Calibration of angular interferometers using electronic autocollimators for the determination of the Abbe errors' uncertainty contributions

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Abstract

Angular devations due to the motion required for a dimensional metrology task lead often to significant uncertainty contributions. These so called Abbe errors can, in general, be minimized by the design of dimensional metrology instrument. They can be reduced even further by introducing angular control loops, which require sufficiently accurate actuators and angular sensors. In order to determine the uncertainty contributions of the Abbe errors, in both cases, the angular deviations caused by the motion need to be measured in a traceable way. Furthermore, for an accurate estimation of the whole Abbe uncertainty contribution, the related Abbe offset needs to be determined as well.

Because a new Yaw angle interferometer was integrated into the Nanometer Comparator and the Pitch interferometer of the Nanometer Comparator had to be reaglined, the angle interferometers were calibrated using an electronic autocollimator. In addition, at this occasion, the angular deviations caused by the motion of the measurement slides were remeasured using calibrated, electronic autocollimators as well. The use of the angular control loop reduced the angular deviations during the motion from 2.5 µrad/m to 0.57 µrad/m for the Yaw - and from 11 µrad/m to below 0.36 µrad/m for the Pitch angle. But suprisnigly a comparison with older data showed that the exchange of the of the Yaw interferometer did not change the related residual angular deviations between the autocollimator and the interferometers.

In this contribution we report on the details of calibration of the angular interferometers, the measurements of the residual angular motion deviations and the efforts to identy the origin of the residual angular deviations undertaken so far.