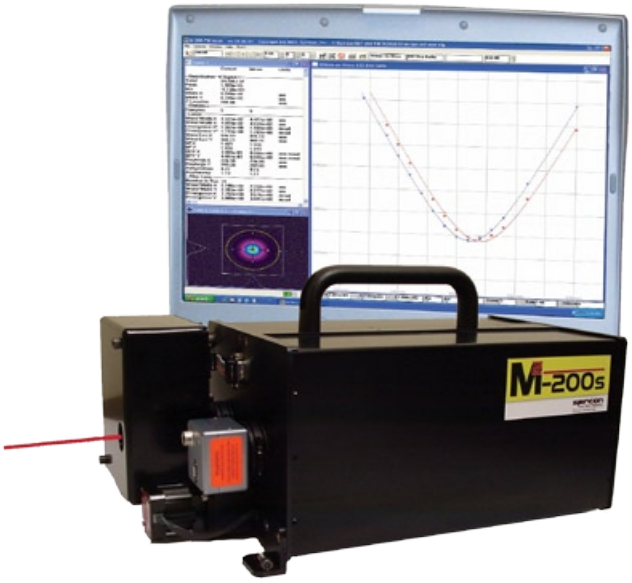
3.6.1 Camera Based Beam Propagation Analyzer: M^2

M^2-200s

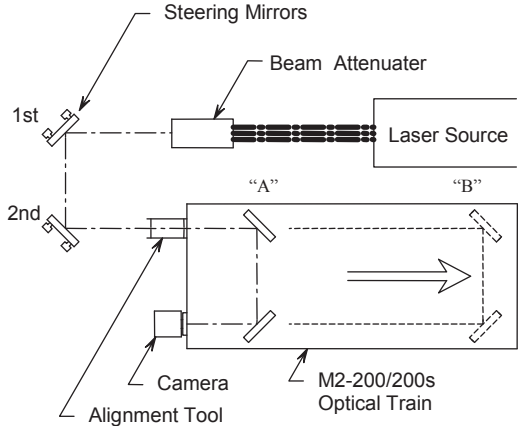
- Automatically measure your beam quality in under 2 minutes
- Tune your laser for best operation
- ISO compliant
- Specifically developed for continuous usage
- Unequaled accuracy using patented Ultracal™
- Calibration
- Automatic attenuation adjustment
- Pulsed and CW for most beam diameters and powers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



Not all commercial M^2 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^2 value and other results can be significantly compromised. Spiricon's M^2-200s and M^2-200 Beam Propagation Analyzers are fully ISO 11146 compliant.

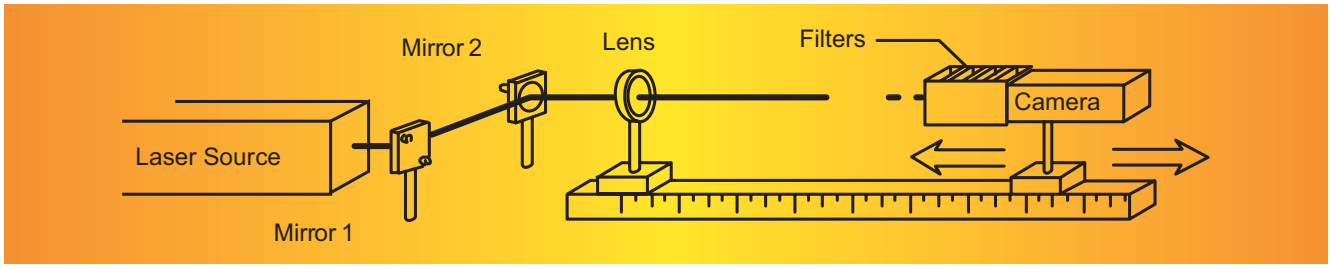
Automatic M^2 - at Production Speeds

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



Manual M^2

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



Accuracy by Design

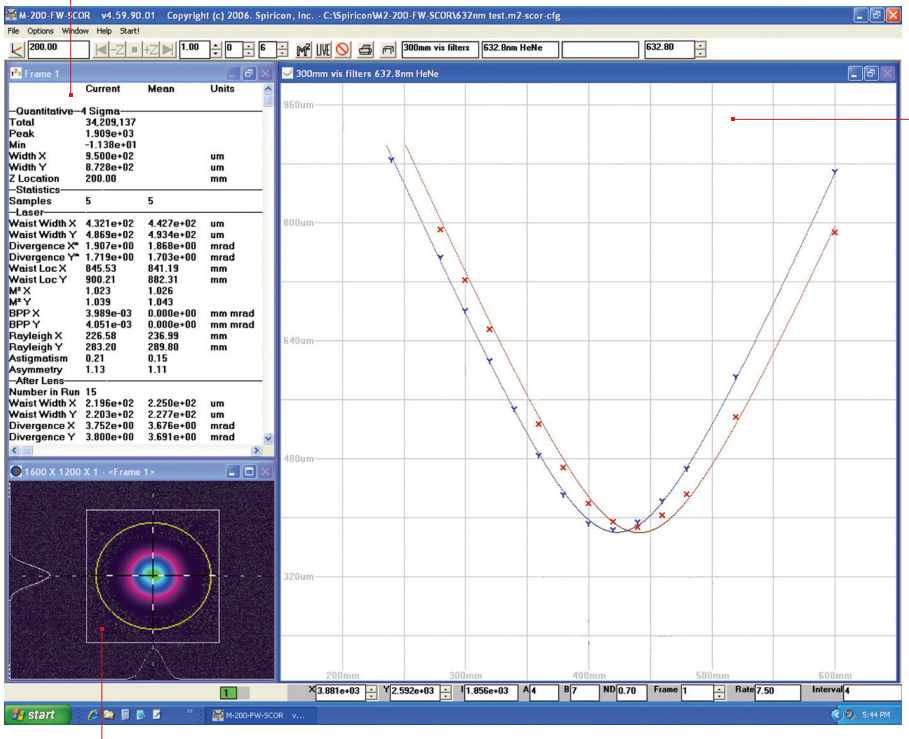
Spiricon products are known for accuracy. Using our patented Ultracal™ calibration method and auto aperturing to exclude noise beyond the wings of the laser beam, assures the user of the most accurate measurements in the industry.

Designed by Our Customers

Spiricon has redesigned the M^2-200, 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^2-200 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, M^2 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 M^2 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.

3.6.1.1 Specifications for the M^2-200s

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
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	4.4µm x 4.4µm
Gain	0 to 25dB
Shutter Control	Programmable from 110µs to 70ms
S/N Ratio	59dB at min gain
Trigger Input	Edge sensitive 3.3 / 5Vdc LVTTL / TTL (positive or negative, user programmable)
	Minimum pulse width 10us
Trigger Out	External Trigger cable provided
Voltage Requirement	3.3Vdc LVTTL, 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^2-200s… 6.8 kg (without camera)

Measurements (Statistical results are available on all measurements)	M^2x, M^2y, Kx, Ky, BPPx, BPPy
	Width at waist Wx, Wy
	Divergence angle qx, qy
	Waist location Zx, Zy
	Rayleigh X, Y
	Astigmatism
	Asymmetry ratio

Wavelength Range		
Different lenses are needed for different wavelength regions		
The M^2-200s model include 3 standard lenses with nominal 300mm focal lengths. See below		
M^2-200s-FW	266 - 587nm (included)	
	400 - 750nm (included)	
	650 - 1300nm (included)	
	1000 - 1300nm (optional)	
Attenuation Range Nominally from ND 0 to ND 4.8. Actual values vary with wavelength		
Beam Size	0.5mm - 10mm	M^2-200s
	Varies with wavelength, waist size and location, and M^2	
Damage Limits [1]		
Camera	0.15 µW/cm² CW mode for a 10 mm input beam diameter	
	1.0 µJ/cm² 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 M^2-200s 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.

Ordering Information

Item	Description	P/N
M^2-200s 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