

BIPM Capacity Building & Knowledge Transfer Programme

2020 BIPM - TÜBİTAK UME Project Placement

REPORT

Project Name	Measurements of flatness standards
Description	Measurements of flatness standard's parameters using Zygo Verifire Flatness interferometer
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Motivation & Introduction

The flatness of optical surfaces is an important parameter that determines the quality indicators of parts used in optical instruments (for example, telescopes) in the optical-mechanical industry. Metrological assurance for measuring parameters of form deviations of optical surfaces is an important task that VNIIMS performs. The goal of this project was to gain theoretical knowledge and practical experience in measuring the form deviation parameters of optical surfaces. The three-flat method was applied was applied in order to reduce the influence of form deviations of the reference surface used in Fizeau interferometer, on the accuracy of measurements. The obtained knowledge and experience will be used my in work related to the development and improvement of calibration method of the Fizeau interferometer owned by VNIIMS.

Research

My training included the study of the Zygo Verifire interferometer, its calibration and the sequence of operations performed during measurements of the flat mirrors. Additional capabilities of the interferometer were also investigated – fore example, angle measurements of the mechanical wedge of an optical element having nonparallel surfaces and measurements of the corner cube prisms (fig. 1).

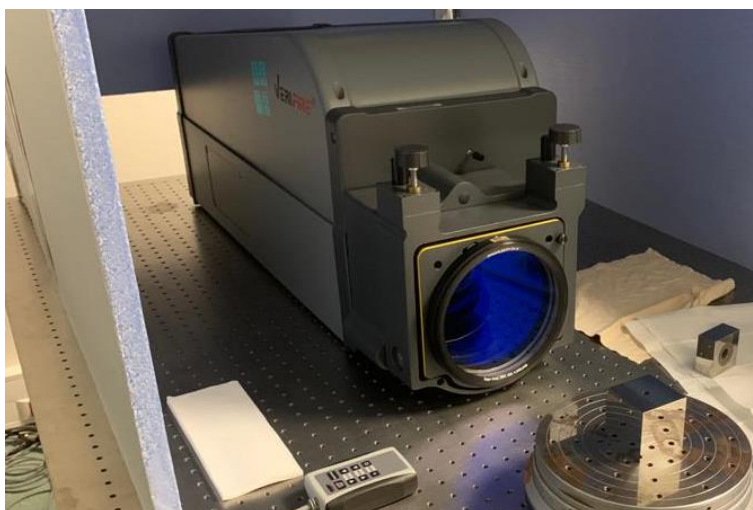


Figure 1 - Measurements of the corner cube prism.

The main task of the research was to comparison of the measurement results obtained for the working surface of the flatness standard by the three-flat method carried out with the help of two instruments: Zygo Verifire interferometer, which is located in Dimensional Laboratory TUBITAK-UME (Turkey), and Fizeau interferometer, which is located in VNIIMS (Russia). The measurements performed within the BIPM Programme, were carried out in the Dimensional Laboratory by the Zygo Verifire interferometer.

The software of the Zygo Verifire interferometer uses the following equations to derive the absolute surface data:

$$\text{Flat A} = [(A+B) + (A+C) - (B+C)] / 2$$

$$\text{Flat B} = [(A+B) + (B+C) - (A+C)] / 2$$

$$\text{Flat C} = [(A+C) + (B+C) - (A+B)] / 2$$

Where capital letters A, B and C describes the three measured surfaces. The A reference plate (A) and the two test plates (B, C) were involved in the measurements. We received topography for each pair of surfaces. In the fourth measurement, one of the surfaces was rotated by 180 degrees. The obtained resulting topographies were saved for farther data acquisition and analysis.

As a result, the topography profiles for the reference surface was determined in two perpendicular directions (fig. 2).

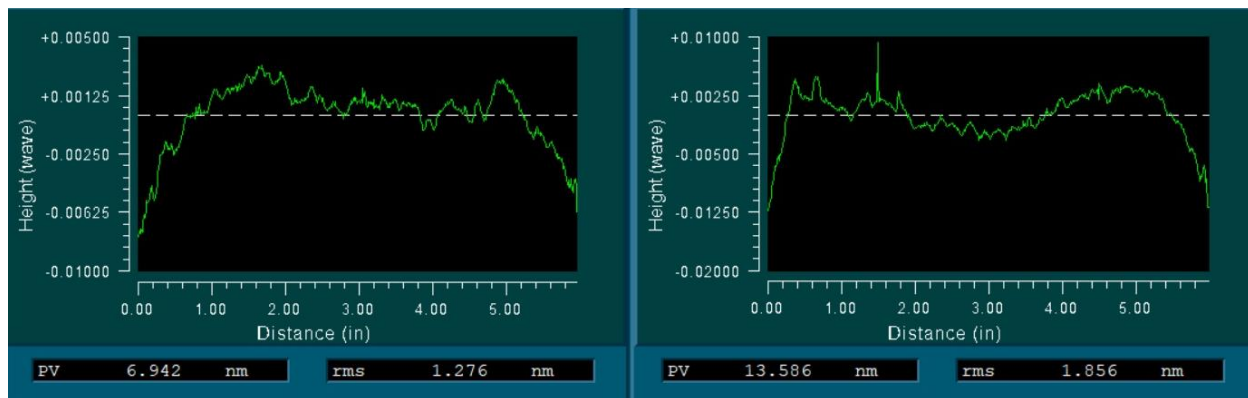


Figure 2 – Topography profiles of the reference surface measured by the Zygo Verifire interferometer.

Then, using the obtained four topographies, the topography of the reference surface A was determined using the software of the Fizeau interferometer. The measurement results are presented in the table 1.

Table 1.

Instrument	Results (PV), nm	
	0°	90°
Zygo Verifire interferometer (TUBITAK-UME)	6,9	13,6
Fizeau interferometer (VNIIMS)	15,3	14,4

The difference in the results can be explained by the different algorithms for three-flat methods.

Conclusions and Future Work

During training, I received theoretical knowledge on measuring the parameters of form deviations for flat surfaces with the help of setup based on Fizeau interferometry, on calibration of the instruments included

into the setup, data acquisition methods, evaluation of measuring uncertainty budget in the measurement of flat standards.

The main part of the practical training was research performed with the three-flat method which implemented on Zygo Verifire interferometer and comparison of the measurement results of the three-flat method obtained on Fizeau interferometer, which is located in VNIIMS (Russia). In the course of the training, errors were identified in the algorithm of measuring of three-flat method in Fizeau interferometer.

I expect to utilize the knowledge and experience I have gained through this project in my work with the calibration of the Fizeau interferometer in VNIIMS.

Acknowledgements

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