

# Method and Implementation of Absolute near Cylindrical Wavefront Testing

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## Overview Center of Applied Optics Key Findings

- 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

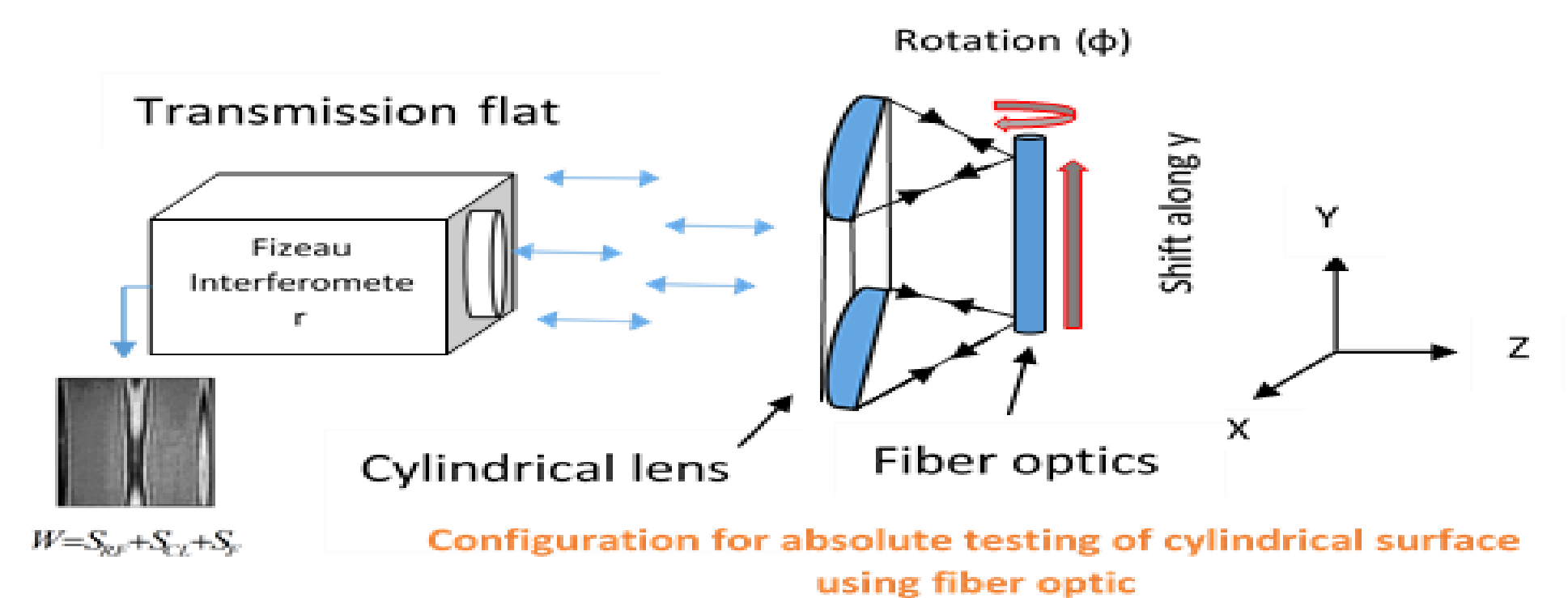
May lead to higher quality , lower cost space based observatories, resulting in more rapid scientific advances.

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

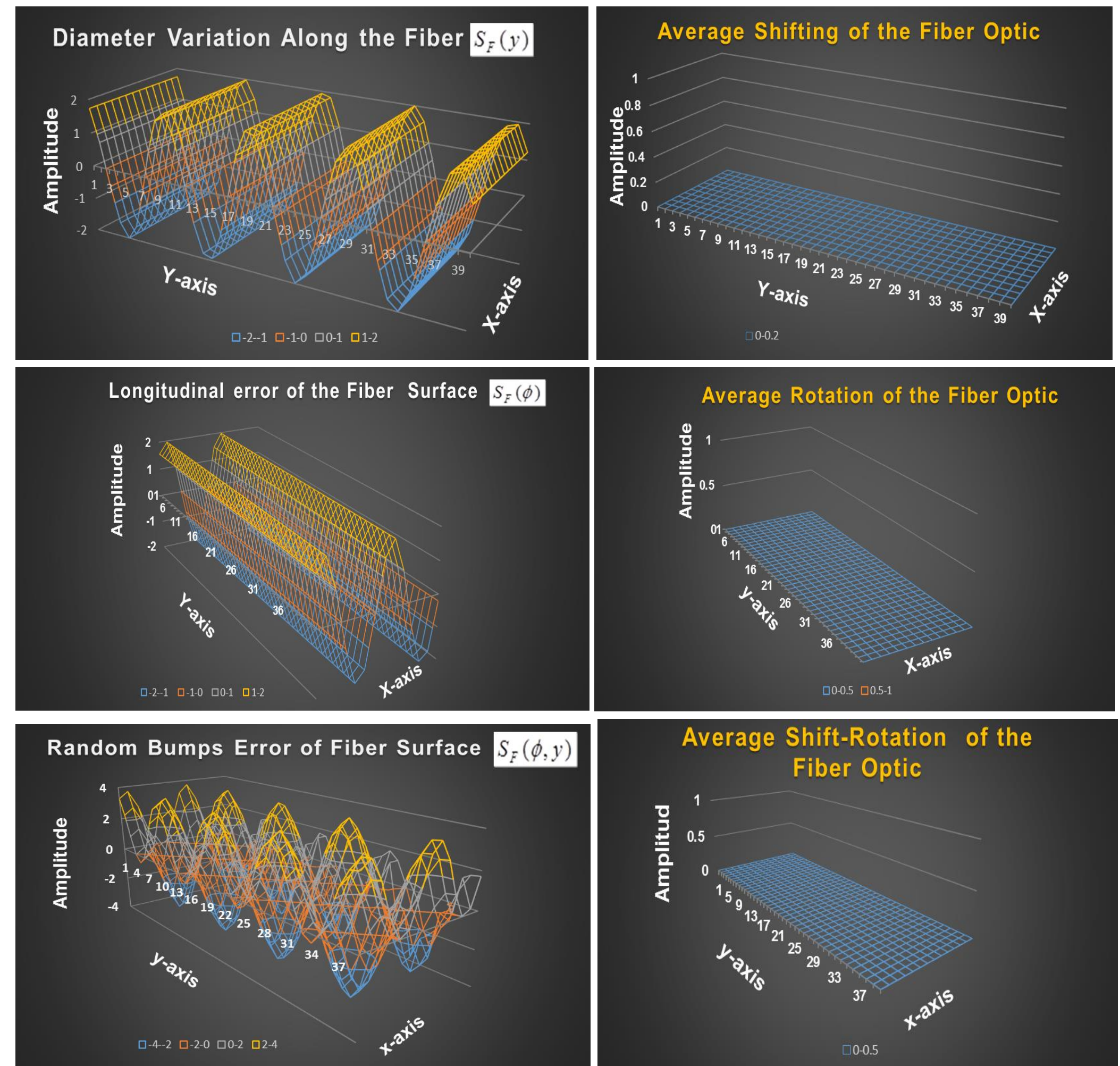
$$S_F(\phi, y) = S_F(y) + S_F(\phi) + S_F(\phi, y)$$

Diameter variation Longitudinal Random bumps

- **Experiment setup**



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

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