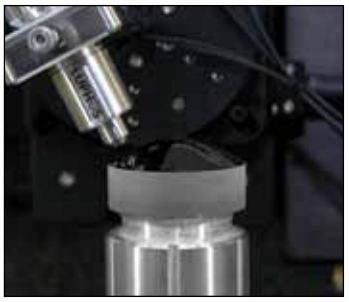
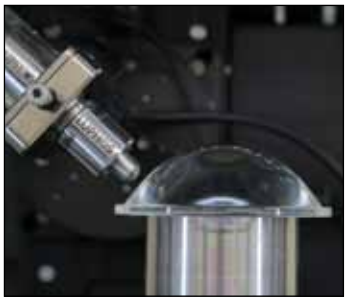
TAYLOR HOBSON®

LUPHOS
Light matters

LUPHOScan 260 HD

Ultra-precision non-contact 3D form measurement of aspheric surfaces





High definition optical metrology

AMETEK®
ULTRA PRECISION TECHNOLOGIES

LUPHOScan 260 HD

Non-contact 3D form measurements of any rotationally symmetric optics

High definition optical metrology.

The LuphoScan 260 HD platform ushers in a new era of high precision metrology of optical surfaces. The new generation devices provide for the first time an absolute measurement accuracy of better than ±50 nm (3σ) up to 90° object slope. This comes along with ultra-high reproducibility of measurement results and a low noise floor.

The new instrument is ideal for applications where the highest accuracy is required and essential to the manufacturing process. This is most beneficial for surfaces with steep slopes, with varying pitch directions, and small surfaces, such as moulds for smartphone lenses.

Buy with confidence - results everyone trusts

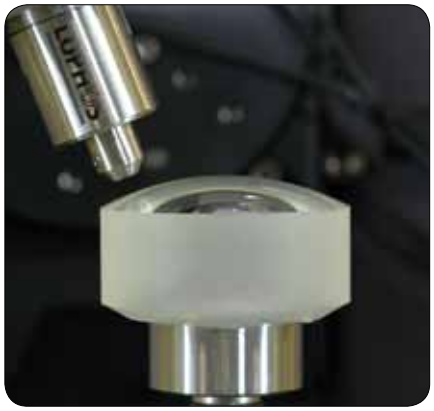
The system has been designed and manufactured to the highest standards.

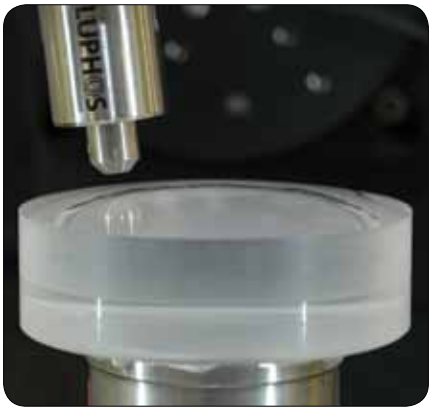
This ensures the stability and accuracy even under the most adverse environmental conditions, such as in manufacturing areas.

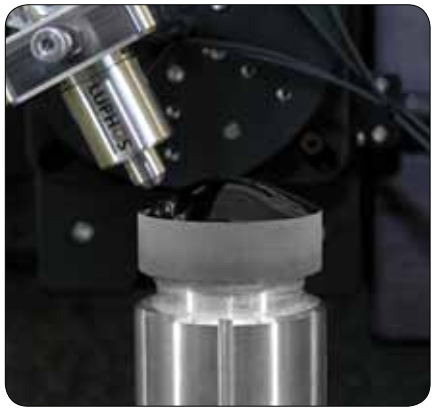
Unparalleled measurement capability

- **HD = High Definition**
  Fast, reliable non-contact real 3D form measurement of aspheres
- **Highest accuracy - up to 90° object slopes**
  Ideal for measuring strong, steep, and small aspheres including cell phone lens moulds
- **Extremely good reproducibility of measurement results**
  Best shot-to-shot stability of Power and PV determination
- **Very low system noise**
  Robust against environmental variations

> “Crucial benefits for 3D form measurements of high quality optical surfaces”







World-leading metrology

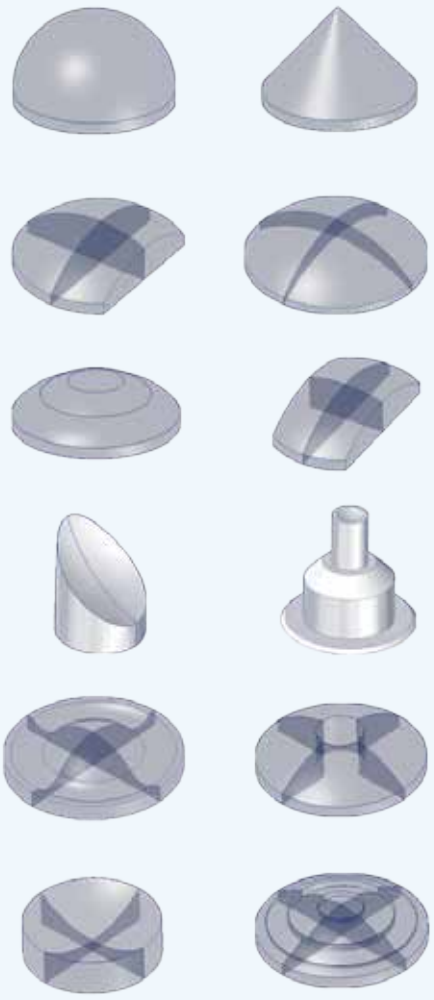
LuphoScan HD instruments represent a new class of metrology tools with highest level of reliability for parts with large spherical departures and with an extreme shot-to-shot stability.

Metrology becomes faster than ever at minimal operator influence since every shot is a hit. In conjunction with their flexibility LuphoScan HD platforms facilitate production of more complex lens designs and are ready for future challenges in lens production.

System benefits

Critical measurements for design and production

- **Ultra high, reproducible accuracy**
  ≤ ± 50 nm (3σ) up to 90°
- **Best available stability**
  Power variation < ± 20 nm (3σ), PV variation < ± 5 nm (3σ)
- **Low noise**
  Less than ± 5 nm (3σ)
- **Investigation of any rotationally symmetric surface**
  Aspheres, spheres, flats
- **Fast measurement speeds**
  E.g. 1:45 min (Ø = 30 mm, Roc = 60 mm, 100 points / mm^2),
  or 3:45 min (Ø = 80 mm, Roc = 120 mm, 50 points / mm^2)
- **Almost every material**
  Transparent, specular, opaque, polished, ground
- **LuphoScan flexibility**
  Measure gullwing surfaces, segmented surfaces, annular optics, rectangular surfaces, surfaces with diffractive structures, axicons, ...
- **Complete lens characterisation (LuphoSwap extension)**
  Lens thickness, wedge error, decentre error, lens–mount positioning



Complete trust in your metrology platform

Low noise floor supports high accuracy

Taylor Hobson takes great pride in its measurement integrity and reproducibility.

Fundamental to any metrology system is its noise floor capability. Measurement accuracy and repeatability performance is directly related to a stable platform and therefore Taylor Hobson take great pride in boasting an excellent noise floor.

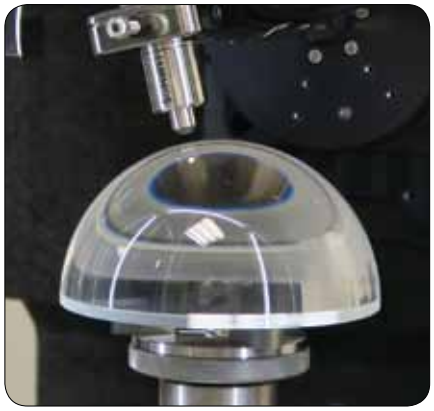
In LuphoScan 260 HD platforms, the concept has been further optimised with a new choice of materials, improved sensor control, the inclusion of ambient conditions in real time and advanced calibration capability.

HD systems provide an absolute measurement accuracy of better than ±50 nm (3σ) up to 90°. Furthermore, in particular the reproducibility of measurement results and the noise floor have been greatly improved.

High precision manufacturing

- **More components made of Invar**
  Upgrade of crucial components to Invar for improved thermal stability.
- **4 temperature sensors, 1 air pressure sensor**
  Real time compensation of ambient conditions.
- **Extended calibration procedure**
  Take into account the thermal response of system.
- **Adapted LuphoSmart sensor control and internal calibration**
  Reduce variations in power error determination.
- **Improved air flow control**
  Minimise characteristic noise.
- **Tighter manufacturing tolerances**
  Process development on the Precitech Nanoform Diamond Turn machining centre.
- **Improved assembly**
  Advanced instrument assembly techniques to ensure repeatability and standardise results.
- **Extended customer calibration procedure**
  Improved steep slope performance.

> “Accuracy of better than ±50 nm (3σ) up to 90°”



Flexible 3D form measurement

Measurement principle

During measurement the probe performs a spiral scan over the entire surface of the object under test and produces high density 3D data. Scanning is achieved by rotating the object by means of an air-bearing spindle whilst the sensor is moved radially and axially using linear stages. A rotary stage keeps the sensor normal to the object surface. The layout of movement stages provides high flexibility, even for uncommon surface shapes including steep slopes or profiles with points of inflection.

LuphoScan software

LuphoScan software enables predefinition of measurement procedures, assists for stressless part mounting, analysis of measurement results, and print out of test reports.

Further features include sophisticated adjustment of apertures and various filtering tools, such as low pass or high pass filters, filters for eliminating peaks caused by dust particles etc. The measurement data can be interpreted as being obtained from a polished or ground surface (after the measurement).

> “Fast non-contact real 3D measurement of aspheres”

Data input and measurement procedure

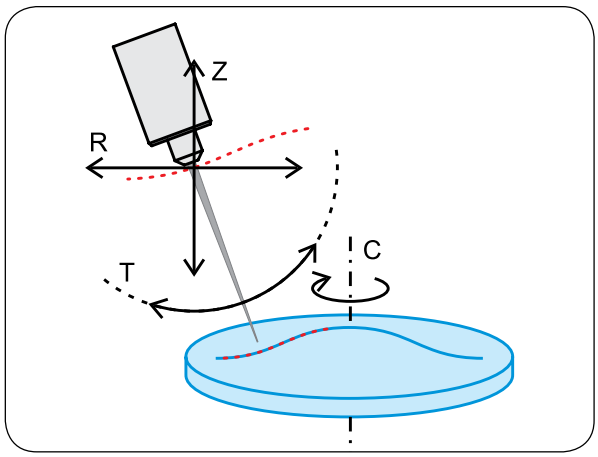
Measurements usually start by putting in a surface description, e.g. by entering the radius of curvature, conic constant, and even and odd aspheric coefficients of the part under test. Subsequently the software displays the trajectory of the object sensor, enabling a straightforward check whether the correct description has been entered. In addition, the software provides an easy way for comparison with a SAG table. The data density can be user adjusted and the program suggests an optimal setting for minimal measurement times. During measurements a countdown shows the remaining time.

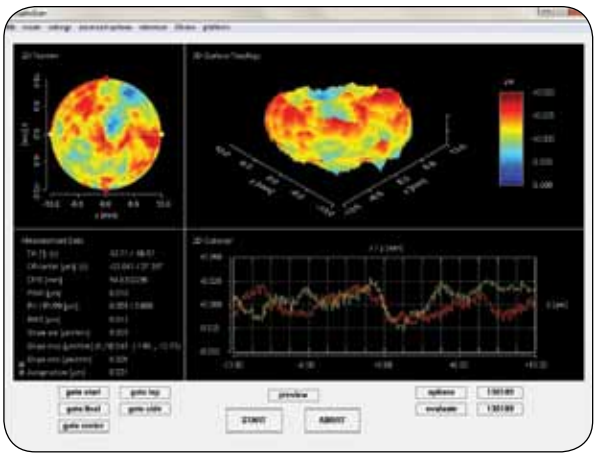
Data analysis

After a measurement has finished a topview, a 3D view and cutaways of the error map are shown. Several tools are available for analysing the data. Of course, all standard parameters for assessing the surface deviation are directly displayed, including power error (PWR), PV and PV99, RMS, slope errors. In addition, with a click also Zernike terms can be evaluated.

Data export

Measurement data can be exported as 3D sets or 2D line scans. Different formats are available that support straightforward import in production machines. The new software also enables user definable auto-export for integrated manufacturing.





High accuracy measurement system

New era of metrology

LuphoScan HD instruments provide an ultra-high measurement performance.

They guarantee a form measurement accuracy of better than ±50 nm (3σ) up to 90° and exceptional reproducibility of measurement results. The performance is based on the outstanding interferometric sensor technology (MWLI®), a sophisticated system design that follows the Abbe principle, and clever concepts that compensate ambient conditions.

LuphoSmart sensor technology

The measurement principle is based on multi-wavelength interferometry (MWLI®) where several discrete wavelengths are used simultaneously. This can be seen as several interferometers, operating independently, sharing the same optical path. Analysis of the beating intervals of the different wavelengths employed delivers high accuracy interferometirc measurement combined with certainty of position over a range of millimetres. In this way the systems guarantee consistent absolute, long term measurement accuracy of 2 nm (3σ). Drift can easily be kept below 1 nm under standard lab conditions and linearity is better than 3 nm over 10 cm.

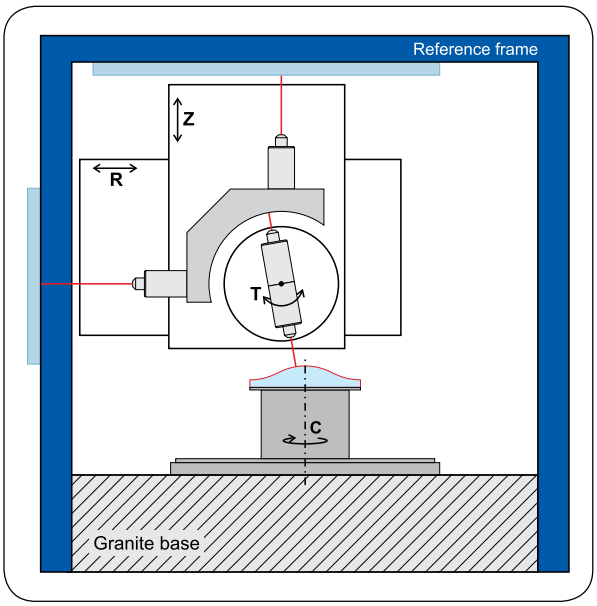
System design

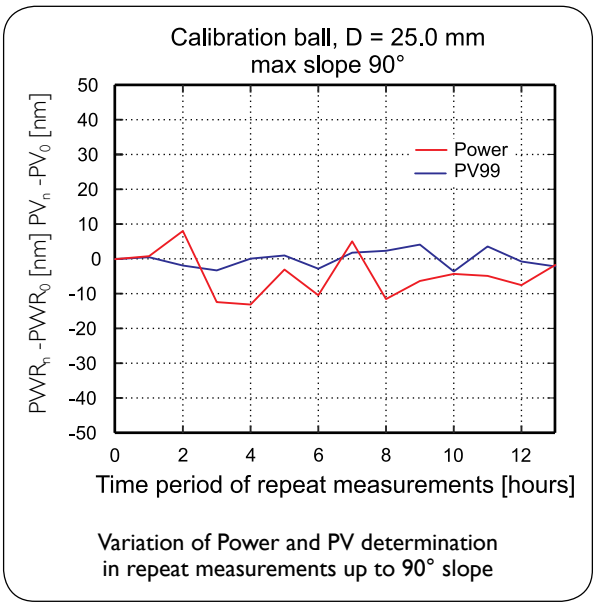
LuphoScan HD platforms utilise an optimised mix of materials, improved sensor control, real-time compensation of ambient conditions and advanced calibration capability. In conjunction with the sophisticated LuphoScan reference frame concept and a patented arrangement of referencing sensors, HD platforms provide a form measurement accuracy of better than ±50 nm (3σ) in the whole measurement volume and up to 90° object slopes. This outstanding performance is achieved by a layout that strictly follows the Abbe principle and that allows correction of all first order errors induced by the stages that move the scanning object probe.

Furthermore, the excellent stability of the systems make them ideal metrology solutions for production environments. Due to effective decoupling of mechanical influences and real time temperature compensation, the systems guarantee highly accurate, reproducible measurement results even when used under adverse conditions.

Reproducibility

The graph shows the variation of the determined Power and PV errors when measuring a calibration ball (D=25.0 mm). In repeat measurements over a period of 13 hours the ball was automatically measured once per hour up to a slope of 90°. During this time period the temperature change was about 1°C. In this experiment the Power and PV variations remained less than ±15 nm and ±5 nm, respectively. The platform was not recalibrated and the graphs are based on raw, unfiltered data. This remarkable shot-to-shot stability impressively demonstrates the excellent capability of the HD design.





Variation of Power and PV determination in repeat measurements up to 90° slope

Ground-breaking performance

Stability of measurement results

One quality characteristic of inspection instruments is the stability of measurement results. The stability will be influenced by various factors, including environmental conditions such as temperature and air pressure changes or floor vibrations. In this context an essential indicator of the achievable precision of an instrument is the repeatability of results. The graphs shown here demonstrate the intrinsic stability of the new generation LuphoScan and LuphoScan HD instruments for the most crucial error parameters, power (PWR) and peak-to-valley (PV).

Evaluating intrinsic stability of LuphoScan systems

The graphs below show the results from three LuphoScan platforms after temperature compensation, achieved by using the simple 15 minute calibration procedure. The measurements were taken on a calibration ball and a gullwing asphere. Two measurements have been taken on each system to determine the power and peak-to-valley errors. In the first measurement a calibration ball with a diameter of 25 mm is measured up to a slope of 90°. In the second experiment a gullwing asphere with a diameter of 25 mm and a maximum slope of 24° is measured. In each test 25 measurements are evaluated.

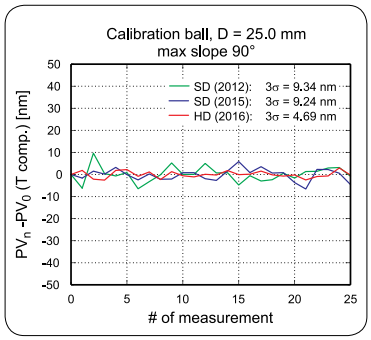
> “Power error stability <±20 nm (3σ) up to 90°”

HD performance

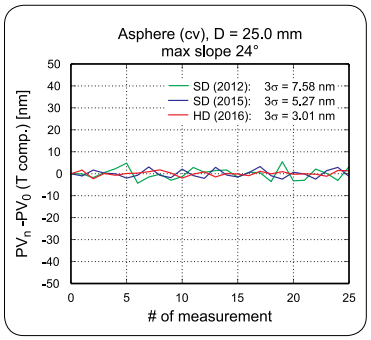
The measurement results impressively demonstrate the extremely high repeatability that is provided by the HD concept and show the improvements in comparison to the first generation platforms. The intrinsic variations are larger when measuring larger slopes, but in an HD platform the 3σ range for measurements up to 90° remains less than 5 nm PV and 12 nm PWR, respectively.

When measuring only up to moderate slopes, in this case of up to 24°, the 3σ ranges for intrinsic variations are just 3 nm PV and 5.5 nm PWR. The combination of this stability with clever compensation of ambient conditions are the core of the ultra high performance of LuphoScan HD instruments.

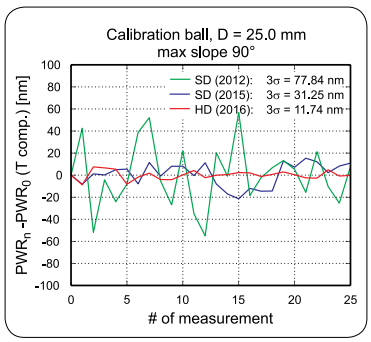
Calibration ball, D = 25.0 mm, max slope 90°



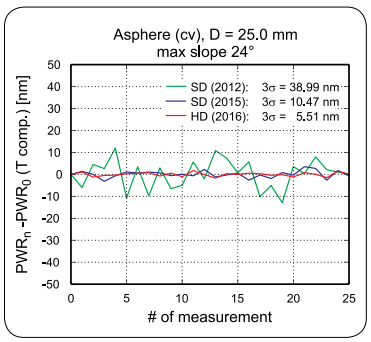
Asphere (cv), D = 25.0 mm, max slope 24°



Calibration ball, D = 25.0 mm, max slope 90°



Asphere (cv), D = 25.0 mm, max slope 24°



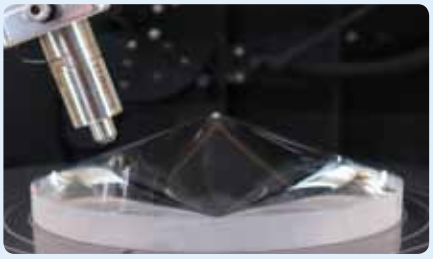
LuphoScan 260 HD accessories

Several add-on software modules are available that enable straightforward measurement of optics that are not just simple aspheres

> “Complete form error characterisation of optical parts by LuphoSwap extension”

Discontinuous surfaces such as segmented, annular, and asphero-diffractive lenses, and axicons

Because of the absolute measurement capability of the MWLI® sensor technology LuphoScan HD instruments also allow inspection of segmented lenses, annular lenses, asphero-diffractive lenses, and axicons. The modules can also be combined, for instance in order to measure a segment of an asphero-diffractive lens with a hole in the centre.



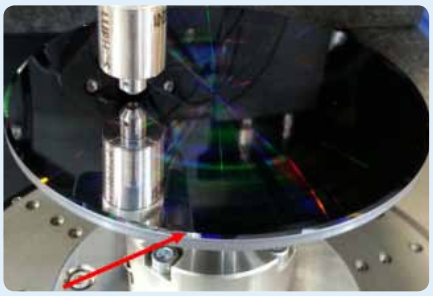
LuphoSwap - Determine wedge error, decentre error, and thickness of lenses

LuphoSwap enables complete characterisation of the positioning of the two sides of a lens to each other. The tool comprises a sophisticated fixture, a calibrated reference ring and a software module. After measuring the form of the first side and its positioning with regard to the reference surfaces, the operator turns over the ring together with the lens and the system automatically measures the second side with regard to the reference surfaces.

Due to the absolute measurement capability of the probes employed, the results from both sides can be correlated in order to determine the exact lens thickness of the part, the wedge and decentre errors of the two surfaces and their rotational orientation.

Interlignment module - Measure the positioning of an optical surface with regard to user defined reference surfaces

The software module enables (fully automated) analysis of the positioning of an optical surface with regard to user-defined reference surfaces, such as the lens perimeter, any lens mount, or the barrel of moulds. After measuring the optical form the system automatically controls the object probe to move to the user specified facets and to determine parameters such as decentring, tilts and height differences.



Custom-designed - Measure mild freeform parts and complex rotationally symmetric parts

The powerful software module “custom-designed” enables the capability for measuring complex rotationally symmetric surfaces and freeform parts that exhibit tangential slopes (e.g. atoric and off-axis parts). By means of this module point clouds can be imported to the system and basically arbitrary surface shapes whose tangential slopes are less than 20° (requires an optional available high NA probe) can be measured.

Further information about the available add-ons can be found in the LuphoScan Accessory brochure

Designed to suit your application

Meeting the ever increasing demands of next generation technologies

4K camera and projector lenses

Measure high precision aspheres at the highest accuracy and best reliability with minimal operator influence. The LuphoScan HD enables manufacturers to accuratly measure their optics.

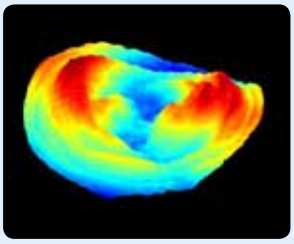
4K Camera

4K camera lens

Steep, complex, segmented aspherical surfaces

Gain from the LuphoScan HD measurement flexibility and reliability in order to fulfil highest demands in optics production. The aims for weight reduction and aberration free optical systems require metrology tools such as the LuphoScan HD that can easily measure increasingly complex lenses including steep aspheres and heavy gullwing shapes.

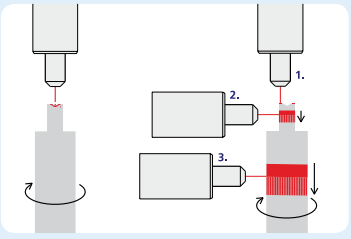
Camera lens



Measurement result

Cell phone and camera lens moulds

Improve the optical and mechanical repeatability of injection mouldings by taking into account the positioning of the optical surface to the mould barrel and mountings.



Measurement principle

Lens mould measurement

Positioning of optical surfaces

Advance the imaging performance of systems that comprise many lenses. The Interlignment module enables determination of tilt and decentre of an optical surface with regard to user-defined reference surfaces, such as the lens perimeter. Employing these results during assembly helps to significantly improve the performance of optical systems and can drastically reduce aberrations.

Multiple optical surfaces

Specification

Measurement system		
Models		LuphoScan 260 HD (A, B)
Machine type		4-axis (3 roller bearings, 1 air bearing)
Measurement principle		Scanning point interferometry
Sensor technology		Fibre optics based multi-wavelength interferometer (MWLI®)
Scanning mode (3D)		Spiral, equidistant, normal
Measurement volume (diameter x height)		260 mm x 75 mm
Maximum tilt		90°
Reference system		3 MWLI® sensors
		Invar frame
		Compensation of 1st order errors by R,Z,T axes (Abbe principle)

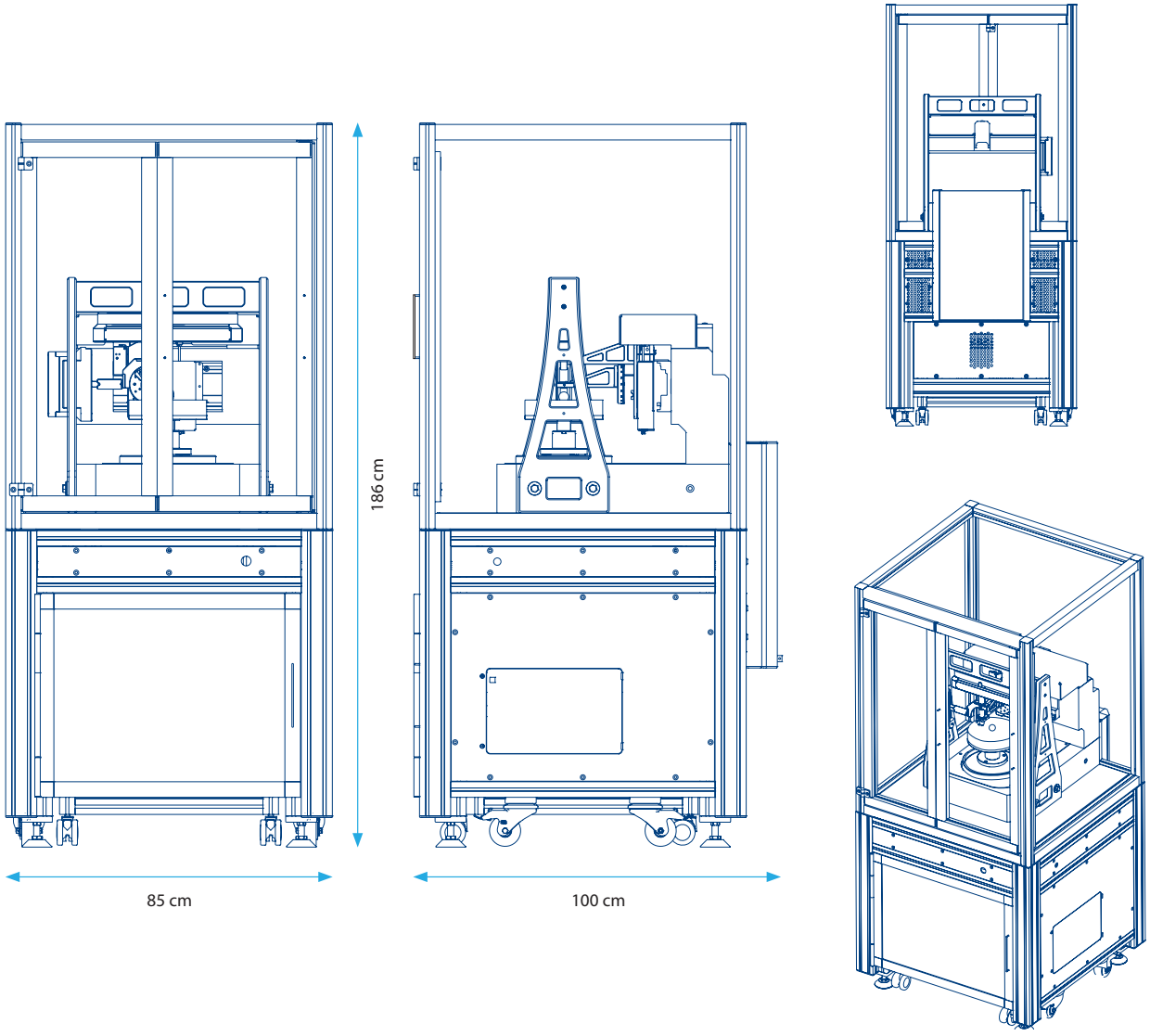
Measurement characteristics*		
Form measurement accuracy (up to 90°)		< ± 50 nm (3σ)
Measurement reproducibility (up to 90°)	Power (PWR)	< ± 20 nm (3σ)
	Peak-to-Valley (PV99)	< ± 5 nm (3σ)
System noise		< ± 5 nm (3σ)
Longitudinal resolution		< 0.05 nm
Spotsize of point probe		4 µm
Lateral resolution (points per mm^2)		(adjustable) up to 2×10^5
Measurement times		Plane, D = 25 mm - 2:20 min (100 points/mm2) Sphere, Roc = ±60 mm, D = 40 mm - 3:45 min (100 points/mm^2) Sphere, Roc = ±100 mm, D = 100 mm - 6:35 min (50 points/mm^2)

Object parameters		
Surface shapes		Aspheric, spheric, flat, slight freeform
Surface finish		Polished, rough, transparent, specular, opaque
Reflectivity range		0.1 % ... 100 %
Spherical departure		Unrestricted (object sensor follows ideal profile)
Maximal slopes	Convex	90°
	Concave	65°
Maximal diameter with 90° slope		180 mm (A), 160 mm (B)
Diameter of largest measurable hemisphere		75 mm (A), 55 mm (B)
Maximal SAG heights	Convex	55 mm (A), 50 mm (B)
	Concave	-20 mm (A), -30 mm (B)
Maximum object diameter		260 mm
Maximum object weight		25 kg

Data handling		
Parameter input		Aspheric coefficients (even, odd)
Measurement data		3D
Data export formats	3D	MetroPro: XYZ/ DAT, TalyMap: SUR, X,Y,Z,dP: ASCII, binary
	2D	Taylor Hobson: MOD, PRF, X,Z,dP: ASCII, binary
Export methods		Manual and automatic (user definable)
Data analysis		3D surface visualisation, adjustable cross-section, 2D graphics, filtering (LPF, HPF, Gaussian), best-fit radius, aspheric fit, Power, PV, RMS, Slope errors, Zernike
Measurement report		PDF (user definable)

***For polished surfaces, depending on environmental conditions**

Machine characteristics	
Object mount	Hydraulic expansion chuck (HD25), optional: 3-jaw chucks, centre & levelling tables
Internal data rate	2500 Hz
Wavelength range	1530 nm ... 1610 nm
Laser classification	Class 1
	Continuous wave output (CW), < 1 mW
Machine dimensions (w x d x h)	85 cm x 100 cm x 186 cm
Machine weight	450 kg
Compressed air requirement	8...10 bar, 20 litre/min
Electrical power requirement	230 VAC, 50/60 Hz, < 700 W



TAYLOR HOBSON®

AMETEK®
ULTRA PRECISION TECHNOLOGIES

The Metrology Experts

Established in 1886, Taylor Hobson is the world leader in surface and form metrology and developed the first roundness and surface finish measuring instruments.

www.taylor-hobson.com

Sales department

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- **Design engineering** – special purpose, dedicated metrology systems for demanding applications.
- **Precision manufacturing** – contract machining services for high precision applications and industries.

Centre of Excellence department

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- **Metrology training** – practical, hands-on training courses for roundness and surface finish conducted by experienced metrologists.
- **Operator training** – on-site instruction will lead to greater proficiency and higher productivity.
- **UKAS calibration and testing** – certification for artifacts or instruments in our laboratory or at customer's site.

Service department

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- **Preventative maintenance** – protect your metrology investment with an AMECare support agreement.

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