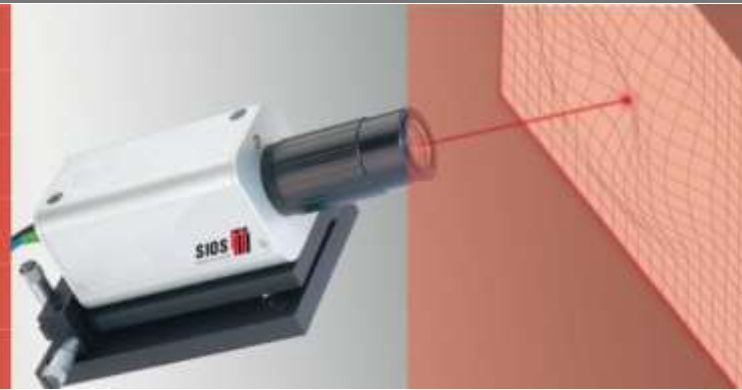


SIOS Meßtechnik GmbH – Am Vogelherd 46 – D-98693 Ilmenau – Germany

**SIOS**



*Precision in  
Measurements*

Tel.: +49 (0) 3677-6447-0 Fax: +49 (0) 3677-6447-8 E-Mail: [info@sios.de](mailto:info@sios.de)

**Measurements with SIOS interferometers, highly precise, fast and effective**

Peter Grundschock - Sales Manager

Precisiebeurs 2017

1991 Foundation of SIOS Meßtechnik GmbH by Prof. G. Jäger and employees of the Institute for Process Measurement and Sensor Technology of TU Ilmenau.

The main focus is the development of laser-interferometric fiber-coupled sensors for length, angular and vibration measurement.

Development and production to 100% in Germany at one location.

SIOS offers standard and customer-specific solutions of the highest precision and dynamics in **4** business areas.



Science



Industry



OEM Products

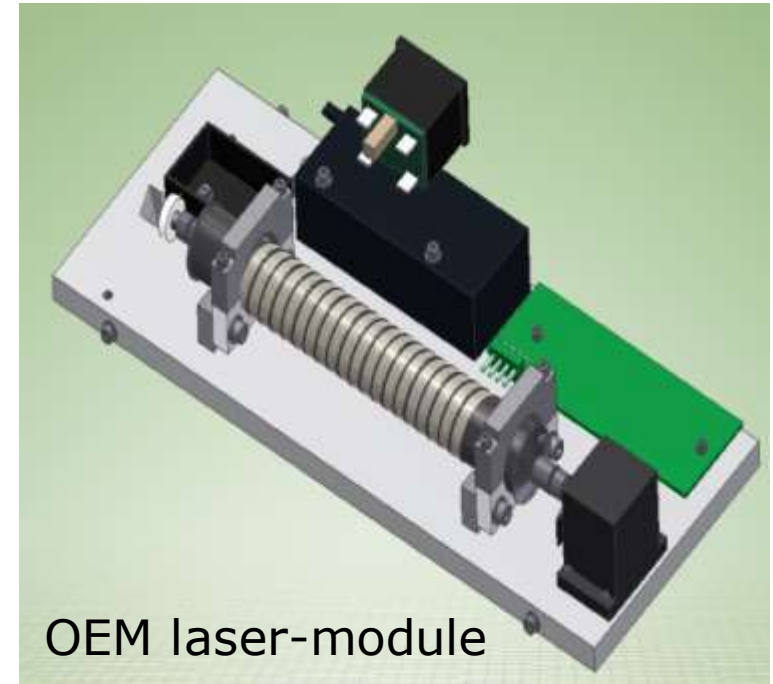


Service



# STANDARD and CUSTOMIZED OEM UNITS

## He-Ne laser



Custom-tailored units for coupling laser beams into single-mode or multimode (polarization-insensitive/polarization-preserving) optical fibers

Available with either factory-fitted fiberoptic connectors (DIN, E2000, etc.) on their loose ends or with fiber pigtailed



# STANDARD PRODUCTS

## MINIATURE RETROREFLECTOR INTERFEROMETER MI Series

Compact version of MI 5000 for service and on site use **MI 5000 K**



Optionally with transportation system case

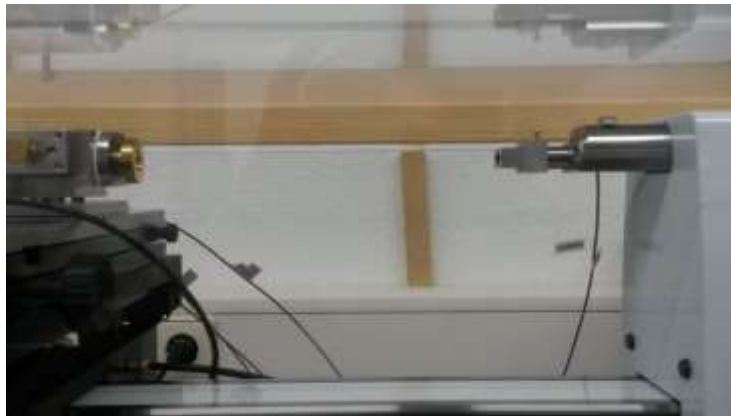
# INDUSTRIAL CUSTOMER APPLICATIONS / CALIBRATIONS

## MINIATURE RETROREFLECTOR INTERFEROMETER MI Series

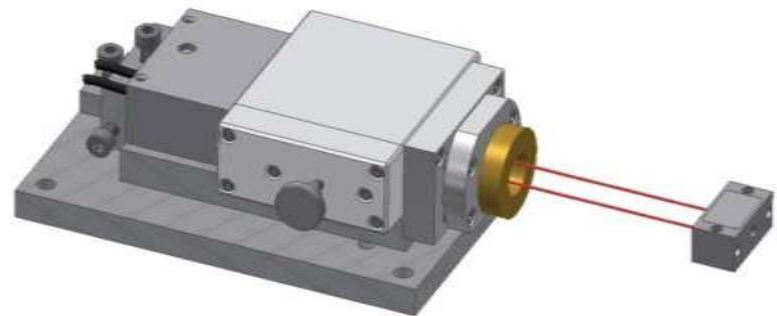
Branch - Calibration services of length - accreditation offices



- first tests with standard MI5000 on the Zeiss ULM 600 comparator
- SIOS designed and manufactured adapter angle
- retro reflector fixed by magnetic holder



- permanent installation of special MI5000
- plane plate mount for lateral beam adjustment
- retro reflector fix mounted in flight to the scale



## STANDARD PRODUCTS

### SP-NG Series Interferometer for industrial applications



- ✓ Easy to use
- ✓ Quick and easy beam direction alignment
- ✓ Small ball reflector with screw and magnetic fastening
- ✓ Robust sensor construction
- ✓ Splash-water protected housing
- ✓ Fiber cable with protection cable conduit
- ✓ Options to minimize alignment errors



90°-Beam deflection



Accessory for measurements up to 80 m



Beam direction alignment for OEM version

## LONG-RANGE INTERFEROMETER

SP 15000 NG

Version with telescope in combination with hollow reflector



### Measurement range

- beam magnification    2x                     $\leq 40$  m  
                                  3x                     $\leq 60$  m  
                                  5x  $\leq 80$  m... $\leq 100$  m

### Lateral displacement

- by 5x beam magnification                     $\pm 15$  mm

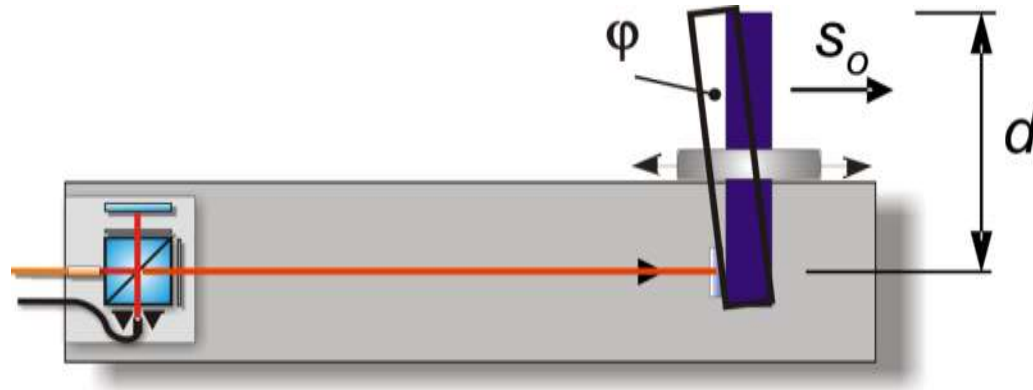
### Max. tilt of hollow reflector

$\pm 22.5^\circ$

up to 80 m



# Abbe - Error in the Application



$$\Delta l_{Abbe} = d \cdot \tan(\phi)$$

$d$  - Abbe- offset  
 $\phi$  - Angle

## Example 1

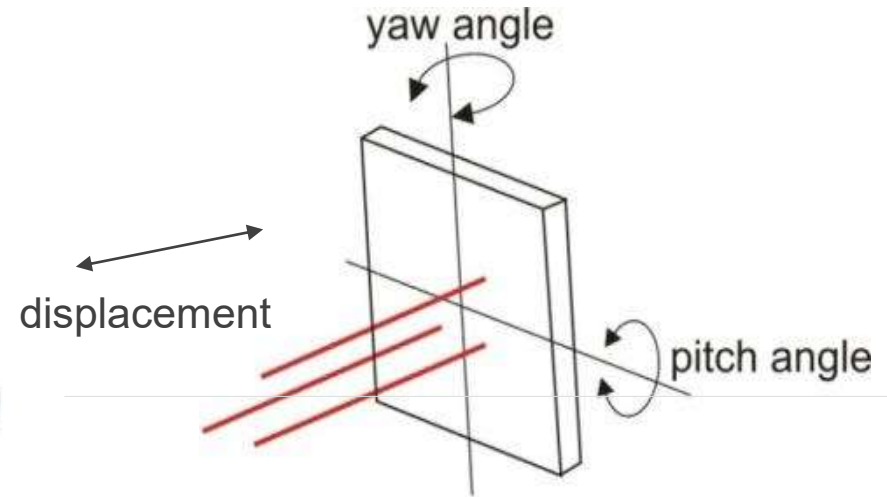
|                               |                                           |
|-------------------------------|-------------------------------------------|
| • Abbe-offset, $d$            | 1 mm                                      |
| • Dynamic mirror tilt, $\phi$ | $\pm 8$ arcsec ( $\pm 39 \mu\text{rad}$ ) |
| <b>Abbe error</b>             | <b><math>\pm 39</math> nm</b>             |

## Example 2

|                               |                                              |
|-------------------------------|----------------------------------------------|
| • Abbe-offset, $d$            | 100 mm                                       |
| • Dynamic mirror tilt, $\phi$ | $\pm 0.8$ arcsec ( $\pm 3.9 \mu\text{rad}$ ) |
| <b>Abbe error</b>             | <b><math>\pm 387</math> nm</b>               |



## TRIPLE-BEAM PLANE-MIRROR INTERFEROMETER SP-TR Series

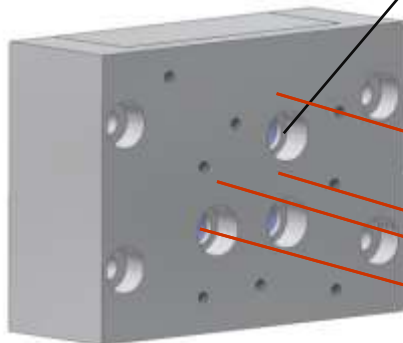
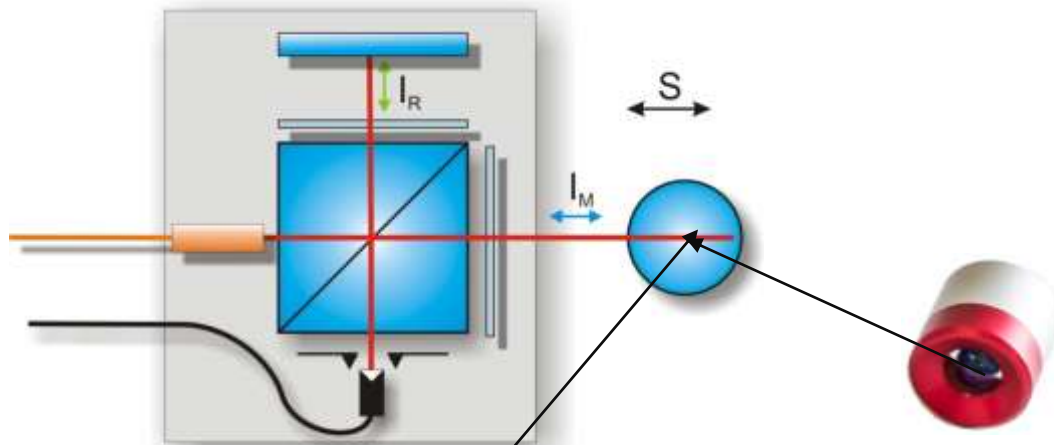


### TECHNICAL DATA

|                                                |                  |
|------------------------------------------------|------------------|
| Length measuring ranges, each channel          | 2 m              |
| Length resolution                              | 0.1 nm           |
| Pitch and yaw measuring ranges                 | $\pm 1.5$ arcmin |
| Angular resolution at 0.1 nm length resolution | 0.002 arcsec     |
| Max. translation range                         | 800 mm/s         |

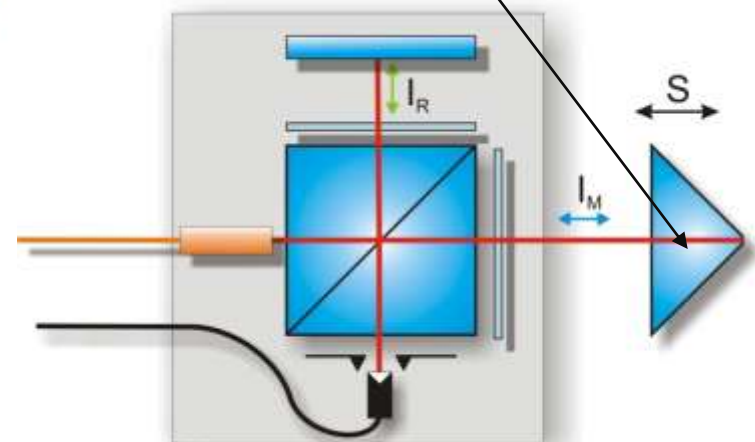
# Interferometer with tilt invariant reflectors

Interferometer SP-Series with ball reflector



Triple-cat's eye reflector  
Increase of angular and  
length measuring range  
up to  $\pm 12.5^\circ$

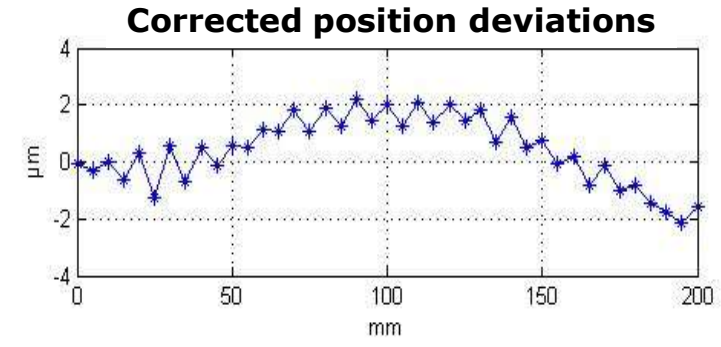
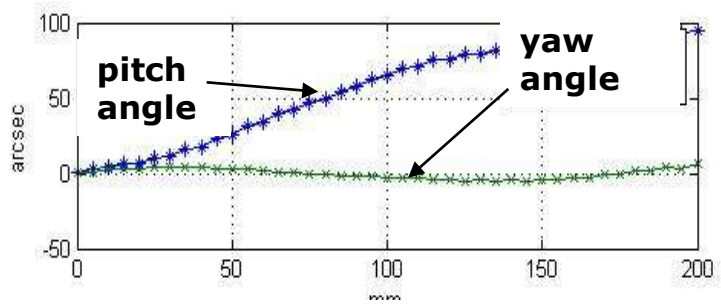
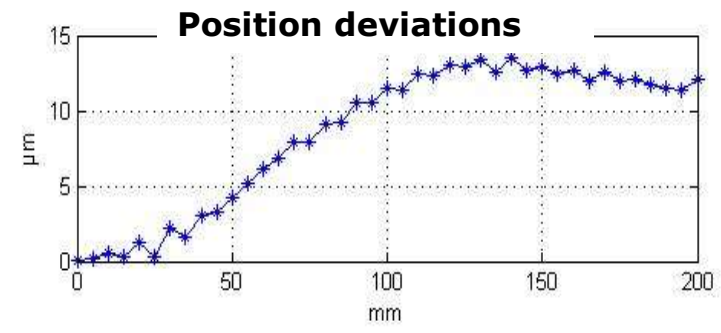
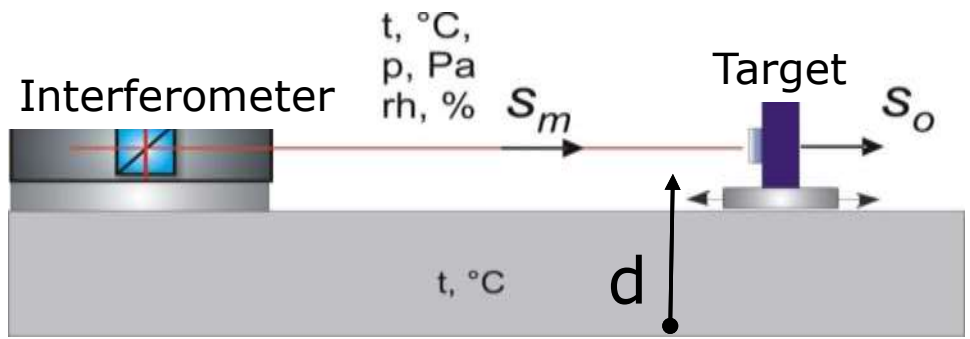
Interferometer SP-Series with hollow reflector



# Correction of Abbe-error in the application

## Correction of Abbe-errors by simultaneous length and angle measurements

- Simultaneous measurement of displacement and angle
- Measuring points are defined by every measuring beam
- Rotation point of the surface can be defined
- Correction of Abbe-errors is possible



# 5 DOF Calibration Interferometer SP15000C5

## Range and Resolution of SP 15000 C5

### Displacement

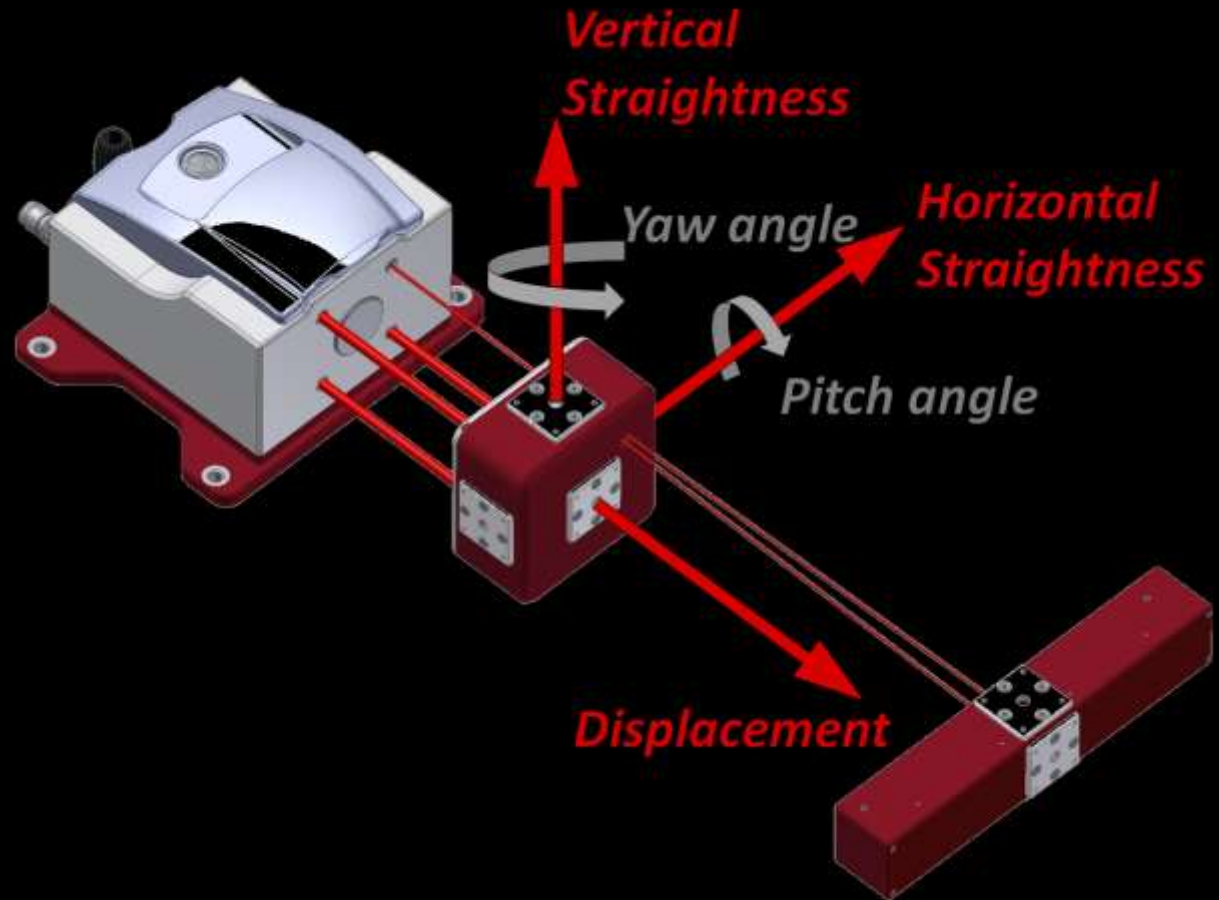
Range 0 ... 15/50 m  
Resolution 20 pm

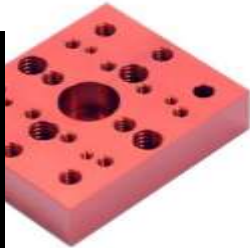
### Straightness

Range  $\pm 4$  mm  
Resolution 10 nm  
Axial Range 6,5 m

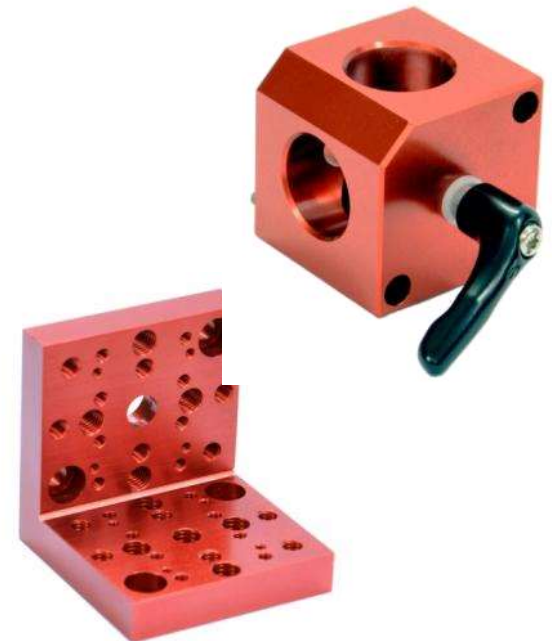
### Pitch / Yaw Angle

Range  $\pm 5^\circ$   
Resolution 0,0004 arcsec



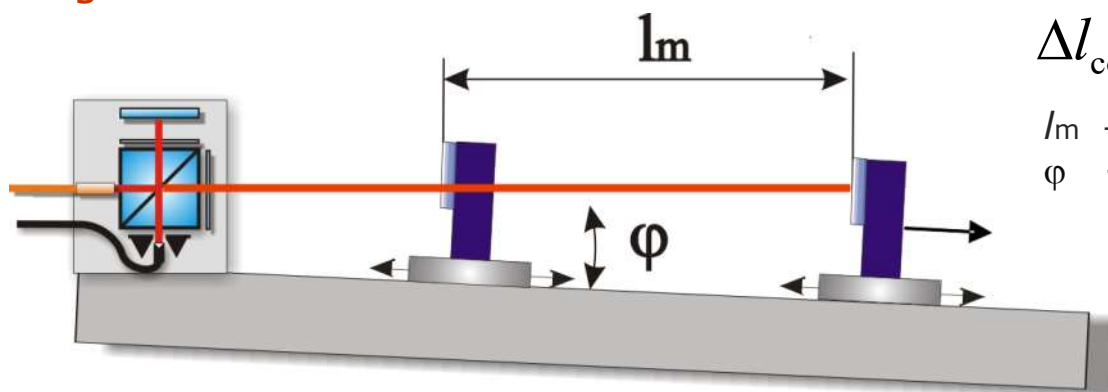


## Accessories



# Cosine- Error in the Application

## Direction alignment error



$$\Delta l_{\cos} = l_m \cdot [1 - \cos(\phi)]$$

$l_m$  - Measuring displacement

$\phi$  - Angle

### Example 1

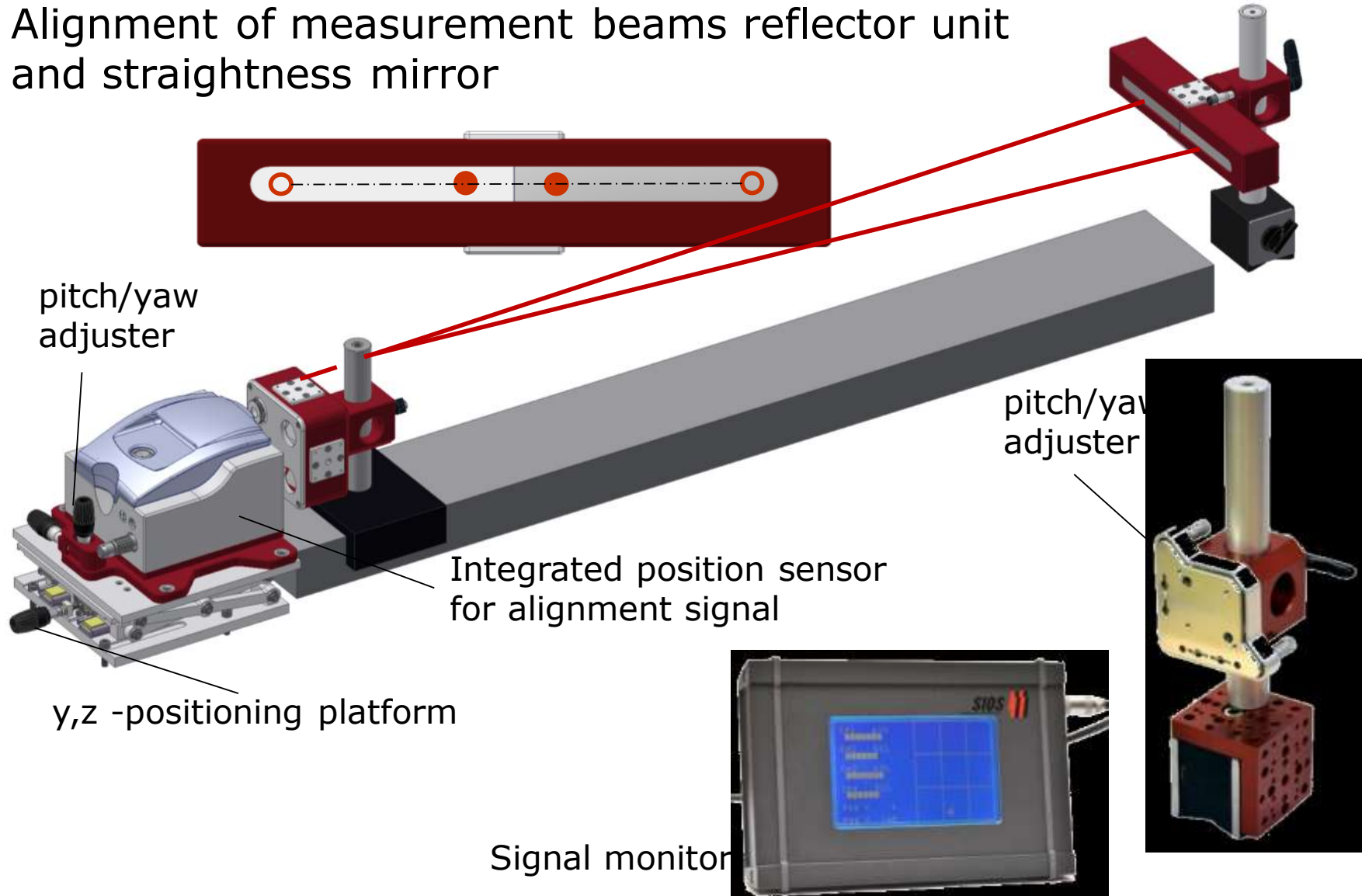
|                                |                     |
|--------------------------------|---------------------|
| • Visible beam shift at target | 0.5 mm              |
| • Movement distance            | 500 mm              |
| Angle                          | 3.4 arcmin (1 mrad) |
| <b>Error</b>                   | <b>500 nm/m</b>     |

### Example 2

|                                |                                              |
|--------------------------------|----------------------------------------------|
| • Visible beam shift at target | 1 mm                                         |
| • Movement distance            | 50 mm                                        |
| Angle                          | 68 arcmin (20 mrad)                          |
| <b>Error</b>                   | <b>200 <math>\mu\text{m}/\text{m}</math></b> |

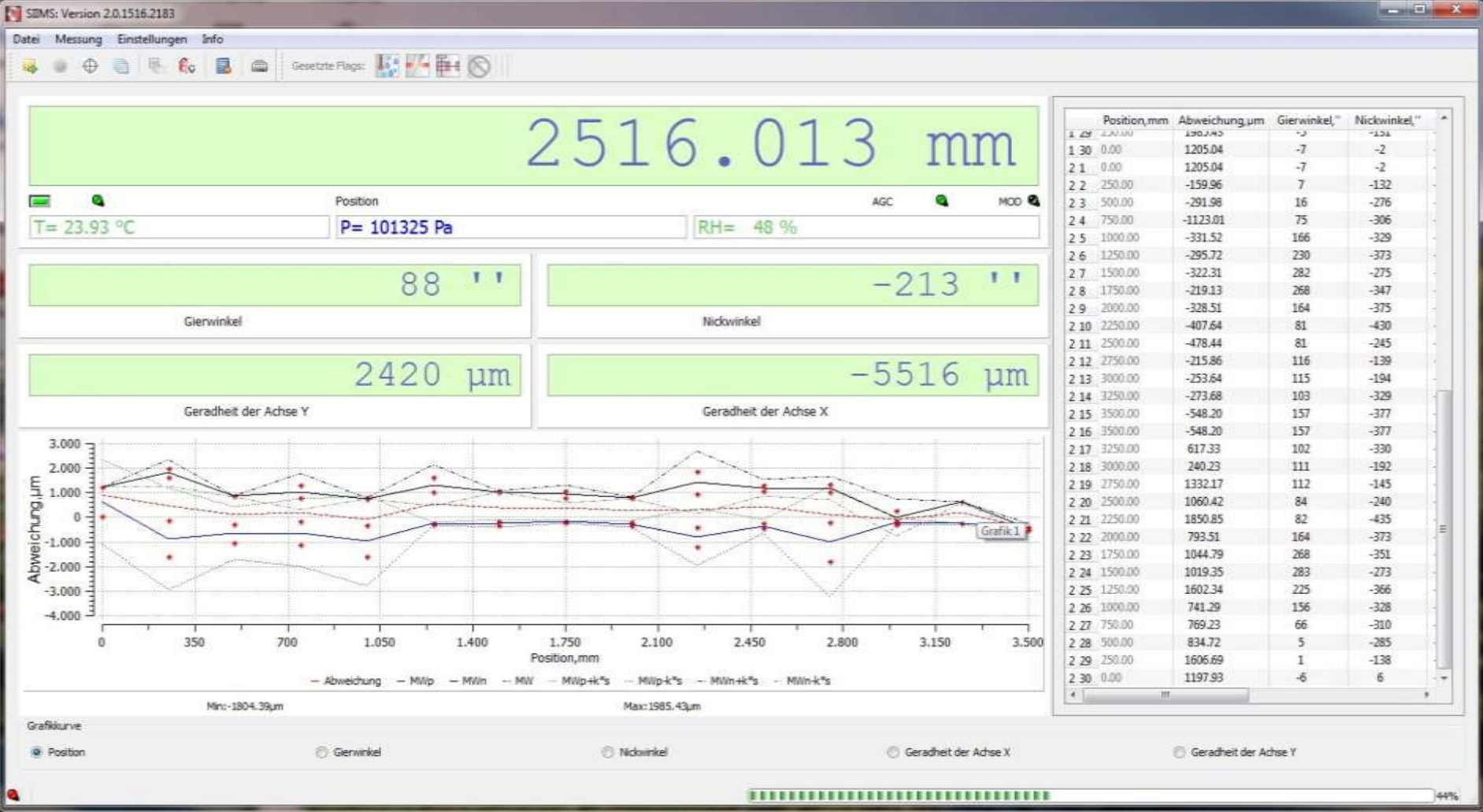
# 5 DOF Calibration Interferometer SP15000C5

Alignment of measurement beams reflector unit and straightness mirror



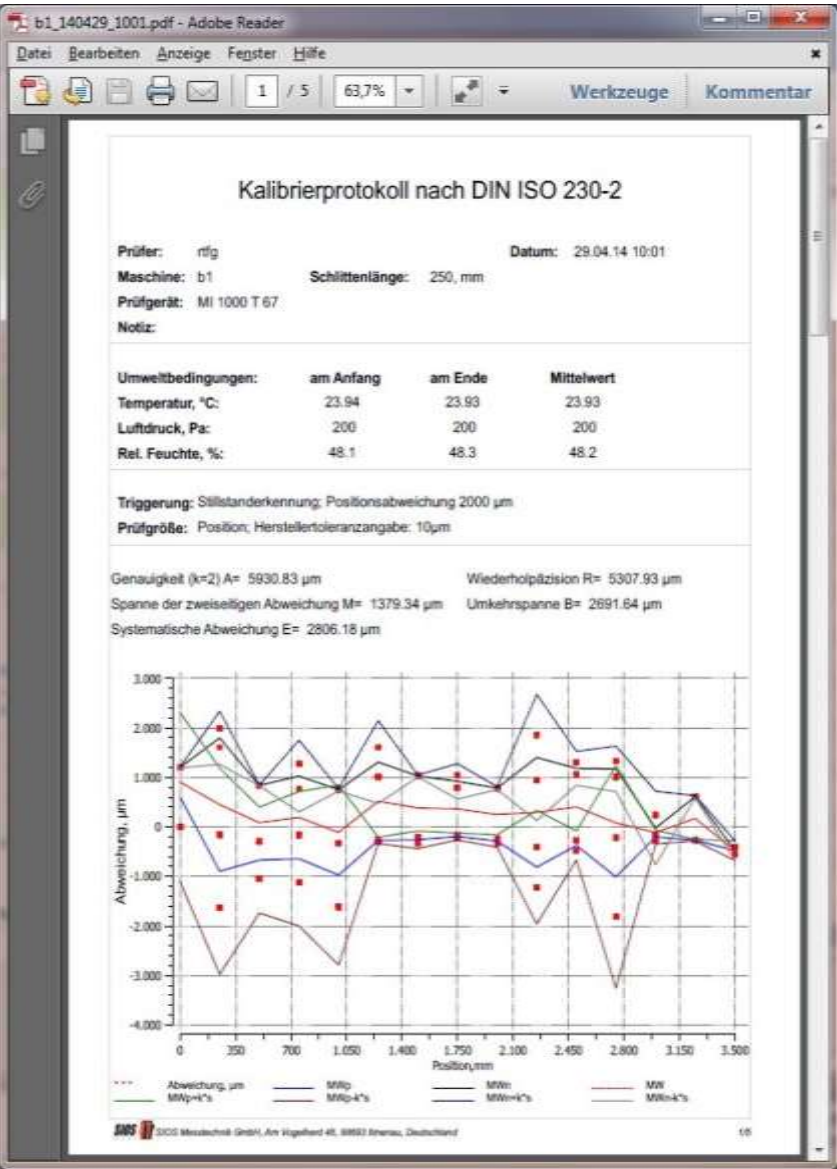
# Calibration Software for SIOS Interferometers InfasAXIS

## Current measurement information:





# Calibration Software for SIOS Interferometers InfasAXIS



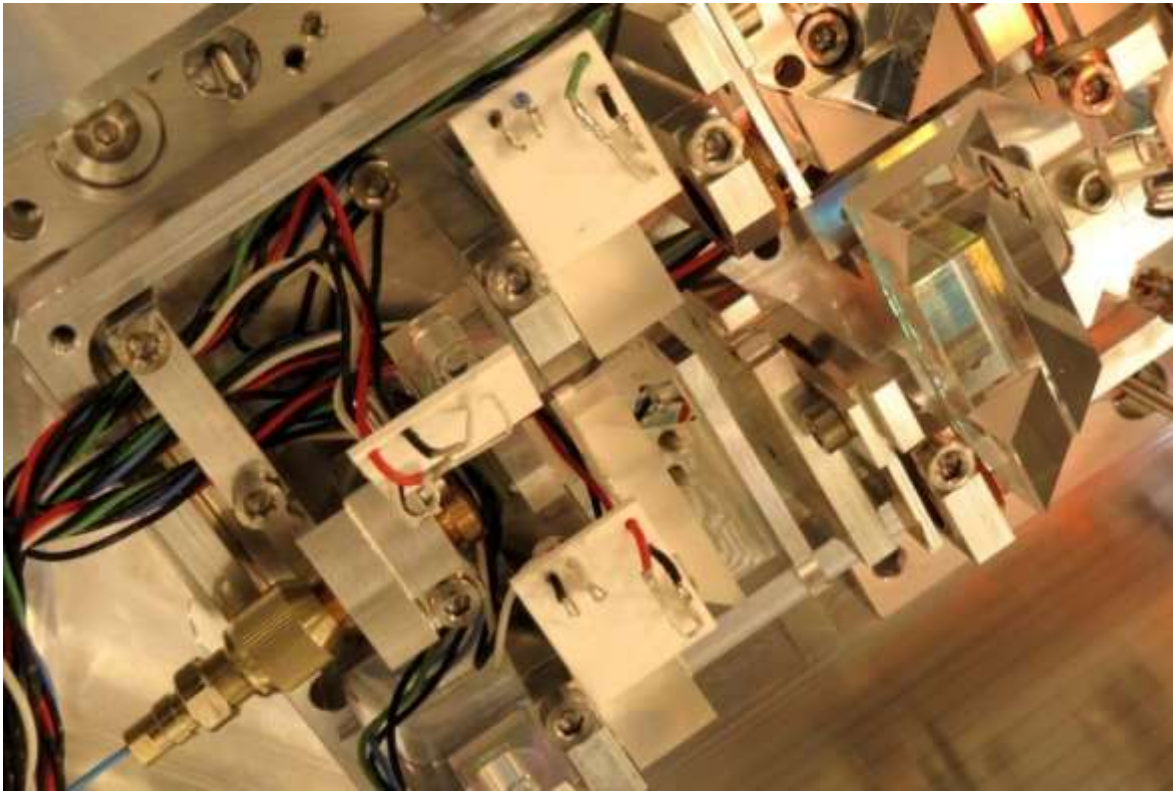
- Supports **all** SIOS calibration interferometers
- All data are stored in the database
- Evaluation can be recalculated at any time
- PDF Protocol
- Available standards for data evaluation:

VDI/DGQ 3441  
DIN ISO 230  
Straightness according to VDI 2617

- Environmental data included



# OEM APPLICATIONS / CUSTOMIZED SYSTEMS



- From single solution to OEM supplier
- Multi-beam arrangements
- UHV Applications



# RETROFIT AND COMPLETE SYSTEMS

## GAUGE BLOCK CALIBRATION SYSTEM

- Upper gauging probe: LM 20
- Replacement of standard gauging probes



## THICKNESS MEASURING SYSTEM

Two probes for both-side operation

High precision thickness measurement of lenses, wafers, foils, plane parts, spheres etc.

Adaptable to specific customer requirements



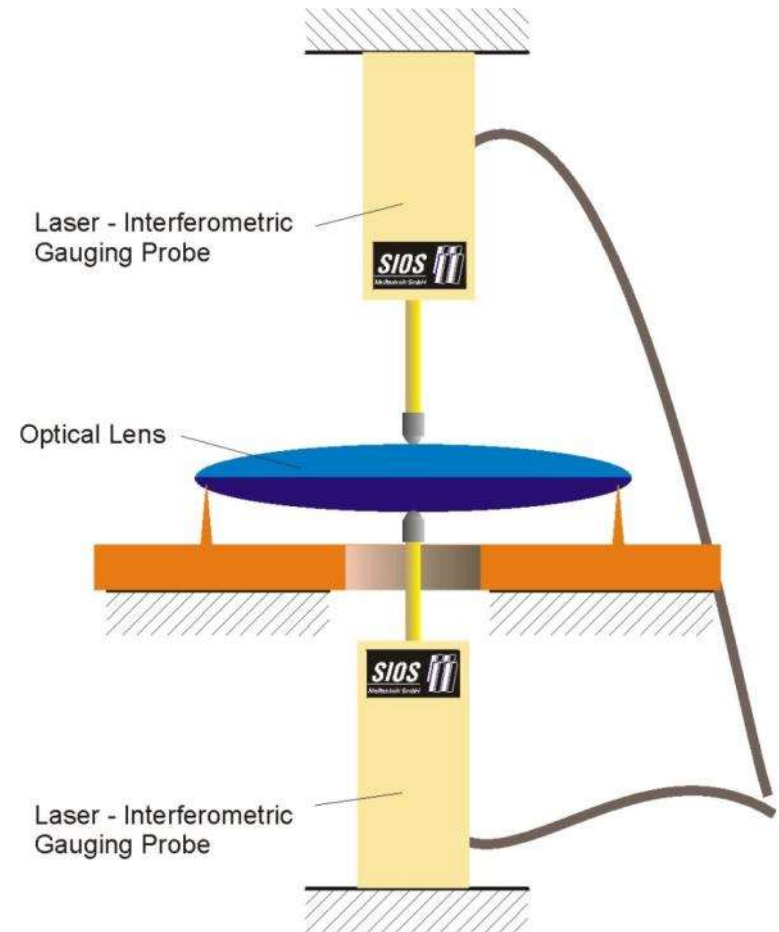
## WAFER THICKNESS MEASURING STATION

High-precision station for measuring semiconductor wafers or other objects with plane-parallel geometries and diameters ranging up to 300 mm



Uncertainty  $\leq 50 \text{ nm}$

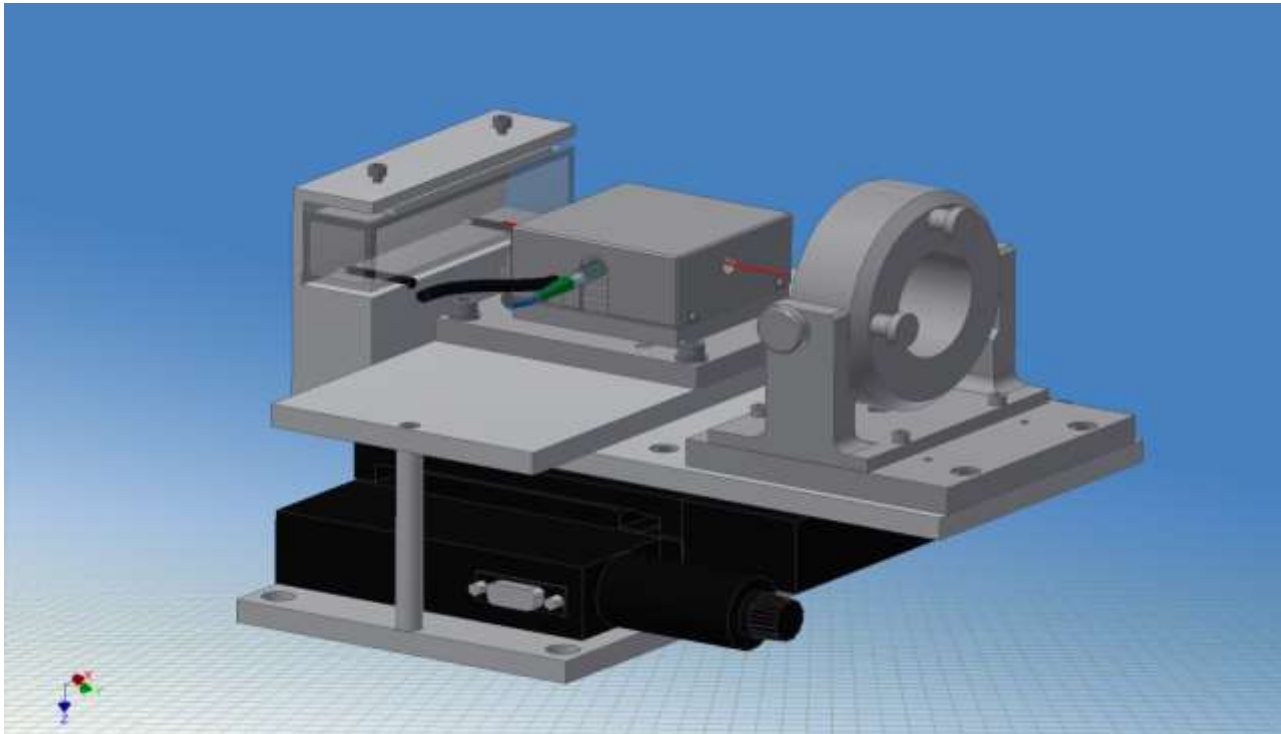
## THICKNESS MEASUREMENT OF OPTICAL LENSES



Uncertainty  $\leq 10 \text{ nm}$

Task: Radius and  
topography measurements

Test bench based on SP2000DI



# RETROFIT AND COMPLETE SYSTEMS

Multi-purpose-calibration-stand



BMW



- Replacement of an old Nano-Mach interferometer
- Development of a new control-unit of the measuring station

# STANDARD PRODUCTS

High-precision temperature, air pressure and air humidity measurements

LCS



Temperature measurement:

- Resolution: 0.1 mK / 1 mK
- Measurement uncertainty:  $\pm 50$  mK  
typical, depending on the kind of calibration
- Measuring intervall:  $>4$  s

Sensor are calibrated digitally together with the measuring electronic

PT100 air and material temperature sensor, customized design possible



TT-01 with air temperature sensor



WT-01 with material temperature sensor

- 4 (up to 15) wired temperature sensor
- 15 wireless temperature sensors
- 2 air pressure sensors
- 2 air humidity sensors

# LASERINTERFEROMETRIC VIBROMETERS

## LSV-NG Series

Working distance  
30...70 mm, 240 mm, 480 mm

Amplitude resolution  
5  $\mu\text{m}$

Working distance  
(continuously selectable) 240 mm - 2500 mm

Amplitude resolution  
5  $\mu\text{m}$

### LSV 120 NG

with a fixed focal length  
or with exchangeable  
lenses



### LSV 2500 NG

with variable focal length

|                   |           |
|-------------------|-----------|
| Frequency range   | 0 – 5 MHz |
| Surface roughness | arbitrary |
| Object velocity   | 3 m/s     |

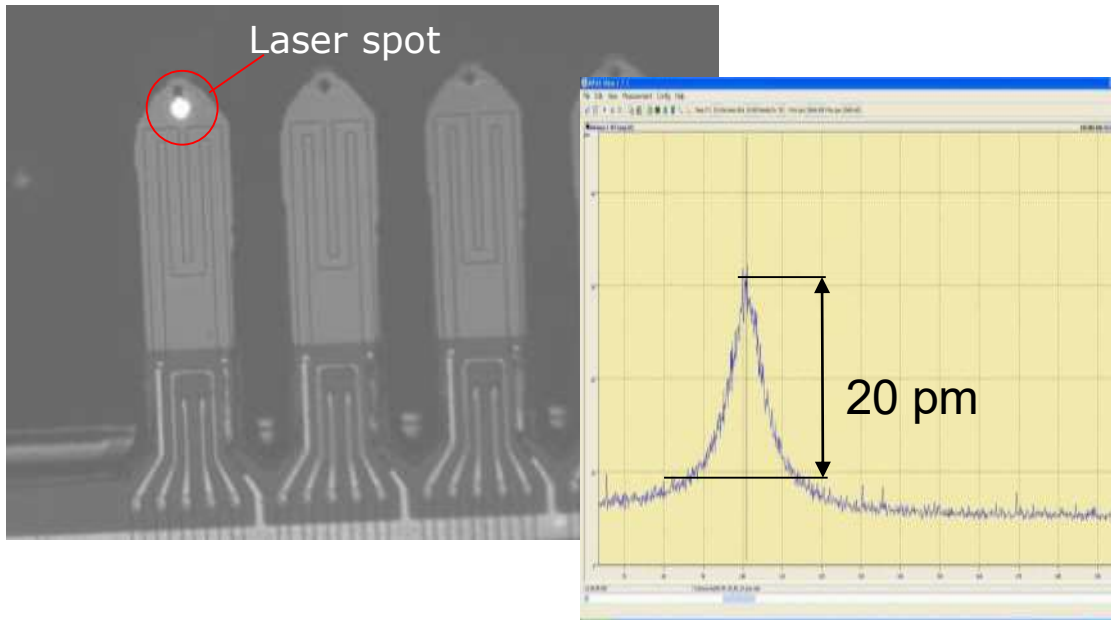


# LASERINTERFEROMETRIC VIBROMETERS

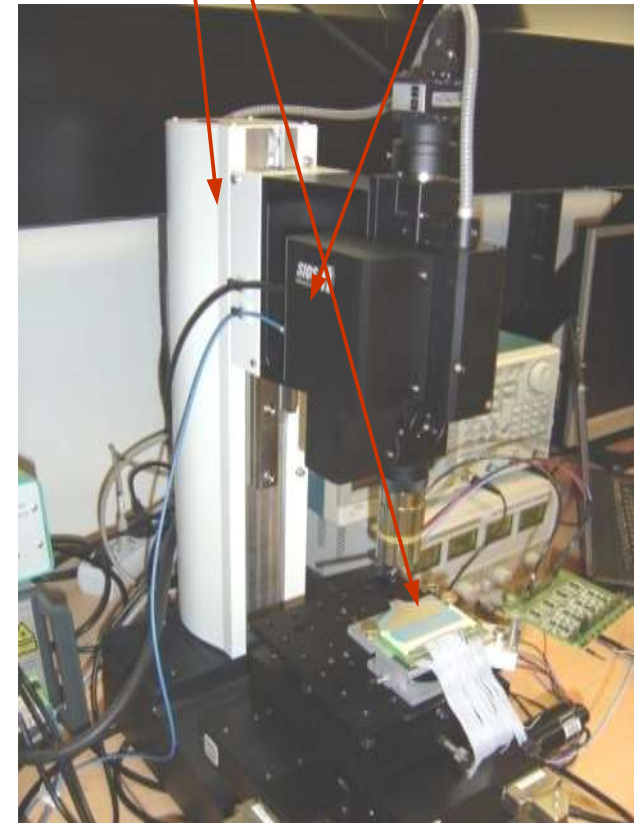
## NANO VIBRATION ANALYZER

NA Series

High resolution frequency analysis of vibrating micro objects



Microscope      Vibrometer  
Cantilever array



Vibrometer application for measurements of

Resonance frequency

Actuator efficiency

Detector sensitivity

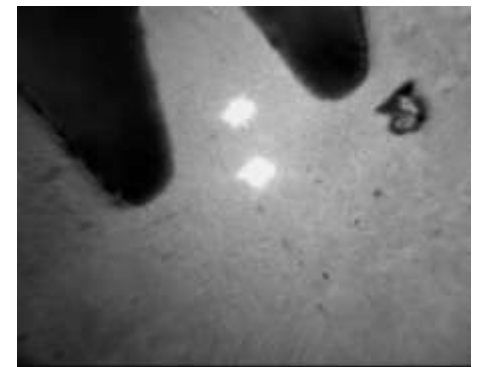
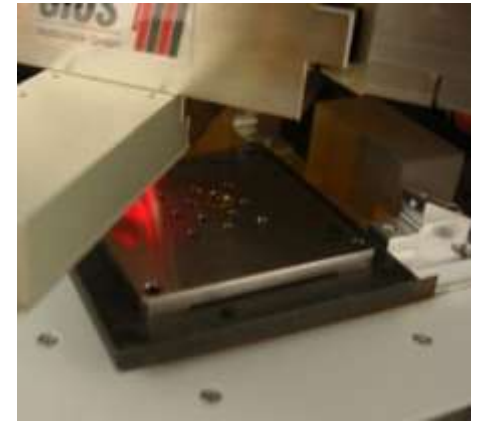
Mechanical crosstalk

## Minute-gear-wheel Alpha

- Measuring object: Mechanical watch (NOMOS Glashütte)
- Material: gold plated brass
- Measuring of flatness
- NMM-1 with laser-focus-s



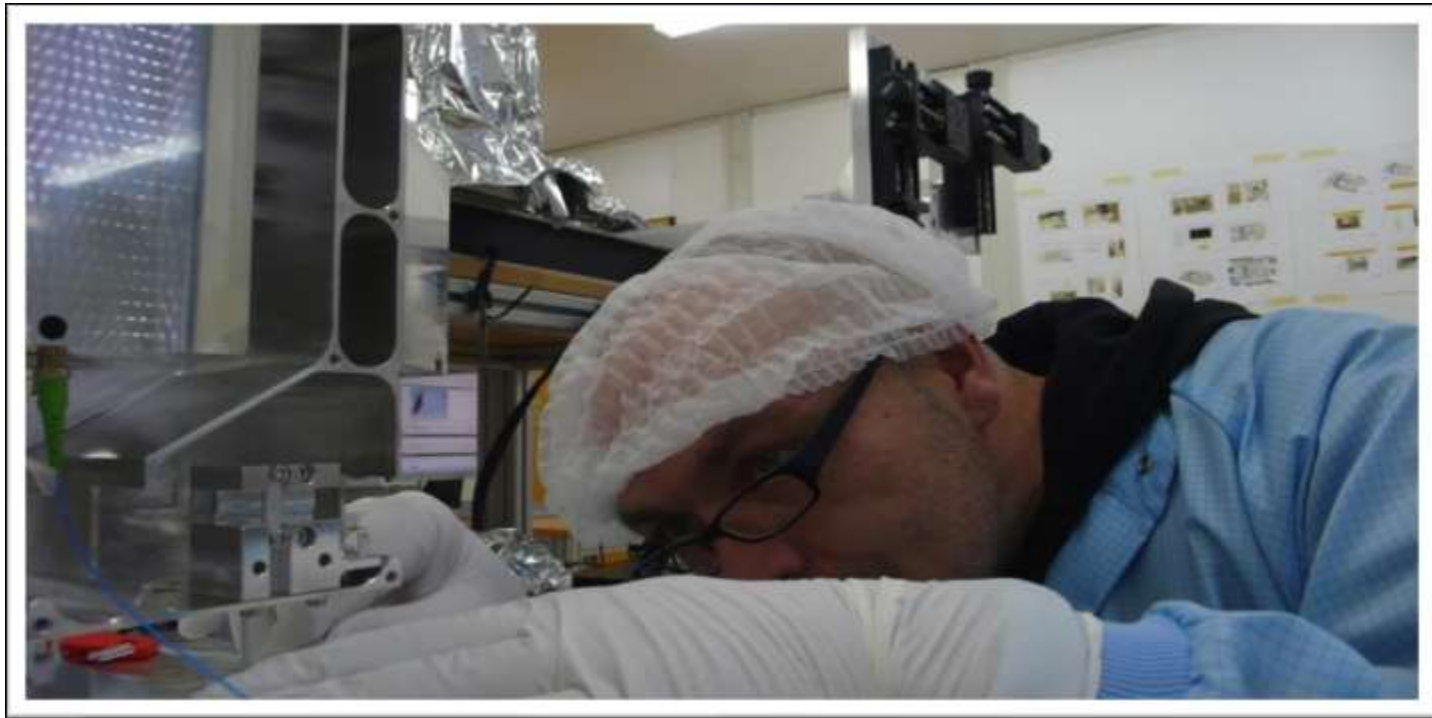
Quelle: <http://www.nomos-glashuette.com>



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**Please visit us on booth no. 95**

*SIOS Meßtechnik GmbH in cooperation with TE LINTELO SYSTEMS BV*





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*photonics is our passion!*

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