BeamView.NET

Operator's Manual

INNOVATIONS THAT RESONATE

COHERENT

Operator’s Manual
BeamView.NET

COHERENT

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1 Introduction

1.1 Scope of Manual

This User Manual includes the following information about BeamView.NET, beam diagnostic software from Coherent, Inc.:

- Introduction
- Install the Software
- Set Up Hardware
- Software Interface
- Capture a Beam Image
- Analyze Calculations
- Troubleshooting

1.2 Signal Words and Symbols in this Manual

This documentation may contain sections in which particular hazards are defined or special attention is drawn to particular conditions. These sections are indicated with signal words in accordance with ANSI Z-535.6 and safety symbols (pictorial hazard alerts) in accordance with ANSI Z-535.3 and ISO 7010.

1.2.1 Signal Words

Four signal words are used in this documentation: **DANGER**, **WARNING**, **CAUTION** and ***NOTICE***.

The signal words **DANGER**, **WARNING** and **CAUTION** designate the degree or level of hazard when there is the risk of injury:

DANGER!
Indicates a hazardous situation that, if not avoided, will result in death or serious injury. This signal word is to be limited to the most extreme situations.

WARNING!
Indicates a hazardous situation that, if not avoided, could result in death or serious injury.

CAUTION!
Indicates a hazardous situation that, if not avoided, could result in minor or moderate injury.

The signal word "***NOTICE***" is used when there is the risk of property damage:

NOTICE
Indicates information considered important, but not hazard- related.

Messages relating to hazards that could result in both personal injury and property damage are considered safety messages and not property damage messages.

1.2.2 Symbols

The signal words **DANGER**, **WARNING**, and **CAUTION** are always emphasized with a safety symbol that indicates a special hazard, regardless of the hazard level:

This symbol is intended to alert the operator to the presence of additional information.

This symbol is intended to alert the operator to the presence of important operating and maintenance instructions.

This symbol is intended to alert the operator to the danger of exposure to hazardous visible and invisible laser radiation.

This symbol is intended to alert the operator to the presence of dangerous voltages within the product enclosure that may be of sufficient magnitude to constitute a risk of electric shock.

This symbol is intended to alert the operator to the danger of Electro-Static Discharge (ESD) susceptibility.

This symbol is intended to alert the operator to the danger of crushing injury.

This symbol is intended to alert the operator to the danger of a lifting hazard.

1.3 Preface

This manual contains user information for the BeamView.net.

NOTICE

Read this manual carefully before operating the laser for the first time. Failure to follow the instructions and safety precautions in this manual can result in serious injury or death. Special attention must be given to the material in 'Safety and Compliance' (p. 217), that describes the safety features built into the use of a laser with the software.

DANGER!

Use of controls or adjustments or performance of procedures other than those specified herein may result in hazardous radiation exposure.

1.4 Export Control Laws

It is the policy of Coherent, Inc. to comply strictly with export control laws of the United States of America (USA).

Export and re-export of lasers manufactured by Coherent are subject to U.S. Export Administration Regulations, which are administered by the Commerce Department. In addition, shipments of certain components are regulated by the State Department under the International Traffic in Arms Regulations (ITAR).

The applicable restrictions vary depending on the specific product involved and its destination. In some cases, U.S. law requires that U.S. Government approval be obtained prior to resale, export or re-export of certain articles. When there is uncertainty about the obligations imposed by laws in the USA, clarification must be obtained from Coherent or an appropriate agency of the U.S. Government.

For products manufactured in the European Union, Singapore, Malaysia, Thailand: These commodities, technology, or software are subject to local export regulations and local laws. Diversion contrary to local law is prohibited. The use, sale, re-export, or re-transfer directly or indirectly in any prohibited activities are strictly prohibited.

1.5 The Operator's Manual

This Operator Manual is designed to familiarize the user with the BeamView.net system and its designated use. It contains important information on how to install, operate the software.

This Manual:

- describes the physical hazards related to use of the software with the laser system, the means of protection against these hazards, and the safety features incorporated in the design of the software
- briefly describes the purpose and operation as well as the primary features, system elements, subsystems, and fundamental laser control routines of the software
- describes the fundamental operation of the software

The screenshots in this manual are only examples and may show configurations or parameter settings which do not apply. Changing parameter settings to correspond with screenshots may reduce laser performance or even damage the laser system!

1.5.1 Numbering of Sections, Pages and Instructions

The sections are numbered continuously. The name of the section appears in the upper outside corner of every odd page. Each section ends with an even page number. Consequently, certain even pages at the ends of sections will be intentionally left blank.

The pages of this manual are numbered continuously by section. The page number appears in the bottom center of every page.

Each step within a procedure is sequentially numbered. Each procedure starts with the step number one.

2 Description of BeamView.NET

2.1 What is BeamView.NET?

BeamView.NET is Coherent's software that extends the analytic capabilities of the LaserCam laser beam diagnostic systems. The software has been designed to provide flexibility, speed, and ease of use to monitor, analyze, and archive laser beam images.

2.2 Products Supported

BeamView.NET supports the following cameras:

- LaserCam-HR-II-1/2-in. 12-bit
- LaserCam-HR-II-2/3-in. 14-bit
- LaserCam-HR-II-2/3-in.-UV 14-bit
- LaserCam-HR-InGaAs 14-bit

In addition, the BeamView.NET software is currently backwards compatible, to directly import images (.bin, .img, or .png), configuration files (.atc), and test files (.ats) generated by old BeamView software into the BeamView.NET software.

To prepare to import selected images, the command to import images clears the current buffer in the software. Selected images replace any previous images in the buffer.

2.3 Features

The BeamView.NET software extends the analytic capabilities of the LaserCam-HR laser beam diagnostic systems, with multiple numerical analysis functions, configurable set-ups, and features to support maximum measurement accuracy.

2.3.1 Flat-Top Beam Analysis

Six additional calculations are available with BeamView.NET software for flat-top beam analysis. These calculations are based on the ISO 13694:2000 standards, and allow greater flexibility for the analysis of applications involving flat-top beam shapes. They also can assist in the analysis of beam uniformity of excimer and Nd:YAG lasers in the near field. The six new calculations are:

- Plateau Uniformity
- Flatness Factor
- Edge Steepness
- Beam Uniformity
- Effective Irradiation Area
- Effective Average Power/Energy Density

2.3.2 Adjustable Trigger Delay

The adjustable Trigger Delay feature lets users add default trigger delay to the LaserCam cameras. This assists by providing additional flexibility when the camera is activated from an external trigger source, such as the SYNC Output of a laser. Adjustable trigger delay assures a valid laser pulse is captured.

2.3.3 Real-Time Laser Monitoring and Alignment

The Live Video mode provides a continuously updated image of the laser beam. This mode is ideal for monitoring the laser and observing change sin the form and structure of the beam as it is adjusted. Live Mode allows for real-time tuning to achieve optimum beam profile quality and laser-cavity alignment. While operating in this mode, no beam or statistical data are displayed; however, if Start mode is activated, the image is stored and can later be analyzed.

2.3.4 Pass/Fail Analysis

Pass/Fail analysis allows simultaneous real-time monitoring of all (or any one) of the analysis results against user-specified minimum and maximum limits. Any combination of (or all) fault actions can be activated to signal a test failure, initiate a visual or audio alarm, stop data capture, reject or save a failed sample, and generate a TTL trigger pulse output signal.

2.3.5 Adjustable Exposure Time

The camera exposure time is adjustable through the camera settings menu for all LaserCam-HR camera models.

2.3.6 Report Generation

BeamView.NET includes a single-page report that can be sent directly to a printer, saved to a file (.txt), or converted to an Adobe .pdf file by using a .pdf file converter. A simple screen print option is available from the same dialog box used to generate a report.

2.3.7 Additional Features

BeamView.NET software offers these additional features:

- Automatic background noise subtraction
- Remote Mode interface and commands
- Both 2D and 3D intensity plots
- Remote Mode interface and new commands
- Support for multiple cameras, each with a separate background image
- ‘Plug-and-play’ feature to automatically recognize cameras
- Set variable aspect ratios for each camera
- Increase in the number of samples that can be captured; save images using industry-standard file formats

- Camera information embedded into image files.Software is currently backwards compatible, to directly import images (.bin, .img, or .png), configuration files (.atc), and test files (.ats) generated by old BeamView software into the BeamView.NET.

2.4 Theory of Operation

The BeamView.NET software uses USB 2.0 cameras to image, capture, store, and perform 2-dimensional intensity distribution analysis on beams from almost any laser or light source.

The digitized beam images are then stored in memory. The beam images can be captured with several different triggering methods and stored in a variety of resolution modes.

Once in memory, a variety of analysis functions can be performed on the stored beam images. Images are then combined with user-selected graphics and calculated analysis results, and displayed on the computer monitor.

A wide variety of other system functions provide the ability to print information, control beam image capture, trigger functions for pulsed laser capture, and control various video and calibration functions.

In Start mode, these cameras can capture video beam images at 10-bit resolution.

A faster Live mode runs at 8 bits per pixel, but at 10 to 15 frames per second. BeamView.NET scales the resolution to 16-bit by up-shifting; all calculations using pixel intensity as an output—for example, Max, Mean, and Min— have a maximum value of 65,535.

For cameras with a 12-bit the max value is 2^12=4096. BeamView converts the 12-bit to a 16-bit making the new max intensity value 2^16=65526. The intensity is shifted up by a factor of 16. For cameras with a 14-bit, the max value is 2^14=16384. Beamview converts the 14-bit to a 16-bit, making the new max intensity value 2^16=65526. The intensity is shifted up by a factor of 4.

3 Install Software

This section describes the process to install the BeamView.NET software.

NOTICE

Complete installation of the software *before* any hardware is connected.

In this User Manual, the term ‘computer’ is used to refer to the device in which the software is installed. That may be commonly referred to as a PC, laptop, workstation, CPU, desktop tower, or other name.

3.1 Before Work is Started

To make both installation and operation of the BeamView.NET software easier, first check the following before work is begun.

3.1.1 IT Procedures and Policies

In today’s world, it is often a challenge for organizations to find a balance between implementing security requirements and managing the user experience.

Security processes and controls required to comply with industry-accepted standards, regulations, and certifications may impose constraints on user authentication and access. Such controls may block a software installation, making it appear as incomplete or non functional.

Should there be difficulties installing the BeamView.NET software, before Coherent Technical Support is called, check with your IT group first to determine if:

- The administrative privileges required for installation are granted.
- There are any internal security policies or controls in place that may render installation of a new software package incomplete.

Another option is to right-click in Windows. For any executable (.exe) files, Coherent recommends that to use this method for installation.

After those issues are resolved, then see ’Service and Support’ (p. 225) for details about how to contact Coherent for assistance.

3.1.2 Software System Requirement

This section describes system requirements:

- Windows 10 (32- or 64-bit)
- 2.5 GHz processor or faster
- 2 GB of RAM or higher
- 5 GB of available hard disk space
- USB 2.0 or RS-232 port

3.2 Install the Software

Go to the Coherent website and download the BeamView.NETsoftware onto the computer.

https://www.coherent.com/measurement-control/measurement/laser-measurement-and-control-help-center

The download files contains the software and drivers necessary to install and operate the BeamView.NET software.

CAUTION!
To avoid application instability, it is strongly recommended to first disable computer hibernation or suspend mode before installing the software.

1. Close all other programs on the computer or laptop.
2. Double-click to run this file for the BeamView.NET software, where 'x' is the latest version:

   BeamView_5.0.3.x.exe

   If AutoRun is enabled on the laptop or computer system, installation starts automatically.
3. Follow the on-screen instructions to complete installation, described in the steps that follow.

3.2.1 Reminder: Close All Programs

As the installation process begins, the first message that is displayed reminds users to first close all other applications. Click OK to dismiss the message.

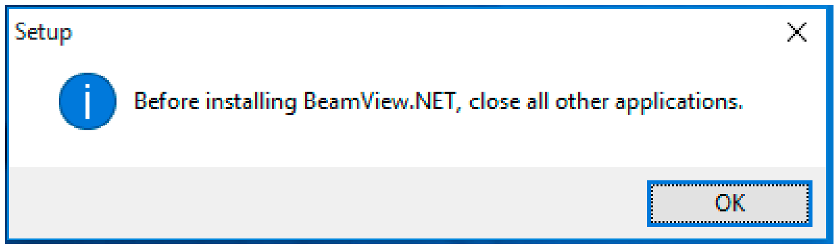

Figure 3-1. Reminder to Close Other Programs

If other programs are running, stop the installation process now and close the other active programs.

If an earlier version of BeamView.NET is installed on the system, the following message is displayed:

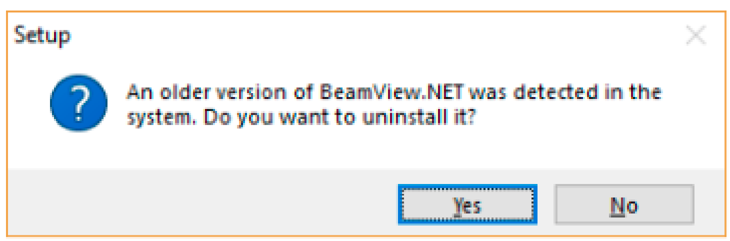

Figure 3-2. Message about Earlier Version

Click Yes to proceed to uninstall the older version, or No to continue without removing it.

3.2.2 Accept License Agreement

The License Agreement for BeamView.NET is displayed. Select the radio button to **Accept** the agreement, then click Next to proceed with the software installation.

Otherwise, click Cancel to stop installation of the software.

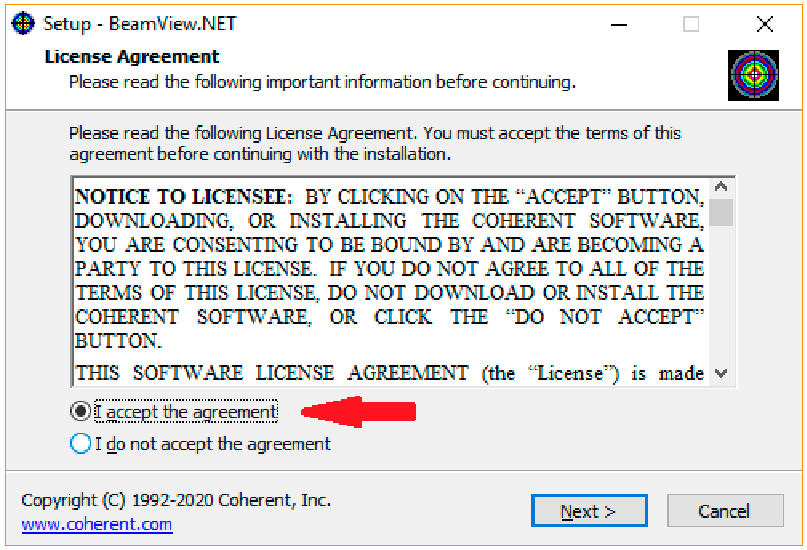

Figure 3-3. Accept License Agreement

3.2.3 Select Destination Location

Review the directory listed in the "Browse" line. If acceptable, click Next, or browse to select a different location, then click Next.

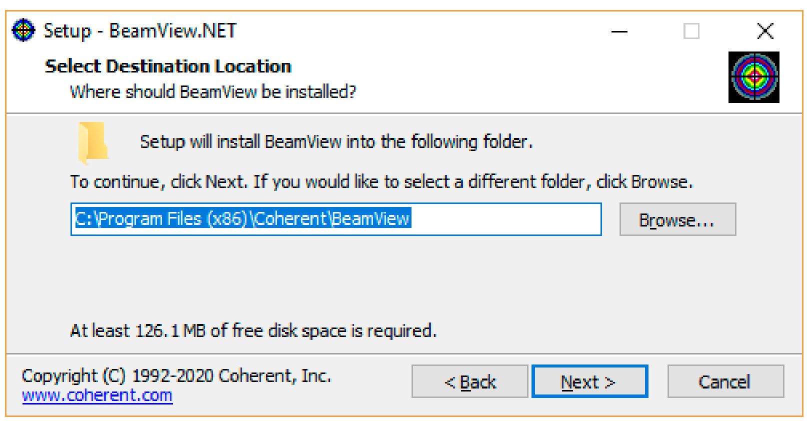

Figure 3-4. Selection Destination Folder

3.2.4 Select Start Menu Folder

Review the directory that is displayed. If acceptable, click Next, or browse to select a different location, then click Next.

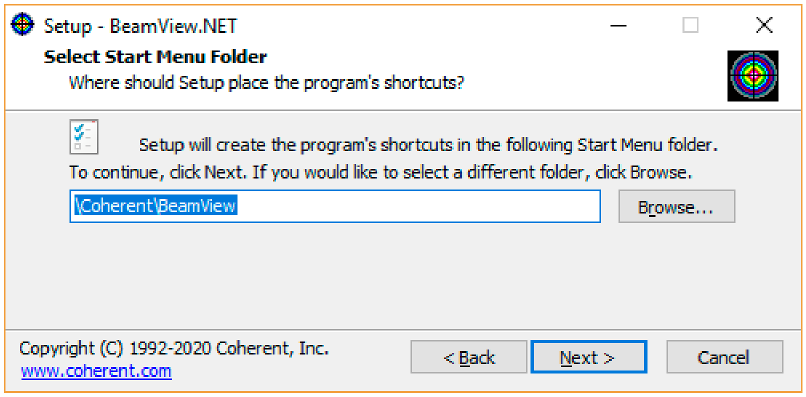

Figure 3-5. Select Start Menu Folder

3.2.5 Set Desktop Shortcut

This option allows users to create a desktop shortcut. Click Next when done.

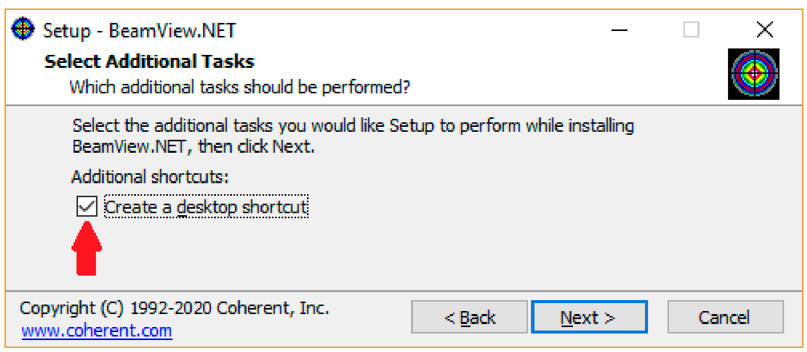

Figure 3-6. Select Desktop Shortcut

3.2.6 Preview Set-Up

This screen shows the selections that were made. To change any setting, click Back. Otherwise, click Install.

A progress bar is displayed as installation proceeds.

Because the software installation includes device drivers, another screen is displayed for explicit permission. Click Install to proceed.

Be aware that the USB drivers may take several seconds to install the first time the camera is connected to the computer.

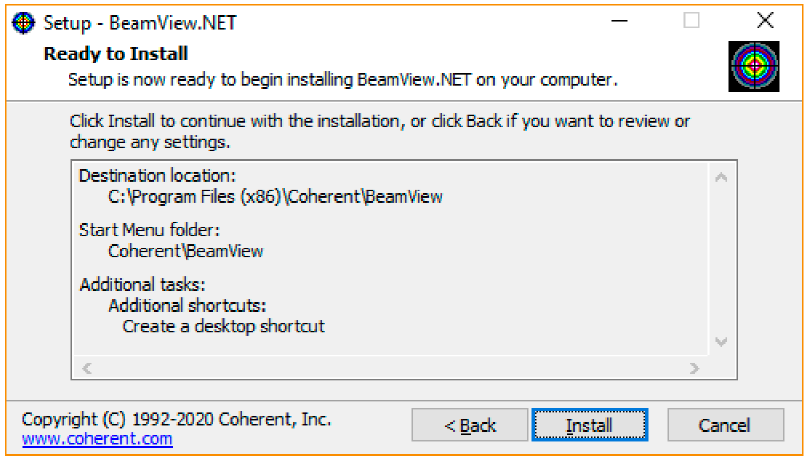

Figure 3-7. Review Set-Up

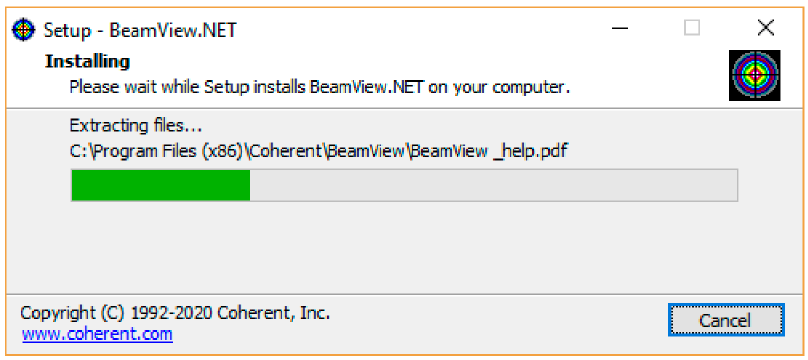

Figure 3-8. Progress Bar

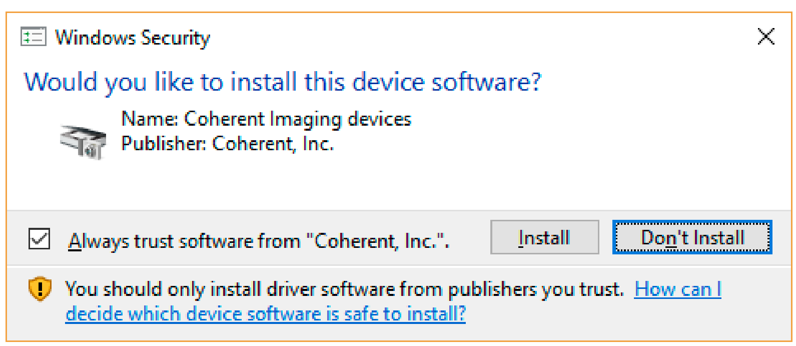

Figure 3-9. Install Drivers

Note that, when the checkbox is clicked to 'Always trust software from Coherent, Inc.', any subsequent installations of Coherent software begins without prompting. For example, if a later revision of BeamView.NET software is installed at any time, the software for device drivers installs automatically with the BeamView.NET software, and this dialog box is not displayed.

3.2.7 Select Computer Restart

When installation is complete, the final set-up screen is displayed. Select the radio button for **Yes** or **No** to restart the computer, then click Finish.

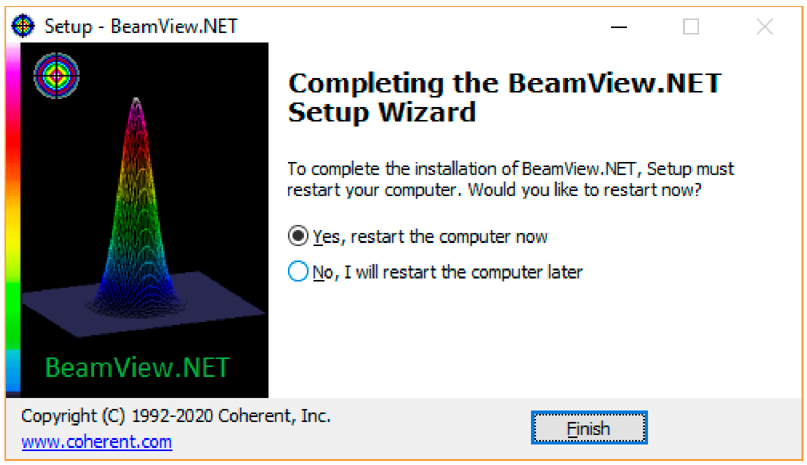

Figure 3-10. Select Computer Restart

NOTICE

If there are difficulties with the software installation, check first to make sure that the workstation has the administrative privileges required for installation.

Before Coherent is called for technical support, also check whether your organization's IT department has security policies or controls in place that may render the software installation incomplete.

- See 'IT Procedures and Policies' (p. 11) for more information.
- Also see 'Service and Support' (p. 225) for details about how to contact Coherent for assistance.

3.3 Uninstall Software

When a later version of the software is installed, Coherent strongly recommends that to first uninstall the old version. Otherwise, the new installation may run over the top of the existing installation, introducing conflicts that can lead to serous system errors.

To uninstall the old versions of software:

1. In Windows, go to Settings > Apps > and, from the list of programs, select the BeamView.NET software, as shown in Figure 3-11:

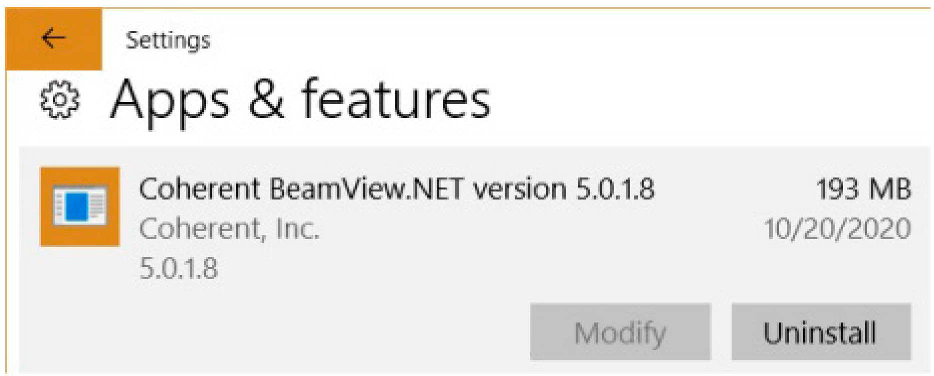

Figure 3-11. Select Software to Uninstall

2. Click Uninstall. A warning message shown in Figure 3-12 is displayed that the application and all of its related files (including drivers) are removed:

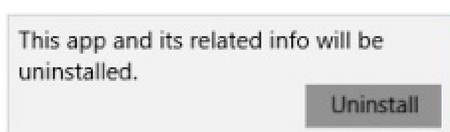

Figure 3-12. Select Software to Uninstall

3. Click Uninstall to process. A confirmation message is displayed, as shown in Figure 3-13:
4. Click Yes to proceed. A progress bar is displayed as the application and its related files are removed from the computer. A confirmation message is then displayed, as shown in Figure 3-14:

A new version of the software can now be installed (go to p. 12).

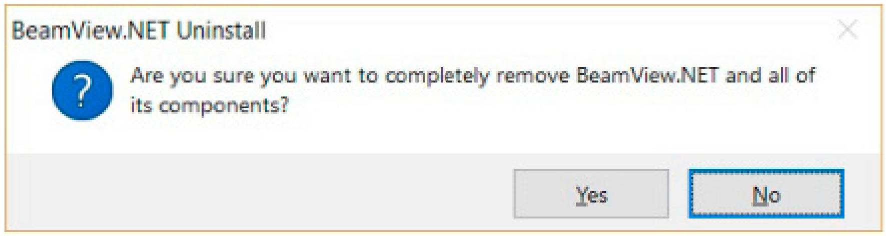

Figure 3-13. Select Software to Uninstall

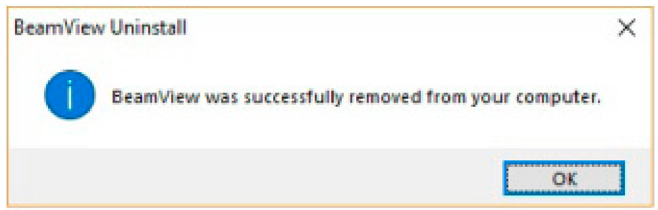

Figure 3-14. Select Software to Uninstall

3.4 Next Steps

Go to 'Set Up Hardware' (p. 21) to connect one or more cameras, make a connection to a PC, and launch the software.

Go to 'Software Interface' (p. 35) to learn about the features and functions of the BeamView.NET application.

Go to 'Capture Beam Image' (p. 71) to create a Background Map (recommended) and capture a beam image and set Trigger options.

4 Set Up Hardware

This section describes how to set up software to work with the BeamView.NET software.

NOTICE

Complete installation of the software *before* users connect any hardware. After a camera is connected, BeamView.NET automatically recognizes the camera. See 'Software Settings for Cameras' (p. 27) for details.

This section describes how to:

- Physically connect cameras
- Define software settings for cameras
- Setting up optics
- Aligning the laser and camera
- Setting up for Remote Mode

Each of these are described in the sections that follow.

4.1 Connect Camera Hardware

To view images from a camera on the computer, connect the camera to the PC. There are two methods and different cables required for this.

- Connect a single camera to a PC
- Connect multiple cameras
- Connect a camera when an external trigger is to be used

Each of these are described in the sections that follow.

NOTICE

Take a new Background Map after each time a camera is set up to make sure that the images and calculations being collected are accurate. See 'Background Map' (p. 74) for more information.

4.1.1 Connect Camera to PC

The LaserCam cameras require only a standard 2-meter USB cable (shipped with each camera) and a computer with a USB 2.0- compliant port. Power is provided to the Coherent LaserCam cameras directly over an standard USB cable.

On the USB cable, an ‘A’ style (flat) connector plugs into the computer or on the side of an LCD monitor. The opposite end—a ’B’ style connector—plugs into the camera, as shown in Figure 4-1:

Figure 4-1. Connect USB Cable to Camera

To establish a connection with a PC:

1. Plug one end of the USB cable into the camera.
2. Plug the other end into the USB port on the PC.

NOTICE
For port replicators, such as a USB connection on the side of a monitor, make sure that the device is a USB v2.0 electronic and provides a good connection and current for reliable and uninterrupted processing. Port replicators can and have been found to reduce the reliability of connection.

The ‘plug-and-play’ feature of the BeamView.NET software automatically detects that a camera is connected, and displays the camera model at the top of the right panel of the main window (see p. 35).

CAUTION!
The 2-meter cable supplied with the LaserCam camera systems has been certified for reliable and low emission operation. At a high data rate, cables longer than 4 meters can cause issues.

When using a USB cable, an error message may be displayed, as shown in Figure 4-2:

Figure 4-2. USB Error Message

This type of error can happen when a computer is unable to supply the 400 mA required by a LaserCam camera, typically a laptop running on a low battery. Also, self-powered USB ports are incapable of supplying this current. Be sure that the laptop is fully charged or the USB port is fully powered.

NOTICE
Connect ALL power cables to a surge-protected power source!

4.1.2 Connect Multiple Cameras

To connect multiple cameras, USB ports must be available that are fully powered.

Some desktop computers have multiple USB ports built in that allow users to connect multiple cameras, as shown in Figure 4-3.

Most laptop computers, however, have a limited number of USB ports. To be able to connect multiple cameras, install a device commonly referred to as a USB hub, dock, or Port Expander. When purchasing such a device, verify that the device has its own power supply (with sufficient power) as well as the correct type of connectors.

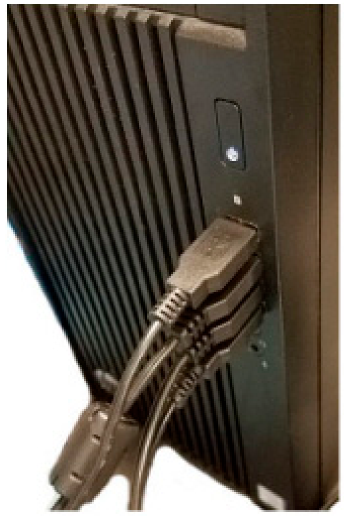

Figure 4-3. Connect Multiple Cameras

With multiple cameras, multiple instances of BeamView.NET cam be opened that display properties specific to that camera.

NOTICE

Multiple cameras may result in speed/performance degradation. Make sure the PC has plenty of computing power and RAM if users want to run multiple cameras. The computing power suggested earlier was intended for single camera operation.

4.1.3 Connect a Camera Using an External Trigger

When the camera is to be used with an external trigger, a trigger cable, must be used, shown in Figure 4-5, instead of a standard USB cable. This cable is shipped with a LaserCam camera.

To connect the trigger cable:

1. Rotate the cable until the orientation at the end of the connector matches the mating connector on the camera, then push the connector securely onto the mating connector. The cable connector is a keyed connector and has a lock type slide.
2. Connect the other end of the trigger cable to a trigger source, such as from the laser or a frequency generator.

   This connects a TTL-level Pass/Fail output signal generated by BeamView.NET from user-configured calculation settings. See

Figure 4-4. Trigger Cable

’Capture > Capture/Trigger’ (p. 78) for information about configuring software for an external trigger.

3. After the camera is plugged in, wait a few seconds for the computer to recognize the hardware.

The trigger cable allows connection of an external trigger source through a BNC receptacle (plug-style connector), as shown here:

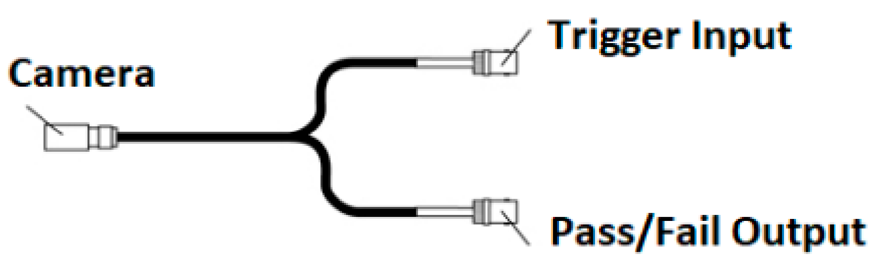

Figure 4-5. Connect Cable for External Trigger

After the software installation is complete, launch BeamView.NET by double-clicking the BeamView.NET desktop icon.

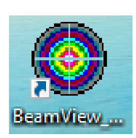

Figure 4-6. BeamView.NET Desktop Icon

4.1.3.1 Trigger Options

A hardware trigger polarity selection is available with the BeamView.NET software. This trigger option selects External Triggering for Pulsed capture.

NOTICE
Trigger selection is ONLY active for Pulsed mode operation.

Table 4-1 lists trigger specifications:

Table 4-1. Trigger Specifications (External/Pulsed)

Parameter	Value
Maximum Voltage	5.5V
High	> 2.0V
Low	< 0.8V
Minimum Voltage	—0.7V

A TRIG IN signal (TTL pulse) must be provided to the camera in Pulsed mode to capture pulsed image data. This signal normally comes from the laser electronics external sync output.

When Pulsed mode is selected (Capture > Trigger > Pulsed), choose either the Rising Edge or the Falling Edge. See 'Capture > Capture/Trigger' (p. 78) for details about setting up parameters for a trigger in Pulsed mode.

4.1.3.2 Auto Trigger | Internal Trigger

The Auto Trigger (also referred to as Internal Triggering) mode does not require any trigger signals; therefore, it is often used for set-up and alignment.

- Auto Trigger is suggested for first time set-up if the repetition rate is greater than approximately 10 Hz. After some images are captured, using more advanced triggering methods can improve capture performance.
- It is not recommended to use the Auto Trigger mode of capture for Pulsed laser sources below 10 to 20 Hz.

See 'Auto Trigger Mode' (p. 85) for more information about this feature.

4.2 Software Settings for Cameras

The "plug-and-play" feature of the BeamView.NET software automatically recognizes a camera after it is connected.

In the software, go to the Setup tab and select Camera.

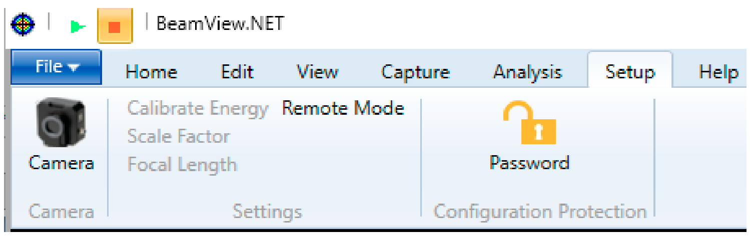

Figure 4-7. Setup Tab

When Camera is selected, the following dialog box is displayed:

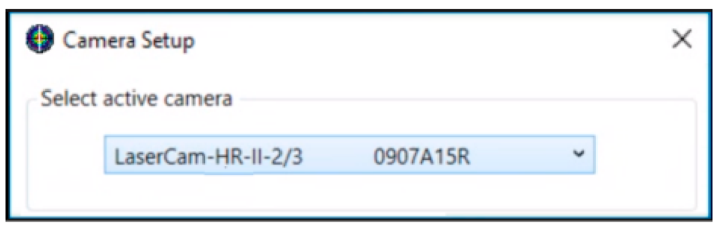

Figure 4-8. Setup — Camera

From the drop-down menu, select the desired Camera for which to configure settings and capture images. Notice that the name and serial number of the camera are listed. Click Select.

A second dialog box is displayed. Notice that the serial number is listed.

NOTICE
Coherent recommends leaving this user-defined number as the serial number of the camera in use in the event that the camera is returned to the factory for any reason.

Click OK to continue.

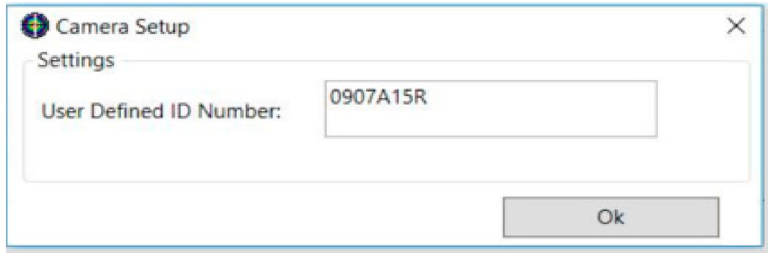

Figure 4-9. Setup — Camera — User-Defined ID

4.2.1 Setup > Settings

The Settings area of the Setup tab includes the following options:

- Calibrate Power
- Scale Factor
- Focal Length
- Remote Mode

For a description of each, go to 'Setup Tab' (p. 63).

4.2.2 Setup > Configuration Protection (Password)

Password protection is used to prevent accidental change to the Beam-View.NET configuration settings.

When users click the icon for Password, the dialog box shown in Figure 4-10 is displayed:

Enter a new password, which can be up to fifteen characters long, and may contain only alphabetic characters and numerical digits (no punctuation marks or spaces). Entering an invalid character or exceeding the maximum length will cause the computer to beep.

When OK is clicked, a confirmation message is displayed. Click OK to dismiss the message:

After the desired configuration settings are established, select the Password command from the Setup menu. After the password is entered, configuration settings cannot be changed unless the password is entered again.

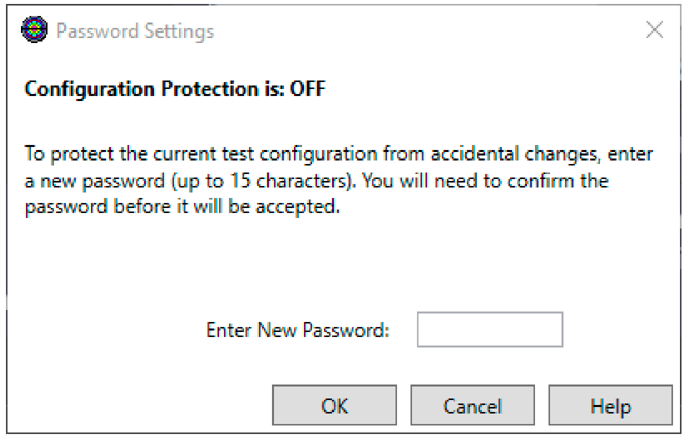

Figure 4-10. Setup — Password Protection

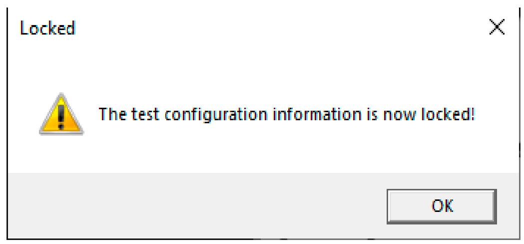

Figure 4-11. Setup — Password Locked Message

All configuration settings and windows can still be viewed as normal, but making a change and pressing the OK button displays a pop-up box requesting that the user enter the correct password before saving the changes.

4.3 Optics Set-Up

As with any sensitive diagnostic tests, accuracy is dependent upon the quality of the optics used in the measurement.

In beam diagnostics testing, it is especially important to deliver the beam to the camera with almost zero distortion. Therefore, only high quality, low distortion optics should be used in the test set up.

Table 4-2 shows the possible causes and effects of issues when using optics:

If using an energy/power meter with the BeamView.NET software, the energy that is seen by the meter is also affected by any front-end optics. Although distortion is not a major concern with most detector types, scattering can affect energy readings (if it causes part of the beam to miss the sensor).

Table 4-2. Issues When Using Optics

Effect	Cause
Interference effects	Caused by parallel optical surfaces. Always set optical surfaces at small angles.
Scatter	Caused by dirty or damaged optics, or poor quality optical coatings.
Aberrations	Caused by poor quality optical surfaces or materials.
Distortions	Often caused by non-uniform optical materials or coatings, and by short focal length optics.
Background noise	Caused by room light, scattered light, or laser flashlamp light.

Note that the energy and power levels that a particular meter can dissipate, and then compensate the optics for the sensor accordingly. For additional information, refer to the owner's manual that came with the meter.

If using an energy/power meter, remember that the displayed energy (and the energy used in calculations) is just the reading from the meter. If there is improper compensation by the front-end optics, all calculations will be inaccurate. Be sure that the meter to be used is able to compensate correctly for the front-end optics that chosen.

Recommended optical set-ups for maintaining minimal beam distortion include:

- Attenuation
- Background Light
- Focus Optics

Each of these are described in the sections that follow.

4.3.1 Attenuation

The most critical set-up operation necessary to avoid saturation or damage of the camera is the attenuation of the laser.

Camera saturation occurs at different levels and can vary dramatically between wavelength, mode of operation (CW or pulsed), and type of sensor. Check the User Manual for estimated saturation levels for the specific LaserCam-HR camera being used.

It is recommended that the laser source is attenuated well below the saturation level of the camera before performing any measurements with the beam profiling system. Using this precaution ensures that damage to the sensor does not occur.

It is important to attenuate the beam without introducing distortions. Do not use absorption-type attenuation optics where distortion and lensing effects can occur. It is best to perform the majority of the attenuation with front surface attenuation schemes—such as laser mirrors—that allow high levels of attenuation with low distortion. Make sure these attenuators are of high quality.

The best method of attenuation is to reduce the beam power with a continuously variable attenuator to provide maximum diagnostics test flexibility. This can be performed with crossed polarizers, variable-step Neutral Density (ND) filters, or continuous variable-wedge devices. Ensure that:

- The ND filters have laser grade surfaces and high quality coatings.
- The variable beam attenuators have the lowest possible distortion.

Coherent offers a selection of variable attenuation modules—C-VARM (continuously variable) and VARM (fixed-level attenuation)—that meet these specifications. For more information about these and other system accessories, visit the Coherent website:

> https://www.coherent.com/measurement-control/measurement/beam-diagnostic-accessories

An example of attenuation scheme is shown in Figure 4-12. Any combination of this set-up can be used to properly attenuate the laser beam.

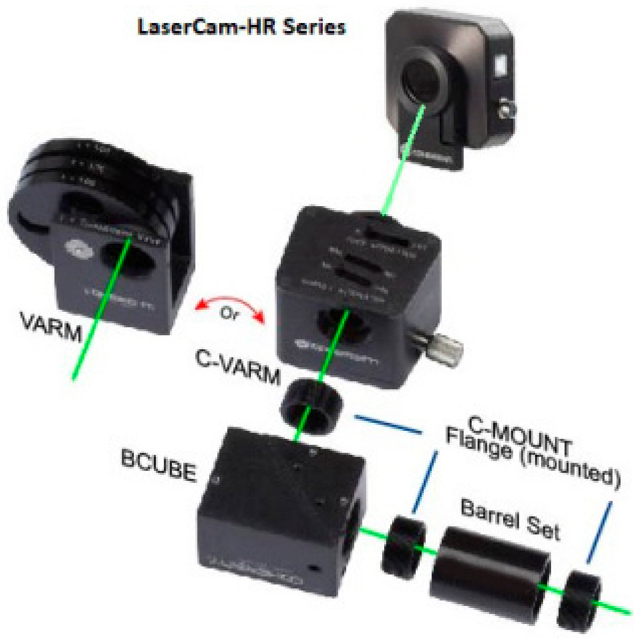

Figure 4-12. Optics Attenuation Set-Up

4.3.2 Background Light

Background light seen by the camera should be closely monitored. This light comes from scattering, room lights, flashlamp lights, and instrumentation lights.

Elimination of background light is especially critical with pulsed laser diagnostics when some cameras are required to time-integrate the image to avoid image splitting. In these situations, low background light may be time integrated to large levels.

The BeamView.NET software cannot distinguish background light from the laser beam image, and includes this light in its analysis. In applications where the beam image size is small, even a modest amount of background light can greatly affect the accuracy of the beam analysis.

An attenuator window with low transmission should be attached to the camera housing to reduce background light and protect the sensor from collecting dust particles from the environment.

Coherent recommends using a Low Distortion Faceplate (LDFP or LDFP-UV), which eliminates ambient room light that may reach the camera array. The Faceplate is made of 2.65 mm thick NG-9 laser-grade filter glass. Both LDFP or LDFP-UV surfaces are laser-grade polished.

The Faceplate provides a protective window for the camera array from UV. It also acts as a background attenuator with 0.03 to 0.06% transmission from 400 nm to 1100 nm. For wavelengths shorter than 400 nm, the camera must be used without the Low Distortion Faceplate. For details, see the specific User Manual for the camera.

4.3.3 Focus Optics

High quality, low-distortion optics and low background light noise are critical to obtain accurate beam diagnostics results with the BeamView.NET software. A focusing optic can be used for Far Field beam diagnostics.

For best results, choose a focal length to get an image size that fills roughly 2/3 of the array diameter. If multiple wavelength testing is to be performed, a parabolic mirror can give better results than a lens, since chromatic aberration is not present in mirrors.

The focusing optic should be of superior quality to avoid distortion and aberrations. Be aware that the shorter the focal length, the larger the inherent aberrations within the image. Focal lengths of 2 meters or more are sufficient to avoid these aberrations for small laser beams of 1/8 to 1/4 inch (0.3 to 0.6 mm) in diameter.

Another important point to consider is the size of the laser beam spot that the camera images. As the image size gets smaller, the digitized spatial data resolution decreases, reducing the accuracy of the results. Therefore, the focusing optics should be chosen so that the beam image is not less than 20 to 30 pixels in diameter.

The maximum allowable beam image size is dependent upon the camera used. The beam image must be contained within the camera's active area and should not overlap the edges. For example, this corresponds to a beam image size of about 6 mm on the 2/3 inch format CMOS LaserCam-HR II sensor. A reduction or expansion telescope may be required if these spot sizes cannot be achieved by varying the focal length of the optics, or if Near Field diagnostics must be performed.

The Focal Length command inputs the focal length for a lens or focusing mirror used in conjunction with the camera for measurement of Far Field values. See ’Setup > Focal Length’ (p. 65) for details.

4.4 Align the Laser and Camera

The **Live Video** feature on the Home Tab is useful when setting up and aligning the laser and camera.

WARNING!
LASER RADIATION! Always avoid eye or skin exposure to both DIRECT and SCATTERED radiation, including damage or noise from laser back reflection. See 'Safety and Compliance' (p. 217) for more information and safety precautions.

The Live Video command switches the BeamView.NET software system from displaying images in Start mode (with overlay graphics and calculations) to a real-time display in Live Video mode (with no overlay graphics or calculations).

When Live Video mode is On, the View area displays a contour or 3D plot, which allows real-time viewing of the camera video.

To choose the Live Video command:

- On the Home tab, select the Live Video command from the toolbar.
- To turn Live Video Off, choose the Stop Capturing command.

4.5 Set Up for Remote Mode

To set up and run a Remote application, follow these general steps:

1. Run the BeamView.NET software and configure settings for the interface that is needed.
2. Turn on Remote Mode in BeamView.NET by clicking the Remote Control icon in the toolbar for the Home tab. This provides a fast, single-click control to set up a connection.
3. Connect a camera, which BeamView.NET then automatically detects.
4. Run the Remote application (such as the Coherent Remote Data Logging Utility) and enable the connection.

For more information about configuring and running applications in Remote Mode, see 'Remote Mode Set Up' (p. 151).

For details about host commands that can be used in a remote interface, see 'Remote Mode Host Communication Protocols' (p. 163).

5 Software Interface

This section describes the various windows and commands for the BeamView.NET software, as well as basic settings to capture beam images.

5.1 Main Window

The following splash screen is briefly displayed after the software is started.

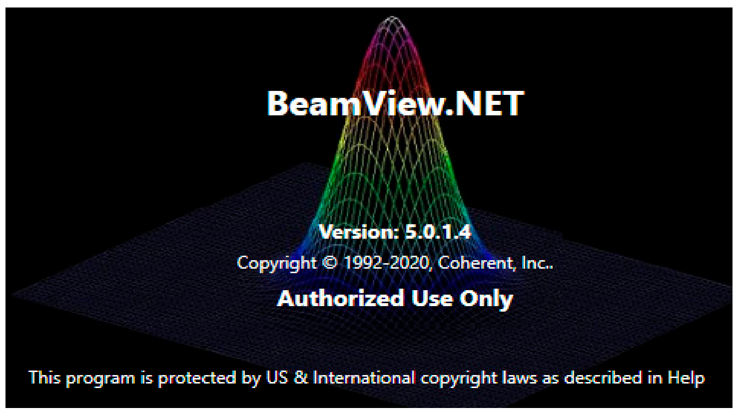

Figure 5-1. BeamView.NET Splash Screen

The splash screen identifies the product name, current version number, and copyright information.

The main window shown in Figure 5-2 is then displayed.

The main window consists of display and control elements similar to most Windows applications, along with the following elements specific to the BeamView.NET application.

5.1.1 Title Bar

The Title Bar displays the software name, version number, and test name (if a configuration or session file has been saved or loaded). This area also includes a File menu.

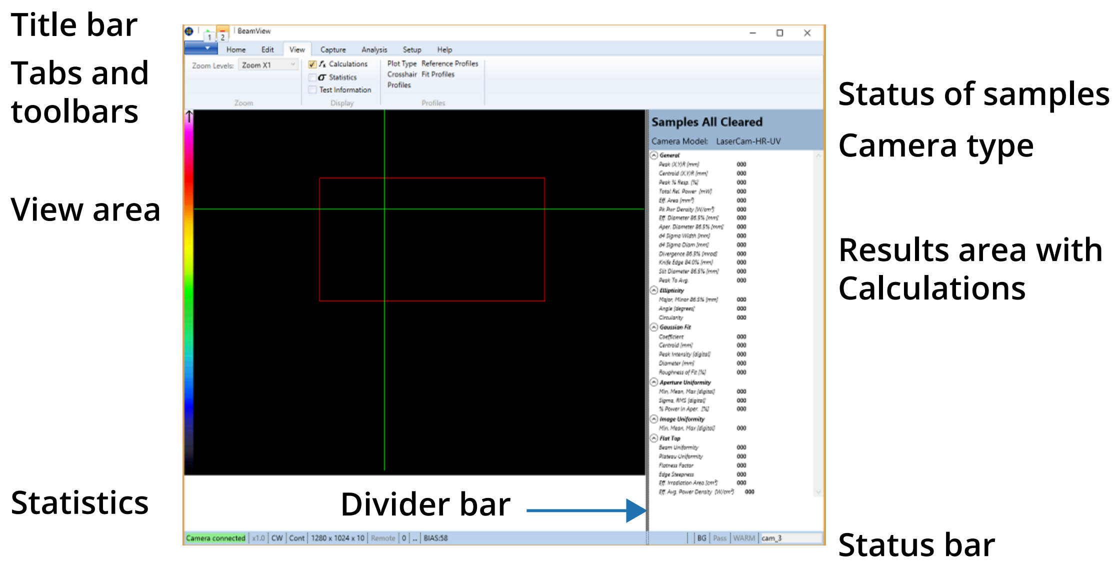

Figure 5-2. Main Window Areas

5.1.2 Tabs

The Tabs list menus available for the BeamView.NET window, and contain commands that allow specific actions to be performed or display dialog boxes. These elements provide various controls for such functions as graphics, analysis, configuration set-up, etc.

5.1.3 Tool Bar

The Tool Bar consists of various icon buttons, which are small symbols that provide quick access alternatives to using menus or keyboard equivalent keys to perform various functions. To use a Smart Icon button, move the mouse cursor over the icon and click on the button using the left mouse button. To view the function of any icon button, place the cursor on the icon and wait momentarily; a brief function description is displayed near the icon.

The set of tabs across the top of the BeamView.NET software application include the following toolbars.

- Home
- Edit
- View
- Capture

- Analysis
- Setup
- Help

5.1.4 View Area

This graphics area on the left side of the BeamView.NET window shows the current beam image, along with cross-section profiles, crosshair cursors, overlaid apertures, and other selected fitted or reference profiles and position graphics.

The digitized pixel intensities of the image can be plotted as a contour map in one of four different color scales shown in the color scale bar at the left side of the image area or as a 3D isometric plot.

A polar wander plot is also available, which plots the location of the centroid for a series of samples, visually showing beam wander over time.

When graphics Zoom is enabled, scroll bars are displayed on the sides of the View area. Interactive mouse control of graphics cursors, 3Dplot view angle, and pan functions are provided when the mouse cursor is within the View area.

5.1.5 Results Area

This area at the right side of the BeamView.NET window display shows the results of selected calculations for the beam image shown in the View area.

The Sample header at the top of the results area reports the sample number, current time, and date.

The panel on the right lists Calculations selected.

When the Stats On command is selected, an area at the bottom of the main window is displayed.

5.1.6 Divider Bar

The divider bar allows users to change the relative size of the View area and Result area. Click and drag the divider bar to the left or to the right to resize.

5.1.7 Status Bar

The Status bar is located at the bottom of the BeamView.NET window, and indicates the current status of key system measurement, as well as configuration and operational parameters.

5.2 File Menu

The file menu at the top of the main window includes commands and menus to manage tests, configurations, images and results.

5.2.1 Open Test

The **Open Test** command opens a Test file from a standard Windows folder.

The Open Test command provides selection of previously-saved test session files. A saved test session file contains all images that were in the image buffer when the file was saved, as well as information about the BeamView.NET software settings (buffer, graphics, calculations, pass/fail, units, etc.).

When a test session file is loaded, the same software settings are changed to those specified in the test session file. All images stored in the test session file are also loaded into the image buffer.

5.2.2 Save Test | Save Test As

Saving a test session file stores all images currently in the image buffer, as well as information about the BeamView.NET system configuration settings (buffer, graphics, calculations, pass/fail, units, etc.) to a user-specified file.

Saving data as a test session allows that data to be recalled at a later date, maintaining the analysis parameters that were in place when the data was captured.

The **Save Test** command saves the current test session to the current file to a standard Windows folder. The default file name extension for the configuration files is ".ATS" (Analyzer Test Session).

NOTICE

After users save the first test session, any subsequent Save Test commands override the contents of the existing test session file and replaces them with the current images and configuration information. If an existing file is replaced, the old file cannot be restored.

To save the test session without destroying the existing test session file, use the **Save Test As** command.

The Save Test As command saves the current test session to a new file to a standard Windows folder.

5.2.3 Load/Save Config

A saved system configuration file contains information about the BeamView.NET software settings (buffer, graphics, calculations, pass/fail, units, etc.). When a saved configuration file is loaded, the same software settings are changed to an identical state in which they were originally saved.

The default file name extension for the configuration files is ".ATC" (for Analyzer Test Configuration).

5.2.3.1 Load Config Command

The **Load Config** (configuration) command loads a previously saved system configuration from a standard Windows folder.

Multiple configuration files can be stored and recalled to quickly reconfigure the BeamView.NET software to other test configurations.

5.2.3.2 Save Config Command

The **Save Config** command saves the current system configuration to a standard Windows folder.

The default file name extension for the configuration files is ".ATC" (for Analyzer Test Configuration).

5.2.4 Import/Export

The default file name extension for image files is ."bin" (for BeamView.NET binary images).

5.2.4.1 Import Image Command

The **Import Image** command allows import (recall) of beam image data from stored files for reanalysis, display, or data comparison.

The command to import images clears the current buffer in the software. Selected images replace any previous images in the current buffer.

Selecting the Import Image command opens a standard Windows folder. Choose an image data file from the list, and click Open.

5.2.4.1.1 Import File Format

Raw Images can be imported (recalled) from any of several different file formats. The standard BeamView.NET formats are Binary and ASCII, but other graphic file formats are supported as well, including .bin, .img, and .png images. Both Binary and ASCII include header information. This is used only by the BeamView.NET software to properly reload images.

When a file type is selected, the File Name list box displays only file names for the selected type.

NOTICE
The .JPEG file format is not supported for import BeamView.NET software.

The Analyzer uses 8-bit, intensity pixel values. Although the 24-bit pixel values can be scaled to 8-bit values, a valid intensity value cannot be derived from an RGB value.

An alternate format that provides good compression, portability, and data integrity is the Portable Network Graphics (.png) format.

5.2.4.1.2 Select Image to Recall

Images can be recalled one at a time, each from an individual file, or select multiple files from the file name list using the Windows click-and-drag, click-and Shift-click, or use multiple Ctrl-clicks. The selected images are added to any images currently in memory, just as if they were captured with the Start Capturing command. The sample number changes to reflect the last image loaded.

NOTICE

The Image files contain only data for a single image and no other information. The current configuration settings may not match the settings used at the time the image was captured.

If a configuration file was stored at the time the image was captured, recall that configuration file before importing the raw image.

5.2.4.2 Export Image Command

The Export Image command allows export (storage) of beam images to disk for import into other programs, data logging, archival, or later recall and reanalysis.

The **Export Image** command saves an image data file in a binary image format (*.bin) to a standard Windows folder. Click Save.

NOTICE

Export Image file formats contain in only the raw image data and no system configuration information. If an image is saved for future recall, remember to store a configuration file under the same name. The configuration file should then be loaded before importing the raw image.

5.2.4.2.1 Export File Format

When entering the filename, it is not necessary to specify the extension for the file type. The correct extension is added automatically.

The BeamView.NET software allows selection of multiple images to export to a file. Most file formats allow only one image to be stored in a file.

When multiple images are selected, the filename is modified by appending the Sample number for each selected image. For example, if the filename is specified as “TestA.png” and Sample numbers 1, 2, and 5 are selected for export, the BeamView.NET software saves three files:

- ‘TestA1.png’
- ‘TestA2.png’
- ‘TestA5.png’

The BeamView.NET Binary image format is the only format that allows multiple image to be stored in a single file. So, if the filename is specified as ‘TestA.bin’ and Sample numbers 1, 2, and 5 are selected for export, the analyzer saves all three images into the single file named “TestA.bin”.

5.2.4.2.2 Select an Image to Store

After a file name has been chosen, the Image Select window is displayed and automatically highlights the numbered icon for the sample that is currently being displayed on the BeamView.NET software.

If that is the only image to be exported, simply click the OK button.

5.2.4.3 Export Results Command

The **Export Results** command saves a Results file (in a .txt format) to a standard Windows folder. Click Save.

The Export Results command allows export (storage) of analysis results data for ALL captured samples to disk in an ASCII text format for data logging and archival.

This is a one-way operation because there is no “Import Results” command. If It is important to be able to access these results inside the BeamView.NET file later, then save the desired images and a configuration file into a special directory where the files are not mixed with other data.

5.2.4.3.1 Results File Format

The Result Data file format contains only the calculated results. The Save as type list shows file names for the following file types:

- Result Data (*.txt): Stores results & statistics for all captured samples.
- All Files (*.*): Use this file type to display all the files contained in a directory.

The Export Results command creates a data file containing the calculations for captured images (from the Image buffer) and statistics on all samples (from the Sample buffer).

- The first data set contains the calculations for each sample in the **Image buffer**. The data set is numbered 1 through x; in this example, results are numbered 1 through 5.

- The second data set contains the statistics on the calculations in the **Sample buffer** and is always numbered 1 through 4. This data set is listed directly below the first data set. in the Export Results file.

The example in Table 5-1 shows the results after exporting a data file from BeamView.NET and importing it into a spreadsheet.

Table 5-1. Export Results File

	Sample	Date	Time	Peak % Response	P/F	Aper. Diameter 86.5% (mm)	P/F
Image Buffer	1	"Dec. 19, 2019"	"03:39:01 PM"	96.1	P	1.690	
	2	"Dec. 19, 2019"	"03:39:01 PM"	95.3	P	1.690	
	3	"Dec. 19, 2019"	"03:39:02 PM"	95.3	P	1.690	
	4	"Dec. 19, 2019"	"03:39:02 PM"	94.9	P	1.690	
	5	"Dec. 19, 2019"	"03:39:02 PM"	95.7	P	1.690	
Sample Buffer	1	"MIN"	""	94.9		1.690	
	2	"MEAN"	""	95.5		1.690	
	3	"MAX"	""	96.1		1.690	
	4	"SIGMA"	""	0.4		0.000	

In the data file, samples are separated by a carriage return and a line feed. Individual results and pass/fail indicators for each sample in the file are separated by tab characters. This file format allows the analysis results to be imported into spreadsheet programs.

A calculation taken while the Perform Pass/Fail checking option (Calculations dialog box) is enabled displays a result that is followed by a 'P' (Pass) or 'F' (Fail). These designations indicate whether that specific result is inside or outside the acceptable test range limits.

In the example above, there are no entries in the 'P/F' column on the far right. This signifies the Perform Pass/Fail checking option was turned off for this calculation.

The Sample buffer always contains all samples in the Image buffer and, in addition, can include samples not in the Image buffer. As a result, users may see something similar to the following example (see highlights to compare).

In the example in Table 5-2, the MIN, MEAN, and SIGMA values are correct. Based on those values, users know the Sample buffer contains more samples than the Image buffer.

To generate statistics based solely on the samples in the Image buffer, remove the unwanted samples (that is, samples with no images) from the Sample buffer before the results are exported:

1. Under the Edit tab, open the Clear Buffer dialog box.
2. Select 'Keep Samples that have Images.'
3. Click the OK button.

Table 5-2. Export Results File — Samples NOT in Image Buffer

	Sample	Date	Time	Peak % Response	P/F	Aper. Diameter 86.5% (mm)	P/F
Image Buffer	1	"Dec. 19, 2019"	"03:39:01 PM"	96.1	P	1.690	
	2	"Dec. 19, 2019"	"03:39:01 PM"	95.3	P	1.690	
	3	"Dec. 19, 2019"	"03:39:02 PM"	95.3	P	1.690	
	4	"Dec. 19, 2019"	"03:39:02 PM"	94.9	P	1.690	
	5	"Dec. 19, 2019"	"03:39:02 PM"	95.7	P	1.690	
Sample Buffer	1	"MIN"	""	1.6		1.690	
	2	"MEAN"	""	39.1		1.690	
	3	"MAX"	""	96.1		1.690	
	4	"SIGMA"	""	22.3		0.000	

5.2.4.4 Export Profiles Command

The **Export Profiles** command allows export (storage) of image profile data to an ASCII text (.txt) file. The profiles that are stored are the image profiles displayed in the View window when Export Profiles is selected.

Reference profiles and fit curves are not stored.

The Export Profiles dialog box provides selection of file names, data types, and directory locations in a standard Windows folder.

The Save as type list shows file names for the following file types:

- Profile Data (*.txt): Stores the currently displayed image profiles. See Profile Data Format for details on the file structure.

- All Files (*.*): Use this file type to display all the files contained in a directory.

5.2.4.4.1 Profile Data Format

When profile data is stored, the image intensity information for each pixel are stored in a single file, along both X and Y axis profiles.

- The X axis profile is stored first, with each pixel value separated by a comma (,) and ending with a carriage return and line feed.
- The Y axis profile is then stored in similar fashion.

As an example, profile data looks similar to:

0,0,0,0,0,1,3,6,13,25, … ,22,17,13,8,4,2,0,0,0,0
0,0,0,1,2,5,8,12,18,23, … 27,22,16,11,7,4,3,1,0,0

Note that the number of data points in a profile vary, relative to the Capture > Resolution settings.

5.2.5 Print Set-Up

The Print Set-Up command displays a standard Windows print dialog box.

This command allows users to select a Windows printer from the list of installed printers, as well as select options for printing. Use this dialog box to verify (or modify) printing parameters.

Click OK to save the currently-displayed printing parameters.

5.2.6 Print Report

The Print Report command prints a report, current image, results, or saves a report to a .PDF file.

Selecting the Print Report command displays the following dialog box:

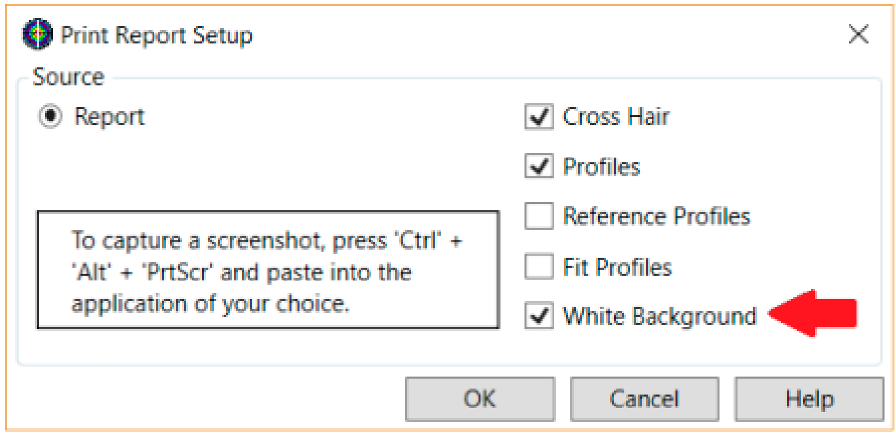

Figure 5-3. File > Print Report Set-Up Dialog Box

NOTICE

The report is set by default to a black background on the image area to better display the laser image. Click the checkbox to select a White Background to safe ink when printing.

Depending on the source selected for the report—Report or Beam-View.NET Window (Screen shot)—a different menu displays when the OK button is clicked in the Report Setup dialog box.

Selecting **Report** as the source then displays a Report that users can then:

- Click the Save button to store a .pdf version of the report to a location that is selectable by the user.
- Click Print on this menu to send the report to the printer previously selected on the Print Setup menu.This prints a single-page report that contains both the image and user-defined calculations.

A sample report is shown in Figure 5-4:

To capture a screen shot, press 'Ctrl' + 'Alt' + 'PrtScr' and paste into the chosen application.

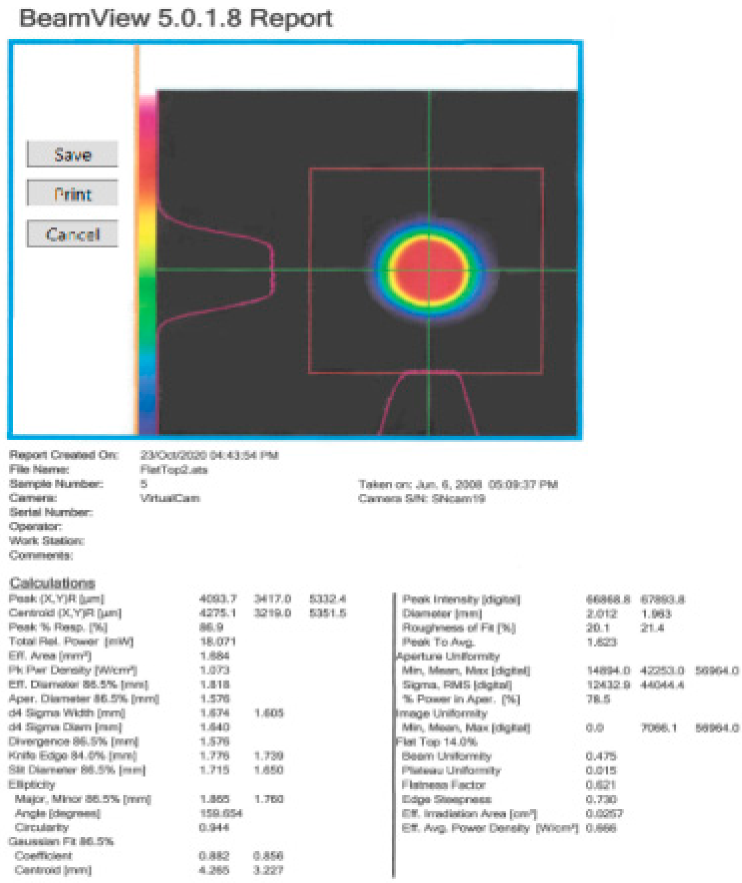

Figure 5-4. Print Report Example

5.2.7 Test Information

The Test Information command displays a dialog box where users can enter descriptive information about the test session, as shown in Figure 5-5:

The Test Information dialog box includes a title, a serial number, an operator name, a comment field, and a workstation number.

Any test information that is entered is displayed on the right side of the display screen, below the calculation Results area. All fields are optional, and only those that have information are displayed.

When a Test Session is saved to disk using either the Save Test or Save Test As menu, the test information is also stored. A subsequent recall of the test session (Open Test) then loads and displays that test information, along with the image and result data from the test session.

The only information that is remembered by the BeamView.NET software after exiting and restarting it is the workstation.

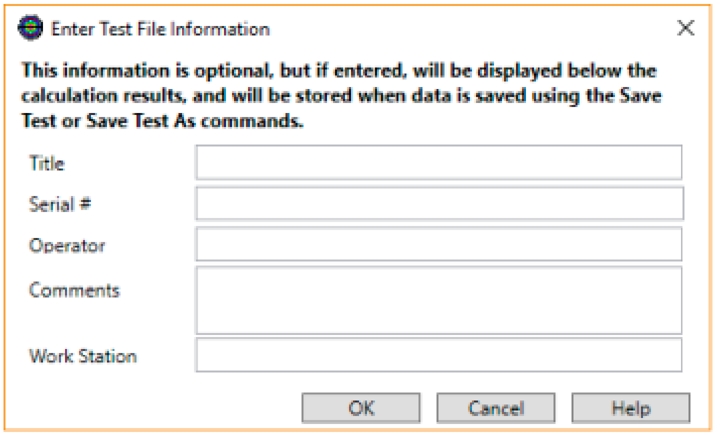

Figure 5-5. File Menu > Test Information

5.2.8 Exit

The Exit command closes the BeamView.NET program.

5.3 Home Tab

The Home Tab shown in Figure 5-6 lets users select the sample, start and stop capture, as well as whether to include crosshair, aperture, profiles or reference positions for the sample. Users can also select the level of zoom and coloring style.

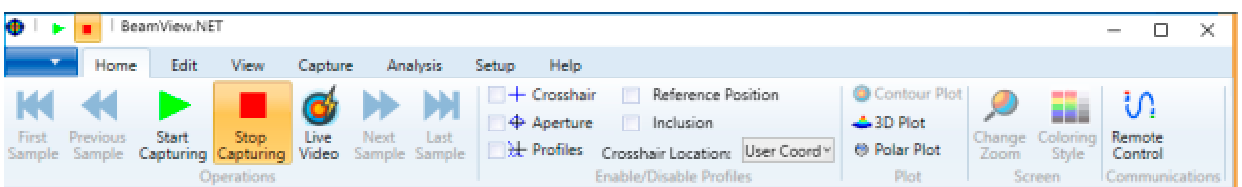

Figure 5-6. Home Tab

The commands available in the Home tab include:

- Operations:
  - Start Capturing Samples
  - Stop Capturing Samples
  - Live Video — Capture and display image samples s fast as possible

    - Select the First Sample, Previous Sample, Next Sample, or Last Sample

- Enable/Disable Profiles - Turn properties for each on or off for:
    - Crosshair
    - Aperture
    - Profiles
    - Reference Position
    - Inclusion
    - Crosshair Location — Drop-down menu to select:
        - User Coordinates
        - Peak
        - Centroid

- Plot Type — Set the plot type:
    - Contour Plot
    - 3D Plot
    - Polar Plot
- Screen
    - Change Zoom — Adjust the zoom level.
    - Coloring Style — Change the plot between colors and black-and-white
- Communications
    - Remote Control — Enable or disable

These are described in more detail in 'Analyze Calculations' (p. 91). For an example about remote data logging, see 'Remote Data Logging Utility' (p. 156).

5.4 Edit Tab

The Edit Tab shown in Figure 5-7 lets users select the current sample displayed, copy the view plot or selected results to the clipboard, and clear the image data buffer.

The Edit tab includes the following options. Selecting the commands displays a dialog box for each:

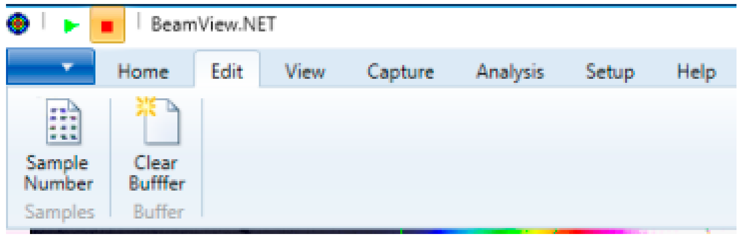

Figure 5-7. Edit Tab

5.4.1 Edit > Sample Number

This command lets users select a specific image sample to display.Enter the sample number in the dialog box shown in Figure 5-8:

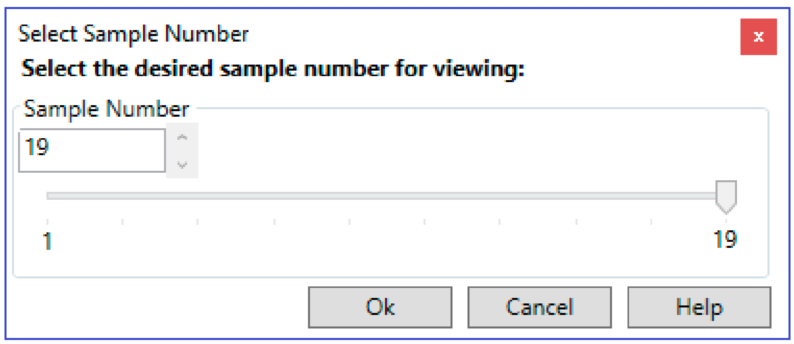

Figure 5-8. Sample Number

5.4.2 Edit > Clear Buffer

This command clears the captured image samples or select buffer properties. The options listed in the dialog box shown in Figure 5-9 include:

- Keep Samples that have Images
- Keep Samples marked "Saved"
- Delete Samples marked "Saved"
- Clear all Samples

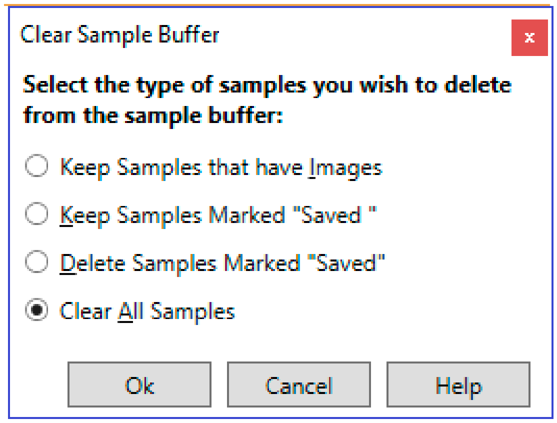

Figure 5-9. Clear Buffer

5.5 View Tab

On the View Tab (shown in Figure 5-10), users can select the level of zoom, display calculations, statistical results, and/or test results. Also, users can configure crosshair and various profile settings.

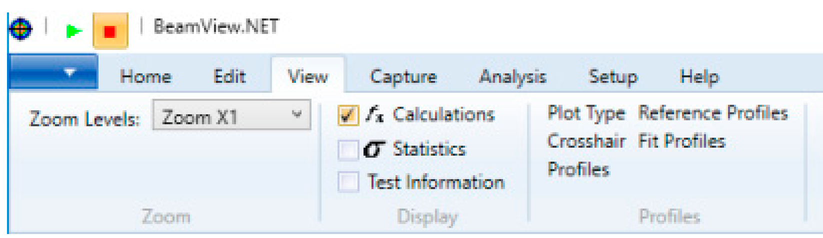

Figure 5-10. View Tab

The View tab includes the following options:

- Zoom
- Display
- Profiles

5.5.1 View > Zoom Levels

Select a zoom level from the drop-down menu.

5.5.2 View > Display

This command sets the fit profile properties and turn the display on or off in the main window of the View Tab for:

- Calculations—The panel shown in Figure 5-11 on the right of the main window is now populated with the following calculations:
  - General calculations
  - Ellipticity
  - Gaussian Fit
  - Aperture Uniformity
  - Image Uniformity
  - Flat Top

  Click the up or down arrows to display or hide each section.

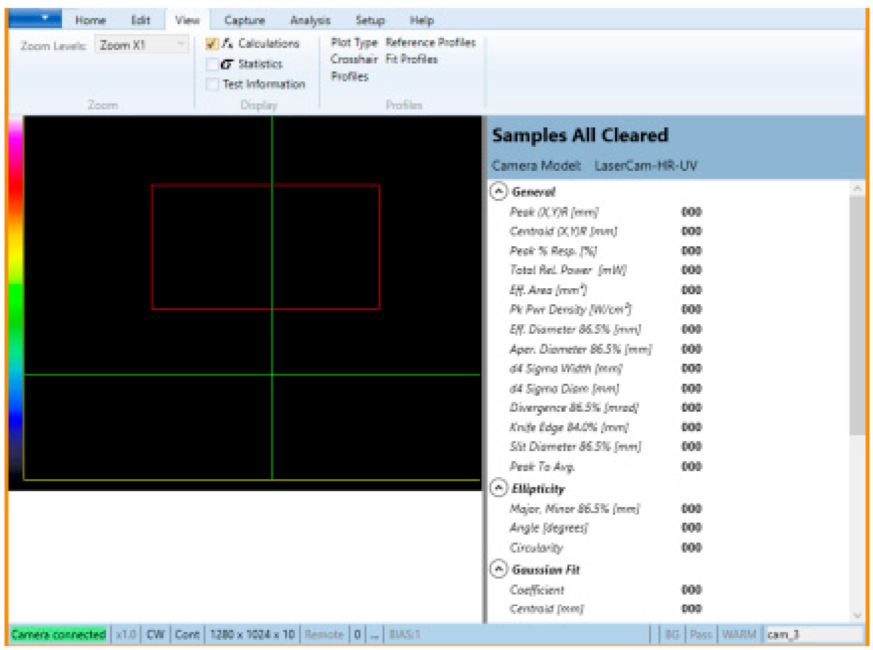

Figure 5-11. View Calculations

- Statistics—The same categories listed for Calculations are displayed in the bottom panel of the main window, shown in Figure 5-12.
  - General calculations
  - Ellipticity
  - Gaussian Fit

- Aperture Uniformity
- Image Uniformity
- Flat Top

Click the up or down arrows to display or hide each section.

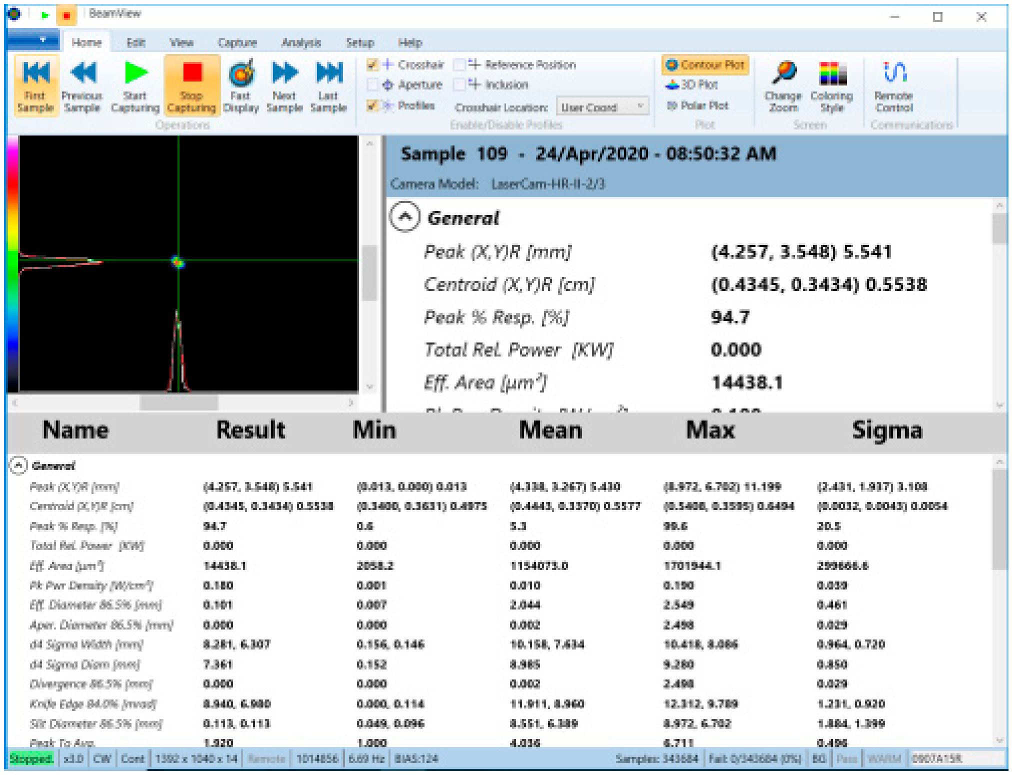

Figure 5-12. View Statistics

- Test Information — Data is displayed under the Results area, shown in Figure 5-13. For more information, see 'Test Information' (p. 47).

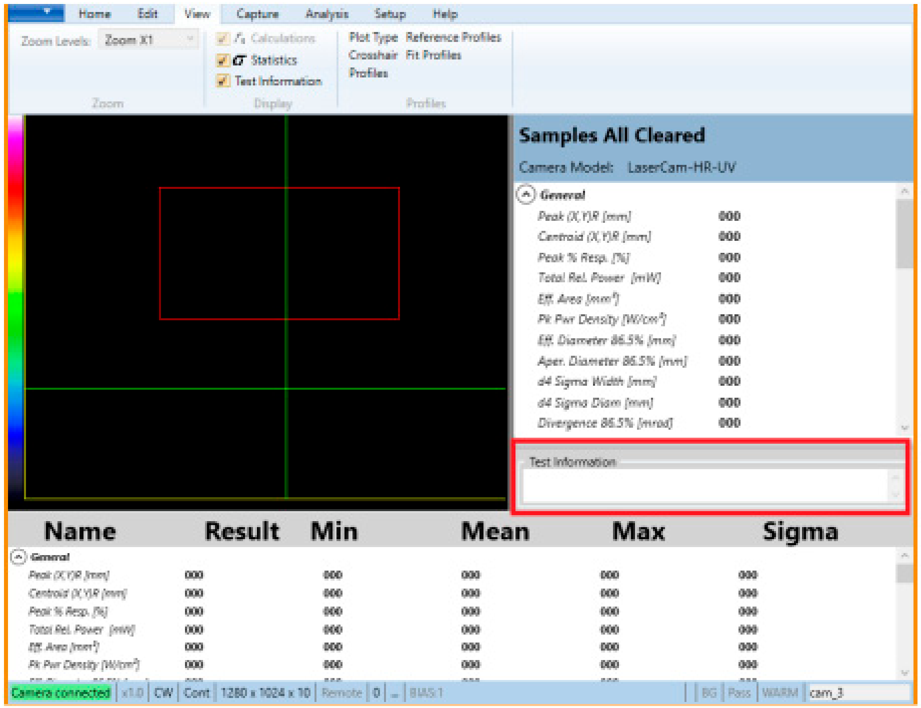

Figure 5-13. View Test Information

5.5.3 View > Profiles

Set fit profile properties for the following:

- Plot Type
- Crosshair
- Profiles
- Reference Profiles
- Fit Profiles

Each of these are described in the sections that follow.

5.5.3.1 View > Plot Type

Set the image plot type properties in the dialog box shown in Figure 5-14:

- Contour

  The options for the Color Scaling under Contour include:

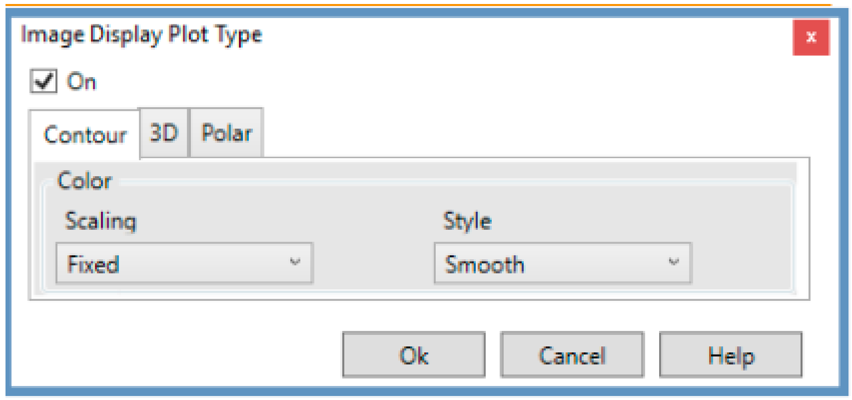

Figure 5-14. Image Display Plot Type — Contour

- Fixed
- Scale to Peak
- Low intensity
- High intensity

The options for the Color Style under Contour include:

- Sharp 17
- Smooth
- Gray Scale
- Shaded Bands

- 3D

  The options for the Type of Plot Construction for image displays under 3D, shown in Figure 5-15, include:

  - Transparent Wire
  - Hidden Wire
  - Solid Wire

  The options for the Movement for the Viewing Angle under 3D include:

  - Stationery
  - Counter Clockwise
  - Clockwise

  The options for the Color Scaling under 3D include:

  - Fixed
  - Scale to Peak

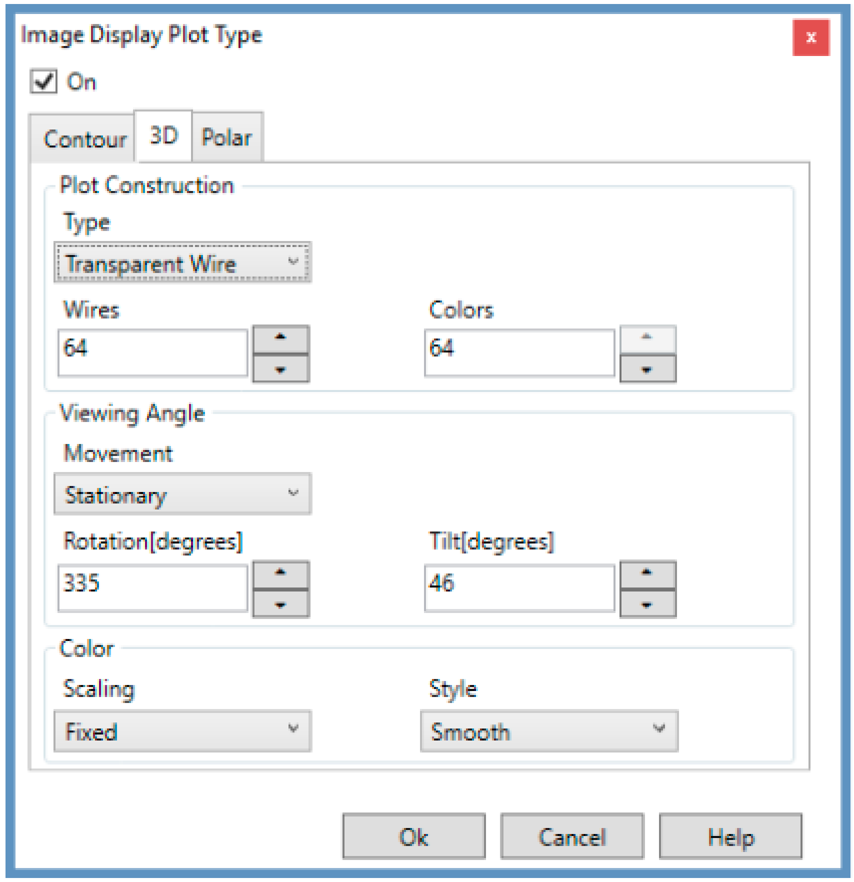

Figure 5-15. Image Display Plot Type — 3D Plot

- Low intensity
- High intensity

The options for the Color Style under 3D include:

- Sharp 17
- Smooth
- Gray Scale
- Shaded Bands

- Polar

  The options for Plot points, shown in Figure 5-16, include:

  - Centroid
  - Peak

  The options for Plot Center include:

  - User Coordinate
  - Mean Centroid/Peak

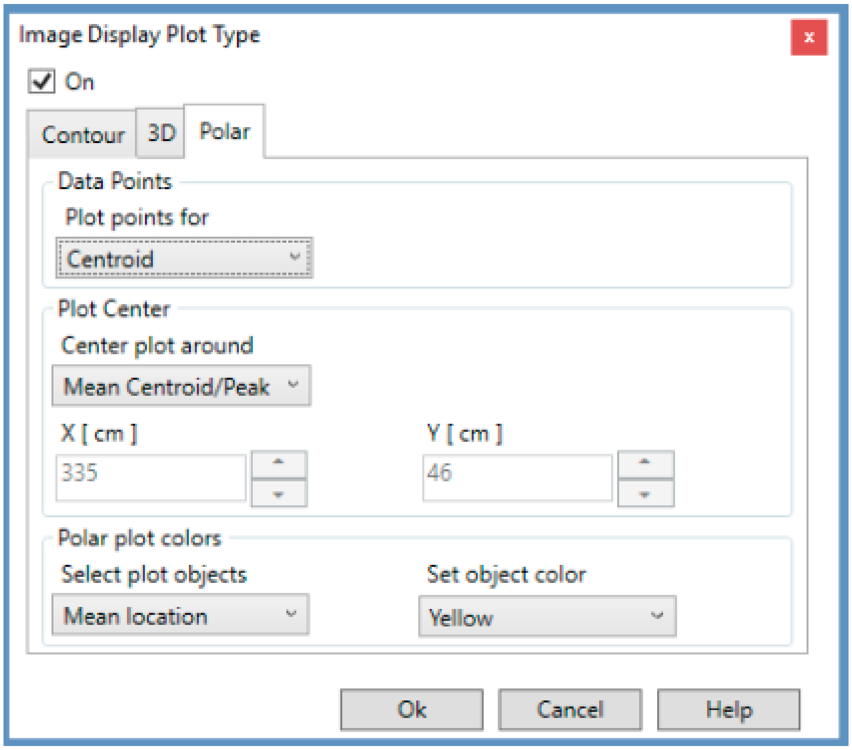

Figure 5-16. Image Display Plot Type — Polar

- Current Centroid/Peak
- Center of Image
- Reference Position

The options for Polar Plot Objects include:

- Mean location
- Center location
- Current sample
- Passing samples
- Failing samples

The options for Object color for a Polar Plot include:

- White
- Red
- Green
- Magenta
- Yellow
- Blue

- Cyan

5.5.3.2 View > Crosshair

The Crosshair feature is commonly set to track the centroid of the beam. This shows the profiles set along the crosshair, as in the example in Figure 5-17.

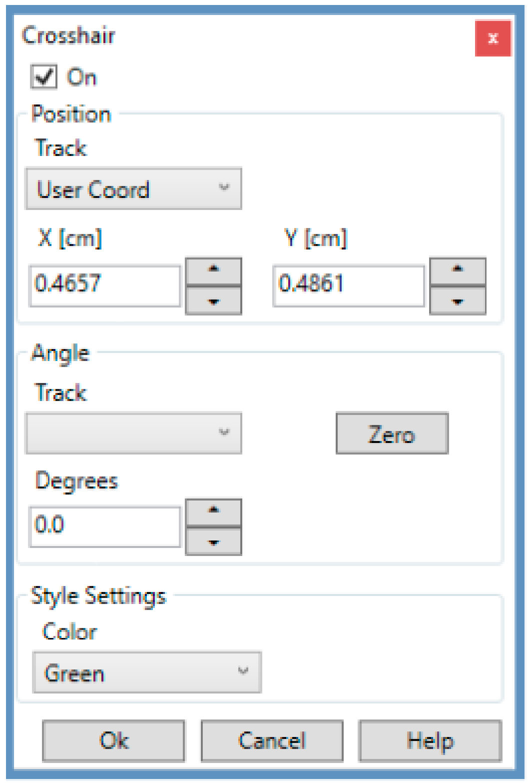

Figure 5-17. Crosshair Properties

The options for Position for the Crosshair include:

- User Coordinate
- Peak
- Centroid

For the crosshair to be most useful, set the angle setting to either user angle or ellipticity.

- User angle: Setting this to 0 degrees displays the crosshair exactly horizontal and vertical in the image.

- Ellipticity: If the laser is an elliptical beam, the angle displays the profile along the long and short axis of the beam.

The options for Color for the Crosshair include:

- White
- Red
- Green
- Magenta
- Yellow
- Blue
- Cyan

5.5.3.3 View > Profiles

Set profile properties as shown in the dialog box in Figure 5-18

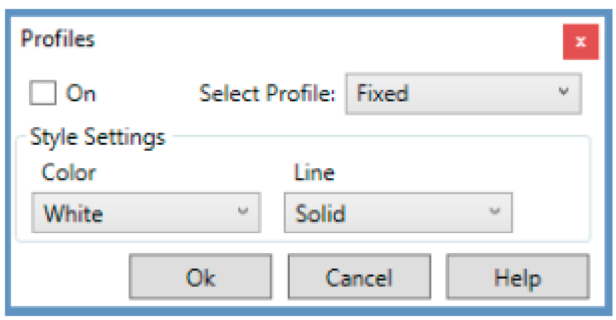

Figure 5-18. Profile Properties

The options the Selected Profile include:

- Fixed
- Scale to Peak

The options for Color for the Profile include:

- White
- Red
- Green
- Magenta
- Yellow
- Blue

- Cyan

The options for a Line for the Profile include:

- Solid
- Dash 1
- Dash 2

5.5.3.4 View > Reference Position

Set reference profile properties as shown in Figure 5-19.

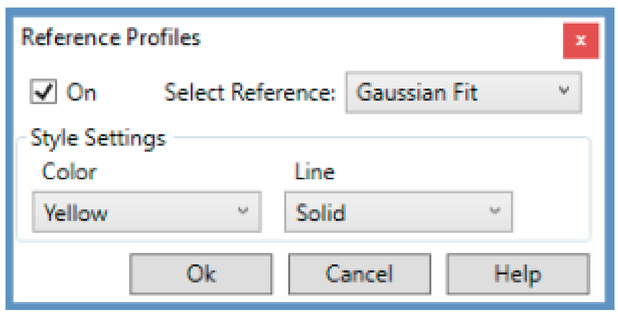

Figure 5-19. Reference Position Properties

The options for a Reference Profile include:

- Current Profile
- Gaussian Fit

The options for Color for the Reference Profile include:

- White
- Red
- Green
- Magenta
- Yellow
- Blue
- Cyan

The options for a Line Style for the Reference Profile include:

- Solid
- Dash 1

5.5.3.5 View > Fit Profiles

Set fit profile properties as shown in Figure 5-20.

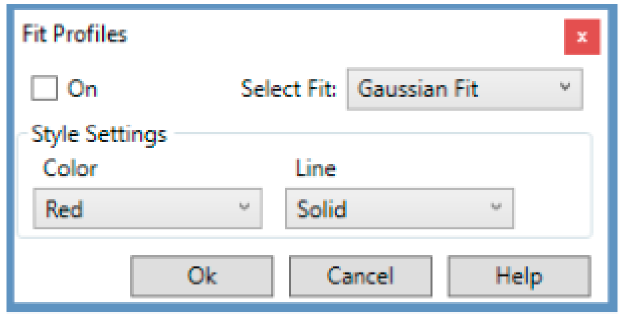

Figure 5-20. Fit Profiles Properties

The options for a Fit Profile include:

- Gaussian Fit

The options for Color for the Fit Profile include:

- White
- Red
- Green
- Magenta
- Yellow
- Blue
- Cyan

The options for a Line Style for the Fit Profile include:

- Solid
- Dash 1

5.6 Capture Tab

On the Capture tab shown in Figure 5-21, users can choose to show or delete the Collection Map, enable CW or pulsed capture operations, select trigger operations, set the resolution and depth, as well as configure the storage buffer for samples. Users can also specify the exposure time.

The sections for the Capture tab include:

- Background Map

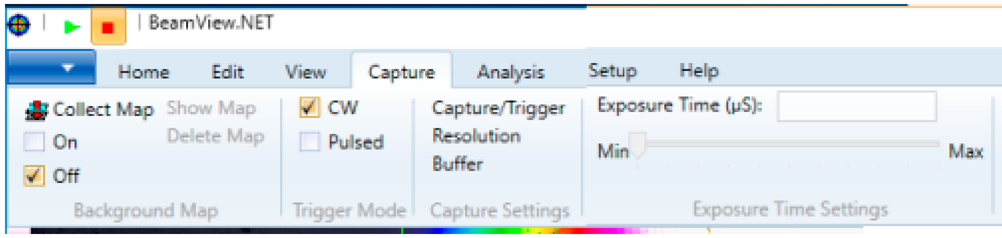

Figure 5-21. Capture Tab

- Trigger Mode (Source)
    - CW (Continuous Wave)
    - Pulsed
- Capture Settings
    - Capture/Trigger
    - Resolution
    - Buffer
- Exposure Time Settings

See 'Capture Beam Image' (p. 71) for details and instructions for settings.

5.7 Analysis Tab

The Analysis tab shown in Figure 5-22 lets users configure settings for analysis calculations, pass/fail options, overlay apertures, and other profile information.

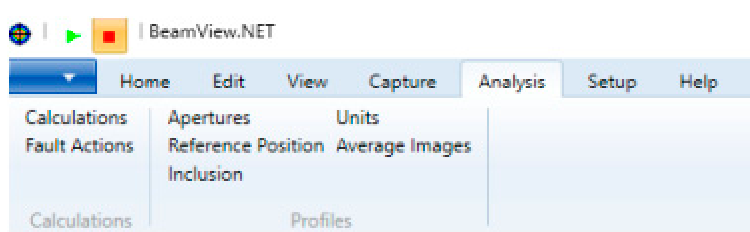

Figure 5-22. Analysis Tab

For details about how to set up and use options this toolbar, see 'Analyze Calculations' (p. 91).

5.8 Setup Tab

In the Set-up Tab shown in Figure 5-23, identify a camera, adjust properties for the selected camera, define input power/energy for calibrations, set the input optical magnification scale, input Far Field optical focal length, and set password protection for configuration settings.

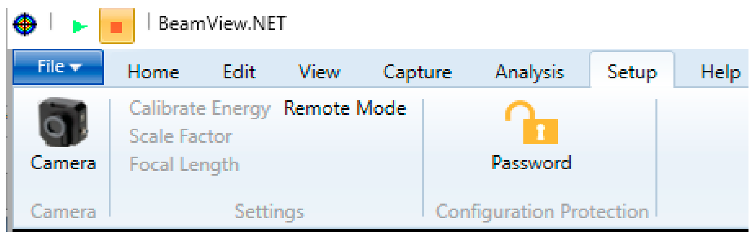

Figure 5-23. Setup Tab

There are three sections in the Setup Toolbar:

- Camera
- Settings
    - Calibrate Power
    - Scale Factor
    - Focal Length
    - Remote Mode
- Configuration Protection (Password)

5.8.1 Setup > Camera

For information about how to connect one or more cameras, see 'Set Up Hardware' (p. 21).

After a camera is connected, the BeamView.NET software automatically recognizes the camera. See 'Software Settings for Cameras' (p. 27) for details.

5.8.2 Setup > Calibrate Power

The Calibrate Relative Power/Energy command provides entry of a power/energy value as a "base" power/energy level.

The power /energy calculation sets the total summed intensity of all pixels in the next sample captured to this value. All subsequent samples are calibrated with this factor for Power/Energy and Peak Power/Energy Density (Fluence) calculations.

To choose the Calibrate Relative Power/Energy command, go to the Setup menu >> Calibrate Power. Select the Calibrate Relative Power/Energy command to open the following dialog box, shown in Figure 5-24:

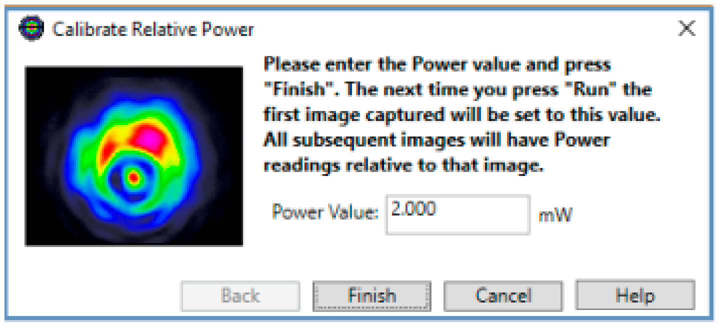

Figure 5-24. Setup >> Calibrate Power

The Power Value function is available in the Calibrate Relative Power dialog box. This function allows users to input the power/energy calibration value, which is entered numerically.

After entering the value, click Finish the displayed instructions to perform the calibration operation

5.8.3 Setup > Scale Factor

The Scale Factor command lets sets the optical magnification scale factor by defining a scaling factor to multiply the camera pixel size.

The Scale Factor settings are defined in the dialog box shown in Figure 5-25:

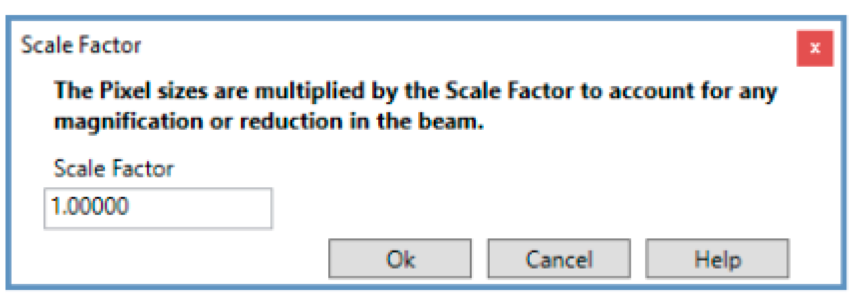

Figure 5-25. Setup > Scale Factor

The Scale Factor command provides input of a scaling factor to multiply the camera pixel size to compensate for magnification or de-magnification of the laser beam by various optical systems, such as a magnifying lens.

If there are optics (either expanding lens or a reducing lens) in the beam path, users can set a Scale Factor into this setting to adjust calculations. For example, if users enter a scale factor of 6 into the BeamView.NET software, and it makes all of the corrections to match the calculations to the actual beam size.

5.8.4 Setup > Focal Length

In the Focal Length dialog box, define the focal length value for a lens or focusing mirror being used with the camera for Far Field measurements (such as Divergence or Pointing Stability).

For all Far Field calculations to be correct, the focal length of the optic being used must be entered in the Focal Length function.

When users select Focal Length, the dialog box shown in Figure 5-26 is displayed:

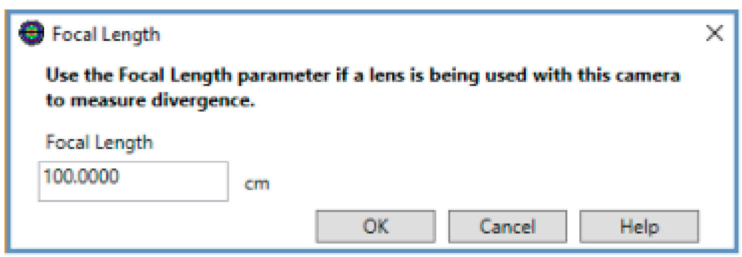

Figure 5-26. Setup — Focal Length

5.8.5 Setup > Remote Mode

Remote Mode lets users set or disable a TCP/IP or serial (RS-232) connection. See 'Remote Mode Set Up' (p. 151) for detailed information about Remote Mode.

5.8.6 Setup > Configuration Protection (Password)

This an option only if users need the added security and is not considered a general set-up task.

To enable Password protection:

1. Click the Lock icon. The dialog box shown in Figure 5-27 is displayed:

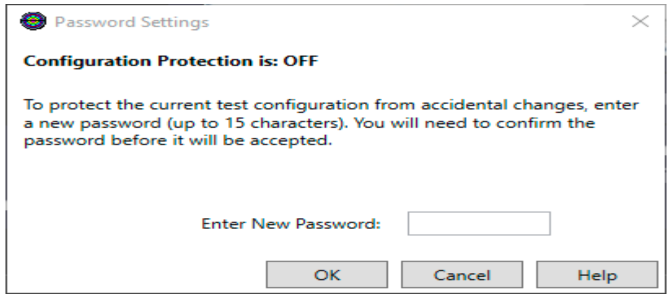

Figure 5-27. Configure Password Protection

2. Enter a password, and click OK. The message shown in Figure 5-28 is displayed.

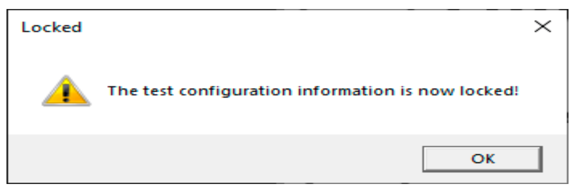

Figure 5-28. Test Configuration Locked

5.9 Help Tab

The Help tab is displayed as shown in Figure 5-29:

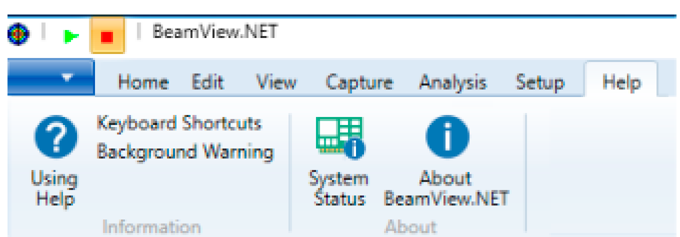

Figure 5-29. Help Tab

In the Information area:

- Using Help — displays contents of the Help file

- Keyboard shortcuts — see 'Keyboard Shortcuts' (p. 68)
- Background Warning — displays Help information about background warnings

In the About area, users can check:

- System Status shown in Figure 5-30 — Details about the host PC.

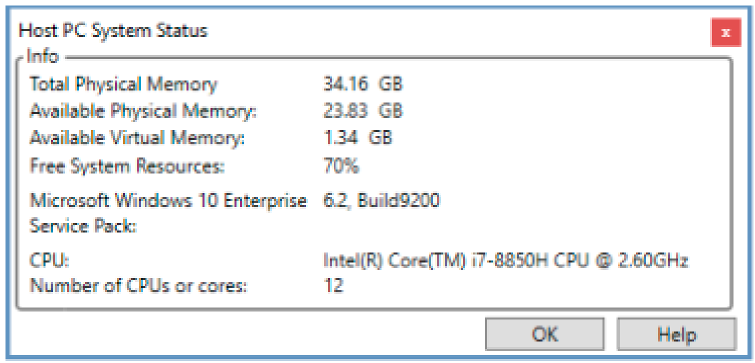

Figure 5-30. Help — System Status

- About shown in Figure 5-31 — View license and copyright information for the software.

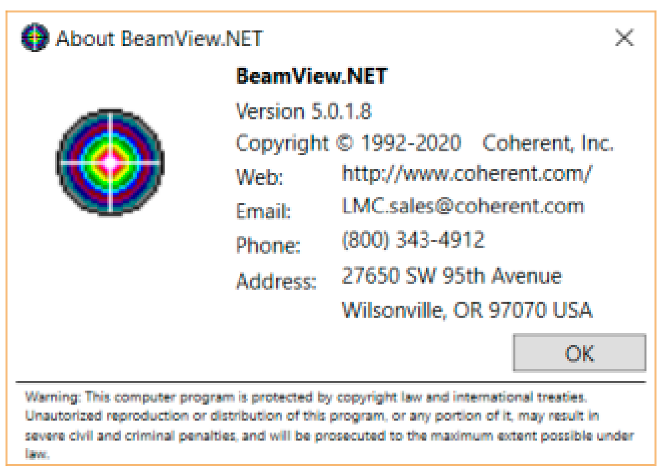

Figure 5-31. Help — About BeamView.NET

5.10 Controls for the User Interface

Within BeamView.NET are a functions offered by the mouse cursor, keyboard shortcuts, and commands/menus.

5.10.1 Mouse Cursor

The BeamView.NET software utilizes a mouse-driven cursor for selection of menus and commands, as well as manipulation and control of various graphics and result display functions.

These different cursor functions are dependent on the position of the mouse within, or over, specific areas of the Windows display.

- When the mouse is moved over menus, command lists, dialog boxes, or icon buttons, it retains its normal "arrow" configuration and functionality.
- When the mouse is moved within the View Area, it changes to a "crosshair" cursor. This allows users to manipulate and position various graphics and data display functions.

Details about the cursor function for various functions are provided in later sections.

5.10.2 Keyboard Shortcuts

Table 5-3 lists shortcuts that provide keyboard access to commonly used operations:

Table 5-3. Keyboard Shortcuts

Operation	Key	Description
Background Subtraction	<Ctrl>+<B>	Open the Background Map Collection dialog window
Calculation/result Configuration	<Ctrl>+<R>	Open the Calculations dialog window
Calculations On/Off	<F7>	Toggle calculation result display On or Off
Centroid Location	<Shift>+<F6>	When in Stop mode, move image crosshair to the centroid location
Crosshair Display	<F5>	Toggle image crosshair display On or Off

Table 5-3. Keyboard Shortcuts (Continued)

Operation	Key	Description
Crosshair Movement	Arrow Keys	When in Stop mode, move image crosshair position
CW/Pulsed Selection	<Shift>+<F7>	Toggle capture settings between CW and Pulsed modes
Goto Sample Number	<Ctrl>+<G>	Open dialog window allowing entry of Sample number to display
Help	<F1>	Opens the Help file
Image Next	<PgUp>	When in Stop mode, go to the next sample
Image Previous	<PgDown>	When in Stop mode, go to the previous sample
Inclusion Area Adjustment	<Shift>+<F8>	Open the Inclusion area dialog window
Live Video	<F9>	Toggle Live Video image display On or Off
Peak Position	<Shift>+<F5>	When in Stop mode, move image crosshair to the peak intensity location
Profile On	<F2>	Toggle profile display On or Off
Reference Position On	<F4>	Toggle reference position On (crosshair location) or Off (upper left corner)
Reference Profile	<F3>	Open the Reference Profile dialog window
Start/Stop	<F12>	Toggle between Start and Stop modes
Statistics On/Off	<F6>	Toggle display of statistics On or Off
Zoom Level	<F8>	Zoom in with each key press. The last zoom level returns to the 1x zoom level.
Test Information	<Ctrl>+<I>	Test Information dialog

5.10.3 Choose Commands

Like most Windows applications, the BeamView.NET commands may not always be functional or available in some modes of operation or configurations. Commands that are not available are dimmed in the user interface.

To choose a command or menu item from an open menu list, use one of the following methods:

- Move the cursor with the mouse or arrow keys over the desired command or item name, and click the left mouse button or Enter key.

- Type the underlined letter (hot key) in the command or item name.

- Type the key equivalent shown to the right of the command or item name.

If a command function is currently active, a check mark is displayed in front of the command or item name.

If a command has a sub-menu associated with it, a right arrow mark (">") is displayed after the command or item name.

If the command has a dialog box associated with it, the box is displayed when the command is selected.

5.11 Next Steps

Go to 'Capture Beam Image' (p. 71) for information about settings for calculations and how to capture a beam image.

6 Capture Beam Image

There are several methods described in this section to capture a beam image using the BeamView.NET software.

Capturing desired samples is important in measurement instrumentation. The Capture toolbar section lets users collect a Background Map, identify the source of the beam image, and define settings (including Trigger options).

NOTICE

It is recommended that to first collect a Background Map, which identifies background noise. That noise map is subtracted from all subsequent beam images before image analysis is performed. See 'Background Map' (p. 74) for more information.

6.1 Image File Formats

The BeamView.NET software currently supports a variety of Graphical formats as well as Image file formats.

6.1.1 Graphic File Formats

Almost any graphics package supports at least one of the following file formats. Some image analysis software imports some of these formats. The intended use of the image should help determine which format to use.

A BeamView.NET software image file can be imported into almost any other graphical application.

The graphic file formats are listed in Table 6-1:

Table 6-1. Graphic File Formats

File Extension	File Format
.bmp	Bitmap Compressed or Uncompressed
.jpg	JPEG, JFIF
.png	Portable Network Graphics

The .jpg format performs compression and is good for image display, but that format alters the data and is NOT suitable if further image analysis is needed.

The .bmp and .png formats perform compression and leave the data intact, so they are good for both display and further image analysis. Some analysis software packages allow direct importation of .bmp formats.

6.1.2 Analysis File Formats

Two file types, Binary and ASCII, store the raw data only. No header information is included. The primary purpose for these file formats is to export for further analysis by other programs, or for later recall and analysis by the BeamView.NET software.

If the file is being stored for later recall, Coherent strongly recommends that users also store a BeamView.NET software Test Configuration file under the same name. That way, the capture settings for the image can be restored before the image is recalled.

The ASCII image file format is the only format guaranteed to preserve the integrity of every data point in the image, and therefore is best suited when further analysis is to be performed on an image.

The ASCII format is a comma delimited file, and can be imported directly into spreadsheets or mathematical software programs.

6.1.2.1 ASCII Image (*.IMG; I*.*)

In ASCII image file format, each image pixel value may require up to 5 bytes (one for each digit of the value), plus a comma to separate pixel values. Each video row in ASCII format must be separated by a carriage return and line feed. It is possible for an ASCII format file to be four times larger than a binary format file of the same image.

The advantage of an ASCII format file is that it may be loaded directly into a word processor or spreadsheet program, whereas a binary file cannot. When this file type is selected, the file list displays all files that end in .IMG.

6.2 Capture a Beam Image

In the Home Tab, the following commands allow users to quickly capture, analyze, and display of beam image data:

- Start a Capture

- Stop Capture
- Live Video (real-time display)
- These icons are displayed in color on the toolbar.

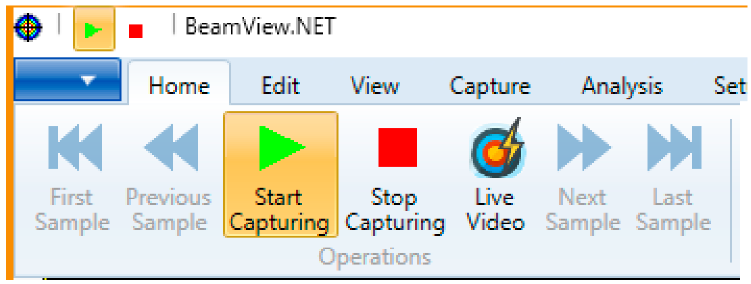

Figure 6-1. Home > Start and Stop Capturing

6.2.1 Start a Capture

The Start Capturing command switches the BeamView.NET software from either Stop Capturing mode or Live Video mode to a Start mode. In Start mode, there is capture, analysis, and display of beam image data.

To choose the Start Capturing command:

- From the Capture toolbar, select the **Start Capturing** icon.
- When Start is On, a green icon is displayed at the top of the window.

To turn Start Capturing Off, click the Stop Capturing icon. The Beam-View.NET software then switches to Stop mode.

6.2.2 Stop a Capture

The Stop Capturing command switches the BeamView.NET software from either Start Capturing mode or Live Video operation to a Stop mode. All data capture, analysis, and display of beam image data is halted.

To choose the Stop Capturing command:

- From the Capture toolbar, select the **Stop Capturing** icon.
- When Stop is On, a red icon is displayed at the top of the window.

To turn Stop Capturing Off, click the Start Capturing icon. The Beam-View.NET software then switches to Start mode.

6.2.3 Real-Time Display in Live Video

BeamView.NET offers a feature that is useful when setting up and aligning the laser and camera. See 'Align the Laser and Camera' (p. 33) for details.

The **Live Video** command switches the BeamView.NET software from displaying images in Start mode (with overlay graphics and calculations) to a real-time display in Live Video mode (with no overlay graphics or calculations).

6.3 Background Map

The Background Map command collects the noise level of the camera and creates a background noise map for that particular camera.

This Background Map can be used to perform a pixel-by-pixel intensity Background Map noise subtraction from all subsequent beam images captured, depending upon whether the background subtraction mode is On or Off. Setting a Background Map ensures that calculations are correct by eliminating fixed-pattern environmental or camera noise and ignoring bad camera pixels.

Before collecting a Background Map, reduce background noise as much as possible. See 'Background Noise Is Too High' (p. 199) for details.

The following options are displayed in the Background Map section of the Capture toolbar:

- Collect Map: Opens the Collect New Background wizard.
- On: Enables (turns ON) the subtraction of the existing Background Map.
- Off: Disables (turns OFF) the subtraction of the existing Background Map.
- Show Map: Displays the Background Map.
- Delete Map: Removes the current Background Map.

NOTICE
Before collecting a Background Map, sources of background noise must be reduced as much as possible. See 'Background Noise Is Too High' (p. 199) for more information.

This Background Map is used to perform a pixel-by-pixel noise subtraction from all subsequent beam images captured before image analysis is performed. (Background subtraction mode can be set to On or Off.) The identified noise is not added into a captured image nor into the calculations.

The centroid and crosshairs in the image may not track correctly if a Background Map was not set in advance.

6.3.1 Capture > Collect a Background Map

To collect a Background Map:

1. Block (cover) the beam at or near the source such that the camera sensor detects no laser light.
2. From the Capture toolbar, go to the Background Map section and select **Collect Map**.

   If there is currently no Background Map for the selected camera, the message shown in Figure 6-2 is displayed:

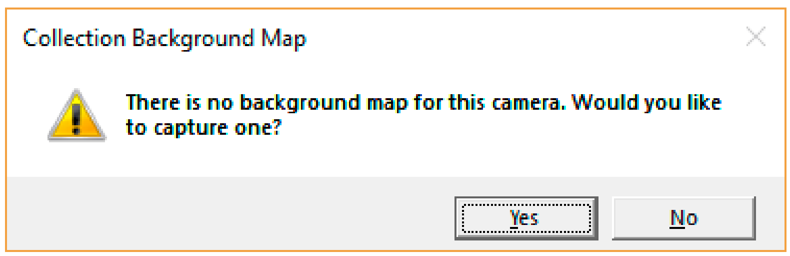

Figure 6-2. Capture — No Background Map Message

3. Click Yes to proceed.

   The Collect New Background wizard is displayed, as shown in Figure 6-3:

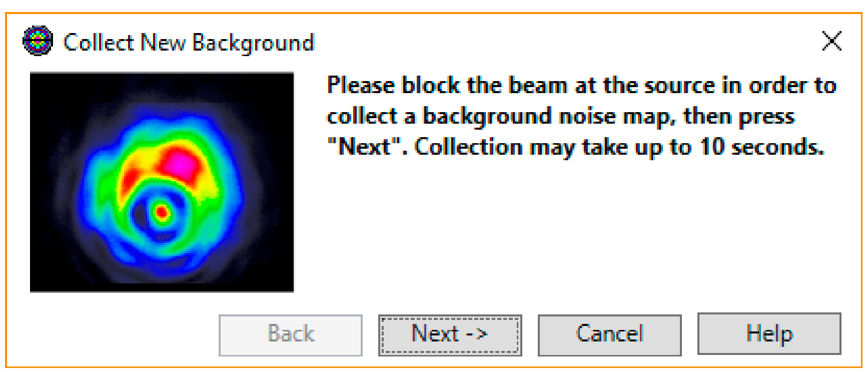

Figure 6-3. Capture—Collect a Background Map Wizard

CAUTION!
If not done so already, first block the laser beam at its source before work is continued.

4. Click Next, and the wizard displays the following:

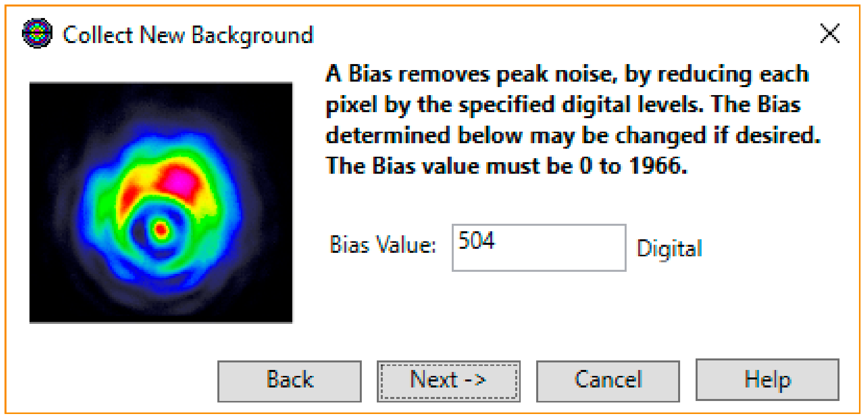

Figure 6-4. Capture—Background Map Bias Value

5. Enter a Background Bias Value in the dialog box. The range is from 0 to 1966.

   This provides additional digital levels of subtraction to reduce the effects of random video noise.

   The software automatically determines a recommended bias value for the selected camera, but users can change that value as desired. The Bias factor depends on the type of LaserCam camera connected to the system, and varies depending on whether the camera has a 10-bit output or a 14-bit output.

6. Click Next, and the dialog box lists the bias factor that was entered.

7. It is recommended to turn the background warning indicator on. To do so, click the checkbox to Enable Background Noise Level Monitoring.

   The BeamView.NET software continuously monitors the background noise level during image capture, and issues a warning if that noise level is significant enough to affect calculation accuracy (see 'Display a Warning Message' (p. 200)).

8. Click Finish, and the Main Window with the crosshair is again displayed.

The BeamView.NET software acquires a Background Map by capturing and averaging a set of 16 images.

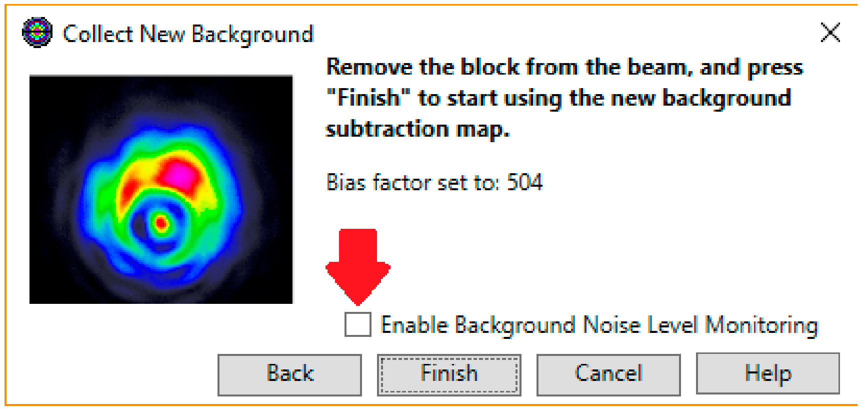

Figure 6-5. Capture—Complete Background Map

6.3.2 Test the Background Map

To study the effects of the Background Map and Bias level:

1. Configure the BeamView.NET software to display a contour map:
   a.) From the View Menu, select Plot Type command.
   b.) In the dialog box, select the Contour tab.
   c.) Select the Scale to Peak scaling function.
   d.) Click OK.
2. Block the laser beam at the source.
3. In the Home toolbar, click Start Capturing and monitor the View area.
   - If the Background Map and Bias level are set correctly, only a few randomly scattered points of noise should be seen.
   - If more than just a few points of noise are seen, click Stop Capturing and take a second Background Map. This time, increase the Bias level by one, then reevaluate the noise in the View area.

When finished, the BeamView.NET software displays the averaged Background Map in the View area. All subsequent images captured with BeamView.NET now have this Background Map subtracted.

The background subtraction can be disabled or re-enabled. In the Capture toolbar, select On or Off in the Background Map section.

- If no Background Map was previously stored, the background subtraction remains disabled (Off) and indicates that no map is available.

- If the background subtraction feature is disabled (turned Off) and a Background Map has been collected, BeamView.NET retains the Background Map, but does not subtract it from the subsequent captured images.

Switching the background subtraction On means the BeamView.NET software uses the already-stored Background Map and subtract it from subsequent images collected. If a new Background Map is collected, it replaces the previously-stored Background Map. An updated map can be collected at any time it seems that the background level has changed.

When changing resolutions or cameras, the BeamView.NET software requires capture of a new Background Map.

6.4 Capture > Capture/Trigger

The BeamView.NET software provides a number of features and options to control the timing of sample capture for both CW (Continuous Wave) and Pulsed laser applications. See details about these settings in 'Capture Tab' (p. 61).

6.4.1 Capture/Trigger: Source

When users select Capture/Trigger in the Capture Settings section, the following dialog box is displayed:

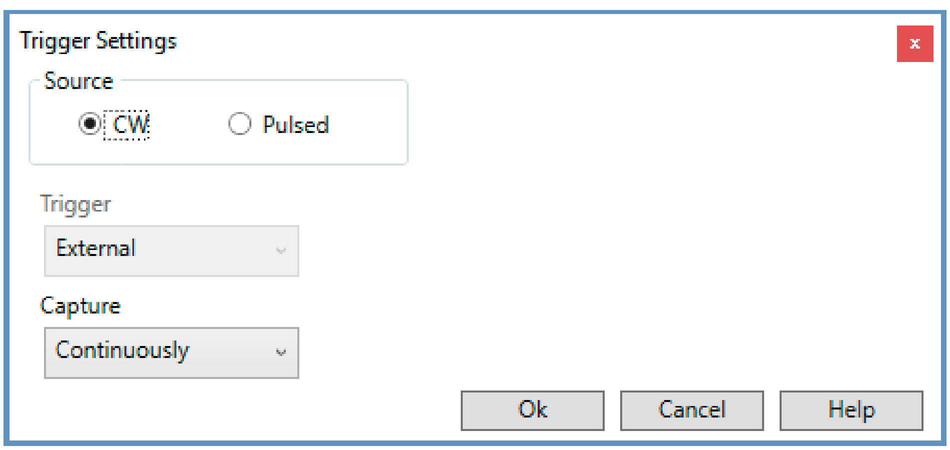

Figure 6-6. Capture Trigger: Source in Status Bar

The following Capture modes are available, with a radio button to select either CW or Pulsed mode.

6.4.1.1 CW (Continuous Wave)

The CW (Continuous Wave) button switches the software from Pulsed source capture to CW source capture mode.

- To choose the CW mode, choose the radio button for CW button.
- To turn CW mode Off, choose the radio button for Pulsed.

6.4.1.2 Pulsed

The Pulsed button switches the BeamView.NET software from CW (Continuous Wave) source capture to Pulsed source capture mode.

- To choose Pulsed mode, choose the radio button for Pulsed.
- To turn Pulsed mode Off, choose the CW button.

6.4.1.3 Capture/Trigger: Edge

If the source selected is Pulsed, the dialog box displays additional selections to select Rising or Falling Edge and enter a Trigger Delay:

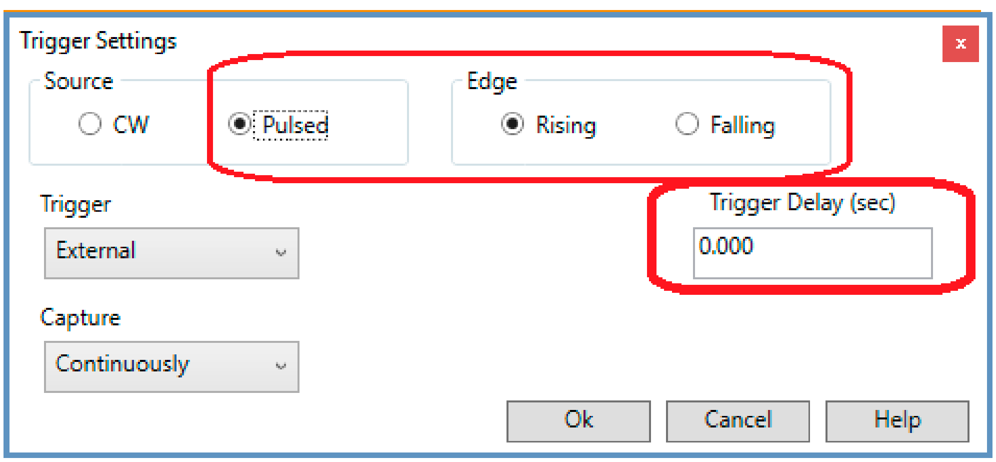

Figure 6-7. Capture > Capture/Trigger Pulsed Settings

1. Select either a Rising or Falling Edge.
2. Enter a Trigger Delay (in seconds).
3. Click OK.

6.4.1.4 Capture/Trigger: Trigger Option

From the drop-down menu, select a Trigger option:

- External
- Auto Trigger

NOTICE
Trigger selection is ONLY active for Pulsed mode operation.
No trigger signal is required in CW (Continuous Wave) operation, so the Trigger drop-down menu is not available for CW.

6.4.1.5 Capture/Trigger: Capture Timing

From the drop-down menu, select an option from the Capture drop-down menu. Click OK when finished.

6.4.1.5.1 Continuously

Beamview.NET continuously captures beam images in a repetitive process until the user intervenes by selecting the Stop function, or the image storage count is achieved.

The speed of capture depends on the computer being used, image capture resolution, number and type of calculations being done, and whether calculations are being done after each image capture or after all specified images have been captured.

6.4.1.5.2 On Time Interval of

Beamview.NET continuously captures beam images only after a user-specified time interval has passed. The units for this time interval setting can be adjusted by selecting the Analysis menu and the Units menu item.

This process repeats until the user intervenes by selecting the Stop function, or the image storage count is achieved.

When this option is selected, the dialog box displays a field for “Interval” - enter a user-defined value in seconds.

6.4.1.5.3 On Key Press

Beamview.NETcaptures beam images only after the <Enter> or <Space-bar> keyboard keys have been pressed, or the OK button in the Capture Image dialog box is selected.

This process repeats until the user intervenes by selecting the Cancel function in the Capture Image dialog box with the mouse, or the image storage count is achieved.

6.4.2 Capture with Trigger (Pulsed Mode)

To capture samples, a trigger signal is often used. This signal tells other devices to either generate or capture data at a specific time.

Most camera types have a small period of vulnerability, between one image and the next, where the incident light on the camera detector is not being recorded or is otherwise invalid (analogous to a camera shutter being closed).

- For CW (Continuous Wave) systems, this period is not important.
- For Pulsed laser systems, the laser pulses must either not be generated during the period of vulnerability, or the image generated during the vulnerable period must be disregarded.

The triggering configuration used is especially important in Pulsed laser applications where these signals are used to fire and/or detect the output laser pulse.

NOTICE
Trigger selection is ONLY active for Pulsed mode operation.

This section describes how to select a trigger to capture beam information. See ’Connect a Camera Using an External Trigger’ (p. 24) for instructions about set up and connecting a cable specific to the trigger function.

6.4.2.1 Triggering Methods

To take Pulsed measurements using the LaserCam, the camera and software offer two triggering methods that can be used to capture images.

- External
- Auto Trigger

The Auto Trigger and Trigger Delay features do not work well for capturing single-pulse lasers. In the case of a single pulse laser, the timing between the trigger signal and the laser firing needs to be adjusted to allow the camera to capture the first pulse while still accounting for the 150 µs delay in the camera. Often a pulse generator or signal delay box can be used to help set this up.

6.4.2.2 External Trigger Mode

External Trigger mode allows the camera to synchronize its capture period to the pulses being fired by the laser.

The software sends a voltage signal (typically a TTL pulse from the laser) to the camera to synchronize its capture period to the timing of the laser.

In External Trigger mode, the software disregards input trigger signals that occur during the period of vulnerability.

To access the Trigger Delay feature:

1. Go to the 'Capture > Capture/Trigger' menu.
2. Select the radio button for Pulsed.
3. Select the radio button for a Rising or Falling Edge.
4. Under Trigger, Select 'External' from the drop-down menu. The dialog boxes changes to display a box where users enter a value for the delay.

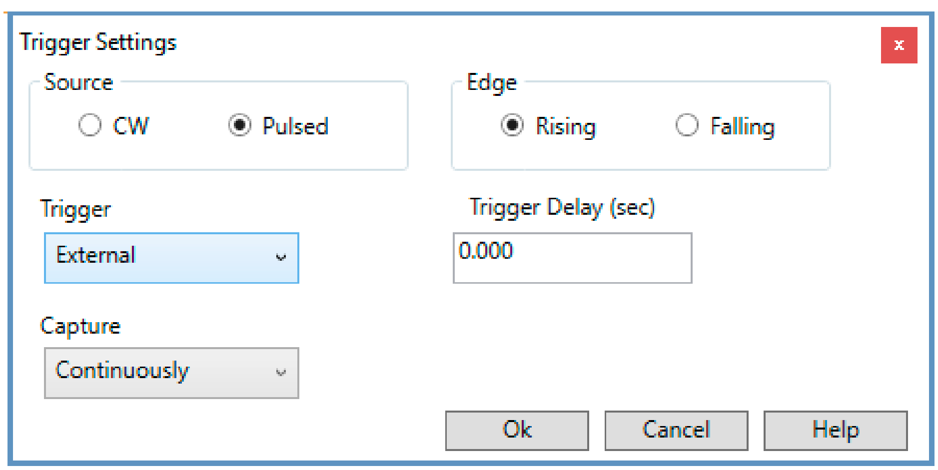

Figure 6-8. Capture — Set Trigger Delay

5. Enter the delay value in microseconds. This is the time from the hardware trigger until exposure begins. The allowable range is 0 to 100,000,000 (one hundred seconds).

The LaserCam external trigger circuit has a variable delay that is set via the Trigger Settings Dialog. This is something that is inherent to the camera and there is no way the delay can be shortened through the camera set-up.

For this camera to operate correctly with an external trigger, the trigger signal needs to occur at least 150 µs before the laser pulse hits the camera. The LaserCam has a 10 ms integration time, which means the camera is 'open' to capturing pulses for 10 ms after the trigger delay.

As long as the trigger delay of 150 µs has passed, the pulse can hit the camera anytime within the next 10 ms and be captured correctly.

Figure 6-9 shows a timeline for the trigger period.

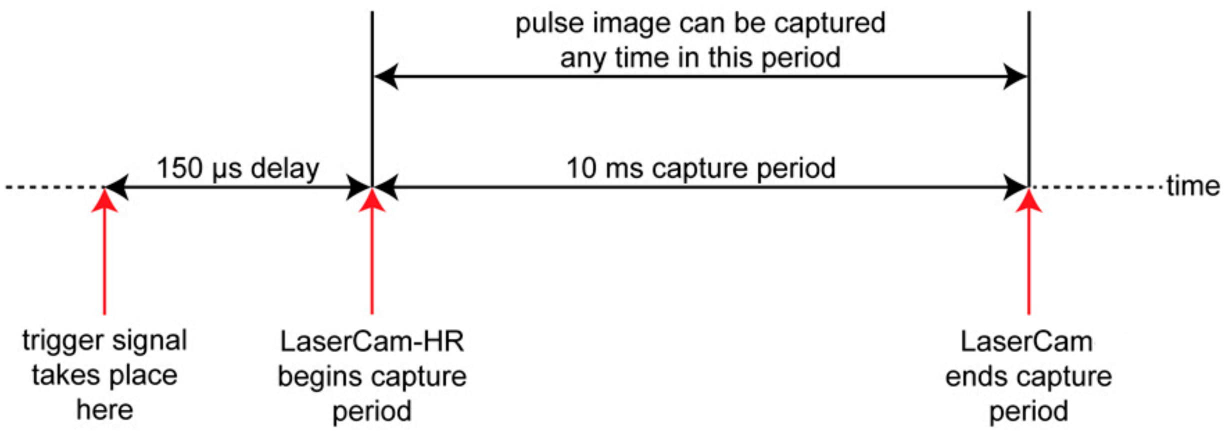

Figure 6-9. Capture — Trigger Delay Timeline

A 150 µs delay can be an issue with some laser systems. On many lasers, the trigger signal and laser pulse may not match up with a 150 µs delay.

6.4.2.3 Trigger Set-Up Example

For example, if a user has a laser that triggers only 50 µs before the pulse fires, the LaserCam triggers but does not capture any images. That is because the laser is firing during the 150 µs delay, so nothing is captured by the camera.

In this situation, the user must add some delay, either into the trigger signal or into the actual firing of the laser. If, for example, a 200 µs delay is added to the time between the trigger signal and the laser firing, it should work correctly.

This can often be done through external delay boxes or signal generators. If the LaserCam is being used in Pulsed mode and is capturing only blank images, trigger timing may be the problem.

The BeamView.NET software added a feature that helps in cases where the trigger delay is causing issues, called the ‘Trigger Delay’ setting. This feature uses the first trigger signal to capture the second laser pulse.

The Trigger Delay feature may be useful in cases such as described here, where the laser is firing only 50 µs after the trigger signal is sent to the camera. Due to the 150 µs delay, this usually results in the camera not capturing anything. If, however, a longer than normal delay is added between the trigger signal and the second pulse, the camera does capture a second pulse while triggering on the first trigger signal.

A user has a pulsed 10 Hz laser with an external trigger that sends a trigger signal about 50 µs before the laser fires a pulse. If hooked up directly to the external trigger connection on a LaserCam camera, this results in the camera triggering but not capturing any images because the laser pulse is firing during the 150 µs delay period.

If the time between the trigger and the laser pulse cannot be adjusted on the laser, the trigger delay on the camera can be lengthened to correctly help capture the pulse.

In this example, one possible solution is to set up a lengthy delay between the trigger signal and the second laser pulse. Because the camera has a 10 ms integration time and the laser is firing one pulse every 100 ms (1/10 Hz), a user could set a trigger delay of 95 ms in the BeamView.NET software. With a 95 ms setting, the laser sends a trigger signal and then, 50 µs later, the laser fires.

The result is that the first pulse is ignored and 95 ms passes before the camera starts its integration time. The laser then triggers again, fires another pulse, and the camera catches this second pulse. This second pulse is taking place approximately 5 ms into the 10 ms integration time and is captured correctly.

6.4.2.4 Set a Trigger Delay

The amount of delay can typically be determined by using an interval slightly shorter than the time between laser pulses. For a 10 Hz laser (100 ms between pulses), a 95 ms delay could be used. For a 50 Hz laser (20 ms between pulses), a 15 ms delay could be used. This sets enough delay for the camera to start its integration period before the next pulse is fired.

The 10 ms capture time on the LaserCam also sets the camera's maximum rep rate that can be used for pulsed measurements. For a 10 ms capture window, the inverse is 100 Hz.

This means the camera can have up to 100 of these 10 ms capture periods per second and, therefore, can capture single-pulse images for rep rates up to 100 Hz.

This does not mean the software captures images at 100 Hz. The update rate of the software is still limited to approximately 10 to 20 Hz, depending on the computer speed and the resolution being used.

However, the camera can capture pulses at up to 100 Hz without getting multiple pulses into the same image. At 200 Hz, the camera picks up two pulses in each capture period, which does not give an accurate image of each pulse. This 10 ms capture period limits the camera to rep rates of 100 Hz while capturing only single pulses in each image. If working at rep rates above 100 Hz, the camera can be put into CW mode, which should capture correctly.

6.4.3 Auto Trigger Mode

The Auto Trigger mode is a simple setting to capture pulses that does not require any trigger signals or need to synchronize the camera to the laser. Therefore, it is often used for set-up and alignment.

> The software uses a set intensity threshold to determine if it captures or discards a pulsed image.
>
> Auto Trigger is similar to the trigger used in oscilloscopes. Image capture occurs when the intensity level on any pixel in the video image is greater than a user-defined level.

Using this trigger method captures video images that have a pixel intensity above a user-defined level. Note that % response refers to a percentage level from 0 to 100 percent of the maximum intensity.

To select Auto Trigger:

1. Go to the Capture tab, select Capture/Trigger from the Capture Settings area in the toolbar, and the following dialog box is displayed:
2. Select the radio button for Pulsed.
3. Select the radio button for a Rising or Falling Edge.
4. Under Trigger, Select ’Auto Trigger’ from the drop-down menu. The dialog boxes changes to display a Qualifying Level:

This feature allows the user to define a pixel intensity threshold that BeamView.NET uses to determine whether to capture an image or discard it. If a laser pulse hits the camera and causes a certain number of pixels to exceed the set intensity level, that image is captured and saved into the BeamView.NET software.

Auto Trigger is suggested for first time set-up if the repetition rate is greater than approximately 10 Hz. After some images are captured, using more advanced triggering methods can improve capture performance.

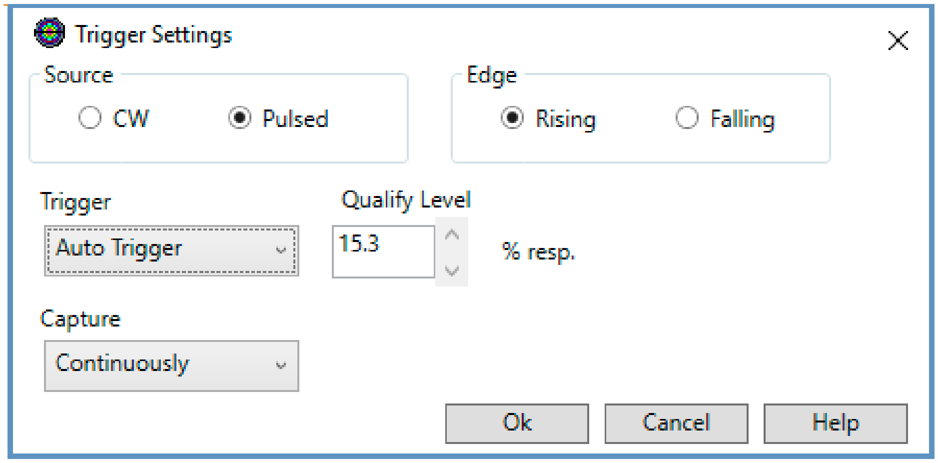

Figure 6-10. Capture — Select Auto Trigger

- Note that % response (Qualify Level box) refers to a percentage level from 0 to 100 percent of the maximum intensity.
- The intensity threshold level can be adjusted to any value between 0 and 100% to qualify whether an image is kept or not. Start with an intensity value of approximately 50%.

It is recommended to not use the Auto Trigger mode of capture for Pulsed laser sources below 10 to 20 Hz.

One drawback to the auto-trigger method is that not all pulses reaching the camera are captured. Due to the timing of the capture period on the LaserCam-HR camera, it is not possible for the camera to capture every pulse when working in auto-trigger mode.

Generally, this is not an issue when collecting pulses from a laser Start running at rep rates higher than 10 Hz or so. At those rates, the camera collects images on a fairly regular interval and runs at a good rate.

Below 10 Hz, BeamView.NET seems to run slower because of the low rep rate and the camera's inability to capture every pulse. For lasers running at rep rates lower than 10 Hz (especially for single-pulse applications), it is recommended to use the External Trigger mode.

6.5 Capture > Resolution

To choose the Resolution command:

1. Select the Capture menu.
2. From the toolbar select Resolution, and the following dialog box is displayed:

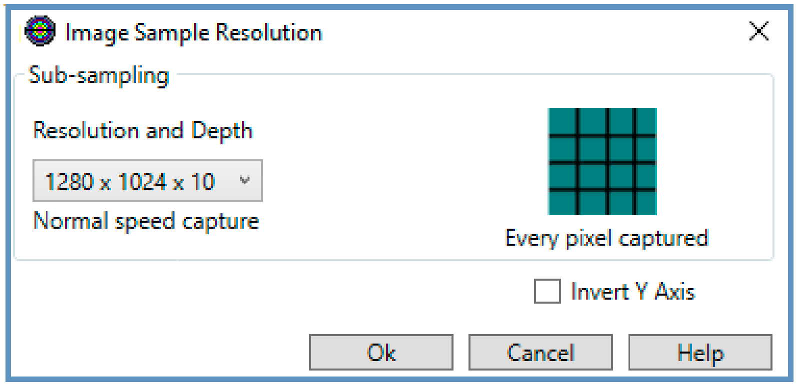

Figure 6-11. Capture > Resolution Command

The drop-down menu lists options, and the selection changes depending on which camera model is used:

- 1280 x 1024 x 16
- 640 x 512 x 16
- 650 x 512 x 8

The grid on the right side of the dialog box changes to reflect the settings, as shown in this example:

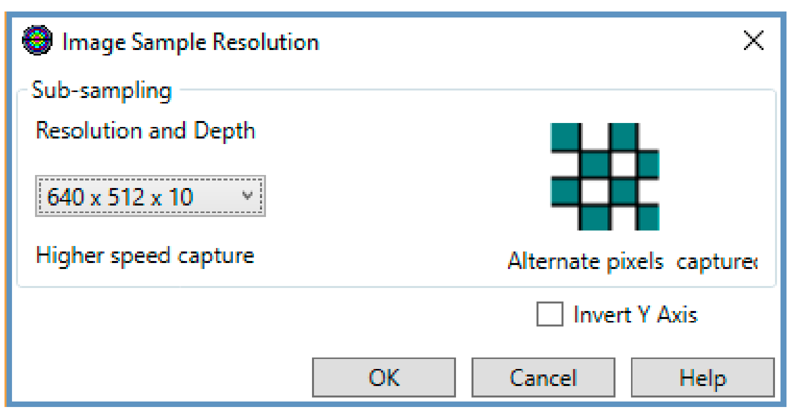

Figure 6-12. Capture > Change in Resolution

6.6 Capture > Buffer

The Buffer command in the Capture toolbar provides configuration of the size and actions of the sample buffer. There are a variety of settings in this dialog that interact with each other. Each sample captured and stored to the sample buffer contains the calculated results for that sample.

To choose the Buffer command:

1. Select the Capture menu.
2. From the Capture Settings section of the toolbar, select Buffer. The following dialog box is displayed:

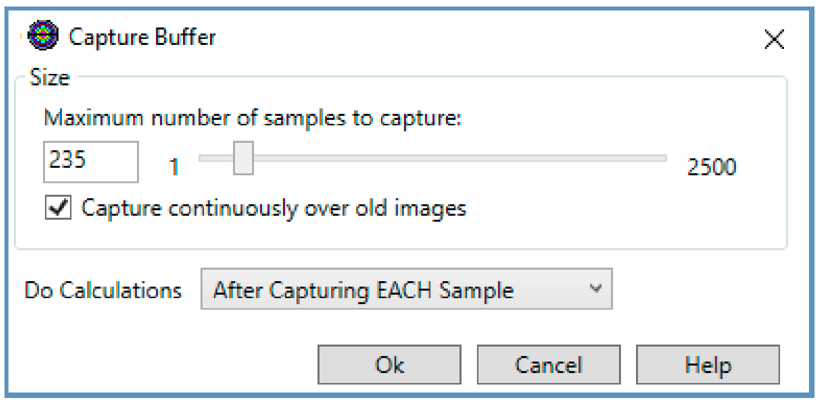

Figure 6-13. Capture – Buffer

3. Enter a value for the maximum number of samples to capture.
4. Click the checkbox if the capture should continuously replace the old images.
5. In the section for Do Calculations, select an option from the drop-down menu:
   - After Capturing EACH Sample
   - After Capturing ALL Samples
6. Click OK to finish the settings.

6.6.1 Buffer Size

This function provides selection of the maximum number of results to be stored to the Sample Buffer.

The maximum sample capacity is dependent on the amount of computer memory available and the selected image resolution, but typically allows up to 2500 samples in the buffer.

NOTICE
Insufficient disk space can lead to errors, causing the software to terminate.

6.6.2 Do Calculations

The Do Calculations function provides control over when the beam images are analyzed after being captured.

Two modes are provided for doing image calculations relative to their capture:

- **After Capturing EACH Sample**

  Selecting After Capturing EACH Sample, configures the BeamView.NET software to perform image analysis and display immediately after each beam image is captured.

- **After Capturing ALL Samples**

  This mode configures the BeamView.NET software to capture the number of beam images specified to the image buffer without analysis or display between captured images. In this mode, the BeamView.NET software captures all images first, and then analyzes and displays the results for each one.

  This mode provides image capture at high rates because calculations and display are not done between each captured image. Because of this, this method of image capture has been called “Burst Mode”. To restart BURST MODE, select the Start command after the specified number of beam images are captured.

Setting ‘Capture continuously over old samples’ is not valid when “Do Calculations” is set to “After Capturing ALL Samples”.

NOTICE
Doing Calculations after all samples is incompatible with the Pass/Fail fault actions because the analyzed results are not available between samples. While in BURST MODE, the BeamView.NET ignores all Pass/Fail fault actions (except the Background Color option).

6.7 Capture > Exposure Time Settings

In the section for Exposure Time, enter a value in µS. Exposure time must be greater than or equal to (68) µS.

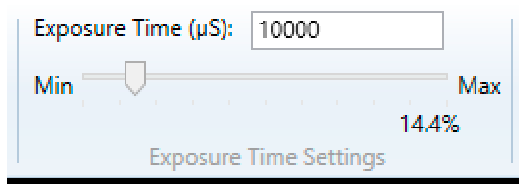

Figure 6-14. Capture — Exposure Time

6.8 Next Steps

Now that images have been captured, go to 'Analyze Calculations' (p. 91) to view and analyze results.

7 Analyze Calculations

The BeamView.NET software can easily be configured to capture and display the information required for a particular application, then perform calculations for the beam image.

In the Calculations area, there are two commands available:

- Calculations
- Fault Actions

7.1 Summary of Calculations

Following are features to consider when setting up calculations in the BeamView.NET software. Click the check boxes to turn calculations on or off.

Table 7-1 lists the calculations that are available for each type of analysis, with a brief description of each:

Table 7-1. Summary of Calculations

Calculation	Description
General Calculations	
Peak (X,Y)R	Beam peak intensity position
Centroid (X,Y)R	Beam centroid position
Peak % Response	Peak intensity of beam as a % response of the camera
Total Relative Power/Energy	Total relative power or energy in beam
Effective Area	Effective area of the laser beam
Peak Power Density	Peak power/energy density of beam
Effective Diameter (%Int)	Effective beam diameter at selected intensity level
Aperture Diameter (%Power/Energy)	Beam diameter with selected % of total power/energy
d4 Sigma Widths	Beam widths based on second moments
d4 Sigma Diameter	Beam diameter based on second moment

Table 7-1. Summary of Calculations (Continued)

Calculation	Description
Divergence	Far field beam divergence at selected % of total power/energy
Knife Edge Widths	Beam widths based on moving knife edge (image profiles)
Slit Diameters	Beam diameters based on moving slit
Peak to Average	Peak-to-average intensity of beam
Ellipticity	Ellipticity of beam at selected intensity level
Major, Minor	Major and minor axes diameter of ellipse
Angle	Angular orientation of major ellipse axis
Circularity	Angular orientation of major ellipse axis
Gaussian Fit	Least squares Gaussian fit of cross-section beam profiles
Coefficient	Fit correlation (normalized residuals)
Centroid	Center location of Gaussian fit
Peak Intensity	Peak intensity of Gaussian fit
Diameter	Beam diameter of Gaussian fit
Roughness	Roughness of Gaussian fit
Aperture Uniformity	Statistical analysis of beam intensity uniformity within an aperture
Minimum, Mean, Maximum	Minimum, mean, maximum beam intensity within the aperture
Sigma, RMS	Sigma (standard deviation) and RMS
% Power/Energy in Aperture	% of total power/energy in selected aperture
Image Uniformity	Statistical calculations of the uniformity of the beam intensity on the captured beam image across the sensor's active area
Minimum, Mean, Maximum	The Uniformity calculates the minimum, mean (average), and maximum of the pixel intensities across the sensor's active area.
Flat Top Fit	
Beam Uniformity	Normalized RMS deviation of the power (energy) density.

Table 7-1. Summary of Calculations (Continued)

Calculation	Description
Plateau Uniformity	Ratio of the full width half maximum to the maximum of the histogram of pixel intensities for all pixels in the active region above the intensity threshold.
Flatness Factor	Ratio of the average power (energy) density to the maximum or peak power (energy) density.
Edge Steepness	Normalized difference between two Effective Irradiation areas with intensity levels above 10% and 90% of maximum intensity.
Effective Irradiation Area	Area of the beam which exceeds the user-defined threshold.
Effective Average Power (Energy) Density	Average power (energy) density of the portion of the beam exceeding the user-defined threshold.

7.1.1 Settings for Calculations

When users select Calculations, a dialog box is displayed for the selected calculation.

- The panel on the left shows which calculations are currently enabled (turned On) for beam analysis and display. These list a check mark to the left of the name of the calculation.

- The panel on the right side of the window changes to display a dialog box with settings and controls unique to the selected calculation.

The dialog box for each calculation includes the following common fields. Any additional fields unique to each calculation are displayed in the dialog boxes.

- **Check Box:** The check box enables or disables the selected calculation. If no x appears, the selection is not calculated nor displayed.

- **Format**: Indicates the format of the analysis result value to be displayed in the Results Area (total number of digits and number of significant digits). The (X,Y)R format means:
  - X is the X axis position relative to the coordinate origin.
  - Y is the Y axis position relative to the coordinate origin.
  - R is the direct radial distance from the (X,Y) coordinate to the coordinate origin.

- **Units:**
  - Indicates the units to be displayed with the analysis results in the Results Area.
  - If the box is disabled, the units for this calculation match the global Units selected from the Units command.

- **Pass/Fail Test Settings**: This function provides selection of parameters to be used to perform a Pass/Fail test on the analysis result to check whether it falls inside (Pass) or outside (Fail) of the settings range. The following functions are provided:
  - Perform Pass/Fail Checking: If x is selected, the Pass/Fail test is performed for every captured and analyzed beam image. If no x appears, no testing is performed.
  - Range: The minimum and maximum values for the test range.
  - Center: The X and Y axis position of the test range Center.
  - Maximum Radius from Center: The maximum radial distance range from the test Center.

- **Fault Actions**: This button provides access to the Fault Actions command to select actions to be taken if the results should fail the selected tests. Click the Fault Actions button at the bottom of the dialog box to display settings (see 'Fault Actions' (p. 135) for more information).

To turn calculations on or off within the BeamView.NET software, double-click anywhere in the calculations portion of the software screen to display a menu of available calculations. The list of available calculations depends on the type of application this system is being used for and the measurements that are wanted.

If the following symbol is displayed in the dialog box, then the calculation is compatible with the proposed International Standards Organization (ISO) standards for laser beam measurements:

Figure 7-1. ISO Symbol

7.1.2 Categories of Calculations

The categories of calculations commonly used in the BeamView.NET software include:

- General
- Ellipticity
- Gaussian Fit
- Aperture Uniformity
- Image Uniformity
- Flat Top

Each of these categories are more fully described in the sections that follow.

7.2 General Calculations

The following options with their units of measurement and associated dialog boxes are available under the General settings:

- Peak (X,Y)R [mm]
- Centroid (X,Y)R [mm]
- Peak % Resp. [%]
- Total Relative Energy [mJ]
- Effective Area [mm^2]
- Fluence [J/cm^2]
- Effective Diameter 86.5% [mm]
- Aperture Diameter 86.5% [mm]
- d4 Sigma Width [mm]
- d4 Sigma Diam. [mm]
- Divergence 86.5% [mrad]

- Knife Edge 84.0$% [mm]
- Slit Diameter 868.5% [mm]
- Peak to Average

7.2.1 General Calculations > Peak (X,Y)R

The beam peak intensity location is found by searching all the pixels in a sample for the maximum digital intensity level. The location of the pixel with maximum intensity is the peak location.

It is possible that more than one pixel is at the maximum intensity signal. In this case, the peak location is the peak intensity pixel which is found first. The search is conducted by scanning the image from left to right, top to bottom.

The Peak (X,Y)R calculation provides the position of the Peak intensity in the captured beam image as defined in the peak location algorithm.

The settings are defined in the following dialog box.

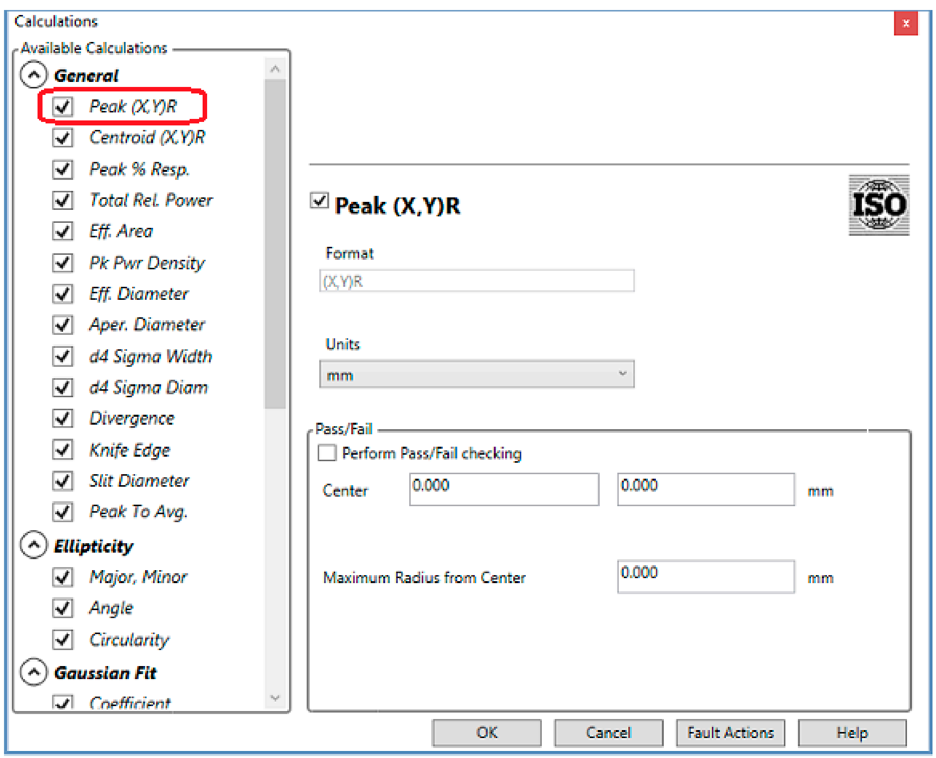

Figure 7-2. General Calculations > Peak (X,Y)R Settings

7.2.2 General Calculations > Centroid (X,Y)R

The Centroid calculation shows where the weighted center of the beam is located. This calculation corresponds with the center of the crosshairs in the main window. This Centroid measurement is typically tracked to determine if the beam is moving.

The Centroid (X,Y)R calculation provides the position of the Centroid intensity in the captured beam image, as defined in the Beam Centroid Location algorithm.

The location of the centroid of power or energy of a beam is determined by summing the intensities of all image pixels in both X and Y axes, and computing the "center of mass" of the power or energy. The pixel coordinates of this location define the beam centroid. The X and Y location of the centroid are computed using the following formula:

$$X = SUM[x * p(x,y)]/I$$

$$Y = SUM[y * p(x,y)]/I$$

where:

- $p(x,y)$ = intensity at location (x,y)
- I = total intensity
- SUM taken over total area.

Because the beam centroid involves summing over the entire sample area, a large area of pixels with a small amount of background illumination signal can have a larger effect on the centroid location than a small area of relatively bright pixels.

NOTICE

For this reason, it is important that steps be taken to reduce the background noise level. Use the Background Subtraction feature to ensure the most accurate calculation (see p. 74).

Click the checkbox in the left column for the calculation that is wanted to use to display settings in the following dialog box.

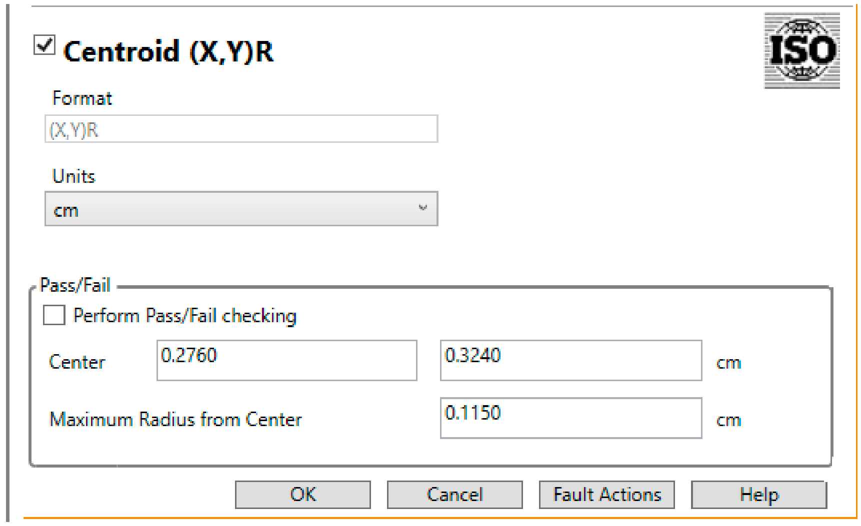

Figure 7-3. General Calculations > Centroid (X,Y)R Settings

7.2.3 General Calculations > Peak % Response

The Peak % Response calculation is one of the most important calculations to use when setting up BeamView.NET because it shows how close users are to saturating the camera.

- Basically, 100% is the saturation level of the camera and, at that level, it may be clipping part of the beam profile.

- Conversely, a response level set too low means that the full dynamic range of the camera is not being used.

A general recommendation is to try getting the Peak % Response setting in the 85% to 95% range. A setting above 95% risks saturating the camera and a setting below 85% may miss out on some of the dynamic range of the camera.

To reach the 85 to 95% range, adjust the attenuation in front of the camera by using something like a C-VARM. A C-VARM has some fine adjustments that allow users to tweak the attenuation until it falls within the appropriate range.

Using this Peak % Response calculation is a good way to track camera saturation. This is also a good way to help monitor if the beam is increasing or decreasing in intensity over time.

The Peak % Resp. calculation provides the beam peak intensity in terms of a percentage (%) of peak camera response, as defined in the Peak Camera Response algorithm.

Click the checkbox in the left column for the calculation needed to use to display settings in the following dialog box.

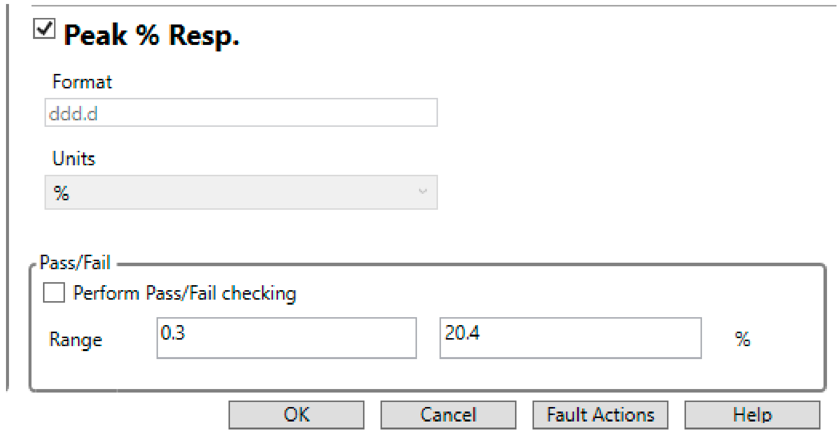

Figure 7-4. General Calculations > Peak % Response

7.2.4 General Calculations > Total Relative Energy

The Total Relative Power/Energy calculation provides the total integrated power or energy in the captured beam image, as defined in the Power and Energy algorithm.

- Total power is calculated for CW beams.
- Total energy is calculated for pulsed beams.

Before taking a measurement, the user should use the Calibrate Relative Power/Energy command; see 'Setup > Calibrate Power' (p. 63).

The Calibrate Relative Power/Energy command provides entry of a power/energy value as a "base" power/energy level. The power /energy calculation sets the total summed intensity of all pixels in the next sample captured to this value.

The method for calculating the Total Power (CW) or Total Energy (Pulsed) of the beam uses an intensity summation of all pixels in the captured image. The power or energy summation is calibrated by measuring the beam using an energy or power meter. The meter reading is then entered into the Relative Power/Energy command in the Set-Up menu.

After the externally-measured power or energy level is entered, the BeamView.NET software stores this value and the total summed intensity for that image. This information is then used as a reference for the power/energy measurement of all the subsequent samples.

Click the checkbox in the left column for the calculation needed to use to display settings in the following dialog box.

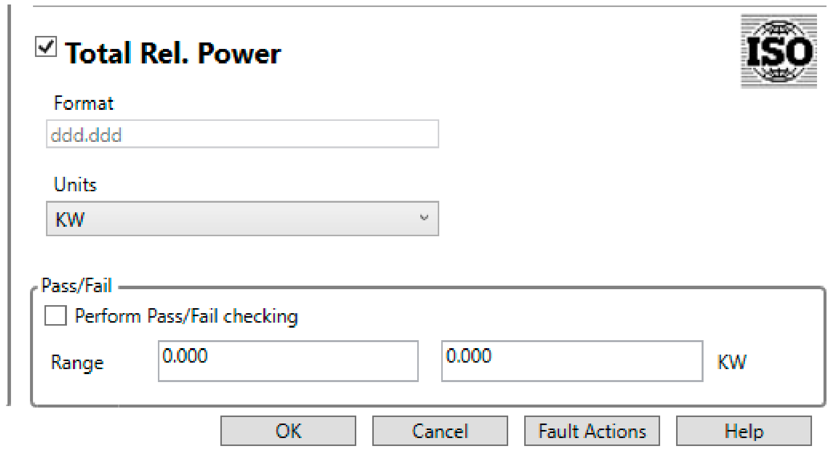

Figure 7-5. General Calculations > Total Relative Energy

7.2.5 General Calculations > Effective Area

The Eff. Area calculation provides the effective area of the captured beam, as defined in the Effective Area algorithm.

Click the checkbox in the left column for the calculation needed to use to display settings in the following dialog box.

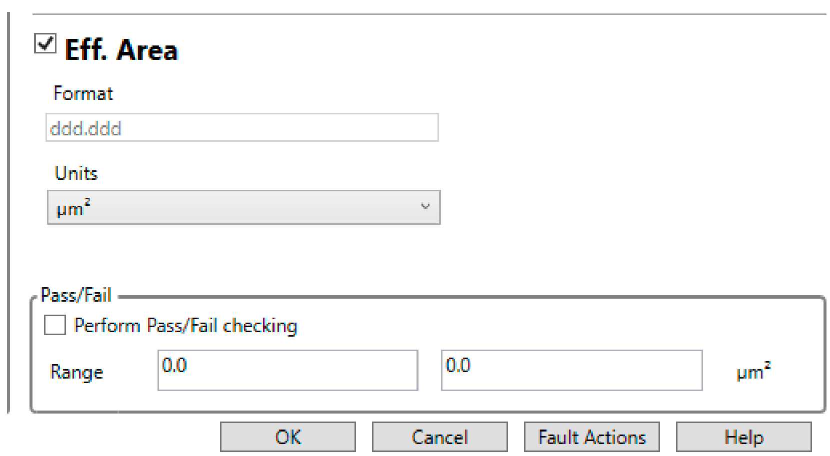

Figure 7-6. General Calculations > Effective Area

The Effective Area of a beam is calculated by dividing the total power or energy, as follows:

EffArea = TotalEnergy / PeakFluence

or

EffArea = TotalPower / PeakDensity

The Effective Area of a beam represents the area of an ideal flat top beam having the same peak intensity and total energy of the measured beam.

7.2.6 General Calculations > Peak Power Density

The Pk. Pwr Density calculation provides the peak power or energy density (Fluence) of the captured beam, as defined in the Peak Power/Energy Density algorithm.

The peak power or energy density (or peak fluence for pulsed laser applications) is the power density at the pixel with the greatest intensity in the beam image.

Click the checkbox in the left column for the calculation needed to use to display settings in the following dialog box:

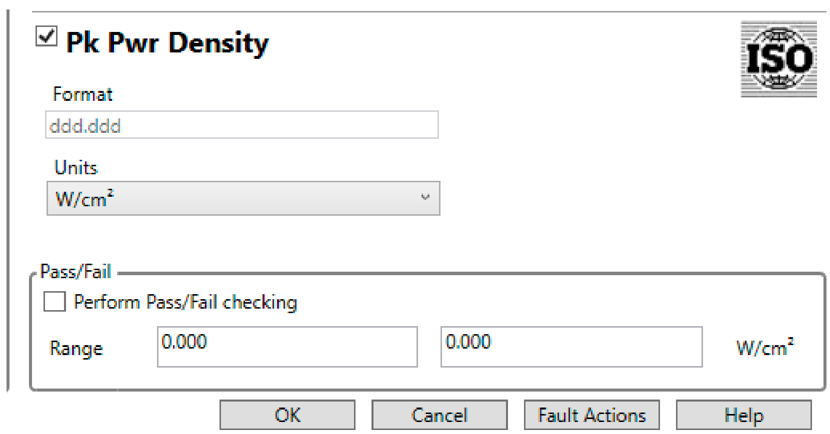

Figure 7-7. General Calculations > Fluence

The peak intensity of the captured beam image and the physical area of a single camera pixel are used to calculate the Peak Power/Energy Density (Fluence) at the beam peak intensity pixel location.

This measurement is calibrated with the Setup > Calibrate Relative Power/Energy command using a reading from an external energy or power meter; see 'Setup > Calibrate Power' (p. 63).

By summing the total digitized intensities over the beam image, the value of energy or power per pixel digital level can be determined. Multiplying this value by the peak pixel intensity yields the total energy or power on the peak pixel. Dividing by the area of the pixel (in cm2) yields the Peak Power Density or Peak Energy Density (Fluence).

7.2.7 General Calculations > Effective Diameter

The Eff. Diameter (%Int) calculation provides the effective beam diameter of the captured beam image, as defined in the Effective Beam Diameter algorithm.

Effective Beam Diameter calculates the diameter of a circle with an area equal to the area of all pixels with intensity above a (user-defined) percent of the measured beam peak intensity.

This intensity level is set in the Eff. Diameter calculation dialog box, and is given as a percentage of the beam peak. The actual level is considered as X% down from the peak response, where X is the user-defined level. For example, if 70% is selected, then the beam diameter is the result of all pixel intensities above 30% of the peak response (70% down from the peak). The effective beam diameter is calculated by the method shown as follows.

1. The intensity level from the user-defined percentage level is determined. For example, to determine the effective beam diameter at the 60% level of a beam that has a peak intensity of 800 (on a scale of 0 to 1023 (10 - bit)), the intensity level is calculated as follows:

    Intensity = Peak Intensity – (Peak Intensity * Percentage Level)

    In this example, this yields:

    Intensity = 800 – (800 * 60) = 320

2. The total area (Apixels) of all pixels that have an intensity greater than the defined level is calculated. This is done by counting the number of pixels with intensity of 320 or more (for this example) and multiplying by the area of a single pixel. The effective beam diameter (Deff) is calculated from this area using the formula for the area of a circle.

    Deff = SQRT(4*Apixels)/SQRT(pi)

The BeamView.NET software calculates the Effective Beam Diameter based on the area of the pixels with an intensity above the user-selected percentage of beam peak intensity. If there are pixels from beam wing structure or satellite images on the camera array with intensities above the selected intensity, they are added to the main beam area and yield a larger beam diameter than expected.

Click the checkbox in the left column for the calculation needed to use to display settings in the following dialog box:

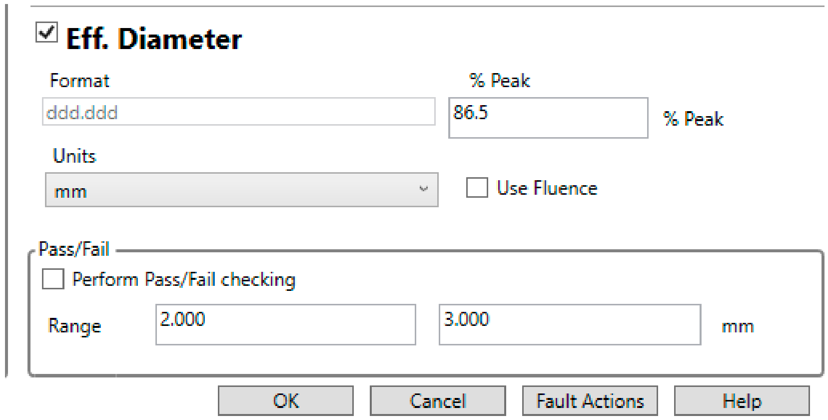

Figure 7-8. General Calculations > Effective Diameter

7.2.7.0.1 Calculation Settings

In addition to common fields, the following parameters define settings for the Effective Diameter calculation:

- **% Peak**: Provides selection of the user defined percentage (%) of Peak intensity level. All beam image pixels above this level will be included in the Beam Diameter calculation.

7.2.8 General Calculations > Aperture Diameter

The Aper. Diameter (%Power/Energy) calculation provides the diameter of the captured beam image containing a specified % of total power or energy.

This command calculates the diameter of a circular aperture that would enclose (encircle) a specified percentage of the total beam power/energy. This percent power/energy level is set in the Aper. Diameter (%Power/Energy) calculation dialog box.

As defined in the Aperture Diameter algorithm, the BeamView.NET software performs this calculation by summing the intensities of all pixels contained within a circular aperture of a certain diameter, centered at the beam centroid location.

The percentage of the total power/energy contained in that area is then calculated. If the resultant power or energy is not equal to the user-defined percentage of the total beam power or energy, the diameter of the artificial aperture is adjusted and the summation calculation is repeated.

This measurement is often called the "energy-in-the-bucket," "encircled energy," or "D86" diameter (if 86.5% of the total power/energy is specified).

NOTICE

It is important that steps be taken to reduce the background noise level. Use the Background Subtraction feature to make sure that the most accurate calculation (see p. 74) is used.

Click the checkbox in the left column for the calculation needed to use to display settings in the following dialog box:

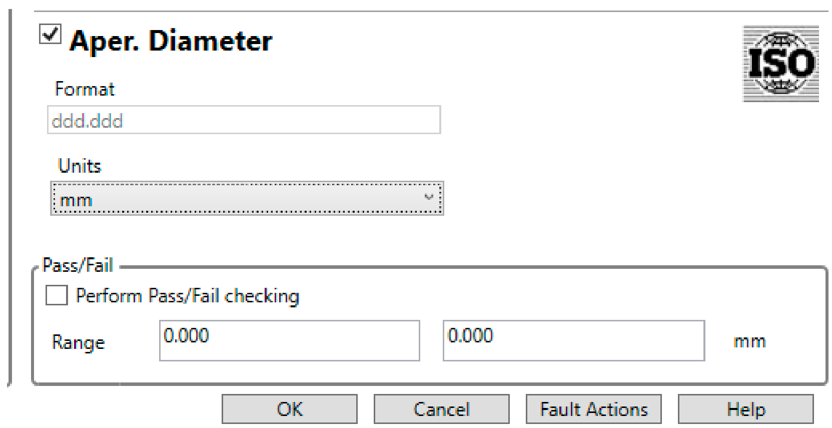

Figure 7-9. General Calculations > Aperture Diameter

In addition to common fields, the following parameters define settings for the Aperture Diameter calculation:

> **% Power/Energy:** Provides specification of the % of Total Power or Energy to be used in the Diameter calculation.

7.2.9 General Calculations > d4 Sigma Width

The d4 Sigma Width calculation provides the X and Y axes widths of the captured beam image, as defined in the d4 Sigma Width Measurement algorithm.

The d4 Sigma Widths are the widths in the X and Y axes, based on the second moments of the power (energy) distribution of the beam.

The widths are derived by summing the square of the distance from each point of the image to the centroid, multiplied by the intensity at that point. The entire summation is then divided by the total power (energy) of the beam, and the square root of that value is multiplied by 4.

$$d4\sigma\ x = 4 * SQRT(SUM\ [(x - xc)2 * p(x,y)] / I)$$

$$d4\sigma\ y = 4 * SQRT(SUM\ [(y - yc)2 * p(x,y)] / I)$$

where:

- xc and yc are the coordinates of the image centroid
- p(x,y) is the intensity at location (x,y)
- I is the total intensity of the image
- SUM is taken over the total image area

NOTICE

Because the d4 Sigma Width measurement uses the square of the distance from the centroid, background noise can have a significant impact on the calculation. Therefore, it is important to use the Background Subtraction feature with this measurement (see p. 74).

Click the checkbox in the left column for the calculation needed to use to display settings in the following dialog box:

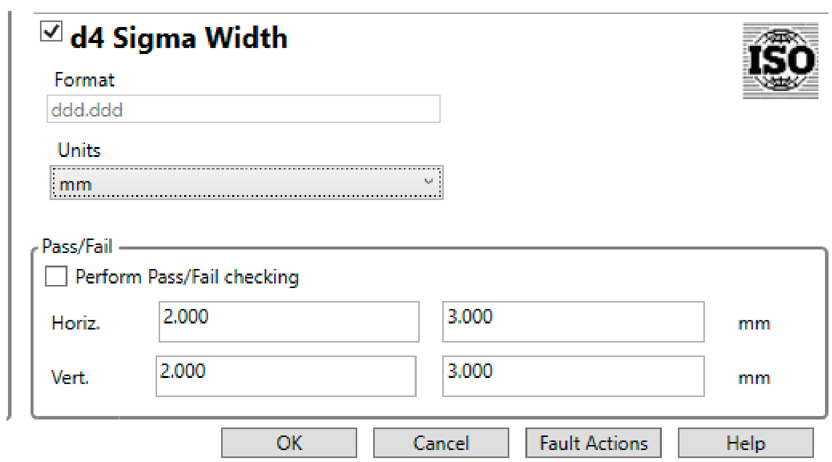

Figure 7-10. General Calculations > d4 Sigma Width

7.2.10 General Calculations > d4 Sigma Diameter

The d4 Sigma Diameter calculation provides the diameter of the captured beam image, as defined in the d4 Sigma Width algorithm. This calculates the beam diameter, based on the second moments of the power (energy) distribution of the beam.

The diameter is derived by summing the square of the distance from each point of the image to the centroid, multiplied by the intensity at that point. The entire summation is then divided by the total power (energy) of the beam, and the square root of that value is multiplied by 2 times sqrt(2).

$$d4\sigma = 2 * SQRT(2 * SUM\ [((x - xc)2 + (y - yc)2) * p(x,y)] / I)$$

where:

- xc and yc are the coordinates of the image centroid
- p(x,y) is the intensity at location (x,y)
- I is the total intensity of the image
- SUM is taken over the total image area

NOTICE

Because the d4 Sigma Diameter measurement uses the square of the distance from the centroid, background noise can have a significant impact on the calculation. Therefore, it is important to use the Background Subtraction feature with this measurement **(see p. 74).**

Click the checkbox in the left column for the calculation needed to use to display settings in the following dialog box:

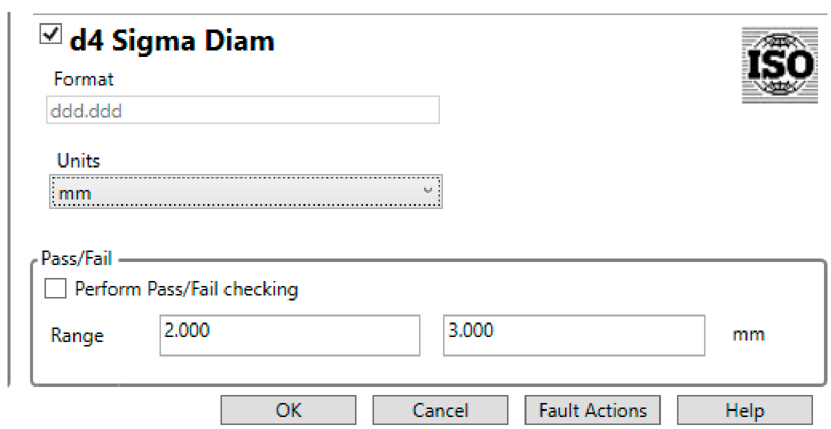

Figure 7-11. General Calculations > d4 Sigma Diameter

7.2.11 General Calculations > Divergence

The Divergence calculation provides the far field divergence of the captured beam image, as defined in the Divergence Measurement algorithm.

CAUTION!

Because the Divergence measurement depends on a percentage of power/energy passing through an aperture, it is extremely sensitive to background light on the camera. Therefore, it is important to use the Background Subtraction feature with this measurement (see p. 74).

The Far Field Beam Divergence is measured by determining the angular spot size of the beam in the far field of a focusing lens or mirror that contains the user-defined percent of total power/energy.

To measure divergence correctly with the BeamView.NET software, a lens or mirror with known focal length must be introduced into the laser path. The sensor plane of the camera is then placed at the focal length of the lens or mirror, as shown in Figure 7-12:

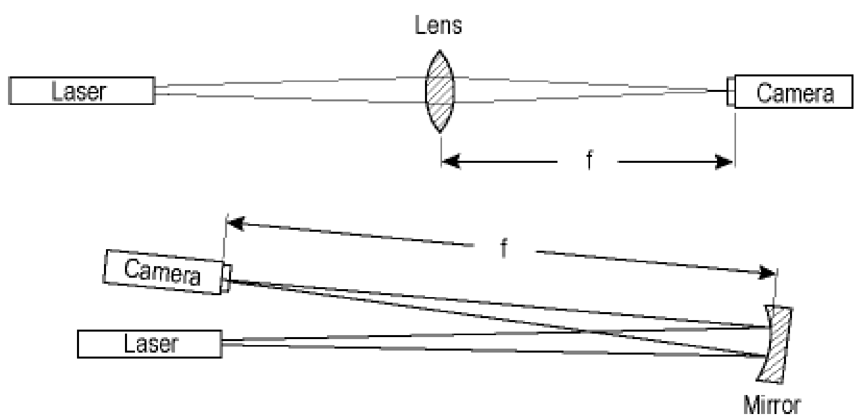

Figure 7-12. General Calculations > Divergence Measurement Optical Set-Up

The camera sensor must be placed at the focal length of the lens to produce a far field image for divergence measurement. Placing the camera sensor at any other location along the beam path (such as the minimum beam waist) does NOT produce the far field image and gives an incorrect divergence measurement.

Divergence measures the far field angular sub-tense of the user-defined percentage of the total power/energy in the image. With this method, the focal length of the lens and the percent of energy at which divergence is to be measured is entered by the user in the Focal length command and the Divergence calculation dialog box.

The BeamView.NET software then calculates the beam divergence and displays it in the Results Area. This method measures the percentage of power/energy passing through a circular aperture containing the specified percentage of energy or power. This is often called the “energy-in-the-bucket” method.

The BeamView.NET software performs this calculation by computing the full angular sub-tense (spot size in the far field) of the beam. This is done by summing the intensities of all pixels contained within a circular aperture of a certain diameter centered at the beam centroid location.

The percentage of the total power/energy contained in that area is then calculated. If the resultant power or energy is not equal to the user-defined percentage of the total beam power or energy, the diameter of the artificial aperture is adjusted and the summation calculation is repeated.

The diameter of the aperture is then divided by the focal length to yield the full angular sub-tense of the input radiation and, therefore, its divergence.

$$\Theta = d / f$$

Where:

- f = the focal length of lens or mirror
- d = the aperture diameter
- Θ = the full angle divergence in radians

A second method can be used to find the divergence manually. This method uses the overlaid Aperture function in the View area to determine the percent of energy in a user-specified aperture using the % Power/Energy in Aperture calculation. The user varies the size, type, and position of the software aperture manually in the Apertures command.

To calculate the percent energy or power within a specified aperture, the total intensity of all pixels contained within the aperture is summed. This value is then used to calculate the power or energy in the aperture as a percentage of the total beam power or energy.

This percent of energy, or power, is displayed in the Results Area. The set aperture diameter divided by the focal length of the lens yields the divergence of the beam for the percentage of energy/power in the aperture.

Click the checkbox in the left column for the calculation needed to use to display settings in the following dialog box:

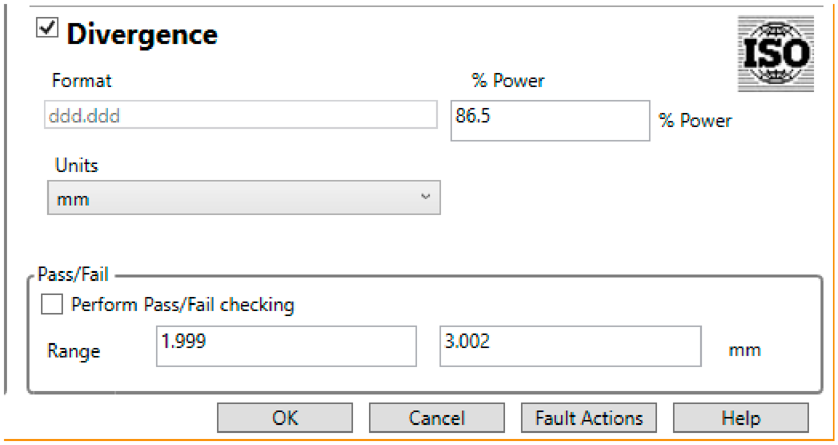

Figure 7-13. General Calculations > Divergence

7.2.12 General Calculations > Knife Edge

The Knife Edge calculation provides the X and Y widths of the captured beam image, as defined in the Knife Edge Measurement algorithm. The Knife Edge widths are calculated by summing profiles, from left to right, and top to bottom, until the profile sums contain specified percentages of the total image energy. The locations at which the energy percentages are reached are used to define the widths.

The Knife Edge Widths are widths in the X and Y axes that are derived by summing profiles across the image until the energy in the summed profiles equals some percentage of the total energy of the image. For example, to determine the knife edge width in the X axis, vertical profiles would be summed, starting from the left edge, and moving right, until the profile sums contain 16% of the total image energy.

When 16% is reached, that location is marked as x1. Then continue summing profiles, moving to the right, until the profile sums contain 84% of the total image energy. That location is marked as x2. 16% and 84% are the levels specified in the ISO standard, however, the BeamView.NET software does allow selection of any percentage level. Once the x1 and x2 locations are determined, the width is twice the difference of the two points.

$$d\,x = 2 * (x2 - x1)$$

The profile in the figure below represents the energy contained in each pixel column of the image, shown here:

The Y axis width is then determined in a similar manner, summing horizontal profiles from the top of the image to the bottom, and determining locations y1 and y2. The width is twice the difference of the two Y locations.

$$d\,y = 2 * (y2 - y1)$$

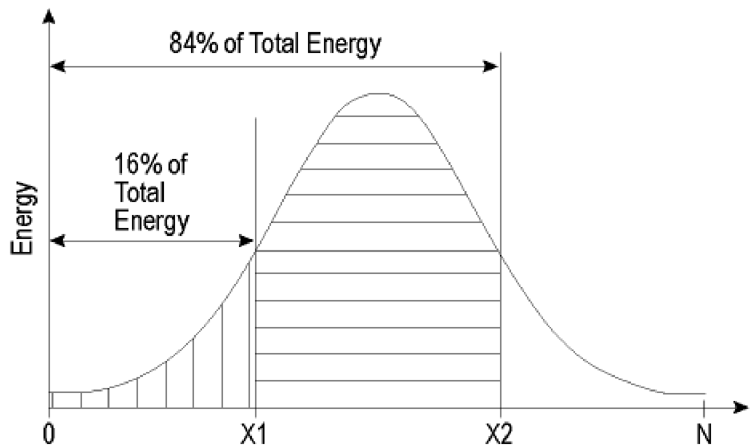

Figure 7-14. General Calculations > Knife Edge Profile

If the crosshair is rotated to a fixed position, or if it is tracking the ellipticity angle, the profiles used to determine the widths will be parallel to the rotated axes, so the widths will also be parallel to the rotated axes.

NOTICE

The Knife Edge measurement is sensitive to background noise. Therefore, it is important to use the Background Subtraction feature with this measurement (see p. 74).

Click the checkbox in the left column for the calculation needed to use to display settings in the following dialog box:

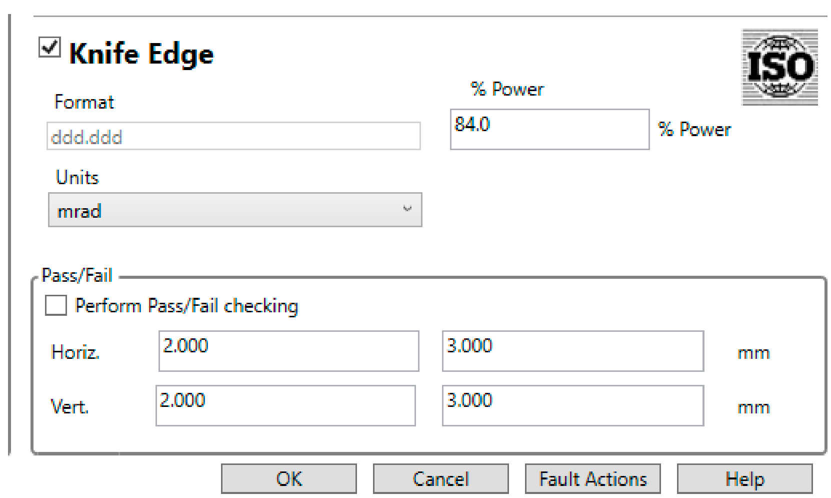

Figure 7-15. General Calculations > Knife Edge Dialog Box

7.2.12.0.1 Calculation Settings

In addition to common fields, the following parameters define settings for the Knife Edge calculation:

% Power/Energy: Provides specification of the % of Total Power or Energy to be used in the Knife Edge calculation. There are two percentage values used by the calculation:

- One is the value entered in this box.
- The other is 100% minus the value in this box.

Therefore, if 16% is entered, then 16% and 84% will be used. If 86.5% is entered, then 13.5% and 86.5% will be used.

7.2.13 General Calculations > Slit Diameter

The Slit Diameter calculation provides the X and Y diameters of the captured beam image, as defined in the Slit Diameter Measurement algorithm.

The Slit Diameters are calculated by scanning a 1-pixel wide slit across the image, and identifying the two outermost positions at which the slit contains the specified percent of Peak power or energy (86.5% by default). The diameter is then the distance between the two positions.

A Slit Diameter is determined by the distance between the two slit positions that define some percent of the peak energy of the beam. By default, the Slit Diameter includes 86.5% of the energy of the beam.

For example, to determine the Horizontal Slit diameter:

1. Define a 1-pixel wide slit.
2. Scan across the image from left to right and find the peak energy through that slit.
3. Starting at the left edge of the image, again with a 1-pixel wide slit, scan across the beam until the slit contains 13.5% of the peak energy, and mark that position as X1.
4. Starting from the right side of the image, scan back across the image until our slit contains 13.5% of the peak energy, and mark that position as X2. The diameter is then the difference between X1 and X2.

   d x = X2 – X1

The profile in the drawing below represents the energy contained in each pixel column of the image, shown here:

To determine the Vertical Slit diameter, perform the same process with a slit that scans from the top of the image to the bottom, marking the points Y1 and Y2.

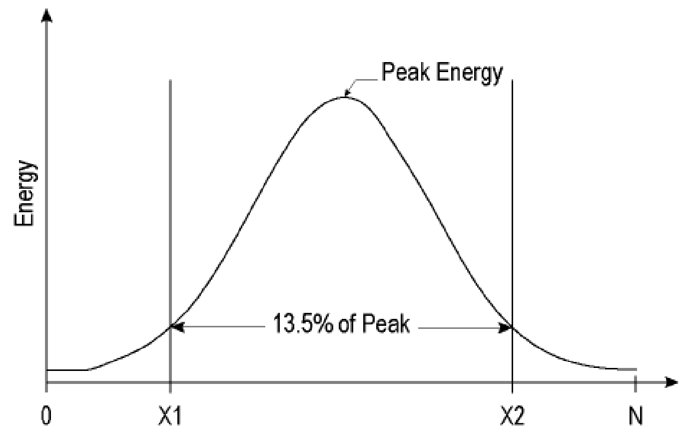

Figure 7-16. General Calculations > Slit Diameter Profile

dy = Y2 - Y1

The Slit Diameter is always calculated ON-AXIS; that is, rotating the crosshair does not cause the Slit Diameter to be performed along the new axes defined by the crosshair.

NOTICE

The Slit Diameter measurement is sensitive to background noise. Therefore, it is important to use the Background Subtraction feature with this measurement (see p. 74).

Click the checkbox in the left column for the calculation needed to use to display settings in the following dialog box:

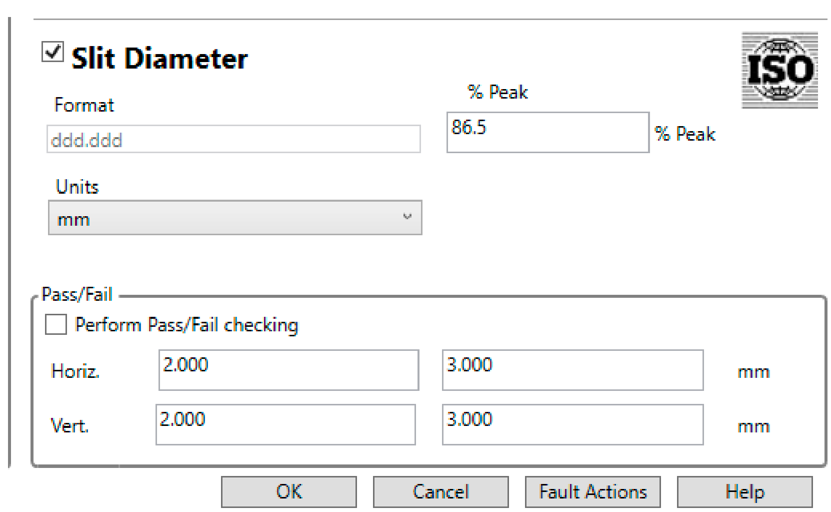

Figure 7-17. General Calculations > Slit Diameter

7.2.13.1 Calculation Settings

In addition to common fields, the following parameters define settings for the Slit Diameter calculation:

> **% Peak:** Provides specification of the % of Peak Power or Energy to be used in the Slit Diameter calculation. The percentage value indicates the amount of energy to include in the diameter (86.5% by default).

7.2.14 General Calculations > Peak to Average

The Peak To Avg. calculation provides analysis of the Peak to Average intensity ratio of the captured beam image, as defined in the Peak-to-Average Ratio algorithm.

The Peak-to- Average Ratio is the ratio of the measured beam peak intensity to the intensity of a flat-top beam containing the same total power or energy within the calculated $1/e^2$ diameter of the actual beam. This gives a measure of the beam flatness. A beam with a peak-to-average ratio of 1 would be a perfect “flat top” beam. An example profile is shown here:

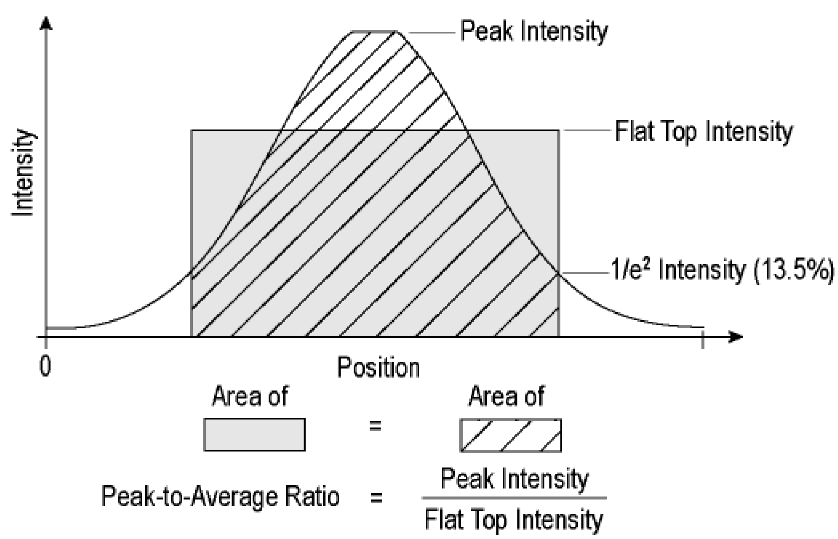

Figure 7-18. General Calculations > Peak to Average Profile

Click the checkbox in the left column for the calculation needed to use to display settings in the following dialog box:

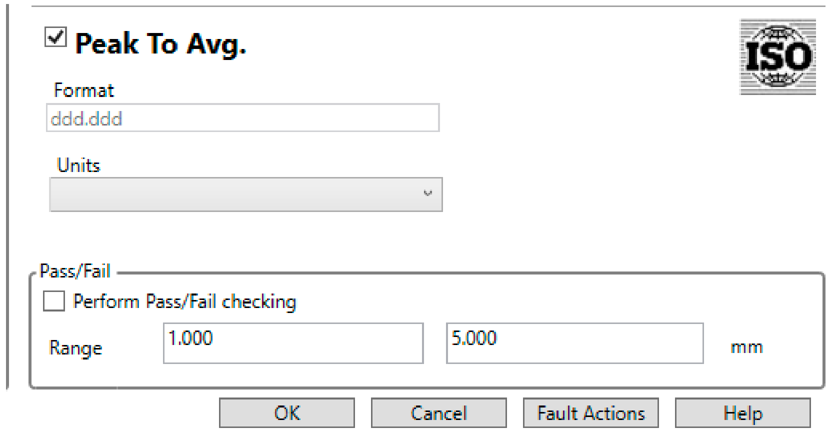

Figure 7-19. General Calculations > Peak to Average

7.3 Ellipticity Calculations

The following options with their units of measurement and associated dialog boxes are available under the Ellipticity calculation:

- **Major, Minor**: Major and minor axes diameter of ellipse
- **Angle:** Angular orientation (degrees) of ellipse axes
- **Circularity:** Circular symmetry of ellipse (ratio of major to minor axes)

Each selection contains a separate dialog box for setting control and analysis parameters.

The Ellipticity group of calculations perform a fitted Ellipticity Measurement to the captured beam image at a specified intensity level to derive the major and minor axis size, the circularity, and angular orientation of the fitted ellipse axes, as defined in the Ellipticity Measurement algorithm.

The Ellipticity measurement fits an ellipse to the beam image data, as follows:

1. The BeamView.NET software first finds the set of intensity points which correspond to the user-defined intensity level (given as a percentage of beam peak). The user-entered percentage level appears in the Ellipticity—Major, Minor calculation dialog box. This intensity level is determined as follows:

   Intensity = PeakIntensity – (PeakIntensity * PercentageLevel)

2. A least-squares fit is used to fit an ellipse to the intensity contour. This fit is done with the centroid of the beam image as the center of the ellipse.

3. The major and minor axes of the fit ellipse are calculated by determining the distance from the centroid to the ellipse.
4. Circularity is the normalized ratio of the minor to the major axis. A circularity of “1” corresponds to a perfectly circular or round beam.
5. Theta (Θ) is a measure of the orientation of the major axes of the fit. Theta is measured from the positive X-axis and varies between +90 and -90.

The dialog box for settings is shown here:

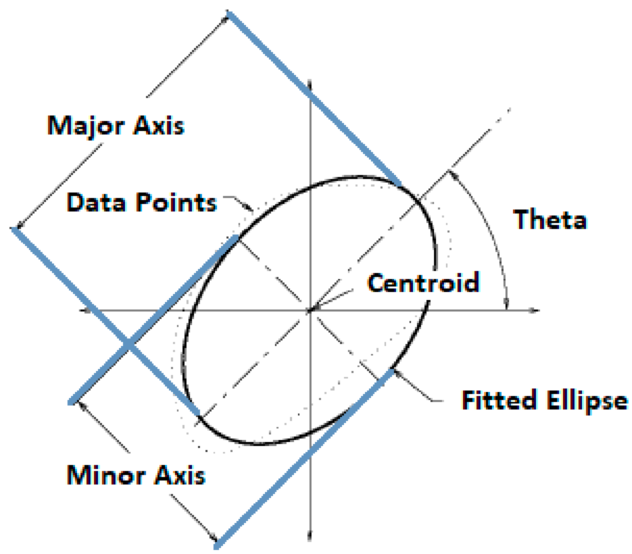

Figure 7-20. Ellipticity Calculations > Elliptical Fit

7.3.1 Ellipticity > Angle

The Ellipticity > Angle calculation provides analysis and display of the Angular Orientation of the major and minor axes of the fitted ellipse at the specified intensity level, as defined in the Ellipticity Measurement algorithm.

Click the checkbox in the left column for the calculation needed to use to display settings in the following dialog box:

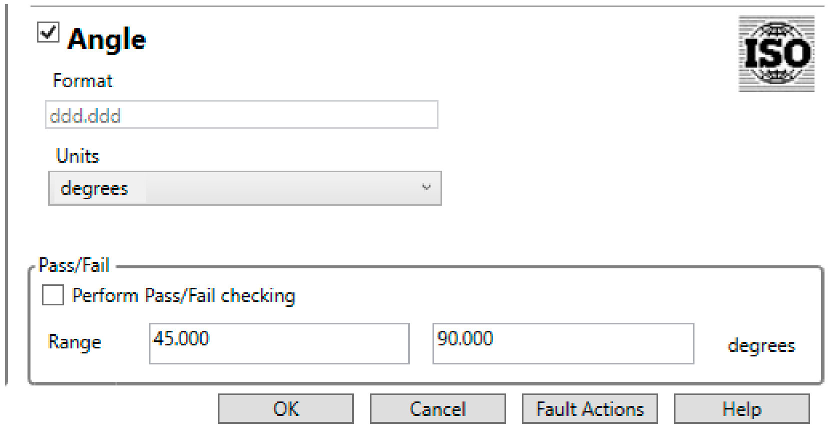

Figure 7-21. Ellipticity Calculations > Angle

7.3.2 Ellipticity > Circularity

The Ellipticity > Circularity calculation can be used to monitor how elliptical a beam is.

- A number near 1.0 is very circular.
- Values dropping from 1.0 becomes more elliptical.

This is a useful calculation when checking the ellipticity of a diode laser or other similar beams.

Click the checkbox in the left column for the calculation needed to use to display settings in the following dialog box:

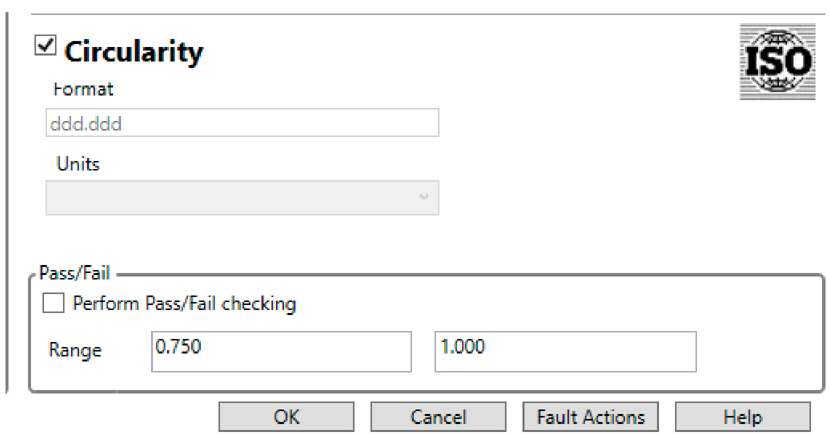

Figure 7-22. Ellipticity Calculations > Circularity

7.3.3 Ellipticity > Major, Minor

The Ellipticity > Major, Minor calculation provides analysis and display of the major and minor axes diameter of the fitted ellipse at the specified intensity level, as defined in the Ellipticity Measurement algorithm.

Click the checkbox in the left column for the calculation needed to use to display settings in the following dialog box:

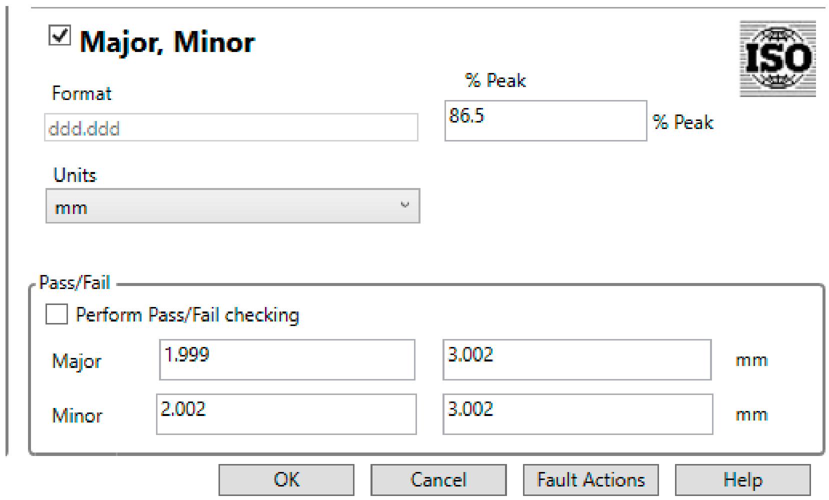

Figure 7-23. Ellipticity Calculations > Major, Minor

7.3.3.1 Calculation Settings

In addition to common fields, the following parameters define settings for this calculation:

> **% Peak:** Provides selection of the user defined % of Peak intensity level. All beam image pixels at this level are included in the Ellipticity calculation.

7.4 Gaussian Fit

The following options are available under the Gaussian Fit settings:

- Coefficient — Fit correlation coefficient (normalized residuals
- Centroid [mm] — Center location (centroid) of Gaussian Fit.
- Peak Intensity [digital] — Peak intensity of Gaussian Fit.

- Diameter [mm] — Beam diameter of Gaussian Fit.
- Roughness of Fit [%] — Roughness of Gaussian Fit (difference between actual profile and fitted curve).

Each selection contains a separate dialog box for setting control and analysis parameters.

A group setting of % Peak provides selection of the user-defined % of Peak intensity level. All pixels above this level in the cross-section profile are used for all Gaussian Fit calculations. The default setting of 86.5 includes all pixels above the 1/e2 intensity level.

The Gaussian Fit is a least-squares fit of a Gaussian equation to the cross-section beam profiles. The correlation coefficient is the normalized sum of the residuals of the fit.

The following equation is used to do the Gaussian Fit:

$I = Ve-2[(x-c)/\sigma]2$

where I = the intensity of a pixel at location x.

In performing a least-squares fit to this equation, the following terms are derived:

V = the maximum intensity of the fitted Gaussian curve (Peak Intensity).

C = the center of the Gaussian fit peak (Centroid).

σ = the radius of the Gaussian fit curve at the 1/e2 intensity level (Diameter).

7.4.1 Gaussian Fit > Coefficient

The Gaussian Fit > Coefficient calculation shows how closely the beam fits a Gaussian profile.

- Numbers near 1.0 are very Gaussian.
- Numbers dropping from 1.0 are further from being Gaussian.

This coefficient is useful to track the quality of the beam profile and how close to Gaussian it is.

Click the checkbox in the left column for the calculation needed to use to display settings in the following dialog box:

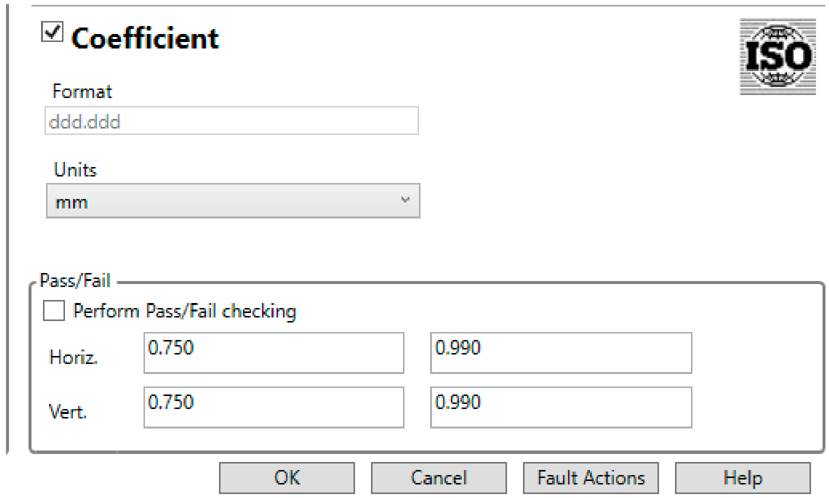

Figure 7-24. Gaussian Fit Calculations > Coefficient

7.4.2 Gaussian Fit > Centroid

The Gaussian Fit > Centroid calculation provides the center location (centroid) of the least squares Gaussian fit of the cross-section profiles.

Click the checkbox in the left column for the calculation needed to use to display settings in the following dialog box:

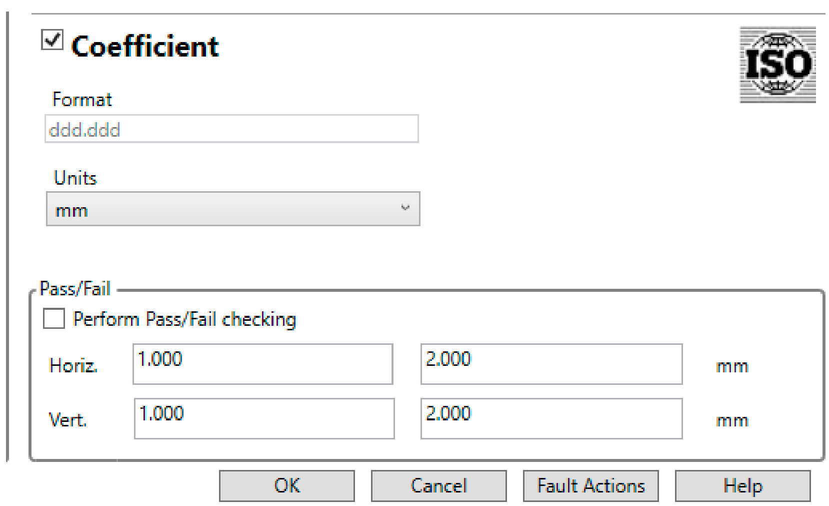

Figure 7-25. Gaussian Fit Calculations > Centroid

7.4.3 Gaussian Fit > Peak Intensity

The Gaussian Fit > Peak Intensity calculation provides the peak intensity of the least squares Gaussian fit of the cross-section profiles.

Click the checkbox in the left column for the calculation needed to use to display settings in the following dialog box:

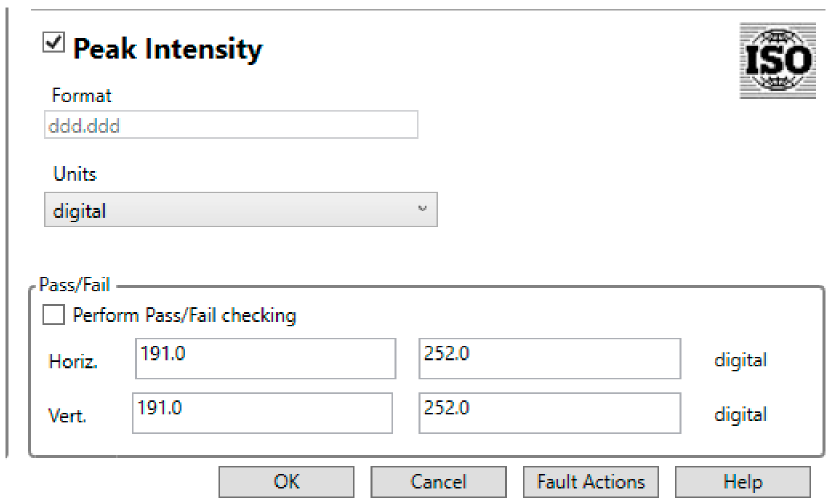

Figure 7-26. Gaussian Fit Calculations > Peak Intensity

7.4.4 Gaussian Fit > Diameter

The Gaussian Fit > Diameter calculation provides the profile diameter of the least squares Gaussian fit of the cross-section profiles at the $1/e^2$ intensity level.

Click the checkbox in the left column for the calculation needed to use to display settings in the following dialog box:

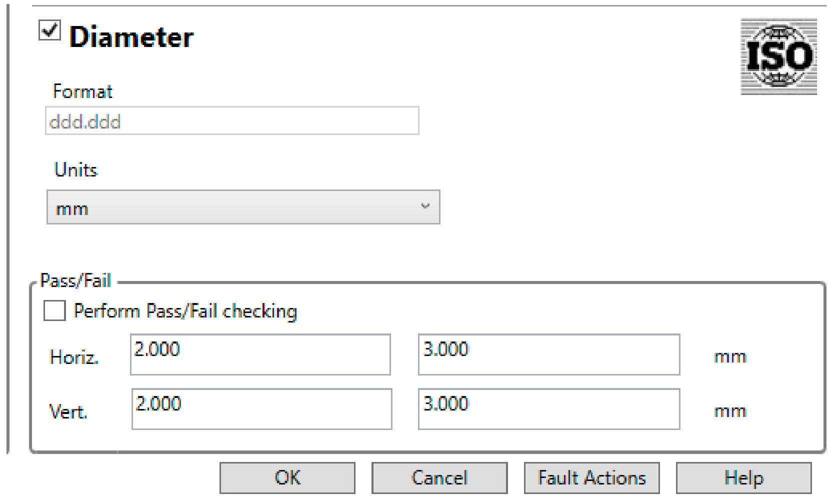

Figure 7-27. Gaussian Fit Calculations > Diameter

7.4.5 Gaussian Fit > Roughness of Fit

The Gaussian Fit > Roughness calculation is a percentage (0 to 100) indicating the difference between the actual profile and the fitted Gaussian curve. The smaller the roughness value, the smaller the difference between the two curves, consequently the more Gaussian the profile.

Click the checkbox in the left column for the calculation needed to use to display settings in the following dialog box:

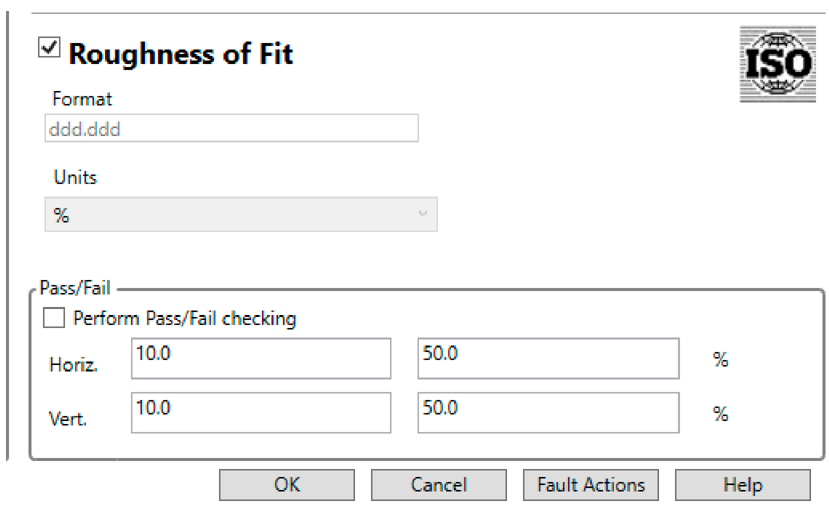

Figure 7-28. Gaussian Fit Calculations > Roughness of Fit

7.5 Aperture Uniformity

The Aperture Uniformity calculation group provides a statistical analysis of pixel intensities within the specified aperture area overlaying the captured beam image, as defined in the Uniformity Measurements algorithm. The Aperture Uniformity calculates the minimum, mean (average), maximum, RMS (root mean square) and Sigma (standard deviation) of the pixel intensities within the defined aperture area.

The following options are available under the Aperture Uniformity settings:

- Min, Mean, Max [digital] — Minimum, mean, and maximum beam intensity within the aperture
- Sigma, RMS [digital] — Sigma (Standard Deviation) and RMS
- % Power/Energy in Aper. {%]

Each of these are described in the sections that follow.

7.5.1 Aperture Uniformity > Min, Mean, Max

The Aperture Uniformity > Min, Mean, Max calculation provides the minimum, mean (average) and maximum of the pixel intensities within the specified overlaid aperture.

Click the checkbox in the left column for the calculation needed to use to display settings in the following dialog box:

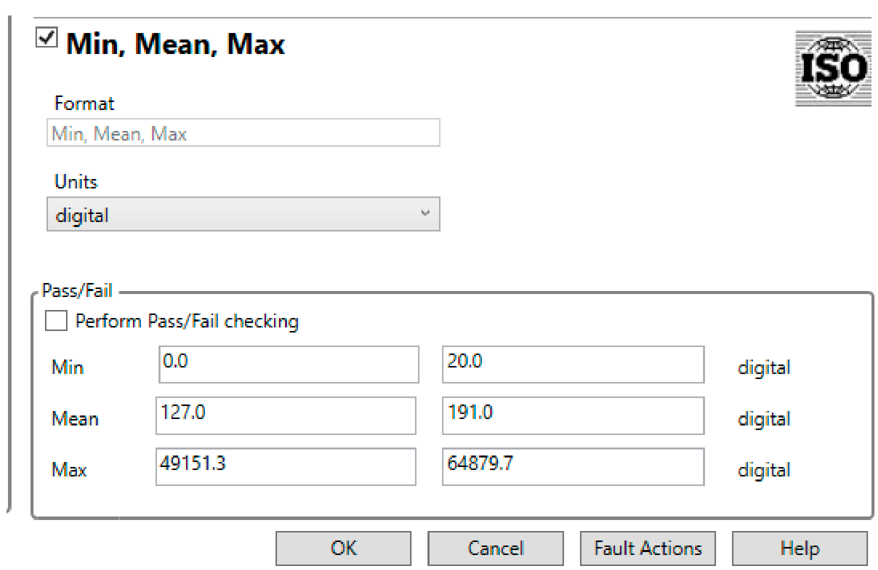

Figure 7-29. Aperture Uniformity Calculations > Min, Mean, Max

7.5.2 Aperture Uniformity > Sigma, RMS

The Aperture Uniformity - Sigma, RMS calculation provides the Sigma (standard deviation) and RMS (root mean square) of the pixel intensities within the specified overlaid aperture.

Click the checkbox in the left column for the calculation needed to use to display settings in the following dialog box:

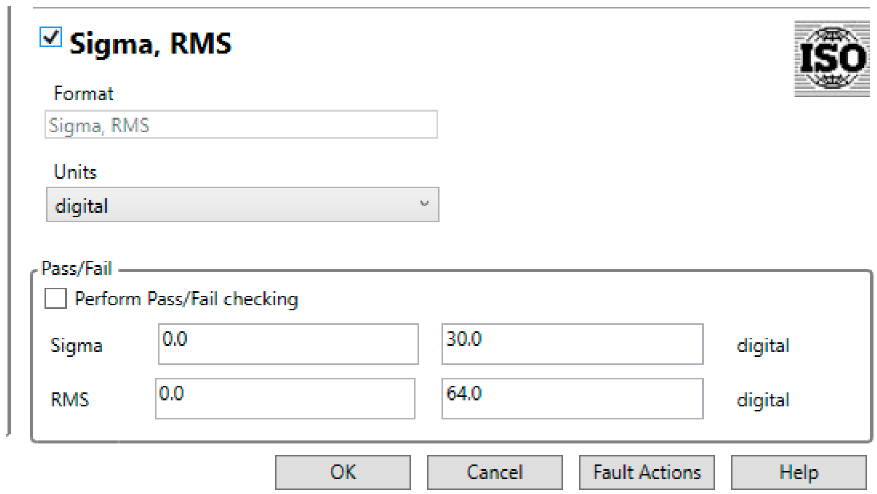

Figure 7-30. Aperture Uniformity Calculations > Sigma, RMS

7.5.3 Aperture Uniformity > % Power/Energy in Aper.

The Aperture Uniformity > % Power/Energy in Aperture calculation provides the percent of total integrated power or energy in a specified aperture area overlaid on the captured beam image in the View area.

Click the checkbox in the left column for the calculation needed to use to display settings in the following dialog box:

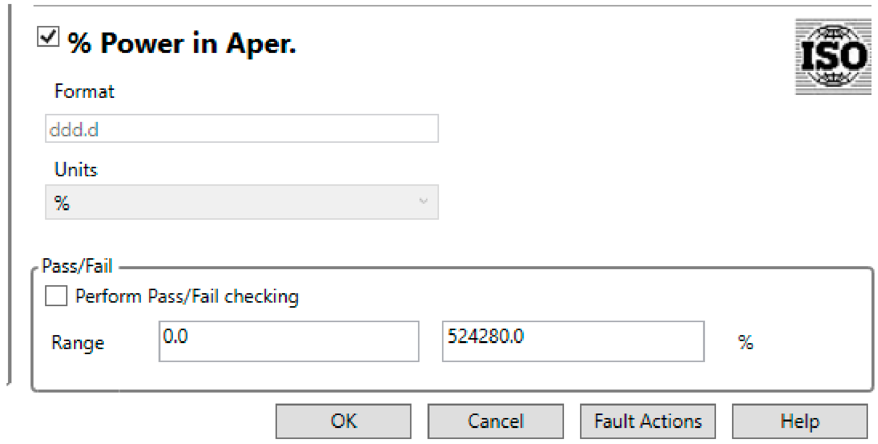

Figure 7-31. Aperture Uniformity Calculations > % Power/Energy in Aper.

7.6 Image Uniformity

The Aperture Uniformity > % Power/Energy in Aperture calculation provides the percent of total integrated power or energy in a specified aperture area overlaid on the captured beam image in the View area, as defined in the Percent Power/Energy in Aperture algorithm.

The following option is available under the Image Uniformity settings:

- Min, Mean, Max [digital]

Click the checkbox in the left column for the calculation needed to use to display settings in the following dialog box:

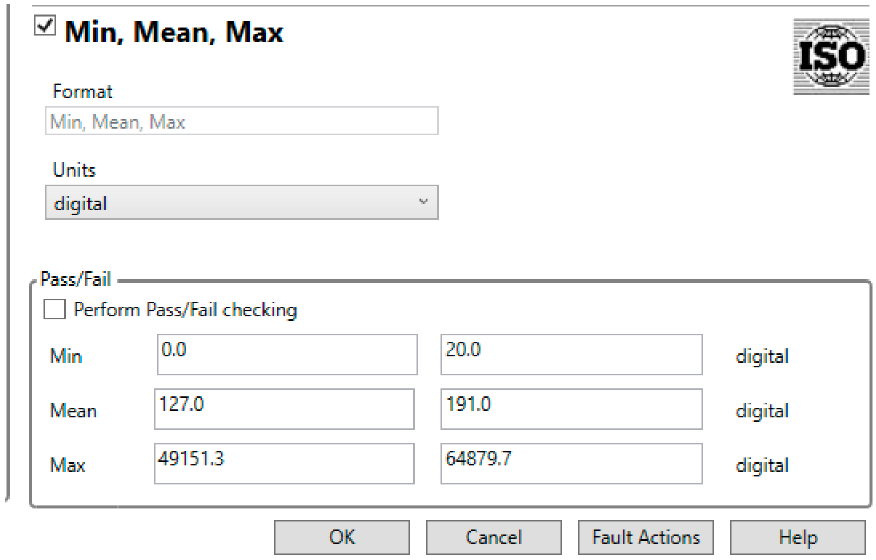

Figure 7-32. Image Uniformity Calculations > Min, Mean, Max

7.7 Flat Top

Flat top calculations are based upon the ISO 13694:2000(E) Standard, although this specific implementation relies upon numerical approximations over a fixed inclusion region.

This inclusion region can be set using the Inclusion Area command on the Analysis menu. This area should be made as large as possible, up to the limit of capture resolution: 1279 x 1023. All calculations are based upon the Inclusion Area—a rectangular region with upper left corner (xm,ym) and lower right corner (xM,yM).

Because these calculations have a chain of dependence, start with the most basic idea: a Threshold Fraction ŋ. This is a ratio of “floor” Power (Pth) to Peak Power (Pm). Note that an equivalent definition is made for pulsed beams, where Uth and Um are threshold and maximum energy, respectively.

Typically this ratio is set based upon the “floor” being close to the observed noise level of the camera. This roughly corresponds to the bias level when taking a Background Map.

For all Flat Top settings, Threshold selects the user-defined % of Peak intensity level. All pixels above this level in the cross-section profile are used for all Flat Top calculations. The default setting is 14.0%.

The following options with their units of measurement and associated dialog boxes are available under the Flat Top settings:

- Beam Uniformity

- Plateau Uniformity
- Flatness Factor
- Edge Steepness
- Eff. Irradiation Area [cm^2]
- Eff. Avg. Energy Density [J/m2]

Each of these are described in the sections that follow.

7.7.1 Flat Top > Beam Uniformity

The Flat Top > Beam Uniformity command is the normalized RMS deviation of the power (energy) density. The Beam Uniformity range is zero to one, with a perfect flat top beam having a value of zero. To calculate this value:

1. Calculate the average power (energy) density of the portion of the beam exceeding the user defined Threshold.
2. Calculate the RMS deviation of the power (energy) density of the portion of the beam exceeding the user defined Threshold.
3. Calculate the ratio:

$$\frac{\text{RMS}\ \text{Power (Energy) Density}}{\text{Avg.}\ \text{Power (Energy) Density}}$$

Figure 7-33. Flat Top Calculations > Beam Uniformity Ratio

4. Enter the value in the dialog box:

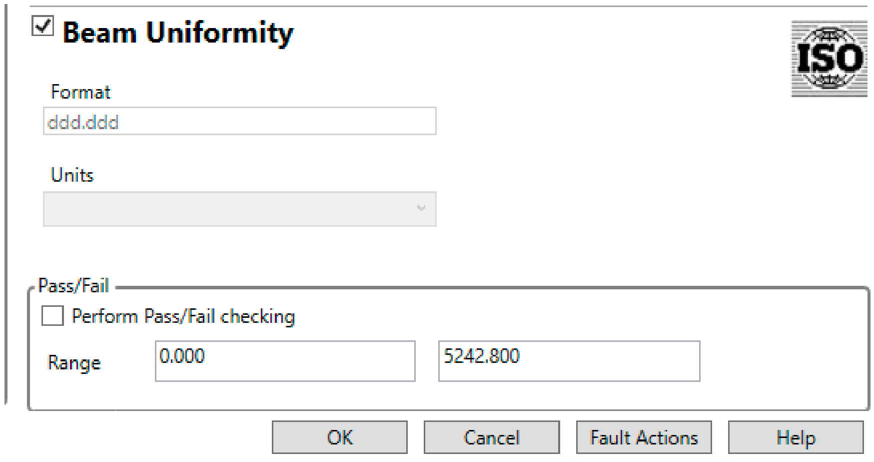

Figure 7-34. Flat Top Calculations > Beam Uniformity

7.7.2 Flat Top > Plateau Uniformity

The Flat Top > Plateau Uniformity is the ratio of the full width half maximum to the maximum of the histogram of pixel intensities for all pixels in the active region above the intensity threshold. The Plateau Uniformity range is zero to one, with a perfect flat top beam having a value of zero.

To calculate Plateau Uniformity:

1. Construct a histogram of pixel intensities for all pixels above the user-defined threshold.
2. Find the peak in the histogram—that is, the pixel intensity value which has the largest number of pixels at that intensity.
3. Measure the full width half maximum (FWHM) of the peak in the histogram.
4. Find the highest pixel intensity (Max).
5. Calculate the ratio:

$$\frac{\text{FWHM}}{\text{Max}}$$

Figure 7-35. Flat Top Calculations > Plateau Uniformity Ratio

The plot in Figure 7-36 illustrates the histogram of pixel intensities with the peak in the histogram, the highest pixel intensity, the full width half max, and the user-defined threshold individually labeled.

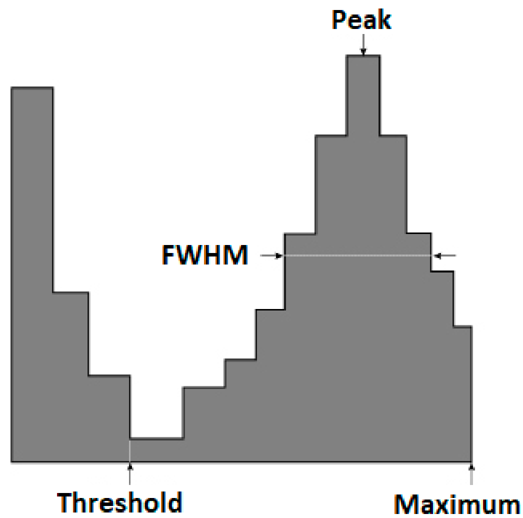

Figure 7-36. Flat Top Calculations > Plateau Uniformity Histogram

Note that there are two peaks in the histogram, one corresponding to the illuminated area of the beam, which is used for the Plateau Uniformity calculation, and one near zero pixel intensity, below the user-defined threshold, which represents the dark region of the camera not illuminated by the laser beam.

Click the checkbox in the left column for the calculation needed to use to display settings in the following dialog box:

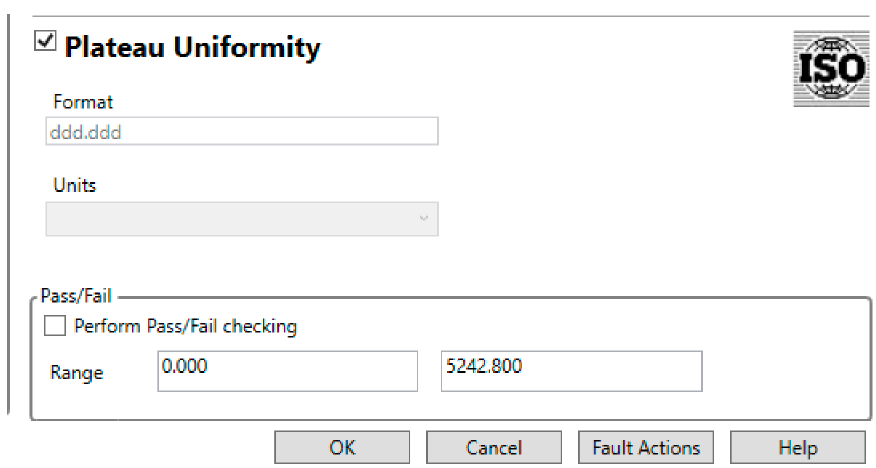

Figure 7-37. Flat Top Calculations > Plateau Uniformity

7.7.3 Flat Top > Flatness Factor

Flat Top - Flatness Factor: The ratio of the average power (energy) density to the maximum or peak power (energy) density. The Flatness Factor range is zero to one, with a perfect flat top beam having a value of one.

Flat Top - Flatness Factor: The ratio of the average power (energy) density to the maximum or peak power (energy) density. The Flatness Factor range is zero to one, with a perfect flat top beam having a value of one.

To calculate Flatness Factor:

1. Calculate the average intensity of all pixels with intensities above the user-defined threshold.
2. Find the peak pixel intensity.
3. Calculate the ratio:

$$\frac{\textbf{Average}}{\textbf{Peak}}$$

Figure 7-38. Flat Top Calculations > Flatness Factor Ratio

4. Enter the value.

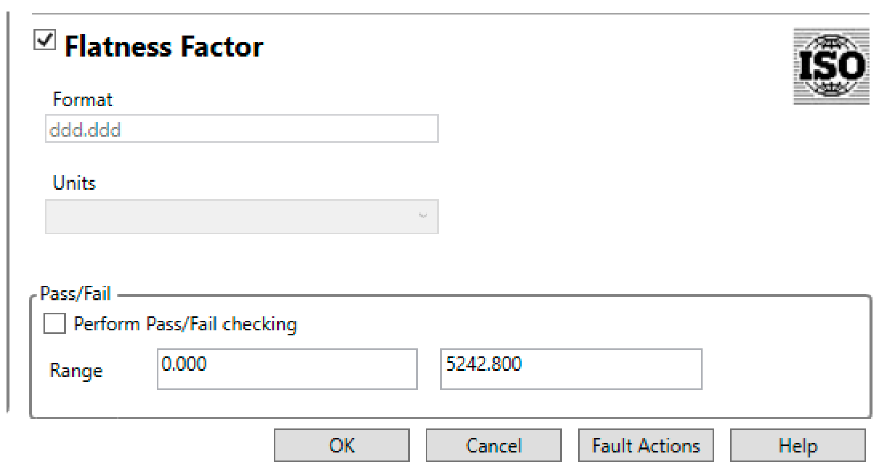

Figure 7-39. Flat Top Calculations > Flatness Factor

7.7.4 Flat Top > Edge Steepness

The Flat Top > Edge Steepness calculation is the normalized difference between two Effective Irradiation areas with intensity levels above 10% and 90% of maximum intensity.

Click the checkbox in the left column for the calculation needed to use to display settings in the following dialog box:

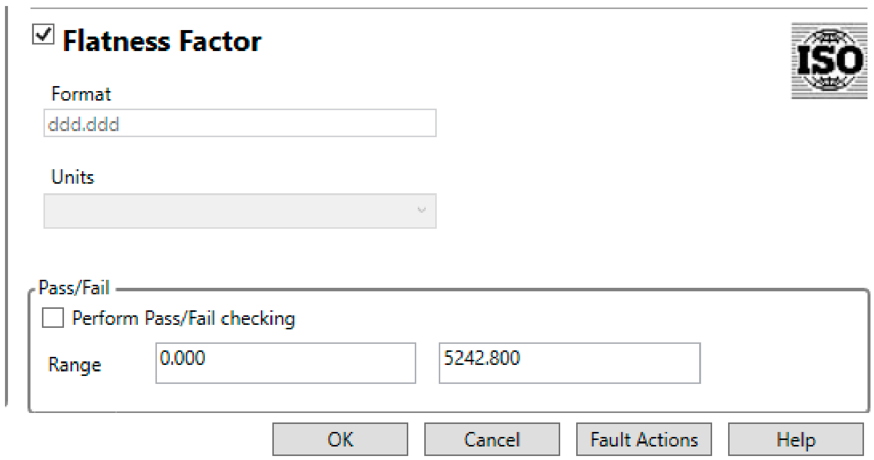

Figure 7-40. Flat Top Calculations > Edge Steepness

The range is zero to one, with a Flat-Top beam with vertical edges having a value of zero.

NOTICE
The Edge Steepness calculation does not use the threshold value per ISO 13694:2000 Standard for laser beam measurement.

To find this value:

1. Find the area of the beam where the intensity is 10% (of the peak intensity) or greater. Call this A1.
2. Find the area of the beam where the intensity is 90% (of the peak intensity) or greater. Call this A2.
3. Normalize to A1 and find the difference, then simplify:

View the “perfect” flat top beam in Figure 7-42:

The area of the beam at 10% intensity is equal to the area at 90% intensity (A1 = A2). For a 1 mm diameter beam, the area is 0.79 mm^2 and the calculation is:

$$\frac{A1}{A1} - \frac{A2}{A1} \quad \text{Simplify to:} \quad \frac{(A1 - A2)}{A1}$$

Figure 7-41. Flat Top > Edge Steepness – Normalize

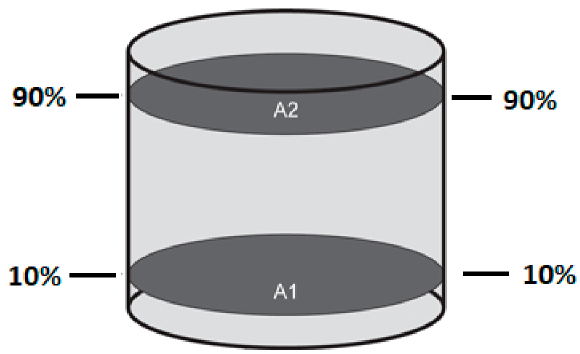

Figure 7-42. Flat Top > Edge Steepness: 'Perfect' Flat-Top Beam

$$\frac{(0.79 - 0.79)}{0.79} = 0$$

Figure 7-43. Flat Top > Edge Steepness – Calculate for 1 mm Beam

The expected Edge Steepness value for a 'perfect' flat top is zero (see row 1 in Table 7-2). Two flat top images are included in the Beam-View.NET sample library.

Now compare the "perfect" beam to the "realistic" beam in Figure 7-44:

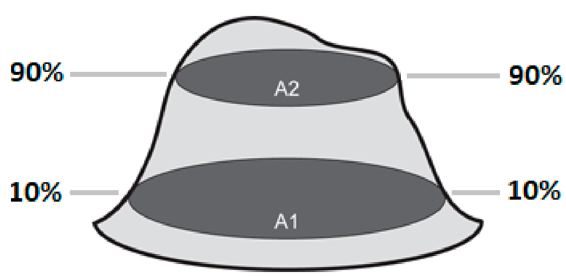

Figure 7-44. Flat Top > Edge Steepness: 'Realistic' Flat-Top Beam

In this beam profile, A1 > A2 and the Edge Steepness is greater than 0. (Note that A1 < A2 is not physically possible.) When the diameter at 10% intensity is 30% larger than the diameter at 90%, the Edge Steepness is:

$$\frac{(1.33 - 0.79)}{1.33} = 0.41$$

Figure 7-45. Flat Top > Edge Steepness Calculation

This measurement corresponds to the information in Row 4 of Table 7-2:

Table 7-2. Flat Top > Edge Steepness Calculations

Row	Diameter at		Area At		Edge Steepness
	10%	90%	10% (A1)	90% (A2)	
1	1.0	1.0	0.79	0.79	0.00
2	1.1	1.0	0.95	0.79	0.17
3	1.2	1.0	1.13	0.79	0.31
4	1.3	1.0	.1.33	0.79	0.41
5	1.4	1.0	1.54	0.79	0.49
6	1.5	1.0	1.77	0.79	0.56

7.7.5 Flat Top > Eff. Irradiation Area [cm^2]

The Flat Top> Effective Irradiation Area is the area of the beam that exceeds the user-defined threshold.

Click the checkbox in the left column for the calculation needed to use to display settings in the following dialog box:

To calculate this value:

1. Count the number of pixels that exceed the user-defined threshold.
2. Multiply the number of pixels counted by the area of a single pixel.

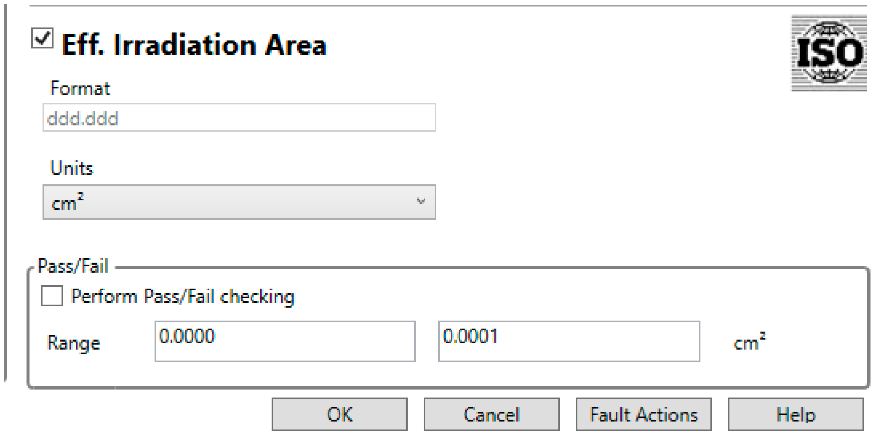

Figure 7-46. Flat Top Calculations > Eff. Irradiation Area

The result is the Effective Irradiation Area, shown in the following example.

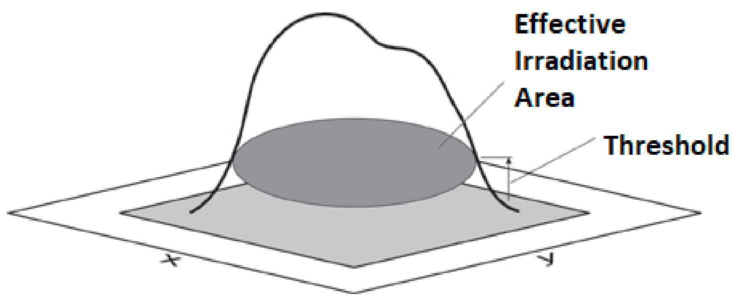

Figure 7-47. Flat Top Calculations > Eff. Irradiation Area

This is similar to the Effective Area calculation, with the distinction that non-symmetrical beams or donut-shaped beams are better represented.

7.7.6 Flat Top > Eff. Avg. Energy Density [J/m2]

The Flat Top - Effective Average Power (Energy) Density is the average power (energy) density of the portion of the beam exceeding the user-defined threshold.

This calculation is an extension of the Effective Irradiation Area.

To calculate this value:

1. Every pixel that is above the user threshold is counted and its Power (Energy) value is recorded.
2. Sum all of the Power (Energy) values recorded in Step 1, and divide by the number of pixels to find the Effective Average Power (Energy).
3. The Effective Irradiation Area is found by multiplying the number of pixels (above the user-defined threshold) by the area of a pixel.
4. Calculate:

$$\frac{\text{Effective Average Power (Energy)}}{\text{Effective Irradiation Area}}$$

Figure 7-48. Flat Top Calculations > Eff. Avg. Energy Density Calculation

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NOTICE

'Effective' means the portion of the beam (or the pixels) where the intensity is above the user threshold.

Click the checkbox in the left column for the calculation needed to use to display settings in the following dialog box:

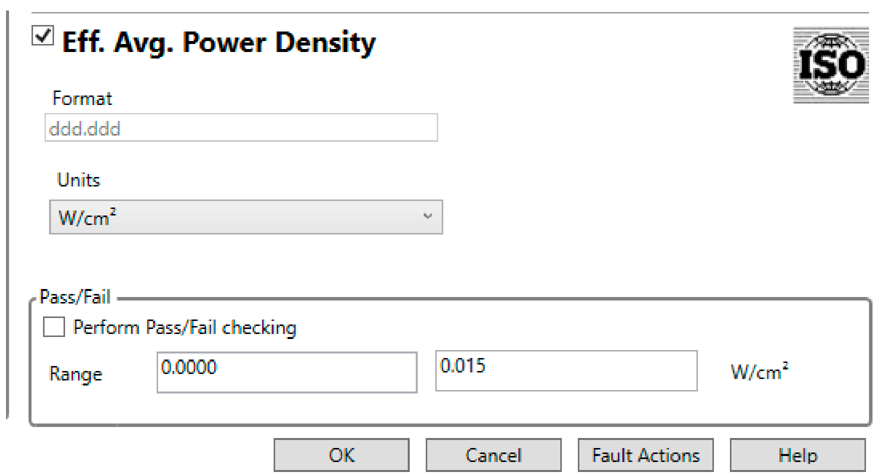


Figure 7-49. Flat Top Calculations > Eff. Avg. Energy Density

7.8 Fault Actions

Each calculation in BeamView.NET has a Fault Action feature. This means that a minimum and maximum value can be set in BeamView.NET for each specific calculation.

The Fault Actions command works in conjunction with the Pass/Fail feature of the Calculations command dialog box to provide selection of the action(s) to be taken when one or more of the selected pass/fail analysis items fall outside the chosen Pass/Fail range.

If that calculation falls outside the minimum and maximum settings, BeamView.NET sends warnings through several user-selectable actions, such as:

- An audible alarm (beep)
- Stop capturing an image
- Reverse the Background color
- Save or discard an image when one of these faults occurs
- TTL pulse out (high or low)

For example, if users always want the diameter of the beam to be between 2.2 mm and 2.5 mm, they can set those values as the minimum and maximum. Then, if the beam size gets too large or too small, BeamView.NET warns users that the beam is outside of those parameters.

This can be useful in manufacturing set-ups where a beam size specification is part of the quality control process on certain types of lasers.

To set Preferences for the type of notification, Go to the Analysis tab and select Fault Actions. The following dialog box is displayed:

Any combination of Fault Actions can be selected—except Image-Save and Image-Discard. All analysis results that fall outside range limits are displayed with an “F” before the result in both the View and Statistics Areas. This provides visual identification of failed results.

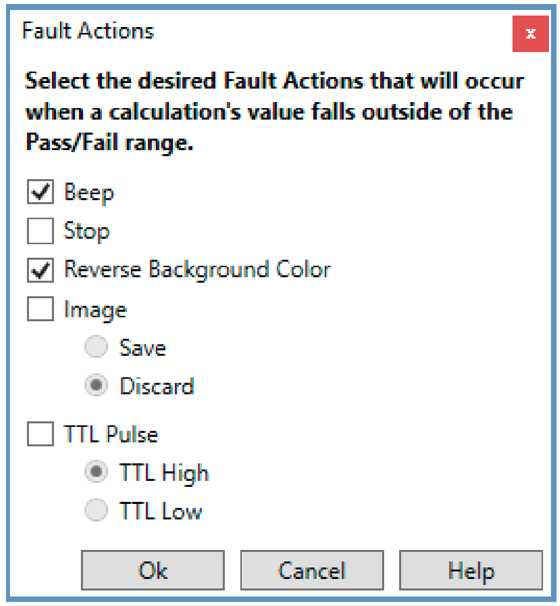


Figure 7-50. Analysis — Fault Actions

7.8.0.0.1 Beep

This option produces an audible tone for each image captured that has any result that falls outside of the acceptable Pass/Fail range set in the Calculations dialog box.

7.8.0.0.2 Stop

This option stops capturing images on the first image captured that has any result that falls outside of the acceptable Pass/Fail range set in the Calculation dialog box.

7.8.0.0.3 Reverse Background Color

This option changes the color of the results area for any sample that has results outside of the acceptable Pass/Fail range set in the Calculations dialog box. This provides a visual identification of failed samples.

7.8.0.0.4 Image Save | Discard

The BeamView.NET software can be configured to save or discard images, depending on whether any of the results are outside of the acceptable Pass/Fail range set in the Calculations dialog box.

Image-Save and Image-Discard functions cannot be active at the same time.

- **Image Save:** This option stores images that have any result outside of the acceptable range. The total number of failed images that can be stored with this function—the BeamView.NET image buffer capacity, minus one—insures at least one image location is available for continued image capture.

  All collected images can be subsequently displayed. All images that have been saved due to a failed result value are indicated in the sample header area with the word "Saved" next to the sample number.

- **Image Discard**: With this option, any image with results that fall outside range limits are not stored in video memory but are discarded. The results for that image are displayed in the View area during the capture process, but are not stored and are not included in the statistics calculations.

  If an image is being discarded, the sample number does not increment, causing the next image to be captured over the image being discarded.

  If Pass/Fail settings are such that all images fail, the sample number in the Results Area title bar does not update.

NOTICE
When Image-Discard is used, make sure that range limits are not set to discard all captured images. The BeamView.NET software appears to be "locked up" and does not store data, when in actuality every image is being discarded.

7.8.0.0.5 TTL Pulse

This option tells the camera to send a pulse whenever a fault is detected. A pulse can be set to Low or High, which means high or low voltage.

Using the optional Trigger In and Pass/Fail cable allows the user to translate pass/fail calculations into TTL voltage levels. The calculation pass/fail state is indicated on the status bar.

This same state is also available on the external camera cable as a TTL HI/LOW output. Polarity is selected from the Analysis > Fault Actions menu by selecting the checkbox for the TTL High (> 2.0V) or TTL Low (< 0.8V) option.

7.9 Analysis Profiles

In the Profiles section of the Analysis toolbar, define parameters for the following settings:

- Apertures
- Reference Position
- Inclusion Area
- Units
- Average Images (dimmed when not available)

7.9.1 Analysis > Apertures

The Apertures command controls the shape, size, and color of the overlay aperture displayed in the View area of the BeamView.NET interface. The position and rotational orientation of the Apertures is controlled from the Crosshair dialog box.

The Aperture setting can help determine if accurate diameter measurements are taken. If the aperture that is drawn around the beam does not fit the beam very well, the diameter calculations may not be accurate either.

The Aperture feature can be used with the different diameter calculations to make sure the diameter calculations are valid. For example, if users set the aperture to track the knife-edge diameter calculations on the beam and the aperture does not actually fit nicely around the beam, the camera is either picking up some noise that is throwing off that specific calculation or the knife-edge diameter calculation is not the best diameter calculation to use on that specific beam.

The Apertures represent a synthetic hard aperture, located with the crosshair for performing aperture related beam analysis functions.

If any part of the aperture moves outside the image area, uniformity calculations can only be performed on the part of the aperture area that is still within the valid image area.

7.9.1.1 Check for Duplications

The aperture setting can help determine if diameter measurements taken are accurate. If the aperture that is drawn around the beam does not fit the beam very well, the diameter calculations may not be accurate either.

The aperture feature can be used with the different diameter calculations to make sure the diameter calculations are valid. For example, if users set the aperture to track the knife-edge diameter calculations on the beam and the aperture does not actually fit nicely around the beam, the camera is either picking up some noise that is throwing off that specific calculation or the knife-edge diameter calculation is not the best diameter calculation to use on that specific beam.

When users select Analysis > Apertures, the following dialog box is displayed:

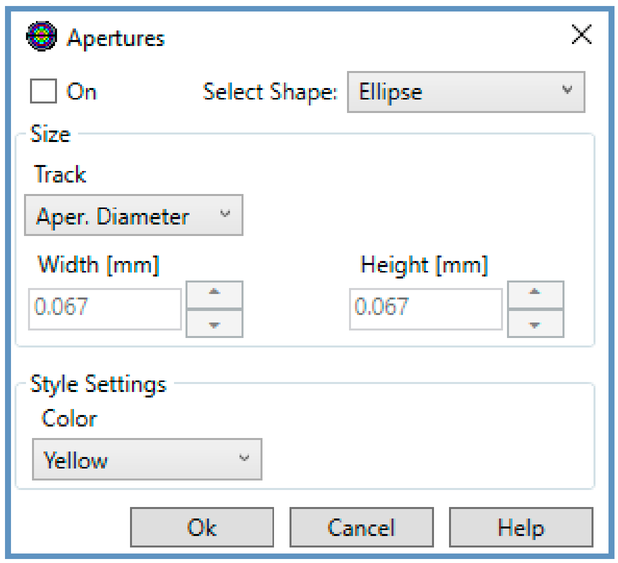


Figure 7-51. Analysis — Profiles — Apertures

Functions in the Apertures dialog box include:

- On
- Select Shape
- Size and Style Settings

The position and rotational orientation of the Apertures is controlled from the Crosshair dialog box.

7.9.1.2 Aperture Settings ON

The On check box enables or disables the display of the overlaid apertures in the BeamView.NET window's View area. If no x appears, the apertures is not shown in the View area.

The apertures are not available with the 3D isometric plot.

7.9.1.3 Shape of the Aperture

The Aperture setting turns on an aperture that is traced around the diameter of the beam. Select from following options for shapes:

- Circle — Provides a circular aperture overlaid on the beam image
- Ellipse — Provides an elliptical aperture overlaid on the beam image
- Square — Provides a square aperture overlaid on the beam image
- Rectangle — Provides a rectangular aperture overlaid on the beam image

The CIRCLE and SQUARE aperture types allow entry of one dimension (width), while the RECTANGLE and ELLIPSE type allow two dimensions (width and height).

7.9.1.4 Size of the Aperture

Select from the following options for the size of the Aperture:

- User Size — Selecting User Size as the tracking method activates the Width and Height boxes, allowing entry of a specific aperture size.
- Effective Diameter
- Aperture Diameter
- d4 Sigma Width
- d4 Sigma Diameter
- Divergence
- Knife Edge
- Slit Diameter
- Elliptical Axes
- Gaussian Diameters

7.9.1.5 Width and Height

Enter values for Width and Height (in millimeters).

- **Width** allows the width of the aperture to be selected by either entering the value numerically or by using the spin buttons (Up and Down arrows) with the mouse to achieve the desired number. The units for the coordinates are shown in parentheses next to the Width label.

- **Height** allows the height of the aperture to be selected by either entering the value numerically or by using the spin buttons (Up and Down arrows) with the mouse to achieve the desired number. The units for the coordinates are shown in parentheses next to the Height label.

7.9.1.6 Color of the Aperture

Selects the color used for display of the Reference Position cross indicator in the View area:

- White
- Red
- Green
- Magenta
- Yellow
- Blue
- Cyan

7.9.2 Analysis > Reference Position

The Reference Position command provides control of the Reference Position coordinate function. This function defines the location of the BeamView.NET system coordinate origin.

When Reference Position is selected, the following dialog box is displayed. The reference position is not available with the 3D isometric plot.

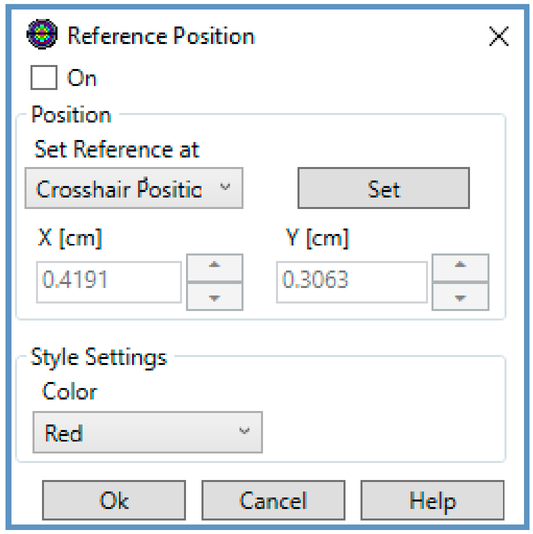


Figure 7-52. Analysis — Profiles — Reference Position

7.9.2.1 Enable Reference Position

The Reference Position point is displayed as a small cross in the View area ("+").

- When this function is Off, the reference point cross is no longer seen and all location values are calculated from 0,0 (located at the upper left-hand corner of the View area).
- When the Ref. Position function is On, a ("±") symbol appears in all coordinate position displays. With this function On, positive calculation values are displayed up and to the right of the reference position in the image.

7.9.2.2 Set Reference Position Location

This item provides selects the location where the Reference position will be located when the Set button is pressed, or when the Reference position is turned on from the Tool Bar Icon. Select from the drop-down menu to locate the Reference Position and click **Set**:

- The current Crosshair Position
- User-specified coordinates
- Minimum centroid location shown in the Statistics
- Mean (average) centroid location shown in the Statistics Area
- Maximum centroid location shown in the Statistics Area

- Minimum peak location shown in the Statistics
- Mean (average) peak location shown in the Statistics Area
- Maximum peak location shown in the Statistics Area

Enter X and Y values for User Coordinates

- X (units) - This item allows the X axis location of the reference position to be selected when User Coordinate location is set either by entering the value numerically or by using the spin buttons (Up and Down arrows) with the mouse to achieve the desired number. The units for the coordinates are show in parentheses next to the X label.

- Y (units) - This item allows the Y axis location of the reference position to be selected when User Coordinate location is set either by entering the value numerically or by using the spin buttons (Up and Down arrows) with the mouse to achieve the desired number. The units for the coordinates are show in parentheses next to the Y label.

7.9.2.3 Style Settings

Select a color:

- White
- Red
- Green
- Magenta
- Yellow
- Blue
- Cyan

7.9.3 Analysis > Inclusion Area

The Inclusion Area is a user-defined area within which the selected analysis calculations are performed. The area is displayed as a red square in the main window.

An Inclusion Area is used (activated) to improve beam diameter accuracy. The size of the Inclusion zone should be approximately 2 to 2.5 times larger than the beam diameter for beams less than 3 mm.

When the Inclusion Area is turned on (activated), BeamView.NET analyzes only the area inside that area. Any beam image data outside the inclusion area are ignored in the calculations.

When an aperture is used with the Inclusion Area, that aperture is allowed to move outside the Inclusion Area, but all uniformity analysis is performed only within the area of the aperture that is inside the Inclusion Area.

Using the Inclusion Zone is a good way to help the software ignore noise from the camera or the environment that may be affecting the image. The goal is to draw the Inclusion Zone around the area where the beam is located.

To choose the Inclusion Area command:

1. From the Analysis menu, select Inclusion from the menu list. The following dialog box is displayed:

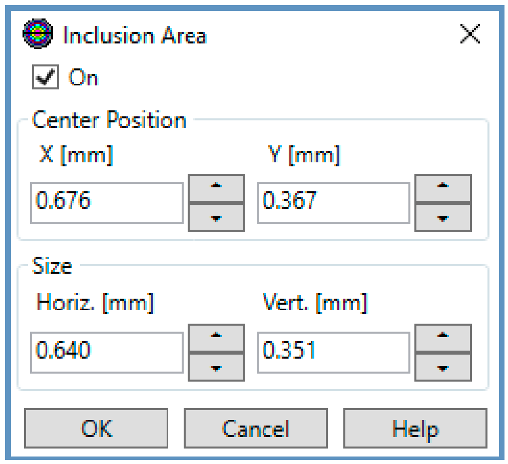


Figure 7-53. Analysis — Profiles — Inclusion Command

There are three functions in the Inclusion Area dialog box:

- On
- Center Position
- Size

For information about using the Inclusion Area in troubleshooting, see 'Divergence measurement seems too large' (p. 203).

7.9.3.1 Enable Inclusion Area

Click the checkbox to turn Inclusion ON, which displays the red square in the main window. When the Inclusion area is Off, the entire captured resolution image area is used for calculations.

7.9.3.2 Define Center Position

‘This function provides the ability to locate the center of the Inclusion area.

- **X [pixels]:** Allows the X axis location of the Inclusion area center position to be selected by either entering the value numerically or by using the spin buttons (Up and Down arrows) with the mouse to achieve the desired number. The units for the coordinates are show in parentheses next to the X label.

- **Y [pixels]:** Allows the Y axis location of the Inclusion area center position to be selected by either entering the value numerically or by using the spin buttons (Up and Down arrows) with the mouse to achieve the desired number. The units for the coordinates are show in parentheses next to the Y label.

Enter values for the X and Y coordinates for the center position (in millimeters).

7.9.3.3 Define Size

This function provides the ability to control the size of the Inclusion area:

- **Horizontal [pixels]:** Allows the width of the Inclusion area to be selected by either entering the value numerically or by using the spin buttons (Up and Down arrows) with the mouse to achieve the desired number. The units for the coordinates are show in parentheses next to the Horz. label.

- **Vertical [pixels]**: Allows the height of the Inclusion area to be selected by either entering the value numerically or by using the spin buttons (Up and Down arrows) with the mouse to achieve the desired number. The units for the coordinates are show in parentheses next to the Vert. label.

Enter values for the Horizontal and Vertical size (in millimeters).

7.9.4 Analysis > Units

The Units command provides selection of desired spatial, power/energy, position, time, and intensity units to be used in the BeamView.NET software. These units are used in the display of the various system-wide function and values, such as input dialog boxes, cursor position, and intensity displays, etc.

NOTICE

Many calculations provide independent unit selection in the Calculations command dialog box. These units are not affected by unit changes made here for Analysis.

When Units is selected, the following dialog box is displayed:

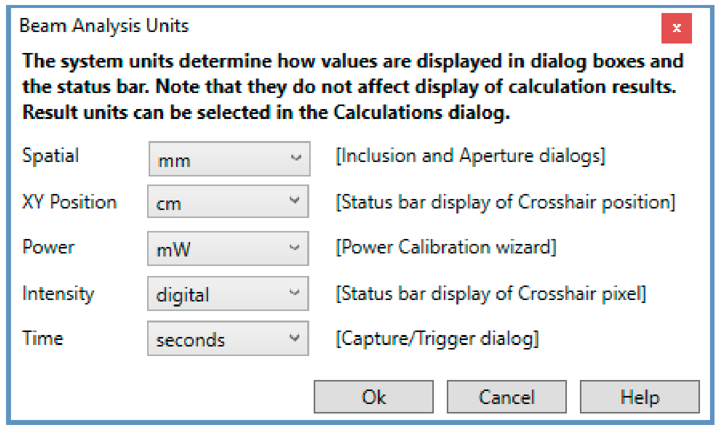


Figure 7-54. Analysis — Profile Settings— Units

The drop-down menu for each setting lists different units of measurement. Select as desired from these lists.

7.9.4.1 Spatial and XY Position

The Spatial function provides selection of different spatial units used for dimensional values.

Both the **Spatial** and **XY Position** settings list the following options:

- mm (microns)
- µm (millimeters)
- cm (centimeters)
- m (meters)
- inch
- pixel
- µrad (radians)

- mrad
- rad
- degrees

7.9.4.2 Energy/Power

Power settings include the following options:

- μW
- mW
- W
- KW
- GW

7.9.4.3 Intensity

The Intensity function provides selection of the units for the pixel Intensity level or energy/power density values. The settings include the following options:

- μW/cm^2
- mW/cm^2
- W/cm^2
- KW/cm^2
- digital
- % resp.

7.9.4.4 Time

The Time function provides a selection of different units used for time values and include the following options:

- milliseconds
- seconds
- minutes

7.9.5 Analysis > Average Images

The Average Images command allows users to select any images in the image buffer to be averaged together. This menu item is dimmed when no images have been captured.

The dialog box shown in Figure 7-55 is displayed:

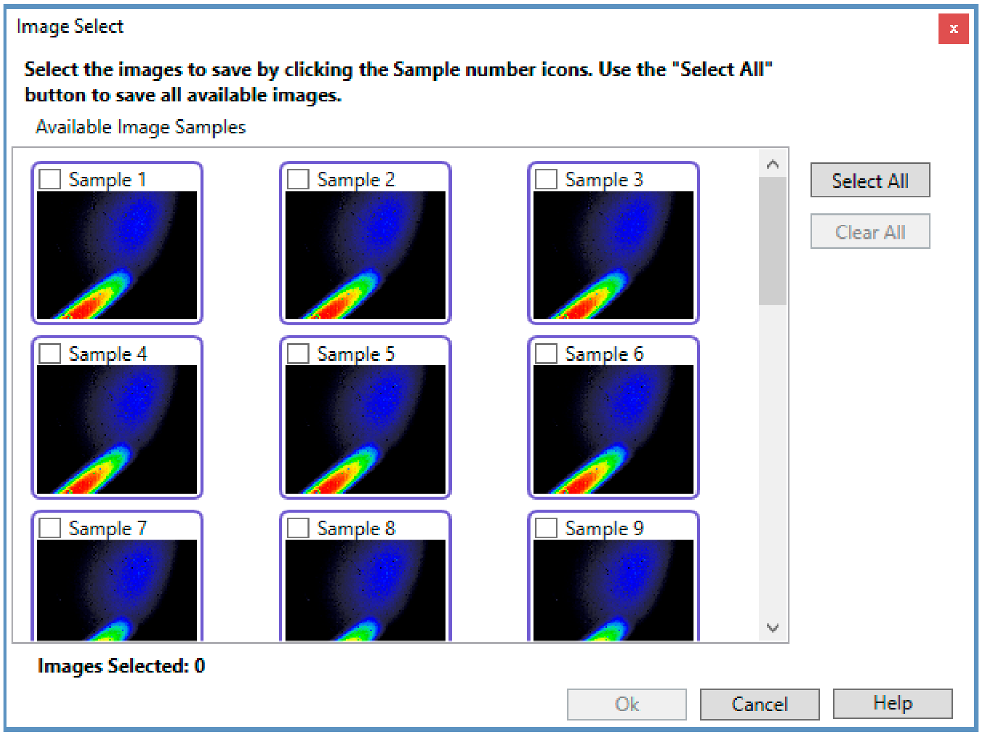


Figure 7-55. Analysis — Average Images

The numbered icons represent samples that still have images in the image buffer. Users can select more than 1024 images to average.

- To select an image, click the mouse on the checkbox beside each icon that needed to compare. Clicking the checkbox a second time deselects that image.

- To select all images in the buffer, use the Select All button.

When the desired images are selected, press OK to perform the average.

A progress bar at the bottom of the dialog box indicates the percent complete during the averaging process.

After the selected images are averaged, the new average image is added to the image and sample buffers, and the calculations are performed on the image. The header bar for the results area displays the word "Average", indicating the image is the result of an average, not a captured image.

Use the Clear All button to deselect all images that are currently selected.

The averaged image overwrites the oldest image in the buffer (the image for Sample #1), as indicated by a Warning message. To avoid overwriting an existing image, either press the Cancel button or stop image collection before the maximum buffer size is reached. This action cancels the averaging operation and closes the dialog box.

7.10 Options to Customize Settings

Table 7-3 lists settings that are commonly customized:

Table 7-3. Options to Customize Settings

To change this	Menu	command	Shortcut
Source Type (CW or Pulsed)	Capture	Capture/Trigger	<Shift> + <F7 >
Trigger Mode (if Pulsed)	Capture	Capture/Trigger	
Resolution (use 1:4 to begin)	Capture	Resolution	
Sample Buffer Size	Capture	Buffer	
Type of Image Plot	View	Plot Type, Profiles, Cross-hair, Fit Profiles	
Graphic Zoom Level (use 1X for Setup)	View	Zoom	<F8>
Aperture Shape & Size	Analysis	Apertures	
Inclusion Area (use Off for the first time)	Analysis	Inclusion	<Shift> + <F8 >
Reference Position (use Off for first time)	Analysis	Reference Position	<F4>
Desired Calculations	Analysis	Calculations	<Ctrl> + <R>
Desired Units	Analysis	Units	
Capture Background Map	Capture	Background Map	
Save Settings	File	Save Config	

8 Remote Mode Set Up

Remote Mode in BeamView.NET allows a terminal application to send and receive commands directly into the Beam VIEW.NET software application. This includes such programs as LabVIEW or a custom Windows application.

Coherent also offers such a terminal application (named “Remote Data Logging Utility”) that can be used to explore BeamView commands and to test response/results. For example, users can use this application to query information from the BeamView or automate data collection using this remote interface, such as monitoring the beam position over time.

BeamView.NET must be running in the background to collect any information from the camera.

8.1 Set Up Remote Mode

Both BeamView.NET and the Remote Data Logging application must be configured before a connection can be established.

In general, here is an overview of the steps to run in Remote Mode. Detailed instructions and more information about set-up are in the sections that follow.

1. Start the BeamView.NET software and configure settings for the inter-face needed to use. (Setup tab > select Remote Mode)
2. After settings are configured, turn on Remote Mode in BeamView.NET (Home tab > Remote Control icon). This provides a fast, single-click control for a connection.
3. Connect a camera, which BeamView.NET then automatically detects.
4. Start the Remote application (such as the BeamView Data Logger Utility from Coherent) and enable the connection.
5. Enter host commands described in ’Remote Mode Host Communication Protocols’ (p. 163).

8.1.1 Define Communications Interface

Set-up for Remote Mode varies by the interface, described in more detail in the following sections.These communication interfaces are supported in the BeamView.NET software:

- RS-232 Serial Interface

- TCP/IP network protocol

To configure **Remote Mode** in BeamView.NET, go to the Set-up Tab, shown in Figure 8-1.

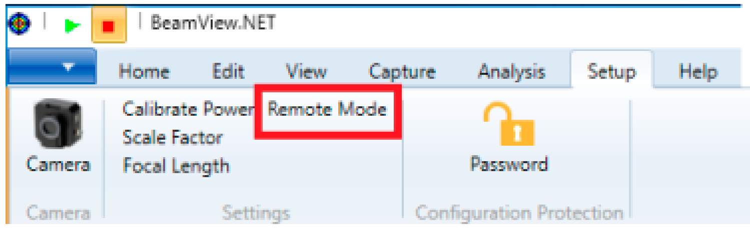


Figure 8-1. Setup Tab

The dialog box shown in Figure 8-2 for **TCP/IP** settings is first displayed.

- Click the check box to 'Enable Remote Mode' and the dialog box changes to show 'Listening' at the bottom, as shown in Figure 8-2.
- The default Port number is assigned by the BeamView.NET software. Enter the Port, Baud Rate, Data Bits, Stop Bits, and select Parity, then click OK.

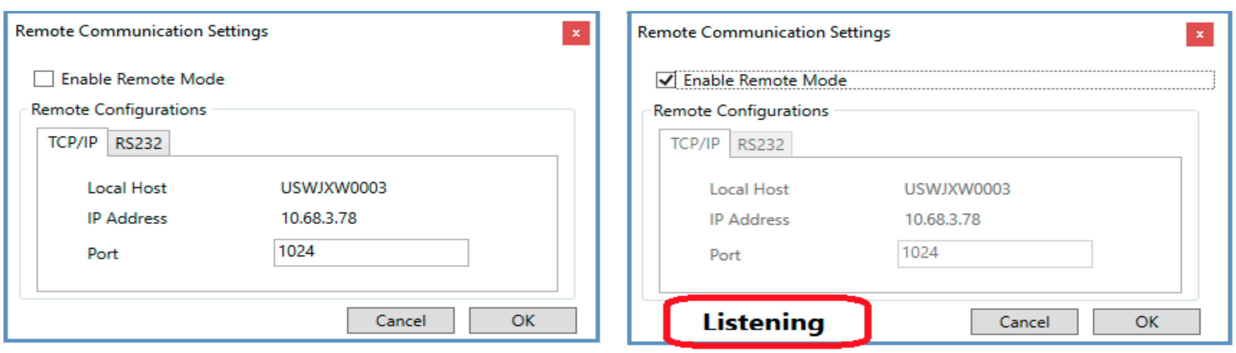


Figure 8-2. Setup — Remote Mode — TCP/IP Connection

When users select the tab for an **RS-232** connection, the contents change.

- Click the checkbox to 'Enable Remote Mode' and the dialog box changes to show "Connected" at the bottom, as shown in Figure 8-3:

In the Remote Communications Settings dialog box, use the controls listed in Table 8-1 to select an interface:

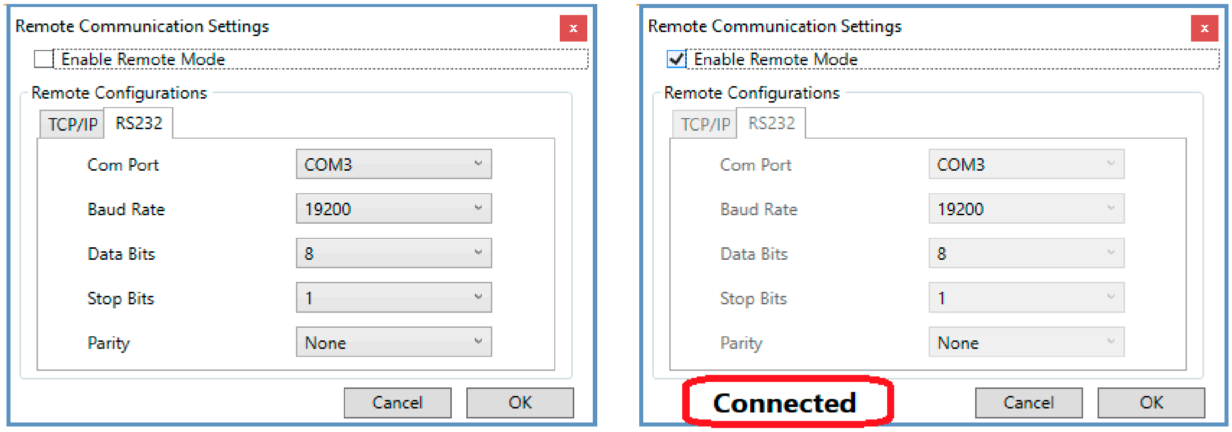


Figure 8-3. Setup — Remote Mode — RS-232 Connection

Table 8-1. Controls for Communication Settings

Control	Description
Enable checkbox	This checkbox toggles between Enable and Disable. • When checked, Enable connects the Serial COM after OK is clicked. • When not checked, disconnects the Serial COM after OK is clicked. To switch interfaces, first ensure that the checkbox for the interface that is NOT to be used is not checked.
OK button	Saves the current settings and connects or disconnects the Serial Port.
Cancel button	Closes the Dialog Box without making any changes to existing settings.

8.1.2 Serial Interface Connection

A Serial RS-232 interface requires both a hardware and software connection.

8.1.2.1 Serial Interface — Cable Requirements

The BeamView.NET software uses the serial port on the host PC for communication. Interface to this port requires a Null Modem RS-232 cable. Table 8-2 shows the pin-outs:

Table 8-2. Serial Null Modem Cable Pin-Outs

9-Pin D-Type			9-Pin D-Type		or…	25-Pin D-Type	
Beam-View.NET on Local PC			Remote PC			Remote PC	
DCD	1		1	DCD		8	DCD
RX	2		3	TX		3	TX
TX	3		2	RX		2	RX
DTR	4		6	DSR		6	DSR
GND	5		5	GND		7	GND
DSR	6		4	DTR		20	DTR
RTS	7		8	CTS		5	CTS
CTS	8		7	RTS		4	RTS
RI	9		9	RI		22	RI

8.1.2.2 Serial Interface — Software Communication Settings

This section describes the BeamView.NET communication settings for the Serial RS-232 interface.

1. Go to the Setup tab in the BeamView.NET software.
2. Click Remote Mode in the Settings section of the toolbar.
3. Ensure that the checkbox for 'Enable' is not checked, then click the tab for RS232. The following dialog box is displayed:

BeamView.NET remembers the 'Connected' state; the application starts up with the Serial Port connected in the state Box is Connected.

The **Available** and **Recommended** settings are listed in Table 8-3:

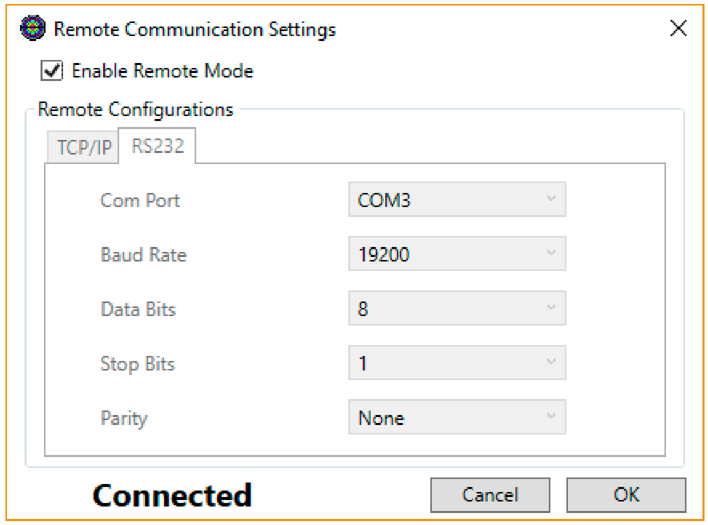


Figure 8-4. Serial Interface Communication Settings

Table 8-3. Communication Settings for RS-232

Setting	Options	Recom-mended
COM Port	COM1, COM2, COM3, COM4	No Hand shaking
Baud Rate	1200, 2400, 4800, 9600, 19200, 38400, 115200	115,200 bps
Data Bits	7, 8	8 Data Bits
Stop Bits	1, 2	1 Stop Bit
Parity	None, Even, Odd	No Parity

8.1.3 TCP/IP Interface

The remote TCP/IP application may be installed on the same computer as BeamView.NET, but this is not necessary. All that must be specified at the client is the BeamView.NET server TCP/IP host name or IP address and the port number.

8.1.3.1 TCP/IP Hardware Requirements

The only requirement to use the TCP/IP protocol is connecting the PC on which the BeamView.NET software is installed to the network.

8.1.3.2 TCP/IP Communication Settings

For TCP/IP settings:

1. Go to the Setup tab in the BeamView.NET software.
2. Click Remote Mode in the Settings section of the toolbar.

Figure 8-5 shows the dialog box that is displayed for the TCP/IP interface:

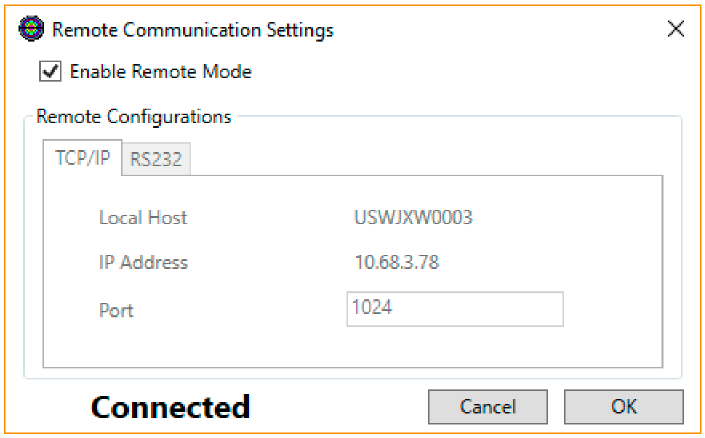


Figure 8-5. TCP/IP Communication Settings

If TCP/IP is selected, the properties of the Local Host and IP address are seen in the window; these are fixed as the computer is a TCP/IP server to a client application. Port number 1024 is used as the default TCP/IP port in the BeamView.NET application.

8.1.4 Run Remote Mode in BeamView.NET

To run Remote Control in BeamView.NET:

Go to the Home tab and click the Remote Control icon in the toolbar, shown in Figure 8-6. This provides a fast, single-click control for a connection.

8.2 Remote Data Logging Utility

This section provides an example about using remote control with the BeamView Data Logging Utility, a software application. To download the Data Logging Utility for BeamView.NET:

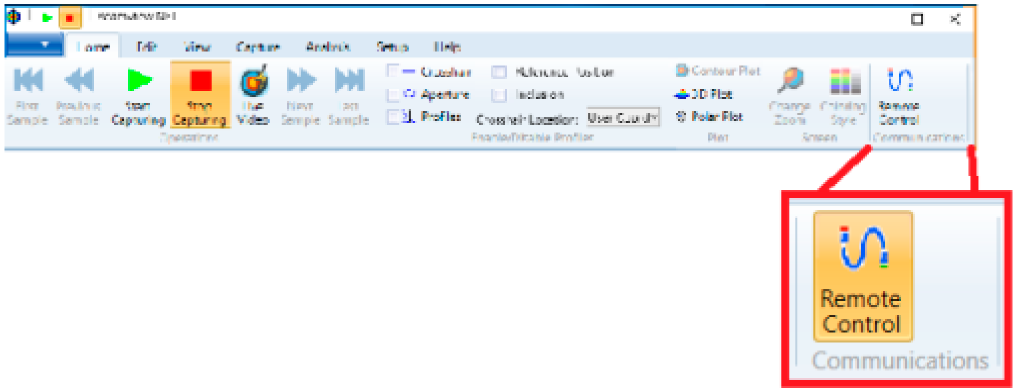


Figure 8-6. Remote Control Icon on Home Tab

1. Go to the Coherent website and locate the following page:

   https://www.coherent.com/resources/

2. Search for ‘BeamView.NET’.

3. Click the name of the Data Logging Utility and download the file `BeamViewNet Data Logger v2002.exe` to the computer.

For BeamView.NET software, v2.0 of the BeamView Data Logging Utility must be used. This software supports cameras listed in ’Products Supported’ (p. 7).

8.2.1 Connect the Data Logging Utility

To set up and connect the BeamView Data Logging Utility to run with the BeamView.NET software:

1. Start the BeamView.NET software, shown in Figure 8-7.
2. Make sure that there is a camera connected and that users can collect information.
3. Verify the serial number for the camera; this is displayed in the bottom right corner of the BeamView.NET window.

8.2.1.1 Verify the Connection

The following test validates the settings and communication that are needed using the **Send/Receive** functions. Perform this test before work is continued.

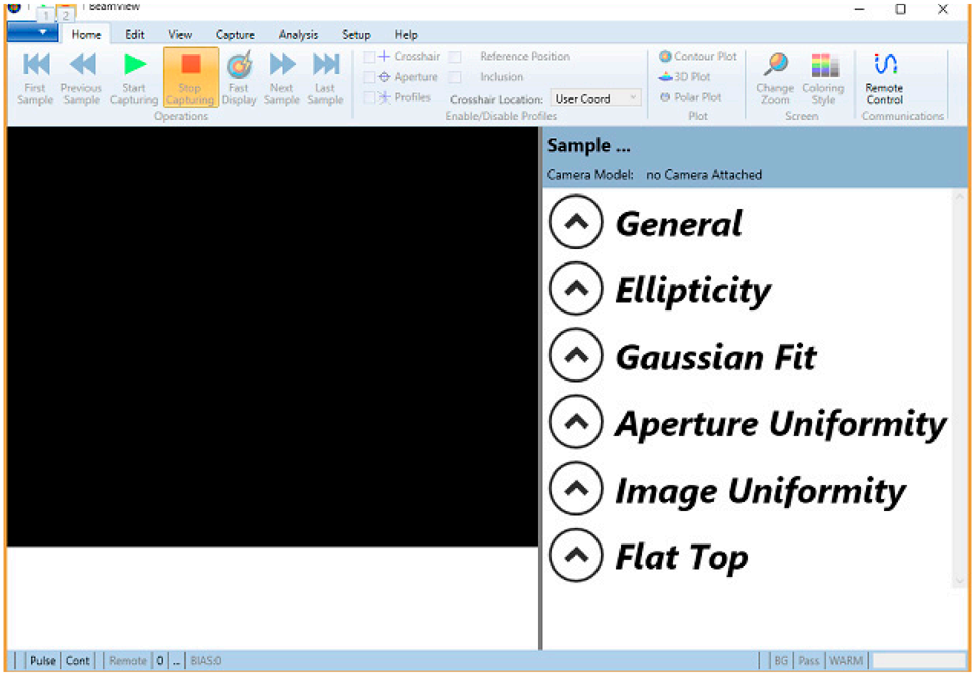


Figure 8-7. BeamView.NET Software

1. Open the BeamView Data Logger Utility, shown in Figure 8-8.

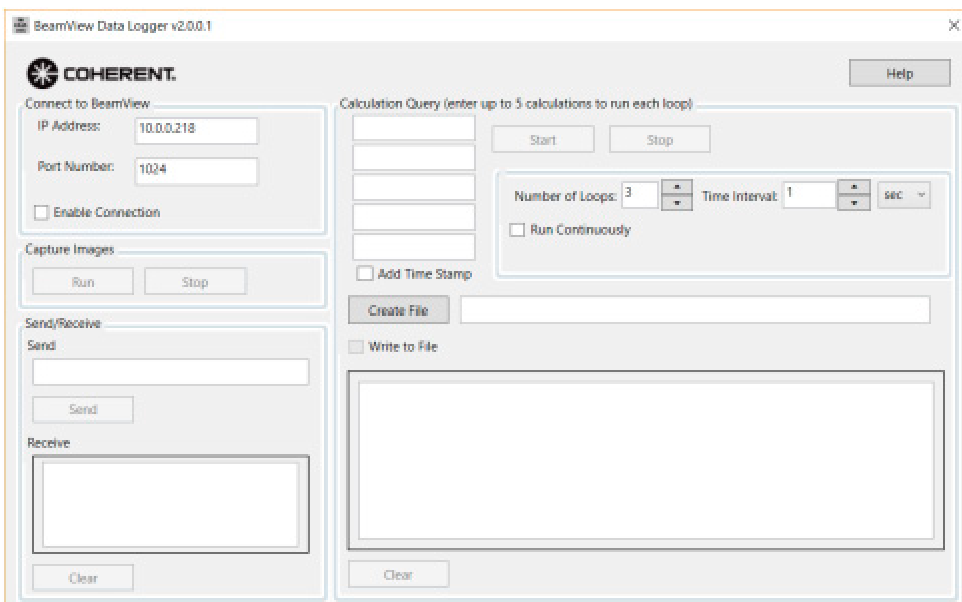


Figure 8-8. Data Logger – Run BeamViewNet Data Logger v2.0

2. In the BeamView Data Logger window, go to Connect to BeamView and click Connect, as shown in Figure 8-9.

3. Enter a command in the Send / Receive window. See 'Remote Mode Host Communication Protocols' (p. 163) for a list of available host commands.

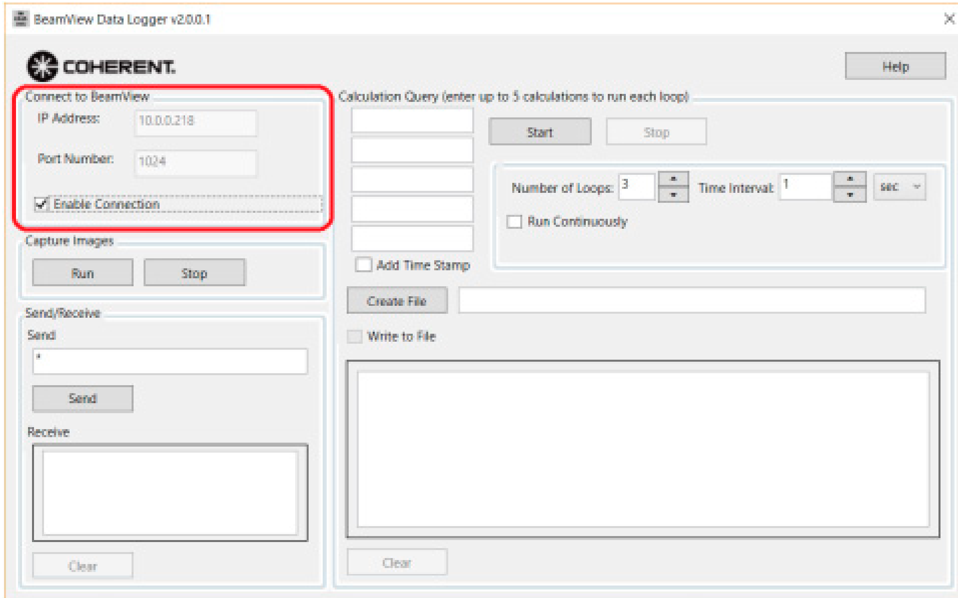


Figure 8-9. Data Logger – Connect to BeamView

For example, enter **`*idn?`** In the Send window and click the Send button, as shown in Figure 8-10:

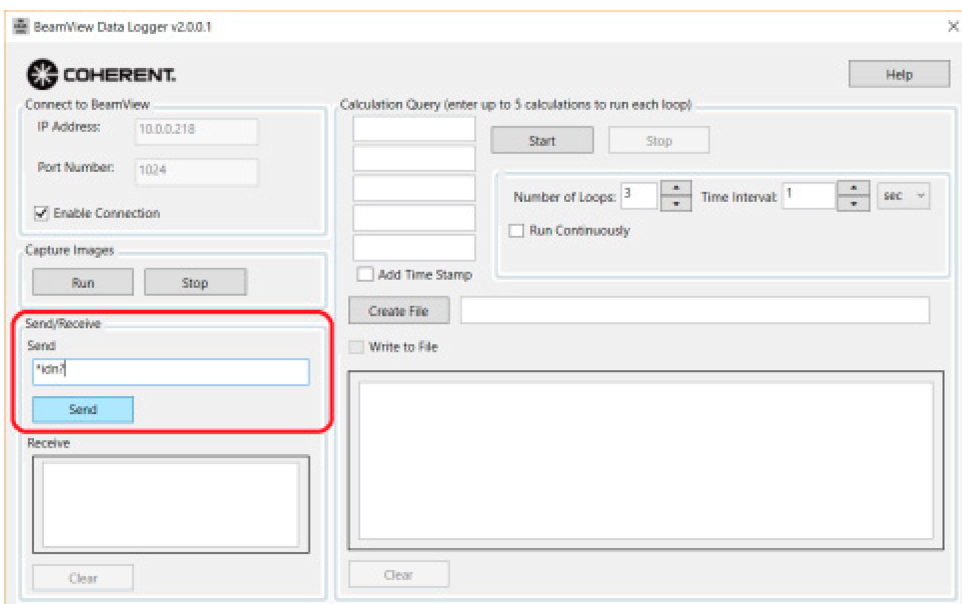


Figure 8-10. Data Logger – Send Command

The response from the camera is displayed in the Receive window, as shown in Figure 8-11.

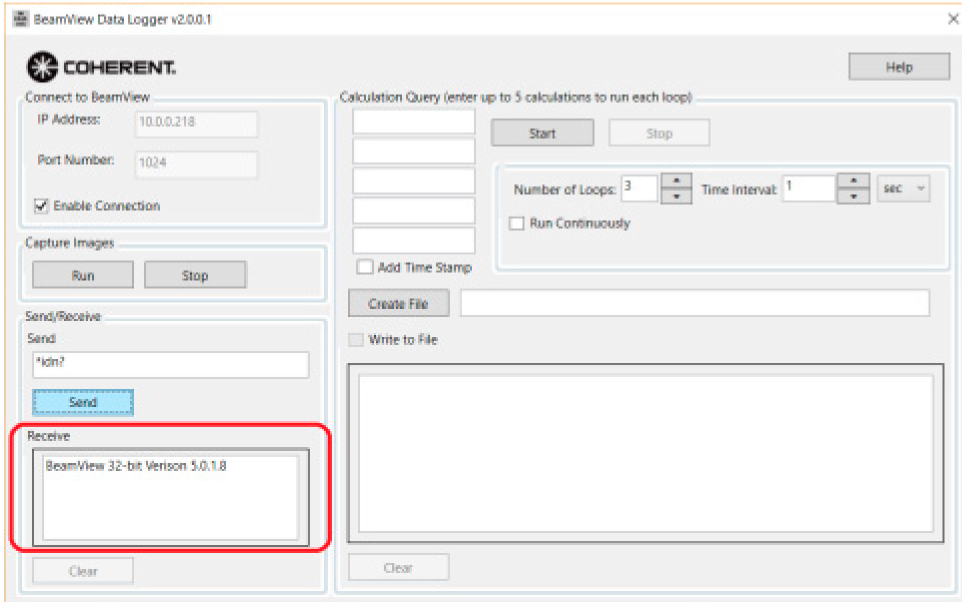


Figure 8-11. Data Logger – Response from Command

8.2.1.2 Using XY Positional Data

For users who want to use the BeamView data logger to provide XY positional data to track beam movement, the following additional **XY Position** settings can be used for reference to help with this task.

- mm (microns)
- µm (millimeters)
- cm (centimeters)
- m (meters)
- inch
- pixel
- µrad (radians)
- mrad
- rad
- degrees

8.2.2 Example Using a Remote Command

Following is an example about how to set up a query for the XY centroid position of the laser beam. This sample test was set up without a laser to track position, but the process works the same.

In the **Calculation Query section**, shown in Figure 8-12:

1. Enter the command “ARCRV?”.

   Other commands are listed in the section, ’Remote Mode Host Communication Protocols’ (p. 163).

2. Set the query to request (loop) the position ten times. Note that there is a checkbox to click if it is desired to run this continuously.
3. Set a time interval (such as three seconds) to wait each time before the next query.
4. If desired, click the checkbox to add a time stamp to the results file.

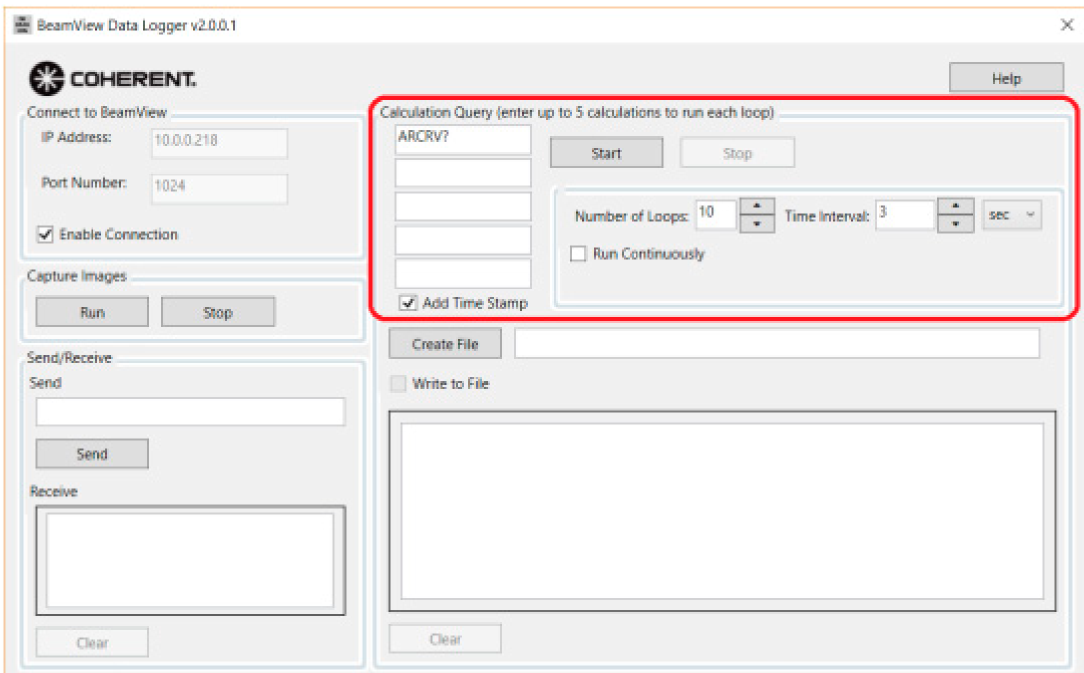


Figure 8-12. Query XY Centroid Position

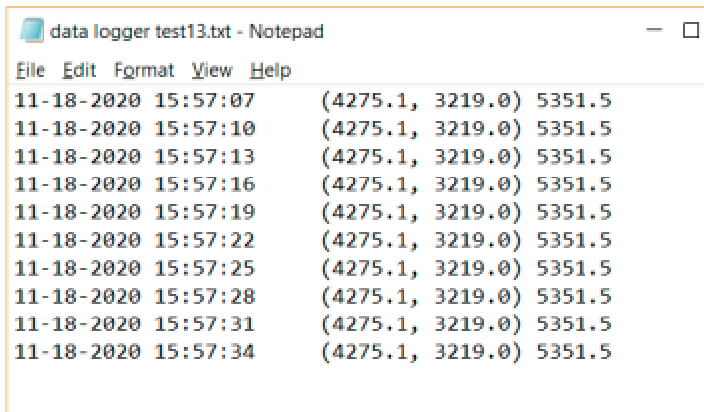
Users can run the query now, or set up a location on the desktop to collect the data.

5. Click Create File and, in the standard Windows browser, select a destination.

6. Click the checkbox for **Write to File** to save a text file. If this checkbox is not clicked, the results are displayed only in the window.

7. Click Start.

The resulting .txt file is collected on the desk top location that was selected. This example text file shown in Figure 8-13 shows the time stamps and XY locations




```
11-18-2020 15:57:07     (4275.1, 3219.0) 5351.5
11-18-2020 15:57:10     (4275.1, 3219.0) 5351.5
11-18-2020 15:57:13     (4275.1, 3219.0) 5351.5
11-18-2020 15:57:16     (4275.1, 3219.0) 5351.5
11-18-2020 15:57:19     (4275.1, 3219.0) 5351.5
11-18-2020 15:57:22     (4275.1, 3219.0) 5351.5
11-18-2020 15:57:25     (4275.1, 3219.0) 5351.5
11-18-2020 15:57:28     (4275.1, 3219.0) 5351.5
11-18-2020 15:57:31     (4275.1, 3219.0) 5351.5
11-18-2020 15:57:34     (4275.1, 3219.0) 5351.5
```

Figure 8-13. Data Logger – Text File Collected

9 Remote Mode Host Communication Protocols

Almost any operation that can be performed or controlled via the keyboard on the BeamView.NET software can be done using remote control commands through the RS-232 serial interface or the TCP/IP interface.

9.1 Before Work is Started

To use the Remote feature, users must first set up the Remote connection. This generally requires both hardware and software (a terminal program that supports the TCP or RS-232 protocol). The requirements vary by interface. Go to 'Set Up for Remote Mode' (p. 34) for instructions.

After image samples have been captured, data can be sent over the RS-232 port.

9.2 Commands in Remote Mode

This section describes the command set in the BeamView.NET software. These commands can be used to turn analysis functions on or off, set configuration parameters (aperture size and shape, Trigger mode, etc.), set Pass/Fail limits, and receive captured image data.

The following commands are available in Remote Mode:

In these commands, replace the 'XX' placeholder with any valid calculation that is listed in the tables.

9.2.0.0.1 Syntax:

For example, to Query for the Result calculation for the Peak (X, Y) R, issue the following command:

ARPXV?

where:

- Analysis Result: AR
- PX = Peak (X,Y)R (the expected calculation)
- V? = Query for Value

9.3 Help Command

Table 9-1 describes the output from Help commands in Remote Mode.

Table 9-1. Help Commands

Command	Description	Example
`HELP;ALL;`	Displays all commands.	`HELP`

`HELP;command;`	Displays the command, its parameter. This command provides more details than a simple HELP command.
	Use only the alphabetic part of the command. The command starts and terminates with a";".
		`HELP;BDIR;`
		`BDIR xxx?`
		Query the Live Image Profile data for the specified image row.
		Example: Enter BDIR 120? Returns the Image Profile Data for row 120.

Table 9-1. Help Commands (Continued)

Command	Description	Example
`HELP;command;`		**`HELP;PFDVR;`** **`PFDVR?`** Query the Pass Fail Range for divergence. ***Example:*** Enter **`PFDVR?`** Returns the Minimum Value followed by the Maximum Value for Pass/Fail on divergence. **`PFDVR`** Set the Pass Fail Range for divergence. Format is PFDVR;x.x,y.y; where x.x is the minimum and y.y is the maximum.
`HELP;command;`		**`HELP;SAMPLE;`** **`SAMPLE?`** Query the Active Beam View Sample. ***Example:*** Enter **`SAMPLE?`** Returns the active sample number. **`SAMPLE;xxx;`** Set the Active Beam View Sample. ***Example:*** Enter **`SAMPLE;4;`** Sets the active sample number to 4.

9.4 File Commands

Table 9-2 shows the file commands.

NOTICE

The file path must first be created on the hard drive before using the File commands.

Table 9-2. File Commands

Command	Description	Example
`FLCL;`Full file path;	File Configuration Load from specified file name.	**`FLCL;C:\BV\USER32\Config_2.ATC;`** **`OK`**

Table 9-2. File Commands (Continued)

FLCS;Full file path;	File Configuration Save to specified file name.	**FLCS;C:\BV\USER32\Config_2.ATC;** **OK**
FLST;Full file path;	File Save Test As to specified file name.	**FLST;C:\BV\USER32\Test_8.ATS;** **OK**
FLEI;Full file path;	File Export Image to specified file name.	**FLEI;C:\BV\USER32\Image_5.BIN;**
FLSI;Image numbers separated by commas;	File Select Images from specified images. This command needs to be preceded by either FLST or FLEI. Commas must separate the image numbers.	**FLSI;012,024,044;** **OK**
	Select ALL images.	**FLSI;ALL;** **OK**
FLSTL; Load .ats files	Load all .ats files.	**FLSTL;C:\BV\USER32\HasToWork2.ATS;**
FLII; Load .bin, .img, and .png files	Load .bin, .img, and .png files	**FLII;C:\BV\USER32\Image_5.bin;** **FLII;C:\BV\USER32\Image_5.img;** **FLII;C:\BV\USER32\Image_5.png;**
	Imports file from specified location	**FLII;C:\BV\USER32\802samples-UV.bin;**

9.5 Edit Commands

Table 9-3 shows the Edit commands.

Table 9-3. Edit Commands

Command	Description	Example
CLIB;ALL;	Clear the Image buffer	**CLIB;ALL;** **OK**

9.6 Control Commands

Table 9-4 shows the first two letters of the command language:

Table 9-4. Control Commands

Sub-command	Description
AR	Analysis Result Calculation sub-command
PF	Pass Fail Calculation sub-command
SR	Statistics Result Calculation sub-command

9.6.1 Calculation Commands

Table 9-5 shows the next two letters apply to each of the calculations. Note that these are listed bu function and are not in alphabetical order.

Table 9-5. Calculation Sub-Commands

Sub-command	Description
PX	Peak (X, Y) R
CR	Centroid (X, Y) R
PR	Peak % Response
TP	Total Relative Power (CW only)
TE	Total Relative Energy (Pulsed only)
EA	Effective Area
PD	Peak Power Density (CW only)
FL	Fluence (Pulsed only)
ED	Effective Diameter
AD	Aperture Diameter
DW	D4 Sigma Width
DD	D4 Sigma Diameter

Table 9-5. Calculation Sub-Commands (Continued)

Sub-command	Description
`DV`	Divergence
`KE`	Knife Edge
`SD`	Slit Diameter
`EM`	Ellipticity - Major, Minor
`EN`	Ellipticity – Angle
`EC`	Ellipticity – Circularity
`GO`	Gaussian Fit Coefficient
`GC`	Gaussian – Fit Centroid
`GP`	Gaussian - Fit Peak Intensity
`GD`	Gaussian - Fit Diameter
`GR`	Gaussian - Roughness of Fit
`PA`	Peak To Average
`AM`	Aperture Uniformity – Min, Mean, Max
`AS`	Aperture Uniformity – Sigma, RMS
`AP`	Aperture Uniformity – % Power in Aperture (CW only)
`AE`	Aperture Uniformity – % Energy in Aperture (Pulsed only)
`IM`	Image Uniformity – Min, Mean, Max

9.6.2 Calculation Sub-Commands

Table 9-6 shows the sub-commands for Calculations. Replace the 'XX' placeholder with a valid calculation listed in the tables. For more information about setting Pass/Fail options, see 'Fault Actions' (p. 135).

9.6.3 Set Sub-Command

Table 9-7 shows the sub-commands in Remote Mode to **Set** various parameters:

Table 9-6. Calculation Sub-Commands

Command	Description		Examples
ARXXF?	Query using Fluence as the Clip Level for calculation (currently only works on Effective Diameter).		**AREDF?** **ON** **AREDF?** **OFF**
ARXXF	Set using Fluence as the Clip Level for calculation (currently only works on Effective Diameter).		**AREDF;ON;** **ON** **AREDF;OFF;** **OFF**
ARXXL?	Query Fluence Value as the Clip Level for calculation (currently only works on Effective Diameter).		**AREDL?** **50.0**
ARXXL	Set Fluence Value as the Clip Level for calculation (currently only works on Effective Diameter).		**AREDL;50.0;** **50.0**
ARXXO?	Query the ON/OFF status for calculation.		**ARDVO?** **OFF** **ARDVO?** **ON**
ARXXO	Set the ON/OFF status for calculation.		**ARDVO;OFF;** **OFF** **ARDVO;ON;** **ON**
ARXXP?	Query the Parameter Value for calculation.		**ARDVP?** **86.5**
ARXXP	Set the Parameter Value for calculation. ***Example:*** Enter ARXXP;x.y; sets the value.		**ARDVP;75.0;** **75.0**
ARXXU?	Query the Units for calculation. Divergence uses Position units. Aperture and Effective Diameter use Spatial units.	Micrometers Millimeters Centimeters Meters Inches Pixels Micro radians Milliradians Radians Degrees	**ARDVU?** **UMRP or UMRS** **MMRP or MMRS** **CMRP or CMRS** **MTRP or MTRS** **INCP or INCS** **PIXP or PIXS** **URDP or URDS** **MRDP or MRDS** **RADP or RAD** **DEGP or DEGS**

Table 9-6. Calculation Sub-Commands (Continued)

Command	Description		Examples
ARXXU	Set the Units for calculation.	Micrometers by Position Millimeters by Position Centimeters by Position Meters by Position Inches by Position Pixels by Position Micro radians by Position Milliradians by Position Radians by Position Degrees by Position Spatial Micrometers Spatial Millimeters Spatial Centimeters Spatial Meters Spatial Inches Spatial Pixels Spatial Micro radians Spatial Milliradians Spatial Radians Spatial Degrees	**ARXXU;xxxx;** **UMRP** **MMRP** **CMRP** **MTRP** **INCP** **PIXP** **URDP** **MRDP** **RADP** **DEGP** **UMRS** **MMRS** **CMRS** **MTRS** **INCS** **PIXS** **URDS** **MRDS** **RADS** **DEGS**
	DIMENSIONLESS UNITS	Percent % Degrees Ratio Coefficient	**PERCENT** **DEGREES** **RATIO** **COEFFICIENT**
	INTENSITY UNITS	Microwatts/CM^2 Milliwatts/CM^2 Watts/CM^2 Kilowatts/CM^2 Microjoules/CM^2 Millijoules/CM^2 Joules/CM^2 Kilojoules/CM^2 Digital % Response	**UWCM** **MWCM** **WCM2** **KWCM** **UJCM** **MJCM** **JCM2** **KJCM** **DIGI** **PRCT**

Table 9-6. Calculation Sub-Commands (Continued)

Command	Description		Examples
	POWER UNITS	Microwatts Milliwatts Watts Kilowatts Gigawatts	**PUWT** **PMWT** **PWAT** **PKWT** **PGWT**
	ENERGY UNITS	Microjoules Millijoules Joules Kilojoules Gigajoules	**PUJL** **PMJL** **PJUL** **PKJL** **PGJL**
	TIME UNITS	Milliseconds Seconds Minutes	**MSEC** **TSEC** **TMIN**
	AREA UNITS	Micrometers squared Millimeters squared Centimeters squared Meters squared Inches squared Pixels squared	**AUMT** **AMMT** **ACMT** **AMTR** **AINC** **APIX**
PFXXR?	Query the Pass/Fail Range for calculation.		**PFDVR?** 2000 3000
PFXXR	Set the Pass Fail Range for calculation. For more information about setting Pass/Fail, see 'Fault Actions' (p. 135). ***Example:*** Enter PFXXR;x.x,y.y; sets the value		**PFDVR;2.0,3.0;** 2.0 3.0
PFXXO?	Query the Pass/Fail ON/OFF status for calculation.		**PFDVO?** **OFF**
PFXXO	Set the Pass/Fail ON/OFF status for calculation. For more information about setting Pass/Fail, see 'Fault Actions' (p. 135).		**PFDVO;OFF;** **OFF** **PFDVO;ON;** **ON**

Table 9-8 shows examples of the Set sub-command. Replace "XX" in the command with the DV (Divergence calculation) from the Calculation sub-command table.

Table 9-7. Set Sub-Commands

Sub-command	Description
`O;ON;`	Set ON/OFF value
`P; XX;`	Set Parameter value
`U; XX;`	Set Units
`R; XX;`	Set Range

Table 9-8. Examples of Set Sub-Commands

Sub-command	Description	Notes
ARXXO	Set the ON/OFF status for calculation.	**ARDVO;OFF;** **OFF** **ARDVO;ON;** **ON**
ARXXP	Set the Parameter value for calculation. ***Example:*** Enter **ARXXP;x.y;** Sets the value.	**ARDVP;75.0;** **75.0**

9.6.4 Query Sub-Command

Table 9-9 shows the sub-commands in Remote Mode to **Query** various values.

Table 9-9. Query Sub-Commands

Sub-command	Description
V?	Query the value
M?	Query the minimum value
N?	Query the mean value
X?	Query the maximum value

Table 9-9. Query Sub-Commands (Continued)

Sub-command	Description
`S?`	Query the sigma value
`O?`	Query the ON/OFF status

Table 9-10 shows the Query sub-commands. Replace “XX” in the command with the DV (Divergence calculation) from the Calculation sub-command table.

Table 9-10. Examples of Query Sub-Commands

Sub-command	Description	Example
`ARXXV?`	Query the value for calculation.	`ARDVV?` `4252`

`PFXXV?`	Query the Pass/Fail value for calculation.	`PFDVV?`
		`FAIL`
		`PFDVV?`
		`PASS`

`SRXXM?`	Query the statistics minimum value for calculation.	`SRDVM?` `4229`
`SRXXN?`	Query the statistics mean value for calculation.	`SRDVN?` `4257.5730`
`SRXXX?`	Query the statistics maximum value for calculation.	`SRDVX?` `4291`
`SRXXS?`	Query the statistics sigma value for calculation.	`SRDVS?` `14718118`

9.6.5 Distance Units

Distance Units can be either Positional or Spatial

- Positional units correspond to a point.
- Spatial units correspond to a surface area.

9.6.5.1 Positional Units

The calculations that use Positional Distance Units are listed in Table 9-11:

Table 9-11. Commands for Distance Units

Sub-command	Description
PX	Peak (X, Y) R
CR	Centroid (X, Y) R
DV	Divergence

9.6.5.2 Spatial Units

The calculations that use Spatial Distance Units are listed in Table 9-12:

Table 9-12. Commands for Spatial Distance Units

Sub-command	Description
ED	Effective Diameter
AD	Aperture Diameter
DW	d4 Sigma Width
DD	d4 Sigma Diameter
KE	Knife Edge
SD	Slit Diameter
EM	Ellipticity - Major, Minor
GC	Gaussian Fit - Centroid
GD	Gaussian Fit - Diameter

9.6.6 Profile and Image Data Commands

Table 9-13 shows the Profile and Image Data commands.

Table 9-13. Profile and Image Data Commands

Command	Description	Example
BDIPH?	Query the image profile X-axis from the Crosshair. These display a profile only if the CMODE is Run. PROFILE EXAMPLE: `0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,5,4,7,18,29,22,23,26,39,36,26,32,41,39,48,51,51,55,63,90,79,84,100,107,99,96,94,103,144,159,15,158,169,174,188,187,198,179,163,106,107,102,84,80,69,73,73,65,65,56,60,61,47,34,27,18,14,11,10,7,5,6,8,5,1,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0`	**BDIPH?** Returns profile example
BDIPV?	Query the image profile Y-axis from the Crosshair. This displays a profile only if the CMODE is set to Run.	**BDIPV?** Returns profile example
BDRPH?	Query the reference profile X-axis. This displays a profile only if the CMODE is set to Run, and Ref. Profile ON, and Ref. Profile is set to GAUSS FIT	**BDRPH?** Returns profile example
BDRPV?	Query the reference profile Y-axis This displays a profile only if the CMODE is set to Run, and Ref Profile ON, and Ref. Profile is set to GAUSS FIT.	**BDRPV?** Returns profile example
BDGFH?	Query the Gaussian fit curve X-axis. This displays a profile only if the CMODE is Run, and FIT Profile ON, and Ref. Profile is set to GAUSS FIT.	**BDGFH?** Returns profile example
BDGFV?	Query the Gaussian fit curve Y-axis. This displays a profile only if the CMODE is set to Run, and FIT Profile ON, and Ref. Profile is set to GAUSS FIT.	**BDGFV?** Returns profile example
BDIR xxx?	Query the data for specified image row xxx.	**BDIR 120?** Returns profile example
BDCL?	Query the current Crosshair location.	**BDCL?** **1.171 -1.260**

9.6.7 Miscellaneous Commands

Table 9-14 shows miscellaneous Remote commands:

Table 9-14. Miscellaneous Commands

Command	Description	Example
*IDN?	Displays the System ID and Revision number.	*IDN? BeamView.NET 32Bit Release 5.0.1.4
TRM?	Queries terminal mode for displaying image or profile data with a CRLF after each 80-byte line.	TRM? ON TRM? OFF
TRM	Sets terminal mode for displaying image or profile data with a CRLF after each 80-byte line.For LabView set TRM to OFF.	TRM;ON; ON TRM;OFF; OFF
CMODE?	Query Capture Mode STOP, RUN, LIVE	CMODE? STOP CMODE? RUN CMODE? LIVE
CMODE;R	Set Capture Mode to Run.	CMODE;R RUN
CMODE;S	Set Capture Mode to Stop.	CMODE;S STOP
CMODE;L	Set Capture Mode to Live.	CMODE;L LIVE
SAMPLE?	Query active sample number.	SAMPLE? 112
SAMPLE;xxx;	Set active sample number.	SAMPLE;100; 100

Table 9-14. Miscellaneous Commands (Continued)

Command	Description	Example

`SCAP`	Set Active Camera
	For use when more than one cameras is connected t Beam-View.NET (Camera 1, Camera 2, and so on).
	An error is displayed when selecting a camera number that is greater than the number of available cameras.
		`SCAP;1;`
		`1`
		`SCAP;2;`
		`2`
		`SCAP;5;`
		`Error:Exceeds number of cams`

`SCAP?`	Query Active Camera For use when more than one cameras is connected t Beam-View.NET (Camera 1, Camera 2, and so on).	`SCAP?` **`1`** `SCAP?` **`2`** `SCAP?` **`3`** `SCAP?` **`4`**

9.7 Capture Parameter Commands

Table 9-15 shows commands that set capture parameters.

Table 9-15. Capture Parameter Commands

Command	Description	Examples
`SCCS?`	Query Capture Source CW/Pulsed	`SCCS?` **`CW`** `SCCS?` **`PULSE`**

`SCCS`	Set Capture Source CW/Pulsed	`SCCS;CW;`
		`CW`
		`SCCS;PULSE;`
		`PULSE`

Table 9-15. Capture Parameter Commands (Continued)

Command	Description	Examples

`SCCT?`	Query Capture Trigger
	SYNC (Freq. in Hz)
	ASYNC
	AUTO (Threshold in %)
		`SCCT?`
		`SYNC 10`
		`SCCT?`
		`ASYNC`
		`SCCT?`
		`AUTO 40`

`SCCT`	Set Capture Trigger
	SYNC (Freq. in Hz)
	ASYNC
	AUTO (Threshold in %)
		`SCCT; SYNC 10;`
		`10`
		`SCCT; ASYNC;`
		`ASYNC`
		`SCCT; AUTO 40;`
		`40`

`SCCI?`	Query Capture Interval
	Continuous
	Time (Interval mS, Sec, Min)
	Pulse (Count)
	On Key Press
	One Shot
		`SCCI?`
		`CONT`
		`SCCI?`
		`TIME 1000`
		`SCCI?`
		`PULSE 2`
		`SCCI?`
		`KEY`
		`SCCI?`
		`ONE SHOT`

`SCCI`	Set Capture Interval - Continuous
	Time
	Pulse (Count)
	On Key Press
	One Shot
		`SCCI;CONT;`
		`CONT`
		`SCCI;TIME 1000`
		`1000`
		`SCCI;PULSE 10;`
		`10`
		`SCCI;KEY;`
		`KEY`
		`SCCI;ONESHOT;`
		`ONESHOT`

Table 9-15. Capture Parameter Commands (Continued)

Command	Description	Examples

`SCCR?`	Query Capture Resolution
	Half Resolution, Full Array ON
	Half Resolution, Full Array OFF
	Full Resolution, Full Array ON
	Full Resolution, Full Array OFF
	Frame Resolution, Full Array ON
	Frame Resolution, Full Array OFF
		`SCCR?`
		`HALF 1`
		`SCCR?`
		`HALF 0`
		`SCCR?`
		`FULL 1`
		`SCCR?`
		`FULL 0`
		`SCCR?`
		`FRAME 1`
		`SCCR?`
		`FRAME 0`

`SCCR`	Set Capture Resolution
	Half Resolution, Full Array ON
	Half Resolution, Full Array OFF
	Full Resolution, Full Array ON
	Full Resolution, Full Array OFF
	Frame Resolution, Full Array ON
	Frame Resolution, Full Array OFF
		`SCCR;HALF,1;`
		`HALF,1`
		`SCCR;HALF,0;`
		`HALF,0`
		`SCCR;FULL,1;`
		`FULL,1`
		`SCCR;FULL,0;`
		`FULL,0`
		`SCCR;FRAME,1;`
		`FRAME,1`
		`SCCR;FRAME,0`
		`FRAME,0`

`SCCP?`	Query Capture Pan (x, y)	`SCCP?` `X=0 Y=0`

`SCCP`	Set Capture Pan (x, y)
	This example is for Full Array only.
		`SCCP;48,0;`
		`SCCP?`
		`48,0`

`SCYI?`	Query Capture Y axis Invert	`SCYI?`
		`OFF`
		`SCYI?`
		`ON`

`SCYI`	Set Capture Y axis Invert	`SCYI;ON;`
		`ON`
		`SCYI;OFF;`
		`OFF`

`SCBZ?`	Query Buffer Size	`SCBZ?` `256`

Table 9-15. Capture Parameter Commands (Continued)

Command	Description	Examples
SCBZ	Set Buffer Size	**SCBZ;256;** **256** **SCBZ;128;** **128**
SCBL?	Query Buffer Location Hard Drive Frame grabber	**SCBL?** **HD C:\TEMP** **SCBL?** **FG**
SCBL	Set Buffer Location The buffer directory set to the HD. Set the buffer on the Frame grabber (FG).	**SCBL;HD,C:\TEMP;** **C:\TEMP** **SCBL;FG;** **FG**
SCBA?	Query Buffer Analysis Normal/Burst NORMAL ON is EACH sample on GUI Capture Continuously is True NORMAL OFF is EACH sample on GUI Capture Continuously is False Burst is Capture ALL samples on GUI	**SCBA?** **NORMAL ON** **SCBA?** **NORMAL OFF** **SCBA?** **BURST**
SCBA	Query Buffer Analysis Normal/Burst NORMAL ON is EACH sample on GUI Capture Continuously is True NORMAL OFF is EACH sample on GUI Capture Continuously is False Burst is Capture ALL samples on GUI	**SCBA;NORMAL ON;** **NORMAL ON** **SCBA;NORMAL OFF;** **NORMAL OFF** **SCBA;BURST;** **BURST**
SCBS?	Query Background Subtract ON OFF Capture	**SCBS?** **ON** **SCBS?** **OFF** **SCBS?** **CAP**
SCBS	Set Background Subtract ON/OFF/Capture Capture (CAP) may fail with ERROR 026 when the camera picks up too much light while capturing a background map.The user can set a background bias value using the SCBB command.	**SCBS;ON;** **ON** **SCBS;OFF;** **OFF** **SCBS;CAP;** **CAP**

Table 9-15. Capture Parameter Commands (Continued)

Command	Description	Examples
`SCBB?`	Query the background Bias	`SCBB?` `1`
`SCBB`	Set Background Bias. SCBB retries to capture a Background Map with the users entered value. The Bias has to be between 1 and 8	`SCBB;4;` `4`

9.8 Analysis Commands

Table 9-16 shows the commands used to configure the apertures Inclusion area.

Table 9-16. Analysis Commands

Command	Description	Example

`ACCP?`	Query Crosshair Position OFF/ Centroid/Peak/User	`ACCP?`
		`OFF`
		`ACCP?`
		`USER COORD`
		`ACCP?`
		`CENTROID`
		`ACCP?`
		`PEAK`

`ACCP`	Set Crosshair Position Off/ Centroid/Peak/USE COORD	`ACCP;OFF;`
		`OFF`
		`ACCP;CENTROID;`
		`CENTROID`

	Move crosshair	`ACCP;USER COORD 0.51,0.41;`
`ACCA?`	Query Crosshair USER ANGLE, ELLIPTICAL	`ACCA?` `USER ANGLE 23.4`

Table 9-16. Analysis Commands (Continued)

Command	Description	Example
ACCA	Set Crosshair USER ANGLE, ELLIPTICAL	**ACCA;USER ANGLE;** **USER ANGLE** **ACCA;ELLIPTICAL;** **ELLIPTICAL**
	Change the angle of the Crosshair	**ACCA;USER ANGLE 23;**
ACIP?	Query Image Profile ON/OFF	**ACIP?** **ON**
ACIP	Set Image Profile ON/OFF	**ACIP;OFF;** **OFF** **ACIP;ON;** **ON**
ACRP?	Query Reference Profile ON/OFF, Profile/Gauss Fit	**ACRP?** **GAUSS FIT** **ACRP?** **REFERENCE FIT** **ACRP?** **OFF**
ACRP	Set Reference Profile ON/OFF, Profile/Gauss Fit. Doesn't actually start on GUI unless Image profile is on, and Gaussian Fit.	**ACRP;ON;** **ON** **ACRP;GAUSS FIT;** **GAUSS FIT**
ACFP?	Query Fit Profile ON/OFF, Gauss Fit	**ACFP?** **GAUSS FIT** **ACFP?** **OFF**
ACFP	Set Fit Profile ON/OFF, Gauss Fit	**ACFP; GAUSS FIT;** **GAUSS FIT** **ACFP;OFF;** **OFF** **ACFP;ON;** **ON**

Table 9-16. Analysis Commands (Continued)

Command	Description	Example
ACAS?	Query Aperture Shape OFF CIRCLE SQUARE ELLIPSE RECTANGLE	**ACAS?** **OFF** **ACAS?** **CIRCLE** **ACAS?** **SQUARE** **ACAS?** **ELLIPSE** **ACAS?** **RECTANGLE**
ACAS	Set Aperture Shape ON/OFF/ Circle/etc.	**ACAS;OFF;** **OFF** **ACAS;ON;** **ON** **ACAS;CIRCLE;** **CIRCLE**
ACAZ?	Query Aperture Size	**ACAZ?** **APER_DIAMETER Width=260 Height=260** **ACAZ?** **USER_SIZE Width=2200 Height=2200** **ACAZ?** **DIVERGENCE Width=260 Height=260** **ACAZ?** **GAUSSIAN DIAMETERS Width=260 Height 260** **ACAZ?** **EFF_DIAMETER Width=260 Height=260** **ACAZ?** **D4_SIG_WIDTH Width=260 Height=260** **ACAZ?** **D4_SIG_DIAM Width=260 Height=260** **ACAZ?** **KNIFE_EDGE Width=260 Height=260** **ACAZ?** **SLIT_DIAMETER Width=260 Height=260** **ACAZ?** **ELLIPTICAL_AXES Width=260 Height=260**

Table 9-16. Analysis Commands (Continued)

Command	Description	Example
ACAZ	Set Aperture Size (can set the width and height for USER_-SIZE only).The user can have different width and heights for Ellipses and Rectangles only. The Height returned for a Square or Circle will be the same as the Width.	**ACAZ;USER_SIZE 1.2,1.4;** **USER_SIZE 1.2,1.4** **ACAZ?** **USER_SIZE Width = 1.2 Height = 1.4** **ACAZ; USER_SIZE 1.00,1.4;** **USER_SIZE 1.2,1.4** **ACAZ?** **USER_SIZE Width = 1.2 Height =1.2**
ACIA?	Query Inclusion Area	**ACIA?** **H = 240 V = 260**
ACIA	Set Inclusion Area	**ACIA;120,240;** **120, 240** **ACIA?** **H = 120 V = 240**
ACIL?	Query Inclusion Location	**ACIL?** **X = 119 Y = 119**
ACIL	Set Inclusion Location	**ACIL;120,119;** **X = 120 Y = 119** **ACIL?** **X = 120 Y = 119**
ACIO?	Query Inclusion ON/OFF State	**ACIO?** **OFF** **ACIO?** **ON**
ACIO	Set Inclusion ON/OFF State	**ACIO;ON;** **ON** **ACIO;OFF;** **OFF**

Table 9-16. Analysis Commands (Continued)

Command	Description	Example

`ACRL?`	Query Reference Position	`ACRL?`
		`OFF`
		`ACRL?`
		`CROSS HAIR X = .1 Y = .2`
		`ACRL?`
		`USER COORDINATE X = .1 Y = .2`
		`ACRL?`
		`CENTROID MIN X = .1 Y = .2`
		`ACRL?`
		`CENTROID MEAN X = .1 Y = .2`
		`ACRL?`
		`CENTROID MAX X = .1 Y = .2`
		`ACRL?`
		`PEAK MIN X = .1 Y = .2`
		`ACRL?`
		`PEAK MEAN X = .1 Y = .2`
		`ACRL?`
		`PEAK MAX X = .1 Y = .2`

`ACRL`	Set Reference Position (can only change coordinates for USER COORDINATE)	`ACRLOFF`
		`OFF;`
		`OFFACRL;ON;`
		`ON`
		`ACRL;USER COORDINATE .1,.12;`
		`USER COORDINATE .1,.12`
		`ACRL?`
		`USER COORDINATE X = .1 Y = .12`
		`ACRL;CROSS HAIR;`
		`CROSSHAIR`
		`ACRL?`
		`CROSSHAIR X = .1 Y = .12`

9.8.1 Analysis Fault Actions and Units Parameters Commands

Table 9-17 shows commands that set and query the analysis fault actions and units parameters.

9.9 System Configuration Commands

Table 9-18 shows commands that set and query the Test Information parameters.

Table 9-17. Analysis Fault Actions and Units Parameters Commands

Command	Description	Examples
SCFA?	Query Fault Actions Beep Stop Reverse Background Color Image Save Discard TTL	**SCFA?** **BEEP** **SCFA?** **STOP** **SCFA?** **REVERSE BACKGROUND COLOR** **SCFA?** **IMAGE** **SCFA?** **SAVE** **SCFA?** **DISCARD** **SCFA?** **TTL PULSE**
SCFA	Set Fault Actions Beep/Stop/Save/Discard/TTL	**TURNS ON BEEP** **TURNS OFF STOP IMAGE AND SAVE** **SCFA; BEEP, ~STOP, ~IMAGE, ~SAVE;** **BEEP, ~STOP, ~IMAGE, ~SAVE**
SCUA?	Query Units Spatial Spatial Micrometers Spatial Millimeters Spatial Centimeters Spatial Meters Spatial Inches Spatial Pixels Spatial Micro Radians Spatial Milliradians Spatial Radians Spatial Degrees	**SCUA?** **UMRS** **SCUA?** **MMRS** **SCUA?** **CMRS** **SCUA?** **MTRS** **SCUA?** **INCS** **SCUA?** **PIXS** **SCUA?** **URDS** **SCUA?** **MRDS** **SCUA?** **RADS** **SCUA?** **DEGS**

Table 9-17. Analysis Fault Actions and Units Parameters Commands (Continued)

Command	Description	Examples
SCUA	Sets Units Spatial	**SCUA; UMRS;** **UMRS**
	Spatial Micrometers	**SCUA;MMRS;** **MMRS**
	Spatial Millimeters	**SCUA;CMRS;** **CMRS**
	Spatial Centimeters	**SCUA;MTRS;** **MTRS**
	Spatial Meters	**SCUA;INCS;** **INCS**
	Spatial Inches	**SCUA;PIXS;** **PIXS**
	Spatial Pixels	**SCUA;URDS;** **URDS**
	Spatial Micro radians	**SCUA;MRDS;** **MRDS**
	Spatial Milliradians	**SCUA;RADS;** **RADS**
	Spatial Radians	**SCUA;DEGS;** **DEGS**
	Spatial Degrees	
SCUL?	Query Units Position	**SCUL?** **UMRP**
	Micrometers by Position	**SCUL?** **MMRP**
	Millimeters by Position	**SCUL?** **CMRP**
	Centimeters by Position	**SCUL?** **MTRP**
	Meters by Position	**SCUL?** **INCP**
	Inches by Position	**SCUL?** **PIXP**
	Pixels by Position	**SCUL?** **URDP**
	Micro radians by Position	**SCUL?** **MRDP**
	Milliradians by Position	**SCUL?** **RADP**
	Radians by Position	**SCUL?** **DEGP**
	Degrees by Position	

Table 9-17. Analysis Fault Actions and Units Parameters Commands (Continued)

Command	Description	Examples
SCUL	Sets Units Position	**SCUL; UMRP;** **UMRP**
	Micrometers by Position	**SCUL;MMRP;** **MMRP**
	Millimeters by Position	**SCUL;CMRP;** **CMRP**
	Centimeters by Position	**SCUL;MTRP;** **MTRP**
	Meters by Position	**SCUL;INCP;** **INCP**
	Inches by Position	**SCUL;PIXP;** **PIXP**
	Pixels by Position	**SCUL;URDP;** **URDP**
	Micro radians by Position	**SCUL;MRDP;** **MRDP**
	Milliradians by Position	**SCUL;RADP;** **RADP**
	Radians by Position	**SCUL;DEGP;** **DEGP**
	Degrees by Position	
SCUP?	Query Units Power (CW only)	**SCUP?** **PUWT**
	Microwatts	**SCUP?** **PMWT**
	Milliwatts	**SCUP?** **PWAT**
	Watts	**SCUP?** **PKWT**
	Kilowatts	**SCUP?** **PGWT**
	Gigawatts	
SCUP	Set Units Power (CW only)	**SCUP;PUWT;** **PUWT**
	Microwatts	**SCUP;PMWT;** **PMWT**
	Milliwatts	**SCUP;PWAT;** **PWAT**
	Watts	**SCUP;PKWT;** **PKWT**
	Kilowatts	**SCUP;PGWT;** **PGWT**
	Gigawatts	

Table 9-17. Analysis Fault Actions and Units Parameters Commands (Continued)

Command	Description	Examples
SCUE?	Query Units Energy (Pulsed only) Microjoule /CM^2 Millijoules/CM^2 Joules/CM^2 Kilojoules/CM^2 Gigajoules/CM^2	**SCUE?** **PUJL** **SCUE?** **PMJL** **SCUE?** **PJUL** **SCUE?** **PKJL** **SCUE?** **PGJL**
SCUE	Set Units Energy (Pulsed only) Microjoules/CM^2 Millijoules/CM^2 Joules/CM^2 Kilojoules/CM^2 Gigajoules/CM^2	**SCUE;PUJL;** **PUJL** **SCUE;PMJL;** **PMJL** **SCUE;PJUL;** **PJUL** **SCUE;PKJL;** **PKJL** **SCUE;PGJL;** **PGJL**
SCUI?	Query Units Intensity (CW and Pulsed) Microwatts/CM^2 Milliwatts/CM^2 Watts/CM^2 Kilowatts/CM^2 Microjoules/CM^2 Millijoules/CM^2 Joules/CM^2 Kilojoules/CM^2 Digital % Response	**SCUI?** **UWCM** **SCUI?** **MWCM** **SCUI?** **WCM2** **SCUI?** **KWCM** **SCUI?** **UJCM** **SCUI?** **MJCM** **SCUI?** **JCM2** **SCUI?** **KJCM** **SCUI?** **DIGI** **SCUI?** **PRCT**

Table 9-17. Analysis Fault Actions and Units Parameters Commands (Continued)

Command	Description	Examples
SCUI	Set Units Intensity (CW and Pulsed)	
	Microwatts/CM^2	**SCUI;UWCM;** **UWCM**
	Milliwatts/CM^2	**SCUI;MWCM;** **MWCM**
	Watts/CM^2	**SCUI;WCM2;** **WCM2**
	Kilowatts/CM^2	**SCUI;KWCM;** **KWCM**
	Microjoules/CM^2	**SCUI;UJCM;** **UJCM**
	Millijoules/CM^2	**SCUI;MJCM;** **MJCM**
	Joules/CM^2	**SCUI;JCM2;** **JCM2**
	Kilojoules/CM^2	**SCUI;KJCM;** **KJCM**
	Digital	**SCUI;DIGI;** **DIGI**
	% Response	**SCUI;PRCT;** **PRCT**
SCUT?	Query Units Time	
	Milliseconds	**SCUT?** **MSEC**
	Seconds	**SCUT?** **TSEC**
	Minutes	**SCUT?** **TMIN**
SCUT	Set Units Time	
	Milliseconds	**SCUT;MSEC;** **MSEC**
	Seconds	**SCUT;TSEC;** **TSEC**
	Minutes	**SCUT;TMIN;** **TMIN**

Table 9-18. System Configuration Commands

Command	Description	Example
TITL?	Query Test Info Title.	**TITL?** **TEST 004**
TITL	Set Test Info Title.	**TITL;TEST 044;** **TEST 044**
TISN?	Query Test Info Serial Number	**TISN?** **004**
TISN	Set Test Info Serial Number	**TISN;005;** **005**
TIOP?	Query Test Info Operator	**TIOP?** **JOE**
TIOP	Set Test Info Operator	**TIOP;ABE;** **ABE**
TICM?	Query Test Info Comment	**TICM?** **ABES TEST**
TICM	Set Test Info Comment	**TICM;JOES TEST;** **JOES TEST**
TIWS?	Query Test Info Work Station	**TIWS?** **USER 001**
TIWS	Set Test Info Work Station	**TIWS;USER 002;** **USER 002**

9.9.1 Scale Factor, Focal Length, and Power Parameter Commands

Table 9-19 shows commands that set and query the set-up > scale factors, focal length, and calibrated power parameters.

Table 9-19. Scale Factor, Focal Length, and Power Parameter Commands

Command	Description	Examples
`SCSF?`	Query Scale Factor	`SCSF?` `1.00000`
`SCSF`	Set Scale Factor	`SCSF;2;` `2`
`SCFL?`	Query Focal Length	`SCFL?` `100.0000`
`SCFL`	Set Focal Length	`SCFL;200;` `200`
`SCPC?`	Query Power Calibrate	`SCPC?` `1`
`SCPC`	Set Power Calibrate	`SCPC;2.4;` `2.4`
`SCEC?`	Query Energy Calibrate	`SCEC?` `1`
`SCEC`	Set Energy Calibrate	`SCEC;2.4;` `2.4`

10 Troubleshooting, Tips, and Best Practices

The following sections describe some common issues and solution, as well as tips and best practices when using BeamView.NET software.

10.1 Categories of Errors

Most issues reported by users of the BeamView.NET software fall into a few categories.

- Errors with Set-Up or Camera
  - USB error
  - Camera not connected or recognized
  - Camera disconnected or underpowered
  - Camera needs calibration
  - Camera not compatible with software
- Operating Errors
  - BeamView.NET does not capture beam images (or stops capturing)
  - See only fragments of the beam
  - Printout has dots in the image background
  - Loss of TCP/IP connection
- Analysis Errors
  - Background noise is too high
  - Calculations do not update fast enough
  - Divergence measurement seems too large
  - Percent energy in the aperture is too large
  - Profiles are “flat topped”
  - The beam is very small
  - The Centroid does not track well
- Errors with Remote Mode
  - No response on terminal screen

10.2 Errors With Set-Up or Camera

General errors may be displayed when using a camera that is not connected corrected or there are other compatibility issues.

10.2.1 USB Error

When using a USB connection, the computer's operating system may display an error message warning about low power on a USB port.

This type of error occurs when a laptop is operating on a low battery or the USB bus is overloaded and unable to supply the 500 mA power required for a USB 2.0 connection.

When troubleshooting, it has been noted that certain systems are not capable of supplying the needed current to its USB ports.

If there are problems with a connection or software freezing, consider the use of a USB hub with its own power supply. These powered USB hubs maintain current to the external USB device if the computer or laptop is unable to do so.

CAUTION!
Connect ALL power cables must be attached to a surge-protected power source!

10.2.2 Camera Not Connected or Recognized

When a LaserCam camera is either not connected or is not being recognized by the computer, the area above the Calculations panel displays "No camera Attached".

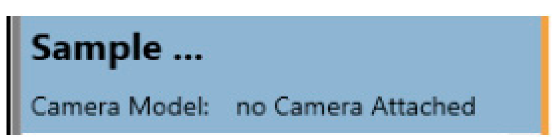


Figure 10-1. Error Message: No Camera Connected

Check the USB connections to the camera. If the USB cable is properly connected, check in Device Manager on the computer to be sure the camera's USB drivers have been installed properly.

The application is now in Analysis Only mode. The Analysis mode of BeamView.NET allows for the full analysis of a previously stored image or the importation of an .ats test session file. Previously stored images, ats files, and data files can be accessed using the File > Open command.

To return to Capture mode, close the application, connect the camera, and restart.

10.2.3 Camera Disconnected or Underpowered

The following error message is displayed when the camera is disconnected or possibly underpowered. Try moving the cable to a different USB port.

Figure 10-2. Error Message: Connection with Camera

10.2.4 Camera Needs Calibration

The Calibration Error message indicates that the gamma correction table in the camera has been either incorrectly stored or corrupted. Contact Coherent Customer Support to arrange for evaluation of the camera evaluated and potential reprogramming.

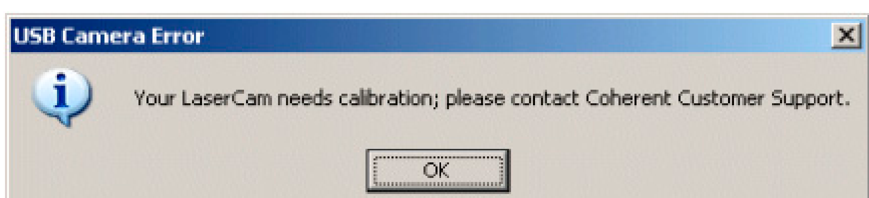


Figure 10-3. Error Message: Camera Needs Calibration

10.2.5 Camera Not Compatible with Software

A compatibility error occurs when the camera and software are not designed to work together. Contact Coherent Customer Support for the right match.

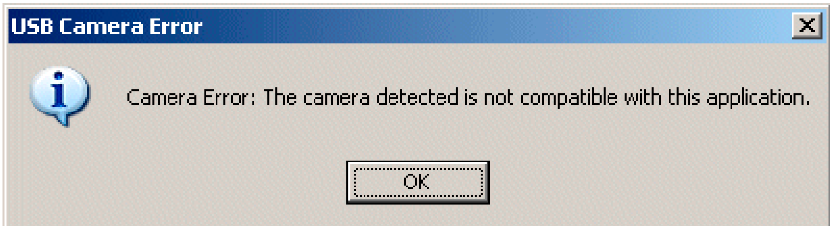


Figure 10-4. Error Message: Compatibility with Camera

10.3 Operating Errors

Operating errors include:

- BeamView.NET does not capture beam images (or stops capturing)
- See only fragments of the beam
- Printout has dots in the image background
- Loss of TCP/IP connection

10.3.1 BeamView.NET does not capture images (or stops)

An error is displayed if the BeamView.NET software does not capture beam images or if it stops capturing after a number of images have been captured.

Check the following:

- Check that the BeamView.NET software is not in Stop mode. Do this by verifying the Stop icon button on the Toolbar is not depressed, or look at the left side of the Status bar to see if it indicates "Stopped".

  If the BeamView.NET software is in Stop mode, select the Start icon button on the Tool Bar or, use the Start command to resume capturing samples.

- Check that the sample buffer size in the Size area of the dialog box is set for the sample size expected. The BeamView.NET software halts after the specified number of samples is reached. Checking the “Capture continuously” check box causes the BeamView.NET software to capture continuously over old images and wrap around to the beginning of the sample buffer without stopping.

- Check that the proper laser source is selected in the Status bar. If Pulse is displayed in the panel, the BeamView.NET software may be waiting for an input trigger. If the LaserCam is being used in Pulsed mode and is capturing only blank images, trigger timing may be the problem.

- When Image-Discard is checked in Fault Action settings, make sure that range limits are not set to discard all captured images. The BeamView.NET software appears to be “locked up” and does not store data, when in actuality every image is being discarded. See ’Image Save | Discard’ (p. 137) for more information.

10.3.2 See Only Fragments of the Beam

An error is displayed if the displayed beam image seems to have almost totally disappeared in the View area, or only a small portion of the beam is visible.

Verify that a Background Map command was not taken while an image was on the camera. If a Background Map is taken with an image on the camera, the BeamView.NET subtracts a beam image from all subsequent images and only the portion of the beam that changes is seen.

To check this:

1. Select the Background Map command from the Capture menu (see p. 74).
2. Turn Off the background subtraction.
3. Go back to the View area and capture images.

The image should now be displayed normally.

10.3.3 Dots in the Image Printout

An error is displayed if the image displayed dots in the image background, similar to the sample shown here:

Notice the black dots around the beam. This effect occurs when the image is captured with a background noise level that is too high.

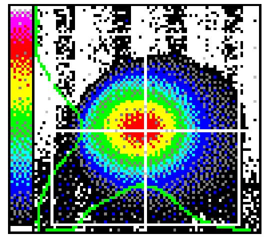


Figure 10-5. Error: Printout has Dots

By default, the print routine turns the bottom four levels of the image to white to help conserve black ink. On properly adjusted images, using background subtraction produces clear printouts.

To tell if the image taken has the proper background levels, be sure to turn on the Automatic Background Warning Level indicator. If this feature is already on, the "Warn" indicator on the right edge of the status bar should be On.

To correct the background problem, click on the warning panel and a Help topic describing the corrective action is displayed.

10.3.4 Loss of TCP/IP Connection

Loss of a TCP/IP connection typically occurs when the computer is assigned an IP address via DHCP.

If the computer that is running BeamView.NET loses its DHCP lease, the DHCP server has to assign the computer a new IP address. (IP addresses are typically allocated to a system only for a fixed period of time.) The DHCP server may assign the computer an address other than the original address. If this happens, BeamView.NET no longer recognize packets that have the old address (this is true, even if the computer is connecting to itself).

Note that "localhost" and "127.0.0.1" are special addresses that always indicate "this computer"— no matter what the computer's assigned external address. When the client and server applications are running on the same system, using "localhost" avoids dropped connections caused by changes to the IP address.

10.4 Analysis Errors

Analysis errors in BeamView.NET include the following:

- Background noise is too high

- Calculations do not update fast enough
- Divergence measurement seems too large
- Percent energy in the aperture is too large
- Profiles are “flat topped”
- The beam is very small
- The Centroid does not track well

10.4.1 Background Noise Is Too High

If the cross-hairs or the diameter calculations do not seem to be tracking the beam correctly, most likely the software is picking up noise from the camera. In such cases, capturing a new Background Map or adjusting the Inclusion Zone could possibly help.

The Background Map function helps maximize system dynamic range by eliminating fixed-pattern noise and ignoring bad camera pixels. For information about collecting a Background Map, see ’Background Map’ (p. 74).

NOTICE
BeamView.NET cannot distinguish between background noise and a true beam profile signal. The background noise must be minimized to perform accurate beam diagnostics.

Several sources of background noise can contribute to the overall noise level in the beam images. Before collecting a Background Map, sources of Background Noise must be reduced as much as possible. If too high, check these sections to reduce Background Noise:

- Sources of Background Noise
- Monitor Background Noise Level
- Noise Reduction
- Eliminate Background Light

Also see information about ’Background Light’ (p. 32) and ’Background Map’ (p. 74).

10.4.1.1 Sources of Background Noise

High quality, low distortion optics, and low background light noise—free from video electronic noise—are CRITICAL to accurate beam diagnostics results.

Electronic noise in a video image is a common concern whenever video systems are used in association with lasers. This is especially the case with Q-switched lasers. Take special care to avoid placing any of the cables in a manner that could make them susceptible to EMI associated with the laser system.

High-frequency sources can also induce noise into the cables and camera electronics. Avoid grounding the camera with the laser or its power supply in a manner that could make them susceptible to ground loops. Severe damage to the camera and synchronization electronics may result.

NOTICE
If using the background subtraction function is used and cameras need to be changed, users must take a new Background Map since a different camera has its own unique background level **(see p. 74).**

Background light noise seen by the camera is another problem that should be closely monitored. This noise can come from sunlight, room lights, flash lamps, and instrumentation lights.

To offset some of these issues, users can attach an attenuator window of polished NG-type absorption glass (with low transmission) to the camera housing to reduce background light. The Low Distortion Face Plate (LD-FP) included with the LaserCam-HR cameras serves this purpose. This allows diagnostics to be performed in a lighted room.

10.4.1.2 Observe Background Noise Levels

When enabled, the BeamView.NET software continuously monitors the background noise level during image capture, and issues a warning if that noise level is significant enough to affect calculation accuracy.

10.4.1.2.1 Display a Warning Message

By examining the intensities of groups of pixels in each corner of the image, the BeamView.NET software can determine the background noise level. If the noise level is determined to be incorrect, the right side of the Status bar displays the word "WARN".

If the WARN indicator is present, click on it to find out what corrective steps should be taken. If this fails to remove the WARN indicator, follow the steps below to check for other sources of noise. Users can also display the background warning by selecting “Background Warning” from the Help menu.

10.4.1.2.2 Check for Background Noise

To check for background noise:

1. Remove any background light, electronic noise, or thermal noise.
2. Capture a Background Map. A Background Map is basically an image of the fixed-pattern noise, which is subtracted from captured beam images before image analysis is performed (see ’Capture > Collect a Background Map’ (p. 75)).
3. If there is still significant random noise after the fixed-pattern noise has been subtracted out, a bias value may need to be added/ increased. The bias value reduces pixel intensity levels for every pixel in the image. The bias factor should be kept as small as possible, because it could remove beam information as well as noise.

To turn the Background Warning indicator On:

1. Run ’Background Map’ (p. 74).
2. Check “Enable Background Noise Level Monitoring” in the last dialog box.

10.4.1.3 Noise Reduction

Most of the sources of background noise can be eliminated by taking the time for proper precautions when setting up the BeamView.NET software.

All noise reduction efforts should first be performed optically:

- The best way to determine the background noise level is to block the laser beam at the laser output port and observe the intensity at the array while the laser is still operating.
- Check attenuation at the camera, shielding to avoid stray light, or darken lights in the room lights to eliminate background light before using the background subtraction feature.
    - Block or cover the camera array so that no light can possibly be detected. In the Results area, check if the minimum, mean, or maximum (Uniformity: Min, Mean Max) values change when the camera array is blocked.

- If so, the camera is sensing background light and requires more light baffling, darker room conditions, or background attenuation.

Next, set up the BeamView.NET software:

1. In the Analysis menu, use the Apertures command and Calculations command to turn on the overlaid Aperture and Aperture Uniformity calculation. Set the aperture size to the maximum size allowed.
2. In the View menu, use the Crosshair command to set the Crosshair position to USER COORD
3. In the Capture menu, use the Resolution command to set the Track position to pixel in the Resolution capture mode.

This procedure sets up the BeamView.NET software to take the uniformity measurement over the entire image area.

This procedure can be used to evaluate possible electronic noise sources. By monitoring the minimum, mean, and maximum values while moving cables, turning off possible noise sources, or adding electronic shielding, users can identify and eliminate some sources of noise.

Accuracy depends on taking the time to eliminate background noise sources as much as possible.

10.4.1.4 Eliminate Background Light

See ’Background Light’ (p. 32) for details about eliminating background light when using optics. Using a Low Distortion Faceplate (LDFP) is also recommended.

10.4.2 Calculations Not Updating Fast Enough

There many things that can influence the speed of the calculations. Here are several suggestions for speeding up the calculations:

- Turn off calculations that are not needed or not being used. Each calculation slows down the update rate. Calculations such as Divergence, Gaussian Fit, and Ellipticity take more time to process than the other calculations.

- Using an Inclusion Area reduces the amount of data processed (see ’Analysis > Inclusion Area’ (p. 143). If using a very small beam or if the Background Map feature does not cancel out all of the noise on the camera, check the Inclusion Zone.

- If Background Noise Level Monitoring is active, the calculations can be increased by turning it off in the 'Background Map' (p. 74).

- Consider using Analysis After ALL Samples Captured. This mode captures images faster because it does not take time to analyze them.

  After the capture cycle is completed, the specified number the images are then analyzed. See the 'Capture > Buffer' (p. 88) to learn about these settings.

10.4.3 Divergence measurement seems too large

If the divergence measurement seems too large, some possible causes include:

- Incorrect focal length is specified in the Focal Length command of the Setup menu.

- Too much background noise is present on the camera.

Possible solutions:

- Double check the focal length setting in the Focal Length command.

- Place an aperture around the beam using the Apertures command of the Analysis menu and check that the percent energy is greater than 90%.

  If the percent energy is less than 90%, use the suggested solutions under Background noise is too high and The beam is very small.

10.4.4 Percent energy in the aperture is too large

If the percent energy in the aperture is too large, a possible cause may be that a Background Map has a Bias Value that is set too high.

Consider reducing the background Bias Value by using the Background Map command in the Capture menu.

10.4.5 Profiles are 'flat topped'

If the horizontal or vertical profiles appear to be "flat topped" in the View area, no matter how much light is put on the camera, the peak intensity does not reach 100%.

If the problem only occurs with Background Subtraction On, try reducing the Bias value using the Background Map command in the Capture menu (see p. 74).

10.4.6 The beam is very small

If the beam is small, use the Inclusion feature to reduce the image area used in the calculations to a small rectangular area surrounding the small beam. This has two positive effects:

- It does not take into account all the noise that may be present outside of the inclusion area.
- It speeds up calculations.

To activate the Inclusion feature, see the Inclusion command in the Analysis menu.

Another solution is to change or add optics to magnify the beam size onto the array. The Scale Factor setting allows the results to take into account the added magnification (see 'Setup > Scale Factor' (p. 64)).

The Focal Length setting allows a longer focal length focusing lens or mirror to be used to enlarge the Far Field beam image for Divergence measurements (see Focal Length Command in the Setup menu).

10.4.7 The Centroid does not track well

If the calculated centroid of the beam is moving around (bouncing), or if it is off to the side from the apparent true centroid, this is an indication that the background noise is too high or that the beam is too small.

10.5 Errors in Remote Mode

If there is no response on terminal screen:

1. Make sure that the computers are connected through the correct COM ports with a NULL modem cable.
2. Make sure that the serial COM port settings match in BeamView.NET and the terminal program.
3. Try to replace BeamView.NET with a terminal session, and check if the two terminal sessions can communicate. That can isolate the problem to Hardware or incorrect settings.

Use the Serial Connect/Disconnect button on the right end of Beam-View.NET toolbar for fast single-click control of the connection.

Capture may fail with ERROR 026 when the camera picks up too much light while capturing a background map.The user can set a background bias value using the SCBB command (see p. 177).

10.6 Errors Codes from the HELP Command

Table 10-1 lists the error codes when using the Help command.

Table 10-1. Error Codes from the Help Command

Error	Description
001	New sample is greater than current sample.
002	HELP command is not recognized.
003	File is password protected.
004	File Load or Save Configuration is invalid file type; should be ATC.
005	Unable to open file.
006	Save Images – nothing selected.
007	Save Images – invalid image.
008	Save Images – Unable to obtain memory to save compressed images. Will save as uncompressed.
009	Export Image File is invalid; it needs to be type BIN.
010	Save Test As File is invalid; it needs to be type ATS.
011	Invalid command.
012	Row too large.
013	Wrong Trigger Mode.
014	No pre-existing Background Map.
015	Selected Profile has no binary data and cannot be displayed.
016	Selected Profile is OFF and cannot be displayed.
017	Invalid Repeat Command.
018	Unable to obtain Latest Divergence.

Table 10-1. Error Codes from the Help Command

Error	Description
019	Unable to Set this parameter.
020	Unknown Units.
021	Unknown Crosshair Position.
022	Unknown Crosshair Angle Setting.
023	Unknown Aperture Size.
024	DLL error.
025	Unable to write to INI.
026	BG Map; A/D Adjust as necessary.
027	BG Map; invalid Bias.
028	SCBL; Unable to find directory.
029	SAMPLE – Sample number is greater than maximum allowed.
030	There is NO parameter value.
031	This Calculation is turned OFF.
032	The units are invalid for this Calculation.
033	The configuration file does not exist.
034	Unable to perform Calculation. No Image.
035	Units not valid for CW mode.
036	Units not valid for Pulsed mode.
037	Invalid Port.
038	Unable to set Fluence Value.

10.7 Tips and Best Practices

This section provides additional information about best practices, tips, and general information to optimize results when using the BeamView.NEt software. This includes such topics as:

- Exporting a binary file
- Ghosting images and solutions
- Camera drawings for depth to imager clarifications
- Preventing contamination
- Optimizing camera calculation

10.7.1 Exporting a Binary File

Exporting Images as a .bin file saves all selected images into one file. Exporting and Importing a .bin file is faster than the other options. It also take up less hard disk space on the computer.

When a binary file is exported, a header is attached to the beginning. This is followed by all selected Images being exported. Images are appended one after another in the file.

The exact size of a header is 128 bytes:

Images: Height = 1024, PixelsPerRow = 1280, sizeOfPixel = 2

PixelsPerRow* sizeOfPixel = bytesPerRow = 2560

Height * bytesPerRow = ImageSize = 2621440 bytes

Header file +2621440 = 2621568 bytes

The remote interface commands for BeamView.NET are the only way to get images or calculations out of the BeamView.NET software. There is no way to directly access the images from the camera itself without the BeamView.NET software. The images that are collected by the camera are a very raw format and they do not have any type of background subtraction or linearity correction performed on them.

In addition, the BeamView.NET software adds some image correction and noise subtraction from the raw camera images in order to produce an accurate beam image on which calculations can be performed. These images can then be exported from BeamView.NET and imported into other programs.

BeamView.NET is focused on data evaluation from the camera. The data is then reviewed in BeamView.NET and is not really designed to be used outside of the software; however, it can be done and will take more work for the user.

Exporting binary files to transfer images directly to LabVIEW or MatLab for analysis is generally not useful because they are not a true representation of the beam.

10.7.1.1 Working with LabVIEW

BeamView.NET is compatible with LabVIEW. The basic commands outlined in the 'Remote Mode Host Communication Protocols' (p. 163) can be interfaced through the LabVIEW application. This acts as a wrapper for the Host commands. The BeamView.NET application must still be used and the application must be set to Remote to run LabVIEW.

Exporting the images to LabVIEW is really of no value. LabVIEW is used to remotely drive the camera through the BeamView.NET software. However, if the customer is simply looking for a way to remote commands to the camera and take images at some rate, this can be done in LabVIEW. The images must later be loaded into BeamView.NET for data evaluation.

An option is to first run the BeamView.NET Data Logger application (described in 'Remote Mode Set Up' (p. 151)) and make sure they can run all of the commands that they want to use to get the camera to do the functions that they want. The next step is to do the same thing in LabVIEW. Again, though, the user must still use the BeamView.NET software to review the images once they are collected.

10.7.1.1.1 Working with MatLab

Remember that MatLab is not an API, so users cannot interact with the BeamView.NET software directly through MatLab.

This can be done directly through the BeamView.NET software or by using the remote commands. However, the images would have to be saved into the BeamView.NET software, then exported, then imported into MatLab. There is no feature in BeamView.NET to allow images to be streamed into another program or a specific folder location.

10.7.2 Ghosting Images

With the introduction of the LaserCam HR II CCD camera many improved performances have been realized. Lower overall noise, increased sensor sizing and extension of the product due to obsolescence issues of the CMOS predecessor. It is important to understand that due to the chip structure camera pixels on the memory layer and the process to get the data to the processor, there are Interactions with IR wavelengths exhibits some vertical artifacts that can negatively impact calculations of beam diameter.

The 1/2" version of the camera is more susceptible to this than the 2/3" version, but both of these cameras can exhibit unacceptable errors in some situations. It is important to understand the methods to compensate for these errors.

- Increasing the integration time and attenuation reduces this effect significantly. The best trade-off on accuracy and frame rate is near 100ms, but the ⅔" camera performs acceptably at integration times as low as 10ms.

- Inclusion Zone, adding an inclusion zone that effectively subtracts unwanted artifacts from the camera calculation will improve the behavior considerably.

10.7.2.1 Examples of Ghosting

Figure 10-6 shows examples of ghosting and the effects of integration time. Notice how the camera picks up the artifacts with the use of our 1047nm laser. The effects of integration time have significant change on the ghost image.

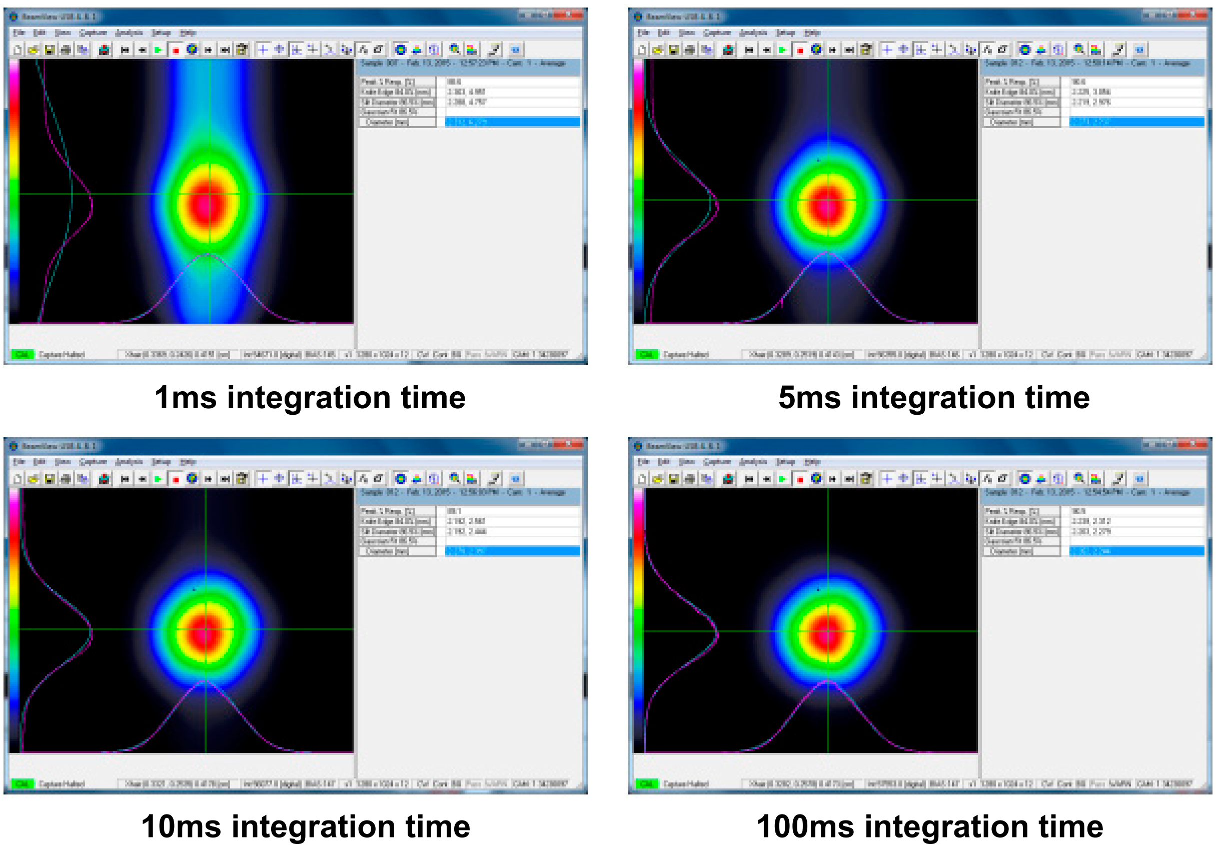
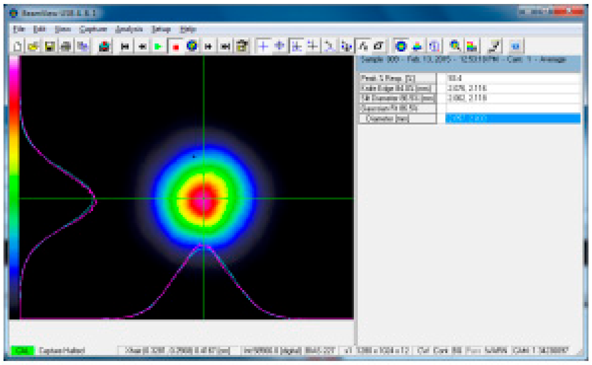


Figure 10-6. Examples of Ghosting



1s integration time

Figure 10-6. Examples of Ghosting

10.7.2.1.1 Examples of Use with Inclusion Zone

Using the inclusion zone selects the area in which the camera will use in its data calculations. This effectively discards all data outside of the selected area.

When using the LaserCam HR 2/3" camera, the effects of ghosting are almost eliminated with a 10ms integration time, as shown in Figure 10-7.

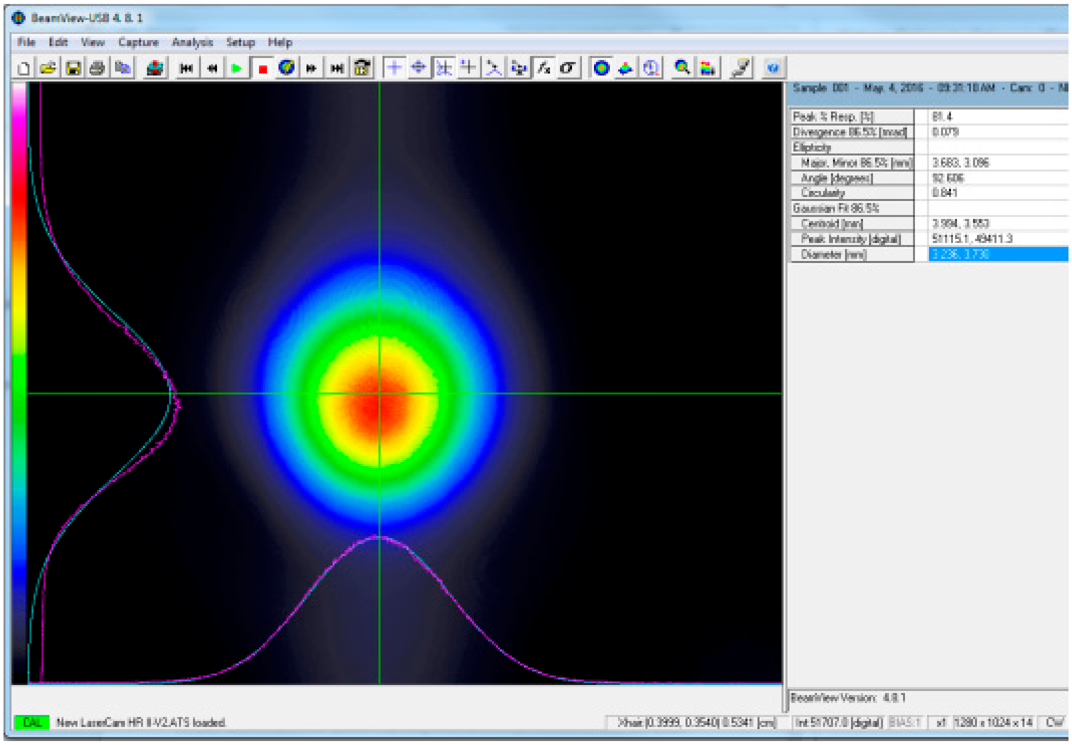
10.7.3 Depth-to-Housing

Depth-to-housing is a reference to the physical dimensions of the device for the following cameras, listed in Table 10-2:

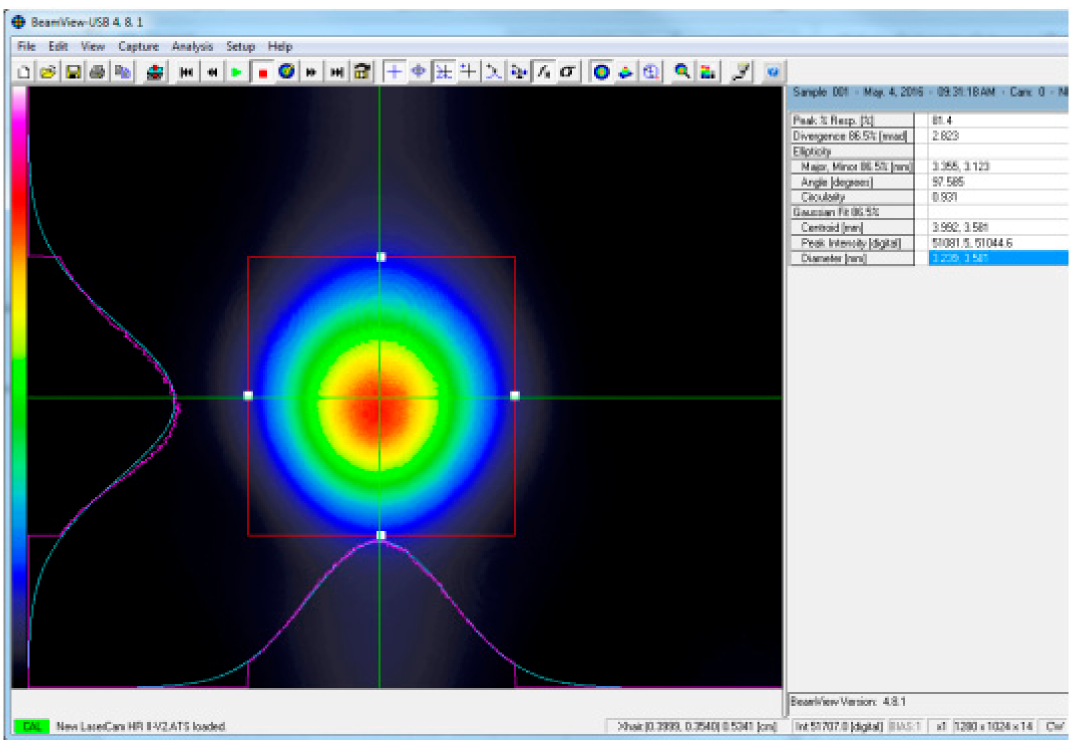
Figure 10-8 shows the depth to housing for the Laser Cam II 1/2" USB Camera system (P/N 1282868):

10.7.4 Prevent Contamination

The CCD array is very sensitive to contaminates. This is the reason for the Low Distortion Faceplate (LDFP) or other sealing type of protective window. When the unit is open to the environment, the bare CCD chip can be easily contaminated by particles and debris that are very difficult to remove.



1ms integration time



10ms integration time

Figure 10-7. Examples of Using the Inclusion Zone

Table 10-2. Depth to Housing

P/N	Camera	Depth to Housing
1282868	LaserCam HR II 1-2/" USB	0.68 in [17.1 mm]
1282870	LaserCam HR II 2/3" USB	0.68 in [17.1 mm]
1360550	LaserCam HR II UV	0.67 in [16.9 mm]

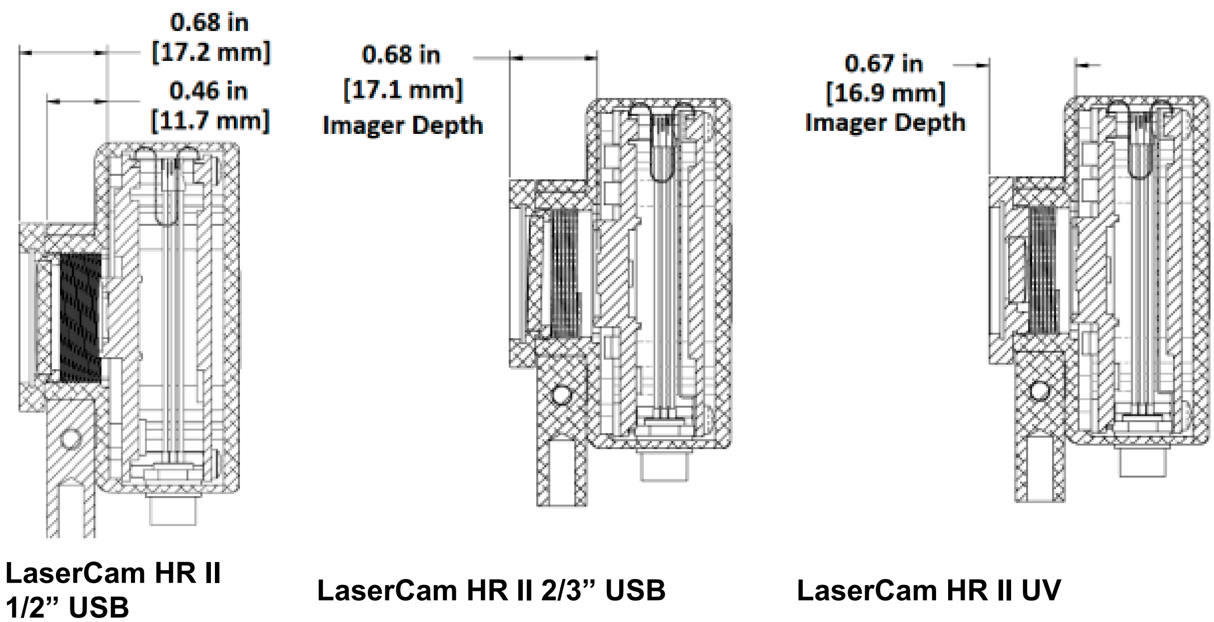


Figure 10-8. Depth to Housing: LaserCam HR II Cameras

Contamination of the imager can also occur when removing the filter. In addition, the attempted removal of debris by a user destroys the imager. To check for symptoms of damage:

- Does the camera currently produce images?
- Does BeamView.NET display only a white screen or bright color, or streaks of color?
- Are marks visible on the image that stay with the camera and appear to block or reduce the image intensity on the defect site?

These are indications that the imager has already been damaged by a cleaning attempt. If the imager has already been damaged, it is less expensive to replace the Camera then repair the unit.

Removal of the Low Distortion Faceplate (LDFP) or other protective window should not be done except when following these recommendations:

- Perform the window exchange under a flow hood, or in a clean room.
- Never leave the CCD array open to the environment.
- Make sure that the protective window being installed has been correctly cleaned before use.

10.7.5 Optimizing Camera Calculations

This section describes what to do to get the most out of the camera calculation.

WARNING!
Coherent cameras are provided with an LDFP filter to protect the imager from contamination. Removing the LDFP filter can allow contamination of debris and affect the image of the camera. These imagers cannot be cleaned in the same way as normal optical components. In most cases, cleaning attempts result in complete camera failure.

A camera needs only a handful of mW to get a good image. The question is how to take a laser and attenuate it down to a level to get the most data from the camera without saturating and loosing valuable information.

Filters have a fixed density, and the camera must have the input power adjusted to properly create the right amount of peak response for the best image. Many times, users need to control the amount of power going into the camera to select a desired level. This requires constant laser power and the ability to knock that power down to a level that would be useful for the camera.

Because lasers are limited in their ability to get a specific power and achieve lasers stability level, Coherent offers variable attenuation options. The use of a C-VARM provides dynamic control of the power level and perfectly controls the power. This assumes users have 1W or less of incoming power. If there is more power than this, then additional attenuation is required. BCUBEs or fix optical attenuation work in this case.

10.7.5.0.1 Laser-Grade Attenuation Optics for Cameras

Features of laser-grade attenuation optics for cameras include:

- Laser-grade attenuation optics

- Compatible with all Coherent beam diagnostic cameras
- Virtually undistorted and interference-free attenuation
- Variable and fixed attenuation for beams up to 2000W/cm2 or 50J/cm2
- C-Mount threads couple directly to cameras

10.7.5.1 Attenuation Optics and Accessories

Most cameras are too sensitive for direct viewing of laser beams. For example, a typical diagnostics camera saturates at only ~0.5 μW/cm2 power density (at ~633 nm) or at ~9 nJ/cm2 (at 1064 nm) pulsed energy density. If the camera has an electronic shutter, it can be used for some CW beam attenuation, but there is more flexibility in using optical attenuation.

Any attenuation optics introduced in the beam path must be manufactured to exacting specifications. The optics must be laser-grade substrate, and use the proper flatness and wedge to avoid etaloning and fringing, so that the beam is not distorted by the introduction of the attenuation.

Coherent offers attenuation optics that are designed to these specifications and packaged for use with our cameras.

Typical attenuations are 1:1 to 400,000:1, but even larger attenuations are possible. All Coherent diagnostic cameras accept C-Mount optics and accessories, and are delivered without a standard window in front of the sensor array. Such windows are liable to distort the optical beam. However, a LDFP (Low-Distortion Face Plate) filter is supplied with each camera purchased from Coherent. The LDFP is a laser-grade optic specified and polished for diagnostics use. It is mounted in a housing with C-Mount threads and provides attenuation of room light so that the camera can be used with the lights on. For operation below 400 nm, the LDFP must be removed.

The Continuously Variable Attenuator Modules (C-VARM and UV C-VARM) contain two wedge attenuators that are continuously variable and a step attenuator that allows attenuation from 107:1 down to 3000:1. The C-VARM and UV C-VARM can be finely adjusted to achieve both precise attenuation levels and maximum use of the camera’s optical dynamic range.

The Variable Attenuator Module (VARM) is a triple-wheel filter holder that contains three filters per wheel. The filters are made to our exacting specifications for transmission value and material quality. The VARM is adjustable in attenuation in 64 discrete steps of approximately 16% reduction each time from 400,000:1 down to 1:1. The VARM can be easily returned to exactly the same attenuation level as previously used.

The BeamCUBE Fixed-Attenuator Modules (BCUBE and UV-BCUBE) provide fixed attenuation and beam pickoff for performing diagnostics on high power laser sources. The BCUBE and UV-BCUBE utilize the front surface reflection from an uncoated laser mirror to achieve beam samples at 2% to 10% of the incident radiation, depending upon beam polarization. Multiple BCUBEs can be coupled together for even higher fixed attenuation levels

BCUBE, UV-BCUBE, VARM, C-VARM, UV C-VARM and all other Coherent cameras have female C-Mount threading, making them easy to connect with the male C-Mount connection flange provided with each attenuator. Also, all attenuators have 1/4-20 tapped holes for independent post or plate mounting.

The C-Mount flanges (threaded rings) also have a female RMS microscope thread. This allows a microscope objective to be coupled to the attenuators and extension barrels in order to create a flexible close-up imaging system for analysis of small/focused beams, fiber optics, laser diodes or LEDs.

10.7.5.2 Avoiding Multi-Filter Beam Distortion

The wavefront distortion through a number of optical filters can be calculated by taking the square root of the sum of the squares of the wavefront distortion of the individual components. For example, if the individual optics are made to λ/10 specifications and six are used, a total λ/4 RMS wavefront distortion will be introduced to the beam:

$$\sqrt{\ } \ 0.12 + 0.12 + 0.12 + 0.12 + 0.12 + 0.12 = 0.25$$

In general, a camera cannot sense less than ~λ/4 total distortion in the beam, so if a series of filters is used, they must be made to very exacting laser-grade specifications. Attenuating optics from Coherent are manufactured to better than a λ/10 surface specification, so at least six optics in series can be used. Calculate the Low-Distortion Face Plate (LDFP) and each BCUBE as one optic, and the VARM or C-VARM as three optics each.

10.7.5.3 Attenuator Selection

Attenuation is selected on the basis of power density in W/cm2 or energy density in J/cm2. The attenuation from the camera's Low-Distortion Face Plate (LDFP) allows an average power density of up to 1.2 mW/cm2.

There are only two more steps to attenuation selection:

1. Choose either the VARM or the C-VARM for up to 1W/cm2.
2. In addition or alternatively, use a BCUBE beam splitter module to pick off between 2% and 10% of the beam (depending on polarization and wavelength).

For more information and assistance with attenuator selection, call a Coherent representative (Toll Free at 1-800-343-4912), go to shopcoherent.com, or contact Coherent Technical Support (see ’Service and Support’ (p. 225)).

Appendix A: Safety and Compliance

This section describes requirements for safety for persons setting up or operating the BeamView.NET software in an environment:

- ’Laser Safety Hazards’ (p. 217)
- ’Optical Safety’ (p. 218)
- ’Laser Back Reflection’ (p. 219)
- ’Safety Precautions for Cameras’ (p. 222)

Users must review these laser safety sections thoroughly BEFORE operating the BeamView.NET software. Carefully follow all safety instructions presented throughout this manual.

NOTICE

This user information reported in this manual is in compliance with the following standards for Light-Emitting Products EN/IEC 60825-1 *“Safety of laser products – Part 1: Equipment classification and requirements”* 21 CFR Title 21 Chapter 1, Subchapter J, Part 1040 *“Performance standards for light-emitting products”*.

A.1 Laser Safety Hazards

Hazards associated with lasers generally fall into the following categories:

- Biological hazards from exposure to laser radiation that may damage the eyes or skin
- Electrical hazards generated in the laser power supply or associated circuits
- Chemical hazards resulting from contact of the laser beam with volatile or flammable substances, or released as a result of laser material processing

The above list is not intended to be exhaustive. Anyone operating a laser must consider the interaction with its specific working environment to identify potential hazards.

For the BeamView.NET software, hazards vary with the input angle and the laser beam.

WARNING!
LASER RADIATION! Always avoid eye or skin exposure to both DIRECT and SCATTERED radiation.

A.2 Optical Safety

Laser light, because of its optical qualities, poses safety hazards not associated with light from conventional light sources. The safe use of lasers requires all operators, and everyone near a laser, to be aware of the dangers involved. Users must be familiar with the instrument and the properties of coherent, intense beams of light.

The safety precautions listed below are to be read and observed by anyone working with or near the laser. At all times, ensure that all personnel who operate, maintain or service the laser are protected from accidental or unnecessary exposure to laser radiation exceeding the accessible emission limits defined in the laser safety standards.

WARNING!
Direct eye contact with the output beam from the laser may cause serious eye injury and possible blindness.

The greatest concern when using a laser is eye safety. In addition to the main beam, there are often many smaller beams present at various angles near a laser. These beams are formed by specular reflections of the main beam at polished surfaces such as lenses or beamsplitters. While weaker than the main beam, such beams may still be sufficiently intense to cause eye damage.

Laser beams are powerful enough to burn skin, clothing, or combustible materials, even at some distance. They can ignite volatile substances such as alcohol, gasoline, ether, and other solvents, and can damage light-sensitive elements in video cameras, photomultipliers, and photodiodes.

A.2.1 Laser Safety Eyewear

Always wear appropriate laser safety eyewear for protection against the specific wavelengths and laser energy being generated.

The appropriate eye protection can be calculated as defined in the 'EN 207 Personal eye protection equipment—Filters and eye-protectors against laser radiation (laser eye-protectors)', in other national or international standards (such as ANSI, ACGIH, or OSHA) or as defined in national safety requirements.

CAUTION!
Laser safety eyewear protects the user from accidental exposure to laser radiation by blocking light at the laser wavelengths. Always wear the appropriate laser safety glasses matched to the lasers used in the environment.

Because laser safety eyewear may also prevent the operator from seeing the beam or the beam spot, exercise caution even while wearing safety glasses.

A.2.2 Viewing Distance

A laser produces optical power levels that are dangerous to the eyes and skin if exposed directly or indirectly. Operate all laser products only with proper eye and skin protection at all times. Never view directly emitted or scattered radiation with unprotected eyes.

When viewing the laser during operation, the operator must maintain the Nominal Ocular Hazard Distance (NOHD) between the laser or scatter radiation and the operator's eyes. Check the Operator's Manual for the laser being used for details.

A.2.3 Maximum Accessible Radiation Level

A laser produces visible radiation over the various wavelengths. See the Product Label on the laser for details about maximum emission levels.

A.3 Laser Back Reflection

This section describes back reflection and tells how to prevent damage or noise caused by back reflection.

A.3.1 What is Back Reflection?

Back reflection (also referred to as retroreflection) occurs when a part of the laser beam is sent back into the laser's exit aperture. Back reflection can be caused by any object in front of the laser (such as other equipment or even a wristwatch) and can result in instability, noise, or damage to the laser.

In a normal application, the laser beam exits the beam aperture and none of the light from the laser is reflected back. Ideally, 100% of the output power from the laser is used in the application and none of the light is scattered or sent back into the laser exit aperture.

The amount of back reflection that can damage a laser diode changes from device-to-device. Sometimes a back reflection as low as 4% of the total beam power is sufficient to cause damage.

Damage from back reflection can be immediate, or it can be subtle and slowly decrease the service life of the laser.

Indications that there are back reflections to the laser that may cause permanent damage include:

- No output power
- Low output power
- Over-current of the laser diode

A.3.2 How to Prevent Back Reflection

The following procedure describes how to prevent a strong back reflection and possible damage to the laser:

1. Use the USB or RS-232 controls to set the power to minimum output power before opening the laser aperture.
2. Do optical or laser alignment at this low output power to confirm there are no back reflections.

Sources of back reflections include:

- Fiber, Fiber Ferrule, or Fiber Connector
- Optical Filters that are not angled but are perpendicular to the beam
- Neutral Density Glass or Beam Attenuators that have a front surface reflection that can create a back reflection.

- Beam Block at normal incidence that reflects power back into the laser
- Plano-concave or Plano-convex lenses where the flat surface reflects back part of the beam
- Power measurement probes that use a reflective attenuator or have a surface that reflects the laser light.
- Mirrors or other shiny surfaces from mounts or other optical components in the beam path.

When measuring laser power with a power meter, always angle the power sensor so that the laser beam does not reflect back into the laser exit aperture.

To properly measure laser power:

1. Take the measurement near the laser.
2. Move the power sensor to maximize the reading of the output power.

CAUTION!
DO NOT let this movement and alignment create a back reflection.

In many cases an object is positioned in front of the laser as a beam block. Make sure the object is not reflective and does not create a back reflection to the laser.

If the application cannot be adjusted to decrease the back reflection of the laser light into the laser's exit aperture, add an optical isolator to protect the laser. Although the optical isolator adds cost and requires additional space, it can be an appropriate safety factor to increase the life of the laser.

Be aware of every optical surface in front of the laser. All object have the opportunity to create a back reflection. In many cases the front surface and the back surface of the optic are a source of back reflection.

- The closer the object is to the laser, the more angle is needed to direct the back reflection away from the laser exit aperture.
- The farther the object is away from the laser, the less angle is needed to direct the back reflection away from the laser exit aperture.

CAUTION!
The Coherent product Warranty does not cover damages to the laser caused by customer handling failure. Take precautions with initial set-up to avoid damage to the laser. Avoid any condition where any part of the laser beam reflects back into the laser exit aperture.

A.4 Safety Precautions for Cameras

Coherent LaserCam products use a Low Distortion Face Plate (LDFP) installed in the camera aperture. The LDFP filter glass eliminates unwanted background light, provides attenuation for the laser beam, and provides protection for the camera sensor.

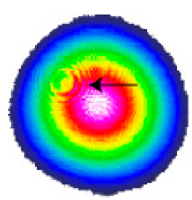
It is important to note that Coherent recommends to **not** remove this under most circumstances, as this is the only protection the camera sensor has against debris and mechanical damage. The LaserCam warranty is void if the LDFP is removed.

CAUTION!
If the Low-Distortion Face Plate (LDFP) is removed, the Warranty is void.

Any modification to remove the LDFP leaves the sensor susceptible to damage. If the LDFP is removed from the camera, special precautions (described next) must be taken to avoid sensor damage.

Dust

If low-intensity spots or small circles are noticed in the camera video, as shown in this example, then dust may be present.



Dust can cause distortion in the form of small circles if present on the LDFP filter glass, or can cause low-intensity spots if present on the sensor array.

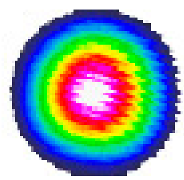
Observe the defects with a flashlight illuminating the camera. If the defect moves when the flashlight angle is changed, then the dust is on the LDFP; otherwise, it is caused by dust on the array.

To correct this situation, use clean air at low-pressure (or methanol and lens tissue) to clean the LDFP filter glass. Use only low-pressure micro-filtered clean air to blow dust off the sensor.

Take all necessary precautions to insure that nothing makes any contact with the sensor surface.

Fringes

If the LDFP filter glass is installed in the camera, then fringes can appear in the video as shown here:



The fringe pattern is due to a second reflection off the sensor and the LDFP superimposing back onto the original beam image.

CAUTION!
Use small, careful movements when rotating any devices to avoid laser back reflection!

Laser Power Input

Depending on the LaserCam HR camera model, saturation occurs at various power levels and wavelengths. See the *User Manual* for the specific camera to read information about saturation levels and damage thresholds at various wavelengths.

A.5 Summary of Precautions

- Review the objects in front of the laser and note which surfaces are a possible hazard for back reflections. Change the objects to be less reflective whenever possible. Adding Anti-Reflective (AR) coatings to optics and more diffuse surfaces to mounts or beam shutters can help.

- If possible, add an angle to the object so that the reflection does not enter the laser exit aperture.

- Take precautions when moving objects that can create a back reflection in front of the laser.

- Decrease the power from any possible back reflections by starting the laser at lower output power—for example 10% output power—before opening the laser shutter.

- ***Using correct safety precautions***, watch where the reflections from objects are returning to make sure the reflections are not at or near the laser exit aperture.

- Take extra precautions when using a laser power meter— consider how close the measurement is being taken to the laser and the angle at which the beam can reflect off the sensor so that it doesn't reflect back into the laser.

- A laser that shows low output power, no output power, over-current, or high noise, indicates a possibility that there is a back reflection into the laser.

- Add an optical isolator to those applications that have laser exit aperture back reflections that cannot be corrected by angling the optics.

Appendix B: Service and Support

This section provides information about:

- How to contact Product Support
- How to obtain service
- Product shipment instructions

B.1 Contact Product Support

Coherent provides telephone and web-based technical assistance as a service to its customers and assumes no liability thereby for any injury or damage that may occur contemporaneous with such services.

For general Technical Support, contact a local Coherent Service Representative as described on the following page, or contact Coherent as follows:

- By phone: 1-(408)-764-4557 or 1-(800)-367-7890
- By e-mail: Product.Support@Coherent.com
- To view a list of contact names, telephone numbers, and addresses worldwide, visit our website: www.Coherent.com

Under no circumstances do these support services affect the terms of any warranty agreement between Coherent and the buyer. Operation of any Coherent laser with any of its interlocks (or safety features) defeated is always at the operator's own risk.

Please be prepared to provide the following information:

- Model or part number of the unit
- Serial number of the unit
- A description of the problem
- Any corrective steps that may have attempted

B.1.1 LSM Support in the USA and North America

If shipping products from within the United States or North America, contact LMC Technical Support directly, as follows:

- By phone: North America (800) 343-4912 or (408) 767-4042
- By e-mail: LSM.service@coherent.com

Telephone coverage is available Monday through Friday (except during U.S. holidays). Inquiries received outside normal office hours are tracked by our automatic answering system and promptly returned the next business day.

For additional information about sensor products, go to:

https://www.coherent.com/measurement-control

For additional support, go to:

https://www.coherent.com/support

B.1.2 International LMC Support

If located in Europe, contact LMC Technical Support directly, as follows:

- Germany: +49–6071–968–0
- Japan: +813–5635–8680

B.2 Obtain Service

To obtain service under this warranty, Customer must notify the Company of the defect before the expiration of the warranty period and make suitable arrangements for the performance of service.

The Company shall, in its sole discretion, determine whether to perform warranty service at the Customer's facility, at the Company's facility, or at an authorized repair station.

If Customer is directed by the Company to ship the product to the Company or a repair station,

Customer shall:

- Package the product (to protect from damage during shipping) as instructed in ’Product Shipment Instructions’ (p. 227) next.

- Ship it to the address specified by the Company, with shipping prepaid. back to Coherent in conjunction with recalibration and recertification.
- Coherent shall pay the cost of shipping the Product back to the Customer in conjunction with product failures within the first twelve (12) months of time of sale or during an extended 12-month warranty period.

B.3 Product Shipment Instructions

Users must include a Returned Material Authorization number (RMA) assigned by the Company on the outside of all shipping packages and containers. Items returned without an RMA number are subject to return to the sender. Detailed instructions to prepare a product for shipping are provided in the next section.

To prepare a product for shipping to Coherent:

1. Contact Coherent Customer Service (see ’Contact Product Support‘ in the next section) for a Return Material Authorization number.
2. Attach a tag to the product that includes the name and address of the owner, the person to contact, the serial number, and the RMA number received from Coherent Customer Service. Pack this tag inside the box.
3. Wrap the product with polyethylene sheeting or equivalent material.
4. Using the original shipping and packaging materials, pack the product.
5. Seal the shipping carton with shipping tape or an industrial stapler.
6. Add the RMA number received from Coherent Customer Service to the shipping label on the outside of the box.
   Ship the product to the following address:

   Coherent, Inc.
   Laser Measurement and Control, Attn: RMA #
   27650 SW 95th Ave.
   Wilsonville, OR 97070
   USA

Appendix C: Warranty

Coherent, Inc. warrants OBIS Laser Systems to the original purchaser (the Buyer) only; that the laser system that is the subject of this sale, (a) conforms to Coherent's published specifications, and (b) is free from defects in materials and workmanship.

Laser systems are warranted to conform to Coherent's published specifications and to be free from defects in materials and workmanship as specified in the sales or service contract. Replacement units shipped within warranty carry the remainder warranty of the failed unit.

C.1 Responsibilities of the Buyer

The Buyer is responsible for providing the appropriate utilities and an operating environment as outlined in the product literature. Damage to the laser system caused by failure of Buyer's utilities or failure to maintain an appropriate operating environment, is solely the responsibility of the Buyer and is specifically excluded from any warranty, warranty extension, or service agreement.

The Buyer is responsible for prompt notification to Coherent of any claims made under warranty. In no event will Coherent be responsible for warranty claims made later than seven (7) days after the expiration of warranty.

The foregoing warranty shall not apply to defects resulting from any of the following conditions:

C.2 Limitations of Warranty

The foregoing warranty shall not apply to defects resulting from any of the following conditions:

- Components and accessories manufactured by companies other than Coherent, which have separate warranties
- Improper or inadequate maintenance by the Buyer
- Buyer-supplied interfacing
- Operation outside the environmental specifications of the product

- Unauthorized modification or misuse
- Improper site preparation and maintenance
- Opening the housing

Coherent assumes no responsibility for customer-supplied material. The obligations of Coherent are limited to repairing or replacing, without charge, equipment that proves to be defective during the warranty period. Replacement sub-assemblies may contain reconditioned parts. Repaired or replaced parts are warranted for the duration of the original warranty period only. The warranty on parts purchased after expiration of system warranty is ninety (90) days. This warranty does not cover damage due to misuse, negligence or accidents; or damage due to installations, repairs or adjustments not authorized specifically by Coherent.

This warranty applies only to the original purchaser at the initial installation point in the country of purchase, unless otherwise specified in the sales contract. The warranty is transferable to another location or to another customer only by special agreement, which will include additional inspection or installation at the new site. Coherent disclaims any responsibility to provide product warranty, technical or service support to a customer that acquires products from someone other than Coherent or an authorized representative.

THIS WARRANTY IS EXCLUSIVE IN LIEU OF ALL OTHER WARRANTIES, WHETHER WRITTEN, ORAL OR IMPLIED, AND DOES NOT COVER INCIDENTAL OR CONSEQUENTIAL LOSS. COHERENT SPECIFICALLY DISCLAIMS THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE.

Appendix D: Extended Warranty Program

Coherent, Corp. (the “Company”) offers original purchasers (the “Customer”) purchasing laser power and energy meters and sensors products (“Products”) an extended twelve (12) month Warranty program, which includes all parts and labor.

To qualify for this Warranty, a Customer must return the Product to the Company for recalibration and recertification.

- The Company will re-certify the Product, provide software upgrades, and perform any needed repairs, and recalibrate the Product, for a fixed service fee (as established by the Company from time to time and in effect at the time of service).

- If the product cannot be re-certified due to damage beyond repair, parts obsolescence, or other reasons, the Customer may be informed that an Extended Warranty program is not available for the Product.

If the Product fails and is returned to the Company within one year following the date of recalibration and recertification service, the Company will, at its option, repair or replace the Product or any component found to be defective. If the Product must be replaced and the Product is no longer available for sale, Coherent reserves the right to replace with an equivalent or better Product. This Warranty applies only to the original purchaser and is not transferable.

Glossary

°C	Degrees Centigrade or Celsius
°F	Degrees Fahrenheit
Ω	Ohm(s)
µ	Micron(s)
µm	Micrometer(s) = 10^{-6} meters
µrad	Microradian(s) = 10^{-6} radians
µsec	Microsecond(s) = 10^{-6} seconds
$1/e^2$	Beam diameter parameter = 0.13534
AC	Alternating current
Address	A unique one-byte identifier assigned to each device on the bus
Amp	Ampere(s)
APC	Angle physical contact
Application Protocol	A set of application defined commands and replies used to implement a system of cooperative devices
Automatic Send Data Control	An optional hardware feature that is useful to control enable/disable of transmit enable line of RS-485 transceiver
BNC	Type of connector
Broadcast Message	Message sent by a master device and received by all connected slave devices
BUSMGMT	Message is a bus management message.
CCB	Coherent Connection Bus, a RS-485 communication bus
CDRH	Center for Devices and Radiological Health
cm	Centimeter(s)
CW	Continuous wave
DC	Direct current
DDL	Direct diode laser
Destination Address	Address of the recipient device for a message
DHCP	Dynamic Host Configuration Protocol. A protocol that provides a means to dynamically allocate IP addresses to computers on a local area network.
DLE	Data link escape
EOM	A two-byte sequence indicating the end of a message packet
ESD	Electrostatic discharge
ETX	End of message data
FC	Fiber-connector
FP	Fiber pigtail

g	Gram(s) or earth's gravitational force (gravity)
GUI	Graphical user interface
HeNe	Helium neon
Hz	Hertz or cycles per second (frequency) (= 1/pulse period)
IEC	International Electrotechnical Commission
IR	Infrared (wavelength)
I/O	Input/output
kg	Kilogram(s) = 10^3 grams
kHz	Kilohertz = 10^3 hertz
kOhm	Kilohm(s) = 10^3 ohms
LCD	Liquid crystal display
LED	Light emitting diode
LS version	OBIS Laser, based on optically pumped semiconductor laser (OPSL) technology
LX version	OBIS Laser, based on direct diode laser (DDL) technology
m	Meter(s) (length)
mA	Milliamp(s) = 10^{-3} Amperes
mAmp	Milliampere(s)
Master	Controlling device which manages bus direction, assigns device addresses, and generally the source for all application protocol command initiation
MHz	Megahertz = 10^6 hertz
mm	Millimeter(s) = 10^{-3} meters
mrad	Milliradian(s) = 10^{-3} radians (angle)
ms	Millisecond(s) = 10^{-3} seconds
mV	Millivolt(s)
MVP	Modulation and variable power
mW	Milliwatt(s) = 10^{-3} Watts (power)
NA	Numerical aperture
nm	Nanometer(s) = 10^{-9} meters (wavelength)
Nm	Newton meter (torque)
OBIS 1L Remote	A dedicated Coherent device that serves as a communication gateway to a single laser and provides a CDRH-compliant Key Switch and interlock capabilities.
OEM	Original equipment manufacturer
OPSL	Optically-pumped semiconductor laser
oz·in.	Ounce inches
PIP	Port Identification Pin, a signal pin located on the cable connecting the slave device to the CCB
PPS	Pulses per second
rms	Root mean square (effective value of a sinusoidal wave)
RMA	Return material authorization

SDR — Shrunk delta ribbon. This connector type is used on the back panel of the OBIS Laser for the full-feature I/O cable.

Slave — Device which receives and interprets messages and responds as required

SOM — A two-byte sequence indicating the start of a message packet

Source Address
: Address of the device transmitting a message

Standard Message
: Message sent from the master device to a specific slave device address

SRCCCB
: Message originated from CCB stack.

SRCCONT
: Message originated from master device (controller).

STX — Start of message data

System Protocol
: A set of predefined bus management commands and responses used by CCB protocol stacks for set-up and management of the bus

TEC — Thermoelectric cooler

TEM — Transverse electromagnetic mode (cross-sectional laser beam mode)

TTL — Transistor-transistor logic

UART — Universal asynchronous receiver/transmitter

UFC — Ultra-flat contact

UV — Ultraviolet

V — Volt(s)

VAC — Volts, alternating current

VDC — Volts, direct current

W — Watt(s) (power)

ST — Version of OBIS Laser, based on optically pumped solid state laser technology (DPSS)

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