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MIM and Experimental Studies of the Thermal Drift in an Ultra-High Precision Instrument for Dimensional Metrology

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Abstract : Thermal drifts caused by the power dissipated by the mechanical guiding systems constitute the main limit to enhance the accuracy of an ultra-high precision cylindricity measuring machine. For this reason, a high precision compact prototype has been designed to simulate the behaviour of the instrument. It ensures in situ calibration of four capacitive displacement probes by comparison with four laser interferometers. The set-up includes three heating wires for simulating the powers dissipated by the mechanical guiding systems, four additional heating wires located between each laser interferometer head and its respective holder, 19 Platinum resistance thermometers (Pt100) to observe the temperature evolution inside the set-up and four Pt100 sensors to monitor the ambient temperature. Both a Reduced Model (RM), based on the Modal Identification Method (MIM) was developed and optimized by comparison with the experimental results. Thereafter, time dependent tests were performed under several conditions to measure the temperature variation at 19 fixed positions in the system and compared to the calculated RM results. The RM results show good agreement with experiment and reproduce as well the temperature variations, revealing the importance of the RM proposed for the evaluation of the thermal behaviour of the system.

Keywords : modal identification method (MIM), thermal behavior and drift, dimensional metrology, measurement
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