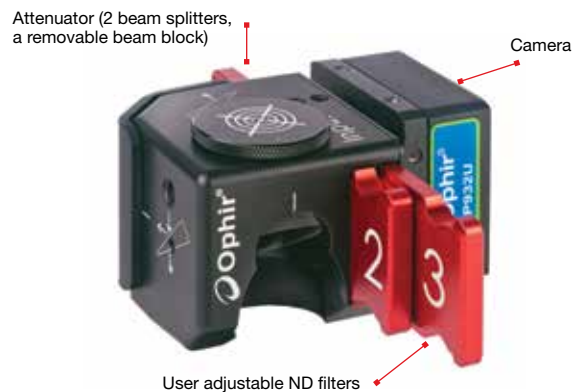


3.3.6 Focal Spot Analyzer

Captures the beam size, shape and profile at focus

- Image focal spots down to $27.4\mu\text{m}$ in size
- For laser powers up to 400W⁽¹⁾ (additional external ND filters required) and up to 5kW for FSA- HP version
- Can measure systems with focal length as short as 73mm⁽²⁾ (exact path length distance within the assembly will be NIST/National Lab calibrated and includes a calibration certificate $\pm 50\mu\text{m}$)
- Produces undistorted sample of laser under test
- Adjustable attenuation maximizes system dynamic range
- Up to 1×10^{-10} attenuation available (without external filters)
- Analyzer includes camera, attenuation, BeamGage software and calibration certificate



Measure your laser beam power distribution and focal spot size of wavelengths from 300 – 1100nm. The average power can be from <1 to 400 Watts and up to 5 kW for FSA-HP. The FSA can also be used to measure how the focal spot shifts with power during its critical start-up phase. The FSA is a combination of a camera, Beam Splitter, natural density filters and a BeamGage software.

FSA-HP

For measurement of focal position and profile of high power lasers above 1kW at NIR ($\sim 1064\text{nm}$) region, FSA-HP version can be used. It allows same operation as standard FSA but operates up to 5kW or $15\text{MW}/\text{cm}^2$ without significant heating.

Only 0.0001% ($1/10^6$) of the incident beam is reflected

towards Ophir Beam Profiler, enabling beam sampling of extremely high powers and power densities.

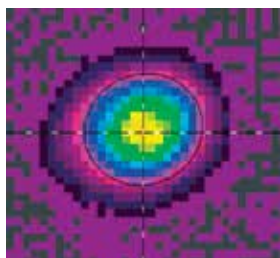
Operation

The assembly is placed below the final focusing lens of the laser at a distance equal to the expected focal length less the $\sim 73\text{mm}$ of the calibrated distance, so the beam will be focused on the camera layer. The focal spot is found by moving the assembly closer and farther from the beam until the smallest spot size is seen. The distance between the focusing lens and the datum point on the FSA assembly is added to the distance from the datum to the camera array (each FSA assembly will be factory calibrated to within $\pm 50\mu\text{m}$). These two measurements will give you the exact distance of your lasers focal spot.

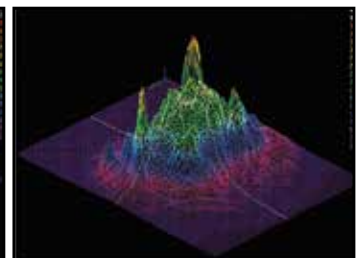
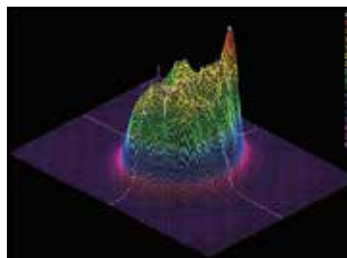
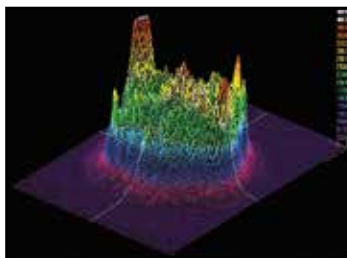
(1) For Gaussian beam diameter $< 1/2$ the clear aperture and depending on ND filter and camera saturation limits the maximum power may be as high as 1000W.

(2) Using beam expanders, focal spots as small as $10\mu\text{m}$ can be measured and calibrated, Ask your Ophir representative about special calibrated focal spot analyzers.

Examples of Usage

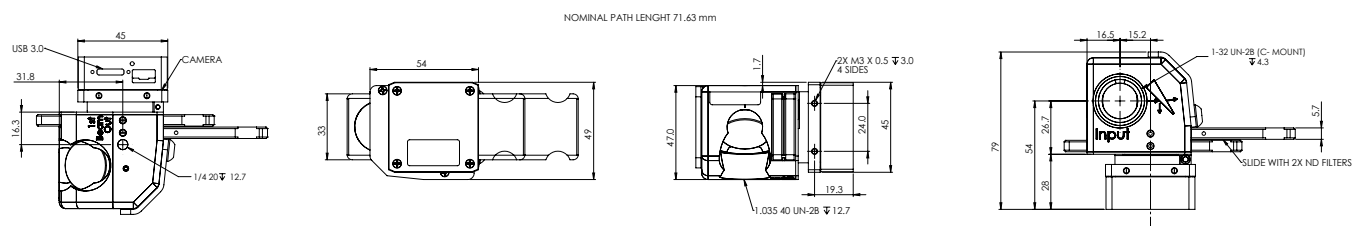


65 μm diameter focal spot



Focal spot spatial power density changing with laser power level

FSA-SP932U / FSA-SP402S



Focal Spot Analyzer Specifications

Model	FSA-UV-SP932U	FSA-VIS-SP932U	FSA-NIR-SP932U	FSA-BB-SP932U	FSA-HP-NIR-SP932U
Wavelengths	300-400nm	400-950nm	950-1100nm	300-1100nm	1000-1100nm
Wedge Material and Coating ⁽¹⁾	UVFS A/R ≤1%	UVFS A/R ≤1%	UVFS A/R ≤1%	UVFS uncoated 4% reflection	UVFS A/R ≤0.1% special surface
Reflection of 2 wedges ⁽¹⁾	0.01%	0.01%	0.01%	0.16%	<0.0001% (1/10 ⁶)
Wedge ND value, each	ND ≥2	ND ≥2	ND ≥2	ND ~1.3	ND ≥3
Clear aperture	17.5mm	17.5mm	17.5mm	17.5mm	15mm
Maximum allowable input to wedge	1MW/cm ² , 5J/cm ²	1MW/cm ² , 5J/cm ²	1MW/cm ² , 5J/cm ²	10MW/cm ² , 20J/cm ²	15MW/cm ² , 10J/cm ²
ND Filters	Inconel	Bulk ND	Bulk ND	Combination of Inconel and Bulk ND	Bulk ND
ND Values, nominal ⁽²⁾	0.3, 0.7, 1.0, 2.0, 3.0, 4.0 (Blue holders)	0.3, 0.7, 1.0, 2.0, 3.0, 4.0 (Green holders)	0.4, 0.8, 1.0, 2.0, 3.0, 4.0 (Red holders)	10 filters UV, VIS and NIR	0.4, 0.8, 1.0, 2.0, 3.0, 4.0 (Red holders)
Maximum allowable input to filter ⁽³⁾	100W/cm ² , 20mJ/cm ² 10ns pulse	50W/cm ² , 1J/cm ² 10ns pulse	50W/cm ² , 1J/cm ² 10ns pulse	50W/cm ² , 1J/cm ² 10ns pulse	See UV, VIS and NIR specifications
Focal Spot position accuracy	±50μ	±50μ	±50μ	±50μ	±50μ
SP932U Cameras Specifications ⁽⁴⁾					
Format	1/1.8"	1/1.8"	1/1.8"	1/1.8"	1/1.8"
Active area	7.06mm x 5.3mm	7.06mm x 5.3mm	7.06mm x 5.3mm	7.06mm x 5.3mm	7.06mm x 5.3mm
Beam sizes	34.5μm - 5.3mm	34.5μm - 5.3mm	34.5μm - 5.3mm	34.5μm - 5.3mm	34.5μm - 5.3mm
Pixel spacing	3.45μm x 3.45μm	3.45μm x 3.45μm	3.45μm x 3.45μm	3.45μm x 3.45μm	3.45μm x 3.45μm
Number of effective pixels	2048 x 1536	2048 x 1536	2048 x 1536	2048 x 1536	2048 x 1536
Dynamic range	72 dB	72 dB	72 dB	72 dB	72 dB
Frame rates ⁽⁵⁾	24 fps at full resolution	24 fps at full resolution	24 fps at full resolution	24 fps at full resolution	24 fps at full resolution
Shutter duration	25μs to 400ms	25μs to 400ms	25μs to 400ms	25μs to 400ms	25μs to 400ms
Gain control	1.46 dB to 256 dB	1.46 dB to 256 dB	1.46 dB to 256 dB	1.46 dB to 256 dB	1.46 dB to 256 dB
Trigger	Hardware/Software trigger & strobe out	Hardware/Software trigger & strobe out	Hardware/Software trigger & strobe out	Hardware/Software trigger & strobe out	Hardware/Software trigger & strobe out
Operation mode	CMOS, Global shutter	CMOS, Global shutter	CMOS, Global shutter	CMOS, Global shutter	CMOS, Global shutter
PC interface	USB 3.0	USB 3.0	USB 3.0	USB 3.0	USB 3.0
OS supported	Win 10, Win 11	Win 10, Win 11	Win 10, Win 11	Win 10, Win 11	Win 10, Win 11
Software	BeamGage Professional	BeamGage Professional	BeamGage Professional	BeamGage Professional	BeamGage Professional
Part number	SP90614	SP90615	SP90616	SP90617	SP90603

Notes: (1) For reflection spectra - see Focal Spot Analyzer User note

(2) Each slide contains 2 ND filters

(3) This is the damage threshold of the filter glass of the filters. Distortion of the beam may occur with average power densities of 5W/cm² for beam size 5mm, 10W/cm² for 2mm beam and >30W/cm² for 1mm beam

(4) Find full camera specifications on camera page

(5) Dependent on PC processor and graphics adapter performance.

Model	FSA-UV-SP402S	FSA-VIS-SP402S	FSA-NIR-SP402S	FSA-BB-SP402S
Wavelengths	300-400nm	400-950nm	950-1100nm	300-1100nm
Wedge Material and Coating ⁽¹⁾	UVFS A/R ≤1%	UVFS A/R ≤1%	UVFS A/R ≤1%	UVFS uncoated 4% reflection
Reflection of 2 wedges ⁽¹⁾	0.01%	0.01%	0.01%	0.16%
Wedge ND value, each	ND ≥2	ND ≥2	ND ≥2	ND ~1.3
Clear aperture	17.5mm	17.5mm	17.5mm	17.5mm
Maximum allowable input to wedge	1MW/cm ² , 5J/cm ²	1MW/cm ² , 5J/cm ²	1MW/cm ² , 5J/cm ²	10MW/cm ² , 20J/cm ²
ND Filters	Inconel	Bulk ND	Bulk ND	Combination of Inconel and Bulk ND
ND Values, nominal ⁽²⁾	0.3, 0.7, 1.0, 2.0, 3.0, 4.0 (Blue holders)	0.3, 0.7, 1.0, 2.0, 3.0, 4.0 (Green holders)	0.4, 0.8, 1.0, 2.0, 3.0, 4.0 (Red holders)	10 filters UV, VIS and NIR
Maximum allowable input to filter ⁽³⁾	100W/cm ² , 20mJ/cm ² 10ns pulse	50W/cm ² , 1J/cm ² 10ns pulse	50W/cm ² , 1J/cm ² 10ns pulse	50W/cm ² , 1J/cm ² 10ns pulse
Focal Spot position accuracy	±50μ	±50μ	±50μ	±50μ
SP402S Cameras Specifications ⁽⁴⁾				
Format	1.1"	1.1"	1.1"	1.1"
Active area	12.3mm x 12.3mm	12.3mm x 12.3mm	12.3mm x 12.3mm	12.3mm x 12.3mm
Beam sizes	27.4μm - 12.3mm	27.4μm - 12.3mm	27.4μm - 12.3mm	27.4μm - 12.3mm
Pixel spacing	2.74μm x 2.74μm	2.74μm x 2.74μm	2.74μm x 2.74μm	2.74μm x 2.74μm
Number of effective pixels	4512 x 4512	4512 x 4512	4512 x 4512	4512 x 4512
Dynamic range	67 dB	67 dB	67 dB	67 dB
Frame rates ⁽⁵⁾	11 fps (2x2 binning)	11 fps (2x2 binning)	11 fps (2x2 binning)	11 fps (2x2 binning)
Shutter duration	10μs - 400ms	10μs - 400ms	10μs - 400ms	10μs - 400ms
Gain control	1.4 dB to 256 dB	1.4 dB to 256 dB	1.4 dB to 256 dB	1.4 dB to 256 dB
Trigger	Hardware/Software trigger & strobe out	Hardware/Software trigger & strobe out	Hardware/Software trigger & strobe out	Hardware/Software trigger & strobe out
Operation mode	CMOS, Global shutter	CMOS, Global shutter	CMOS, Global shutter	CMOS, Global shutter
PC interface	USB 3.0	USB 3.0	USB 3.0	USB 3.0
OS supported	Win 10, Win 11	Win 10, Win 11	Win 10, Win 11	Win 10, Win 11
Software	BeamGage Professional	BeamGage Professional	BeamGage Professional	BeamGage Professional
Part number	SP90651	SP90652	SP90653	SP90654

Notes: (1) For reflection spectra - see Focal Spot Analyzer User note

(2) Each slide contains 2 ND filters

(3) This is the damage threshold of the filter glass of the filters. Distortion of the beam may occur with average power densities of 5W/cm² for beam size 5mm, 10W/cm² for 2mm beam and >30W/cm² for 1mm beam

(4) Find full camera specifications on camera page

(5) Dependent on PC processor and graphics adapter performance.