



USER MANUAL

BA Series - Optical Attenuators

WARRANTY

The Gentec-EO BA Optical Attenuators 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

Website: 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 BA Optical Attenuators if they look damaged, or if you suspect that the BA Optical Attenuators 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

The Gentec-EO Optical Attenuator BA Series includes four optical attenuators: three models with 16-mm aperture for lower powers and a 1-kW model with a 32-mm aperture. The Optical Attenuator BA Series is expressly designed to be used simultaneously with a BEAMAGE beam profiler. For further information about the BEAMAGE Profiler, refer to the corresponding manual on gentec-eo.com/resources/download-center.



BA16-60S



BA16K-150S-H5-D0



BA16K-500F-H9-D0



BA32-1KW

Model	Maximum Power
BA16-60S	60 W
BA16K-150S-H5-D0	150 W
BA16K-500F-H9-D0	500 W
BA32-1KW	1000 W

For Gentec-EO's nearest office contact information, see p. ii, Contacting Gentec Electro-Optics Inc.

2. WARNINGS AND DISCLAIMER

In no event shall Gentec-EO or any of its affiliates be liable for any indirect, special, incidental or consequential injury to persons or damage to property caused by the use of any of our products, by purchasing from Gentec-EO or any of its affiliates, you hereby indicate that you understand and agree to the following:



Disclaimer

I am fully responsible for the safe application and use of this product and agreed to such by completing the sales process.

I will not use a laser device without wearing approved laser safety goggles designed for such purpose.

I am aware and responsible of safely dealing with any back reflections.
I will not use the product in violation of any local, state or federal law, and I understand that it is my responsibility to know and abide by those laws relating to the ownership and use of the product in my jurisdiction.

Attenuator temperature while in operation

During usage, the attenuator (especially the beam dump) can become hot enough to cause burns.



Warning

Be careful not to exceed the maximum levels and densities stated in the specifications.

3. BA16 OPTICAL ATTENUATOR SERIES

3.1. INCLUDED WITH YOUR BA16

The following items are included with your BA16 optical attenuator:

Description
BA16 optical attenuator
Protective covers for optical apertures ¹
Power meter calibration certificate (models that include a power meter)
Personal Wavelength Correction™ certificate (models that include a power meter)
Tube coupler for BEAMAGE camera

The following items can be purchased separately:

Description	Part name	Part number
Stand	See website	See website

3.2. POWER DETECTOR

The BA16K-150S-H5-D0 and BA16K-500F-H9-D0 come with a built-in UP power detector which can be used via a DB-15 connector. The power detector included with your attenuator model is specified at section 3.3. For further information about the UP power detector itself, refer to the *UP Manual* (available at gentec-eo.com/resources/download-center).

3.3. SPECIFICATIONS

The following specifications are based on an operating temperature of 15°C to 28°C (59 to 82°F) and a relative humidity not exceeding 80%. Attenuators must be stored in an environment between 10°C to 65°C and a relative humidity not exceeding 90%.

Gentec-EO	BA16-60S	BA16K-150S-H5-D0	BA16K-500F-H9-D0
	Measurement Capability		
Spectral Range	200 nm – 2100 nm		
Spectral Range with BEAMAGE Camera	350 nm – 1150 nm		
Sampled Percentage ²	0.0588% (1/1700) @ 1.064 μm		
Integrated Power Meter	None	UP19K-15S-H5-D0	UP19K-110F-H9-D0
Maximum Power	60 W	150 W	500 W
Aperture Diameter	16 mm		
Maximum Beam Diameter	16 mm		
Optical Wedges Material	UV Fused Silica (uncoated)		
Sampled Beam Lateral Shift	21mm		
Sampled Beam Deviation	90°		
Residual Beam Deviation	5.6°		
CW Laser Damage Thresholds on the Optical Wedge 1.064 μm, CW	Average Power Density 10 MW/cm ²		

¹ Models that include a power meter do not come with a protective cover for Residual Beam 2.

² Considering 0° AOI referred to the input aperture.

Pulsed Laser Damage Thresholds on the Optical Wedge 1.064 μm, 7 ns, 10 Hz	Max. Energy Density 10 J/cm ²		
Max. Average Power Density on the Power Meter 1.064 μm, 10W CW 10.6 μm, 10W CW	45 kW/cm ² 14 kW/cm ²	36 kW/cm ² 11 kW/cm ²	45 kW/cm ² 14 kW/cm ²
Pulsed Laser Damage Thresholds of the Power Meter ³ 1.064 μm, 360 μs, 5 Hz 1.064 μm, 7 ns, 10 Hz 532 nm, 7 ns, 10 Hz 266 nm, 7 ns, 10 Hz	Max. Energy Density H5: 5 J/cm ² H9: 9 J/cm ² 1.0 J/cm ² 0.6 J/cm ² 0.3 J/cm ²		
	Peak Power Density H5: 14 kW/cm ² H9: 25 kW/cm ² 143 MW/cm ² 86 MW/cm ² 43 MW/cm ²		
	Physical Characteristics		
Dimensions	81H x 47W x 45D mm	86H x 54W x 50D mm	126H x 54W x 54D mm
Fan Input Voltage	NA	NA	12 VDC
Weight	0.26kg	0.37kg	0.46kg
Mounting	¼ - 20 (imperial) threaded holes / 30mm cage system		
Input & Output Aperture Threading	SM1		
Product Number	203791	203792	203793

Specifications are subject to change without notice

The attenuation between the input aperture and the sampled beam is polarization-insensitive, but it varies with the wavelength. The graph below presents the attenuation factor as a function of the wavelength considering an angle of incidence of 0° with the input aperture.

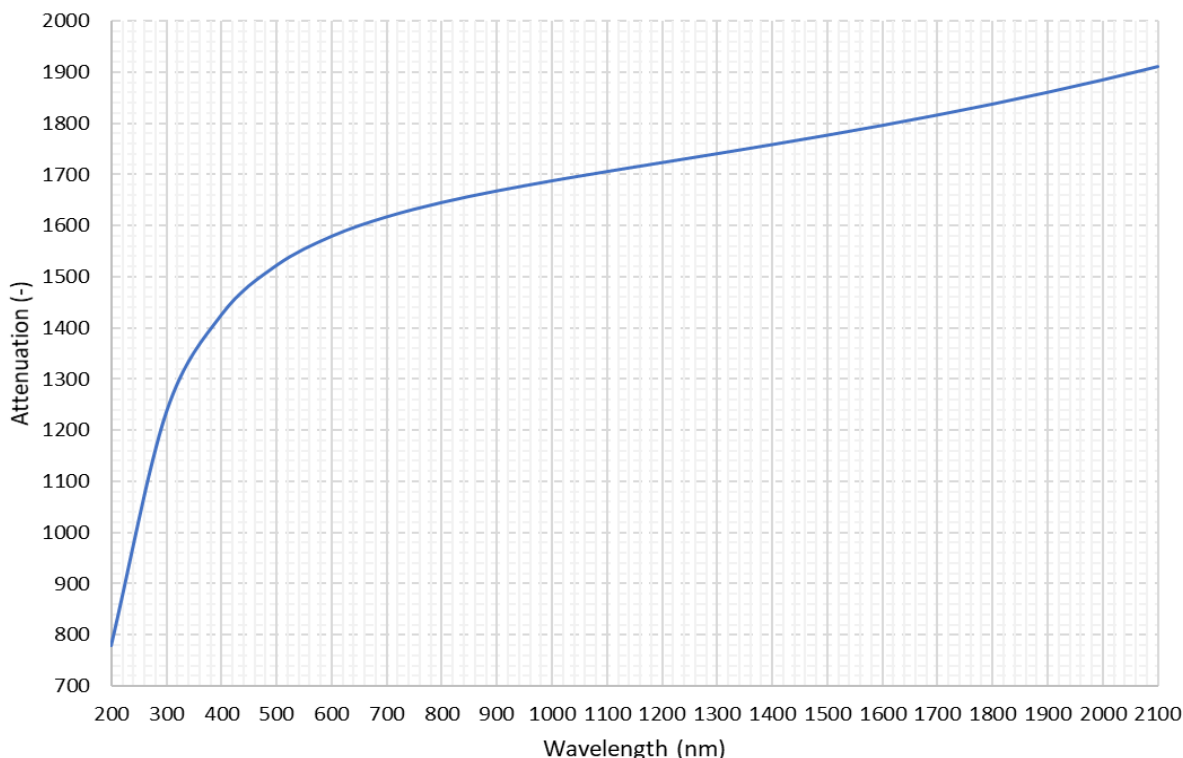
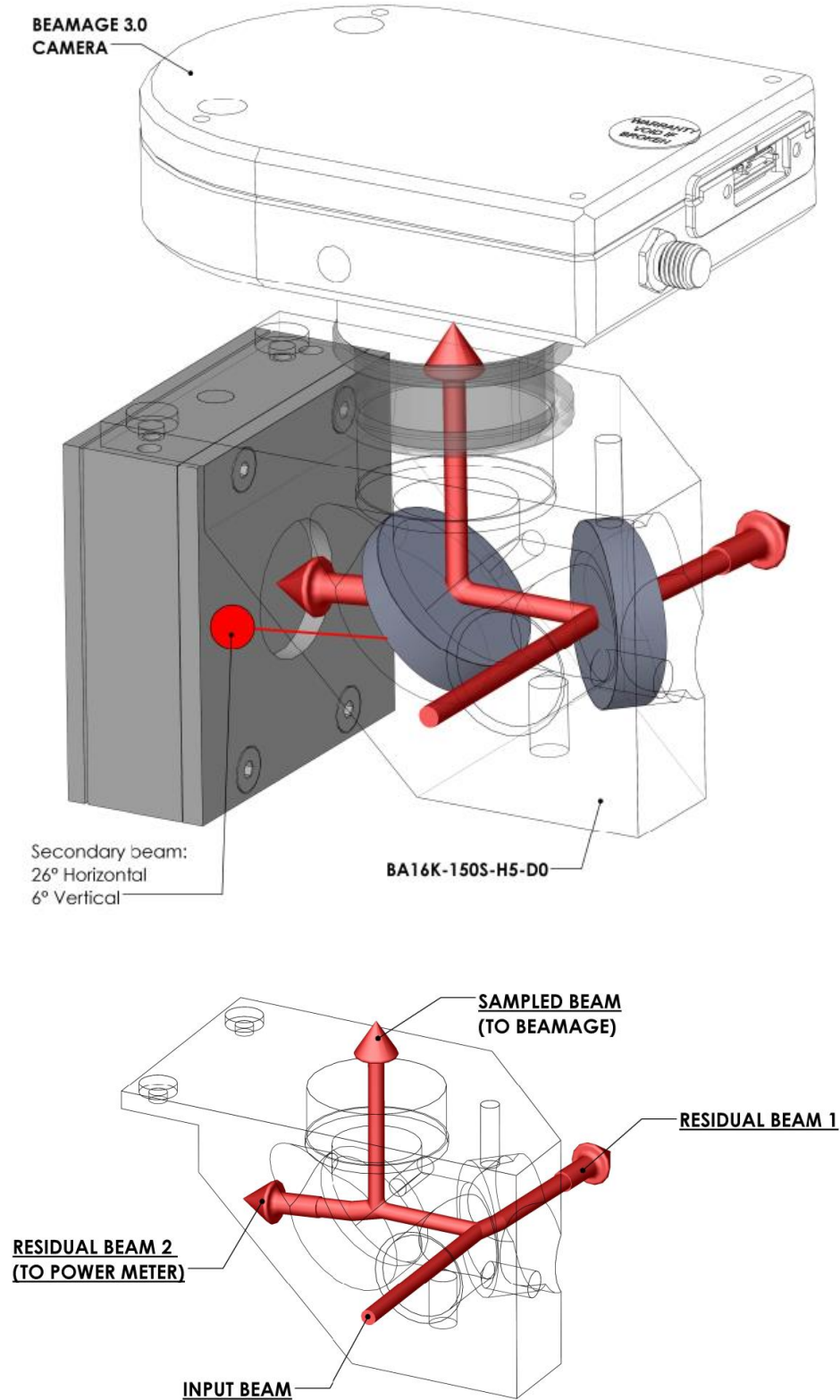
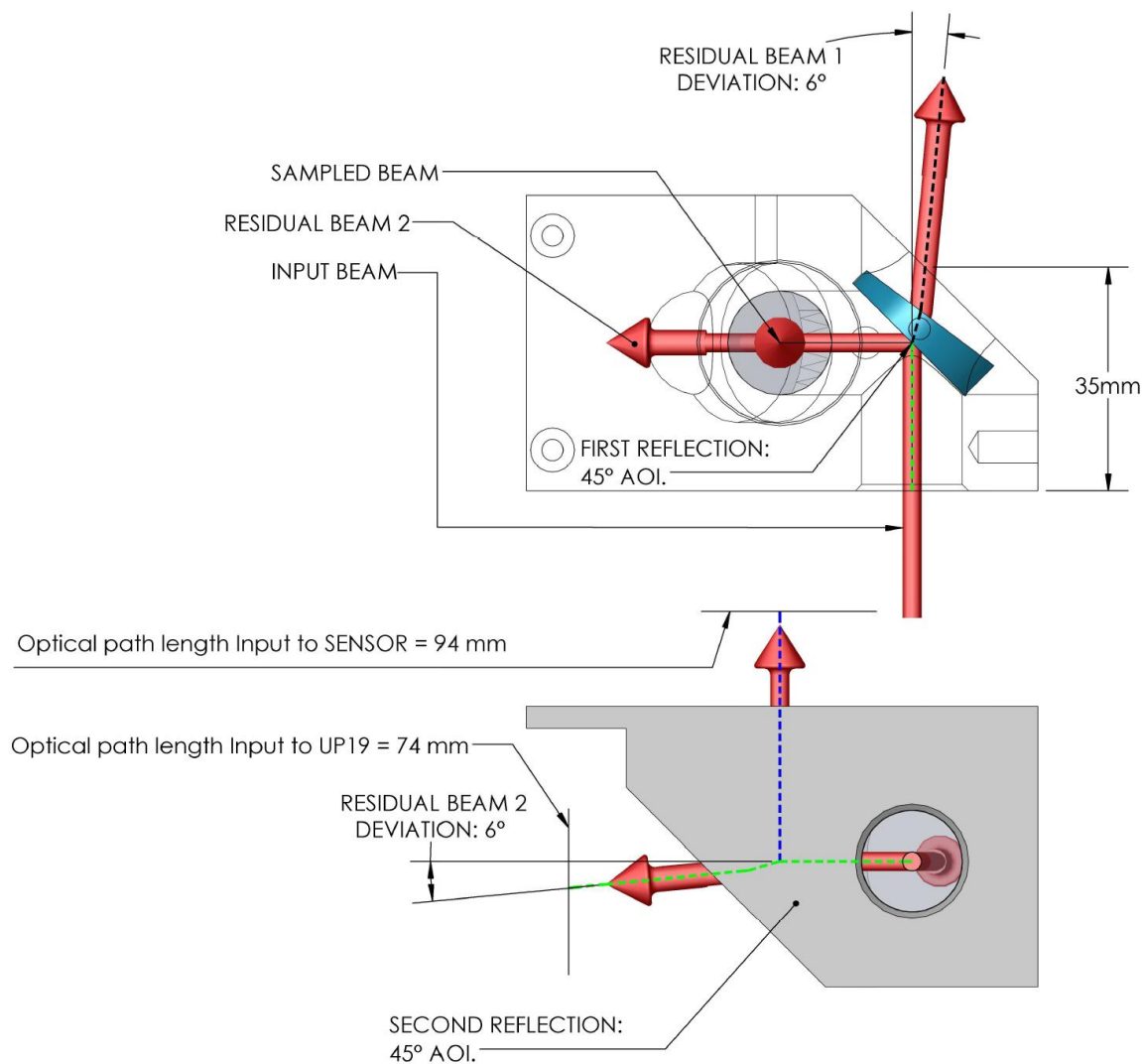


Figure 1 : Spectral attenuation factor

³ Attenuation factor of 24 @ 1.064 μm assuming a random polarization at 0° angle of incidence of the input aperture.

3.4. BEAM PATH DETAILS





Typical power values @1070nm (% of incident beam)	
Residual Beam 1	92%
Between the 2 wedges	2 x 4% = 8%
Residual Beam 2	2 x 3.7% = 7.4%
Sampled Beam	0.1%

Typical optical path length	
Input to <i>Sampled Beam</i> output (without accessory)	69 mm
Input to <i>Residual Beam 1</i> output	35 mm
Input to <i>Residual Beam 2</i> output	56 mm
Input to <i>UP19K</i> (BA16K-150S-H5-D0 / BA16K-500F-H9-D0)	74 mm
Input to <i>BEAMAGE's</i> sensor	94 mm

3.5. OPERATING INSTRUCTIONS

Storage

In order to ensure a long lifetime of accurate measurements, it is recommended that attenuators be held within the following ambient conditions:

Storage environment temperature: 10 to 60 °C, RH < 90 %

Operating environment temperature: 15 to 28 °C, RH < 80 %.

It is possible to store and operate your Optical Attenuator beyond this range. For any specific requirements, please contact your local Gentec-EO representative.

General operation with BEAMAGE beam profiling camera

For the BA16K-500F-H9-D0 only, connect the fan to the included power supply to ensure an adequate cooling. Once appropriate cooling is achieved, the Attenuator is ready to be aligned in the intended optical set-up.

1. Remove the protective covers from the Attenuator and power detector.
2. Using the supplied coupler, install the BEAMAGE camera on the attenuator's sampled beam aperture. Use the locking rings to secure the BEAMAGE on the coupler and the coupler to the Attenuator.
3. Download and install the software *PC-BEAMAGE* (available at gentec-eo.com).
4. Connect the BEAMAGE to the computer. For further information about *PC-BEAMAGE*, refer to the corresponding manual on gentec-eo.com/resources/download-center.
5. Align the Attenuator in the optical set-up using a safe "low-power" laser by centering the beam into the power detector and in the BEAMAGE. In order to ensure an optimum, polarization-independent attenuation, the laser beam should ideally be perfectly aligned and centered within the Attenuator's input aperture and in the BEAMAGE.



Warning

Never touch directly the optics or the absorbing surface of the beam dump/power detector.

In the case of a joint use of a BA16 and a BEAMAGE camera in order to profile a high-power beam, an additional neutral density filter to the camera may be necessary. **If an additional ND filter is necessary, make sure to not exceed the maximum average power density of the power meter.** Refer to the section 3.3 or the *UP User Manual* (available at gentec-eo.com/resources/download-center) for additional information and specifications about the power meter.

Calibration procedure to use the integrated power detector (models BA16K-150S-H5-D0 and BA16K-500F-H9-D0 only)

In order to use the integrated power detector for input beam power live monitoring, you need to determine the **attenuation factor** by using the following steps:

1. Measure the power of your laser beam before the optical aperture of the Optical Attenuator.
2. Measure the power of your laser beam with the integrated power detector (after the second wedge).
3. Divide the power obtained in 1 by the power obtained in 2 to calculate the attenuation factor "A".

4. Enter the calculated factor “A” in the PC-Gentec-EO software or in your Maestro display as a *Multiplier* to get a live measurement of the *input beam* power.

**Important**

The laser beam alignment and power must be steady for the steps 1 and 2.

Note: The attenuation factor “A” between the *input beam* and the integrated power detector depend on the polarization and the alignment of your laser beam. The attenuation factor “A” should be recalculated (steps 1 to 4) after any alignment modification.

Compatibility

The attenuators of the BA series are compatible with many Gentec-EO detectors.

In addition, the BA series attenuators can easily be used with any detector or device threaded according to SM1 standard and specifically with the following Gentec-EO detectors:

- PRONTO-Si with the threaded adaptor accessory
- Photodetectors PH and PE series
- Thermal power detector XLP12 and UP10 series

For more information about compatibility, please contact your local Gentec-EO representative.

Damage to the optical absorber material

Damage to the optical absorber material is usually caused by exceeding the manufacturer's specifications, such as:

- Incident Average Power Density
- Incident Pulse Energy Density

Refer to the specification pages for the Optical Attenuator BA Series. Damage may also be caused if the absorber surface and/or optics are contaminated. A slight discoloration of the coating does not affect the absorption.

In any case, the beam's incident area should not be less than 10% of the beam dump's aperture. Please contact Gentec-EO to make measurements with such smaller beams.

In the event of significant damage to the coating, the UP sensors or the beam dump can be recoated. Contact your local Gentec-EO representative for information on repair and recalibration. See p. ii Contacting Gentec Electro-Optics Inc

4. BA32 OPTICAL ATTENUATOR SERIES

4.1. INCLUDED WITH YOUR BA32

The following items are included with your BA32 optical attenuator:

Description
BA32 optical attenuator
Protective covers for optical apertures
Heavy duty carrying case

The following items can be purchased separately:

Description	Part name	Part number
Mounting kit for UP55	BA32-UP55	205320
Mounting kit for BEAMAGE FOCUS	BA32-FOCUS	205321
Mounting kit for BEAMAGE 3.0 or 4M	BA32-B3	205322
Stand	See website	See website

4.2. POWER DETECTOR

The BA32 series can be used with a UP power detector (optional). The optional power detectors compatible with your attenuator model are described in the specifications section. For further information about the UP power detector itself, refer to the *UP Manual* (available at gentec-eo.com/resources/download-center).

4.3. COOLING WATER

The fluid used to cool the Optical Attenuators of the BA32 series must be clean water.

Water fittings and tubing:

- The BA32 are equipped with 10mm (OD) push-to-connect fittings.
- It must be used with plastic pressure tube systems (like PE tubes).

The fittings are not compatible with copper or stainless steel tubes.

Water quality:

- The BA32 cooling fluid must be water, do not use glycol or other additive.
- Use filtered (< 50µm) water to avoid any residue.

Gentec-EO can provide an external water filter if water quality is an issue (202290 Metric or 202984 Imperial). If you require an external water filter, please contact your local Gentec-EO representative.

Note: The water filter provided by Gentec-EO is a chemical resistant filter. **However, it is not compatible with mineral acids.**

- The resistivity of the water must be over 100 kOhm-cm.
- Distilled water can be used, but it is not recommended to use highly deionized ultra-pure water because the water cavity is not completely inert.
- If an algacide must be used in the chiller, we recommended Optishield Plus or equivalent.
- If chloride is present in the system, the concentration should not exceed 25 PPM and the PH maintained between 6.0 to 8.0. (Low PH will remove the protective oxide layer)

Water temperature:

- The cooling water can be between 15 and 25°C **but must always remains above the dew point.**
- The temperature should be regulated with a chiller or a re-circulator.

Water flow rate:

- The water flow rate should be monitored.
- NOTE: the water pressure at the BA32 input must never exceed 60 psi / 413 kPa.

Note: All these parameters should remain in the range stated in the specifications.

4.4. SPECIFICATIONS

The following specifications are based on an operating temperature of 15 °C to 28 °C (59 to 82 °F) and a relative humidity not exceeding 80 %. Attenuators must be stored in an environment between 10 °C to 65 °C and a relative humidity not exceeding 90 %.

Gentec-EO	BA32-1KW
	Measurement Capability
Spectral Range	200 nm – 2100 nm
Spectral Range with BEAMAGE Camera	350 nm – 1150 nm
Sampled Percentage ⁴	0.0526% (1/1900) @ 1.064 µm
Integrated Power Meter (Optional)	Compatible with UP55N/M series
Maximum Power	
With coolant	1 kW
Without coolant	100 W
Aperture Diameter	32 mm
Maximum Beam Diameter	32 mm
Optical Wedges Material	UV Fused Silica (uncoated)
Sampled Beam Lateral Shift	4.5 mm
Sampled Beam Deviation	90°
Residual Beam 1 & 2 Deviation	3.6° @ 1.064 µm
CW Laser Damage Thresholds on the Optical Wedge 1.064 µm, CW	Average Power Density 10 MW/cm ²
Pulsed Laser Damage Thresholds on the Optical Wedge 1.064 µm, 7 ns, 10 Hz	Max. Energy Density 10 J/cm ²
	Cooling Requirements
Liquid Coolant	Water
Cooling Flow Rate	1 to 2 L/min
Coolant Pressure Drop	< 5 PSI
Heat Load	< 100 W
Coolant temperature	15 – 25 °C
Coolant Maximum Input Pressure	60 PSI
	Physical Characteristics
Dimensions ⁵	145(H) x 250(W) x 132(D) mm
Weight	5.5 kg
Mounting	M6 (metric) threaded holes
Optical Apertures Threading	SM2
Product Number	205319

Specifications are subject to change without notice

⁴ Considering 0° AOI referred to the input aperture.

⁵ Overall dimensions and weight while using BEAMAGE and/or power detector will be different.

The attenuation factor between the input aperture and the sampled beam is polarization-insensitive, but it varies with the wavelength. The graph below presents the attenuation factor as a function of the wavelength considering an angle of incidence of 0° with the input aperture.

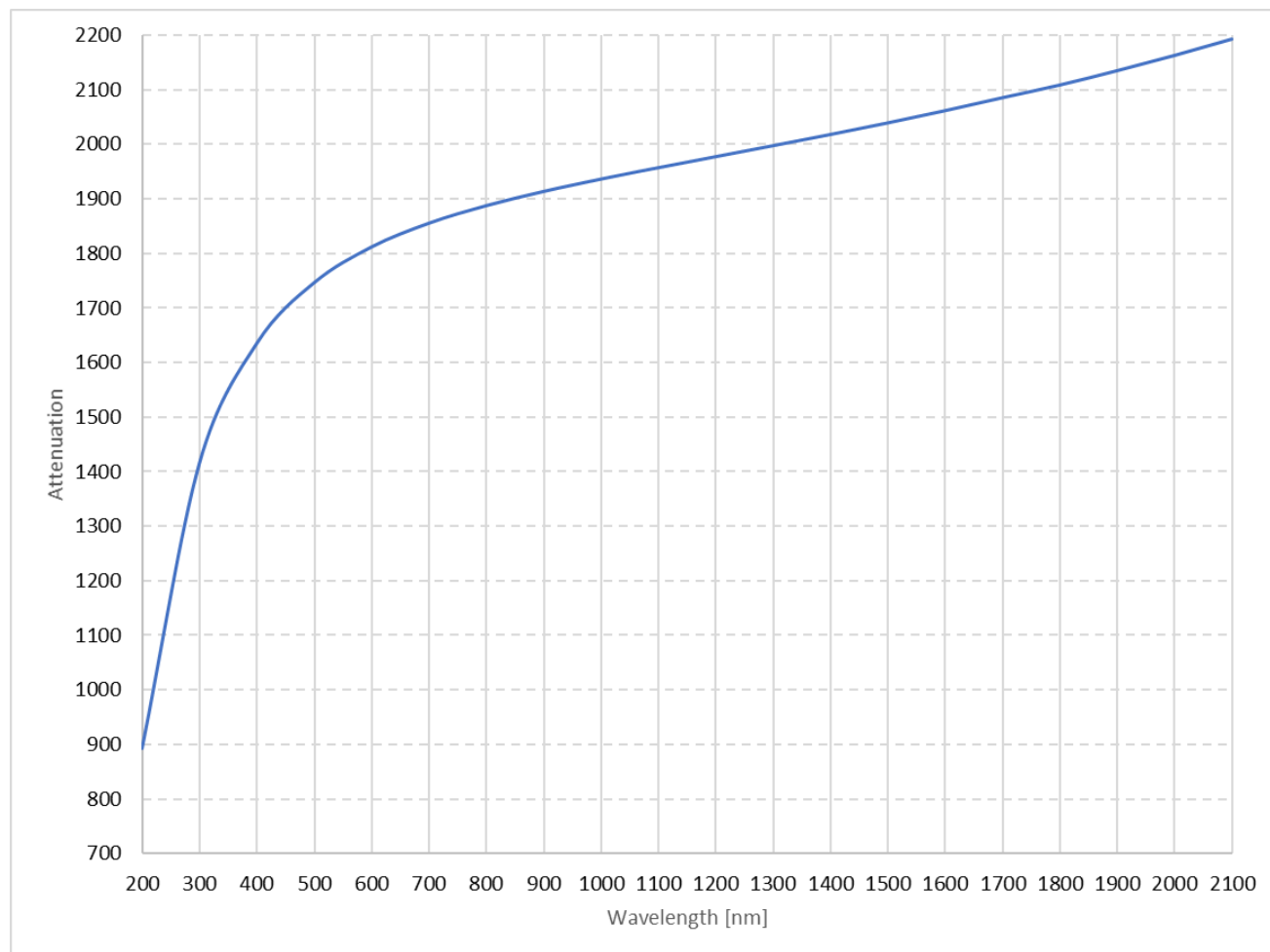
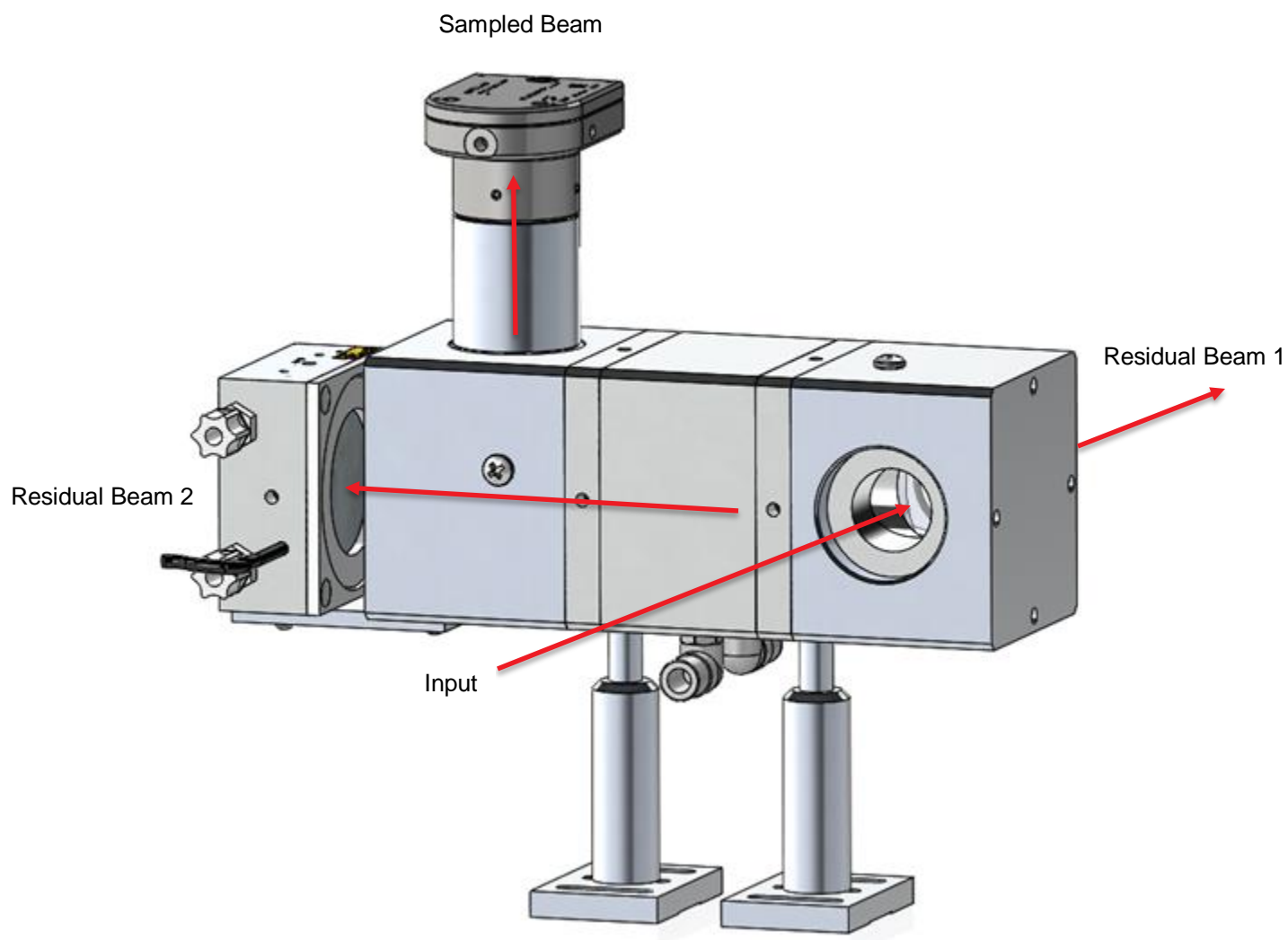


Figure 2 : Typical Spectral attenuation factor

4.5. BEAM PATH DETAILS



Typical power values @1070nm (% of incident beam)	
Residual Beam 1	92%
Between the 2 wedges	$2 \times 4\% = 8\%$
Residual Beam 2	$2 \times 3.7\% = 7.4\%$
Sampled Beam	0.1%

Optical path length	
Input to Sampled Beam (without accessorie)	263 mm
Input to Residual Beam 1	100 mm
Input to Residual Beam 2	257 mm
Sampled Beam to BEAMAGE-4M-FOCUS with BA32-FOCUS mounting kit	123 mm
Sampled Beam to BEAMAGE-4M with BA32-B3 mounting kit	113 mm

4.6. OPERATING INSTRUCTIONS

Storage

In order to ensure a long lifetime of accurate measurements, it is recommended that attenuators be held within the following ambient conditions:

Storage environment temperature: 10 to 60°C, RH < 90%
Operating environment temperature: 15 to 28°C, RH < 80%.

It is possible to store and operate your Optical Attenuator beyond this range. For any specific requirements, please contact your local Gentec-EO representative.

The protective covers should always remain on your BA32 Optical Attenuator while not using.

General operation with BEAMAGE beam profiling camera

Once appropriate cooling is achieved, the Attenuator is ready to be aligned in the intended optical set-up.

1. Connect your BA32 Optical Attenuator to the cooling circuit.
2. Ensure your BA32 Optical Attenuator is cooled adequately (following the specifications in the sections 4.3 and 4.3).
3. Remove the protective cover from the *Residual Beam 2* aperture.
4. Install your UP55 power detector with the power detector mounting kit BA32-UP55 (optional).
5. Remove the protective cover from the *Sampled Beam* aperture.
6. Using the mounting kit provided for your BEAMAGE (optional mounting kit BA32-FOCUS / BA32-B3), install the BEAMAGE camera on the attenuator's *Sampled Beam* aperture. Use the locking rings to secure the BEAMAGE on the coupler and the coupler to the Attenuator.
7. Download and install the software *PC-BEAMAGE* (available at gentec-eo.com).
8. Connect the BEAMAGE to the computer. For further information about *PC-BEAMAGE*, refer to the corresponding manual on gentec-eo.com/resources/download-center.
9. Remove the protective cover from the *Residual Beam 1* aperture.
10. Align the BA32 Attenuator in the optical set-up using a safe "low-power" laser by centering both: the beam on the target of the input protective cover and in the BEAMAGE. In order to ensure an optimum, polarization-independent attenuation, the laser beam should ideally be perfectly aligned and centered within the Attenuator's input aperture and in the BEAMAGE.
11. Remove all the protective covers prior to use the Optical Attenuator BA32.



Warning

Never touch directly the optics or the absorbing surface of the beam dump/power detector.

In the case of a joint use of a BA32 and a BEAMAGE camera in order to profile a high-power beam, an additional neutral density filter to the camera may be necessary. **If an additional ND filter is necessary, make sure to not exceed the maximum average power density of the power meter.** Refer to the section 4.3 or the *UP User Manual* (available at gentec-eo.com/resources/download-center) for additional information and specifications about the power meter.

Calibration procedure to use the integrated power detector

In order to use the integrated power detector for input beam power live monitoring, you need to determine the **attenuation factor** by using the following steps:

1. Measure the power of your laser beam before the input of the BA32 Optical Attenuator.
2. Measure the power of your laser beam with the integrated power detector (at the *Residual Beam 2* output).
3. Divide the power obtained in 1 by the power obtained in 2 to calculate the attenuation factor "A".
4. Enter the calculated factor "A" in the PC-Gentec-EO software or in your Maestro display as a *Multiplier* to get a live measurement of the *input beam* power.



Important

The laser beam alignment and power must be steady for the steps 1 and 2.

Note: The attenuation factor "A" between the *input beam* and the integrated power detector depend on the polarization and the alignment of your laser beam. The attenuation factor "A" should be recalculated (steps 1 to 4) after any alignment modification.

Compatibility

The attenuators of the BA32 series are compatible with many Gentec-EO detectors. For more information about compatibility, please contact your local Gentec-EO representative.

Damage to the optical absorber material

Damage to the optical absorber material is usually caused by exceeding the manufacturer's specifications, such as:

- Incident Average Power Density
- Incident Pulse Energy Density

Refer to the specification pages for the Optical Attenuator BA32 Series. Damage may also be caused if the absorber surface and/or optics are contaminated. A slight discoloration of the coating does not affect the absorption of the power detector.

In any case, the beam's incident area should not be less than 10% of the beam dump's aperture. Please contact Gentec-EO to make measurements with such smaller beams.

In the event of significant damage to the coating, the UP sensors or the beam dump can be recoated. Contact your local Gentec-EO representative for information on repair and recalibration. See p. ii Contacting Gentec Electro-Optics Inc

ANNEXE A: WEEE DIRECTIVE

Refer to the UP User Manual if necessary (available at 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 cm²). (if applicable)

Glass: Optical component. (if applicable)

Aluminum: Accessory housing. (if applicable)

LEADER IN LASER BEAM MEASUREMENT SINCE 1972



POWER & ENERGY METERS



BEAM PROFILING



THZ MEASUREMENT

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