

3.5 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.

3.5.1 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. 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 c-mount camera.



| Model | Stackable ND Filters ND1 / ND2 / ND3 | ATP-K Variable Attenuator | UV ND Filters | Specialty Filter for 355nm |
|------------------|--|---|--|-------------------------------------|
| Nominal ND value | 1, 2, 3 | 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 |
| Clear aperture | Ø19mm | Ø15mm | Ø20mm | Ø19mm |
| Damage threshold | ~50W/cm ² / 1J/cm ² for ns pulses no distortion | 100mW/mm no thermal lensing | 100W/cm ² CW, 10ns pulses, no distortion | 5W/cm ² no distortion |
| Mounting | 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 and also can be combined with beam splitters.

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

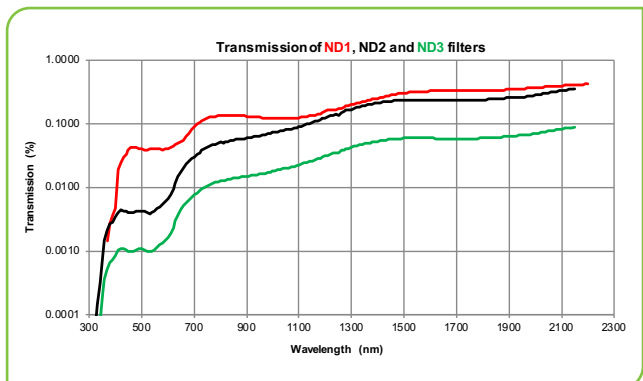
Transmission vs. Wavelength

These bulk-absorbing "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

| Model | ND1 Stackable Filter (Red housing) | ND2 Stackable Filter (Black housing) | ND3 Stackable Filter (Green housing) |
|-----------------------------|---|--------------------------------------|--------------------------------------|
| Nominal ND (vis) | 1 | 2 | 3 |
| Transmission ⁽¹⁾ | between 20% and 5% | between 7% and 0.5% | between 2% and 0.05% |
| Clear Aperture | Ø19mm | | |
| Damage threshold | ~50W/cm ² / 1J/cm ² for ns pulses | | |
| Part number | SPZ08234 ⁽²⁾ | SPZ08235 ⁽³⁾ | SPZ08253 |

Notes:
 (1) Depending on spectral range.
 (2) One ND1 filter is included in Ophir cameras.
 (3) Two ND2 filters are included in Ophir cameras.



ATP-K Variable Attenuator

This option makes beam profiling easy. The ATP-K attenuates your laser without ghost reflections, fringes and light leaks. A knob-operated variable wedges attenuation of ND 1.7 -4.6 with fixed gray-glass attenuator with ND 2.8, provides total attenuation capability of ND 7.4.

The ATP-K is also designed to be used with the HP-series, high power attenuators and beam splitters. Both types of attenuators attach directly to the ATP-K via C-mount while a Beam profiler camera is attached from the opposite side. 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.



Specifications

| Model | ATP-K |
|--|---|
| Maximum Power/Energy Handling ⁽¹⁾ | 100 mW/mm, 100 mJ total avg. Energy Damage threshold: 5J |
| Wavelength Range | 360-2500+ nm Near flat response out to 1500nm |
| Attenuation Range ⁽²⁾ | Variable filters: ND = 1.7 to 4.6 Maximum ND 7.4 (with fixed 2.8 gray-glass attenuator) |
| Clear Aperture | 15mm diameter |
| Dimensions | 94 (W) x 28 (H) x 43 (D) mm |
| Thickness Tolerance | ±0.25mm |
| Mounting | C-mount |
| Base Mount | 1/4-20 |
| Part number | PH00128 |

Note: (1) 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).

(2) 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%.

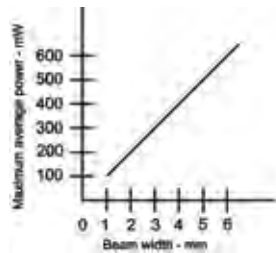


Figure 1 – Safe average power for negligible beam distortion

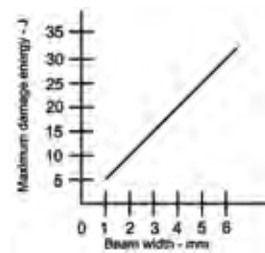
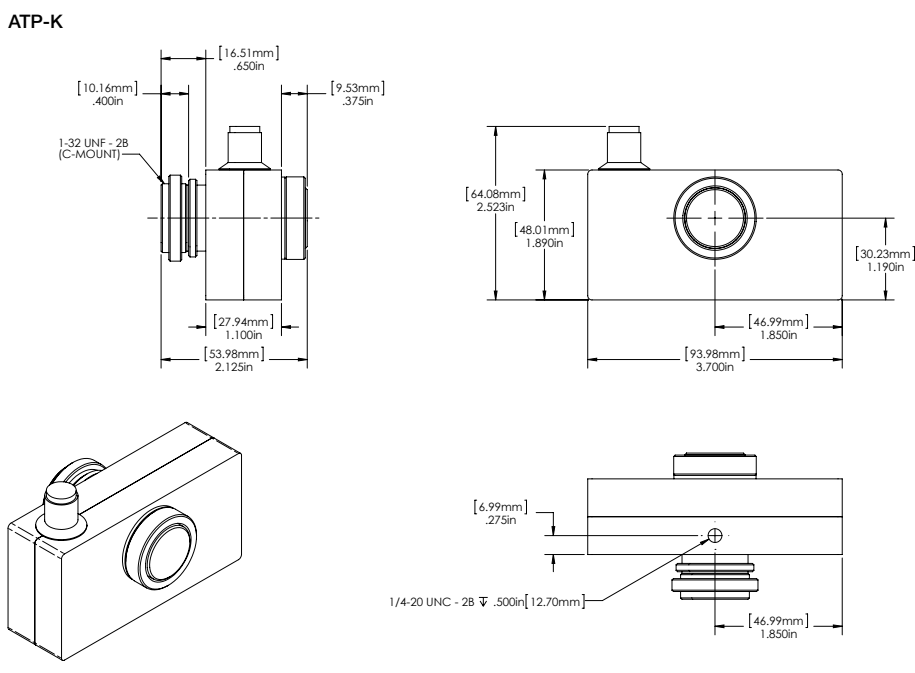


Figure 2 – Point at which damage will occur with pulsed energy



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.

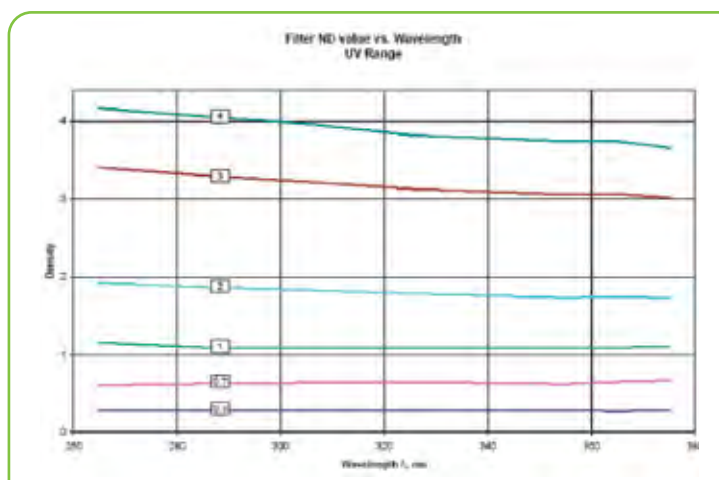
Additional Beam Splitters can be added for attenuation of high power UV lasers.

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



Specifications

| Model | 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, 20mJ/cm ² , 10ns pulses |
| Filter material | Inconel |
| Part number | SP90228 |



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:

The 355nm filter for monitoring the 3rd harmonic of YAG. This filter transmits 355nm but blocks 532nm and 1064nm.



Specifications

| Model | Filter for 355nm |
|------------------|--|
| Transmission | ~ 60 at 355nm, zero at 532nm, and 5E-6 at 1064nm |
| Filter Thickness | 4mm |
| Filter Spacing | 8mm |
| Flatness | 2 waves in the visible |
| Damage threshold | 50W/cm ² / 0.6J/cm ² |
| Part number | SPZ08246 |

This filter has the same standard thread so it can be mixed with all the other components.