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USER MANUAL

BEAMPRO | Beam Profiling Camera

WARRANTY

The Edmund Optics BeamPro 3.0 series beam profiler carries a one-year warranty (from date of shipment) against material and/or workmanship defects, when used under normal operating conditions. The warranty does not cover damages related to battery leakage or misuse.

Edmund Optics Inc. will repair or replace, at Edmund Optics Inc.'s option, any BeamPro 3.0 that proves to be defective during the warranty period, except in the case of product misuse.

Any attempt by an unauthorized person to alter or repair the product voids the warranty.

The manufacturer is not liable for consequential damages of any kind.

In case of malfunction, contact your local Edmund Optics distributor or nearest Edmund Optics Inc. office to obtain a return authorization number. The material should be returned to:

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Barrington, NJ 08007

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To obtain warranty service, contact your nearest Edmund Optics agent or send the product, with a description of the problem, and prepaid transportation and insurance, to the nearest Edmund Optics agent. Edmund Optics Inc. assumes no risk for damage during transit. Edmund Optics Inc. will, at its option, repair or replace the defective product free of charge or refund your purchase price. However, if Edmund Optics Inc. determines that the failure is caused by misuse, alterations, accident or abnormal conditions of operation or handling, it would therefore not be covered by the warranty.

SAFETY INFORMATION

Do not use a BeamPro 3.0 if the device or the detector looks damaged, or if you suspect that a BeamPro 3.0 is not operating properly.

Note: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses, and can radiate radio frequency energy. If not installed and used in accordance with the instructions, it may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, try to correct the interference by taking one or more of the following steps:

- Reorient or relocate the receiving antenna.
- Increase the distance between the equipment and receiver.
- Connect the equipment to an outlet that is on a different circuit than the receiver.
- Consult the dealer or an experienced radio/TV technician for help.

Caution: Changes or modifications not expressly approved in writing by Edmund Optics Inc. may void the user's authority to operate this equipment.

SYMBOLS

The following international symbols are used in this manual:



Refer to the manual for specific Warning or Caution information to avoid any damage to the product.



DC, Direct Current

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1. BEAMPRO 3.0

1.1. INTRODUCTION

Edmund Optics introduces the new BeamPro 3.0. Its sleek and thin design allows the BeamPro 3.0 to fit between tight optical components. Its USB 3.0 connection and improved algorithm allows very fast frame rates. The new 2.2 MPixel CMOS sensor has a large $\frac{2}{3}$ " optical format with a small 5.5 μm pixel pitch allowing high resolution on large beams. Most importantly the innovative and improved PC-BeamPro software is simple and intuitive to any new or expert beam profiling user.

1.2. SPECIFICATIONS

The following specifications are based on a one-year calibration cycle, an operating temperature of 18 to 28°C (64 to 82 F) and a relative humidity not exceeding 80%.

Table 1-1 List of Specifications

	<i>Sensor Specification</i>
Sensor Technology	CMOS without coverglass
Sensor Size	11.3 x 6.0 mm
Sensor Area	0.67 cm ²
Pixel Count	2.2 MPixels
Pixel H x V	2048 x 1088
Optical Format	$\frac{2}{3}$ "
Pixel Dimension	5.5 μm
Minimum Measurable Beam	55 μm
ADC	12 bit (default) or 10 bit
Shutter Type	Global
Wavelength Range	350 -1150 nm
Frame Rate	8 fps (2.2 MPixel Full Frame) 15 fps (1.1 MPixel Active Area 2048 x544) 32 fps (0.066 MPixel Active Area 256 x 256)
RMS noise	1000:1 (60 dB)
Minimum and Maximum Exposure Times	0.06 to 200 ms
External Trig	SMA connector 1.1 volts to 24 volts, the rise edge response time is 300 ns Trigger signal pulse width: 300 ns to 230 ms Optional SMA to BNC adaptor (202273) :

	Damage Thresholds
Maximum Average Power	1 W with ND filter
Saturation Level (1064 nm, CW, ND4)	10 W/cm ²
Saturation Level (1064 nm, Pulsed, ND4)	300 μJ/cm ²

	PC Requirements
USB Port	USB 3.0 port for optimal performance USB 2.0 port
Operating System Compatibility	Windows 8 (for optimal performance) Windows 7 (for optimal performance) Windows Vista
Average RAM Allocation	500 MB Up to 1250 MB for 128 images in buffer
Recommended Requirement	4 Gb RAM minimum 8Gb RAM for optimal performance Intel i series processors (i3, i5, i7) or equivalent for optimal performance, other processors will have lower specifications. i7 for optimal performance BeamPro 3.0 is a new and a high end product. It needs an equally recent high end computer to work. Computer hardware must be from 2010 or after. No computer or parts bought before 2010 will be supported
For Optimal Performance	Close all programs except the PC-BeamPro; Keep a minimum of 1 GB RAM free when running the PC-BeamPro; Keep a minimum of 50% of free CPU power when running the PC-BeamPro Use an Image Buffer of 1
Multi Camera Recommendations	When working with more than one camera, we strongly recommend using one USB3.0 port per camera and a recent high end computer for optimal performance

	Physical Characteristics
Dimensions	61 H x 81.1W x 19.7D
Weight	138 g
Default Attenuation	ND 4.0

	<i>Measured and Displayed Parameters</i>
Displays	3D, 2D, XY (crosshair), Beam Tracking
Beam Diameter Definition	4 Sigma (ISO) - ISO-11146-1:2005 FWHM along crosshair (50%) $1/e^2$ along crosshair (13.5%) 86% effective diameter (D86)
Beam Center Definition	Centroid - ISO-11146-1:2005 First Encountered Peak
Displayed Measurements	Major Axis Minor Axis Effective Diameter Ellipticity Orientation Centroid X and Y Peak X and Y Peak Saturation Level Peak to Average Ratio X and Y Divergence Fitted Gaussian equations Roughness fit along crosshairs Gaussian fit along crosshairs Mean Centroid Position Azimuth Beam Position Stability M^2 Quality Measurement
Setup Options	Exposure Time (auto or manual) Image Orientation (rotation and flip) Image Averaging (temporal filter) Active Area Pixel Addressing Gain ADC Level Magnifying Lens
Processing Option	Background Subtraction Area Filters (triangular and flat spatial filters) Normalized Display Trigger
Buffer	Buffer size from 1 to 128 frames Possibility to animate stored frames
File options	Save 1 or all images in buffer Save in native format, text format, or binary format Load native format files Default and custom print report Save 3D or 2D image in bitmap format Save crosshairs in text format Data Acquisition of measurements in text format and in native format

1.2.1. BeamPro 3.0 Series Mechanical Drawings

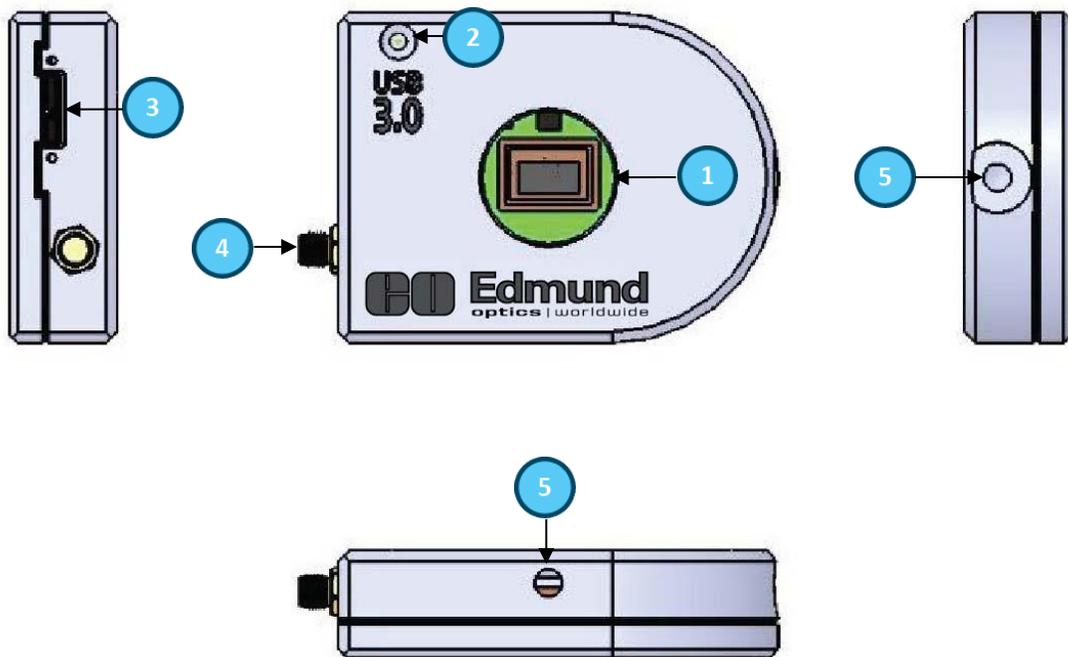


Figure 0-1 BeamPro 3.0 Series Front and Side Views

- 1 Aperture:** The BeamPro 3.0's aperture and screw threads are C-MOUNT, allowing easy connectivity with optical accessories such as attenuation filters, UV converters or lenses. The sensor is centered with the aperture's center.
- 2 LED Indicator:** The LED indicates if the BeamPro 3.0 has been detected by the computer and if it is currently streaming.
- 3 USB 3.0 connector:** The USB 3.0 connector is now more rugged with its screwable holes. Please note that only USB 3.0 compliant cables can be used with the BeamPro 3.0. USB 2.0 ports can be used, but it will lower the BeamPro 3.0 speed performances.
- 4 SMA connector:** The SMA connector is used to externally trigger the BeamPro 3.0. A SMA to BNC adaptor is available.
- 5 Post holes:** $\frac{1}{4}$ "-20 holes are aligned with the sensor's center allowing easy optical alignment.

1.2.2. Sensor and Filter Spectral Responses

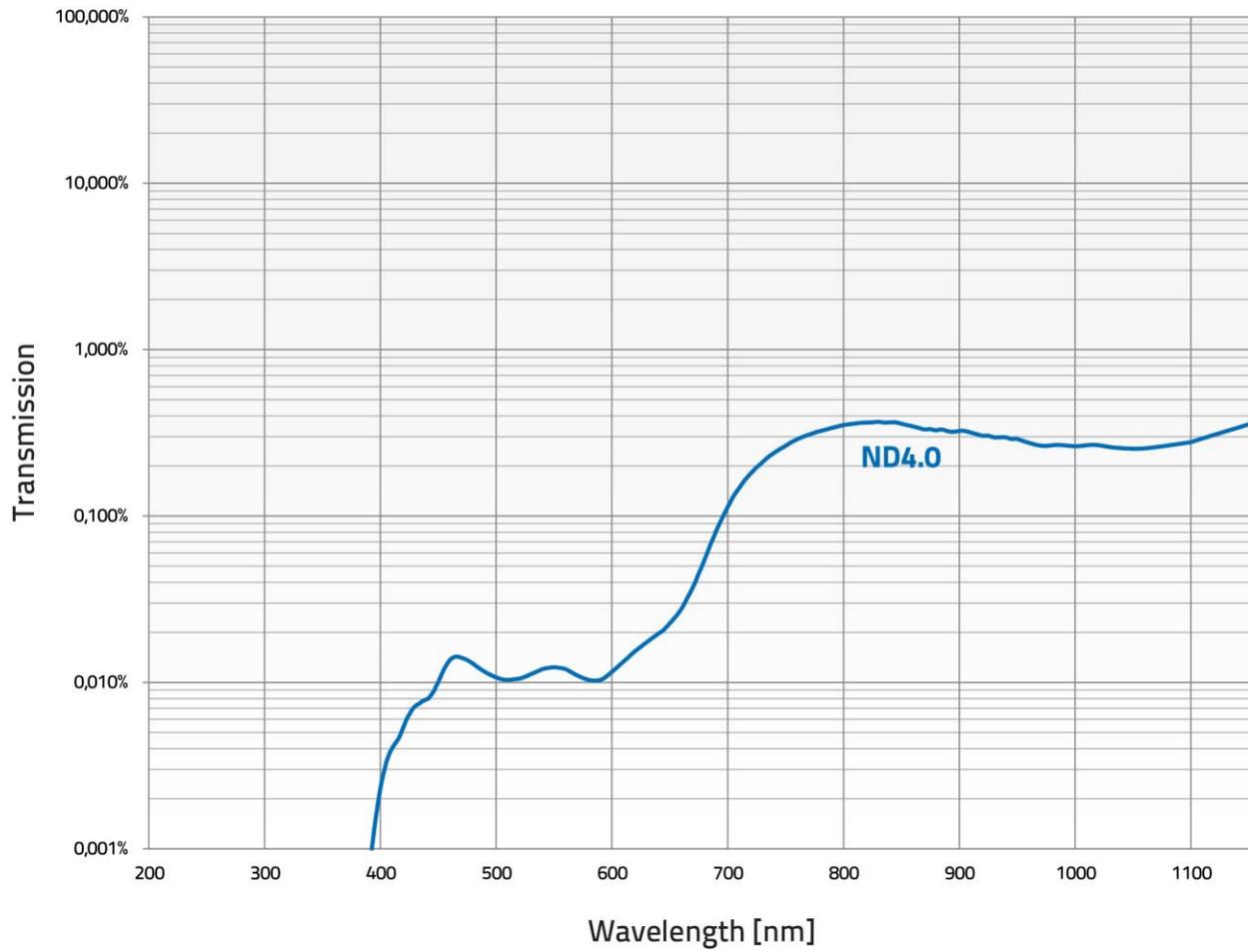
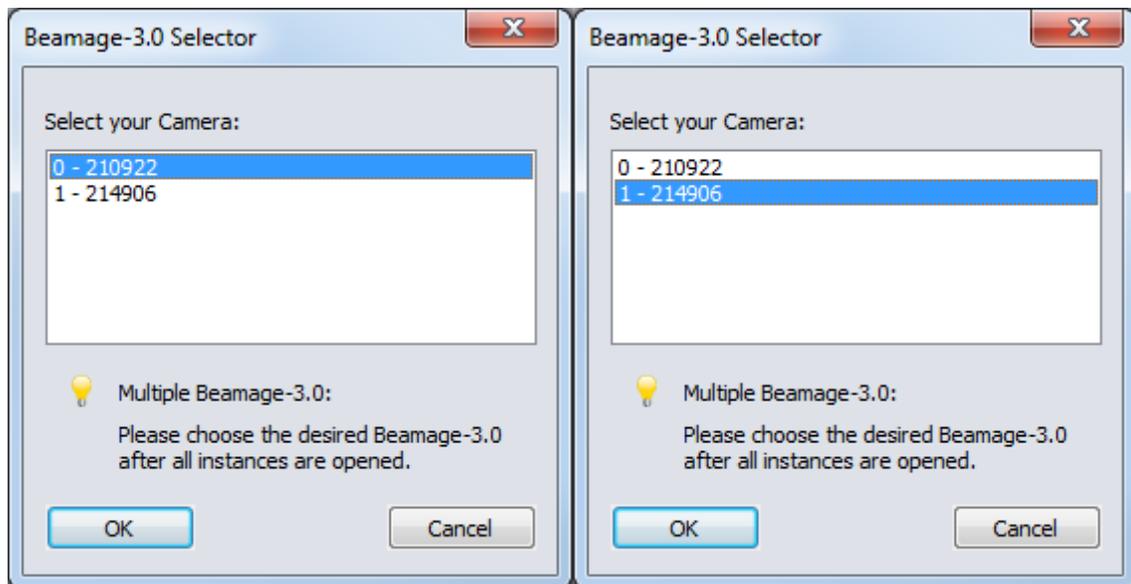


Figure 0-2 Attenuation Filter Transmission

2. QUICK START PROCEDURE

These steps must be followed in the specified order.

1. Install the PC-BeamPro software.
2. Install the BeamPro 3.0 USB driver by following the BeamPro 3.0 Driver Installation Quick Guide (refer to Appendix B). The driver must be reinstalled if a new version of software was updated;
 - a. If necessary, update the BeamPro 3.0's firmware, using the BeamPro 3.0Updater (refer to Appendix C);
3. Connect the BeamPro 3.0 to a USB 3.0 port or USB 2.0 port. Please fix the USB connector on the BeamPro 3.0 using the set screws to ensure a stable connection;
 - a. If multiple BeamPro 3.0 are used, please connect them all to the computer;
4. Start your laser and align in the BeamPro 3.0 aperture;
5. Start the PC-BeamPro software. Select the desired BeamPro 3.0 from the displayed list. The green led button in the "Main Controls" indicates that communication has been established.
 - a. If multiple BeamPro 3.0 are used, please start multiple instances of the software one by one before selecting the desired BeamPro 3.0 in the appropriate instance. For example, if you have 2 cameras, first open an instance of PC-BeamPro and wait for the Beamage-3.0 Selector dialog. Then, open another instance of PC-BeamPro and wait for the Beamage-3.0 Selector dialog. Then, go back to the first instance and select the appropriate serial number. Go back to the second instance and do the same;



6. Press "Start Capture";
 - a. If multiple BeamPro 3.0 are used, press "Start Capture" for both PC-BeamPro instances.
7. Let the auto-exposure find the correct exposure time. This should take a few seconds. If the exposure time is at 200 ms and your beam is under exposed, please decrease the ND filter

attenuation. If the exposure time is at 0.06 ms and the beam is saturated (maximum is white) please increase the ND filter attenuation;

8. Click on the “*Subtract Background*” in the Ribbon;
9. A message box will appear. Once this message appears, block your laser beam and click “*OK*”;
10. Once the “*Please wait*” message box disappears, you can unblock your laser beam;
11. The measures will appear in the “*Home*” tab on the right-hand side;
12. Choose the appropriate graphic for your measurement mode on the bottom left hand-side:

- a.  3D display;
- b.  2D display;
- c.  XY display;
- d.  Beam tracking display.

3. MAIN USER INTERFACE

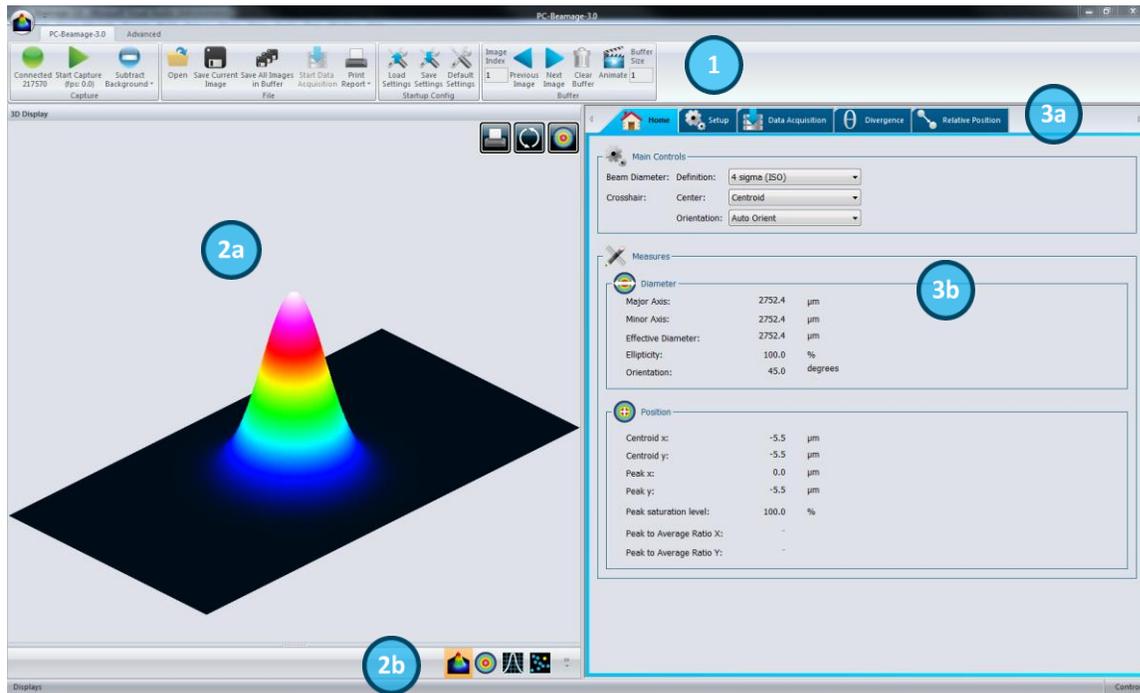


Figure 3-1 PC-BeamPro User Interface

- 1 The Main Controls:** The top portion of the software is in a ribbon format and includes all the main controls. These are grouped by family, including *Capture* controls, *File* controls, *Startup Config* controls, *Buffer* controls, *Data Computation* controls (which include a very useful spatial filter and a normalizing function), *M2* controls and *Information* controls.
- 2a Displays:** The left-hand side of the software is the display panel. Three displays are available: *3D*, *2D*, and *XY* (cross-sectional graphs along the crosshairs).
- 2b Displays Selector:** At any time, it is possible to change the type of display by selecting the desired graphic (*3D Display*, *2D Display*, *XY Display*).
- 3a Analysis Panel - Tab Selector:** Choose between the *Home*, *Setup* or *Data Acquisition* panel tab.
- 3b Analysis Panel - Controls:** The right-hand side of the software contains the *Home*, *Setup* and *Data Acquisition* tabs. The first tab (*Home*) allows the user to select the type of measurements to be performed, it also shows the resulting measures of the beam. The second tab (*Setup*) contains all the measurement parameters, such as the *Exposure Time*, *Image Orientation*, *Averaging*, *Active Area*, and more. The third tab (*Data Acquisition*) lets the user specify the desired acquisition parameters.

4. THE MAIN CONTROLS

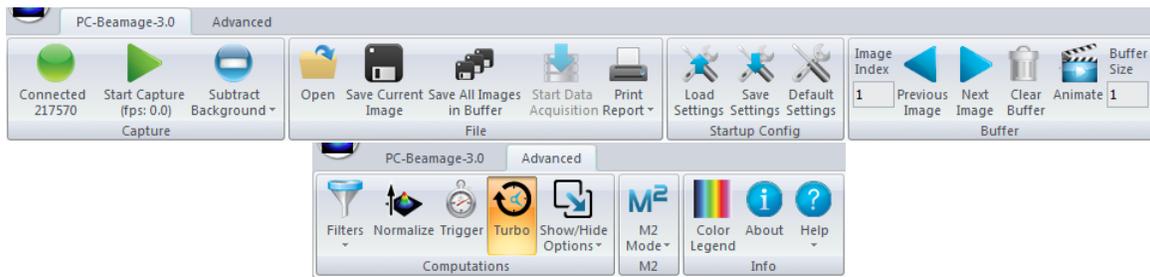


Figure 4-1 PC-BeamPro Main Controls

To give more room to the graphical display and less to the ribbon, you can minimize the ribbon by right-clicking on it and choosing “Minimize the ribbon”. You can retrieve the ribbon at any time by right-clicking on the upper portion of the window and unchecking “Minimize the ribbon”.

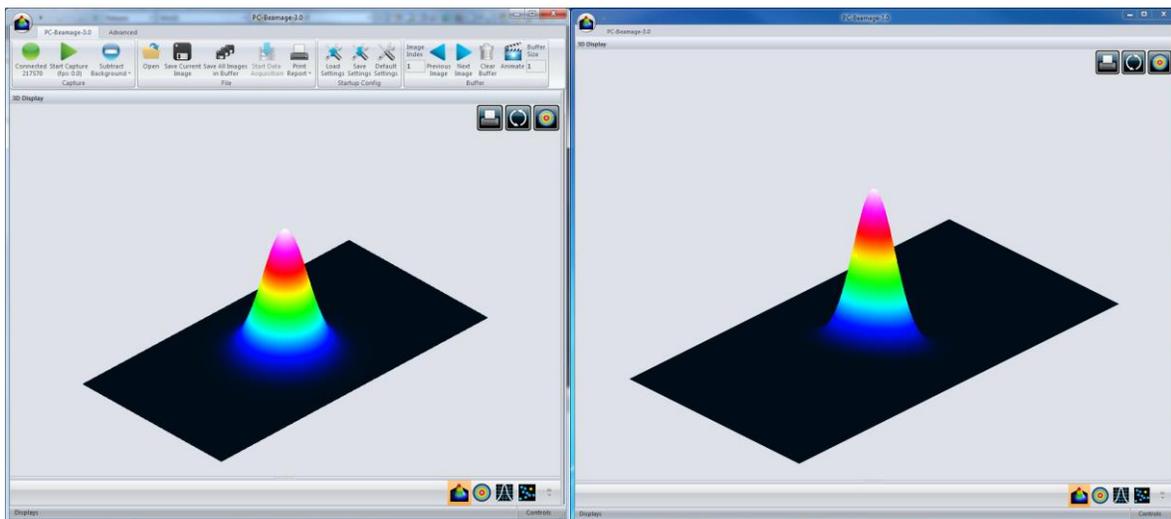


Figure 4-2 The PC-BeamPro Interface With and Without the Main Controls Ribbon

4.1. MULTIPLE BEAMPRO 3.0 MODE

It is possible to connect multiple BeamPro 3.0 units to a single computer. When you start the PC-BeamPro, the following window showing all the serial numbers of the connected cameras will appear. If numerous BeamPro 3.0 are connected to the computer, please select the desired camera. To connect to another BeamPro 3.0 simultaneously, you must first start all desired PC-BeamPro instances one by one before selecting the desired serial number for each instance. For example, if you have 2 cameras, first open an instance of PC-BeamPro and wait for the BeamPro 3.0 Selector dialog. Then, open another instance of PC-BeamPro and wait for the BeamPro 3.0 Selector dialog. Then, go back to the first instance and select the appropriate serial number. Then, go back to the second instance and do the same. You can start streaming after all the desired BeamPro 3.0 units have been connected to a PC-BeamPro instance.

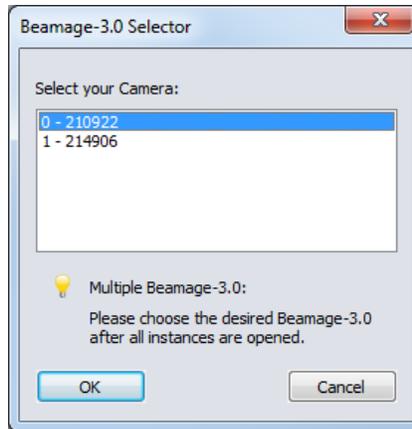


Figure 4-3 BeamPro 3.0 Selector for Numerous Connected BeamPro 3.0



Multiple BeamPro 3.0 beam profilers can be connected to a single computer. However, PC-BeamPro is not a multiple device software so you need to open a new instance of the program for each camera that is connected to your computer.

4.2. CAPTURE CONTROLS

The “*Capture Menu*” displays the BeamPro 3.0 current status, controls the capture, and captures an *average detector background map*.

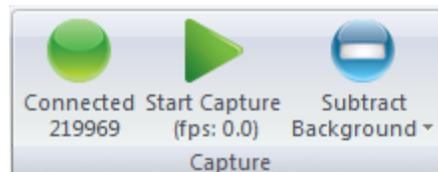


Figure 4-4 Capture Controls

4.2.1. Camera Status



Figure 4-5 Camera Status

The software will automatically detect when a BeamPro 3.0 is connected to the computer and it will be indicated in the *Camera Status* with a green button, while a red button indicates that there is no BeamPro 3.0 connected. When the PC-BeamPro is capturing an image, the status green button will flash as well as the LED on the BeamPro 3.0. Each time the BeamPro 3.0’s pixels are capturing an image, the LED will

be off to avoid parasitic lighting from the LED. Note that clicking on this button will not do anything since it is not a control button, but rather a status indicator. It also indicates the serial number of the connected BeamPro 3.0 3.0.

4.2.2. Capture Button

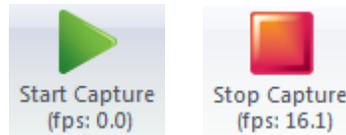


Figure 4-6 Capture Button

To start capturing images with the BeamPro 3.0, click on the “*Start Capture*”. If no BeamPro 3.0 is connected to the computer or if the “*Animate*” mode (refer to section 4.5.4) is on, this button will not be available. Once the BeamPro 3.0 starts streaming, the frame rate will be displayed below the button in frames per second (fps). This measure includes the acquisition and computation time.

4.2.3. Subtract Background Button

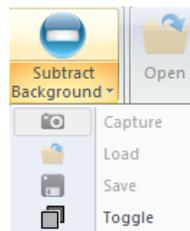


Figure 4-7 Subtract Background Button

The “*Subtract Background*” button includes a drop down menu in its lower part. The list contains a “*Capture*” button, a “*Load*” button, a “*Save*” button and a “*Toggle*” button.



To abide by ISO-11146-3:2004 (Section 3) and have an accurate measurement, a background subtraction must be done.

Once you have clicked the upper part of the “*Subtract Background*” button or the “*Capture*” button in the drop down menu, the following message box will appear:

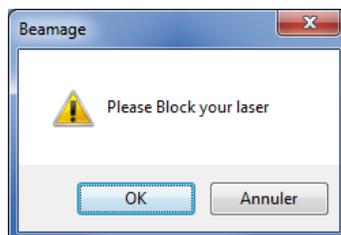


Figure 4-8 Subtract Background Message Box

Once this message box appears, block the beam and click on “OK”. The software will capture 10 images and average pixel by pixel to compute the *average detector background map*. A “Please Wait” message box will appear while the software is capturing the *background map*. The detector background map will be subtracted from all the images that will follow. Note that once the background subtraction has been done, the exposure time will no longer be in “Auto” mode and set to the current exposure time.

To load a background map (*.BMG file) that already exists on your computer, simply click the “Load” button in the drop down menu and browse the file on your computer. To save your background map (*.BMG file) on your computer, simply click the “Save” button in the drop down menu.

It is possible to toggle ON or OFF the background subtraction at any moment by simply clicking the “Toggle” button in the drop down menu.

It is also possible to see the background. To see it, stop the capture and simply click the “Open File Button” (section 4.3.1). The background has the same format (*.BMG file) as all BeamPro 3.0 images.

**Tip**

If the *Exposure Time* is set to “Auto”, be sure to block your beam only when the Message Box appears and not before.

4.3. FILE CONTROLS

The “File Menu” opens and saves frames captured with the BeamPro 3.0, and also prints a complete report. These controls are not available while capturing images, except for “Start Data Acquisition” function, which is only available while the camera is streaming.

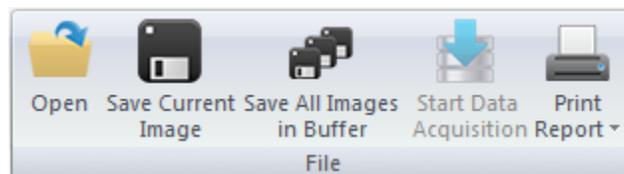


Figure 4-9 File Controls

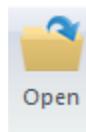
4.3.1. Open

Figure 4-10 Open File Button

Click on the “Open” file button to retrieve previously saved data. The PC-BeamPro software will only open native *.BMG files. The files can contain between 1 and 128 frames, depending on how the file was

created (refer to section 4.3.2 and 4.3.3). If the file was saved with multiple frames, it will be possible to access all of them with the *Buffer Control* (refer to section 4.4).

4.3.2. Save Current Image



Figure 4-11 Save Current Image Button

Click on the “*Save Current Image*” button to save the currently displayed image. This option will only save 1 frame. Data can be saved in native *.BMG format, in text *.TXT format or in binary *.BIN format. Note that only the *.BMG format can be re-opened with the PC-BeamPro software.

The *.TXT and the *.BIN files must be used with a compatible software. The *.TXT file saves a header containing the measurements settings followed by the sensor’s output matrix. Every pixel output is separated by a coma. The *.BIN file only saves the data and does not contain a header. The *.BIN file saves data on signed 32 bit integers.

4.3.3. Save All Images in Buffer



Figure 4-12 Save All Images in Buffer Button

Click on the “*Save All Images in Buffer*” button to save all the frames stored in the buffer. Data can be saved in native *.BMG format, in text *.TXT format or in binary *.BIN format. Note that only the *.BMG format can be re-opened with the PC-BeamPro software. When opening the *.BMG file, all the stored images will be accessible via the *Buffer Controls* menu including all the calculated measurement values (refer to section 4.4).

When saving in *.TXT or *.BIN file, a series of files will be saved and identified with their respective buffer index number. The *.TXT and the *.BIN files must be used with a compatible software. The *.TXT file saves a header containing the measurements settings followed by the sensor’s output matrix. Every pixel output is separated by a coma. The *.BIN file only saves the data and does not contain a header. The *.BIN file saves data on signed 32 bit integers.

4.3.4. Start Data Acquisition

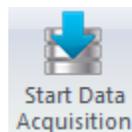


Figure 4-13 Start Data Acquisition Button

Click on the “*Start Data Acquisition*” button to start the data logging of all the measurements displayed in the “*Home*” tab. This function is only available while the camera is streaming. The acquisition parameters

can be modified in the “*Data Acquisition*” tab on the right-hand side of the user interface (refer to section 5.3).

It is only possible to save the beam profiling results shown in the “*Home*” tab (refer to section 5.3) in a *.TXT file. The *.TXT file includes a header, containing the acquisition settings, followed by the data. Each line corresponds to a single frame and all the measurements are separated by a tab. This file can be opened in a spreadsheet software, such as Microsoft Excel.

It is also possible to save the images associated with the measurements saved in the *.TXT logging file. Each image will be individually saved in a native *.BMG file. Each file will have the same filename as the *.TXT file, followed by the corresponding increment.



Each *.BMG file can take up to 8.50 MB on the hard drive. Acquiring multiple frames can quickly sum up to multiple GigaBytes.

Fast acquisition should only be done on the computer's hard drive and cannot be done on an external drive or on a server hard drive.

4.3.5. Print Report



Figure 4-14 Print Report Button

Click on the “*Print Report*” button and choose the *Default* option to print a complete report of the current measurement. To print only specific information from the current measurement, choose the *Custom* option and a dialog box will show up. Check every measurement wanted in the report and uncheck every measurement not wanted in the report.

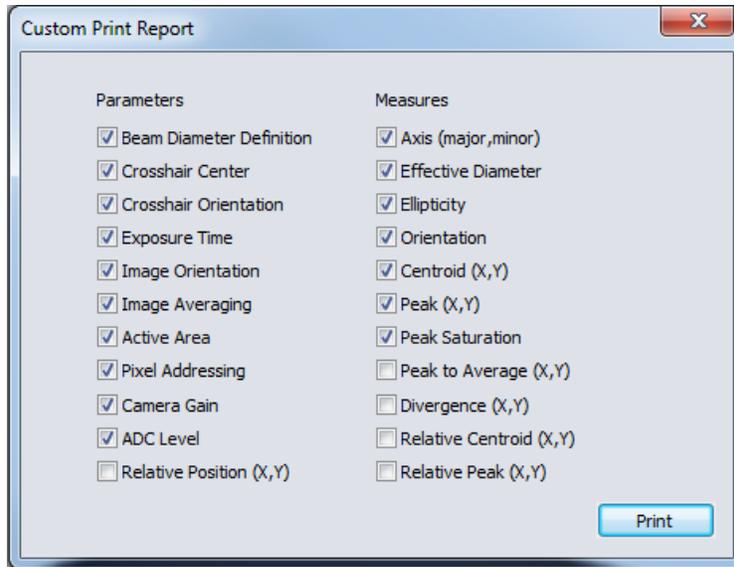


Figure 4-15 Custom Print Report dialog

After choosing the default or the custom report, a print preview will appear in the PC-BeamPro software. To print the report, click “Print”. To exit without printing, click “Exit”. These buttons are located on the right-hand side.

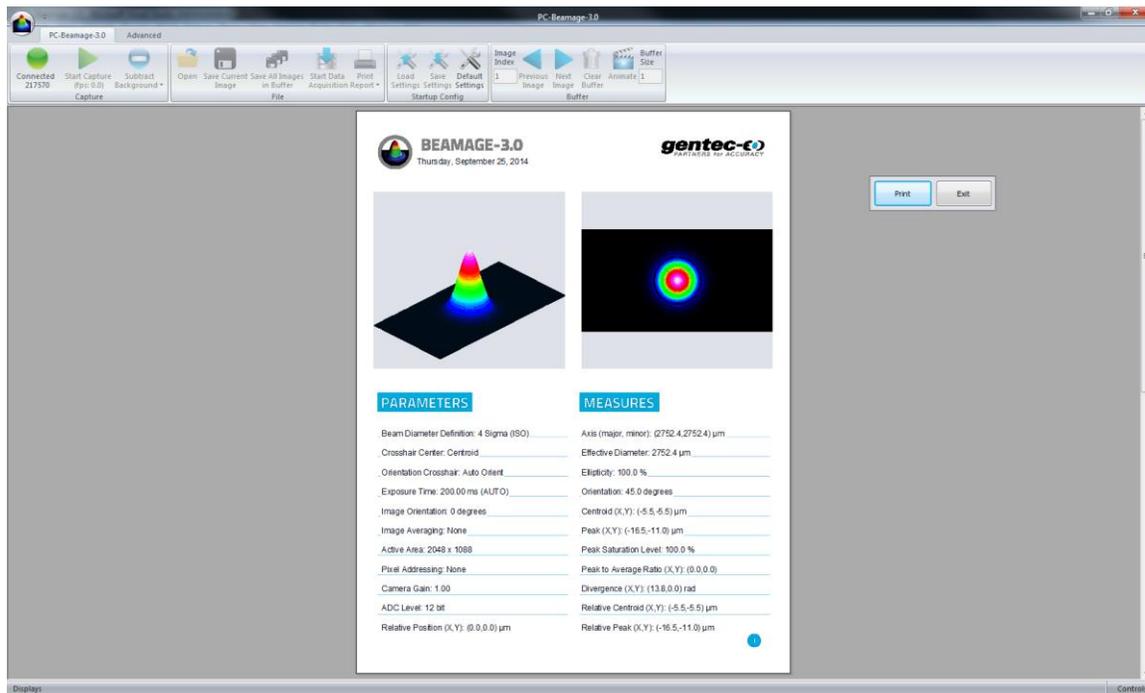
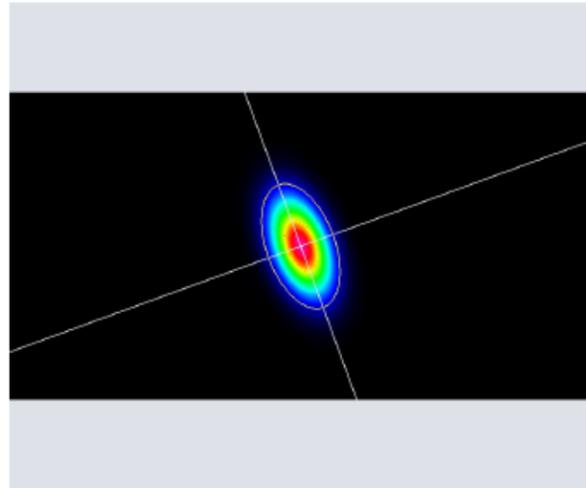
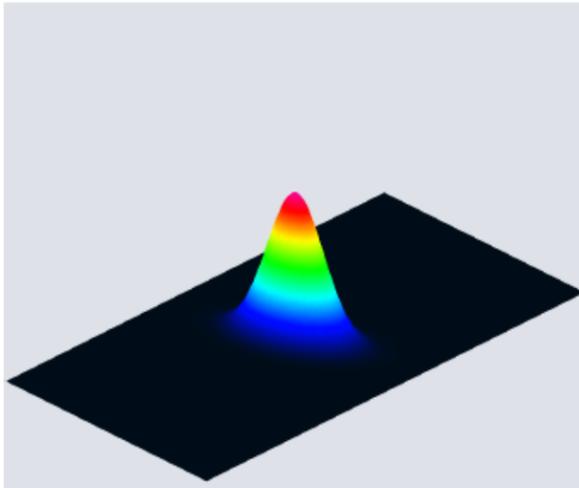


Figure 4-16 Print Report Preview

The report fits on 2 pages. The first page presents the 3D and 2D images, measurement results, and the BeamPro 3.0’s settings.



PARAMETERS

Beam Diameter Definition: 4 Sigma (ISO)

Crosshair Center: Centroid

Orientation Crosshair: Auto Orient

Exposure Time: 1.50 ms (MANUAL)

Image Orientation: 0 degrees

Image Averaging: None

Active Area: 2048 x 1088

Pixel Addressing: None

Camera Gain: 1.00

ADC Level: 10 bit

MEASURES

Major Axis: 973.5 μm

Minor Axis: 486.8 μm

Effective Diameter: 769.7 μm

Ellipticity: 50.0 %

Orientation: 10.0 degrees

Position X: -5.5 μm

Position Y: -5.5 μm

Peak Position X: 0.0 μm

Peak Position Y: -5.5 μm

Centroid Peak Saturation Level: 100.0 %

Figure 4-17 Default Print Report Page 1

The second page prints the cross-sectional XY graphs along the crosshairs. If the "Cursor", the "Gaussian Fit", "FWHM", or the "1/e²" options are selected (refer to section 6.3.1), they will also appear in the report.



BEAMAGE-3.0

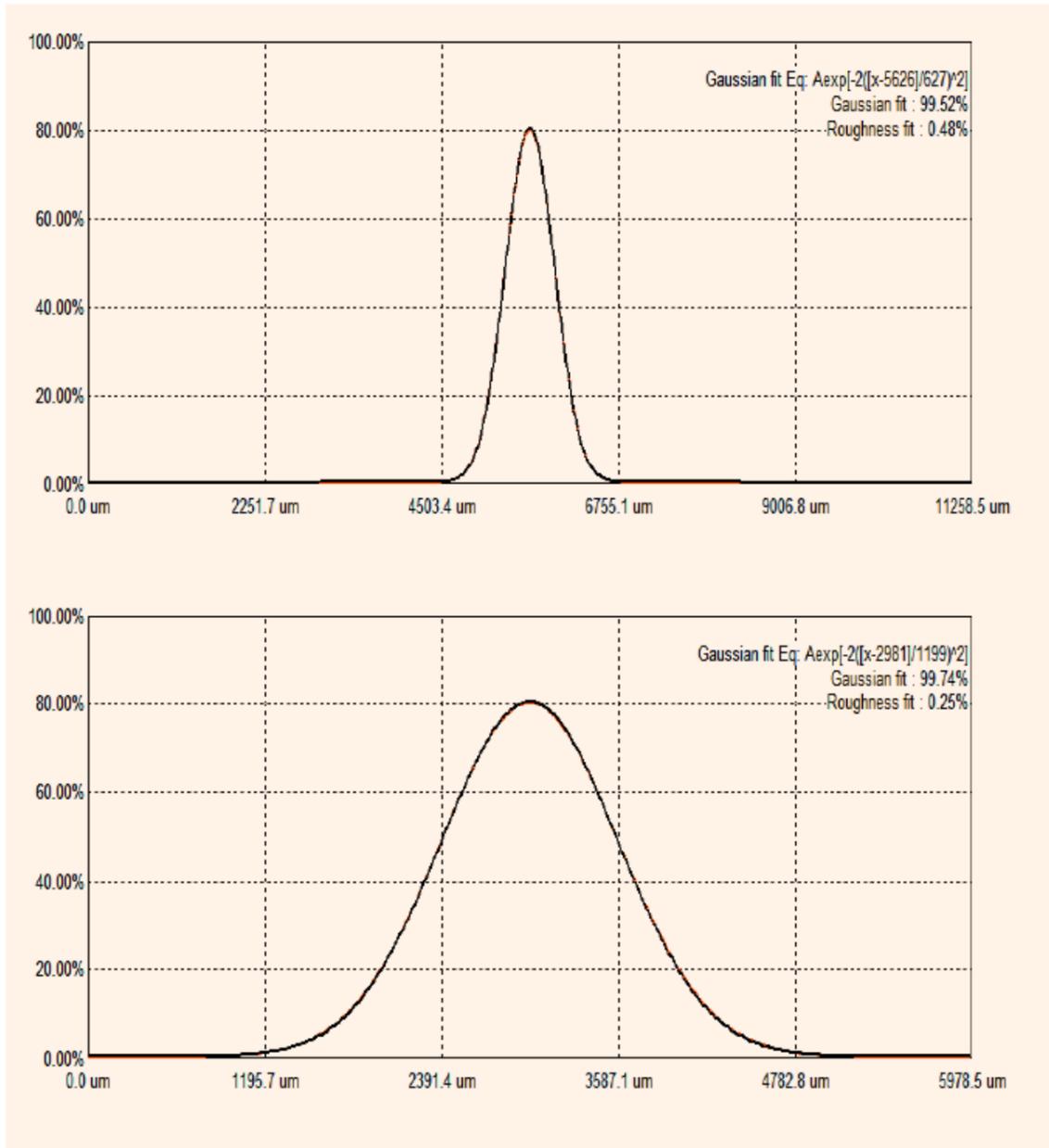


Figure 4-18 Default Print Report Page 2

4.4. STARTUP CONFIG CONTROLS

The PC-BeamPro software can load, save and reset to the default factory state the software settings. The file extension is *.geo.



Figure 4-19-Startup Config Controls



Tip

When closing the PC-BeamPro, all current settings will be saved and will automatically be loaded next time the PC-BeamPro is opened.

The complete list of settings saved could be finding in the annex section.

4.5. BUFFER CONTROLS

The PC-BeamPro software saves the last 128 frames in the buffer. This buffer is circular, the first stored frame is replaced by the last taken image. The buffer can store from 1 to 128 frames. By default, the buffer size is 10.

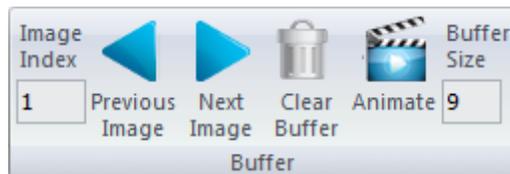


Figure 4-20 Buffer Controls



Warning

Note that all images are stored in the RAM memory of your computer, which could limit the number of images in the buffer.

4.5.1. Image Index

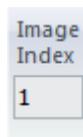


Figure 4-21 Image Index

The *“Image Index”* edit box displays the current image index. When the BeamPro 3.0 is not streaming, it is possible to access different frames by typing the desired image index.

4.5.2. Previous Image and Next Image

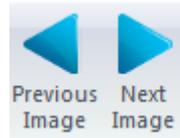


Figure 4-22 Next and Previous Image Buttons

The *“Next Image”* and *“Previous Image”* buttons access the next and previous image in the buffer.

4.5.3. Clear Buffer



Figure 4-23 Clear Buffer Button

The “*Clear Buffer*” button clears the entire buffer. The captured frames will no longer be available, any measures and graphical displays will also be erased.

4.5.4. Animate

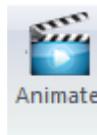


Figure 4-24 Animate Button

Once the BeamPro 3.0 has captured frames in its buffer, it is possible to stream them in a playback manner. With as much as 128 frames temporarily saved in the buffer, simply clicking the animation button will create an animation with any display (2D, 3D, and XY). This allows to visualize the beam while working offline and to have a recalculation process if the beam diameter definition or crosshair parameters are changed.

4.5.5. Buffer Size

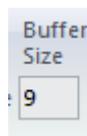


Figure 4-25 Buffer Size

The “*Buffer Size*” edit box displays the number of images stored in the buffer. It is possible to change the buffer size from 1 to 128 images.

4.6. DATA COMPUTATIONS

The “*Data Computations*” menu filters and normalizes the current frame and enables the BeamPro 3.0’s trigger and divergence options.

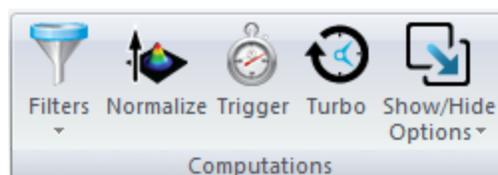


Figure 4-26 Data Computations

4.6.1.Filters

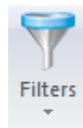


Figure 4-27 Filters Button



Figure 4-28 Available Filters

The “*Filters*” button opens a drop-down menu. Two spatial filters are available: “*Smoothing*” and “*Despeckle*”. These tools are great with low quality laser or low level signals. Note that the “*Despeckle*” filter is more “aggressive” than the “*Smoothing*” filter, which makes it ideal for very poor quality beams.

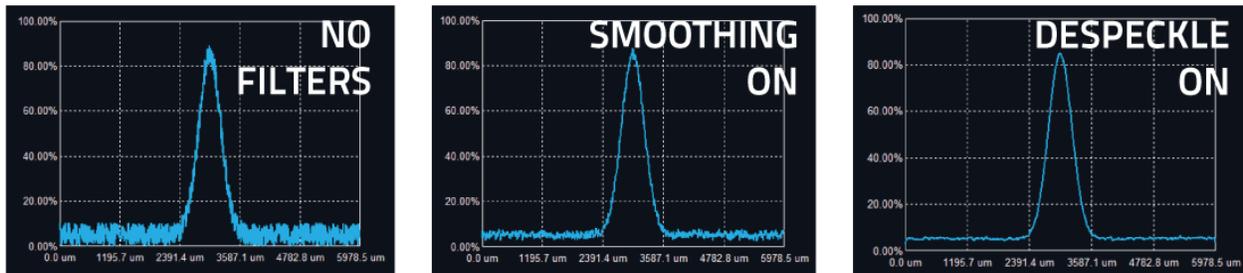


Figure 4-29 Spatial Filter Example



Warning

If an image is saved while it is in “*Filter*” mode, the resulting filtered image will be saved

Smoothing Filter

The “*Smoothing*” filter performs a 3x3 mask triangular filter. The center pixel has a higher weight (3/11) than the surrounding pixels (1/11). If the filtered pixel is on the edge, it will set the surrounding pixels outside the image to 0.

Despeckle Filter

The “*Despeckle*” filter uses a 9x9 mask flat filter to perform a simple averaging of the central pixel. All pixels have the same weight (1/81). If the filtered image is on the edge, the surrounding pixels outside the image will be set to 0.

IR Sensors Filter

This function is not available with your model.

4.6.2. Normalize

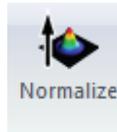


Figure 4-30 Normalize Button

The “*Normalize*” button will spread the graph’s (3D, 2D, and XY) intensity over the full range (0% to 100%). Note that only the displays are normalized, the normalization does not affect the centroid and diameter computations.

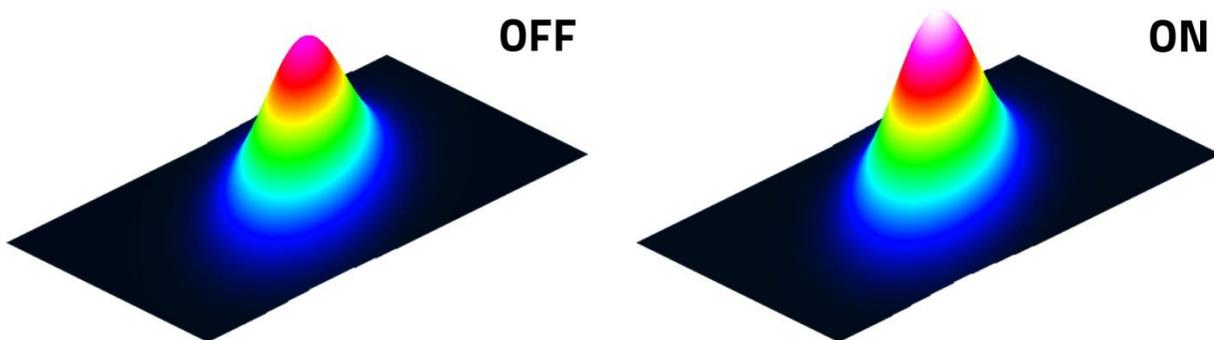


Figure 4-31 Normalization Example

4.6.3. Trigger



Figure 4-32 Trigger Button

The “*Trigger*” button enables the camera to capture images only when an electric signal is sent to the BeamPro 3.0 via the SMA connector. This can synchronize the system’s capture rate with a pulsed laser source. A SMA to BNC adaptor is provided (202273). The input trigger signal can be from 1.1 volts to 24 volts. The rise edge response time is 300 ns. The pulse width of the trigger signal must be between 300 ns and 230 ms.



Figure 4-33 SMA Connector for Trigger Input

4.6.4. Turbo



Figure 4-34 Turbo Button

The “*Turbo*” button modifies the flow of data between the BeamPro 3.0 camera and the computer. By default, the turbo mode is activated when the application starts, assuming the user has a computer that works with the latest generation of USB 3.0 technology. If the streaming stops and error messages appear while running, the user is working with a computer that cannot handle such a flow of data. Simply click on the icon to deactivate or activate the Turbo mode.

4.6.5. Show/Hide Options

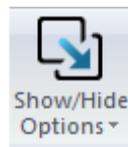


Figure 4-35 Show/Hide Options Button

The “*Show/Hide Options*” button will show or hide the “*Divergence*”, the “*Relative Position*”, “*Camera Lens Calibration*” and “*Fixed Crosshair*” panels beside the “*Data Acquisition*” tab. By clicking on “*Show All*” or “*Hide All*”, one can show or hide both tabs at the same time. The “*Start LabVIEW Pipeline*” button will open the communication channel between the PC-BeamPro and the LabVIEW driver. Please refer to section 7 for more information about this function.

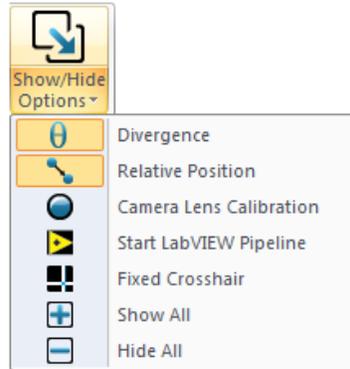


Figure 4-36 Show/Hide Options

4.6.5.1. *Divergence*

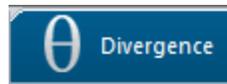


Figure 4-37 Divergence Button

The “*Divergence*” button activates a new tab on the right-hand side of the user interface. It contains all the settings and results relative to the beam divergence (refer to section 5.4). To compute the divergence and abide by the ISO-11146-1:2005 standard, the first step is to place an aberration-free lens between the BeamPro 3.0 and the laser. The lens should be placed in the far-field of the laser beam while the BeamPro 3.0 should be at the focal point of the lens. The second step is to enter the focal length of the lens in the software. Since the focal length is wavelength dependent, make sure to use the correct value for your laser in the settings. The divergence in both main axes (x and y) are computed as defined by the ISO-11146-1:2005 and ISO-11146-2:2005 standards and displayed at the bottom of the “*Divergence*” tab.



Warning

The BeamPro 3.0 sensor must be placed precisely at the focal point, not at the beam waist.

4.6.5.2. *Relative Position*

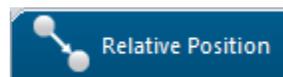


Figure 4-38 Relative Position Panel

The “*Relative Position*” panel activates a new tab on the right-hand side of the user interface. It contains all the settings and results relative to the origin position. This tool allows you to easily align a laser to any desired position. Please refer to section 5.5 for more information about this functionality.

4.6.5.3. Camera Lens Calibration



Figure 4-39 Camera Lens Calibration Panel

The “Camera Lens Calibration” panel activates a new tab on the right-hand side of the user interface. It contains the procedure relative to the camera lens calibration. This tool allows you to easily calibrate a system that contains a magnifying lens. Please refer to section 5.6 for more information about this function.

4.6.5.4. Fixed Crosshair



Figure 4-40 Fixed Crosshair Panel

The “Fixed Crosshair Panel” panel activates a new tab on the right-hand side of the user interface. It contains the settings relative to the fixed crosshair. This tool allows you to easily fix and see the crosshair at a precise position on the sensor, and also to adjust the crosshair’s orientation. Please refer to section 5.7 for more information about this function.

4.7. BEAMPRO 3.0-M2 MODE



Figure 4-41 Show/Hide M2 Mode Button

The M2 mode activates the M² measurement functions of PC-BeamPro software when using the BeamPro 3.0-M2 accessory. For more information on how to use this mode, please refer to the BeamPro 3.0-M2 manual which can be found in the Help section (refer to 4.8.3).

The M² factor can be considered as a quantitative indicator of laser beam quality. In terms of propagation, it is an indicator of closeness to an ideal Gaussian beam at the same wavelength. Paired with a BeamPro 3.0 beam profiling camera, the BeamPro 3.0-M2 module can provide Real-Time M² measurements directly in the PC-BeamPro software. The calculations are based on the second order spatial moments and therefore are fully compliant to the ISO 11146 and 13694 standards.

Unlike other M² measurement systems, the BeamPro 3.0-M² can measure the propagation parameters of a laser beam without the need of any moving part or an external power supply, providing calculation of the M² factor in less than a second. This condition allows the possibility to do on-line monitoring. Its modular design allows users who only want to measure the energy or intensity spatial profile of their beam to remove the BeamPro 3.0 from the M² module and use it as a simple beam profiler.

4.8. SOFTWARE INFO

The “*Information Menu*” displays important and useful information about the BeamPro 3.0 and provides help.



Figure 4-42 Software Info

4.8.1. Color Legend



Figure 4-43 Color Legend Button

The “*Color Legend*” button shows the colors corresponding to the 3D and 2D display intensity levels.

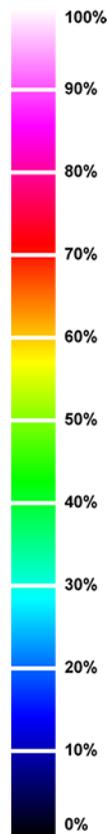


Figure 4-44 Color Legend

4.8.2.About

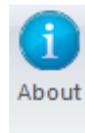


Figure 4-45 About Button

To learn more about the PC-BeamPro software, camera and sensor, click the “*About*” Button.

4.8.3.Help



Figure 4-46 Help Button

The “*Help*” button opens the BeamPro 3.0 Series user manual. All information, tips, warnings and troubleshooting about the software are in this manual. It is also possible to open both the BeamPro 3.0-M2 user manual and the BeamPro 3.0 accessories user manual.



Warning

The help file is in PDF format. A PDF reader needs to be installed on your computer to open the file.

5. HOME AND SETUP PANELS

The PC-BeamPro offers different panels to view the measures and set different options for the BeamPro 3.0.

-  **Home:** Controls the computation parameters and displays the beam's diameter and centroid information.
-  **Setup:** Controls the BeamPro 3.0 parameters.
-  **Data Acquisition:** Controls the acquisition parameters
-  **Divergence:** Controls the divergence parameters and displays the results. This tab is available when the *Divergence* button is activated in the *Main Controls* (refer to section 4.6.5).
-  **Relative Position:** Sets the origin position (0,0) to a user-defined value. This tab is available when the *Relative Position* button is activated in the *Main Controls* (refer to section 4.6.5).
-  **Camera Lens:** Calibrates the *Pixel Multiplication Factor* when using a Camera Lens. This tab is available when the *Camera Lens* button is activated in the *Main Controls* (refer to section 4.6.5).
-  **Fixed Crosshair:** Set the crosshair origin position (0,0) and orientation to a user-defined value. This tab is available when the *Fixed Crosshair* button is activated in the *Main Controls* (refer to section 4.6.5).

To choose the desired display mode, click on the corresponding tab above the Controls and Measure panel

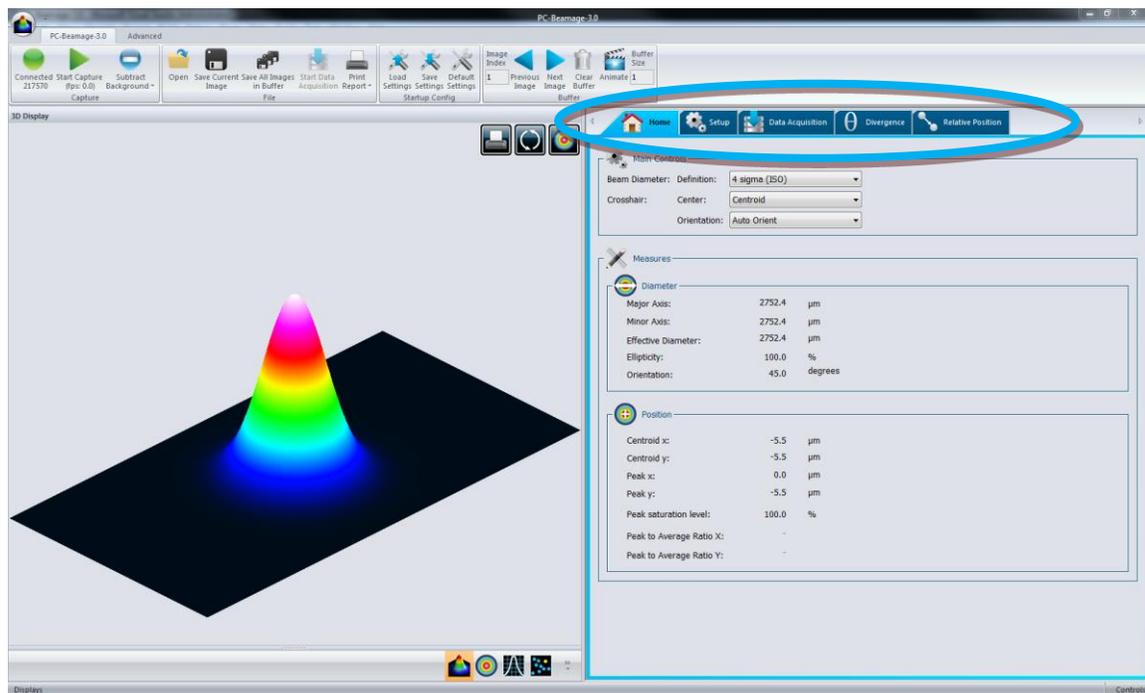


Figure 5-1 Graphic Display

5.1. HOME

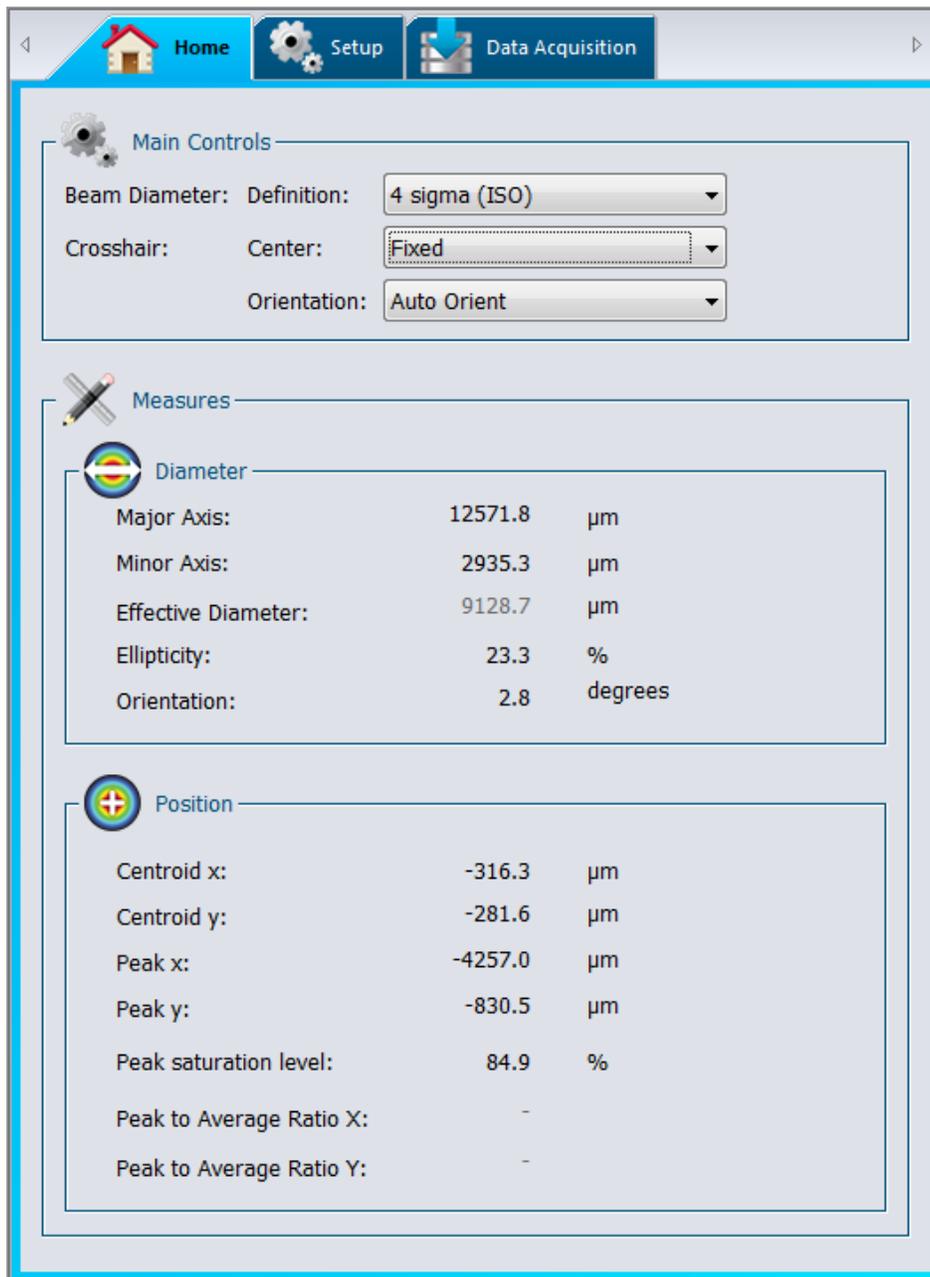


Figure 5-2 Home Tab



Main Controls: Defines the beam width definition and crosshair position.



Diameter: Displays the beam diameter computation results.



Centroid: Displays the beam's centroid and peak coordinates.

5.1.1.Main Controls

The “*Main Controls*” section allows the user to set the desired beam diameter definition and crosshair position. Use the drop-down menu to select the desired settings.

5.1.1.1. Beam Diameter Definition

By default, the beam width definition is set to “*4 sigma (ISO)*” which respects the ISO-11146-1:2005 and ISO11146-2:2005 standards (refer to Appendix A. ISO11146 and ISO11670 Definitions). This definition takes the entire image to compute the beam parameters, which slows the computation time and reduces the frame rate.

The “*FWHM along crosshairs (50%)*” finds the crosshair’s Full Width Half Maximum (FWHM). The algorithm will return the width corresponding to the curve’s first half maximum and the curve’s last half maximum. Because the beam definition only takes into account a slice of the beam, the computation time is much faster and higher frame rates can be achieved.

The “*1/e² along crosshairs (13.5%)*” finds the crosshair’s width corresponding to $1/e^2$ (about 13.5%) of its maximum. Similarly to the FWHM, this beam definition will increase the frame rate.

The “*86% effective diameter (D86)*” computes the circular beam containing 86% of the total intensity. This definition assumes the beam is circular.

5.1.1.2. Crosshair Definition

The crosshair is defined by its center (intersection of the 2 crosshairs) and its orientation. The crosshair center can be set to the beam’s centroid as defined by the ISO-11146-1:2005 and ISO-11146-2:2005 standards, the beam’s peak position or at a user-defined fixed position. If many pixels correspond to the peak value, the crosshair’s center will be set to the first peak.

The crosshair’s orientation is set to “*Auto Orient*” by default, which aligns it to the beam’s orientation as defined by the ISO-11146-1:2005 and ISO-11146-2:2005 standards. It can also be set to a fixed 45° or 0° angle, or at a user-defined fixed angle.



Warning

The crosshair definition will affect the XY Display (refer to section 6.36.3) and the beam width if it is defined by the FWHM or $1/e^2$ along crosshair

5.1.2.Measures

The “*Measures*” section presents the beam’s diameter and centroid information according to the selected beam definition (refer to section 5.1.1.1).

The computation algorithm first determines an approximate beam diameter (13.5% clip level). The algorithm will consider that all pixels outside 2 times the approximate beam diameter are the *outside area*. The *outside area*’s average will become the *baseline*, which will be subtracted from the *area containing the beam*. Only the *area containing the beam* will be used to compute the diameter. This means that a smaller beam will have a smaller area which will decrease the computation time and increase the frame rate. If the beam is larger and all pixels contain the *area containing the beam*, there will be no *baseline* subtraction and the frame rate will be slower.

5.1.2.1. Diameter

The “Major Axis” is the beam maximum width whereas the “Minor Axis” is the minimum beam width.

The “Effective Diameter” is the beam’s diameter considering it is circular.

The effective diameter is only valid if the ellipticity is greater than 87%. If the beam’s ellipticity is lower than 95%, the effective diameter will be grayed-out, indicating it is not valid.

The “Ellipticity” is the ratio between the minor axis and the major axis. For a perfect round Gaussian beam, the ellipticity would be equal to 100%.

The “Orientation” is defined as the “angle between the x-axis [...] and that of the principal axis of the power density distribution which is closer to the x-axis.”¹ From this definition, the angle is comprised between -45° and 45°.

For more information on beam diameter computations as defined by the ISO-11146-1:2005 and ISO-11146-2:2005 standards, please refer to Appendix A. ISO11146 and ISO11670 Definitions)



Warning

According to the beam definition, the displayed measures will vary. For example, for “86% effective diameter (D86)”, only the effective diameter will be displayed, as the major, minor axis, and orientation are not relevant in a perfectly circular beam.

5.1.2.2. Centroid

All positions are relative to the image center which is (0,0). The horizontal axis increases toward the right-hand side and the vertical axis increases toward the top.

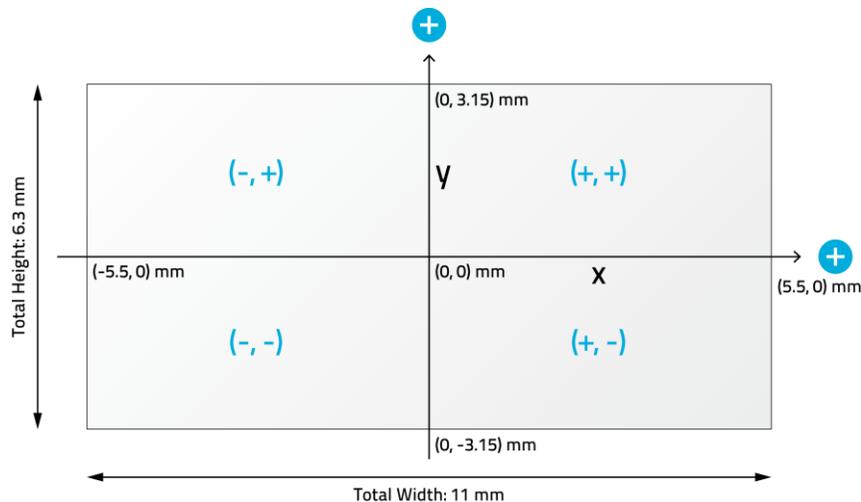


Figure 5-3 Fixed Coordinates System for the Sensor

¹ International Organization for Standardization, ISO 11146 :2005 Laser and laser-related equipment – Test methods for laser beam widths, divergence angles and beam propagation ratios, 2005, Geneva

The beam “Centroid” corresponds to the beam’s first order distribution as defined by the ISO-11146-1:2005 and ISO-11146-2:2005 standards (refer to Appendix A)

The beam’s “Peak” position corresponds to the pixel’s peak value position. If many pixels correspond to the peak value, the crosshair will be centered on the first peak.

The beam “Peak to Average Ratio” corresponds to the ratio between the actual beam peak value and the height of an equivalent simulated flat-top beam. The simulated beam’s width is the $1/e^2$ diameter of the actual beam and has the same area (same energy). The software computes the ratios for both the X and Y axes.

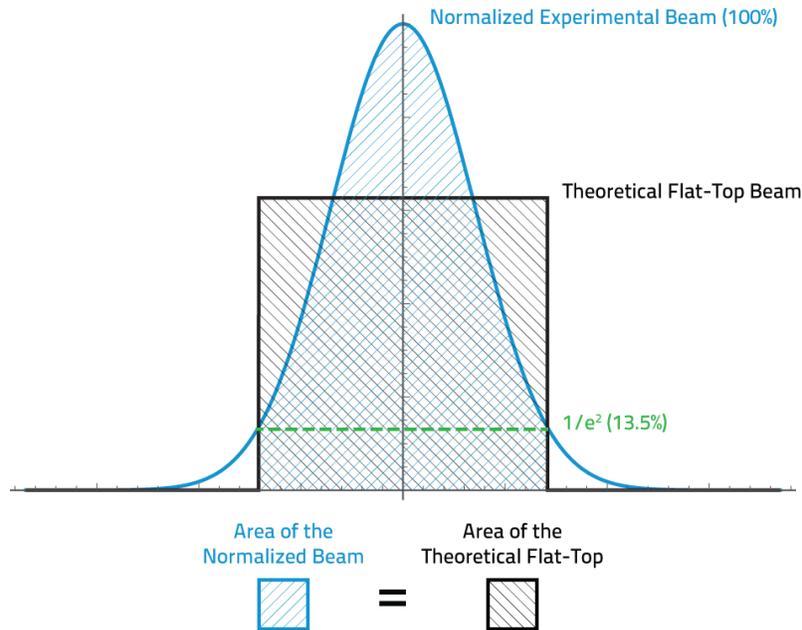


Figure 5-4 Peak to Average

These results are only available when the “1/e2 along crosshairs (13.5%)” beam diameter definition is selected. If any other definition is used, the “Peak to Average Ratios” are not computed and dashes are displayed. When the crosshair center is set to “Centroid” instead of “Peak”, results are grayed out to remind the user that the values do not correspond to the “Peak to Average Ratios”.

Centroid		
Centroid x:	-5.5	µm
Centroid y:	-5.5	µm
Peak x:	0.0	µm
Peak y:	-5.5	µm
Peak saturation level:	100.0	%
Peak to Average Ratio X:	1.674	
Peak to Average Ratio Y:	1.672	

Figure 5-5 Peak to Average Ratio Example

5.2. SETUP

The “Setup” tab allows the user to set the BeamPro 3.0 parameters.



Figure 5-6 Setup Tab



Exposure time: Controls the BeamPro 3.0 sensor’s exposure time.



Image orientation: Rotates or flips the captured image.



Image Averaging: Applies a temporal filter by averaging multiple frames



Active Area: Selects the region of interest.



Pixel Addressing: Reduces the spatial resolution by averaging or decimating pixels.



Gain: Adds numerical gain to captured image.



ADC Level: Selects the BEAMPRO 3.0's ADC level for each pixel



Pixel Multiplication Factor: Adjusts the pixel multiplication factor when using optical components

5.2.1.Exposure Time

The “*Exposure Time*” controls the BeamPro 3.0's exposure time settings. It can be set from 0.06 ms to 200 ms. The “*Auto*” option will automatically set the exposure time in order to have the maximum beam intensity at 85% of the sensor's saturation level. The exposure time can also be set manually by clicking on the corresponding radio button and changing the value in ms.



Tip

If the beam is still saturated at a 0.06 ms exposure time, please increase the attenuation in front of the BeamPro 3.0. If the beam intensity is too low at 200 ms exposure time, please lower the attenuation in front of the BeamPro 3.0.

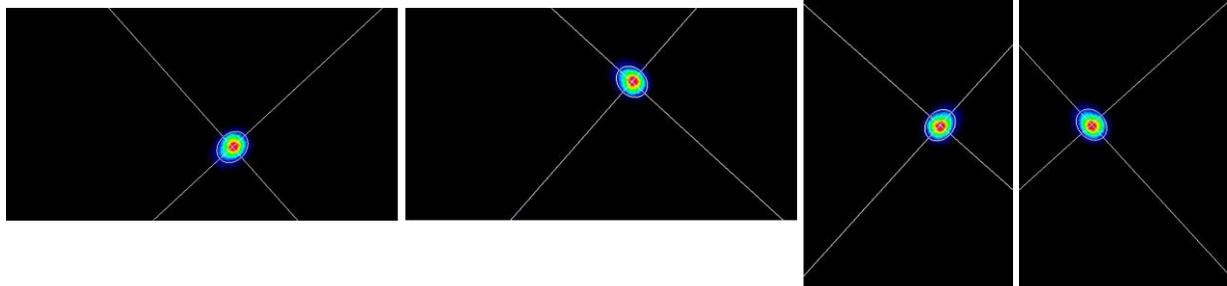
5.2.2.Image Orientation

The “*Image Orientation*” controls rotate or flip the captured frame. The captured frame can be rotated to 90°, 180°, or 270°. All angles rotate clockwise. The captured frame can also be flipped horizontally or vertically. If a frame is saved with a rotation and/or a flip, it will keep these orientation settings. Note that the reference axis for the centroid is neither flipped nor rotated. All positions are always relative to the image's center which is (0,0) and the horizontal axis always increases towards the right-hand side and the vertical axis always increases towards the top.



Warning

When the BeamPro 3.0 is not capturing images and is in “*Animate*” mode or buffer viewing mode, it will neither flip nor rotate the current image, as it has already been captured.



Initial image (no rotation, no flip) Flip horizontal 90° rotation Flip & rotation

Figure 5-7 Image Orientation Examples

5.2.3. Image Averaging

The “*Image Averaging*” function is a temporal filter that captures a specified number of frames (2, 5, or 10) and averages the frames pixel by pixel to create a single time-averaged image. This lowers the total frame rate because multiple frames need to be captured for one computation.



Tip

Image Averaging will smooth the beam fluctuations that can occur over time. It is very useful when working with unstable laser sources.

5.2.4. Active Area

The “*Active Area*” function allows the user to select a region of interest (ROI) on the sensor. This will increase the frame rate, as fewer pixels need to be transferred from the BeamPro 3.0. This can only be done on small beam sizes, since a cropped beam would invalidate the beam width measurements. Furthermore, to have an accurate measurement, the active area must be at least 2 times the beam size.

The user can select the desired area from a preset selection or enter a custom size. By default, the area will be placed at the sensor’s upper left corner pixel (0, 0). This position can be changed by entering the active area’s upper left position. Checking the “*Center*” check box will center the active area to the sensor’s center.



Tip

When working with small beams, optimize the speed of the data transfer and still maintain accurate results, by using an *Active Area* that is twice the size of your beam.

5.2.5. Pixel Addressing

The “*Pixel Addressing*” mode allows the user to downsample the captured image. The “*Average 2x2*” will take a 2x2 pixel cluster and return its average as one larger pixel. The “*Average 2x2*” function is only available in the 12 bit ADC mode. The “*Decimate 2x2*” will only return 1 out of the 4 pixels. Because the pixel area is doubled with this mode, it can be used with large beams, where the spatial resolution is not crucial. It will increase the frame rate because fewer pixels are transferred from the BeamPro 3.0.

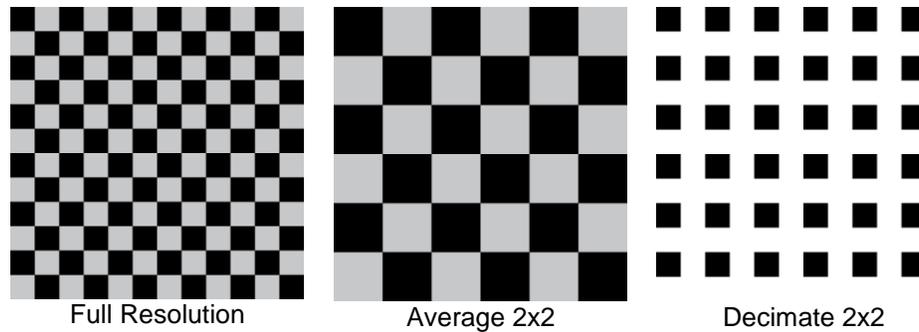


Figure 5-8 Pixel Addressing Mode

**Tip**

When working with large beams, optimize the speed of the data transfer by reducing the spatial resolution using the *Pixel Addressing* function.

5.2.6. Gain

The “*Gain*” setting allows the user to set a numerical gain on the captured image. The gain must be between 1 and 10. If the pixel value is over the maximum ADC level (For 12-bit $\rightarrow 2^{12} = 4096$), the pixel value will be topped at the maximum ADC level.

5.2.7. ADC Level

The ADC level is the pixel’s depth which can be set to 12 or 10 bit. In the 12 bit mode, each pixel value is on $2^{12} = 4096$ levels while the 10 bit mode is on $2^{10} = 1024$ levels. The 12 bit mode has a slower frame rate.

**Warning**

If the BeamPro 3.0 is set in 12 bit mode, it will slow the frame rate.

5.2.8. Pixel Multiplication Factor (PMF)

If the BeamPro 3.0 camera is operated with an optical component that has magnification properties (such as a magnifying lens, a UV Converter or an IR Adaptor), the Pixel Multiplication Factor must be adjusted in order to have the exact beam dimensions. The “*Pixel Multiplication Factor*” section can be found at the bottom of the “*Setup*” tab.

**Tip**

The default value for the *Pixel Multiplication Factor* is 1.

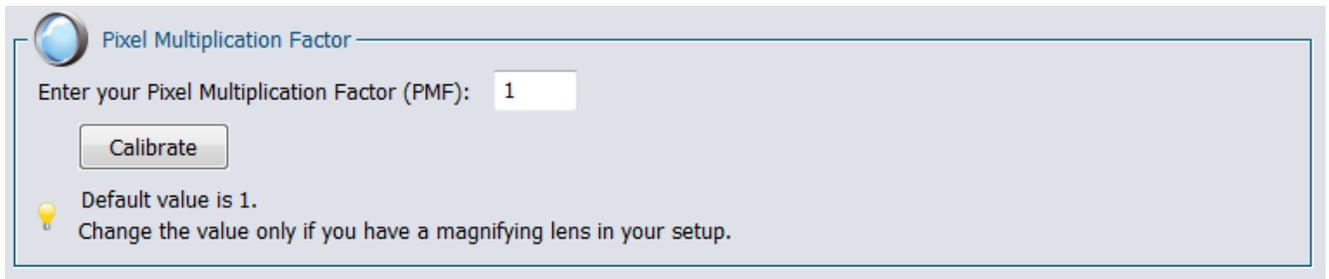


Figure 5-9 Pixel Multiplication Factor

It is possible to manually set a value for the PMF. Simply enter the desired value in the white box and press enter. The beam dimensions will be adjusted accordingly. If a camera lens is used with the BeamPro 3.0 camera, it is possible to follow the camera lens calibration steps by clicking on the “Calibrate” button. This will open the “Camera Lens” tab. Refer to section 5.6 for more information about the camera lens calibration

5.3. DATA ACQUISITION

The “Data Acquisition” tab allows the user to set the acquisition parameters. It is possible to save the beam profiling results shown in the “Measures” tab (refer to section 5.1.2) in a *TXT file. The *TXT file includes a header, containing the acquisition settings, followed by the data. Each line corresponds to a single frame and all the measurements are separated by a tab. This file can be opened in a spreadsheet software, such as Microsoft Excel. It is also possible to save the images associated with the measurements saved in the *.TXT logging file. Each image will be individually saved in a native *.BMG file.

Camera Name: PC-Beamage-3.0													
Serial Number: 208111													
Firmware: 1.7													
Description: PC-Beamage-3.0													
Sample Rate: 1 / 1 pulse[s]													
Total Duration: 0:0:0:15 (DD:HH:MM:SS)													
Date	Elapsed time(sec)	Major Axis(um)	Minor Axis(um)	Effective Diameter(um)	Ellipticity(%)	Orientation(degrees)	Centroid X(um)	Centroid Y(um)	Peak X(um)	Peak Y(um)	Peak Saturation	Peak to Average Ratio X	Peak to Average Ratio Y
09:43:39, Thursday, June 13, 2013	0.421	2666.7	1281.5	2092.1	48.1	29.5	-141.2	977.1	-159.5	858	93.9	2.8	2.4
09:43:39, Thursday, June 13, 2013	0.874	2666.6	1281.5	2092	48.1	29.5	-141.9	977.1	-462	880	89.7	2.8	2.4
09:43:40, Thursday, June 13, 2013	1.466	2667	1282.6	2092.6	48.1	29.5	-141.2	978	-462	880	90.5	2.8	2.4
09:43:40, Thursday, June 13, 2013	1.919	2666.4	1282.2	2092.1	48.1	29.5	-141.8	976.9	-170.5	858	92.4	2.8	2.4
09:43:41, Thursday, June 13, 2013	2.371	2666.1	1281.2	2091.6	48.1	29.5	-141.3	976.1	-456.5	880	95.1	2.8	2.4
09:43:41, Thursday, June 13, 2013	2.808	2669.3	1285.3	2094.9	48.2	29.6	-140.2	978.9	-198	858	93	2.8	2.4
09:43:42, Thursday, June 13, 2013	3.26	2668.2	1284.6	2094	48.1	29.4	-140.6	977.7	-462	880	95.8	2.8	2.4
09:43:42, Thursday, June 13, 2013	3.713	2667.3	1282.5	2092.8	48.1	29.4	-141.8	976.7	-165	858	91.3	2.8	2.4
09:43:43, Thursday, June 13, 2013	4.165	2667.6	1283.3	2093.2	48.1	29.4	-141.9	976.9	-198	858	91.7	2.8	2.4
09:43:43, Thursday, June 13, 2013	4.618	2668	1283.8	2093.6	48.1	29.5	-141.3	977.1	-170.5	869	93.4	2.8	2.4
09:43:44, Thursday, June 13, 2013	5.07	2669.2	1287.1	2095.4	48.2	29.4	-141.1	977.5	-170.5	858	92.5	2.8	2.4
09:43:44, Thursday, June 13, 2013	5.522	2667.7	1283.3	2093.3	48.1	29.4	-141.4	976.7	-170.5	858	94.3	2.8	2.4
09:43:45, Thursday, June 13, 2013	5.975	2668.7	1285.5	2094.5	48.2	29.5	-141.6	977.3	-159.5	869	92.9	2.8	2.4
09:43:45, Thursday, June 13, 2013	6.443	2670	1286.4	2095.6	48.2	29.4	-140.6	978	-462	880	92.7	2.8	2.4

Figure 5-10 Example File of a Measurement Acquisition

To start the acquisition, click on the “Start Data Acquisition” button in the “Main Controls” (refer to section 4.3.4).

The screenshot shows the 'Data Acquisition' tab in the software. It features a navigation bar with 'Home', 'Setup', and 'Data Acquisition' tabs. The main area is titled 'Acquisition' and contains the following fields and options:

- Choose your acquisition mode:**
 - Measurements only (.TXT)
 - Full images and measurements (*.BMG & *.TXT)
- Enter the total duration:**
 - Day(s): 0
 - Hour(s): 0
 - Minute(s): 1
 - Second(s): 0
- Enter the sampling rate for the measurements:**
 - 1 / 10 Image(s)
- Enter the sampling rate for the full images:**
 - Day(s): 0
 - Hour(s): 0
 - Minute(s): 1
 - Second(s): 0
- File Name:** [Text input field] [Browse button (...)]

A warning icon (lightbulb) is present next to the following text:

If you choose to save full images (in *.BMG format), choose a location on your hard drive. Do not save the data on a USB key or any remote location since it could slow down the acquisition.

Figure 5-11 Data Acquisition Tab

The “*Duration*” defines the time for which the acquisition will keep running. The countdown starts as soon as the user presses the “*Start Data Acquisition*” button located in the “*Main Controls*”. The user can select the number of days, hours, minutes and seconds.

The “*File Name*” allows the user to specify a name and a path for his file. A filename must be defined to start an acquisition. If the “*Full images and measurements*” is selected, then a series of “.BMG” files with the same filename concatenated with its corresponding increment will be saved.

The “*Sample Rate*” defines the rate at which the samples are saved. When choosing the “*Measurements only*” acquisition mode, the sample rate is defined as 1/X images. To save every frame computed, enter the value “1” in the box. To keep track of only a small amount of frames, enter a higher value. When choosing the “*Full images and measurements*” acquisition mode, the sample rate is defined temporally. The fastest rate is limited to 1 per second.



Warning

Each *.BMG file can take up to 8.50 MB on the hard drive. Acquiring multiple frames can quickly sum up to multiple GigaBytes. If the total acquisition is over 1 GB, a warning message will appear. If there is only 10 GB left on the hard drive, a warning message will appear and the acquisition will be stopped.

Fast acquisition should be done on the computer’s hard drive and cannot be done on an external drive or on a server hard drive since it could slow down the acquisition.

5.4. DIVERGENCE

The divergence tab opens when the divergence button is clicked in the Main Controls (refer to section 4.6.5).

To compute the divergence and abide by the ISO-11146-1:2005 standard, the first step is to place an aberration-free lens between the BeamPro 3.0 and the laser. The lens should be placed in the far-field of the laser beam while the BeamPro 3.0 is at the lens' focal point. The second step is to enter the lens' focal length in the software. Since the focal length is wavelength dependent, make sure to use the correct value for your laser in the prior settings. The divergence in both main axes (x and y) are computed as defined by the ISO-11146-1:2005 and ISO-11146-2:2005 standards and displayed at the bottom of the "Divergence" tab (refer to Appendix A).

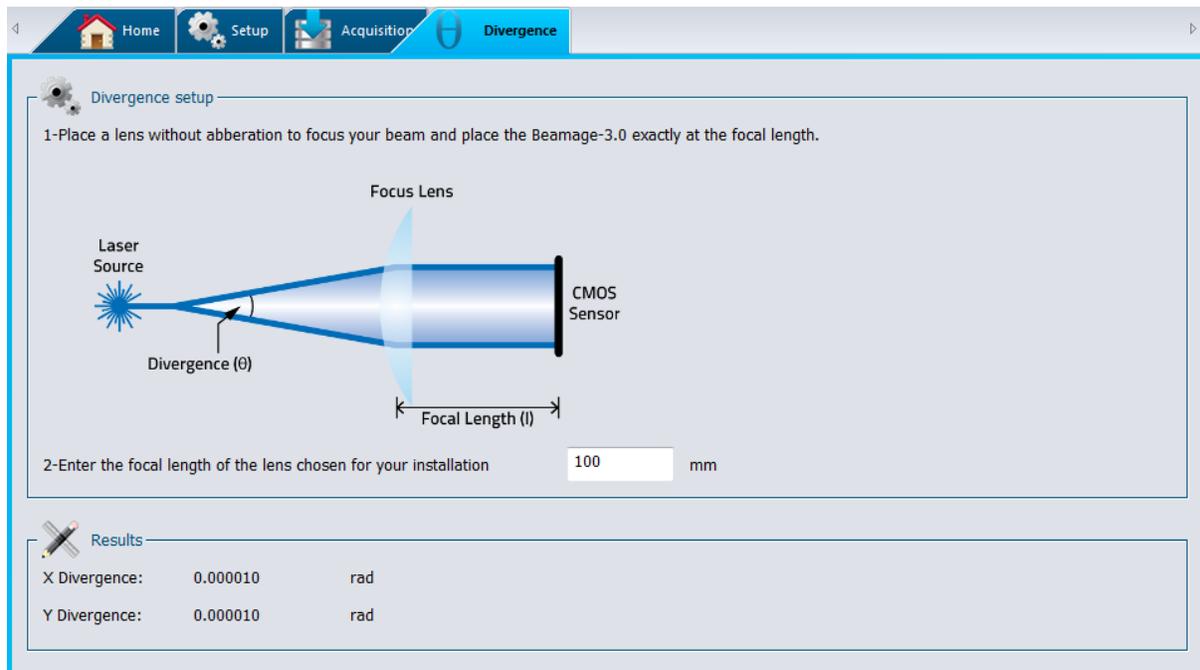


Figure 5-12 Divergence Tab



The BeamPro 3.0 sensor must be placed precisely at the focal point, not at the beam waist.

5.5. RELATIVE POSITION

5.5.1. Setup

The “*Setup*” section, which displays the coordinate system of the BeamPro 3.0 sensor on the right side, allows the user to select the parameter that will be considered as the origin (0,0) by the software.

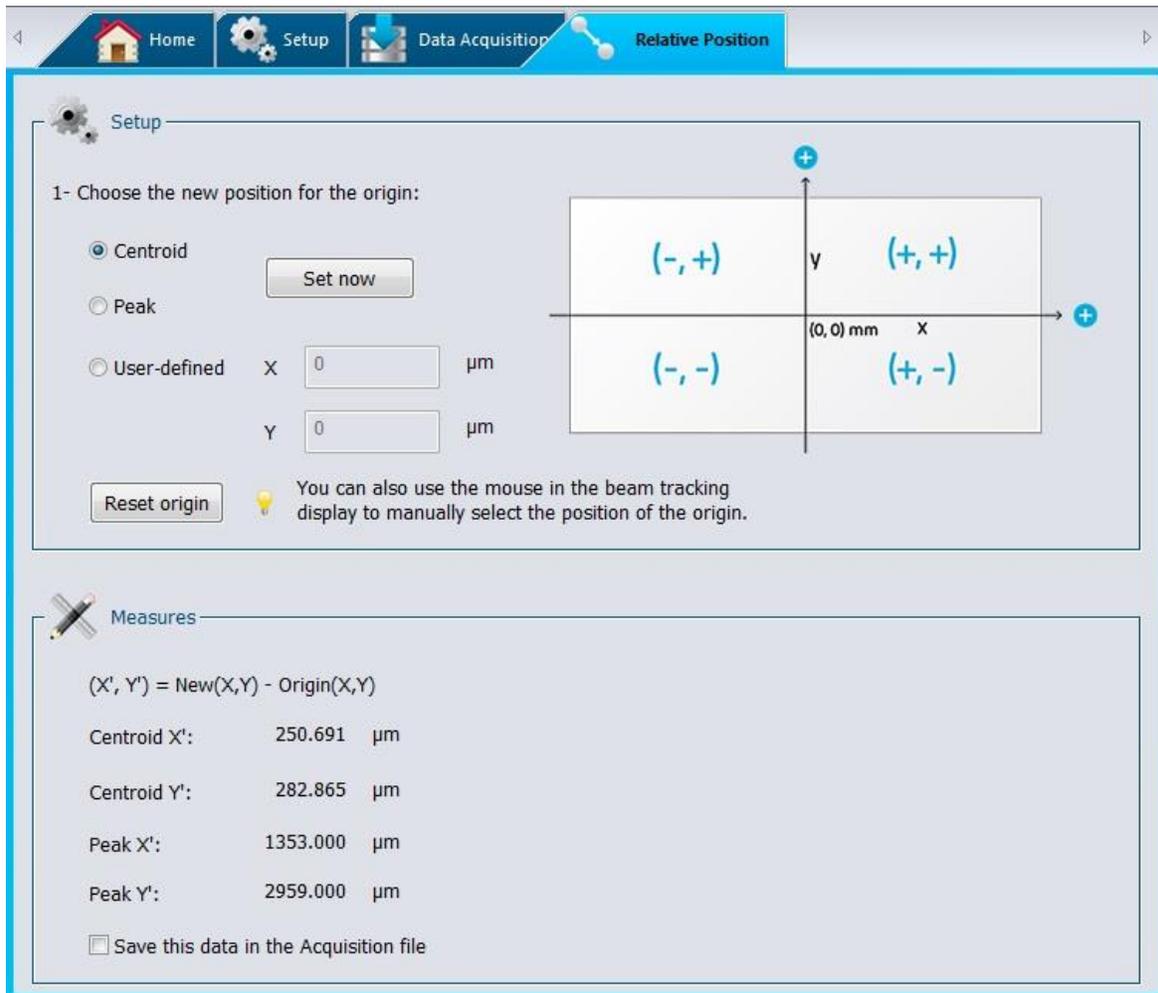


Figure 5-13 Relative Position Tab

By selecting “*Centroid*” and clicking “*Set now*”, the user chooses to position the origin at the computed centroid (center of energy). By selecting “*Peak*” and clicking “*Set now*”, the user chooses to position the origin at the computed energy peak (highest measured value). The option “*User-defined*”, allows the user to manually enter origin position values for both the X and Y axes.

It is also possible to position the origin by simply clicking with the mouse in the display. This can be done in the Beam Tracking Display, which shows the coordinate system of the BeamPro 3.0 sensor (refer to section 6.4). First, click on the “*Beam Tracking Display*” button at the bottom of the display screen to open

the Beam Tracking window. Then, activate the pointer button at the top of the display , and click where you want to position the new origin of the coordinate system. Once you have clicked on the desired point, the coordinate values for both X and Y axes will automatically be set beside “*User-defined*” in the “*Relative Position*” tab.

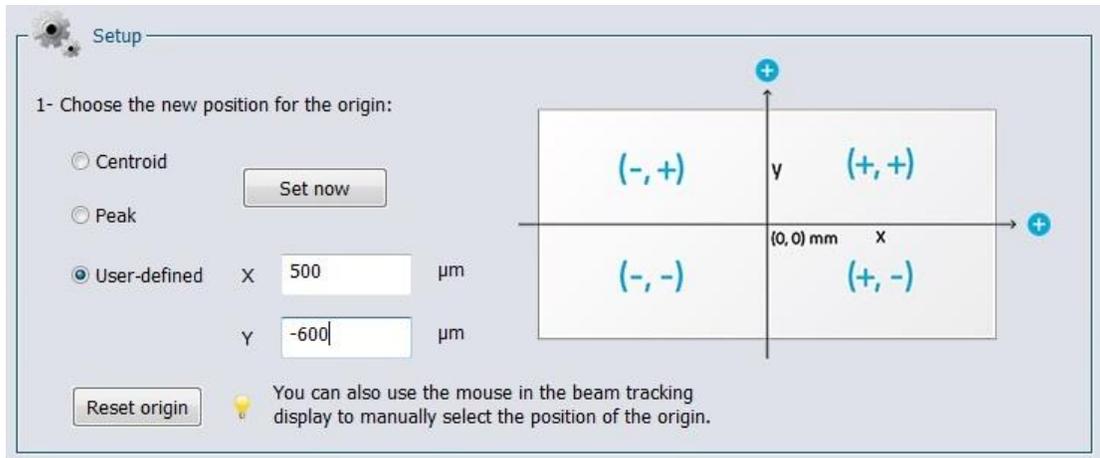


Figure 5-14 Coordinates Defined by User

To set the origin back to its default position (0,0), click on the “Reset origin” button below “User-defined”. This will also automatically select the default option “Centroid” for the origin position.

5.5.2.Measures

Once the origin position is determined by the user, the software will calculate the difference between the coordinates of this new position and the latest computed centroid or peak coordinates. The results are displayed in the “Measures” section of the “Relative Position” tab.

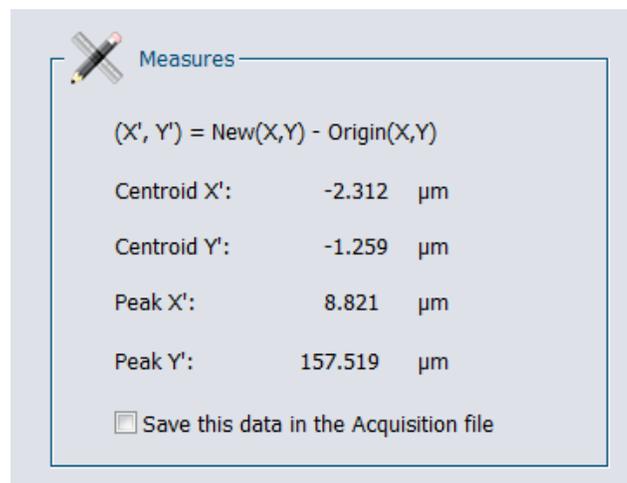


Figure 5-15 Measures Section

It is possible to save the data in the Acquisition file. To do so, select the “Save this data in the Acquisition file” option at the bottom of the “Measures” section.

5.6. CAMERA LENS

Prior to profiling a beam with a camera lens, one must adjust the *Pixel Multiplication Factor* of the lens (see section 5.2.8).

The “*Camera lens calibration*” section allows the user to calibrate the PC-BeamPro software when a camera lens is used with the BeamPro 3.0. This panel is accessible by clicking “*Calibrate*” in the “*Pixel Multiplication Factor*” section in the “*Setup*” panel or in the “*Show/Hide Options*” in the Ribbon.

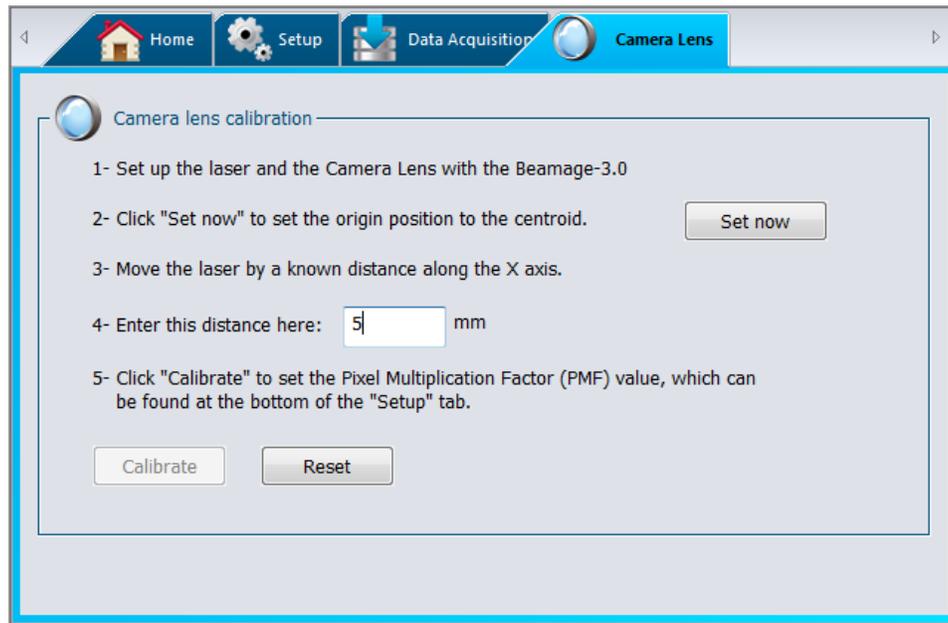


Figure 5-16 Camera Lens Calibration Section

1. Set up the laser and the camera lens with the BeamPro 3.0.
2. Click on “*Set now*” to set the centroid to the current position
3. Then, move the laser source (or the BeamPro 3.0 camera) by a known distance along the X axis, parallel to the diffuser.

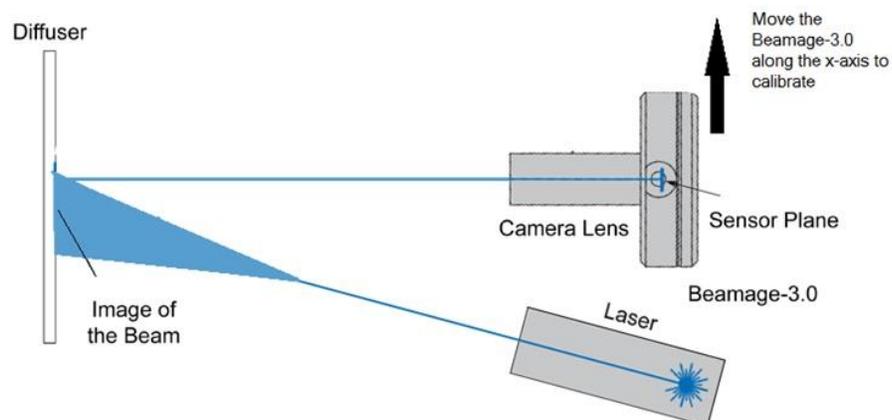


Figure 5-17 - Camera Lens Calibration Moving Direction

4. Enter this distance (in mm) in the appropriate box and press enter.
5. Finally, click on the “Calibrate” button to automatically set the *Pixel Multiplication Factor (PMF)* value found in the bottom of the “*Setup*” tab. Once the PMF is set, the beam dimensions will be adjusted to compensate for the magnification of the camera lens (Beam Tracking Display).

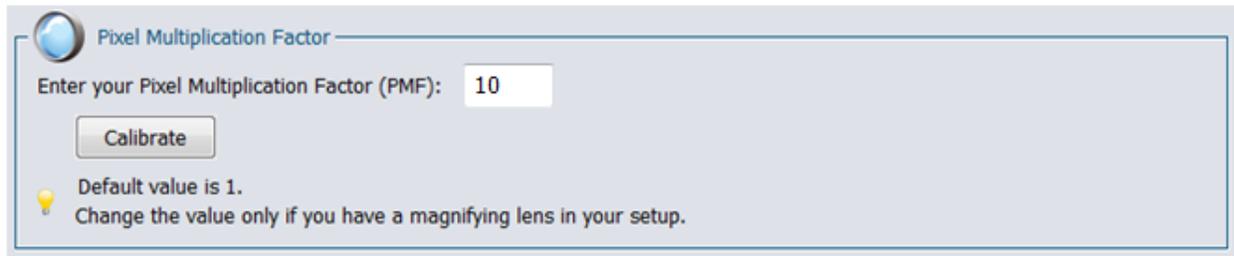


Figure 5-18 Pixel Multiplication Factor Section

6. To return to original values for the *Pixel Multiplication Factor*, click on “*Reset*”

5.7. FIXED CROSSHAIR

5.7.1.Center Setup

To activate the fixed crosshair center option, go to the “*Home*” panel, in the “*Main Controls*” section and choose the *Fixed* option for the crosshair center. This will automatically open the “*Fixed Crosshair*” panel.

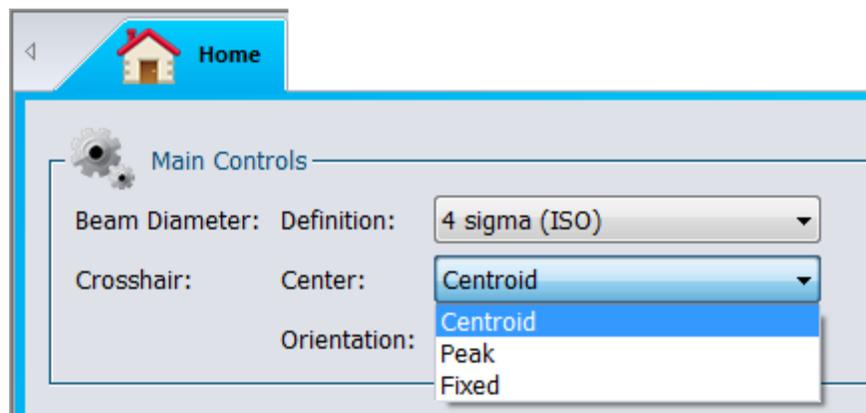


Figure 5-19 Fixed Crosshair Center Section

The “*Center Setup*” section, which displays the coordinate system of the sensor on the right side, allows the user to select the parameter that will be considered as the origin of the crosshairs (0,0).

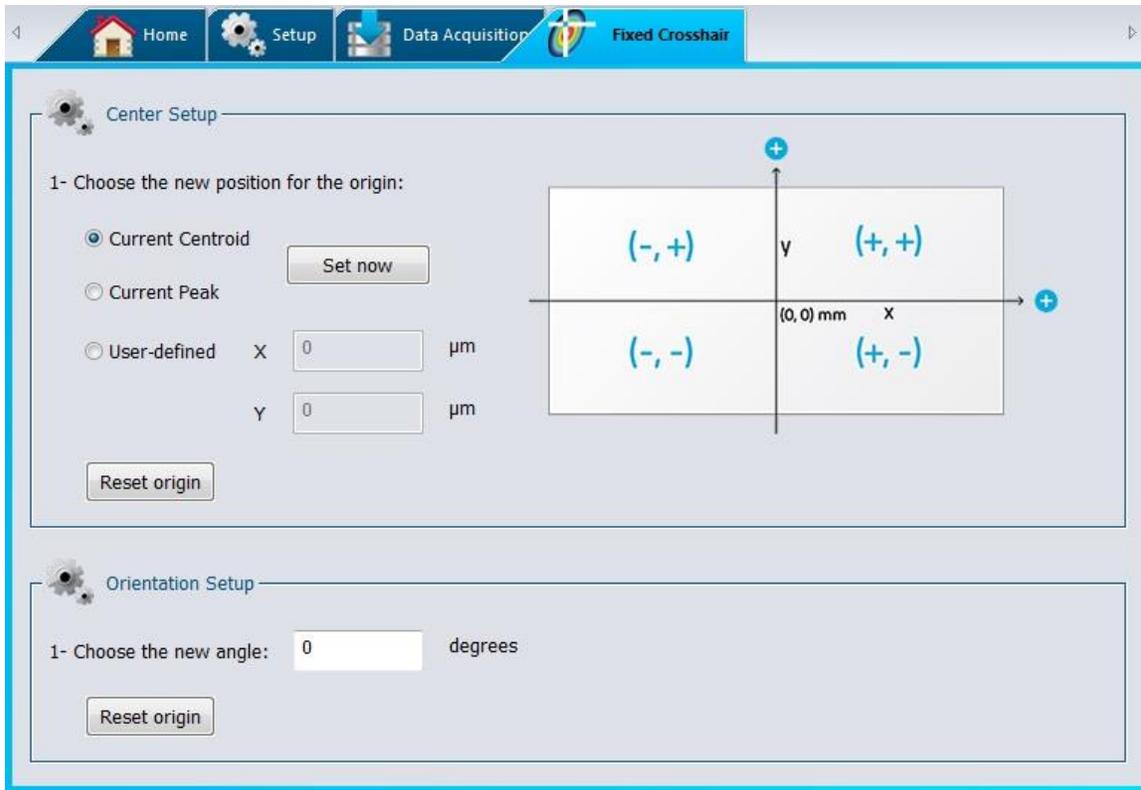


Figure 5-20 Fixed Crosshair Section

By selecting “Centroid” and clicking “Set now”, the user chooses to position the origin of the crosshairs at the calculated centroid position (center of energy). By selecting “Peak” and clicking “Set now”, the user chooses to position the origin of the crosshairs at the calculated peak energy position (highest measured value). The option “User-defined”, allows the user to manually enter the origin of the crosshairs at a defined position in both the X and Y axes.

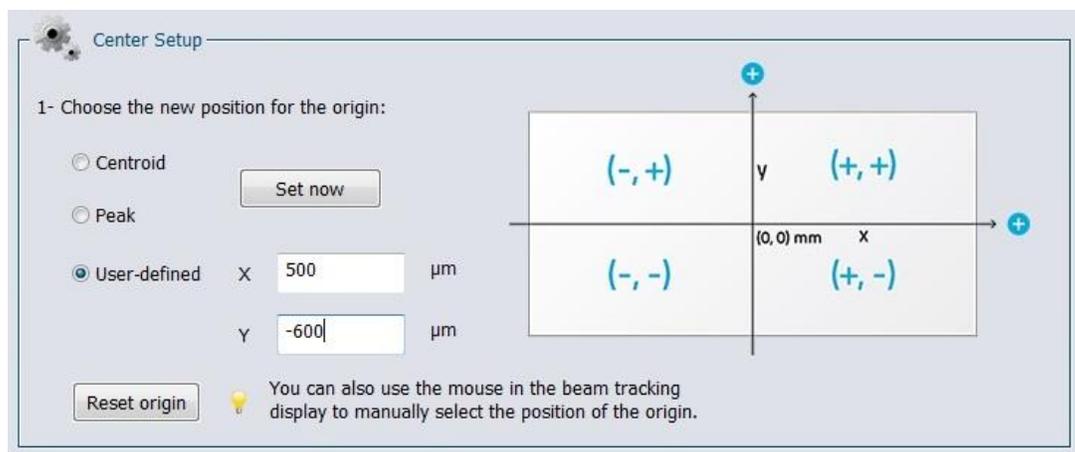


Figure 5-21 User-Defined Origin

Once the origin of the crosshairs is determined by the user, the software will be able to see the crosshairs from this particular origin in the 2D Display.

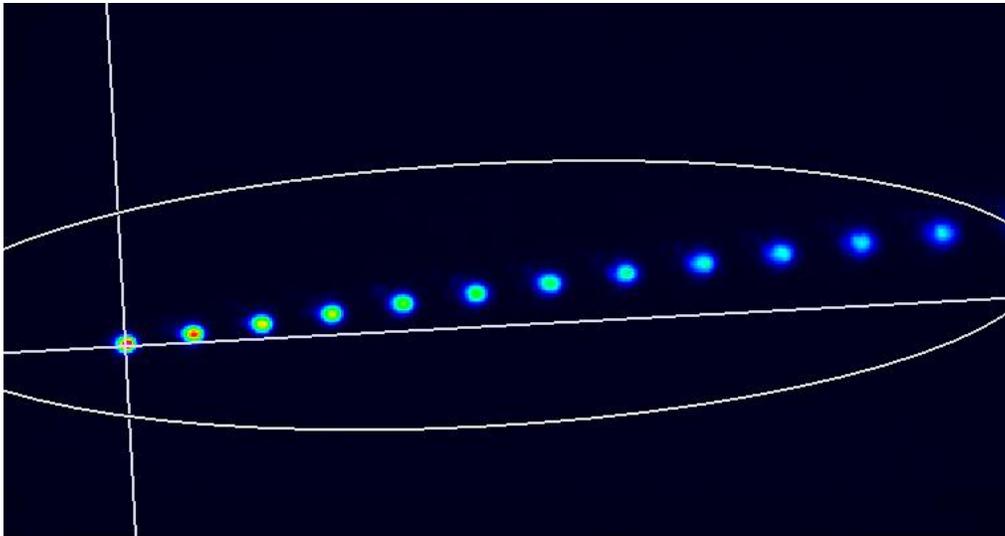


Figure 5-22 Fixed Crosshairs at Peak Position in the 2D Display

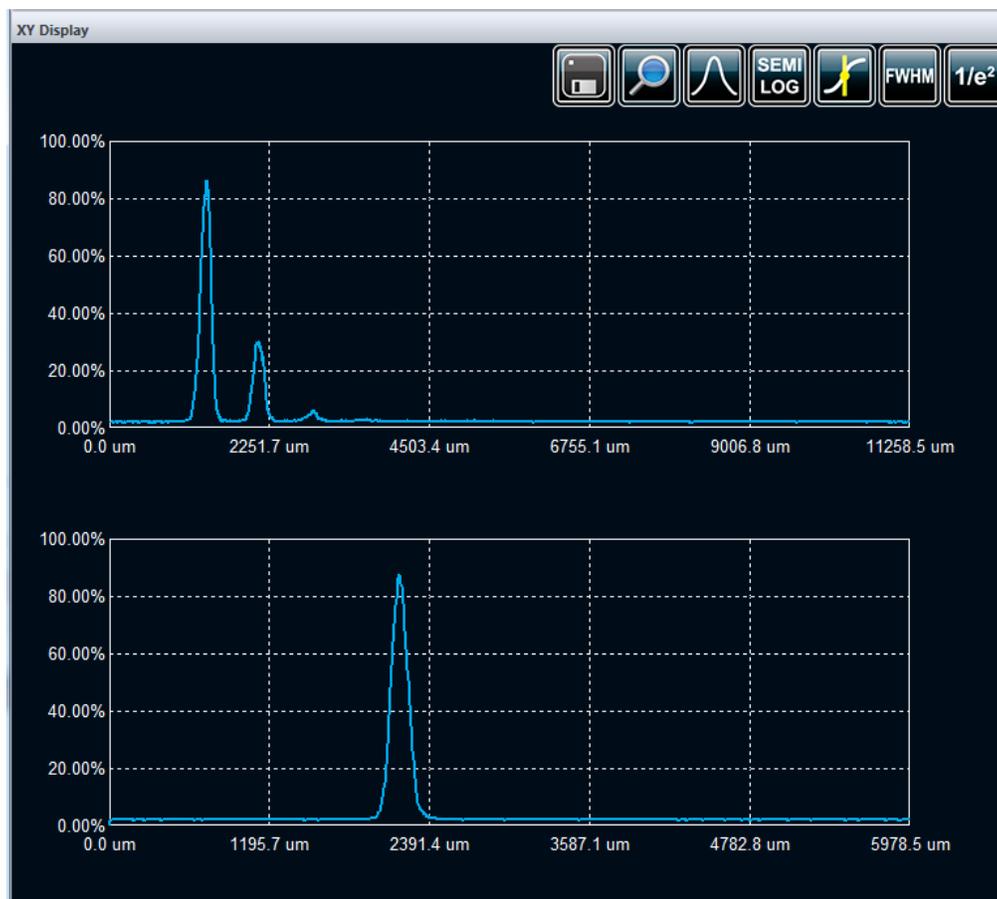


Figure 5-23 Fixed Crosshairs at Peak Position in the XY Display

5.7.2. Orientation Setup

To activate the fixed crosshair orientation option, go to the “Home” panel, in the “Main Controls” section and choose the *Fixed* option for the crosshair orientation. This will automatically open the “Fixed Crosshair” panel.



Figure 5-24 Fixed Crosshair Orientation Section

The “*Orientation Setup*” section allows the user to set the crosshair orientation. Once the orientation of the crosshairs is determined by the user, the software will be able to see the crosshairs at this particular angle with respect to the sensor’s main axes.

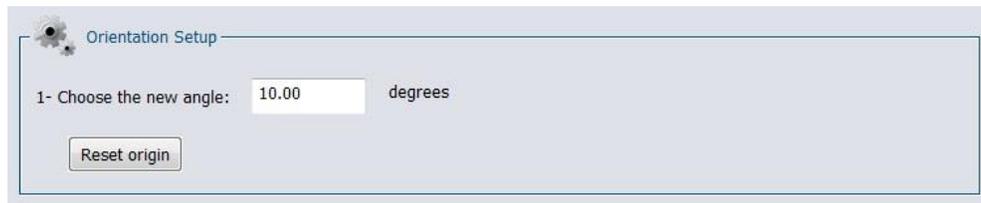


Figure 5-25 User-Defined Crosshair Orientation

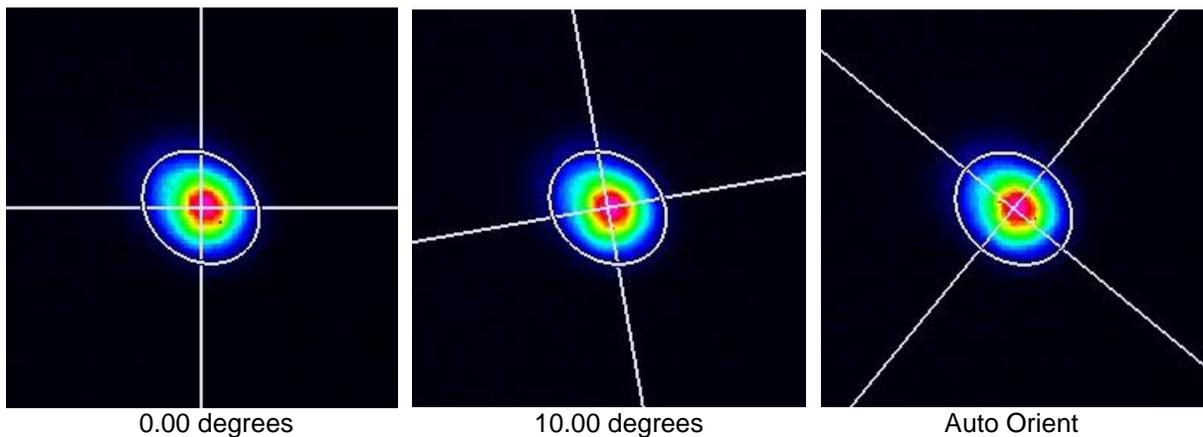


Figure 5-26 Different Crosshair Orientations for the Same Beam

6. DISPLAY PANEL

The PC-BeamPro offers four different graphical displays to view and analyze the laser beam.



3D Display: A real time display of the beam intensity in a 3D representation.



2D Display: A real time display of the beam intensity in a 2D representation.



XY Display: A real time display of the beam's XY cross-sectional graphs along the crosshairs.



Beam Tracking Display: A real time display of the beam's position stability

To choose the desired display mode, click on the corresponding icon in the lower control bar under the display panel.

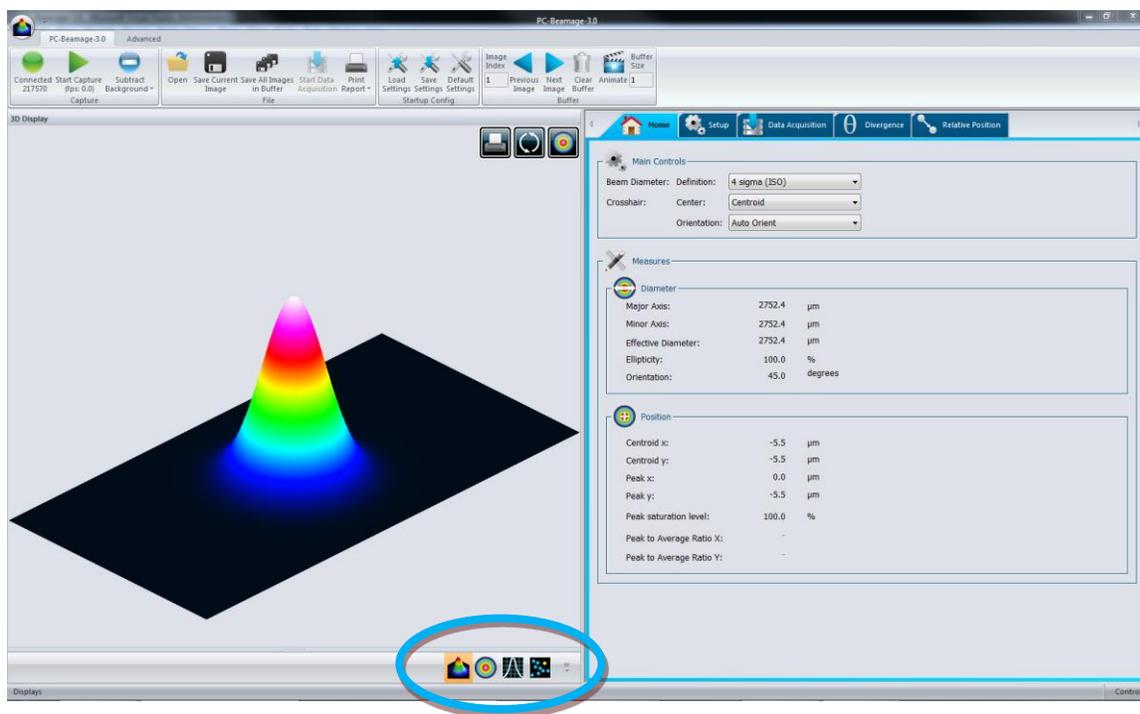


Figure 6-1 Display Panel

6.1. 3D DISPLAY

The 3D Display represents the beam's intensity in three dimensions. False coloring is added to increase the contrast. The color legend used for the various intensity levels is available in the "Main Controls" ribbon (refer to section 4.8.1).

To rotate the image, hold down the left button on the mouse and move the mouse. The scroll button on the mouse zooms the image in or out. It is also possible to zoom in the image by pressing the "+" key on the keyboard and similarly, it is possible to zoom out the image by pressing the "-" key on the keyboard. Pressing the Ctrl button while holding down the left mouse button will pan the 3D image along its Y axis. Doing the same procedure with the Shift button pans the 3D image along its X axis.

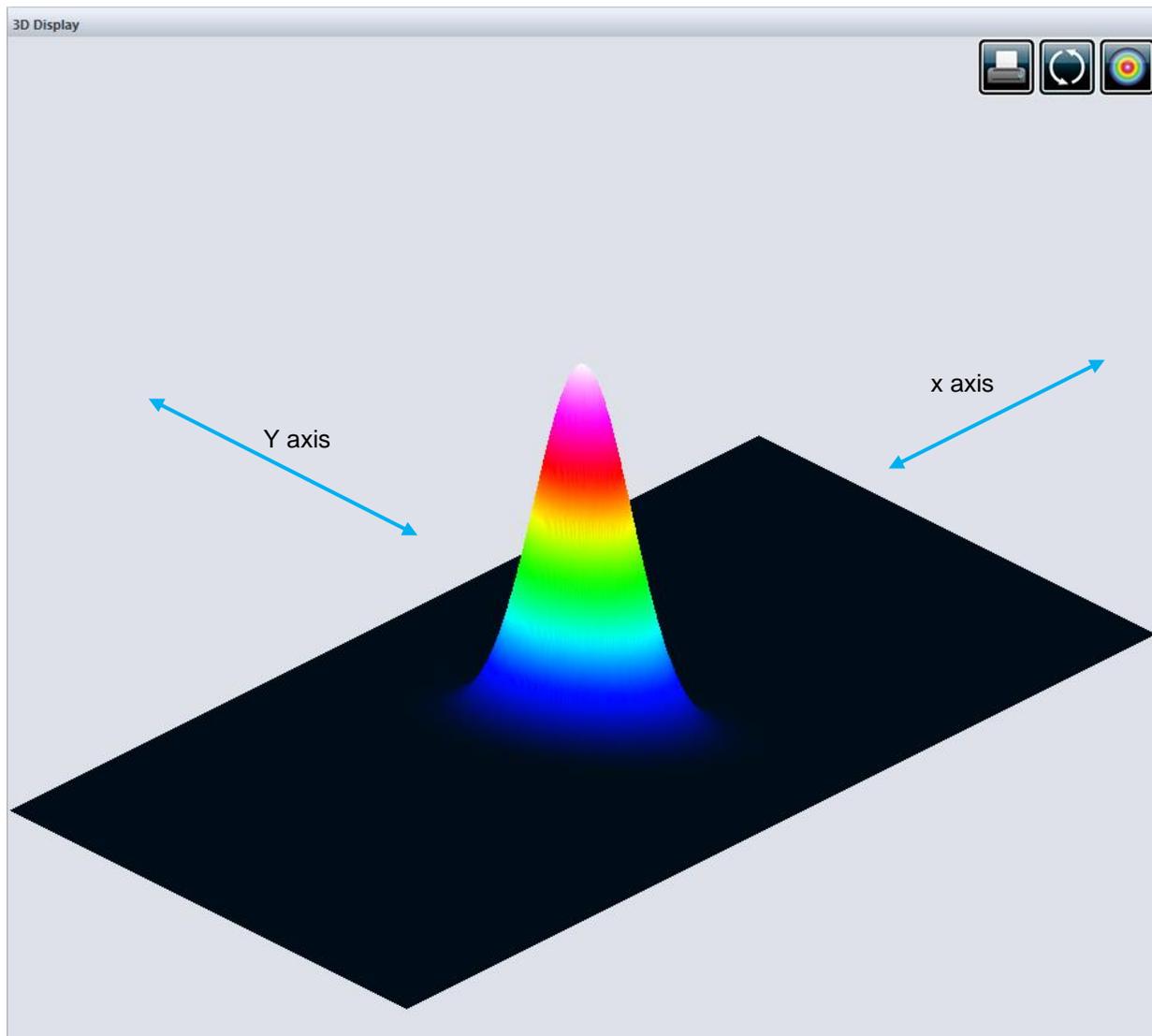


Figure 6-2 3DDisplay

6.1.1.3D Display: Controls

The toolbar buttons on the upper right corner control the 3D image.



Print Screen: Saves a *.BMP image of the current 3D display.



Reset View: Resets the display to its original parameters.



Top View: Views the 3D image from the top, creating a top-view projection.

6.2. 2D DISPLAY

The 2D Display represents the beam's intensity in two dimensions. False coloring is added to increase the contrast. The color legend used for the various intensity levels is available in the "Main Controls" ribbon (refer to section 4.8.1). The 2D display also features the crosshairs (set to the major and minor axis or along specified angles).

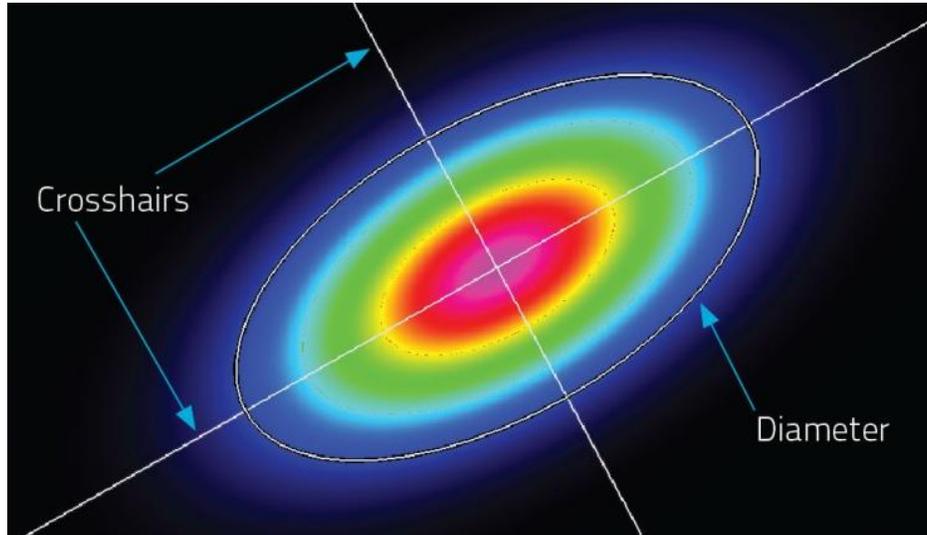


Figure 6-3 2D Display Showing Crosshairs and Diameter Positions

To optimize the software's performance, the resolution of the 2D image is downsampled when the BeamPro 3.0 is streaming. Nonetheless, the computation is done on all transferred pixels. For images larger than 1000x1000 only 1/16 pixels are displayed, for images larger than 500x500 only 1/4 pixels are displayed and for smaller images all pixels are displayed. When the BeamPro 3.0 is stopped or in the animate mode, all pixels are always displayed regardless of the image size.

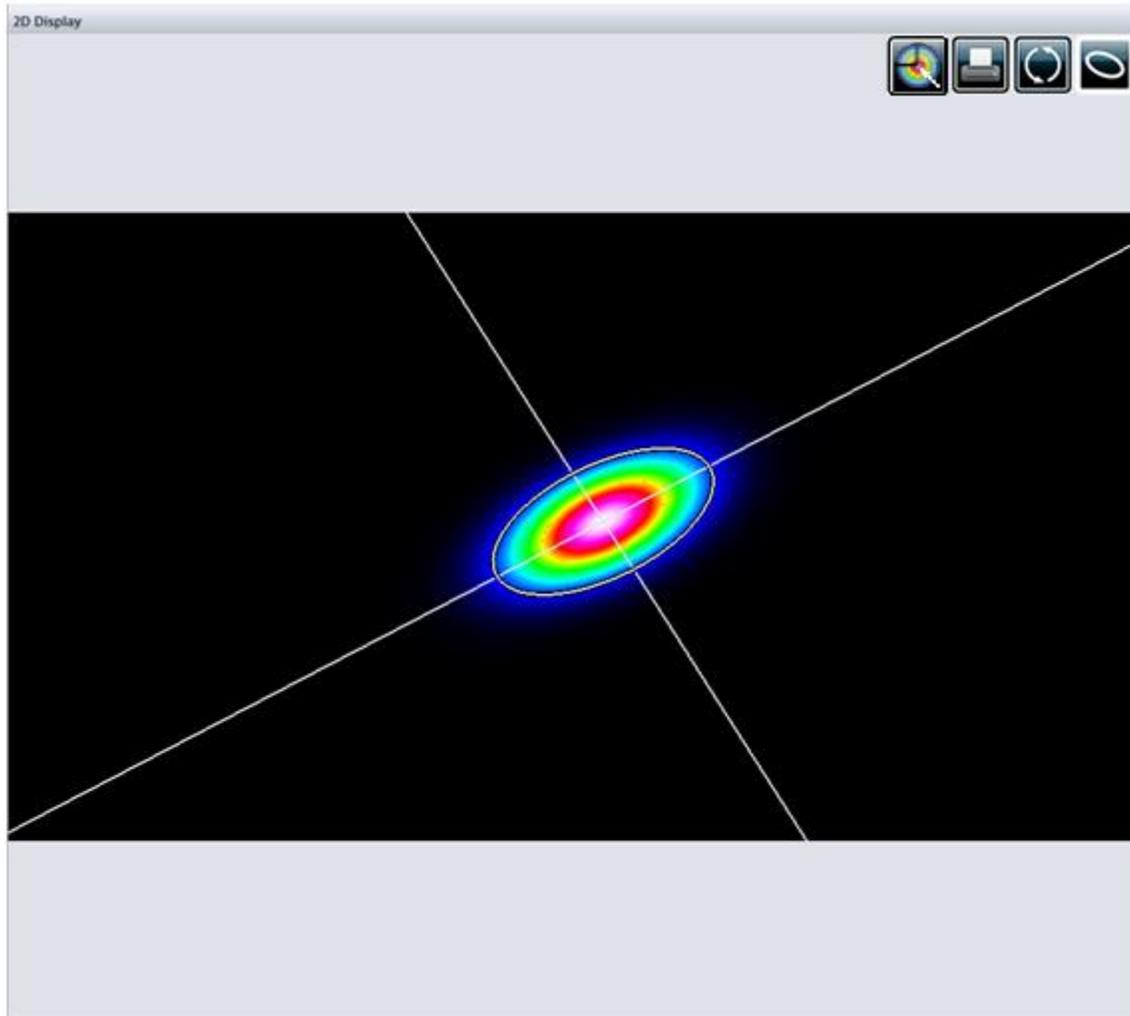


Figure 6-4 2D Display

To translate the image, hold down the left button on the mouse and move the mouse. The “up arrow”, “down arrow”, “left arrow” and “right arrow” will also move the image accordingly. The scroll button on the mouse zooms the image in or out. It is also possible to zoom in the image by pressing the “+” key on the keyboard and similarly, it is possible to zoom out the image by pressing the “-” key on the keyboard.

6.2.1.2D Display: Controls

The toolbar buttons on the upper right corner control the 2D image.



Print Screen: Saves a *.BMP image of the current 2D display.



Reset View: Resets the view settings to its original parameters.



Show/Hide Diameter: Displays the ellipse corresponding to the beam diameter (refer to section 5.1.1.1).



Select Active Area: Selects with cursor an active area.

6.3. XY DISPLAY

The “XY display” plots cross-sectional graphs of the beam along the crosshairs. The crosshairs position and orientation are defined in the “Home” tab (refer to section 5.1.1.2)

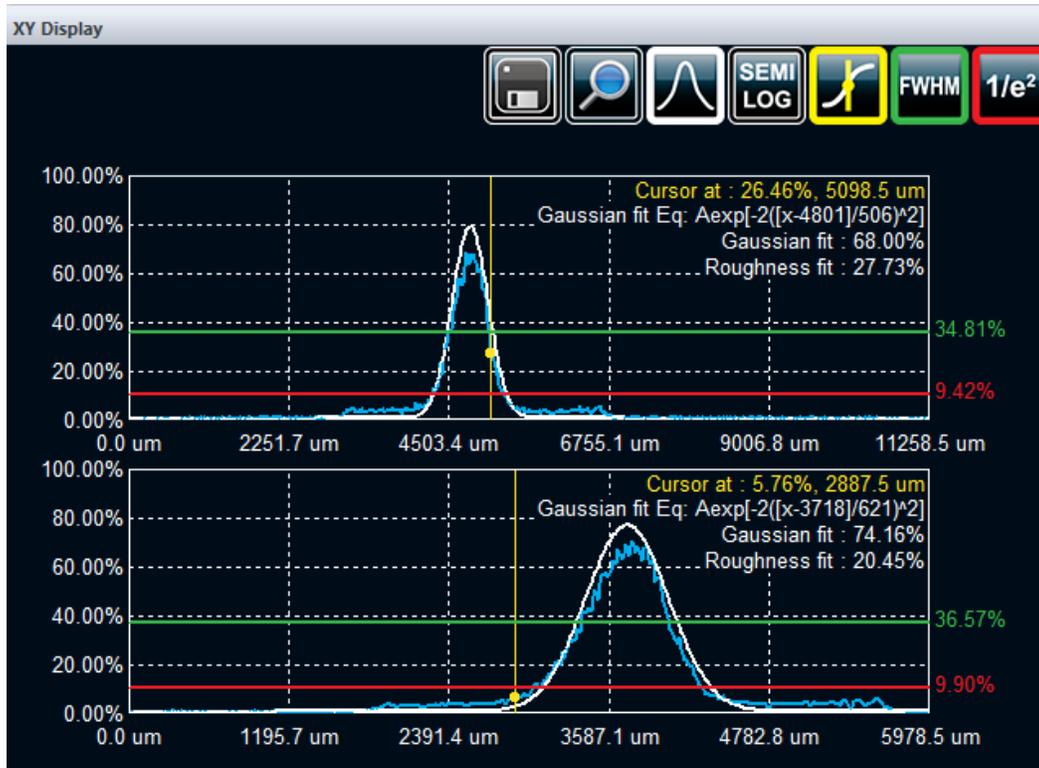


Figure 6-5 XY Display

6.3.1.XY Display: Controls

The toolbar buttons on the upper right corner control the XY graphics.

-  **Save:** Saves the crosshair information in a *.TXT file. If the “Gaussian Fit” was activated, the crosshair information of the Gaussian fit will also be saved in the file.
-  **Zoom:** Activates the zoom for both graphics individually. Zooming can be done by selecting an area with the left mouse button. Double-clicking the image returns it to the original state.
-  **Gaussian Fit:** Shows/Hides the best fitted Gaussian along the experimental curve. Refer to section 6.3.2 for more information.
-  **Semi-Log:** Transforms the linear graphics to semi-logarithmic graphs to enhance the details in the low intensity parts of the beam.
-  **Cursor Position:** Shows/Hides a cursor on each graph with their intensity and position value in the graph’s upper right corner. The cursors are positioned by clicking on the desired spots with the left mouse button.
-  **FWHM:** Shows/Hides the level corresponding to the half maximum value.



1/e²: Shows/Hides the level corresponding to the 1/e² value.

6.3.2. Gaussian Fit

The “*Gaussian Fit*” function fits the best Gaussian curve on the experimental data. When the “*Gaussian Fit*” is activated, it displays three information on the graphic’s upper right corner.

6.3.2.1. The Gaussian equation

The first information to be displayed is the equation of the fitted Gaussian. The Gaussian equation is defined by:

$$f(x) = Ae^{\left[-2\left(\frac{x-c}{w}\right)^2\right]}$$

where w is the beam’s radius, c its centroid.

6.3.2.2. The Gaussian Fit factor

The Gaussian Fit factor is defined as:

$$\text{Gaussian fit (\%)} = \left[1 - \frac{\sum |E_i - E_i^a|}{\sum E_i^a} \right] \times 100\%$$

where E is the experimental curve and E^a is the theoretical Gaussian curve.

The closer to 100%, the better the Gaussian fit.

6.3.2.3. The Roughness Fit factor

The Roughness Fit factor is the maximum deviation between the theoretical Gaussian curve and the measured curve, as defined by ISO13694:2000²:

$$\text{Roughness fit (\%)} = \left[\frac{|E_i - E_i^a|_{max}}{E_{max}} \right] \times 100\%$$

where E is the experimental curve and E^a is the theoretical Gaussian curve.

The closer to 0%, the better the Gaussian fit.

² International Organization for Standardization, ISO 13694 :2000 *Laser and laser-related equipment – Test methods for laser beam power (energy) density distribution*, Geneva

6.4. BEAM TRACKING DISPLAY

The “*Beam Tracking Display*” shows the variation of the position of the centroid on the sensor. The yellow cross represents the last calculated centroid position while the blue dots represent the previous ones. A dot is added to the chart at each computation. The buffer can memorize as many as 2000 calculations. The buffer is circular, which means that once it is full, it replaces the oldest value in memory by a new one. The mean position of all the centroid positions is represented by a red cross and the origin position is represented by a large white cross with a green center.

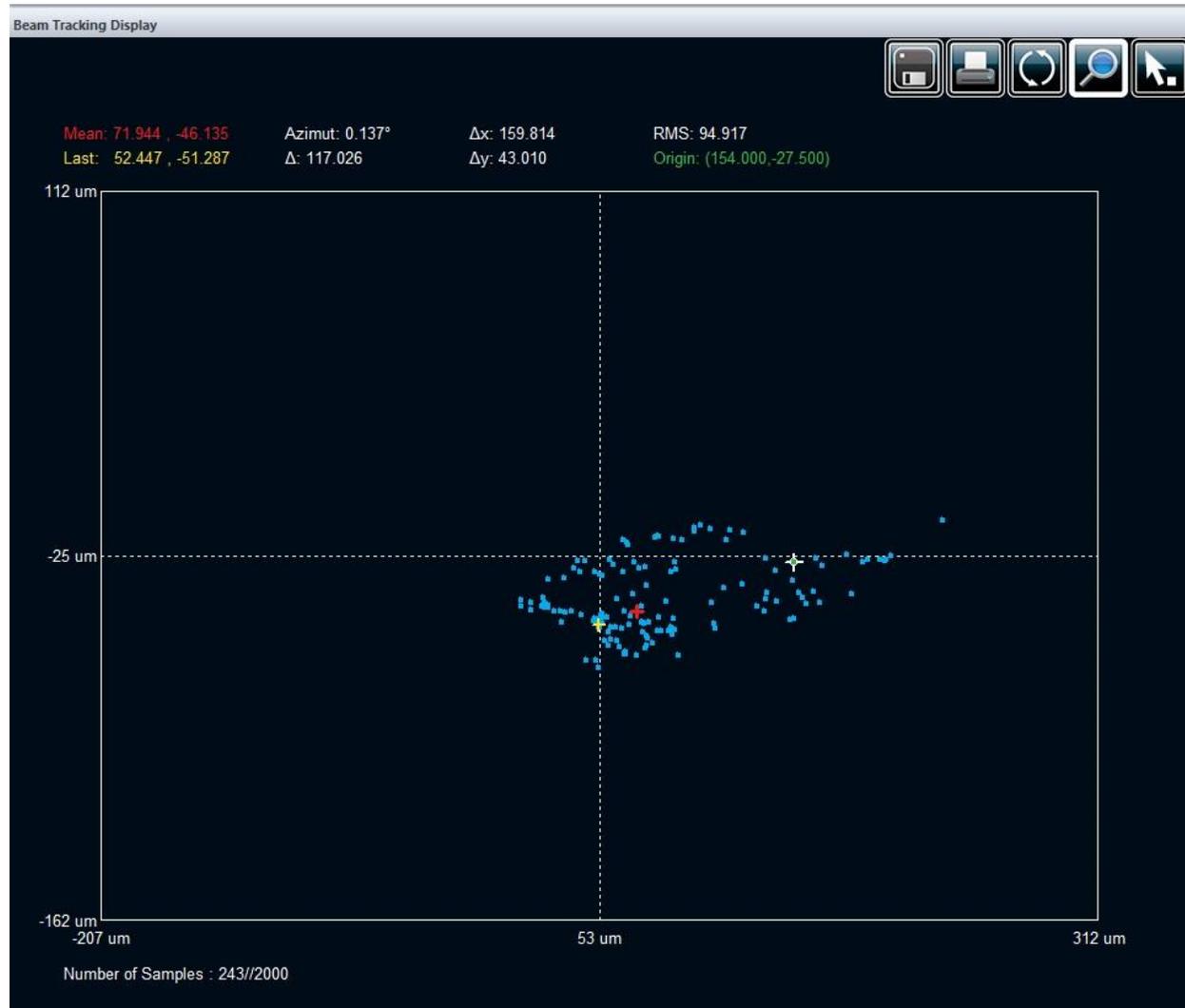


Figure 6-6 Beam Tracking Display

Useful ISO 11670 compliant values appear above the chart. They give an indication on how much the beam drifts from its mean position.

- *Mean*: Coordinates of the mean position of the centroid.
- *Last*: Coordinates of the last calculated position of the centroid.
- *Azimuth*: Orientation for which the drift is maximal.
- Δ : Overall beam positional stability
- Δx : Beam positional stability in the azimuth direction.

- Δy : Beam positional stability perpendicularly to the azimuth.
- *RMS* : RMS standard deviation value of the centroid's position (not ISO measure)
- *Origin*: Relative position of the centroid

The beam positional stability values are based on the standard deviation concept³. Small values represent small deviations and a good stability.

Please refer to Appendix A for ISO mathematical definitions of the quantities listed above.

6.4.1. Beam Tracking Display: Controls

The toolbar buttons on the upper right corner control the beam tracking plot.



Save: Saves all the centroid coordinates available in the buffer in a *.TXT file.



Print Screen: Saves a *.BMP image of the current beam tracking display.



Reset Buffer: Erases all the data from the buffer and clears the chart.



Zoom: Activates the zoom. Zooming can be done by selecting an area with the left mouse button and de-zooming can be done by double-clicking the image.



Set Origin Point: Sets the origin point (0, 0) of the sensor for the relative positioning, Please refer to section 4.6.5.2.

³ International Organization for Standardization, *ISO 11670:2003 Laser and laser-related equipment – Test methods for laser beam parameters – Beam positional Stability*, Geneva

7. LABVIEW DRIVER

7.1. PC-BEAMPRO LABVIEW EXAMPLE VI'S

The PC-BeamPro Software can be controlled from LabVIEW using the VI Library supplied by Edmund Optics. They are individual VIs to implement each of the supported control and measurement functions. There is also an example VI that demonstrates how to use the individual VIs to build a standalone LabVIEW application. Before using the VIs, the PC-BeamPro Software must be running, and the LabVIEW Pipe must be opened.

The VIs can be grouped into 6 basic categories.

1. Connection VIs
2. Control VIs
3. Measurement VIs
4. Display VIs
5. Activation VIs
6. Miscellaneous VIs

7.1.1.Connection VIs

- *Verify DLL.*

This VI checks to ensure the required DLL file is present in the directory in which the LabVIEW VIs are located.

- *Connect to PC BeamPro 3.0.*

This VI connects to the LabVIEW pipeline opened by the PC-BeamPro software.

- *Disconnect from PC BeamPro 3.0.*

This VI disconnects from the LabVIEW pipeline opened by the PC-BeamPro software.

7.1.2.Control VIs

- *Control Stop Capture.*

This VI stops the capture from the PC-BeamPro software and the BeamPro 3.0 USB Camera. Running this VI is the same as pressing the Stop Capture button in the software.

- *Control Start Capture.*

This VI starts the capture from the PC-BeamPro software and the BeamPro 3.0 USB Camera. Running this VI is the same as pressing the Start Capture button in the software.

The following Control VIs are Main Controls.

- *Control 4 Sigma.*

This VI sets the Beam Diameter Definition Control in the PC-BeamPro Software. Running this VI is the same as pressing the selecting the 4 Sigma (ISO) control in the software.

- *Control FWHM.*

This VI sets the Beam Diameter Definition Control in the PC-BeamPro Software. Running this VI is the same as pressing the selecting the FWHM control in the software.

- *Control 10VRe².*

This VI sets the Beam Diameter Definition Control in the PC-BeamPro Software. Running this VI is the same as pressing the selecting the $1/e^2$ along crosshairs (13.5%) control in the software.

- *Control 86%.*

This VI sets the Beam Diameter Definition Control in the PC-BeamPro Software. Running this VI is the same as pressing the selecting the 86% effective diameter (D86) control in the software.

- *Control Centroid.*

This VI sets the Crosshair Center Control in the PC-BeamPro Software. Running this VI is the same as pressing the selecting the Centroid control in the software.

- *Control Peak.*

This VI sets the Crosshair Center Control in the PC-BeamPro Software. Running this VI is the same as pressing the selecting the Peak control in the software.

- *Control Auto.*

This VI sets the Crosshair Orientation Control in the PC-BeamPro Software. Running this VI is the same as pressing the selecting the Auto Orient control in the software.

- *Control Zero.*

This VI sets the Crosshair Orientation Control in the PC-BeamPro Software. Running this VI is the same as pressing the selecting the 0 degrees control in the software.

- *Control 45.*

This VI sets the Crosshair Orientation Control in the PC-BeamPro Software. Running this VI is the same as pressing the selecting the 45 degrees control in the software.

7.1.3.Measurement VIs

The measurement VIs for the Diameter and Position. Position VIs have separate VIs for the X and Y measurements. Running the selected VI returns the reading from the software.

7.1.3.1. Diameter VIs.

- *Measure Effective Diameter*
- *Measure Effective Diameter*
- *Measure Ellipticity*
- *Measure Orientation*
- *Measure Peak Saturation*
- *Measure Major Axis*
- *Measure Minor Axis*

7.1.3.2. Position VIs.

These measurements are on the XY Display. Use the Display VIs to choose the XY Display and the Activate VIs to set the software before requesting measurement data from the software.

- *Measure X 10VRE² and Measure Y 10VRE²*
- *Measure X Centroid and Measure Y Centroid*
- *Measure X FWHM and Measure Y FWHM*
- *Measure X Gaussian Equation and Measure Y Gaussian Equation*
- *Measure X Gaussian Fit % and Measure Y Gaussian Fit %*
- *Measure X Peak to Average and Measure Y Peak to Average*
- *Measure X Peak and Measure Y Peak*
- *Measure X Roughness Fit and Measure Y Roughness Fit*

These measurements are on the TRACK Display. Use the Display VIs to choose the TRACK Display before requesting measurement data from the software.

- *Measure X Last and Measure Y Last*
- *Measure X Mean and Measure Y Mean*
- *Measure X Delta and Measure Y Delta*
- *Measure Azimuth*
- *Measure Delta*
- *Measure Number of Samples*
- *Measure RMS*

7.1.4. Display VIs.

These VIs decide which display the PC-BeamPro software will use. Using them is the same as pressing one of the four display buttons on the bottom of the software screen.

- *Display 2D. Switches to the 2 D display screen.*
- *Display 3D. Switches to the 3 D display screen.*
- *Display XY. Switches to the XY display screen.*
- *Display TRACK. Switches to the Beam Track display screen.*

7.1.5. Activate VIs.

These VIs select which measurement the PC-BeamPro software will use. Using them is the same as pressing one of the four buttons on the top of the XY Display software screen. The Cursor Control Button is not implemented in this release of LabVIEW VIs. You must run each of these VIs at least one time before requesting the respective measurement.

- *Activate Gaussian.*

Running this VI has the same effect as pressing the Gaussian button in the XY Display.

- *Activate LOG.*

Running this VI has the same effect as pressing the SEMI LOG button in the XY Display.

- *Activate LIN.*

Running this VI has the same effect as releasing the SEMI LOG button in the XY Display.

- *Activate FWHM.*

Running this VI has the same effect as pressing the FWHM button in the XY Display.

- *Activate 1OVRE.*

Running this VI has the same effect as pressing the 1/e2 button in the XY Display.

7.1.6. Miscellaneous VIs.

- *Query PC BeamPro 3.0 Version.*

Returns the PC-BeamPro software version.

- *Query Serial Number.*

Returns the serial number of the camera that is currently connected to the software.

- *Read PC BeamPro 3.0.*

Interfaces with the DLL file to read data from the software.

- *Write PC BeamPro 3.0.*

Interfaces with the DLL file to write data to the software.

- *Stay or Go.*

This VI is used to determine the behavior of the example application when it exits. If the example is being run in the LabVIEW Development environment, it will stay in memory and stay loaded on exit. If it is being run as an executable file, it will unload and clean memory when it exits.

7.1.7. The Example VI.

The VIs have all been used to create an example software. The front panel of this example is shown below.

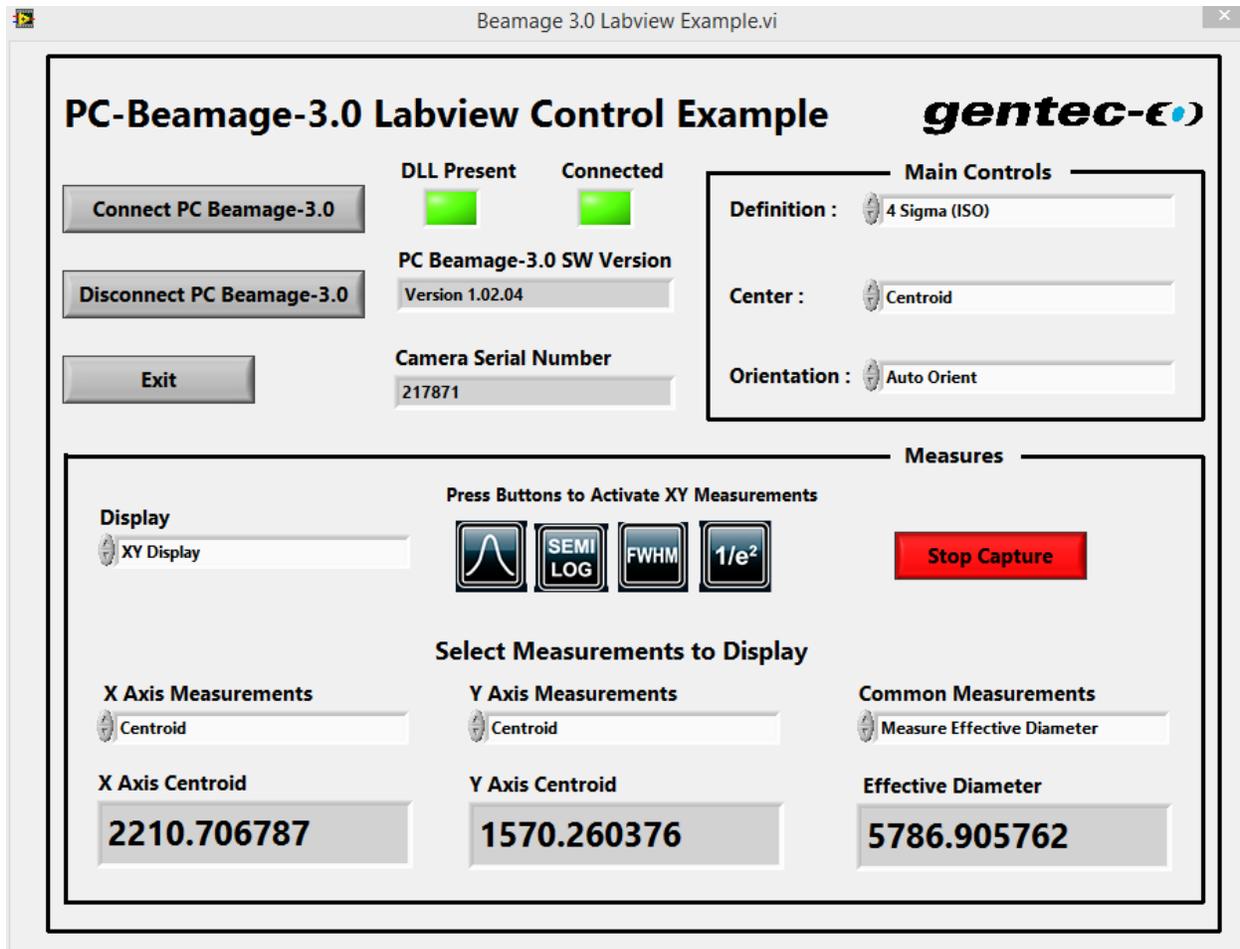


Figure 7-1 - BeamPro 3.0 LabVIEW Example

The example is written to be easy to use and understand so as to aid in the development of custom LabVIEW software. It uses an event structure to show the various controls. To use the example:

1. Copy the VIs into the folder of your choice, along with the supplied DLL file.
2. Start LabVIEW and run the example VI.
3. The VI will check to ensure the DLL is present. A warning will be issued if it cannot be located, and the required location will be displayed. Place the DLL in that location.
4. Plug a BeamPro 3.0 Camera into a USB port on the PC in use. Start PC-BeamPro and let it connect to the camera.
5. Under the Show/Hide Options menu item, select Start LabVIEW Pipeline. The PC-BeamPro software will verify the connection. You may now minimize the PC-BeamPro software as LabVIEW can now control the functions.

6. Press the Connect PC BeamPro 3.0 button on the LabVIEW software. The Connected LED will turn on. The VI will ask the PC-BeamPro for some information, and the software Version and Serial Number indicators will appear.
7. Press the Start Capture button. The Selected measurements will activate. Use the Main, Display, Activate buttons, and Measurements controls to select the desired measurements. The Activate buttons are only visible when the XY Display is selected.
8. Pressing Disconnect or Exit will automatically stop all measurements and close the LabVIEW pipeline.

8. TROUBLESHOOTING AND TIPS

8.1. WHILE TRYING TO INSTALL PC-BEAMPRO, THE FOLLOWING MESSAGE APPEARS: THE PROGRAM CAN'T START BECAUSE MSVCR100.DLL IS MISSING [...]

You must download the missing dll from Microsoft software and install it on your computer:

32 bit: <http://www.microsoft.com/download/en/details.aspx?id=5555>

64 bit: <http://www.microsoft.com/download/en/details.aspx?id=14632>

8.2. BEAMPRO 3.0 IS NOT DETECTED

Make sure the BeamPro 3.0 is connected to a USB 3.0 Super Speed port. The BeamPro 3.0 will work if plugged directly in a USB 2.0 port at a slower transfer rate.

Close the software application, disconnect and reconnect the USB 3.0 to the BeamPro 3.0 and open the software application. The LED indicator on the BeamPro 3.0 should blink in green and then in red before turning on green. If the LED does not turn on at the software's startup or if it does not turn on completely, please contact your Edmund Optics representative.

8.3. THE DISPLAY AREA IS COMPLETELY WHITE

Press the "Refresh" button and the display should come back.

8.4. CHANGING THE OPTICS IN FRONT OF THE BEAMPRO 3.0

Because the BeamPro 3.0's sensor does not have a coverglass, it is very sensitive to dust. Change the optics in a clean environment and put the BeamPro 3.0's aperture facing down to minimize the dust.

8.5. SMALL BLACK SPOTS APPEAR ON THE IMAGE

If these small black spots do not change place even if you rotate the attenuation filter, it is probably dust on the sensor. **DO NOT TOUCH** the surface of the chip to remove the dust as this will damage the sensor. **AT YOUR OWN RISK**, you can use an oil-free air jet to blow the dust away or contact your Edmund Optics representative.

8.6. IT IS NOT POSSIBLE TO START AN ACQUISITION. IT KEEPS OPENING A WARNING MESSAGE INDICATING THAT 0 GB IS AVAILABLE ON HARD DRIVE

This is probably due to the fact the path in/ which the PC-BeamPro was not installed in the default **C:\Program Files\Edmund Optics\PC-BeamPro** directory.

8.7. THERE IS NO SERIAL NUMBER DISPLAYED IN THE CAMERA

- Please close the PC-BeamPro software program, wait a couple of seconds and open the PC-BeamPro again.
- If the problem persists, please verify in Window's Task Manager if there is only one PC-BeamPro.exe instance running. If more than one are running, end all processes and open PC-BeamPro again.
- If the problem persists, please disconnect the BeamPro 3.0 and connect it again.
- If the problem persists, please contact your Edmund Optics representative.

8.8. THE DETECTED SERIAL NUMBER IS 000000

This happens when you connect a BeamPro 3.0 for the first time in a new USB port. The drivers need to be installed each time a new BeamPro 3.0 is plugged for the first time in a new USB port. When this happens, the PC-BeamPro software often opens before the drivers are installed, indicating a 000000 serial number. Close the PC-BeamPro software and restart the application.

8.9. THE 10 BIT ADC LEVEL IS NOT AVAILABLE EVEN WHEN THE BEAMPRO 3.0 IS CONNECTED TO A USB 3.0 PORT

The 10 bit ADC level is only available when using a USB 3.0 port. If it is not available even when connected on a USB 3.0 port, reboot the computer. If it is still not available, please contact your Edmund Optics representative.

8.10. DO NOT DISCONNECT THE BEAMPRO 3.0 WHILE IT IS STREAMING

The BeamPro 3.0 must not be disconnected when it is streaming.

8.11. TIPS TO INCREASE THE FRAME RATE

The BeamPro 3.0's frame rate greatly depends on the computer's performances. Here are a few tips to increase the frame rate:

- Use a USB-3.0 port;
- Use a computer with high performances (refer to PC Requirements section 1.2);
- Use Windows 7 or Windows 8;
- Follow the PC operating state for optimal conditions (refer to section 1.2)
- Do not use Filters (refer to 4.6.1);
- Do not use Image Averaging (refer to 5.2.3);
- For a large beam, use Pixel Addressing (refer to 5.2.5);
- For a small beam, use an Active Area (refer to 5.2.4);
- Make sure you have a short exposure time;
- Do not stream multiple BeamPro 3.0 units simultaneously.

9. DECLARATION OF CONFORMITY

Application of Council Directive(s): 2004/108/EC The EMC Directive



Manufacturer's Name: Gentec Electro Optics, Inc.
 Manufacturer's Address: 445 St-Jean Baptiste, suite 160
 (Québec), Canada G2E 5N7

European Representative's Name: Laser Components S.A.S.
 Representative's Address: 45 bis Route des Gardes
 92190 Meudon (France)

Type of Equipment: Laser Beam Diagnostic Equipment.
 Model No.: BeamPro 3.0
 Year of test & manufacture: 2012

Standard(s) to which Conformity is declared:
 EN 61326 :2005/EN 61326 : 2006/ Emission generic standard

Standard	Description	Performance Criteria
CISPR 11 :2009 +A1 2010	Industrial, scientific and medical equipment – Radio-frequency disturbance characteristics – Limits and methods of measurement	Class A
EN 61326 :2005/EN 61326 : 2006	Limits and methods of measurement of radio interference characteristics of information technology equipment. Testing and measurements of radiated emission	Class A
IEC 61000-4-2:2001	Electromagnetic compatibility (EMC) – Part 4: Testing and measurements techniques- Section 2: Electrostatic discharge.	Class B
IEC 61000-4-3:2002	Electromagnetic compatibility (EMC) – Part 4: Testing and measurements techniques- Section 3: Radiated, Radio Frequency immunity.	Class A

I, the undersigned, hereby declare that the equipment specified above conforms to the above Directive(s) and Standard(s).

Place: Québec (Québec)
 Date : December 13, 2012

(President)

APPENDIX A. ISO11146 AND ISO11670 DEFINITIONS

The beam centroid coordinates are given by:

$$\bar{x}(z) = \frac{\int_{-\infty}^{\infty} \int_{-\infty}^{\infty} E(x, y, z) x dx dy}{\int_{-\infty}^{\infty} \int_{-\infty}^{\infty} E(x, y, z) dx dy}$$

$$\bar{y}(z) = \frac{\int_{-\infty}^{\infty} \int_{-\infty}^{\infty} E(x, y, z) y dx dy}{\int_{-\infty}^{\infty} \int_{-\infty}^{\infty} E(x, y, z) dx dy}$$

The beam widths are defined as an “extent of a power density distribution in a cross section of beam based on the centered second order moments of the power density distribution.”

The second order moments of power density distribution are given by:

$$\sigma_x^2(z) = \frac{\int_{-\infty}^{\infty} \int_{-\infty}^{\infty} E(x, y, z) (x - \bar{x})^2 dx dy}{\int_{-\infty}^{\infty} \int_{-\infty}^{\infty} E(x, y, z) dx dy}$$

$$\sigma_y^2(z) = \frac{\int_{-\infty}^{\infty} \int_{-\infty}^{\infty} E(x, y, z) (y - \bar{y})^2 dx dy}{\int_{-\infty}^{\infty} \int_{-\infty}^{\infty} E(x, y, z) dx dy}$$

$$\sigma_{xy}^2(z) = \frac{\int_{-\infty}^{\infty} \int_{-\infty}^{\infty} E(x, y, z) (x - \bar{x})(y - \bar{y}) dx dy}{\int_{-\infty}^{\infty} \int_{-\infty}^{\infty} E(x, y, z) dx dy}$$

The beam widths are given by:

$$d_{\sigma_x} = 2\sqrt{2} \left\{ (\sigma_x^2 + \sigma_y^2) + \gamma \left[(\sigma_x^2 - \sigma_y^2)^2 + 4(\sigma_{xy}^2)^2 \right]^{\frac{1}{2}} \right\}^{\frac{1}{2}}$$

$$d_{\sigma_y} = 2\sqrt{2} \left\{ (\sigma_x^2 + \sigma_y^2) - \gamma \left[(\sigma_x^2 - \sigma_y^2)^2 + 4(\sigma_{xy}^2)^2 \right]^{\frac{1}{2}} \right\}^{\frac{1}{2}}$$

where:

$$\gamma = \frac{\sigma_x^2 - \sigma_y^2}{|\sigma_x^2 - \sigma_y^2|}$$

The major axis is the width's maximum whereas the minor axis is the width's minimum.

The effective diameter of the beam is an “extent of a circular power density having an ellipticity greater than 0.87. [...] If the ellipticity is larger than 0.87, the beam profile may be considered to be of circular symmetry at that measuring location and the beam diameter can be obtained from:”

$$d_{\sigma} = 2\sqrt{2}(\sigma_x^2 + \sigma_y^2)^{1/2}$$

The beam ellipticity is the “ratio between the minimum and maximum widths”

The beam orientation is the “angle between the x-axis [...] and that of the principal axis of the power density distribution which is closer to the x-axis.” From this definition, the angle is comprised between 45° and -45°.

$$\varphi(z) = \frac{1}{2} \arctan \left(\frac{2\sigma_{xy}^2}{\sigma_x^2 - \sigma_y^2} \right)$$

The beam's divergences transformed by an aberration-free focusing element of focal length f are given by the following equations:

$$\theta_x = \frac{d\sigma_x}{f}$$

$$\theta_y = \frac{d\sigma_y}{f}$$

$$\theta_\sigma = \frac{d\sigma}{f}$$

In the laboratory or usual system of coordinates (X',Y',Z'), the coordinates of the latest calculated position of the centroid for both X' and Y' axes are given by the following equations:

$$\bar{x}'(z) = \frac{\int_{-\infty}^{\infty} \int_{-\infty}^{\infty} E(x', y', z') x' dx' dy'}{\int_{-\infty}^{\infty} \int_{-\infty}^{\infty} E(x', y', z') dx' dy'}$$

$$\bar{y}'(z) = \frac{\int_{-\infty}^{\infty} \int_{-\infty}^{\infty} E(x', y', z') y' dx' dy'}{\int_{-\infty}^{\infty} \int_{-\infty}^{\infty} E(x', y', z') dx' dy'}$$

The coordinates of the mean position of all computed centroids for both X' and Y' axes are thus defined by the following equations, which are simple arithmetic means,

$$\bar{x}'_M = \frac{\sum_i \bar{x}'_i}{n}$$

$$\bar{y}'_M = \frac{\sum_i \bar{y}'_i}{n}$$

Where $\bar{x}'_i(z)$ and $\bar{y}'_i(z)$ are the centroid coordinates for X' and Y' axes already saved in the buffer, and n the number of computed centroid positions saved in the buffer.

The azimuth angle, which is the angle between the usual X' axis and all computed centroids, is given by the following equation:

$$\psi = \frac{1}{2} \arctan \left(\frac{2s_{\bar{x}\bar{y}}}{s_{\bar{x}}^2 - s_{\bar{y}}^2} \right)$$

where we have the following definitions:

$$s_x = \sqrt{\frac{\sum_i \bar{x}_i'^2}{n-1}}$$

$$s_{\bar{y}}^2 = \frac{\sum_i (\bar{y}'_i - \bar{y}'_M)^2}{n-1}$$

$$s_{\bar{x}\bar{y}}^2 = \frac{\sum_i (\bar{x}'_i - \bar{x}'_M)(\bar{y}'_i - \bar{y}'_M)}{n-1}$$

In the beam axis coordinate system (X,Y,Z), the beam positional stability values in the azimuth direction (X) and perpendicularly to the azimuth direction (Y), which are 4 times the standard deviations of all computed centroid values, are given by the following equations:

$$\Delta_x(z) = 4s_x$$

$$\Delta_y(z) = 4s_y$$

The overall positional stability is given by:

$$\Delta(z) = 2\sqrt{2}s$$

In the previous 3 equations, the standard deviations are defined by the following equations:

$$s_x = \sqrt{\frac{\sum_i \bar{x}_i'^2}{n-1}}$$

$$s_y = \sqrt{\frac{\sum_i \bar{y}_i^2}{n-1}}$$

$$s = \sqrt{\frac{\sum_i \bar{x}_i^2 + \bar{y}_i^2}{n-1}}$$

\bar{x}_i^2 and \bar{y}_i^2 are derived from \bar{x}'_i^2 and \bar{y}'_i^2 by transformation of coordinates. (X',Y',Z') is the usual or laboratory coordinate system and (X,Y,Z) is the beam axis coordinate system.

The RMS standard deviation value of the centroid position, which is not an ISO standard, is given by the following equation:

$$RMS = \sqrt{\left(\frac{\sum_i x_r^2 + y_r^2}{n}\right)}$$

where x_r^2 and y_r^2 are relative values.

APPENDIX B. BEAMPRO 3.0 DRIVER INSTALLATION QUICK GUIDE

- 1) Do not connect the *BeamPro 3.0*'s USB cable to your computer before installing the appropriate software and drivers. The camera will not be recognized if so.
- 2) The latest available version of *PC-BeamPro* must be installed before setting the drivers.
- 3) If the software is already installed on your computer, please make sure it is the latest available version of *PC-BeamPro*. To do so, open the *PC-BeamPro* software and click on *About*. Another window will appear and you will be able to *Update* the software.

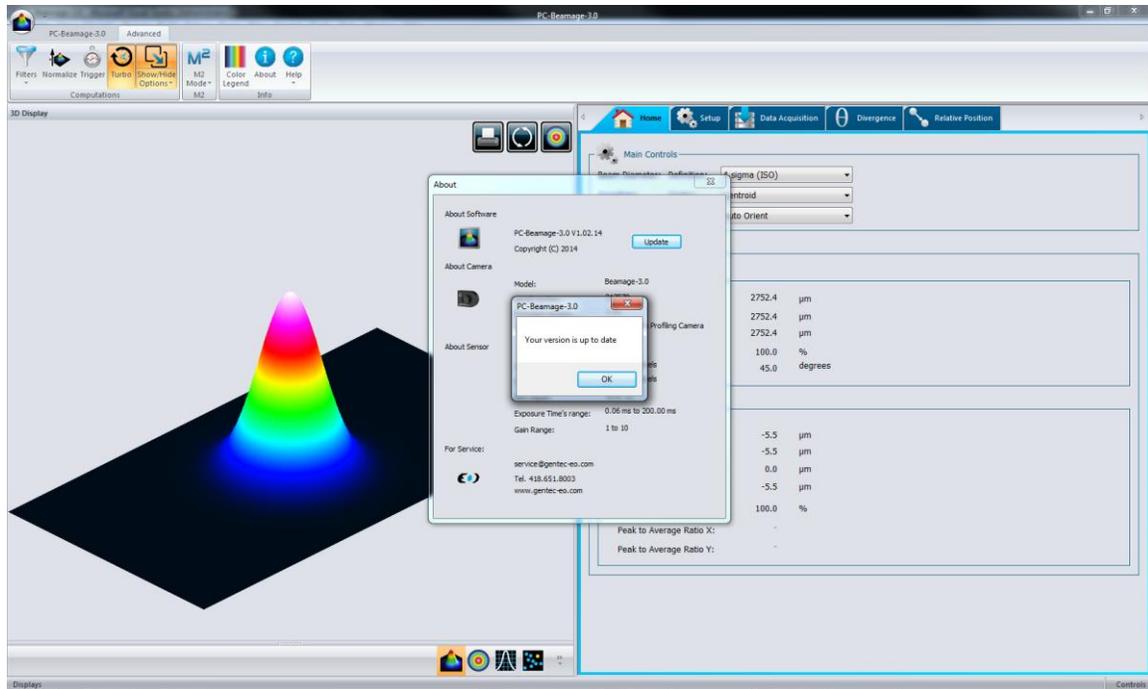


Figure B- 1: PC-BeamPro

- 4) You can now open the *Drivers Installer*. Once the file is opened, a security warning should appear. Click on *Run*.

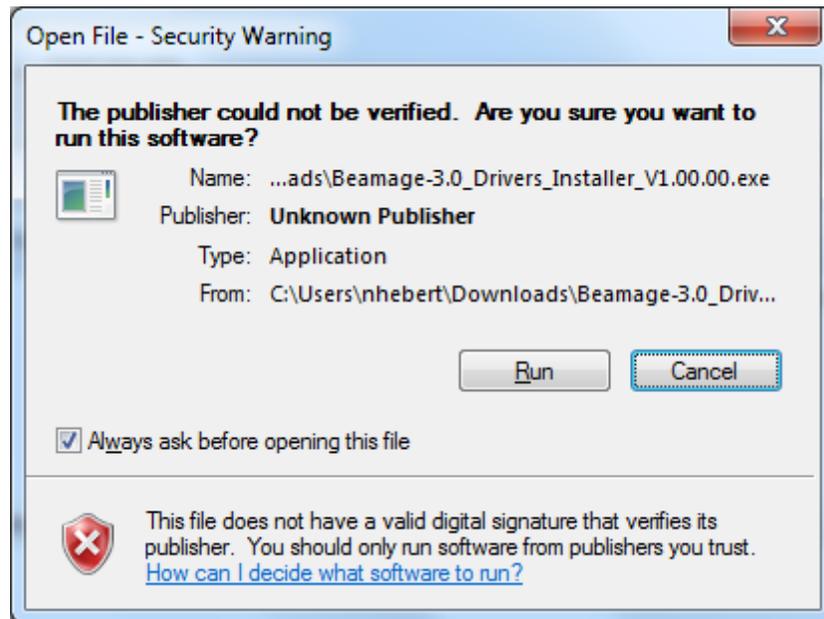


Figure B- 2: Security Warning

- 5) Choose the option that corresponds to your operating system. Please note that Windows XP is not officially supported and thus Edmund Optics does not provide assistance if this OS is used.

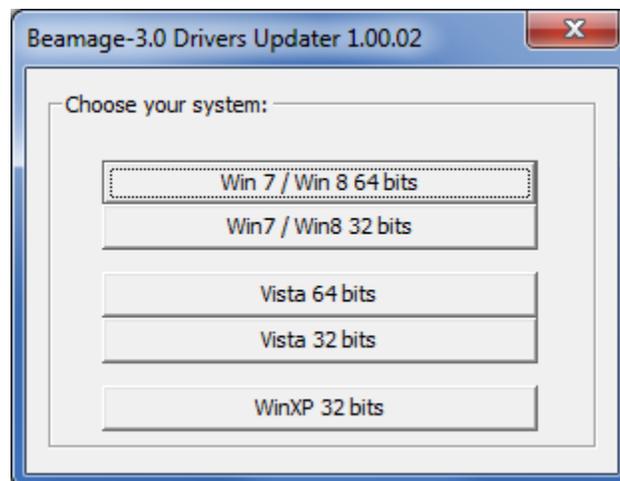


Figure B- 3: Choose your system

To find out what is your operating system, click on the *Start* (Windows home screen) button and type in *System* in the search field. Click on *System* under *Control Panel*. A window will appear, indicating which operating system is used. The x64 choices are applicable to 64-bit systems while the x86 choices are applicable to 32-bit systems.

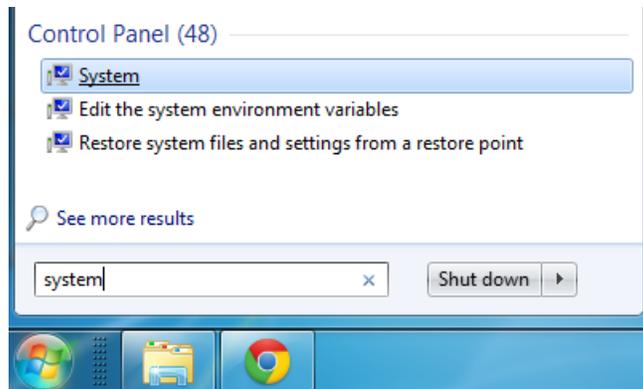


Figure B- 4: Search for “System”

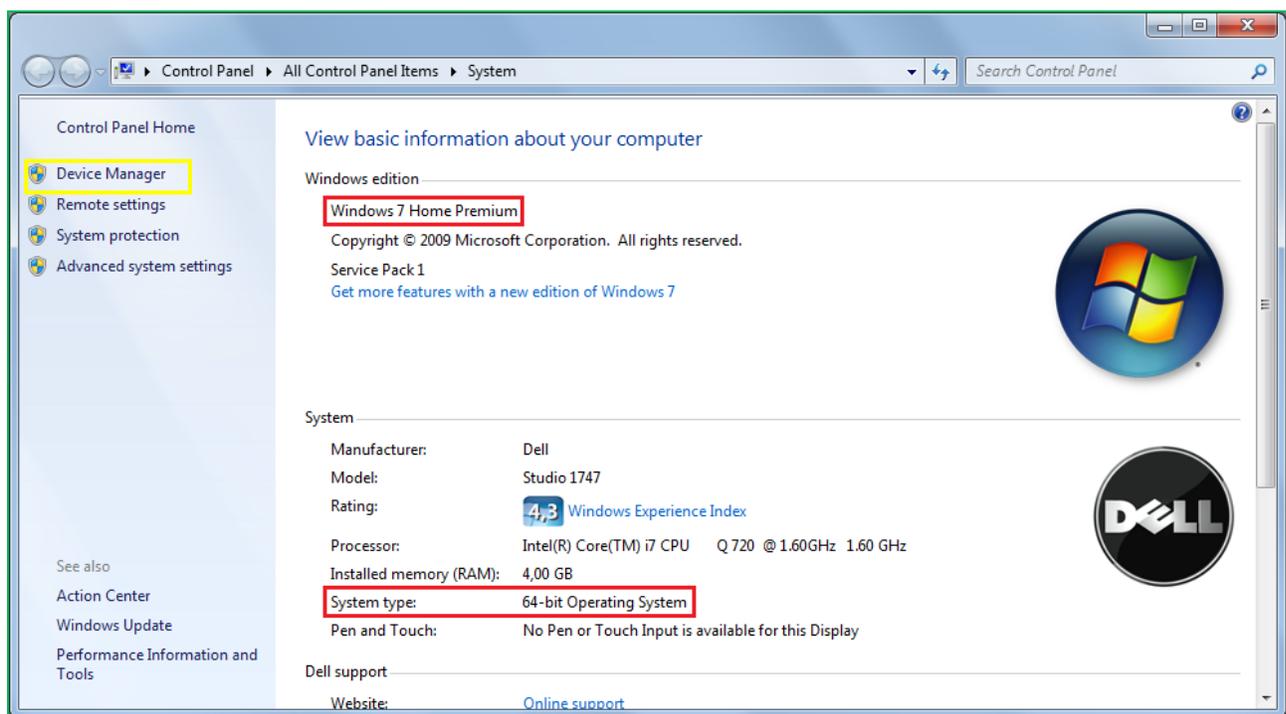


Figure B- 5: System information

- 6) After choosing the operating system, you will be asked to unplug the camera. If you followed the former steps, the camera should already be unplugged. Click on *OK*.

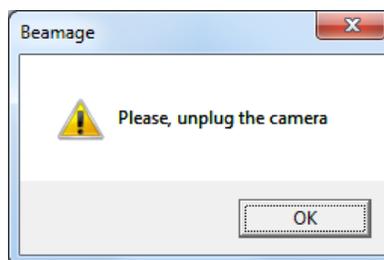


Figure B- 6: Unplug the camera

- 7) You will be asked if you want to allow the program to make changes to your computer. Click on Yes.

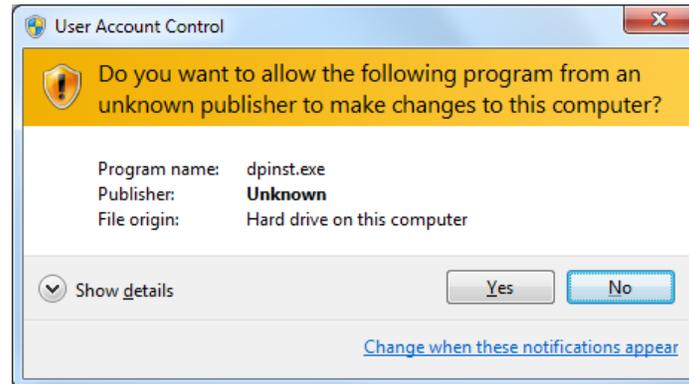


Figure B- 7: User Account Control

- 8) The driver installation wizard will appear. Click on Next.

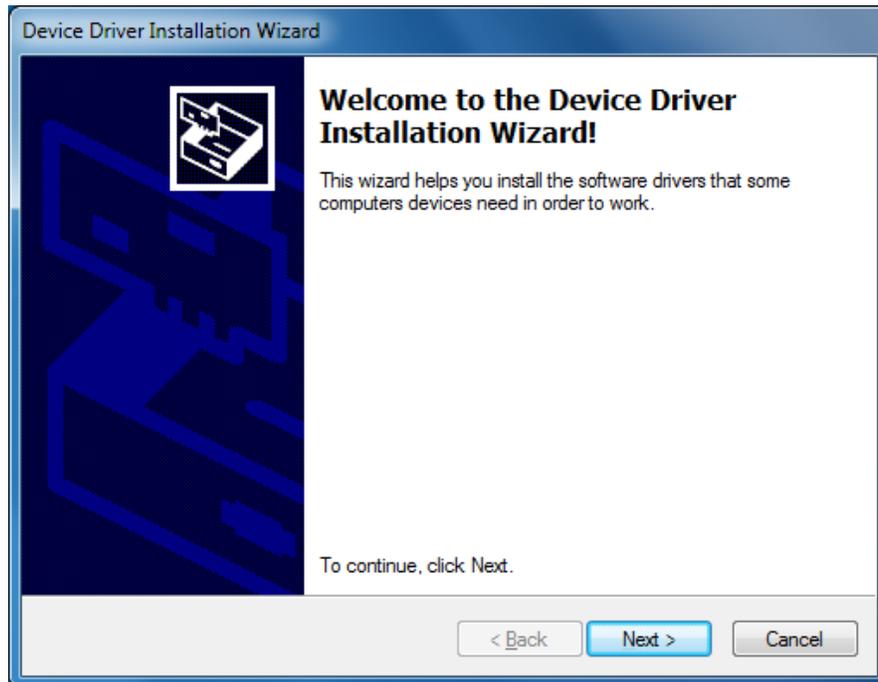


Figure B- 8: Device Driver Installation Wizard

- 9) To confirm that you want to install the device software, click on *Install*.

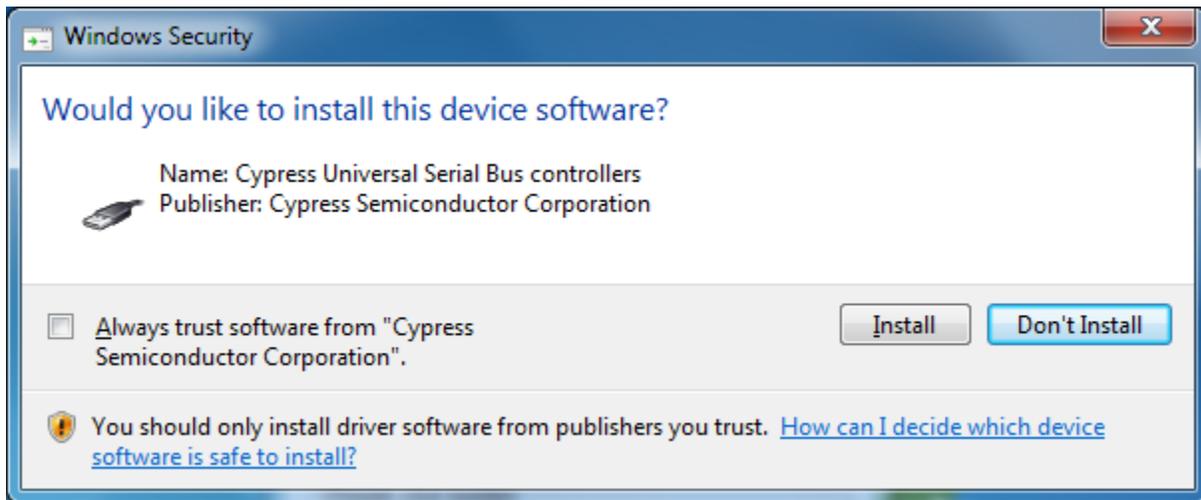


Figure B- 9: Confirmation Window

- 10) Once the installation is completed, click on *Finish*.

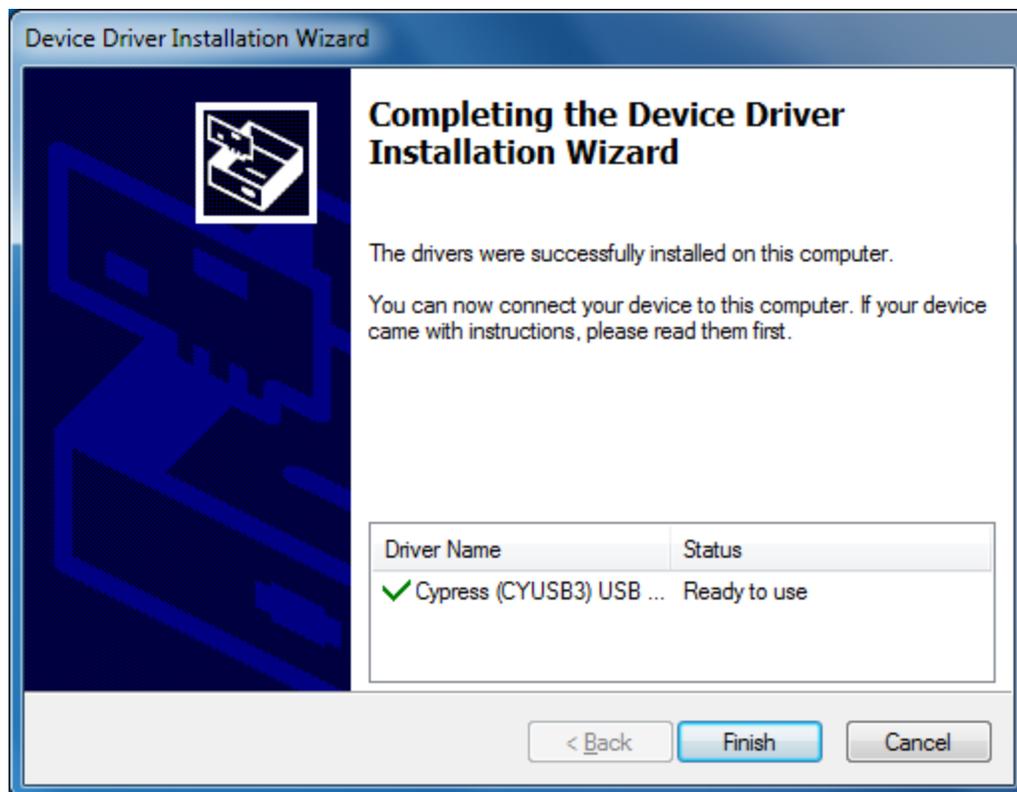


Figure B- 10: Installation Completed

- 11)

- 12) You will be prompted to connect the camera. Connect it through your USB port, but **DO NOT CLICK ON OK RIGHT AWAY**. Wait for the following message to appear at the bottom right of your screen before clicking on **OK**.

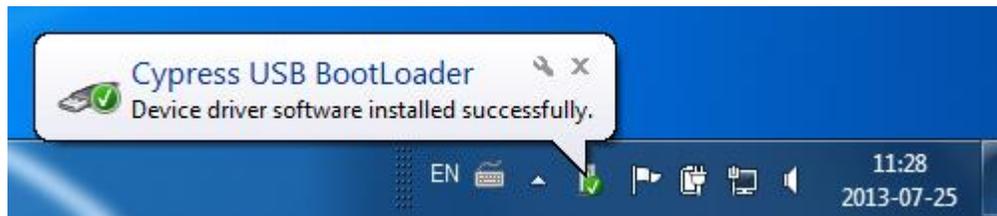


Figure B- 11: Driver installed successfully (1)

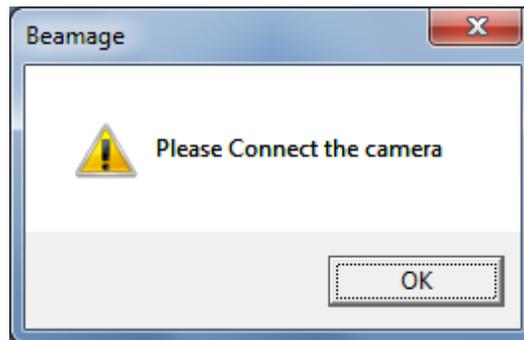


Figure B- 12: Connect the camera

- 13) Another window will inform you that you can now use PC-BeamPro. Click on **OK**.

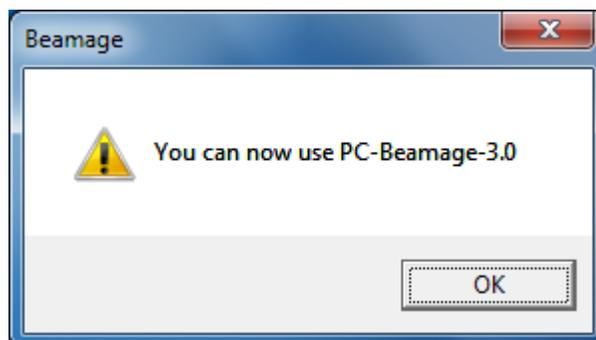


Figure B- 13: You can now use PC-BeamPro

- 14) To allow the device to be recognized by your computer, unplug and plug back the USB cable.

- 15) Start the PC-BeamPro application. A camera selector will appear, with a series of zero as the single option. Meanwhile, the last driver will be installed. Wait for the following message to appear at the bottom right of your screen. Click on *OK* in and close the application.

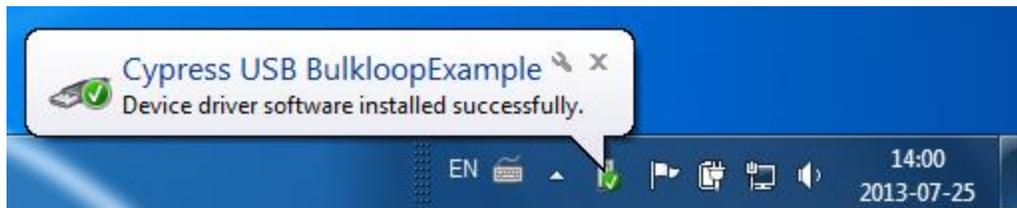


Figure B- 14: Driver installed successfully (2)

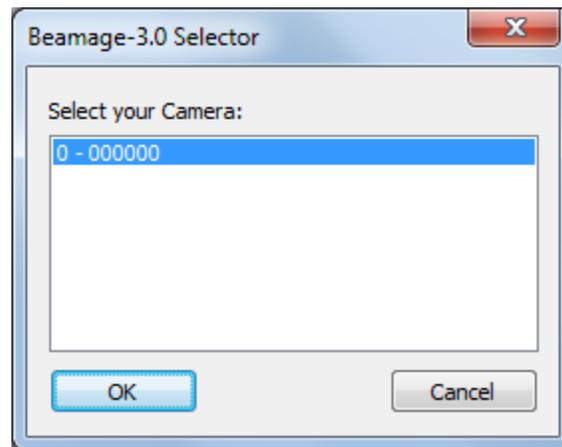


Figure B- 15: Camera Selector (1)

- 16) Restart the PC-BeamPro application. Select your camera and click on *OK*. The 6 digits following the dash correspond to the serial number of your device. You are now ready to use your BeamPro 3.0.

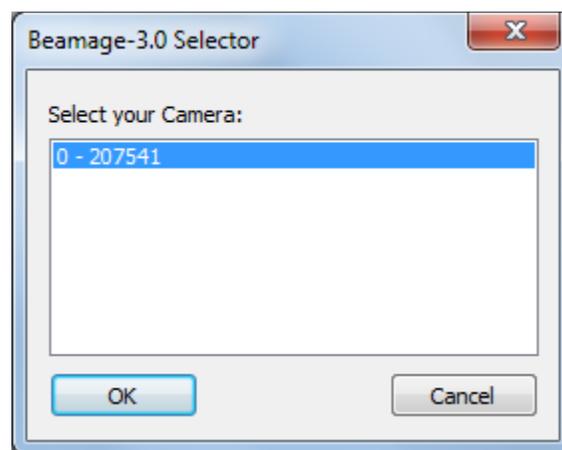


Figure B- 16: Camera Selector (2)

Verify that the driver has been correctly installed

It is not necessary to follow these steps to install the USB drivers. They are verification steps only.

- 1) Open your Device Manager. To open the *Device Manager*, click on the *Start* (Windows home screen) and type in *Device Manager* in the search field. Click on *Device Manager* under *Control Panel*. Be careful not to click on *Devices and Printers* instead of *Device Manager*.

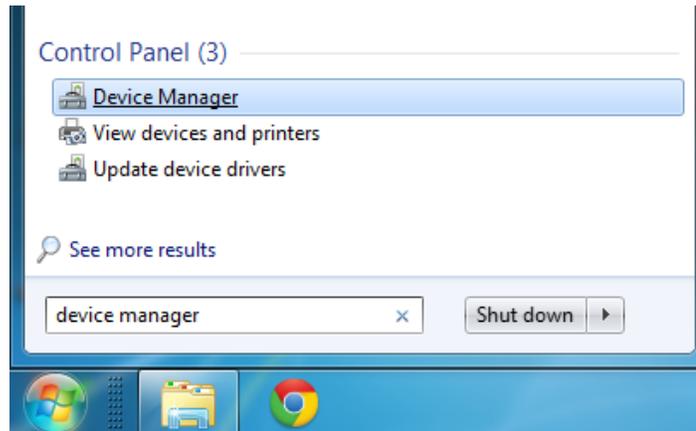


Figure B- 17: Search for “Device Manager”

You can also open the Device Manager through the System Window

- 2) Close the PC-BeamPro application (if it is already opened). Connect the BeamPro 3.0 camera to your computer. If everything went well until now, the device *Cypress USB BootLoader* should be marked by a yellow warning in the *Device Manager*. It should be located under *Universal Serial Bus controllers*.

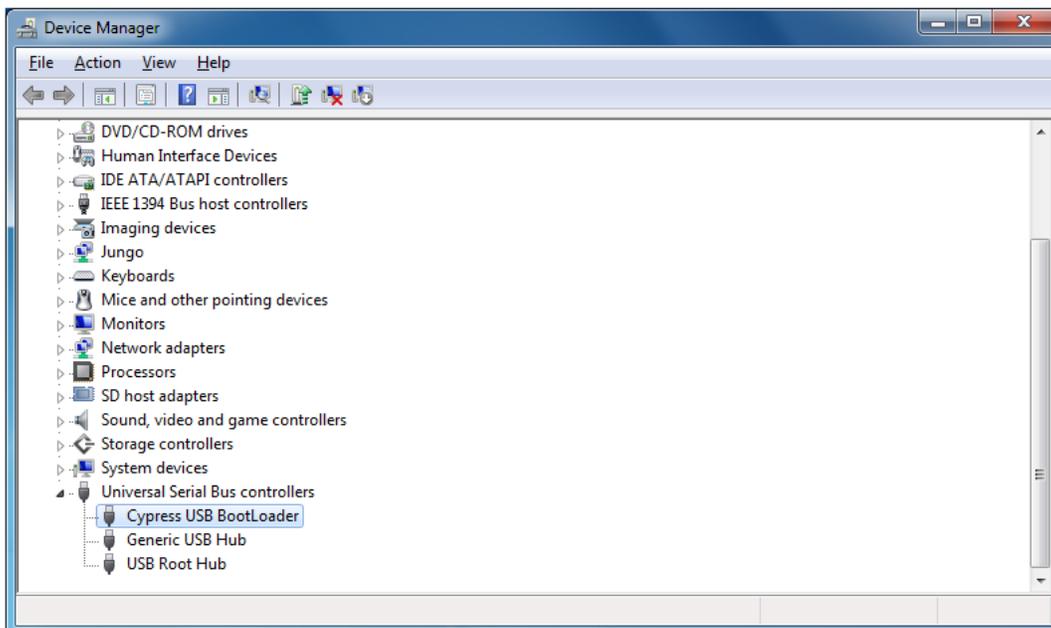


Figure B- 18: Cypress USB BootLoader

- 3) Open PC-BeamPro and make sure *Cypress USB BootLoader* has been replaced by *Cypress USB BulkloopExample*.

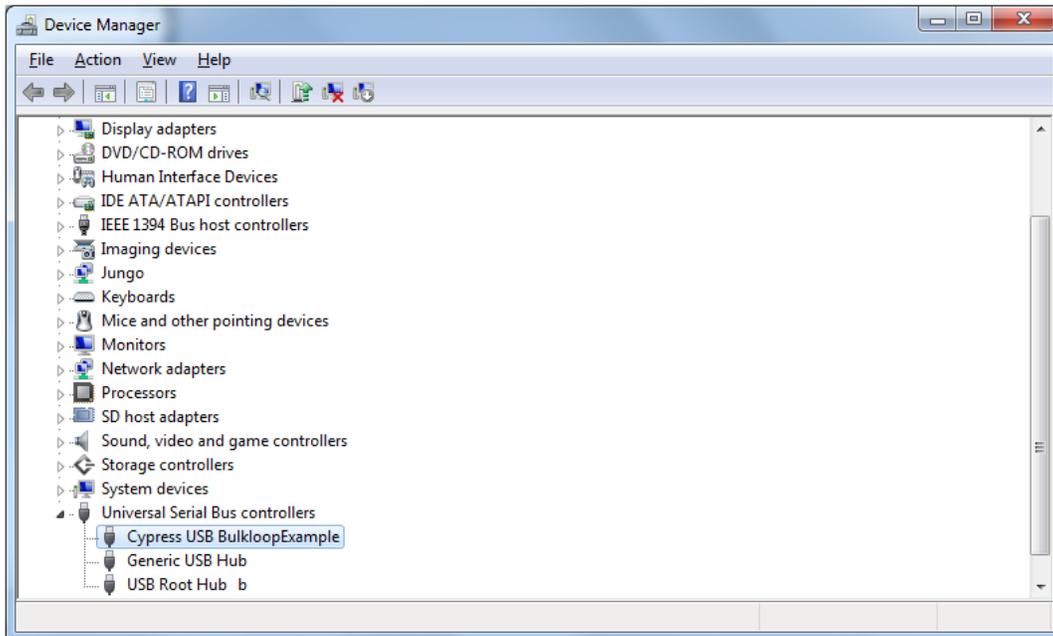


Figure B- 19: Cypress USB BulkloopExample

APPENDIX C. BEAMPRO 3.0 FIRMWARE INSTALLATION QUICK GUIDE

- 1) If the software version of the PC-BeamPro is not compatible with the BeamPro 3.0's firmware version, an error message will appear. **If so, it is important to update the firmware version and to reinstall the drivers in order to use the PC-BeamPro's new functions.**
- 2) First, download the latest BeamProUpdater.
- 3) Connect the BeamPro 3.0 to your computer. If the BeamPro 3.0 is already connected, please disconnect and reconnect it.
- 4) Run the BeamPro 3.0 Updater.
- 5) Click on "Update".

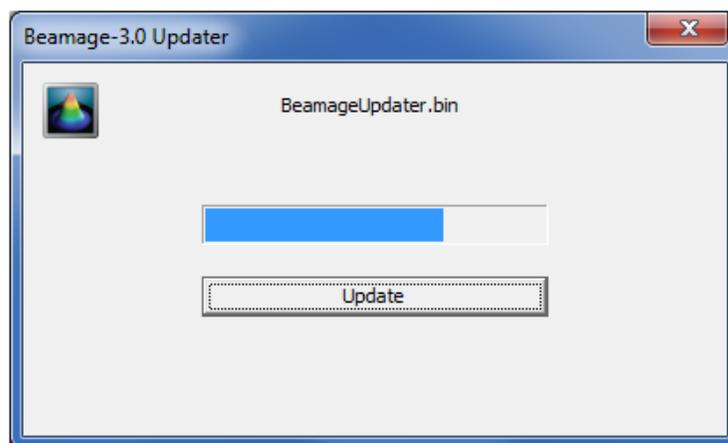


Figure C-1

- 6) The BeamPro 3.0 Updater might ask you to reset the BeamPro 3.0. If so, please disconnect and reconnect the BeamPro 3.0 and click on "Update" again.
- 7) Once this is done, a message box will appear. Click on *OK*.



Figure C-2

- 8) Once the Beamage-3.0's firmware is up to date, update the drivers by following the steps described in Appendix B. Please note that even if the drivers were previously installed, the new software and firmware versions need a new driver installation.

APPENDIX D. RECYCLING AND SEPARATION PROCEDURE FOR WEEE

This section is used by the recycling center when the BeamPro 3.0 reaches its end of line. Breaking the calibration seal or opening the BeamPro 3.0's case will void the warranty

The complete BeamPro 3.0 contains:

- 1 BeamPro 3.0
- 1 USB 3.0 cable with screw locks
- 1 BNC to SMA connector
- 1 Software CD-ROM

SEPARATION

Plastic: Aperture cap, SMA cap.

Metal: BeamPro 3.0's case, screws, SMA connector, BNC to SMA connector, ND filter holder.

Wires: USB cable.

Printed circuit board: inside the BeamPro 3.0.

Glass: ND filter.

CD: CD-ROM.

DISMANTLING PROCEDURE

Remove the 3 screws on the BEAMPRO 3.0's back cover with an Allen key.

Remove the 1 screw holding the PCB's with a flat screw driver.

Cut the wire between the PCB and the SMA connector.

Remove the ND filter and remove the glass with a spanner wrench.

APPENDIX E. COMPLETE LIST OF SAVED SETTINGS

- Image buffer size
- Smoothing filter activated
- Despeckle filter activated
- IR filter activated
- Normalize option activated
- Trigger option activated
- Turbo option activated
- Divergence tab is activated
- Relative position tab is activated
- Camera lens calibration tab is activated
- Fixed crosshair tab is activated
- XY display options :
 - Gaussian activated
 - Semilog activated
 - Data cursor activated
 - FWHM activated
 - 1/e2 activated
- Measure tab options:
 - Beam diameter definition
 - Crosshair center choice
 - Crosshair orientation choice
- Setup tab options:
 - Is auto exposure time activated
 - Exposure time
 - Image rotation
 - Image flip vertical
- Image flip horizontal
- Image buffer averaging
- Active area :
 - Choice
 - Left
 - Top
 - Center activated
 - Width
 - Height
- Pixel addressing mode
- Camera numerical gain
- Camera bit depth
- Magnification factor
- Acquisition tab options:
 - Acquisition mode
 - Duration:
 - Days
 - Hours
 - Minutes
 - Seconds
 - Sample rate images
 - Sample rate:
 - Days
 - Hours
 - Minutes
 - Seconds

- Acquisition filename
- Divergence tab options:
 - Focal distance
- Relative position tab options:
 - Relative position mode
 - X baseline position
 - Y baseline position
 - Save to log activated
- Camera lens calibration tab options:
 - X baseline position
 - Moving distance in X
 - Is calibrated activated
- Fixed crosshair tab options:
 - Fixed crosshair mode
 - X crosshair baseline position
 - Y crosshair baseline position
 - Crosshair angle



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