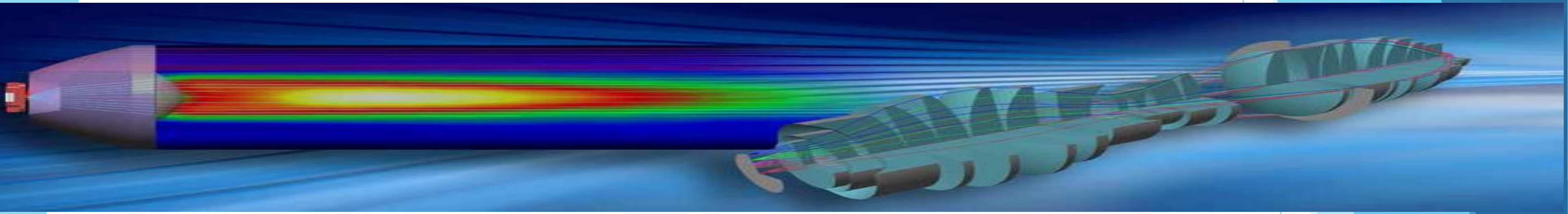
Temporal change in flatness of flat surface due to optical mounting and gravity



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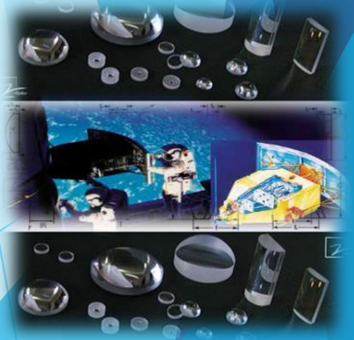


Outline of the presentation

1. Background and the importance of the research
2. Principle of Fizeau interferometer
3. Experimental Setup
4. Results and Discussion
5. Conclusions

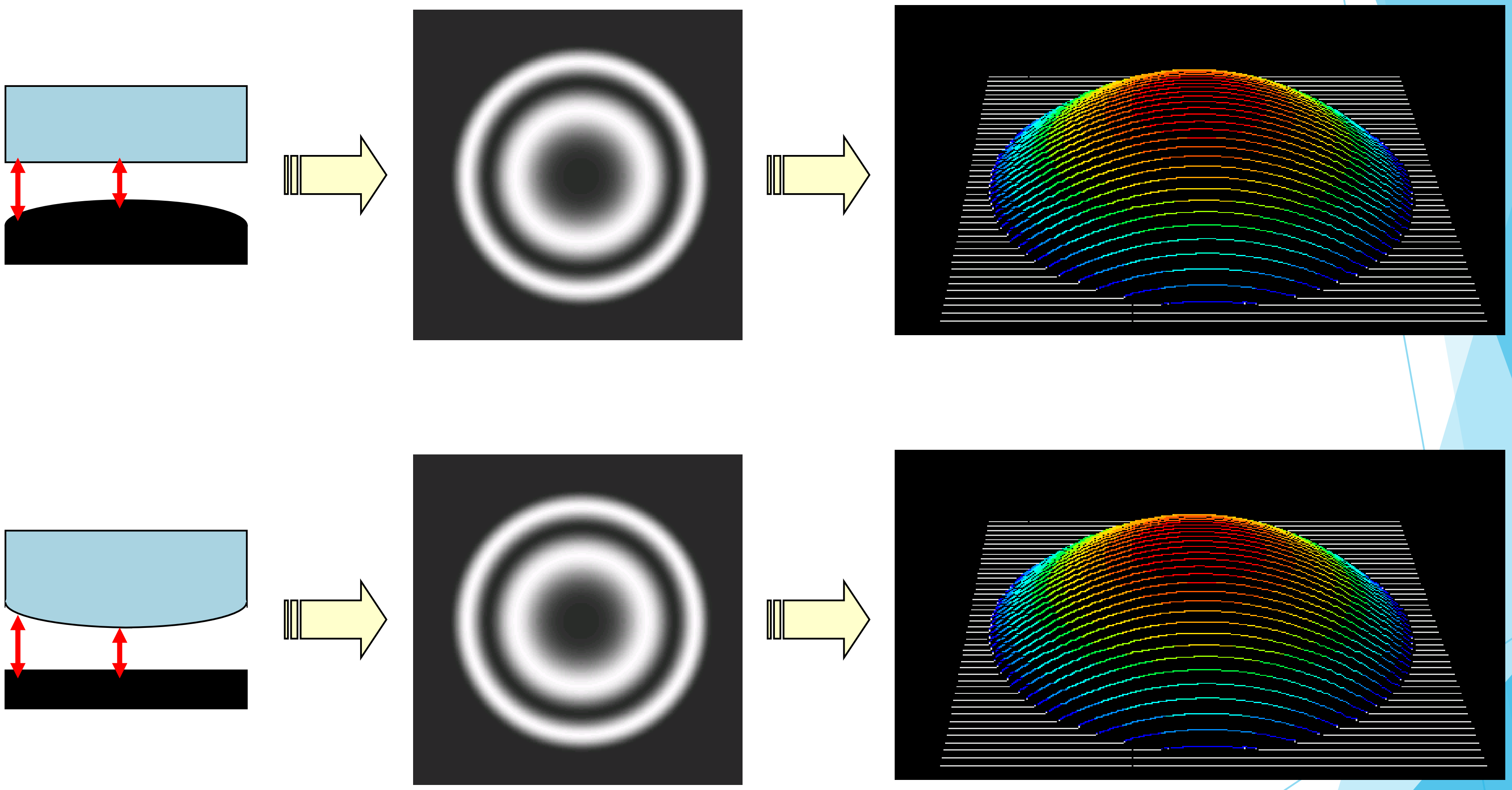
Background and the importance of the research

The challenge of modern machining industries involves the achievement of high quality and high geometric and dimensional accuracy of work piece.

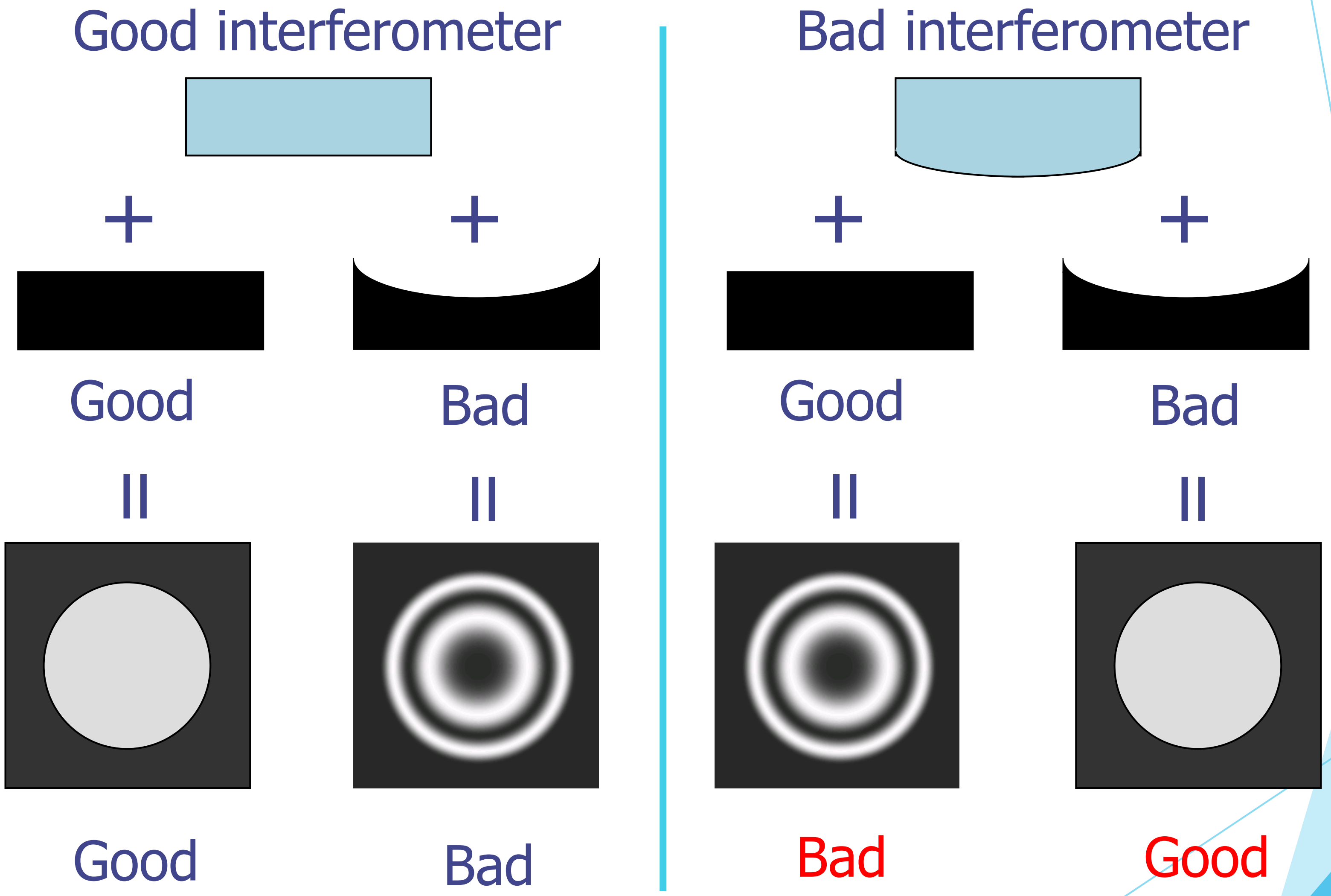
In the process of measuring flatness, there are many effects that affect accuracy of the measurement.

The more advanced flatness measuring instrument with the highest accuracy is by using flatness interferometer. Fizeau interferometer is equipped with the He-Ne laser generating a single wavelength illumination and phase shifter.

Background and the importance of the research

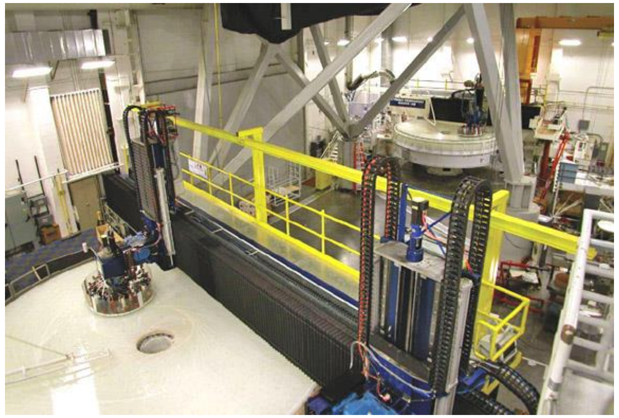


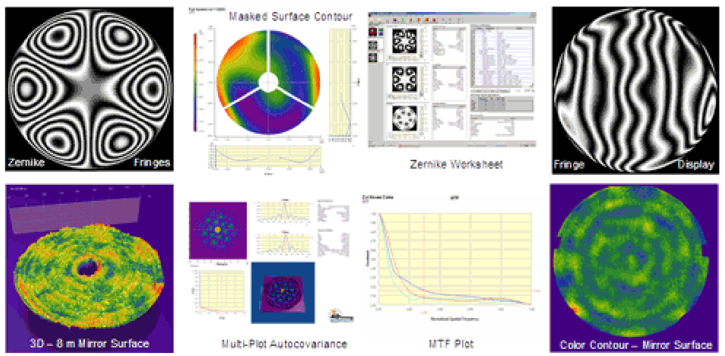
Background and the importance of the research



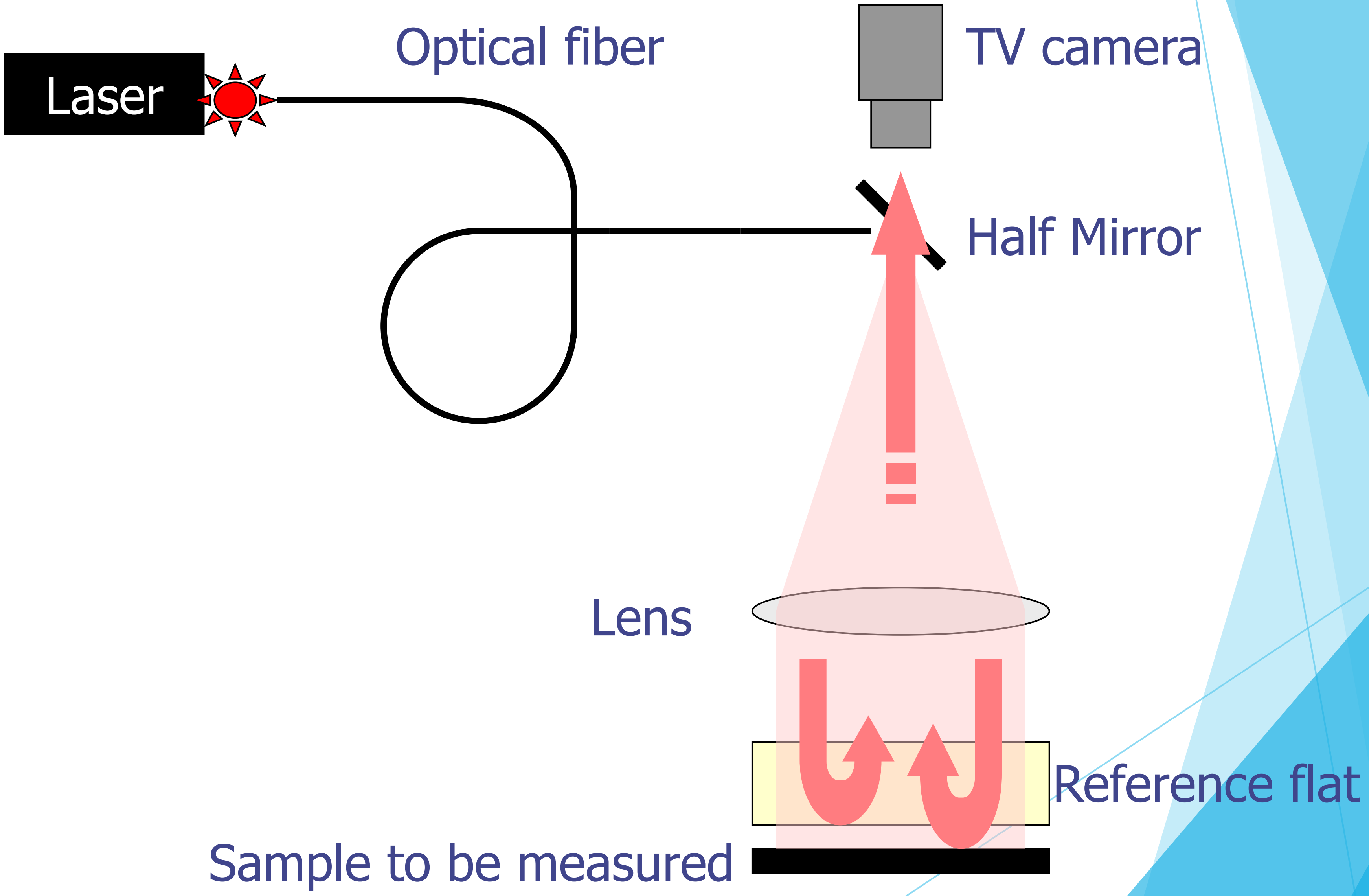
Background and the importance of the research

In this presentation, the optical flats diameter range from 60 mm up to 300 mm were mounted on two types of mounting vertically. Flatness of the optical flats were measured by using Fizeau interferometer for over period of time. Temporal changes in flatness due to geometry and mounting mechanism were investigated.





Principle of Fizeau interferometer



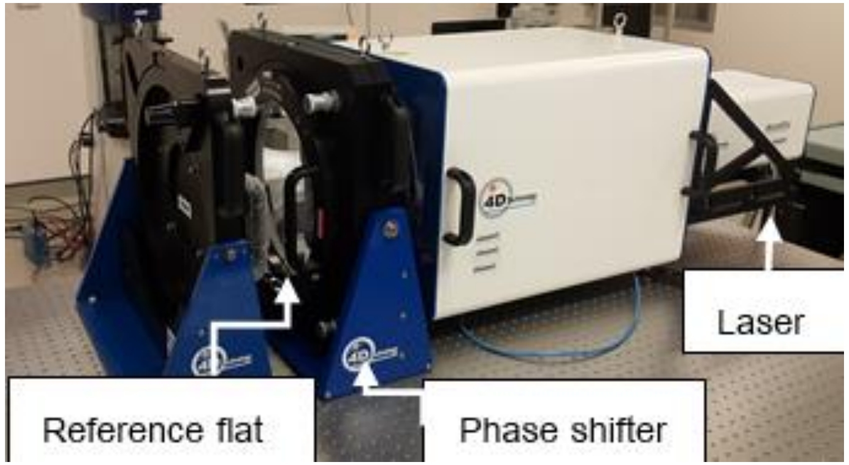
Experimental Setup

Specimens	ϕ /mm	Thickness/mm	Weight/g
A	60	20	140.63
B	100	20	397.97
C	150	30	1341.67
D	300	50.8	9087.58

The quartz optical flats with various dimensions were used in this study. Size and weight of all specimens are detailed in Table. Temporal change in flatness of the surface was investigated by measuring flatness of the optical flat at the time interval of 5 minutes for 400 minutes.

Experimental Setup

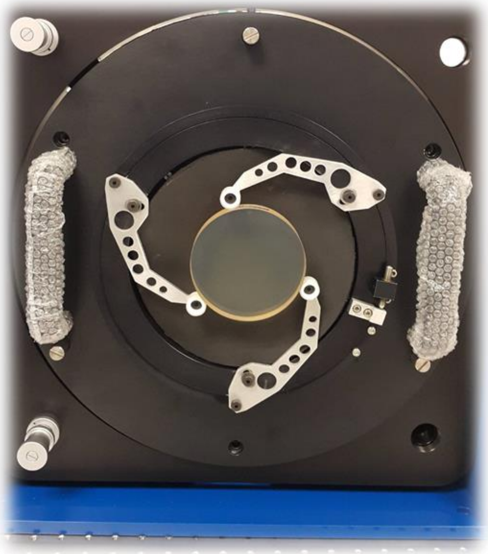
The flatness interferometer used, manufactured by 4D technology, can measured flatness of the specimen diameter up to 300 mm.



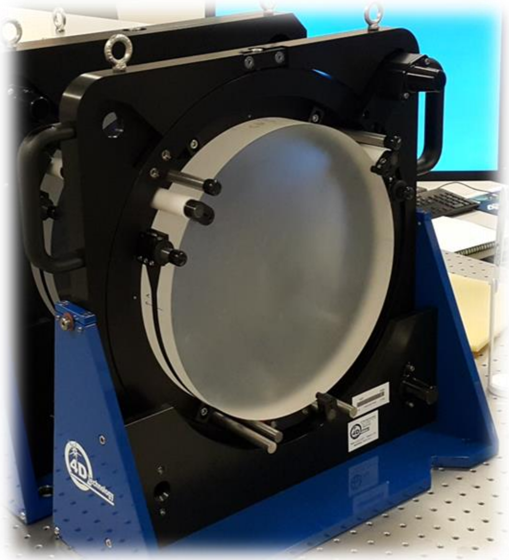
Phase shifter and reference flat with flatness quality better than λ/20 (31.65nm)

Experimental Setup

Two types of optical mount were used in this study, sling type and three-point type. Configuration of the optical mounts are show in Figure.



Three-point type



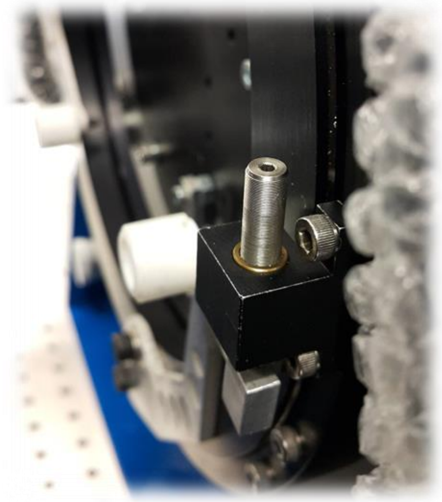
Sling type

Experimental Setup

I. Study of specimen geometry effect

The measurement were carried out for 400 minutes and the equilibrium time of all optical flat were determined.

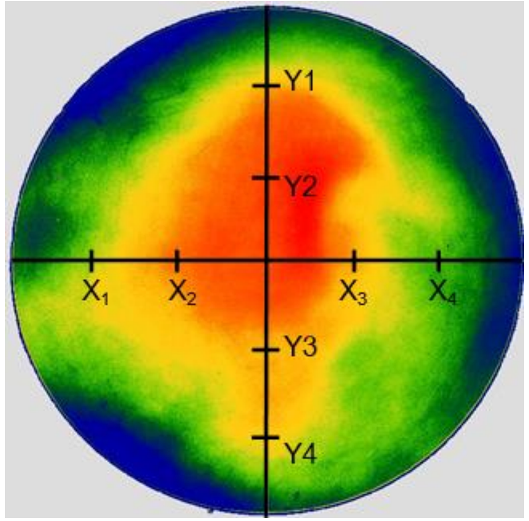
II.Study of mounting effect



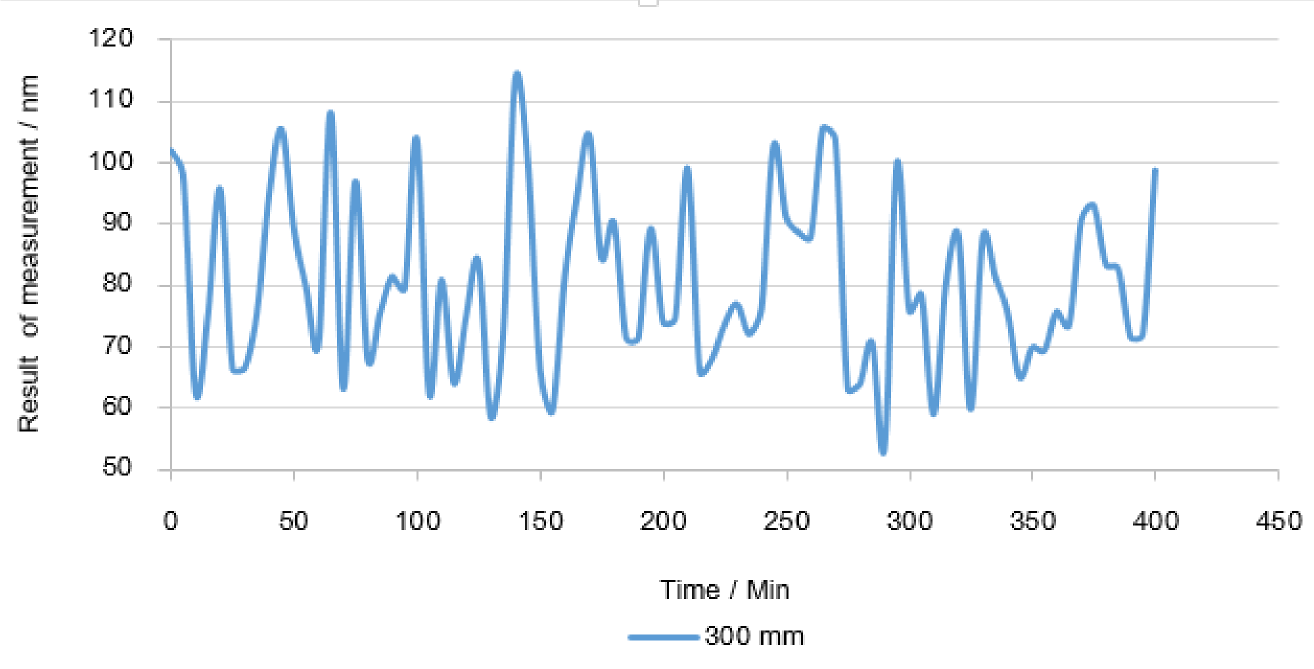
Thread for adjusting the clamping force

The optical flats were mounted on the three-point type mounting. It should be noted that the mounting can be adjusted the clamping force by the screw, pitch distance of 0.7 mm

Results and Discussion

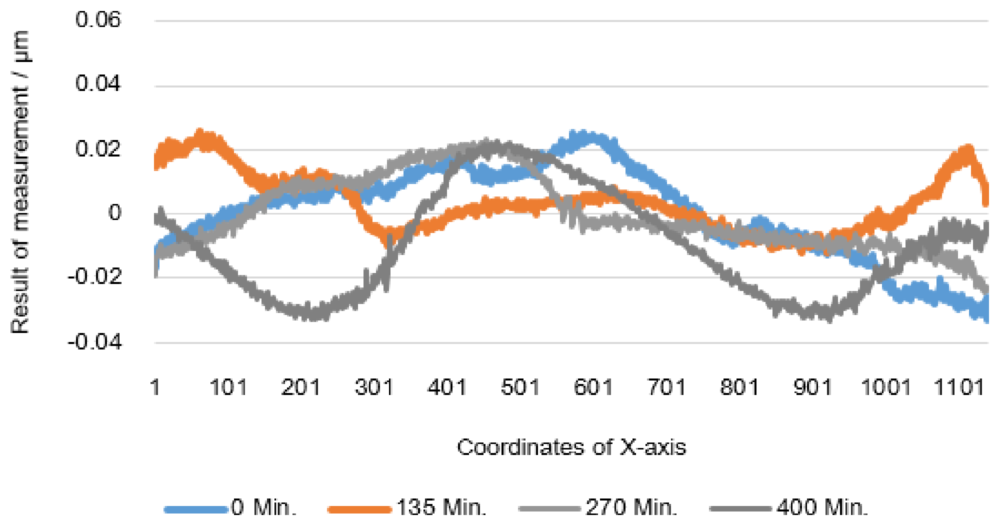


Contour map of the optical flat D

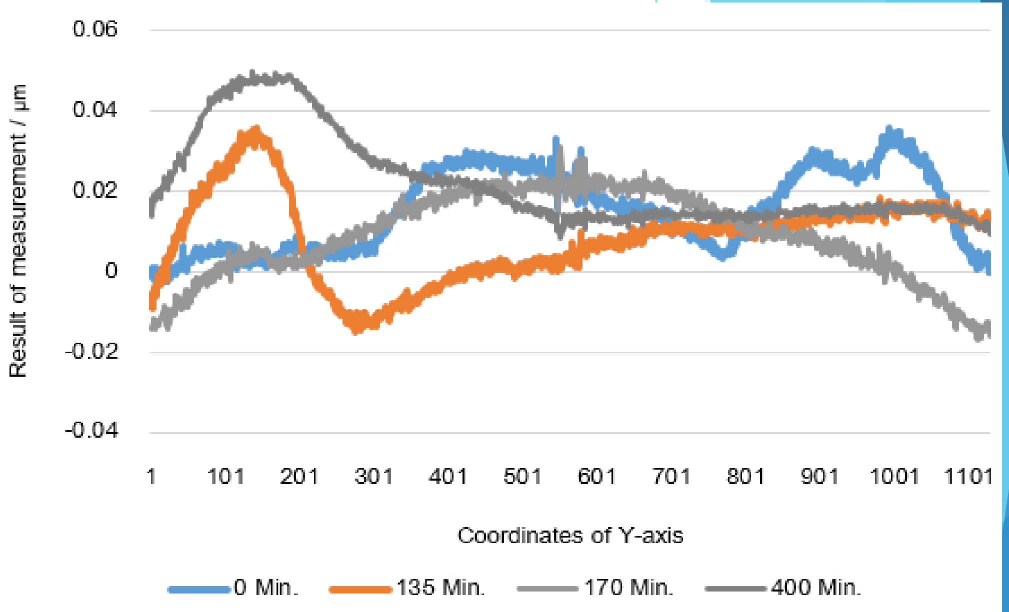


Flatness value of the optical flat D recorded for 400 minutes

Results and Discussion

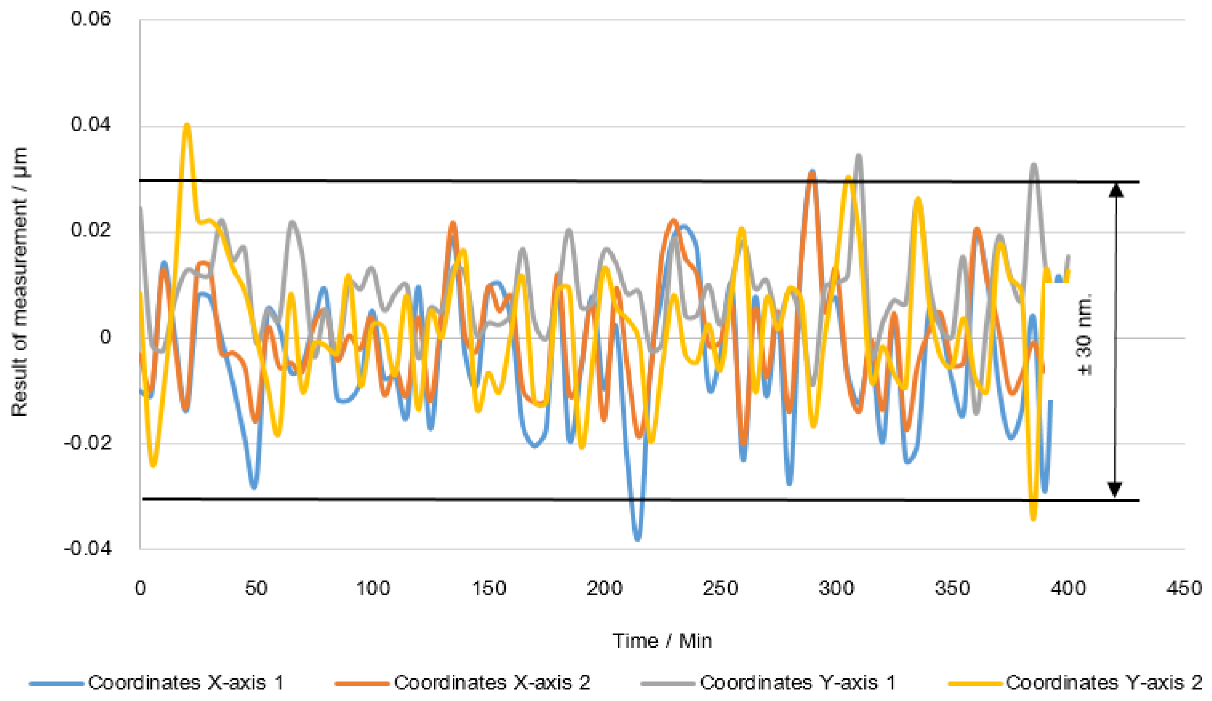


Profile along X-axis of optical flat D



Profile along Y-axis of optical flat D

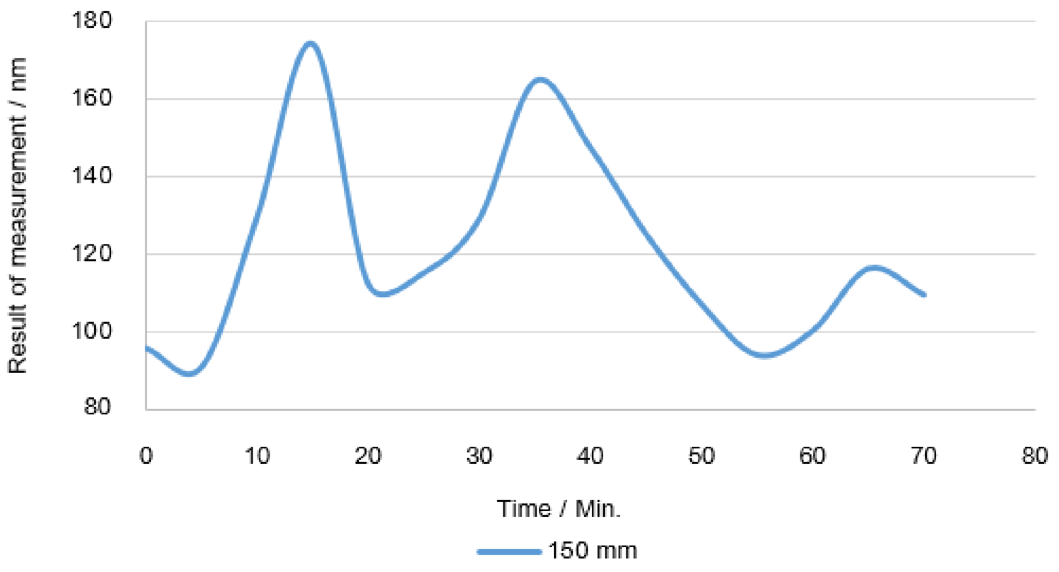
Results and Discussion



Variation in height at point X_1, X_2, Y_1, and Y_2 of optical flat D

The variation is well within ± 30 nm. It should be noted that the measurement uncertainty of the flatness interferometer is ± 31.65 nm Thus, are can conclude that the variation of ± 30 nm can be due to environment and it is well within the measurement uncertainty.

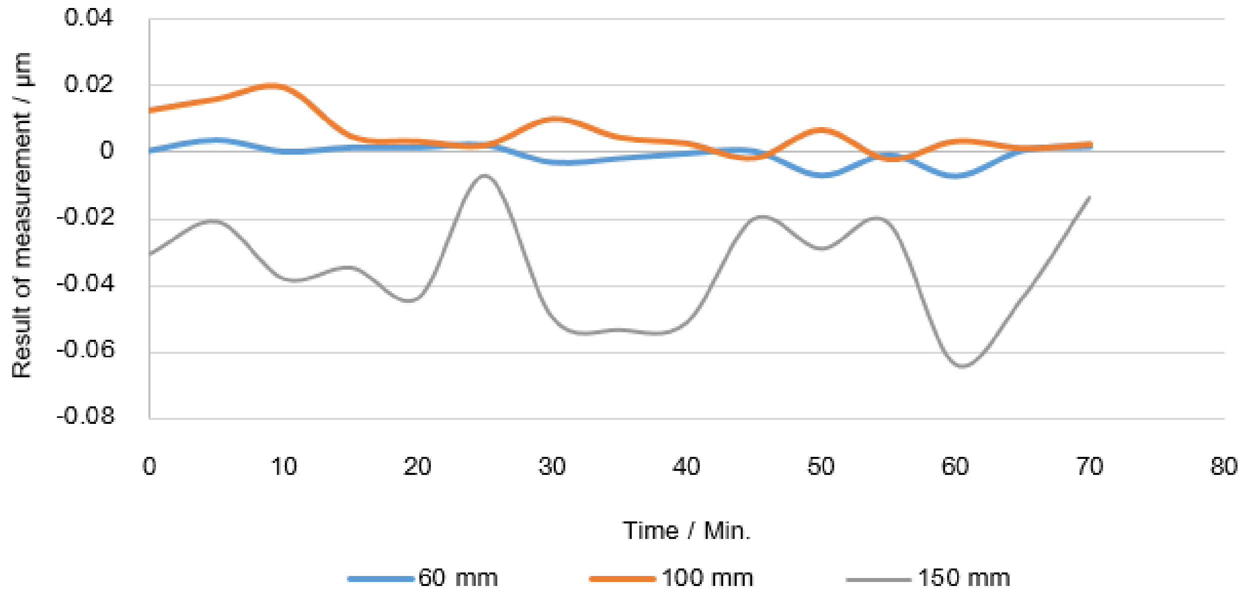
Results and Discussion



Flatness measure value of 150 mm

The variation is observed to be ± 50 nm which is larger than the measurement uncertainty. Thus, it can be concluded that the three-point mounting has some effect to the shape of the specimen.

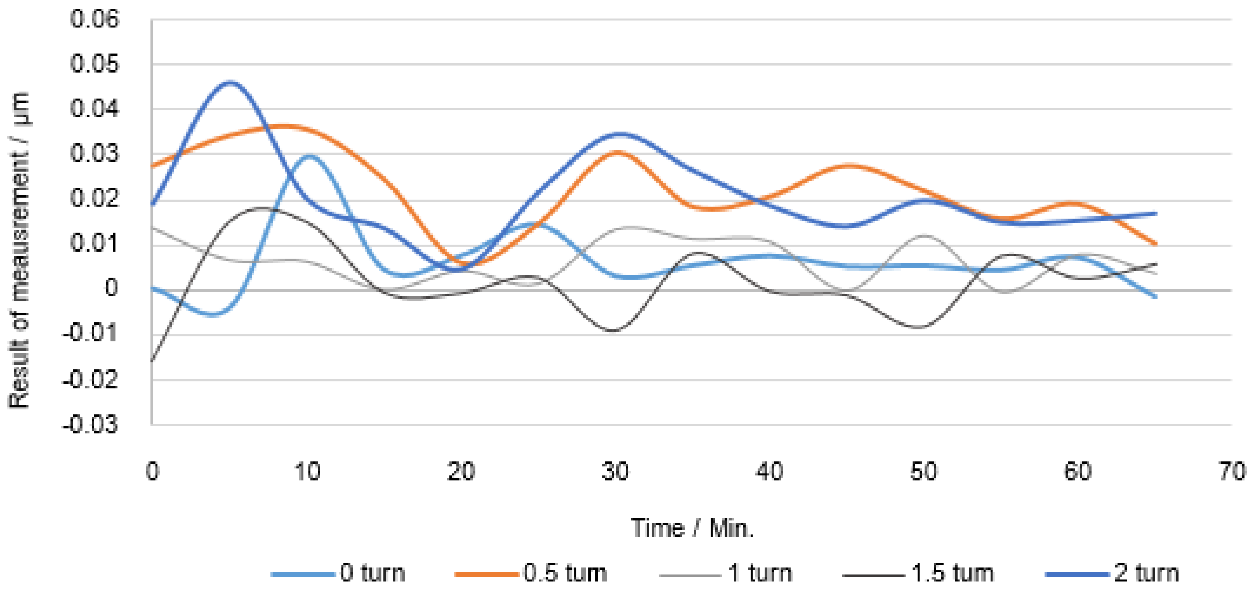
Results and Discussion



Variation in height at point Y_1 of optical flat A, B, and C

The equilibrium time or the resting time required for the optical to stabilize with the clamping force for the optical flat C. The temporal change in height value of point Y_1. Optical flat A has the smallest variation an also appeared to reach equilibrium fastest.

Results and Discussion



Variation in height at point Y_1 of optical flat at various clamping force

Result when the optical flat mounted on the three-point type mounting with increasing clamping force. The harder clamping force is, the large variation in flatness observed. The clamping force may result to deformation of the optical flat.

Conclusions

Mounting is the key factor that effect flatness quality of the optical flat. Mounting optical flat on the sling type mount shows no requirement of the resting time in order to achieve measurement accuracy of 32 nm. The three-point mounting type requires at least 60 minutes for optical flat to reach equilibrium. The bigger C heavier, specimen, the longer resting time required and the larger variation in measured flatness value.

Thank you for your attention