
PRIMES
COMPETENCE IN BEAM DIAGNOSTICS

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MEASURING LASER POWER - BETWEEN FLEXIBILITY AND MACHINE INTEGRATION

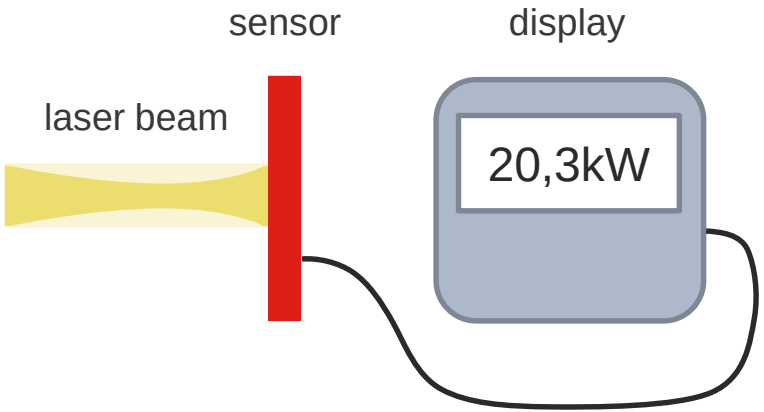
PRIMES GmbH Pfungstadt
11.09.2018

CONTENT

1. **Power measurement – the oldest trick in the book…**
2. **… with some open questions and decisions to make**
3. **Technology aspects**
4. **Outlook**

WHY MEASURING POWER – THE OLDEST TRICK IN THE BOOK

- Quality assurance
- Determine service intervals
- Standardize processes
- Facilitate the exchange of a beam source
- Save money



Cheapest sensor technology

How accurate?

UNCERTAINTY OF MEASUREMENT – THE PTB

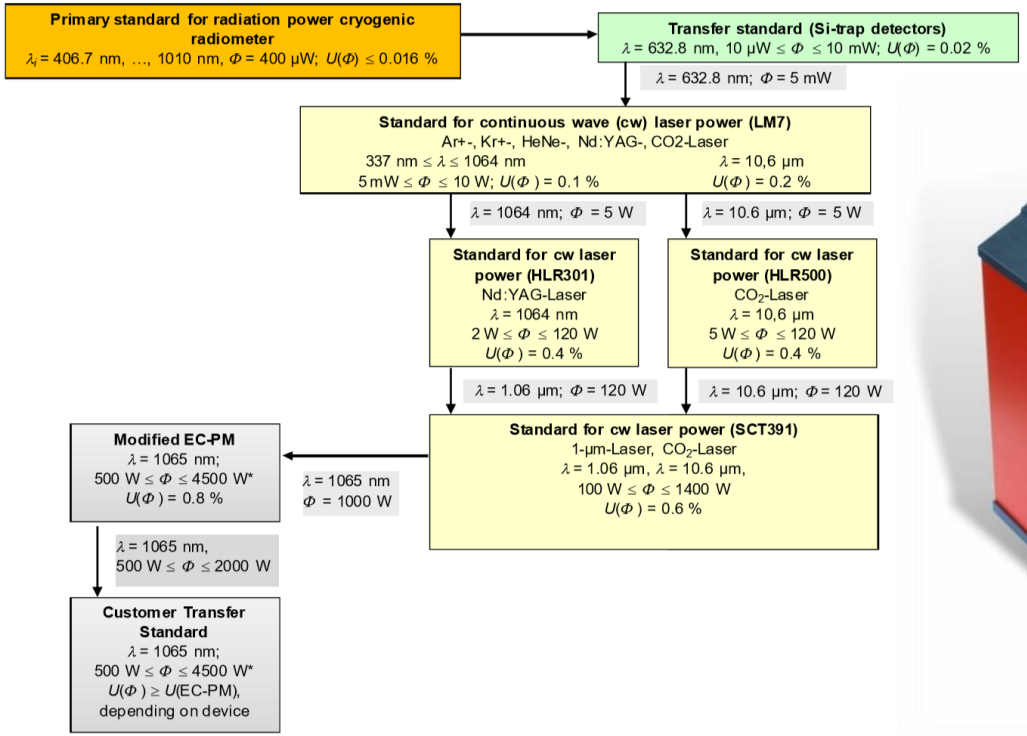
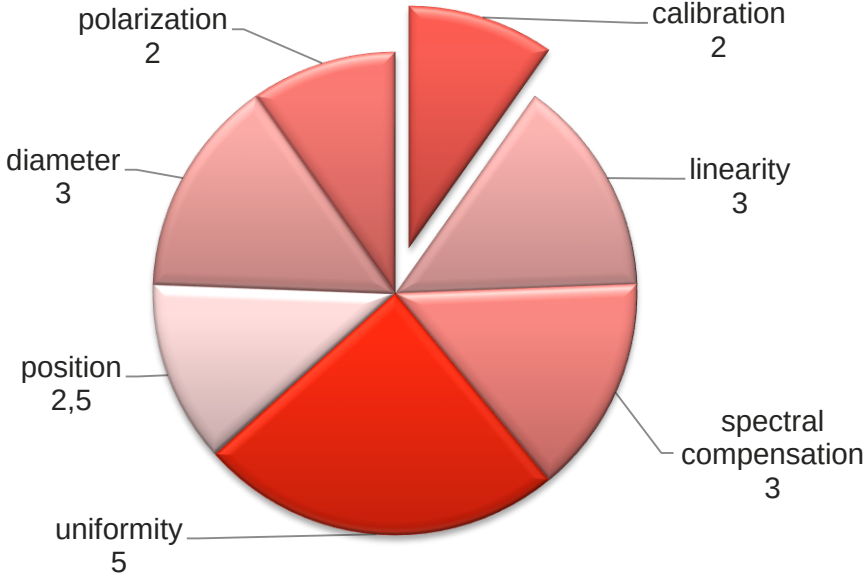


Image property of the Physikalisch Technische Bundesanstalt PTB

UNCERTAINTY OF MEASUREMENT - INFLUENCE OF OTHER LASER PARAMETERS

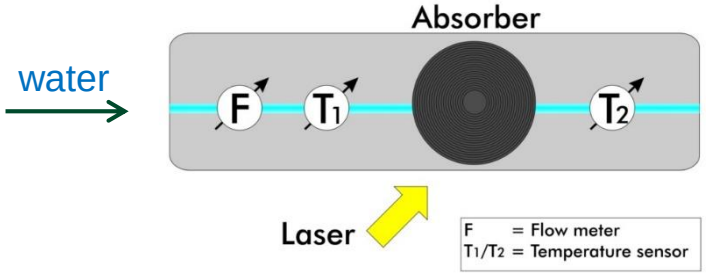
Contribution to Uncertainty of Measurement / %

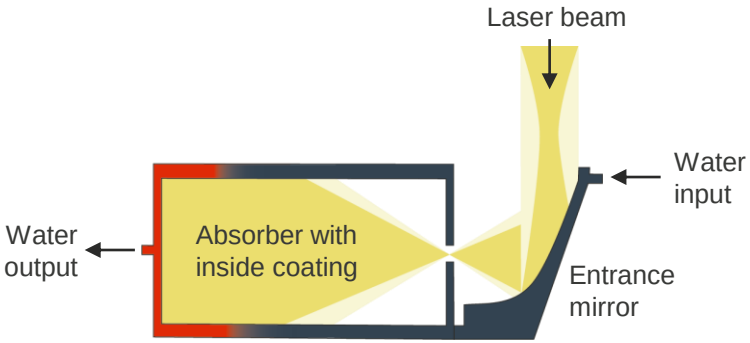


How to eliminate all these contributions?

WHY PRIMES IS BUILDING CALORIMETERS SINCE >20 YEARS

$$P = \dot{m} \cdot c_p \cdot \Delta T;\ genauer \int_{T_1}^{T_2} \dot{m} \cdot c_p(T) dT$$





Advantages (Ulbricht sphere):

- Position independence
- Diameter independence
- Wavelength independence
- Absorption >99%
- High intensity
- Robust, industry approved
- Long term stability
- Laser safety

NOT EVERYONE LIKES WATER COOLING

image courtesy of Neil Phillips, creative commons

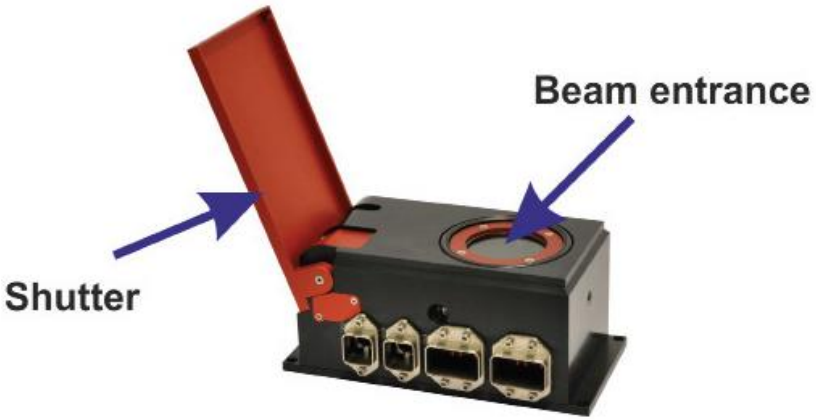
CALORIMETER – PASSIVE COOLING

$$\Delta Q = m \cdot c_p(T) \cdot (T_{End} - T_{Start})$$

$$\boldsymbol{P = \frac{\Delta Q}{\Delta t}}$$

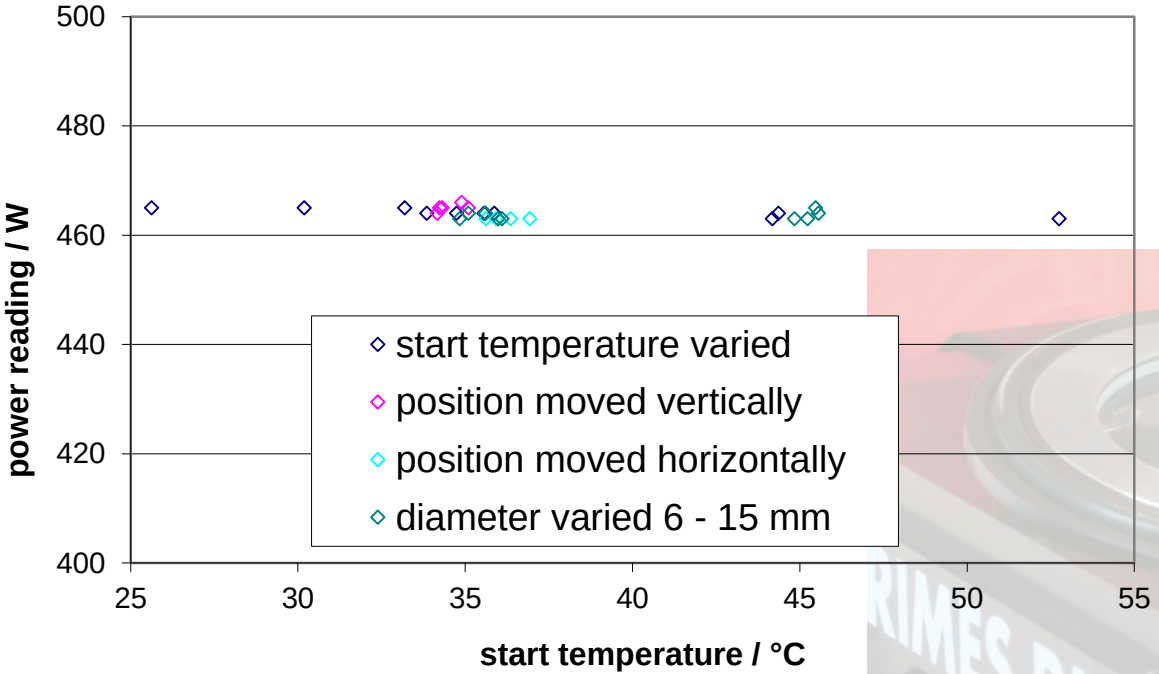
P = Power
ΔQ = energy increase (heat)
Δt = Irradiation time
$C_p(T)$ = specific heat capacity of absorber
m = mass of absorber

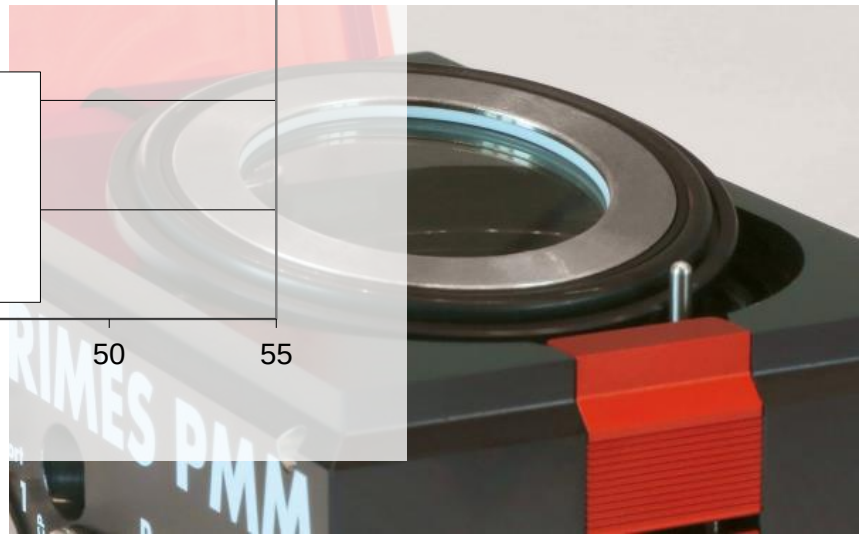
Discontinuous / Ballistic: T, t



INDEPENDENCE FROM OTHER BEAM PARAMETERS

$\sigma < 0.3\%$

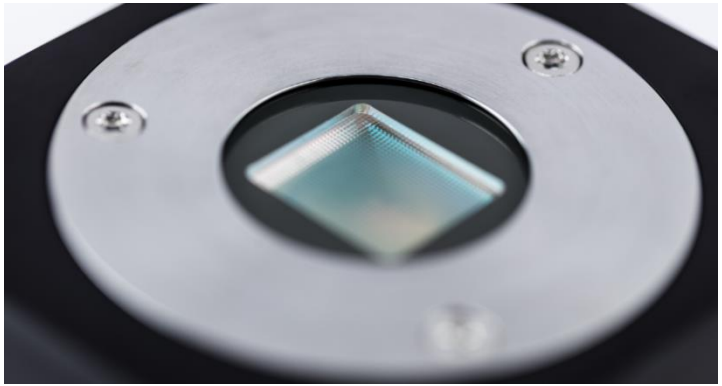


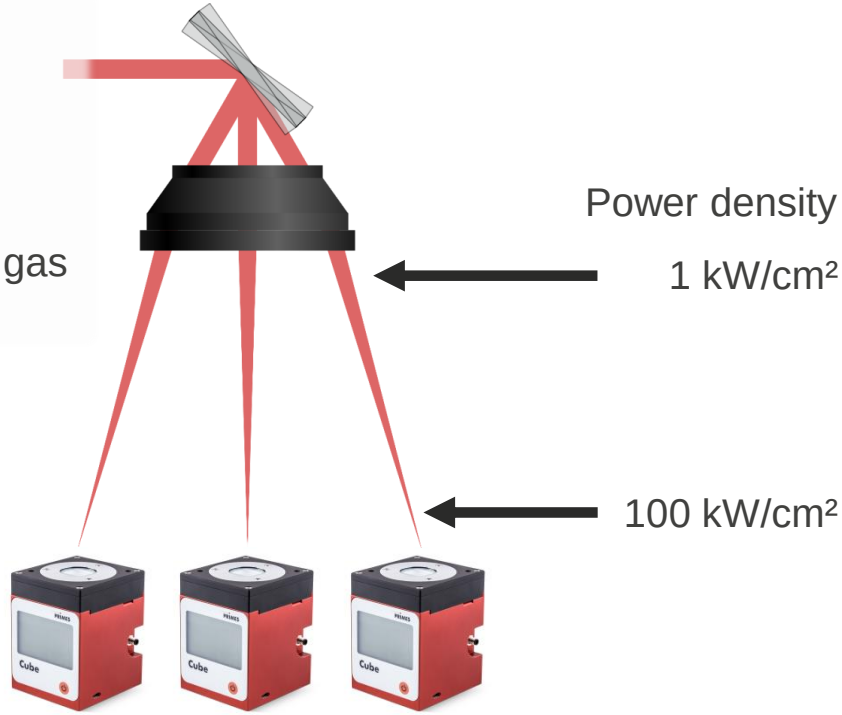


THE APPLICATION DETERMINES THE POWER SENSOR – Cube M

Scanner application:

- Fast
- Angle
- Small beam diameter
- High power density
- Small compartment, sealed, maybe inert gas
- Large dynamic range for power





THE APPLICATION DETERMINES THE POWER SENSOR – PowerMeasuringModule PMM

Production line:

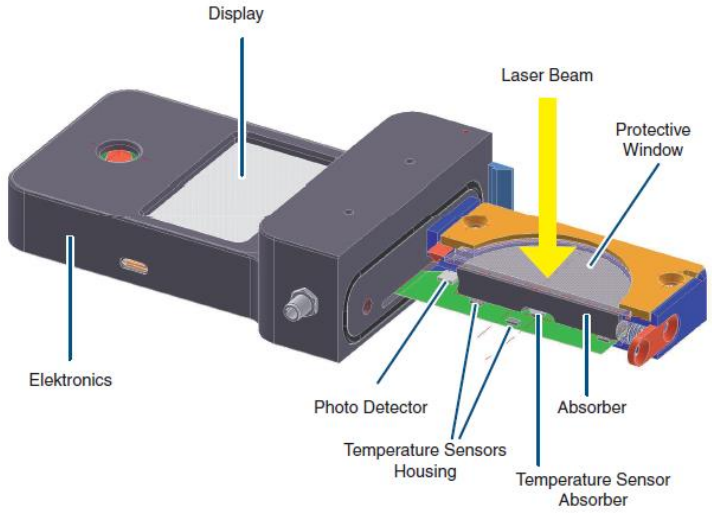
- Fast
- Fully automatic / no operator
- Protection against dust/particles
- Rugged, reliable
- Fieldbus for easy integration into existing hardware and software

EtherNet/IP™ CC-Link PROFIBUS® PROFINET® DeviceNet™ EtherCAT®

THE APPLICATION DETERMINES THE POWER SENSOR - PowerMeasuringCassette PMC

Cassette for focusing head:

- Confined space
- Easy handling



Characteristics

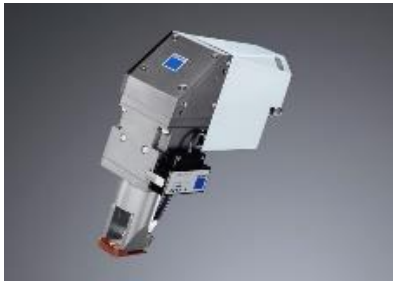
- Thermally insulated absober plate
- Protection glass
- Photodetector measures laser pulse duration
- Interlock for laser

Technical Data

Max. power density for absorber:	1.5 kW/cm²
Max. beam diameter on absorber:	30 mm
Irradiation time:	0.1 – 1.0 sec
Laser power:	100 – 8,000 W
Wavelength:	800 – 1090 nm
Accuracy:	± 3 %
Reproducibility:	± 1 %
Nominal measuring frequency:	1 cycle/min

CASSETTE APPLICATIONS

Trumpf CFO 50



Source: Trumpf GmbH

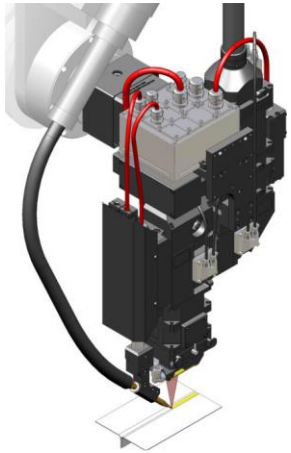
Trumpf BEO 70

Source: Trumpf GmbH

Precitec YW52

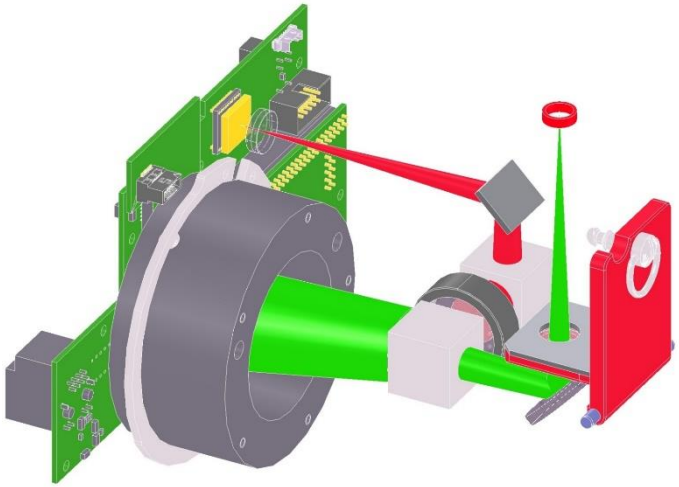
Source: Precitec GmbH & Co. KG

Scansonic ALO3



Source: Scansonic IPT GmbH

POWER MEASUREMENT: THE NEXT STEP
FocusParameterMonitor FPM



Beam Profile + Power in the Tool Center Point in 0.3 seconds

COMBINATIONS WITH POWER

Power plus	water cooling	= permanent beam dump
	cassette	= compact, easy handling
	microlens array	= indepencence of angle and small beam diameter
	bluetooth	= measurement in a cabin without cable
	laser-on time	= large dynamic range
	fieldbus	= machine integration
	beam profile	= power density on the workpiece

SUMMARY

Quality assurance using power meters

Independence from other laser parameters through the use of a calorimeter

The application determines the right sensor

Combine power measurements with other quantities for additional benefits

THANK YOU FOR YOUR ATTENTION

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