



# USER MANUAL

Accessories for Beam Diagnostics and Attenuators

## WARRANTY

The Gentec-EO accessories for beam diagnostics carry a one-year warranty (from date of shipment) against material and/or workmanship defects, when used under normal operating conditions. The warranty does not cover damages related to battery leakage or misuse.

Gentec-EO Inc. will repair or replace, at Gentec-EO Inc.'s option, any accessories for beam diagnostics that prove to be defective during the warranty period, except in the case of product misuse.

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

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

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

Gentec Electro-Optics, Inc.  
445, St-Jean-Baptiste, Office 160  
Quebec, QC  
Canada, G2E 5N7

Tel: (418) 651-8003  
Fax: (418) 651-1174  
E-mail: [service@gentec-eo.com](mailto:service@gentec-eo.com)

Website: [www.gentec-eo.com](http://www.gentec-eo.com)

## CLAIMS

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

## SAFETY INFORMATION

Do not use the BEAMAGE accessories if they look damaged, or if you suspect that the BEAMAGE accessories are not operating properly.

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

## SYMBOLS

The following international symbols are used in this manual:



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

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## 1. INTRODUCTION

### 1.1. HOW TO CAREFULLY MANIPULATE THE BEAMAGE WHEN USING ACCESSORIES

Profiling a laser beam is a nice and convenient complement to measuring its power or energy because it provides additional useful information that may help you determine if your lasers are operating optimally.

For the most extended and complete use of your BEAMAGE beam profiling camera, optical components that provide attenuation, beam splitting, beam sampling, spectral sensitivity extension and large beam imaging may be required as practical accessories.

In most cases, these optical components are very easy to use and to manipulate. However, as a precaution, it is important to follow a few rules when fixing an accessory onto the camera's aperture or when removing one from it. Doing so will prevent any damage that could be done to the CMOS sensor of the BEAMAGE.

Once they are stuck on the CMOS sensor, dust particles and other contaminants cannot be removed without serious risk of damaging it. Therefore, one must preferably:



#### Warning

Fix or remove accessories in a clean room or very clean environment.

Position the front cover of the camera downwards when fixing or removing accessories.



## 2. POWER MANAGEMENT

### 2.1. ND FILTERS (< 1W ATTENUATION)

Gentec-EO offers various SM1 threaded absorptive Neutral Density (ND) filters that can be stacked directly on the aperture of the BEAMAGE camera via a SM1 to C-mount adaptor, included with the BEAMAGE. Subsequent filters can be stacked directly on each other. These filters have the ability to equally reduce the intensity of all wavelengths without affecting the wavefront of the beam or distorting the image. The attenuation is wavelength dependant; see Figure 5. An empty SM1 threaded filter holder is available for those who would like to use their own ND filters with their camera. It holds 25 mm wide filters. Sets of 3 filters or 6 filters are also available. Optical density varies with the wavelength. To see the complete transmission spectrum, please refer to “Figure 1: Transmission Curve of all ND Filters” on next page

For the BEAMAGE-FOCUS, Gentec-EO also offers 6 ND filters with a diameter of 50 mm, mounted in an SM2-threaded holder and with a T-mount adaptor.

#### Neutral Density Filters Specifications

	SM1-threaded	SM2-threaded
<b>Specified OD Spectral Range</b>	400 nm – 650 nm	
<b>Spectral Range</b>	350 nm – 1600 nm	
<b>Filter Diameter</b>	25 mm Ø	50 mm Ø
<b>Clear Aperture</b>	22.5 mm Ø (90% of diameter)	45.7 mm Ø
<b>Dimensional Tolerance</b>	+0.0/-0.25 mm	
<b>Optical Density Tolerance</b>	±5%	
<b>Parallelism</b>	< 10 arcsec	
<b>Transmitted Wavefront Error</b>	< $\lambda/10$ at 633 nm	N/A
<b>Surface Flatness</b>	< $\lambda/4$	< $\lambda$
<b>Surface Quality</b>	40-20 Scratch-Dig	
<b>Maximum Power</b>	1 W	
<b>Damage Thresholds</b>	100 W/cm <sup>2</sup> or 3 J/cm <sup>2</sup>	

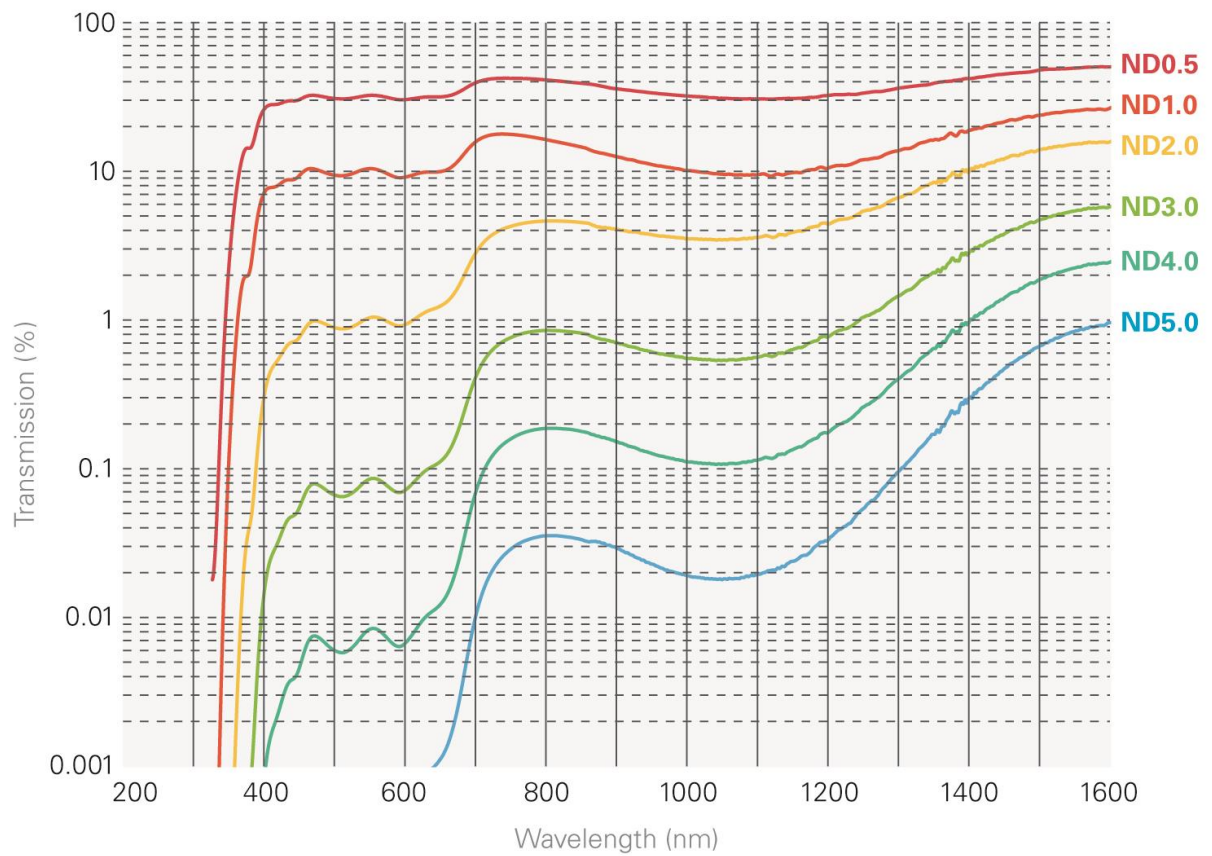
Data specified at 633 nm

#### Available Products Characteristics

Model	P/N	Description	Optical Density @ 633 nm	Equivalent Attenuation	Transmittance @ 633 nm	Substrate	Substrate Thickness
<b>ND0.5</b> <b>ND0.5-FOCUS</b>	201094 203403	ND filter	0.5	(1/3.16)	~32%	NG4	~0.91 mm
<b>ND1.0</b> <b>ND1.0-FOCUS</b>	201045 203404	ND filter	1.0	(1/10)	~10%	NG4	~1.89 mm
<b>ND2.0</b> <b>ND2.0-FOCUS</b>	201046 203405	ND filter	2.0	(1/100)	~1%	NG9	~1.40 mm
<b>ND3.0</b> <b>ND3.0-FOCUS</b>	201047 203406	ND filter	3.0	(1/1000)	~0.1%	NG9	~2.11 mm
<b>ND4.0</b> <b>ND4.0-FOCUS</b>	202600 203407	ND filter	4.0	(1/10 000)	~0.01%	NG9	~2.83 mm
<b>ND5.0</b> <b>ND5.0-FOCUS</b>	202601 203408	ND filter	5.0	(1/100 000)	~0.001%	NG9	~3.55 mm
<b>NDSET-6</b>	202605	Set of all 6 filters	See above	-	See above	See above	See above
<b>NDSET-3</b>	202606	Set of 3 filters (ND1, ND2, ND3)	See above	-	See above	See above	See above
<b>ND-H</b>	Call	ND filter holder	-	-	-	-	-

**Warning**

When using multiple ND filters, it is necessary for the light to pass through the less attenuating filter first. For example, if you wish to have a  $1/10^7$  (ND 7.0) attenuation ratio, you need to put the ND 3.0 on the front and then the ND 4.0 filter between the ND 3.0 filter and the BEAMAGE camera.



**Figure 1: Transmission Curve of all ND Filters**

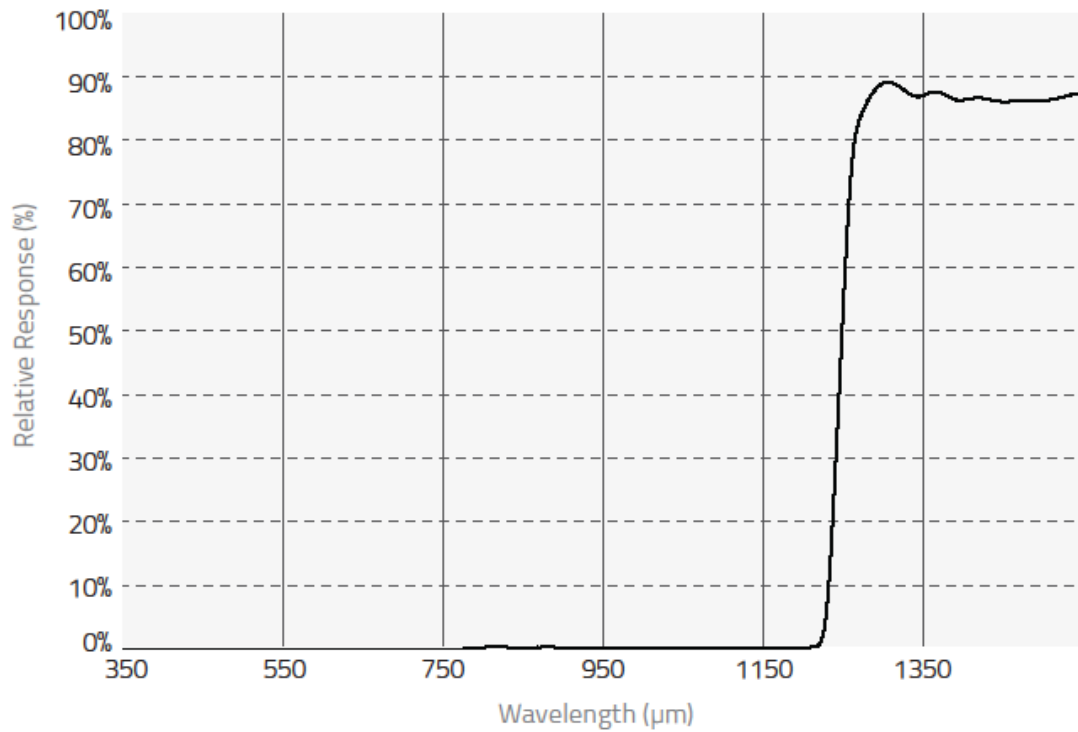
### 3. WAVELENGTH MANAGEMENT

#### 3.1. IR FILTER

Gentec-EO also offers a color glass filter specially designed for IR wavelengths. The IR filter transmits 70% of the incident light. It is particularly useful for applications with wavelengths ranging between 1250 nm and 1350 nm. Other wavelengths are stopped by the filter. The IR filter is SM1 threaded.

#### IR Filter Specifications

<b>BEAMAGE Spectral Range with IR filter</b>	1250 nm – 1350 nm
<b>Diameter</b>	25 mm Ø
<b>Clear Aperture</b>	80% of area
<b>Dimensional Tolerance</b>	+0.0/-0.2 mm
<b>Thickness</b>	6.3 mm max
<b>Parallelism</b>	< 3 arcmin
<b>Surface Flatness</b>	< $\lambda/4$
<b>Maximum Power</b>	1 W
<b>Surface Quality</b>	80-50 Scratch-Dig
<b>Damage Threshold</b>	30 W/cm <sup>2</sup> (typical)
<b>Part Number</b>	202855



**Figure 2:** Transmission Curve of IR filter



### 3.2. IR ADAPTOR

The *IR Adaptor* takes advantage of a multi-photon absorption process to extend the sensitivity of the BEAMAGE beam profiling camera to a portion of the near-IR spectrum.

The module converts wavelengths ranging between 1495 nm and 1595 nm (telecom wavelengths band) to shorter wavelengths ranging between 950 nm and 1075 nm.

After going through an anti-reflection coated input window, the laser beam gets instantaneously converted with high resolution, low distortion and good uniformity.

The *IR Adaptor* can be C-mounted onto the entrance port of the BEAMAGE camera.



#### Important

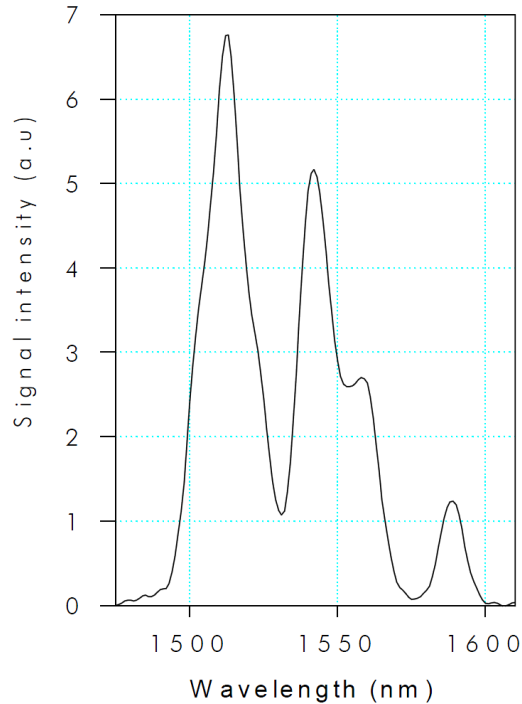
It is mandatory to factory adjust the IR Adaptor to its twin camera.



Figure 3: IR Adaptor

#### IR Adaptor Specifications

<b>Active Area</b>	27.5 mm Ø
<b>IR Spectral Range</b>	1495 nm – 1595 nm
<b>Peak IR Sensitivity</b>	1510 nm and 1540 nm
<b>Converted Wavelengths</b>	950 nm – 1075 nm
<b>Pixel Multiplication Factor</b>	3.29
<b>Minimum Beam Size</b>	230 µm
<b>Maximum Beam Size</b>	19 mm
<b>Maximum Resolution</b>	12 lp/mm over active area 40 lp/mm at sensor focal plane
<b>Distortion</b>	-1.0% barrel distortion (inverted image)
<b>Linearity</b>	Non-Linear, IR converted output $\propto$ IR input intensity $^{1.41}$
<b>Spectral Transmission</b>	360 nm – 2000 nm @ F30.8
<b>Damage Threshold</b>	1 W/cm <sup>2</sup>
<b>Dimensions</b>	46 mm Ø x 97 mm L
<b>Operating Temperature</b>	-10°C to +40°C
<b>Weight</b>	210 g
<b>Part Number</b>	201061



**Figure 4:** BEAMAGE-IR and IR Adaptor Excitation Spectrum

**Important Steps to Follow When Using the IR Adaptor:**

**1. Remove the ND4.0 filter from the camera**

Remove the ND4.0 filter that is supplied with the BEAMAGE camera before using the *IR Adaptor*.

**2. Determining and Entering the Pixel Multiplication Factor**

The Pixel Multiplication of the *IR Adaptor* at the focus point is 3.29.



**Warning**

When using the IR adaptor, you must enter its Pixel Multiplication Factor in the PC-BEAMAGE software.

Enter this value in the software below *Magnifying Lens*. The on-screen dimensions will now be correct.

**3. Screw the ND filter in front of the IR adaptor.**

Depending on the laser source's power, screw the appropriate ND filter in front of the IR adaptor.

**4. Make a Background Subtraction or Select an Active Area**

Since this optical component is suitable for 1/2" sensor format only (does not work for 2/3" sensor format), a portion of the sensor will not be available when using it. Therefore, it is necessary to make a background subtraction or to select an active area on the sensor via the PC-BEAMAGE software.

## 5. Apply the Despeckle Filter

The phosphor coated glass used inside the *IR Adaptor* produces speckles that may alter the intensity profile of the beam and thus affect the accuracy of the measurements.

Therefore, it is important to use the *Despeckle Filter* when viewing a beam with the *IR Adaptor* because it will remove speckles and noise related to transmission of light through the phosphor coating.

The *Despeckle filter* is a new and aggressive spatial filter that performs a 9x9 pixels simple averaging around each pixel, with all of the pixels having the same relative weight (1/81).

*Please note that using the Despeckle Filter can slightly reduce the resolution.*



### Warning

Please note that the minimum measurable beam diameter at a 50% clip level is approximately 230  $\mu\text{m}$ . Any smaller beam will be significantly broadened by the point spread function of the phosphor.

### 3.3. UG11-UV – UV BANDPASS FILTER

Gentec-EO also offers a color glass filter specially designed for UV wavelengths. The UG11-UV filter transmits 20% to 77% of the incident light, depending on wavelength. It is particularly useful for applications with wavelengths ranging between 250 nm and 370 nm. Other wavelengths are stopped by the filter. The UG11-UV is SM1 threaded.

#### UG11-UV Bandpass Filter Specifications

<b>Spectral Range</b>	250 nm – 370 nm
<b>Diameter</b>	25 mm Ø
<b>Clear Aperture</b>	80% of area
<b>Dimensional Tolerance</b>	+0.0/-0.38 mm
<b>Thickness</b>	3 mm
<b>Thickness Tolerance</b>	+0.0/-0.2 mm
<b>Parallelism</b>	< 3 arcmin
<b>Maximum Power</b>	1 W
<b>Surface Quality</b>	80 - 50
<b>Damage Threshold</b>	30 W/cm <sup>2</sup> (typical)
<b>Part Number</b>	202602



#### Warning

It is important to remove the ND 4.0 filter that comes with the BEAMAGE before using the UG11-UV Bandpass Filter.

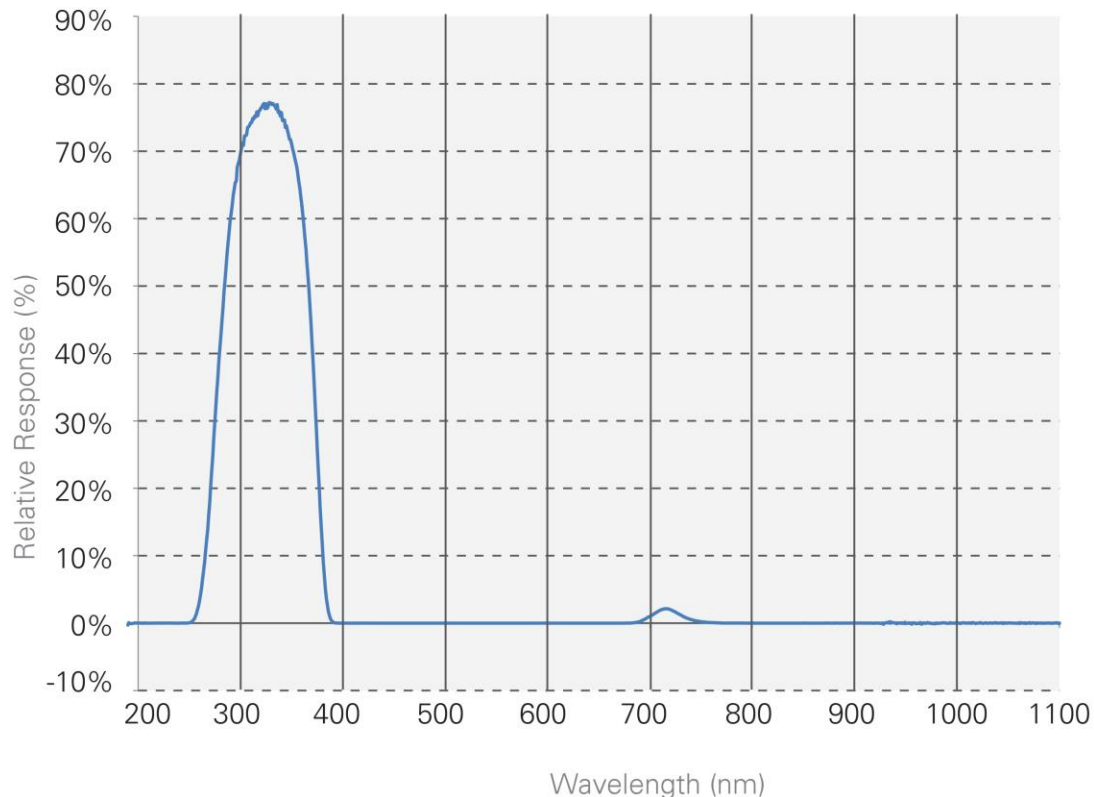


Figure 5: Transmission Curve of UG11-UV Bandpass Filter

### 3.4. UV CONVERTERS

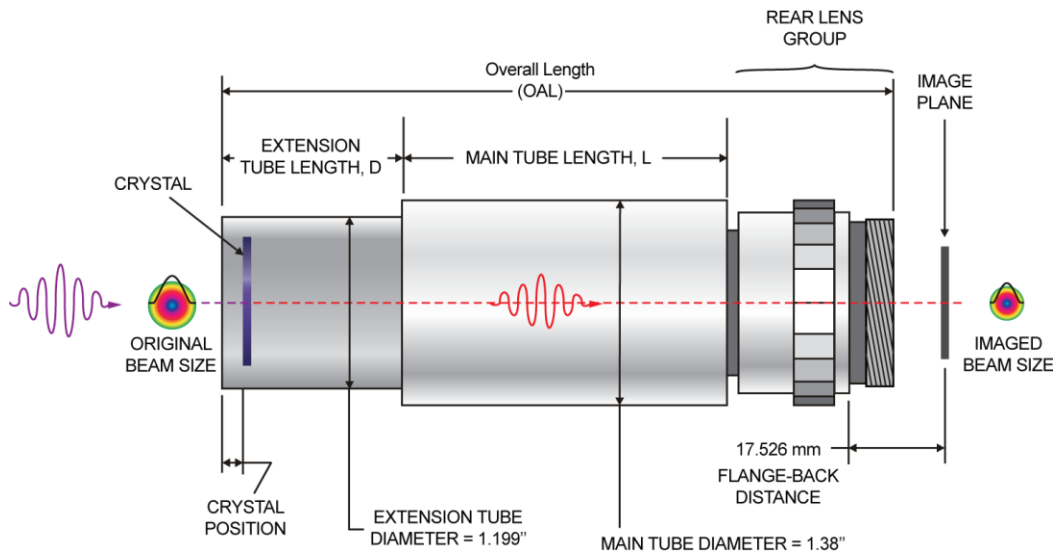
UV converters take advantage of a phenomenon called fluorescence to extend the wavelength range of the BEAMAGE to the UV wavelengths. The fluorescent crystal is located at the entrance of the converter. It absorbs UV wavelengths and reemits longer wavelengths (visible spectrum), which are less energetic. The rest of the device is mainly composed of optics. An iris at the end controls the exposure on the sensing device.

The light emitted from the fluorescent crystal is non-coherent and non-collimated. The multiple lenses inside the converter compensating for this affect the beam size. Therefore, it is important to know that UV Converters have magnification properties, which are detailed in tables 9 and 10.

Like an IR adaptor, a UV converter is an extension tube that is simply fixed onto the aperture of the camera.



It is mandatory to factory adjust the UV converter to its twin camera.



**Figure 6: UV Converter Diagram**

### UV Converters Specifications (23 mm aperture)

Model	BF23C23N	BF23G23N	BF23P23N	BF23R23N
Input Aperture $\varnothing$ [mm]	23	23	23	23
Closest Standard Optical Camera Format	2/3"	2/3"	2/3"	2/3"
Main Tube Length (L) [mm]	76.3	76.3	76.3	76.3
Extension Tube Length (D) [mm]	30	30	30	30
Overall Length (OAL) [mm]	108	108	108	108
Max Input Beam Size [mm]	13.8 x 18.4	13.8 x 18.4	13.8 x 18.4	13.8 x 18.4
Max Beam Size on CMOS [mm]	5.3 x 7.1	5.3 x 7.1	5.3 x 7.1	5.3 x 7.1
Magnification ( $\pm 10\%$ )	2.6	2.6	2.6	2.6
Crystal Type	C	G	P	R
Wavelength Range [nm]	110 - 225	X-ray - 400	110 - 350	110 - 535
Relative Response	193 nm	22	480	48
	248 nm	0.17	480	15
	308 nm	0.03	112	1
Saturation Level [mJ/cm <sup>2</sup> ]	193 nm	400	10	30
	248 nm	N/A	10	30
	308 nm	N/A	50	50
Damage Threshold [mJ/cm <sup>2</sup> ]	500	250	500	500
Max Average Power [W/cm <sup>2</sup> ]	2	2	2	2
Decay Time [ $\mu$ s]	3 - 5	0.5	5	3000
Max Repetition Rate	30 - 20 kHz	200 kHz	20 kHz	30 Hz
Part Number	202325	202327	202329	202331

#### Important Steps to Follow When Using a UV Converter:

##### 1. Remove the ND4.0 filter from the camera

Remove the ND4.0 filter that is supplied with the BEAMAGE camera before using a *UV Converter*.

##### 2. Choosing the appropriate UV Converter

Gentec-EO offers a complete array of UV converters. For more details and information on how to choose the appropriate UV converter, please contact your local Gentec-EO representative.

##### 3. Determining and Entering the Pixel Magnification Factor



#### Warning

When using a UV converter, you must enter its Pixel Multiplication Factor in the PC-BEAMAGE software.

Enter the value in the software in the *Pixel Multiplication Factor* section in the *Setup Tab*. The on-screen dimensions will now be correct.

## 4. BEAM SIZE MANAGEMENT

### 4.1. CL-25 AND CL-50 – CAMERA LENSES

A *Camera Lens* works by indirectly imaging on the sensor the reflection or the transmission of a beam (refer to Figure 7: Imaging a transmitted beam and Figure 8: Imaging a reflected beam) that previously went through a diffusing material such as glass.

It is necessary to use a *Camera Lens* to image beams that are larger than the CMOS sensor (11.3 mm X 6.0 mm) of the BEAMAGE beam profiling camera.



**Warning**

Please note that the image is inverted on the sensor since the mechanism of this optical device involves convergent lenses.

A *Camera Lens* can be directly C-mounted onto the aperture of the BEAMAGE camera as they are both C-mount.

#### **Important Steps to Follow When Using a *Camera Lens***

##### 1. Choosing the appropriate *Camera Lens*

*Camera Lens* are offered with 2 different focal lengths, 25 mm and 50 mm. To determine which lens fits your requirements, refer to the table below.

Names	Part Number	Focal Length	Horizontal FOV	FOV at 1 m	Minimum Working Distance
CL-25	202343	25 mm	14°	245 mm	0.5 m
CL-50	202344	50 mm	7 °	120 mm	1 m

To calculate the linear FOV (Field of View) at distances other than 1 m, simply multiply the value found in the table by the distance in meters.

##### 2. Remove the ND4.0 filter from the camera

Remove the ND4.0 filter that is supplied with the BEAMAGE camera before using a *Camera Lens*.

##### 3. Install the optical setup

You can setup the BEAMAGE with a camera lens in transmission or reflection mode. Please refer to Figure 7 and Figure 8. Please adjust the focus of the *Camera Lens* in order to clearly see the target.



**Warning**

Please note that if the setup is in reflection mode, the viewing angle must be as small as possible to minimize distortion.

#### 4. Flip the image horizontally

In the PC-BEAMAGE software select the “Flip Horizontally” option in the Setup Tab to compensate the Camera Lens’ inversion. Please refer to section 5.2.2 of the BEAMAGE user manual.

#### 5. Subtract Background

Because the Camera Lens will image the laser, but also the entire scene, it is important to perform a background subtraction to only view the laser.

#### 6. Determining and entering the Pixel Magnification Factor

Prior to profiling a beam with a *Camera Lens*, one must determine the *Pixel Magnification Factor* of the lens and enter its value in the PC-BEAMAGE software in order to have the exact beam dimensions. The “*Pixel Multiplication Factor*” section can be found at the bottom of the “*Setup*” tab.

It is possible to manually set a value for the Pixel Multiplication Factor. Simply enter the desired value in the white box and press enter. The beam dimensions will be adjusted accordingly.

Otherwise, it is possible to follow the camera lens calibration steps in the “*Camera Lens*” panel. This panel can be opened by clicking the “Calibrate” button in the Pixel Multiplication Factor section or by selecting it in the Show/Hide Options button in the ribbon.

- i. Once you are ready to start, click on the “Set now” button to set the centroid to the current position.
- ii. Then, move the BEAMAGE (or the laser source) by a known distance along the X axis.
- iii. Enter this distance (in mm) in the appropriate box.
- iv. Finally, click on the “Calibrate” button to automatically set the Pixel Multiplication Factor (PMF) value found in the bottom of the “*Setup*” tab.

Once the Pixel Multiplication Factor is set, the beam dimensions will be adjusted to compensate for the magnification of the *Camera Lens*.

For more information about the automatic calibration of the *Pixel Multiplication Factor*, please refer to section 5.2.8 of the BEAMAGE user manual.

#### 7. Apply the Despeckle Filter

Any static diffusing material such as glass will show speckles, typically producing intensity variation of  $\pm 20\%$  and thus significantly affecting the accuracy of measurements. Apply the Despeckle filter to remove any unwanted intensity variations and to get the most accurate measurements. It is important to use the Despeckle Filter when imaging a beam with a Camera Lens because it will remove speckles and noisy signal related to irregularities of the diffusing material and distortions of the reflection-transmission optical process.

*Please note that using the Despeckle Filter can slightly reduce the resolution*



Camera Lens Specifications

	CL-25	CL-50
<b>Focal lengths</b>	25 mm	50 mm
<b>Maximum beam size</b>	2000 mm X 2000 mm (not a limiting factor)	
<b>Maximum measurable intensity / energy</b>	Very high because of indirect mechanism	
<b>Inverted image</b>	Yes	
<b>Beam distortion</b>	Setup, lens aberration and speckles from diffusing glass	
<b>Diffusing material needed</b>	Yes	
<b>Magnification calibration needed</b>	Yes	
<b>Possibility of wavelength conversion</b>	Yes	
<b>Optical filter needed</b>	Rarely to never	
<b>Removable</b>	Yes	

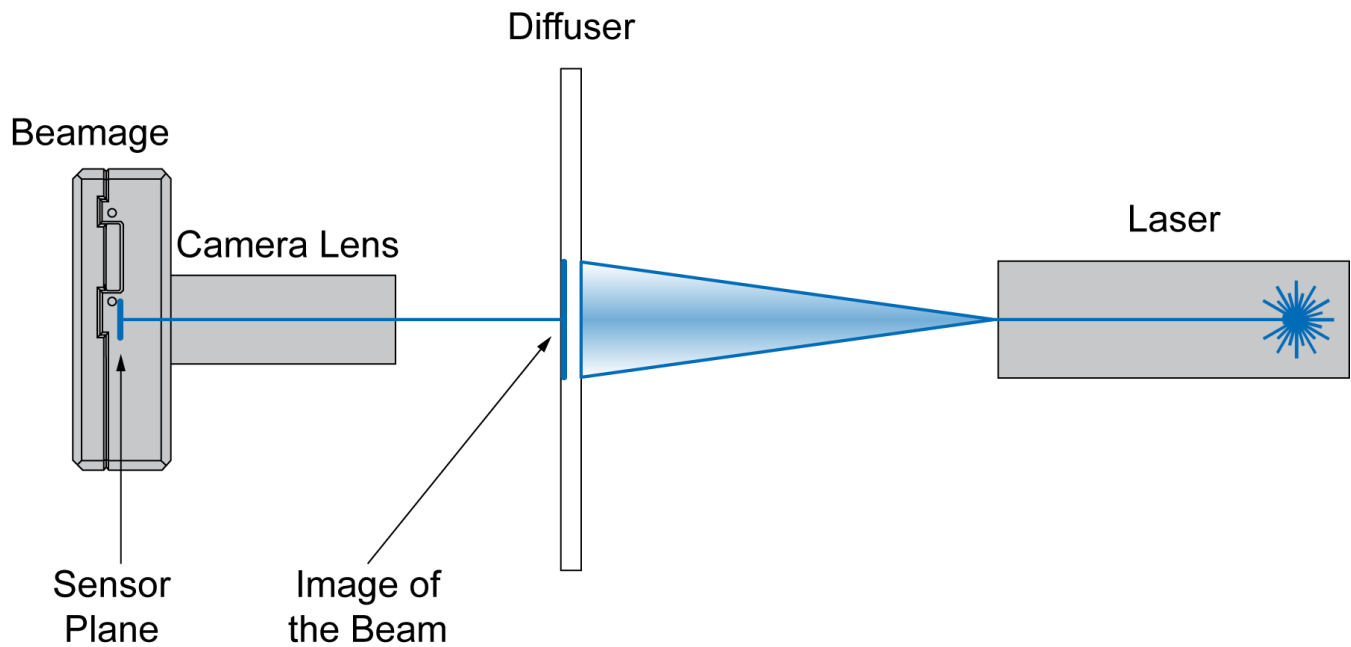
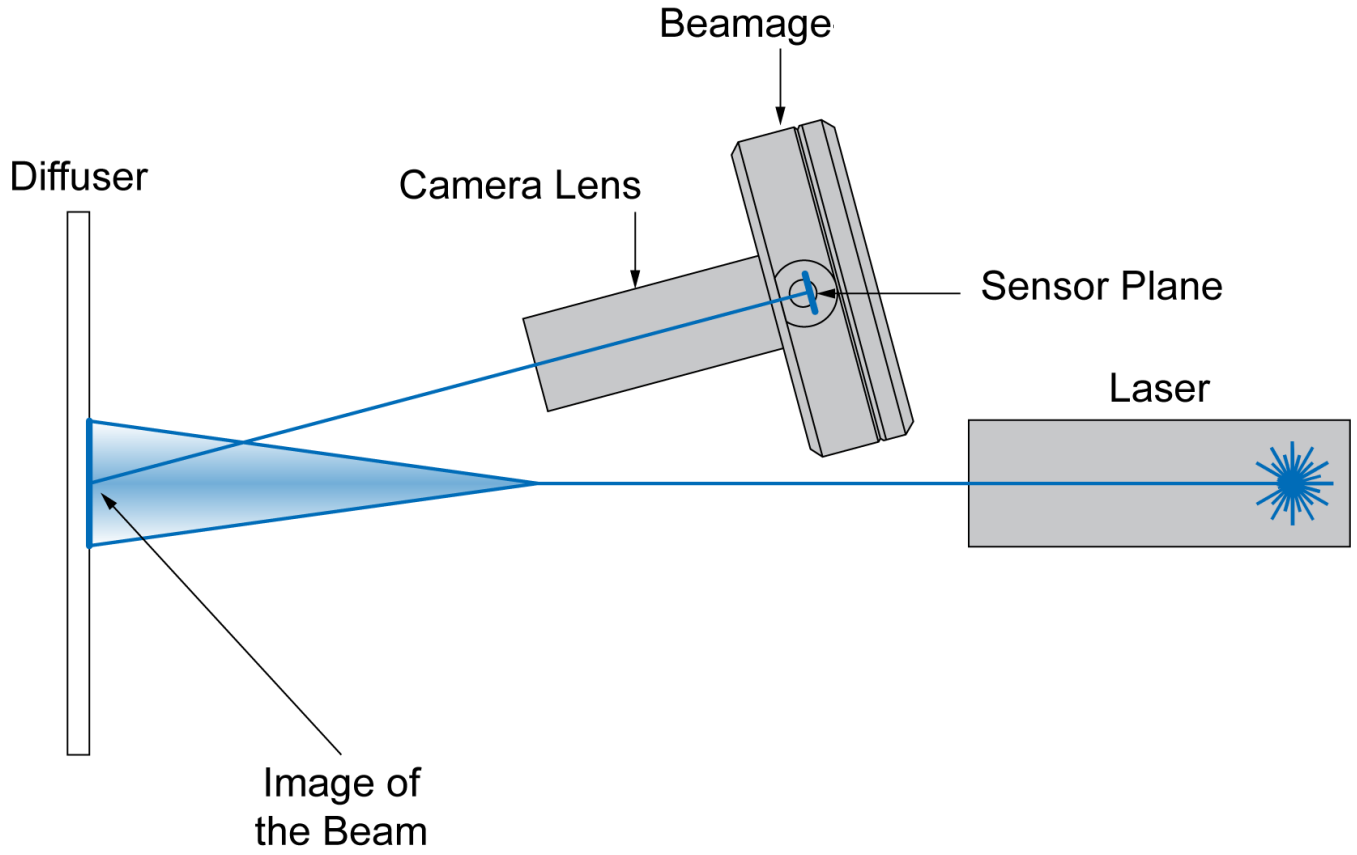


Figure 7: Imaging a transmitted beam



**Figure 8:** Imaging a reflected beam

## APPENDIX A: WEEE DIRECTIVE

Refer to the UP User Manual if necessary (available at [www.gentec-eo.com](http://www.gentec-eo.com)) for the power detector declaration of conformity.

### WEEE compliance

These products comply with the European Directive 2012/19/EU – WEEE

### Recycling and separation procedure for WEEE directive 2012/19/EU

This section is used by the recycling center when the detector reaches its end of life. Breaking the calibration seal or opening the monitor will void the detector warranty.

The complete accessory package can contain:

- 1 Accessory
- 1 Detector with DB-15.
- 1 Instruction manual
- 1 Calibration certificate

### Separation

Paper: Certificates (if applicable)

Wires: Detector cable. (if applicable)

Printed circuit board: inside the Detector (for -MT, -MA, -BT and -CP version only) or DB-15, no need to separate (less than 10 cm<sup>2</sup>). (if applicable)

Glass: Optical component. (if applicable)

Aluminum: Accessory housing. (if applicable)



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BEAM PROFILING



THz MEASUREMENT

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