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THORLABS

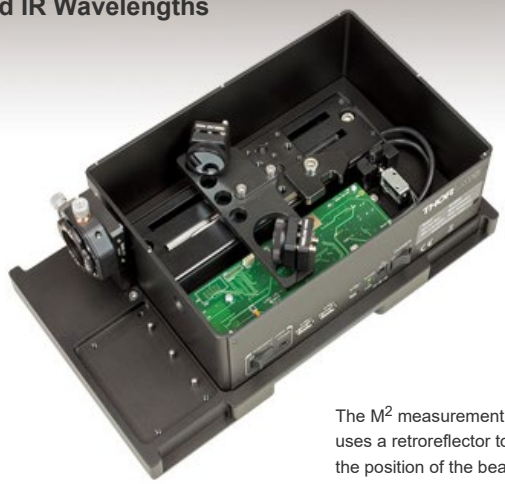
M2MS-BP209IR - January 13, 2022

Item # M2MS-BP209IR was discontinued on January 13, 2022. For informational purposes, this is a copy of the website content at that time and is valid only for the stated product.

COMPLETE M² MEASUREMENT SYSTEMS

- **Complete M^2 Measurement Systems for UV, Visible, and IR Wavelengths**
- **For CW & Pulsed Sources**

M2MS-BP209IR
M^2 Measurement System
with a Scanning-Slit Beam Profiler



The M^2 measurement system uses a retroreflector to change the position of the beam waist with respect to the beam profiler.

OVERVIEW

Features

- Self-Contained Systems for Measuring Laser Beam Quality
- Measure Beam Properties Including M^2, Divergence, Focus Diameter, Waist Position, and Rayleigh Length
- 2 Beam Profiler Options
  - Thorlabs Scanning-Slit Beam Profiler
  - System Without a Beam Profiler
- Systems Cover 250 nm - 2700 nm Wavelengths, See Table Below for Options
- Compliant with ISO 11146 Standards for Beam Quality Measurements

Click to Enlarge
The included alignment laser is shown mounted in place of the beam profiler. Use the beam output from the center of the input aperture to align the test laser source with the axis of the M^2 measurement system.

Thorlabs' M^2 Measurement Systems provide self-contained, turnkey solutions for measuring M^2, divergence, focus diameter, waist position, Rayleigh length and other laser beam quality metrics. Pre-configured, factory-aligned systems covering wavelength ranges between 250 nm and 2700 nm are available. Choose from among systems that have a scanning-slit beam profiler or no beam profiler. Each system includes a set of lenses, an alignment laser, and a variety of accessories. Configuration options are outlined in the table below.

Click to Enlarge
Several lenses with AR-coatings optimized for different wavelength ranges are included with each M² measurement system. They are mounted in a quick-release mounting carriage so that they can be easily exchanged.

The M^2 factor, also called the beam quality factor or the beam propagation factor, is a measure of the quality of a beam. This parameter is defined as the ratio of the beam parameter product (waist size times the far-field divergence angle) of a laser beam to that of a diffraction-limited Gaussian beam at the same wavelength. A value of 1 is indicative of a pure TEM_{00} beam (or a diffraction-limited beam). Higher values imply that a beam is not strictly a TEM_{00} beam. Please see the product manual for more details on the M^2 parameter.

Thorlabs' scanning-slit beam profilers are compatible with near-Gaussian beams. Scanning-slit beam profilers acquire power measurements while sampling segments of the beam along two orthogonal axes, and the beam profile is reconstructed from these measurement data. These beam profilers measure pulsed laser beams using an averaging technique.

Extension Sets for Thorlabs' Beam Profilers

Our extension sets without beam profilers are offered for users interested in adding M^2 measurement capability to one or more of Thorlabs' beam profilers that were purchased separately. These extension sets convert any of our BP209 Scanning Slit Beam Profilers, BC207 CMOS Camera Beam Profilers, or previous-generation BP10x Scanning Slit and BC106N CCD Camera Beam Profilers into a fully automated, motorized M^2 analysis system. Each extension set includes mounting adapters for the BP209 slit and BC207 camera beam profilers that raise the input port to the height of the beam path through the M² analysis system. To purchase the adapter compatible with the previous-generation BC106N camera profilers, please contact Tech Support.

M^2 Measurement Technique

The M^2 measurement system acquires measurements while translating mirrors inside of the enclosure vary the beam path length. The focusing lens and the beam profiler, which is mounted to the front of the enclosure, remain stationary during operation. The two moving mirrors form a retroreflector, and they are mounted on a translation stage. The mirrors in the M2MS-based systems are optimized for 400 nm - 2700 nm wavelengths, while those in the M2MS-AL-based systems are for 250 nm - 600 nm wavelengths. The length of the beam path can be varied by 200 mm (-100 mm to +100 mm centered about the focal plane), which corresponds to the stage translating over its full 100 mm range. The stage has a maximum velocity of 500 mm/s, and a typical measurement can be completed in 15 - 30 seconds.

Alignment Laser and Other Included Accessories

Each extension kit ships with a Class 1 alignment laser.

Each system includes a set of lenses with 250 mm focal lengths, an alignment laser, and additional accessories. The lens set included with the M2MS-based systems cover wavelengths between 350 nm and 3000 nm, and those included with the M2MS-AL-based systems are for wavelengths between 290 nm and 700 nm. As is shown in the image to the left, the AR coated lenses are attached to the input port using the CXY1Q XY translating mount that includes the CXY1QF quick-release plate, which enables lenses to be easily exchanged and translated by ±1 mm. Please see the *Shipping List* tab for a list of the lenses included with each system. The alignment laser is a useful tool that assists the user in coarsely aligning the test laser with the M^2 measurement system. As shown in the image above, the alignment laser mount in place of the beam profiler. The alignment laser beam exits the center of the input port. It can be steered using any of our kinematic mirror mounts equipped with metallic or dielectric mirrors. After aligning the test laser, remove the alignment laser and install the beam profiler in its place.

Beam Software and Programming Guides

The M^2 measurement systems are controlled via the Thorlabs Beam software package, which is also used to control our beam profilers, enabling accurate measurements of a variety of beam-related parameters. Please see the *User Interface* tab for an introduction to the software's capabilities and GUI, and the manuals for the system of interest for a detailed discussion. The software can be downloaded from the *Software* tab, as well as programming reference guides for LabVIEW™, Visual C++, Visual C#, and Visual Basic.

Housing Features

The side of the M² measurement system features ports for various peripherals. Two USB 2.0 (type A) hubs are provided and can be used to connect to the slit beam profiler and one other device such as the TSP01 USB temperature and humidity sensor. The phono jack supplies power to the alignment laser, and the mini-B USB port is used to connect to the controlling PC. The translation stage inside of the system also communicates with the computer through this port.

The housing of the M^2 measurement system rests on four feet at the corners created by a 0.5 mm deep relief cut in the base. A set of RDF1 rubber damping feet are included. Five M6 taps allow for the installation of four feet with one near each corner or in a configuration using three feet. Four CL6 table clamps are also provided to secure the system to an optical table.

Item #[a]	M^2 System Wavelength Range	Included Beam Profiler			Mirrors[b]		Wavelength Range Covered by Lenses[c]
		Type	Wavelength Range	Item #	Type	Wavelength Range	
M2MS-AL	250 - 600 nm[d]	None[e]			Aluminum	250 - 600 nm	245 - 700 nm
M2MS	400 - 2700 nm[d]				Protected Silver	400 - 2700 nm	350 - 3000 nm
M2MS-BP209VIS-AL(/M)	250 - 600 nm	Scanning Slit	200 - 1100 nm	BP209-VIS(/M)	Aluminum	250 - 600 nm	245 - 700 nm
M2MS-BP209VIS(/M)	400 - 1100 nm				Protected Silver	400 - 2700 nm	350 - 3000 nm
M2MS-BP209IR	900 - 1700 nm		900 - 1700 nm	BP209-IR[f]	Protected Silver	400 - 2700 nm	350 - 3000 nm
M2MS-BP209IR2(/M)	900 - 2700 nm		900 - 2700 nm	BP209-IR2(/M)	Protected Silver	400 - 2700 nm	350 - 3000 nm

a. Imperial and metric Item #s differ only in the threading of their tapped holes.
b. The mirrors are permanently installed inside of the system and cannot be removed.
c. Lenses for use further into the UV and IR than those included with the systems are available separately, as are additional CXY1QF mounting carriages.
d. Supported wavelength range. Wavelength range of a specific M^2 system is determined by the beam profiler integrated with the system.
e. Adapters for the BP209 Scanning Slit and the BC207 CMOS Camera Beam Profilers are included.
f. This previous generation item is no longer available for purchase.

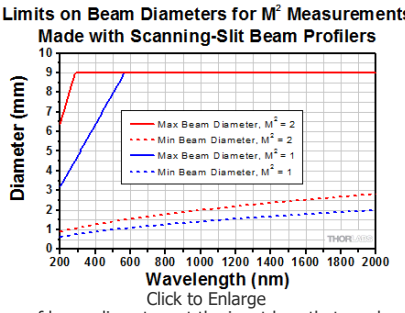
S P E C S

M² Analysis Systems with a Dual Scanning-Slit Beam Profiler

Item #	M2MS-BP209VIS-AL(/M)	M2MS-BP209-VIS(/M)	M2MS-BP209IR	M2MS-BP209IR2(/M)
Beam Profiler Item #	BP209-VIS(/M)		BP209-IR(/M)[a]	BP209-IR2(/M)
System Wavelength Range	250 - 600 nm	400 - 1100 nm	900 - 1700 nm	900 - 2700 nm
Beam Diameter Range	20 µm - 9 mm (at Beam Profiler Input Aperture)[b]			
Power Range	1 µW to 10 W (Depending on Beam Diameter; See Plot Below Right)			

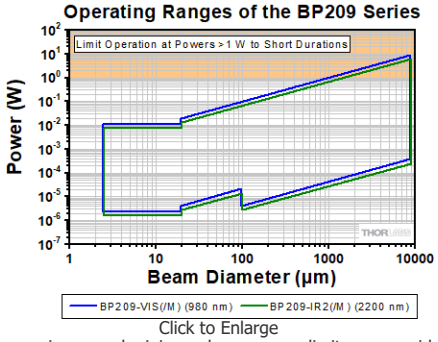
Internal Translation Stage	**Travel Range**	100 mm
	Velocity (Max)	500 mm/s
	Effective Translation Range	200 mm, -100 mm to +100 mm from Focal Point
Lens Focal Length		250 mm
Optical Axis Height		70 mm (Without Additional Feet)
M² Measurement Range		≥1.0 (No Upper Limit)
Typical M² Accuracy		±5%, Depending on Optics and Alignment
Accepted Beam Diameterfor 5% Uncertainty		20 µm - 4.5 mm (at Beam Profiler Input Aperture)
Minimum DetectableDivergence Angle		<0.1 mrad
Applicable Light Sources		CW and Pulsed Sources ≥300 kHz
Typical Measurement Time		15 - 30 s (Depending on Beam Shape and Settings)
General Specifications		
Size		300 mm x 175 mm x 130 mm
Weight		4.6 kg

a. This previous generation item is no longer available for purchase.
b. This is the range of diameters that the beam profiler can measure in standard mode. The scanning slit beam profilers also support a knife-edge mode that can measure beam sizes down to Ø2.5 µm, but this mode should not be used for M² or divergence measurements.



Click to Enlarge

The range of beam diameters at the input lens that can be analyzed by the M² measurement systems for two cases: M² = 1 and M² = 2 are limited by the wavelength-dependent bounds plotted above. These limitations apply only to measurements of M² and related parameters, such as the Rayleigh length. For other measurements, such as standard beam analysis or divergence measurements, the standard beam diameter ranges given in the table immediately above this plot apply.



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These maximum and minimum beam power limits are provided as functions of $1/e^2$ beam diameter for knife-edge and scanning-slit measurements and may not apply to measurements of total power. Please see the scanning-slit beam profiler page for more information. To prevent thermal damage to the measurement head, do not operate for longer than 5 s with input powers exceeding 1 W.

M² Analysis Systems without an Included Beam Profiler

Item #		M2MS-AL	M2MS
Wavelength Range		250 - 600 nm[a]	400 - 2700 nm[a]
Beam Profiler Compatibility		Scanning Slit Beam Profilers: BP209 and Previous-Generation BP10x Camera Beam Profilers: BC207 and Previous-Generation BC106[b]	
Internal Translation Stage	**Travel Range**	100 mm	
	Velocity (Max)	500 mm/s	
	Effective Translation Range	200 mm, -100 mm to 100 mm from Focal Point	
Lens Focal Length		250 mm	
Optical Axis Height		70 mm (Without RDF1 Feet Installed)	
M² Measurement Range		≥1.0 (No Upper Limit)	
Typical M² Accuracy		±5% (Depending on Optics and Alignment)	
Minimum Detectable Divergence Angle		<0.1 mrad	
Applicable Light Sources		CW, Pulsed[a]	
Typical Measurement Time		15 - 30 s (Depending on Beam Shape and Settings)	
General Specifications			
Size		300 mm x 175 mm x 109 mm (Without Beam Profiler)	
Weight		4.2 kg	

a. Depending on the beam profiler used with the system. The wavelength range applies to the mirrors used in the retroreflector. The M2MS-AL includes a set of AR-coated lenses that covers the 250 - 700 nm range, while the M2MS includes a set of AR-coated lenses that cover the 350 - 1700 nm range. Additional lenses with AR-coatings extending deeper into the IR and CXY1QF mounting carriages are available separately.
b. Contact Tech Support to purchase the appropriate mounting adapter for the previous-generation BC106 camera profilers.

SHIPPING LIST

Item #	Beam Profiler	Beam Profiler Adapters	Included Lenses[a]	Other Included Accessories
M2MS-AL	None	Adapters for BC207 and BP209 Beam Profilers	Lenses with f = 250 mm Mounted in CXY1QF Quick Release Carriage: LA4158-UV (AR Coated for 245 - 400 nm) LA1461-A (AR Coated for 350 - 700 nm)	Alignment Laser USB 2.0 to Mini B Cable, 3 m USB 2.0 to Mini B (Angled), 0.5 m 15 V, 3.0 A Power Supply[b] 0.05" Hex Key3 mm Balldriver CL6 Table Clamps (Qty. 4) M4 Cap Screws[c] (Qty. 6)
M2MS	None	Adapters for BC207 and BP209 Beam Profilers	Lenses with f = 250 mm Mounted in CXY1QF Quick Release Carriage: LA1461-A (AR Coated for 350 - 700 nm) LA1461-B (AR Coated for 650 - 1050 nm) LA1461-C (AR Coated for 1050 - 1700 nm) LA5255-D (AR Coated for 1650 - 3000 nm)	
M2MS-BP209VIS-AL(/M)	BP209-VIS(/M)	Beam Profiler is Pre-Installed	Lenses with f = 250 mm Mounted in CXY1QF Quick Release Carriage: LA4158-UV (AR Coated for 245 - 400 nm) LA1461-A (AR Coated for 350 - 700 nm)	
M2MS-BP209VIS(/M)	BP209-VIS(/M)		Lenses with f = 250 mm Mounted in CXY1QF Quick Release Carriage: LA1461-A (AR Coated for 350 - 700 nm) LA1461-B (AR Coated for 650 - 1050 nm) LA1461-C (AR Coated for 1050 - 1700 nm)	
M2MS-BP209IR	BP209-IR(/M)[d]		Lenses with f = 250 mm Mounted in CXY1QF Quick Release Carriage: LA1461-A (AR Coated for 350 - 700 nm) LA1461-B (AR Coated for 650 - 1050 nm) LA1461-C (AR Coated for 1050 - 1700 nm) LA5255-D (AR Coated for 1650 - 3000 nm)	
M2MS-BP209IR2(/M)	BP209-IR2(/M)		Lenses with f = 250 mm Mounted in CXY1QF Quick Release Carriage: LA1461-A (AR Coated for 350 - 700 nm) LA1461-B (AR Coated for 650 - 1050 nm) LA1461-C (AR Coated for 1050 - 1700 nm) LA5255-D (AR Coated for 1650 - 3000 nm)	

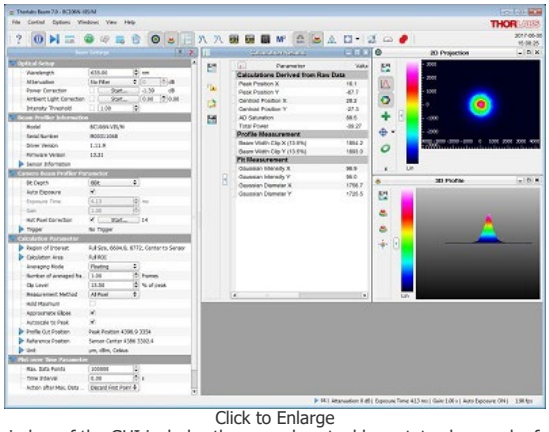
a. All included lenses have a 250 mm focal length to ensure that the focal plane for a perfectly collimated beam is at the beam profiler when the retroreflector is positioned at the midpoint of the translation stage. Additional lenses for shorter UV or longer IR wavelengths and magnetic mounting plates are available separately to allow further customization of your system.
b. The appropriate mains cord for the power supply is included based on the ordering location.
c. These are extra screws provided for securing the beam profiler adapter to the M2MS system base plate. (One packet of 6 screws included.)
d. This previous generation item is no longer available for purchase.

USER INTERFACE

Thorlabs Beam Software for Thorlabs' M² Measurement Systems

- GUI with Adjustable Layout: Windows with Different Measurement Results can be Rearranged and Resized within the Workspace
- M² and Divergence Measurements Compliant with ISO 11146
- Data Export:
  - Results can be Exported from Windows in Different Formats
  - Sequential Saving of Long Term Test Data
- Pass/Fail Tests with Customizable, Lockable and Saveable Pass/Fail Parameters
- 2D and 3D Views of the Beam Profile
  - Selectable Overlays such as Peak, Centroid, and Cut Profiles
  - 3D View is Fully Rotatable
- Power Correction Available for Absolute Power Measurements
- Supports TSP01 for Temperature Logging During Long-Term Measurements

Main Window



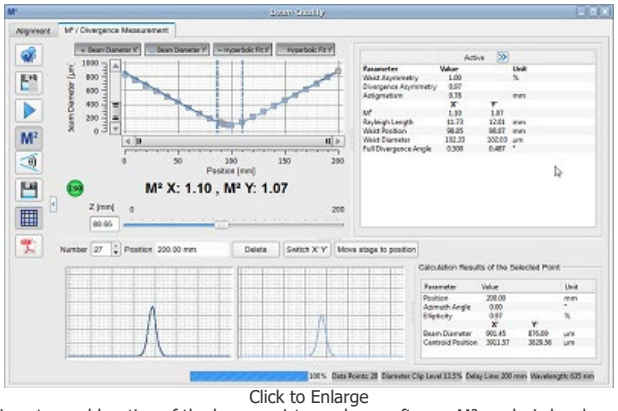
Click to Enlarge

The main window of the GUI includes the menu bar, tool bar, status bar, and a frame where several windows can be displayed. This view includes a Beam Settings Panel that displays all important information in a single location and can be unpinned from the main window and moved to a second location, such as another monitor.

Thorlabs' M² Measurement Systems, Scanning Slit Beam Profilers, and Camera Beam Profilers all use the Thorlabs Beam software package. The screenshots below highlight key features and measurement modes that can be used with our M² Measurement systems, including M² and divergence measurements, 2D views of the beam profile, and measurement of the beam stability and position.

The latest version of the Beam package can be downloaded from the *Software* tab.

M^2 Measurements



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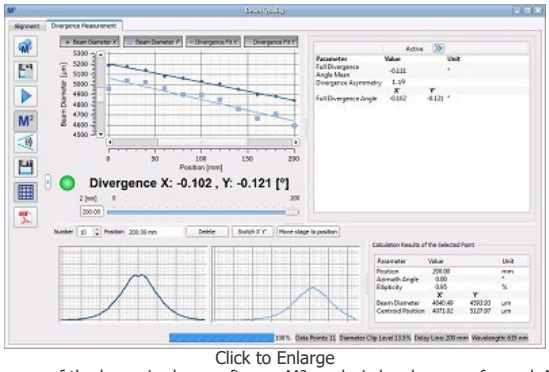
The beam diameter and location of the beam waist are shown after an M² analysis has been performed.
Note: This functionality is only enabled when one of the M² analysis systems is connected to the PC.

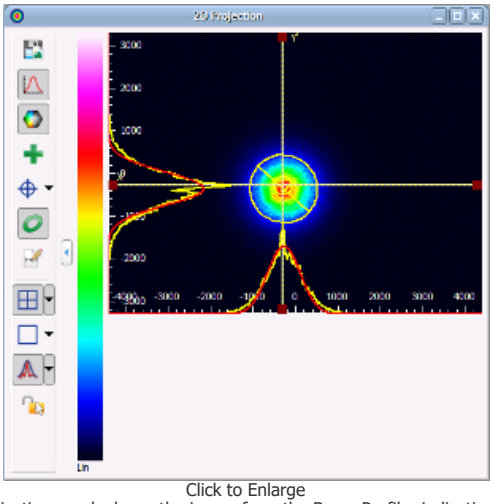
Divergence Measurements



Click to Enlarge

The divergence of the beam is shown after an M² analysis has been performed. Note: This functionality is only enabled when one of the M² analysis systems is connected to the PC.

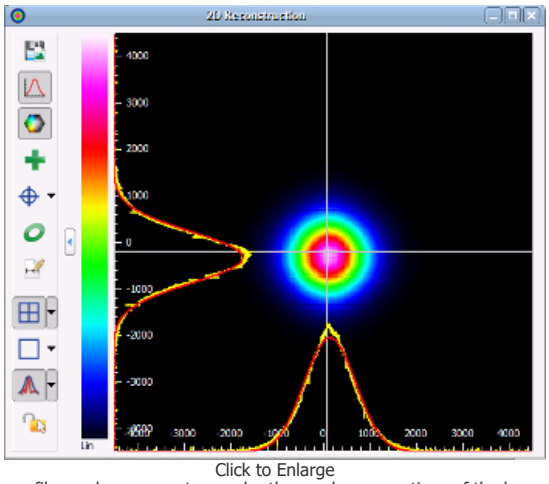
2D Projection (Camera Beam Profilers Only)



Click to Enlarge

The 2D Projection graph shows the image from the Beam Profiler indicating the power intensity distribution within the selected Region of Interest (ROI). Buttons along the side allow users to save the image, show or hide the x and y scales, mark the centroid or peak positions, and display an approximated Beam Ellipse superimposed on the image.

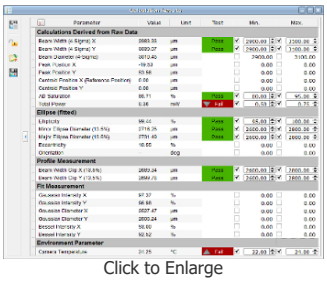
2D Reconstruction (Scanning Slit Beam Profilers Only)



Click to Enlarge

Slit beam profilers only measure two real orthogonal cross sections of the beam (i.e., the beam profile in X and Y). Assuming a Gaussian-like beam profile, the Beam software package can create a 2D reconstruction of the beam profile from the two cross sections, seen in the screenshot above. Buttons along the side allow users to save the image, show or hide the x and y scales, mark the centroid or peak position, and display an approximated Beam Ellipse superimposed on the image.

Calculation Results

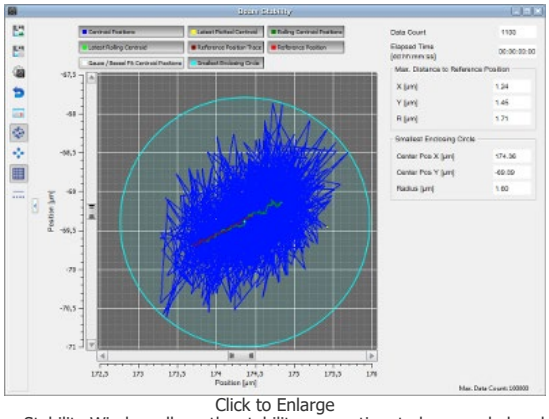


Click to Enlarge

Click to Enlarge

The Calculation Results window displays the results of calculations performed by the software, including beam width, centroid and peak positions, power, ellipticity, and fits of the beam profile. This panel also includes a Pass/Fail test. For each parameter, a minimum or maximum can be set as criteria. After the calculations are complete, the user can save them in .txt, csv, or .xls format. In addition to saving single measurement results, diagrams, and device data, the software can automatically sequentially save this information for a series of measurements.

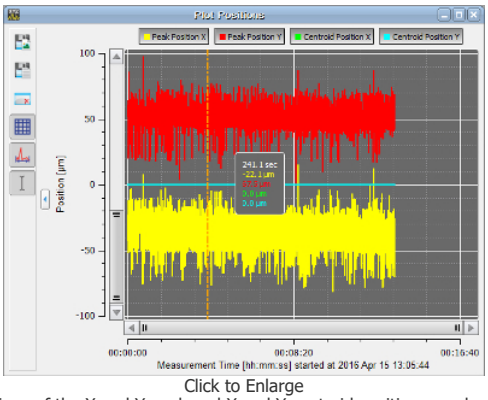
Beam Stability



Click to Enlarge

The Beam Stability Window allows the stability versus time to be recorded and viewed. Display options include the Centroid Positions, Latest Plotted Centroid, Rolling Centroid Positions, Reference Positions, and Smallest Enclosing Circle.

Plot Centroid and Peak Positions



Click to Enlarge
The positions of the X and Y peak and X and Y centroid positions can be displayed as a function of time in this window.

SOFTWARE

Software Packages for Thorlabs' Beam Profilers

The Beam software package can be downloaded by clicking on the Software button below. The software download page also offers programming reference notes for interfacing with our beam profilers using LabVIEW™, Visual C++, Visual C#, and Visual Basic. Please see the *Programming Reference* tab on the software download page for more information and download links.

System Requirements			
Beam Profiler		**BP209**	**BC207**
Operating System		Windows® 8.1 (32 Bit or 64 Bit),10 (32 Bit or 64 Bit)	
Connectivity		USB 2.0 High Speed Port	USB 3.0 High Speed Port
Monitor Resolution		1024 x 758 Pixel (Min), ≥16 Bit Color Depth	
Processor (CPU)	Minimum	Pentium 4 (2.6 GHz Min), Intel or A64 3000+ AMD (3.0 GHz Min)	≥3.0 GHz Intel Core (i5 or Higher)
	Recommended	Intel Core 2 i5 or AMD Ryzen 5 (3.0 GHz Min)	
Memory (RAM)	Minimum	4.0 GB RAM	
	Recommended	8.0 GB RAM	
Graphics Adapter	Required	OpenGL (Specification GLX 1.3 Up)	
	Minimum	Radeon: X100 Series ≥X850, X1000 Series ≥X1600, HD Series ≥2400; Geforce: 7 Series ≥7600, 8 Series ≥ 8500, 9 Series ≥9600; Quadro: FX Series ≥FX770M	
	Recommended	Radeon: HD Series ≥7000; Geforce: GTX Series ≥500;	

a. Intel Core i3 processors and mobile versions of Intel processors may not satisfy the requirements

Features

- Settings Panel Displays All Important Parameters in a Central Location
- Customizable Calculation Results
  - Measured Parameters can be Individually Hidden
  - Adjustable Row Heights
  - Enhanced Beam Stability Window Measures and Displays the Smallest Enclosing Circle Around the Centroid Point Cloud
- Alignment Wizard to Aid in Correctly Aligning the M2MS M^2 Measurement Systems
- Language Settings of English, German, or Chinese

Software

Version 8.0.5157.366 (October 14, 2021)

Standard full version of software package for 32-bit and 64-bit Windows with driver and graphical user interface for operating the device in standard applications.

Software

M^2 Measurement System

Part Number	Description	Price	Availability
M2MS-BP209VIS/M	M² Measurement System with BP209-VIS, 400-1100 nm, Metric	$10,215.47	Lead Time
M2MS-BP209VIS-AL/M	M² Measurement System with BP209-VIS, 250-600 nm, Metric	$10,215.47	Lead Time
M2MS-BP209IR2/M	M^2 Measurement System with BP209-IR/M, 900 - 2700 nm, Metric	$12,505.36	Lead Time

M2MS-AL	M² Measurement System Extension Set, 250 - 600 nm	$6,366.63	Lead Time
M2MS	M² Measurement System Extension Set, 400 - 2700 nm	$6,366.63	Lead Time
M2MS-BP209VIS	M² Measurement System with BP209-VIS, 400-1100 nm	$10,215.47	Lead Time
M2MS-BP209VIS-AL	M² Measurement System with BP209-VIS, 250-600 nm	$10,215.47	Lead Time
M2MS-BP209IR	M² Measurement System with BP209-IR, 900-1700 nm	$10,781.13	Lead Time
M2MS-BP209IR2	M^2 Measurement System with BP209-IR/M, 900 - 2700 nm	$12,505.36	Lead Time