

3.1.4 Beam Propagation Analyzer: M²

M²-200s

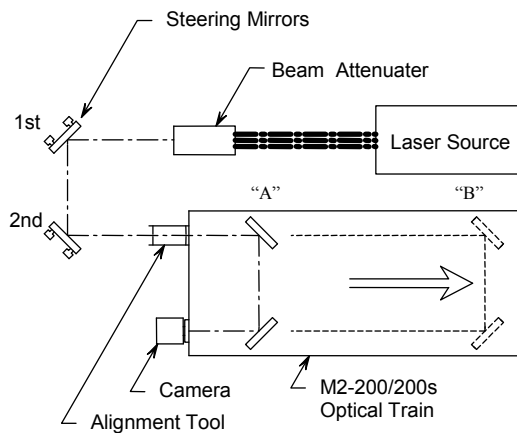
- Automatically measure your beam quality in under 2 minutes
- Tune your laser for best operation
- ISO compliant
- Specifically developed for continuous usage
- Unequaled accuracy using patented Ultracal™ calibration
- Automatic attenuation adjustment
- Pulsed and CW for most beam diameters and powers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

Not all commercial M² 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 M² value and other results can be significantly compromised. Spiricon's M²-200s and M²-200 Beam Propagation Analyzers are fully ISO 11146 compliant.



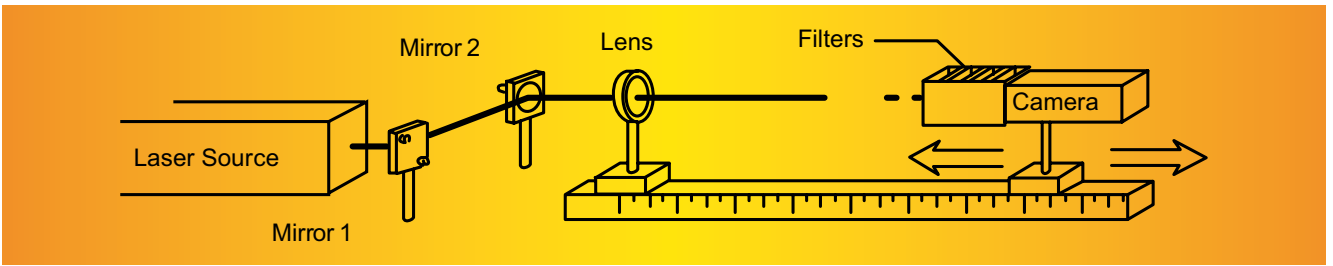
Automatic M² - at Production Speeds

The M²-200s 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 M²-200s software. Software improvements in the M²-200s, including more efficient algorithm execution, has decreased the measurement reporting time by 2-3 times, making it possible to report M² in under two minutes.



Manual M²

Manual mode is available for beams that are too large or too small or at wavelengths outside the standard optical train.



Accuracy by Design

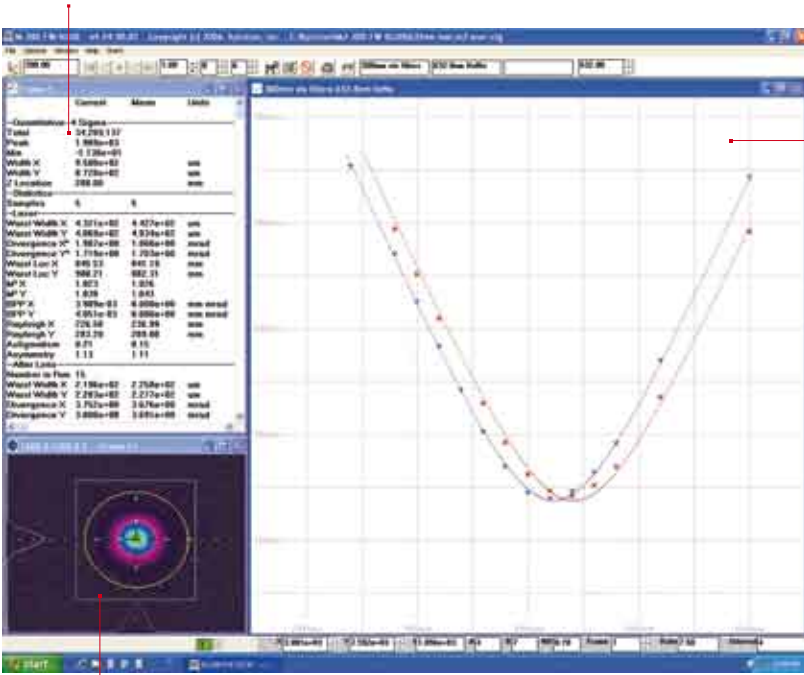
Spiricon products are known for accuracy. Using our patented Ultracal™ calibration method and auto aperturing, to exclude noise beyond the wings of the laser beam, you are assured of the most accurate measurements in the industry.

Designed by Our Customers

Spiricon has redesigned the M²-200, 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 M²-200 measurement system has provided over the years.

Main Screen Functions

This window displays quantitative measurements of the laser parameters. These include the X and Y beam widths, M² or K, the divergence angles, the Rayleigh range, and other parameters shown.

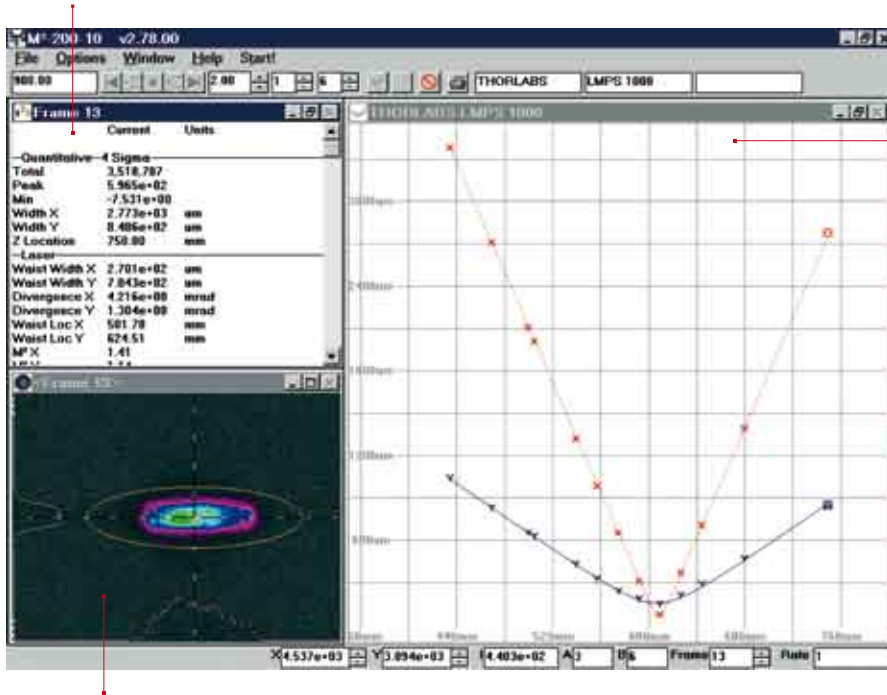


This window presents measurements of beam width vs. position for a given run. After measuring a few points, the software extrapolates a curve fit. The Xs and Ys represent individual measurement points. The solid lines present the best fit hyperbola of the beam propagation equation to the measured points. The M² and other laser parameters are computed from the best fit hyperbola since it provides a smoothing of the data points.

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.

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Specifications for both the M²-200 and M²-200s

Measurements (Statistical results are available on all measurements)	$M^2x, M^2y, Kx, Ky, BPPx, BPPy$ Width at waist W_x, W_y Divergence angle qx, qy Waist location Z_x, Z_y Rayleigh X, Y Astigmatism Asymmetry ratio
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Wavelength Range Different lenses are needed for different wavelength regions. The M ² -200s model include 3 standard lenses with nominal 300mm focal length. See below.	The M ² -200 model comes with only one lens. Additional lenses can be ordered separately and interchanged within a single model.
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M²-200s-FW	266 - 587nm (included) 400 - 750nm (included) 650 - 1300nm (included) 1000 - 1300nm (optional)	M²-200-FW-VIS	400 - 850nm
		M²-200-FW-NIR	1064nm
		M²-200-FW-BB	266 - 1300nm
		Lenses to order	*-VIS 500mm f.l. *-NIR 500mm f.l. *-BB 450mm f.l.

Attenuation Range Nominally from ND 0 to ND 4.8. Actual values vary with wavelength. (Older M²-200 models will vary)

Beam Size	M ² -200s 0.5mm - 10mm M ² -200 1mm - 10mm varies with wavelength, waist size and location, and M^2
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Damage Limits¹	
Camera	0.15 uW/cm ² CW mode for a 10 mm input beam diameter 1.0 uJ/cm ² pulse mode for a 10 mm input beam diameter both of the above for an $M^2=1$ @ 1064nm

¹ CCD cameras can be damaged by power in excess of 100 mW/cm² or energy in excess of 100 mJ/cm². The M²-200/200s 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.

Specifications for both the M²-200 and M²-200s

General	
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 ² - 200 s 190 - 600 mm, typical M ² - 200 380 - 1200 mm, typical
Camera Specifications (for GRAS20 camera)	
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)
Environmental	
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)
Power Requirements*	
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.	
Physical	
Weight	M ² -200... 5.9 Kg (without camera) M ² -200s... 6.8 Kg (without camera)

Ordering Information

Item	Description	P/N
M²-200s Beam Propagation Analyzer		
M ² -200s-FW	M ² -200 software, software license, GRAS 20 Firewire camera, short optical train, automatic and manual operation, recommended for 266nm - 1064nm wavelengths.	SP90144
M ² -200s-FW-A	M ² -200 software, software license, short optical train, automatic and manual operation, recommended for 266nm - 1064nm wavelengths (GRAS 20 camera not included)	SP90145
M ² -200sM-FW	Manual mode M ² -200 software, software license, GRAS 20 Firewire camera, manual operation with a GRAS 20 Firewire camera (optical train not included)	SP90146
M ² -200sM-FW-A	Manual mode M ² -200 software, software license, manual operation with a Firewire camera (GRAS 20 Firewire camera and optical train not included)	SP90147
M²-200 Beam Propagation Analyzer		
M ² -200-FW-VIS	M ² -200 software, software license, GRAS 20 Firewire camera, optical train, automatic and manual operation, recommended for 400nm - 700nm wavelengths.	SP90016
M ² -200-FW-NIR	M ² -200 software, software license, GRAS 20 Firewire camera, optical train, automatic and manual operation, recommended for 1064nm wavelength.	SP90017
M ² -200-FW-BB	M ² -200 software, software license, GRAS 20 Firewire camera, optical train, automatic and manual operation, UV and Near IR wavelengths.	SP90015
M ² -200-FW-A-VIS	M ² -200 software, software license, optical train, automatic and manual operation, recommended for 400nm - 700nm wavelengths (GRAS 20 camera not included)	SP90019
M ² -200-FW-A-NIR	M ² -200 software, software license, optical train, automatic and manual operation, recommended for 1064nm wavelength (GRAS 20 camera not included)	SP90020
M ² -200-FW-A-BB	M ² -200 software, software license, optical train, automatic and manual operation, UV and Near IR wavelengths (GRAS 20 camera not included)	SP90018
M ² -200M-FW	Manual mode M ² -200 software, software license, GRAS 20 Firewire camera, manual operation with a GRAS 20 Firewire camera (optical train not included)	SP90029
M ² -200M-FW-A	Manual mode M ² -200 software, software license, manual operation with a Firewire camera (GRAS 20 Firewire camera and optical train not included)	SP90084
M ² -200-PIII	M ² -200 software, software license for Pyrocam III, manual operation only (Pyrocam III not included)	SP90031