3.7.1 Camera Based Beam Propagation Analyzer: M^2

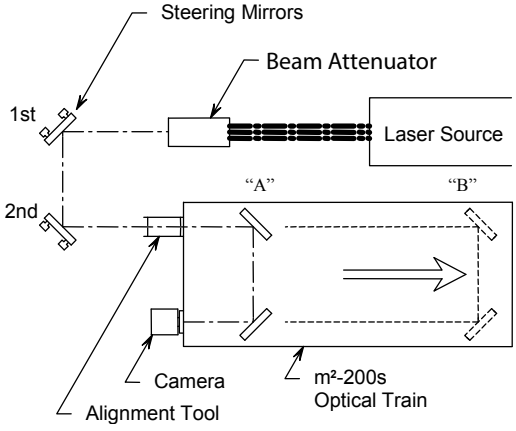
3.7.1.1 M²-200s

- 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 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 Beam Propagation Analyzer is fully ISO 11146 compliant.

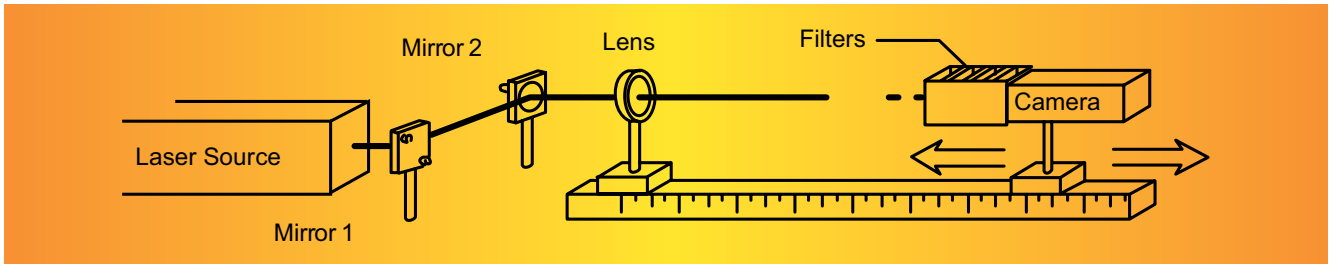
Automatic M^2 - at Production Speeds

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

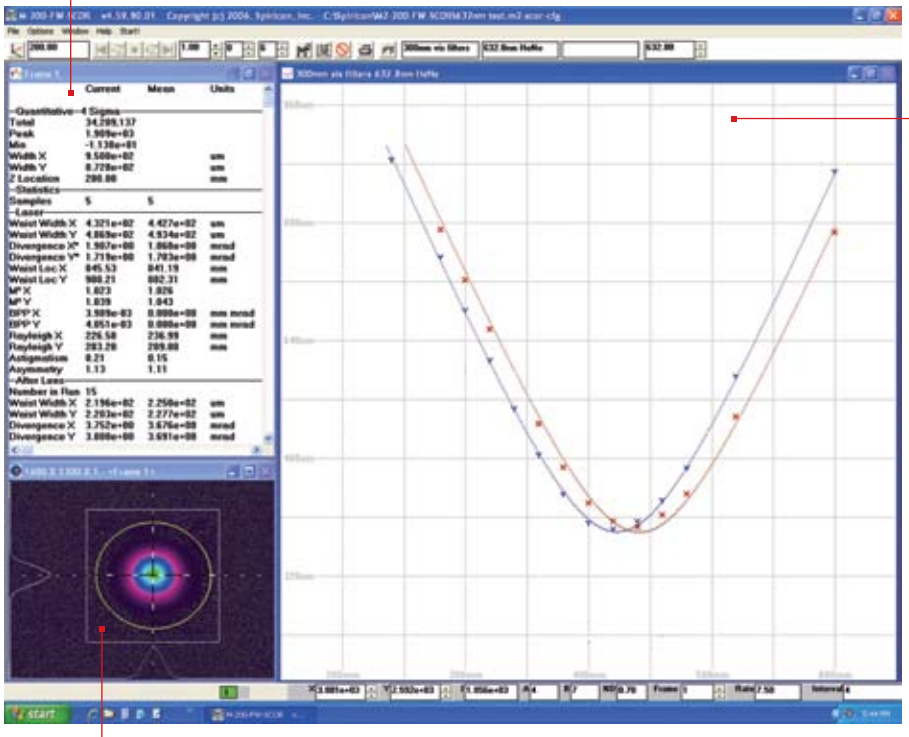
Spiricon products are known for accuracy. Using our patented Ultracal™ calibration method and auto aperturing to exclude noise beyond the wings of the laser beam, assures the user of the most accurate measurements in the industry.

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.

3.7.1.1.1 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	190 - 600 mm, typical
Camera Specifications (for SP300 camera)	
Imager	1/1.8" CCD, 1928 x 1448 pixels
Dynamic Range	12 bit A to D
Frame Rates	26 FPS (at full resolution)
Pixel size	3.69µm x 3.69µm
Gain	0 to 24 dB
Shutter Control	Programmable from 110µs to 70ms
S/N Ratio	56dB at min gain
Trigger Input	Edge sensitive 3.3 / 5Vdc LVTTL / TTL (positive or negative, user programmable) Minimum pulse width 10us. External Trigger cable provided
Trigger Out	3.3Vdc LVTTL, Programmable
Voltage Requirement	Powered through USB 3.0, USB 2.0
Power Consumption	<3.5watts
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 for required for Laptop computer use	
Physical	
Weight	15lbs, 6.8 kg (without camera)
Measurements	M^2x, M^2y, Kx, Ky, BPPx, BPPy
Statistical results	Width at waist Wx, Wy
are available on	Divergence angle qx, qy
all measurements	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 - 1125nm (included)
	1000 - 1300nm (optional)
Attenuation Range Nominally from ND 0 to ND 4.8. Actual values vary with wavelength	
Beam Size	0.5mm - 10mm
	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 0.1 mW/cm² or energy in excess of 1 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.

3.7.1.1.2 Ordering Information

Item	Description	P/N
M2-200s-USB	M2-200s software, software license, SP300 USB 3.0 camera, short optical train, automatic and manual operation, recommended for 266nm - 1300nm wavelengths.	SP90144
M2-200s-USB-A	M2-200 software, software license, short optical train, automatic and manual operation, recommended for 266nm - 1300nm wavelengths (SP300 camera not included)	SP90145
M2-200sM-USB	Manual mode M2-200s software, software license, SP300 USB 3.0 camera, manual operation with a SP300 camera (optical train not included)	SP90146
Accessories		
1000-1300nm lens	Lens assy telecom, 300mn fl	11402-001
SP300	Replacement SP300 USB 3.0 camera	SP90392