Vacuum Support for a Large Interferometric Reference Surface

<u>Masaki Hosoda</u>, Robert. E. Parks, James. H. Burge

College of Optical Sciences
University of Arizona
Tucson, AZ 85721

mhosoda@optics.arizona.edu

Outline

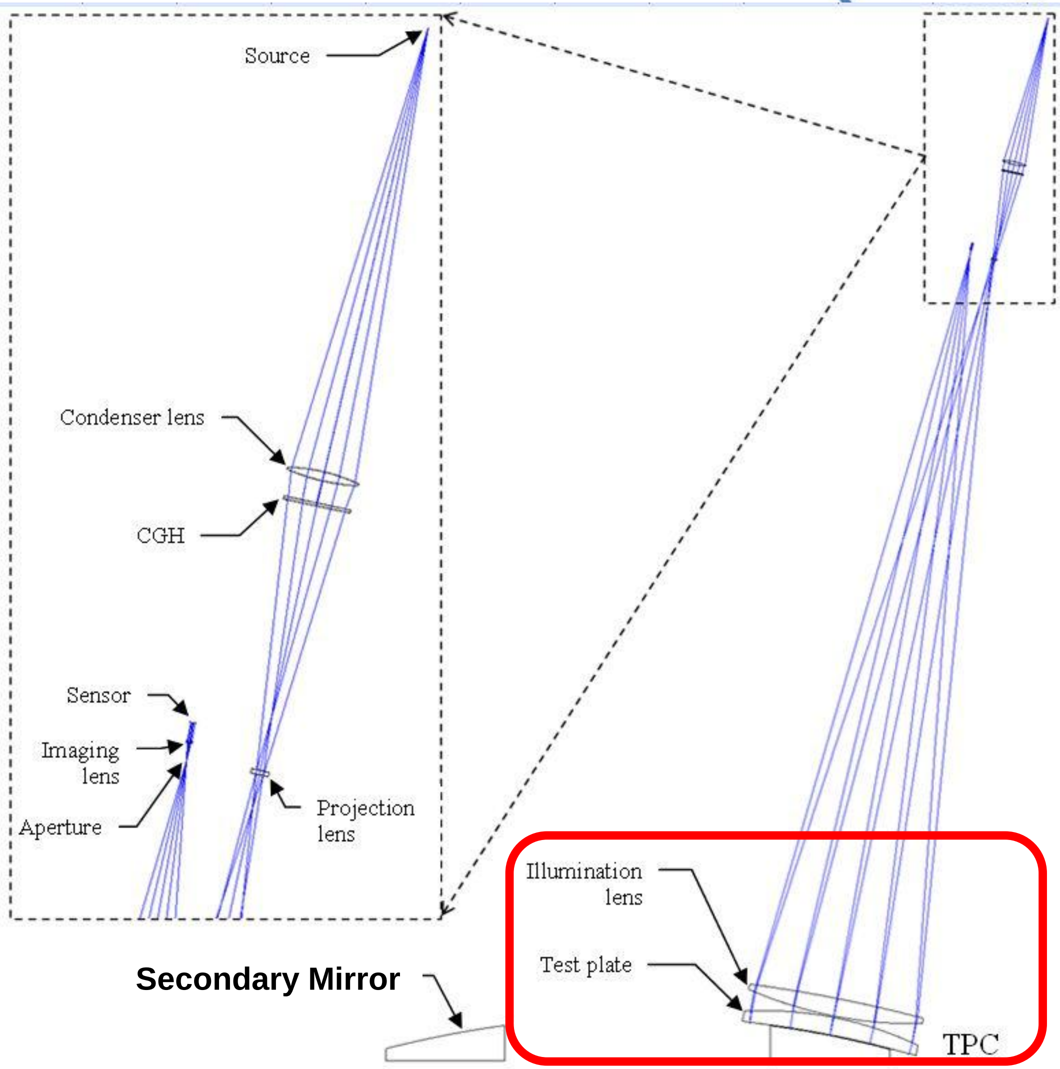
- Background
- Purpose
- Requirements for the system
- Experiments for a simple model
- Simulations for an actual model
- Summary

THE UNIVERSITY OF ARIZONA® TUCSON ARIZONA

Background

LOFT Large Optics Fabrication & Testing

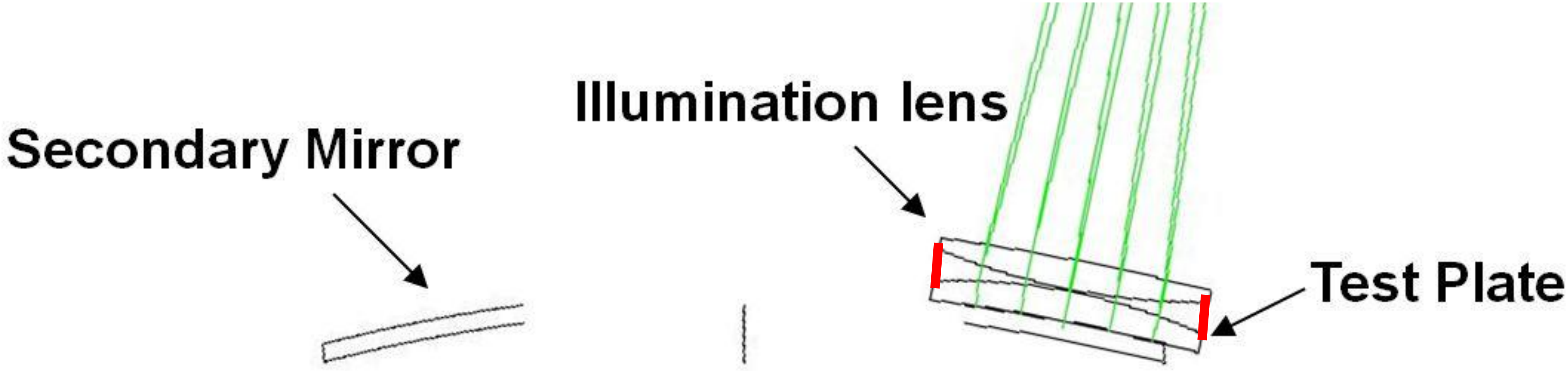
- We try to measure a secondary mirror for a telescope by Fizeau type interferometer with 5mm gap as shown in the right Figure [1].
- In this case, the bending of the test plate caused by the gravity becomes a problem, since the test plate is flipped around after polishing the reference surface.
- Reducing an unexpected bending in the reference surface is required.



[1] M. B. Dubin, et al., "Fizeau interferometer with spherical reference and CGH correction for measuring large convex aspheres", Proceedings of the SPIE, Volume 7426 (2009)

Purpose

- The scope of this study is to show an effectiveness of the vacuum support for the large interferometric reference surface by simulations.
  - Validate simulations by simple experiments.
  - A mechanical mount for the test plate is also discussed.



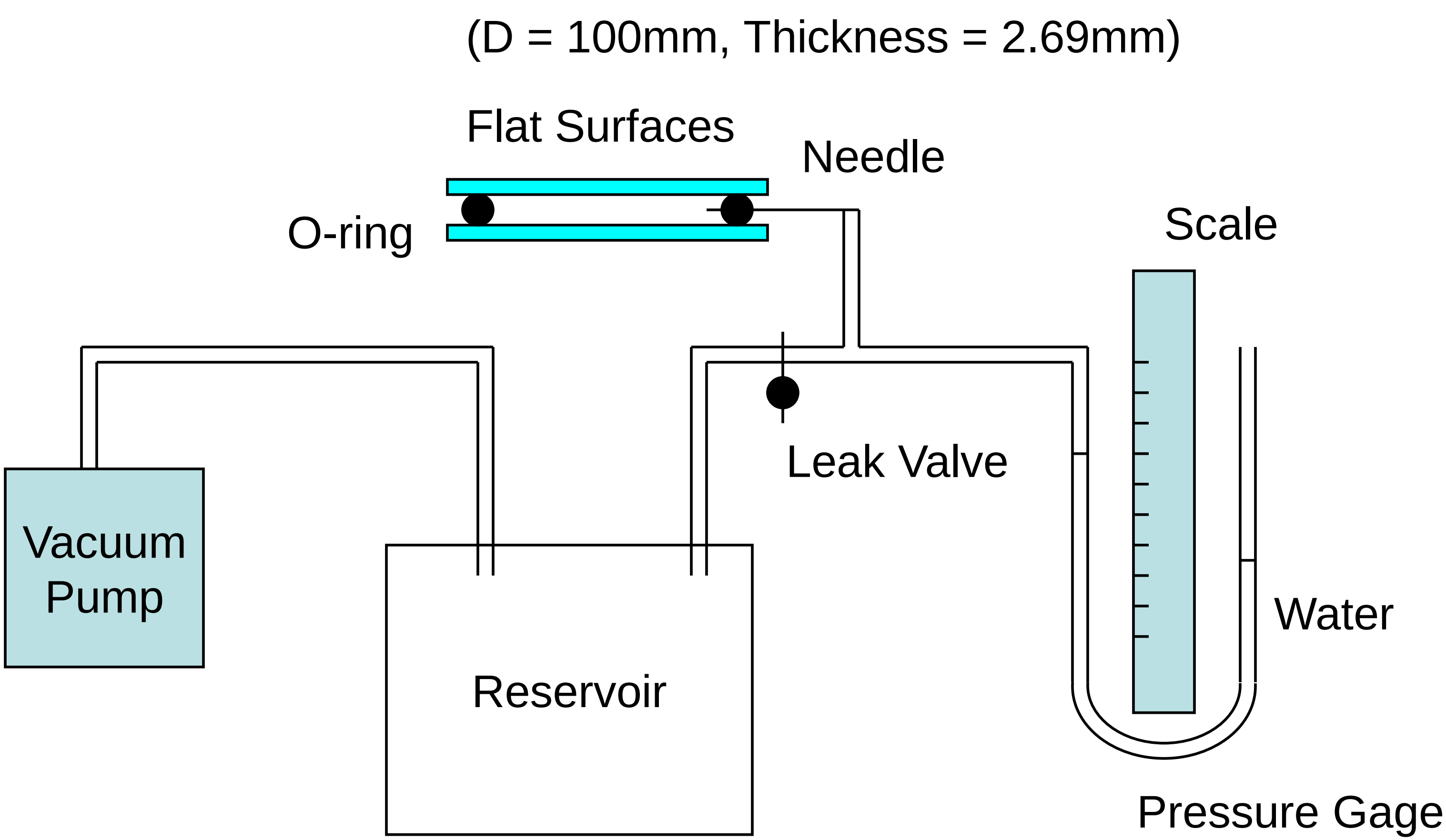
THE UNIVERSITY OF ARIZONA® TUCSON ARIZONA

Requirements

LOFT Large Optics Fabrication & Testing

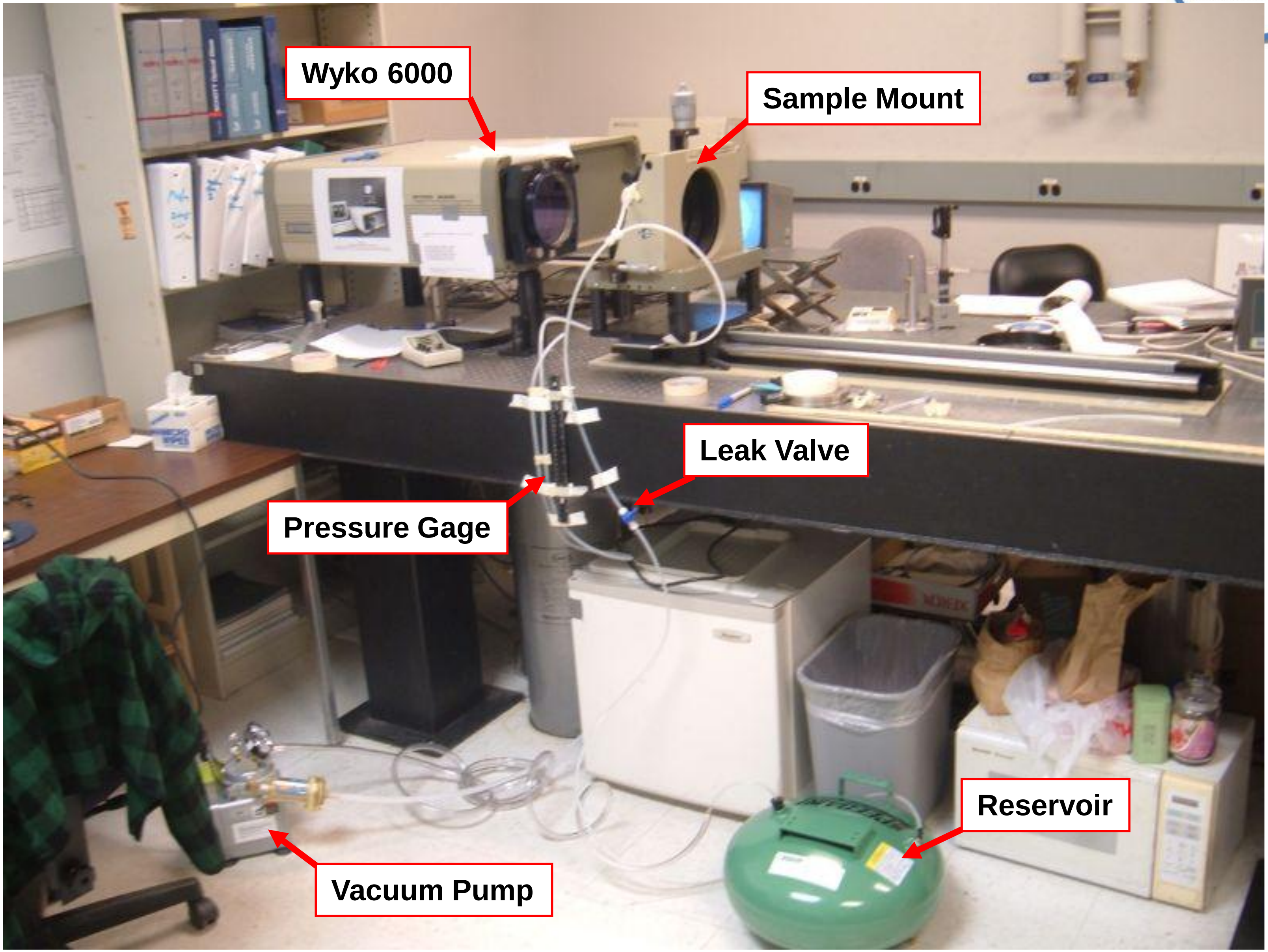
	Requirements		Verifications
1.	Difference between simulation and experiment	< 20 [%]	Test
2.	Supported with edge face	NA	Inspection
3.	Surface Slope Irregularity	< 10 [nm/cm RMS]	Analysis
4.	Resonant Frequency	> 30 [Hz]	Analysis
5.	Stability - power - w/o power	 20 [nm] 3 [nm]	Analysis

Experimental Setup 1

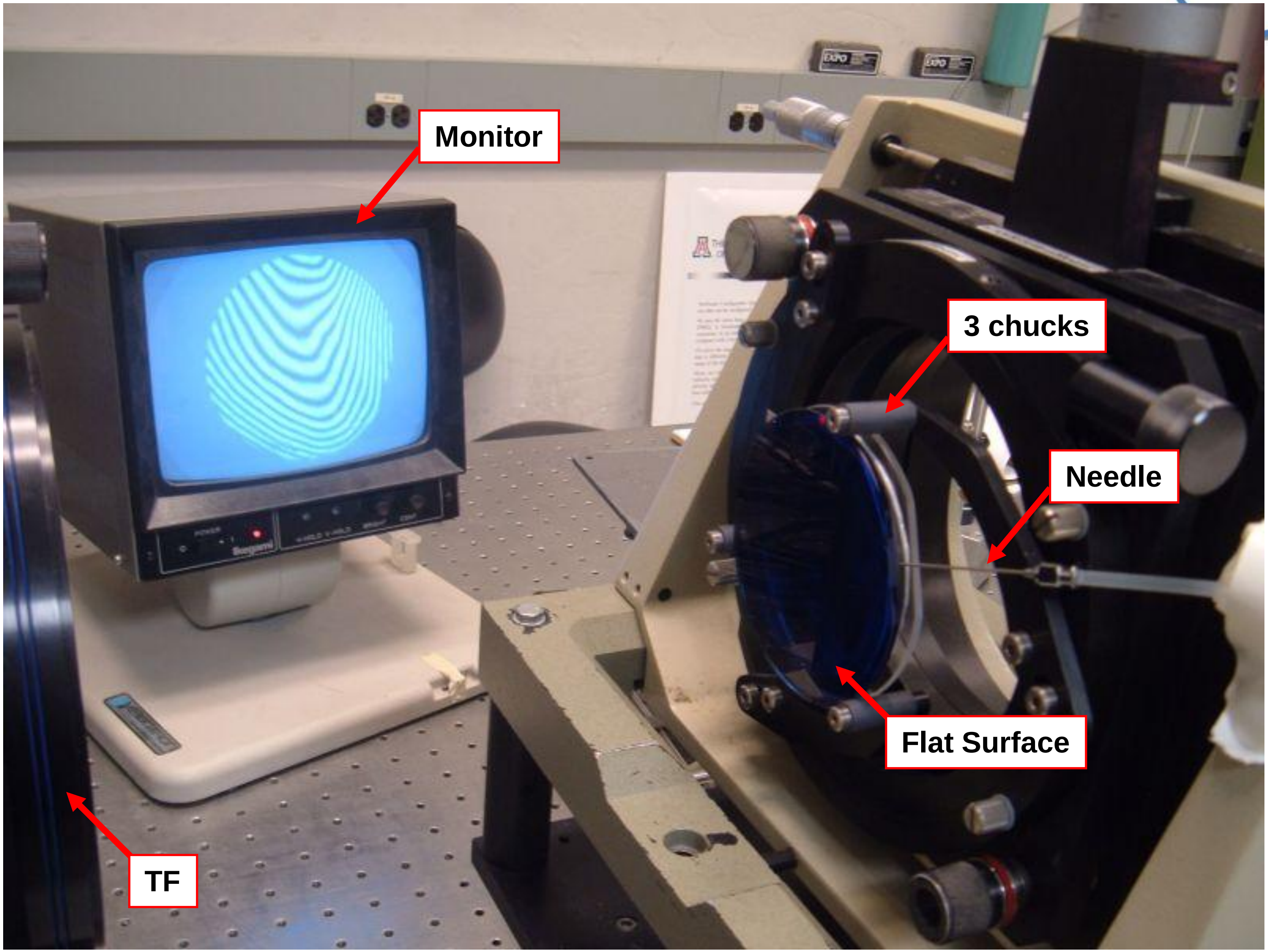


Sensitive around air pressure
Cheap

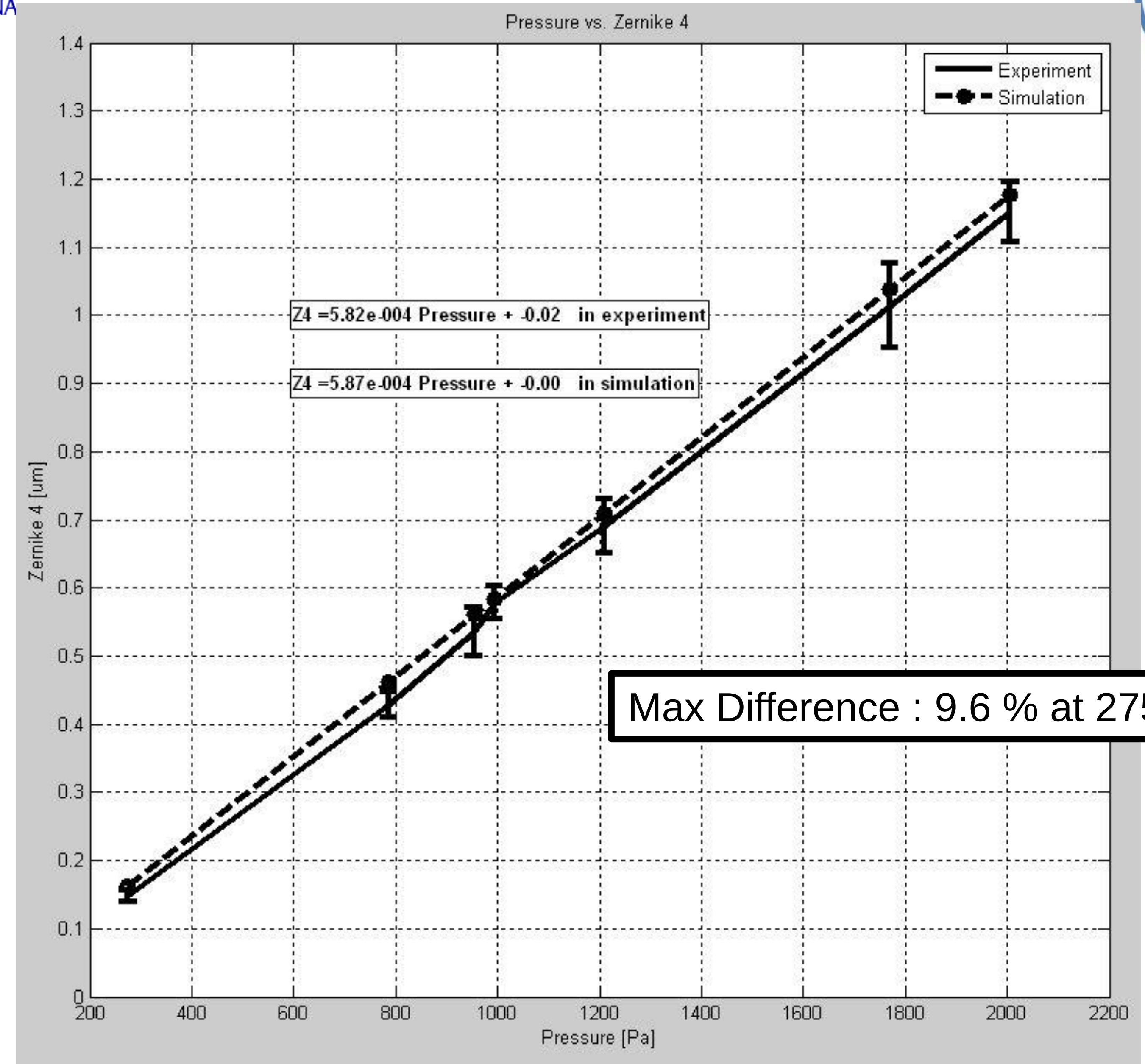
Experimental Setup 2



Experimental Setup 3

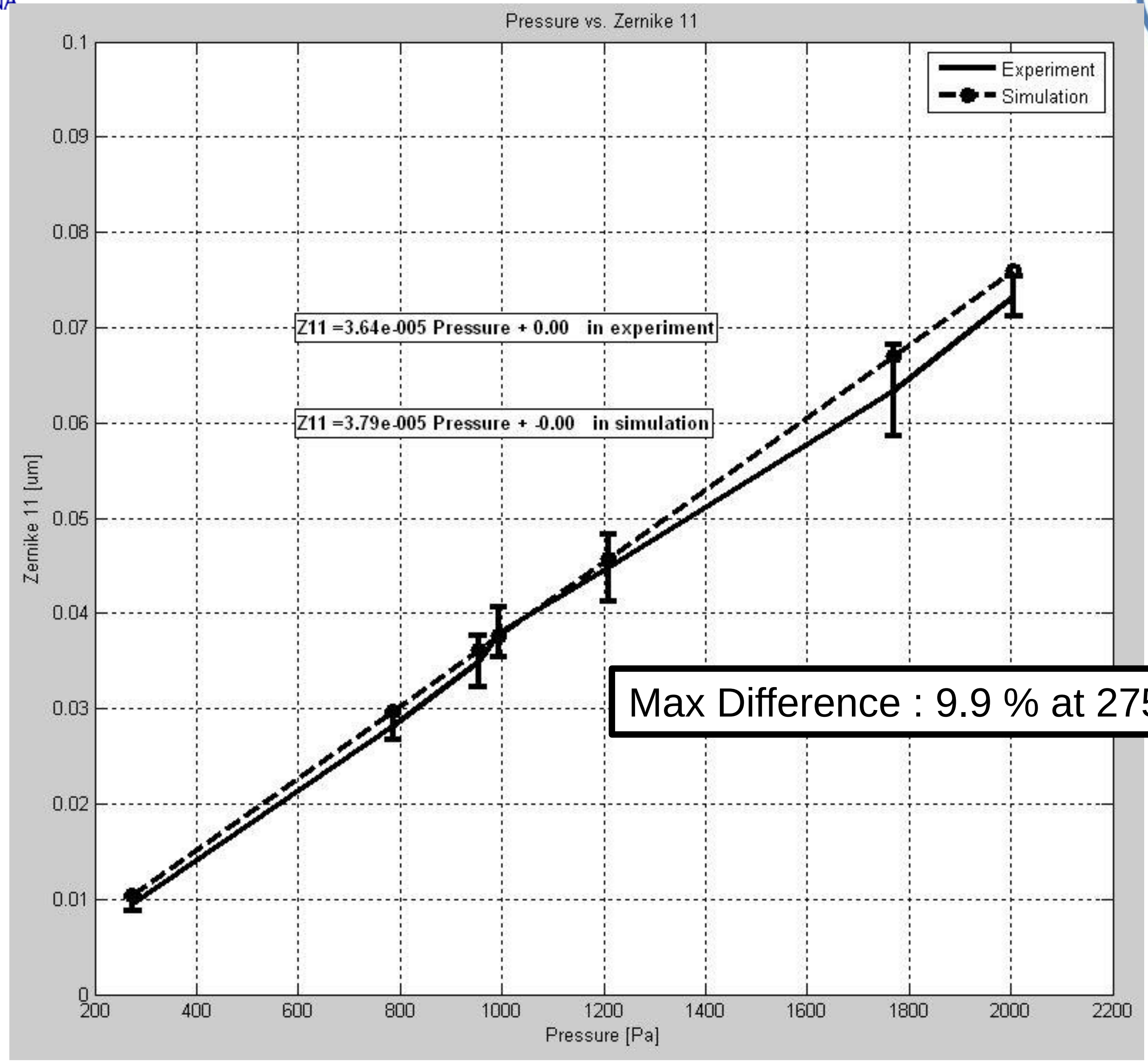


Experimental Results (Power; Z4)



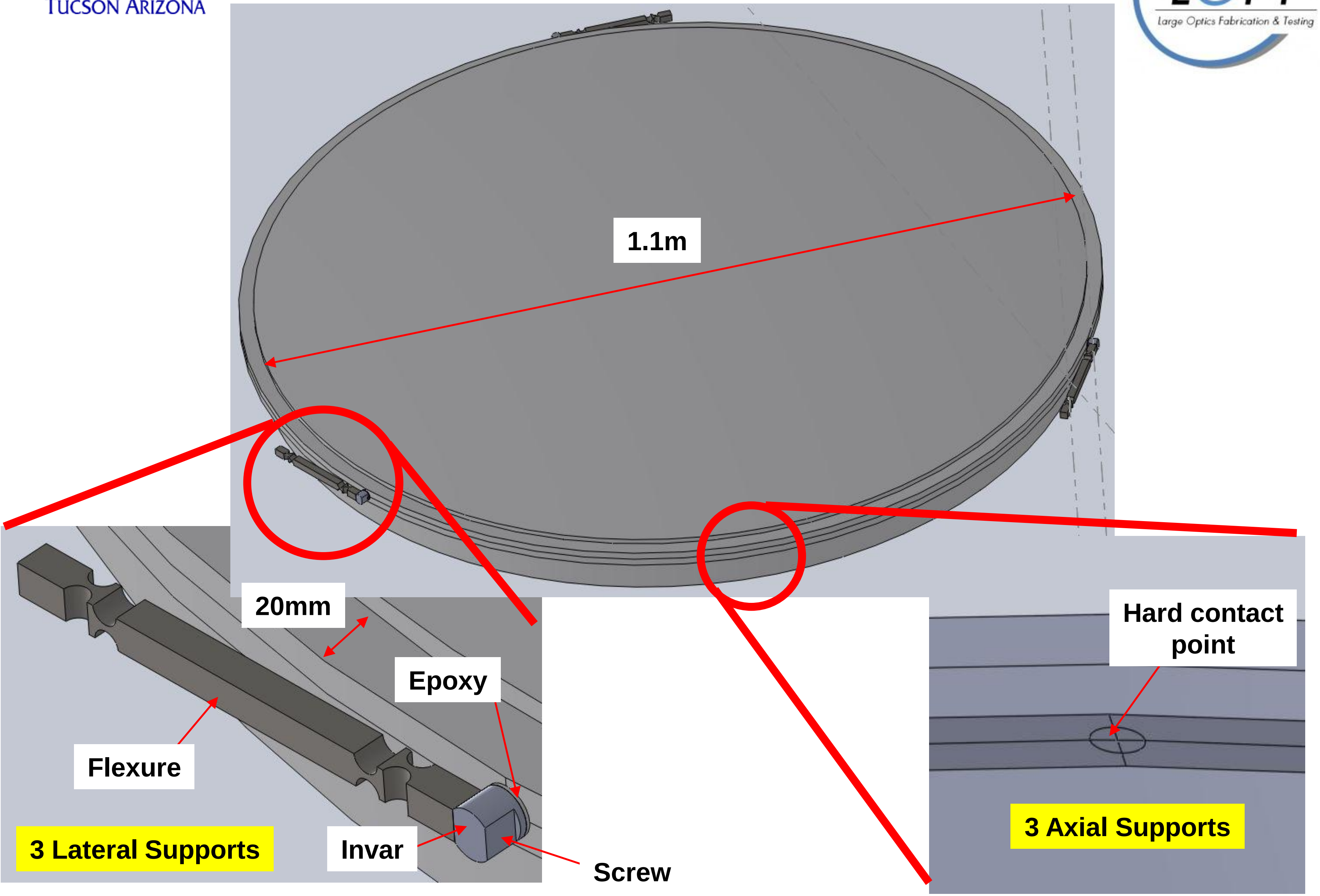
Max Difference : 9.6 % at 275 Pa

Experimental Results (ρ^4 term; Z11)

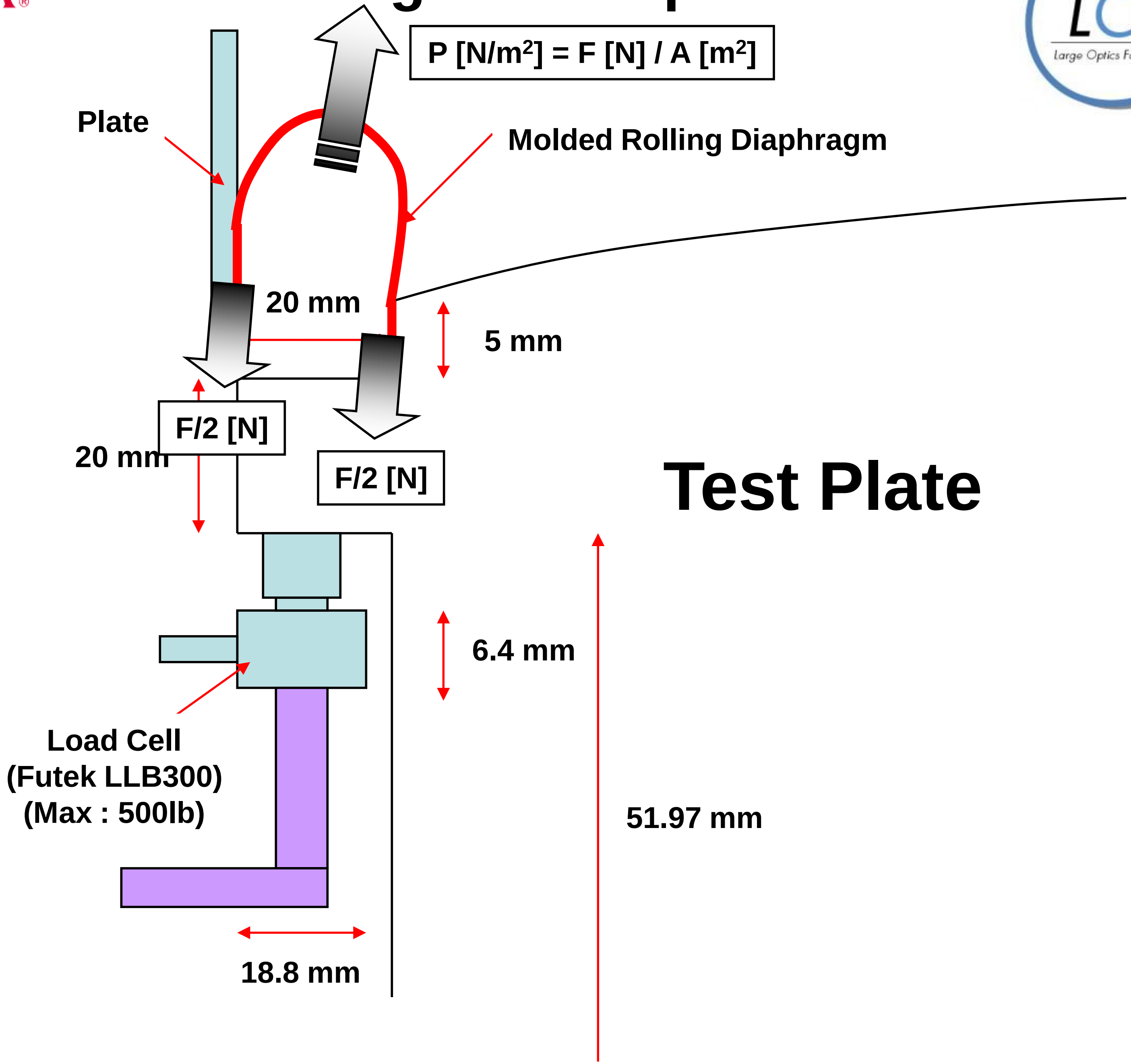


Max Difference : 9.9 % at 275 Pa

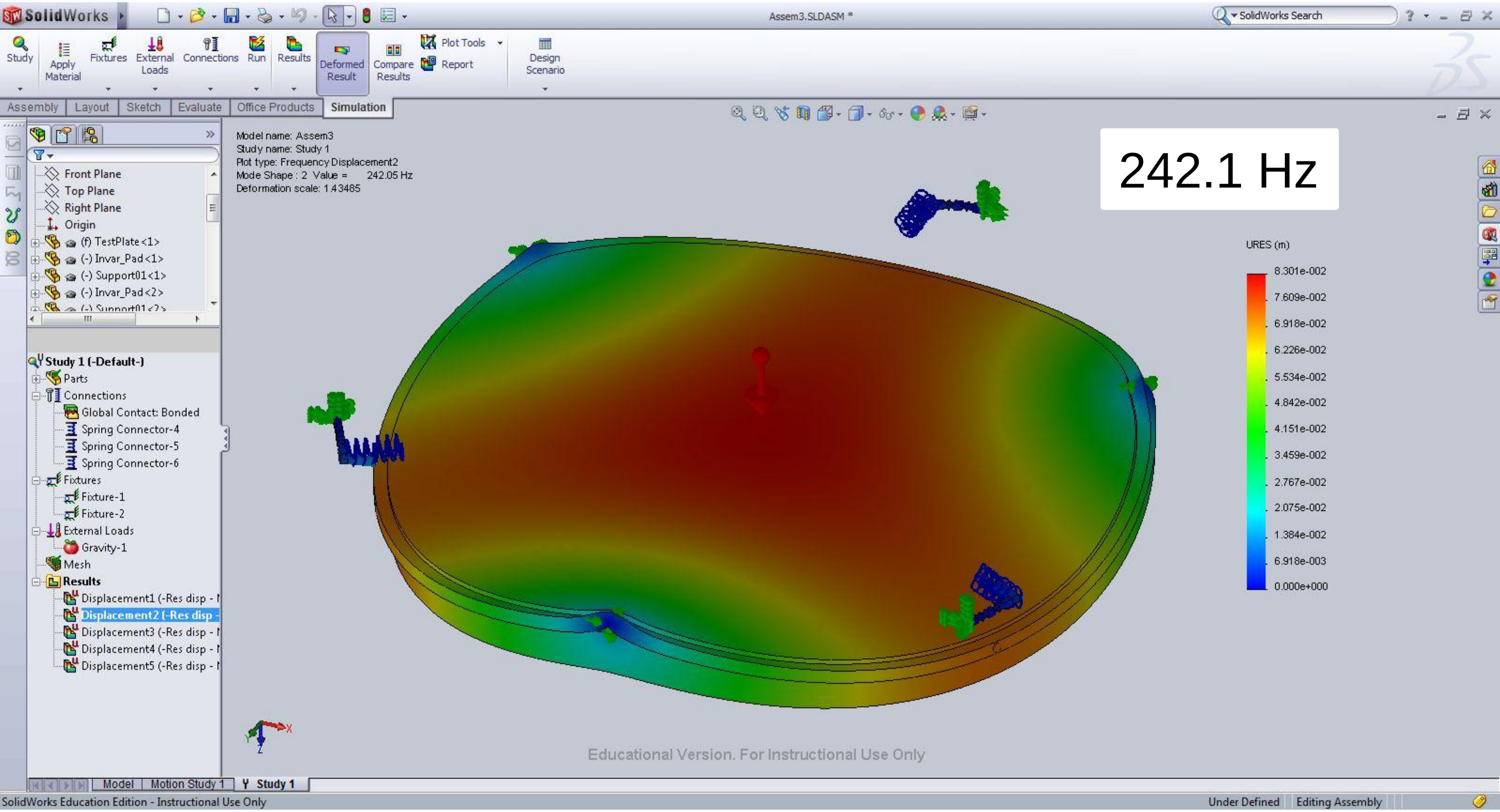
Design Concept 1



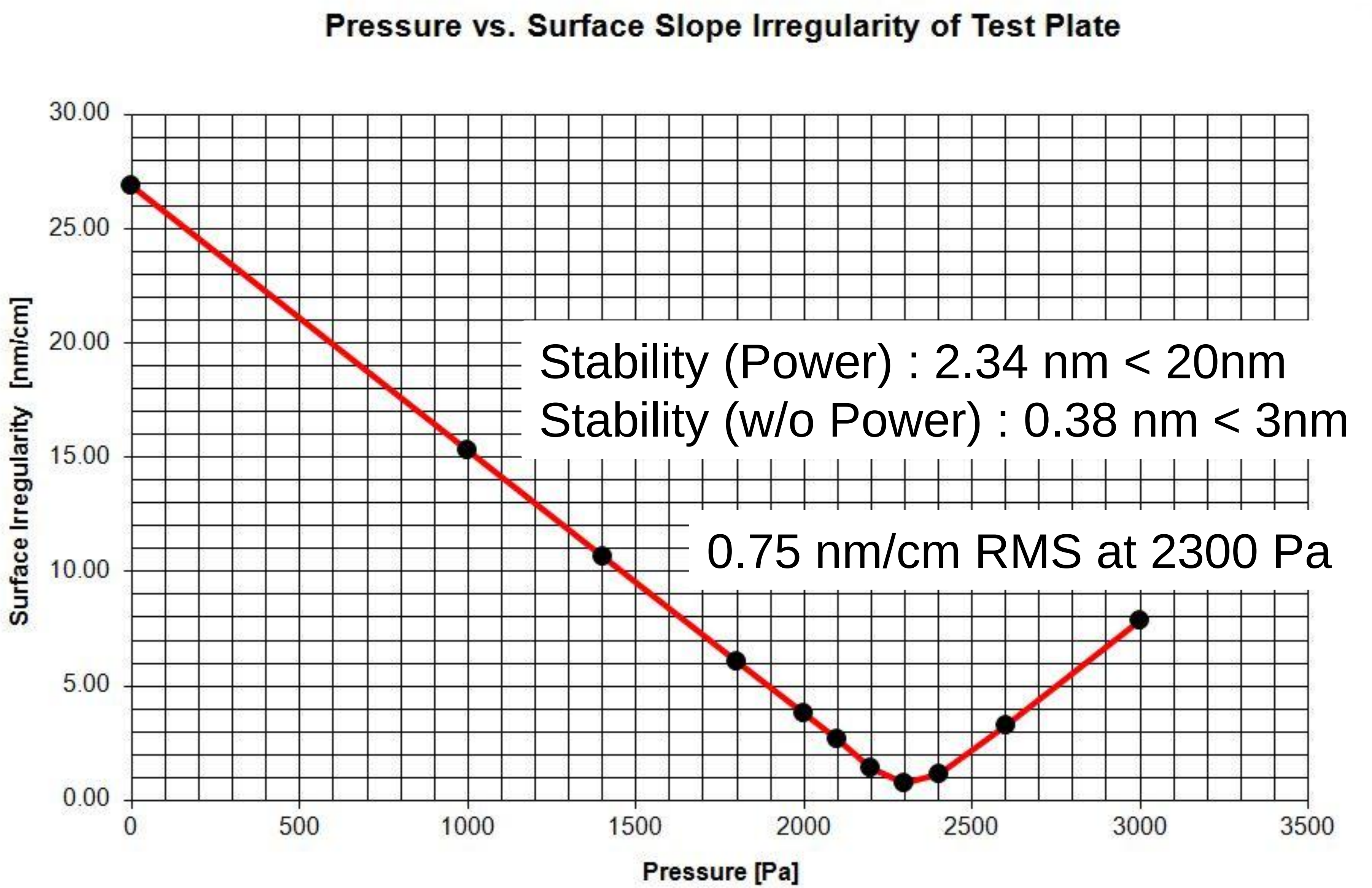
Design Concept 2



Resonant Frequency



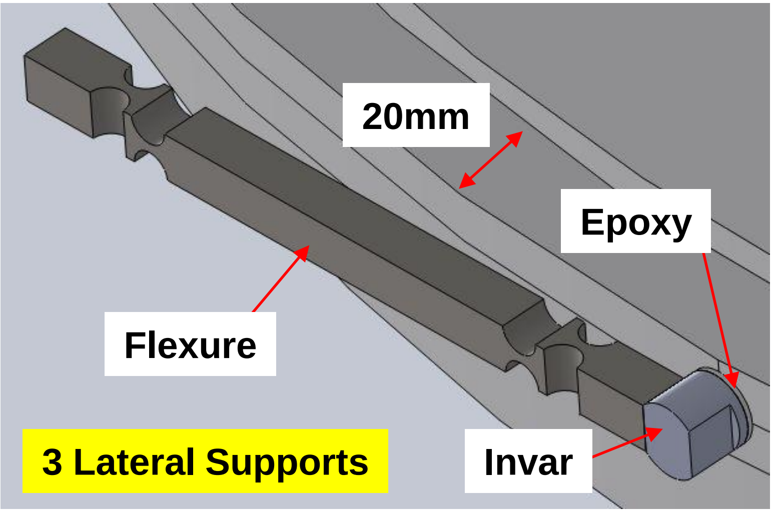
Pressure vs. Surface Slope Irregularity

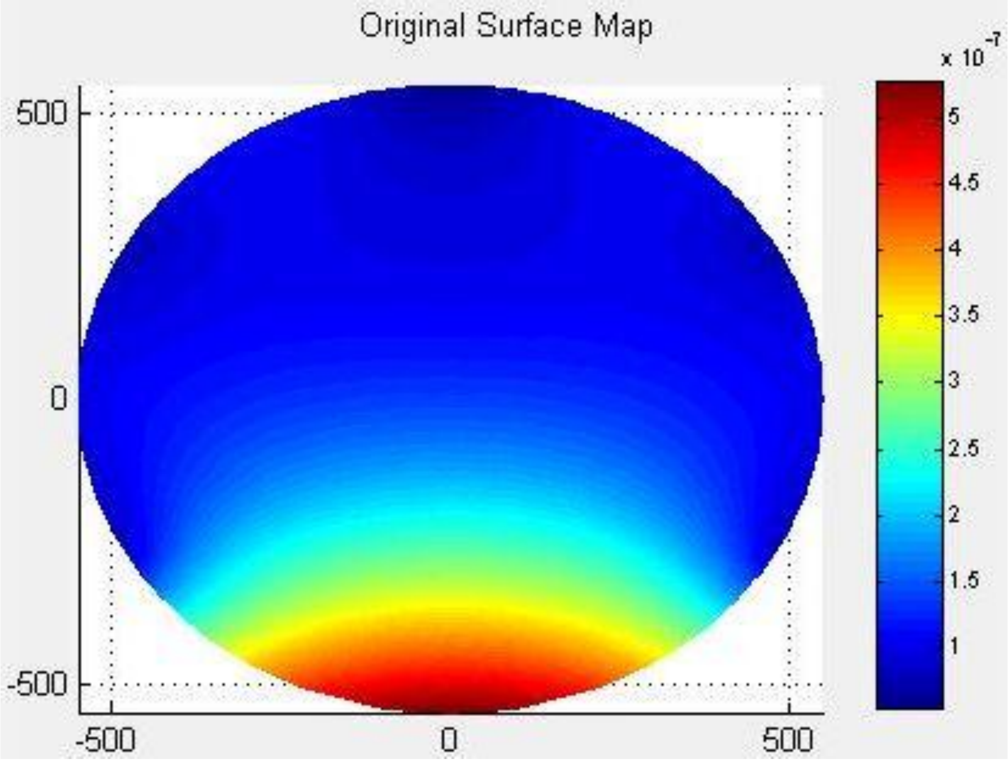


THE UNIVERSITY OF ARIZONA® TUCSON ARIZONA

Flexure Effect

LOFT



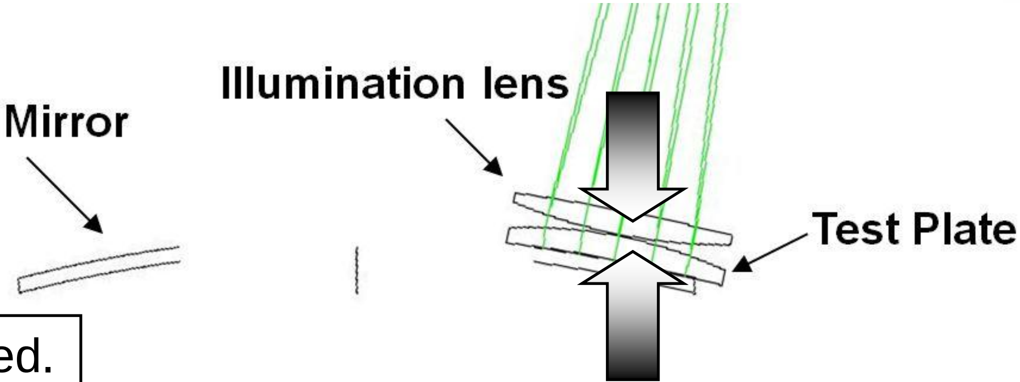


(Matlab code by Won Hyun Park)

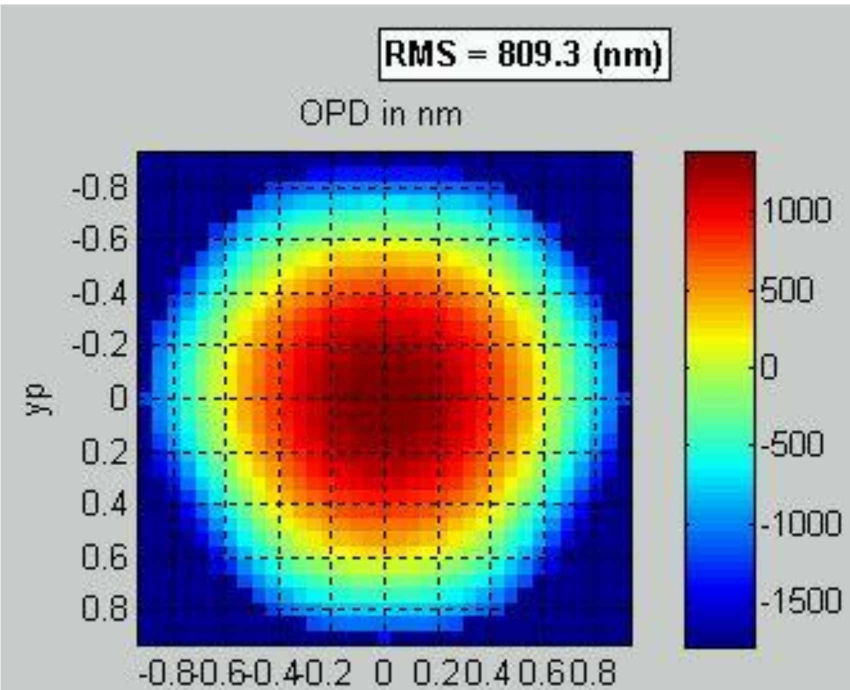
100 um tolerance at flexure causes 0.2 N-m moment at the test plate.
This causes 2.71 nm/cm RMS surface slope irregularity.

Since this issue is independent from vacuum support,
(Total RMS) = SQRT((0.75 nm/cm)^2 + 3 x (2.71 nm/cm)^2) = 4.75 nm/cm RMS
< 10 nm/cm RMS

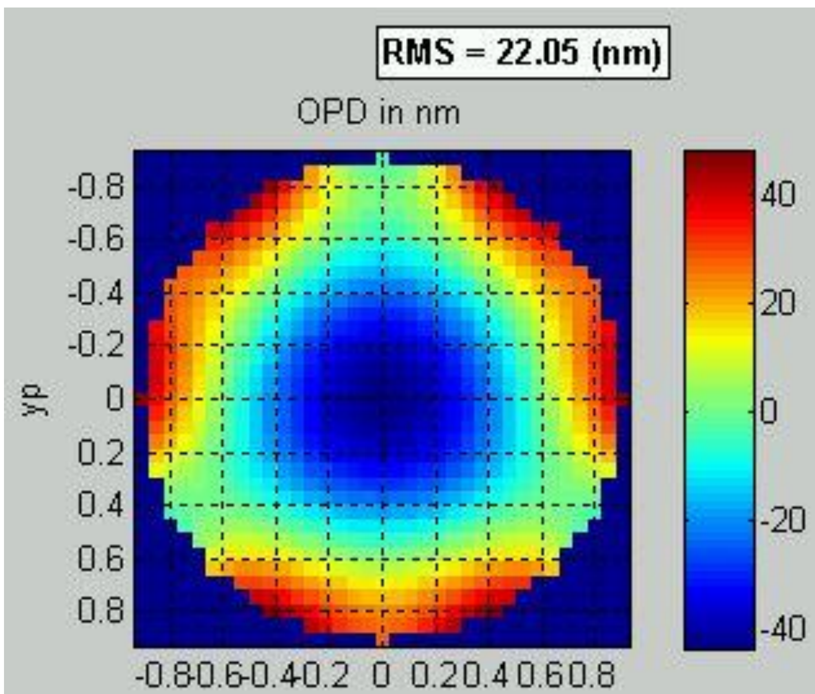
Interferogram with Vacuum Support



Piston and Tilts are removed.



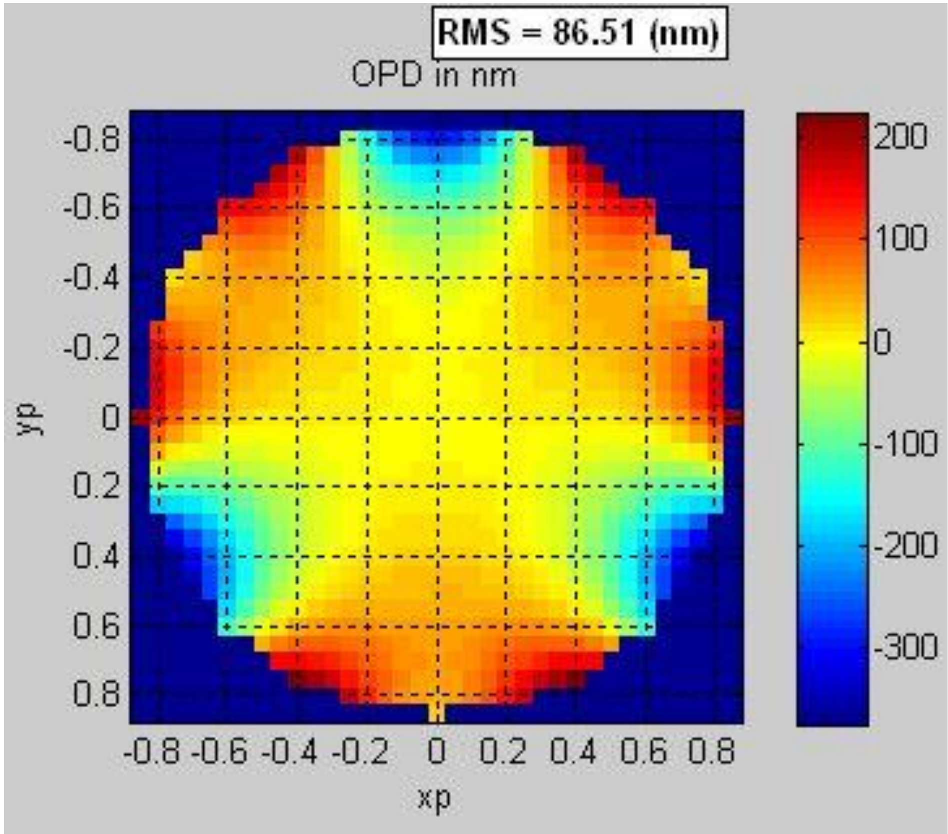
W/O Vacuum Support



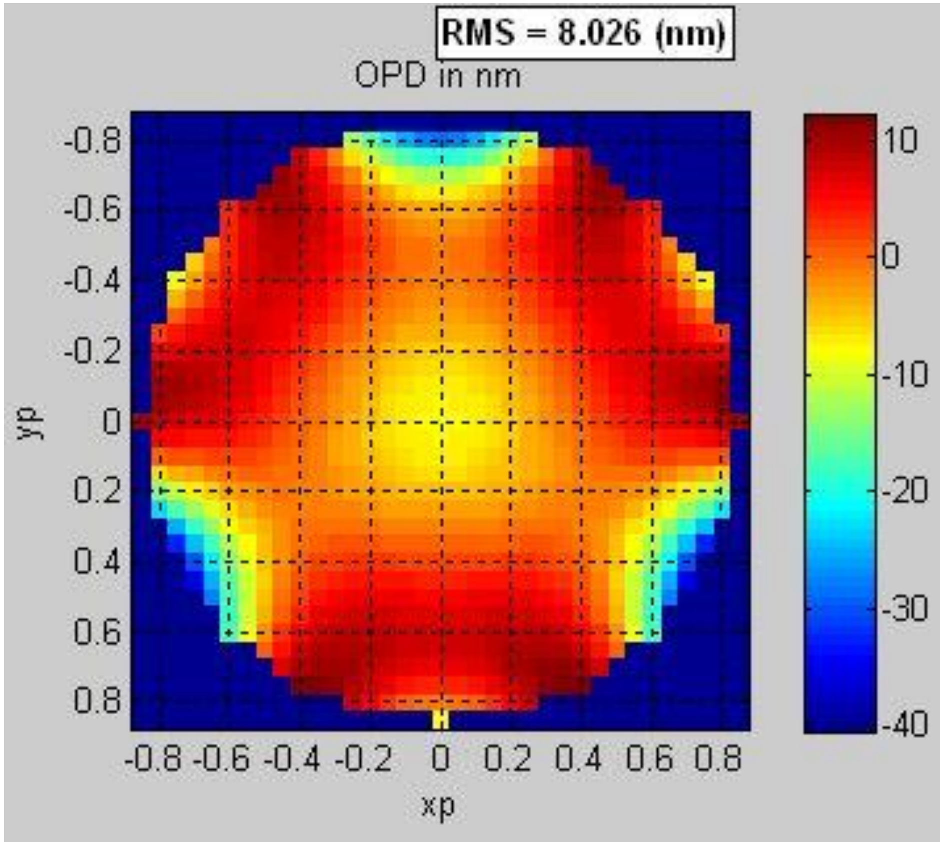
W/ Vacuum Support

Interferogram with Vacuum Support

Piston, Tilts, and Power are removed.



W/O Vacuum Support



W/ Vacuum Support

THE UNIVERSITY OF ARIZONA
TUCSON ARIZONA

Summary

LOFT
Large Optics Fabrication & Testing

- I did the simple experiment and the simulation to evaluate the vacuum support.
  - Difference between exp. and sim. was 10% < 20% in spec.
  - Surface slope irregularity was 4.75 nm/cm < 10 nm/cm in spec.
  - Resonant Frequency was 242.1 Hz > 30 Hz in spec.
  - Stability of Power was 2.34 nm < 20 nm
  - Stability of w/o Power was 0.38 nm < 3 nm
- The vacuum support for the large interferometric reference surface can be effective.

- Future Work
  - Detail design around the diaphragm
  - Check an effect of index change
  - Comparison with actual experiment