

# Laser Beam Sampler & Attenuator

- Model LBS-100 for 400nm to 1250nm
- Model LBS-100YAG for 1064nm
- Model LBS-100IR for 9 $\mu$ m to 11 $\mu$ m



- Samples laser beam while experiment is in progress
- Compatible with all “C-mount” cameras and Spiricon’s Pyrocam III
- 6.5° wedge samples pass-through beam
- Left-hand, right-hand, or vertical beam sampling

# Integral Beam Sampler and Attenuator

The models LBS-100, LBS-100YAG, and LBS-100IR Laser Beam Sampler/Attenuators, shown in Figure 1, are designed to be utilized as integral components of the LBA-PC series Laser Beam Analyzer and Pyrocam III systems. Capable of right-hand, left-hand, or vertical beam sampling and wide dynamic range, the LBS-100, LBS-100YAG, and LBS-100IR minimize diagnostic setup time and facilitate in-situ laser beam analysis of pulsed and CW applications.

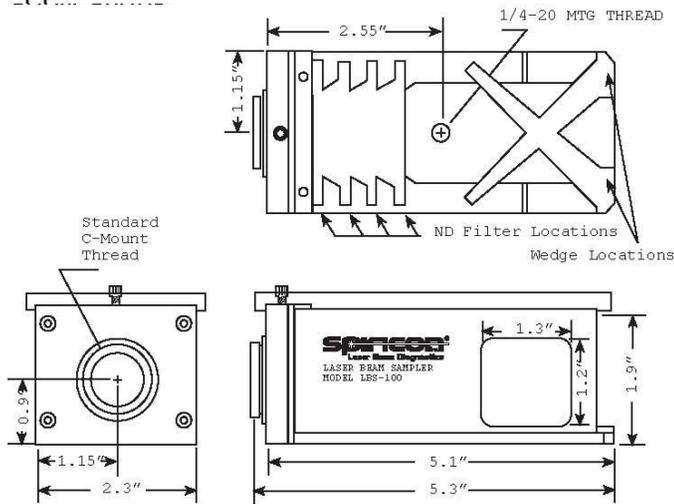


Figure 1 - Mechanical drawing of LBS-100 Beam Samplers.

A slip-ring collar with locking setscrew permits the Laser Beam Sampler to be interfaced with a C-mount camera at any angle of rotation. A non-marking thumb screw secures the wedge in place.

## Beam Sampling

The LBS-100 has an uncoated 6.5° Quartz wedge that intercepts the laser beam at 45° and diverts approximately 4% of the beam power/energy through the neutral density filters to the video camera. Approximately 92% of the laser beam is transmitted to the experiment target. The transmitted beam is deflected approximately 4.5° from the original path. It is diverging an additional 5° in the axis of the wedge. The LBS-100YAG consists of a quartz wedge A/R coated for 1% reflection of both S and P polarizations at 1064nm. This provides

accurate analysis of any YAG laser by providing equal S and P reflection. (For multiple wavelength applications where the beam polarization is critical we recommend the Beam Tap II in combination with the BA Series Attenuators.)

The LBS-100IR has a 6.5° ZnSe wedge coated for minimum reflection at 10.6µm. One version diverts 0.5% (±0.15%) of the beam to the camera. The other version diverts approximately 5% of the beam. Order the 0.5% reflecting wedge for laser power up to 1kW, and the 5% wedge for laser power up to 100W. From 9µm to 11µm the reflection of both versions increases about 40% above the value at 10.6µm. The transmitted beam is deflected by the wedge from the original path by about 11°. The reflection vs. wavelength of the 0.5% AR coated wedge is shown in Figure 6. The reflection spectrum of the 5% version is similar.

## Beam Attenuation

For additional attenuation after beam sampling, the LBS-100 and LBS-100YAG use bulk absorbing ND filters. The filters supplied for the LBS-100 and LBS-100YAG come in a set of 6 each 2" X 2" filters, with ND number and transmission shown in Table 1.

ND VALUE	TRANSMISSION
0.3	50%
0.7	20%
1.0	10%
2.0	1%
3.0	0.1%
4.0	0.01%

Table 1 - ND Filter Set Values for LBS-100 and LBS-100YAG.

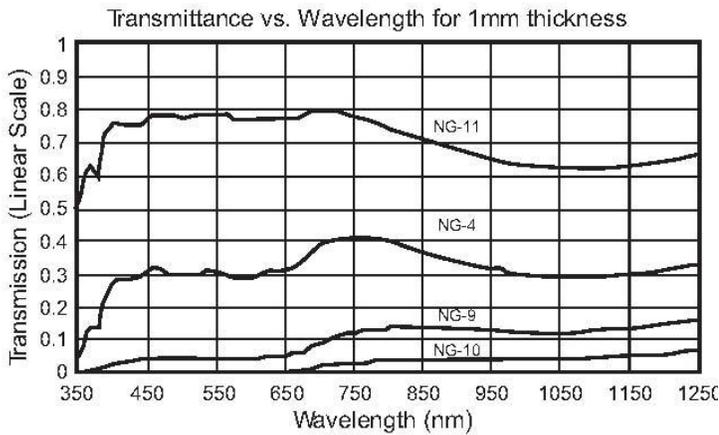


Figure 2 - Transmission vs. wavelength for LBS-100 bulk absorbing filters using a linear scale.

The wavelength response of the filters is shown in Figures 2 to 3. The LBS-100 filters of Figures 2 and 3 are calibrated at 546nm, and give fairly uniform attenuation from 400nm to 700nm. While they attenuate from 351nm to 400nm and from 700nm to 2600nm, the stated calibration steps can be much different for these wavelength ranges. The ND filters for the LBS-100YAG are calibrated specifically at 1064nm.

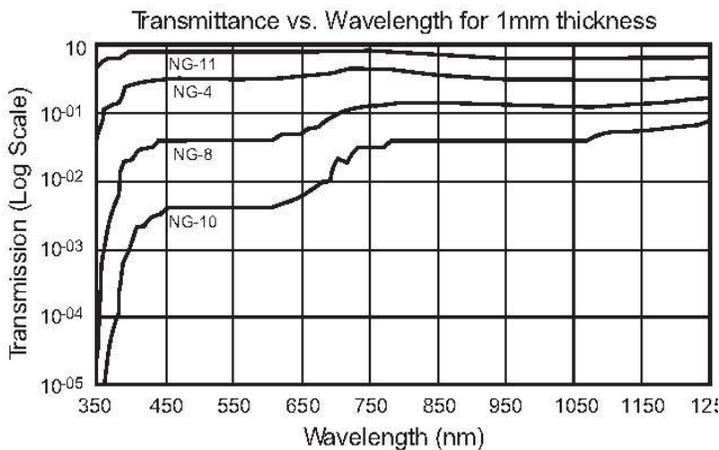


Figure 3 - Transmission vs. wavelength for LBS-100 bulk absorbing filters using a logarithmic scale.

A set of  $\text{CaF}_2$  flats is used in the LBS-100IR for further attenuation. It consists of 4 pieces. Three pieces are 3mm thick and provide about 30% transmission at  $10.6\mu\text{m}$ , or  $\text{ND} = 0.5$ . The fourth piece is 1mm thick and provides 65% transmission at  $10.6\mu\text{m}$  or  $\text{ND} = 0.2$ . Figure 4 shows the transmission vs. wavelength of  $\text{CaF}_2$  in 1mm and 3mm thickness.

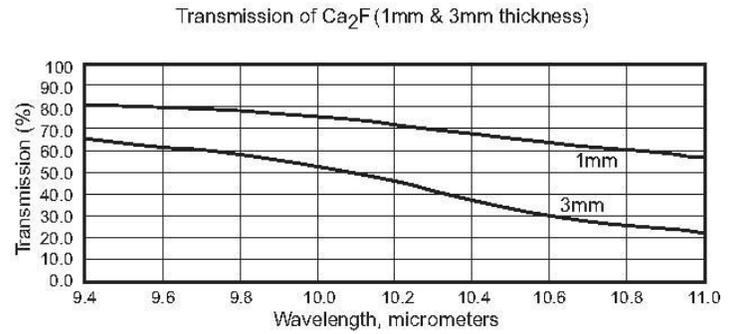


Figure 4 - Transmission vs. wavelength of  $\text{CaF}_2$ .

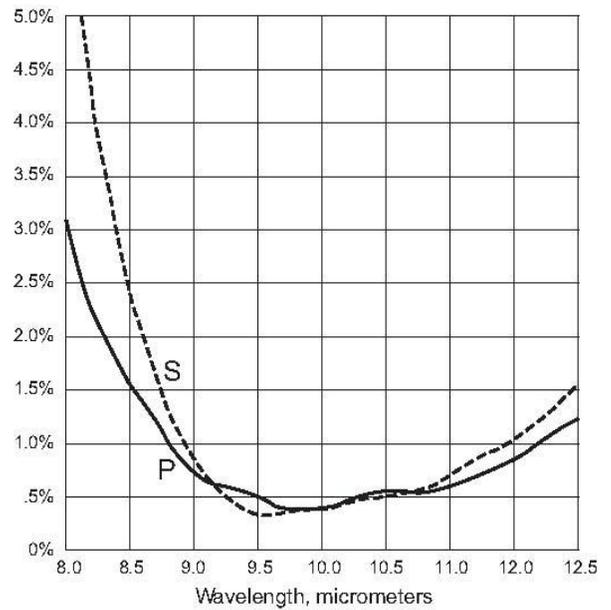


Figure 5 - AR coated ZnSe wedge typical reflection curves for S and P polarization.

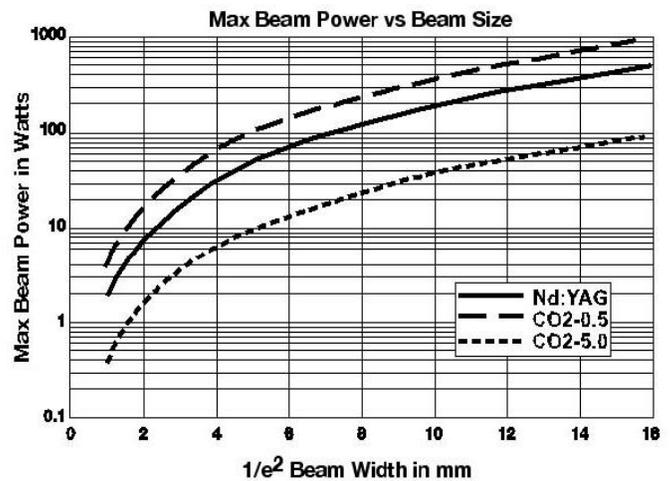


Figure 6 - Maximum power input to wedge versus beam size.

# Performance Specifications

Characteristic	LBS-100	LBS-100YAG	LBS-100IR
Optical wedge material	Quartz	Quartz	ZnSe
Wedge angle	6.5°	6.5°	6.5°
Wavelength range			
Recommended	400nm-700nm	1064nm	10.6µm
Functional	400nm-2600nm	400nm-2600nm	9µm to 11µm
Wedge A/R coating reflection	Uncoated	1% @ 1064nm	0.5% or 5% @ 10.6µm
Through beam deflection angle	4.5°	4.5°	10.7°
Through beam added divergence	≈5°	≈5°	≈5°
Clear aperture	.9 inch	.9 inch	.9 inch
Damage input power to wedge* (see fig. 6)	100W/cm <sup>2</sup>	500W/cm <sup>2</sup>	1000W/cm <sup>2</sup> for R = 0.5% 100W/cm <sup>2</sup> for R = 5%
Damage input energy to wedge*	6kJ/cm <sup>2</sup> (1ms pulse)	30kJ/cm <sup>2</sup> (1ms Pulse)	10 <sup>5</sup> J/cm <sup>2</sup> for R = 0.5% 10 <sup>4</sup> J/cm <sup>2</sup> for R = 5%
Damage input power to ND filters*	5W/cm <sup>2</sup>	5W/cm <sup>2</sup>	5W/cm <sup>2</sup>
Damage input energy to ND filters*	300J/cm <sup>2</sup> (1ms pulse)	300J/cm <sup>2</sup> (1msec pulse)	300J/cm <sup>2</sup> (1ms pulse)
Surface quality - wedge			
Scratch/Dig	60/40	60/40	60/40
Flatness @632.8nm	λ/4	λ/4	λ/4
Surface quality - ND filters			
Scratch/dig	80/50	80/50	60/40
Flatness @632.8nm	λ/4	λ/4	2λ
Parallelism	<2 arc min	<2 arc min	<3 arc min
Mounting	1/4"-20	1/4"-20	1/4"-20
Weight with wedge and filters	24oz	24oz	24oz

## Notes:

\*Maximum recommended power or energy is about 10% of damage to avoid thermal lensing.

Typical damage threshold of a CCD camera sensor is approximately  $1.5 \times 10^{-4} \text{W/cm}^2$  and  $1.0 \times 10^{-3} \text{J/cm}^2$ .

Typical saturation level of a CCD camera sensor is approximately  $3 \times 10^{-7} \text{W/cm}^2$  and  $4 \times 10^{-9} \text{J/cm}^2$ .

Exposure to laser power/energy levels greater than the damage values listed here may cause permanent damage to the ND filter materials, which may also result in permanent damage to the camera.