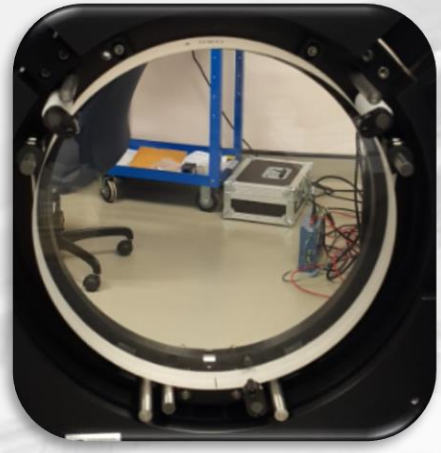
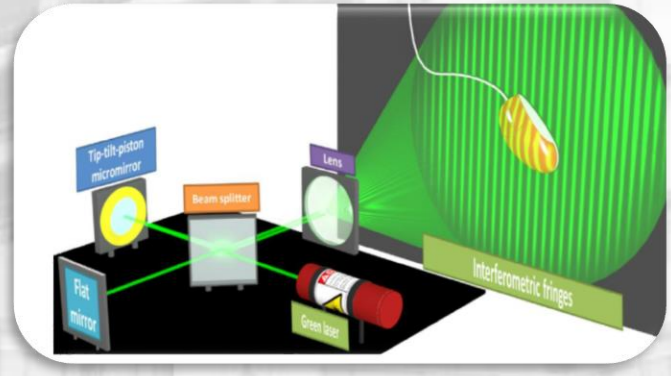
Simulation Analysis of Surface Deformation Due to Gravitational Force and Mounting Orientation Using Numerical Model





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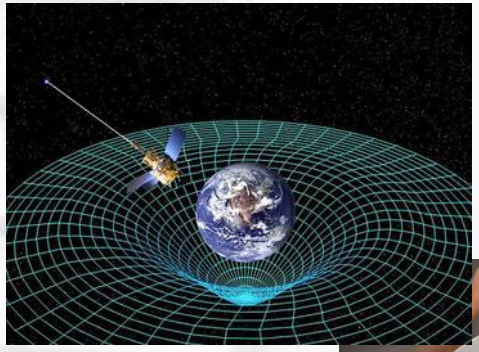
Outline of the presentation

1. Introduction
2. Experimental Setup
3. Results
4. Conclusions



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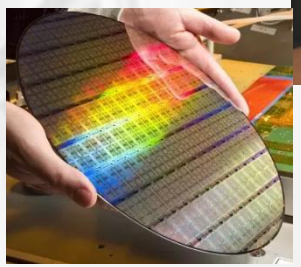

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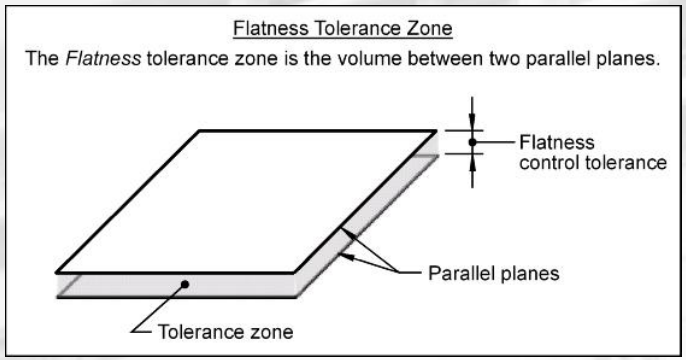
1. Introduction

The optical design for both optics and mounting unit is very crucial for high precision measurement. For large optics, mounting is much trickier due to its dimension and weight. Numerical method for analysis of mounting has widely used in order to help optical mount designer testing and ensuring design before installation.



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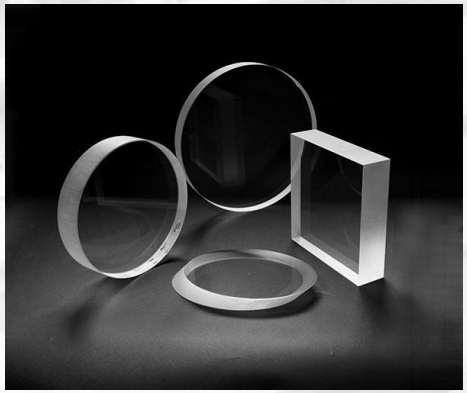

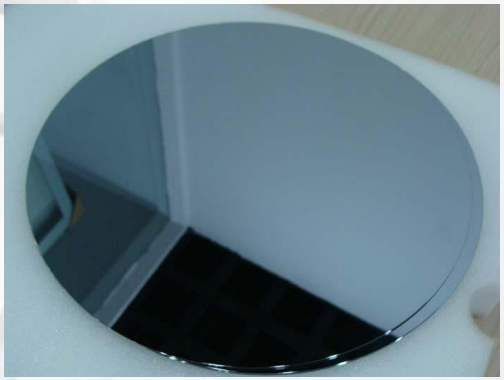

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Flatness is one of the key components that determine quality of the mating parts. It also can be used to interpret performance of the production process or the machine tools. Orientation and fixture used in holding the object also affect flatness of the surface.

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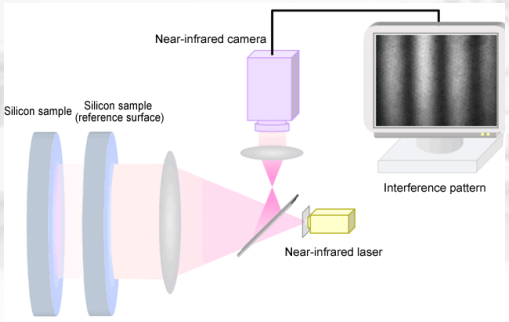
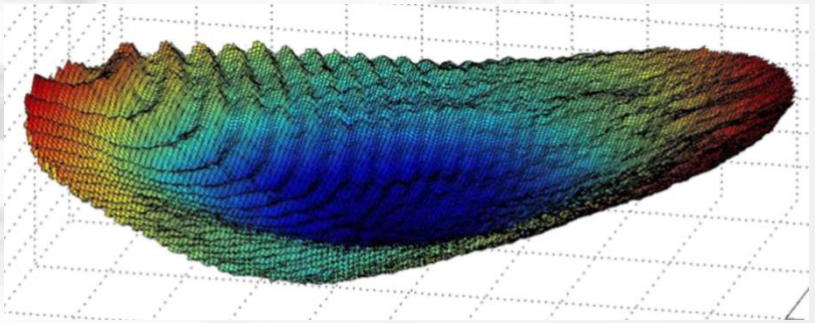
1. Introduction

Finite element method (FEM) has been used in the evaluate deformation and design optical mounting. Konto Y and Bitou Y. demonstrated deformation value of the reference flat can be corrected by the FEM analysis performed on the vertically aligned Fizeau interferometer. S Quabis et al. compared FEM results of deformation due to gravity for horizontally and vertically aligned optical flat.

This research FEM is conducted in order to investigate effect of gravity and clamping direction to the surface of the flat part oriented vertically.





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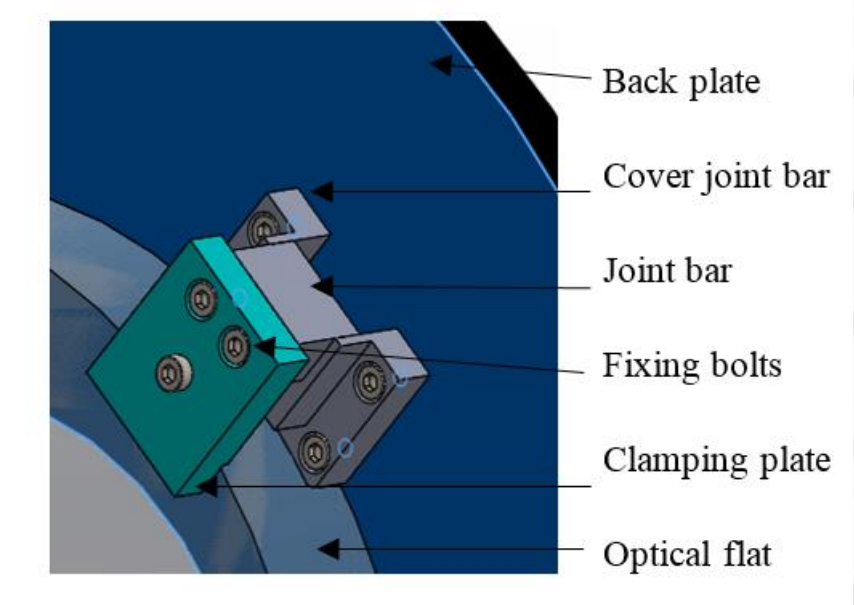
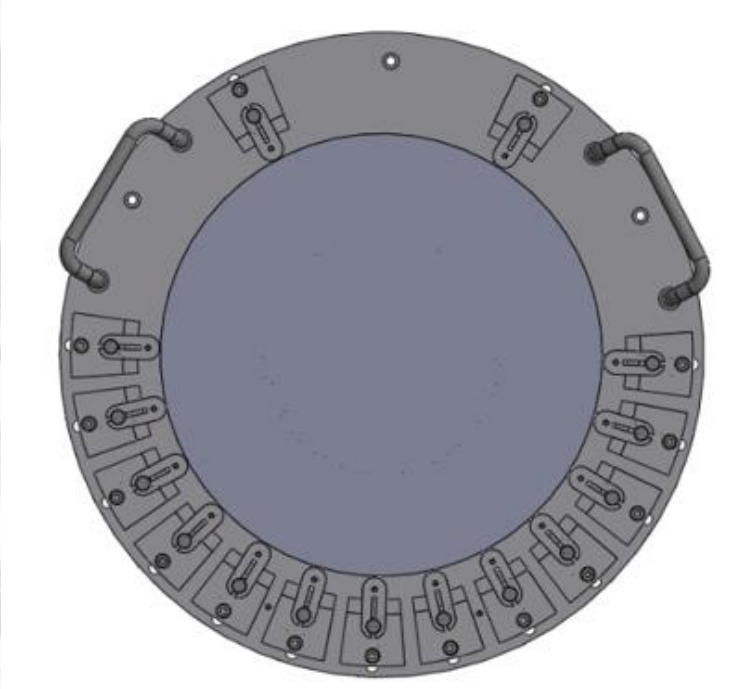
2. Experiment setup



Geometry of the optical mounting I

2. Experiment setup



Geometry of the optical mounting II.

FEM inputs

The finite element model all components consists of rigid part and the optical flat is the deformable part. Clamping plate was treated as an isotropic elastic-plastic.

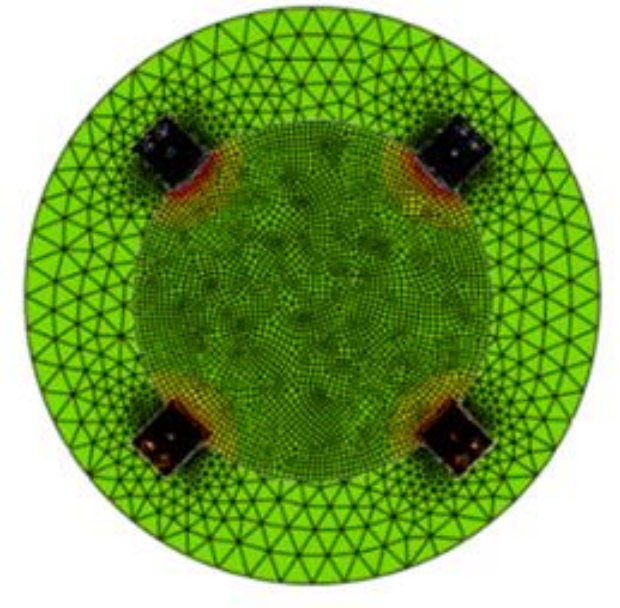
Table 1 Mechanical properties of optical mounting materials

Material /Properties	Density (kg/m^3)	Young's modulus (GPa)	Poisson's ratio
Quartz	2200	72	0.17
Polyether ether ketone	1320	3.60	0.40
Aluminum	2700	70	0.33

The contact between optical flat, cover joint bar, joint bar and clamping plate at the friction coefficient was 0.1.

3. Results and discussion

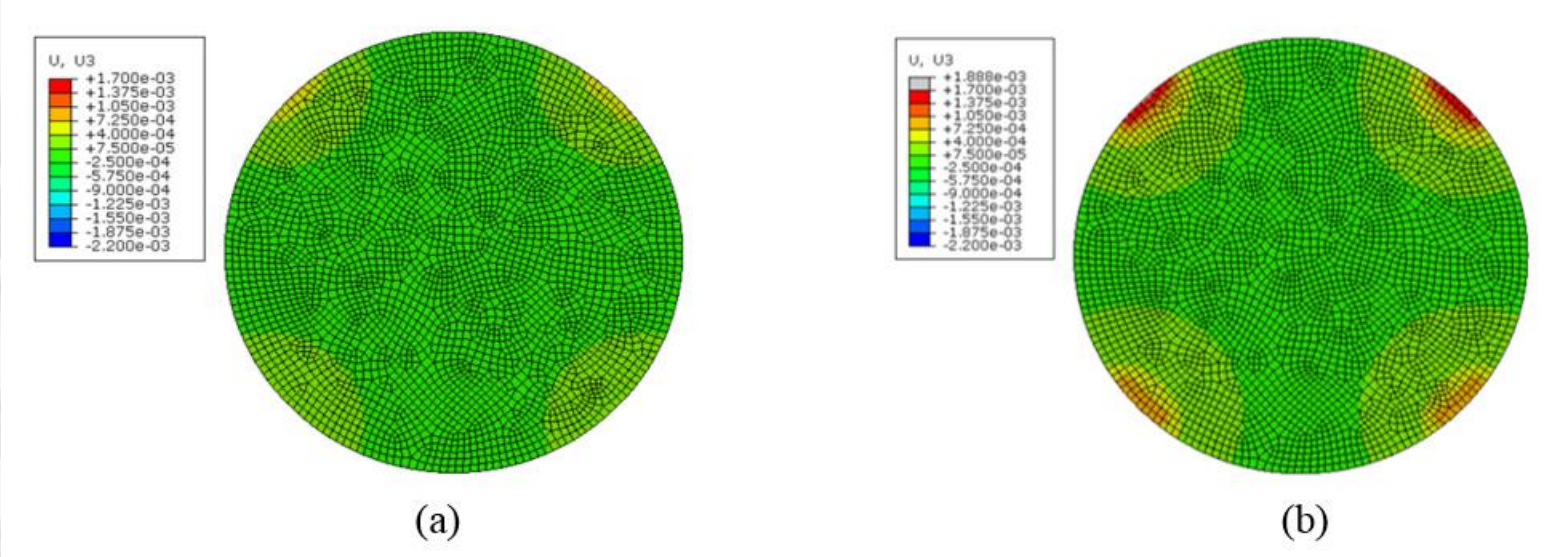
The FEM analysis includes clamping force and the gravitational force.



The FE model of contour plot of optical and fixture.

3. Results

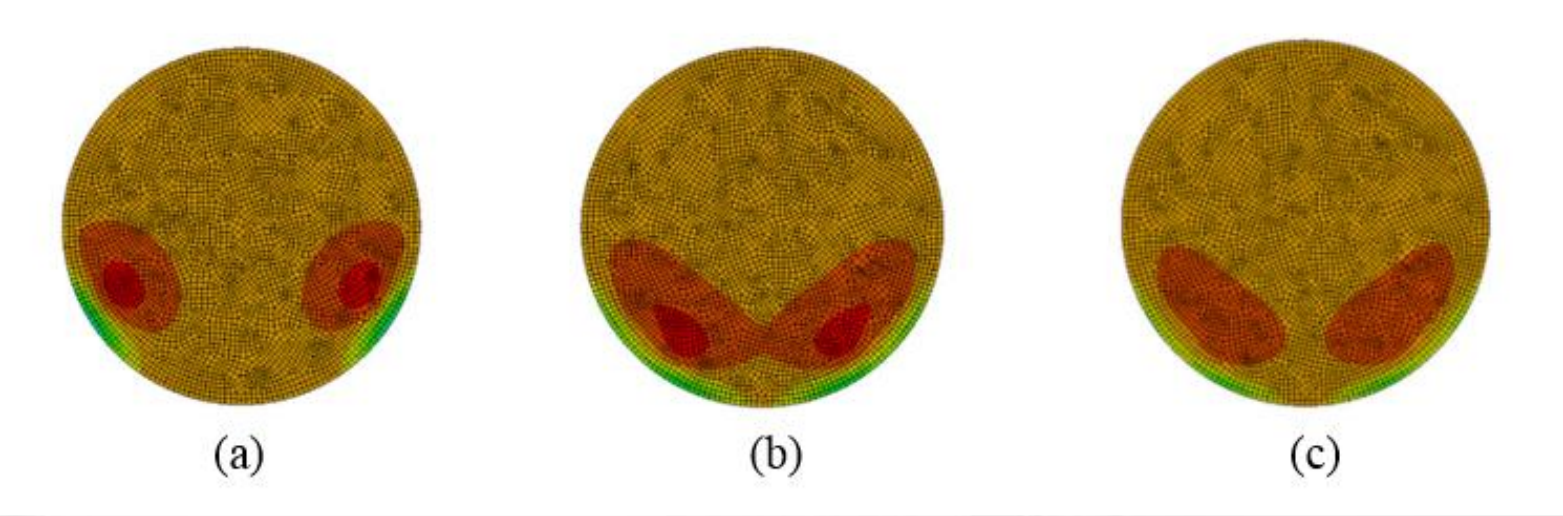
Peak-to-value (PV) value obtained are 737 nm and 1774 nm



The FEM analysis for the deformation when apply clamping force at (a) 250 N and (b) 600 N.

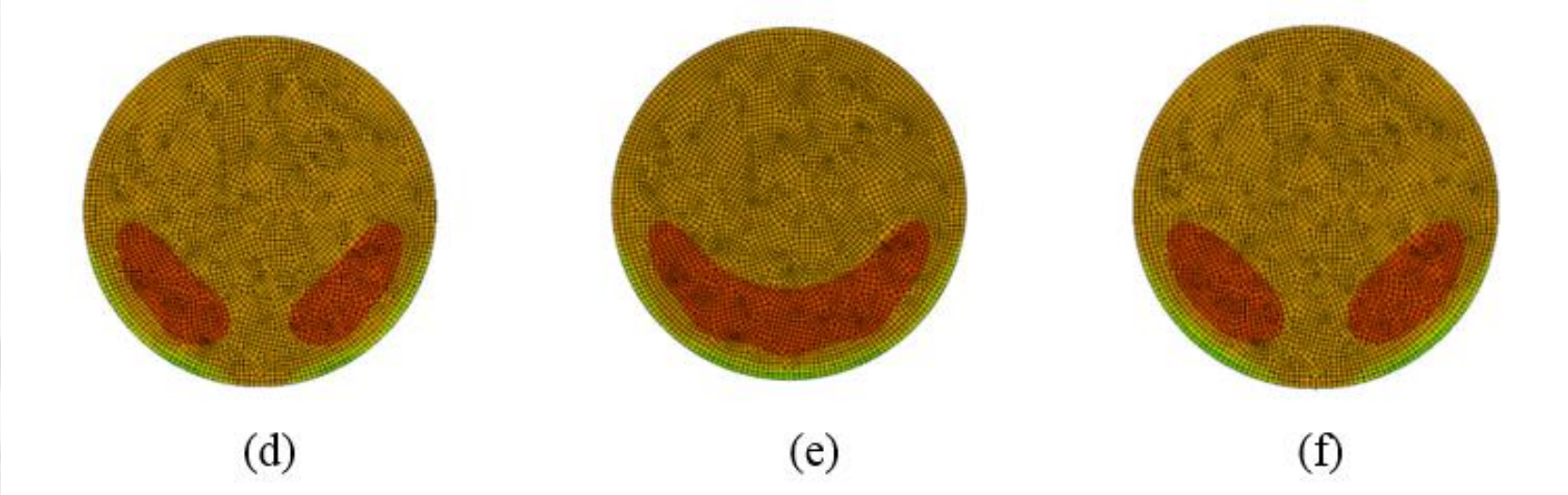
3. Results

The same approach was conducted for the optical mounting II. The optical flat is simply rest on pin, 20 mm in diameter. Number of pins (up to 13 pins) and distance between pins can be adjusted. This figure is the summary of the FEM analysis obtained from 9 mounting configurations. It should be noted that all configurations were simulated from pins position at equally spacing.



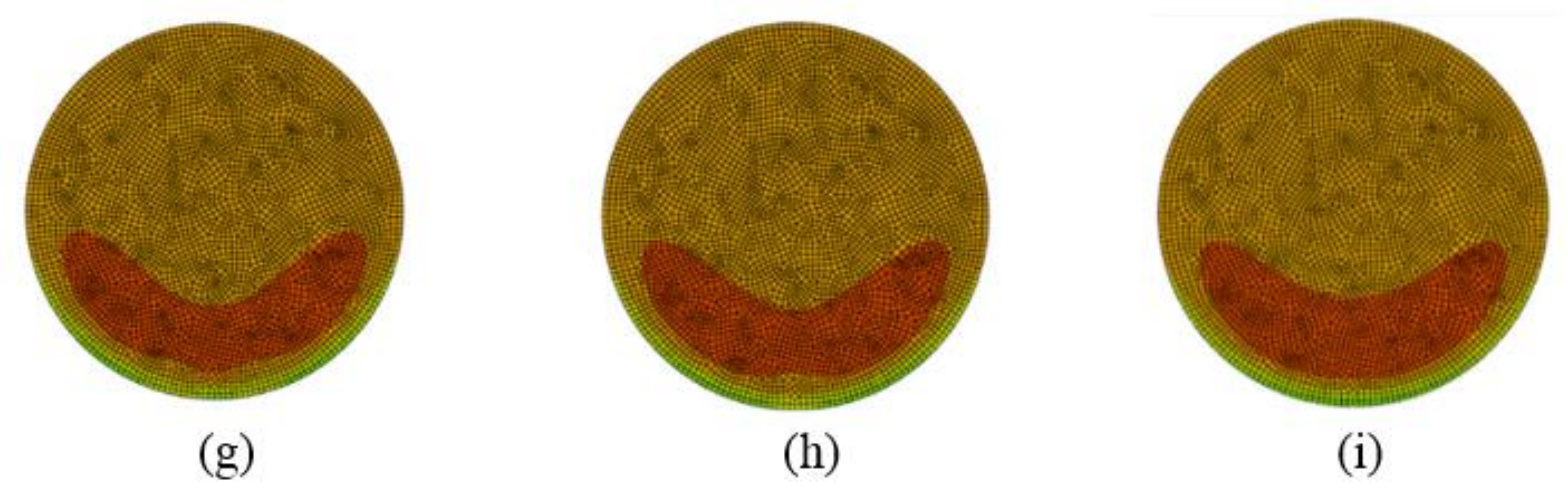
FEM calculation when support using (a) 2 pins (b) 4 pins (c) 6 pins

3. Results



FEM calculation when support using (d) 8 pins (e) 9 pins (f) 10 pins

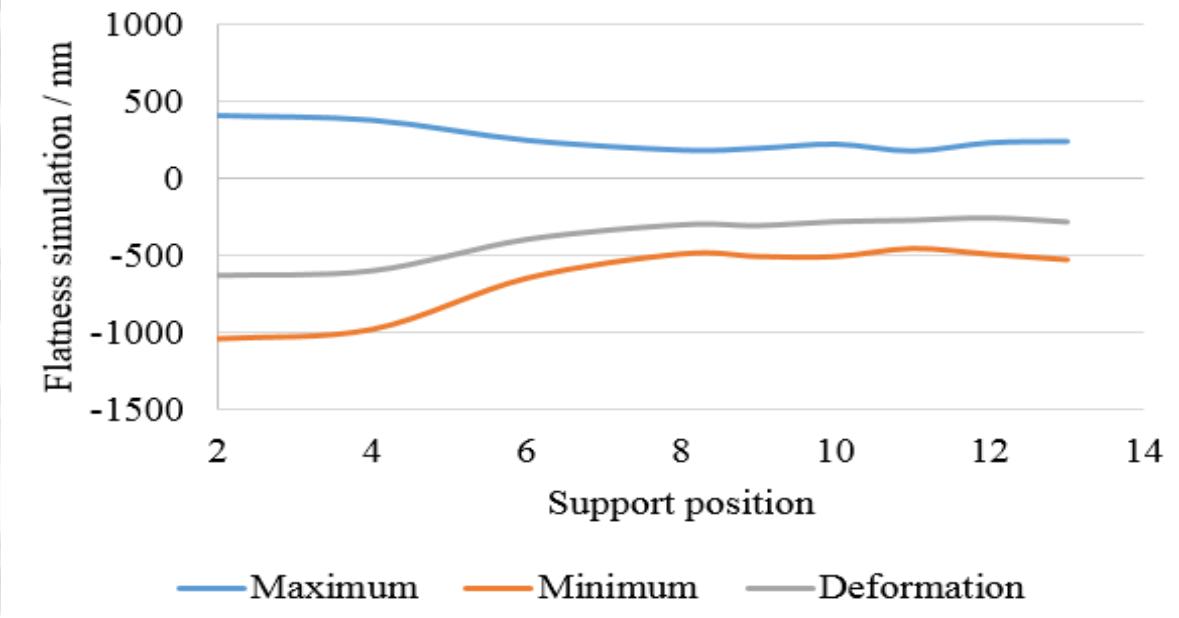
3. Results



FEM calculation when support using (d) 11 pins (e) 12 pins (f) 13 pins

3. Results

PV values of above 9 configurations were analyzed and summarize in Figure. We observed that the deformation is much less than that obtained from the mounting I. By resting the optical flat on 2 pins, deformation up to 600 nm is observed. This deformation is due to gravitational force. By increasing number of pin, deformation is decreasing down to 250 nm.



PV values obtained from 9 clamping configurations.

4. Conclusions

Numerical model was conducted to investigate effect of the optical mounting to the surface deformation of the flat surface. The optical mounting I, where holding the part by squeezing, yields deformation to the part linearly depends on the force applied. The optical mounting II, where a part is rest freely on pins, does not put extra force to the part. However, number of pins plays a crucial role to minimize deformation. At least 8 pins are required to reduce deformation to 300 nm. This observation will lead to a design of an optical mounting that create deformation at minimum.

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Question

THANK YOU
FOR
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