

3.4 Accessories for Beam Profiling

Introduction

Spiricon has the most extensive array of accessories for beam profiling existing. There are components for attenuating, filtering, beam splitting, magnifying, reducing and wavelength conversion. There are components for wavelengths from the deep UV to CO₂ wavelengths. Most of the components are modular so they can be mixed and matched with each other to solve almost any beam profiling requirement needed.

3.4.1 Neutral Density Attenuators/Filters

For almost all applications, the laser beam intensity is too high for the operating range of the CCD. Therefore ND glass attenuator filters are available to reduce the intensity to the proper level at the CCD. In general, either the LBF-50 attenuating filter set or a set of individual, stackable, screw on filters is recommended. These filters are carefully designed not to affect beam quality or cause interference effects. One stackable ND1 filter and 2 ND2 filters are supplied standard with each camera.



Model	Stackable ND Filters ND1/ND2/ND3	LBF-50	Continuously Variable	ATP-K Variable Attenuator	UV ND Filters	Speciality Filter for 355nm	Speciality Filter for 1300nm
Nominal ND value	1,2,3	0.3, 0.7, 1, 2, 3, 4	1-6 continuously variable	ND=1.7-4.6 Max. ND: 7.4 (with fixed 2.8 gray-glass attenuator)	0.3, 0.7, 1.0, 1.3, 1.7, 2.0, 2.3, 2.7, 3.0, 3.3, 3.7, 4.0, 4.3, 4.7, 5.0, 6.0	Pass 355nm, blocks 532nm & 1064nm	Pass 1300nm, blocks <1100nm
Clear aperture	Ø19mm	Ø12mm	Ø20mm	Ø15mm	Ø20mm	Ø19mm	Ø19mm
Damage threshold	5W/cm ² no distortion	5W/cm ² no distortion	5W/cm ² no distortion	100mW/mm no thermal lensing	100W/cm ² CW, 10ns pulses, no distortion	5W/cm ² no distortion	5W/cm ² no distortion
Mounting	C-Mount Threads	C-Mount Threads	C-Mount Threads	C-Mount Threads	C-Mount Threads	C-Mount Threads	C-Mount Threads

Stackable ND filters

The individual filters come in three versions, the ND1 filter in the red housing with ~10% transmission in the visible, the ND2 filter in the black housing with ~1% transmission and the ND3 filter in the green housing with ~0.1% transmission. The individual filters can be screwed on top of each other and thus stacked.

They are set at a small wedge angle in the housing so as not to cause interference effects.



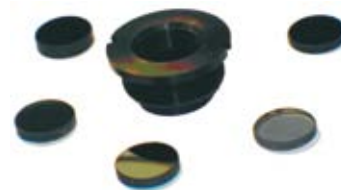
ND1, ND2 and ND3 stackable filters



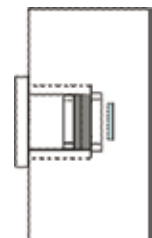
Stackable filter showing wedge

LBF-50

The LBF-50 comes with a set of filters that are inserted into the flange shown, mounted on top of each other and secured. A set of 6 filters is provided that can achieve attenuation anywhere from ND 0.3 to ND 8. The LBF-50 is especially useful for CS or C mount cameras with the CCD recessed way below the surface. The filters are recessed into the camera thus saving thickness as shown in the illustration to the right.



LBF - 50 filter assembly

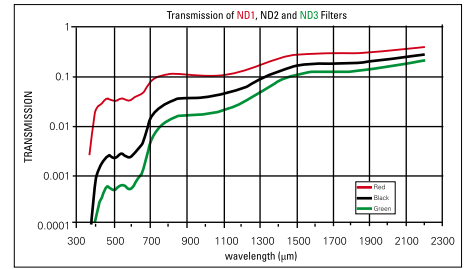


LBF-50 on C mount camera

3.4.1 Beam Profile

Transmission vs. Wavelength

These "neutral density" or ND filters do not have a flat response in attenuation vs. wavelength. See the graph for typical transmission vs. wavelength characteristics.

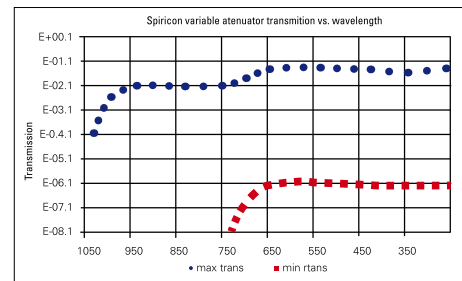
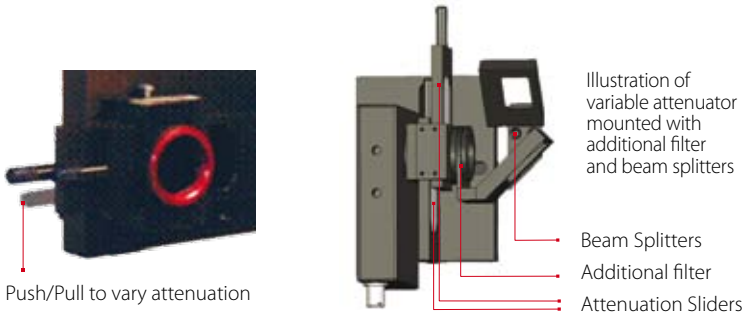


Specifications

Item	ND1 / ND2 / ND3	LBF-50
Nominal ND (vis)	1, 2, 3	0.3, 0.7, 1, 2, 3, 4
Clear Aperture	Ø19mm	Ø12mm
Damage threshold	5W/cm ² , 1J/cm ² for ns pulses	

Continuously Variable Attenuator

For maximum ease of use there is the continuously variable attenuator that can vary its attenuation over a very wide range just by pushing and pulling the filters laterally. The attenuator consists of two opposite wedges of ND glass. The surfaces are arranged so that no parallel surfaces face each other so as to eliminate interference effects. The variable attenuator uses the same C-mount thread as the other components so it can be combined with additional stackable filters and beam splitters, if necessary, as shown.



Specifications

Item	Variable attenuator
Nominal ND (vis)	1 - 6 continuously variable
Aperture	Ø20mm
Optical quality	2 waves in visible
Damage threshold	5W/cm ² , 1J/cm ² for ns pulses

ATP-K Variable Attenuator

This option makes beam profiling easy. The ATP-K attenuates your laser without ghost reflections or fringes and has a knob-operated variable wedge attenuator of ND 1.7–4.6, and comes with a fixed gray-glass attenuator with ND 2.8.

The ATP-K is also designed to be used with the HP-XXX high power attenuators and beam splitters. Both types of attenuators attach directly to the ATP-K via C-mount. The ATP-K has simple reproducible attenuation settings, and has a wavelength range of 360 to 2500+ nm.



Figure 1 below shows the safe average power for negligible beam distortion from thermal lensing. Absorptive filters, such as used in the ATP-K have an upper power limit of approximately 100mW per mm beam diameter. For pulsed beams, Figure 2 shows the damage threshold for energy where breakage of the glass wedge may occur. This is approximately 5J per mm beam diameter. For lasers with power or energy levels above this the first stage of attenuation will need to come from our line of high power reflective attenuators.

Figure 1 – Safe average power for negligible beam distortion

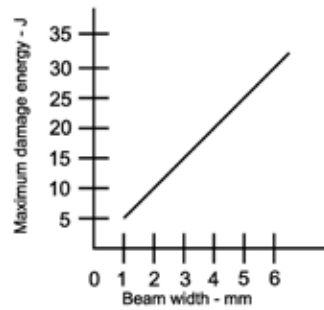
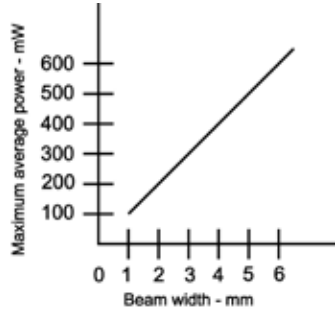


Figure 2 – Point at which damage will occur with pulsed energy

ATP-K Specifications

Maximum Power/Energy Handling 100 mW/mm beam diameter 100 mJ total avg. energy Damage threshold: 5J

Note: Powerful laser sources may require additional attenuation prior to the beam's exposure to Model ATP-K. Additional attenuation usually is achieved by use of high-power laser mirror attenuators or clean, high-quality quartz plates (recommended with slight wedge angles).

Wavelength Range 360-2500+ nm Near flat response out to 1500nm

Attenuation Range Variable filters: ND = 1.7 to 4.6 Maximum ND 7.4 (with fixed 2.8 gray-glass attenuator)

Note: ND (optical density) = $\log(1/T)$ or $T=10^{-ND}$ where T is the fraction of light transmitted. For example, an ND of 5 transmits 0.00001 or 0.001%.

Clear Aperture 15mm diameter

Dimensions 94 (W) x 28 (H) x 43 (D) mm

Thickness Tolerance ± 0.25 mm

Mounting C-mount

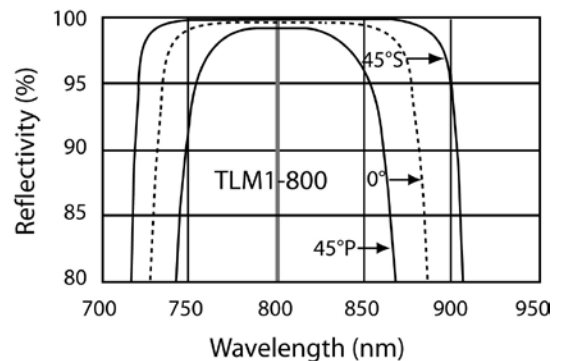
Base Mount 1/4-20

High Power Attenuators

Our high-power laser mirror attenuator transmits <1%, and comes in a C-Mount threaded adapter ring. It is also AR coated for either straight on or 45° orientation.

Available standard configurations:

- HP-266 — Use for 266 \pm 50nm
- HP-355 — Use for 350 \pm 50nm
- HP-450 — Use for 450 \pm 50nm
- HP-600 — Use for 500–700nm
- HP-800 — Use for 700–900nm
- HP-1064 — Use for 1000–1100nm



Other wavelengths available upon request.

Note that if more than one reflective attenuator is required to reduce the beam power, one of them must be oriented 45° to the beam. Unlike absorptive attenuators, reflectors cannot be stacked, because they will form a laser cavity.

UV ND Filters

This accessory can be used with any camera fitted with C-mount threads. Simply thread the attenuator assembly into the front of the camera and then slide the ND filter arrays to get the desired amount of attenuation. This device can be used with laser outputs from microwatts to Watts. Three filter holders are provided with two filters in each holder. Each filter in the holder provides for a different value of attenuation. To use, slide the desired holder into the housing slot. A click is felt when the filter is properly aligned with the beam. The holders provided will allow for attenuation of up to ND 6.

C-mount interface for universal application to our CCD and Pyroelectric cameras 190-380nm attenuation covers Excimer, Helium Cadmium, and the Nd:YAG UV harmonic laser wavelengths. Attenuation with these ND filters permits the best use of the dynamic range of a beam profiling camera.

Attenuation range of 0.3 to 6.0 optical densities (ND).

Set consists of three slides with two filters in each slide.

The Six Filters include 0.3, 0.7, 1.0, 2.0, 3.0 and 4.0 optical densities.

Two filters can be employed at one time for 0.3 – 6.0 optical attenuation in 0.3 or 0.4 ND steps.

20mm clear aperture will not vignette any of our applicable camera sensors.

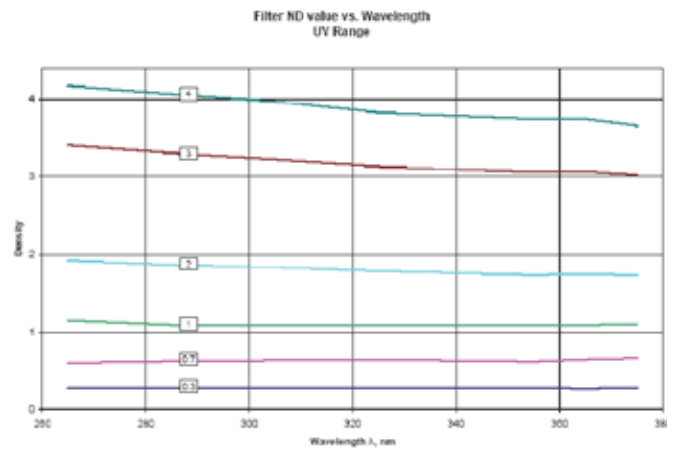
Damage threshold = 100W/cm² for CW lasers and 20mJ/cm² for nano-second pulse width lasers.

Additional Beam Splitters can be added for attenuation of high power UV lasers.

UV attenuation system uses high quality optics from the leader in laser beam diagnostics.



Specifications	
Item	UV ND Filters
Nominal ND (UV)	0.3, 0.7, 1.0, 1.3, 1.7, 2.0, 2.3, 2.7, 3.0, 3.3, 3.7, 4.0, 4.3, 4.7, 5.0, 6.0
Aperture	Ø20mm
Damage threshold	100W/cm ² CW, 10ns pulses, no distortion



Specialized Filters

There are also specialized filters available to eliminate extraneous wavelengths when measuring very short or very long wavelengths where the CCD cameras are not sensitive and the desired signal can get swamped by extraneous light of other wavelengths. These filters are as follows:

1. The 355nm filter for monitoring the 3rd harmonic of YAG. This filter transmits 355nm but blocks 532nm and 1064nm.
2. The 1300nm filter transmits 1300nm but blocks wavelengths shorter than 1100nm.

These filters are also on the same standard thread so they can be mixed with all the other components.

See ordering information pages for more details.

Ordering Information

Item	Description	P/N
ND1 stackable filter (red housing)	4mm spacing screw on filter for camera with transmission of between 20% and 5% depending on spectral range. Can be stacked and combined with other filters and beam splitters. One filter is included with Spiricon cameras.	SPZ08234
ND2 stackable filter (black housing)	4mm spacing screw on filter for camera with transmission of between 7% and 0.5% depending on spectral range. Can be stacked and combined with other filters and beam splitters. Two filters are included with Spiricon cameras.	SPZ08235
ND3 stackable filter (green housing)	4mm spacing screw on filter for camera with transmission of between 2% and 0.05% depending on spectral range. Can be stacked and combined with other filters and beam splitters.	SPZ08253
LBF-50 filter set	Compact screw in filter holder with set of ND filters. Attenuations from low to 106.	SP90081
Filter holder and 50x50 filter set	Filter holder with set of 4 standard Schott 50X50mm neutral density filters. Useful to reduce intensity before inputting into 4X beam reducer. Mounts to standard 1/4" thread, 1/2" diameter laboratory rod.	SPZ08240
Variable filter	Continuously variable filter for complete control over beam intensity. Especially useful for pulsed lasers. Varies the intensity over more than 4 orders of magnitude between wavelengths 350nm and 1100nm. Can be stacked and combined with other filters and beam splitters.	SPZ17012
ATP-K	Variable Attenuator Package provides smooth knob operated variable wedges with attenuation of optical density (ND) 1.7–4.6 for a total attenuation capability of ND 7.4. Specially designed to eliminate ghost reflections, fringes, and light leaks. Small compact module including C-mount adapter to attach to camera, and C-mount receptacle to easily attach additional HP-series attenuators.	PH00128
HP-266	High power laser grade fused silica reflective mirror attenuator for UV applications at 266nm. Second surface anti-reflection coated. Transmits <1%. Useful 266 ±50nm.	PH00129
HP-355	High power laser grade fused silica reflective mirror attenuator for UV applications at 355nm. Second surface anti-reflection coated. Transmits <1%. Useful 355 ±50nm.	PH00130
HP-450	High power laser mirror attenuator for applications in the visible from 400-500nm. Second surface anti-reflection coated. Transmits <1%. Useful 450 ±50nm.	PH00131
HP-600	High power laser mirror attenuator for applications in the visible from 500-700nm. Transmits <1%.	PH00132
HP-800	High power laser mirror attenuator for applications in the visible-Near IR from 700-900nm. Transmits <1%.	PH00133
HP-1064	High power laser mirror attenuator for applications in the Near IR from 1000-1100nm. Transmits <1%.	PH00134
UV ND Filters	3 Filters holders each with 2 inconel UV ND. Filters for attenuation up to ND 6.	SP90228
Filter for 355nm-V2; give an undistorted image of the 355nm light	Silicon cameras can see the 355nm 3rd harmonic radiation of YAG. The YAG however usually emits some light at 532nm and 1064nm as well. This filter filters out the other 2 wavelengths to give undistorted image of the 355nm light.	SPZ08246
Filter for 1300nm	For all cameras that can operate at 1300nm but are quite insensitive there. This filter filters out all light below 1100nm to allow viewing 1300nm radiation without background interference.	SPZ08242

3.4.2 Beam Splitter + Neutral Density Filters Combo

The attenuators described before can provide a high degree of attenuation however, these neutral density attenuators cannot dissipate more than 5W or so. Therefore we often place beam splitters in front of the attenuators to reduce the intensity before the ND filters. These beam splitters are made of UV grade fused silica for use from 190 to 2000nm. Since they do not absorb light, they have a much higher power handling capacity than the ND attenuator/filters.



Model	LBS-300	LBS-100
Wavelength	multiple versions from 190 to 1550nm	multiple versions; 400-900nm, 1064nm, 10.6µm
Reflection	0.01% of incident beam	4% @ 400-900nm, 1% @1064nm, 0.5% or 5% @10.6µm
Nominal ND value (vis)	0.3, 0.7, 1, 2, 3, 4	0.3, 0.7, 1, 2, 3, 4 for 300-900nm & 1064nm 30% & 60% for 10.6µm
Clear aperture	Ø17.5mm	Ø19mm
Damage threshold	see spec sheet	5W/cm² no distortion
Mounting	C-Mount Threads	Lab post mounted