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Traceable sub-nanometre interferometry to improve nanopositioning applications at synchrotron & XFEL beamlines

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Coupled with faster detectors, X-ray optic upgrades, new flagship beamlines, and advanced data pipelines, the new low emittance Diamond-II source will benefit a wide range of scientific communities. Smaller, brighter, X-ray beams enable sample scanning systems to progress from slow, step-based motion to rapid, freeform dynamic trajectories. Metrology feedback devices, such as interferometers or capacitive displacement sensors, are increasingly used for real-time monitoring and correction of parasitic errors of micro- and nano-positioning stages∗. Beamlines are often noisy environments, with mechanical, acoustic and electrical disturbances, and temperature or humidity fluctuations. To provide accurate, closed-loop feedback for nano-positioning stages, metrology instruments need to be calibrated and optimised to nullify errors caused by variations on the beamline. We demonstrate the importance of characterising a nano-positioning stage in the ultra-stable environment of the Precision Metrology Lab using a traceable, linear interferometer. Lessons learnt are applied to compensate for environmental changes in "real-world"beamline conditions to achieve sub-nm nano-positioning.

Footnotes

∗ "Generating and measuring pico-radian angles", S.G Alcock et al, Metrologia 59, 6, 064002 (2022).

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