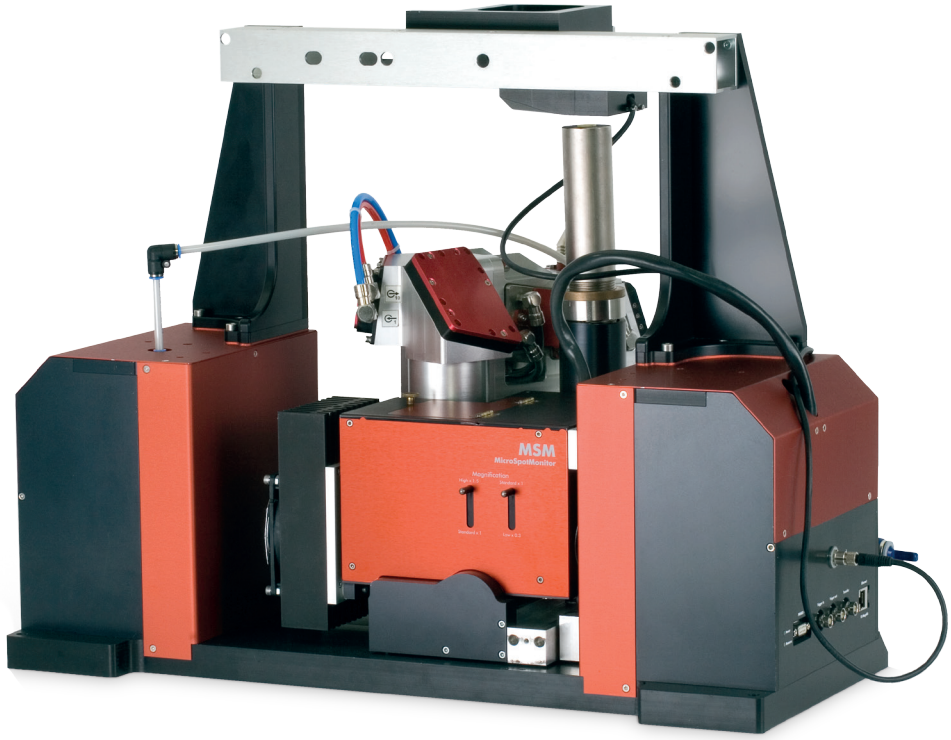
HighPower-MSM-HighBrilliance



Especially for brilliant high power lasers with an additional HighBrilliance option: The HighPower-MSM-HighBrilliance (HP-MSM-HB) can measure power density distributions of single mode lasers up to 10 kW directly in the focal plane.

Measuring Focus Geometries of Multi-kilowatt Lasers

NIR lasers with high beam qualities and high medium powers are increasingly used in the field of laser material processing. Focus geometries in the range of 20 up to several 100 micrometers can be realized by these lasers. No known material can permanently withstand the resulting power densities up to the GW/cm^2 range. Conventionally scanning measuring procedures for analysis are not suitable for such peak power densities. Especially for finely focused high power lasers, PRIMES has added a High-Brilliance option to the camera-based focus analysis system, the MicroSpotMonitor (MSM).

The HighPower-MSM-HighBrilliance can measure focus geometries of lasers with high brilliance and single mode lasers with a beam power of up to ten kilowatts. In doing so, the system is able to determine the beam parameters of focused beams of multi-kilowatt lasers with spot sites from 20 to 1000 micrometers. This is done directly in the processing zone at typical process parameters. A CCD chip registers the power density distribution of the laser beam two-dimensionally. The measurement objective is protected from contamination by the integrated air flushing.

Improved Measurement Characteristics

The HighPower-MSM-HighBrilliance improves the measurement characteristics:

- Internal focus shift < 10 % of the Rayleigh length/kW in case of single mode lasers
- The observation planes of all three internal beam paths are aligned better than ± 1 mm.

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In Practice

PRIMES presents its new system to all laser- and plant manufacturers as well as end users. The HighPower-MSM-HighBrilliance can support not only the beginning of the development of new processing concepts but also the quality assurance in existing plants. In doing so, it ensures the reliability of processes.

Measured Beam Parameters

- Beam diameter
- Rayleigh length
- Far field divergence
- M^2 / BPP

Measuring Procedure – the Principle

The HighPower-MSM-HighBrilliance determines beam parameters of focused laser beams of multikilowatt lasers in the range of 20 micrometers up to one millimeter directly in the processing zone under full power.

For this purpose, 95 % of the laser power is transmitted by the measuring objective by means of a beam splitter and is then absorbed. The remaining five percent are continuously attenuated in the measuring objective and are finally absorbed by water-cooled absorbers. A partial beam with a power of only a few milliwatts is magnified and imaged onto the CCD sensor.

The measuring objective was designed for beam powers of up to 10 kilowatts single mode. Additionally, the HighPower-MSM-HighBrilliance is equipped with a safety circuit which can be connected to the laser. In case of overheating or device errors, laser emission will be interrupted. This protects the measuring device from possible damages.

The HighPower-MSM-HighBrilliance individually measures power density distributions in the focus range in up to 50 measuring planes. The focus caustic is then made up of these power distributions. Beam geometries, such as beam position, beam radius and the length of the half axes as well as the tilting of the half axes towards the device axis are determined according to the procedures stipulated in the norm ISO 11146, i.e. 2. moments and $1/e^2$ (86 %) power inclusion.

The beam propagation parameters, such as focus position, focus radius, Rayleigh length, divergence, M^2 and beam parameter product are determined by the beam geometry data.

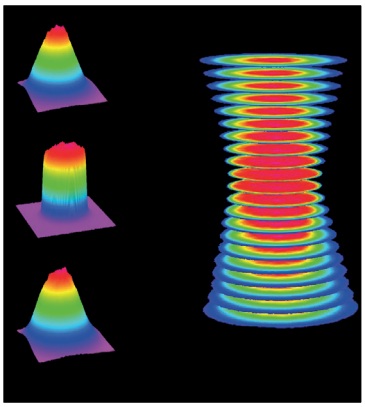
According to ISO 11146 the ellipticity of the focus as well as the astigmatic difference are determined by means of the measuring data for the half axes of the beam. Moreover, the beam pointing error out of a fiber can be determined.

In addition to the described caustic measurements, the HighPowerMSM-HighBrilliance is also able to carry out analyses with regard to the temporal behavior of the power density distribution of a certain plane. The behavior of the laser in the work piece plane can be monitored with a temporal resolution of approx. 2 seconds, for example.

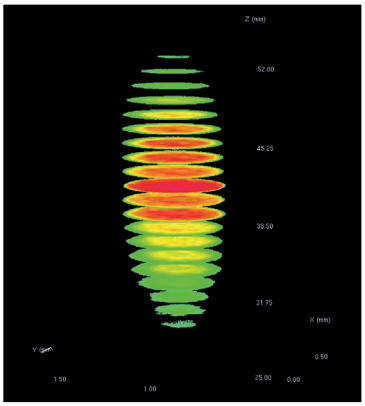
Operation

There are two alternatives for the operation of the HighPower-MSM-HighBrilliance:

1. The computer-based LaserDiagnosticsSoftware (LDS) enables the manual or semi-automatic measurement of the beam distribution as well as the determination of the beam position and the beam dimensions.
2. Scripts control the HighPower-MSM-HighBrilliance semi-automatically, e.g. for repetitive measuring tasks in service, quality assurance and qualification.



Measured power density distribution of a focussed 4 kW fiber laser



Power density scaled presentation of a caustic measurement result

HighPower-MSM-HighBrilliance

Both alternativs are individually adapted to the current measuring procedure. Advantage: The programmed user guidance can reduce the demands on the operation of the HighPower-MSM-HighBrilliance considerably.

Models and Options

Using a special mount for fiber optic cables, the beam geometry can be measured directly out of the fiber. Adapters for LLK-B, LLK-D, QBH and HLC 16 are available.

The power measurement option enables a direct measurement of the beam power coupled into the absorber. The LaserDiagnosticsSoftware enables the evaluation of measuring results and the monitoring of limit values.

Moreover, the LaserDiagnosticsSoftware enables the use of alternative beam radius definitions: 2. moments (standard), 86 % power inclusion (standard), moving slit method, knife-edge method, Gaussian-fit method, 86 % power-density-drop, two additional power inclusion procedures with a freely selectable power threshold.

Technical Data

Measurement Parameters	
Power range	10 W – 10 kW average power
Wavelength range	1025 – 1080 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 • 6-level switchable optical attenuator 0 – 100 dB • Measuring range x-, y-direction: Adjustment range of measuring window dependent on sensor and objective: 0.03 – 8 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	0,7 l/min/kW, particle free, additives under 10 vol. -%
Cooling (power measurement option)	> 4,5 l/min
Compressed air	3 – 4 bar, dry and oil-free
Communication	
Interface	Ethernet
Dimensions and Weight	
Dimensions (L × W × H)	600 (excluding connectors) × 400 × 391 mm
Weight	approx. 34 kg
Environmental Conditions	
Operating temperature range	+10 °C up to +40 °C
Permissible relative humidity (non-condensing)	10 – 80 %