Development of on-line interferometric metrology techniques for high dynamic range surface measurement

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1. Introduction

The aim of the research is to improve the performances of an interferometer for online surface measurement. The instrument is a wavelength scanning interferometer (WSI) with environmental noise compensation feature and parallel computing for image processing. The WSI schematic is shown in figure 1.

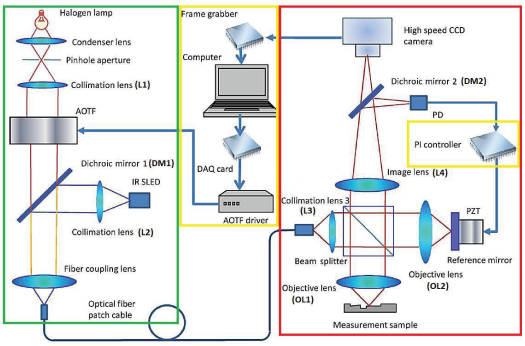

Figure 1: WSI schematic. In green the light source, in red the interferometer, in yellow the control electronics.

2.The Interferometer

A Linnik interferometer configuration is used to allow large working distance. The interferometer uses visible light to measure the surface and infra-red light to compensate for environmental noise. The visibile light is separated from the infra-red by the dichroic mirror. The detector record the interference fringes to calculate the surface heigth and the interference signal measured at the photo detector is used to compensate for the environmental noise by moving the reference mirror.

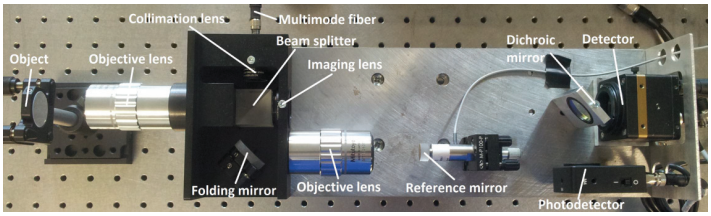

Figure 2:Interferometer optical setup.

3. Objective

To investigate the imaging performances of the interferometer in terms of lateral resolution, via optical design software simulation.

4. Simulation

4.1 Sequential models

Sequential models of the interferometer optics for the arms is implemented and the resolution capabilities analysed.

4.2 Point Spread Function (PSF)

The PSF size gives an estimation of the lateral resolution performances. Different configuration are simulated to estimate the lateral resolution and to check whether there is space for improvement.

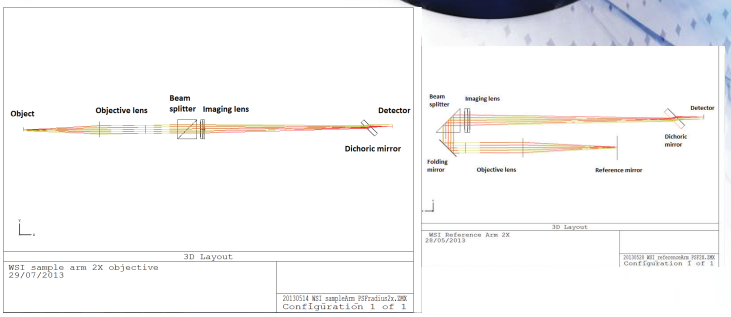

Figure 3: Models of the interferometer measurement and reference arm.

5.Results and discussion

- The main aberration is astigmatism due to focused light passing through the tilted dichroic mirror (DM).
- Reduction of the amount of astigmatism is possible using a thinner DM.
- Without the DM the instrument is diffraction limited.

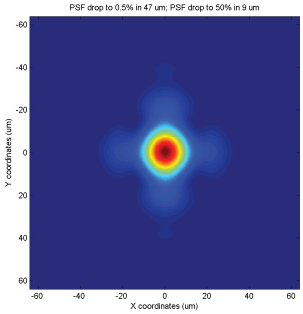

Figure 4: PSF for current DM..

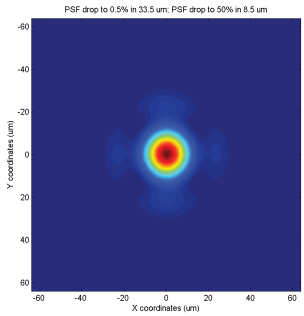

Figure 5: PSF for thinner DM.

Lateral resolution across the depth of focus (DOF)

Lateral resolution is reduced for different surface height values due to defocus. Simulated values are reported in fig. 6 and 7.

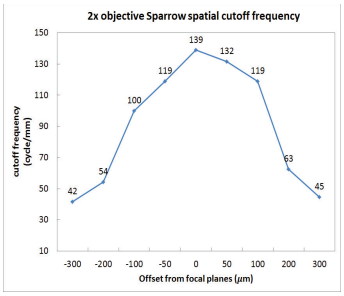

Figure 6:Lateral resolution along DOF for 2X objective lens

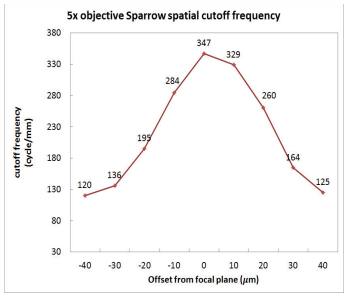

Figure 7:Lateral resolution along DOF for 2X objective lens

6.Future work

- Calibration of the interferometer;
- PSF and optical transfer function (OTF) measurements;
- Algorithm correction of linear error introduced by the optics.

7. Acknowledgement

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