PRESENTATION

BEAM PROFILING CAMERA

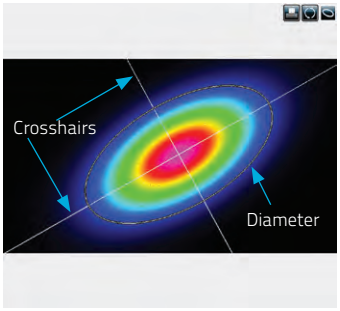
See page 172

BEAMAGE-3.0

- Up to **10X faster** than regular USB 2.0 connections
- 2.2 MPixels resolution gives accurate profile measurements on **very small beams**
- 11.3 x 6.0 mm sensor allows to measure **very large beams**
- **ISO Compliant**: D4σ Definition of Diameter, Centroid, Ellipticity and Orientation are ISO 11146:2004 and 11146:2005 compliant
- **Easy to navigate interface**, with many display and control features
- **External Trigger** to synchronize the camera with a pulsed laser
- The most **affordable**, large size camera-based beam profiler on the market!

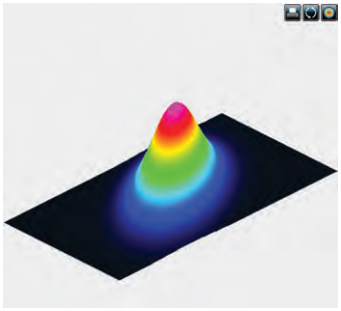
2D, 3D AND XY DISPLAYS

2D



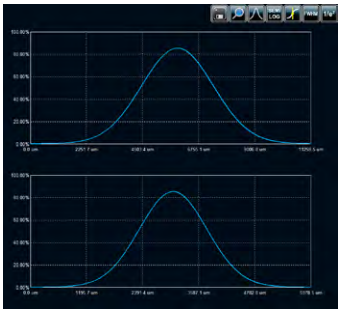
The 2D display features the crosshairs (set to the major and minor axis or along specified angles) and the measured diameter of the beam. This diameter varies with the chosen definition (4-sigma, FWHM, $1/e^2$, etc.) and its display can be turned ON or OFF.

3D



The 3D display shows the actual shape of the beam. It is possible to easily zoom, pan and rotate the data. The very useful Reset button allows to put the data back in its original configuration.

XY



The XY display plots cross-sectional graphs of the beam along the crosshairs. This display features many useful tools, like zoom, cursor, and FWHM and $1/e^2$ level bars. It is also possible to display the graphs in semi-log format.

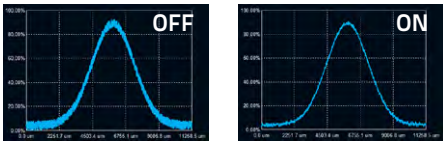
MAIN FUNCTIONS

SUBTRACT BACKGROUND

The background subtraction function is a necessary tool to have an accurate measurement and to abide by the ISO-11146-3:2004 standards. Contamination of all images can be avoided with the help of environment noise subtraction.

FILTER

Filter out the noise in your beam profile by using this spatial filter function. This tool is great for low quality lasers or low level signals.



ACTIVE AREA (ROI)

Increase the data transfer rate by reducing the area of the sensor that is scanned.

PRESENTATION

REAL-TIME M2 MODULE (Available Fall 2013)

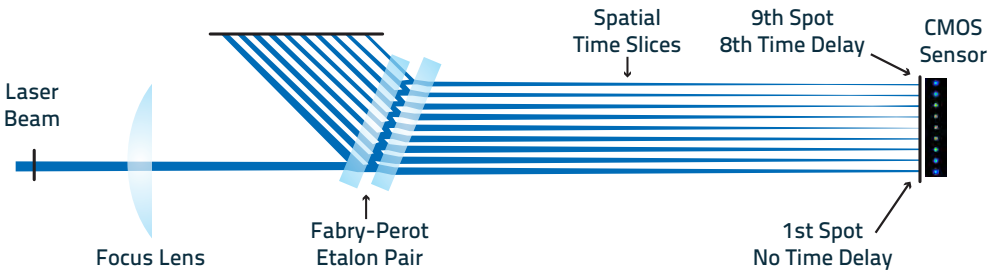
See page 178

BEAMAGE-M2

- **Instant Measurement**: the Fabry-Perot optics allow the M2 factor measurement in less than a second with no moving parts
- **ISO Compliant**
- **Built –In Attenuation**: OD4 attenuation provided by the Fabry-Perot optics itself and optional removable attenuators are available for attenuation up to OD7
- **Modular:** The Beamage-3.0 camera can be used separately from the M2 module for needs of spatial intensity or energy profiling
- **Complete Software:** Easy-to-use with an array of useful functions and tools

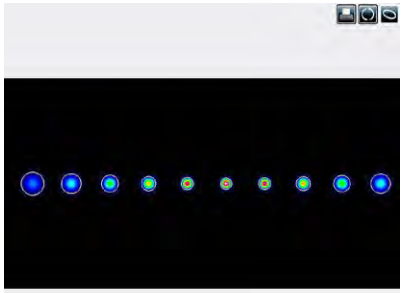
Measurements are done using a completely passive optical approach. The heart of the Beamage-M2 is a Fabry-Perot interferometer that creates time delayed slices of the beam. After these slices have landed on the sensor, each one a spatial cross section along the waist, the software simultaneously tracks and analyzes them.

THE FABRY-PEROT INTERFEROMETER



INTUITIVE SOFTWARE

The M^2 measurements are taken directly in our PC-Beamage-3.0 software. An easy step-by-step procedure is clearly indicated directly in the software and allows the user to get the fastest M^2 measurement available. The ISO calculations give M^2 values in both the X and Y axes. The M^2 measures are taken at a rate of 3 fps. The system also automatically detects the multiple beams, allowing for an easy setup. Once the system is calibrated, you can take as many measurements as you like, without moving any parts or modifying parameters.



DIFFRACTIVE OPTICS

See page 182

HBS Series

- **Online Monitoring**: Do real-time sampling of your laser and measure your profile while working
- **Saptial Profile Preserved**: The HBS will not create artefacts in your measurements or in your main beam
- **Environment Insensitive:** The ONLY sampling component that is trully insensitive to ALL environmental variations, including polarization and vibrations
- **Very High Damage Threshold:** The damage threshold of the HBS Series can be as high as that of fused silica

BEAMAGE-3.0

CMOS Beam Profiling Camera

KEY FEATURES

1. **USB 3.0 for the Fastest Transfer Rates**
   Up to 10X faster than regular USB 2.0 connections (also USB 2.0 compatible)
2. **High Resolution**
   2.2 MPixels resolution gives accurate profile measurements on very small beams
3. **Large Area Sensor**
   The 11.3 x 6.0 mm sensor allows to measure very large beams
4. **ISO Compliant**
   D4σ Definition of Diameter, Centroid, Ellipticity and Orientation are ISO 11146:2004 and 11146:2005 compliant
5. **Intuitive Software Interface**
   Easy to navigate interface, with many display and control features:
   - 2D, 3D and XY Displays
   - Background Subtraction Function
   - Unique "Animate" Function
   - Gaussian Fit
   - Semi-Log Graph
6. **External Trigger**
   To synchronize the camera with a pulsed laser
7. **Low-Cost**
   The most affordable, large size camera-based beam profiler on the market

AVAILABLE MODEL

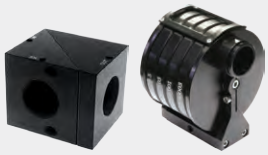
Beamage-3.0
(⅔ in CMOS Camera)

MAIN FUNCTIONS

Subtract Background | Animate | Normalize | Filter | Trigger | Active Area (ROI) | Image Averaging | Pixel Addressing

ACCESSORIES

Stand with Delrin Post
(Model Number: 200428)



BSC-190, BSC-350, VA-0-93
Beam Splitters and Attenuators

Stackable ND Filters
(0.5, 1.0, 2.0, 3.0, 4.0 & 5.0)

UV Converters &
IR Adaptors

Pelican Carrying Case

SEE ALSO

BEAMAGE-3.0

SPECIFICATIONS

MODEL	BEAMAGE-3.0
SENSOR TECHNOLOGY	CMOS
EFFECTIVE APERTURE	11.3 x 6.0 mm

MEASUREMENT CAPABILITY	
Wavelength Range	350 - 1150 nm
Pixel Count	2.2 MPixels
H x V	2048 x 1088
Pixel Dimension	5.5 x 5.5 µm
Minimum Measurable Beam	~55 µm
Shutter Type	Global
Frame Rate (at 1 MPixels)	10 fps
RMS Noise	1000:1 (60 dB)
ADC Level (User Setable)	12 bit (default) / 10 bit (option)
M2 Measurement	In Real-Time, no moving parts, with the Beamage-M2 Module* (see page 178)
DAMAGE THRESHOLDS [a]	
Maximum Average Power	1 W
Saturation Level (1064 nm)	CW: 10 W/cm^2 ; Pulsed: 300 µJ/cm^2
SOFTWARE	
Displays	2D, 3D and XY
Display Features	2D: Print Screen, Reset View, Show/Hide Beam Diameter
	3D: Print Screen, Reset View, Top View
	XY: Save Data, Zoom, Gaussian Fit, Semi-Log, Show/Hide Cursor, Show/Hide FWHM, Show/Hide 1/e^2
Beam Diameter Definitions	D4σ (ISO compliant)
	1/e^2 along crosshairs (13.5%)
	FWHM along crosshairs (50%)
	86% effective diameter (D86)
Buffer Controls	**Open File, Save Current Data, Save All Data, Previous/Next Image, Clear Buffer, Animate**
Printing and Reports	**Full Report in Print Ready Format (2D, 3D, XY, Measures, Parameters)**
	Print Screen in BMP format (2D and 3D)
PHYSICAL CHARACTERISTICS	
Sensor Size	11.3 x 6.0 mm
Sensor Area	0.67 cm^2
Dimensions (not including filter)	61H x 81.1W x 19.7D mm
Weight (head only)	139 g
ORDERING INFORMATION	
Full Product Name	Beamage-3.0
Product Number (Stand not included)	201939 [b]

a. With ND4 filter.
b. Available for order now, deliveries start in April 2013. Ask your Gentec-EO representative for pricing.
* Available Fall 2013.

Specifications are subject to change without notice

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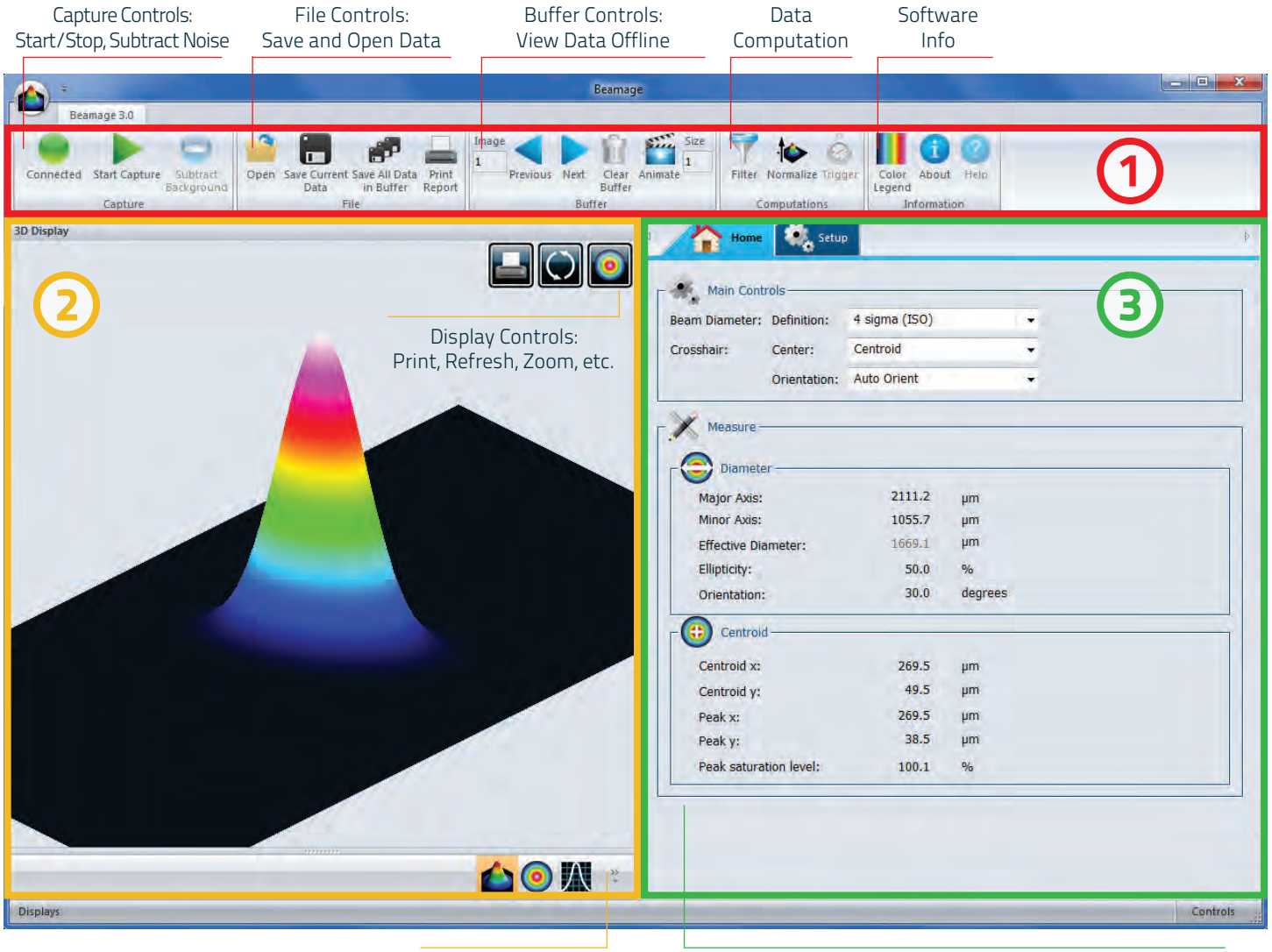
BEAMAGE-3.0

INTUITIVE SOFTWARE INTERFACE



1 MAIN CONTROLS

The top portion of the software is in a ribbon format and includes all the main controls. These are grouped by family, including capture controls, file controls, buffer controls and data computations such as a very useful spatial filter and a normalizing function.

2 DISPLAYS

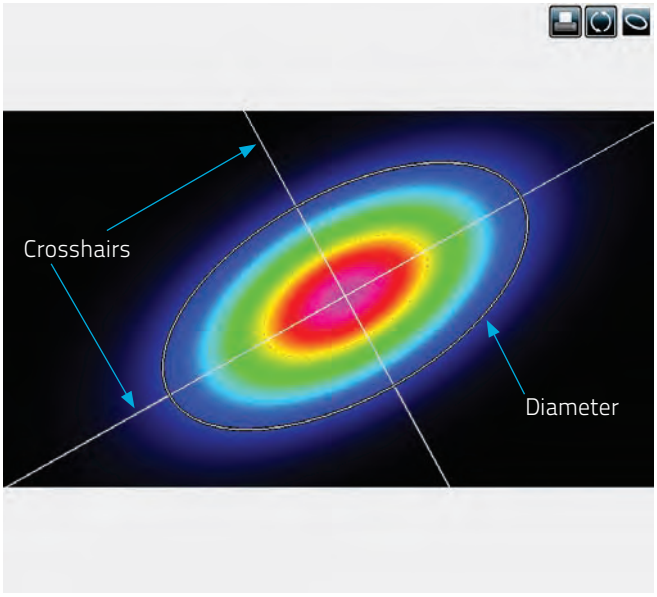
The left-hand side of the software is the display panel. 3 displays are available: 3D, 2D and XY (cross-sectional graphs along the crosshairs). The various displays are chosen using the corresponding icons at the bottom of the panel. Convenient Print Screen controls are located the 2D and 3D displays and allow the user to save an image of the current view in BMP format.

3 HOME and SETUP TABS

The right-hand side of the software contains the Home and Setup tabs. The Home tab allows the user to select the type of measurements performed (like 4-sigma and FWHM). It also shows the resulting measures of the beam. The Setup tab contains all the measurement parameters, like Exposure Time, Image Orientation, Averaging, Active Area definition (ROI) and more.

BEAMAGE-3.0

2D, 3D AND XY DISPLAYS



2D DISPLAY

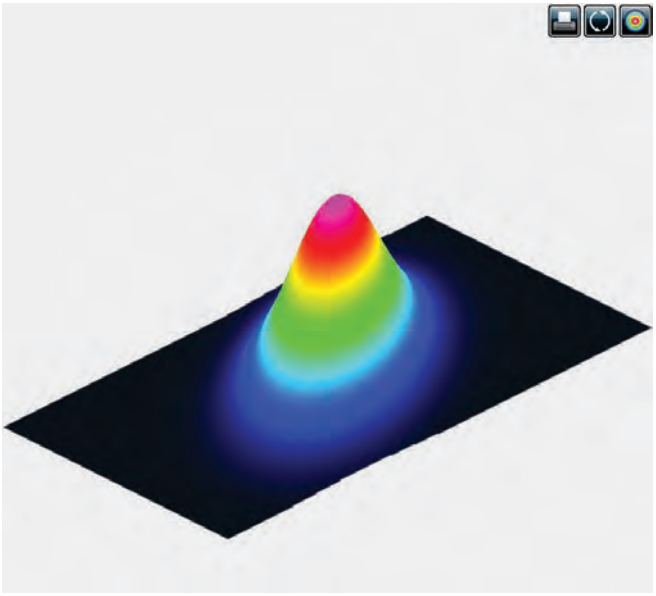
The 2D display features the crosshairs (set to the major and minor axis or along specified angles) and the measured diameter of the beam. This diameter varies with the chosen definition (4-sigma, FWHM, $1/e^2$, etc.) and its display can be turned ON or OFF. The Print Screen button allows to save a picture of the current screen in BMP format.

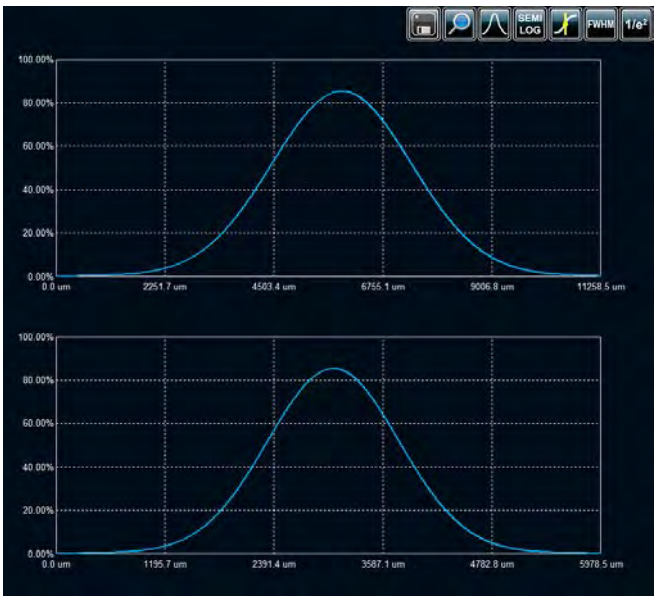
Print Screen Reset View Show/Hide Diameter

3D DISPLAY

The 3D display shows the actual shape of the beam. It is possible to easily zoom, pan and rotate the data. The very useful Reset button allows to put the data back in its original configuration. This display also features a Print Screen button to save the latest image in BMP format.

Print Screen Reset View Top View





XY DISPLAY

The XY display plots cross-sectional graphs of the beam along the crosshairs. This display features many useful tools, like zoom, cursor, and FWHM and $1/e^2$ level bars. It is also possible to display the graphs in semi-log format to enhance the details in the low intensity parts of the beam.

Save Data Zoom Gaussian Fit
Semi-Log Graph Show/Hide Cursor Show/Hide FWHM

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BEAMAGE-3.0

MAIN FUNCTIONS

SUBTRACT BACKGROUND

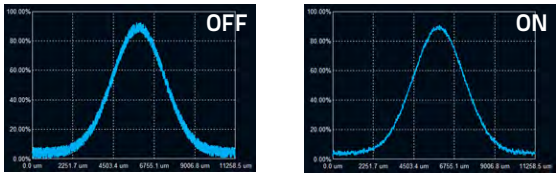
The background subtraction function is a necessary tool to have an accurate measurement and to abide by the ISO-11146-3:2004 standards. By taking 10 images and averaging them pixel by pixel to compute the average background map, contamination of all images can be avoided with the help of environment noise subtraction.

ANIMATE

Give life to your measures with the animate function. With as much as 32 frame images temporarily saved in the buffer, simply pressing the animation button will create a movie with any display (2D, 3D and XY). This allows to visualize the beam while working offline and have a recalculation process if the beam diameter definition or crosshair parameters are changed.

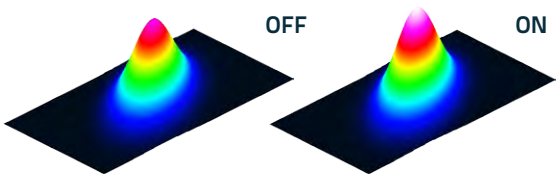
FILTER

Filter out the noise in your beam profile by using this spatial filter function. This tool is great for low quality lasers or low level signals.



NORMALIZE

The normalize function spreads the intensity over the full range (0% to 100%). This is especially useful with low level signals or to enhance the variations in the beam.



TRIGGER

For the case of pulsed laser sources, the trigger function will be useful to synchronize the system's capture rate with the source's repetition rate, especially when this one is low (<16 Hz). To be achieved, a TTL (0-5 V) or other (1.1-24 V) trigger signal can be connected to the Beamage-3.0 camera via a BNC or SMA plug.

IMAGE AVERAGING

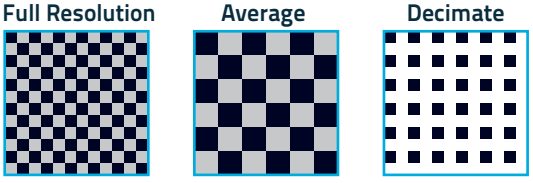
The image averaging function uses a temporal filter to provide the possibility to take 2, 5 or as much as 10 images of the beam to create a single time-averaged image with them. This process will smooth the beam fluctuations that can occur over time when working with unstable laser sources.

ACTIVE AREA (ROI)

Increase the data transfer rate by reducing the area of the sensor that is scanned. This tool is perfect for small beams that don't need the full sensor area.

PIXEL ADDRESSING

Increase the data tranfer rate by using larger pixels or by reducing the number of pixels. This is great for large beams that don't need the full resolution.



Every function may not be available yet

BEAMAGE-3.0

CHOOSING THE CORRECT BEAM DIAMETER DEFINITION

Since Gaussians are infinitely large, borders have to be defined for the validity of calculation. To suit all types of requirements, the Beamage-3.0 software offers 4 different definitions for the beam diameter (d_σ) measurement. The first 3 definitions are appropriated for elliptical and circular profiles and the last one is for circular profiles only:

- **4 sigma (ISO):** The beam diameter definition is set by default to 4 sigma because it conforms to the ISO 11146-1:2005[1] and ISO 11146-2:2005[2] standards. With this definition, the computation time is raised and thus the frame rate is reduced because almost the entire image (4 times the curve standard deviation) is used to compute the beam parameters.
- **1/e2 along crosshairs (13.5%):** This definition is similar to 4 sigma but allows a faster frame rate. With this definition, the Gaussians are cut where the energy or intensity reaches 13,5 % of the peak value. Users can use this definition to increase the frame rate and still have a good approximation of the diameter of their elliptical beam.
- **FWHM along crosshairs (50%):** This definition is also faster than 4 sigma and works in a similar fashion as 1/e2 along crosshairs, but clips the beam at 50% of the peak value.
- **86% effective diameter (D86):** This beam definition is designed for circular (or almost circular) profiles only. It computes the diameter of a circular beam containing 86% of the total energy or intensity. Since the software assumes the beam is cicular, it does not calculate the major and minor axes, nor the orientation and ellipticity, which makes D86 the fastest measurement mode.

BEAM CENTROID, ELLIPTICITY AND ORIENTATION (ISO 11146:2005[1,2] COMPLIANCE)

The **beam centroid** (center of energy) coordinates for both X and Y axes are given by these equations, which are weighted means for energy:

$$\overline{x} = \frac{\int_{-\infty}^{\infty}\int_{-\infty}^{\infty} E(x,y,z)x\,dx\,dy}{\int_{-\infty}^{\infty}\int_{-\infty}^{\infty} E(x,y,z)\,dx\,dy} \qquad \overline{y} = \frac{\int_{-\infty}^{\infty}\int_{-\infty}^{\infty} E(x,y,z)y\,dx\,dy}{\int_{-\infty}^{\infty}\int_{-\infty}^{\infty} E(x,y,z)\,dx\,dy}$$

The **ellipticity**, which can take a value between 0% and 100%, is defined as the ratio between the shorter (minor axis) and longer (major axis) widths. Evidently, a perfectly circular beam will have an ellipticity of 100%.
The **beam orientation**, which can take a value from -45° to 45°, is defined as the angle between the X axis of the sensor and the beam axis (either minor or major, whichever is closest) .

GAUSSIAN FIT AND ROUGHNESS FIT

According to the ISO 13694:2000[3] standards , the roughness fit factor, which is an indicator of the maximum deviation between the theoretical Gaussian curve and the measured one, takes a value between 0% and 100% and is given by this equation:

$$\text{Roughness Fit (\%)} = \left[\frac{\left|E_i - E_i^a\right|_{max}}{E_{max}}\right] \text{x } 100\%$$

E is the measured curve and E^a the theoretical one. The closer to 0% the better is the roughness fit.

The Gaussian fit factor, on the other hand, indicates how the experimental curve is close to a theoretical Gaussian. It can take a value between 0% and 100% and is given by this equation:

$$\text{Gaussian Fit (\%)} = \left[1 - \frac{\sum\left|E_i - E_i^a\right|}{\sum E_i^a}\right] \text{x } 100\%$$

E is the measured curve and E^a the theoretical one. The closer to 100% the better is the Gaussian fit.

1. ISO 11146-1:2005 : methods for measuring beam width, among others, only applicable for stigmatic and simple astigmatic beams.
2. ISO 11146-2:2005 : applicable to general astigmatic beams or unknown types of beams. Within this standard, the description of laser beams is done with the second order moments of the Wigner distribution. Relevant physical quantities such as beam widths can be calculated from them.
3. ISO 13694:2000 : test methods for laser beam power (energy) density distribution.

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BEAMAGE-M2

Real-Time M^2 Module for Beamage-3.0

NEW

Coming in fall 2013

* Beamage-3.0 camera not included

AVAILABLE MODEL

Beamage-M2
(M^2 Module)

KEY FEATURES

1 Instant Measurement
Innovative technology The Fabry-Perot optics allow the M2 factor measurement in less than a second with *no moving parts*

2 ISO Compliant
All the calculations are ISO 11136 and 13694 compliant

3 Built–In Attenuation
OD4 attenuation provided by the Fabry-Perot optics itself and optional removable attenuators are available for attenuation up to OD7

4 Passive Device
No external power source needed to operate the M^2 Module

5 Modular
The Beamage-3.0 camera profiler can be used separately from the M^2 module for needs of spatial intensity or energy profiling

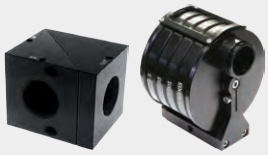
6 Versatile
The compact design makes it suitable for a wide range of scientific, medical and industrial applications

7 Complete Software
Easy-to-use software with an array of useful functions and tools

8 Compact Assembly
Can be inserted almost anywhere in optical systems for accurate troubleshooting

ACCESSORIES

Stand with Steel Post
(Model Number: 201102)



BSC-190, BSC-350, VA-0-93
Beam Splitters and Attenuators

SEE ALSO

ACCESSORIES FOR BEAM DIAGNOSTICS 186
LIST OF REGULAR ACCESSORIES 188

BEAMAGE-M2

SPECIFICATIONS

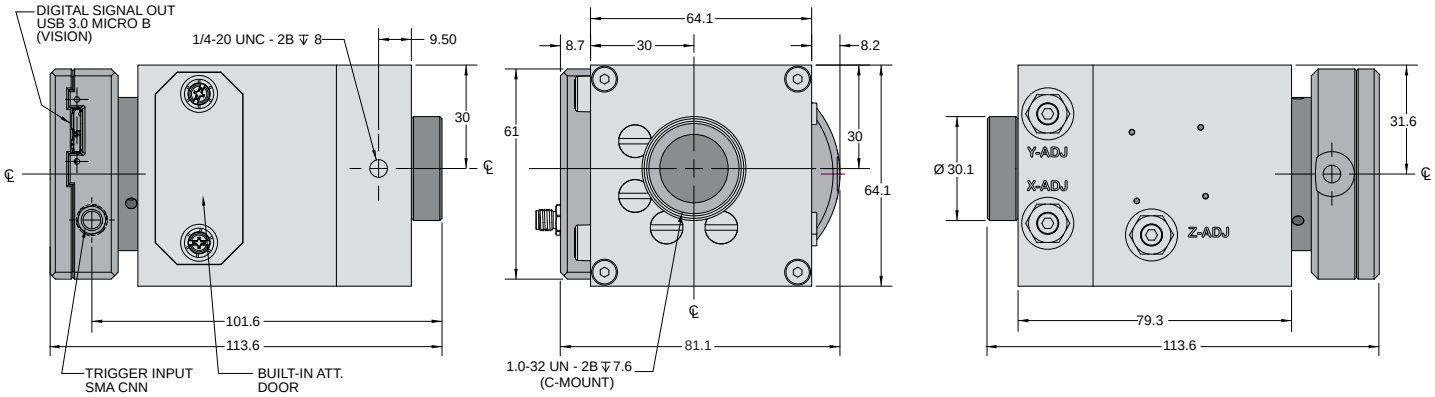
MODEL	BEAMAGE-M2
MEASUREMENTS	Real-Time M^2, Divergence and Waist

MEASUREMENT CHARACTERISTICS	
M^2 Measurement	Real-Time ISO Compliant measurement with *no moving parts*
Rayleigh Range	50 µm - 6 mm
Setup & Alignment	Easy setup and alignement System can be calibrated and ready to go within minutes
SETUP	
Wavelength Range	190 - 1100 nm [a] (covered by interchangeable sets of optics)
Minimum Focal Length	100 mm
Built-In Attenuation (Included)	Fabry-Perot Reflective Glasses: OD4 Built-in Attenuation: OD2 (user changeable)
Additional Built-In Attenuation	Choice of OD1 to OD3
PHYSICAL CHARACTERISTICS	
Dimensions (Module only)	64.1H x 77.3W x 97.6D mm
Dimensions (With Beamage-3.0)	64.1H x 81.1W x 113.6D mm
Weight (Module only)	535 g
Operating Temperature Range	10°C - 30°C
Operating Relative Humidity	5% - 80%
ORDERING INFORMATION	
Full Product Name	Beamage-M2
Product Number (Stand not included)	202302

Specifications are subject to change without notice

a. Limited by the spectral range of the camera.

TECHNICAL DRAWING



All dimensions in mm.
Beamage-3.0 camera not included.

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BEAMAGE-M2

THE FABRY-PEROT INTERFEROMETER

To achieve measurements, the system uses a completely passive optical approach. Inside the device, a Fabry-Perot interferometer made with a pair of partially reflective glasses is positioned in front of the sensor of the Beamage-3.0 camera with a convenient angle for the light to oscillate, thus creating time delayed slices. After these slices have landed on the sensor, each one a spatial cross section along the waist, the software simultaneously tracks and analyzes them for unparalleled speed of M^2 calculation.

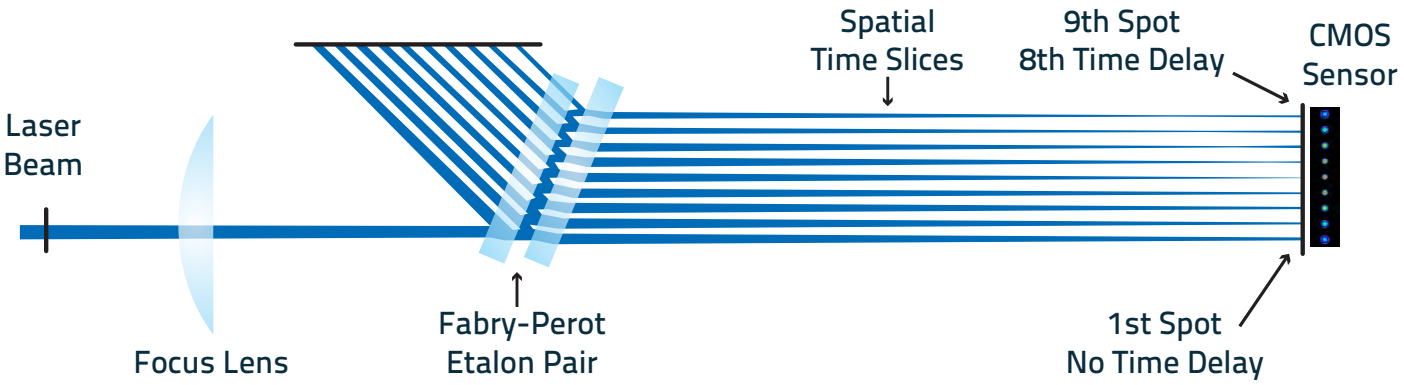
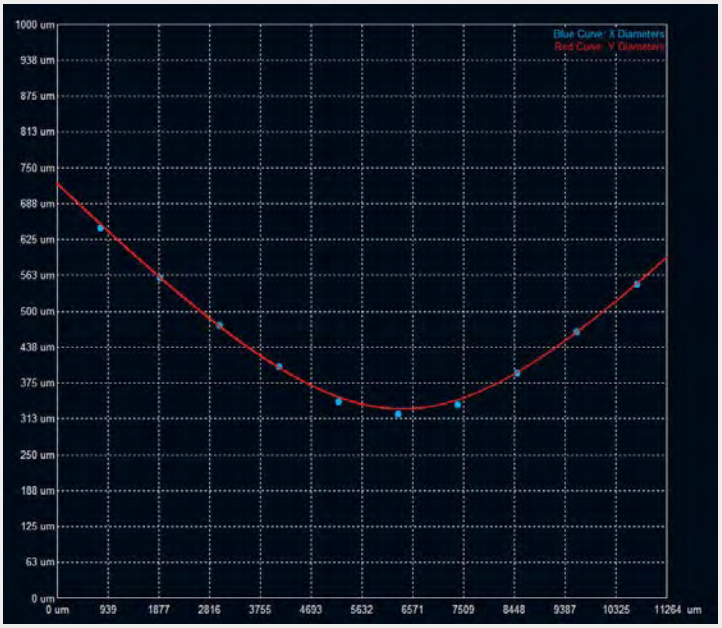


Figure 1.
Schematic of the Fabry-Perot optics with time-delayed slices of the beam

INTUITIVE SOFTWARE

The M^2 measurements are taken directly in our PC-Beamage-3.0 software. An easy step-by-step procedure is clearly indicated directly in the software and allows the user to get the fastest M^2 measurement available. The ISO calculations give M^2 values in both the X and Y axes. Thanks to the module having no moving parts and the lightweight software, the M^2 measures are taken at a rate of 3 fps. The system also automatically detects the multiple beams, allowing for an easy setup. Once the system is calibrated, you can take as many measurements as you like, without moving any parts or modifying parameters.



BEAMAGE-M2

BUILT-IN ATTENUATION

For a large range of powers to be covered and to avoid saturation of the CMOS sensor, the system is equipped with all the necessary built-in attenuation modules. For a focused beam entering the system aperture, the Fabry-Perot interferometer itself first provides an OD4 attenuation (ten thousand times). If this is still not sufficient, attenuators can be inserted in a removeable compartment located between the Fabry-Perot pair and the CMOS sensor. This provides an optional attenuation up to OD3 (thousand times), for a total attenuation up to OD7 (ten million times). In the case that a greater attenuation is necessary to avoid overheating of the optics, additional partially reflective glasses can be easily mounted on the C-mount aperture of the device.

ISO COMPLIANT M^2 FACTOR

The M^2 factor can be considered as a qualitative indicator of beam quality. In other words, it is an indicator of closeness to an ideal Gaussian beam at the same wavelength in terms of propagation. It can be defined as the ratio between the beam parameter product (beam waist multiplied by divergence) of the measured experimental beam and the one of the ideal Gaussian beam. Since the ideal Gaussian beam diverges more slowly than any other shape, the M^2 is always greater or equal to one. An M^2 very close to 1 indicates an excellent beam quality. To conform to the ISO 11146 and 13694 standards, the software uses the second order spatial moments to compute the M^2 factor. All the calculations are ISO compliant.

FOCAL LENGTHS

For the measurement of the propagation parameters of a laser beam, the latter must be focused through a convergent lens. This creates the optical far-field, where the divergence is constant at the focus spot of the lens. The adjustable distance between the Fabry-Perot etalons allows the measurement of beam propagation parameters for a large range of focal lengths. Measurement is possible for any system that uses a lens of focal length equal or higher than 100 mm.

REAL-TIME MONITORING AND MODULARITY

Unlike other M^2 measurement systems, the Beamage-M2 can measure the beam propagation parameters of a laser beam without the need of moving parts, providing calculation of the M^2 factor in less than a second. This condition allows the possibility to do on-line monitoring. By establishing limit values and monitoring the M^2 factor to keep it within acceptable range, it is possible to perform fast troubleshooting to ensure that the laser is doing its job correctly and to maintain the control and reliability of a process. Its modular design allows users who only want to measure the energy or intensity spatial profile to remove the Beamage-3.0 from the M^2 module and use it separately as a beam profiler.

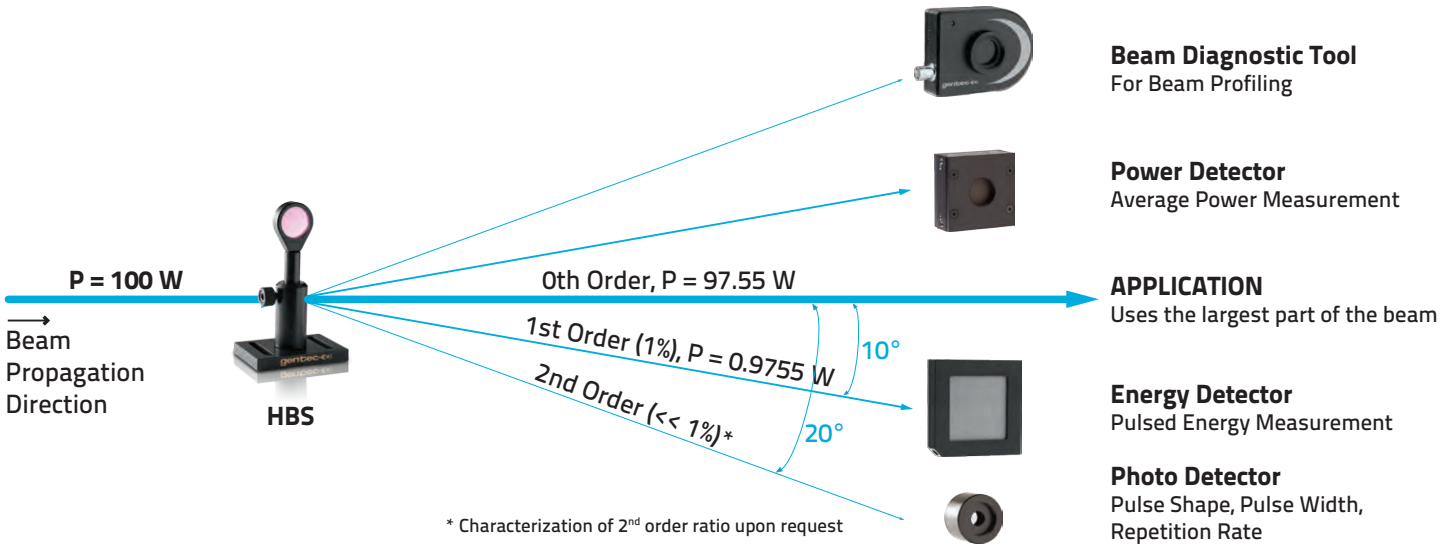
DIFFRACTIVE OPTICS

OVERVIEW

What if you need to measure the performance of the beam in real-time while your application is online? You cannot insert or remove optical components or interrupt the beam either. How do you do that? One way is to divert a small fraction of the beam that is an exact replica of the main beam. Sampling is also a solution if the beam is too 'hot" for your diagnostic instruments to handle. In either case, almost all of the main beam is available to do its job.

Figure 1. Example HBS Application

Pulsed ND:YAG, 1064 nm, 1J @ 100 Hz (100 W)



SAMPLING

One approach is to use something like a moveable mirror to sample in time. The beam is interrupted and diverted for small slices of time. A big disadvantage though is that the time sampler provides average values so it is not well suited for real-time operation, especially with pulsed lasers. The other way is to continuously divert a tiny fraction of the beam to another angle while the main beam passes through, along its original line. However it is done, the sample needs to be a low power replica of the main beam.

REAL-TIME BEAM SAMPLING

The components or methods suitable for real-time beam sampling are summarized in Table 1. The particular requirements of an application will narrow down the list of acceptable methods. All of these methods provide a decent replica of the main beam in the sampled beam and all can withstand reasonably high power. If it is important that the polarization of the sample be the same as the beam, then the Mirror and the Frustrated Total Internal Reflection are not good choices due to mixing of the horizontal and vertical polarizations. Low sampling fraction is very good. This means that most of the beam passes on to the application with a tiny percentage being diverted. The Mirror and Hole Matrix remove much more energy from the beam than the other components which is a problem for many applications.

DIFFRACTIVE OPTICS

ISSUES IN BEAM SAMPLING

Table 1. Comparison of Real-Time Sampling Methods

Table 1. Comparison of Real-Time Sampling Methods

	Spatial Profile Available	Polarization Insensitive	Low Sampling Fraction	Sustain High Power	V bration Insensitive	Environment Insensitive	Cartesian Main Beam	Small Unusable Losses	Commercial Product Available
Reflective Samplers									
Wedge: Low-Reflective dielectric coatings on both faces (Rmin)	✓	✓	✓	✓				✓	✓
Mirror: Leakage from high reflectivity mirror (Rmax)	✓			✓	✓		✓	✓	✓
Refractive Samplers									
Cascaded Wedges	✓	✓	✓	✓		✓			
Frustrated Total Internal Reflection (FTIR): Adjustable gap between two prisms	✓		✓	✓			✓	✓	
Transmission Samplers									
Hole matrix: Periodic array of holes machined in highly reflective mirror or transparent substrate	✓	✓		✓	✓		✓	✓	
Holographic: Relief hologram etched on transparent substrate	✓	✓	✓	✓	✓	✓	✓	✓	✓

ENVIRONMENTAL ISSUES

If the relative position of the beam on the sampler is critical, vibration will have a disruptive effect. The methods employing refraction to some degree (eg. prisms and wedges) are highly sensitive to vibration. This includes vibration in the beam as well as the sampler. You will prefer other choices in rough environments or for laser beams that do not have great pointing stability. Changing temperature and humidity can be a problem for all but the Holographic sampler and Cascaded Wedges. This is an important consideration for industrial environments.

APPLICATION ISSUES

Cartesian main beam: if it is important that the main beam continue either parallel or perpendicular to the incident beam, you would have to rule out the Cascaded Wedges or the Wedge. The need for that depends on the design of the optical train. The other problem for the Cascaded Wedges is its unusable losses. Compared to the other methods, a significant fraction of the energy that is diverted from the main beam is not useful for sampling and must be dissipated. That can be substantial in high power applications. From the table you can see that the holographic sampler is suited to the widest range of applications.

HBS

355 nm, 532 nm and 1064 nm, 1 % and 0.05 %

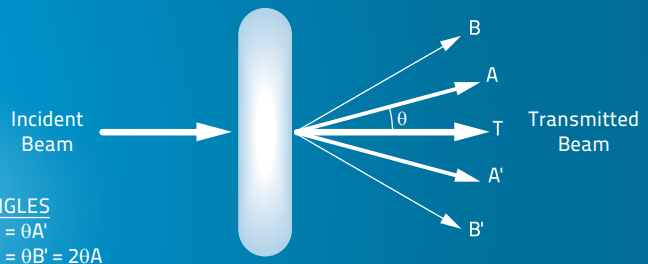
KEY FEATURES

1 On-Line Monitoring
Do real-time sampling of your laser and measure your profile while working

2 Spatial Profile Preserved
The HBS will not create artefacts in your measurements or in your main beam

3 Environment Insensitive
The ONLY sampling component that is insensitive to ALL environmental variations, including polarization

4 Very High Damage Threshold
Can be as high as fused silica itself



ANGLES
θA = θA'
θB = θB' = 2θA
A = Specified Diffraction Order

AVAILABLE MODELS

HBS-355-100-1C-10 (355 nm-1%-Coated)	HBS-532-100-1C-10 (532 nm-1%-Coated)	HBS-532-100-1U-10 (532 nm-1%-Uncoated)	HBS-1064-100-1C-10 (1064 nm-1%-Coated)	HBS-1064-100-1U-10 (1064 nm-1%-Uncoated)	HBS-1064-2000-1C-10 (1064 nm-0.05%-Coated)

ACCESSORIES

Stand with Steel Post
(Model Number: 200160)

1 inch Mount
(Model Number: 101543)

Pelican Carrying Case

SEE ALSO

LIST OF ALL ACCESSORIES 188

HBS
SPECIFICATIONS

MODELS	STANDARD HBS	CUSTOM CAPABILITIES
1ST ORDER RATIO	0.05 % or 1 %	0.05 % to 10 %
WAVELENGTHS	355, 532 & 1064 nm	250 to 2100 nm
DIAMETER	1 inch	Up to 2 inches

MEASUREMENT CAPABILITY		
Wavelengths	355, 532 & 1064 nm	250 to 2100 nm
Substrate		
Shape	Slight wedge 1/2°	With or without edge
Contour	Flat	Flat
Thickness	1/8"	Up to 1/4"
Diameter [a]	1"	Up to 2.5"
Coatings	V-AR (both sides or uncoated)	V-AR (both sides or uncoated)
Type of Grating	Sinusoidal	Sinusoidal or Binary
Typical Calibration Accuracy (1st order)	±3 %	±2 %
1st Order Ratio	Depends on Wavelength	Depends on Wavelength
355 nm	1 %	0.2 to 5 %
532 nm	1 %	0.05 to 10 %
1064 nm	1 % and 0.05 %	0.05 to 10 %
1st Order Angle	Depends on Wavelength	Depends on Wavelength
355 nm	10°	Up to 13°
532 nm	10°	Up to 20°
1064 nm	10°	Up to 20°
Total Insertion Loss (V-AR)	0.3 % per side (typical)	0.2 % to 2 % per side
Total Insertion Loss (Uncoated)	4 % per surface	4 % per surface

DAMAGE THRESHOLDS		
Maximum Energy Density (1064 nm, uncoated)	Up to 86 J/cm²	Up to 86 J/cm²
Maximum Power Density (1064 nm, V-AR)	Up to 2 MW/cm²	Up to 2 MW/cm²

STANDARD HBS MODELS	Wavelenght	1st Order Ratio	Coating	Max En. Dens.	Max Power Dens.	Product Number
HBS-355-100-1C-10	355 nm	1 %	V-AR 355	5 J/cm²	0.5 MW/cm²	23799
HBS-532-100-1C-10	532 nm	1 %	V-AR 532	10 J/cm²	1 MW/cm²	20731
HBS-532-100-1U-10	532 nm	1 %	None	58 J/cm²	N/A	21262
HBS-1064-100-1C-10	1064 nm	1 %	V-AR 1064	20 J/cm²	2 MW/cm²	20733
HBS-1064-100-1U-10	1064 nm	1 %	None	86 J/cm²	N/A	21263
HBS-1064-2000-1C-10	1064 nm	0.05 %	V-AR 1064	20 J/cm²	2 MW/cm²	23977

Specifications are subject to change without notice

a. Clear aperture of the grating is 80% of the surface of the substrate.

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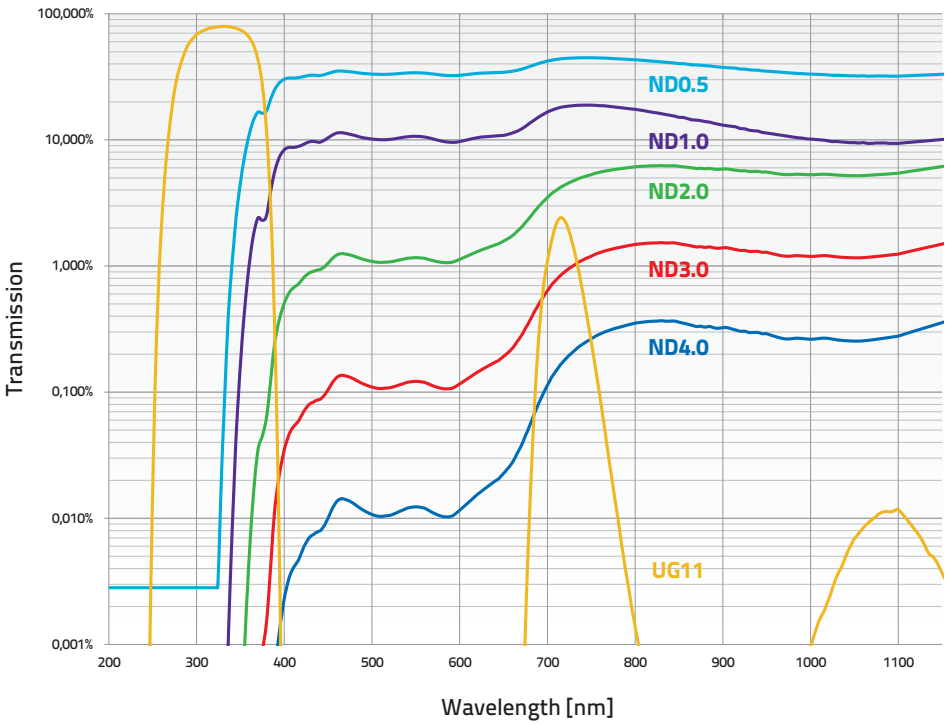
ACCESSORIES FOR BD

ND FILTERS

DESCRIPTION

We offer various Neutral Density filters that are C-Mount threaded and can be stacked directly at the aperture of the camera. Sets of 3 or 5 filters are also available. We also offer a special color glass filter designed for the UV. The UG11-UV filter transmits between 20% and 70%, depending on the wavelength and is useful for applications between 250 nm and 370 nm. Check the parts list on the right for details on all the models available.

Transmission curves for all the ND and color glass filters



Part #	Description
ND0.5	T = ~20%
ND1.0	T = ~10%
ND2.0	T = ~1%
ND3.0	T = ~0.1%
ND4.0	T = ~0.01%
ND5.0	T = ~0.001%
UG11	T = ~20 - 70% (from 250 - 370 nm)
NDSET-3	Set of 3 ND filters: ND1.0, ND2.0, ND3.0
NDSET-5	Set of 5 ND filters: ND1.0, ND2.0, ND3.0, ND4.0, ND5.0

ACCESSORIES FOR BD

VA-0-93 - VARIABLE ATTENUATOR

DESCRIPTION

The VA-0-93 is a simple-to-use variable attenuator. It consists of a bank of four filter wheels, each with three different filters ranging from 100% transmission down to 0.003 %. This filter bank offers almost continuous attenuation from 0 to more than 93 dB (Optical Density > 9).

The VA-0-93 has three M6 mounting holes and can also connect directly to the C-mount port of a camera. VA-0-93 uses Schott NG absorbing filter glass (NG). The filters have a clear aperture of 18 mm Ø. All filters are mounted at a 4° angle to suppress back-reflection interference fringes.

SPECIFICATIONS

Maximum Attenuation:	93 dB (OD9)
Minimum Attenuation:	0 dB
Maximum Power Density:	1 W/cm²
Maximum Energy Density:	100 mJ/cm²
Wavelength Range:	350 - 2200 nm
Clear Aperture:	18 mm Ø
Angle:	4°
Mounting:	3 x M6, C-Mount

		Wheel # 1		2		3		4	
		dB	%	dB	%	dB	%	dB	%
Filter #	1	0	100	0	100	0	100	0	100
	2	0.5	90	5	30	20	1	35	0.03
	3	1	80	10	10	25	0.3	40	0.01
	4	3	50	15	3	30	0.1	45	0.003

BSC-190 & BSC-350 - BEAM SPLITTER CUBES

DESCRIPTION

The BSC beam splitter cube takes a fixed ratio beam sample. It uses the front surface reflection from an uncoated laser mirror to achieve a reflection of 3% to 10% of the main laser beam for further analysis.

The surface is polished to 10-5 scratch-dig and 1/10 wave finish, wedged at 30 arcmin to avoid interference fringes and can take power densities up to 2 GW/cm². Like the VA-0-93 attenuator, it has C-Mount ports and can be connected to the VA-0-93 and your camera with compatible connecting tubes. It can post mount from an M6 threaded post.

SPECIFICATIONS

Attenuation:	3% to 10% (Polarization dependent)
Spectral Range:	
BSC-350:	350 - 2200 nm
BSC-190:	190 - 2200 nm
Clear Aperture:	19 mm
Damage Threshold:	50 J/cm²

Part #	Description
BSC-350	Beam Splitter Cube (350 - 2200 nm)
BSC-190	UV Beam Splitter Cube (190 - 2200 nm)