PRIMES

PRODUCTS AND SYSTEMS
FOR LASER BEAM ANALYSIS

CONTENTS

PRIMES – Competence in Beam Diagnostics

PRIMES: Leader in Laser Beam Diagnostics

Founded in 1992 and based in the Rhine-Main region, today the company is an important player on the market, where it is represented by 12 distributors worldwide as well as an affiliate company recently established in Japan. We offer innovative and process-optimized measuring devices for characterizing and measuring the power output of laser beams. Our broad spectrum of high-precision, field proven and robust products is put to use in numerous industrial applications as well as for research and development. System characterizations or failure analyses can be carried out.

Precision: On-Site at the Customer's Facilities or at the PRIMES Laser Technical Center

With its precisely timed manufacturing processes, there is no place for production outages in Industry 4.0. A lot can happen, however, before a laser beam reaches its precise location on the workpiece. Qualified beam diagnostics and beam monitoring on-site at the customer's facilities using powerful PRIMES measuring devices is capable of revealing sources of disruption and error and assisting with the tracking of parameter changes.
At our state-of-the-art Laser Technical Center, typical application situations for the customer can be simulated.

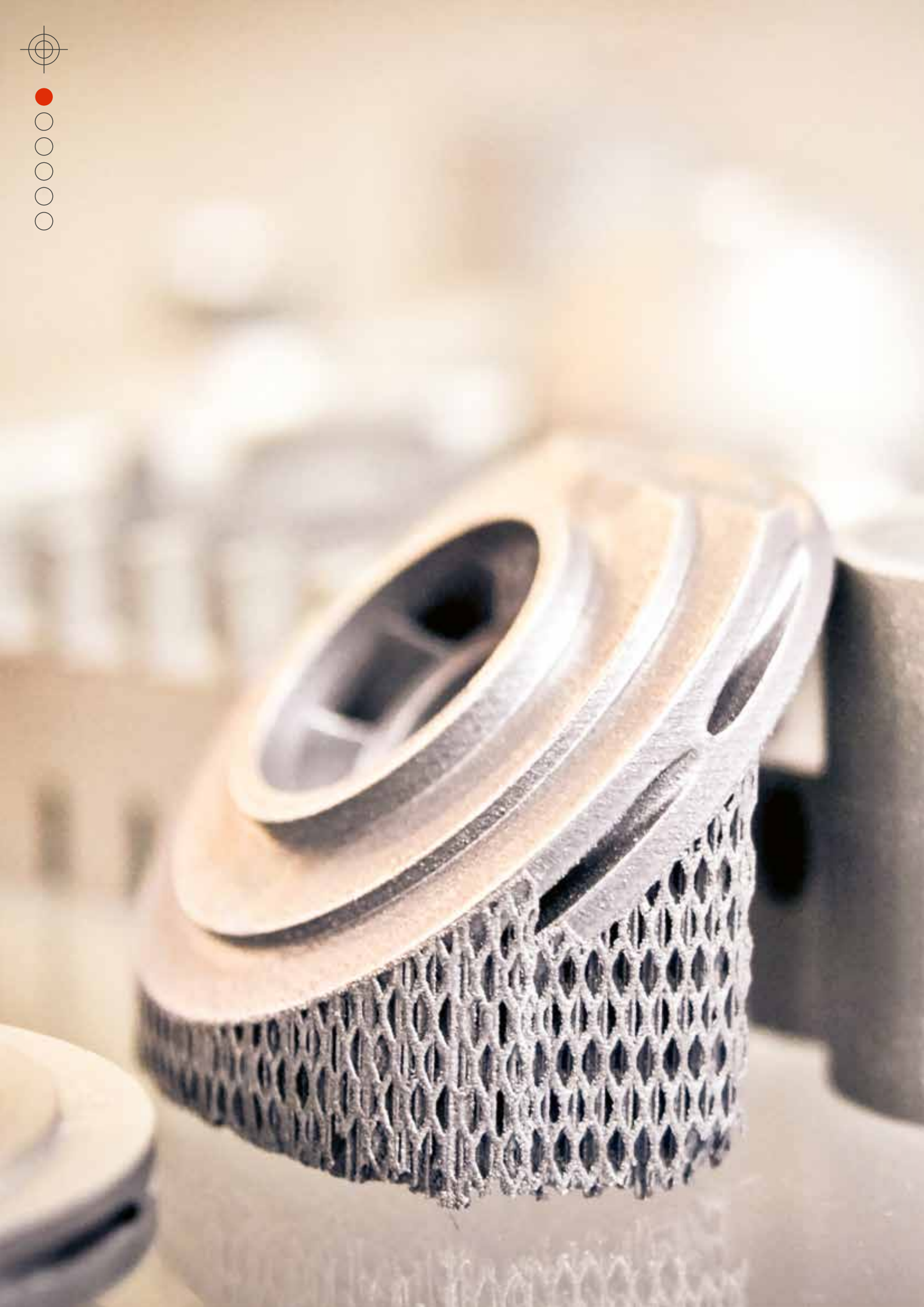
This capability helps us identifying root causes of failures in customer's application. Our broad spectrum of over 10 different beam sources – from the CO_2 laser through to solid-state, disc and diode lasers as well as fiber lasers – offers the perfect conditions for this.

The PRIMES Calibration Lab: No Room for Mistakes

As a certified company, high precision is our standard. Our calibration lab has experience with almost all laser applications and calibrates measuring devices from all manufacturers. The PRIMES reference standard instrument is calibrated at the German National Metrology Institute (PTB) against its National Power Standard instruments.

Capacity for Innovation and Patents

Less than 1 % of German companies are active in research. PRIMES is one of these companies and has been recognized for its special achievements in research and development with the seal of approval of the *Stifterverband*. Releasing between 4 and 6 patents each year, PRIMES is constantly showing its extraordinary capacity for innovation and passion for new proprietary solutions in laser beam diagnostics.



ADDITIVE MANUFACTURING

Layer by Layer

How we achieve high-precision measurements of the laser beam in your 3D system

The technology is still new, yet it has initiated a revolution in production halls. The ability to digitally reproduce shapes using 3D printing and “conjure up” three-dimensional parts practically without tools just by building them up layer by layer has broken the mold for traditional production processes. The more complex a component is, the more economic it will be to produce it using additive processes, whether it be a dental prosthesis, a turbine unit, or replacement parts for a car.

Making the next step into mass production, however, requires adherence to the most exacting requirements for process precision and quality assurance simultaneously with ISO conformity. On the one hand the use of lasers provides the maximum flexibilty in producing complex parts. On the other hand new challenges such as lack of space, excess heat and various angles of incidence of the laser light come into play. This makes it difficult for the measuring devices currently used in additive manufacturing to achieve thorough laser beam diagnostics.

In order to meet the growing needs of this market, we have developed the PRIMES **ScanFieldMonitor** and along with it a patented measuring procedure for additive manufacturing processes. Not only does the new device measure beam propagation parameters such as focus position, focus radius, and Rayleigh length, but it also provides a lot of additional valuable information on the dynamics of your laser machine.

Do you need to measure the power of very high power densities? Then the **Cube M** is the perfect device for you. Its special micro optic makes it suitable for even very slanted beam incidence and facilitates measuring directly in the focus of the laser.

Completing our range of offerings are the **FocusMonitor FMW+** and the **MicroSpotMonitor-Compact**, which can perform complete beam analyses in the small spaces typical of additive manufacturing.

ScanFieldMonitor

Lightyears Ahead: Our All-In-One Turbo

Find out everything worth knowing about your production parameters in less than 3 seconds from the **ScanFieldMonitor** (SFM). You'll soon find that it is as innovative and creative as the 3D production industry itself. A revolutionary patented[1)] measuring process from PRIMES for additive manufacturing processes characterized by a small glass structure, a compact design, and our innovative measuring principle make the ScanFieldMonitor a multifaceted, nimble handheld turbo for laser beam diagnostics and process optimization.

[1)] PRIMES is the owner of US patent 10,184,828 which protects a method for determining properties of a laser beam. The SFM is a sophisticated tool that makes it easier for you to implement this method.

ScanFieldMonitor

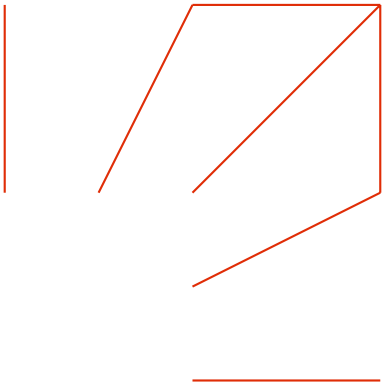
A piece of glass with a specific measuring structure is what distinguishes the innovation of the ScanFieldMonitor (SFM). A photo diode captures the scattered light while scanning the laser beam over this structure and uses this information for fast laser beam characterization. Not only will it tell you the width of the beam on the measuring plane, but it will also allow you to reconstruct the path, position, and length of the beam and determine its speed of movement.

Complex relations such as pincushion distortion, the merging of overlapping scanning fields, and delays in laser activation and deactivation can be analyzed using special measuring schemes. This can be used to synchronize the laser with its scan unit. Using the 3D machine construction platform to move along the z-axis makes it possible to measure the caustic and determine the evenness of the plane. In summary, you will find all of this in the cube-shaped ScanFieldMonitor being small enough to be placed just about anywhere over the working area: a new measuring instrument unique to the market.

All-in-One: All Measuring Tasks in One Device

The greatest advantage of the SFM is that it combines multiple measuring tasks in a single device. This saves the user time and money, regardless of whether you're a mechanical engineer commissioning and maintaining AM machines or a user managing processes and quality.

The compact measuring unit with wireless communication enables you to identify properties at arbitrary positions in the working area under actual process conditions.



The measuring structure of the ScanFieldMonitor

The Key Benefits

1. Access to relevant process parameters outside the range of conventional beam diagnostics devices, such as marking speed or beam analysis in various positions on the structural panel.

2. Combining separate applications for various calibration tasks into a single device cuts down on investments, complexity, and work time.

3. Measurements can be taken under actual operating conditions for laser sintering: laser power and inert gas atmosphere.

4. A compact, powerful service tool suitable for comprehensive on-site scanner analysis.

On a Practical Level

The ScanFieldMonitor meets the demands of scanner-specific measuring tasks, including aspects such as surface evenness, pincushion distortion, focal point shift, or precision of the position and marking speed. The device operates by detecting the scattered laser light on a structured glass plate and is therefore independent of the optical power. This makes it possible to reconstruct the travel path taken by the light and calculate the beam width at multiple positions across the working area.

All of the variables mentioned above can be measured with high resolution and reproducibility.

Model created in laser sintering machine.

Technical Data ScanFieldMonitor

MEASUREMENT PARAMETERS	
Power range	10 – 1 500 W
Wavelength range	1 000 – 1 100 nm
Beam diameter	50 – 500 µm
Max. power density (1 000 – 1 100 nm)	100 MW/cm²
DEVICE PARAMETERS	
Max. angle of incidence perpendicular to inlet aperture	0 – 20 °
Marking speed	0.1 – 10 m/s
Dimension of the scattering pattern	5 mm x 5 mm
SUPPLY DATA	
Power supply	24 V DC; 20 400 mAh Integrated lithium-ion cell in the processing unit, which can be charged via a USB port on the PC with 5 V charging voltage
COMMUNICATION	
Interfaces	WLAN
DIMENSIONS AND WEIGHT	
Dimensions (L x W x H)	80 x 80 x 100 mm ScanFieldMonitor 326 x 160 x 91 mm Processing Unit
Weight (approx.)	1,15 kg ScanFieldMonitor 2,9 kg Processing Unit

SPONSORED BY THE
Federal Ministry of Education and Research

More info about the ScanFieldMonitor

can be found in our whitepaper on our website under
www.primes.de/en/company/latest-news/press.html

Cube M

Power Measuring in the Smallest of Spaces

Narrow, hot, and contorted? Under even the most adverse conditions, our Cube M will show you exactly how your laser system is working in just one shot: so you'll never have to hear the ugly word "power loss" ever again. With its compact and small design, this little power pack can be used even in the tightest working areas and with the highest power densities. This makes the robust, cooling water free power meter perfect for all areas of additive manufacturing.

Rugged, mobile, and yet still extremely precise – that's what you're getting with the Cube M power meter. Internal power readouts from laser beam sources can only show changes at the source of the laser. The full path taken by the laser beam to reach the work piece is of utmost importance, which is why it makes sense to measure power as close to the working area as possible. We developed the Cube M especially for this type of use.

Its palm-sized design allows it to fit easily into the very tight spaces inside machines for use in laser material processing and it is designed to handle very high power densities. For some high-power applications, the irradiation is too intense for standard power meters and will destroy the coating on the absorber. The Cube M, however, can measure power densities of up to 250 kW/cm² with power of up to 2 kW!

Something Special

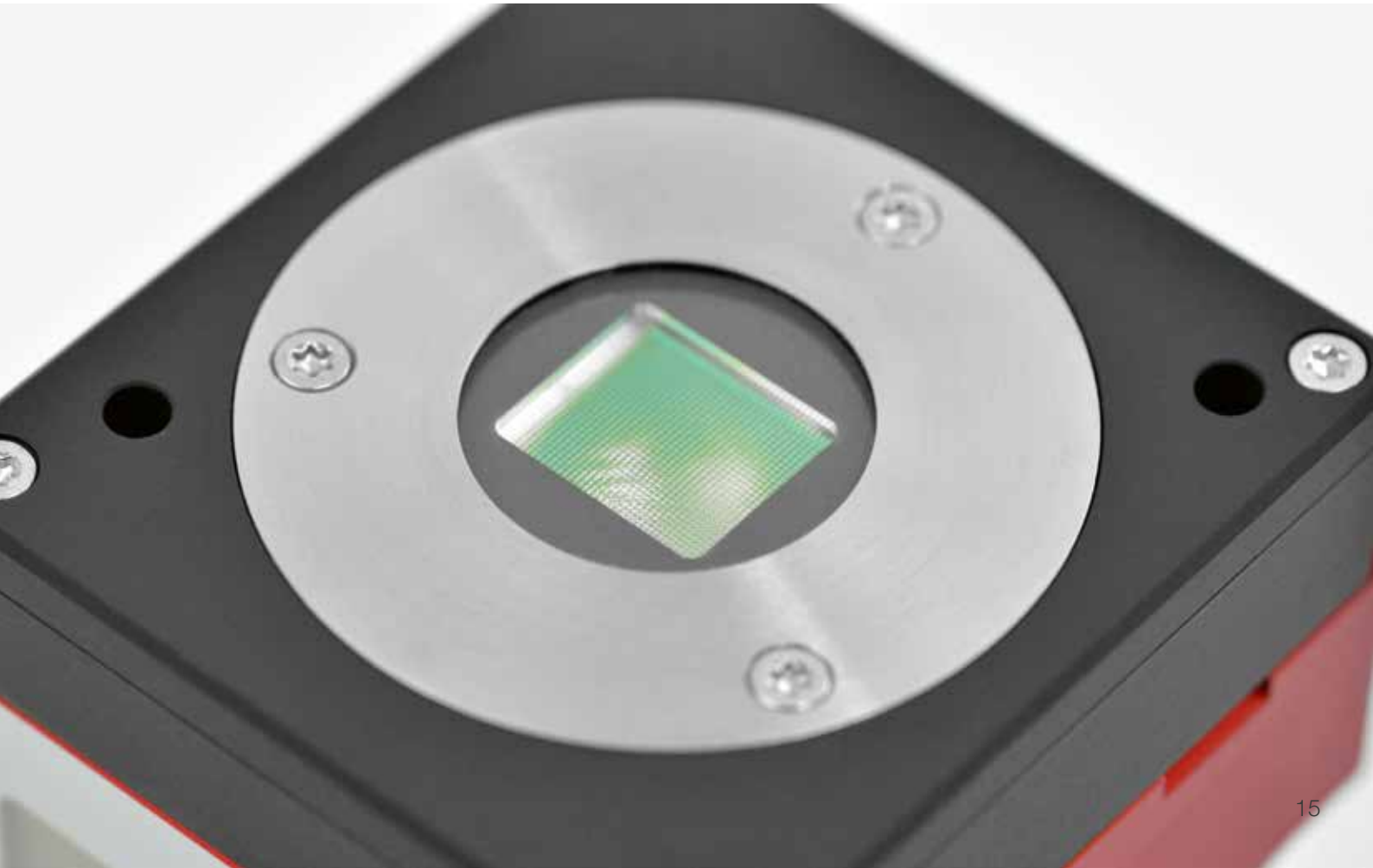
Thanks to the **micro optic at beam incidence** developed by PRIMES, the Cube M can be placed directly under the processing lens in the focused laser beam. Here it is not absolutely necessary for the laser beam to have a perpendicular incidence; deviations of ± 20° in relation to the vertical are acceptable.

These properties make the Cube M perfectly suited to use in micromachining and the revolutionary new industry of additive manufacturing.

The Principle

The absorber of the calorimetric measuring system is irradiated with the laser beam for a short time. Between the beginning and end of irradiation, the temperature of the absorber is recorded. Based on the temperature increase and the thermal properties of the absorber, the microprocessor-based electronic is capable of producing a high-precision calculation of the laser power.

Determining the temperature difference makes it possible to take multiple power measurements in succession. In the display start window, the current temperature of the absorber is shown. When the absorber overheats, an interlock signal will be activated that will stop the laser from emitting power. It is recommended that you use this signal.



The Key Benefits

1. The compact design of just 60 x 65 x 80 mm enable use of the Cube M in places within the system that might normally be out of the question

2. Do more than just record power changes at your laser source, be certain of the entire path of irradiation through to the workpiece

3. By systematically measuring performance at the working level over the entire working range, optical contaminants can be located quickly and effectively

4. Specialized for high-performance applications with highest power densities of up to 250 kW/cm^2

5. Wireless and without cooling water, dust and shock protection

Cube App – Mobile Measuring Using Your Smartphone

Using the PRIMES Cube app (bluetooth) for mobile devices with Android™, you can operate and monitor all Cube models simply and conveniently on a tablet or smartphone. Entire measuring series can be preset through the user-friendly interface on the mobile terminal and transmitted wirelessly to the Cube. It will graphically display the measuring values of laser power, pulse duration, and collected energy per pulse on the mobile terminal.

The Cube app also supplements this information with the standard deviations. You can download the PRIMES Cube app for free from the Google Play Store. A micro-USB interface can be used to connect with a stationary computer and thus use it in tandem with our new LaserDiagnosticsSoftware (LDS) to control the device, analyze and back up data.

Technical Data Cube M

MEASUREMENT PARAMETERS	
Power range	25 – 2 000 W [1]
Wavelength range	1 030 – 1 090 nm
Beam diameter on the protective window	1 - 4 mm
Max. power density on the protective window	250 kW/cm²
Irradiation time	0.1 – 2.0 s [1] (depending on laser power)
Min. on/off times (duty cycle) for pulsed lasers	50 µs (e.g. max. 10 kHz at 50% duty cycle)
Max. laser rise time	100 µs
Energy per measurement	50 – 3 000 J
Recommended energy per measurement	300 – 500 J
Total duration until measurement value output	< 15 s
Nominal measurement frequency	300 J: 1 cycle/min; 3 000 J: 1 cycle/15 min
DEVICE PARAMETERS	
Max. absorber temperature	120 °C
Max. angle of incidence perpendicular to inlet aperture	± 20 °
Max. centered tolerance	± 2.0 mm
Accuracy Angle of incidence up to 5 ° Angle of incidence from 10 ° to 20 °	 ± 3 % ± 5 %
Reproducibility	± 1 %
SUPPLY DATA	
Power supply	Integrated lithium-ion cell, which can be charged via a micro-USB port
Temperature range for charging the lithium-ion cell	0 – 45 °C
COMMUNICATION	
Interfaces	USB/Bluetooth
DIMENSIONS AND WEIGHT	
Dimensions (L x W x H) (without connectors)	60 x 65 x 80 mm
Weight (approx.)	800 g

[1] The stated limit values are to be understood in correlation with the permitted maximum energy (E = P · t).

FocusMonitor FMW+

The Universal Tool for Focus Measurement

Efficient and advanced: Anyone using technology to shed light on things is focused not only on efficiency, but also on consistency. PRIMES beam diagnostics devices are unmatched in their ability to help your beam source ensure consistent workpiece quality. With the FocusMonitor FMW+, we provide a true jack of all trades, ready to show its true colors even in the tightest spaces.

The FocusMonitor FMW+ is specially designed for analyzing continuous irradiation, even at high beam powers. Our universal tool for high-power radiation is the compact version of our proven, globally successful FocusMonitor FM+ with new electronics and an absorber for powers up to 1000 W. Gain the peace of mind that comes with knowing that the quality of the laser beam in your processing system is up to par when you use the compact FocusMo-

nitor FMW+, capable of reliably determining the geometric dimensions of the focused laser beam as well as the focal point location in space, the beam parameter product, and the beam quality factor M^2.

The Principle

The FocusMonitor FMW+ is a mechanically scanning measuring system for measuring focused laser beams with diameters between 100 µm and 3 mm in tight spaces. Unlike the FM+, the FMW+ does not have its own z-axis. You will therefore have to use the z-axis of the laser system to take caustic measurements.

The device can be used to measure NIR as well as CO_2 beams up to 1 000 W laser power. All you need to do is exchanging the measuring tip and the corresponding detector. With a maximum size of 8 x 8 mm, the measurement window can be gaged with a resolution of up to 1024 x 1024 pixels.

Just Exchange: Measuring Tips and Detectors

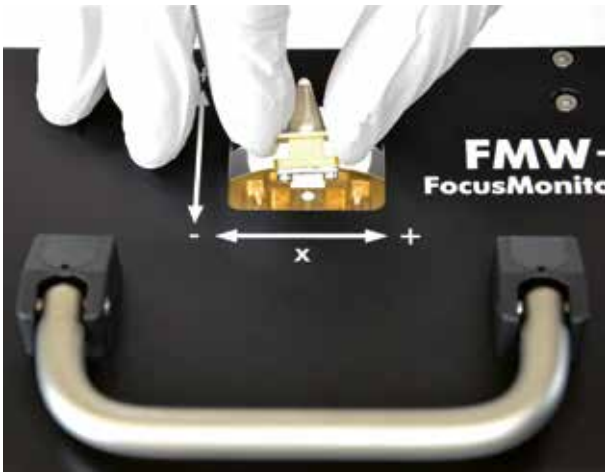
Changing the detector and the measuring tip is easy and can be done by the user in just a few minutes. The full FocusMonitor FMW+ system set includes the main device as well as two detectors, two measuring tips, and a practical transport box as well as other accessories.

(1) Measurement set for NIR beams

- Detector DFIG-PS+
  For measuring NIR lasers, incl. photo diode with electrically variable, adjustable sensitivity, wavelength range 1 – 1.7 µm
- Measuring tip FocusMonitor NIR high div
  For measuring high-power solid-state lasers with adjusted sensitivity, damage threshold up to 10 MW/cm² (7500 1/min and He inert gas)

(2) Measurement set for CO_2 beams

- Detector DFC+
  With passive infrared detector for measuring CO_2 lasers, wavelength range 9 – 12 µm
- Measuring tip FocusMonitor CO_2 high power
  for measuring high-power CO_2 lasers with adjusted sensitivity, damage threshold up to 30 MW/cm² (7500 1/min and He inert gas)



Enhanced Functionality Thanks to new LaserDiagnosticsSoftware

With the new diagnostics tool LaserDiagnosticsSoftware (LDS), the FocusMonitor FMW+ offers considerably more functionality than ever before. In addition to faster data communication via Ethernet, it also allows for semi-automatic or manual measurement of beam density distribution in keeping with innovative standards as well as the measurement of beam position and beam dimensions.
For more information about the new LDS, see **page 96**.

Technical Data FocusMonitor FMW+

MEASUREMENT PARAMETERS	
Power range	up to 1 000 W
Wavelength range	1.0 – 1.7 µm and 9 – 12 µm
Beam dimensions, typ.	100 – 3 000 µm (optionally up to 5 000 µm)
Max. energy per measurement	90 kJ
DEVICE PARAMETERS	
Measurement window sizes	0.1 x 0.1 up to 8 x 8 mm (at 64 pixel resolution)
Resolution	32 x 32 – 1 024 x 1 024 pixel
Rotation speed	1 875, 3 750 rpm
SUPPLY DATA	
Power supply	24 V DC ± 5 %, max. 1.8 A
COMMUNICATION	
Interfaces	Ethernet
DIMENSIONS AND WEIGHT	
Dimensions (L x W x H) Height with the carrying handle folded down	185.5 x 153 x 237.5 mm 208.5 mm
Weight (approx.)	8 kg

MicroSpotMonitor-Compact

Your Eye on the Ground in Micromachining

Camera on: Are you in the business of milling and cutting for micromachining? Then there's no way you can afford to let flaws in quality slip by when you're machining a workpiece. The camera-based focus analysis system MicroSpotMonitor-Compact is specially designed for use in tight spaces in micromachining systems and can be modularly expanded to meet your requirements. Focus in on your beam parameters and benefit from a consistently high level of quality during production.

Top precision is the name of the game for applications such as spot welding in medical technology, laser sintering in SLM systems, or drilling cooling ducts into turbine blades. Beam analysis can be especially hard to perform in tight spaces. It is for precisely these specialized needs that we designed the solid MicroSpotMonitor-Compact, which is perfectly suited to measuring beam waist diameters of NIR beams of 20 – 600 µm and is sure to impress with its many different user prompts.

We have designed the MicroSpotMonitorCompact to take up so little space that it can accommodate a minimal beam entrance height of 150 millimeters resting on the surface of a DIN A5 sheet of paper. It measures the power density distribution (for a single intersecting plane), the beam measurements, and the orientation of the beam in the measuring plane. Depending on the chosen spatial

resolution, repeated measurements can be taken with a repetition rate of up to one Hertz. Although this monitoring device does not have its own axes of movement, caustic measurements conforming to standards can be easily performed in conjunction with an external z-axis: Focus dimensions, focus location in space, beam quality factor M^2, Rayleigh length, and far field divergence are then standard.

The Principle

The laser beam is then magnified using a measuring objective, diffused through two beam splitters, and mapped on a CCD sensor via a reflecting mirror. An additional filter can also be installed in front of the sensor to further attenuate the beam.

The measured data is transmitted to a PC via Ethernet and analyzed using the PRIMES LaserDiagnosticsSoftware. Data can also be optionally determined internally to the device and transmitted to the system controller via a PROFIBUS® interface.

MSM-C redirection with attached cyclone

Operating Modes: From Manual to Fully Automatic

1. The PC-based LaserDiagnosticsSoftware enables you to measure beam density distribution manually and determine the beam position and beam dimensions.

2. Scripts provide semi-automatic control of the MicroSpotMonitor-Compact, for instance for repetitive measuring operations in service, quality assurance, and final inspection. They are individually adapted to the current measuring task. This programmed set of user prompts facilitates highly convenient operation of the MSM-C.

3. The PROFIBUS® option facilitates fully automatic measuring operation. Measuring processes can be controlled completely by machine programs when the machine controller is connected. There is no need for an additional PC when taking advantage of this option.

The Key Benefits

1. Can be fully integrated into the system controller, enabling you to directly control and adjust the beam parameters in your system. Using the optional PROFIBUS® option with or without PC connection, the MicroSpotMonitor-Compact can be controlled directly from your laser machine.

2. Modularly adaptable to your process by accessories such as overhead mounting and 90° beam deflection.

3. From manual to fully automatic, a variety of operating modes are available.

4. Space-saving dimensions of just 230 x 120 x 60 mm for a camera casing with electronics, attenuation, and power absorbers.

Technical Data MicroSpotMonitor-Compact

MEASUREMENT PARAMETERS	
Power range	10 mW – 1 kW average power multi mode and up to 100 W average power single mode
Wavelength range	1 030 – 1 090 nm
Beam dimensions	20 – 600 µm (depending on optics)
CAMERA MODULE	
Modules	3.3× (NA = 0.1) Triggered measurement of pulsed lasers
SUPPLY DATA	
Power supply	24 V DC ± 5 %, max. 1.8 A
Cooling water flow rate	0.7 – 1.2 l/min
Max. water inlet pressure	2 bar
Recommended pre-filter with filter fineness	50 µm
COMMUNICATION	
Interfaces	Ethernet, PROFIBUS® (optional)
DIMENSIONS AND WEIGHT	
Dimensions (L x W x H) (without connectors)	231 × 120 × 60 mm (standard) 275 × 120 × 127 mm (with beam benders) 231 × 120 × 85 mm (PROFIBUS®)
Weight (approx.)	2.6 kg (standard), 3.1 kg (with beam benders), 3.1 kg (PROFIBUS®)

AUTOMATED MANUFACTURING

Laser Beam Diagnostics for Industry 4.0

Don’t let your machines get out of whack

The production of the future will face high demands: It will have to be intelligent, flexible, efficient, and sustainable. But isn’t it already like that today? Ever briefer product life cycles are satisfying ever more rapidly changing demands even faster and correspondingly bring with them high demands for process system flexibility. Top-notch quality is a key factor here and detecting deviations is an integral part of this.

Stopping machines embedded in a network of interrelated steps is often an economic disaster. Maintaining the consistent quality of the laser beam is a basic prerequisite to ensuring ever shorter cycle times in production. The bundled light is a tool vulnerable to wear, however, and even the smallest irregularity could result in lower workpiece quality or unnecessary excess waste. With regular focus analysis, you can track gradual changes in the laser beam, interfere in a targeted manner, and perform predictive maintenance: Is it caused by the beam position, beam symmetry, an alignment error, or thermal effects?

Dirty production environment, systems operating 24/7, limited construction space, electromagnetic disruptions: This too can be a face of state-of-the-art Industry 4.0. PRIMES offers solutions suited to these and many other challenges in laser beam diagnostics. For heavily polluted production environments, we use particularly robust components to protect the valuable lenses and mirrors of the measuring devices. When space is limited, we use especially compact measuring devices or recommend integrating online focus measurement to accompany production into your existing systems, so the line will never have to come to a standstill. All of the major German automotive manufacturers and many international laser manufacturers trust the quality of PRIMES measuring devices for laser beam diagnostics – as part of their strategy for efficiency and flexibility.

Photo: MANZ AG

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.

FocusMonitor FM+

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 geometric 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.

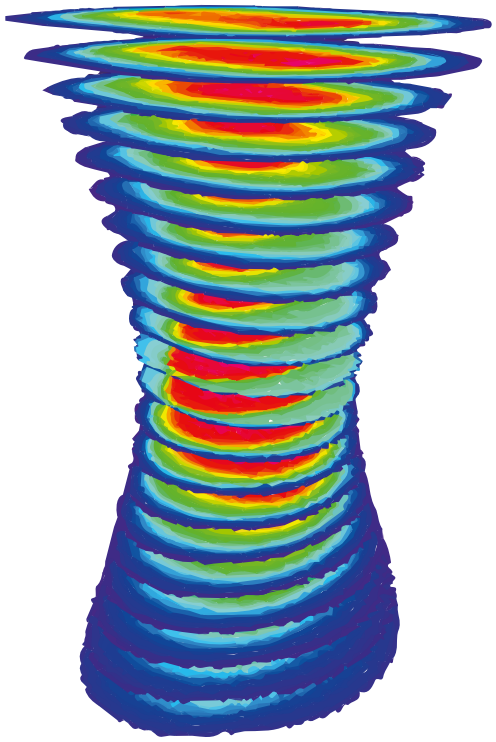
We have further developed the globally successful design of the FocusMonitor FM to create the FM+: sure to excite with new electronics designed to meet current and future requirements for signal processing and a new motherboard ahead of its time with a 16-bit AD converter. An Ethernet interface allows 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

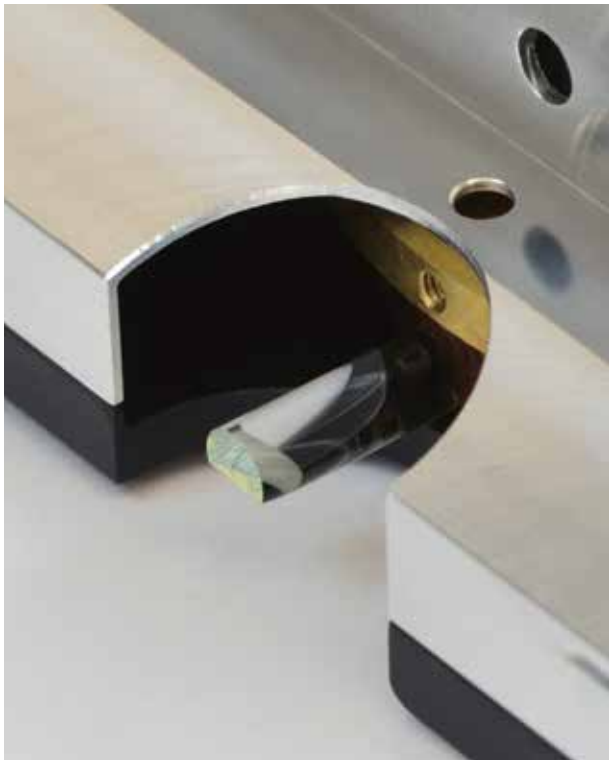
The FM+ is an opto-mechanically scanning measuring system that scans the laser beam with a special measuring tip. This is equipped with a small hole (typically with a diameter of approximately 20 µm) that lets through a small

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 CO_2 lasers (λ = 9 – 12 µm):
Pyroelectric infrared sensors such as DFC+ together with CO_2 high-power measuring tips.

Solid-state irradiation:
High-dynamic detector DFY-PS+ for wavelengths λ = 0.4 - 1.1 µm with automatic signal adjustment. For wavelengths λ = 1 – 1.7 µm 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 (see page 42)**. This makes it possible to measure the laser power as well and ensure that the radiation is securely absorbed.

Technical Data FocusMonitor FM+ and FocusMonitor FM+ HPD

	FM+	FM+ HPD
MEASUREMENT PARAMETERS		
Power range	30 – 25 000 W	100 – 25 000 W
Wavelength range	0.4 – 1.6 µm and 9 – 12 µm	1.0 – 1.1 µm (other wavelengths ranges on request)
Beam dimension, typ.	100 – 3 000 µm (up to 5 000 µm optionally)	100 – 1 200 µm
Max. power density	CO_2 laser (10.6 µm): 30 MW/cm² NIR laser: 10 MW/cm²	NIR laser: 50 MW/cm²
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	yes	yes
DEVICE PARAMETERS		
Working range x-y	8 x 8 mm (12 x 12 mm optional)	8 x 8 mm (12 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	32 x 32 px – 1 024 x 1 024 px	32 x 32 px – 1 024 x 1 024 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	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

FocusParameterMonitor

Know more about your Laser Beam Power

Light as a feather at 10 kilograms – and yet still a heavyweight when it comes down to the analysis of high-power laser systems. Our FocusParameterMonitor can be full automated and integrated into your system to measure your system's laser beam power and geometry. With more knowledge on your current laser beam parameters, you can make predictive planning and maintenance a natural aspect of your processes.

The FocusParameterMonitor (FPM) is a broadly established field-proven system on the market that enables fast determination of laser beam parameters in the processing zone. Its benefits: It is easily integrated into the system and its field bus interface also makes it easy to connect a host of industrial controllers and networks. The FPM was initially designed for laser beam measurements for a special application – laser seam stepper – and has since established itself in a wide range of other areas. Its three

main components, the power meter unit, beam analysis unit, and field bus interface, are all incorporated into a robust aluminum casing.

In order to protect the beam entrance against soiling, we have equipped the FPM with an electrically driven shutter and a removable protective window that can be purged with compressed dry air. The beam parameters of the processing zone are measured periodically. These automated checks form the foundation for process quality assurance.

One of the most common areas of application for the FPM is the automated and periodic monitoring of laser applications – especially in production with high-power lasers possessing a low beam divergence, such as in remote welding or when using laser seam stepper to work sheet metal. The FocusParameterMonitor is your reliable workhorse for laser power parameters, beam propagation, and beam positioning at a wavelength of 1 030 – 1 090 nm. Its maximum laser power is an outstanding 8 kW. Just 0.3 seconds are needed to measure a beam.

The Principle

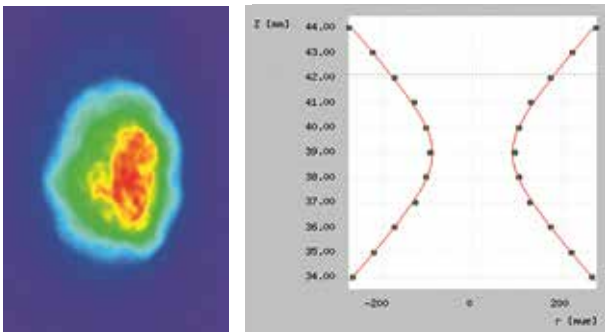
The beam produced by the laser and passing through the processing head is guided into the device using a deflection mirror, where it passes through a beam splitter and deflects off another mirror to reach the measuring component.
The laser power is measured calorimetrically. In order to do so, the laser irradiates the absorber for a defined period of time. Power is calculated based on known heat capacity, temperature increase in the test specimen, and irradiation time. The camera-based beam analysis unit measures the beam geometry and beam position using a CCD sensor. A fieldbus interface will then ultimately convey the measurement data to the system controller, making an additional PC unnecessary.

The Key Benefits

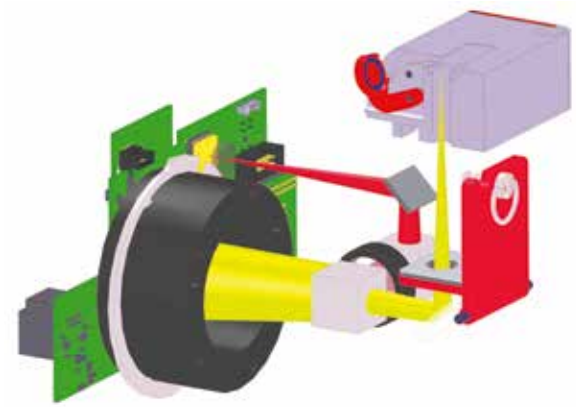
1. Flexible mounting: The FPM can be mounted horizontally as well as vertically. Since there is a risk of soiling, vertical mounting with horizontal beam incidence is recommended.

2. Fully automatic operation: The operation of the FocusParameterMonitor is fully automated. Measuring processes can be controlled completely by existing machine programs when the machine controller is connected.

3. Three imaging types to meet your specific needs, each available with a fieldbus interface (PROFIBUS®, PROFINET®): Display 1:1 with maximum divergence 60 mrad, display 5:1 with maximum divergence 100 mrad or display 3:1 with maximum divergence 160 mrad.



Measuring a caustic with the FPM (Optional interface to the external z-axis is necessary)



Measuring principle of the FocusParameterMonitor

Technical Data FocusParameterMonitor

MEASUREMENT PARAMETERS	
Power range (300 ms; 3000 J)	400 – 8 000 W
Wavelength range	1 030 – 1 090 nm
Beam dimensions	50 – 1 000 µm
Max. spot diameter at the aperture	2 mm
Max. power density (60 mm below aperture on protective window)	1 MW/cm²
Max. beam divergence (depending on configuration)	60, 100 or 160 mrad
Irradiation time	0.3 – 1 s
Energy per measuring cycle	100 – 3 000 J
SUPPLY DATA	
Power supply	24 V DC ± 5 %, max. 0.5 A
Pressure	0.5 – 1 bar
COMMUNICATION	
Interfaces (alternatively)	PROFINET®, PROFIBUS®, Ethernet (optionally)
DIMENSIONS AND WEIGHT	
Dimensions (L × W × H) (without connectors)	210 × 185 × 153 mm
Weight (approx.)	10 kg

BeamControlSystem

Always on the Safe Side

More options with 2-in-1: The BeamControlSystem combo device is designed to automatically measure the most important laser beam parameters on industrial laser production lines. This robust system reliably measures beam power, caustic, and power density distribution. Discover the many different functions it has to offer!

With our proven FocusMonitor and powerful CompactPowerMonitor all packed into one, the BeamControlSystem (BCS) offers focus analysis and power metering and is perfectly suited for permanent integration into a laser material processing system. The beam entrance is protected in standby mode by a pneumatic shutter. This allows the BeamControlSystem to be operated reliably

in rough, industrial environments. A laser beam welding robot cell is a typical area of application for the BeamControlSystem, where it might be mounted at a reference point for example. Every time the robot and/or Cartesian axes are referenced, a laser beam analysis can be performed. The robot or master controller open the entrance shutter and a measuring cycle starts.

The Principle

Both systems communicate via a superordinate controller, preferably using script control from the PRIMES LaserDiagnosticsSoftware. This enables fully automatic measurement of laser power and focus geometry using the laser or system controllers. In order to determine the quality, measurement data can be compared with specified limit values using the EVALUATION feature.

The Key Benefits

1. Full control: When min./max values are set for the focus dimensions, laser beam power, etc., a warning is issued with the EVALUATION FEATURE as soon as these threshold values are exceeded.

2. Predictive quality assurance: Manual evaluations allow for the recording of measurement data and the identification of trends. This is helpful, since changes in the focus location, focus dimensions, beam quality factor M^2, or beam parameter product can often creep up on you, changing subtly over time.
As a result, the heat-affected zone of a laser beam welding process may grow slowly and steadily. Accordingly, heat-related warping of the finished components would then gradually increase constantly over time and perhaps even go unnoticed.

Interior view of the BeamControlSystem

Measured Beam Parameters

- Beam power
- Focus position
- Focus diameter
- Rayleigh length
- Beam parameter product
- M^2
- Ellipticity
- Beam direction

Properties of the BeamControlSystem

- Focus measurement from 0.2 mm to 3 mm radius
- Script-controlled automatic measurement processes
- Monitoring limit values for beam parameters
- Electro-pneumatic shutter
- PLC interface for communicating with laser and system controllers
- Control and measurement data management via PC
- Fieldbus interface for system integration

Technical Data BeamControlSystem

MEASUREMENT PARAMETERS	
Power range, typ.	1 – 10 kW
Wavelength range, typ.	NIR, 10.6 µm
Beam dimensions, typ.	200 – 1 000 µm
SUPPLY DATA	
Cooling water flow rate, typ.	5 – 12 l/min
Cooling water pressure	6 bar
COMMUNICATION	
Interfaces (alternatively)	PROFIBUS®, PROFINET®, RS485, Ethernet
DIMENSIONS AND WEIGHT	
Dimensions (L × W × H)	400 × 245 × 355 mm
Weight (approx.)	30 kg depending on configuration

Please see technical data for FocusMonitor (page 26) and CompactPowerMonitor (page 58).

More info on the BeamControlSystem

Speak with our sales team to figure out the perfect BSC configuration to meet your needs: Sales@primes.de or by phone at +49 6157 9878-0.

PowerMeasuringModule

Tracking the Pulse of a Robot

Regardless of whether you're welding or soldering with a laser, macroprocessing or microprocessing, using pulsed or continuous irradiation – wherever high light intensities come into play, the PowerMeasuring-Module will be close at hand. It measures the current laser power from its permanent position mounted directly in the production environment and ensures the consistently high quality of industrial materials processing with a laser.

Permanently installed and with no need for cooling water and compressed dry air, the highly reliable laser power measurement system PowerMeasuringModule (PMM) is perfectly suited to a wide variety of applications in auto-mated production with solid-state lasers. The system can be optimally integrated into the system controller via a fieldbus interface. This is allowing you to monitor and document the optical power fully automatically during production and directly in the process environment.

You can thus form the foundation for laser beam monitoring in tandem with production processes - a key component of quality assurance when manufacturing with a laser.

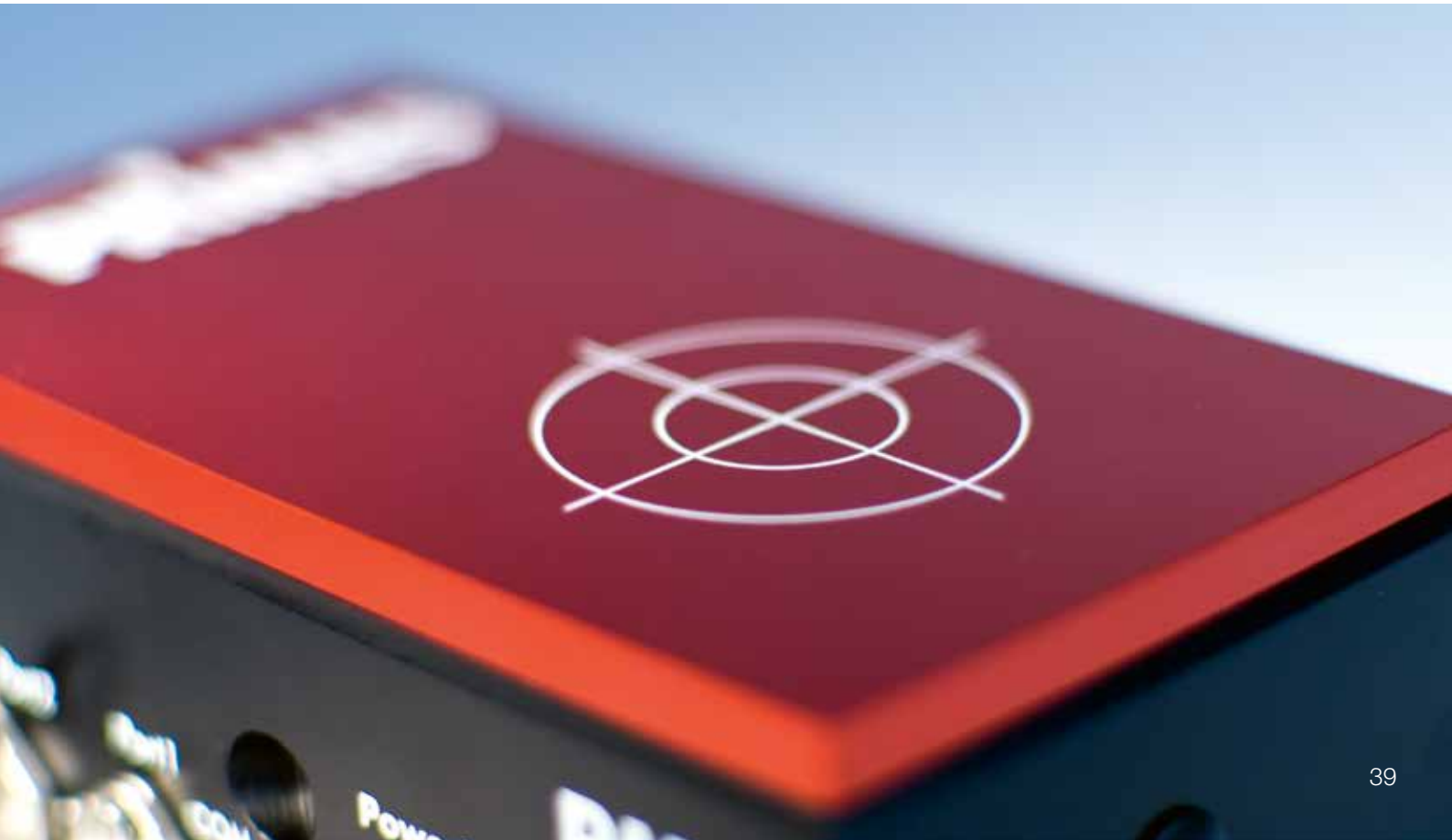
The Principle

The PowerMeasuringModule performs calorimetric measurements of laser power. In order to do so, it uses the laser to irradiate the test sample (absorber) for a defined period of time. Three parameters are enough to calculate the optical power within just a few seconds: heat capacity of the absorber, increase in temperature, and irradiation time. The measuring result itself is independent of the beam dimensions and beam position. Measuring the exposure time further enhances the reliability of the results. The power meter operates without cooling water and compressed dry air. The absorber cools off solely through thermal conduction of the ambient air. This does, however, limit the system's measurement frequency. The system controller can, however, retrieve the absorber temperature at any time and thus determine if and possibly which new irradiation time is possible for the PowerMeasuringModule. A mechanical shutter on the entrance opening and protective window securely protect the measuring device from soiling.

New: Thanks to the new absorber, the maximum power density has been increased to 4 kW/cm^2.

On a Practical Level

Our PowerMeasuringModule is made for plant manufacturers or end users specialized in production with lasers. The system has been successfully put to use in the automotive manufacturing industry, where solid-state lasers are often used to weld the autobodies (Nd: YAG, fiber, disc, or diode lasers). Often the systems are run by robots, with the laser power being monitored during process breaks or auxiliary process time as necessary. In order to take a measurement, the robot with the laser processing head will move to the measurement position where the PowerMeasuringModule is located. The measurement is taken of the defocused beam.
Our industrial power meter PMM has proven effective for



macro as well as micro processing. Its area of application can be optionally expanded to include low to medium power levels and pulsed irradiation. The PowerMeasuring-Module can reliably diagnose the laser power parameter at a wavelength of 900 – 1 090 nm. Its maximum laser power amounts to an outstanding 12 kW and a beam is typically measured in 0.3 seconds.

Measuring Process in 3 Steps

The PowerMeasuringModule is operated exclusively using the system controller. A measuring process is essentially comprised of three steps.

1. Getting ready for measurement: The robot head moves to the measuring device, while the shutter opens. The robot is in position.

2. Measurement is performed: The laser pulse is triggered and ended.

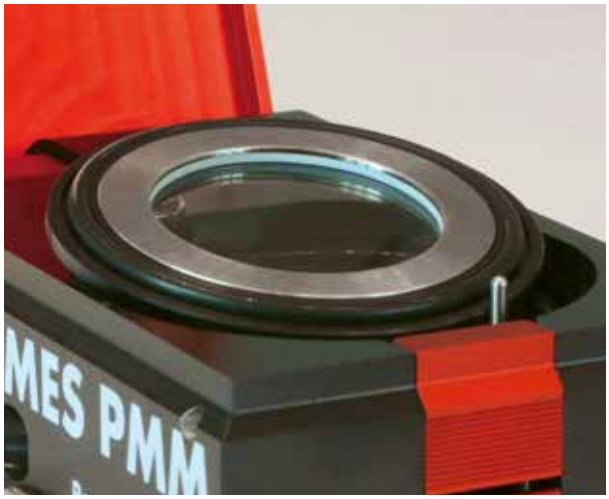
3. Assessing the measurement: The robot can move away. Now just wait to receive the signal “measurement ended”.

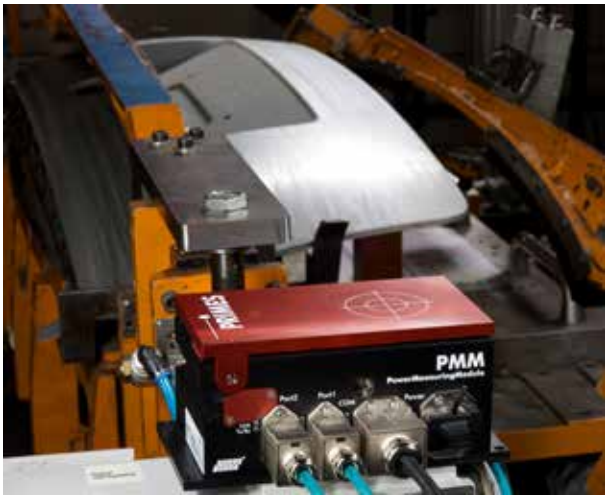
The Key Benefits

1. Time-saving measurement process and short cycle: In order to shorten the measurement duration, the robot’s standstill period can be shortened to irradiation time.

2. Custom design: The end user can use the system controller to independently and optimally configure the measuring results to meet their own needs. The fieldbus system used determines how data is communicated.

3. Numerous models and options: It comes standard with exposure time measurement and protective window cartridge, which can be quickly replaced without tools. Choose one of our designs: with PROFINET® copper line, with PROFINET® glass optical fiber technology, with PROFIBUS®, with Ethernet/IP™, with EtherCAT™, with DeviceNet™, for use with low to medium power levels (of 50 W) as well as pulsed radiation.





The PowerMeasuringModule is employed especially in robot based production such as the automotive industry

Technical Data PowerMeasuringModule

MEASUREMENT PARAMETERS	
Power range	400 – 12 000 W [1]
Wavelength range	900 – 1 090 nm
Max. beam dimensions	30 mm
Typ. beam dimensions	15 – 25 mm
Max. power density (peak) on the absorber (approx. 25 mm underneath the protective window) at beam diameters: > 10 mm	 4 kW/cm²
Irradiation time	0.1 – 2.0 s [1] (depending on laser power)
Max. laser rise time	100 µs
Energy per measurement	50 – 3 000 J
Recommended energy per measurement	300 – 500 J
Total duration until measurement value output	< 15 s; optional 3 s [2])
Nominal measurement frequency	400 J: 1 cycle/min; 3 200 J: 1 cycle /10 min
DEVICE PARAMETERS	
Max. angle of incidence perpendicular to inlet aperture	± 5 °
Max. centered tolerance	± 2.0 mm
Accuracy with an angle of incidence up to 5 °	± 3 %
Reproducibility	± 1 %
SUPPLY DATA	
Power supply DC IN DC OUT	 24 V DC +25 % / -20 %; 250 mA 24 V DC / max. 5 A
COMMUNICATION	
Interfaces (alternatively)	PROFINET® copper/fiber optics PROFIBUS® DeviceNet™ Ethernet/IP™ EtherCAT™
DIMENSIONS AND WEIGHT	
Dimensions (L × W × H)	200 × 100 × 89 mm (closed) 246 × 100 × 227 mm (open)
Weight (approx.)	2.2 kg

[1] The stated limit values are to be understood in correlation with the permitted maximum energy (E = P · t).
[2] Optional: Reduction of total duration until measurement value output to 3 seconds possible. Please contact us.
[3] The On/Off-time must be greater than 500 µs.

PowerMonitor

The Superstar for your Light Power Measurements

More than just monitoring: Designed for a very high degree of absorption with minimal back reflection, the PowerMonitor is our best in class for all laser power measurements.
Prevent unnecessary idle periods, sorting out, or production losses and ensure the quality of your laser system, in short: Put your company's trust in the capacity and reliability of the PowerMonitor.

The PowerMonitor (PM) is the perfect match for each and every laser manufacturer as well as production equipment manufacturer who needs to measure high-power laser beams. Its attractive qualities include flexibility in the area of use: Thanks to its great degree of mobility, the device can also be used on a wide variety of machines within your factory. It can be permanently installed, so integrated into the industrial production system, as a fixed component of your laser machine.

Connector panel of the PM 48

Shutter and entrance aperture

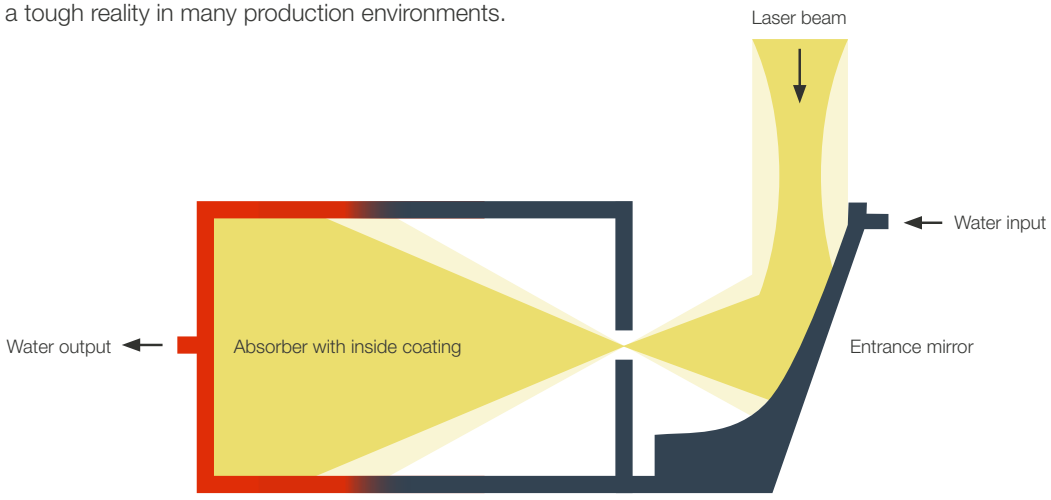
The Principle

Laser power is measured calorimetrically. The laser is guided into a cylindrical absorber via a focusing mirror. A highly absorbent coating has been applied to the inside of the water-cooled absorber, which produces a very high degree of absorption with very little back reflection.

This procedure works even at the highest powers. All parts that come in contact with the cooling water are made of copper or brass, thus effectively preventing voltage corrosion in the cooling circuit. A pneumatic shutter protects the PowerMonitor against the soiling that is ultimately a tough reality in many production environments.

Impressive Beam Parameters

The PowerMonitor measures the beam parameters of continuous wave lasers in the wavelength range of solid-state lasers (NIR) or CO_2 lasers, depending on design and calibration. Choose one of a variety of models covering power ranges from 300 W to 25 kW in order to meet your needs. PRIMES even offers a powerful 75 kW variant for unique areas of application.



Schematic beam path in the PowerMonitor with cylindrical absorber and entrance mirror

Display and Data Communication

All measurement data can be shown on the integrated LCD display of the PowerMonitor. It is also possible to operate the PowerMonitor on a PC using the graphic user interface of the new LaserDiagnosticsSoftware.

This facilitates analog display of current power as well as the recording of development over time. An output signal proportional to power (0 – 10 V) is also available. In addition to the irradiated power, the current flow rate, water temperature, and temperature increase at the water intake and output are also displayed.

The Key Benefits

1. Absorption of high-intensity radiation
2. Highest degree of absorption
3. Long-term stability
4. Precision
5. Reproducibility
6. Short measuring time

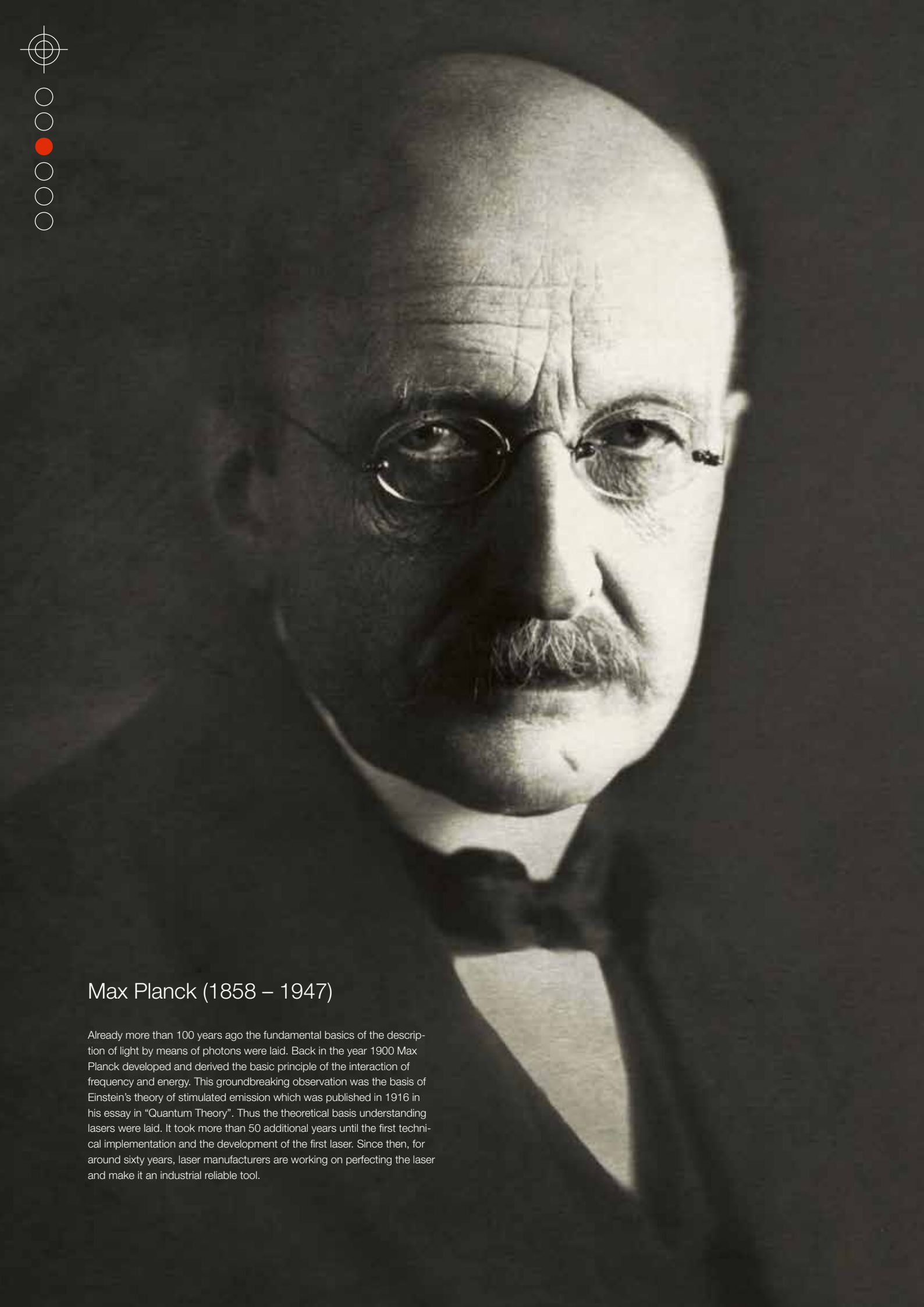
Close-up of the entrance mirror

Technical Data PowerMonitor

	PM 48	PM 100
MEASUREMENT PARAMETERS		
Power range	300 W – 8 kW	1 kW – 25 kW
Wavelength range	800 – 1 100 nm or 10 600 nm	800 – 1 100 nm or 10 600 nm
Irradiation time	continuous	continuous
Max. power density	15 kW/cm²	5 kW/cm²
DEVICE PARAMETERS		
Entrance aperture	48 mm	100 mm
Accuracy	± 2 %	± 2 %
Reproducibility	± 1 %	± 1 %
Time constant	15 s up to 99 % of final value	60 s up to 99 % of final value
SUPPLY DATA		
Power supply	24 V DC ± 5 %, max. 0.5 A	24 V DC ± 5 %, max. 0.5 A
Cooling water flow rate	> 5 l/min	> 5 l/min
Minimum cooling water flow rate (load limit)	0,8 l/min/kW	0,8 l/min/kW
Maximum water inlet pressure	6 bar	6 bar
COMMUNICATION		
Interfaces	serial/RS485/USB	serial/RS485/USB
DIMENSIONS AND WEIGHT		
Dimensions (L x W x H) (without connectors)	405 x 242 x 125 mm	580 x 330 x 215 mm
Water connection, diameter	12 mm	16 mm
Weight (approx.)	10 kg	50 kg
Mounts for connection of a FocusMonitor	optional	optional
Fiber adapter	optional	optional

More Information about the PowerMonitor

PowerMonitor ready to measure up to 75 kW is coming soon!



Max Planck (1858 – 1947)

Already more than 100 years ago the fundamental basics of the description of light by means of photons were laid. Back in the year 1900 Max Planck developed and derived the basic principle of the interaction of frequency and energy. This groundbreaking observation was the basis of Einstein's theory of stimulated emission which was published in 1916 in his essay in "Quantum Theory". Thus the theoretical basis understanding lasers were laid. It took more than 50 additional years until the first technical implementation and the development of the first laser. Since then, for around sixty years, laser manufacturers are working on perfecting the laser and make it an industrial reliable tool.

LASER MANUFACTURER

Power is Energy Over Time

You transform power into output. We take care of consistency.

Precision meets precision: With growing acceptance of laser technology in industry, not only are laser manufacturers discovering new applications and opportunities for growth, but they are also encountering new challenges. That's because as a manufacturer of laser beam sources, "quality and reproducibility" is the currency you deal in, and it has to remain consistent and top-notch.

Developing technically solid lasers is one thing. Meeting the demands of the laser integrator is another thing altogether. As demand for high-quality beam sources rises, you as a laser manufacturer need highly flexible and yet robust measuring systems to reliably measure your beam sources, improve them, and ensure your own quality. Above all, the laser as a tool must offer the greatest power stability and must be capable of delivering 100 % reproducible results starting in the first millisecond of operation.

Benefit from PRIMES measuring devices "made in Germany". For almost 30 years, we have been developing products and systems for high-tech laser beam diagnostics. We register patents regularly and are always a step ahead of the demands on the market. Make this fascinating expertise your competitive advantage.

At PRIMES, laser manufacturers enjoy a comprehensive, innovative, selection of measuring systems for a wide variety of industrial applications that can be used for spot-on discovery of the optimization potential of your beam sources. Relevant measuring values include beam quality, power, power stability, and power density distribution. In our CompactPowerMonitor, for example, you will find a compact measuring device to facilitate continuous output measurements directly out of the fiber not only on-site in your manufacturing plant, but also at your customer's plants.


Step
Locking
1
2

LaserQualityMonitor LQM+

Safety First for Laser Manufacturers

Fast & safe: The **LaserQualityMonitor LQM+** is the perfect measuring device for automatically determining the beam parameters of a beam source.

The measuring system is compact, easy to adjust, easily customizable, and offers measuring methods that go above and beyond the current market standards. These are ideal conditions for manufacturers and operators of beam sources.

LaserQualityMonitor LQM+

With the LQM+, PRIMES provides an integrated solution for fast, simple analysis of a beam of lasers. Not only does it measure, characterize, and qualify the beam propagation of lasers from the UV to NIR range, but it also allows you to more easily analyze errors in the optical design of resonators and beam display systems. One very common area of application for the LaserQualityMonitor is in quality assurance for the production of laser light sources.

Impressive Concept

The LaserQualityMonitor LQM+ directly measures the power density distribution of a focus geometry generated by an integrated focusing lens. That and its compact design makes this system so popular and successful on the market. Advantages of this measuring method: Disruptions caused by diffraction patterns, misalignment, asymmetries, and other effects are immediately visible in the measured power density distributions. With this

measuring instrument the automated parameter measurement is carried out in strict conformity with the ISO 11146 standard in a very short time.

The LQM+ is positioned directly in front of the laser to be measured and aligned toward the laser beam. All optical components and measuring functions are integrated in the basic system. With attachment modules, a beam splitter, absorber, and alignment unit can be added at any time and thus increase its capacity to deal with power levels up in the multi-kilowatt range. The water-cooled absorbers are each equipped with integrated modules for measuring the laser power. Fiber holders, collimators, neutral-density fiber inserts, and additional measuring objectives are available as necessary.

The Principle

Background: Characterizing the properties of a collimated laser beam with Rayleigh lengths of typcially 10 meters requires a lot of work because of the very long measuring paths of 3 – 6 Rayleigh lenghts. This generally makes it impossible to perform this type of measurement due to space constraints. Therefore the ISO 1146 recommends alternatively measuring a caustic created by focusing in order to determine the beam quality factor M^2.

The LQM+ generates this caustic internal to the device by focusing the collimated laser beam shining in. The focused beam passes through multiple integrated attenuators and a lens to appear magnified on the CCD chip. Using the two-dimensional power density distribution, the new LaserDiagnosticsSoftware determines the radius, location, and alignment of the beam. It is through this process of setting up and repeating measurements at different positions in the device that all parameters necessary to describe the artificial caustic are determined. The electronic exposure time control of the CCD chip expands the system's dynamic area. As a result of this, it generally isn't necessary to adjust the filter during a measurement.

By focusing and characterizing the laser beam, it is possible to shorten the measuring path from several meters to a few millimeters. This makes it easy to determine the M^2 value, since it is possible to ensure that the optical setup used for focusing will not produce any aberrations that could influence the measured beam. The values of the beam parameters from the focused laser beam are used to derive the values of the collimated beam as specified in ISO 11146.

The new Features of the LQM+

1. Accelerated measurement
2. Fully automated caustic analysis according to ISO 11146
3. Operation and presentation with the new PRIMES LaserDiagnosticsSoftware
4. Optionally available for up to 20 kW
5. Integrated power measurement in the versions LQM+ 500, LQM+ HP10 and LQM+ HP20

Beam Parameters

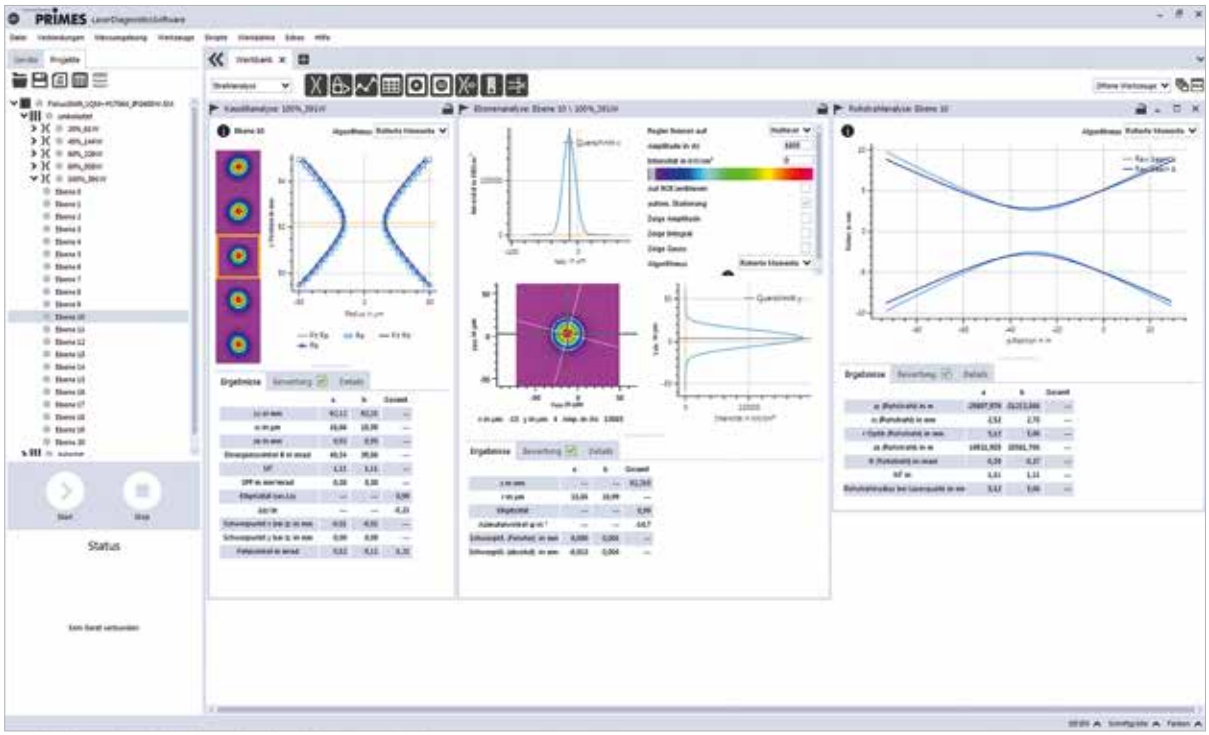
- Focal point/focus in relation to the beam entrance in the LQM+
- Beam radius
- Far field divergence
- Rayleigh length
- Laser power
- Beam quality factor M^2

Diverse Models & Options

- Tool holder for collimators with 35 and 40 mm outer diameter
- Collimators with fiber connectors LLKD and QBH
- Measuring objective 1:1, 5:1 and 1:2
- Wavelength range: 1 030 – 1 090, 515 – 545 and 340 – 360 nm
- Neutral-density filters OD1, OD2, OD3, OD4, OD5

The Key Benefits

1. Full caustic measurement in a few seconds
2. Fully automated measurement of M^2 value
3. Laser qualification in accordance with ISO 11146 in a few seconds
4. Easy operation thanks to programmed user prompts
5. Integrated solution, optionally expandable



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

Technical Data LaserQualityMonitor LQM+

	LQM+ 20	LQM+ 200/500	LQM+ HP10	LQM+ HP20
MEASUREMENT PARAMETERS				
Max. laser power (for 1064 nm) [1, 2]	20 W	200 W (opt. 500 W)	3 kW (single mode) 10 kW (multi mode)	5 kW (single mode) 20 kW (multi mode)
Pulse duration	100 fs – cw	100 fs – cw	100 fs – cw	100 fs – cw
Wavelength range	340 – 360 nm 515 – 545 nm 1 030 – 1 090 nm	340 – 360 nm 515 – 545 nm 1 030 – 1 090 nm	1 030 – 1 090 nm	1 030 – 1 090 nm
Beam dimensions [1] Single mode Single mode (reduced power) Multi mode Multi mode (reduced power)	 1,5 – 9 mm - 1,5 – 15 mm -	 1,5 – 9 mm - 1,5 – 15 mm -	 7 – 9 mm 1,5 – 7 mm 12 – 15 mm 1,5 – 12 mm	 14 – 16 mm 8 – 14 mm 18 – 22 mm 8 – 18 mm
Max. beam divergence	10 mrad	10 mrad	10 mrad	10 mrad
SUPPLY DATA				
Power supply	24 V DC ± 5 %, max. 1.8 A	24 V DC ± 5 %, max. 1.8 A	24 V DC ± 5 %, max. 1.8 A	24 V DC ± 5 %, max. 1.8 A
Cooling	air cooling	air cooling (opt. water cooling)	water cooling	water cooling
Recommended Cooling water flow rate	–	1.5 l/min	7 – 8 l/min	18 – 20 l/min
COMMUNICATION				
Interfaces	Ethernet	Ethernet	Ethernet	Ethernet
DIMENSIONS AND WEIGHT				
Dimensions (L x W x H)	285 x 190 x 180 mm	350 x 230 x 190 mm	480 x 300 x 190 mm	495 x 320 x 190 mm
Weight (approx.)	10 kg	18 kg	35 kg	40 kg

[1] Single mode < 1,5 mm x mrad < multi mode

[2] The maximum allowed laser power depends on wavelength, beam quality, raw beam diameter and the pulse characteristics of your laser. For further information please contact your local sales partner.

BeamMonitor BM+

Brilliant Minds rely on Beam Analysis

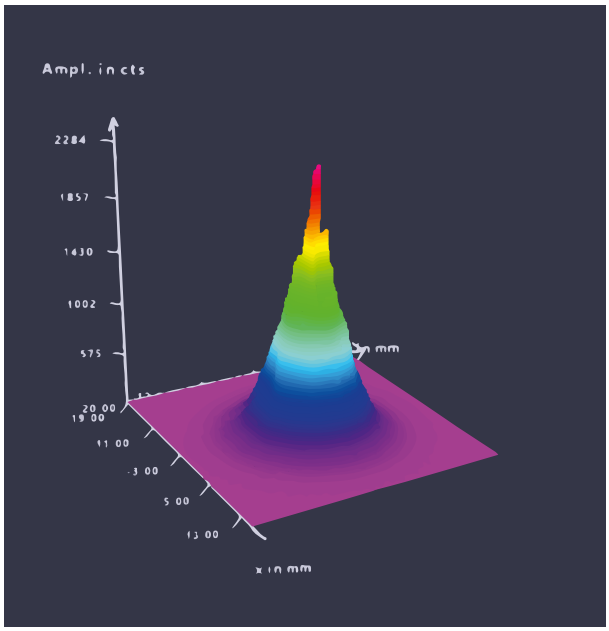
Are you using an industrial laser for cutting and joining or finishing surfaces? Then surely you are no stranger to the radiant power of precision and its significance for efficiency and productivity in your company. Even the smallest deviation, a gradual increase in degradation, is an absolute economic no-go that you can now proactively combat with a reliable solution for analyzing unfocused beams: the BeamMonitor BM+.

Regular monitoring helps: The BeamMonitor BM+ is a measuring device possessing the latest electronics for performing beam diagnostics on the unfocused, continuous wave laser beams of CO_2 and solid state lasers with high power output. Analyzing and documenting the laser parameters can allow you to further optimize working processes and/or identify undesirable deviations such as soiling, incorrect beam positioning, or faulty optics adjustment. The BeamMonitor BM+ reliably measures beam position, beam dimensions, beam symmetry, and power density distribution. Especially developed for use in harsh industrial production environments, the device can be adapted to all kinds of spacial conditions and can even be installed upside down without additional components.

Detecting Wear and Deviations

In practice, laser beams are often “customized” for the respective area of application using telescopes and adaptive lenses. As a result of this, the beam waist diameter and divergence of the laser beam often change dynamically, which then might change the focus dimensions or focus location in modern systems for laser cutting or welding.

The focus is therefore on penetration through the material surface, but it is "pushed" into the material for the actual cutting process. For laser welding, one setting may be used to tack a piece, while the another is used to weld. In addition to variation, a number of other variable parameters can also be analyzed and documented. With its ability to detect wear on laser lenses, which could have a negative impact on processing results, the BeamMonitor BM+ has also earned a place in quality assurance and laser approval. Diode lasers and other solid-state lasers are checked in the collimated range and can thus be assessed with relatively little effort.



Measurement of the power density distribution with the BM+

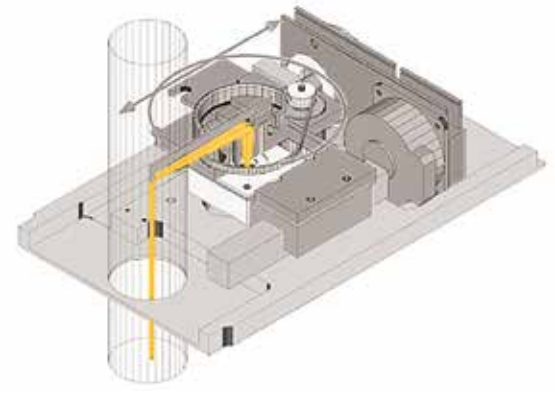
The Principle

A rotating measuring tip gathers measurements of the laser beam at points. The mirror holder is also moved linearly in order to scan the entire beam profile. One partial beam is directed to the detector at a time and measured in this way. The fast 16-bit AD converter and a high resolution of up to 1 024 x 1 024 pixels facilitate exact analysis of even the smallest disturbances in the raw beam.

The raw data generated by BM+ can be analyzed using the new LaserDiagnosticsSoftware developed by PRIMES. Here is what LDS offers standard:

- Beam measurement
- Beam position
- Measurements: single measurements, series measurements (monitor operation), and measurement of development over time (linescan)
- Displays: isometry, false colors, contour, line presentation and display of numeric results
- Data storage in PRIMES format .lpf as well as CSV and export graphic

Note: During the measurement, the entire beam exits the BeamMonitor and must be absorbed as fully and securely as possible, with the PowerMonitor for example.



Sketch to the mechanical setup of the BM+

Easy Operation

You will love operating the BeamMonitor BM+: Our diagnostics tool LaserDiagnosticsSoftware contains extensive tools for analyzing, presenting, and preparing measurement data, including a report feature. Data communication via Ethernet connection.

BeamMonitor BM+ 100

Diverse Models & Options

1. BeamMonitor BM+ 60 and BM+ 100: Depending on the beam size and geometry, the BeamMonitor BM+ can be used with apertures of 60 or 100 mm. Both are available for CO_2 and NIR lasers. The aperture must correspond to at least 1.4 times the laser beam diameter, so that any intensity along the edge does not hit the BM+ housing, the measuring range is not unnecessarily limited, and/or a distorted measuring result is not produced.

2. BeamMonitor BM-HQ: Model for a detailed analysis of CO_2 irradiation with small outside dimensions, low weight of just 1.5 kg and additional linescane feature. The BM-HQ has been successfully in use for many years now and replaces the typical plexiglass penetrations for identifying the beam profile or the beam symmetry. Its mechanically scanning system measures the power density of collimated laser beams at full power.

Technical Data BeamMonitor BM+ and BM-HQ

	BM+ 60	BM+ 100	BM-HQ
MEASUREMENT PARAMETERS			
Power range	50 – 25 000 W	50 – 25 000 W	50 – 10 000 W
Wavelength range	1 030 – 1 090 or 10 600 nm	1 030 – 1 090 or 10 600 nm	10 600 nm
Beam dimensions	10 – 42 mm	10 – 70 mm	5 – 35 mm
Max. power density	10 kW/cm²	10 kW/cm²	< 10 kW/cm²
Max. beam divergence	100 mrad	100 mrad	< 100 mrad
Irradiation time	2 s – infinity	2 s – infinity	2 s – infinity
A/D conversion	16 bit	16 bit	14 bit
Nominal measuring frequency	0.5 Hz	0.5 Hz	0.5 Hz – Linescan 30 Hz
DETERMINED PARAMETERS			
Beam position x, y	yes	yes	yes
Beam dimensions x, y	yes	yes	yes
Power density distribution	2D, 3D	2D, 3D	2D, 3D
Linescan	optional	optional	optional
Measurement duration per plane dependent on measured parameters (like resolution, rotation speed, position of measuring window)	5 – 40 s	5 – 40 s	5 – 40 s
DEVICE PARAMETERS			
Working range x-y	60 x 60 mm	100 x 100 mm	50 x 50 mm
Measurement window sizes	0.1 x 0.1 mm – 60 x 60 mm	0.1 x 0.1 mm – 100 x 100 mm	3.5 x 3.5 mm – 45 x 45 mm
Resolution	32 x 32 – 1 024 x 1 024 px	32 x 32 – 1 024 x 1 024 px	32 x 32 – 256 x 256 px
Rotation speed of the measuring tip	1 562 min^{-1}	1 562 min^{-1}	2 154 min^{-1}
Accuracy (beam diameter)	± 5 %	± 5 %	± 5 %
Reproducibility (beam diameter)	± 3 %	± 3 %	± 3 %
SUPPLY DATA			
Power supply	24 V DC ± 5 %, max. 1.8 A	24 V DC ± 5 %, max. 1.8 A	24 V DC ± 5 %, max. 0.7 A
COMMUNICATION			
Interfaces	Ethernet, RS485 [1)]	Ethernet, RS485 [1)]	Ethernet, RS485 [1)]
DIMENSIONS AND WEIGHT			
Dimensions (L × W × H)	316 × 212 × 83 mm	436 × 292 × 83 mm	182 × 139 × 68 mm
Weight (approx.)	9 kg	10 kg	1.5 kg

[1)] Only for communication with PowerMonitor.

CompactPowerMonitor

Compact, Mobile, Precise

The CompactPowerMonitor family is prepared to attend to your needs with an entire model series. Every one of the five models is sure to win you over with their compact design as well as simple handling and operation. Depending on the model in use, the devices can measure laser power ranging from 100 watts to 30 kW. Absolute power and maximum power density of the irradiation are the decisive factors here.

Knowing what's important: The CompactPowerMonitor (CPM) is designed to meet the demands of laser users and laser manufacturers as well as equipment manufacturers. Its greatest advantage is its outer appearance: An astoundingly compact construction make the device extremely mobile. This allows you to use it on a wide variety of different machines within the factory or the laboratory. The various designs in the series are differentiated mainly by absorber size and the necessary cooling water flow rate. Connecting, operating, and handling is exactly the same for all five models.

Beam Parameters

CompactPowerMonitor devices are ideally suited to measuring the beam power of continuous wave laser sources. It can be used at a variant of wavelenghts, for example

- 1030 nm – 1080 nm (NIR)
  typ. YAG-, fiber- and disk laser
- 808 nm – 1030 nm
  typ. diode laser
- 515 nm – 532 nm
  frequency doubled solid state laser
- 450 nm
  blue diode laser
- 343 nm – 366 nm
  typ. frequency trippled solid state laser
- 10 600 nm for the CPM C-9
  CO_2 laser

The Principle

The calorimetric measuring principle facilitates high-precision measurements regardless of beam diameter and striking position on the absorber. All models in the CPM family are characterized by an extremely low rate of back reflection. They are water-cooled and meant for long-term use – even with deionized water.

Diverse Models & Options

CPM F-10

- Power range 0.5 – 10 kW
- Large, level absorber

CPM F-1

- Power range 100 W – 1.4 kW
- Derived from CPM F-10; it is considerably smaller and can be used in very tight laser processing cells

CPM F-20

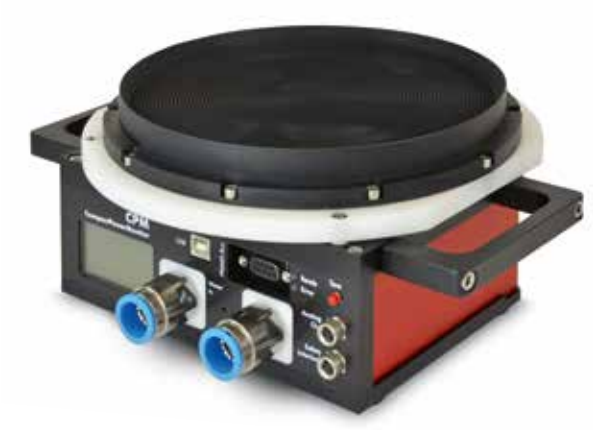
- Power range 1.0 – 20 kW
- The free aperture of 135 mm facilitates power measurements far behind the focus plane or even of very large raw beam diameters, behind a telescope for example

CPM F-30

- Power range 2.0 – 30 kW
- For power densities up to 1 kW/cm^2
- 185 mm aperture

CPM C-9

- Power range 0.5 – 9 kW
- For power densities up to 10 kW/cm^2
  with conical reflector and cylindrical absorber, can also be used at 10 600 nm



CompactPowerMonitor CPM F-30

CompactPowerMonitor C-9

Your Benefit: Optional Accessories

1. Adapter for measuring fibers (LLKB, LLKD, QBH, QD)
2. Safety-, transport-, and storage box
3. External display unit

Higher Safety with Fiber Adapter

The fiber adapter makes it possible to directly connect a fiber to a power meter. This allows for laser power measurements of even very high-power lasers under protected conditions.

Adapters for some of the most common fiber couplers such as LLKB and LLKD as well as QBH and QD are available for the CompactPowerMonitors CPM F-1, CPM F-10, and CPM F-20.

CompactPowerMonitor F-20

CompactPowerMonitor F-1 with adapter ring

CompactPowerMonitor F-10 with LLK-D fiber connector

Technical Data CompactPowerMonitor

	CPM F-1	CPM F-10	CPM F-20	CPM C-9 [1]
MEASUREMENT PARAMETERS				
Power range	0.1 – 1.4 kW	0.5 – 10 kW	1.0 – 20 kW	0.5 – 9 kW
Wavelength range	800 – 1 100 nm	800 – 1 100 nm	800 – 1 100 nm	800 – 1 100 and 10 600 nm
Irradiation time	continuous	continuous	continuous	continuous
Max. power density	1 kW/cm²	1 kW/cm²	1 kW/cm²	10 kW/cm² (Ø < 10 mm) 5 kW/cm² (Ø 10 – 30 mm) 0.5 kW/cm² (Ø 30 – 55 mm)
Average power density	0.5 kW/cm²	0.5 kW/cm²	0.5 kW/cm²	10 kW/cm² (Ø < 10 mm) 5 kW/cm² (Ø 10 – 30 mm) 0.5 kW/cm² (Ø 30 – 55 mm)
DEVICE PARAMETERS				
Entrance aperture	45 mm	90 mm	135 mm	55 mm
Accuracy	± 3 %	± 3 %	± 3 %	± 3 %
Reproducibility	± 1.5 %	± 1.5 %	± 1.5 %	± 1.5 %
Time constant	< 10 s	< 10 s	< 10 s	< 10 s
SUPPLY DATA				
Power supply	24 V DC ± 5 %, max. 0.5 A	24 V DC ± 5 %, max. 0.5 A	24 V DC ± 5 %, max. 0.5 A	24 V DC ± 5 %, max. 0.5 A
Cooling water flow	1 – 2 l/min	8 – 11 l/min	15 – 23 l/min	8 – 11 l/min
Minimum cooling water flow rate (load limit)	0.5 l/min	4 l/min	8 l/min	4 l/min
Minimum water inlet pressure	2 bar	3 bar	3 bar	2 bar
Maximum water inlet pressure	4 bar	4 bar	4 bar	4 bar
COMMUNICATION				
Interfaces	USB ans analog	USB ans analog	USB ans analog	USB ans analog
DIMENSIONS AND WEIGHT				
Dimensions (L x W x H) (excl. connectors)	180 x 123 x 71 mm	180 × 162 × 71 mm	260 × 162 × 113 mm	180 × 162 × 136 mm
Weight (approx.)	2.2 kg	3.1 kg	4.7 kg	5.1 kg

[1] This model requires a beam incidence central to the aperture.

RESEARCH AND DEVELOPMENT

High Effectiveness for New Knowledge

High power, enormous intensity: We will light the new way

Some things always go hand-in-hand. Not least of all due to our own roots in applied research, we see ourselves as a reliable partner for development labs and R&D departments. The laser industry is experiencing dynamic growth and it hasn't come even close to reaching its full potential: Laser sources are becoming ever stronger, light pulses ever shorter, previously unthinkable wavelength ranges are being tapped into, and new materials are being put to use in laser material processing.

This whirlwind of development makes a lot of demands on the measuring systems expected to measure all of this. Research labs need highly flexible, precise, and yet tough measuring systems capable of quantifying experimental beam parameters such as focus diameter, power density distribution, and Rayleigh length as well as focus location (TCP) and laser power with absolute reliability and under real conditions of use.

Only when process parameters are precisely recognized can process windows be defined and a new stable process consistently put to use in industrial manufacturing. New industrial applications are made possible and this is where the PRIMES measuring devices can make a significant contribution to the precision and reproducibility of measuring parameters.

Designed to meet the specific demands of research & development, we offer a product portfolio distinguished particularly by high accuracy, flexibility, and durability of measuring devices as well as a setup requiring little or no effort. Wavelengths of 266 – 1 080 nm and astounding power values of up to 10 kW single mode and 20 kW multi mode can be measured with the devices of the MSM family, which includes the MicroSpotMonitor and the **HighPower-MSM-HighBrilliance**, which is designed for even higher values. The **EC-PowerMonitor** sets standards in accuracy and precision while at the same time being highly durable. Join us in celebrating the ideas and innovations benefiting a wide variety of different industries – from automotive manufacturing or 3D production to aeronautical, construction, and medical technology.

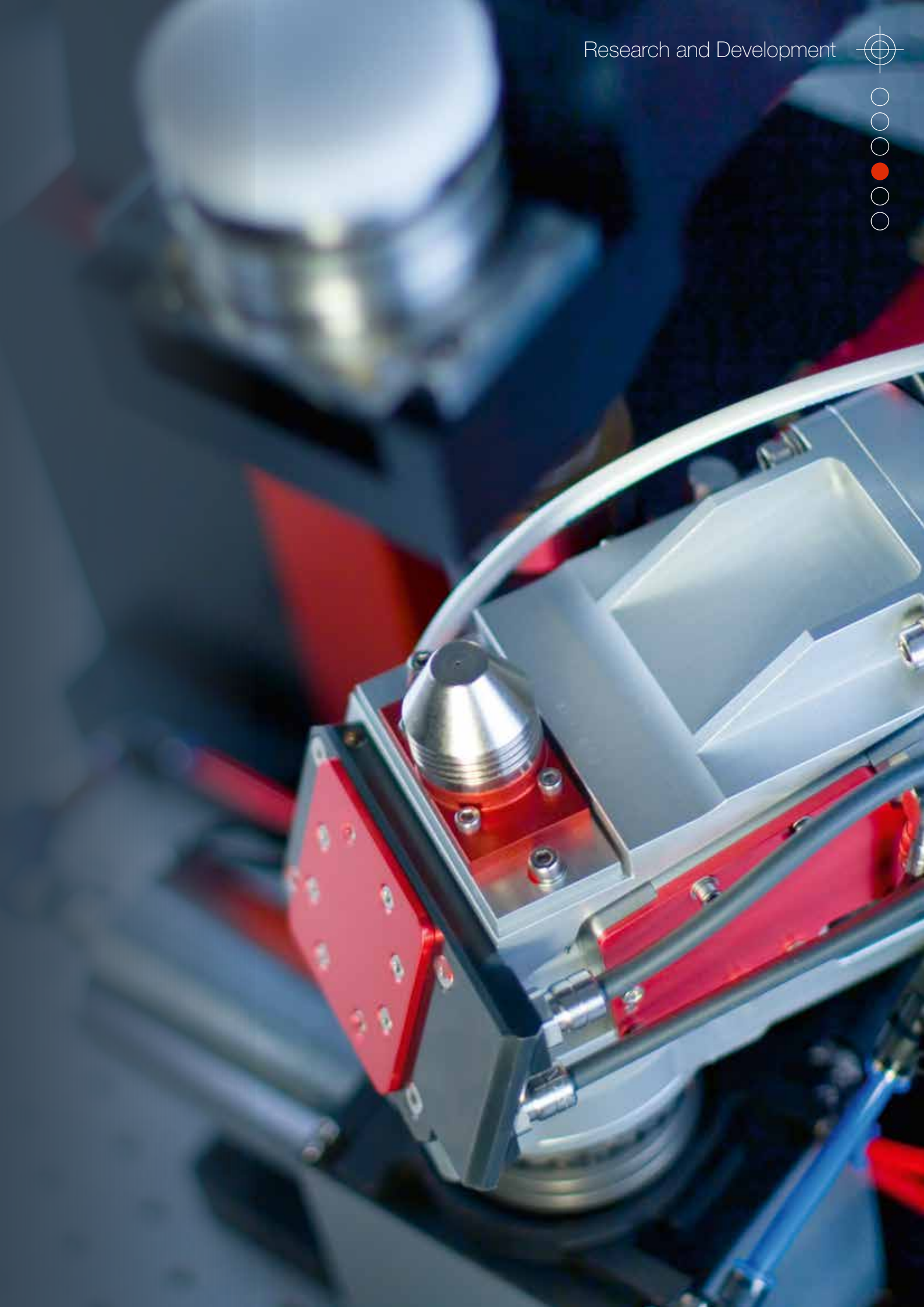
HighPower-MSM-HighBrilliance

Anything but Conventional: Our “Eye of the Tiger”

Our Formula 1 race car for extra fine, focused laser beams will tell you everything you need to know about the quality and precision of the laser beam in your processing system – and all that right in focus at full power.

The **HighPower-MSM-HighBrilliance** reaches its full potential in development departments as well as quality assurance.

And it sure lives up to its name.



HighPower-MSM-HighBrilliance

Technology is constantly advancing. Are you using NIR lasers with ever higher beam quality and high intermediate power for laser material processing as well? And are you able to achieve tiny focus diameters in the range of 20 to several 100 micrometers using these laser tools? There is no known material capable of withstanding the power densities produced during this process. Yet it is at exactly such small focus diameters that conventional scanning measuring procedures for analysis stop functioning. PRIMES has therefore expanded its camera-based focus analysis system, MicroSpotMonitor, with a highly precise HighBrilliance option especially for such finely focused high-power lasers.

Heavyweight with Outstanding Measuring Properties

The HighPower-MSM-HighBrilliance measures the focus geometries of lasers with high brilliance and single mode lasers with up to 10 kW of beam power in the range of 20 – 1 000 micrometers beam diameter directly in the processing zone – even at full power. A CCD chip makes a two-dimensional record of the power density distribution of the laser beam, with an integrated constant gas supply protecting the measuring objective from soiling.

With the HighPower-MSM-HighBrilliance, you benefit from enhanced measuring properties:

- Internal focus shift < 10 % of the Rayleigh length/kW for single mode lasers
- Observation planes of all three internal beam paths are together on a better ±1 mm

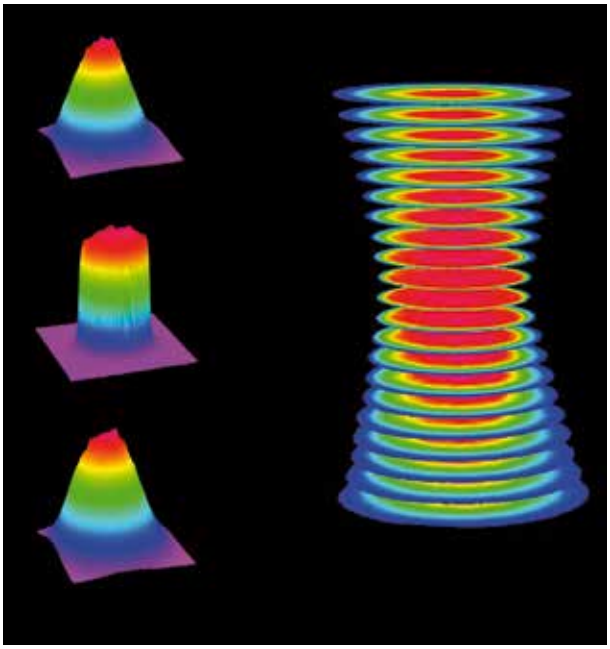
The Principle

95 % of the laser power is transmitted through the measuring objective via a beam splitter and absorbed. The remaining 5 % are further attenuated in the measuring objective and dissipated by internal water-cooled absorbers. A partial beam with a few milliwatts of power is imaged magnified on the CCD sensor.

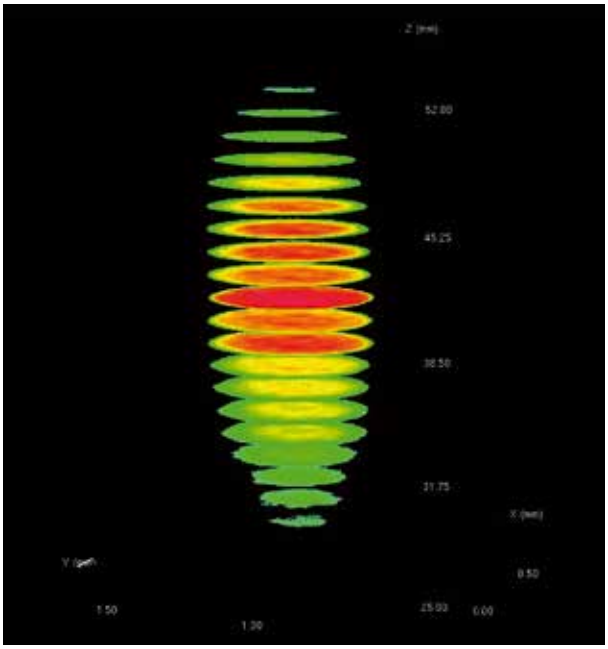
The measuring objective was designed for beam powers of up to 10 kW single mode. In addition, the HP-MSM-HB is also equipped with a safety interlock that will disrupt laser emission when there is overheating or a device failure. This protects the measuring device against damage.

Within the focus range, the HP-MSM-HB measures power density distributions individually on up to 50 measuring planes. Beam geometry such as beam position, beam dimensions as well as the tilt of the beam axes are determined from every single distribution in keeping with the ISO11146 standard (2nd moments and power inclusion 86 %).

Beam propagation parameters such as focus location, focus radius, Rayleigh length, divergence, beam quality factor M^2, and beam parameter product can be derived from the beam geometry data.
Practical: The beam direction error can be determined from the fiber. In addition to measuring caustics, you can also use the HighPower-MSM-HighBrilliance to investigate the temporal trend of the power density distribution of a certain plane. With a timed trigger of about 2 seconds, the behavior of the laser on the workpiece plane can be considered for example.



Measured power density distribution of a focussed 4 kW fiber laser



Power density scaled presentation of a caustic measurement result

Two Alternatives for Operation

1. The PC-based LaserDiagnosticsSoftware enables you to measure beam density distribution manually and semi-automatically and determine the beam position and beam dimensions.

2. Scripts control the HP-MSM-HB semi-automatically, for repetitive measuring operations in service, quality assurance, and final inspection for example. They are both alternatively individually adapted to the current measuring process. Benefit: The programmed user prompts simplify operation of the HP-MSM-HB considerably.

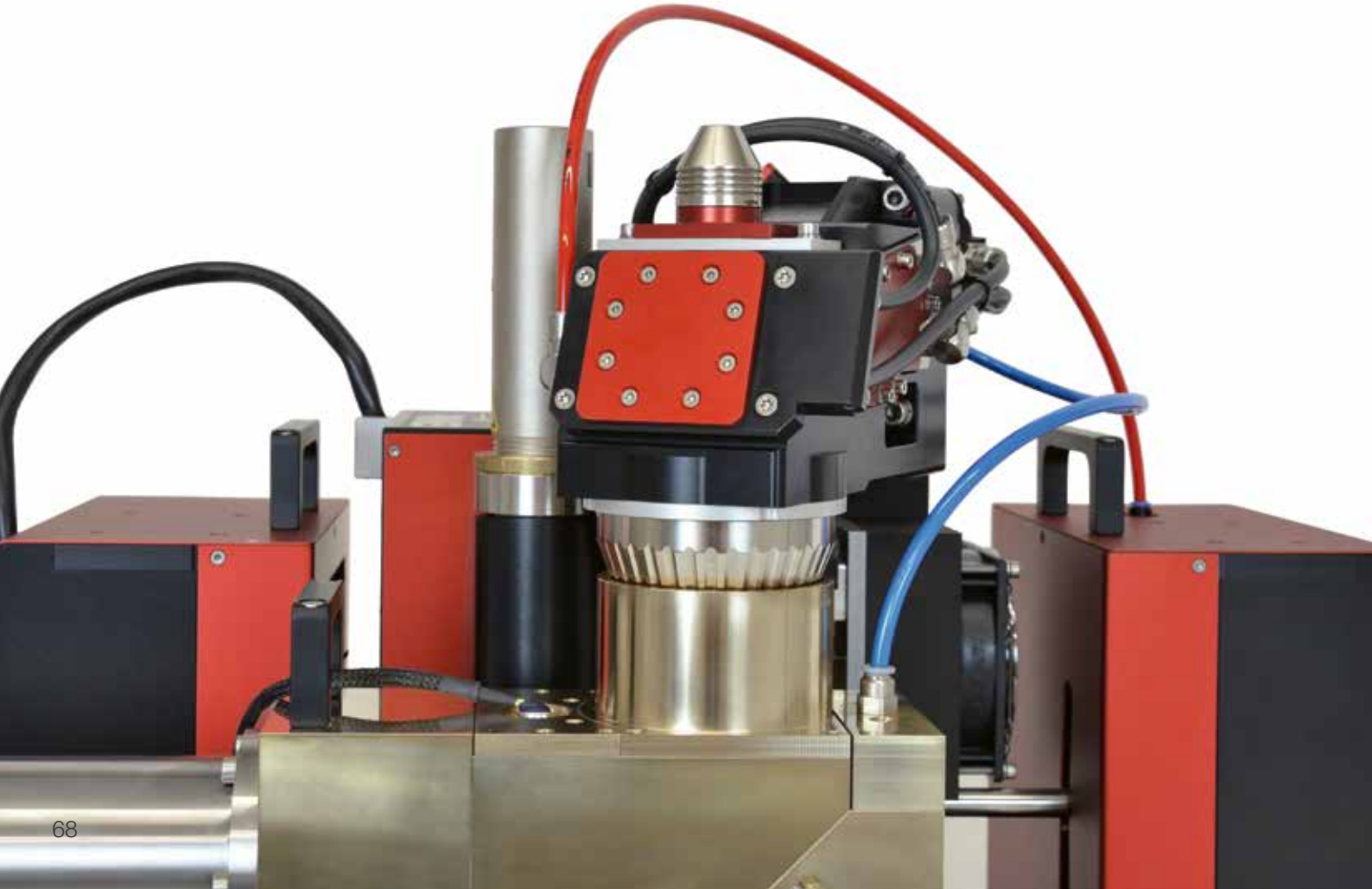
Diverse Models & Options

1. Measure beam geometry straight from the fiber: with a special holder for optical cable. Adapter available for LLKB, LLKD, QBH and HLC 16.

2. Measure the beam power injected into the absorber directly: with the option for power measurement.

3. Evaluate measuring results and monitor limit values with the LaserDiagnosticsSoftware (LDS).

4. Alternative beam radius definitions thanks to LDS: 2nd moments, power inclusion 86 %, channel/cutting/Gaussian fit process, power density decline process 86 %, and two additional power inclusion processes with freely chosen power threshold.



Technical Data HighPower-MSM-HighBrilliance

MEASUREMENT PARAMETERS	
Power range	10 W – 10 kW average power (up to 20 kW on request)
Wavelength range	1 025 – 1 080 nm
Beam dimensions	20 µm – 600 µm

FUNCTION OF THE MEASURING SYSTEM

- 2-dimensional recording of the power density distribution of the laser beam in the xy-plane by means of a CCD chip
- 6-level switchable optical attenuator 0 – 100 dB
- Measuring range x-, y-direction: 0.03 – 2 mm
- 120 mm z-range
- Spatial resolution in x- and y-direction (number of measurement points per line 32, 64, 128, 256) up to 0.5 µm per pixel, diffraction limited by the objective
- Measurement duration standard window with 64 × 64 pixels: 100 ms, repetition rate of the measurement approximately: 0.5 – 1 Hz in video mode

SUPPLY DATA	
Power supply	24 V DC ± 5 %, max. 1.8 A
Cooling (power measurement option)	6 – 12 l /min
COMMUNICATION	
Interfaces	Ethernet
DIMENSIONS AND WEIGHT	
Dimensions (L × W × H)	600 (excluding connectors) × 400 x 391 mm
Weight (approx.)	34 kg

MicroSpotMonitor

Mini, Micro, & Multi – All Facets of Measurement

Radiation dominates matter: In the realm of very tiny structures, where microchannels are drilled and shapes just micrometers in size are created on surfaces, the MicroSpotMonitor is in its element. The camera-based measuring system can help you to check the laser beam you are using for micro working and recognize gradual signs of wear in advance. Take control – with the MicroSpotMonitor, which is suitable for use in a wide variety of different environments.

The MicroSpotMonitor is the perfect measuring system for inspecting, monitoring, and qualifying very finely focused laser beams, such as those used for micro material processing. This proven system will automatically measure and analyze the spacial beam density distribution surrounding the focus in various positions along the beam propagation direction. The measuring results form the basis for error analysis first and foremost and process optimization beyond that. The MicroSpotMonitor can be used in a wide variety of environments, thus offering diverse solutions for approaching your application.

The Principle: Camera-Based Measuring Process

The MicroSpotMonitor (MSM) is capable of measuring the beam parameters of focused laser beams from lasers with medium power levels of up to 200 W in the range

of 20 micrometers to one millimeter beam dimensions in the process zone. Being purely air-cooled, the system makes use of various beam splitters and neutral-density filters to project the attenuated laser beam on a CCD sensor. A plane's beam density distribution thus identified will indicated the beam position and beam radius. Beam parameters are determined and recorded with the aid of the integrated z-axis and the measurement of various positions along the beam diffusion directly.

You can choose the measuring objective of the MSM individually and regardless of the beam source to be measured. Here it is the wavelength (λ = 340 to 1 090 nm) and the focus diameter of certain magnifications (3:1, 5:1, 15:1) that are decisive. The dynamic area of the integrated CCD sensor is expanded to over 130 dB using the exposure time controller, which makes it possible to measure caustics over more than 4 Rayleigh lengths (conforms to ISO 11146).

It is also possible to optionally equip the MicroSpotMonitor with a filter wheel containing neutral-density filters (OD1 to OD5), which enables measurements of power densities in the range of a few W/cm^2 to several MW/cm^2 without having to convert the system.

Two Types of Operation

1. The PC-based LaserDiagnosticsSoftware enables you to measure beam density distribution manually and semi-automatically and determine the beam position and beam dimensions.

2. Scripts control the MSM semi-automatically, for repetitive measuring operations in service, quality assurance, and receiving for example.

Both types are individually adapted to the current measuring process. **Benefit:** The programmed user prompts simplify operation of the MicroSpotMonitor considerably.

Diverse Models & Options

1. There are three different measuring objectives (MOB) to choose from, depending on the beam parameters: 3.3× MOB, 5× MOB, 15× MOB

2. Each available measuring objective can be designed for the following wavelength ranges: 340 – 360 nm, 515 – 545 nm, 1 030 – 1 090 nm. Other wavelength ranges are supported, but the lens coatings must be adapted.

3. Interchangeable fixed neutral-density filters are helpful for attenuating the most intense power from the pulsed and USP lasers.

4. The filter wheel equipped with neutral-density filters (OD1 to OD5) makes it easy to adjust the measuring range of the MSM.

5. Evaluate measuring results and monitor limit values with the LaserDiagnosticsSoftware. The software also allows for the use of alternative beam radius definitions: 2nd moments, power inclusion 86 %, channel process, power density decline procedure 86 %, cutting/Gaussian fit process as well as two additional power inclusion procedures with freely chosen power threshold.

Beam Parameters

- Power density distribution on the individual measuring planes
- Focus dimensions
- Focus location in the space
- Rayleigh length
- Divergence
- Beam parameter product BPP
- Beam quality factor M^2

The Key Benefits

1. Process development: document laser beam parameters simply and reproducibly.
2. Startup and acceptance of laser systems: carried out quickly and with consistent quality.
3. It is possible to recognize aging processes in optical components causing a change in beam parameters early on, which in turn facilitates targeted planning and maintenance work.
4. When there are system outages: idle times are reduced drastically due to the ease with which the source of the error is localized.
5. Measuring pulsed lasers.

Technical Data MicroSpotMonitor

MEASUREMENT PARAMETERS	
Power range	1 mW – 200 W
Wavelength range	257 – 272 nm (on request) 340 – 360 nm 515 – 545 nm 1 030 – 1 090 nm
Beam dimensions	20 µm – 1 mm
FUNCTION OF THE MEASURING SYSTEM	
• 2-dimensional recording of the power density distribution of the laser beam in the xy-plane by means of a CCD chip • Measuring range x-, y-direction: depending on the used objective: 0.02 – 2 mm • Measuring range in z-direction: 35 or 120 mm • Spatial resolution in x- and y-direction (number of measurement points per line 32, 64, 128, 256) up to 0.3 µm per pixel, diffraction limited by the objective • Optional: 6-level switchable optical attenuator typ. 0 – 100 dB	
SUPPLY DATA	
Power supply	24 V DC ± 5 %, max. 1.8 A
COMMUNICATION	
Interfaces	Ethernet, RS 485
DIMENSIONS AND WEIGHT	
Dimensions (L × W × H)	427 (+12 mm) excluding connectors × 202 x 181 mm (+ 35 mm or 120 mm movement range) + Excess end of the measuring objective (depending on the measuring lens used)
Weight (approx.)	15 kg

EC-PowerMonitor

Everything Ship Shape Thanks to Proper Calibration

Precision is everything. That's why we boosted the heavy-duty superstar PowerMonitor, which is capable of measuring beam power close to the process zone, with an integrated self-test feature, and upgraded it "electronically calibrated" to the EC-PowerMonitor. It meets highest industrial standards. You benefit from the ability to check the functionality and precision of the measuring device at any time – without any limitations on your planned work processes.

The EC-PowerMonitor is designed for the development departments of laser manufacturers and users for use as a factory standard. With its self-test feature, production using irradiation can be compared across different factories and branch offices in order to ensure a unified measuring standard. It can measure beam power from continuous wave laser sources with the utmost precision while simultaneously performing internal referencing through the heating element used.

The Principle: Self-Test Feature

A heating cartridge warms up the cooling water and the electrically generated heating power is calormetrically measured. This value is compared with the electric power recorded from the heating element.

The EC-PowerMonitor has a high-precision measuring system for current consumption and operating voltage of the heating element for exactly this purpose.

The Key Benefits

The EC-PowerMonitor meets the highest standards for industrial practice. Its electronic calibration system can act as a reference system, ensuring that you can trust in the consistency of your laser beam power and recognize any problems as soon as possible.

1. State-of-the-art power meter suitable for use as a reference and relation system.

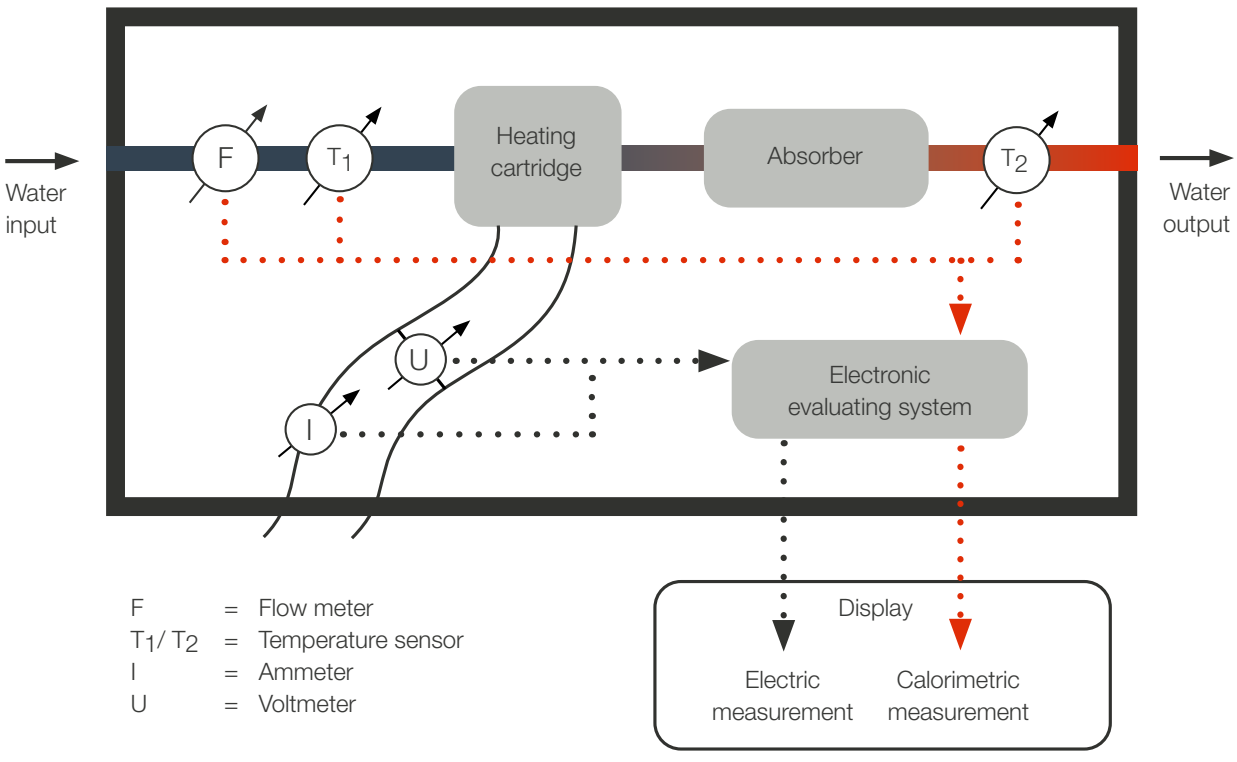
2. Long-term stability thanks to durable setup and the use of flow rate sensors without moving parts.

3. Precision and reproducibility, since PRIMES only uses the best sensors and components.

Your Benefit: Optional Accessories

We provide the following options for the EC-PowerMonitor:

- Fiber adapter for directly measuring irradiation from the fiber for many standard systems: LLKB, LLKD, QBH
- Holder for mounting a FocusMonitor



Principle of the reference measurement in the EC-PowerMonitor

Technical Data EC-PowerMonitor

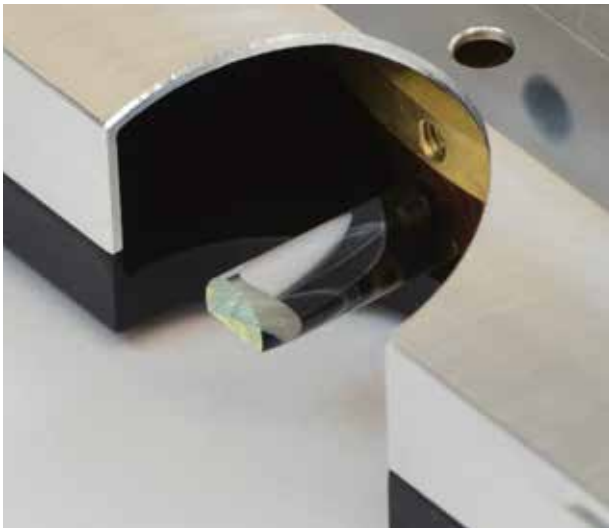
MEASUREMENT PARAMETERS	
Power range	200 W – 8 kW
Wavelength range	800 – 1 100 nm or 10 600 nm
Irradiation time	continuous
Max. power density	15 kW/cm²
DEVICE PARAMETERS	
Entrance aperture	48 mm
Accuracy	± 2 %
Reproducibility	± 1 %
Time constant	15 s up to 99 % of final value
ELECTRONIC CALIBRATION PARAMETERS	
Power heating cartridge	3 200 W
Accuracy self-test	better than 0.5 %
Power consumption heating cartridge	230 V, 16 A
SUPPLY DATA	
Power supply	24 V DC ± 5 %, max. 0.5 A
Cooling water flow rate	8 – 11 l/min
Maximum water inlet pressure	6.5 bar
COMMUNICATION	
Interfaces	serial/USB
DIMENSIONS AND WEIGHT	
Dimensions (L × W × H)	400 x 242 x 205 mm
Weight (approx.)	16 kg

FocusMonitor FM+ for R&D

The FocusMonitor FM+ is also the ideal instrument in research and development for the analysis and measurement of laser beam sources.

The FocusMonitor FM+ reliably determines the beam properties of focused laser beams: in addition to the geometrical dimensions of the focused laser beam it also measures the focus position in space, the beam parameter product and the diffraction factor.

The integrated z-axis enables the automatic measurement of complete caustics up to four Rayleigh lengths and thus enables standard-compliant measurement.



The innovation for measuring high power densities

For the measurement of particularly high power densities, we have developed the FocusMonitor FM+ HDP (High Power Densities).

Now you can carry out caustic analysis of laser beams in previously difficult to evaluate performance areas - up to 50 MW/cm²!

For more information about the FocusMonitor FM+
see **page 28 to 31**.

Technical Data FocusMonitor FM+ and FocusMonitor FM+ HPD

	FM+	FM+ HPD
MEASUREMENT PARAMETERS		
Power range	30 – 25 000 W	100 – 25 000 W
Wavelength range	0.4 – 1.6 µm and 9 – 12 µm	1.0 – 1.1 µm (other wavelengths ranges on request)
Beam dimension, typ.	100 – 3 000 µm (up to 5 000 µm optionally)	100 – 1 200 µm
Max. power density	CO_2 laser (10.6 µm): 30 MW/cm² NIR laser: 10 MW/cm²	NIR laser: 50 MW/cm²
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	yes	yes
DEVICE PARAMETERS		
Working range x-y	8 x 8 mm (12 x 12 mm optional)	8 x 8 mm (12 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	32 x 32 px – 1 024 x 1 024 px	32 x 32 px – 1 024 x 1 024 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	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

QUALIFICATION AND SERVICES

From Property to Result

PRIMES measuring devices will be there for you from product receipt to troubleshooting

Exactly how precise is it really? It pays to get to the heart of the matter in manufacturing with lasers that will yield exact measuring results. Do you use standardized machine tools in your production system such as flatbed laser cutter machines? Or is it necessary for you to use specialized machines for your contracts to do things like weld gearbox parts? In any case, beam sources, fiber- or mirror-based beam guidance, and optical systems are typically involved. These three components essentially determine the properties of the laser beam when it is used as a tool in your manufacturing process. Such properties of your laser, which is essentially your tool, affect your process result, quality, and therefore your company's success – it pays to keep track of them.

The leading companies on the market put their trust in PRIMES for high-precision devices that do just that. Our devices are used to inspect beam parameters in a wide variety of production phases, whether it's during the initial qualification phase, product incoming inspection, startup, or regular inspection for maintenance purposes. PRIMES measuring devices are especially valuable for onsite error searches in order to get to the bottom of the matter when a laser beam is deformed, whether you're experiencing a degradation of edge or cut component quality or your welding seams are not longer clean.

Take advantage of measuring devices designed for an array of different needs and power ranges to complete these tasks: from the simple flexible power meter device for the service box to integrated devices for full beam qualification up to 20 kW beam power.

Cube

The Flexible and Compact Power Meter for Service Uses

High energy packed onto the smallest of surfaces: There is still plenty of untapped potential remaining in the application options for laser beams, while at the same time quality requirements continue to rise.

We developed the **Cube** to ensure maximum productivity of your beam source even in inaccessible locations. As compact as a Rubik's Cube, it fits in the palm of your hand. It measures the laser beam directly under the processing lens wirelessly and with high precision.


PRIMES
3008 W
Absorber: 56.818°C
Time: 191.0 ms
Blueth: connected
Status: finished
Cube

Cube

The Cube power meter device is especially suited for single shot measurements of solid-state lasers up to 12 kW. Thanks to its compact design of just 60 x 65 x 65 mm, the Cube can be easily used in the tight spaces in and around machines used for laser material processing.

Durable and Independent, Wireless and Cooling Water Free

What's special about the Cube: It functions all on its own, requiring neither a wire for power supply and data exchange nor a tube for cooling water supply. The Cube gets its energy to operate from a lithium cell that can be charged through a micro-USB connection. The integrated LCD display shows relevant operating data, such as the

last measured laser power, the irradiation time, or the current temperature of the absorber. A robust and yet stylish casing protects it against shocks and dust. All this makes it the perfect measuring system for daily operation.

The Principle

The absorber of the calorimetric measuring system is irradiated with the laser beam for a short time. Between the beginning and end of irradiation, the temperature of the absorber is recorded. Based on the rise in temperature and the known thermal heat capacity of the absorber, the microprocessor-based electronics are capable of producing a high-precision calculation of the laser power. Determining the temperature difference makes it possible to take multiple power measurements in succession. In the display start window, the current temperature of the absorber is shown. When the absorber overheats, an interlock signal will be activated that stops the laser from emitting power. It is highly recommended that you use this signal.

The new power pack: Cube L

The new model for your high power application: with the Cube L, you can easily measure the power of solid-state as well as fiber lasers up to 20 kW.

Key Benefits

1. Compact design enables use of the Cube and Cube L in places within the production process that might normally be out of the question.

2. Do more than just record power changes at your laser source, be certain of the entire path of irradiation through to the workpiece.

3. Specialized for high-performance applications up to 20 kW.

4. Wireless and without cooling water, dust and shock protection.

For high power application: Cube L

Cube App – Mobile Measuring Using Your Smartphone

Using the PRIMES Cube app (bluetooth) for mobile devices with Android™, you can operate and monitor all Cube models simply and conveniently on a tablet or smartphone. Entire measuring series can be preset through the user-friendly interface on the mobile terminal and transmitted wirelessly to the Cube. It will graphically display the measuring values of laser power, pulse duration, and collected energy per pulse on the mobile terminal.

The Cube app also supplements this information with the standard deviations. You can download the PRIMES Cube app for free from the Google Play Store. A micro-USB interface can be used to connect with a stationary computer and thus operated with our new LaserDiagnosticsSoftware (LDS) to control the device, analyze and back up data.

Technical Data Cube and Cube L

	Cube	Cube L
MEASUREMENT PARAMETERS		
Power range	25 – 12 000 W [1]	200 – 20 000 W
Wavelength range	900 – 1 090 nm	900 – 1 090 nm
Max. beam diameter on the absorber	30 mm	45 mm
Max. power density on the absorber at beam diameters > 10 mm 10 – 3 mm 3 – 1.5 mm < 1.5 mm	(approx. 30 mm underneath the protective window) 4 kW/cm² 5 kW/cm² 10 kW/cm² 12 kW/cm²	(approx. 29 mm underneath the protective window) 4 kW/cm² - - -
Irradiation time	0.1 – 2.0 s [1] (depending on laser power)	0.1 – 2.0 s [1] (depending on laser power)
Min. on/off times (duty cycle) for pulsed lasers	50 µs (e.g. max. 10 kHz at 50% duty cycle)	50 µs (e.g. max. 10 kHz at 50% duty cycle)
Max. laser rise time	100 µs	100 µs
Energy per measurement	50 – 3 000 J	depending on beam diameter[3]: d > 35 mm: 200 - 5000 J 28 - 35 mm: 200 - 4000 J 20 - 28 mm: 200 - 3000 J d < 20 mm: 200 - 2000 J
Recommended energy per measurement	300 – 500 J	500 - 2 000 J
Total duration until measurement value output	< 15 s	< 15 s
Nominal measurement frequency	300 J: 1 cycle/min; 3 000 J: 1 cycle /15 min	700 J: 1 cycle/min 5 000 J: 1 cycle/15 min
DEVICE PARAMETERS		
Max. angle of incidence perpendicular to inlet aperture	± 5 °	± 5 °
Max. centered tolerance	± 2.0 mm	± 5.0 mm
Accuracy Angle of incidence up to 5 °	± 3 %	± 3 %
Reproducibility	± 1 %	± 1 %
SUPPLY DATA		
Power supply	Integrated lithium-ion cell, which can be charged via a micro-USB port	Integrated lithium-ion cell, which can be charged via a micro-USB port
Temperature range for charging the lithium-ion cell	0 – 45 °C	0 – 45 °C
COMMUNICATION		
Interfaces	USB/Bluetooth	USB/Bluetooth
DIMENSIONS AND WEIGHT		
Dimensions (L x W x H) (without connectors)	60 x 65 x 65 mm	92 x 97 x 65 mm
Weight (approx.)	400 g	1 100 g

[1] The stated limit values are to be understood in correlation with the permitted maximum energy (E = P · t).

PowerMeasuringCassette

On the Heels of the Defect in a Neck and Neck Race

Clever minds: When cycle times grow ever shorter and error tolerances ever lower, it is important to be sure of your beam power every day and at all times. That's why you should put your trust in the mobile laser power sensor PowerMeasuringCassette, which measures right at the processing head and is designed for the processing heads from Trumpf, Precitec, and Scansonic.

The laser power in the interaction zone is a key parameter to the process result in laser material processing. Before a drop in power causes serious quality issues on a component being processed, it makes sense to measure the laser power directly in or near the process zone. As a mobile laser power sensor, the PowerMeasuringCassette (PMC) makes it possible to determine the laser power right at the processing head. The PMC is available for pro-

cessing heads from Trumpf, Precitec, and Scansonic and replaces the protective window when directly integrated. This special power meter is used to measure the power of solid-state lasers.

Measuring: Daily, Mobile, via App

This measuring system is suitable for monitoring beam power during daily operation. Thanks to its compact design, power measurements can be taken even when there isn't enough space below the processing head for a measuring device.

A protective casing shields the PowerMeasuringCassette from shocks and moisture. It has an integrated LCD display. The Cube gets its energy to operate from a lithium cell that can be conveniently charged through a micro-USB connection.

The temperature of the PMC should not exceed the critical temperature limit. An interlock signal is available for monitoring of this important system parameter and we recommend that you use it. The PowerMeasuringCassette is now also available in an especially compact model with bluetooth (PMC-C) instead of the display. It can then be controlled via a mobile phone or tablet (Android) using the PRIMES Cube app.

Variety of Models

In addition to the special model for Trumpf-BEO processing heads, we have expanded the selection to include two more models. The slot in the geometry of the protective window cartridge of Precitec-YW52 processing heads has been adjusted for the PMC-YW. With the PMC-ALO, the slot is designed precisely for Scansonic-ALO3 processing heads.

From left to right: PMC-BEO, PMC-YW, PMC-ALO, PMC-C

Special Properties

The absorber of the calorimetric measuring system is irradiated with the laser beam for a short time. The absorber temperature is then measured. Based on the rise in temperature, the microprocessor-based electronics are capable of producing a high-precision calculation of the laser power.

Mechanical integration is achieved by making use of the concept for a removable cartridge in the focusing head. For the duration of the power measurement, the protective window cartridge of the processing head is replaced by the PowerMeasuringCassette.

Parameters

Power of solid-state lasers at

- Wavelength: 900 – 1 090 nm
- Power range: 400 – 12 000 W
- Measuring time: 100 – 1 000 ms (depending on laser power)

Technical Data PowerMeasuringCassette

	PMC-BEO	PMC-YW	PMC-ALO	PMC-C
MEASUREMENT PARAMETERS				
Power range	400 – 12 000 W	400 – 6 000 W	400 – 6 000 W	400 – 12 000 W
Wavelength range	900 – 1 090 nm	900 – 1 090 nm	900 – 1 090 nm	900 – 1 090 nm
Max. beam diameter on the absorber	30 mm	10 – 30 mm	10 – 30 mm	10 – 30 mm
Max. power density on the absorber (approx. 2 mm underneath the protective window) at beam diameters > 10 mm 10 – 3 mm 3 – 1.5 mm < 1.5 mm	 4 kW/cm² 5 kW/cm² 10 kW/cm² 12 kW/cm²	 1.5 kW/cm² 2.5 kW/cm² 5 kW/cm² 6 kW/cm²	 1.5 kW/cm² 2.5 kW/cm² 5 kW/cm² 6 kW/cm²	 4 kW/cm² 5 kW/cm² 10 kW/cm² 12 kW/cm²
Irradiation time	0.1 – 1 s (depending on the laser power) [1]	0.1 – 1 s (depending on the laser power) [1]	0.1 – 1 s (depending on the laser power) [1]	0.1 – 1 s (depending on the laser power) [1]
Min. on/off times (duty cycle) for pulsed lasers	50 µs (e.g. max. 10 kHz at 50% duty cycle)	50 µs (e.g. max. 10 kHz at 50% duty cycle)	50 µs (e.g. max. 10 kHz at 50% duty cycle)	50 µs (e.g. max. 10 kHz at 50% duty cycle)
Max. laser rise time	100 µs	100 µs	100 µs	100 µs
Energy per measurement	50 – 3 000 J	30 – 2 000 J	25 –1 500 J	50 – 3 000 J
Recommended energy per measurement	300 – 500 J	300 – 500 J	300 – 500 J	300 – 500 J
Nominal measuring frequency	300 J: 1 cycle/min 3 000 J: 1 cycle/15 min	300 J: 1 cycle/min 3 000 J: 1 cycle/15 min	300 J: 1 cycle/min 3 000 J: 1 cycle/15 min	300 J: 1 cycle/min 3 000 J: 1 cycle/15 min
DEVICE PARAMETERS				
Max. angle of incidence	± 5°	± 5°	± 5°	± 5°
Measuring accuracy at angles of incidence up to 5 °	± 3 %	± 3 %	± 3 %	± 3 %
Reproducibility	± 1 %	± 1 %	± 1 %	± 1 %
SUPPLY DATA				
Power supply	Integrated lithium-ion battery, which can becharged via a micro-USB port			
COMMUNICATION				
Interfaces	USB	USB	USB	USB/Bluetooth
DIMENSIONS AND WEIGHT				
Dimensions (L x W x H)	179 x 84 x 31 mm	171 x 84 x 24 mm	177 x 84 x 24 mm	100 x 76 x 31 mm
Weight (approx.)	460 g	280 g	280 g	350 g

[1] The stated limit values are to be understood in correlation with the permitted maximum energy (E = P · t).

PocketMonitor

Small Jack of All Trades for Robust Power Measurement

Take care of your tools by measuring the power of your laser beam source with a measuring device that only weights a pound, is two fingers wide, but is tailor-made for your needs with just the right options. Do you remember Newton and his cradle? This palm-sized pocket monitor uses the exact same ballistic principle of momentum transfer and is ready to prove its worth wherever great mobility is required in a tough environment.

The PocketMonitor (PMT) is a mobile, easy-to-use power meter device developed specifically for everyday use in production. It is sure to impress with its compact, durable design as well as its fast, easy use. A full aluminum casing protects sensitive electronics from shocks and moisture. When folded together, the absorber protects operating elements from undesired damages.

The microprocess-based electronics measure the temperature increase of the absorber and then use this to calculate the power of the laser beam with a high accuracy of ± 4 %. High resolution makes it possible to perform measurements in a very broad power range while maintaining the same precision. In the large 4.5-digit display, the exact power or the temperature are shown interchangeably. An incorporated lithium cell supplies enough power to the PocketMonitor for about 10 000 measurements.

Size Matters in Tight Spaces

Due to the absorber's astoundingly compact dimensions, which lie between a tiny 2.1 cm and 9.9 cm, and its ease of use, clients love using the PocketMonitor in spaces where many laser beam sources are used. This makes it a power meter device that is equally enticing to the service engineers of laser and machine manufacturers as well as technicians in inspection establishments and labs. The device's great degree of mobility without any external connections is both a top reason to buy and a decisive factor overall.

The Principle

The PocketMonitor measures laser power according to the ballistic principle. In this process, an absorber is exposed to irradiation for a defined period of time (10 s/20 s).
After a period of thermal exposure, the heating and known weight of the absorber can be used to determine the amount of power.

Beam Parameters

Power of continuous wave lasers at

- Wavelength: 800 – 1 100 nm or 10.6 µm
- Maximum laser power: 500 W – 12 kW (depending on the model)
- Measuring time: depending on power 10 s or 20 s

Models & Options

1. Large selection with four different absorber versions for different power ranges. PocketMonitor 70icu and 120icu with copper cone are designed for the highest power densities.

2. When it comes to choosing a suitable device, the power density is often just as important as the maximum power. Especially high reserves are offered by our models PMT 70icu and PMT 120icu, that can be used for even those measurements with laser powers exceeding 5 kW/cm² at 5 kW.

3. All models are available with a separate absorber and various cable lengths.

4. More options: a type with power interface (5 – 20 mA) or an OEM version for direct, mechanical integration with a processing lens.

5. Take advantage of the option offered by a calibration certificate. Regular recalibration is recommended.

6. We recommend having a suitable case for safe transport and storage.

PMT 70icu with separate absorber

Technical Data PocketMonitor

	PMT 01p[1]	PMT 05p[1]	PMT 30p[1]	PMT 70iag, 70icu[1]	PMT 120iag, 120icu[1]
MEASUREMENT PARAMETERS					
Power range	5 W – 100 W[2]	25 W – 500 W[2]	150 W – 3000 W[2]	350 W – 7000 W[2]	500 W – 12000 W[2]
Wavelength range	800 - 1100 nm or 10.6 µm	800 - 1100 nm or 10.6 µm	800 - 1100 nm or 10.6 µm	800 - 1100 nm or 10.6 µm	800 - 1100 nm or 10.6 µm
Max. beam diameter on the absorber	15 mm	27.5 mm	48 mm	36 mm	36 mm
Max. power density on the absorber (inlet aperture) at < 1 kW at < 3 kW at 5 kW	 2.5 kW/cm² – –	 2.5 kW/cm² – –	 2.5 kW/cm² 1.5 kW/cm² –	 – – 5 kW/cm²	 – – 5 kW/cm²
Irradiation time	10 s (at maximum permissible laser power), 20 s (at 50 % of the maximum permissible laser power)				
DEVICE PARAMETERS					
Max. angle of incidence perpendicular to inlet aperture	± 5 °	± 5 °	± 5 °	± 5 °	± 5 °
Max. centered tolerance	± 2.0 mm	± 2.0 mm	± 2.0 mm	± 2.0 mm	± 2.0 mm
Measuring accuracy	± 4 %	± 4 %	± 4 %	± 4 %	± 4 %
Reproducibility	± 2 %	± 2 %	± 2 %	± 2 %	± 2 %
DIMENSIONS AND WEIGHT					
Absorber diameter	25 mm	45 mm	79 mm	79 mm	99 mm
Absorber height	20 mm	15 mm	20 mm	75 mm	75 mm
Weight (approx.)	0.53 kg	0.56 kg	0.67 kg	1.11 kg	1.55 kg
ENVIRONMENTAL CONDITIONS					
Operating temperature range	10 – 40 °C	10 – 40 °C	10 – 40 °C	10 – 40 °C	10 – 40 °C
Storage temperature range	5 – 50 °C	5 – 50 °C	5 – 50 °C	5 – 50 °C	5 – 50 °C
Reference temperature	22 °C	22 °C	22 °C	22 °C	22 °C
Permissible relative humidity (non-condensing)	10 – 80 %	10 – 80 %	10 – 80 %	10 – 80 %	10 – 80 %
PROTECTION					
Protection category	IP 51	IP 51	IP 51	IP 51	IP 51

[1] Please refer to the specifications on the identification plate for the type of your device.
[2] The stated limit values are to be understood in correlation with the permitted maximum energy (E = P · t).

SUPPORT AND SOLUTIONS

Interaction between Radiation and Matter

Calibrating, further developing, and supporting: We are here for you

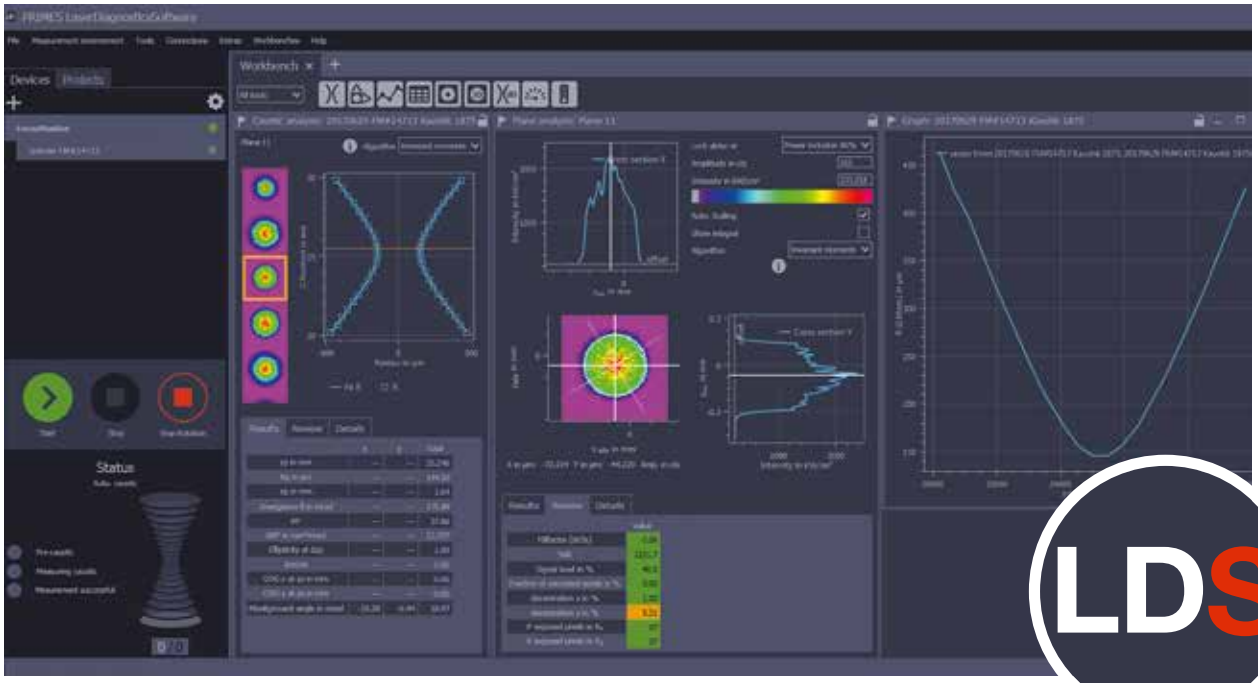
PRIMES sells its fine measuring devices to the largest laser manufacturers worldwide and all of the major German automobile manufacturers. With around 20 000 laser measuring devices already installed on the market, we are one of the most renowned providers in this sector. Just as with irradiation, our customers benefit from the interplay of in-depth knowledge offered by our engineers on the one hand with the full production of measuring devices in-house on the other hand. The result is high-precision measuring technology “made in Germany”.

Maintain control: with LaserDiagnosticsSoftware LDS. Ease of use and high usage are what distinguish our LDS software developed in-house at PRIMES, which can be used to obtain meaningful analyses of your measured laser beam parameters. The latest version of the LDS brings together laser power measurement and beam propagation analysis in one convenient and intuitive user interface. This allows for automated, standard-conforming measurements at the flick of the wrist.

PRIMES is your partner for innovation & individuality. New technologies are now facilitating working processes that would have been unthinkable a few years ago. With our measuring devices, we will assist you with the transition from laser technology to industrial use. To help you qualify all relevant laser technologies, we offer an entire array of high-performance standard products that we are constantly expanding through product improvements and the development of new products for beam diagnostics and beam monitoring. A third of our employees are passionately working interdisciplinarily to transform innovation into high-quality, durable measuring systems that meet your individual requirements to the letter.

Calibration & measuring order. We track down the causes of undesired deviations in our own calibration lab and will gladly calibrate your laser beam power measuring devices, regardless of manufacturer, since we are at home in the entire world of laser measuring. Or a PRIMES employee with PRIMES measuring devices will take time to perform a qualified beam diagnosis and beam monitoring on-site when you book a measuring order. You will receive even more added value with our specialized interpretation of the results or a system characterization, during which we will precisely identify your optimization potential.

LaserDiagnosticsSoftware



Centerpiece of beam diagnostics

The new LaserDiagnosticsSoftware LDS is the software to operate all PRIMES devices of the +-generation (e.g. FocusMonitor FM+, BeamMonitor BM+, LaserQuality-Monitor LQM+) and works with the power measurement systems (PowerMonitor, CompactPowerMonitor, EC-PowerMonitor, Cube) as well. Older generation devices (FM, LQM, MSM, BM-HQ) are operated by the LDS 2.98.

The new LDS features all functionalities the LDS 2.98 had to offer and more. It can be used to manage large series of measurements, has optimized algorithms for faster measurements, a clearly structured user interface, and added comfort, like user guidance for standard applications in laser beam measurement. The user interface layout can be individually customized to specific user needs. As laser power measurement and beam propagation analysis are combined into an intuitive user guidance, automated measurements are possible at the click of a single button. Multiple devices can be connected to the LDS and operated at the same time. For easy documentation of the measurement results a pdf-report function is available. Based on the measured power density distributions, the software can be used to calculate and graphically display

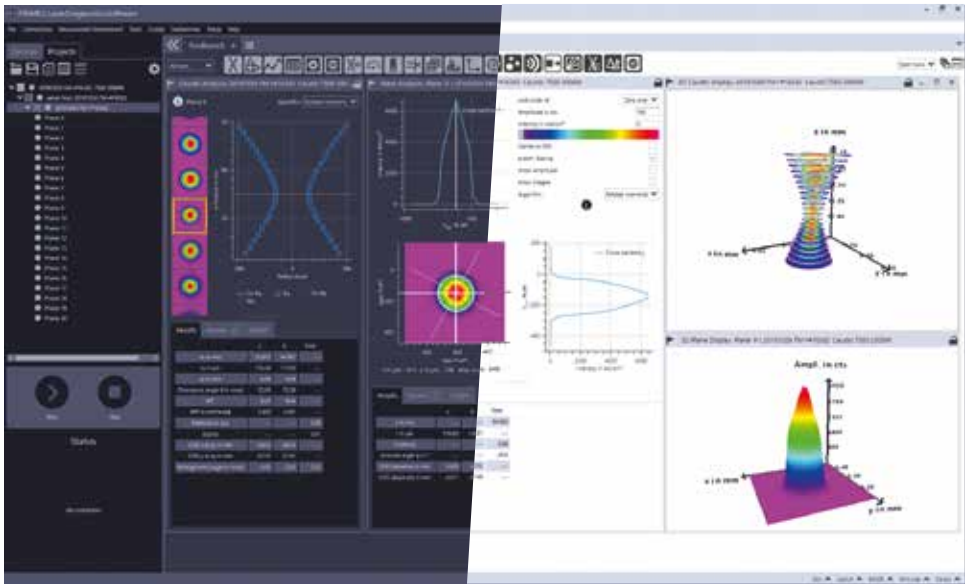
the beam position (center of gravity) as well as the beam dimensions for different positions along the beam axis. Derived from these values, important beam characteristics like the Rayleigh length, the beam waist radius and position, the beam quality factor M^2, the divergence angle, the misalignment angle and the beam parameter product (BPP) can be determined. The user can choose between different algorithms, which are in compliance with the applicable standards, and frames of reference (device coordinates, beam coordinates) to calculate these values. The algorithms used are the 2nd moment method and the 86 % power inclusion method, which are described in DIN EN 11146.

An important feature in the new LDS is the automated evaluation of the calculated results. Various parameters (e.g. caustic fit deviation from the measured values, fill factor, number of Rayleigh lengths covered in measurement, signal-noise-ratio) are assessed with regard to set limit values, showing if the measurement is valid and the results reliable, thereby allowing an operator independent evaluation of the measurement results.

Furthermore, a variety of evaluation tools allow the user to carry out complex analyses regarding time stability, reproducibility and process characteristics. The new LDS is the perfect tool for convenient beam diagnostics in a variety of applications from standardized routine measurements to specialized in-depth analysis of laser beam characteristics.

Features of the new LDS at a glance:

- automated one-click measurements
- operation of several devices
- management of large amounts of data/measurements
- user-defined presets for device/measurement settings
- customizable user interface display
- optimized algorithms for faster measurements
- automated review/evaluation of measurement parameters for robust, valid measurements independent of operator and measurement environment
- wide range of graphical displays and evaluation tools for complex analyses regarding time stability, reproducibility, process characteristics
- report function for easy documentation of results with customized reports upon request
- light and dark color schemes for use in dark and light lab environments
- evaluation tools for special measurement applications (e.g. Trifocal Analysis) can be provided upon request



Dark and light color scheme of the new LaserDiagnosticsSoftware

Custom Solutions

The Tailored Suit off the Shelf

In addition to the standard products, PRIMES has been developing new beam diagnostics and beam monitoring products as well as product improvements for many years now. One third of the PRIMES staff is dedicated to turning innovations into robust, high quality measuring systems. Many of the special-purpose solutions were developed on the basis of special customer demands and are now generally available:

- OpticsQualityMonitor: Monitoring of absorption characteristics of optics in supplier‘s, processor‘s and user‘s quality assurance.
- PowerLossMonitor: Calorimetric power measuring module which determines the cooling capacity of a cooling circuit (0.1 to 30 kW).

Our latest innovation for focus control during processing: OnlineFocusTracker

- Measurement of beam divergence and focus position in beam propagation direction.
- Very high measuring accuracy of 5 % of a Rayleigh length.
- Measurement at speeds of 10 to 100 Hz.
- No special optics necessary.

For more information:

We will gladly be prepared to advise you concerning the optimal system for your beam diagnostics requirements: Sales@primes.de or by phone at +49 6157 9878-0.

Services

All „Standard“ in the Calibration Laboratory

PRIMES calibrates laser beam power measuring instruments by all manufacturers and, of course, mainly its own devices like the Cube, PowerMonitor, CompactPowerMonitor, PocketMonitor and the PowerMeasuringModule.

Thus, this service is available to all interested parties. A reference standard (CompactPowerMonitor F-1), referenced by the *Physikalisch-Technische Bundesanstalt (PTB, Braunschweig, Germany)*, as well as four high power laser sources, a 3.5 kW CO_2 laser, a 1 kW Nd:YAG laser, a 2 kW disk laser and a 4 kW fiber laser, form the technological basis for our services.

Our reference standard, a modified CompactPowerMonitor, is certified by the PTB with an accuracy of 0.6 – 0.9 % for both, YAG and CO_2 wavelengths. Traceability to national standards has been ensured at power levels from 120 W to 2 kW. We offer calibrations of power meters traceable to national standards for the following laser beam sources:

- CO_2 laser (λ = 10.6 µm)
- Nd:YAG-, fiber- and disk laser (λ = 1 030 – 1 080 nm)

Measurement Services

Here, our emphasis lies upon the field of beam diagnostics and the determination of all laser relevant parameters. However, we can also draw from a wide ranging experience for processes and beam source development. Thus, we can support laser users during their manufacturing process. Our strength, your advantage:

- the application of our measuring systems and the analysis of their results
- the elimination of errors on laser systems
- the dimensioning of telescopes and beam guidance systems
- process development, process optimization
- the transfer of beam parameters and process parameters from one production line to another

Our comprehensive range of measurement devices forms the basis for a reliable measurement of processing systems according to the current DIN EN ISO regulations for beam characterization.

- DIN EN ISO – 11146
  Test methods for laser beam widths, divergence angles and beam propagation ratios
- DIN EN ISO – 11554
  Test methods for laser beam power
- DIN EN ISO – 11670
  Test methods for laser beam parameters - Beam positional stability

Measurement services enable a comprehensive system characterization.

Device Overview

		CUBE M	FMW+	MSM-C	FM+	FPM	BCS	PMM	PM	LQM+
CATALOG PAGE		14	18	21	26	32	35	38	42	48
APPLICATION										
Power measurement		•		•		•	•	•	•	•
Beam distribution in the raw beam										•
Beam distribution in the focal plane			•	•	•		•			
Beam propagation (caustic)			•		•		•			
Raw beam propagation										•
Direct fiber measurement										•
Power monitoring in production		•				•	•	•	•	•
Focus monitoring in production				•		•	•			
Focus geometry monitoring in production						•	•			
Factory standard										
BEAM PARAMETERS										
Power		•				•	•	•	•	•
Power density					w/ CPM and PM	•	•			•
Raw beam diameter										•
Beam waist diameter			•	•	•	•	•			
Focus position			(•)	(•)	•		•			in the raw beam
Divergence			(•)	(•)	•		•			•
Rayleigh length			(•)	(•)	•		•			•
M^2			(•)	(•)	•		•			•
LASER TYPES	λ IN nm									
CO_2 laser	9 000 – 12 000		•		•		•		•	
Disk-, rod-, fiber lasers	1 000 – 1 100	•	•	•	•	•	•	•	•	•
Diode laser	780 – 980				•		•		•	
Diode laser	900 – 1 100	•	•		•		•	•		
SSL (SHG)	520 – 550			•	•					•
SSL (THG)	340 – 360			•	•					•
POWER RANGE										
< 200 W		•	•	•	•			•		•
200 W – 1 kW		•	•	•	•	•	•	•	•	•
1 kW – 8 kW		•			•	•	•	•	•	•
> 8 kW					•			(•)	•	•
COMMUNICATION										
Serial							•		•	
USB		•							•	
Ethernet			•	•	•		•			•
Bluetooth		•								
Fieldbus systems				•		•	•	•		
Analog out									•	
MEDIA										
Water				•			•		•	•
Compressed air						•	•		•	
Inert gas					•		•			

		BM+	CPM	HP-MSM-HB	MSM	EC-PM	CUBE	PMC	PMT
CATALOG PAGE		54	58	64	70	73	80	86	90
APPLICATION									
Power measurement			•			•	•	•	•
Beam distribution in the raw beam		•							
Beam distribution in the focal plane				•	•				
Beam propagation (caustic)				•	•				
Raw beam propagation									
Direct fiber measurement				•					
Power monitoring in production			•				•		
Focus monitoring in production									
Focus geometry monitoring in production									
Factory standard						•			
BEAM PARAMETERS									
Power			•			•	•	•	•
Power density		w/ CPM and PM		w/ PLM					
Raw beam diameter		•							
Beam waist diameter				•	•				
Focus position				•	•				
Divergence				•	•				
Rayleigh length				•	•				
M^2				•	•				
LASER TYPES	λ IN nm								
CO_2 laser	9 000 – 12 000	•	•			•			•
Disk-, rod-, fiber lasers	1 000 – 1 100	•	•	•	•	•	•	•	•
Diode laser	780 – 980	•	•			•			•
Diode laser	900 – 1 100						•	•	
SSL (SHG)	520 – 550	•			•				
SSL (THG)	340 – 360				•				
POWER RANGE									
< 200 W		•	•	•	•		•	•	•
200 W – 1 kW		•	•	•		•	•	•	•
1 kW – 8 kW		•	•	•		•	•	•	•
> 8 kW		•	•						•
COMMUNICATION									
Serial		•	•			•			
USB			•			•	•	•	
Ethernet		•		•	•				
Bluetooth							•		
Fieldbus systems									
Analog out			•			•			•
MEDIA									
Water			•	•		•			
Compressed air				•		•			
Inert gas									

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