HEXAGON | ETALON
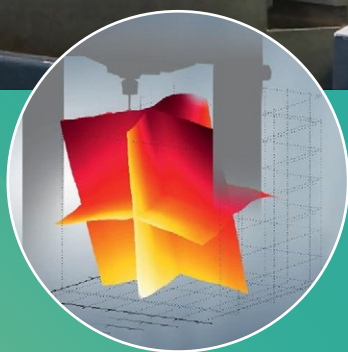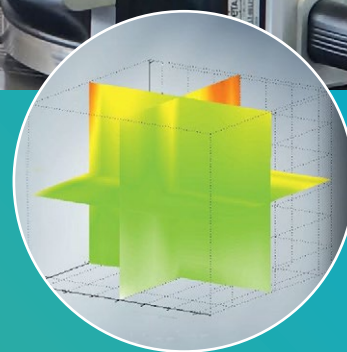
Etalon LaserTRACER-NG

The system solution for calibration, compensation and verification of machine tools and coordinate measuring machines

Before

After

Volumetric compensation

Depending on the machine and environmental conditions, the axis errors can be reduced by 50% to 90%.

Etalon LaserTRACER-NG

In shortest time to the geometrical fingerprint of your machine

The geometric accuracy of machine tools and coordinate measuring machines (CMMs) is one of the most important decision critera, as it has direct impact to the working precision of the machine. The LaserTRACER-NG was developed for the quick and easy monitoring, calibration and compensation of machine tools and CMMs.

Etalon builds on a patented, geometrical method, with which also the Global Positioning System (GPS) is working, the so called Multilateration. A sphere with deviations in the nanometer range serves as the optical reflector for the interferometer. The exact position of this reflector is determined by highly accurate distance measurements. Instead of satelites for GPS, Etalon uses the LaserTracer, which measures the distance to the reflector from multiple locations on the machine table. The exact position is afterwards calculated in precision of sub-micrometers. This way, the mechanical inaccuracy of linear and rotary axes can be determined and even compensated.

U = 5 m

U = 0,5 μm
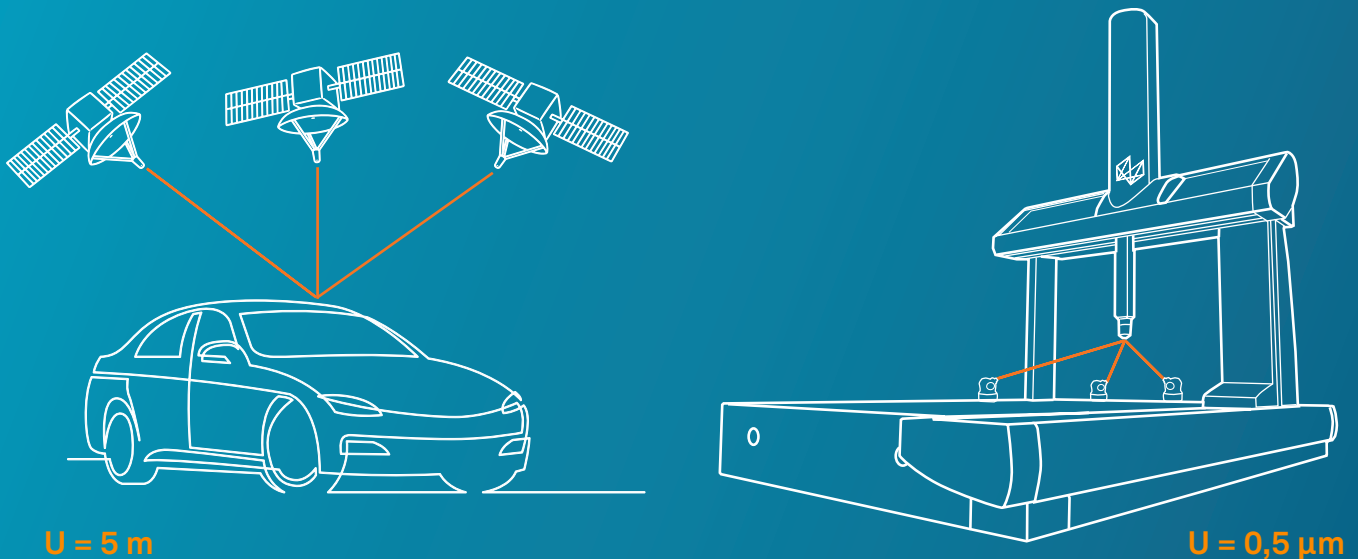
Advantages

- Easy check of the current condition of machine tools and coordinate measuring machines

- Quick checks, calibrations and volumetric compensations of machine tools and coordinate measuring machines

- Minimal time compared to test standards or conventional laser interferometers

- Automated generation of compensation data for most control systems (conventional or volumetric)

- Flexible use on machines of different sizes and types

Etalon
LaserTRACER-NG

Application cases

Manufacturers of machine tools are enabled to efficiently and reliably create a complete geometric fingerprint of their produced machine before use at the customer. As proof of machining ability, the test can be repeated directly on site at the customer or regularly as service offering.

Users of machine tools are provided with a tool with which machines of different types can be geometrically monitored. If necessary, volumetric compensation can significantly increase the machine's accuracy throughout the machining volume to meet demanding tasks.

Benefits

- Efficient testing and calibration of machine tools and CMMs

- Standardized monitoring of CMMs and machine tools

- Accuracy improvement of multi-axis machines by volumetric compensation

The Etalon principle

Easy and quick calibration, monitoring and accuracy enhancement

The unique principle of the measurement with the LaserTRACER-NG: As with the Global Positioning System (GPS), spatial information is obtained by pure distance measurements in space.

- The geometrical interaction af all machine axes is captured and with the proven ETALON method, the 6 degrees of freedom (DOF) of all axes and their squareness to each other are determined.

- In the entire working volume of a measuring machine or machine tool, spatial accuracies in the submicrometer range can be achieved with largely automated measuring routines. The principle is scalable to different machine sizes.

- The Etalon LaserTRACER-NG can be used both for the calibration of linear axes and for rotary axes. In addition, e.g. the elastic deformations on horizontal arm machines can be detected without additional artefacts.

- A fine alignment for the measurements is not required. This makes the application easy, reduces user impact and saves time.

- All results are based on spatial interferometric measurements. This ensures the highest accuracy and metrological traceability, and the recalibration requirement of sensors is kept to a minimum.

- A log for the output of the axis deviations in different representations and, if necessary, correction data can be output at the push of a button.

- A machine acceptance according to current, international standards can also be carried out without fine alignment.
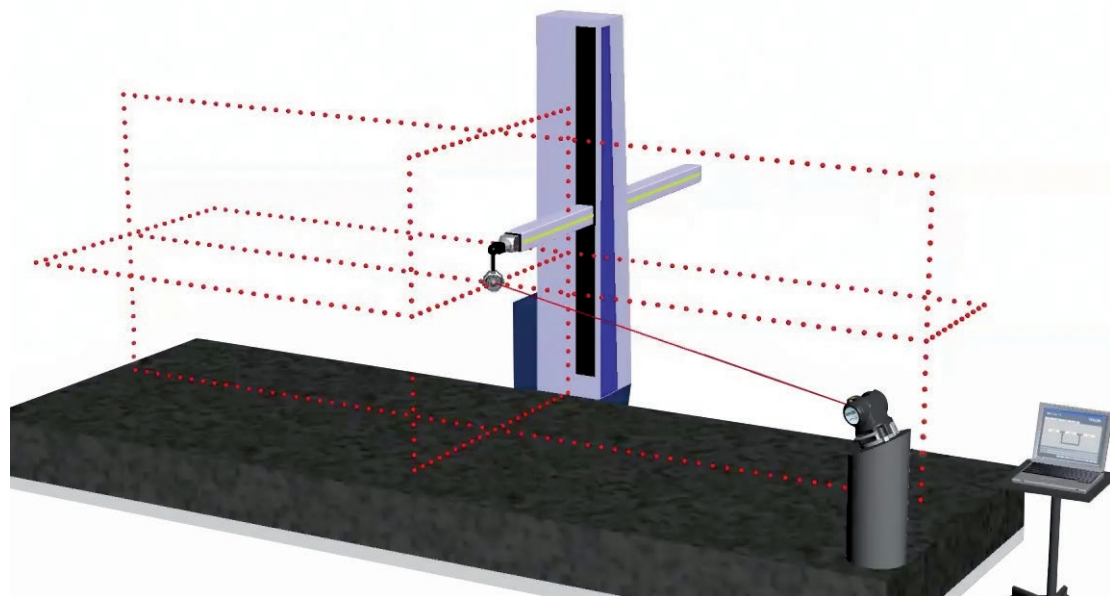
Etalon LaserTRACER-NG

System for verification and calibration of linear and rotary axes

LaserTRACER-NG combines highest precision, short measurement time, universal use and full collection of deviation data.

$$U_{95} = 0{,}2\ \mu m + 0{,}3\ \mu m/m$$
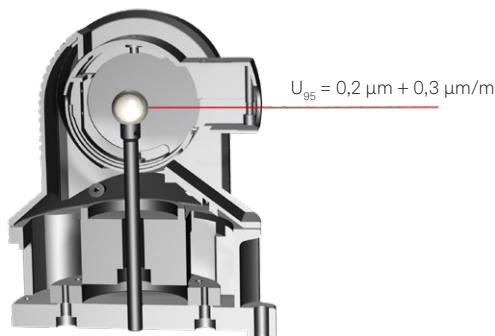
For measurement, the compact LaserTRACER-NG is placed several times in the machine volume without special fine alignment. Instead of a tool or a probe, a reflector is mounted in the machine. In the subsequent automated measuring process, the LaserTRACER-NG tracks the travel of the machine in its working space. It records highly accurate readings from which the Trac-Cal and Trac-Check software packages can accurately calculate and analyze machine deviations to fractions of a micron.

Trac-Cal

Analysis of geometrics and calibration of all axes

The clearly arranged Trac-Cal software guides the user through the individual steps of the measuring process. In conjunction with the LaserTRACER-NG, the software determines all systematic geometric deviations of measuring machines and machine tools. This includes positional deviations, straightness deviations, rotational deviations (pitch, yaw, roll) and the squareness of the axes to each other.

The result is a detailed analysis of all geometrical axis deviations. At the push of a button, Trac-Cal generates compensation tables for a wide variety of control systems. Many controllers have direct online interfaces.

Trac-Check

Fast, standard-compliant condition-checks of linear axes

By using the LaserTRACER-NG with the Trac-Check software, it can be determined in less than 30 minutes it a CMM or machine tool meets the requirements or a compensation or even mechanical maintenance has to be carried out. The patented method for automatic alignment of the measuring beam drastically shortens the measuring time.

Reflectors with large working angles (up to 160 °) enable the detection of machine movement directly at the tool center point

Linear and rotary axes are subject to geometric deviations in all degrees of freedom, the etalon system can determine this quickly, easily and with high precision and provide correction tables.

Sensors measure air temperature, pressure and humidity and correct the laser measurement.

Radio-based temperature sensors can optionally record and assess the thermal expansion of the machine axes.

The laser source and the electronics for motor control and signal evaluation are within an external unit. Thanks to this, the LaserTRACER-NG is compact and thermally extremely stable.

Trac-Cal results

Based on the measured data, the deviations of the machine in space and the temperature profile can be checked Trac-Cal then outputs the individual deviations of the machine axes by a press of a button. In multiple visualizations, the 6 degrees of freedom (DOF) of the axes are displayed.

For linear axes, these are the deviations of positioning, straightness in both directions, pitch, yaw and roll. For rotary axes these are the deviations of the positioning axial movement, radial movement and the wobbling in both directions. The squareness deviations of the axes to each other or orientation of the axis of rotation to the linear axes is also evaluated.

Selectable views illustrate the geometric actual state of the machine. A measurement report for documentation is automatically generated.
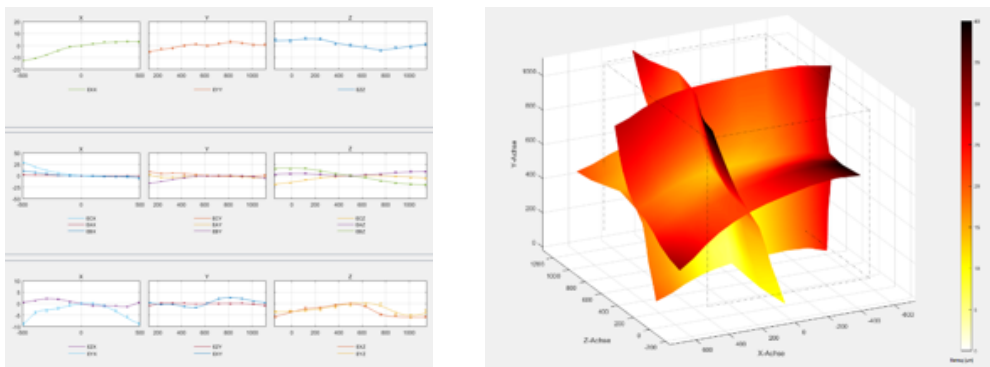

Volumetric compensation

If the geometric deviations of a machine are determined by measurement, they can be compensated numerically. Volumetric compensation has been indispensable in coordinate measuring machines for a quarter of a century to achive an accuracy beyond mechanical precision.

With the latest control technology, this technique is available for machine tools since several years to meet the highest accuracy requirements. In addition to the tables for the complete numerical axis correction, conventional formats can also be exported.

User of Etalon-technology can reduce axis errors by 50% to 90%, depending on the machine and environmental conditions.
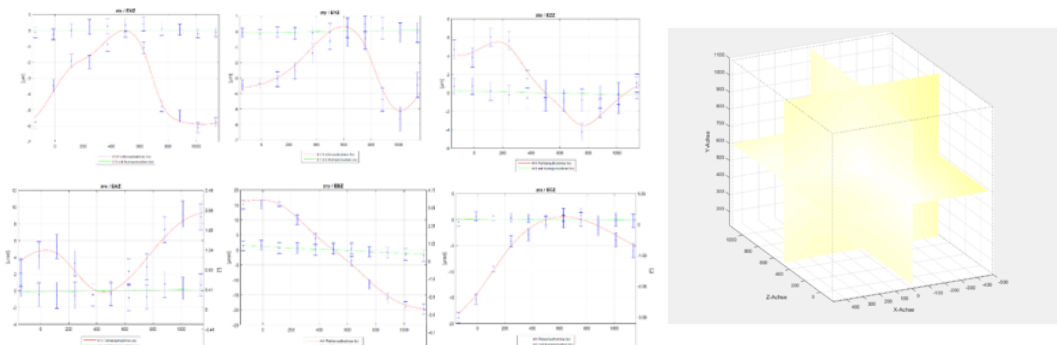
Trac-Check results

If it is less about a detailed analysis of the axis errors, but about a simply comparable, standard-compliant machine inspection or acceptance, Trac-Check provides the necessary information. The software is based on the following current standards.
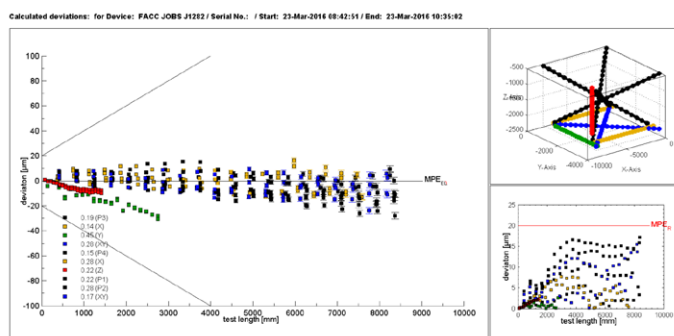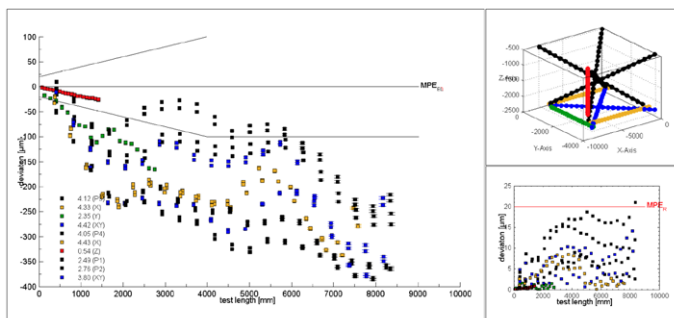
For machine tools

- ISO 230-2 (axis parallel lines)

- ISO 230-6 (plane and space diagonals)

- VDI 3441

- ISO 230-4 (Circular test)

Coordinate measurement machines

- ISO 10360-2 (including probe testing)

The diagrams show the comparison of the axis deviations without (red) and with compensation (yellow), measured at the tool centre point or probe point. The 3D representation shows the residual deviation of the same machine (see left side).

Even with independent measuring lines or measuring instruments, the success of volumetric compensation can be clearly demonstrated.

Existing standards

For machine geometry

ISO 230-1
Basic document on machine tool errors and their measurement.
Also defines the volumetric accuracy.

ISO 230-2
International standard for linear verification along machine axes. Established worldwide in the industry. Often the main acceptance criterion for machines.

VDI 3441
Superseded German standard for linear verification along the machine axes (similar to ISO 230-2). Still in international use.

ISO 230-6
Extends the geometric verification according to ISO 230-2 to the plane and space diagonals. Gives good indication of volumetric accuracy. Increasingly adopted in the industry, especially for large machines.

AMSE B5.54
American adoption of the ISO 230-2 and ISO 230-6. Combines the test of axis parallel lines with the diagonal lines – volumetric accuracy is covered.

ISO 230-4
Ballbar test: Checking of the dynamic path accuracy based on circular paths.
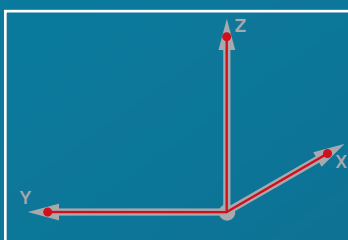
ISO 16907
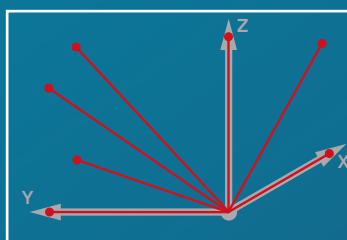Technical guideline for numerical compensation of machines.

ISO 10360-2
International standard for testing coordinate measuring machines. Includes space diagonals for full testing of the measurement volume.
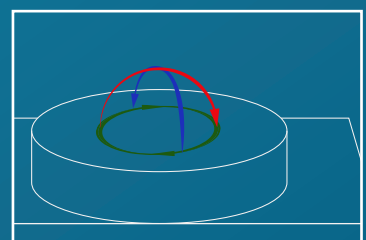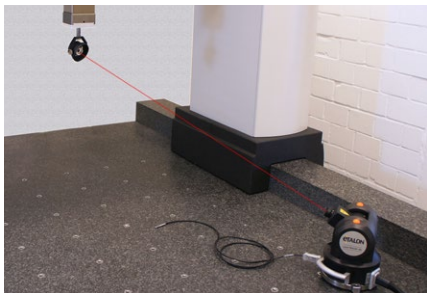
ISO 230-2

ISO 230-6

ISO 230-4

Application examples

Etalon systems demonstrate their accuracy, efficiency and versatility in many applications. Renowned CMM and machine tool manufacturers, users and service providers benefit from their unique capability in daily use.
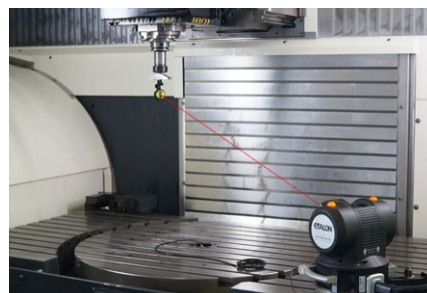

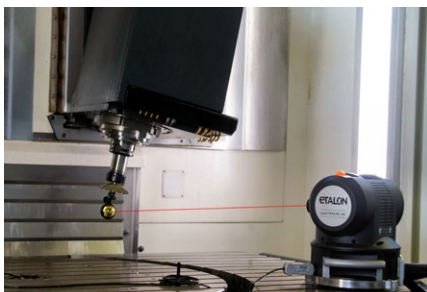Complete measurement of linear CMM axes

Testing and verification of a CMM according to ISO 10360-2

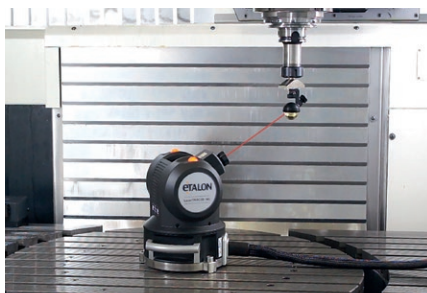Complete measurement of linear machine tool axes

Testing and verification of a machine tool according to ISO 230-2/6

Complete measurement of rotary head axis of a machine tool

Complete measurement of rotary table axis of a machine tool

Testing and verification of a machine tool based on ISO 230-4

Hexagon is a global leader in sensor, software and autonomous solutions. We are putting data to work to boost efficiency, productivity, and quality across industrial, manufacturing, infrastructure, safety, and mobility applications.

Our technologies are shaping urban and production ecosystems to become increasingly connected and autonomous – ensuring a scalable, sustainable future.

Etalon, part of Hexagon's Manufacturing Intelligence division, provides system solutions for the accurate and comprehensive geometric analysis, monitoring and accuracy improvement of machine tools, measuring machines and structures. Learn more at etalon-gmbh.com. Hexagon's Manufacturing Intelligence division provides solutions that utilise data from design and engineering, production and metrology to make manufacturing smarter. For more information, visit hexagonmi.com.

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