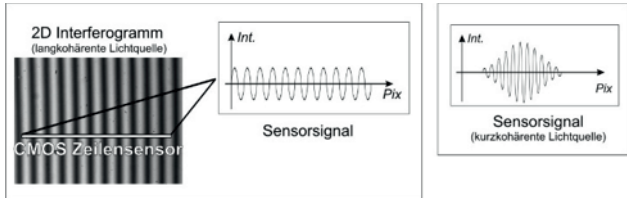
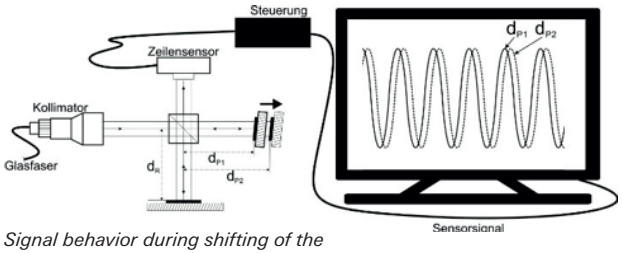
Interferometer module

These fringes are scanned simultaneously by the sensor elements so that a spatially extended interferogram is achieved. The recorded interferograms are interpreted as a periodic pattern.

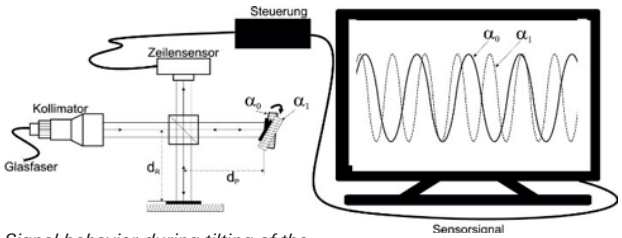
The phase values correlate with the position (see Figure 2), whereas the angle position of the measurement mirror can be determined from the frequency spectrum (see Figure 3).



Detection of a spatially extended interferogram



Signal behavior during shifting of the measurement mirror: the phase is changing



Signal behavior during tilting of the measurement mirror: the frequency is changing

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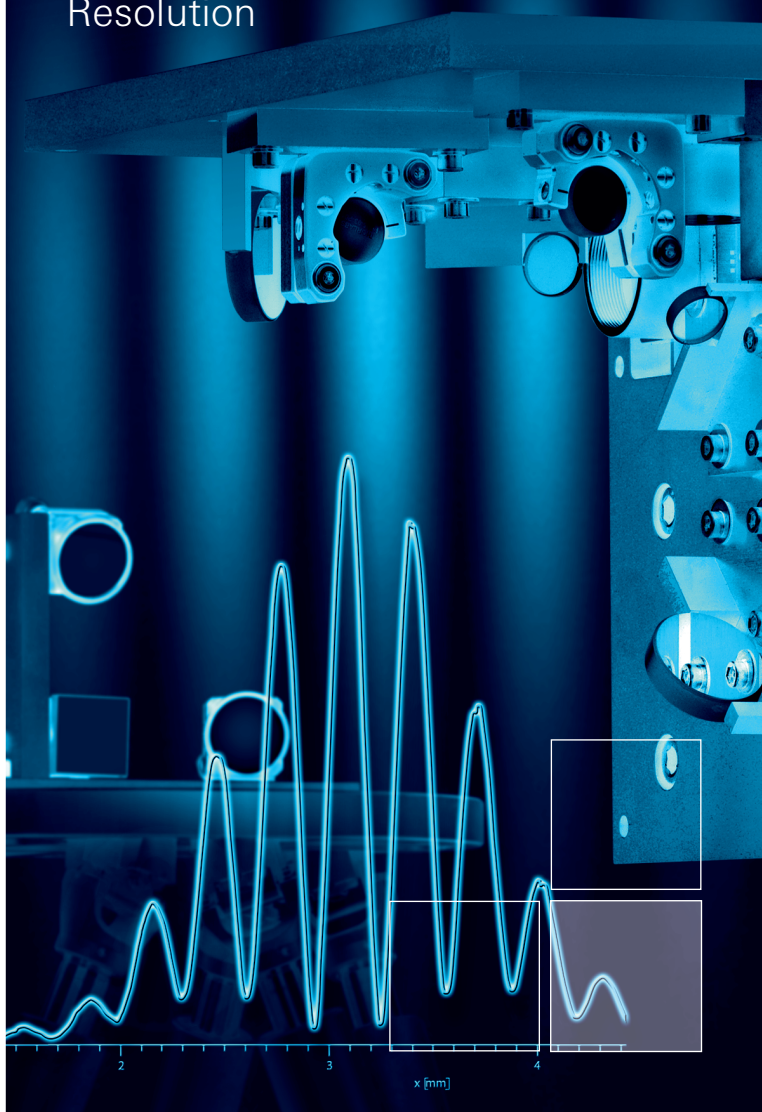
As of: 04/19

Physikalisch-Technische Bundesanstalt
National Metrology Institute

Compact 3D Desktop Measuring Machine with Nanometer Resolution



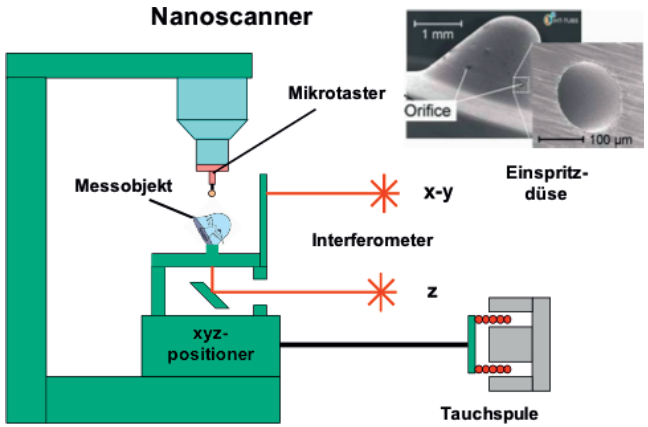
Compact 3D desktop coordinate measuring machine

The Physikalisch-Technische Bundesanstalt (PTB) is currently working on a technology transfer project in cooperation with its project partner MPro GmbH. The aim is to realize a compact desktop coordinate measuring machine. For this purpose, the following single components developed at PTB,

- a measuring microprobe,
- a multiaxial positioning unit including a moving coil drive, and
- an interferometric measuring system

are joined together into a compact modular tactile measuring machine with nanometer resolution. This measuring instrument is to carry out measurement tasks which go beyond the measurement range of a scanning probe microscope (several centimeters in all three dimensions) and detect structures which are too fine for conventional coordinate measuring machines. Typical applications for this system include the measuring at diesel injection nozzles or at miniature gears. By means of the interferometric position measurement and the novel measuring microprobe, it is possible to detect ultra-fine mechanical structures. The measurement uncertainties are in the two-digit nanometer range.

Prototype



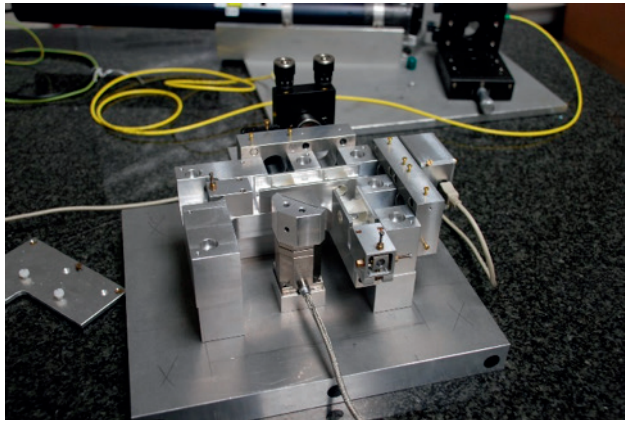
It is hoped that the prototype presented will appeal to industrial users who cannot make use of the standard solutions on the market due to special requirements. Many of the tasks require a compact or modular construction of the measuring instrument enabling integration into an existing apparatus. Some applications still require very small, high-resolution probes to be able to test the quality of ultra-fine structures or small drill holes. The measuring machine presented is to fulfil these requirements with high precision by means of the measuring microprobe and interferometric position determination.
Many parts of the technologies and components which are required for such a measuring machine have already been developed at PTB in earlier projects or are a portfolio component of its industrial partner MPro GmbH.

Microprobe

A microprobe was developed at PTB within the scope of several projects. This probe is manufactured using microtechnical production methods, partly at PTB and partly by external service providers. This is a measuring probe, which means that it provides a signal according to the applied displacement of the probing sphere for all three dimensions. The resolution of the measured displacement is in the one-digit nanometer range.

Interferometer module

At PTB, an interferometer concept for simultaneous length and angle measurements has been developed over the recent years. The underlying concept and its signal evaluation are new, and a patent has been filed. The basis of the measurement procedure is a spatial evaluation of the obtained interferogram. The signals are processed by means of FPGA (Field Programmable Gate Array), whereby a real-time determination of the angles and the position will be possible.
The innovation of this new method is the ability to measure displacement and angle simultaneously.



Interferometer module

The measurement concept is based on the working principle of a Twyman-Green interferometer. The small number of optical and mechanical components enables the realization of a miniaturized measurement head and minimizes the adjustment effort.

To be able to determine the length and angle difference of the measurement and of the reference mirror, the interferogram is detected over the surface. Figure 1 shows an example of a sinusoidal intensity pattern.