IBS Precision Engineering

ISARA400

NEXT GENERATION ULTRA-PRECISION
COORDINATE MEASURING MACHINE

"Creativity"

How do you produce unique results in the area of measurement – achievements that excel in precision, efficiency and usefulness and help make products better?

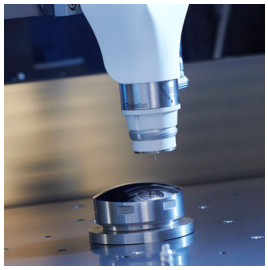
WHAT MAKES ISARA400 SO UNIQUE?

- Metrology tool for measuring complex surfaces and free form optics in full 3D with nanometer resolution
- Measurement uncertainties down to 50 nm (1D) in all three directions
- A significantly increased measurement range of 400 x 400 x 100 mm, unlike any other comparable CMM
- Capability to reference optical surfaces to mechanical references
- Fully traceable measurements
- Multi-probe machine, enabled by a kinematic probe holder
- All guides with porous media air bearings, enabling smooth, frictionless motion, ideal for 3D scanning measurements

REMBRANDT VAN RIJN

DUTCH PAINTER

(1606 - 1669) Rembrandt Harmenszoon van Rijn is generally regarded as the greatest painter of Holland's "Golden Age". He was an innovative genius whose stylistic mastery and minute refinement have enthralled generations of artists ever since.



ISARA400

SPECIAL MACHINE FOR MAXIMUM ACCURACY

NEXT GENERATION ULTRA-PRECISION COORDINATE MEASURING MACHINE

In various fields of manufacturing and research, a growing demand for high-accuracy 3D measurements of large products exists.
To fulfill this demand, IBS Precision Engineering has developed a new ultra-precision coordinate measuring machine (CMM) with an unprecedented ratio of measurement volume vs. measurement accuracy, the **ISARA**400.

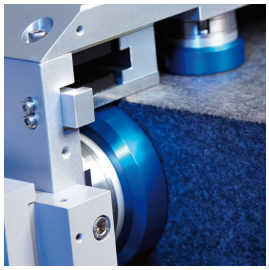
The **ISARA**400 is a multi-probe 3D CMM which takes the measurement of large and complex parts to the nanometre level. This measuring machine is able to measure complex surfaces like aspheres, free-forms or integrated optics with nanometre accuracy and overcomes the limitations presented by the optical methods or contacting profilers which are currently used, making it the most accurate three-dimensional coordinate measuring machine available on the market!

In addition, the **ISARA**400 can be used for the measurement of geometrical dimensions of industrial parts. Measurement of planes, holes, curvatures and the corresponding tolerances is possible, similar to conventional CMMs, but with a much higher accuracy.

ISARA
The Syro-Mesopotamian goddess of the oath and queen of judgement.

The Hittites called her *Queen of the mountains*.

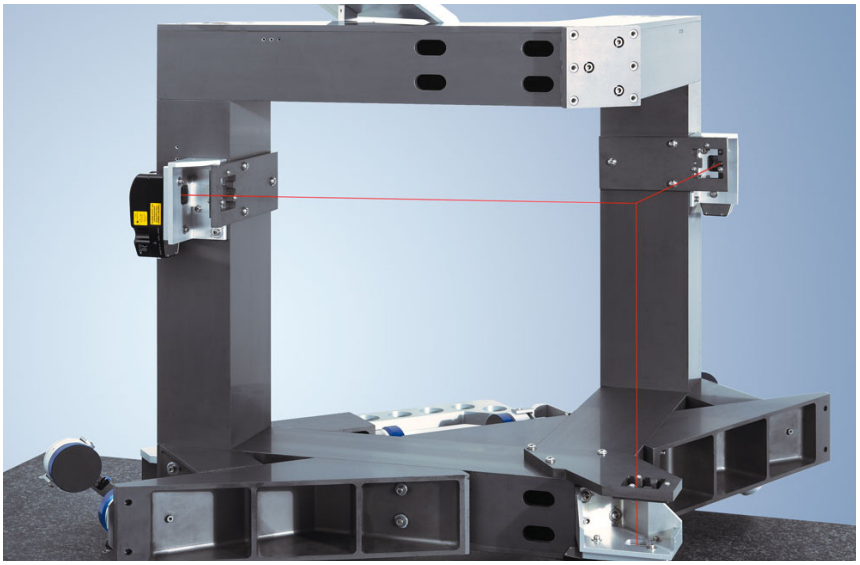
TECHNICAL INFORMATION



TO ACHIEVE ITS LEADING PERFORMANCE, ISARA400 IS DESIGNED ACCORDING TO SEVERAL IMPORTANT DESIGN PRINCIPLES

ABBE PRINCIPLE

To avoid parallax errors, a measuring system must be placed coaxially with the axis along which displacements are to be measured.
This is known as the Abbe principle. In the Isara concept, the Abbe principle is fulfilled in all three coordinate axes over the entire measuring volume.
ISARA400 features a floating table design, moving in x and y. The metrology frame moves in z-direction.
The relative position of the mirror table with respect to the metrology frame is measured using three plane mirror laser interferometres with compensation for air temperature, pressure and humidity. The three lasers always remain aligned with the centre of the probe tip, thus fulfilling the Abbe principle in 3D.



METROLOGY AND STRUCTURAL FRAME

The requirements for the metrology and structural functions are completely different: the **ISARA**400 CMM is able to reach a measurement uncertainty in the nanometre range by applying different frames to perform these functions. While the metrology frame is optimized for positional stability of the measurement systems, the base frame handles the actuator forces. Deformations of the base frame have no influence on the measurement, due to the stress-free coupling between the two frames.

CALIBRATION

A very important design aspect of Isara is the ability to calibrate the metrology loop on the machine itself. Since the Abbe principle is fulfilled for all axes, geometric calibration only concerns the shape of the mirror table (flatness deviation and out-of-squareness). This is performed with a well-known reference body. All sensors and other measuring systems used in Isara are calibrated and traceable to well-known international standards.

THERMAL SENSITIVITY

In general, thermal effects are among the largest sources of non-repeatability in measuring machine accuracy. The **ISARA**400 CMM minimizes these effects by making use of low-expansion materials such as Zerodur®, Silicon Carbide (SiC) and Invar® for critical parts such as the mirror table and the metrology frame. During measurement, the measurement area is covered by an enclosure to minimize heat input from the environment of the machine (e.g. operators). Thanks to an optimized design, the Isara 3D CMM is able to reduce its thermal sensitivity to the nanometre level.

APPLICATIONS

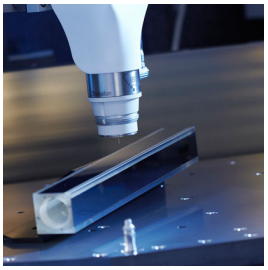
SPECIAL MACHINE FOR MAXIMUM ACCURACY

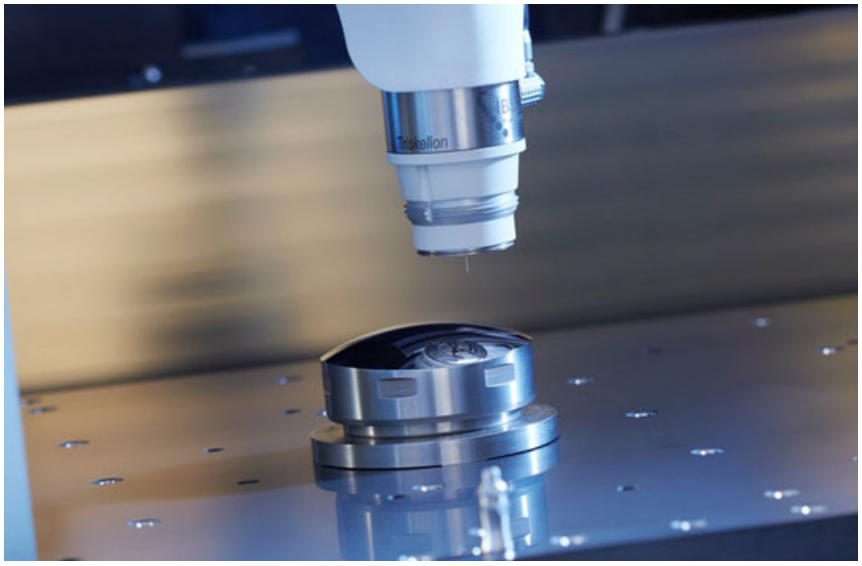
POINT MEASUREMENTS

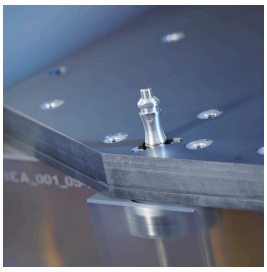
As with any conventional CMM, measurement points are taken by bringing a probe system into interaction with the work piece. The probe system is typically an ultra-precision tactile probe, which makes physical contact with the work piece surface, but it is also possible to apply non-contact measuring systems such as optical probes.

At the start of the measurement, the alignment of the work piece is determined by measuring the position and orientation of specific points or planes on the work piece. The operator can then select the features to be measured using the supplied CAD interface software and begin measurement of the dimensions which are of interest.

For freeform measurements, for example, the operator may want to measure a large cloud of points over the complete surface. After setting up the measurement and programming the sequence, this measurement sequence is performed automatically.







SCANNING MEASUREMENTS

Because the **ISARA**400 CMM typically uses analogue measuring probes, which measure their own tip deflection, it is possible to perform automated scanning measurements. When the probe performs a scan measurement over the surface of a work piece, it remains in contact at all times. The contact force between probe tip and work piece is kept constant within about 0.1 mN.
The result is a profile measurement of the surface with a high measurement point density (depending on scanning speed and sample frequency, subsequent measurement points typically have less than 1 µm spacing).

No prior knowledge of the work piece form is required; the scanning measurement software uses the measured probe deflection to control the displacements of the machine. As a result, the time required to set up the measurement of a new product is minimal, thus offering excellent flexibility for continuously varying measurement tasks.

SOME APPLICATION EXAMPLES CAN BE FOUND BELOW:

- Measurement of large scale optics with nanometre measuring uncertainty
- Measurement of point clouds on freeform optics
- Scanning measurement of aspherical lenses and moulds, allowing the optimization of production processes
- Measurement of geometrical dimensions and quality control of critical tolerances
- Measurement of multiple (small) features in a single orientation; a unique capability to reference optical surfaces to mechanical references
- Measurement of optical assemblies
- Measurement of small products in array setups

SPECIFICATIONS

MAIN DIMENSIONS

ISARA 3D CMM	2.6 X 2.3 X 2.4 m
Control cabinet	0.8 X 0.8 X 2.1 m

MACHINE MASS

Suspended machine mass	Approximately 3000 kg
Total including subframe and enclosure	Approximately 4000 kg

POWER AND AIR SUPPLY

Power supply	AC 230 V ± 5%, 10 A
Pneumatic supply dry air	7 bar, 80 nl/min
	Quality class 3 (ISO 8573.1)
	Dirt particle size: < 5 µm Oil, including vapor: < 1 mg/m^3
	WATER CONTENT @ 7 BAR: Pressure dew point: < -20°C ppm. vol.: < 128 ppm

OPERATING ENVIRONMENT

Allowable temperature range	15 ... 25 °C
Max. temperature range for specified accuracy	20 °C ± 0.5 °C
Short term temperature variation	Less than 0.1 °C / h
Air pressure range	900 - 1100 hPa
Humidity	40 - 60 %
Vibration level	Compliant with vibration criterion D[1]

A clean environment is required.

[1] *Colin G. Gordon, Generic criteria for vibration-sensitive equipment, Proceedings of International Society for Optical Engineering (SPIE), Vol. 1619, San Jose, CA, November 4-6, 1991, pp. 71-85.*

XYZ STAGE

Measurement range X-axis	400 mm
Measurement range Y-axis	400 mm
Measurement range Z-axis	100 mm
Travel velocity selectable	0.01 …10 mm/s
Probing velocity selectable	0.01 …1 mm/s
Positioning accuracy	Better than ± 0.5 µm (x,y,z) during standstill
Overshoot	≤ 10 µm at maximum probing velocity

PRODUCT TABLE

Allowable product mass	32 kg
Interface	Removable product table with grid of threaded holes

MEASURING SYSTEM

Measurement resolution of laser interferometres (X, Y and Z):	1.6 nm

1D MEASUREMENT UNCERTAINTY

(e.g. one-sided measurement of step gage along a single machine axis)

		1D measurement uncertainty (k=2)		
	Full stroke	x-axis	y-axis	z-axis
1D measuring uncertainty of CMM including probe system	Lx= 400 mm Ly= 400 mm Lz= 100 mm	52 nm	49 nm	57 nm

2D MEASUREMENT UNCERTAINTY

(e.g. profile measurement along 2 machine axes)

	2D measurement uncertainty (k=2)		
	xz-axes	yz-axes	xy-axes
2D measuring uncertainty of CMM (over full stroke) including probe system	72 nm	70 nm	71 nm

3D MEASUREMENT UNCERTAINTY

(full 3D measurement e.g. freeform optics)

	3D measurement uncertainty (k=2)
3D measuring uncertainty of CMM (over full stroke) including probe system	109 nm

Total 1D, 2D and 3D measuring uncertainty of CMM, including probe system.
Specified uncertainty is valid for measurement over full stroke of all axes

PROBE SYSTEMS

Various different probe systems can be applied on the ISARA400 CMM. Standard the machine can be supplied with the 'Triskelion' ultra-precision probe, a novel tactile probe system with nanometre accuracy and very low contact forces. To enable the measurement of small features, this probe applies very small probe tips. The tip radius typically is 250 micrometre or less.

TRISKELION | ULTRA-PRECISION TOUCH PROBE

The probe design features an elastically suspended stylus, which is free to deflect during probing measurements. Three ultra-precision capacitance sensors, which are integrated into the probe body, are used to measure this deflection. Each sensor measures the displacements of a target disc, connected to leaf springs which form the suspension of the stylus. After performing a calibration of the 3D sensitivity of the probe system, the displacement (magnitude and orientation) of the probe tip can be computed from these three sensor readings, with a 3D measuring uncertainty of less than 15 nm.

More information on our Triskelion probe is available in a separate brochure which is available on our website.

OTHER PROBE SYSTEMS

The ISARA400 CMM is a multi-probe machine. Aside from the Triskelion probe system offered by IBS Precision Engineering, other probe systems can be integrated into the machine as well, making use of the kinematic probe mount which is part of the metrology frame. The measuring capabilities of the Isara 400 CMM can thus be expanded, to enable a wide range of measuring tasks.

The practical integration of each probe system can be evaluated upon request.

TRISKELION | ULTRA-PRECISION TOUCH PROBE

PICTURE EXPLANATION :

1. Stylus and probe tip
2. Target disc for capacitive sensor
3. Three legged stiff body

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