Interferometric Metrology for Multi-beam Displacement Measuring Interferometer Assemblies

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Multi-axis displacement measuring interferometer assemblies present two distinct advantages to the integrators of closed-loop stage metrology systems.

1. Much of the system alignment task is transferred to the interferometer manufacturer.
2. It enables use of designs which are inherently more compact and stable.

In this paper we describe interferometric metrology techniques applied to multi-axis, two-pass plane mirror type interferometers for use in heterodyne motion metrology systems. These measurement techniques facilitate the adjustment and confirmation of:

- Axis position relative to mechanical datums
- Axis parallelism
- Axis signal efficiency

These parameters can be evaluated through non-interferometric techniques, though as specifications become more rigorous, interferometric techniques are advantageous.

Several of the parameters of interest are not easily measured. These are derived from other measurements of the multi-axis interferometer assembly. Measurements made include:

- Primary and secondary beam positions relative to mechanical datums
- Primary and secondary beam pointing
- Systematic errors of the measurement system to apply as corrections

In-process metrology was based on a phase-measuring, Fizeau interferometer. The Fizeau interferometer was illuminated via an optical fiber from an external laser. A portion of the light from the laser was split off and used to coherently illuminate the interferometer assembly under test. The measurement geometry provided for interferometric measurement of the primary and secondary beams of the interferometer under test, as seen from the target mirror. The Fizeau interferometer system collected both phase data and modulation depth data. The former was used for beam pointing and wavefront quality measurement. The latter was used for beam position measurement.

The measurement setup, measurements techniques, and analysis were successfully used to align and qualify multi-beam interferometers. Accuracy of measurement, and post-correction algorithms, relied on the use of several optical and mechanical references. Axis position accuracy was established to the level of 25 microns. This easily met the requirements of the project. Beam parallelism accuracy was at the level 10 micro-radians. Corrective improvements for this measurement will be discussed.