

# YAG Focal Spot Analyzer

- Image focal spots down to below 25µm in size
- For laser powers up to 400W
- Measure exactly how focal distance shifts with power
- Can measure systems with focal length as short as 50mm
- Modular design allows flexibility in use

There are instances when one wants to measure the focal spot of relatively high power laser, in particular YAG laser. The average power can be from 10 to 400 Watts or so and the focal spot can be 50µm and up in size. The focal length from the lens to the focal spot is usually on the order of 70 to 120mm. We could measure such a focal spot using 2 or 3 beam splitters as shown elsewhere in the catalog but the path length from the laser lens to the focal spot is not long enough to go through the 2 or 3 beam splitters and focus at the CCD. For this purpose we have the YAG FSA assembly which adds to the beam splitters a negative lens to increase the focal path and at the same time to enlarge the image. The unit has a totally reflective mirror to reflect the main beam away from the camera at the same time. Several focal length lenses are available to accommodate different host system focal paths. The system is completely modular and can be easily mounted to all standard stackable beam splitters, screw on attenuators or variable attenuator for maximum flexibility of use.

An excel spreadsheet is downloadable from our website that calculates which lens to use for your application, how far to mount the FSA from your focusing lens in order to see the focal spot and what the magnification of the image will be. The FSA can also be used to measure how the focal spot shifts with power.

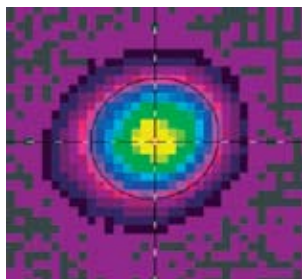
## Operation:

The beam splitters and attenuators are mounted to the camera as shown. Then the assembly is placed below the final focusing lens of the laser at the calculated distance. The focal spot is found by moving the assembly closer and farther from the beam until the smallest spot size is seen.

The exact magnification factor (usually 2-3 times) is calculated by moving the stage holding the FSA assembly a given lateral distance and seeing how far the centroid of the focal spot moves in the beam profiling software.

This scaling factor is then entered into the software. In order to find focal spot shift with laser power, simply find focal spot at one power, change the power and measure how far the stage has to be moved up or down to get to the smallest beam size again.

## Examples of Usage

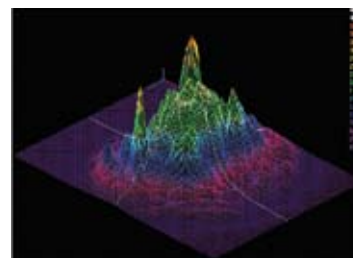
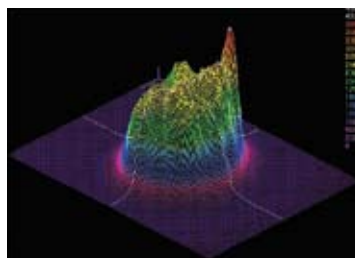
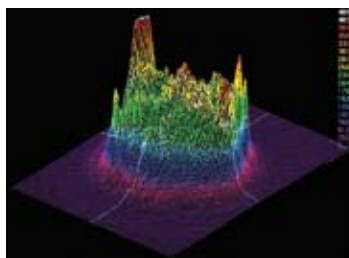
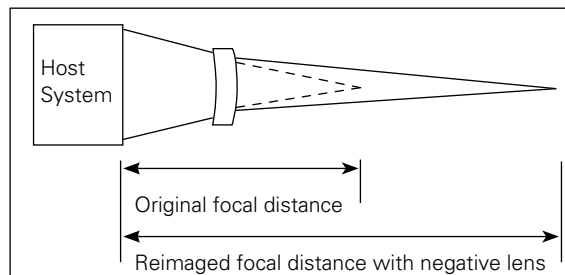
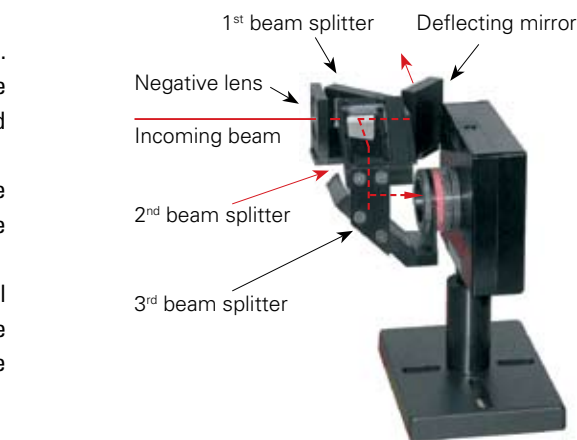


65µm diameter focal spot



### Focal Spot Assembly

this is mounted to standard beam splitter assembly to enable measurement of focal spots



Focal spot shape changing with laser power level

# Beam Splitters

The attenuators described before can provide a high degree of attenuation. However, these neutral glass 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 attenuators. These beam splitters are made of UV grade fused silica for use from 0.19 to 2000nm. Since they do not absorb light, they have a much higher power handling capacity than the attenuator/filters.

We have two types of beam splitters, For general use we have compact stackable beam splitters that are compatible with the screw on filters and variable attenuator as well as other accessories.

Where a closed system is desired with larger aperture, we have the Beam Tap cube beam splitters.

All of our beam splitters are wedge type so that there is no spurious image projected into the camera. In some cases, the user has to arrange for a beam stop for the transmitted and rear reflected beams.

## Stackable Beam Splitters:

The stackable beam splitters are designed for maximum modularity and shortest beam path. They are compatible with our other modular components and as many as needed can be stacked on each other as shown in the diagram. They are compatible with almost all of our cameras having our standard C mount thread and can mount either to our standard attenuators or to the camera itself.

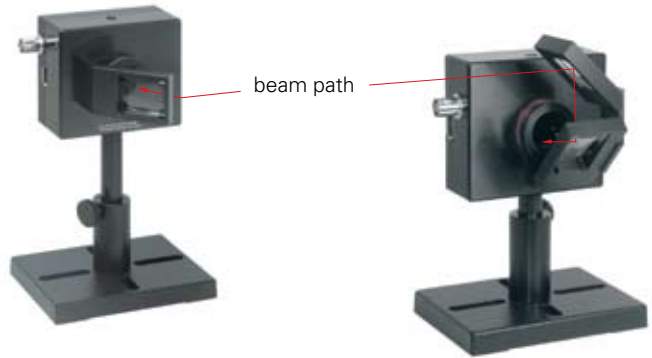
Each beam splitter reduces the intensity of the beam by ~20 times (see graph below) so if a camera is equipped with filters that can operate with lasers typically up to ~1 Watt, with one beam splitter it can operate up to ~20 Watts and with two beam splitters up to ~400W.

Note that even three beam splitters can be mounted in series in this fashion. The damage threshold of the beam splitters is >5J/cm<sup>2</sup> for 10ns pulses. The beam splitters are mounted over the fixed or variable attenuators with a simple fastening ring and can be oriented in any direction with the beam coming from right, left up, down, or front.

The Beam Splitters will operate for wavelengths from 190nm to 2000nm.

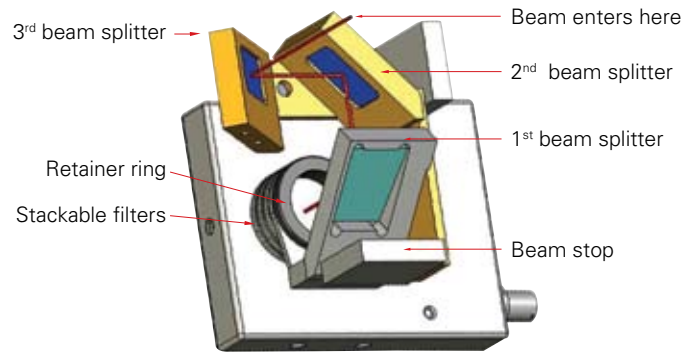
The wedge angle of 10 degrees insures that only the reflection from the front surface will appear on the camera with no double images. The user must insure that there are beam stops for the transmitted and reflected beams that are not provided for.

Note that if possible, the user should use an even number of beam splitters so as to cancel any possible polarization effects.



One beam splitter mounted

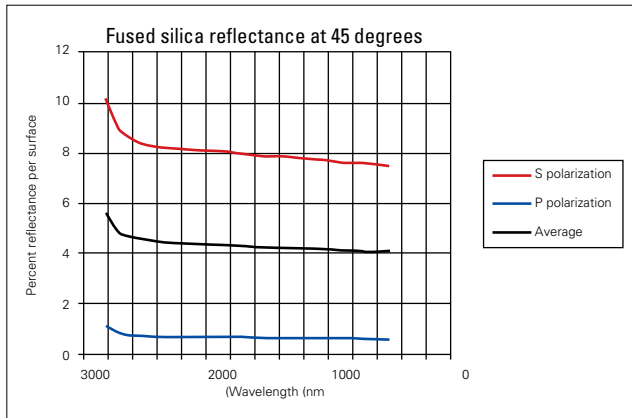
Two beam splitters mounted



Three beam splitters mounted



With large beam splitter mounted showing how to image converging beam



aperture	Path length to CCD with 3 filters and.....	1 beam splitter	2 beam splitters	3 beam splitters
15mm <sup>1</sup>		60mm	93mm	127mm
Note 1: For converging beams a larger aperture 1 <sup>st</sup> beam splitter is available P/N SPZ17025. In that case, the aperture at the 1 <sup>st</sup> beam splitter is 30mm				

M2-200 Beam Propagation Analyzer		
M2-200s-FW	M2-200 software, software license, SCOR 20 FireWire camera, short optical train, automatic and manual operation, recommended for 266nm – 1064nm wavelengths.	SP90144
M2-200s-FW-A	M2-200 software, software license, short optical train, automatic and manual operation, recommended for 266nm – 1064nm wavelengths (SCOR 20 camera not included)	SP90145
M2-200sM-FW	Manual mode M2-200 software, software license, SCOR 20 FireWire camera, manual operation with a SCOR 20 FireWire camera (optical train not included)	SP90146
M2-200sM-FW-A	Manual mode M2-200 software, software license, manual operation with a FireWire camera (SCOR 20 FireWire camera and optical train not included)	SP90147
M2-200-10D-VIS	M2-200 software, software license, 10-bit Analog PCI RS-170 Framegrabber card with 8 to 16-bit LVDS Digital, optical train, automatic operation, recommended for 400nm – 700nm wavelengths. (Camera not included) non-RoHS	SP90010
M2-200-10D-NIR	M2-200 software, software license, 10-bit Analog PCI RS-170 Framegrabber card with 8 to 16-bit LVDS Digital, optical train, automatic operation, recommended for 1064nm wavelength. (Camera not included) non-RoHS	SP90011
M2-200-10D-BB	M2-200 software, software license, 10-bit Analog PCI RS-170 Framegrabber card with 8 to 16-bit LVDS Digital, optical train, automatic operation, UV and Near IR wavelengths. (Camera not included) non-RoHS	SP90009
M2-200-FW-VIS	M2-200 software, software license, SCOR 20 FireWire camera, optical train, automatic and manual operation, recommended for 400nm – 700nm wavelengths.	SP90016
M2-200-FW-NIR	M2-200 software, software license, SCOR 20 FireWire camera, optical train, automatic and manual operation, recommended for 1064nm wavelength.	SP90017
M2-200-FW-BB	M2-200 software, software license, SCOR 20 FireWire camera, optical train, automatic and manual operation, UV and Near IR wavelengths.	SP90015
M2-200-FW-A-VIS	M2-200 software, software license, optical train, automatic and manual operation, recommended for 400nm – 700nm wavelengths (SCOR 20 camera not included)	SP90019
M2-200-FW-A-NIR	M2-200 software, software license, optical train, automatic and manual operation, recommended for 1064nm wavelength (SCOR 20 camera not included)	SP90020
M2-200-FW-A-BB	M2-200 software, software license, optical train, automatic and manual operation, UV and Near IR wavelengths (SCOR 20 camera not included)	SP90018
M2-200M-FW	Manual mode M2-200 software, software license, SCOR 20 FireWire camera, manual operation with a SCOR 20 FireWire camera (optical train not included)	SP90029
M2-200M-FW-A	Manual mode M2-200 software, software license, manual operation with a FireWire camera (SCOR 20 FireWire camera and optical train not included)	SP90084
M2-200M-10D	Manual mode M2-200 software, software license, manual operation only, 10-bit Analog PCI RS-170 Framegrabber card with 8 to 16-bit LVDS Digital (optical train not included) non-RoHS	SP90028
M2-200-PIII	M2-200 software, software license for Pyrocam III, manual operation only (Pyrocam III not included)	SP90031

Laser Profiling Kits for high and low power CO2 and YAG lasers		
LPK-YAG-2.5-FW	LBA-FW software, SCOR 20 camera, LBS-100-YAG beam splitter/attenuator, base plate, miscellaneous hardware. Suitable for beams 0.1 to 2.5mm.*	SP90072
LPK-YAG-7-FW	LBA-FW software, SCOR 20 camera, LBS-100-YAG beam splitter/attenuator, 3X telescope, base plate, miscellaneous hardware. Suitable for beams 1.0 to 7mm.*	SP90073
LPK-YAG-16-FW	LBA-FW software, SCOR 20 camera, LBS-100-YAG beam splitter/attenuator, 10X telescope, base plate, miscellaneous hardware. Suitable for beams 3.0 to 16mm.*	SP90074
LPK-YAG-2.5-USB	LBA-USB software, L230 camera, LBS-100-YAG beam splitter/attenuator, base plate, miscellaneous hardware. Suitable for beams 0.1 to 2.5mm.*	SP90168
LPK-YAG-7-USB	LBA-USB software, L230 camera, LBS-100-YAG beam splitter/attenuator, 3X telescope, base plate, miscellaneous hardware. Suitable for beams 1.0 to 7mm.*	SP90169
LPK-YAG-16-USB	LBA-USB software, L230 camera, LBS-100-YAG beam splitter/attenuator, 10X telescope, base plate, miscellaneous hardware. Suitable for beams 3.0 to 16mm.*	SP90170
LPK-CO2-6.4-0.5	LBA-PC-PIII software, Pyrocam III with chopper (PY-III-P-B-10.6), LBS-100-IR-0.5 beam splitter/attenuator, base plate, miscellaneous hardware. Suitable for beams 1.0 to 6.4mm.*	SP90075
LPK-CO2-6.4-5.0	LBA-PC-PIII software, Pyrocam III with chopper (PY-III-P-B-10.6), LBS-100-IR-5.0 beam splitter/attenuator, base plate, miscellaneous hardware. Suitable for beams 1.0 to 6.4mm.*	SP90076
LPK-CO2-16-0.5	LBA-PC-PIII software, Pyrocam III with chopper (PY-III-P-B-10.6), LBS-100-IR-0.5 beam splitter/attenuator, 3X telescope, base plate, miscellaneous hardware. Suitable for beams 3.0 to 16mm.*	SP90077
LPK-CO2-16-5.0	LBA-PC-PIII software, Pyrocam III with chopper (PY-III-P-B-10.6), LBS-100-IR-5.0 beam splitter/attenuator, 3X telescope, base plate, miscellaneous hardware. Suitable for beams 3.0 to 16mm.*	SP90078
	* Maximum beam size assumes zero diffraction from the wings of the beam. Beams of up to 1.5X the maximum size can be applied with minimal diffraction. Beams of up to 2X the above size can be applied, but noticeable diffraction will occur.	
YAG Focal Spot Analyzer accessory	Screw on accessory to beam splitter system which allows user to look at focal spots of YAG lasers of up to 400W average power. The set consists of an AR coated for 1064nm and a dielectric full reflector for 1064nm 45deg incidence and well as other components. See below under imaging systems for details	SPZ17021

<b>Beam Splitters and Attenuators</b>		
<b>Stackable beam splitters and filters/attenuators</b>		
Beam splitter for mounting on cameras	45 degree angle wedge beam splitter which mounts onto camera. Reduces beam intensity by ~20 times. For spectral range 190 – 2500nm. Fits all cameras	SPZ17015
Additional beam splitters for mounting to previous beam splitter	Additional wedge beam splitter as above which mounts at right angles to previous beam splitter. As many as 3 beam splitters can be mounted in this fashion in series, each one reducing intensity by ~20 times.	SPZ17026
Large beam splitter	45 degree angle wedge beam splitter with large 30mm aperture. When stacked on top of smaller beam splitters especially useful for monitoring a converging beam.	SPZ17025
Stand alone large wedge beam splitter	Large size Wedge beam splitter which mounts to standard ¼" thread ½" laboratory rod. Reduces beam intensity by ~20 times. For spectral range 190 – 2500nm. Especially for 4X beam reducer.	SPZ17018
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
4mm spacer	Blank stackable spacer / filter holder where 4mm spacing is needed but no attenuation is needed	SPG01698
5mm spacer	Spacer ring for adapting 12.5mm recess CS cameras to 17.5mm recess C mount lenses	SPG02106
8mm spacer	Spacer ring for adapting 4.5mm recess cameras to work with 12.5mm recess CS mount lenses	SPG02067
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 ¼" thread, ½" diameter laboratory rod.	SPZ08240
LBF-50 filter set	Compact screw in filter holder with set of ND filters. Attenuations from low to 10 <sup>6</sup>	SP90081
Variable attenuator	Continuously variable attenuator 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
Filter for 355nm-V2	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 an 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 1200nm to allow viewing 1300nm radiation without background interference	SPZ08242
<b>LBS System Beam Splitters and attenuators</b>		
BA-NIR	Beam Attenuator calibrated at 1064nm	SP90159
BA-VIS	Beam Attenuator calibrated for the Visible region.	SP90158
BT-II	Beam Tap II (250nm-2000nm), UVFS, 0.16% R <sub>avg</sub>	SP90133
BT-II VIS	Beam Tap II-VIS (400nm-700nm)	SP90172
BT-I	Beam Tap I (250nm-700nm), Beam Tap-1 - YAG (1064nm)	SP90173
BT-I VIS	Beam Tap I-VIS (400nm-700nm)	SP90136
LBS-100-C	19mm clear aperture, recommended for 400nm to 900nm. Kit contains one uncoated fused silica beam splitter wedge and 6 ND filters	SP90061
LBS-100-YAG	As above but for YAG with beam splitter wedge AR coated to give a reflection of 1% for both S and P polarizations.	SP90057
LBS-100-IR-0.5	As above but for CO <sub>2</sub> . Contains 1 ZnSe wedge with 0.5% reflection and set of 4 CaF <sub>2</sub> flats.	SP90058
LBS-100-IR-5.0	As above but with 5% reflecting wedges	SP90059
LBS-100-UV	19mm clear aperture, recommended for 266nm to 355nm. Kit contains one uncoated fused silica beam splitter wedge and 6 ND filters	SP90171
LBS-100 to 4X beam reducer adapter	This adapter enables mounting of the LBS-100 beam splitter / attenuator assembly in front of the 4X beam reducer. The combined assembly can image large high power beams in one unit. See illustration on page 149.	SPZ17029