

## COMPONENTS FOR LASER BEAM DELIVERY



### HR Laser Line Mirrors

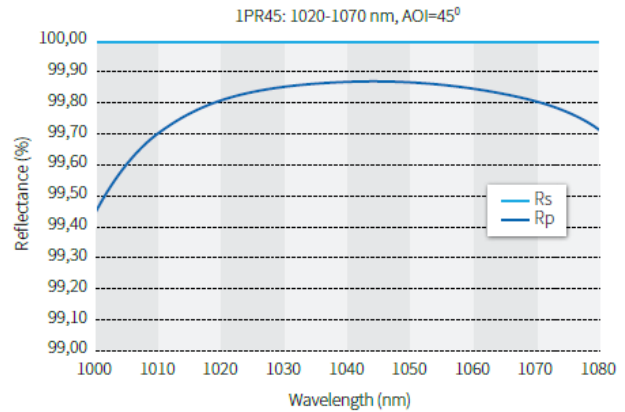
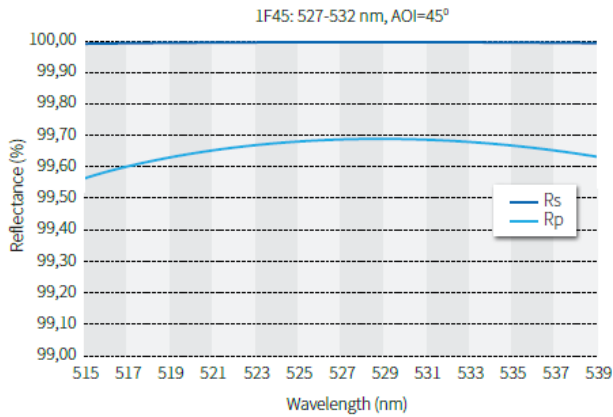
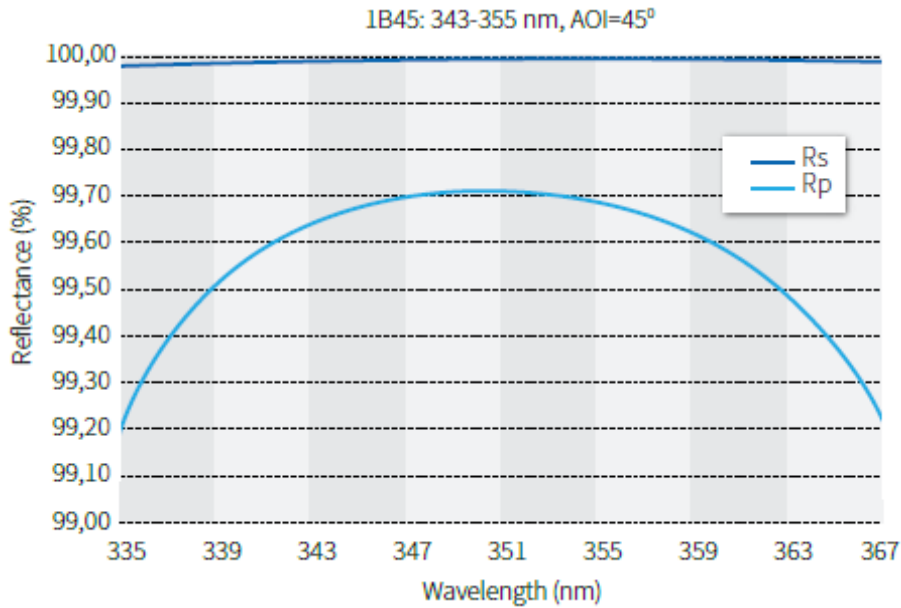


#### Description

Dielectric HR Laser Line Mirrors provide higher reflectivity values than metallic mirrors, making them a perfect choice for high-performance laser systems. HR mirrors can be optimized for certain wavelength, angle of incidence and polarization. We design mirrors in-house to meet your desired specifications and provide high-performance optics. Every coating batch is tested to confirm reflectivity values. Mirrors can also be optimized for high LIDT and LIDT measurements can be conducted upon request.

#### Features

- HR laser line coatings (HR) highly reflect at wavelength range of  $<10\%$  of the central wavelength (CWL)
- Mass production capabilities: 1'000 pieces per month
- Custom coatings are available for any wavelength in the range 0.19 -  $10\mu\text{m}$
- Surface flatness, P-V:  $<\lambda/8$  @ 632.8nm
- Laser damage threshold up to  $35.2 \text{ J/cm}^2$  @ 532 nm, 6.2ns, 50Hz

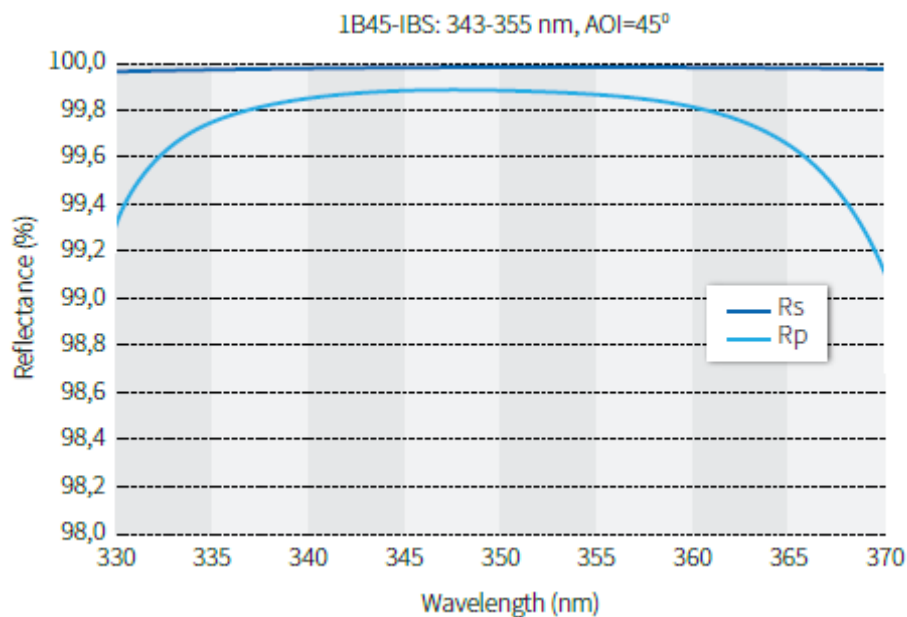


Wavelength, nm	Reflectance s/p, %**	Substrate material	Product ID for AOI=45°, Ø25.4mm
250-266	>99.6/>99.0	UVFS	1-OS-2-0254-5-[2AA45]
343-355	>99.5/>99.0	UVFS	1-OS-2-0254-5-[1B45]
380-420	>99.5/>99.0	UVFS	1-OS-2-0254-5-[1C45-GDD]
515	>99.5/>99.0	UVFS	1-OS-2-0254-5-[1E45]
527-532	>99.8/>99.3	BK7	1-OS-1-0254-6-[1F45]
760-840	>99.5/>99.0	UVFS	1-OS-2-0254-5-[1K45-GDD]
1030	>99.5/>99.0	UVFS	1-OS-2-0254-5-[1P45]
1020-1070	>99.8/>99.6	UVFS	1-OS-2-0254-5-[1PR45]
1047-1064	>99.5/>99.0	BK7	1-OS-1-0254-6-[1R45]
	<b>Reflectance, %</b>		<b>Product ID for AOI=0°, Ø25.4mm</b>
343-355	>99.5	UVFS	1-OS-2-0254-5-[1B00]
760-840	>99.5	UVFS	1-OS-2-0254-5-[1K00-GDD]
1000-1060	>99.5	UVFS	1-OS-2-0254-5-[1P00]
1047-1064	>99.5	BK7	1-OS-1-0254-6-[1R00]

\* Customized HR Laser Line Mirrors are available on request.

\*\* "p" stands for value of reflected p polarization at 45°, "s" stands for value of reflected s polarization beam at 45°.

## Low Loss HR Mirrors

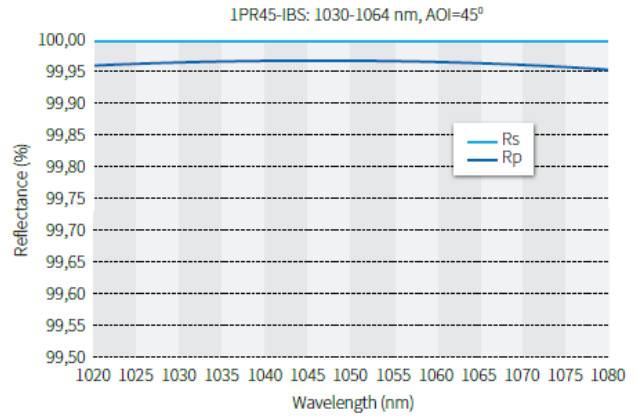
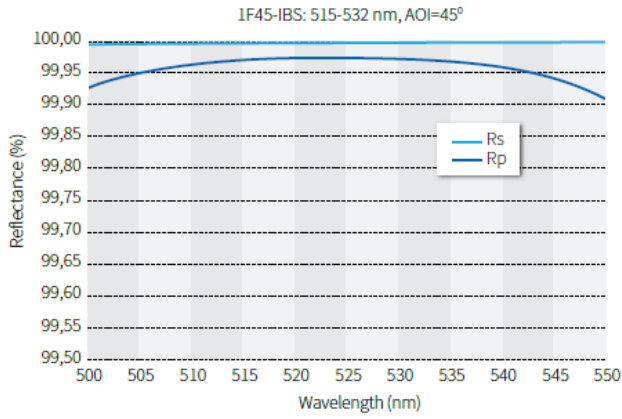


### Description

Low Loss HR mirrors are essential in laser systems where the lowest possible losses are required. Mirrors are manufactured with Ion Beam Sputtering technology (IBS) reaching extremely high-quality specifications. IBS thin films feature higher density and durability than e-beam coatings, making them resistant to environmental conditions such as heat, humidity and pressure. IBS mirrors reach highest reflectance (>99.9%) in a certain wavelength range and angles of incidence (AOI). Also, scattering is minimized which is usually a limiting factor for high reflectivity.

### Features

- Resistant to environmental conditions
- Wide-angle (AOI: 0-50°) mirrors are available
- Mass production capabilities: 1000 pieces per month
- Reflectance higher than 99.9%
- Surface flatness, P-V:  $< \lambda/8$  @ 632.8nm
- Laser damage threshold up to  $17\text{J}/\text{cm}^2$  @ 1064nm, 10ns, 10Hz

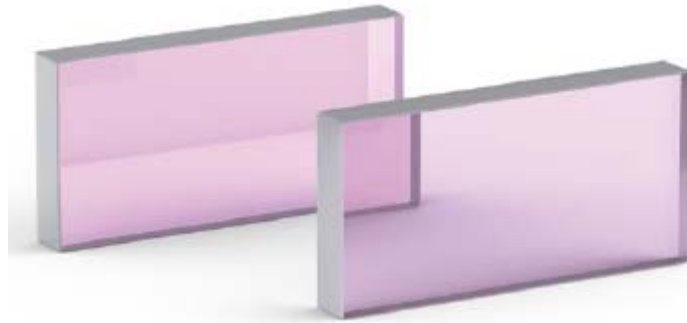


Wavelength, nm	Reflectance, %	Substrate material	Dimensions, mm	Product ID for AOI=0°
515-532	>99.94	UVFS	Ø25.4x5	1-OS-2-0254-5-[1F00-IBS]
1030-1064	>99.95	UVFS	Ø25.4x5	1-OS-2-0254-5-[1PR00-IBS]
	<b>Reflectance s/p, %</b>			<b>Product ID for AOI=45°</b>
343-355	>99.9/>99.7	UVFS	Ø25.4x5	1-OS-2-0254-5-[1B45-IBS]
515-532	>99.97/>99.93	UVFS	Ø25.4x5	1-OS-2-0254-5-[1F45-IBS]
800	>99.97/>99.93	UVFS	Ø25.4x5	1-OS-2-0254-5-[1K45-IBS]
1030-1064	>99.97/>99.93	UVFS	Ø25.4x5	1-OS-2-0254-5-[1PR45-IBS]
1030-1064	>99.98/>99.93	UVFS	Ø30x5	1-OS-2-0300-5-[1PR45-IBS]
1550	>99.98/>99.93	BK7	Ø25.4x6	1-OS-1-0254-6-[1V45-IBS]
				<b>Product ID for AOI=0°-45°</b>
355	>99.9/>99.6	UVFS	Ø12.7x6	1-OS-2-0127-6-[1B45-IBS]-0-45
1027-1033	>99.9/>99.8	UVFS	Ø25.4x6	1-OS-2-0254-6-[1P45-IBS]-0-45

\* Customized Low Loss HR Mirrors are available on request.

\*\* "p" stands for value of reflected p polarization at 45°, "s" stands for value of reflected s polarization beam at 45°.

## High Contrast Thin Film Polarizers



### Description

High Contrast Thin Film Polarizers (TFP) are made using advanced Ion Beam Sputtering (IBS) coating technology. These thin film polarizers separate s- and p-polarization components of high energy laser beams. Due to very low losses they are perfect for intra and extra cavity usage. Because of their high damage threshold and extinction ratio (>1000:1), thin film polarizers are a good replacement for Glan laser polarizing prisms or polarizing cube beam splitters. For optimal performance, polarizers should be mounted in an appropriate holder allowing angular adjustment. We offer two types of high contrast polarizers: with higher LIDT or higher contrast values.

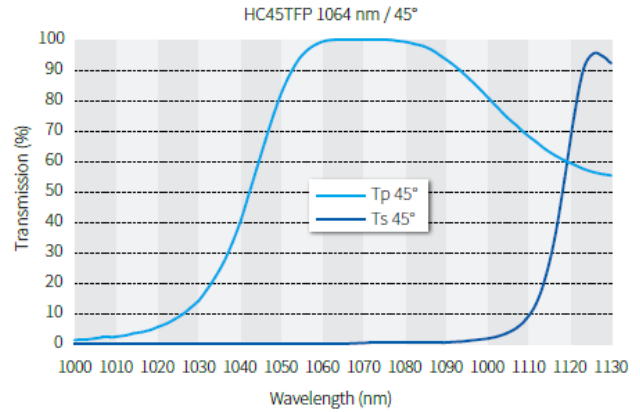
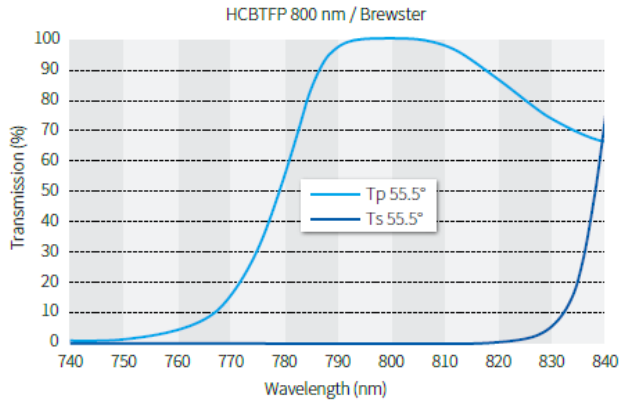
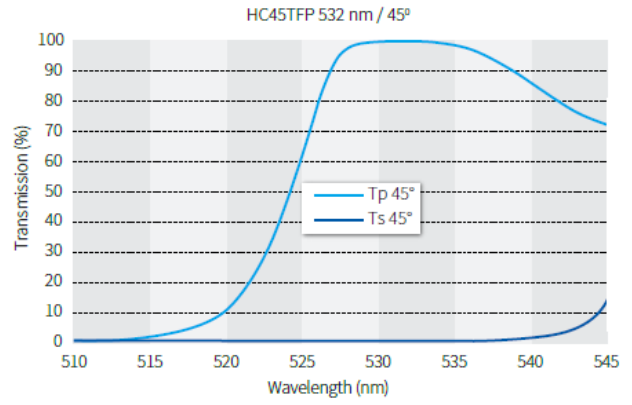
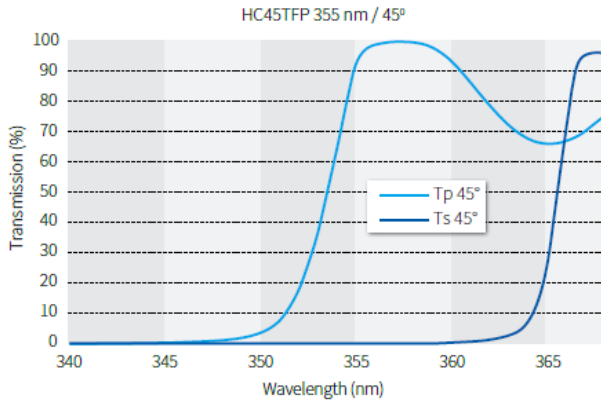
### Features

- High  $T_p$ , low absorption & scattering
- No aging effects due to negligible porosity of the coatings
- Transmitted wavefront distortion (TWD), P-V:  $<\lambda/10$  @ 632.8 nm
- Laser damage threshold up to 20 J/cm<sup>2</sup> @ 532 nm, 10 ns, 10 Hz (s-pol)

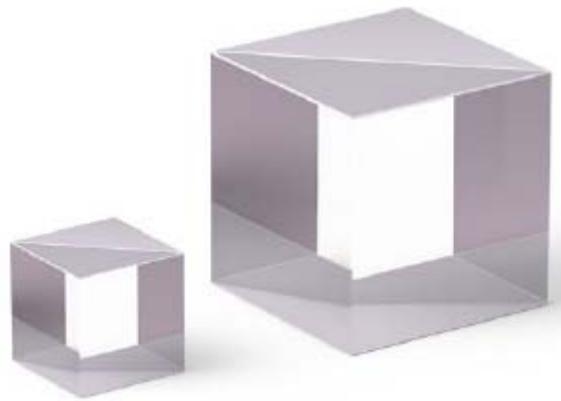
Wave-length, nm	Transmission, p-pol, %	Reflection, s-pol, %	Contrast, (Tp/Ts)	Typical LIDT @ 10 ns, 10 Hz for s-pol, J/cm <sup>2</sup>	Typical LIDT @ 10 ns, 10 Hz for p-pol, J/cm <sup>2</sup>	Product ID for AOI=Brewster
343	>97	>99.7	>300:1	>4	>1	2-HCBTFP-0343-0254
355	>97	>99.7	>300:1	>4	>1	2-HCBTFP-0355-0254
515	>99	>99.9	>1000:1	>5	>2	2-HCBTFP-0515-0254
532	>98	>99.8	>500:1	>7	>3	2-HCPBTFP-0532-0254
532	>99	>99.9	>1000:1	>5	>2	2-HCBTFP-0532-0254
800	>99	>99.9	>1000:1	>7	>3	2-HCBTFP-0800-0254
1030	>99	>99.8	>500:1	>20	>10	2-HCPBTFP-1030-1020
1030	>99	>99.9	>1000:1	>7	>3	2-HCBTFP-1030-0254
1064	>99	>99.8	>500:1	>20	>10	2-HCPBTFP-1064-1020
1064	>99	>99.9	>1000:1	>7	>3	2-HCBTFP-1064-0254

Wave-length, nm	Transmission, p-pol, %	Reflection, s-pol, %	Contrast, (Tp/Ts)	Typical LIDT @ 10 ns, 10 Hz for s-pol, J/cm <sup>2</sup>	Typical LIDT @ 10 ns, 10 Hz for p-pol, J/cm <sup>2</sup>	Product ID for AOI=45°
355	>95	>99.8	>500:1	>4	>1	2-HC45TFP-0355-0254
532	>98	>99.8	>500:1	>7	>3	2-HCP45TFP-0532-0254
532	>97	>99.9	>1000:1	>5	>2	2-HC45TFP-0532-0254
1030	>97	>99.8	>500:1	>20	>10	2-HCP45TFP-1030-0254
1030	>97	>99.8	>1000:1	>7	>3	2-HC45TFP-1030-0254
1064	>97	>99.8	>500:1	>20	>10	2-HCP45TFP-1064-0254
1064	>97	>99.9	>1000:1	>7	>3	2-HC45TFP-1064-0254

\* Customized solutions are available on request. Typical dimensions are Ø25.4 x 5 mm, 20 x 40 x 5 mm and 10 x 20 x 5 mm.



## Polarizing Cubes for High Energy Applications



### Description

Polarizing beamsplitter cubes offer several advantages over plate beamsplitters. They are easy to handle, high contrast and high extinction ratio polarizers that split a randomly polarized beam into two orthogonal linearly polarized components. These products are typically used in laser beam separation, combination and optical-isolation applications. The epoxy-free construction of the cubes enables a superior performance at high energy levels.

### Features

- Easy, deformation-free mounting
- High extinction ratio in transmission:  $T_p/T_s > 1000:1$
- Low reflected and transmitted wavefront distortion, P-V:  $< \lambda/10 @ 632.8\text{nm}$
- No ghost reflections
- Minimal beam displacement
- Negligible absorption of reflected and transmitted beams
- High transmission of p-polarization:  $T_p > 97\%$
- No material fluorescence in UV region
- Laser damage threshold up to  $20 \text{ J/cm}^2 @ 1064\text{nm}$ , 10ns, 100Hz

Wavelength, nm	Dimensions, mm	Reflection s-pol, %	Transmission p-pol, %	Product ID
345-365 (centered @ 355)	12.7x12.7x12.7	>99.5	>96	2-HPCB-A-0125
	25.4x25.4x25.4	>99.5	>96	2-HPCB-A-0254
510-550 (centered @ 532)	12.7x12.7x12.7	>99.5	>97	2-HPCB-B-0125
	25.4x25.4x25.4	>99.5	>97	2-HPCB-B-0254
1020-1090 (centered @ 1064)	12.7x12.7x12.7	>99.5	>97	2-HPCB-C-0125
	25.4x25.4x25.4	>99.5	>97	2-HPCB-C-0254
1510-1580 (centered @ 1550)	12.7x12.7x12.7	>99.5	>97	2-HPCB-D-0125

\* Customized solutions are available on request.

## High Energy Waveplates



### Description

We provide standard (air-spaced) and high power (optically bonded) wave plates. They are made from materials that has a birefringence property. Most common types are designed so ordinary ray would exhibit half ( $\lambda/2$ ) or quarter ( $\lambda/4$ ) wave retardation with respect to an extraordinary one. Such wave plates are used to rotate the plane of polarization, convert linear polarization to circular and vice versa. Such elements are used for electro-optic modulation and as a variable ratio beam splitter, when used in conjunction with a polarization cube. Although latter two types of wave plates are the most common, we offer custom retardation values on request.

### Features

- High extinction ratio
- Wide acceptance angle
- Wide temperature bandwidth
- Exceptional durability in UV applications
- Wide wavelength range available

	<b>Product ID</b>	<b>Product ID</b>	<b>Product ID</b>
<b>Wavelength, nm</b>	<b><math>\lambda/2</math> retardation, clear aperture &gt;8mm</b>	<b><math>\lambda/2</math> retardation, clear aperture &gt;18mm</b>	<b><math>\lambda/4</math> retardation, clear aperture &gt;18mm</b>
266		2-CPW-TSO-L2-0266	2-CPW-T40-L4-0266-W
343	2-CPW-TFO-L2-0343-S	2-CPW-TFO-L2-0343-W	2-CPW-TT0-L4-0343-W
355	2-CPW-TFO-L2-0355-S	2-CPW-TFO-L2-0355-W	2-CPW-TSO-L4-0355-W
400	2-CPW-TFO-L2-0400-S	2-CPW-TFO-L2-0400	2-CPW-TSO-L4-0400
515	2-CPW-TZO-L2-0515-S	2-CPW-TFO-L2-0515	2-CPW-TSO-L4-0515
532	2-CPW-TZO-L2-0532-S	2-CPW-TFO-L2-0532	2-CPW-TFO-L4-0532
780			2-CPW-TFO-L4-0780
800	2-CPW-TZO-L2-0800-S	2-CPW-TZO-L2-0800	2-CPW-TFO-L4-0800
1030	2-CPW-TZO-L2-1030-S	2-CPW-TZO-L2-1030	2-CPW-TFO-L4-1030
1064	2-CPW-TZO-L2-1064-S	2-CPW-TZO-L2-1064	2-CPW-TFO-L4-1064
1550	2-CPW-TZO-L2-1550-S	2-CPW-TZO-L2-1550	2-CPW-TZO-L4-1550

\* Customized solutions are available on request.



## Watt Pilot Motorized Attenuators



### Description

Watt Pilot is a laser beam intensity attenuator. Enhanced version contains a rotating quartz  $\lambda/2$  phase waveplate and one or two thin film plate polarizers for parallel s-polarized and p-polarizer beam separation, meanwhile Standard version attenuator contains a single polarizing cube beam splitter for orthogonal s-polarized and p-polarized beams separation. The intensity ratio of two separated beams is continuously tuned by rotating the waveplate. Despite the stand-alone look, Watt Pilot motorized attenuator is a compact, rigid and precise device and it can be easily integrated into custom optical systems.

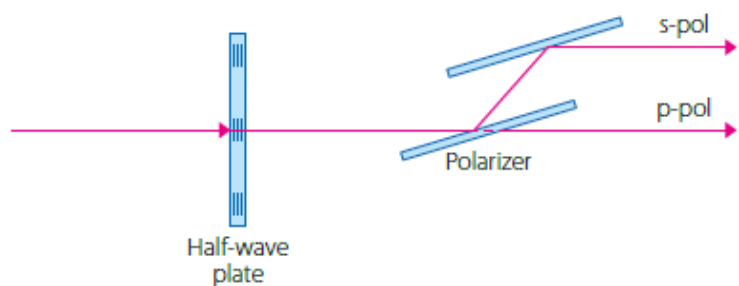
### Features

- User-friendly software interface, RS232 connection
- Divides laser beam into two s-pol and p-pol beams of adjustable intensity ratio
- Low dispersion for ultrashort and high energy laser pulses
- Clear aperture: >15 mm

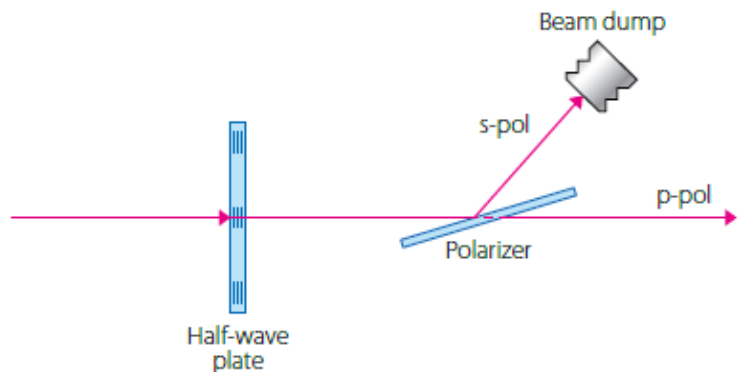
### Standard version

Standard specifications

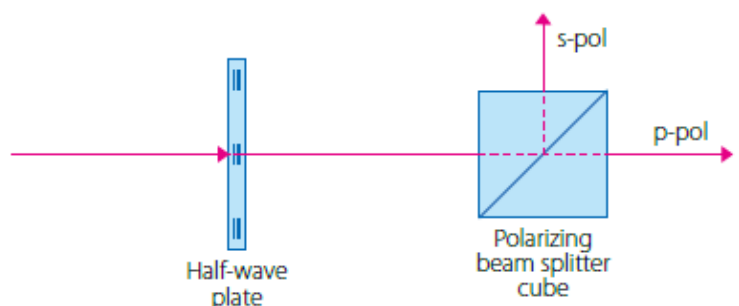
#### Enhanced Reflection Type



#### Enhanced Transmission Type



#### Standard Cube Type



Clear aperture	10 mm
Bandwidth	Up to $\pm 10$ nm
Configuration	$\lambda/2$ ZO Waveplate + High Energy Polarizing Cube
Attenuation range (Tmin-Tmax) @ CWL	Up to 0.5-95%
Typical applications	Medium and high power CW and pulsed lasers, LDs
Damage threshold	$>20$ J/cm <sup>2</sup> @ 1064 nm, 10 ns, 10 Hz
Dimensions (H x L x W)	63 x 78 x 91 mm
Time between min and max attenuation	$<3$ sec
Steps between min and max attenuation	3900

#### Typical items

Wave-length, nm	Bandwidth, nm	Configuration	Optimization	Attenuation range (Tmin-Tmax) @ CWL	Product ID
355	$\pm 10$	$\lambda/2$ ZO waveplate + High Energy PBS cube	Transmission/Reflection	0.5-95%	SWP-HP-0355
532	$\pm 10$	$\lambda/2$ ZO waveplate + High Energy PBS cube	Transmission/Reflection	0.5-95%	SWP-HP-0532
1064	$\pm 10$	$\lambda/2$ ZO waveplate + High Energy PBS cube	Transmission/Reflection	0.5-95%	SWP-HP-1064

#### Enhanced version

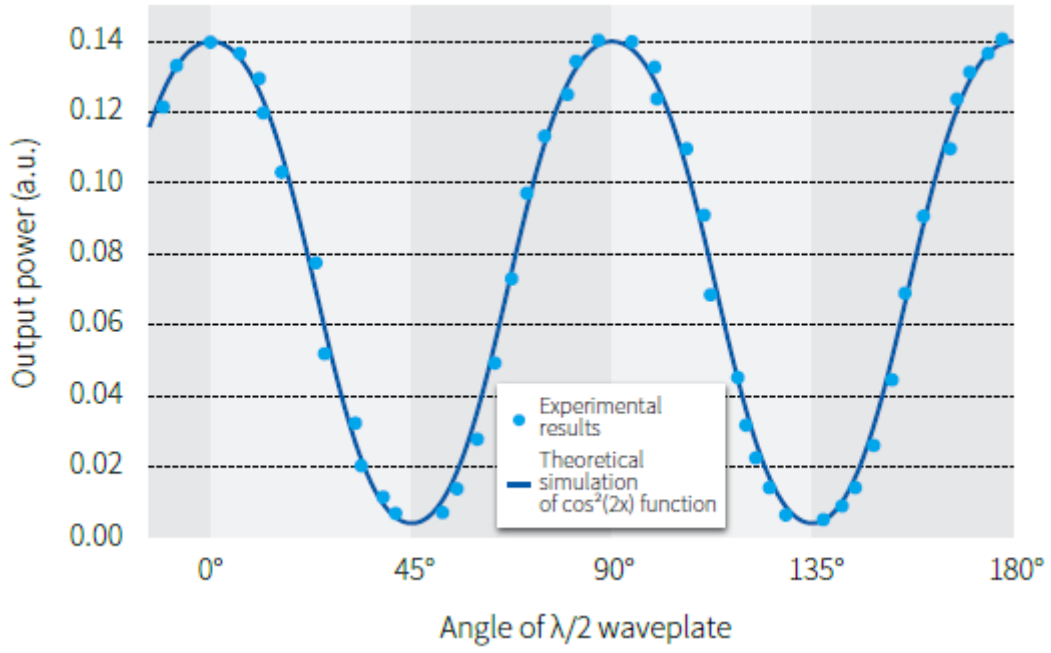
##### Standard specifications

Clear aperture	15mm
Bandwidth	Up to $\pm 10$ nm (20 $>$ 10)
Optimization	Reflection or transmission type
Configuration	$\lambda/2$ ZO Waveplate + 1x or 2x Thin Film Polarizers
Attenuation range (Tmin-Tmax) @ CWL	Up to 0.3-99%*
Typical applications	High power CW and pulsed lasers, LDs
Damage threshold	$>5$ J/cm <sup>2</sup> @ 1064 nm, 10 ns, 10 Hz
Dimensions (H x L x W)	63 x 108 x 91mm - reflection mode 63 x 106 x 91mm - transmission mode
Time between min and max attenuation	$<3$ sec
Steps between min and max attenuation	3900
*Attenuation range for transmission type	Tmax (when open): $>95\%$ ; Tmin (when closed): $<0.5\%$ (P-pol output)
*Attenuation range for reflection type	Tmax (when open): $>95\%$ ; Tmin (when closed): $<0.5\%$ (P-pol output) Tmax (when open): $>99\%$ ; Tmin (when closed): $<0.3\%$ (S-pol output)

#### Typical items

Wave-length, nm	Bandwidth, nm	Configuration	Optimization	Attenuation range* (Tmin-Tmax) @ CWL	Product ID
266	$\pm 5$	$\lambda/2$ ZO waveplate + 2x TFP	Reflection	0.3-99%	EWP-R-0266
343	$\pm 5$	$\lambda/2$ ZO waveplate + 2x TFP	Reflection	0.3-99%	EWP-R-0343
355	$\pm 5$	$\lambda/2$ ZO waveplate + 2x TFP	Reflection	0.3-99%	EWP-R-0355
515	$\pm 5$	$\lambda/2$ ZO waveplate + 2x TFP	Reflection	0.3-99%	EWP-R-0515
532	$\pm 5$	$\lambda/2$ ZO waveplate + 2x TFP	Reflection	0.3-99%	EWP-R-0532
1030	$\pm 10$	$\lambda/2$ ZO waveplate + 2x Broadband TFP	Broadband Reflection	0.3-99%	EWP-R-1030
1064	$\pm 5$	$\lambda/2$ ZO waveplate + 2x TFP	Reflection	0.3-99%	EWP-R-1064
266	$\pm 5$	$\lambda/2$ ZO waveplate + TFP	Transmission	0.5-95%	EWP-T-0266
343	$\pm 5$	$\lambda/2$ ZO waveplate + TFP	Transmission	0.5-95%	EWP-T-0343
355	$\pm 5$	$\lambda/2$ ZO waveplate + TFP	Transmission	0.5-95%	EWP-T-0355
515	$\pm 5$	$\lambda/2$ ZO waveplate + TFP	Transmission	0.5-95%	EWP-T-0515
532	$\pm 5$	$\lambda/2$ ZO waveplate + TFP	Transmission	0.5-95%	EWP-T-0532
1030	$\pm 10$	$\lambda/2$ ZO waveplate + Broadband TFP	Broadband Transmission	0.5-95%	EWP-T-1030
1064	$\pm 5$	$\lambda/2$ ZO waveplate + TFP	Transmission	0.5-95%	EWP-T-1064

Example of performance provided by attenuator comprising a waveplate and a polarizer.



## PowerXP – Motorized Attenuators



### Description

We offer two types of laser beam intensity attenuator for high energy applications - Compact (CA 8 mm) and Maxi (CA 15 mm) version. With an upgraded belt drive and electronics for quick and precise power control, PowerXP motorized attenuators are reliable solution for industrial applications. Attenuators contain a motorized rotating quartz  $\lambda/2$  phase waveplate and one or two thin film polarizers are used to separate the input beam into s-polarized and p-polarized parallel output beams. Pure p-polarization should be selected for maximum transmission and pure s-polarization for maximum attenuation. The intensity ratio of separated beams is continuously tuned by rotating the waveplate. Small footprint and high energy compatible optics of Compact version makes it a goto solution for power control and beam-splitting in demanding laser processing applications.

### Features

- User-friendly software interface, RS232 connection
- Divides laser beam into two s-pol and p-pol beams of adjustable intensity ratio
- Low dispersion for ultrashort and high energy laser pulses
- Ideal for integration in other systems
- Time between min and max attenuation less than 0.2 sec

### Compact version

Standard specifications

Clear aperture	8mm
Bandwidth	Up to $\pm 5$ nm
Optimization	Transmission type
Configuration	$\lambda/2$ High Energy Waveplate + IBS coated High Contrast Thin Film Polarizer
Attenuation range (Tmin-Tmax) @ CWL	Up to 0.1-99%
Typical applications	High power CW and pulsed lasers
Damage threshold	$>10\text{J}/\text{cm}^2$ @ 1064nm, 10ns, 10Hz
Dimensions (H x L x W)	74 x 32 x 66 mm
Time between min and max attenuation	$<1\text{sec}$
Steps between min and max attenuation	10800

Typical items:

Wave-length, nm	Bandwidth, nm	Configuration	Optimization	Attenuation range (Tmin-Tmax) @ CWL	Product ID
343	$\pm 5$	$\lambda/2$ High Energy waveplate + High Contrast TFP	Transmission	0.3-97%	PXP-08-0343
355	$\pm 5$	$\lambda/2$ High Energy waveplate + High Contrast TFP	Transmission	0.3-97%	PXP-08-0355
515	$\pm 5$	$\lambda/2$ High Energy waveplate + High Contrast TFP	Transmission	0.1-99%	PXP-08-0515
532	$\pm 5$	$\lambda/2$ High Energy waveplate + High Contrast TFP	Transmission	0.1-99%	PXP-08-0532
1030	$\pm 5$	$\lambda/2$ High Energy waveplate	Transmission	0.2-99%	PXP-08-1030

		+ High Contrast TFP			
1064	±5	λ/2 High Energy waveplate + High Contrast TFP	Transmission	0.2-99%	PXP-08-1064

### Maxi version

#### Standard specifications

Clear aperture	15mm
Bandwidth	Up to ±10nm
Optimization	Reflection or transmission type
Configuration	λ/2 ZO Waveplate + 1x or 2x Thin Film Polarizers
Attenuation range (Tmin-Tmax) @ CWL	Up to 0.3-99%*
Typical applications	High power CW and pulsed lasers
Damage threshold	>5 J/cm <sup>2</sup> @ 1064nm, 10ns, 10Hz
Dimensions (H x L x W)	56 x 99 x 90 mm
Time between min and max attenuation	<0.2sec
Steps between min and max attenuation	24000
*Attenuation range for transmission type	Tmax (when open): >95%; Tmin (when closed): <0.5% (P-pol output)
*Attenuation range for reflection type	Tmax (when open): >95%; Tmin (when closed): <0.5% (P-pol output) Tmax (when open): >99%; Tmin (when closed): <0.3% (S-pol output)

#### Typical items

Wave-length, nm	Bandwidth, nm	Configuration	Optimization	Attenuation range* (Tmin-Tmax) @ CWL	Product ID
266	±5	λ/2 ZO waveplate + 2x TFP	Reflection	0.3-99%	PXP-15-R-0266
343	±5	λ/2 ZO waveplate + 2x TFP	Reflection	0.3-99%	PXP-15-R-0343
355	±5	λ/2 ZO waveplate + 2x TFP	Reflection	0.3-99%	PXP-15-R-0355
515	±5	λ/2 ZO waveplate + 2x TFP	Reflection	0.3-99%	PXP-15-R-0515
532	±5	λ/2 ZO waveplate + 2x TFP	Reflection	0.3-99%	PXP-15-R-0532
1030	±10	λ/2 ZO waveplate + 2x Broadband TFP	Broadband Reflection	0.3-99%	PXP-15-R-1030
1064	±5	λ/2 ZO waveplate + 2x TFP	Reflection	0.3-99%	PXP-15-R-1064
266	±5	λ/2 ZO waveplate + TFP	Transmission	0.5-95%	PXP-15-T-0266
343	±5	λ/2 ZO waveplate + TFP	Transmission	0.5-95%	PXP-15-T-0343
355	±5	λ/2 ZO waveplate + TFP	Transmission	0.5-95%	PXP-15-T-0355
515	±5	λ/2 ZO waveplate + TFP	Transmission	0.5-95%	PXP-15-T-0515
532	±5	λ/2 ZO waveplate + TFP	Transmission	0.5-95%	PXP-15-T-0532
1030	±10	λ/2 ZO waveplate + Broadband TFP	Broadband Transmission	0.5-95%	PXP-15-T-1030
1064	±5	λ/2 ZO waveplate + TFP	Transmission	0.5-95%	PXP-15-T-1064

## MBE – Motorized Beam Expanders



### Description

MBE is a zoom beam expander designed for automated applications. It combines multiple lenses to provide variable magnification and automated divergence adjustment from 1x to 6x. Driver and all the motors are integrated in the casing of the beam expander which makes it compact and convenient for usage. High pointing stability ( $<0.1$  mrad) and fast magnification speed (1 sec from 1x to 6x) offers suitable performance for precision and high speed industrial applications.

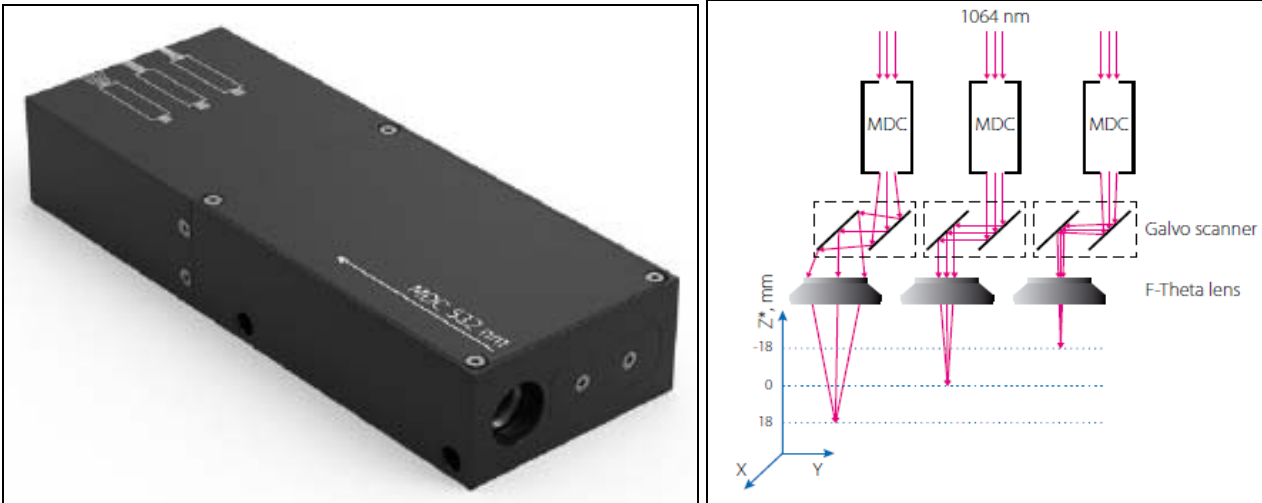
### Features

- Aberration minimized design
- Plug & play solution (controller included)
- Suitable for ultrafast picosecond and femtosecond lasers
- Direct control from microcontrollers and embedded systems
- Laser damage threshold up to  $100\text{mJ}/\text{cm}^2$  @ 1064nm, 10ps, 400kHz
- Custom wavelengths are available in the range of 250-3000nm

### Standard specifications:

Wavelength	343-355nm, 515-532nm, 1020-1070nm
Magnification factor	1 - 6 continuous
Pointing stability	$<0.1$ mrad
Magnification speed (1x to 6x)	$<1$ sec
Diffraction limited maximum input beam diameter	6mm
Total transmission	$>98\%$
Lens material	UVFS
LIDT (coating)	$>10\text{J}/\text{cm}^2$ @ 1064nm, 10ns, 10Hz
Dimensions (H x W x L)	62 x 62 x 161 mm
Control interface	RS232
Housing material	Black anodized aluminum
Collimator hole	Yes

## MDC – Motorized Divergence Controller



### Description

MDC is a motorized device which changes beam divergence from approximately -2 mrad (converging) to +4 mrad (diverging). As an add-on to 2D galvo scanners this device upgrades automated 2D fabrication setup to 3D. It is achieved by changing focal point position along z-axis when adjusting beam divergence. MDC can control working distance and focus beam diameter in real time. Device is lighter in weight and smaller in dimensions compared to other solutions in the market. Due to simplified design it is a cost saving and user-friendly device.

### Features

- Aberration minimized design
- Plug & play solution (controller included)
- Suitable for ultrafast picosecond and femtosecond lasers
- Active position tracking and correction function is available
- Custom wavelengths are available in the range of 250-3000nm

### Standard specifications:

Max input beam diameter	Up to 6mm
Focus speed	200 mm/s
Divergence adjustment rate	Up to 30mrad/s
Damage threshold	>10 J/cm <sup>2</sup> 10 Hz, 10 ns, 1064nm >7 J/cm <sup>2</sup> 10 Hz, 10 ns, 532nm
Resolution	< μrad/step
Beam wander	<0.5mrad
Dimensions (H x W x L)	26.5 x 55 x 147mm
Weight	340g
Control interface	USB, RS232 (available under request)

### Typical Items:

Wave-length, nm	Focus range*, mm	Divergence adjustment range*, mrad	Product ID
343-355	32	from -0.6 to +5.5	MDC-0355
515-532	34	from -0.8 to +4.9	MDC-0532
1030-1064	36	from -0.9 to +4.4	MDC-1064

\*Using F=+163 mm F-Theta lens when Ø3 mm (at 1/e<sup>2</sup> intensity level). entrance beam has M<sub>2</sub>=1 and 1 mrad divergence.

Focus shift depends on the distance between MDC and focusing objective, and laser beam parameters before MDC (dia @  $1/e^2$ ; divergence;  $M^2$ ). If you provide us with these laser beam parameters we will be able to provide exact calculations. Below you will find example, which can be good reference.

F- $\theta$ FL, mm	Focus shift if F- $\theta$ is placed 100 mm after MDC, mm		Focus shift if F- $\theta$ is placed 200 mm after MDC, mm	
	@1064nm	@355nm	@1064nm	@355nm
50	4		5	
100	16		19	
160	35	36	46	50
180	47		55	
200	56		66	
254	84		98	
260	88		102	

Our standard version has a speed of 30mrad/s; controller and software are included. Customized versions are available on request (higher speed, position tracking, additional trigger, etc).



## Fixed Ratio Beam Expanders

### Description

Our beam expanders are assembled using one diverging and one converging lenses. As there is no focal point inside the beam expander, it can be used for high powers. Special treatment of lenses and mechanics is performed for UV application to improve lifetime and LIDT of the expander. Standard magnifications are from 1.1x to 10x. Beam expanders for any wavelengths between 266 - 2000 nm are available upon request.

### Features

- Custom magnification and design on request
- Extended lifetime and LIDT for UV applications
- Individual reports of beam ellipticity, M2 and pointing stability parameters
- Custom wavelengths are available in the range of 250-3000nm



Standard specifications:

Lens material	UVFS
Transmitted wavefront distortion	$\lambda/4$ p-v @ 632 nm
Overall transmission	99%
Laser induced damage threshold	>10 J/cm <sup>2</sup> @ 1064 nm, 10 ns, 10 Hz
Housing material	Black anodized aluminium
Diameter	30 mm
Mounting thread	SM1

Typical items:

Wavelength, nm	Expansion	Input aperture, mm	Exit aperture, mm	Housing dimensions, mm	Product ID
343-355	1.2X	10	12	Ø30 x 56.6	FBE-1.2X-0355
	1.5X	8.5	12.75	Ø30 x 55.7	FBE-1.5X-0355
	2X	5	10	Ø30 x 58.1	FBE-2X-0355
	2.5X	5	12.5	Ø30 x 79.4	FBE-2.5X-0355
	3X	5	15	Ø30 x 56.6	FBE-3X-0355
	4X	4	16	Ø30 x 80.1	FBE-4X-0355
	5X	3	15	Ø30 x 85.1	FBE-5X-0355
515-532	1.2X	10	12	Ø30 x 58.2	FBE-1.2X-0532
	1.5X	9	13.5	Ø30 x 57.3	FBE-1.5X-0532
	2X	6	12	Ø30 x 59.6	FBE-2X-0532
	2.5X	6	15	Ø30 x 78.8	FBE-2.5X-0532
	3X	4.5	15	Ø30 x 58.2	FBE-3X-0532
	4X	4	16	Ø30 x 81.7	FBE-4X-0532
	5X	3	15	Ø30 x 87.6	FBE-5X-0532
1020-1070	1.2X	10	12	Ø30 x 59.4	FBE-1.2X-1064
	1.5X	10	15	Ø30 x 58.4	FBE-1.5X-1064
	2X	6	12	Ø30 x 60.8	FBE-2X-1064
	2.5X	6	15	Ø30 x 80.6	FBE-2.5X-1064
	3X	5	15	Ø30 x 59.4	FBE-3X-1064
	4X	4.5	18	Ø30 x 82.9	FBE-4X-1064
	5X	3.5	17.5	Ø30 x 87.5	FBE-5X-1064

## Variable Beam Expanders



### Description

Variable beam expanders are ideal for systems in which different magnifications and precise control of laser beam divergence are required. We offer Galilean type variable beam expanders with high LIDT AR coatings that minimize ghost reflections. Our variable beam expanders allows to separately adjust magnification and divergence. Two main standard products change magnification in the range of 1x-4x and 2x-8x.

### Features

- High pointing stability (<1 mrad)
- Individual reports of beam ellipticity, M2 and pointing stability parameters
- Mounting adapters at the input, output and middle are available on request
- Extended lifetime and LIDT for UV applications

Wavelength, nm	Expansion range	Max input beam diameter*, mm		Housing dimensions, mm	Product ID
343-355	1x-4x	1X	4.0	Ø41 x 120	VBE-1X-4X-0343-0355-B
		2X	5.5		
		3X	3.0		
		4X	3.0		
343-355	2x-8x	2X	5.0	Ø41 x 145	VBE-2X-8X-0343-0355-B
		3X	5.0		
		4X	4.0		
		5X	3.0		
		6X	2.5		
		7X	2.25		
		8X	2.0		
515-532	1x-4x	1X	4.5	Ø41 x 120	VBE-1X-4X-0515-0532-B
		2X	6.5		
		3X	4.0		
		4X	3.5		
515-532	2x-8x	2X	5.0	Ø41 x 147.5	VBE-2X-8X-0515-0532-B
		3X	5.0		
		4X	4.0		
		5X	3.0		
		6X	2.5		
		7X	2.25		
		8X	2.0		
1030-1064	1x-4x	1X	4.5	Ø41 x 120	VBE-1X-4X-1030-1064-B
	2X	7.0			
	3X	5.0			
	4X	4.0			

	2x-8x	2X	5.0	Ø41 x 147.5	VBE-2X-8X-1030-1064-B
		3X	5.0		
		4X	5.0		
		5X	4.0		
		6X	3.0		
		7X	2.5		
		8X	2.5		

\* Max input beam diameter ensuring diffraction limited performance.