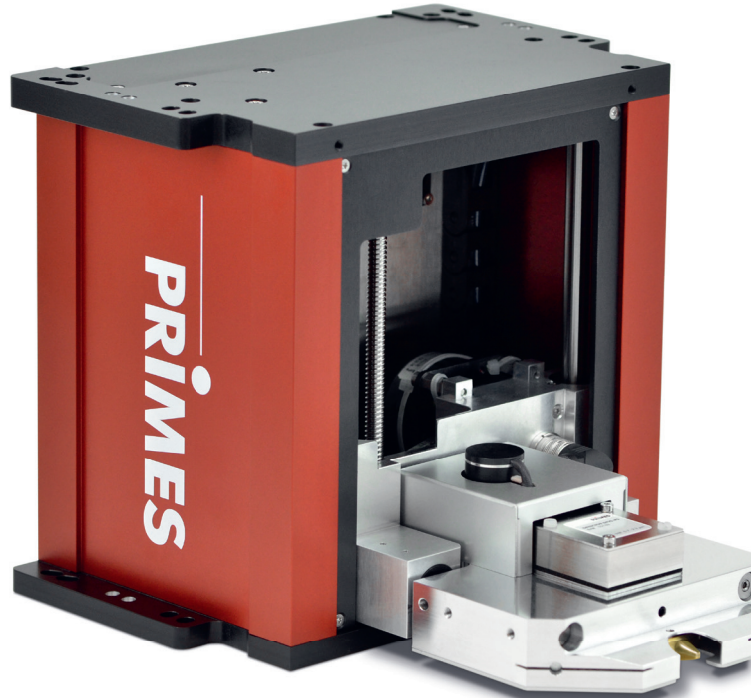




FocusMonitor FM+



Our Multifaceted Flagship

Everything and more: The FocusMonitor FM+ is outfitted today for the challenges of tomorrow and thinks on a broad scale when it comes to the absolute quality of your laser beam. Cutting, welding, surface treatment – the tool laser has to function as flawlessly as possible to make all of this happen. As a modern jack of all trades, the FocusMonitor FM+ is sure to impress not only with its unique versatility and outstanding functionalities, but also with its easily interchangeable measuring tips and detectors.

Even at very high beam powers, the FocusMonitor FM+ is the perfect device for analyzing and measuring laser beam sources in material processing. Reliably determining the beam properties of focused laser beams: in addition to the geomet-

ric dimensions of the focused laser beam, focal position, the beam parameter product, and the beam quality factor. The integrated z-axis allows for automatic measuring of entire caustics up to four Rayleigh lengths, thus facilitating measuring compliance with standards.

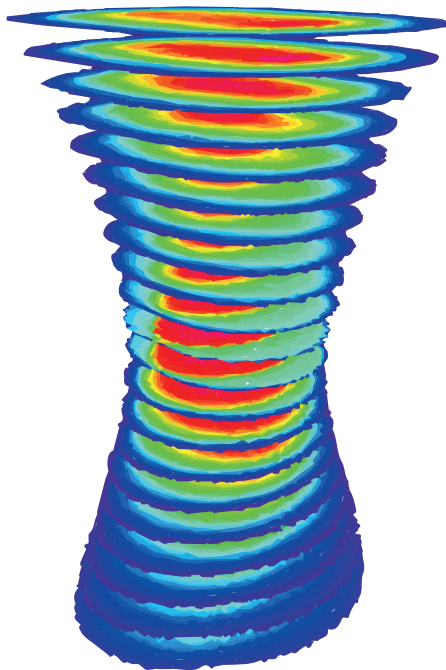
We have further developed the globally successful design of the FocusMonitor FM to create the FM+: sure to excite with new electronics designed to meet current and future requirements for signal processing and a new motherboard ahead of its time with a 16-bit AD converter. An Ethernet interface allows for fast and secure data exchange with computers or system controllers. Practical: The new mechanical design also accommodates upside down installation without additional components.



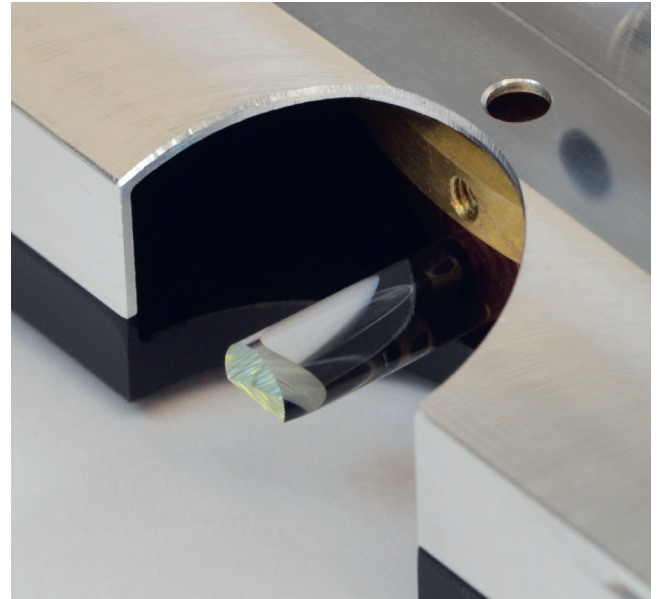
The Principle

The FM+ is an opto-mechanically scanning measuring system that scans the laser beam with a special measuring tip. This is equipped with a small hole (typically with a diameter of approximately 20 μm) that lets through a small section of the laser beam. Two reflecting mirrors guide this portion of the laser light to a detector selected and configured depending on the laser power and wavelength. This makes it possible to measure the different laser beam sources and systems solely by selecting the optimal measuring tip and corresponding detector. The high orbital velocity of the rotating measuring tip facilitates analysis of high power densities.

A very high signal-to-noise ratio is achieved thanks to the dynamics of the analog-digital converter used. Very low intensities are shown with equal precision next to the high peak intensities. That is one of the requirements for automatically measuring caustics in the area near the focal point over at least four Rayleigh lengths in accordance with ISO 11146.



Astigmatic beam: false color presentation at different z-positions



Top of innovative measuring principle FS³

New Milestone in the Measurement of high Power Densities

As the latest innovation in the FocusMonitor FM+ family, PRIMES introduces the **FocusMonitor FM+ HPD**. Through continuous development and the special design of the new measuring principle FS³, it is now possible to measure and evaluate laser beams with very high power densities of up to 50 MW/cm². Here, beam diameters of 100 μm – 1 200 μm can be evaluated. The revolutionary design and the new functionality of the FocusMonitor FM+ HPD are available for beam sources in the wavelength range of 1.0 – 1.1 μm .

With the FocusMonitor FM+ HPD, we present a milestone in the caustic analysis of laser beams in previously difficult to evaluate power ranges, which find use in cutting applications, for example.



Enhanced Functionality thanks to the new LaserDiagnosticsSoftware

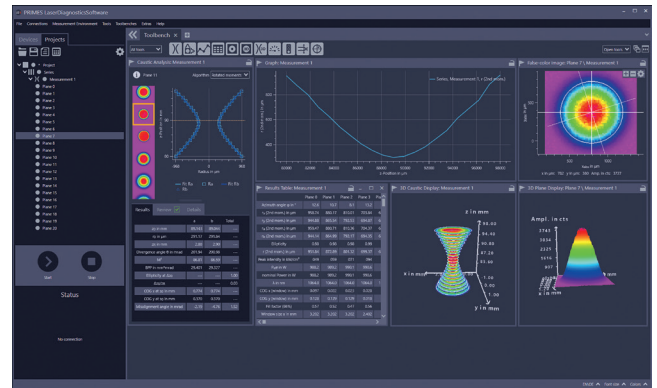
With the new LaserDiagnosticsSoftware (LDS), the FM+ offers considerably more functionality than ever before. It allows for fully automatic, semi-automatic, or manual measurement of the power density distribution, beam position, and beam dimensions. The measurements can be recorded with a high resolution and freely selectable ROI (region of interest). Higher dynamics enable you to determine the beam diameter even when there is a bad signal-to-noise ratio. Other parameters such as beam waist diameter, divergence angle, Rayleigh length, and beam quality factor M^2 can also be determined through the LDS tool.

The measurement of the intensity distribution of multi spot configurations is enabled by a special LDS plugin. Considering the increasing importance of multi spot laser systems this is just one example for the high applicability and flexibility of the new LDS.

The number of measuring planes can be freely programmed and typically lies between 11 and 21 planes. Full measuring series and calculation results can be saved and used later to measure and compare with this previously defined basic data again.

Just Exchange: Measuring Tips and Detectors

The user can change the detector and the measuring tip in just a few minutes. An entire set of adapted measuring tips and detectors is at your disposal for various divergences and wavelengths of various beam sources. Detectors equipped with an EEPROM can be seamlessly connected with the LaserDiagnosticsSoftware. Detector triggering and the measurement window size can be programmed using the software.



Presentation of typical measuring results of the FM+ within the new LaserDiagnosticsSoftware

Wavelength range of CO₂ lasers ($\lambda = 9 - 12 \mu\text{m}$):

Pyroelectric infrared sensors such as DFC+ together with CO₂ high-power measuring tips.

Solid-state irradiation:

High-dynamic detector DFY-PS+ for wavelengths $\lambda = 0.4 - 1.1 \mu\text{m}$ with automatic signal adjustment.

For wavelengths $\lambda = 1 - 1.7 \mu\text{m}$ the detector DFIG-PS+ is recommended. Combination of these detectors generally with an NIR highdiv measuring tip. Additional measuring tips are available for higher divergence diode lasers.

Optional:

Adjusted detectors, e.g. with optimal signal-to-noise ratio or measuring tips with increased/reduced sensitivity. Since almost no laser beam power is absorbed during diagnostics, the FM+ should ideally be operated in combination with a power meter such as the **PowerMonitor**. This makes it possible to measure the laser power as well and ensure that the radiation is securely absorbed.



Technical Data

	FM+	FM+ HPD
MEASUREMENT PARAMETERS		
Power range	30 – 25 000 W	30 – 25 000 W
Wavelength range	0.4 – 1.6 µm and 9 – 12 µm	0.4 – 12 µm
Beam dimension, typ.	100 – 3 000 µm (up to 5 000 µm optionally)	100 – 3 000 µm (up to 5 000 µm optionally)
Max. power density at different measuring tips	CO ₂ laser (10.6 µm): 30 MW/cm ² Nd:YAG-Laser (1 000 – 1 100 nm): 10 MW/cm ² VIS-Laser (515 – 550 nm): 5 MW/cm ² Dioden-Laser (400 – 1 000 nm): 1 MW/cm ²	CO ₂ laser (10.6 µm): 30 MW/cm ² Nd:YAG-Laser (1 000 – 1 100 nm): 50 MW/cm ² VIS-Laser (515 – 550 nm): 5 MW/cm ² Dioden-Laser (400 – 1 000 nm): 1 MW/cm ²
DETERMINED PARAMETERS		
Focus position x, y, z	yes	yes
Focus radius x, y	yes	yes
Beam propagation ratio M ²	yes	yes
Measured rayleigh length, typ.	28 mm	28 mm
Power density distribution	2D, 3D	2D, 3D
Measurement time per plane dependent on measured parameters (like resolution, rotation speed, position of measuring window)	5 s - 40 s	5 s - 40 s
Linescan	optional	optional
DEVICE PARAMETERS		
Working range x-y	8 x 8 mm (12 x 12 mm or 24 x 12 mm optional)	8 x 8 mm (12 x 12 mm or 24 x 12 mm optional)
Working range z	120 mm	120 mm
Measurement window sizes	0.1 x 0.1 – 8 x 8 mm (at 64 pixel resolution)	0.1 x 0.1 – 8 x 8 mm (at 64 pixel resolution)
Resolution	32x32 px – 1 024x1 024 px	32x32 px – 1 024x1 024 px
Rotation speed	1 875, 3 750, 7 500 min ⁻¹	1 875, 3 750, 7 500 min ⁻¹
SUPPLY DATA		
Power supply	24 V DC ± 5 %, max. 3.5 A	24 V DC ± 5 %, max. 3.5 A
Protective gas (water and oil free)	Helium, nitrogen or argon	Helium, nitrogen or argon
Max. pressure	typ. 0.5 bar (option)	typ. 0.5 bar (option)
COMMUNICATION		
Interfaces	Ethernet, RS485	Ethernet, RS485
Trigger-delay port	optional	optional
DIMENSIONS AND WEIGHT		
Dimensions (L x W x H)	280 x 242 x 218 mm	280 x 242 x 218 mm
Weight (approx.)	8.5 kg	8.5 kg
ENVIRONMENTAL CONDITIONS		
Operating temperature range	15 – 40 °C	15 – 40 °C
Storage temperature range	5 – 50 °C	5 – 50 °C
Reference temperature	22 °C	22 °C
Permissible relative humidity (non-condensing)	10 – 80 %	10 – 80 %