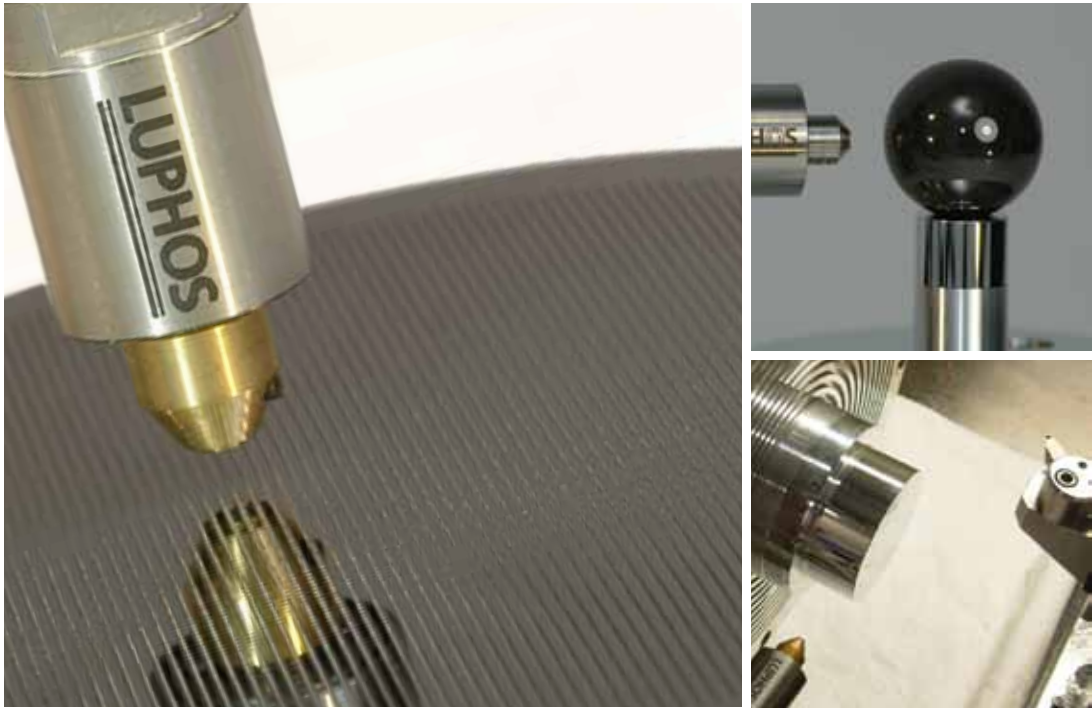


# LUPHOS*Smart*

Ultra-precise distance measurement based on  
MWLI® technology



Your optical sensor solution for measuring  
distances with nanometre accuracy



LuphoSmart sensor systems open up new dimensions in ultra-precise distance measurement and optical metrology. The MWLI® technology (multi wavelength interferometry) enables non-contact measurement of the distance towards an object surface at nanometre accuracy. Typical applications include position control, planarity, roundness and concentricity measurements, adjustment of assembly groups, and profile scans.

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## LuphoSmart sensor systems introduce unique features to the field of non-contact high precision distance measurement

- Extremely high accuracy and precision  
± 2 nm ( $2\sigma$ ) on polished surfaces
- Large measurement range and working distance  
Up to several cm, while still providing maximum accuracy and precision
- Extremely low noise  
Less than ± 0.05 nm
- Long term stability  
Drift less than ± 1.5 nm over 72 hours
- Absolute measurement  
Tolerates signal interruption and measures step heights up to 1.25 mm
- Almost every material  
Polished, rough, specular, transparent, opaque
- Small probe dimensions and long supply lines  
Straightforward implementation in existing machines
- Multi probe systems  
Operate up to 8 probes simultaneously, for example to enable compensation of stage errors



## LuphoSmart technology

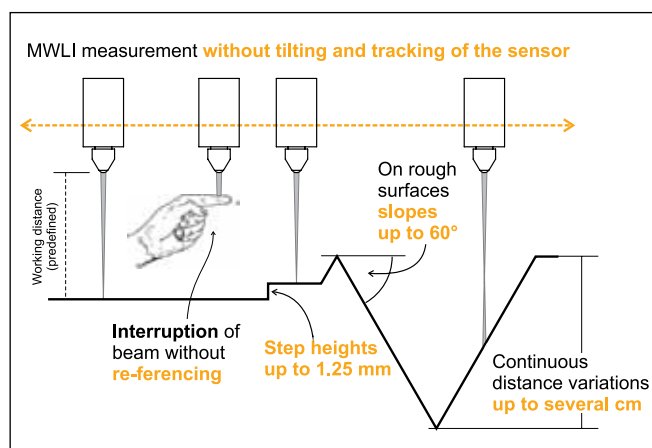
The LuphoSmart optical system is a fibre coupled multi-wavelength interferometer (MWLI®). In contrast to simple interferometers, several discrete wavelengths are used simultaneously. This can be seen as several independent, highly coherent interferometers sharing the same optical path. By computing beat frequencies of the employed wavelengths the absolute measurement range is drastically increased.

### Absolute measurement

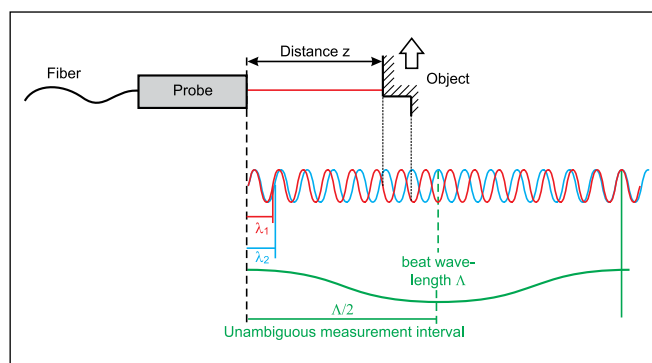
It is an outstanding feature of the MWLI® principle that it provides absolute distance measurement over a large range of up to 1.25 mm. This characteristic allows determination of the height of vertical surface steps as well as continuation of measurements after signal interruption – e.g. due to dust particles or holes in the surface.

### Measuring rough surfaces

The MWLI technique also allows for measurements on rough surfaces, such as ground lenses. Simple interferometric techniques that use highly coherent light sources fail at this task because the reflected light is disturbed by coherent noise (laser speckles). The MWLI approach enables the possibility to use the artificial beating wavelengths between all wavelengths involved to determine correct distance values.



MWLI measurement without surface tracking.



Absolute measurement by means of utilising a beat frequency

## LuphoSmart devices

LuphoSmart systems can be utilised as standalone devices or as OEM solutions. Besides a single probe system, several multi-probe systems are available that allow the operation of up to 8 probes at the same time. By measuring several distances truly simultaneously these systems can be used for measuring reference objects from different directions (see picture) or for effective compensation of stage errors. In many cases the latter is indispensable when aiming for scans at nanometre accuracy. All probes connected to a LuphoSmart system can be synchronized with an external machine by means of standard trigger signals.

## Control software

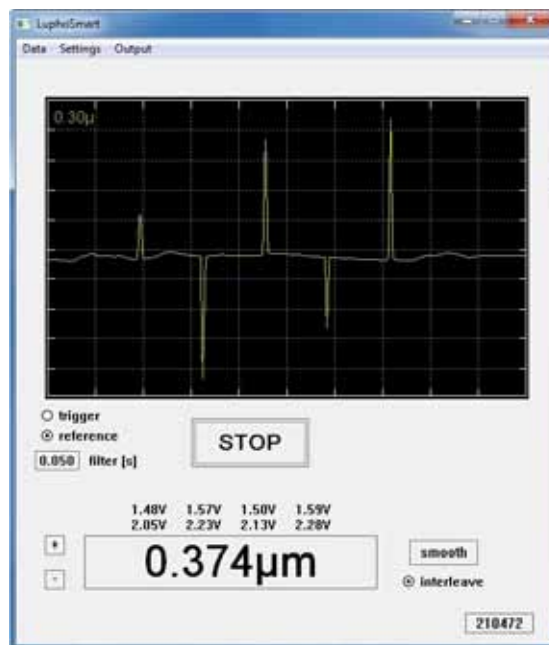
By default the systems come with standalone software that enables full control of all parameters, such as adjusting trigger thresholds, internal data rates, or data storage options. In addition, a special software interface (DLL) is available for integrating and controlling LuphoSmart devices in one's own application – e.g. a C/C++, LabView or MATLAB program.

## LuphoSmart probes

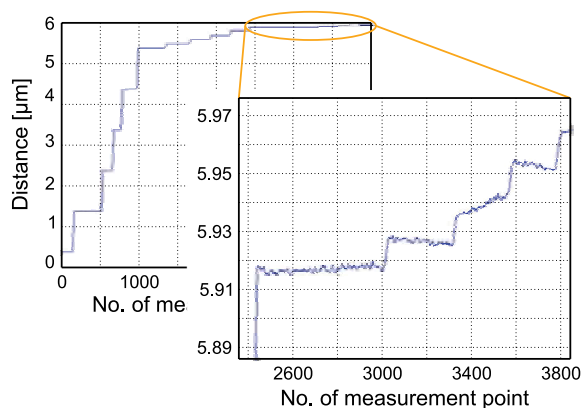
All LuphoSmart probes come in the same small INVAR body whose standard dimensions are 18 mm (diameter) × 37 mm (length). The probes are connected to LuphoSmart controllers via a 1.5 m supply line, which can be extended up to 20 m. Due to the entirely fibre optical setup and the small probe dimensions it is straightforward to integrate probes into existing production machines or measurement systems. The technical data of some LuphoSmart probes (that cover measurement ranges and working distances from 2.6 mm up to 30 cm) are summarized in the specifications section. Apart from standard probes, it is also possible to supply customised probes to suit specific applications. These probes can vary in terms of working distance, measuring range, numerical aperture, enclosure dimensions, etc. For instance, adapters are available that allow for measurements of inner cylinder surfaces. All probes can always be operated with any LuphoSmart system.



LuphoSmart 4λ-5 system that enables simultaneous operation of up to 5 probes



Main window of the LuphoSmart software



Positioning accuracy of the tool holder in a diamond turning machine



Error characterisation of a high precision rotary stage

## Technical data

Optical measurement system				
Measurement principle		Fibre-based multi-wavelength interferometry (MWLI®)		
Wavelength range		1530 nm ... 1610 nm		
Laser safety class		1		
Object reflectivity range		0.1 % ... 100 %		
Surface finish		polished, rough, transparent, specular, opaque		
Accuracy ( $2\sigma$ ) ( $\alpha$ =angle of incidence)	–	polished	$R_a < 1 \mu\text{m}$	$1 \mu\text{m} \leq R_a \leq 3 \mu\text{m}$
	$\alpha = 0^\circ$	$\pm 2 \text{ nm}$	$\pm 200 \text{ nm}$	$\pm 1 \mu\text{m}$
	$\alpha = 3^\circ$	$\pm 3 \text{ nm}$	$\pm 200 \text{ nm}$	$\pm 1 \mu\text{m}$
	$\alpha = 8^\circ$	–	$\pm 300 \text{ nm}$	$\pm 1.5 \mu\text{m}$
	$\alpha = 25^\circ$	–	$\pm 2 \mu\text{m}$	$\pm 3 \mu\text{m}$
Longitudinal resolution		0.05 nm		
Absolute measurement interval		1.25 mm		
Max. speed of distance change		450 $\mu\text{m/s}$		

Controller		
Models	LuphoSmart 4 $\lambda$ -1, 4 $\lambda$ -2	LuphoSmart 4 $\lambda$ -4, 4 $\lambda$ -5, 4 $\lambda$ -8
Dimensions (h x w x d)	154 mm x 258 mm x 283 mm	154 mm x 474 mm x 343 mm
Weight	approx. 6 kg	approx 9 to 10 kg
Electrical power requirement <sup>1</sup>	230 V~ 50/60 Hz, < 100 W	
Type	USB 2.0 device (Windows)	
Maximal data rate (per probe)	2500 Hz	
Standard data format	ASCII, binary	
Data resolution	< 0.01 nm	
Data recording	triggered / non-triggered	
Input trigger rate	0..25 kHz (0..10V)	
Auxiliary inputs	3 (0..10V)	
System integration	SDK	
Live data display	2D profile plot, numeric values	



Probes					
Models (examples) <sup>2</sup>		P030-30-R15	P050-30-R15	P100-30-R15	P500-30-R15
Measurement range <sup>3</sup>	Tracking	2.6 ... 3.0 mm	5 ... 10 mm	10 ... 60 mm	50 ... 300 mm
	Absolute measurements	2.6 ... 3.0 mm	5 ... 8 mm	10 ... 25 mm	50 ... 100 mm
Lateral resolution (spotsize)		4 µm	20 µm	60 µm	> 100 µm
Angle of acceptance (to surface)	Rough	± 60°	± 60°	± 60°	± 45°
	Polished, specular	± 7°	± 3°	± 1,5°	± 0.5°
Probe dimensions (length x diameter)		37 mm x 18 mm			
Length of supply line		up to 20 m			
Weight of probe		45 g			

1 Devices intended for use at 115V~ come with an external power transformer (85 mm × 130 mm × 70 mm, ca. 1kg).

2 Further probes are available on request.

3 The measurement ranges are valid for polished specular surfaces.



## Serving a global market

Taylor Hobson is world renowned as a manufacturer of precision measuring instruments used for inspection in research and production facilities. Our equipment performs at nanometric levels of resolution and accuracy.

To complement our precision manufacturing capability we also offer a host of metrology support services to provide our customers with complete solutions to their measuring needs and total confidence in their results.

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- **Operator training**  
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