Technical Information
PRIMES Calibration Laboratory

1. General information

The calibration laboratory of PRIMES GmbH is based on the requirements of DIN EN ISO/IEC 17025. At present PRIMES GmbH builds a new additional company building. With its completion additional space will be available, which will allow a better and easier implementation of the structural and organizational requirements of DIN EN ISO/IEC 17025. These requirements imply among other aspects the effective separation between areas as well as an adequate control of the premises regarding the environmental conditions and access. After completion of the new building, the activities for preparing and applying for accreditation according to DIN EN ISO/IEC 17025 will be resumed accordingly.

The quality management system of PRIMES GmbH is certified according to DIN EN ISO 9001:2015. Calibrations, which should meet the requirements of IATF 16949 / chapter 7.1.5.3, can be performed for all power meters manufactured by PRIMES GmbH.

As a manufacturer, PRIMES is the only one who, in addition to calibrating (incl. certificate) or verifying (incl. CoQ) PRIMES measuring instruments, can also officially adjust or repair them.

2. Definition of terms

Term	Definition
Calibration	“Calibration means the determination and documentation of the deviation of the display of a measuring instrument (or the specified value of a material measure) from the conventionally correct value of the measured quantity.” Source: DAkkS-DKD-4 "Traceability of measuring and test equipment to national standards". “Operation that, under specified conditions, in a first step, establishes a relation between the quantity values with measurement uncertainties provided by measurement standards and corresponding indications with associated measurement uncertainties and, in a second step, uses this information to establish a relation for obtaining a measurement result from an indication. NOTE 1: A calibration may be expressed by a statement, calibration function, calibration diagram, calibration curve, or calibration table. In some cases, it may consist of an additive or multiplicative correction of the indication with associated measurement uncertainty. NOTE 2: Calibration should not be confused with adjustment of a measuring system, often mistakenly called “self-calibration”, nor with verification of calibration”. Source: VIM, JCGM 2012, Term: calibration 2.39 (6.11)

Term	Definition
Verification	"Provision of objective evidence that a given item fulfils specified requirements. EXAMPLE 2: Confirmation that performance properties or legal requirements of a measuring system are achieved. EXAMPLE 3: Confirmation that a target measurement uncertainty can be met. Note 3 to entry: The specified requirements may be, for example, that a manufacturer's specifications are met. NOTE 5 to the term: Verification should not be confused with calibration. Not every verification is a validation." Source: DIN EN ISO/IEC 17025:2017
Metrological confirmation	"Set of operations required to ensure that measuring equipment (3.11.6) conforms to the requirements (3.6.4) for its intended use. Note 1 to entry: Metrological confirmation generally includes calibration or verification (3.8.12), any necessary adjustment or repair (3.12.9), and subsequent recalibration, comparison with the metrological requirements for the intended use of the equipment, as well as any required sealing and labelling. Note 2 to entry: Metrological confirmation is not achieved until and unless the fitness of the measuring equipment for the intended use has been demonstrated and documented." Source: DIN EN ISO 9000:2015-11

Table 1: Terms

3. Laboratory scope

The calibration laboratory of PRIMES GmbH offers the calibration for laser power as well as the verification of the beam geometry for PRIMES measuring instruments. Services for devices of other manufacturers are available on request.

3.1. Power calibration

Wavelength	Power	Uncertainty in measurement
CO_2	50 W – 3000 W	± 2 %
NIR	20 W – 6000 W	± 2 %

Table 2: Achievable measurement uncertainty by power calibration

The given values describe the measurement uncertainty that is achievable in our laboratory. Essentially, it is determined by the measurement uncertainty assigned to our reference standards. The measurement uncertainty of our reference standards is typically in the range of 1 %. Electronic copies of the certification of our reference standards can be viewed on our website (https://www.primes.de/en/services/calibration-laboratory.html).
Certificates issued by our laboratory state whether the uncertainty of a measurement of a test sample determined during a calibration corresponds to the specifications in the data sheet of the test sample.

3.2. Verification of beam geometry: measurement of beam diameters and beam caustics

For the following table it is assumed that a measurement was evaluated with a positive overall rating in the 'Review' window of our software, i.e. that it meets the criteria of ISO 11146 for a reliable measurement.

The measurement uncertainty is the sum of a relative part (of the measured value) and an absolute part (of the edge length of the measurement window in the area of the focus or the examined measurement plane).

Measurand	Wavelength	Device*	Uncertainty in measurement
Raw beam	10 600 nm (only via mechanical scanning (BM, for small beams FM)); 1 070 nm, 1 064 nm, 532 nm and 355 nm (mechanical scanning and direct measurement with camera (LQM))	BM, LQM, for small beams FM	Radius: relative share: ±4 % of meas.value, absolute share ±2 % of full scale (measurement window size)
Focused beam	Reference measurement on a focused raw beam; only the specific raw beams mentioned in the row above can be considered as reference beams (beam parameters are known)	FM, MSM	Radius: relative share: ±4 % of meas.value, absolute share ±2 % of full scale (measurement window size)
Divergence	Derived by beam diameter via propagation (verification of z-axis against mechanical standard)	BM, FM, LQM, MSM	± 10 % of measurement value
M^2	Derived by beam diameter via propagation (verification of z-axis against mechanical standard)	BM, FM, LQM, MSM	± 10 % of measurement value

Table 3: Achievable measurement uncertainty by the verification of beam geometry

* The mentioned abbreviations stand for the complete device families

4. Calibration procedure

4.1. Power measurement

The power calibration is carried out according to the technical specifications of DIN EN ISO 11554 and is traceable to national standards of the PTB (Physikalisch-Technische Bundesanstalt, Braunschweig, Germany). A calibration certificate is issued as the result of the measurement.

4.2. Verification of the beam geometry

As one of few manufacturers we offer various devices with different physical working principles (mechanical scanning devices as well as camera-based devices). This allows us to make direct comparisons of different device classes and thus exclude artifacts caused by working principle.
The verification of the measurement of the geometrical properties of the beam can be done with traceability to internal factory standards. The verification is based on traceability to mechanical quantities (length) and intensity (linearity). Among other things, we rely on the comparison with a fiber end of known diameter as well as mechanical reference standards.
As a result of the verification a Certificate of Quality (CoQ) is issued.

5. Calibration work instructions

Our calibration laboratory has work instructions for all processes in the laboratory area for which calibration certificates or CoQs are issued. These work instructions are integrated into our quality management system.

6. Calibration laboratory personnel

For more than 25 years PRIMES GmbH is dedicated to beam diagnostics of high power lasers. During this period it has achieved a leading role in many industrial sectors worldwide. Our organisational structure ensures that only trained and instructed personnel calibrates equipment. The department managers will ensure that each calibration is carried out and checked correctly.
Continuous quality assurance and the expansion of calibration competencies are ensured by the Calibration Working Committee.
The monitoring of the calibration and measuring equipment is ensured by a measuring equipment officer.

The competence of calibration laboratory personnel is ensured by various factors/procedures:

- Scientific studies
- Training as a physics laboratory technician
- Training and experience in the operation of PRIMES measuring instruments
- Participation in internal training courses

The following personnel functional areas are defined for the calibration laboratory:

- Organizational management of the calibration laboratory
- Technical management of the calibration laboratory
- Head of Calibration Laboratory 1 / Head of Calibration Laboratory 2
- Physics laboratory technician
- Trainee physics laboratory technician

In addition, there is a small number of clerks, especially for the commercial part of order processing, shipping or documentation.
Personal information on individual employees is subject to data protection.

7. Metrological traceability of power calibrations

The starting point for the work in the calibration laboratory is a reference standard certified by PTB, which serves as our reference/gold standard. Our PTB-certified reference standards are certified with a deviation of 0.8-1.2 % for the different power ranges (120 W to 2 kW) and wavelengths (YAG and CO_2). Together with our various high power lasers we can calibrate all power meters in real operating conditions.
More information on the subject of standards and traceability can be found in our Traceability Chart, which is part of every certificate or available on demand via our sales or technical support team.

8. Storage periods of records

Calibration data and certificates shall be kept for a period of 10 years. After expiry of the period, the data will not be deleted but, if possible, kept indefinitely for customer enquiries and statistical evaluations.

9. Supporting documents

- *Traceability chart*
- *Template Calibration Certificate*
- *Template Certificate of Quality*
- *Final inspection and calibration PVA_8-5*
- *Calibration working committee PAA_5-3-2-7*

10. Change history

Version	Date	Changes, Abbreviation
1.0	17.03.2020	First edition, Members AKK (VB, RK, SW, TU), QM (LMF), Translation: Technical Support (BK)
2.0	14.09.2020	Format, adapt to the CI (MW)
3.0	28.10.2020	Revision of chapter 1 (LMF, TU, RK, BK)
3.1	09.11.2020	CI adaption (MW)
3.2	23.11.2020	CI Adaption (MW)
4.0	28.04.2021	Chapter 8 Storage period added, jra
4.1	26.01.2022	Paragraph 3 in chapter 1 added, lmf
4.2	23.05.2022	Adjustment of the laboratory scope, jra, th