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Method and Implementation of Absolute near Cylindrical Wavefront Testing

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Overview

•High resolution space-based x-ray telescopes require ever better optics.
•Testing near-cylindrical optics is challenging, especially removing systematic errors inherent in the test optics.
•Calibration methods for spheres are well documented, but the few published methods for cylindrical tests are difficult and provide incomplete data on the test beam.
•This project intends to prove a new, relatively easy procedure to calibrate cylindrical test waves. The new approach based on the merging of random ball test (RBT) method with the fiber optics reference method.
•RBT employs a high-quality specular ball tested at many random orientations. The ball figure errors will average to zero leaving the spherical reference surface error.
•The fiber reference method employs a metal-coated single mode fiber, coincident with the line focus of the tested optic. The wavefront returning to the mirror from the fiber acts as a cylindrical wavefront reference.
•The fiber optic is not perfect, and therefore adds some errors to the optical figure measurement.
•This poster describes the combination of the two concepts for cylindrical absolute test , and provides some preliminary results.

Impact

Combined with ever better optical fabrication capability, calibrated interferometric measurement of near cylindrical optics will enable higher resolution space-based x-ray systems. Additionally, this approach can be applied to testing other near cylindrical components, such as solar trough concentrators, precise laser pumping cavities, and conformal windows.

Explanation

May lead to higher quality , lower cost space based observatories, resulting in more rapid scientific advances.

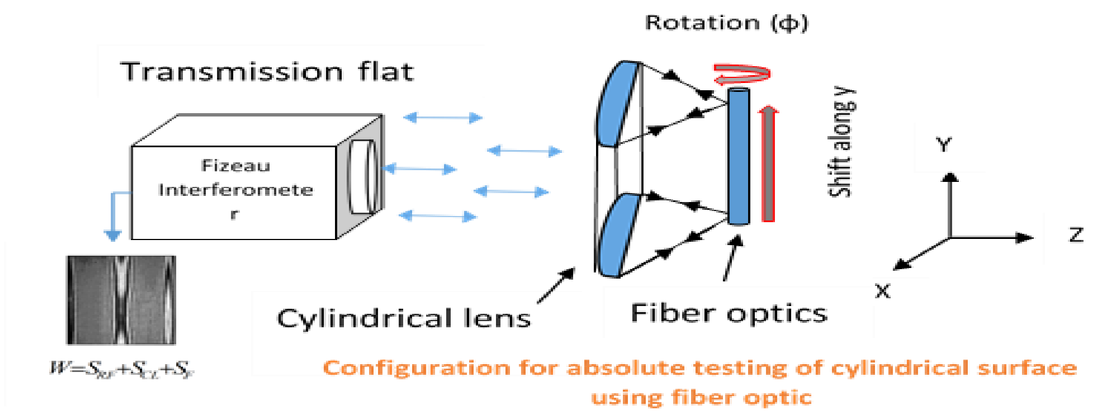
Key Findings

- The errors encoded into the wavefront from the fiber are decomposed into three geometric error forms

$$S_F(\phi, y) = S_F(y) + S_F(\phi) + S_F(\phi, y)$$

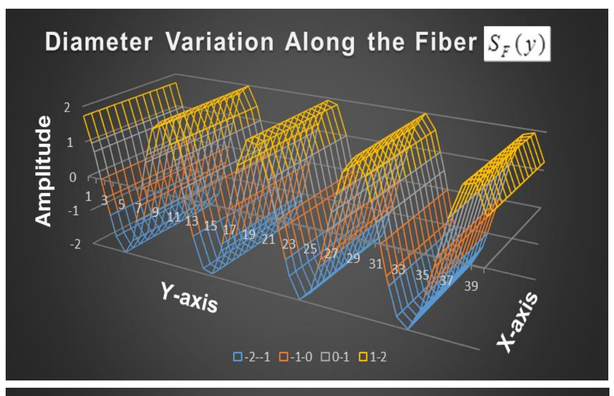
Diameter variation — Longitudinal — Random bumps

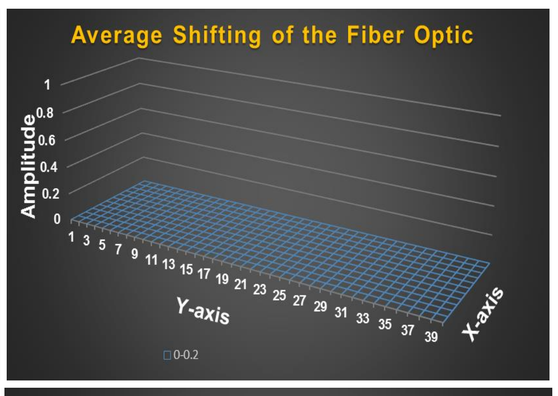
- **Experiment setup**

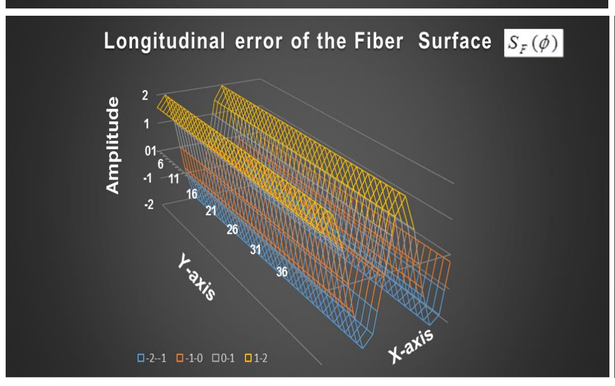


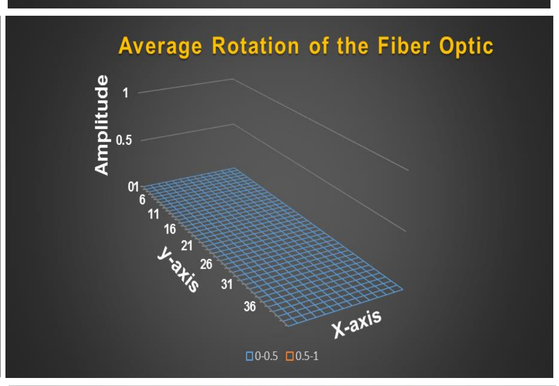
Configuration for absolute testing of cylindrical surface using fiber optic

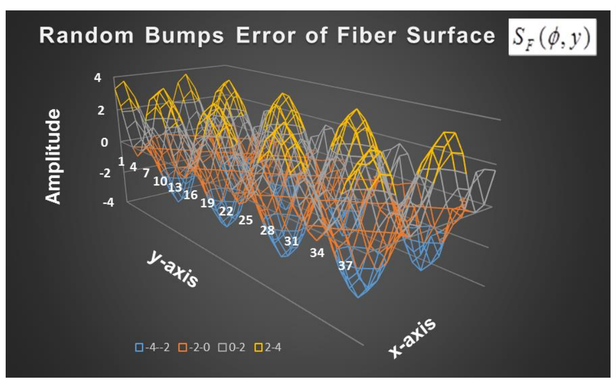
- **Simulated Results**

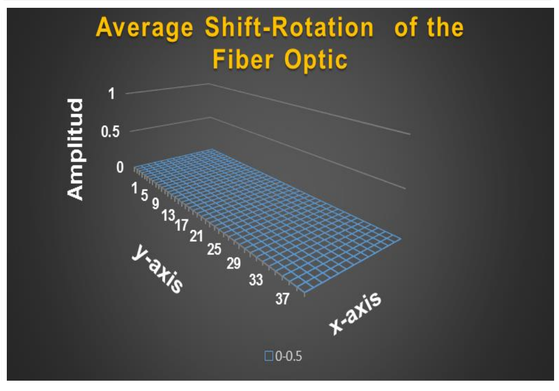












Methods to eliminate the different errors of the fiber surface are

1. Average of y-Shifted tests: removes S_F(y) errors.
2. Average of ϕ-Rotation tests: removes $S_F(\phi)$ errors.
3. Average of Shifted and Rotation tests: removes S_F(ϕ,y)

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