mks

Ophir BeamWatch® Standard

User Notes

Dear Ophir-Spiricon Customer,

Thank you for your recent purchase of the BeamWatch system.

At Ophir-Spiricon we strive to provide the highest level of leading edge photonic measurement technology and service possible. We hope that your experience with us is a pleasant one, and anticipate the relationship we build will serve your photonic measurement needs for years to come.

As a valued customer, your comments and opinions are always very important to us. If you have any concerns, questions, or comments, bring them to our service department's attention. We are ready to help with everything from basic setup to working with you to find solutions for your most complex photonics measurement needs.

Please let us know if there is any way we can be of service. Thank you once again for your business.

Sincerely,

Ophir-Spiricon, LLC

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North Logan, UT 84341, USA
Tel 435-753-3729
Fax 435-755-5231
www.ophiropt.com/photonics

How to Use this Guide

Symbol Notation

Indicates general information that poses no risk.

Indicates important information about the product with little or no risk.

Indicates warning information. Failure to follow instruction may result in harm to the user or product damage.

Safety

While BeamWatch itself does not present the user with any safety hazards, this instrument is intended for use with laser systems. Therefore, the user should be protected from any hazards that the laser system may present. The greatest hazards associated with laser systems are damage to the eyes and skin due to laser radiation.

Optical Radiation Hazards

BeamWatch is designed for use with high power lasers and therefore safety precautions must be taken. Users must be protected against accidental exposure. Exposure to personnel other than the user must also be considered. Hazards include direct beam exposure and reflected radiation. Protective eye shields and clothing must be worn.

Electrical Hazards

BeamWatch utilizes only low voltages, derived from the Ethernet and camera power supplies. Thus there is little risk of electrical shock presented to the user.

When installing or removing any hardware from a PC, the power to the computer should always be disconnected.

The computer should always be operated with its covers in place and in accordance with its manufacturer's recommendations.

The computer should always be operated with a properly grounded AC power cord.

Chapter 1 Information

1.1 Introduction

BeamWatch is the laser industry's first completely non-interfering beam monitoring system, which allows beam measurements without contacting the laser beam. Measurements are taken by imaging the Rayleigh scatter of the beam from the side using conventional cameras making BeamWatch ideal for measurements of high power lasers. Ophir-Spiricon has measured beams up to 100 kilowatts.

BeamWatch provides simultaneous measurements of multiple profiles along the beam caustic in the camera field-of-view (FOV). The speed of measurement operates at video rates allowing for real-time determination of:

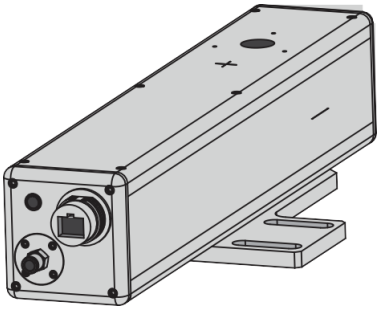
- waist (focus spot) width and location
- focal shift
- centroid
- M^2 or K
- divergence
- Beam Parameter Product
- Rayleigh length
- relative power

Real-time performance also allows for measurement of dynamic focal shift during laser startup.

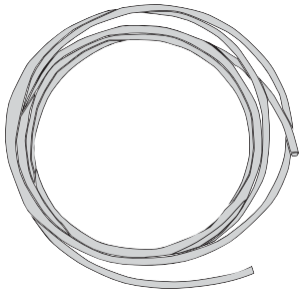
The technique is based on Rayleigh scattering of laser light by oxygen and nitrogen molecules in the air as the beam propagates. Measurement of this scattered light provides an equivalent slit scan of the laser beam in the direction of the view observed. The scattered light is measured using conventional CCDs and image capture systems.

BeamWatch has GigE connectivity to standard personal computers for data acquisition, analysis, and display.

1.1.1 Equipment

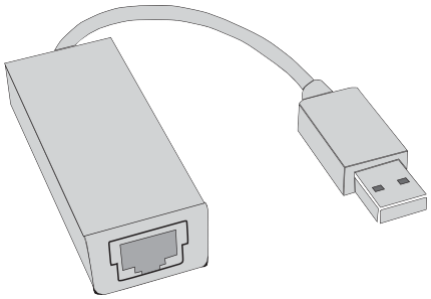


BeamWatch Standard

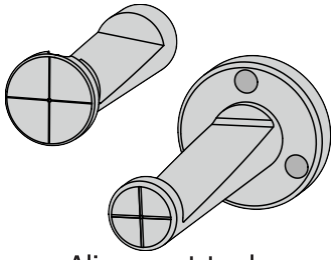


¼" Polyurethane tubing 10ft

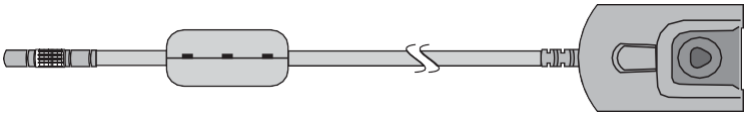
Ethernet Cable 4.5m



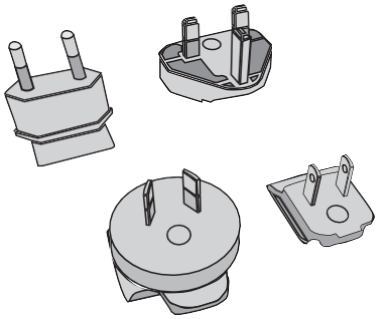
Gigabit to USB 3.0 Adapter



Alignment tools

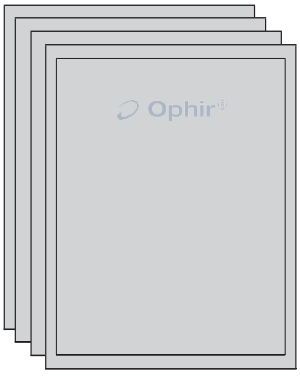


Power Supply Cable



Power Supply Adapter Kit

BeamWatch Software Installation Disk



User documentation:

- Alignment tool User Notes
- Calibration Certificate
- Gig-E Camera User Notes
- Quick Start Guide

1.2 Optional Equipment

Additional Optional equipment (Not Pictured)

We recommend one or more of these additional products.

- BeamWatch rotation mount (SP90346)
- Locking Ethernet cable (SP90394)
- 10kW water cooled power sensor
- 30kW water cooled power sensor
- 100kW water circulated power sensor
- Juno PC interface

Consult your Ophir-Spiricon Representative or call Ophir-Spiricon's Sales Department for ordering information.

1.3 Specifications

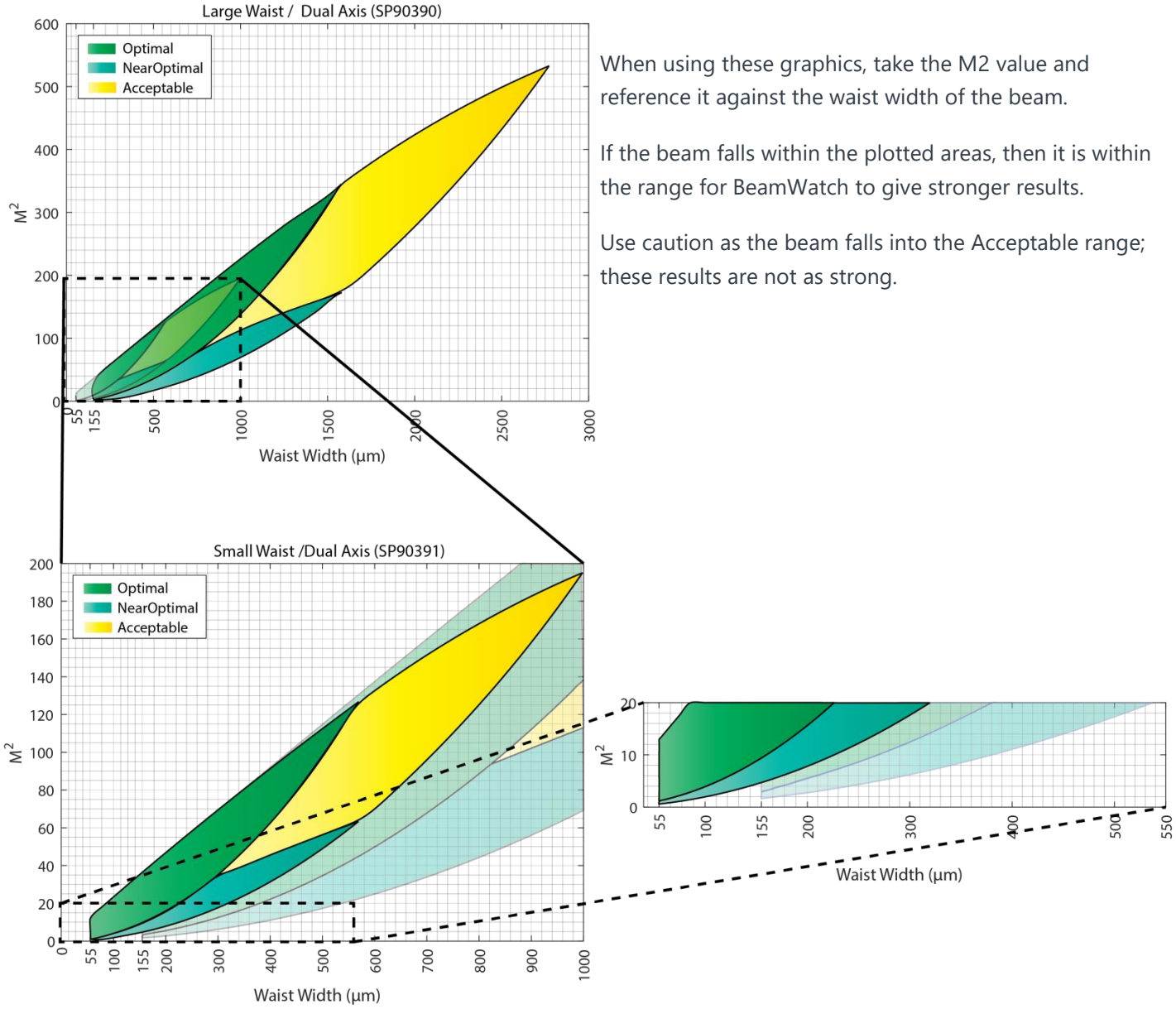
Wavelength	980 – 1080 nanometers
Minimum Power density	~2 Megawatts/cm^2
Minimum Focus Spot **SP90390** **SP90391**	 155 microns 55 microns
Maximum Beam diameter at entrance/exit	12.5 millimeters
Communication to PC	GigE Ethernet
Power	12 Volts DC, 1.67 Amps max
Particulate Purge	~10 SLPM (35 PSI / 2.5 BAR) Air, Nitrogen, or Argon. 1/4" hose fitting included.

Camera Field of View inside the BeamWatch unit	
SP90390 (Dual Axis)	32.17mm x 8.55mm
SP90391 (Dual Axis)	11.26mm x 2.99mm

1.4 Operating Limits

The graphics below are intended to give a visual indication of the recommended operating space for BeamWatch. If BeamWatch is operated outside of this space, it may be more difficult to see the curvature of the caustic or the beam may be large enough at the edges of the image that it is out of focus.

- Optimal has at least 3 Rayleigh lengths on both sides of the waist, with the waist at the center of the image
- Near Optimal has at least 3 Rayleigh lengths on one side of the waist, with the waist at the end of the image
- Acceptable has at least 1.5 Rayleigh lengths on both sides of the waist, with the waist at the center of the image

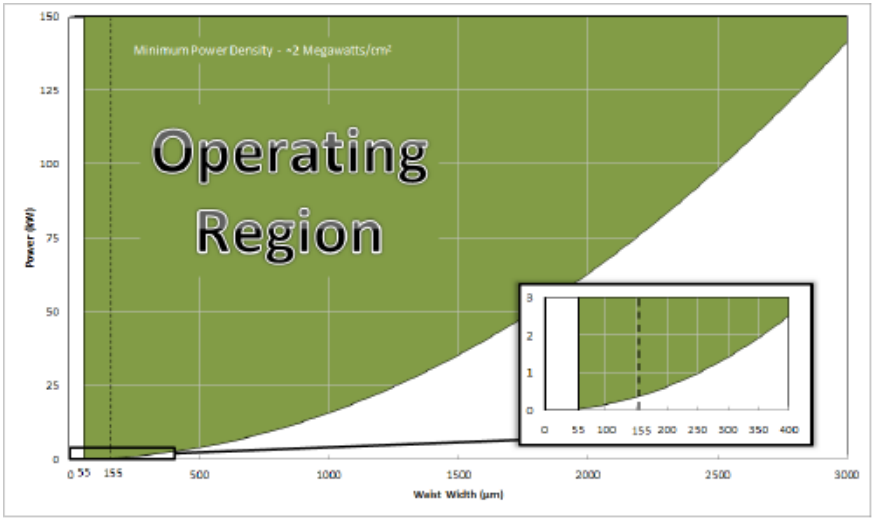


When using these graphics, take the M2 value and reference it against the waist width of the beam.

If the beam falls within the plotted areas, then it is within the range for BeamWatch to give stronger results.

Use caution as the beam falls into the Acceptable range; these results are not as strong.

Power density also plays a role in the operating space. The chart below shows the required power vs. focus spot size for a top hat beam.



The equation to estimate the maximum spot size is derived from the power density equation:

$$Power\ Density = \frac{P_{ave}}{A_{D4\sigma}} \geq 2 \times 10^6 \frac{W}{cm^2}$$

Where P_{ave} is the average beam power and $A_{D4\sigma}$ is the area of the beam at the $D4\sigma$ location.

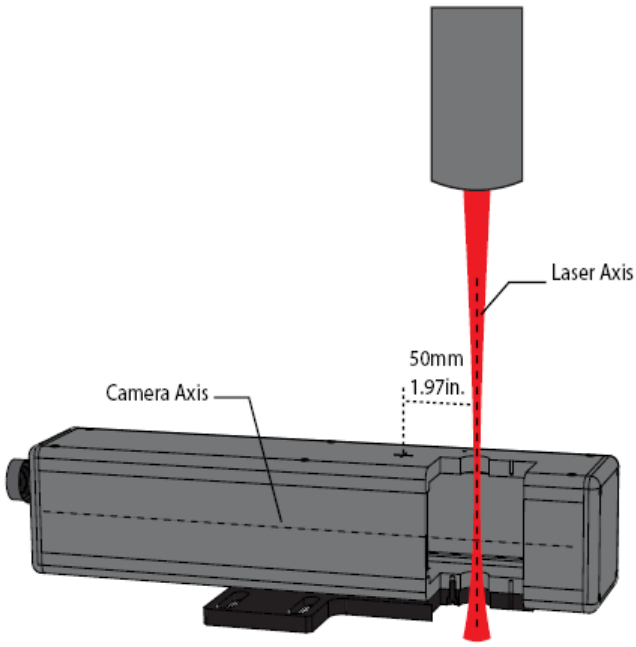
Chapter 2 Hardware Configuration

This chapter walks through how to setup and start using your BeamWatch.

2.1 BeamWatch Standard Mounting

The BeamWatch unit must be mounted to a stable surface where the laser can pass through the entrance and exit apertures unobstructed.

The center of the entrance aperture is located 50mm from the crosshair marked on the top of the camera (see image right).

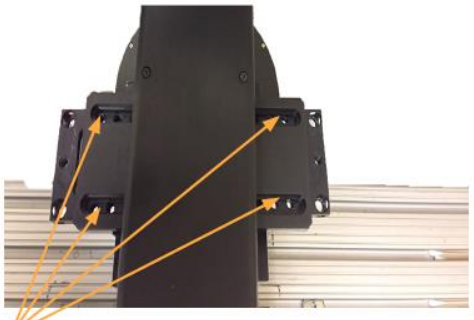


Position the BeamWatch unit at the nominal focus position along the laser axis, and make sure the beam waist is as close to the camera axis as possible.

There is a scribe mark on the side of the camera that references this position. The calibrated distance from the top of the BeamWatch to the center of the detector array can be found on the calibration sticker.

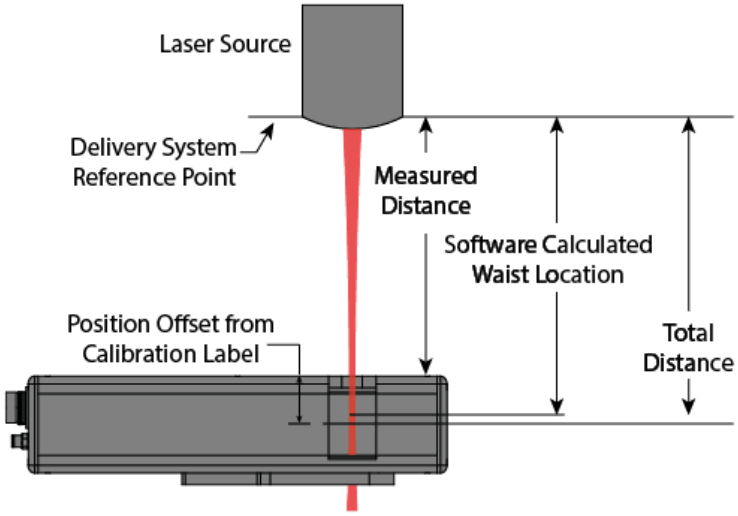
To obtain results within ±5% accuracy, the camera must be aligned perpendicular to the beam with minimal tilt (<5°) in all directions and the beam must lie in the plane of the camera focus. Use either a translation stage or the laser robotics to facilitate the positioning of the beam in the camera focus plane.

Once in the desired location, secure the unit with four ¼-20 or M6 screws in the slots, two on each side. If not mounted in a fixed position, measurement error and/or damage to the unit may occur.



Secure with ¼-20 or M6 Screws

After the BeamWatch is mounted, measure the distance from any desired reference point on the laser delivery head to the top face of the camera as shown right. This value is the **Distance** of the laser and must be entered into the software during setup (see section 4.4.2 in the BeamWatch Software User Guide).



2.1.1 Mounting for Elliptical Beams

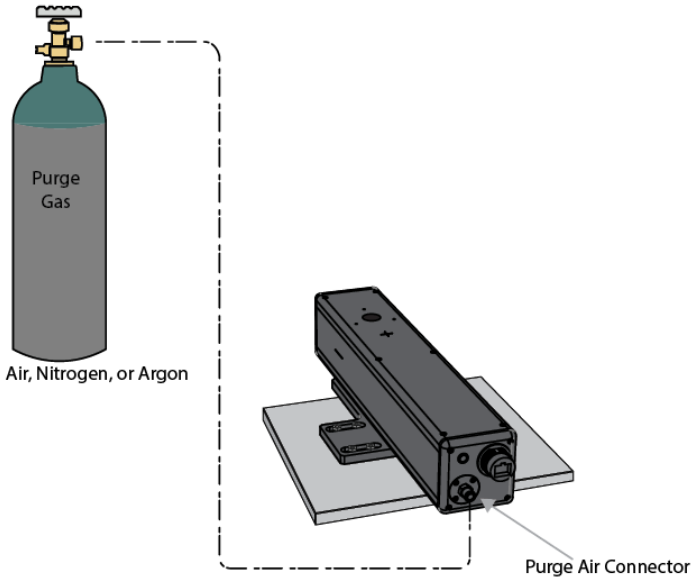
There is no automated method for finding the major and minor axes of an elliptical beam. The BeamWatch unit must be manually rotated to find these axes. A rotation mount (SP90346) is available as an accessory to assist in this alignment. After the software is installed and the beam is centered in the BeamWatch unit, rotate the unit around the beam while viewing the Waist Width result in the software until max/min values are found. For best measurements with dual axis BeamWatch units, rotate the BeamWatch until the major and minor axes of the beam are aligned with the X and Y axes of the software. It is irrelevant which of the BeamWatch axes views the major or minor axes of the beam.

2.1.2 Beam Dump

A suitable beam dump is required. An Ophir Power Sensor rated for the power of the laser is recommended. Other options are acceptable, but must have minimal backscatter, such as a cone type or black absorber power sensor. Contact your Ophir-Spiricon representative for additional information.

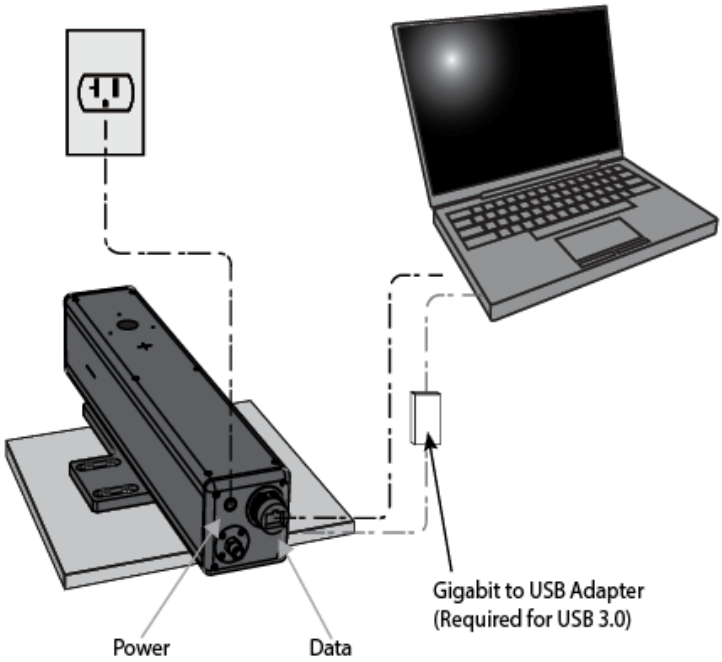
2.1.3 Particulate Removal

The industrial laser environment has high levels of particulates that must be removed from the camera FOV to obtain accurate results. With BeamWatch, this is accomplished by generating a laminar flow region at the camera FOV using a clean, dry gas source. Air, Nitrogen, or Argon is recommended. Connect the provided ¼" hose to the gas source as shown in the diagram right.



2.1.4 BeamWatch Electrical

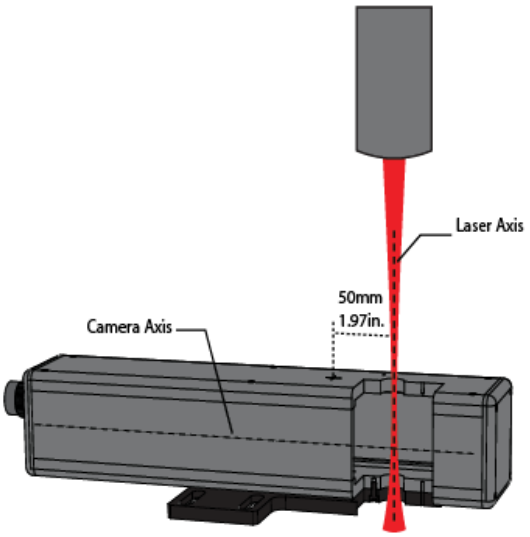
1. Connect the provided power cord to the power port on the BeamWatch unit.
2. Connect the remaining end into a surge protected 100-240 VAC outlet.
3. Connect one end of the provided Ethernet cable to the data source on the BeamWatch unit.
4. Connect the remaining end into an Ethernet port on the PC, or connect to the Gigabit to USB Adapter and connect the adapter to a USB 3.0 port.



*Two plugs are provided to keep dust out of the BeamWatch system. Make sure **both** of these plugs are removed before applying laser.*

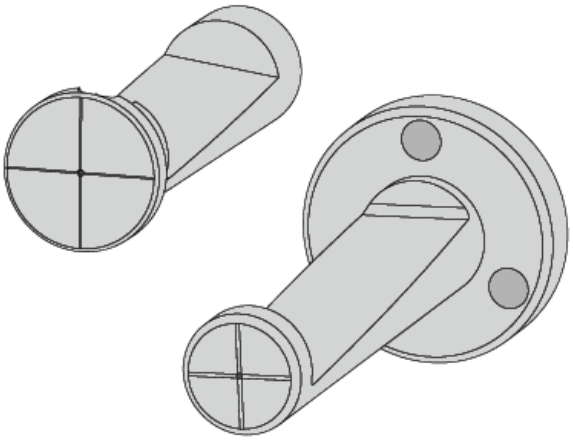
2.1.5 Laser Setup

1. After installing and launching the software apply the purge gas at approximately 10 SLPM (35 PSI/2.5 BAR) and remove the dust caps from the BeamWatch STD unit. (Applying the gas before removing the dust caps helps prevent dust from entering the unit.)
2. Apply the guide beam.



2.1.6 Alignment

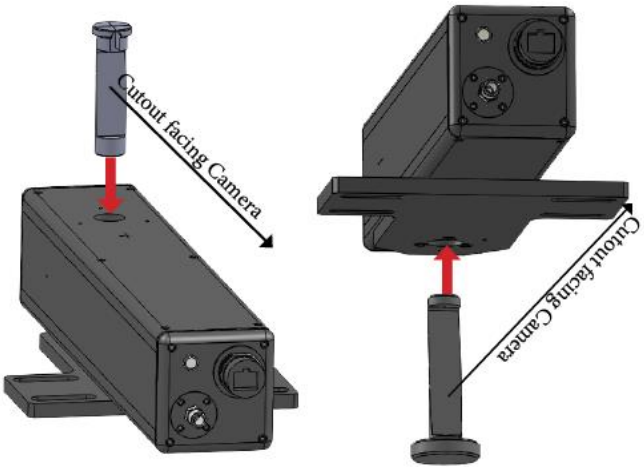
BeamWatch contains two alignment tool accessories; one is designed to be inserted from the top and the other from the bottom. For accurate results the beam must be aligned with the center of the input aperture, perpendicular to the top of the unit. A beam offset in any direction can produce inaccurate results. This is especially important when used with the optional rotation mount accessory.



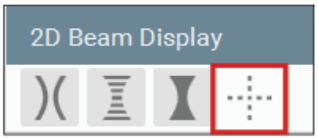
The alignment tool is provided for use with low power alignment beams only. Do not use with high power beams.

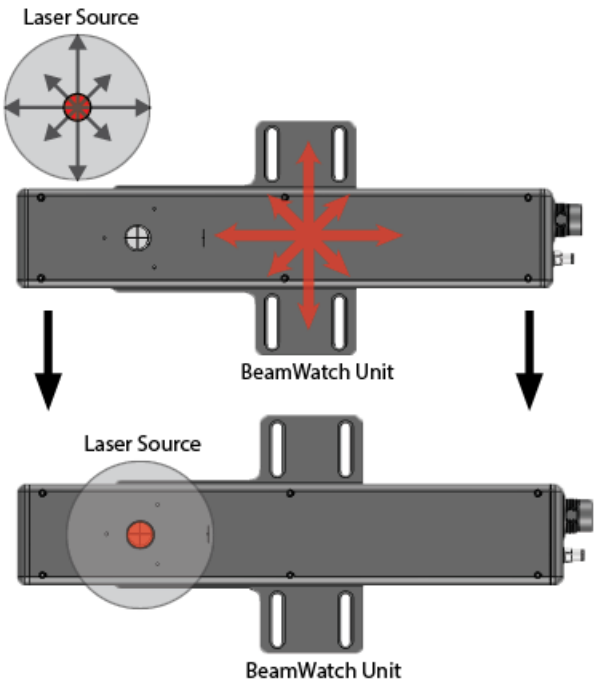
Using the alignment tool:

1. Determine which tool to use.
   a. Use the bottom mount tool if the beam is directed horizontally, or if there is a short working distance between the delivery head and the top of the BeamWatch unit.
   b. Use the top mount tool if the beam dump or power sensor is located close to the bottom of the BeamWatch, or if the BeamWatch is contained in an environment where the bottom is inaccessible.



2. Insert the alignment tool into the BeamWatch with the cutout side facing the camera as shown. Ensure the alignment tool is flush with the top.
3. Start the BeamWatch software and enable the Crosshair located at the top of the 2D Beam Display window.
4. Turn on the alignment beam and center it on the alignment tool by adjusting either the beam or the BeamWatch unit, with the beam perpendicular to the BeamWatch as shown below.

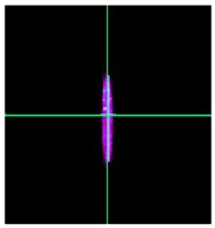
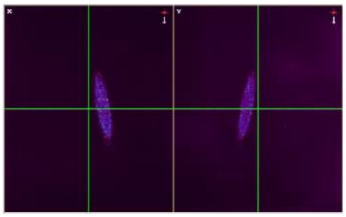
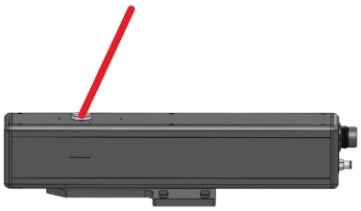
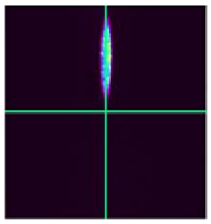
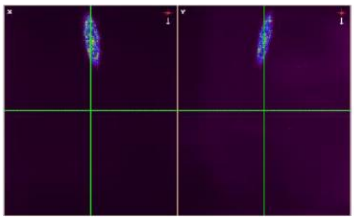
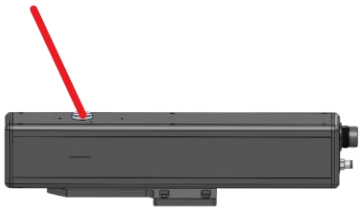
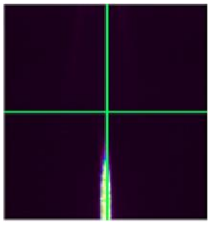
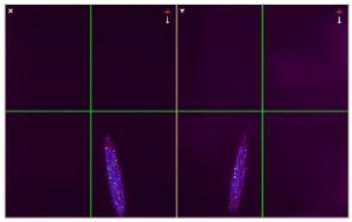
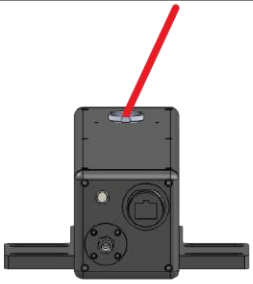
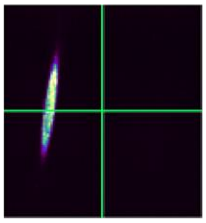
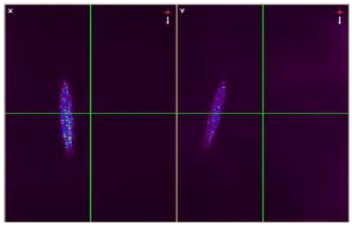
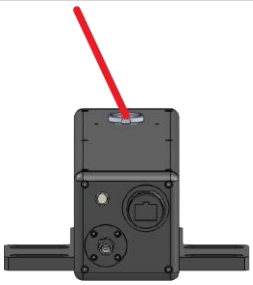
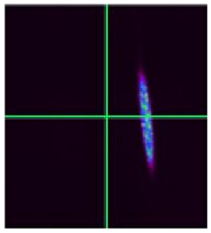
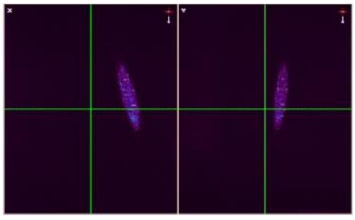




The BeamWatch alignment tool is intended for use with low power alignment beams. Severe damage can occur if the high power beam is directed when the alignment tool is in place.

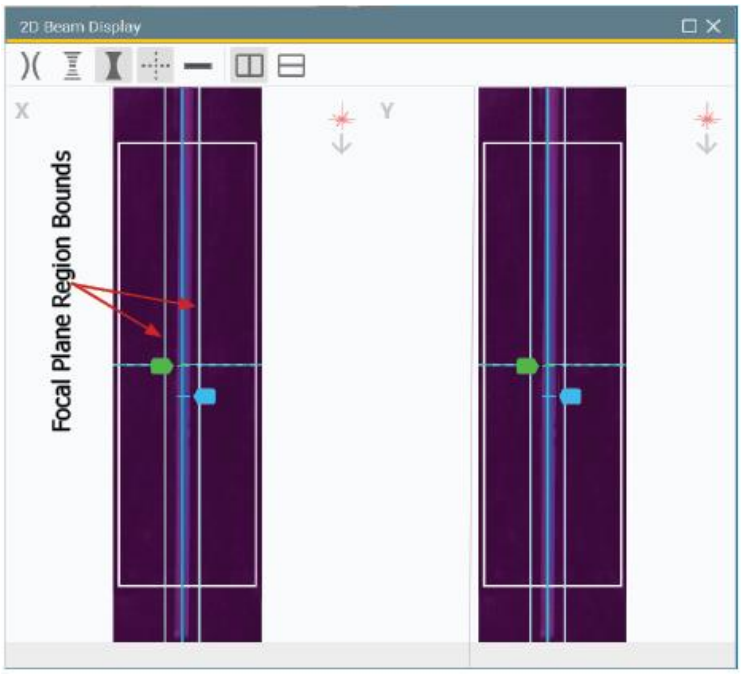
5. The beam is displayed in the BeamWatch software as an ellipse as shown in the images below. It may be necessary to adjust the Exposure and/or Frame Summing to bring the alignment beam to a viewable level.
6. If the beam is centered on the crosshair as shown in the properly centered example, the beam is aligned. If the beam is not centered, adjust the angle the beam enters the BeamWatch. The following illustrations show beam deviations and the resulting displays.

Note: The angle of the beam is exaggerated for clarity.

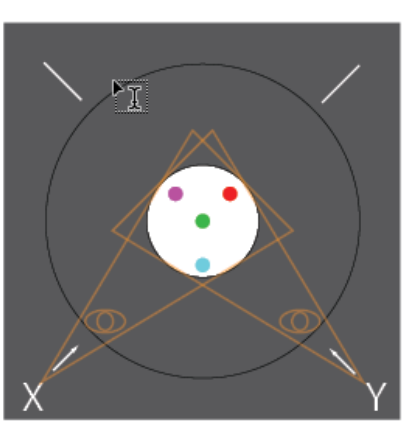
Alignment	Illustration	Single Axis	Dual Axis
Properly centered			
Beam angled away from camera			
Beam angled toward camera			
Beam angled toward the left			
Beam angled toward the right			

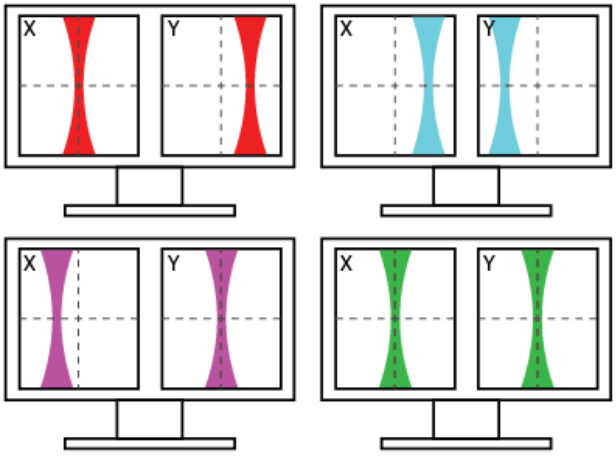
2.1.7 Final Setup Steps

1. Once the beam is aligned remove the alignment tool and switch from the guide beam to the high power beam.
2. Enable live Playback from the Source Ribbon in the software.
3. Adjust the gas level until a minimum amount of particulates can be seen. This may be an iterative process. Particulates appear as a streak of high intensity light when viewing the beam, often saturating the image. A weak flow is not effective, and too strong of a flow can become turbulent.
4. Check the 2D Beam Display and make sure the beam falls within the Focal Plane Region Bounds (±350µm for High Mag units, and ±1000µm for Low Mag units). The beam should be aligned within these bounds, in both views, to get the strongest results.



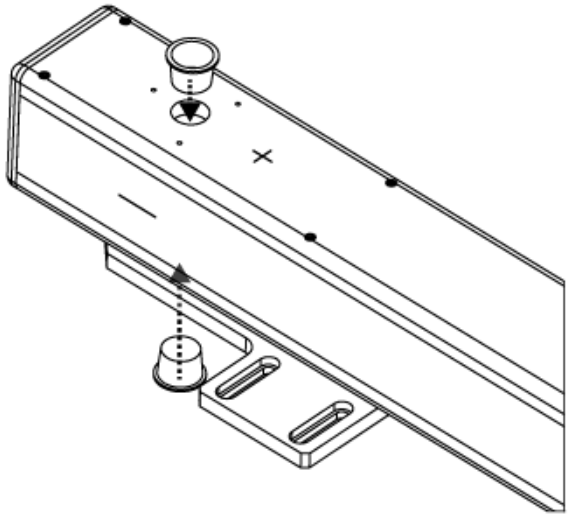
The diagram below shows how various degrees of misaligned beams appear on the screen.
The **red** beam is off in the view of the Y axis. It needs to be moved down and left to center.
The **blue** beam is off in both axes and appears close to the insides of the views. It needs to be moved up to center.
The **purple** beam is off in the view of the X axis. It needs to be moved down and right to center.
The **green** beam represents a perfectly aligned beam.
The **orange** lines represent the field of view of each axis.



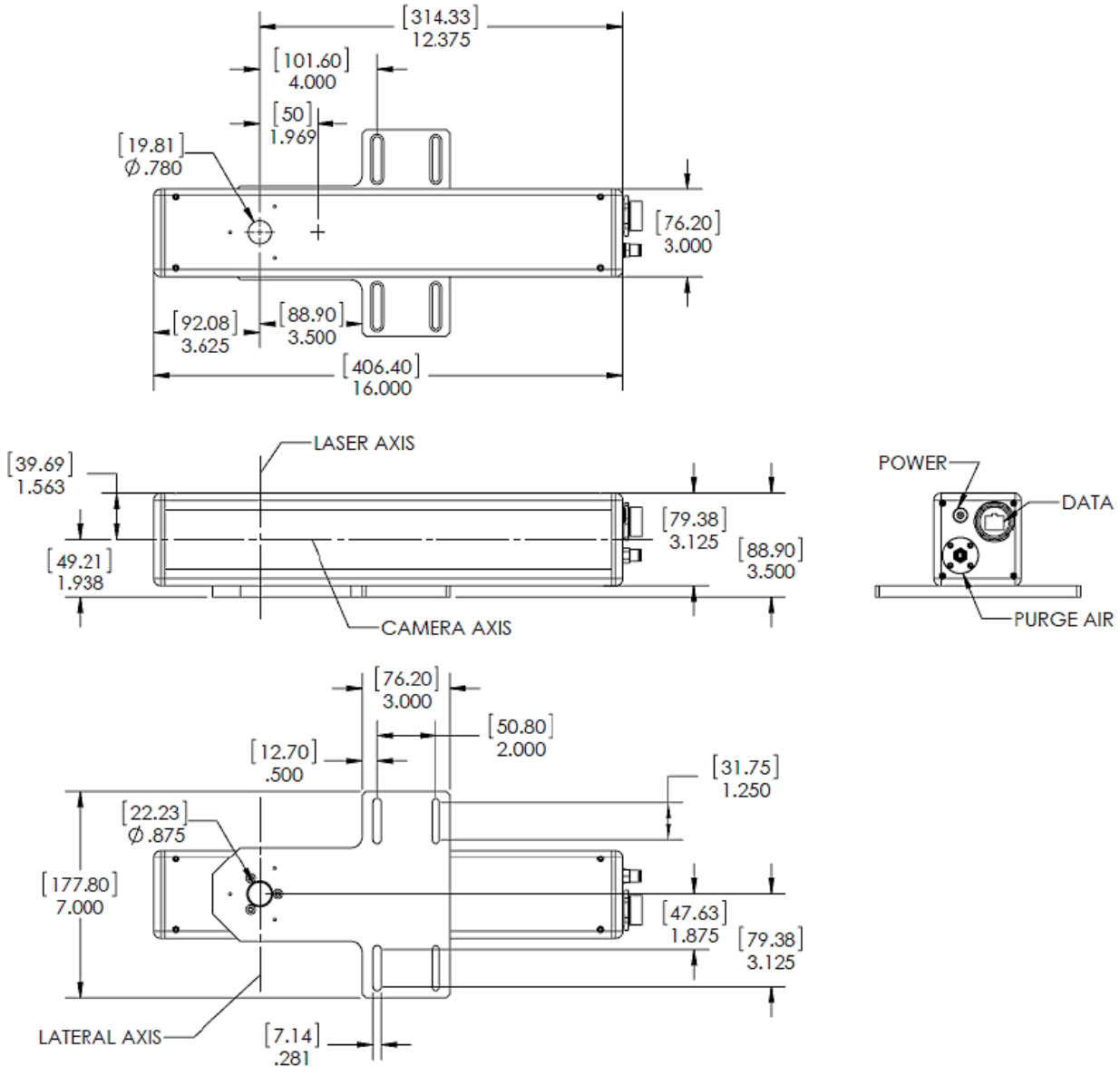


2.1.8 Ending a Run

1. After data collection has completed turn off the beam.
2. Re-insert the dust caps on the unit.
3. Turn off the purge gas. (Always turn the purge gas off after the dust caps have been re-inserted.)
4. If needed disconnect the purge gas and electrical connections, and remove the unit from the working area.



Chapter 3 Dimensions



Notes:

Notice

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