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# **Manual for SP2 Beam-Scan Camera and Software**



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DOC-0175 Revision D

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## Introduction

Optimum performance of the SP2 is obtained when the YAG laser beam is operating in the TEM<sub>00</sub> mode. This is defined by a single laser beam spot which has a Gaussian profile. Higher-order modes will have multiple spots, which may not affect the measurement of black carbon incandescence but will almost certainly limit the utility of the scattering data collected. In cases where very high-order modes are present, the incandescence data can also be compromised.

The SP2 beam scan camera and software is designed to facilitate observing and setting the mode of the YAG laser in the SP2. The system consists of a Mightex CCD camera which has been fitted with a high Optical Density (OD) filter. A mounting bracket allows the camera to be mounted in the position normally occupied by the YAG power monitor on the SP2. The light-intensity data from the camera is recorded and processed by a software package made by Visulux, called vBeam. In the Windows 7 32-bit version, the vBeam software has code in it to read only a camera with a specific serial number. If multiple units of the camera and software are purchased, the installed software must be correlated with a given camera. With Windows 7 64-bit version and newer, the drivers should enable the software to find the correct serial number of your camera automatically. In both versions of Windows 7, it is necessary to load the software thru both USB ports so that the camera will be found by the system. If the software is loaded into one port and the camera is plugged into the other USB port, the camera will not be found.

## Installation

For installation of the software, follow the instructions given in the Visulux manual. This manual will discuss the installation of both the driver for the camera and the Visulux executable software. In the setup of the Visulux software, one minor change from the default values is recommended. The software will be installed in the folder Program Files/Visulux. Navigate to the Visulux folder and open the file **mightex.prop** using Notepad. The following shows the contents of this file. The default for the **exposure time** is 10000. This will result in saturation of the camera response, and it is recommended that this be set at **5000** for a starting value. This can be adjusted later as needed.

The following is the listing of the mightex.prop file:

```
; gain is normally 1.0, but can be as high as 16  
gain=1.0  
; gamma is from 0.0 to 2.0  
gamma=1.0  
; contrast is from 0 to 100 in percent  
contrast=50  
; brightness is from 0 to 100 in percent  
brightness=50  
; exposure time is in microseconds, so 30000 us = 30 ms  
; can be up to 750 ms (750000)  
exposure time=10000  
;  
; the frame rate slows greatly at the higher exposure times. 750000  
; is the maximum exposure time on the Mightex cameras. That should  
; be enough to integrate multiple laser pulses if needed.
```

It is recommended that exposure time be lengthened until saturation happens. Then back off the exposure time by 500 or 1000 units. Saturation will not cause damage to the camera, and it can be useful to operate in this mode, as the base of the beam will be easier to visualize. No studies have been done on modifying the other parameters in the mightex.prop file.

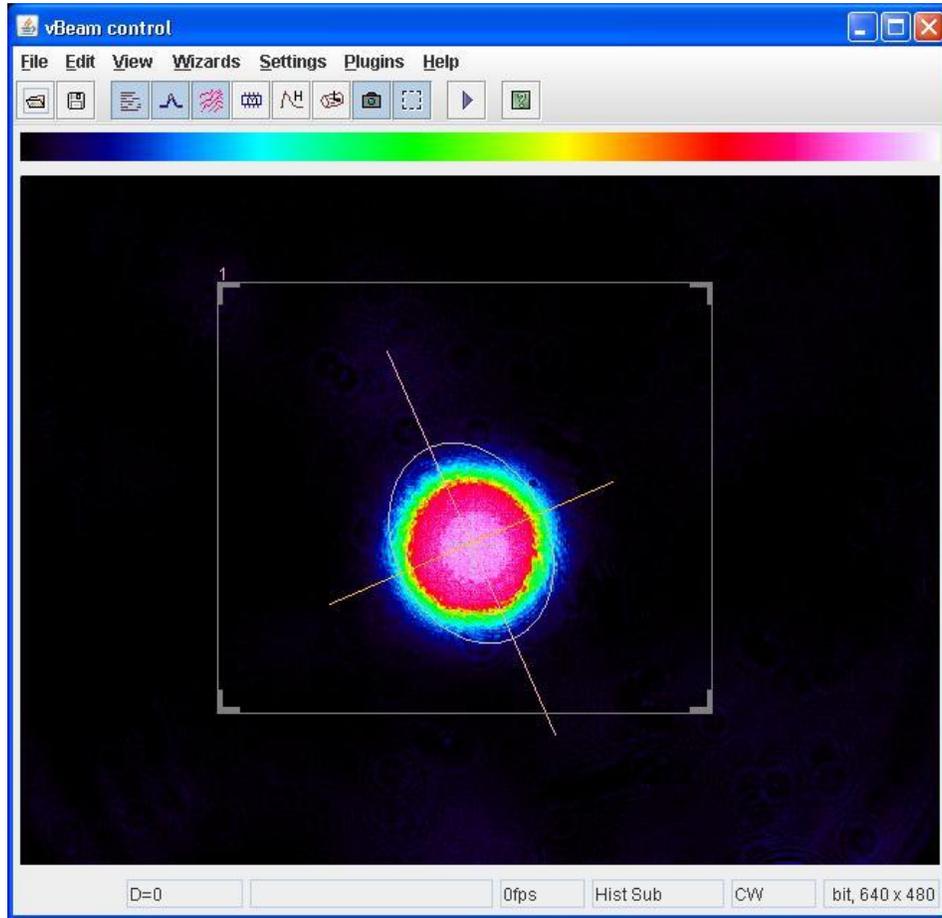
CAUTION: The Mightex camera is fitted with a 5 OD filter for standard operation. This reduces the laser power to a range where the camera can provide a good beam profile. The laser power that is available at the YAG power monitor can be up to 200mW. The Mightex camera is rated to withstand laser power of up to a MAXIMUM of 70mW only under certain conditions, which are unspecified. Operation of the camera on the SP2 with any neutral density filter having an OD of less than 2 will void the warranty of the product. The Measured leakage should be between 80 – 100 mw

## Operation

The Visulux software is computationally intensive and testing of the simultaneous operation of the Visulux software and the SP2 acquisition software has not been conducted. No conflicts are expected, but the performance of both software operations simultaneously is not known. It is possible that these programs can operate simultaneously, but it is the responsibility of the user to determine the suitability of the SP2 computer for simultaneous operation.

Remove the YAG power monitor and insert the pin (See Appendix B) of the Mightex camera into the bracket mounted on the SP2. The bracket provides the proper alignment for the camera and no alignment adjustments are needed. If a simple check of the laser mode is being conducted, start the Visulux software, and in addition to the basic control window, it is suggested that the surface and plot windows be opened. These are initialized by clicking on the appropriate boxes in the View menu of the tool bar. Turn on the SP2 instrument, and if the Visulux software is being used on a separate computer, the standard SP2 startup and operation is recommended. If the user is operating the Visulux software on the SP2 computer and is testing performance with both software packages, it is recommended the standard SP2 operation be set up and then the Visulux software started.

**Figures 1 -3** show the data obtained for a YAG laser beam when set properly. These plots show the view of the beam effectively end-on in the control panel, and the beam profile in the plot and surface views. The measurement will appear to have considerable jitter in the plot view. This is caused by the short exposure time. If the beam profile appears basically Gaussian, (normal or even distribution) but the top of the view is flat in the plot or profile views, this is caused by measurement saturation. The exposure time should be reduced to change this.



*Figure 1: SP2 Laser Mode in the TEM<sub>00</sub> Mode, as Viewed in the vBeam Control Panel*

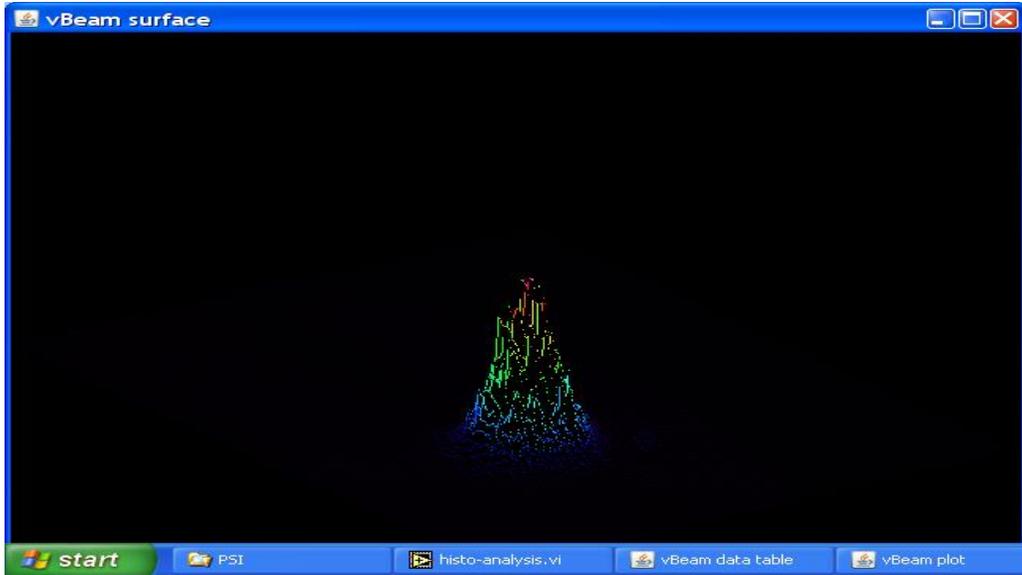


Figure 2: The SP2 Laser Beam in the  $TEM_{00}$  Mode, as Viewed in the Surface Plot

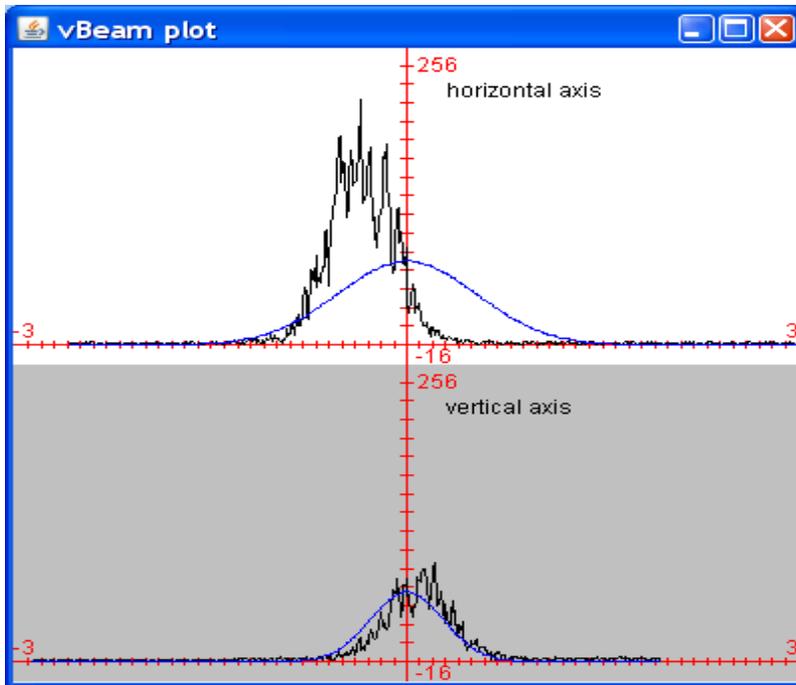
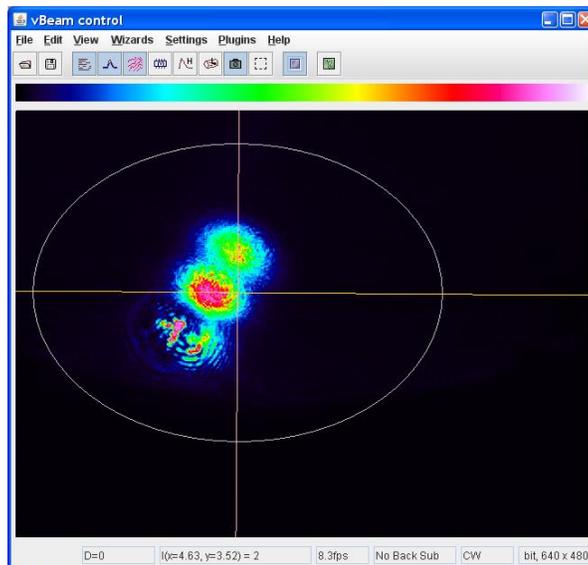


Figure 3: SP2 Laser Beam in the  $TEM_{00}$  Mode, as viewed in the Graphical Plot. The upper plot shows the beam slightly out of adjustment and not following the Gaussian curve.

The Visulux software will allow for power measurement of the YAG laser. If a power meter is available, the laser power can be measured with the YAG power monitor and the camera removed from the output of the YAG laser. The camera is then installed on the laser, and the **Settings** toolbar opened. Then open the **Calibrate Power/Energy** window. Either the laser power as measured above can be entered, or the voltage as measured from the YAG power monitor can be entered. Click on **OK**, and this power reading will appear in the data table. It is important to note that this power reading will be valid only for the same value of **exposure time** as when the calibration parameters were entered. It is highly unlikely that the relationship between power readout and **exposure time** setting is linear, so if the **exposure time** is changed the power should be recalibrated. Any changes in the neutral-density filter will also change this value. The **exposure time** is being run at or below the minimum recommended value, and this will result in considerable variation in the power readout with the camera.

If the above tests show that the SP2 YAG laser beam is in a satisfactory mode, no further adjustments are needed. Upgrades to the Visulux software are planned in the future to allow for continuous logging of the data, and this may be useful while collecting data with the SP2.

**Figures 4-6** show measurements of a YAG laser that is in a higher-order mode. These can appear as either a distortion of a single spot, or even multiple distinct spots. If both the X and Y axis are in higher-order modes, multiple spots in both directions can appear.



*Figure 4: The SP2 Laser Beam in a Higher-Order Mode, as viewed in the vBeam Control Window*

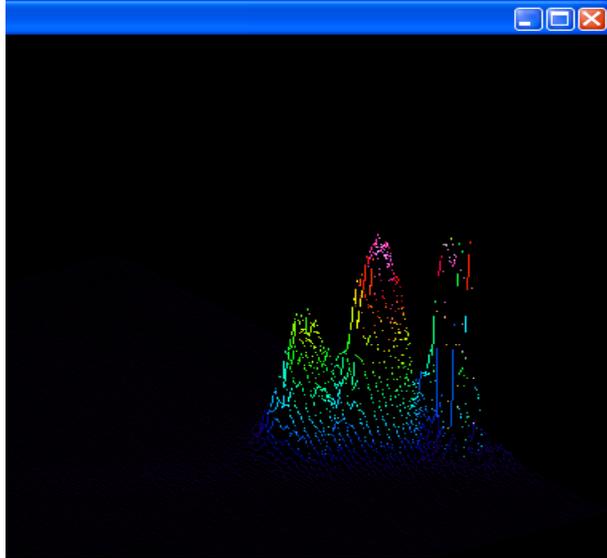


Figure 5: The SP2 Laser Beam Plot in a Higher-Order Mode

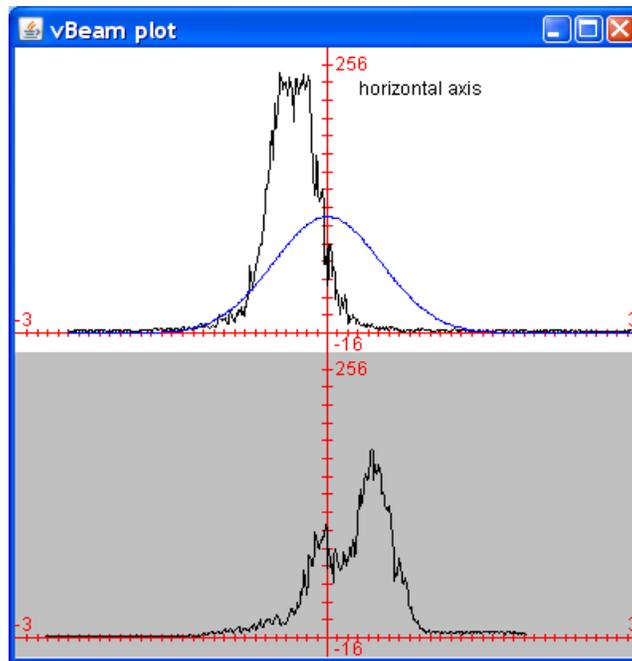


Figure 6: The SP2 Laser Beam Viewed Graphically in a Higher-Order Mode

If the YAG laser is out of adjustment, or the user wishes to observe the mode structure, the following procedure should be followed:

1. Install the camera as directed previously.
2. Remove the SP2 mode aperture from the holder.
3. Remove the two screws on the top of the coupler mount that allow access to the adjustment screws.
4. Start the Visulux software.
5. Start the YAG laser and observe the laser beam profile.
6. For SP2 instruments SN 007 and above, insert a 5/64" ball driver into the access hole. SP2 instruments below this serial number require a 1/8" ball driver. It can be useful to use a flashlight to look into the access hole and locate the position of the adjustment screw. For some of the SP2 instruments, the adjustment screws will be either forward or backward of the access hole. It will always be in line along the long axis of the laser frame. Insert the ball drivers carefully, trying not to turn the adjustment screws.
7. Turn the adjustment screws a minimal amount until a feeling is obtained for the amount of adjustment to bring the laser in and out of TEM<sub>00</sub> mode. If the laser is operating in a very high-order mode and an adjustment is made, the laser can be extinguished. Very carefully turn the screw in the reverse the direction and the laser should restart.
8. After the laser is adjusted satisfactorily, remove the adjustment tools, while the laser is still operational. This will insure that no unintended adjustment takes place while the tools are removed.
9. Shut off the YAG laser, reinstall the screws on the top of the coupler mount, and install the mode aperture.
10. For optimal instrument performance, it is recommended that the mode aperture adjustment be checked as well as the alignment of the chamber. Please see the most current Revision of the SP2 Operator Manual DOC-0171 for instructions on these adjustments.

## Troubleshooting

<b><i>Problem</i></b>	<b><i>Possible Cause</i></b>	<b><i>Solutions</i></b>
No response when > is clicked in Visulux software.	Camera is not responding.	Check the serial number of camera and open the Visulux software folder to check for the presence of the proper key. There may be more than one key present in the software folder, and the key ID may be a bit hard to decipher but check the camera serial number and it should be close to one of the keys present. The master CD of the Visulux software will contain the proper key file.
Beam plot and surface picture appear truncated at the top of the profile.	Camera is saturated and cannot respond properly.	Reduce laser power or reduce exposure time.
No response when > is clicked in Visulux software.	Camera is not selected as input device.	On the toolbar, go to <b>View</b> (if <b>Input Control</b> is not checked, check the box to bring up this window, which will be titled <b>Camera</b> ). Under <b>Select a video board</b> , the camera should appear here and be highlighted. If it is not, highlight this.

## Appendix A: Changes to Manual

<b>Revision Date</b>	<b>Revision #</b>	<b>Summary</b>	<b>Section</b>
4-8-10	C	Updated assembly drawing	Appendix B
1/10/17	D	General updates	All Sections

