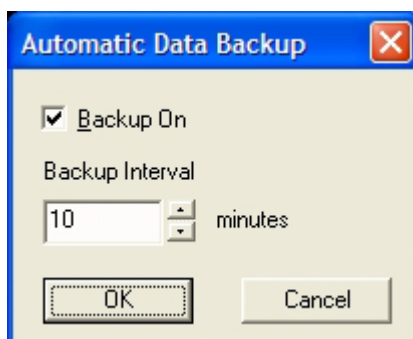
<b>Save</b>	Saves the current data and windows configuration in the currently active file. The name of this file is displayed on the main window title bar.
<b>Save As...</b>	Opens the <b>File Save As</b> dialog box. It lists Data Files from the current working directory. Either select an existing file from the list or enter a new name in the <b>File Name</b> edit box. To save as a data file, simply select the <b>Save</b> button. There are 5 different file types, identified by their extensions:
<b>*.fwd</b>	Data File: Includes screen configuration and associated image and computed data. Only the FireWire BeamPro Acquisition and Analysis Software can use this file.
<b>*.fwc</b>	Configuration File: Includes screen configuration only. Only the FireWire BeamPro Acquisition and Analysis Software can use this file.
<b>*.prw</b>	Frame Data – Raw File: Includes raw image data only. The Frame Data File is a binary file. It contains the number of columns and rows, saved as unsigned short (16-bit unsigned), then each pixel of the frame as an unsigned short (16-bit unsigned). The pixels are saved line by line, starting with the top line. This file cannot be read back by FireWire BeamPro Acquisition and Analysis Software.
<b>*.tif</b>	Frame Data – TIFF File. Saves the current frame (raw image) as uncompressed 16-Bit TIFF image.
<b>*.asc</b>	ASCII File. Saves data displayed in all open views in ASCII format.
<b>IMAGE</b>	Saves the program screen as an IMAGE file, either BMP, JPEG, GIF, TIFF, or PNG File. This is used for exporting graphics into documents and reports. The IMAGE file format is selected under <b>Image Settings</b> dialog in the <b>File</b> menu <b>Preferences</b> item.

## Preferences



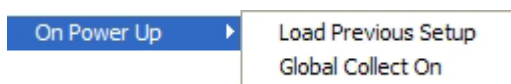
### **Timed Backup**

Opens the **Automatic Data Backup** dialog box. If the **Backup On** checkbox is selected, then all data will be saved automatically at the specified interval. Use this feature when collecting data over extended periods to prevent data loss in the event of a power outage or other catastrophe. When the program is restarted after such an event, the backup file will load and data collection resumes from the point of the last automatic save.



### **On Power Up**

Opens a menu with the following selections:



*Load Previous Setup*

When checked, the last data file will automatically load at startup.

*Global Collect On*

When checked, data collection resumes at startup.

### **On Exit**

Opens a menu with the following selections:



*Save Setup*

When checked, the **Save As** dialog box appears, prompting the user to save the latest data.

*Prompt*

When checked, the user is prompted with an **Leaving Already?** dialog upon exit.

### **Background Logo**

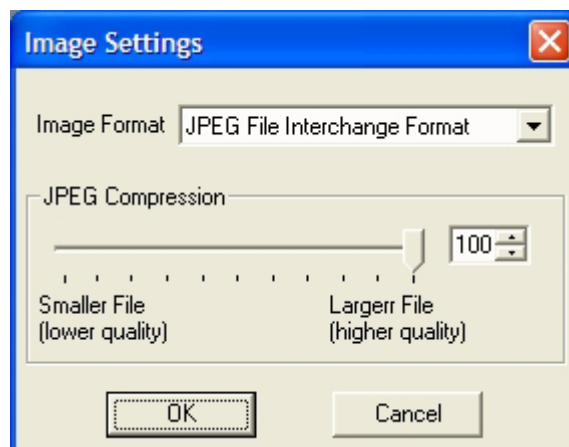
When checked, the Photon Logo appears as the background for the main window.

**Image Settings...**

Opens a dialog box for selecting the image export format for the active window and the full screen. Available choices for Image Format are:

<b>BMP</b>	Windows Bitmap
<b>JPEG</b>	JPEG File Interchange Format (JFIF)
<b>GIF</b>	Graphics Interchange Format
<b>TIFF</b>	Tagged Image File Format
<b>PNG</b>	Portable Network Graphics

This dialog is also used to set the image compression for JPEG Files.

**Print...**

Prints a picture of all open windows to the currently selected default printer. The user may change this printer from the **Print** dialog if desired.

**Print Setup...**

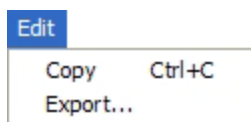
Opens a dialog box for selecting and configuring printers

**Exit**

Exits the program.

**4.4.2. Edit Menu**

When **Edit** on the Menu Bar is clicked, the pull-down menu below appears:

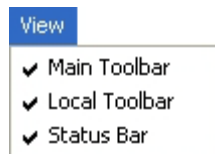
**Copy**

Copies the current window to the Windows clipboard as a bitmap image and/or text, depending on the active view. From there, the information can be pasted into other program applications.

**Export...** Opens the **File Save As** dialog box for exporting the active window as an image file, either BMP, JPEG, GIF, TIFF or PNG, used for exporting graphics into documents and reports. The image file format is selected under **Image Settings** dialog in the **File** menu, **Preferences** item.

### 4.4.3. View Menu

When **View** on the Menu Bar is clicked, the pull-down menu below appears:



**Main Toolbar** When checked, the toolbar on the main window is visible.

**Local Toolbar** When checked, the toolbar of the currently active view is visible, if available.

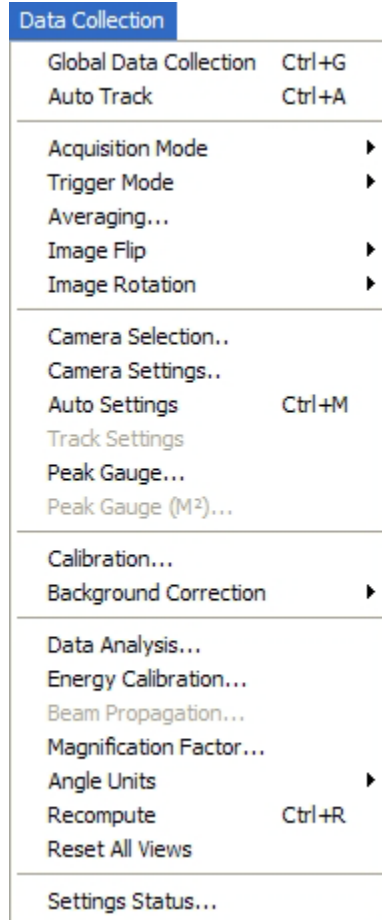
**Status Bar** When checked, the status bar at the bottom of the main window is visible.

### 4.4.4. Options Menu

There are various options associated with each window. These are selected in the **Options** menu. When a particular window is selected or active, the various options associated with that window are listed in the **Options** menu. The list of options is unique for each window. The options list for each window can be found below, under the window descriptions.

### 4.4.5. Data Collection Menu

The **Data Collection** menu includes selections that determine or affect the collection of data. When **Data Collection** on the Menu Bar is clicked, the pull-down menu below appears:



#### Global Data Collection

Enables data collection and updates for all windows.

#### Auto Track

Selects the autotracking feature, which automatically locates and tracks the laser beam and defines an optimal region, called the Beam Area, for performing data analysis.

**Acquisition Mode**

Opens a menu for selecting the acquisition mode:



Choices are:

***Laser Positioning***

Captures and displays images in the Video window. No calculations are performed, thus providing the fastest update rate. This mode is intended for setup prior to acquiring quantitative data. Use this mode for positioning your laser in the sensor aperture, adjusting attenuation, or for visually tuning the laser.

***Analysis***

Enables data analysis computations.

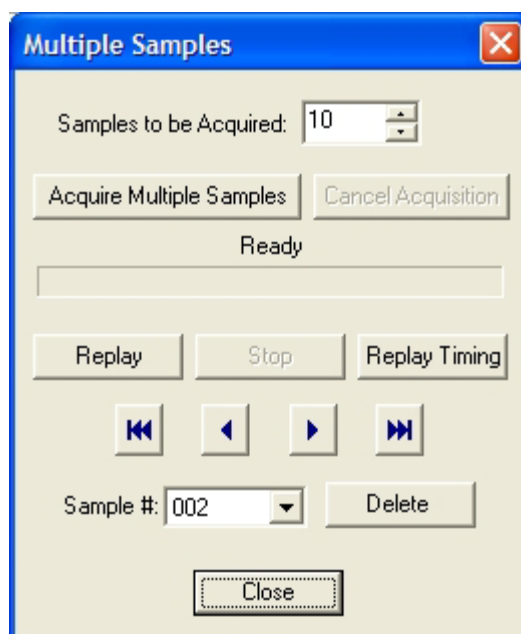
***Single Shot***

Enables single shot acquisition and analysis. One frame is acquired and processed each time the user selects the Global Data Collection in the Data Collection menu or, alternatively, after clicking the Global Data Collection icon on the toolbar.

***Multiple Samples...***

Enables the multiple samples acquisition mode. Sequential samples are acquired and stored for later playback and analysis.

The maximum number of samples cannot exceed 512 and depends on the video format and the available space on the hard drive.

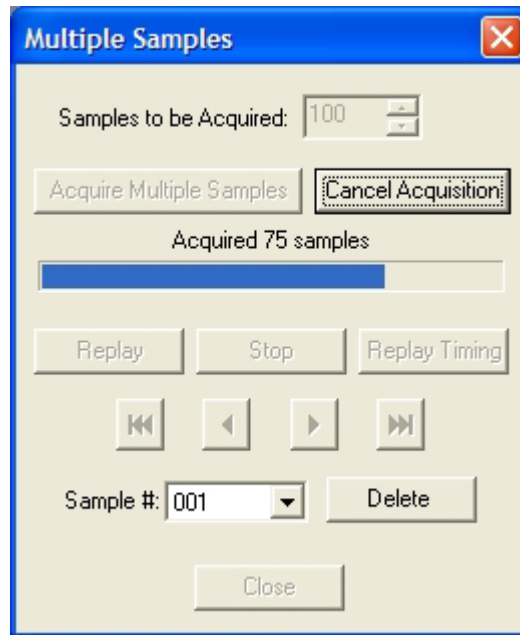


*Samples to be Acquired*

Select the desired number of samples to be acquired in the edit box (or by using the attached spin control).

*Acquire Multiple Samples*

Start the sequential acquisition. During the acquisition process the progress bar will indicate how many frames were already acquired. Once the acquisition process is done, the software will return full control to the user.



*Cancel Acquisition*

Cancels the multiple acquisition process and return full control of the software to the user. All the samples already acquired will be available for display and analysis.

*Replay*

Replay the acquired samples. The sample number from where the replay begins can be selected by entering this number in the Sample # dialog box. All the BeamPro analysis features are available in the replay mode.

*Stop*

Stop the replay sequence.

*Replay Timing*

Opens a dialog box for selecting the replay update rate.



First: displays the first acquired sample in the sequence.



Previous: displays the previous sample in the sequence.



Next: displays the next sample in the sequence.





Last: displays the last acquired sample in the sequence.

*Sample #*

Enter the sample number to be displayed, deleted or used as start for replay.

*Delete*

Deletes the sample selected in the Sample # dialog box. When a sample is deleted, all other samples keep their initial index value.

*Close*

Close the Acquire Multiple Samples dialog box.

### Trigger Mode

Opens a menu for selecting 1 of 3 trigger modes.



Choices are:

***CW***

Captures and displays images continuously. Use this mode when measuring CW laser beams.

***Pulsed***

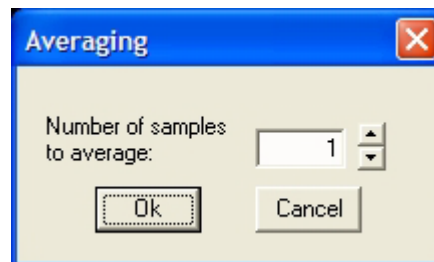
Captures and displays good images continuously. Use this mode when measuring pulsed lasers where external triggering is not available. In this mode the software rejects invalid frames.

***External***

Captures and displays images whenever an external trigger pulse is detected. Use this mode when measuring **pulsed lasers** where external triggering is available. In this mode the software rejects invalid frames. This is the best mode for your **pulsed laser**.

### Averaging...

Opens a dialog box for setting the number of frames to average. Entire frames are sequentially added up to the set value and then divided by the number of frames to obtain an average frame. This is not a rolling average; therefore, setting this number higher will slow the update rate significantly.



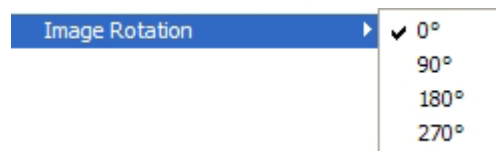
## Image Flip

Opens a menu for selecting the orientation of the image with respect to Vertical and Horizontal. Select None to display the original frame, Horizontal to flip the image about the horizontal axis, Vertical to flip the image about the Vertical axis. This operation takes precedence over Image Rotation.



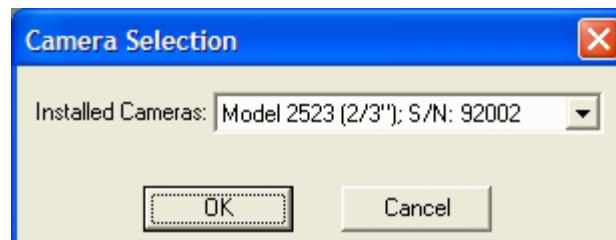
## Image Rotation

Opens a menu for selecting rotation of the image. Select 0° to display the original frame, or 90°, 180°, 270° to rotate the image in clockwise direction.



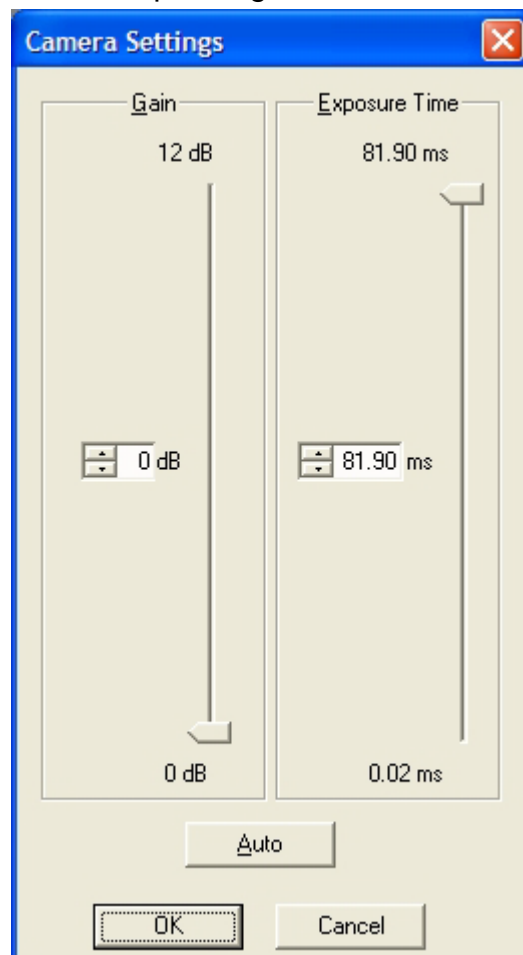
## Camera Selection...

Opens the **Camera Selection** dialog for selecting FireWire BeamPro cameras for use by Model and Serial Number. When a new camera is selected the system will not be calibrated and the data collection would be turned off.



**Camera Settings...**

Opens the **Camera Settings** dialog for setting the camera **Gain** and **Exposure Time**. The Gain ranges from 0 to 12 dB for Models 2512 and 2523 and from 0 to 7 dB for Model 2518, while the exposure ranges between 20 $\mu$ s and 81.9ms for Models 2518 and 2523 and between 20 $\mu$ s and 27.52ms for Model 2512. The gain increment is 1dB, while the exposure increment is 0.02ms (20 $\mu$ s). The selected gain and exposure time are displayed on the edit box placed on the left side of the corresponding slider.

**Auto**

Initiates a one-shot automatic setting of exposure and gain. The target amplitude is 90-95% full scale. Exposure is adjusted first and then gain.

**Auto Settings**

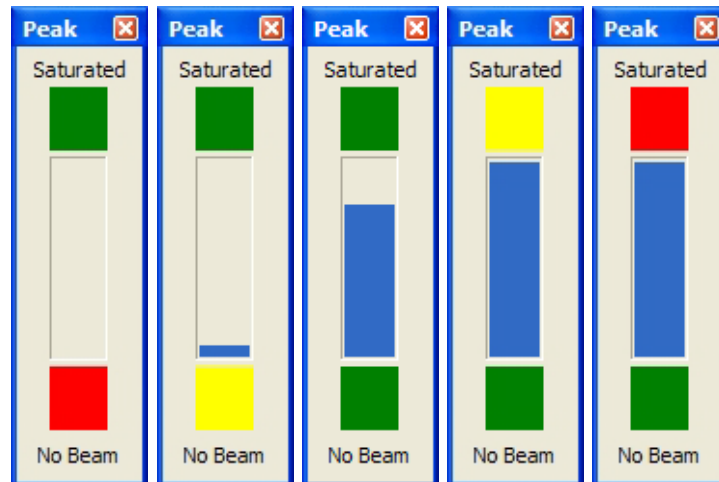
Initiates a one-shot automatic setting of exposure and gain. The target amplitude is 90-95% full scale. Exposure is adjusted first and then gain.

## Track Settings

Enables continuous automatic setting of exposure and gain to maintain peak amplitude at 90-95% full scale. This option is currently unavailable.

## Peak Gauge...

Opens the Peak dialog, showing the status of the peak signal amplitude of the beam profile in the entire camera frame. All 5 conditions of the dialog are shown below. The dialog includes a level indicator and uses colorization to display status near saturation and “no beam” conditions. The “No Beam” condition corresponds to a level below 32 counts, and is indicated by “red” in the box at the bottom. Above 32 counts the box changes in color to yellow, and stays yellow up to 400 counts, at which point it changes to “green”. (400 counts is the minimum amplitude at which the beam diameter accuracy is within the specification of  $\pm 2\%$  for a  $64\mu\text{m}$  beam.) For saturation, the top box is green if the amplitude is below 4000 counts, changing to “yellow” above 4000 counts and to “red” at 4095 counts. The blue level indicator is a linear display of the signal amplitude from 0-4095 counts. Generally, for a good measurement the color indicators should be all green.



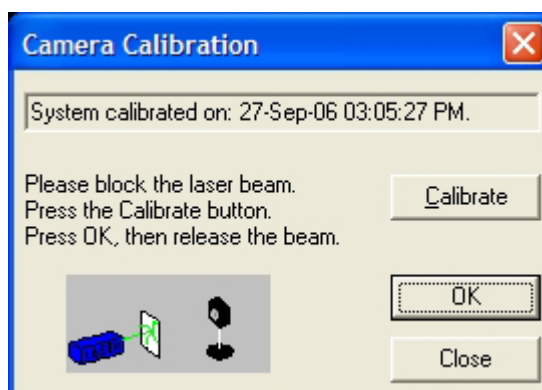
## Peak Gauge (M<sup>2</sup>)...

This option is available only with the ModeScan Model 1780 system.

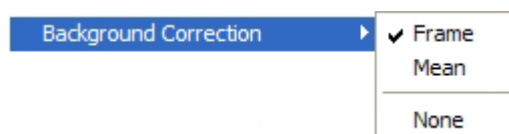
**Calibration...**

Opens the **Calibration** dialog for performing a background calibration of the camera. The info field displays the date and the time of the last calibration. If the camera was not calibrated the message *"The system is not currently calibrated."* is displayed.

To perform a calibration, simply follow the instructions in the dialog box. First, block the laser beam (as far from the camera aperture as possible). Then click on the **Calibrate** button. The calibration is complete when the **OK** button becomes active. The current date and time will be displayed in the info field. Then click on the **OK** button to exit the **Calibration** dialog.

**Background Correction**

Opens a menu for selecting the method of background correction. The available choices are:

**Frame**

Selects the background frame correction method. The background frame values are subtracted from each data frame on a pixel-by-pixel basis.

**Mean**

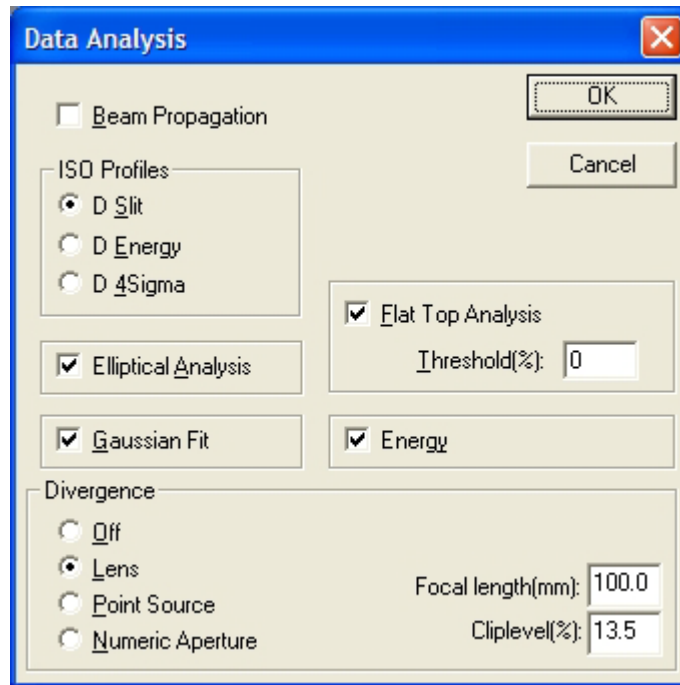
Selects the background mean value correction method. The mean value of the background frame is subtracted from each pixel value in the data frame.

**None**

Selects no background correction.

**Data Analysis...**

Opens the **Data Analysis** dialog for selecting the calculations to be performed on each data frame.



The various selection choices are:

**Beam Propagation** Selects the Beam Propagation Analysis mode, available only with the ModeScan Model 1780 system.

**ISO Profiles** Selects the method of **ISO Profiles** beam width computation. Choose from 1 of 3 possible selections:

*D slit* Selects the slit method for determining beam widths. The computation simulates a scanning slit aperture with slit width equal to the effective pixel dimension of the camera used for measurement. Scans are performed along the horizontal and vertical directions or along the directions of the major and minor axes if elliptical analysis is selected.

*D energy* Selects the encircled energy method for determining beam widths. The computation simulates circular apertures centered at the laser beam centroid and calculates the energy through the aperture. The diameter of the circular aperture is increased until the specified energy percentage is obtained.

*D 4sigma* Selects the second moment method for determining beam widths. The computation

	determines the second moment of the laser beam distribution.
<b><i>Elliptical Analysis</i></b>	By default, data analysis is performed along the horizontal and vertical directions of the pixel array. If the <b>Elliptical Analysis</b> box is checked, the analysis will be performed along the directions of the major and minor axes of the beam.
<b><i>Gaussian Fit:</i></b>	To enable Gaussian fit calculations of the profiles displayed in the <b>Profile</b> window (either <b>Slit</b> or <b>Pinhole</b> scans), check the box labeled <b>Gaussian Fit</b> . The Gaussian fit to the profiles can then be displayed as overlays on the profiles in the <b>Profile</b> window by selecting the Fit option for that window. The corresponding Gaussian Goodness-of-Fit parameter can be displayed in the <b>Beam Statistics Parameters</b> or the <b>Time Statistics</b> window.
<b><i>Flat Top Analysis</i></b>	Enables <b>Uniformity</b> or <b>Flat Top Analysis</b> of Energy Region of Interest (ROI). The Energy ROI is a user-defined region in the <b>Video</b> window.
<b><i>Threshold (%)</i></b>	Defines the threshold as a percentage of the peak pixel value for which the <b>Flat Top Analysis</b> will be performed. Only those pixels in the Energy ROI that are greater than this value are included in the analysis.
<b><i>Energy</i></b>	When selected, the total energy or power in the Beam Area is computed. In addition, the energy or power in the Energy ROI and the percentage of the energy in the Beam Area are computed in the <b>Flat Top Analysis</b> , if enabled. Also, the Min, Mean, and Max values in the <b>Flat Top Analysis</b> will be reported as Fluence or Irradiance per pixel.
<b><i>Divergence</i></b>	Selects the method for divergence computation. Choose from 1 of 4 possible selections:
<b><i>Off</i></b>	No divergence computations will be made
<b><i>Lens</i></b>	Selects the <b>Lens</b> method for computing divergence. When selected, the lens focal length, in millimeters, and the beam width clip level percentage must be specified.

**Point Source**

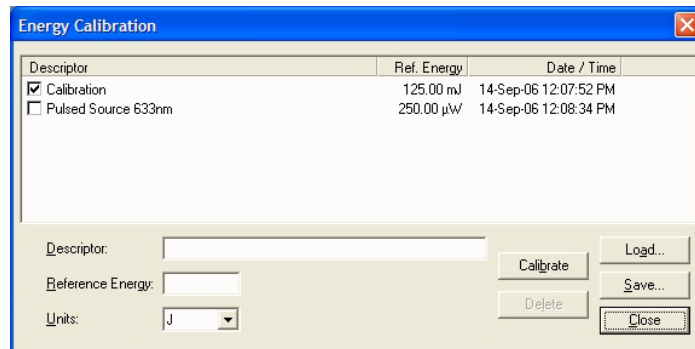
Selects the **Point Source** method for computing divergence. When selected, the distance from the point source to the measurement plane, in millimeters, and the beam width clip level percentage must be specified.

**Numerical Aperture**

Selects the **Numerical Aperture** method for computing divergence. When selected, the distance from the point source to the measurement plane, in millimeters, and the beam width clip level percentage must be specified. The numerical aperture equivalent of the divergence half-angle is reported ( $\sin(\theta/2)$ ).

**Energy Calibration...**

Opens the **Energy Calibration** dialog for entering calibration reference records and for selecting the calibration reference record for use. When the first calibration file has been added, it will display as the default and the box will be checked. With multiple calibrations, set the default calibration by checking the desired checkbox. The listed records will be saved with the FireWire BeamPro data file if it is saved. The records can also be saved as separate calibration record files using the Save feature described below.

**Descriptor**

Text Field for entering Calibration information. Maximum 256 characters.

**Reference Energy**

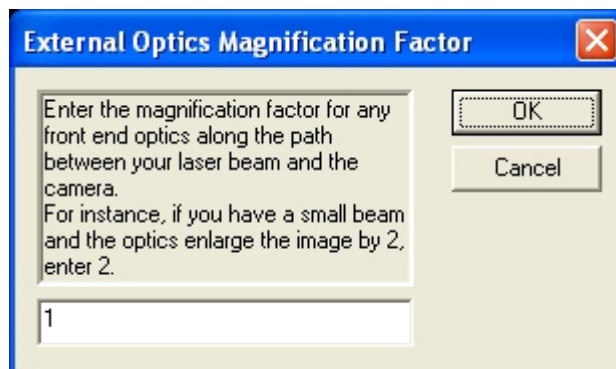
Numeric Field for entering the Calibration Reference Energy/Power obtained from independent measurements of the beam with an energy or power meter. Values between 1 and 1000 are allowed. Units are selected in the Units Combo Box.

**Units**

Combo Box for setting the units of Energy/Power. Units range from J to pJ or W to pW.



<b>Calibrate</b>	Initiates the Calibration Procedure. At least one of the calibration text fields must be different from the previous calibration. There should be a calibration for each type of laser to be measured. The power meter is a relative meter and must be calibrated to a known source for each wavelength and power range to be measured.
<b>Delete</b>	Deletes the selected Calibration.
<b>Load...</b>	Opens a dialog for selecting files containing calibration reference records. When the file is loaded all previously listed records in the Energy Calibration Dialog are deleted.
<b>Save...</b>	Opens a dialog for selecting the name and path for the file that contains calibration reference records.
<b>Beam Propagation...</b>	Opens a dialog box for entering the parameters for $M^2$ measurement, available only with the Model 1780 ModeScan.
<b>Magnification Factor...</b>	Opens a dialog box for entering an optical magnification factor that will scale the camera pixel dimension. This is necessary to obtain accurate beam width values whenever optical components such as lenses or mirrors with magnification are used to image a laser beam. It allows compensation of any optical or imaging schemes that change the size of the beam image. This factor is used to scale the linear pixel dimension of the camera selected for measurements. The default magnification factor is 1.



<b>Angle Units</b>	Opens a menu for selecting the units used for reporting all the angles, either milliradians or degrees.
<b>Recompute</b>	Click on <b>Recompute</b> to redo computations on the image data currently in memory. Use this feature if

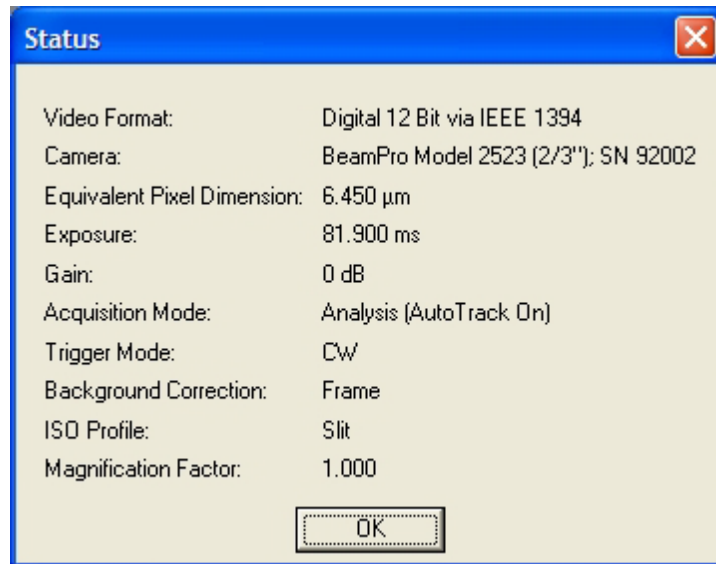
any changes to the analysis are desired, e.g., changing the method of beam width computation, or changing the Beam Area or the Energy ROI to analyze a different region of the image.

### Reset All Views

Resets all open data-display windows.

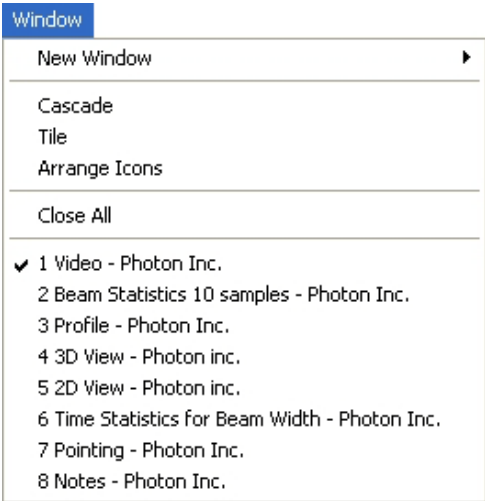
### Settings Status...

Opens the **Settings Status** screen dialog, which displays the current program settings.

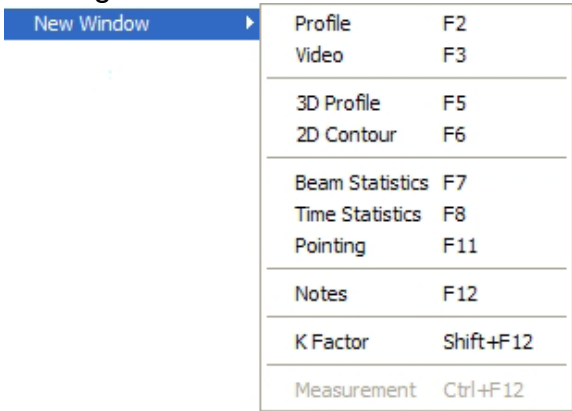


4.4.6. Window Menu

When **Window** on the **Menu Bar** is clicked, the pull-down menu below appears.

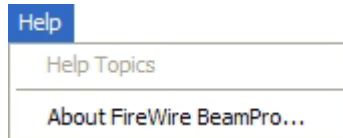


The **Window** menu is used to open new windows, arrange windows and window icons and to close all open windows. The list at the bottom of the menu shows which windows are open with the currently active window checked.

<b>New Windows</b>	Opens a menu for selecting windows for viewing.
	
<b>Cascade</b>	Arranges the open windows in cascade format.
<b>Tile</b>	Arranges the open windows in tile format.
<b>Arrange Icons</b>	Arranges the minimized window as icons on the bottom of the main window.
<b>Close All</b>	Closes all open windows.
<b>Window List</b>	Displays a list of all open windows and displays a check before the currently active window name.

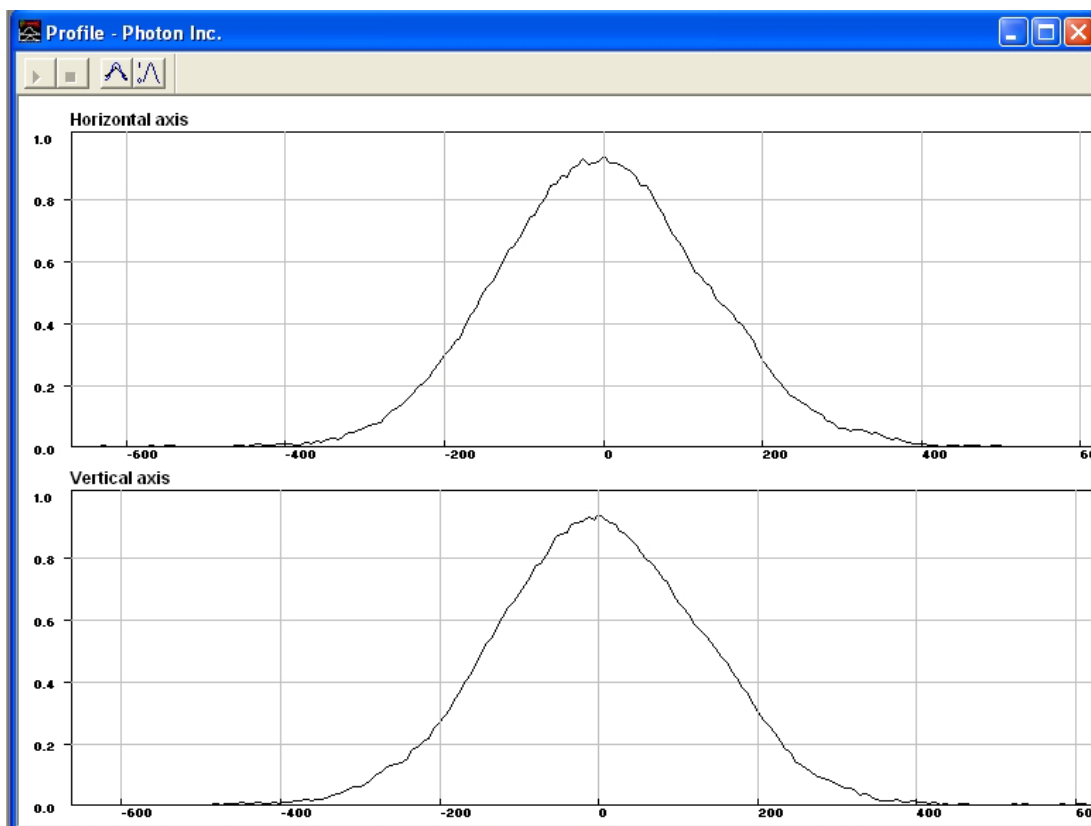
### 4.4.7. Help Menu

Use the **Help** menu to access **Help Topics**, and the **About FireWire BeamPro** dialog box. Help Topics is currently unavailable.



## 4.5. Window Descriptions

### 4.5.1. Profile

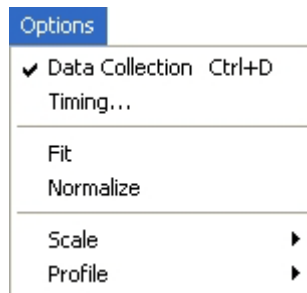


The **Profile** window displays either Pinhole or equivalent Slit profiles in orthogonal directions along the crosshairs displayed in the live **Video** window. An example of the **Profile** window is given above. If data analysis is set to the default XY mode, then the profile axes are horizontal and vertical. If data analysis is set to **Elliptical Analysis Mode**, then the profile axes are oriented along the major and minor axes of the laser beam image.

The locations of the Pinhole profiles are identified by the crosshairs in the **Video** window. The pinhole profile locations can be selected to be through either the beam centroid, the peak pixel, or through user selected points by dragging the crosshairs with the mouse to the desired location. Also, when in elliptical analysis mode, the orientation of the axes can be changed arbitrarily by holding down the control key and using the mouse to rotate the axes.

For Slit profiles the crosshairs identify the direction of the equivalent slit scan.

The **Options** menu available when the **Profile** window is active is shown below.



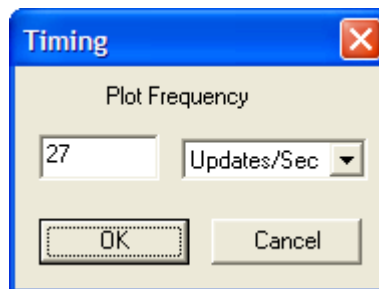
The selections are:

**Data Collection**

Turns data collection on/off.

**Timing...**

Opens a dialog box for selection of the profile update rate.



**Fit**

Places a blue-colored Gaussian fit overlay on the profiles if **Gaussian Fit 1D** is enabled in the **Data Analysis** dialog box.

**Normalize**

Scales the profile amplitude to have a peak value of 1, i.e. full scale.

**Profile**

Selects either the **Pinhole** or the **Slit** profiles for display.



## Scale

Allows the user to choose between a **Linear** and a **Logarithmic** scale.



These options can also be selected using the **Profile** window toolbar:



Starts data collection.



Stops data collection.



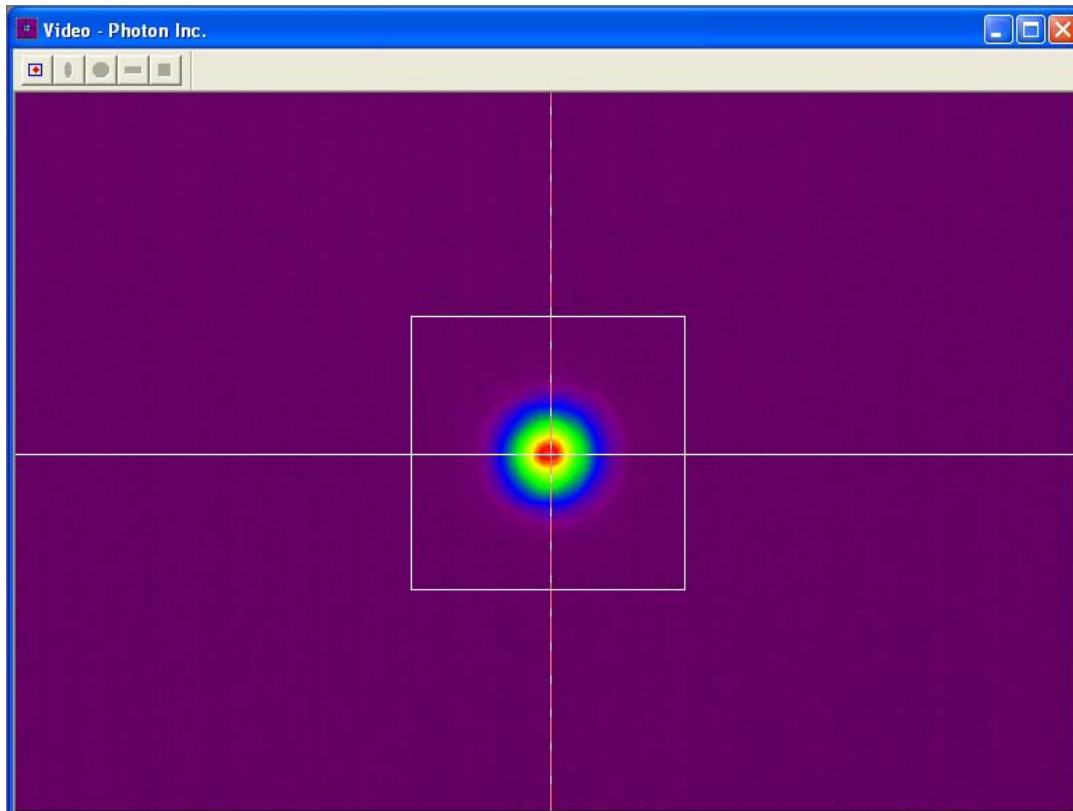
Turns Gaussian Fit overlay on/off.



Turns Normalization on/off.

## 4.5.2. Video

The **Video** window displays the video laser image. An example of the **Video** window is given below.



The crosshairs in the image identify the location and/or direction of profiles displayed in the **Profile** window, depending on the type of profile selected, either **Pinhole** or **Slit**, in the Profile options. If data analysis is set to the default XY mode, then the profile axes are horizontal and vertical. If data

analysis is set to elliptical mode, then the profile axes are oriented along the major and minor axes of the laser beam image.

For Pinhole profiles the pinhole profile locations can be selected to be through either the beam centroid, the peak pixel, or through user selected points by dragging the crosshairs with the mouse to the desired location. Also, when in elliptical analysis mode, the orientation of the axes can be changed arbitrarily by holding down the control key and using the mouse to rotate the axes.

For Slit profiles the crosshairs identify the direction of equivalent slit profiles.

The **Options** menu available when the **Video** window is active is also shown below.



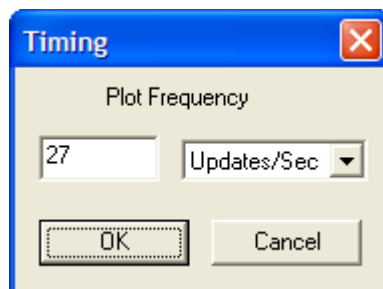
The selections are:

**Data Collection**

Turns data collection on and off.

**Timing...**

Opens a dialog box for selection of the display update rate.



**Select Colors...**

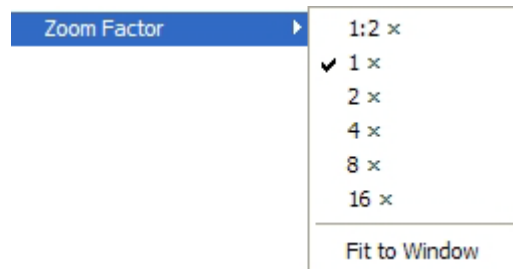
Opens a dialog box for selection of the display color scheme. Choices available are: Rainbow, Gray, Red, Green and Blue.

**View Finder**

Opens a display box that shows the entire camera video image.

**Zoom Factor**

Opens a menu for selecting the zoom factor. Choices available are: **1:2x**, **1x**, **2x**, **4x**, **8x**, **16x**, and **Fit to Window** proportional to the camera array dimension.

**Auto Position**

When auto position is selected the laser beam image will automatically be positioned in the displayed portion of the **Video** window.



**Overlays**

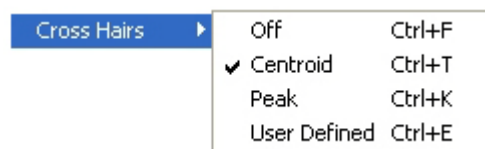
Opens a menu for selecting which overlays will be displayed in the **Video** window.



Choices available are:

**Cross Hairs**

Selecting Cross Hairs opens a second menu with the following choices:



The selection is available only if the Pinhole is selected under the Profile option in the **Profile** Window. When the Profile display is set to **Slit**, the Cross Hairs are drawn through the centroid and cannot be moved, so no other selections can be made.

*Off*

Turns the cross hair overlay off.

*Centroid*

Places the cross hairs at the centroid.

*Peak*

Places the cross hairs at the peak.

*User Defined*

Allows the cross hairs to be positioned manually at an arbitrary position using the mouse.

**Beam Area**

Turns the Beam Area overlay off or on.

**Energy ROI**

Turns the Energy ROI overlay off or on if Flat Top Analysis is enabled.

**Set Beam Area**

Allows the user to set a Beam Area manually.

The beam area can be defined/adjusted using the mouse or defining the top, left, width and height coordinates.

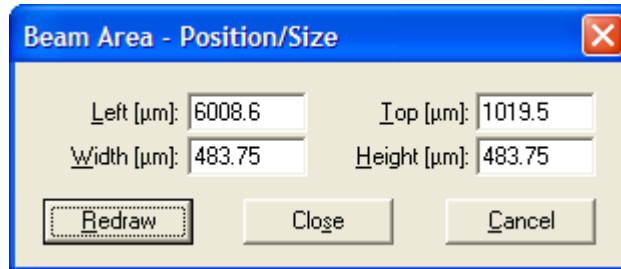
To set Beam Area using the mouse:

First click on **Set Beam Area**. Next, use the mouse to draw and/or adjust the desired beam area in the **Video** window. Finally, click on **Set Beam Area** a second time to validate the Beam Area previously drawn. In drawing/adjusting mode, depress ESC to discard all the changes and revert Beam Area to its original size and position.

**Note:** Selecting the **Set Beam Area** will also open (or close) the **Beam Area-Position/Size** dialog box.

To set Beam Area using coordinates:

Click on **Set Beam Area**. In the **Beam Area-Position/Size** dialog box, enter the Top, Left, Width and Height coordinates in the designated edit boxes.



*Redraw*

Redraws the beam area based on the new coordinates and keep the **Beam Area-Position/Size** dialog box open.

*Close*

Closes the dialog box.

*Cancel*

Ignores any changes made during the drawing/adjusting mode, reverts Beam Area to its original size and position and closes the dialog box.

## Set Energy ROI

Allows the user to set the Energy ROI manually. The ROI can only be drawn inside the Beam Area. The ROI can be defined/adjusted using the mouse or defining its coordinates.

**Note:** Flat Top Analysis (from Data Collection menu, Data Analysis dialog) must be enabled for the ROIs to be available.



To set Energy ROI using the mouse:

First click on **Set Energy ROI**; this opens a second menu with the following selection choices. **Rectangle**, **Square**, **Elliptic**, and **Circle**. Click on one of these to determine the general shape of the Energy ROI to be drawn. Next, use the mouse to draw and/or adjust the desired Energy ROI in the **Video** window. Finally, click on the shape selection a second time to validate the Energy ROI previously drawn. In drawing / adjusting mode, depress ESC to discard all the changes and revert Energy ROI to its original size and position.

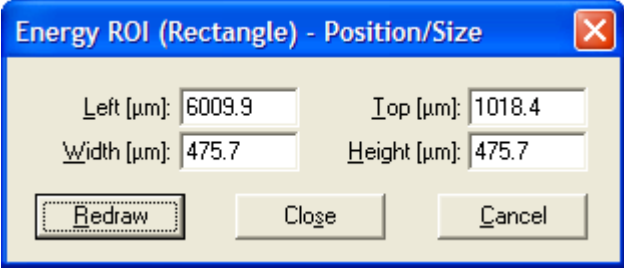
Note: Selecting the one of the **Set Energy ROI** item will also open (or close) the corresponding **Energy ROI – Position/Size** dialog box.

To set Energy ROI using coordinates:

Click on **Set Energy ROI**; this opens a second menu with the following selection choices. **Rectangle**, **Square**, **Elliptic**, and **Circle**. Click on one of these to determine the general shape of the Energy ROI to be drawn..

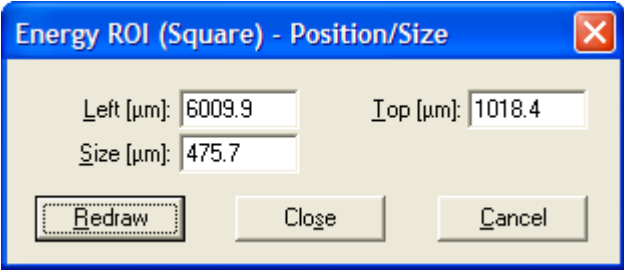
***Rectangle:***

Enter the **Left**, **Top**, **Width** and **Height** coordinates for the Rectangle Energy ROI.



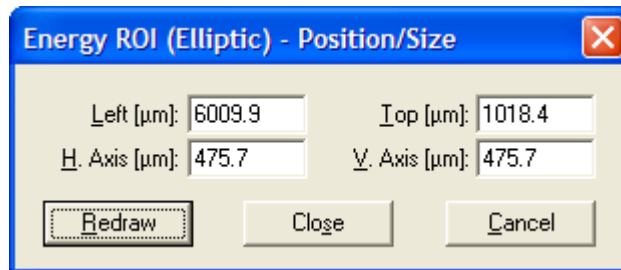
***Square:***

Enter the **Left**, **Top** coordinates and the **Size** for the Square Energy ROI.

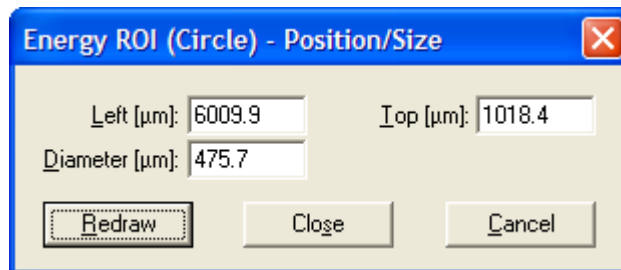


**Elliptic:**

Enter the **Left**, **Top** coordinates and the **Horizontal Axis** and **Vertical Axis** for the Elliptical Energy ROI.

**Circle:**

Enter the **Left**, **Top** coordinates and the **Diameter** of the Circle Energy ROI.

**Redraw**

Redraws the beam area based on the new coordinates and keep the **Energy ROI-Position/ Size** dialog box open.

**Close**

Closes the dialog box.

**Cancel**






Ignores any changes made during the drawing/adjusting mode, reverts Energy ROI to its original size and position and closes the dialog box.

**Record (AVI)**

Turns the video record mode on or off, for recording live video sequences of laser beam profile images. When turned on a Save As dialog appears for entering the name of the AVI file. The maximum number of frames that can be stored in a file is 512. The AVI files cannot be played back in the software.

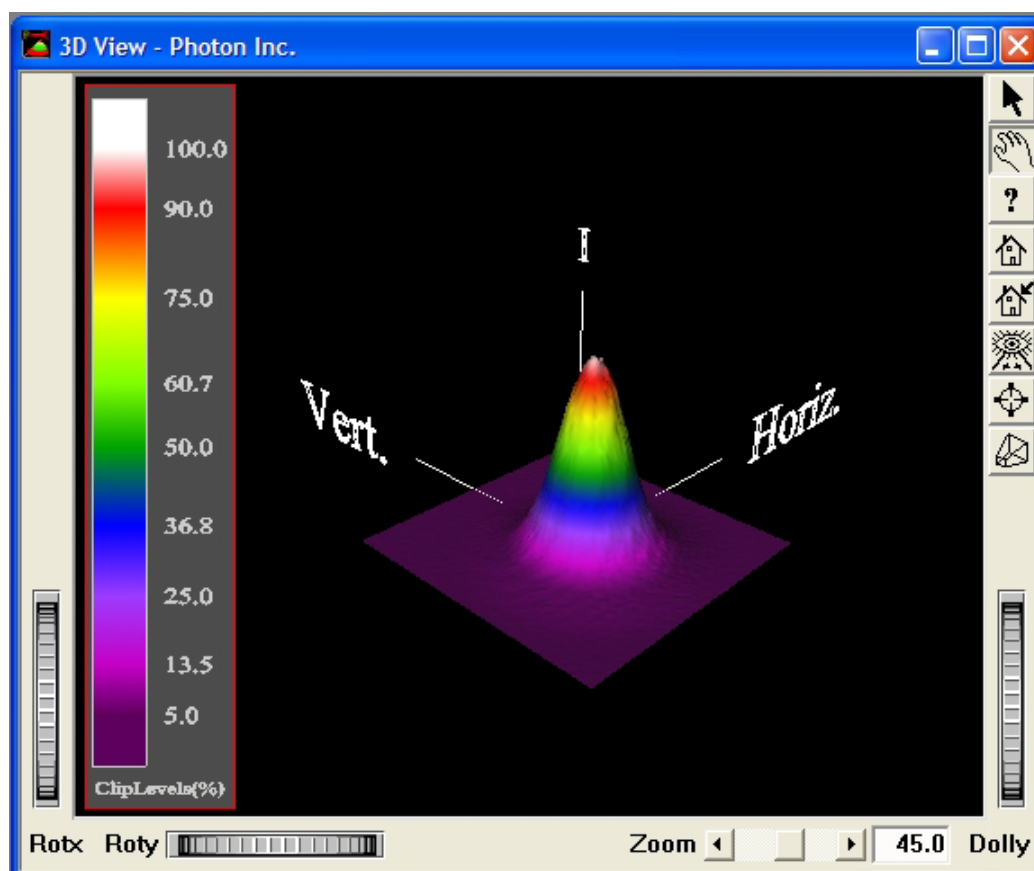
The Beam Area and Energy ROI setting tools can also be accessed on the **Video** window toolbar: (Note: The Energy ROI tools are available only if **Flat Top Analysis** is enabled.)



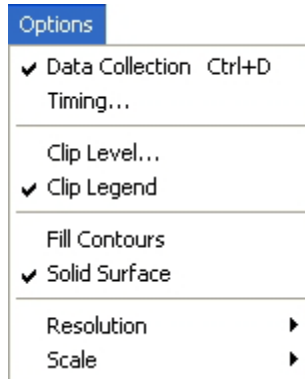
-  Set Beam Area.
-  Energy ROI: Elliptical
-  Energy ROI: Circular
-  Energy ROI: Rectangular
-  Energy ROI: Square

### 4.5.3. 3D Profile

The **3D Profile** window displays the laser beam image in a '3-dimensional' viewing format. The laser beam image can be rendered with either a wireframe or solid surface, with user selected clip levels and colors.



The **Options** menu available when the **3D Profile** window is active is shown below.



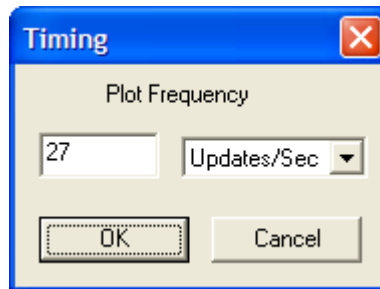
The selections are:

**Data Collection**

Turns data collection on and off.

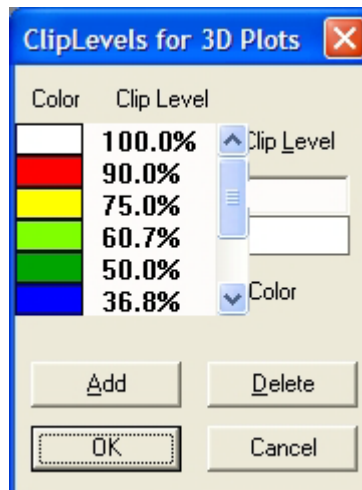
**Timing...**

Opens a dialog box for selection of the display update rate.



**Clip Level...**

Opens a dialog for selecting clip level contours and their colors.



This option is not available for data displayed using the logarithmic scale. In this case, the contour levels are fixed at the 0, -3, -5, -10, -13, -20, -23, -30, and the -33 dB levels.

**Clip Legend** When selected, the **Clip Level** legend will be displayed in the view.

**Fill Contours** When selected, the different clip levels on the beam will be clearly delineated. Please be aware that this option will slow the acquisition rate of the system.

**Solid Surface** When selected, the image will have a solid surface. When not selected, the image will be rendered as a wireframe.

**Resolution** Opens a menu for selecting the resolution of the 3D display. Choices are: **High**, **Medium**, and **Low**. Data update rate is reduced and image manipulation is slower as resolution is increased.



**Scale** Allows the user to choose between a **Linear** and a **Logarithmic** scale.



The toolbar at the right border of the window contains 8 buttons used to select several viewing and image manipulation features. These buttons are, from top to bottom:



Chooses the **Arrow** cursor, which allows image manipulation only using the mouse and the thumbwheel controls.



Chooses the **Hand** cursor, which allows image manipulation using the mouse directly in the image or by using the thumbwheel controls. (When the mouse is moved to the window border the **Hand** cursor changes to the **Arrow** cursor).



This **Help** menu is inactive.



Resets the view to a preset **Home** default position, size and orientation.



Sets the default settings for the **Home** button.



Restores the view to include the entire image.



Activates the **Seek** cursor. After positioning this cursor on a selected point in the image and clicking the left mouse button, a close-up zoom to that point will be performed automatically. Also, the center of rotation will be set to that point.



Toggles between the **Perspective** and **Orthographic** projection modes.



There are also three thumbwheels along the window border, designated **Dolly**, **Rotx**, and **Roty**, which are used to zoom and rotate the 2D image.

The image can be rotated, translated, panned, and zoomed using the mouse with the **Arrow** cursor and the thumbwheel control knobs or using the mouse with the **Hand** cursor, as described below.

#### Rotation

Rotate the image using the mouse and the Arrow cursor with the thumbwheels labeled **Rotx** and **Roty**. Alternatively, use the mouse and the Hand cursor to directly rotate the image; Position the hand cursor over the image, depress the left mouse button, and drag the mouse to obtain the desired orientation.

#### Pan/Translate

While depressing the control key <CTRL>, use the mouse and the Hand cursor to directly pan the image. Position the hand cursor over the image, depress the left mouse button, depress the control key, and drag the mouse to move the image to the desired location.

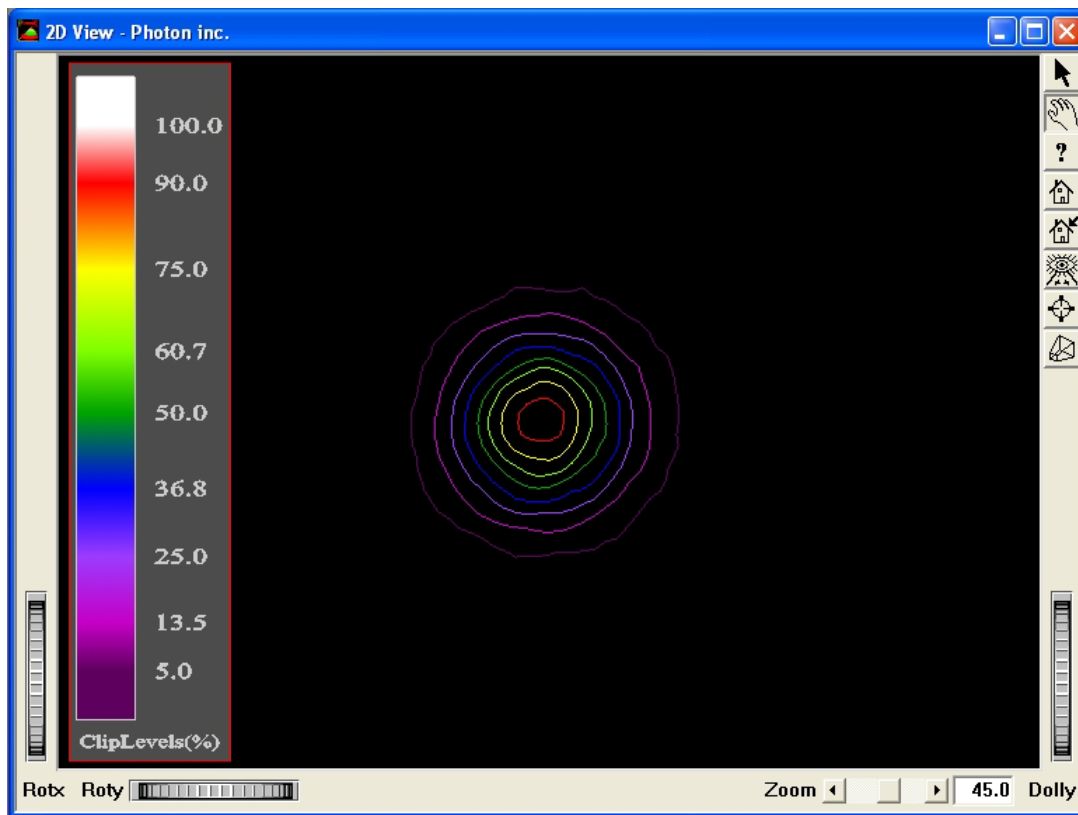
#### Zoom

The method for zooming the image depends on the type of display projection selected. In the Perspective projection mode, use either the zoom control scroll bar at the bottom of the window, or use the **Dolly** thumbwheel at the lower right border of the window. In the **Orthographic** projection mode, use the **Zoom** thumbwheel at the lower right border of the window. You can also zoom by using the mouse. To zoom in (out) hold the Ctrl+Shift keys down and drag the mouse toward (away from) the center while holding the left mouse button.

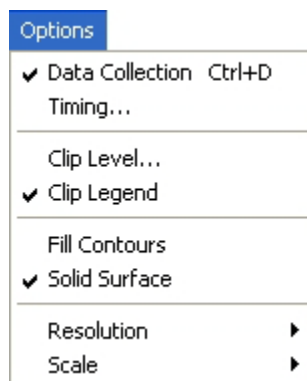


### 4.5.4. 2D Contour

The **2D Contour** window displays the laser beam image with user specified contour overlays. An example of the **2D Contour** window is shown below.



The **Options** menu available when the **2D Contour** window is active is shown below.



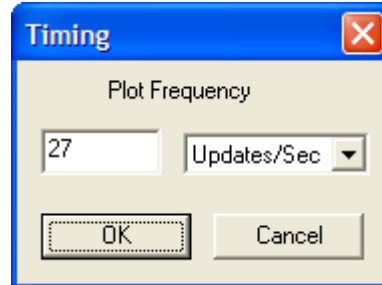
The selections are:

**Data Collection**

Turns data collection on and off.

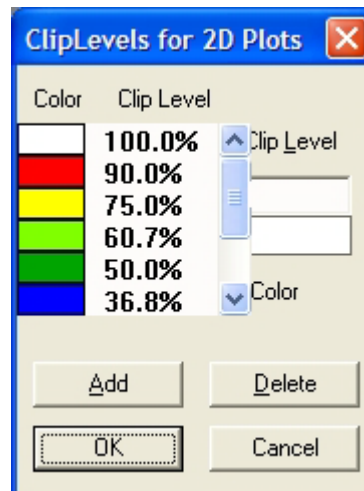
**Timing...**

Opens a dialog box for selection of the display update rate.



**Clip Level...**

Opens a dialog for selecting clip level contours and their colors.



This option is not available for data displayed using the logarithmic scale. In this case, the contour levels are fixed at the 0, -3, -5, -10, -13, -20, -23, -30, and the -33 dB levels.

**Clip Legend**

When selected, the **Clip Level** legend will be displayed in the view.

**Fill Contours**

When selected, the different clip levels on the beam will be clearly delineated. Please be aware that this option will slow the acquisition rate of the system.

**Solid Surface**

When selected, the image will have a solid surface. When not selected, the image will be rendered as a wireframe.

## Resolution

Opens a menu for selecting the resolution of the 3D display. Choices are: **High**, **Medium**, and **Low**. Data update rate is reduced and image manipulation is slower as resolution is increased.



## Scale

Allows the user to choose between a **Linear** and a **Logarithmic** scale.



The toolbar at the right border of the window contains 8 buttons used to select several viewing and image manipulation features. These buttons are, from top to bottom:



Chooses the **Arrow** cursor, which allows image manipulation only using the mouse and the thumbwheel controls.



Chooses the **Hand** cursor, which allows image manipulation using the mouse directly in the image or by using the thumbwheel controls. (When the mouse is moved to the window border the **Hand** cursor changes to the **Arrow** cursor).



This **Help** menu is inactive.



Resets the view to a preset **Home** default position, size and orientation.



Sets the default settings for the **Home** button.



Restores the view to include the entire image.



Activates the **Seek** cursor. After positioning this cursor on a selected point in the image and clicking the left mouse button, a close-up zoom to that point will be performed automatically. Also, the center of rotation will be set to that point.



Toggles between the **Perspective** and **Orthographic** projection modes.



There are also three thumbwheels along the window border, designated **Dolly**, **Rotx**, and **Roty**, which are used to zoom and rotate the image.

The image can be rotated, translated, panned, and zoomed using the mouse with the Arrow cursor and the thumbwheel control knobs or using the mouse with the Hand cursor, as described below.

#### Rotation

Rotate the image using the mouse and the **Arrow** cursor with the thumbwheels labeled **Rotx** and **Roty**. Alternatively, use the mouse and the **Hand** cursor to directly rotate the image; Position the hand cursor over the image, depress the left mouse button, and drag the mouse to obtain the desired orientation.

#### Pan/Translate

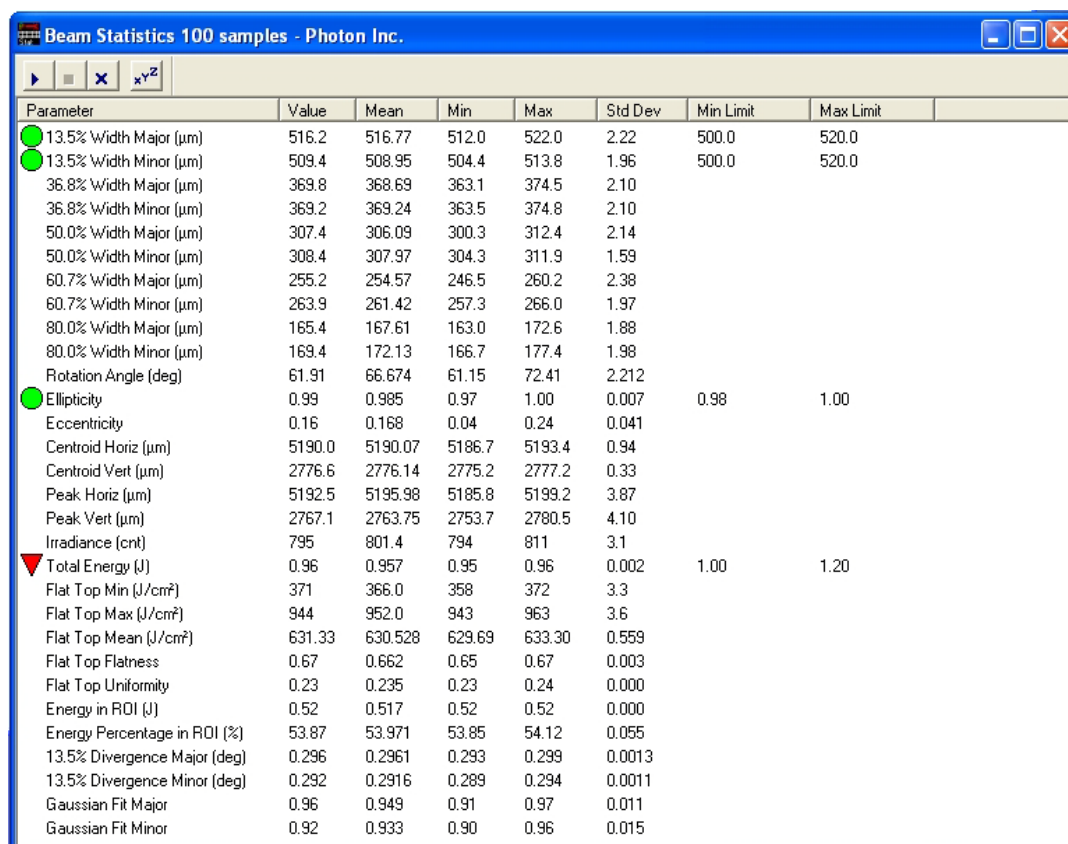
While depressing the control key <CTRL>, use the mouse and the Hand cursor to directly pan the image. Position the hand cursor over the image, depress the left mouse button, depress the control key, and drag the mouse to move the image to the desired location.

#### Zoom

The method for zooming the image depends on the type of display projection selected. In the Perspective projection mode, use either the zoom control scroll bar at the bottom of the window, or use the **Dolly** thumbwheel at the lower right border of the window. In the **Orthographic** projection mode, use the **Zoom** thumbwheel at the lower right border of the window. You can also zoom by using the mouse. To zoom in or out hold the Ctrl + Shift keys down and drag the mouse toward (away from) the center while holding the left mouse button.

### 4.5.5. Beam Statistics

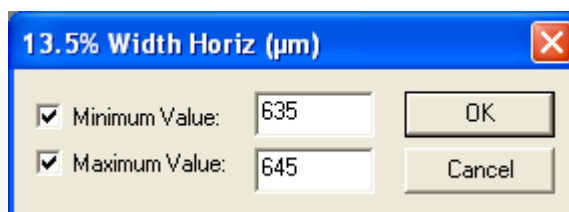
The **Beam Statistics** window, as shown below, displays a tabular summary of beam parameters and statistics. Any or all of the computed beam parameters set up in the **Data Analysis** dialog may be viewed in this way. It is also used for Limit Analysis. The parameters for viewing are selected in the **Beam Statistics Parameters** dialog box.



Parameter	Value	Mean	Min	Max	Std Dev	Min Limit	Max Limit
13.5% Width Major (μm)	516.2	516.77	512.0	522.0	2.22	500.0	520.0
13.5% Width Minor (μm)	509.4	508.95	504.4	513.8	1.96	500.0	520.0
36.8% Width Major (μm)	369.8	368.69	363.1	374.5	2.10		
36.8% Width Minor (μm)	369.2	369.24	363.5	374.8	2.10		
50.0% Width Major (μm)	307.4	306.09	300.3	312.4	2.14		
50.0% Width Minor (μm)	308.4	307.97	304.3	311.9	1.59		
60.7% Width Major (μm)	255.2	254.57	246.5	260.2	2.38		
60.7% Width Minor (μm)	263.9	261.42	257.3	266.0	1.97		
80.0% Width Major (μm)	165.4	167.61	163.0	172.6	1.88		
80.0% Width Minor (μm)	169.4	172.13	166.7	177.4	1.98		
Rotation Angle (deg)	61.91	66.674	61.15	72.41	2.212		
Ellipticity	0.99	0.985	0.97	1.00	0.007	0.98	1.00
Eccentricity	0.16	0.168	0.04	0.24	0.041		
Centroid Horiz (μm)	5190.0	5190.07	5186.7	5193.4	0.94		
Centroid Vert (μm)	2776.6	2776.14	2775.2	2777.2	0.33		
Peak Horiz (μm)	5192.5	5195.98	5185.8	5199.2	3.87		
Peak Vert (μm)	2767.1	2763.75	2753.7	2780.5	4.10		
Irradiance (cnt)	795	801.4	794	811	3.1		
Total Energy (J)	0.96	0.957	0.95	0.96	0.002	1.00	1.20
Flat Top Min (J/cm²)	371	366.0	358	372	3.3		
Flat Top Max (J/cm²)	944	952.0	943	963	3.6		
Flat Top Mean (J/cm²)	631.33	630.528	629.69	633.30	0.559		
Flat Top Flatness	0.67	0.662	0.65	0.67	0.003		
Flat Top Uniformity	0.23	0.235	0.23	0.24	0.000		
Energy in ROI (J)	0.52	0.517	0.52	0.52	0.000		
Energy Percentage in ROI (%)	53.87	53.971	53.85	54.12	0.055		
13.5% Divergence Major (deg)	0.296	0.2961	0.293	0.299	0.0013		
13.5% Divergence Minor (deg)	0.292	0.2916	0.289	0.294	0.0011		
Gaussian Fit Major	0.96	0.949	0.91	0.97	0.011		
Gaussian Fit Minor	0.92	0.933	0.90	0.96	0.015		

### Limit Analysis

Limit analysis can be performed on any of the parameters reported in the **Beam Statistics** window. The parameters are checked against user specified maximum and/or minimum values and the result of the analysis is displayed using icons in the **Beam Statistics** window, as shown above. To configure the analysis, either double click with the left mouse button on the desired parameter, or, alternatively, use the **Up/Down Arrow** keys to highlight the parameter and then press the **Space** key. This will open the following dialog box for setting the parameter limits for the analysis.






**13.5% Width Horiz (μm)**

☒ Minimum Value: 635

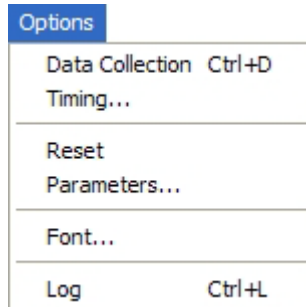
☒ Maximum Value: 645

OK Cancel

Either one or both limits can be set. The icons for reporting the analysis are:

-  Parameter value is within the set limit or limits.
-  Parameter value is greater than the maximum limit.
-  Parameter value is less than the minimum limit.

The **Options** menu available when the **Beam Statistics** window is active offers the following selections:

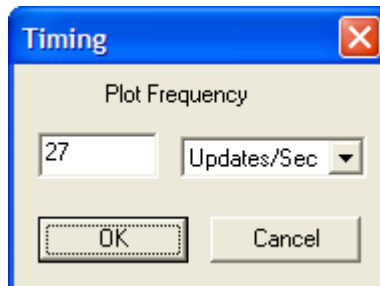


**Data Collection**

Turns data collection on and off.

**Timing...**

Opens a dialog box for selection of the display update rate.



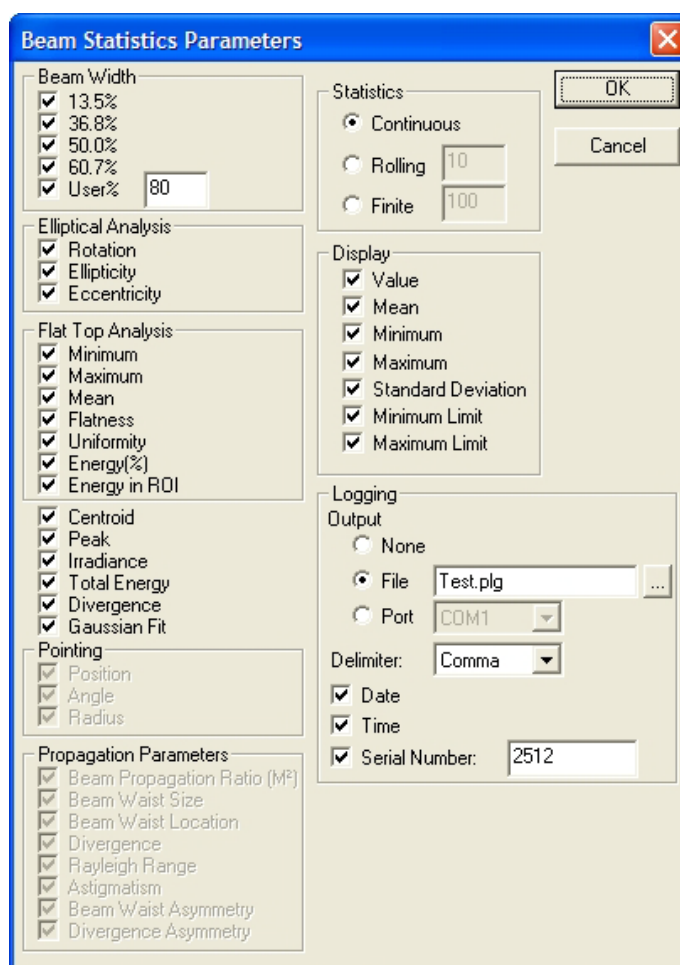
**Reset**

Resets the Beam Statistics table.

**Parameters...**

Opens the **Beam Statistics Parameters** dialog, shown below, for selecting the parameters to be listed in the Beam Statistics table. Parameters available for selection are determined by the selections made in the **Data Analysis** dialog. Those parameters that are unavailable for display are grayed out in the dialog box. This dialog is also used to select which statistical quantities to list in the table for each parameter selected and how the statistics will be calculated. All the parameters are computed in accordance with ISO Standards. In addition, the setup for data logging to files or serial communication ports is made here.

Selection options in the **Beam Statistics Parameters** dialog box are listed below.



**Note:** If a selection is not available or grayed out in this box, that option must first be turned on in the **Data Analysis** dialog box. In order to do this, go to **Data Collection**, select **Data Analysis** and then mark the appropriate selection.

### **Beam Width**

(when D slit is selected in the Data Analysis Dialog Box for ISO Profiles)

13.5%	Beam diameter at 13.5% cliplevel, horizontal and vertical or major and minor axes.
36.8%	Beam diameter at 36.8% cliplevel, horizontal and vertical or major and minor axes.
50.0%	Beam diameter at 50% cliplevel, horizontal and vertical or major and minor axes.
60.7%	Beam diameter at 60.7% cliplevel, horizontal and vertical or major and minor axes.
User %	Beam Diameter at the User Specified clip level

	value, horizontal and vertical or major and minor axes.
<b>Beam Energy</b>	(when D energy is selected in the Data Analysis Dialog Box for ISO Profiles)
86.5%	Beam diameter containing 86.5% of total energy, horizontal and vertical or major and minor axes.
63.2%	Beam diameter containing 63.2% of total energy, horizontal and vertical or major and minor axes.
50.0%	Beam diameter containing 50% of total energy, horizontal and vertical or major and minor axes.
39.3%	Beam diameter containing 39.3% of total energy, horizontal and vertical or major and minor axes.
User %	Beam diameter containing the user specified total energy, horizontal and vertical or major and minor axes.
<b>Beam Width</b>	(when D 4Sigma is selected in the Data Analysis Dialog Box for ISO Profiles)
4Sigma	Second-moment beam diameter, horizontal and vertical or major and minor axes.
<b>Elliptical Analysis</b>	
Rotation	Angle of the major axis with respect to horizontal.
Ellipticity	Ellipticity Factor.
Eccentricity	Eccentricity Factor.
<b>Flat Top Analysis</b>	
Min	Minimum value in the Energy ROI.
Max	Maximum value in the Energy ROI.
Mean	Mean value in the Energy ROI.
Flatness	Flatness Factor.
Uniformity	Uniformity Factor.
Energy %	The percentage of Beam Area total energy or power in the Energy ROI.
Energy in ROI	The energy or power in the Energy ROI.



<b>Centroid</b>	Location of the beam centroid reported in microns ( $\mu\text{m}$ ) from the upper left corner of the image in the Beam Area.
<b>Peak</b>	Location of the peak of the image in the Beam Area.
<b>Irradiance</b>	The value of the irradiance at the peak location.
<b>Total Energy</b>	The value of the total energy or power in the Beam Area.
<b>Divergence</b>	Beam Divergence angle
<b>Gaussian Fit</b>	Gaussian Goodness-of-Fit Value.
<b>Pointing</b>	
<i>Position</i>	The beam area Centroid from the <b>Pointing</b> window.
<i>Angle</i>	The pointing angle from the <b>Pointing</b> window.
<i>Radius</i>	Distance from the reference position in the <b>Pointing</b> window.
<b>Statistics</b>	
<i>Continuous</i>	Selects a continuous average of data samples.
<i>Rolling</i>	Selects a rolling average with user-specified number of samples.
<i>Finite</i>	Selects a finite average with user-specified number of samples.
<b>Display</b>	
<i>Value</i>	Selects display of the present value of the beam parameter.
<i>Mean</i>	Selects display of the mean value of the beam parameter.
<i>Min</i>	Selects display of the minimum value of the beam parameter.
<i>Max</i>	Selects display of the maximum value of the beam parameter.
<i>Std Dev</i>	Selects display of the standard deviation of the beam parameter.
<i>Min Limit</i>	Selects display of the minimum limit value of the beam parameter set in Limit Analysis.

*Max Limit*

Selects display of the maximum limit value of the beam parameter set in Limit Analysis.

**Logging***Output*

None

No data logging.

File

Data logging to specified file.



Opens a **Save As** dialog box for selecting the path and file name for the log file. After you click OK the full path and file name will be displayed in the File edit box.

Port

Data logging to serial port (COM).

*Delimiter*

Date

Selects the delimiter format for the logged data. If selected, the date is attached to the logged file.

Time

If selected, the time is attached to the logged file.

Serial  
Number

If selected, the specified serial number is attached to the logged file.

**Font...**

Opens a dialog box for selecting the type and size.

**Log**

If data logging is enabled, one additional set of data is acquired and then displayed and/or logged to the file. If data collection is disabled for the **Beam Statistics** window, it allows the user to take individual data one set at a time and log into a file. The Hot Key 'Ctrl+L' enables logging even if another window is active as long as the **Beam Statistics** is open.

Some of the options can also be selected from the **Beam Statistics** window toolbar:



Starts data collection



Stops data collection

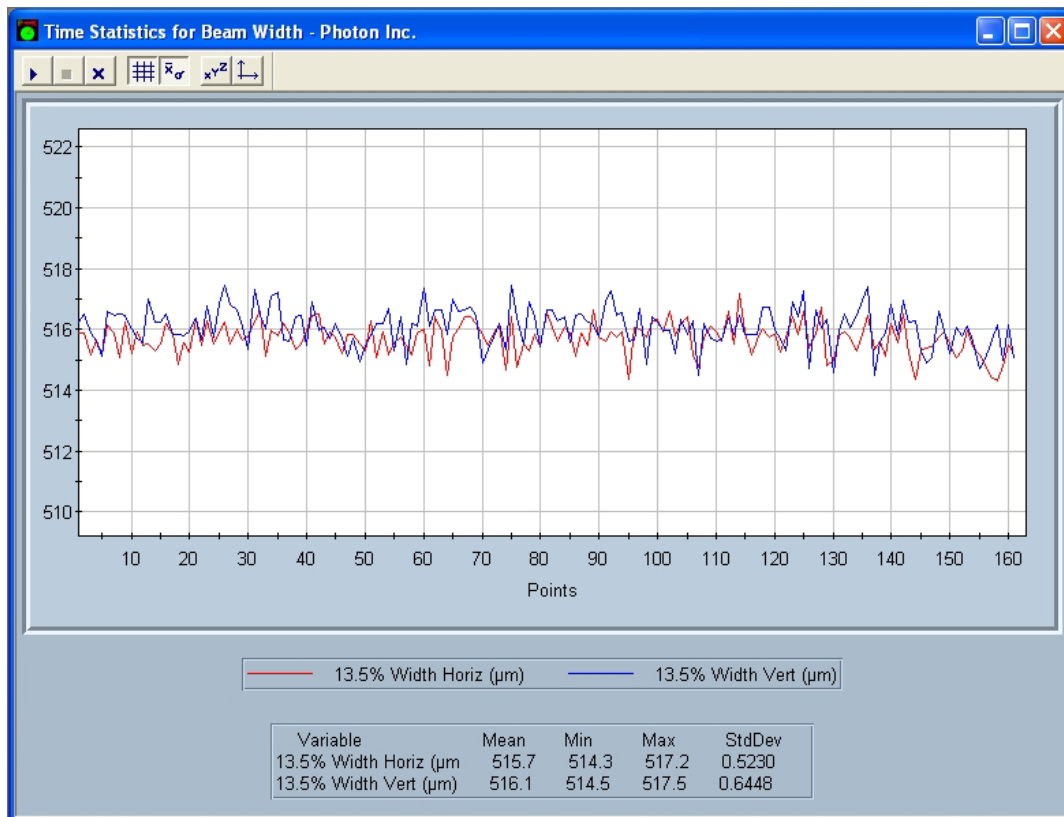


Resets the Beam Statistics table

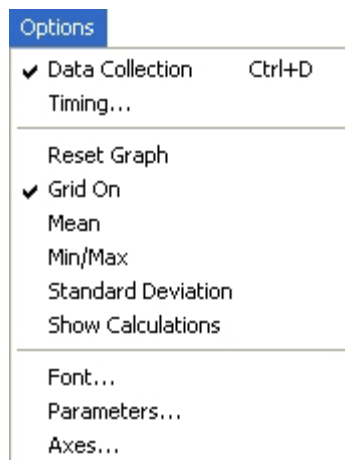
Opens Beam **Statistics Parameters** dialog

### 4.5.6. Time Statistics

The **Time Statistics** windows display strip charts of beam parameters versus time. Any or all computed beam parameters may be viewed in this way. Up to 15 **Time Statistics** windows can be opened. Several overlays are available in the **Options** menu, including grids, statistical markers, and numerical statistical summaries.



The **Options** menu available when the **Time Statistics** windows are active offer the following selections:

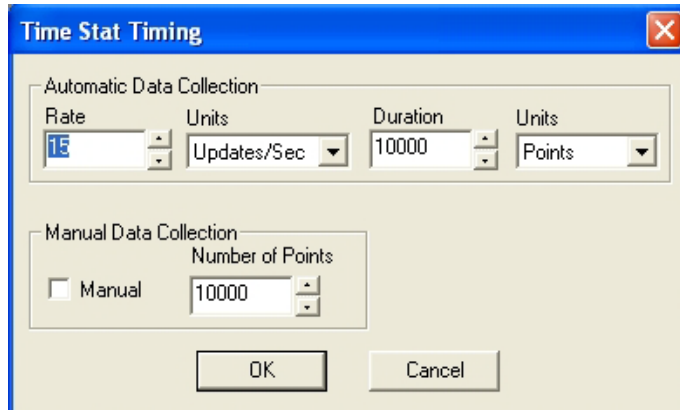


**Data Collection**

Turns data collection on and off.

**Timing...**

Opens a dialog box for selection of the display update rate and for how long data will be acquired in the active chart. If **Manual** is checked, one set of data points will be acquired each time the user selects **Data Collection**.

**Reset Graph**

Resets the active **Time Statistics** window. (A message prompt warns the user that old data will be lost).

**Grid On**

When selected, a grid overlay is displayed on the **Time Statistics** graph.

**Mean**

When selected, an overlay plot of the mean value is displayed.

**Min/Max**

When selected, overlay plots of the minimum and maximum values are displayed.

**Standard Deviation**

When selected, an overlay plot of the standard deviation is displayed.

**Show Calculations**

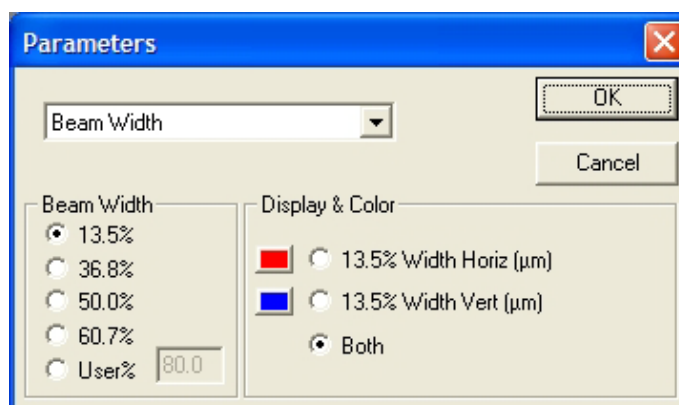
When selected, the numerical values of the mean, minimum, maximum, and standard deviation values are displayed beneath the plot area.

**Font...**

Opens a dialog box for selecting the font type and size used in the chart.

**Parameters...**

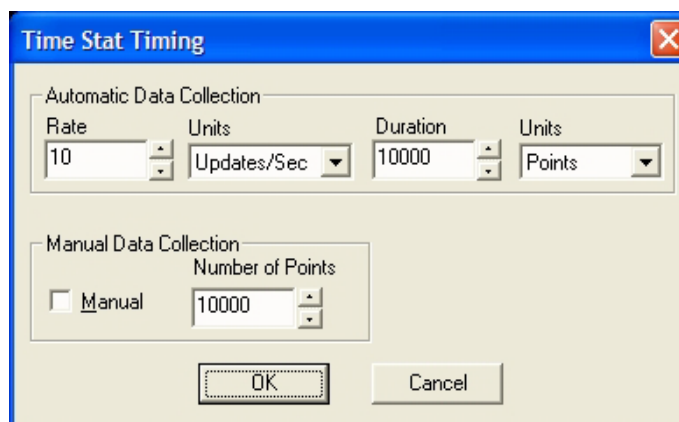
Opens the **Parameters** dialog box for selecting parameters to be plotted in the active **Time Statistics** window.



The choice of parameters are limited to those which are presently being computed, as set up in the **Data Analysis** dialog accessed in the **Data Collection** menu. These are the same parameters available to the **Beam Statistics** window. In addition to selecting the parameters to be plotted, this dialog is used to set the color of the plotted lines.








**Axes...**

Opens a dialog box for selection of manual or automatic configuration of the axes in the **Time Statistics** display.



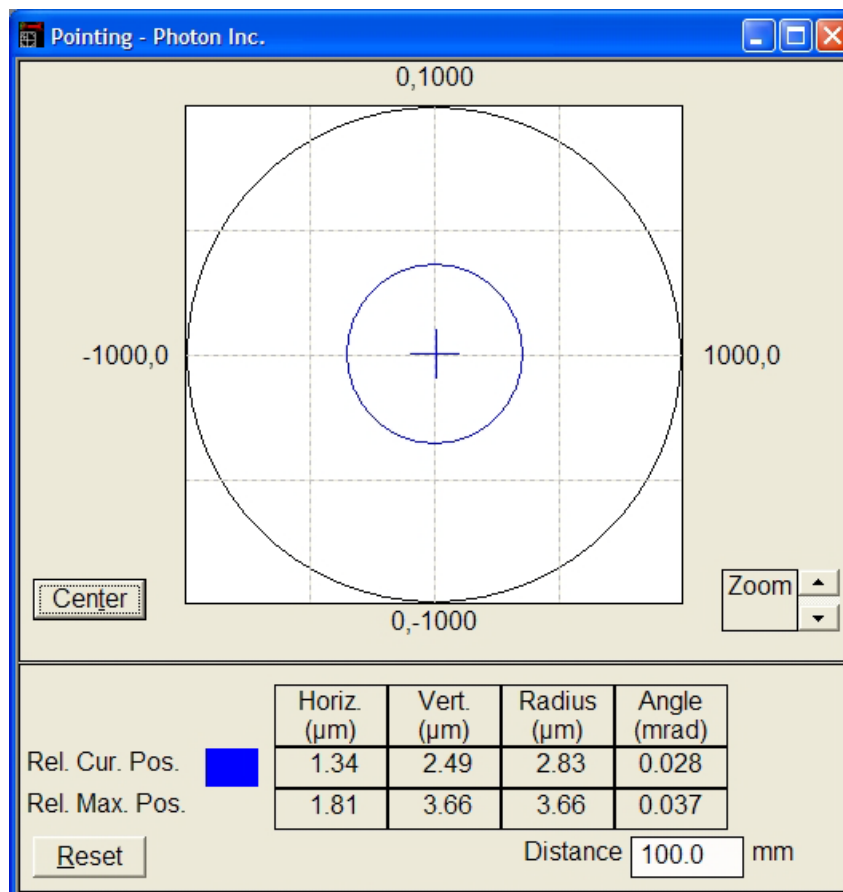
Some of the options can be selected using the **Time Statistics** window toolbar:



-  **Starts** data collection
-  **Stops** data collection
-  **Resets** the Time Statistics graph
-  **Grid overlay** on/off
-  **Statistical calculations overlay** on/off
-  Opens **Time Statistics Parameters** dialog
-  Opens the **Time Stat Axes** dialog

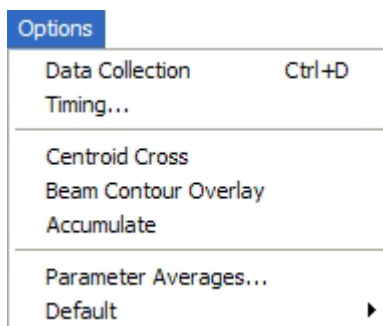
### 4.5.7. Pointing

The **Pointing** window displays a screen that shows and tracks the location of the beam centroid with a colored dot or cross. An example is shown below.



It also displays a table showing the relative current position and the relative maximum position in the horizontal, vertical, and radial directions, and the corresponding angular displacement. Clicking on the colored box in the window opens a color selection dialog for choosing the color of the beam dot or cross indicator. A zoom control allows the user to scale the aperture of the pointing screen.

The **Options** menu available when the **Pointing** window is active is shown below.



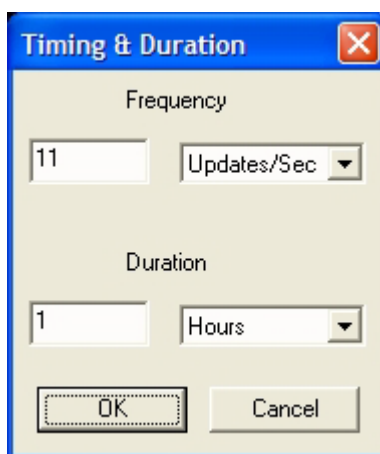
The selections are:

**Data Collection**

Turns data collection on and off.

**Timing...**

Opens a dialog box for selection of the display update rate and for how long the window will update.



**Centroid Cross**

Selects the cross indicator for the centroid. If not selected the indicator is a dot.

**Beam Contour Overlay**

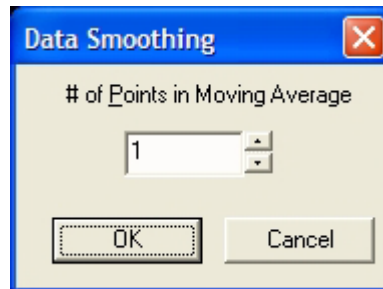
When selected, a beam contour overlay is drawn around the current centroid value. The overlay is a circle or ellipse with the  $1/e^2$  width of the beam.

**Accumulate**

Turns on the **Accumulate** mode, which displays centroid values for all subsequent data on the same plot, allowing observation of beam movement.

**Parameter Averages...**

Opens a dialog for setting the number of points to be used in a moving average of the centroid position value.

**Default****Load**

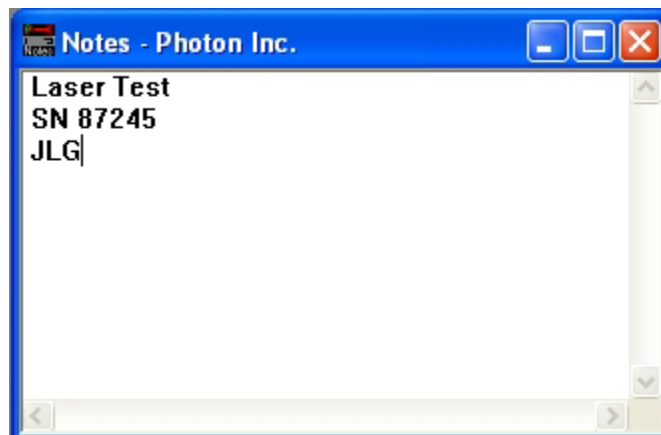
Opens a dialog for loading a previously saved pointing screen setup.

**Save**

Opens a dialog for saving a pointing screen setup.

### 4.5.8. Notes

The **Notes** window is used for entering user information. When active, a cursor appears in the **Notes** window. Use the keyboard to enter text, and the arrow keys to navigate. There are no options available for the **Notes** window.





### 4.5.9. K-Factor (M<sup>2</sup>) Wizard

The **K-Factor Wizard** window is an interactive program for determining the K-factor by the Rayleigh Method. The **K-Factor Wizard** window is a series of dialog boxes that prompt and guide the user through a series of measurements and data entries required for calculating the K-factor and M<sup>2</sup>. The calculated values are displayed in the final dialog box.

**K Factor Wizard - Photon Inc.**

Step 1: Beamwaist Measurement

Enter the laser wavelength in nanometers.  
Clear the values of D\_min using Reset.

Slowly translate the camera through the lens focal region.  
The minimum beamwaist diameters are automatically entered.

The current values of the beam diameter, D\_current, are shown below D\_min.

Wavelength  nm

Aperture 1      Aperture 2

D min  um

D current      um

Setup the laser and sensor so that you can easily move the sensor along the Z-axis (nearer or farther from the laser). Then start the K-Factor wizard. Follow the instructions that appear. Measurements are performed for each aperture independently to allow for astigmatism and ellipticity. Upon completing each step, select the **Next** button to continue. If you make a mistake select the **Previous** button and redo that step. When you have completed all of the steps, the wizard will display the results. It's that easy!

For more information, please read **Application Note 230** available from your Photon Inc. representative or the Photon website, [www.photon-inc.com](http://www.photon-inc.com).

The formula is:

$$K = \frac{2\lambda \times 2Z_r}{\pi \times D_{min}^2} \quad \text{or} \quad M^2 = \frac{1}{K}$$

where:

$\lambda$  wavelength in nm

$2Z_r$   $|Z_{max} - Z_{min}|$  – Rayleigh range

$D_{min}$  Beam diameter in the beam waist

$Z_{max}$  Distance along  $Z$  axis where beam diameter is  $1.414 \times D_{min}$   
(distal to test lens or laser)

$Z_{min}$  Distance along  $Z$  axis on the other side of the waist where  
beam diameter is  $1.414 \times D_{min}$  (proximal to test lens or laser)

#### 4.5.9.1. Measuring the K-Factor

The K-Factor is a propagation constant for a laser source defined in the ISO standard as

$$K = \frac{1}{M^2} = \frac{2\lambda \times 2Z_r}{\pi \times D_{min}^2}$$

Physically,  $M$  can be thought of as a factor times the diffraction limit. For example, if one calculates the diffraction limit for a particular lens, the source with an  $M = 1.2$  will produce a spot width 1.2 times the theoretical calculated value.

The ISO standard requires 10 beam measurements and a curve-fitting algorithm. A faster method, called the Rayleigh method, provides accurate result with only 3 measurements.

The Rayleigh Method can easily be derived from the definitions and gives fast, highly accurate and repeatable K-Factor values. This method requires you to measure twice the Rayleigh length for a source. A long focal length lens (high  $F\# \geq 20$ ) should be used. You also need the wavelength and the minimum observed beam width,  $D_{min}$ , while sweeping through the beam waist.

#### 4.5.9.2. Lens Selection and the Expected Rayleigh Length

How does one select a focusing lens? How does one determine the Rayleigh distance for a source and a lens?

We have found that the distance along the beam axis can be measured to the nearest 1/2mm if one selects a focused beam size from 80mm to 200mm ( $1/e^2$ ) beam width.

**Example:**

Source nearly collimated wavelength  $0.7\mu\text{m}$  and approximate exit beam width is  $500\mu\text{m}$  ( $1/e^2$ ).

The divergence for a diffraction limited source ( $M = K = 1$ ) will be:

$$\theta = \frac{4 \times \lambda}{\pi \times D}; \quad \theta = \frac{4 \times 0.7\mu\text{m}}{\pi \times 500\mu\text{m}} = 0.0018\text{rad};$$

We can select the lens by assuming:

$$d = f \times \theta$$

or, if we want the predicted waist diameter  $d$  near the focal plane to be  $125\mu\text{m}$ , the required focal length is:

$$f = \frac{125\mu\text{m}}{0.0018} = 69,444\mu\text{m} \text{ or } 69\text{mm}$$

Let's use a 75mm lens, which is more commonly found in a laboratory. The expected spot size is:

$$d = f \times \theta = 75,000\mu\text{m} \times 0.0018 = 135\mu\text{m}$$

The expected Rayleigh length in the region of the waist will be:

$$Z = \frac{\pi}{4} \times \frac{d^2}{\lambda}$$

where,  $d$  is the above  $135\mu\text{m}$  calculated spot width.

$$Z = \frac{0.7854 \times 135\mu\text{m}^2}{0.7\mu\text{m}} = 20,448\mu\text{m} \text{ or } 20.4\text{mm}$$

$$2Z = 40,896\mu\text{m} \text{ or } 40.8\text{mm}$$

Thus we have a rough starting point for K-Factor measurements. If the K-Factor is much less than 1.0, the spot size will be larger than calculated and the Rayleigh length will be less than calculated. What is important is that by using the diffraction limited case one has a starting point. We suggest that one try this method with a small visible HeNe laser which is nearly always close to  $K=1$  to gain an appreciation for the method before trying an unknown source. If you get close to one with the HeNe source, you will have the measurement method understood! If you get  $K>1.0$ , recheck alignment and go through the waist slowly enough to allow the software time to select the correct minimum waist.

### 4.5.9.3. Alignment

To measure K-Factor, the user should position the sensor in the beam waist. Setup the laser and the sensor so the sensor can easily move along the Z-axis. This alignment is extremely important for getting accurate results!

#### **Alignment of the sensor and laser beam without the focusing lens:**

Before inserting the lens into the path, align the sensor axial travel motion parallel to the axis of the laser. We suggest that the non-alignment be no more than a couple of beam widths. For the example laser above, this would be  $\pm 500$  microns. The **Pointing** window can be used to measure the misalignment over the Rayleigh range.

For the example source (previous section) this means one should see no more than  $\pm 500\mu\text{m}$  motion either X or Y as one translates the sensor along the beam axis through a distance of  $2Z$  (or 41mm for our example).

**Note!** *Move slowly through the waist region so the software can keep up with the measurement process.*

### 4.5.9.4. Insert the lens

Once the sensor and source are aligned, insert and center the lens into the beam path. Now translate the sensor through the  $2Z$  length and again try to keep the cross translation to less than  $\pm 1-2$  beam widths. For the example beam, use the calculated  $135\mu\text{m}$  as a goal.

Be sure the lens is well centered or you will be measuring the lens aberration as well as the K-Factor for the source. With a visible source, one can usually observe a back reflection from both lens surfaces. Place the back-reflected beams just slightly to the side of the laser exit aperture. Sending the reflections back into the source may cause laser oscillations due to interference.

Another centering approach is to use a machined centered removable aperture stop just before the lens. This could fit into the lens mount during alignment and be removed before measurements. Direct the beam through this small aperture (our source example uses a 2mm hole) during alignment. Be sure to remove the stop once aligned to prevent truncation of the source and consequently errors in measured K-Factors.

Now you are ready to use the K-Factor Wizard.

#### 4.5.9.5. Rayleigh Test Fixture Accessory

Photon offers an accessory, a Rayleigh Test Fixture, which consists of a base plate, a slide that allows manual sensor axial [ $Z$ ] translation and an LCD measurement ruler. The base plate is rigidly mounted to an optical table or rail. The translation distance readout is a Mitutoyo LCD ruler that spans 150mm of travel and gives position values to the nearest 25 $\mu$ m. The total 150mm travel allows the Rayleigh range to be such that a beam waist of approximately 200 $\mu$ m can be measured.

The Mitutoyo scale can be zeroed at the first Rayleigh location, translated to the second to find a single direct read number in mm units to be inserted into the Wizard software. This accessory's purpose is to make measurements of the Rayleigh range very easy and very repeatable. The user provides a source, a focusing lens and mount.

#### Example Using the Rayleigh Test Fixture Accessory:

1. Move the sensor to  $D$  Target for Aperture 1. Reset the Mitutoyo scale. Enter 0 for  $Z$  Position 1 under the Aperture 1 heading.
2. Move the sensor to  $D$  Target for Aperture 2. Enter 10 for  $Z$  Position 1 under the Aperture 2 heading. Select the Next button.
3. Move slowly through the waist for Aperture 1 and verify the  $D_{min}$  is correct.
4. Move slowly through the waist for Aperture 2 and verify the  $D_{min}$  is correct.
5. Move the sensor to  $D$  Target for Aperture 1. Enter 24 for  $Z$  Position 2 under the Aperture 1 heading.
6. Move the sensor to  $D$  Target for Aperture 2. Enter 30 for  $Z$  Position 2 under the Aperture 2 heading. Select the Next button.

#### 4.5.10. Measurement

The **Measurement** window is available only with ModeScan Model 1780.

## 4.6. Toolbars

Toolbars are provided to speed access to some of the most commonly used operations and features of the FireWire BeamPro Acquisition and Analysis Software. Instead of accessing these features through the pulldown menus, simply click on the appropriate icon buttons on the toolbars. The operations and features include: opening windows, turning data collection on and off, selecting the acquisition mode, turning **Autotracking** on and off, and selecting options. In addition, some file handling operations such as opening and saving files, opening new files and printing can be initiated in this way. General program features are accessed on the main toolbar, while option features for the **Video** window, **Profile** window, **Beam Statistics** window, and **Time Statistics** window are accessed on window toolbars. The toolbars and descriptions of their icon buttons and functions are given below.

For user convenience and preference, toolbars can be placed at different screen locations by dragging and dropping.

### 4.6.1. The Main Toolbar



	Opens a new file
	Opens the <b>Open</b> file dialog
	Saves the current file
	Opens the <b>Print</b> dialog
	Opens specific <b>Help</b> topics (currently inactive)
	Turns <b>Autotracking</b> on/off
	Turns <b>Track Settings</b> on/off (currently inactive)
	Turns <b>Global Data Collection</b> on/off
	Opens the <b>Calibration</b> dialog (also indicates the calibration status)



Sets system to **Laser Positioning** mode



Sets system to **Analysis** mode



Sets system to **Single Shot** mode



Opens the **Profile** window



Opens the **Video** window



Opens the **3D Profile** window. Up to 5 2D and 3D windows combined can be opened.



Opens the **2D Contour** window



Opens the **Beam Statistics** window



Opens the **Time Statistics** windows. Up to 15 windows can be opened simultaneously.



Opens the **Pointing** window



Opens the **K-Factor** window



Opens a **Measurement** window (available only with ModeScan Model 1780)



Opens the **Notes** window.

#### 4.6.2. The Video Window Toolbar



Set **Beam Area** drawing tool



Energy ROI: **Elliptical** region drawing tool



Energy ROI: **Circular** region drawing tool







Energy ROI: **Rectangular** region drawing tool



Energy ROI: **Square** region drawing tool





### 4.6.3. The Profile Window Toolbar



-  Starts data collection
-  Stops data collection
-  **Gaussian Fit** overlay on/off
-  Turns **Normalization** on/off








### 4.6.4. The Beam Statistics Window Toolbar



-  **Starts** data collection
-  **Stops** data collection
-  **Resets** the Beam Statistics table
-  Opens **Beam Statistics Parameters** dialog

### 4.6.5. The Time Statistics Window Toolbar

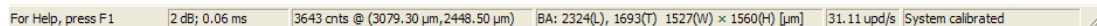


-  **Starts** data collection
-  **Stops** data collection
-  **Resets** the active Time Statistics graph
-  **Grid overlay** on/off
-  **Statistical calculations overlay** on/off
-  Opens **Time Statistics Parameters** dialog
-  Opens **Time Stat Axes** dialog



## 4.7. Status Bar

The status bar at the bottom of the screen displays the camera settings (gain and exposure), cursor location and the Beam Area information. The first pane displays the camera settings: gain (in dB) and exposure (in ms). The second pane displays the intensity in counts at the mouse cursor location (when is pointing over the Live Window), given by position coordinates in microns, from the upper left corner. The third pane displays the position coordinates of the upper left corner in the Beam Area (BA) and the dimensions in microns of the Beam Area. The fourth pane displays the update rate in frames/second while global data collection is turned on. The last pane displays information about the calibration status.



For Help, press F1 | 2 dB; 0.06 ms | 3643 cnts @ (3079.30  $\mu$ m, 2448.50  $\mu$ m) | BA: 2324(L), 1693(T) 1527(W)  $\times$  1560(H) [ $\mu$ m] | 31.11 upd/s | System calibrated

## 4.8. ActiveX Automation

FireWire BeamPro Acquisition and Analysis Software provides a Microsoft Automation interface. As an automation server, FireWire BeamPro Acquisition and Analysis Software exposes a set of methods and properties. Using ActiveX compatible programs such as LabVIEW or Microsoft Excel, a user can create his own Automation controller, which can display and process data from FireWire BeamPro Acquisition and Analysis Software.

The type library “*FWBeamPro.tlb*” file in the Automation folder where the software has been installed contains a full description of the ActiveX interface. You can open and view this file with an OLE/COM viewer program.

The properties and methods that FireWire BeamPro Analysis Software exports are explained below.

### 4.8.1. ShowWindow

#### Property Type:

VT\_BOOL – Show flag

#### Remarks:

Shows or hides the FireWire BeamPro Analysis Software main window. Call this function with TRUE if you want to show the FireWire BeamPro Analysis Software. Call this function with FALSE as parameter to hide the FireWire BeamPro Analysis Software.

### 4.8.2. AcquisitionMode

**Property Type:**

VT\_I2 – acquisition mode

**Remarks:**

Gets or sets acquisition mode.

Possible values are defined in the type library file by the SelectionAcquisitionMode enumeration:

Acquisition Mode Selection	Value	Comments
SEL_ACQMODE_ANALYSIS	0	Analysis Acquisition Mode
SEL_ACQMODE_LASERPOS	1	Laser Positioning Acquisition Mode
SEL_ACQMODE_SINGLESOT	2	Single Shot Acquisition Mode

### 4.8.3. TriggerMode

**Property Type:**

VT\_I2 – trigger mode

**Remarks:**

Gets or sets trigger mode.

Possible values are defined in the type library file by the SelectionTriggerMode enumeration:

Trigger Mode Selection	Value	Comments
SEL_TRIGGER_CW	0	Trigger Mode – CW
SEL_TRIGGER_PULSED	1	Trigger Mode – Pulsed
SEL_TRIGGER_EXT	2	Trigger Mode – External

### 4.8.4. ImageRotation

**Property Type:**

VT\_I2 – image rotation

**Remarks:**

Gets or sets the clockwise rotation of the image from the original frame. Possible values are 0, 90, 180 or 270.

### 4.8.5. ImageFlip

**Property Type:**

VT\_I2 – image flip

**Remarks:**

Gets or sets the orientation of the image with respect to Vertical and Horizontal.

Possible values are defined in the type library file by the ImageFlipSelection enumeration:

Image Flip Selection	Value	Comments
SEL_FLIP_NONE	0	Display the original frame
SEL_FLIP_HORIZ	1	Flip the image about the horizontal axis
SEL_FLIP_VERT	2	Flip the image about the vertical axis

### 4.8.6. MagnificationFactor

**Property Type:**

VT\_R4 – magnification factor

**Remarks:**

Gets or sets the external optics magnification factor. The range for the magnification factor value is between 0.01 and 1000.

### 4.8.7. Averaging

**Property Type**

VT\_I2 – average value

**Remarks:**

Gets or sets the number of frames used in averaging. The range for the average value is between 1 and 1000.

### 4.8.8. CameraExposure

**Property Type**

VT\_R4 – camera exposure

**Remarks:**

Gets or sets the exposure time for the camera, in ms. The range for the exposure value is between 0.02 to 81.90 for the Models 2518 and 2523 and between 0.02 and 27.52 for the Model 2512. The exposure increment is 0.02ms.

### 4.8.9. CameraGain

**Property Type:**

VT\_I2 – camera gain

**Remarks:**

Gets or sets the gain for the camera, in dB. The range for the gain value is between 0 and 12 for Models 2512 and 2523 and between 0 and 7 for Model 2518.

### 4.8.10. CameraAutoSettings

**Method Return Value:**

VT\_BOOL –Automatic Settings status

**Method Parameter List:**

VTI\_NONE – none

**Remarks:**

Performs a one-shot automatic setting of exposure and gain. If the operation was successful, the method returns TRUE, otherwise returns FALSE.

### 4.8.11. AngleUnits

**Property Type:**

VT\_I2 – angle units

**Remarks:**

Gets or sets the units used for reporting all the angles. Possible values are defined in the type library file by the SelectionAngleUnits enumeration:

Angle Units Selection	Value	Comments
SEL_ANGLE_UNITS_MRAD	0	Reports all the angles in milliradians
SEL_ANGLE_UNITS_DEG	1	Reports all the angles in degrees

### 4.8.12. GlobalDataCollection

**Property Type:**

VT\_BOOL – global data collection

**Remarks:**

Starts or stops global data collection and queries the state of it.

### 4.8.13. AutoTracking

**Property Type:**

VT\_BOOL – auto track

**Remarks:**

Enables or disables the auto track feature and queries the state of it.

#### 4.8.14. SetBeamArea

**Method Return Value:**

VT\_BOOL – TRUE if Beam Area has been modified successfully, FALSE otherwise.

**Method Parameter List:**

VT\_S\_R4 – left

VT\_S\_R4 – right

VT\_S\_R4 – top

VT\_S\_R4 – bottom

**Remarks:**

Sets a manual Beam Area. Turn AutoTrack off before you use this function, otherwise the Beam Area may change automatically while the software is trying to track the beam. The parameter list values are the coordinates of the Beam Area rectangle in microns, from the upper left corner of the array (which is (0,0)). If the Beam Area cannot be set (the coordinates are not within the array range), the return value is FALSE. If the Beam Area has been modified successfully, the return value is TRUE.

#### 4.8.15. GetBeamArea

**Method Return Value:**

VT\_BOOL – Beam Area status

**Method Parameter List:**

VT\_S\_PR4 – left

VT\_S\_PR4 – top

VT\_S\_PR4 – right

VT\_S\_PR4 – bottom

**Remarks:**

Gets the Beam Area coordinates. The parameter list values are the coordinates of the Beam Area rectangle in microns, from the upper left corner of the array (which is (0, 0) ). If there is no Beam Area the return value is FALSE. If there is a valid Beam Area the return value is TRUE.

#### 4.8.16. DoCalibration

**Method Return Value:**

VT\_BOOL – TRUE if calibration was successfully, FALSE otherwise.

**Method Parameter List:**

VTS\_NONE – none

**Remarks:**

Performs a calibration routine for the camera.

#### 4.8.17. IsCalibrated

**Method Return Value:**

VT\_BOOL - calibration status.

**Method Parameter List:**

VTSPDATE – date when the system calibration occurred.

**Remarks:**

This method returns the calibration status of the system.

#### 4.8.18. BackgroundCorrection

**Property Type:**

VT\_I2 – background correction method

**Remarks:**

Gets or sets the method used for subtracting the camera background.

Possible values are defined in the type library file by the SelectionBackgroundSubtraction enumeration:

Acquisition Resolution Selection	Value	Comments
SEL_BKGND_NONE	0	No background subtraction
SEL_BKGND_FRAME	1	Frame subtraction
SEL_BKGND_MEAN	2	Mean subtraction

#### 4.8.19. ComputationsDone

**Property Type:**

VT\_BOOL – computations status

**Remarks:**

Gets or sets the status of the frame computation. If this flag is TRUE that means that at least one frame was acquired and processed. Set this flag to FALSE before initiate a data acquisition and then wait until the state is TRUE in order to be sure a new frame was acquired and processed.

### 4.8.20. Recompute

**Method Return Value:**

VT\_EMPTY – none

**Method Parameter List:**

VT\_NONE – none

**Remarks:**

Redo computations for selected parameters based on the current settings. Computations are done on the image data that is currently in memory.

### 4.8.21. IsSaturated

**Method Return Value:**

VT\_BOOL – saturation flag

**Method Parameter List:**

VT\_NONE – none

**Remarks:**

Returns TRUE if signal is saturated, FALSE otherwise.

### 4.8.22. ISOWidthMethod

**Property Type:**

VT\_I2 – method for computing beam width

**Remarks:**

Gets or sets the method used for computing beam widths.

If the 4Sigma method is selected, only the  $1/e^2$  clip level beam width is computed.

Possible values are defined in the type library file by the SelectionISOWidth enumeration:

ISO Width Method Selection	Value	Comments
SEL_ISO_D_SLIT	1	Slit method used for computing beam widths.
SEL_ISO_D_ENERGY	2	Encircled energy method used for computing beam widths.
SEL_ISO_D_4SIGMA	3	Second moment method (4Sigma) used for computing beam widths.

### 4.8.23. UseCliplevel

**Method Return Value:**

VT\_EMPTY – none

**Method Parameter List:**

VTS\_R4 – cliplevel in percentage

VTS\_BOOL – use

**Remarks:**

Enables or disables beam width computation at the specified clip level.

If the selected ISO method for computing the beam width is Energy, the beam energy should be used instead of the clip level.

To enable beam width computation at a specified clip level, set the use flag to TRUE. To disable beam width computation at a specified clip level, set the use flag to FALSE.

Without this function call, the beam width numbers returned from FireWire BeamPro may not be valid.

This function has to be called only once, at the beginning of the program, before any call to GetWidth, GetEllipticity, GetEccentricity or GetPeakDivergence.

### 4.8.24. GetWidth

**Method Return Value:**

VT\_R4 – beam width

**Method Parameter List:**

VTS\_I2 – axis

VTS\_R4 – cliplevel

**Remarks:**

Returns the beam width in microns.

If the selected ISO method for computing the beam width is Energy, the beam energy should be used instead of the clip level.

Possible values for the axis are 0 and 1. If elliptical analysis has been enabled (see EllipticAnalysis), 0 represents the major axis and 1 the minor axis. Otherwise 0 is the horizontal axis and 1 the vertical axis, where horizontal and vertical are relative to the camera.

If the selected ISO method for computing the beam width is Energy, then only one beam width number is computed. In this case, the beam width values for axis 0 and axis 1 are equal.

If the selected ISO method for computing the beam width is 4Sigma, then only the beam width is computed. The specified “clip level” must be  $1/e^2$ .

To enable beam width computations for the specified clip level, UseCliplevel has to be called before the first call to GetWidth.



#### 4.8.25. GetPeakPosition

**Method Return Value:**

VT\_R4 – peak position

**Method Parameter List:**

VT\_S\_I2 – axis

**Remarks:**

Returns the peak position in microns.

Possible values for the axis are 0 and 1. If elliptical analysis has been enabled (see EllipticAnalysis), 0 represents the major axis and 1 the minor axis. Otherwise 0 is the horizontal axis and 1 the vertical axis, where horizontal and vertical are relative to the camera.

#### 4.8.26. GetCenter

**Method Return Value:**

VT\_R4 – centroid position

**Method Parameter List:**

VT\_S\_I2 – axis

**Remarks:**

Returns the centroid position in microns.

Possible values for the axis are 0 and 1. If elliptical analysis has been enabled (see EllipticAnalysis), 0 represents the major axis and 1 the minor axis. Otherwise 0 is the horizontal axis and 1 the vertical axis, where horizontal and vertical are relative to the camera.

#### 4.8.27. GetPeakIrradiance

**Method Return Value:**

VT\_I2 – peak irradiance

**Method Parameter List:**

VT\_S\_NONE – none

**Remarks:**

Returns the irradiance of the peak. Possible values are 0...4095.

### 4.8.28. EllipticAnalysis

**Property Type:**

VT\_BOOL – elliptic analysis

**Remarks:**

Gets or sets the elliptical analysis state.

If the state is TRUE, the elliptical analysis is enabled and GetRotationAngle, GetEllipticity and GetEccentricity will return valid numbers. If the state is FALSE, the elliptical analysis is disabled.

### 4.8.29. GetRotationAngle

**Method Return Value:**

VT\_R4 – rotation angle

**Method Parameter List:**

VTS\_NONE – none

**Remarks:**

Returns the orientation of the computed major axis (the angle is reported in trigonometric direction).

This function returns valid numbers only if elliptical analysis has been enabled, using EllipticAnalysis property.

### 4.8.30. GetEllipticity

**Method Return Value:**

VT\_R4 – ellipticity

**Method Parameter List:**

VTS\_R4 – cliplevel

**Remarks:**

Returns the ellipticity of the beam.

If the selected ISO method for computing the beam width is Energy, the beam energy should be used instead of the clip level. In this case, the ellipticity will be 1, because there is only one beam width value.

This function returns valid numbers only if elliptical analysis has been enabled, using EllipticAnalysis property.

Also the beam width computation for the specified clip level should have been enabled, using UseCliplevel, because the beam width numbers are used in the computation of the ellipticity.

### 4.8.31. GetEccentricity

**Method Return Value:**

VT\_R4 – eccentricity

**Method Parameter List:**

VT\_S\_R4 – cliplevel

**Remarks:**

Returns the eccentricity of the beam.

If the selected ISO method for computing the beam width is Energy, the beam energy should be used instead of the clip level. In this case, the eccentricity will be 0, because there is only one beam width value.

This function returns valid numbers only if elliptical analysis has been enabled, using EllipticAnalysis property.

Also the beam width computation for the specified clip level should have been enabled, using UseCliplevel, because the beam width numbers are used in the computation of the eccentricity.

### 4.8.32. GetTotalEnergy

**Method Return Value:**

VT\_R4 – total energy

**Method Parameter List:**

VT\_S\_NONE – none

**Remarks:**

Returns total sum of the pixels inside of the defined Beam Area.

### 4.8.33. FlatTopThreshold

**Property Type:**

VT\_R4 - flat top threshold

**Remarks:**

Gets or sets the threshold value (percentage of the peak pixel value) used for flat top analysis.

The allowed range of the threshold is between 0 and 100.

### 4.8.34. FlatTopAnalysis

**Property Type:**

VT\_BOOL – flat top analysis

**Remarks:**

Gets or sets the flat top analysis state.

Flat top numbers will be computed over a Region of Interest that can be user-defined.

If the state is TRUE, the flat top analysis is enabled and GetFlatTopMin, GetFlatTopMax, GetFlatTopMean, GetFlatTopFlatness, GetFlatTopUniformity and GetFlatTopEnergy will return valid numbers. If the state is FALSE, the flat top analysis is disabled.

### 4.8.35. GetFlatTopMin

**Method Return Value:**

VT\_R4 – flat top minimum

**Method Parameter List:**

VTS\_NONE – none

**Remarks:**

Returns the minimum pixel value in the defined Region of Interest.

This function returns valid numbers only if flat top analysis has been enabled, using FlatTopAnalysis.

### 4.8.36. GetFlatTopMax

**Method Return Value:**

VT\_R4 – flat top maximum

**Method Parameter List:**

VTS\_NONE – none

**Remarks:**

Returns the maximum pixel value in the defined Region of Interest.

This function returns valid numbers only if flat top analysis has been enabled, using FlatTopAnalysis.

#### 4.8.37. GetFlatTopMean

**Method Return Value:**

VT\_R4 – flat top mean

**Method Parameter List:**

VTN\_NONE – none

**Remarks:**

Returns the mean value of all pixels in the defined Region of Interest.

This function returns valid numbers only if flat top analysis has been enabled, using FlatTopAnalysis.

#### 4.8.38. GetFlatTopFlatness

**Method Return Value:**

VT\_R4 – flat top flatness

**Method Parameter List:**

VTN\_NONE – none

**Remarks:**

Returns the beam flatness in the defined Region of Interest.

This function returns valid numbers only if flat top analysis has been enabled, using FlatTopAnalysis.

#### 4.8.39. GetFlatTopUniformity

**Method Return Value:**

VT\_R4 – flat top uniformity

**Method Parameter List:**

VTN\_NONE – none

**Remarks:**

Returns the beam uniformity in the defined Region of Interest.

This function returns valid numbers only if flat top analysis has been enabled, using FlatTopAnalysis.

#### 4.8.40. GetFlatTopEnergy

**Method Return Value:**

VT\_R4 – flat top energy

**Method Parameter List:**

VT\_NONE – none

**Remarks:**

Returns the total sum of the pixels inside of the defined Region of Interest.

This function returns valid numbers only if flat top analysis has been enabled, using FlatTopAnalysis and if energy analysis has been enabled.

#### 4.8.41. GaussianFitAnalysis

**Property Type:**

VT\_BOOL – Gaussian Fit analysis

**Remarks:**

Gets or sets the Gaussian analysis state.

If this state is TRUE, the 1-dimensional Gaussian analysis is enabled and Gaussian fit numbers can be computed using Get1dGaussianFit. If the state is FALSE the Gaussian Fit analysis is disabled.

#### 4.8.42. Get1dGaussianFit

**Method Return Value:**

VT\_R4 – Gaussian fit

**Method Parameter List:**

VT\_I2 – axis

**Remarks:**

Returns Gaussian fit numbers.

This function returns valid numbers only if Gaussian Fit analysis has been enabled, using GaussianFitAnalysis.

Gaussian fit numbers are computed for the profiles, either pinhole or slit scan through the data. In FireWire BeamPro these profiles and their correspondent Gaussian fitted profiles can be visualized in the Profile view.

Possible values for the axis are 0 and 1. If elliptical analysis has been enabled (see EllipticAnalysis property), 0 represents the major axis and 1 the minor axis. Otherwise 0 is the horizontal axis and 1 the vertical axis, where horizontal and vertical are relative to the camera.

The profile type (slit or pinhole scan) can be modified with the ProfileType method; for the pinhole scans the Cross Hair type can be modified using the ProfileCrossHairsType method, while the position can be modified using and SetProfileCrossHairsPos, respectively GetProfileCrossHairsPos properties.

### 4.8.43. SetDivergenceMethod

**Method Return Value:**

VT\_EMPTY – none

**Method Parameter List:**

VTI\_I2 – divergence method

VTI\_R4 – distance

VTI\_R4 – cliplevel

**Remarks:**

Sets the divergence method and associated parameters used for the divergence calculation.

If the selected ISO method for computing the beam width is Energy, the beam energy should be used instead of the clip level.

Possible values for divergence method are defined in the type library file by the SelectionDivergenceMethod enumeration:

Divergence Method Selection	Value	Comments
SEL_DIV_METHOD_OFF	0	No divergence computations.
SEL_DIV_METHOD_LENS	1	Lens method for computing divergence.
SEL_DIV_METHOD_PTSRC	2	Point Source method for computing divergence.
SEL_DIV_METHOD_NA	3	Numerical Aperture method for computing divergence.

The distance parameter represents the Focal Length if the Lens method has been selected, or the Distance from the Point Source if the method is Point Source or Numerical Aperture.

### 4.8.44. GetDivergenceMethod

**Method Return Value:**

VT\_EMPTY – none

**Method Parameter List:**

VTI\_PI2 – divergence method

VTI\_PR4 – distance

VTI\_PR4 – cliplevel

**Remarks:**

Gets the divergence method and associated parameters used for the divergence calculation.

### 4.8.45. GetDivergence

**Method Return Value:**

VT\_R4 – divergence

**Method Parameter List:**

VT\_S\_I2 – axis

**Remarks:**

Returns the divergence.

Before measuring divergence, the divergence parameters should have been set using SetDivergenceMethod property and the beam width computation should have been enabled for the specified clip level using UseCliplevel property.

The divergence is returned in the unit selected by AngleUnits if the selected divergence method is Lens or PointSource and is unitless if the selected divergence method is NumericAperture.

Possible values for the axis are 0 and 1. If elliptical analysis has been enabled (see EllipticAnalysis property), 0 represents the major axis and 1 the minor axis. Otherwise 0 is the horizontal axis and 1 the vertical axis, where horizontal and vertical are relative to the camera.

### 4.8.46. ProfileType

**Property TType**

VT\_I2 – profile type

**Remarks:**

Gets or sets the profile types, either Pinhole or equivalent Slit. The value set with this function will impact the arrays obtained by GetProfileData method. Possible values are defined in the type library file by the ProfileTypeSelection enumeration:

Profile Type Selection	Value	Comments
SEL_PROFILE_PINHOLE	0x00	Pinhole profiles through the crosshairs.
SEL_PROFILE_SLIT	0x01	Equivalent slit profiles.



### 4.8.47. ProfileCrossHairsType

#### Property Type

VT\_I2 – profile cross hairs

#### Remarks:

Gets or sets profile cross hairs type. If the Profile Type is set to Slit (Equivalent Slit Profiles) the only option available is Centroid.

Possible values are defined in the type library file by the SelectionProfileCrossHairsType enumeration:

Profile Cross Hairs Selection	Value	Comments
SEL_XHAIR_CENTROID	0	Cross hairs through the centroid
SEL_XHAIR_PEAK	1	Cross hairs through the peak
SEL_XHAIR_USERDEF	2	Cross hairs through a user defined position

### 4.8.48. SetProfileCrossHairsPos

#### Method Return Value:

VT\_BOOL –flag indicating if position for profile Cross Hairs has been modified successfully

#### Method Parameter List:

VT\_S\_R4 – posHoriz

VT\_S\_R4 – posVert

#### Remarks:

Sets the position (horizontal and vertical) for the user defined crosshairs, in microns (the point of coordinates (0, 0) is the upper left corner of the array). This method can be called only if the Profile Type is set to Slit (Equivalent Slit Profiles).

#### 4.8.49. GetProfileCrossHairsPos

**Method Return Value:**

VT\_BOOL – flag indicating if position for profile Cross Hairs has been retrieved successfully

**Method Parameter List:**

VTS\_PR4 – posHoriz

VTS\_PR4 – posVert

**Remarks:**

Retrieves the position (horizontal and vertical) for the crosshairs, in microns. The point of coordinates (0, 0) is the upper left corner of the array.

#### 4.8.50. GetProfileData

**Method Return Value:**

VT\_VARIANT – profile data array

**Method Parameter List:**

VTS\_I2 – axis

VTS\_I4 – start index

VTS\_I4 – number of points

**Remarks:**

Returns an array of data points that represent a pinhole or slit scan through the beam area. (In FireWire BeamPro interface these profiles can be visualized in the Profile view.)

Possible values for the axis are 0 and 1. If elliptical analysis has been enabled (see EllipticAnalysis property), 0 represents the major axis and 1 the minor axis. Otherwise 0 is the horizontal axis and 1 the vertical axis, where horizontal and vertical are relative to the camera.

Start index represents the index in the pinhole scan data array that will correspond to the first data point returned.

Number of points represents how many points will be copied in the returned array.

The profile type (slit or pinhole scan) can be modified with the ProfileType method; for the pinhole scans the Cross Hair type can be modified using the ProfileCrossHairsType method, while the position can be modified using and SetProfileCrossHairsPos, respectively GetProfileCrossHairsPos properties.

### 4.8.51. GetProfileSampleSize

**Method Return Value:**

VT\_R4 – sample size

**Method Parameter List:**

VTI\_I2 – axis

**Remarks:**

Returns the sample size: the distance between two data points of the profile data array, in microns.

Possible values for the axis are 0 and 1. If elliptical analysis has been enabled (see EllipticAnalysis property), 0 represents the major axis and 1 the minor axis. Otherwise 0 is the horizontal axis and 1 the vertical axis, where horizontal and vertical are relative to the camera.

### 4.8.52. GetProfileNumPts

**Method Return Value:**

VT\_I2 – number of points

**Method Parameter List:**

VTI\_I2 – axis

**Remarks:**

Returns the number of points in the profile data array, which is bound, by the beam area.

Possible values for the axis are 0 and 1. If elliptical analysis has been enabled (see EllipticAnalysis property), 0 represents the major axis and 1 the minor axis. Otherwise 0 is the horizontal axis and 1 the vertical axis, where horizontal and vertical are relative to the camera.

### 4.8.53. GetSampleSize

**Method Return Value:**

VT\_R4 – sample size

**Method Parameter List:**

VTI\_NONE – none

**Remarks:**

Returns the dimension of one pixel from the data array, in microns.

#### 4.8.54. GetNumPts

**Method Return Value:**

VT\_I4 – number of points

**Method Parameter List:**

VTI\_I2 – axis

**Remarks:**

Returns the number of points inside the beam area along the designated axis.

Possible values for the axis are 0 and 1. If analysis has been enabled (see EllipticAnalysis property), 0 represents the major axis and 1 the minor axis. Otherwise 0 is the horizontal axis and 1 the vertical axis, where horizontal and vertical are relative to the camera.

#### 4.8.55. GetTotalSize

**Method Return Value:**

VT\_I4 – total size

**Method Parameter List:**

VTI\_I2 – axis

**Remarks:**

Returns the total span of the profiles, either slit or pinhole, in microns.

Possible values for the axis are 0 and 1. If elliptical analysis has been enabled (see EllipticAnalysis property), 0 represents the major axis and 1 the minor axis. Otherwise 0 is the horizontal axis and 1 the vertical axis, where horizontal and vertical are relative to the camera.

#### 4.8.56. GetStartPos

**Method Return Value:**

VT\_I4 – start position

**Method Parameter List:**

VTI\_I2 – axis

**Remarks:**

Returns the distance from the edge of the camera chip to the beam area in microns.

Possible values for the axis are 0 (horizontal) and 1 (vertical), where horizontal and vertical are relative to the camera.

### 4.8.57. Get2DData

**Method Return Value:**

VT\_VARIANT – 2D data array

**Method Parameter List:**

VT\_S\_R4 – left

VT\_S\_R4 – top

VT\_S\_R4 – right

VT\_S\_R4 – bottom

VT\_S\_I2 – decimation

**Remarks:**

Returns a 2D-array (matrix) of data points representing the 2D intensity data (values between 0 and 4095). The first four values from the parameter list are the coordinates of the rectangle area from where the data is exported, in  $\mu\text{m}$ , the coordinates are reported from the upper left corner of the array (which is (0, 0)). The decimation value can be used to read out a smaller array of data and it is used in both lines and columns of the matrix (transfer every  $n^{\text{th}}$  pixel on every  $n^{\text{th}}$  line, where  $n$  is the decimation value).

### 4.8.58. SaveFrameAsTIFF

**Method Return Value:**

VT\_BOOL – Save Flag status

**Method Parameter List:**

VT\_S\_BSTR – file full name (with qualified path if necessary)

**Remarks:**

Saves the current frame (raw image) as an uncompressed 16-bit TIFF file. If the operation was successful, the method returns TRUE, otherwise returns FALSE.

### 4.8.59. GetCameraList

**Method Return Value:**

VT\_VARIANT – array of strings; each string uniquely corresponds to a camera present on the system

**Method Parameter List:**

VTS\_NONE – none

**Remarks:**

Call this property to retrieve the number of cameras present on the system, and for each camera the uniquely associated corresponding string (camera identifiers). The first element in the array always corresponds to the camera that is currently used by the FireWire BeamPro software. These strings need to be passed as parameter to SelectCamera method in order to select a specific camera.

### 4.8.60. SelectCamera

**Method Return Value:**

VT\_BOOL – Camera Select status

**Method Parameter List:**

VTS\_BSTR – Camera identifier

**Remarks:**

Selects a different camera for use with the FireWire BeamPro software. To select a camera pass the uniquely associated string with the camera that was listed in the GetCameraList method.

If the operation was successful, the method returns TRUE, otherwise returns FALSE.

After a new camera was selected the system is not calibrated and the global data collection is turned off. If a different model camera was selected it is possible that Beam area, Region of interest and the user defined cross hairs position may be automatically modified by the software; therefore it is highly recommended either to set the desired values or to retrieve the values from the software and check them against the desired values. Also it is recommended to retrieve other important parameters from software, i.e. the sample size.

### 4.8.61. IsBeamPropagation

**Method Return Value:**

VT\_BOOL – Beam Propagation Availability.

**Method Parameter List:**

VT\_S\_NONE – none

**Remarks:**

Returns TRUE if the selected camera is part of ModeScan Model 1780 and therefore allows the software to enable Beam Propagation Analysis mode.

### 4.8.62. BeamPropagationAnalysis

**Property Type:**

VT\_BOOL – Beam Propagation analysis

**Remarks:**

Gets or sets the Beam Propagation analysis state.

If this state is TRUE, the Beam Propagation analysis is enabled and Beam Propagation parameters be computed. Also, all the Beam Propagation characteristics can be set or get if this analysis is on. If the state is FALSE the Beam Propagation analysis is disabled.

To set this property to TRUE the system should be part of the ModeScan Model 1780 (it can be verified with IsBeamPropagation method).

### 4.8.63. SetBeamPropagationParameters

**Method Return Value:**

VT\_BOOL – TRUE if Beam Propagation parameters were set successfully, FALSE otherwise.

**Method Parameter List:**

VT\_S\_R4 – laser wavelength

VT\_S\_R4 – laser reference position

VT\_S\_R4 – lens focal length

VT\_S\_R4 – lens nominal position

**Remarks:**

Returns TRUE if all the following are all true: the selected camera is part of the ModeScan Model 1780 system, the Beam Propagation Analysis mode is enabled and all the parameters were set successfully. In all the other cases the method returns FALSE. The laser wavelength is specified in nm, while all the other parameters are specified in mm. The lens nominal position, the laser reference position and the focal length must be positive numbers.

#### 4.8.64. GetBeamPropagationParameters

**Method Return Value:**

VT\_BOOL – TRUE if Beam Propagation parameters were retrieved successfully, FALSE otherwise.

**Method Parameter List:**

VTS\_PR4 – laser wavelength

VTS\_PR4 – laser reference position

VTS\_PR4 – lens focal length

VTS\_PR4 – lens nominal position

**Remarks:**

Retrieves the parameters associated with Beam Propagation Analysis mode. The parameter list values are the laser wavelength (in nm), the laser position (in mm), the lens focal length (in mm) and the lens position (in mm). If the Beam Propagation Analysis (see the BeamPropagationAnalysis property) is not enabled this method returns FALSE.

#### 4.8.65. GetBeamPropagationRatio

**Method Return Value:**

VT\_R4 – Beam propagation ratio ( $M^2$ )

**Method Parameter List:**

VTS\_I2 – axis

**Remarks:**

Returns the beam propagation ratio.

Possible values for the axis are 0 and 1. If elliptical analysis has been enabled (see the EllipticAnalysis property), 0 represents the major axis and 1 the minor axis. Otherwise 0 is the horizontal axis and 1 the vertical axis, where horizontal and vertical are relative to the camera.

The Beam Propagation Analysis must be enabled (see the BeamPropagationAnalysis property) and all the parameters set appropriate in order to obtain accurate results.



#### 4.8.66. GetBeamWaistSize

**Method Return Value:**

VT\_R4 – Beam waist size (in  $\mu\text{m}$ )

**Method Parameter List:**

VT\_S\_I2 – axis

**Remarks:**

Returns the beam propagation ratio.

Possible values for the axis are 0 and 1. If elliptical analysis has been enabled (see the EllipticAnalysis property), 0 represents the major axis and 1 the minor axis. Otherwise 0 is the horizontal axis and 1 the vertical axis, where horizontal and vertical are relative to the camera.

The Beam Propagation Analysis must be enabled (see the BeamPropagationAnalysis property) and all the parameters set appropriate in order to obtain accurate results.

#### 4.8.67. GetBeamWaistLocation

**Method Return Value:**

VT\_R4 – Beam waist location (in mm)

**Method Parameter List:**

VT\_S\_I2 – axis

**Remarks:**

Returns the beam waist location.

Possible values for the axis are 0 and 1. If elliptical analysis has been enabled (see the EllipticAnalysis property), 0 represents the major axis and 1 the minor axis. Otherwise 0 is the horizontal axis and 1 the vertical axis, where horizontal and vertical are relative to the camera.

The Beam Propagation Analysis must be enabled (see the BeamPropagationAnalysis property) and all the parameters set appropriate in order to obtain accurate results.

#### 4.8.68. GetRayleighRange

**Method Return Value:**

VT\_R4 – Rayleigh range (in mm)

**Method Parameter List:**

VT\_S\_I2 – axis

**Remarks:**

Returns the Rayleigh range.

Possible values for the axis are 0 and 1. If elliptical analysis has been enabled (see the EllipticAnalysis), 0 represents the major axis and 1 the minor axis. Otherwise 0 is the horizontal axis and 1 the vertical axis, where horizontal and vertical are relative to the camera.

The Beam Propagation Analysis must be enabled (see the BeamPropagationAnalysis property) and all the parameters set appropriate in order to obtain accurate results.

#### 4.8.69. GetAstigmatism

**Method Return Value:**

VT\_R4 – Astigmatism value (in %)

**Method Parameter List:**

VT\_S\_NONE – none

**Remarks:**

Returns the beam astigmatism value.

The Beam Propagation Analysis must be enabled (see the BeamPropagationAnalysis property) and all the parameters set appropriate in order to obtain accurate results.

#### 4.8.70. GetWaistAsymmetry

**Method Return Value:**

VT\_R4 – Beam Waist Asymmetry value

**Method Parameter List:**

VT\_S\_NONE – none

**Remarks:**

Returns the beam waist asymmetry value.

The Beam Propagation Analysis must be enabled (see the BeamPropagationAnalysis property) and all the parameters set appropriate in order to obtain accurate results.

### 4.8.71. GetDivergenceAsymmetry

**Method Return Value:**

VT\_R4 – Divergence Asymmetry

**Method Parameter List:**

VT\_S\_NONE – none

**Remarks:**

Returns the divergence asymmetry value.

The Beam Propagation Analysis must be enabled (see the BeamPropagationAnalysis property) and all the parameters set appropriate in order to obtain accurate results.

### 4.8.72. GetBeamWaistWidthFromFit

**Method Return Value:**

VT\_R4 – Beam Waist Width determined by the hyperbolic curve fit

**Method Parameter List:**

VT\_S\_I2 – axis

**Remarks:**

Returns the beam waist width determined by the hyperbolic curve fit.

Possible values for the axis are 0 and 1. If elliptical analysis has been enabled (see the EllipticAnalysis), 0 represents the major axis and 1 the minor axis. Otherwise 0 is the horizontal axis and 1 the vertical axis, where horizontal and vertical are relative to the camera.

The Beam Propagation Analysis must be enabled (see the BeamPropagationAnalysis property) and all the parameters set appropriate in order to obtain accurate results.

### 4.8.73. IsFitWeighted

**Method Return Value:**

VT\_BOOL – Returns true if the fit is weighted, false otherwise

**Method Parameter List:**

VT\_S\_PI2 – Weight Power -- Output parameter to contain the weighted fit power

**Remarks:**

Weight power will always be set to 2, in this version of the software. This output parameter was included in case future versions allow changing of the weighting power.

### 4.8.74. SetFitWeighting

**Method Return Value:**

VT\_BOOL – Returns true if successful, false otherwise

**Method Parameter List:**

VTS\_BOOL – Weight fit flag – Pass TRUE for a weighted fit, and FALSE for un-weighted

VTS\_PI2 – Weight Power -- Weighted fit power to use

**Remarks:**

Weight power must be 2 in this version of the software, if it is not the function will fail. Currently changing the fit weighting is not supported. This parameter was included in case future versions allow changing of the weighting power.

### 4.8.75. Example files

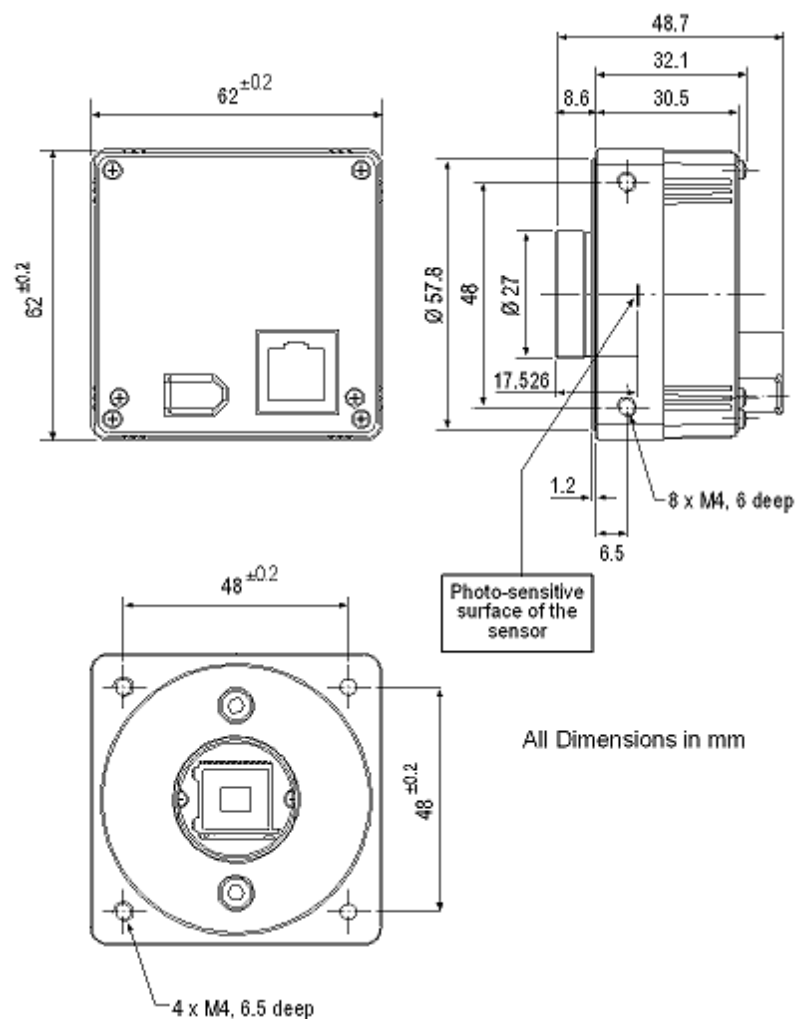
In the Automation folder under the folder where the software has been installed (the default settings is “C:\Program Files\Photon\FireWire BeamPro”) there are two detailed examples about using ActiveX: one written in Visual Basic for Application (VBA) using Microsoft Excel “FireWire BeamPro ActiveX Example.xls” and one developed in LabView “FireWire BeamPro ActiveX Example.vi”.

# Appendix

## Mechanical Dimensions

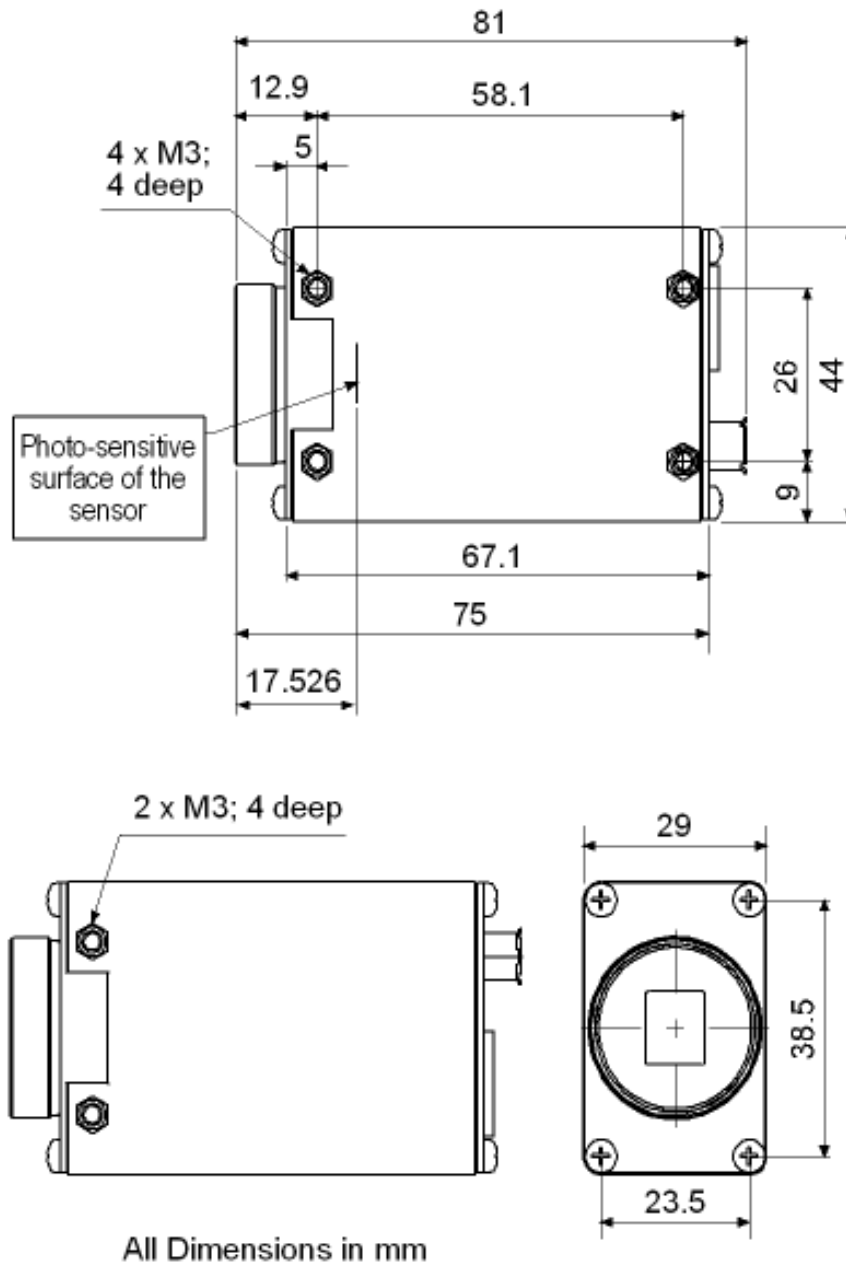
### 1. Model 2512

#### Mechanical dimensions of Model 2512 1/2" IEEE 1394 FireWire BeamPro Camera



## 2. Model 2518

### Mechanical dimensions of Model 2518 1/1.8" IEEE 1394 FireWire BeamPro Camera



**Mounting plate for Model 2518: 67.1mm W × 36.0mm H × 8.0mm D**

### 3. Model 2523

#### Mechanical dimensions of Model 2523 2/3" IEEE 1394 FireWire BeamPro Camera

