

A close-up, artistic photograph of a microscope's objective lens and brass housing. The lens is in sharp focus, showing its internal elements. The background is blurred, showing other parts of the microscope and a red surface. The overall tone is professional and technical.

PRIMES

COMPETENCE IN **BEAM DIAGNOSTICS**

The logo for PRIMES, featuring the word "PRIMES" in a bold, black, sans-serif font. A red horizontal line is positioned above the "P", and a red dot is placed above the "I".

PRIMES

COMPETENCE IN **BEAM DIAGNOSTICS**

CONVENIENT BEAM DIAGNOSTICS IN LASER QUALITY INSPECTION

PRIMES GmbH Pfungstadt
12.09.2018

LASER QUALITY MEASUREMENTS

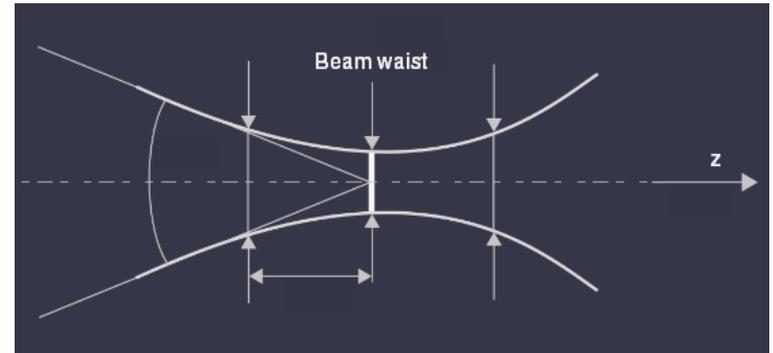
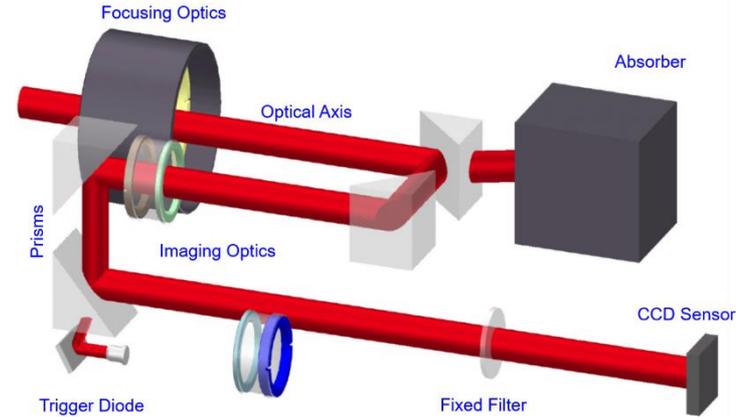
Problems with qualification of beam sources

- sheer volume of lasers to be qualified per day
- required measurement accuracy and reproducibility
- > fast and robust qualification measurement and documentation

LaserQualityMonitor LQM+

Measurement Principle:

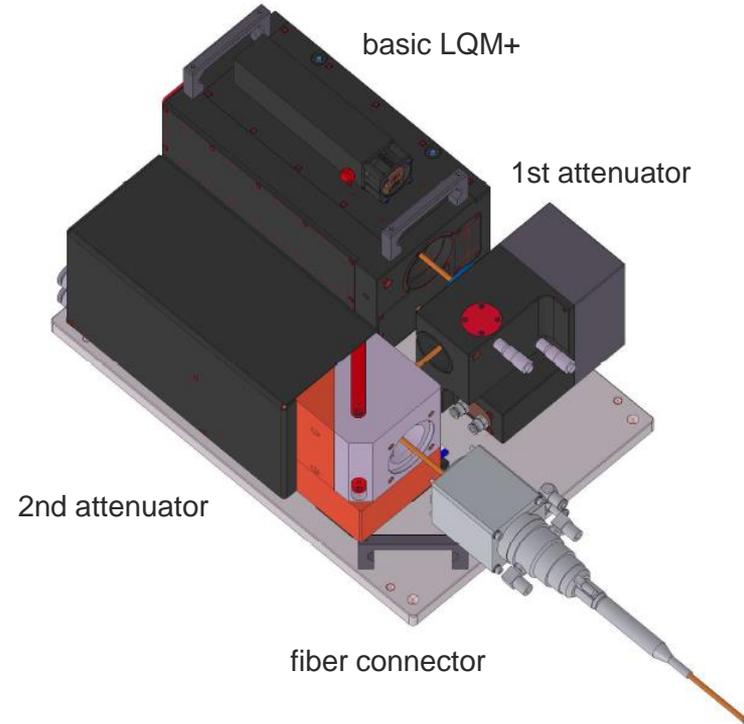
- Measurement of artificial caustic according to ISO11146
- Backcalculate, using second moments, from caustic to raw beam parameters:
 - Beam waist position
 - Beam waist radius
 - M^2



MEASURING LASER QUALITY WITH THE LQM+

Device specifications

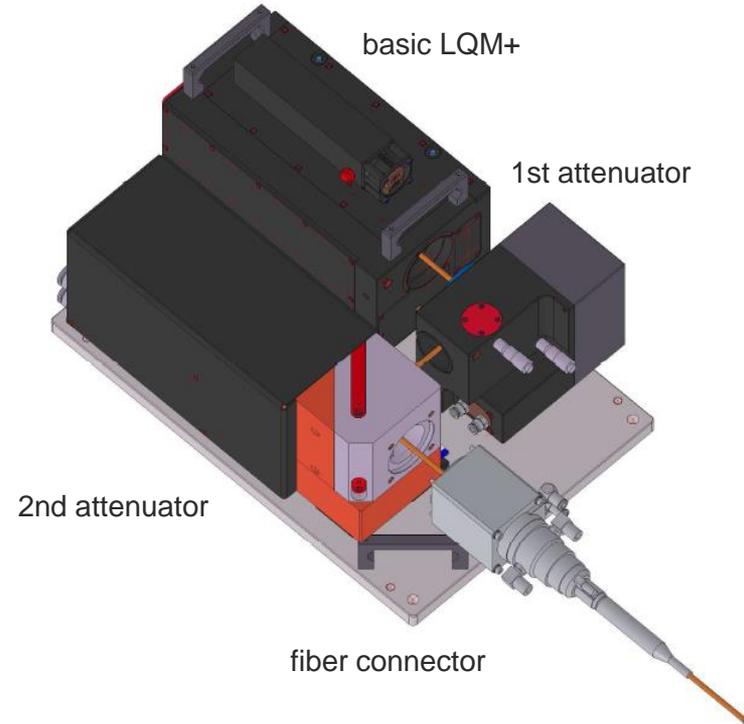
Laser pulse duration	100 fs - cw
M^2	1 - 50
λ	340 - 1100 nm
Power	100 mW - 20 kW
Beam diameter	1 - 15 mm
Max. power density	up to 10 kW/cm ²



LaserQualityMonitor LQM+

What's the „+“ in LQM+?

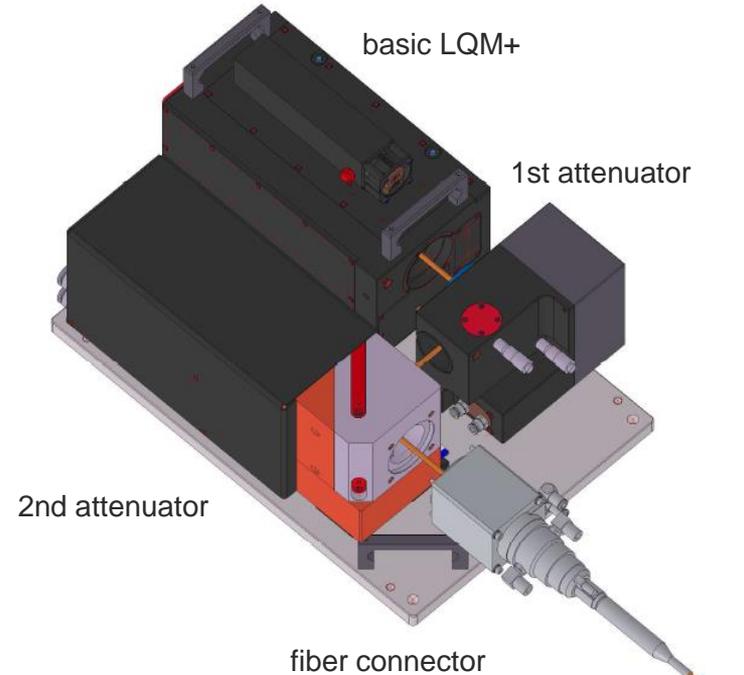
- Modular system to maximise the range of application => 20kW
- „Plug and play“ for fibers
- Fast alignment mode for all other applications
- Simultaneous power measurement in attenuators



LaserQualityMonitor+

What's the „+“ in LQM+?

- Works with new LDS
- Auto-caustic: 3 times faster than LQM!
- Higher measurement accuracy and reproducibility
- Interchangeability of lenses, OD filters, attenuators
- Increased signal-noise-ratio

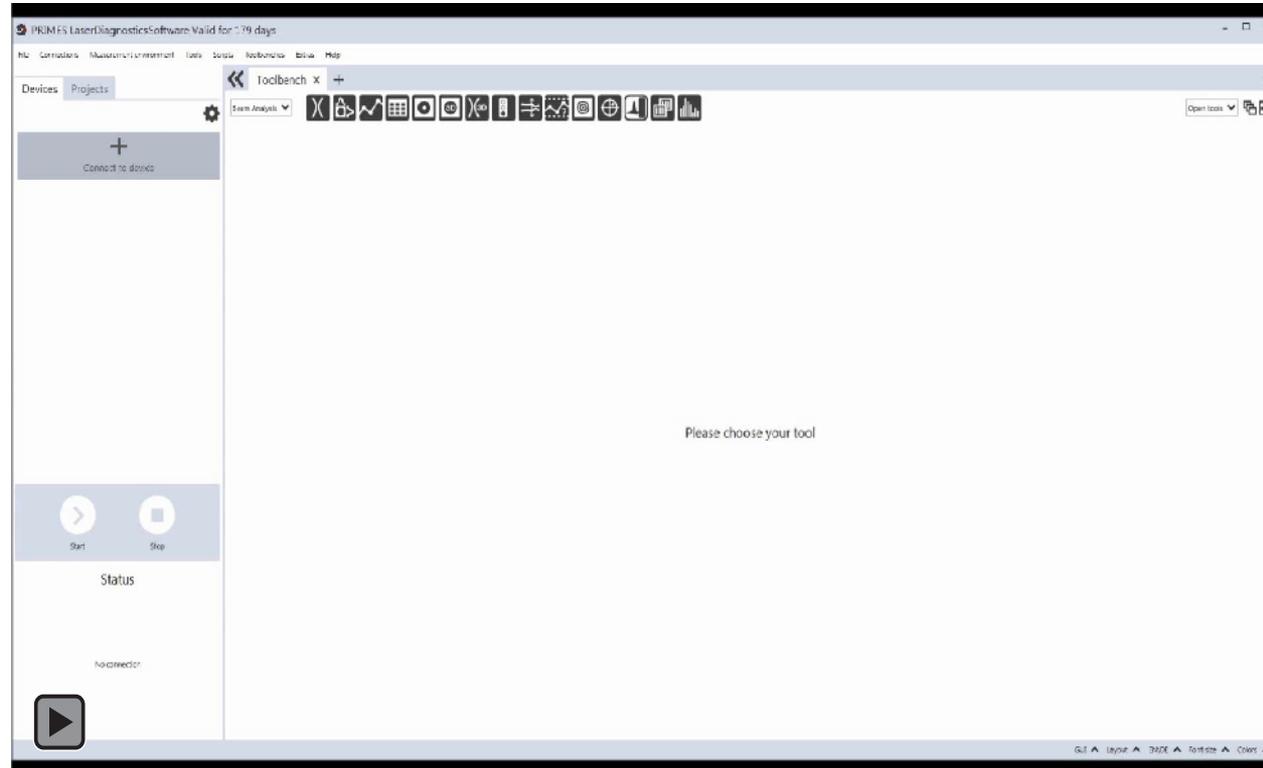


AUTOCAUSTIC MEASUREMENT

Measurements with LQM+ and new LDS:

1. Plug fiber
2. Choose Auto caustic
3. Press Play
4. Measurement (ca. 1 min)

- > fast
- > accurate
- > operator independent
- > environment independent

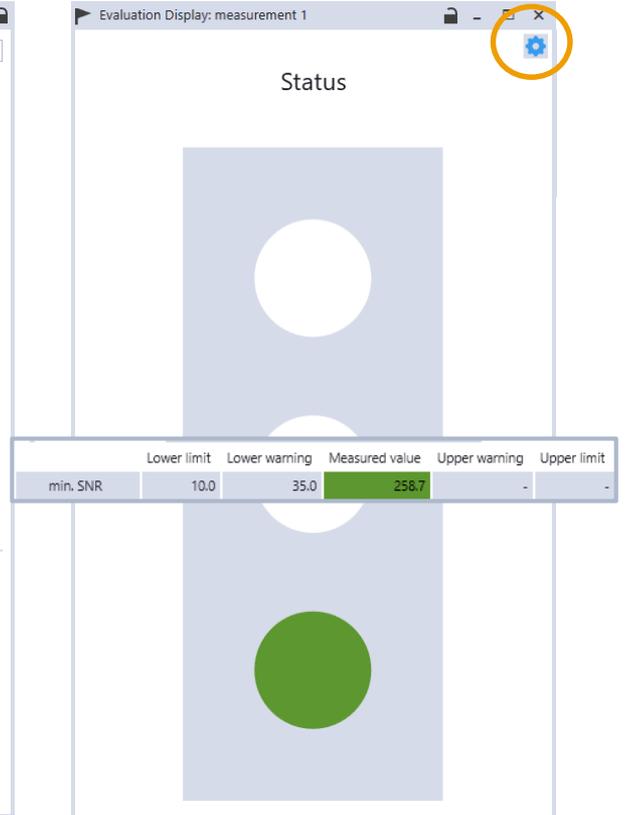
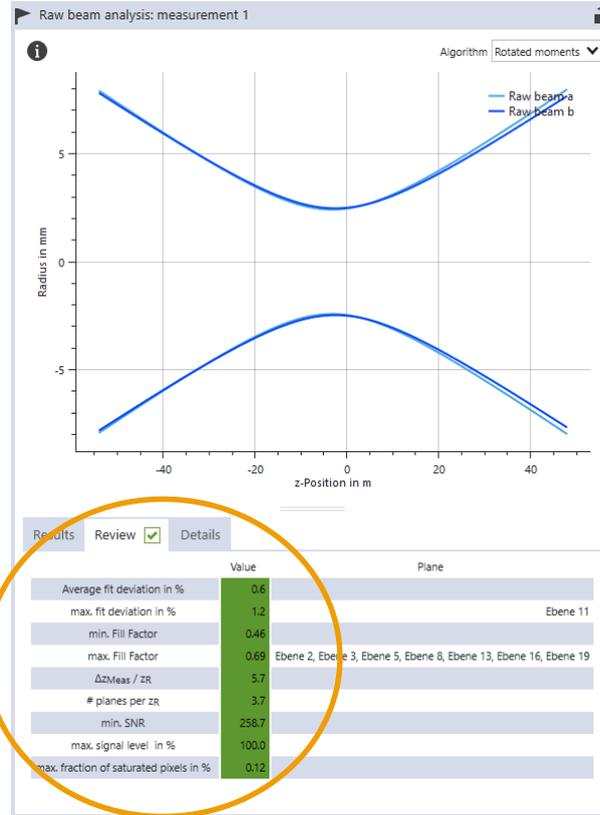


MEASUREMENT EVALUATION

Laser

OK

Not OK

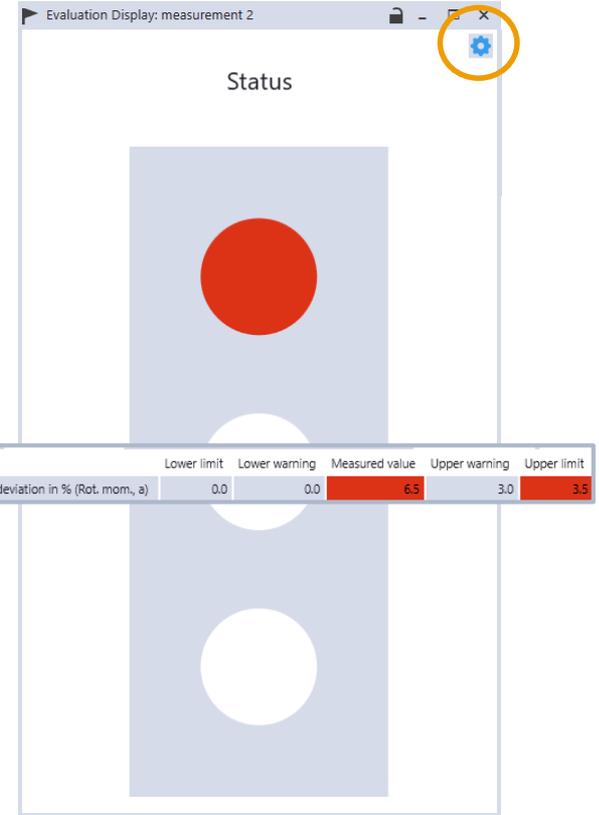
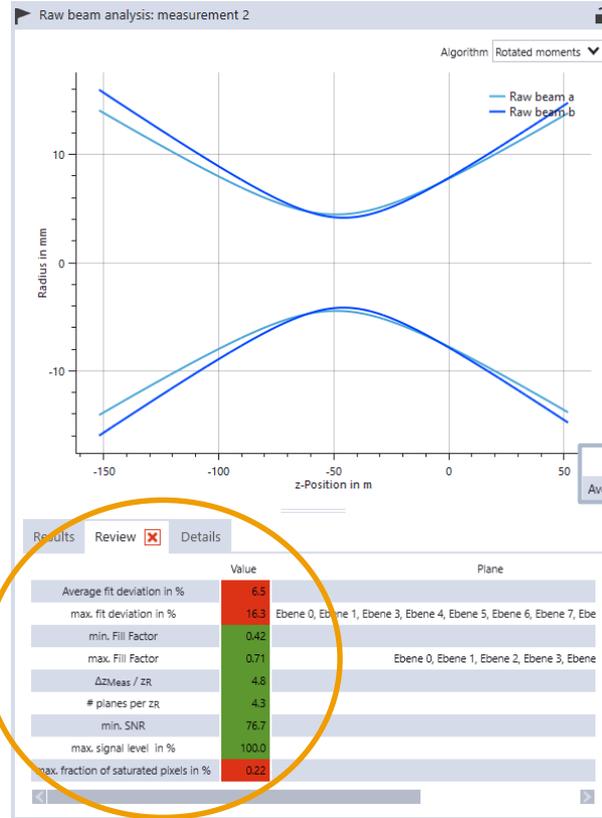


MEASUREMENT EVALUATION

Laser

OK

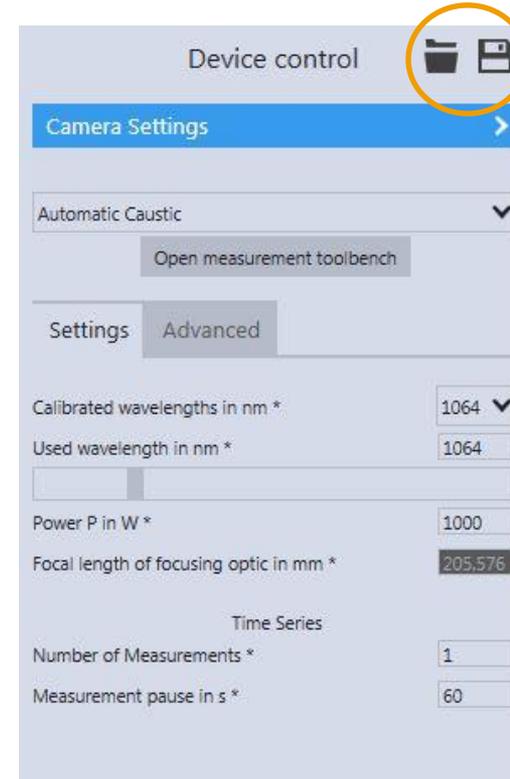
Not OK



PRESETS

Laser Quality Measurements:

- Same setup
 - Same laser type
 - High volume of measurements/day
- > Save time by setting parameters once, then load and use presets for measurement



REPORT FUNCTION

Documentation of measurements:

- pdf-Report with measurement results
- Customized reports possible upon request

Measurement report



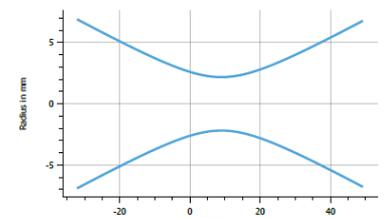
Report date: 8/31/2018

Measuring device:	LaserQualityMonitor	Comment:
Serial number:	16177	
Year of construction:		
Last certification:	1/1/2017	
Last service:		
ROI:	0.5	

Measurement: LaserQualityMonitor Caustic

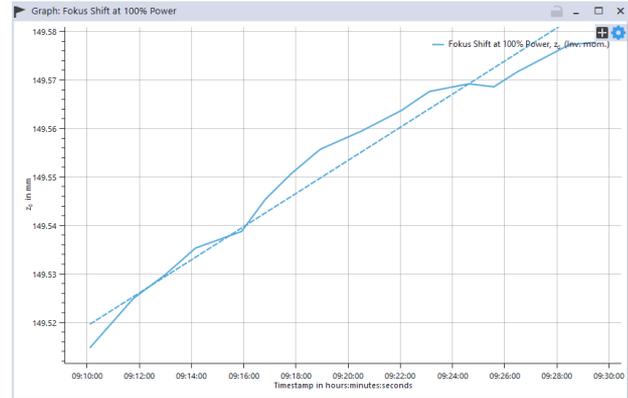
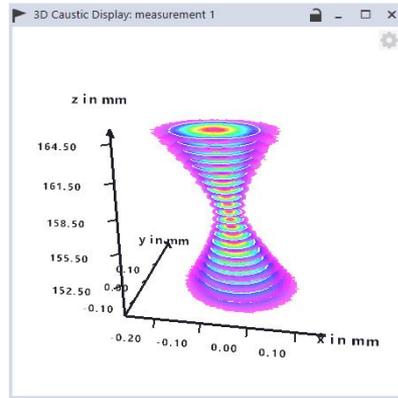
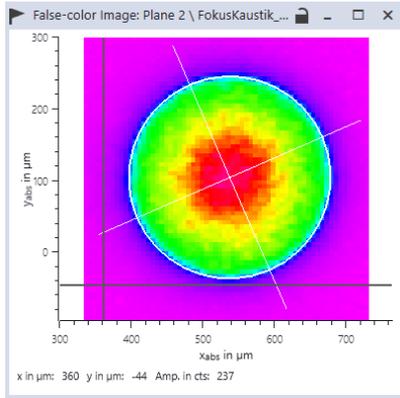
Caustic results 2nd moment

z_0 in μm	27.20
z_0 in mm	151.029
z_1 in mm	2.13
BPP in $\text{mm}^{\circ}\text{mrad}$	0.347
k	0.98
$M^{\#}$	1.02
CDG x at z_0 in mm	0.044
CDG y at z_0 in mm	-0.028
Divergence Angle θ in mrad	25.52



Caustic review 2nd moment		Caustic details 2nd moment	
	Value		Value
Average fit deviation in %	9.3	Focal length of focusing optic in mm	205.57%
max. fit deviation in %	3.9	Distance device/laser in m	0.000
min. Fill Factor	0.25	Wavelength λ in nm	1064.0
max. Fill Factor	0.31	P in W	1000.0
$\Delta z_{\text{max}} / z_0$	6.1	Timestamp	8/31/2018 1:06:19 PM
# planes per z_0	3.4		
min. SNR	730.6		
max. signal level in %	87.9		
max. fraction of saturated pixels in %	0.00		

SOFTWARE EVOLUTION



Graph list

Fit algorithms

- Trend
- Average
- Caustic
- Wavelength λ 1064
- Rise
- Decay
- Rise 2
- Fit sensitivity 0.1

Caustic parameters

- Global parameters
- Device moments
- Rotated moments
- Invariant moments
- Parameter
 - Beam waist radius r_0
 - Beam waist position z_0
 - Rayleigh length z_R
 - Beam parameter product k

	a	b	Total
z in mm	---	---	84.565
r in μm	141.65	140.86	---
Ellipticity	---	---	0.99
Azimuth angle ϕ in $^\circ$	---	---	23.5
COG (window) in mm	0.005	0.003	---
COG (absolute) in mm	0.537	0.106	---

	a	b	Total
z ₀ in mm	151.519	151.657	---
r ₀ in μm	29.64	28.95	---
z _R in mm	2.45	2.36	---
Divergence Angle θ in mrad	24.16	24.52	---
M ²	1.06	1.05	---
BPP in mm ² mrad	0.358	0.355	---
Ellipticity at Δz_0	---	---	1.02
$\Delta z_0/z_R$	---	---	-0.06
COG x at z ₀ in mm	0.012	0.010	---
COG y at z ₀ in mm	-0.017	-0.017	---
Misalignment angle in mrad	-8.03	1.21	1.41

=> Complex Analysis:

- time stability
- reproducibility
- comparison of lasers
- process characterizations

EASY HANDLING OF MEASUREMENT DATA

- Parallel displaying of different datasets / measurements for comparison
- All tools can be opened any number of times



OUTLOOK: LDS PRO

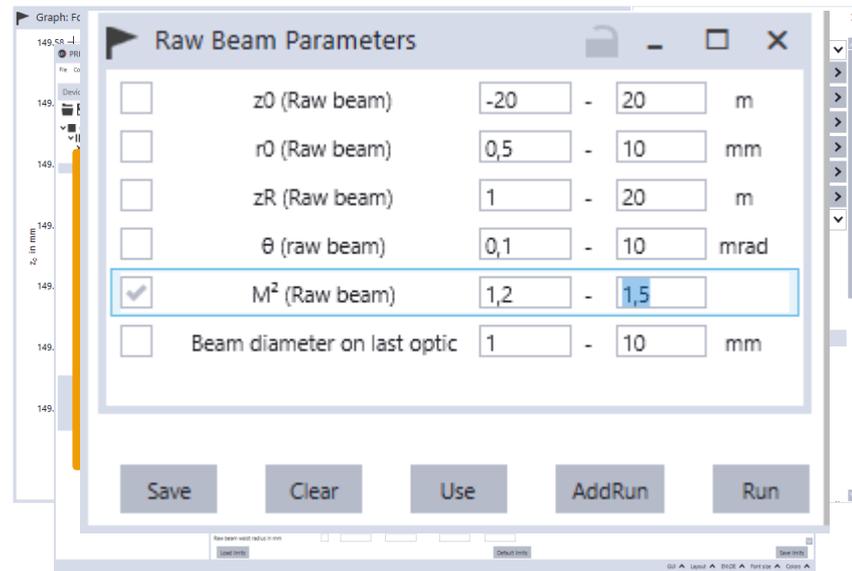
Database:
Management of
large amounts of
measurements

Customized limit
values: Process
condition monitoring

Tools for statistical
evaluations

„Intelligent“ tools to
quickly answer
complex questions

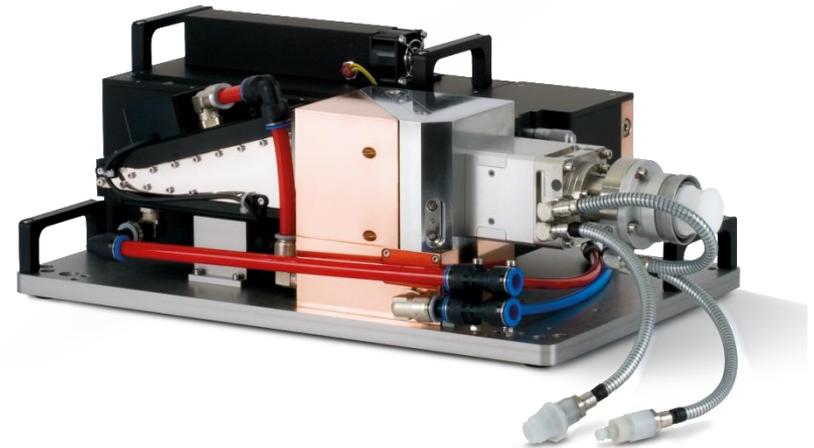
Software interfaces



SUMMARY

Easy, fast and accurate measurements of laser quality due to:

- „Plug-and-play“ for fibers
- Fast, accurate 1-click measurements
- Evaluation of measurement results
- Tools for analyzing big datasets and time-related effects
- Report function for documentation



THANK YOU FOR YOUR ATTENTION!

PRIMES GmbH | Max-Planck-Str. 2 | 64319 Pfungstadt | Germany | www.primes.de

