

# M<sup>2</sup>-200s Beam Propagation Analyzer

- Automatically measure your beam quality in under 2 minutes
- Tune your laser for best operation
- ISO compliant
- Specifically developed for continuous usage
- Unequaled accuracy using patented Ultracal™ calibration
- Automatic attenuation adjustment
- Pulsed and CW for most beam diameters and powers
- Compact and portable



The M<sup>2</sup>-200s maintains our leadership position providing the only ISO compliant system for all reported measurements. The high speed optical train uses a fixed position lens, and automatically translates the image on the camera from the near field to the far field. All measurements and translations, as well as incremental beam attenuation, are automatically computer controlled. Manual mode is available for beams that are too large or too small or at wavelengths outside the standard optical train. The Spiricon M<sup>2</sup>-200s Beam Propagation Analyzer is fully ISO 11146.

## Automatic M<sup>2</sup> - at Production Speeds

The M<sup>2</sup>-200s optical train uses a fixed position lens and camera. The mirrors that direct the focused beam into the camera are moved to precise locations, translating the beam through both the waist region and the far field regions. All these measurements and translations, as well as incremental beam attenuation, are automatically controlled by the M<sup>2</sup>-200s software. Software improvements in the M<sup>2</sup>-200s, including more efficient algorithm execution, has decreased the measurement reporting time by 2-3 times, making it possible to report M<sup>2</sup> in under two minutes.

## Accuracy by Design

Spiricon products are known for accuracy. Using our patented Ultracal™ calibration method and auto aperturing, to exclude noise beyond the wings of the laser beam, you are assured of the most accurate measurements in the industry.

## Designed by Our Customers

Spiricon has redesigned the M<sup>2</sup>-200, the world's top selling beam propagation system to include customer input, increased attention to durability, and operational robustness for continuous use applications; three shifts a day, seven days a week. Novice and seasoned users will appreciate these new features along with the time-tested excellence that the Spiricon M<sup>2</sup>-200 measurement system has provided over the years.

Laser Power  
& Energy

Heads

Displays

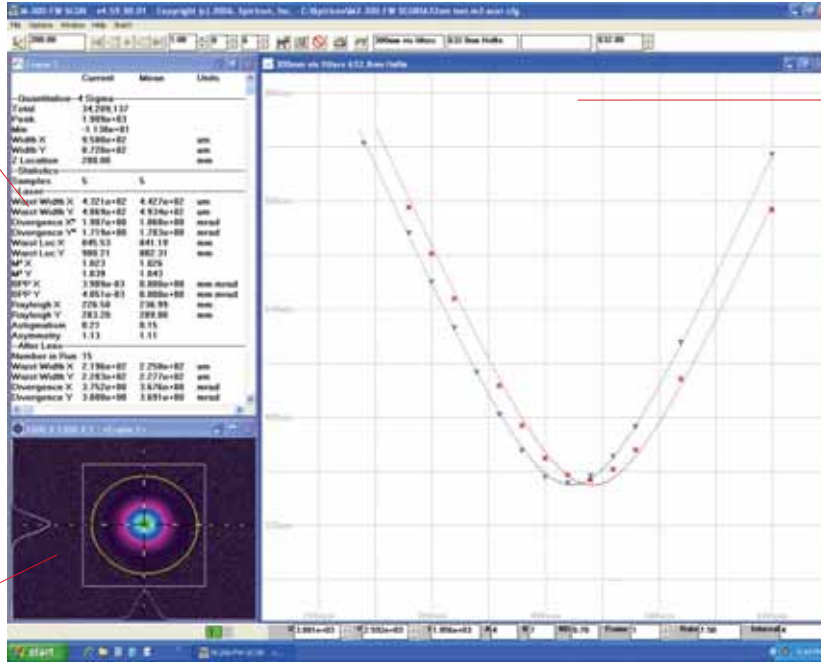
Beam Profile  
Wavelength

OEM Products

# Main Screen Functions

This window displays quantitative measurements of the laser parameters. These include the X and Y beam widths,  $M^2$  or K, the divergence angles, the Rayleigh range, and other parameters shown.

The 2D or 3D beam profile of the currently measured point in the beam propagation curve. This image enables visual intuitive verification of the beam profile behavior through focus. After each run the user can click any individual measured point and observe the beam profile. Outlying or anomalous points can be automatically or manually excluded from the curve fit calculations for more accurate results.



This window presents measurements of beam width vs. position for a given run. After measuring a few points, the software extrapolates a curve fit. The Xs and Ys represent individual measurement points. The solid lines present the best fit hyperbola of the beam propagation equation to the measured points. The  $M^2$  and other laser parameters are computed from the best fit hyperbola since it provides a smoothing of the data points.

# M<sup>2</sup>-200 Beam Propagation Analyzer

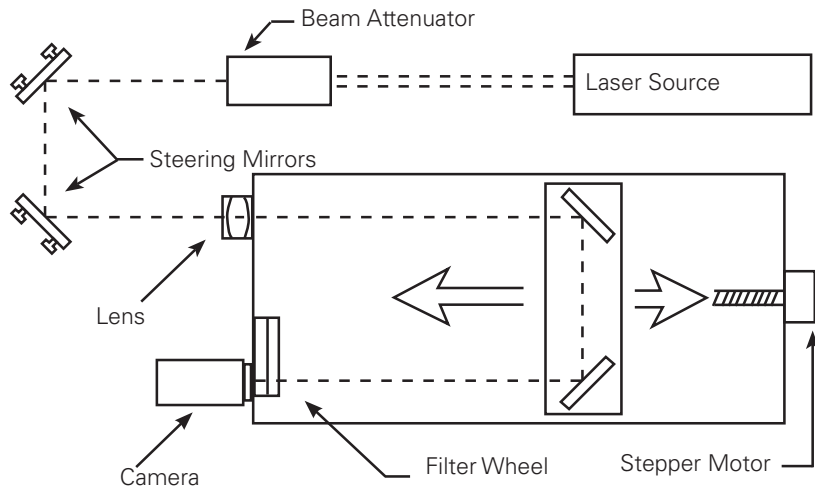
- Automatically measure your beam focusability in as little as 3 minutes
- Tune your laser for best operation
- ISO compliant
- Specifically developed for continuous usage
- Unequaled accuracy using patented Ultracal™ calibration
- Automatic attenuation adjustment
- Pulsed and CW for most beam diameters and powers



Not all commercial M<sup>2</sup> measuring instruments conform to the ISO 11146 method of employing a fixed position lens and moving detector. Instead, some manufacturers use a fixed position detector and a moving lens. If the laser beam is diverging or converging within the travel range of a moving lens, the reported M<sup>2</sup> value and other results can be significantly compromised. The Spiricon M<sup>2</sup>-200 Beam Propagation Analyzer is fully ISO 11146 compliant.

## Automatic M<sup>2</sup>

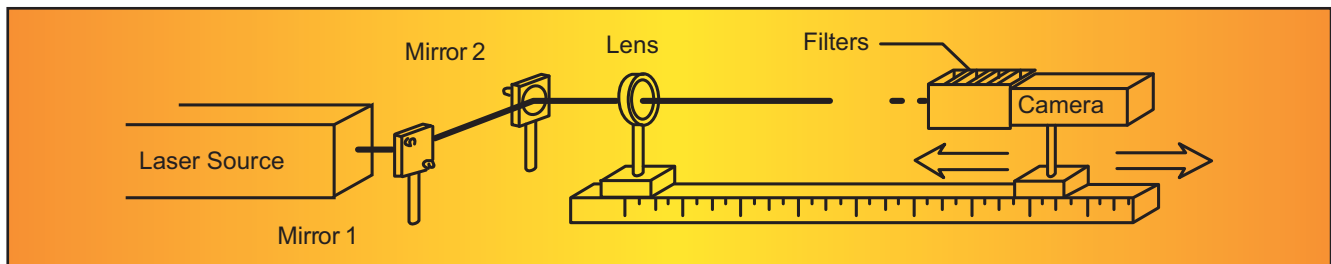
The automatic version of the M<sup>2</sup>-200 system includes an optical train with a fixed position lens. The optical train automatically translates the camera through the waist region and the far field regions. Mounted steering mirrors direct the focused beam onto the camera. The table is connected to a very precise lead screw and stepper motor to translate the table in known increments. This generates a series of beam width measurements along the path of the focused beam. All of these measurements and translations, as well as incremental beam attenuation, are automatically controlled by the M<sup>2</sup>-200 software. A high speed USB interface allows use with laptop computers.



## Manual M<sup>2</sup>

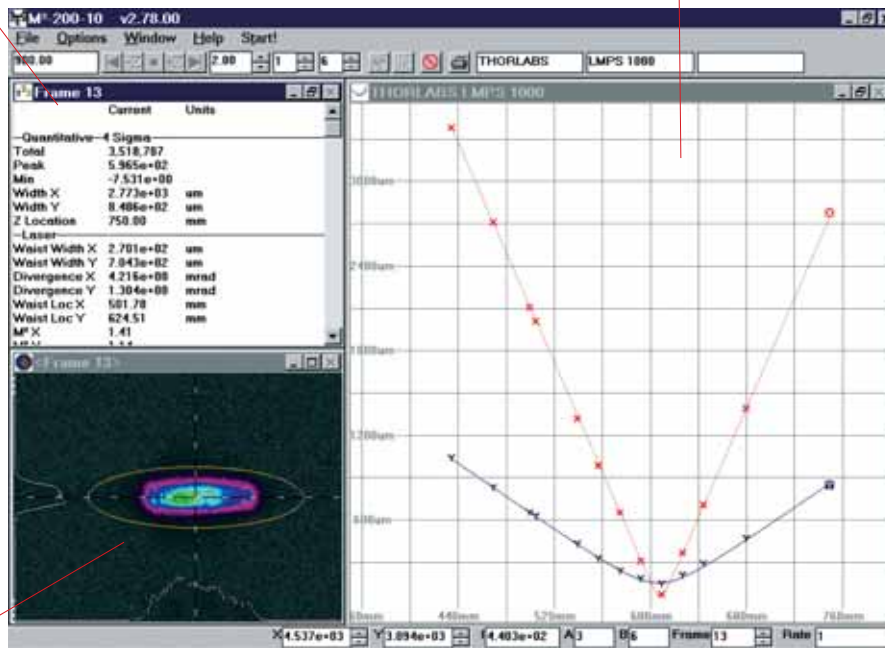
The M<sup>2</sup>-200 can be purchased without the optical train. Manual measurements may be taken from beams that are too large or too small or at wavelengths incompatible with the optics and camera contained in the optical train. UV and IR lasers from 157 to 248nm and 1μm to 1000μm can be measured manually with a Pyrocam III camera (see description below). The user manually positions the camera on a rail, adjusts the attenuation to match the camera's dynamic range, and captures each frame individually, with each step prompted by the M<sup>2</sup>-200 software.

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The 2D or 3D beam profile of the currently measured point in the beam propagation curve. This image enables visual intuitive verification of the beam profile behavior through focus. After each run the user can click any individual measured point and observe the beam profile. Outlying or anomalous points can be automatically or manually excluded from the curve fit calculations for more accurate results.

## Specifications for both the M<sup>2</sup>-200 and M<sup>2</sup>-200s

<b>Measurements</b> (Statistical results are available on all measurements)	$M^2_x, M^2_y, K_x, K_y, BPP_x, BPP_y$ Width at waist $W_x, W_y$ Divergence angle $\theta_x, \theta_y$ Waist location $Z_x, Z_y$ Rayleigh X, Y Astigmatism Asymmetry ratio
<b>Wavelength Range</b>	
Different lenses are needed for different wavelength regions. One lens is included with the M <sup>2</sup> -200 systems. Additional lenses must be ordered separately. The M <sup>2</sup> -200s model include 3 standard lenses with nominal 300mm focal lengths. See below.	
M <sup>2</sup> -200-FW *-VIS 500mm f.l. *-NIR 500mm f.l. *-BB 450mm f.l.	M <sup>2</sup> -200s-FW 266-587nm (std) 400-750nm (std) 650-1125nm (std) 1000-1300nm (opt.)
Attenuation Range Nominally from ND 0 to ND 4.8. Actual values vary with wavelength. (Older M <sup>2</sup> -200 models will vary)	
<b>Optical Limits</b>	
Wavelength Range	M <sup>2</sup> -200-FW-VIS 400-850nm M <sup>2</sup> -200-FW-NIR 1064nm M <sup>2</sup> -200-FW-BB 266-1300nm M <sup>2</sup> -200s-FW 266-1300nm
The SCOR20 CCD camera is only operational from 266 to 1300nm. Newer cameras may be incorporated in the future which may extend this operating range	

Beam Size	M <sup>2</sup> -200	1mm - 10mm
	M <sup>2</sup> -200s	0.5mm - 10mm
	varies with wavelength, waist size and location, and M <sup>2</sup>	
<b>Damage Limits <sup>1</sup></b>		
Camera	15 uW/cm <sup>2</sup> CW mode for a 10 mm input beam diameter 100 uJ/cm <sup>2</sup> pulse mode for a 10 mm input beam diameter	
<b><sup>1</sup> CCD cameras can be damaged by power in excess of 100 mW/cm<sup>2</sup> or energy in excess of 100 mJ/cm<sup>2</sup>. The M<sup>2</sup>-200/200s employs a focusing optic. While it may be that the laser input power or energy measures well below this damage threshold, it can easily exceed these levels when focused onto the camera sensor. Use caution and error on the side of safety. CCD cameras can be costly to repair or replace.</b>		
<b>General</b>		
Accuracy	5% typical, 12% waist location and Rayleigh length typical (Note: Accuracy can be degraded by a variety of situations)	
Measurement Cycle Time	2-3 minutes typical, depending on setup conditions and operating mode.	
Camera Attachment	Std C-mount, 90° camera on axis rotation	
Translation System	Step motor-driven lead screw	
Translation Pitch	4 mm/rev optical pitch	
Step Angle	1.8° (200 steps/rev)	
Sample Range	M <sup>2</sup> - 200 380 - 1200 mm, typical M <sup>2</sup> - 200s 190 - 600 mm, typical	
<b>Camera Specifications (for GRAS20 camera)</b>		
Imager	1/1.8" CCD, 1600 x 1200 pixels	
Dynamic Range	12 bit A to D	
Frame Rates	7.5 FPS (at full resolution)	
Pixel size	4.4um x 4.4um	
Gain	0 to 25dB	
Shutter Control	Programmable from 110us to 70ms	
S/N Ratio	59dB at min gain	
Trigger Input	Edge sensitive 3.3 / 5Vdc LVTTTL / TTL (positive or negative, user programmable) Minimum pulse width 10us	
Trigger Out	External Trigger cable provided.	
Voltage Requirement	3.3Vdc LVTTTL, Programmable	
Power Consumption	Powered over Firewire Cable <3.5watts	
Dimensions	44mm (1.74") wide, 29mm (1.14") tall and 66mm(2.6") deep	
Mass	104g (3.7oz)	
<b>Environmental</b>		
Storage Temperature	-30°C to 65°C	
Storage Humidity	95% maximum (non-condensing)	
Operating Temperature	10°C to 40°C	
Operating Humidity	95% maximum (non-condensing)	
<b>Power Requirements*</b>		
Line Voltage	95V AC to 250V AC	
Line Frequency	47Hz to 63Hz	
Maximum Power	4.5 Watts	
* For the Optical Train only. The PC computer supplies the power for the system components, such as the CCD camera. An external power supply is provided for Laptop computer use.		
<b>Physical</b>		
Weight	M <sup>2</sup> -200... 5.9 Kg (without camera) M <sup>2</sup> -200s... 6.8 Kg (without camera)	

Laser Power & Energy

Heads

Displays

Beam Profile Wavelength

OEM Products

Ordering Information		
Item	Description	P/N
M <sup>2</sup> -200 Beam Propagation Analyzer		
M <sup>2</sup> -200s-FW	M <sup>2</sup> -200 software, software license, GRAS 20 Firewire camera, short optical train, automatic and manual operation, recommended for 266nm – 1064nm wavelengths.	SP90144
M <sup>2</sup> -200s-FW-A	M <sup>2</sup> -200 software, software license, short optical train, automatic and manual operation, recommended for 266nm – 1064nm wavelengths (GRAS 20 camera not included)	SP90145
M <sup>2</sup> -200sM-FW	Manual mode M <sup>2</sup> -200 software, software license, GRAS 20 Firewire camera, manual operation with a GRAS 20 Firewire camera (optical train not included)	SP90146
M <sup>2</sup> -200sM-FW-A	Manual mode M <sup>2</sup> -200 software, software license, manual operation with a Firewire camera (GRAS 20 Firewire camera and optical train not included)	SP90147
M <sup>2</sup> -200-FW-VIS	M <sup>2</sup> -200 software, software license, GRAS 20 Firewire camera, optical train, automatic and manual operation, recommended for 400nm – 700nm wavelengths.	SP90016
M <sup>2</sup> -200-FW-NIR	M <sup>2</sup> -200 software, software license, GRAS 20 Firewire camera, optical train, automatic and manual operation, recommended for 1064nm wavelength.	SP90017
M <sup>2</sup> -200-FW-BB	M <sup>2</sup> -200 software, software license, GRAS 20 Firewire camera, optical train, automatic and manual operation, UV and Near IR wavelengths.	SP90015
M <sup>2</sup> -200-FW-A-VIS	M <sup>2</sup> -200 software, software license, optical train, automatic and manual operation, recommended for 400nm – 700nm wavelengths (GRAS 20 camera not included)	SP90019
M <sup>2</sup> -200-FW-A-NIR	M <sup>2</sup> -200 software, software license, optical train, automatic and manual operation, recommended for 1064nm wavelength (GRAS 20 camera not included)	SP90020
M <sup>2</sup> -200-FW-A-BB	M <sup>2</sup> -200 software, software license, optical train, automatic and manual operation, UV and Near IR wavelengths (GRAS 20 camera not included)	SP90018
M <sup>2</sup> -200M-FW	Manual mode M <sup>2</sup> -200 software, software license, GRAS 20 Firewire camera, manual operation with a GRAS 20 Firewire camera (optical train not included)	SP90029
M <sup>2</sup> -200M-FW-A	Manual mode M <sup>2</sup> -200 software, software license, manual operation with a Firewire camera (GRAS 20 Firewire camera and optical train not included)	SP90084
M <sup>2</sup> -200-PIII	M <sup>2</sup> -200 software, software license for Pyrocam III, manual operation only (Pyrocam III not included)	SP90031