# Programmable Phase Nulling Interferometer for Giant Mirrors

## Phase I SBIR

Mirror Tech Days 2018

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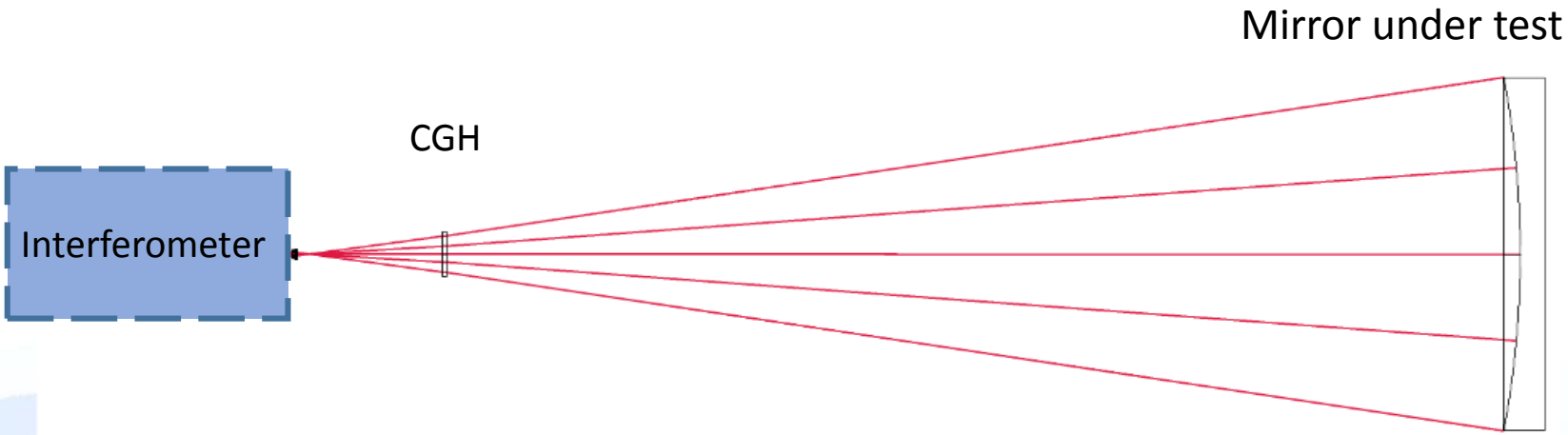
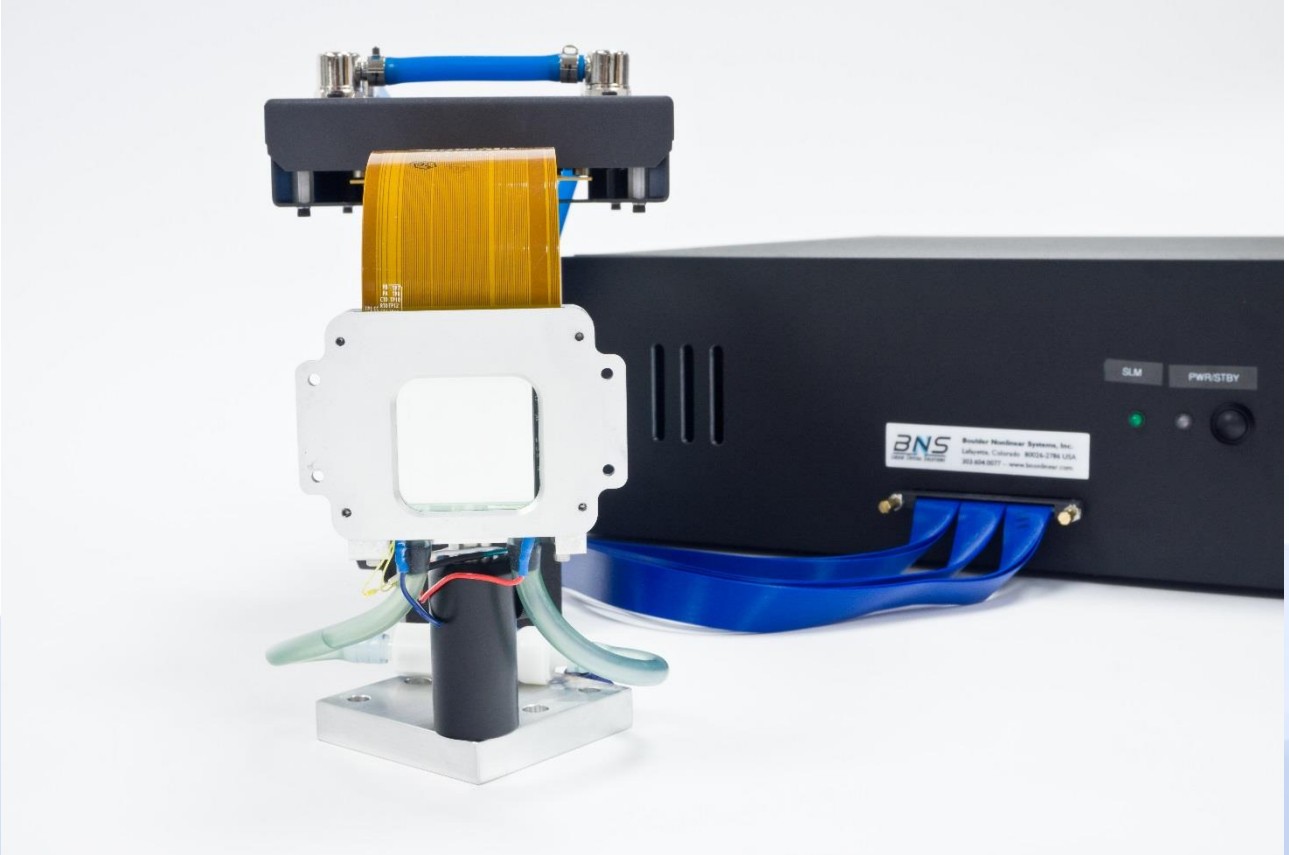
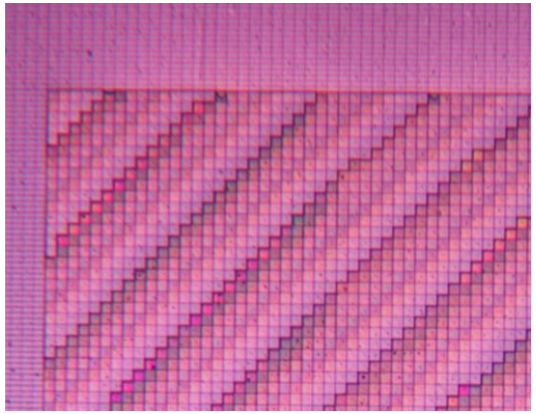
# Motivation: mirror characterization

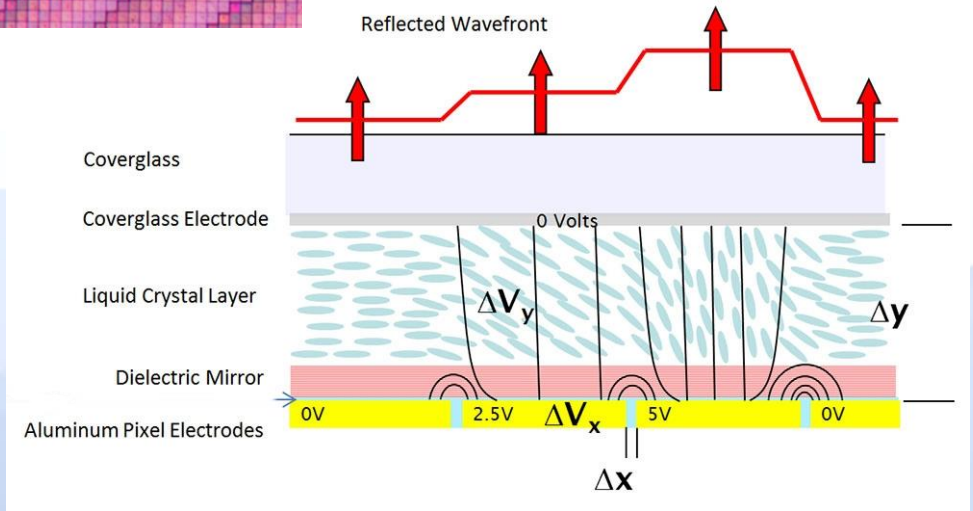


# LCoS Spatial Light Modulators

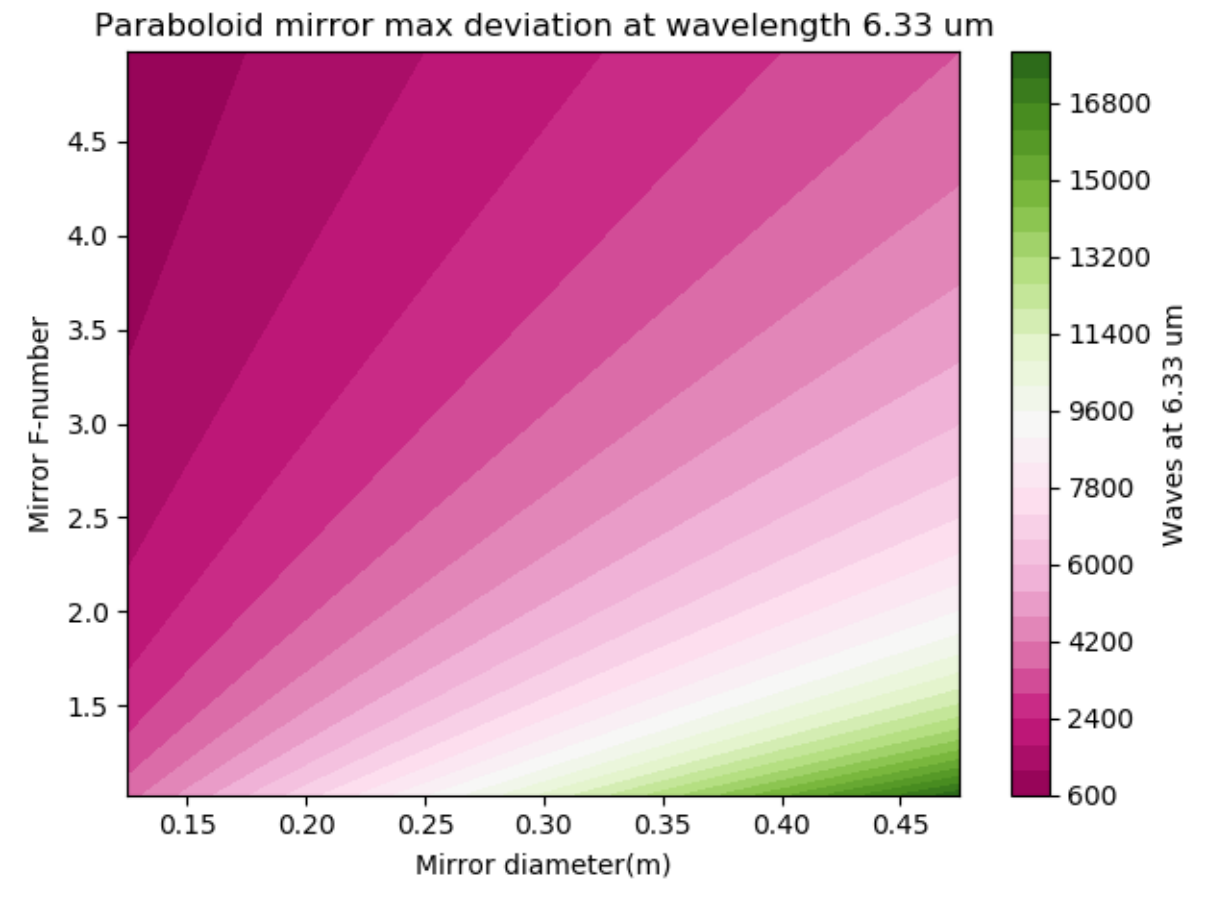
Liquid Crystal on Silicon (LCoS) Spatial Light Modulators (SLMs)



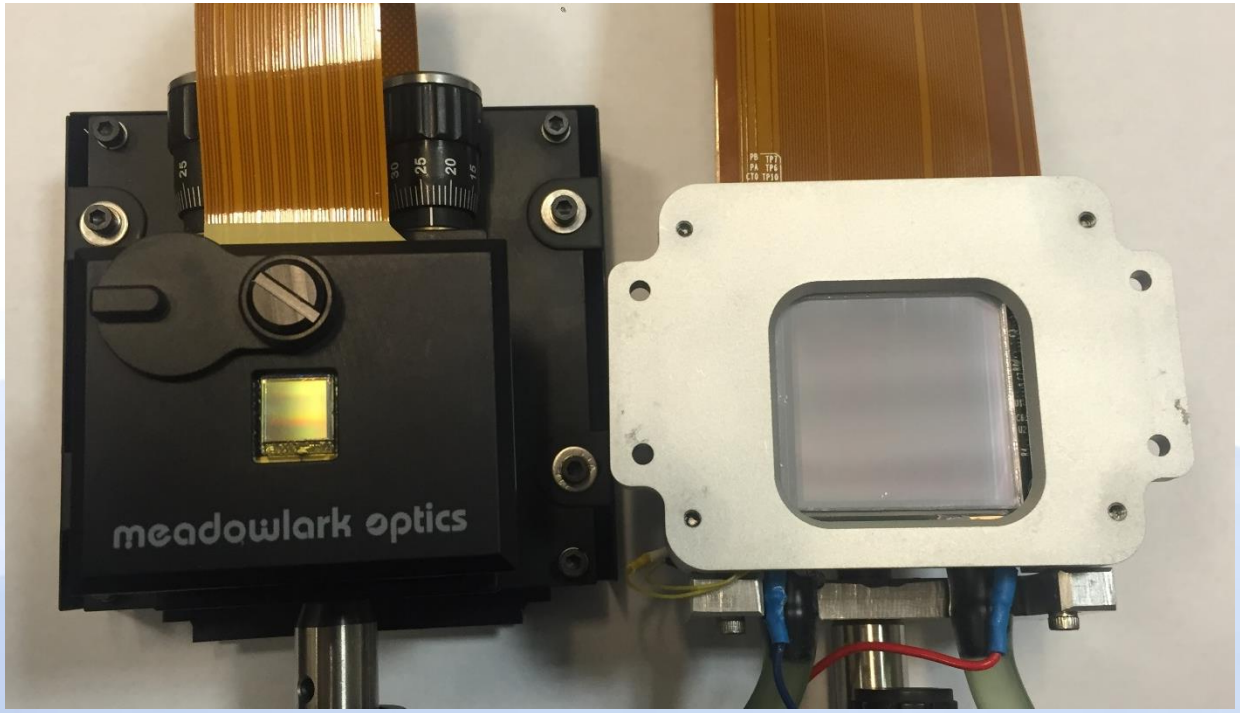


# SLM nulling range




Phase I 512x512 SLM
Binary range: < 256 waves
15 µm pixels

Phase II 1536x1536 SLM
Binary range: < 768 waves
25 µm pixels



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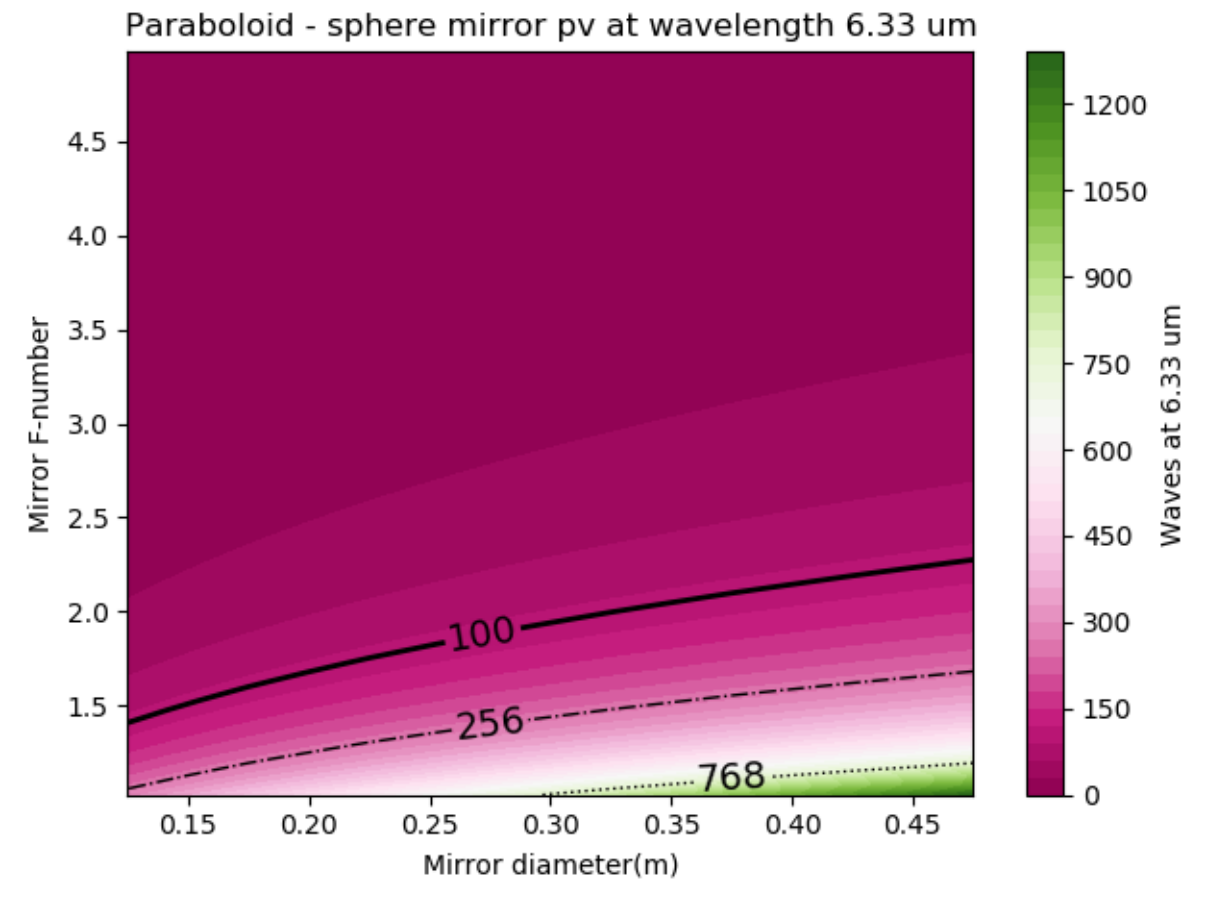


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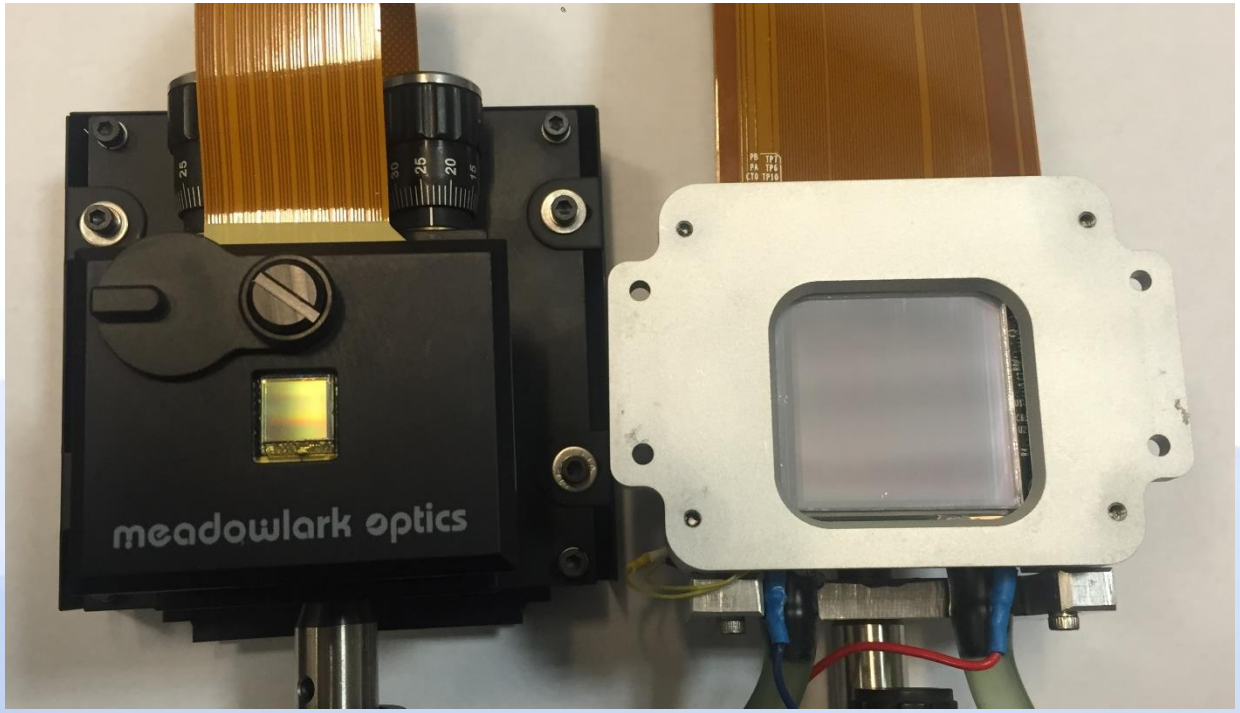
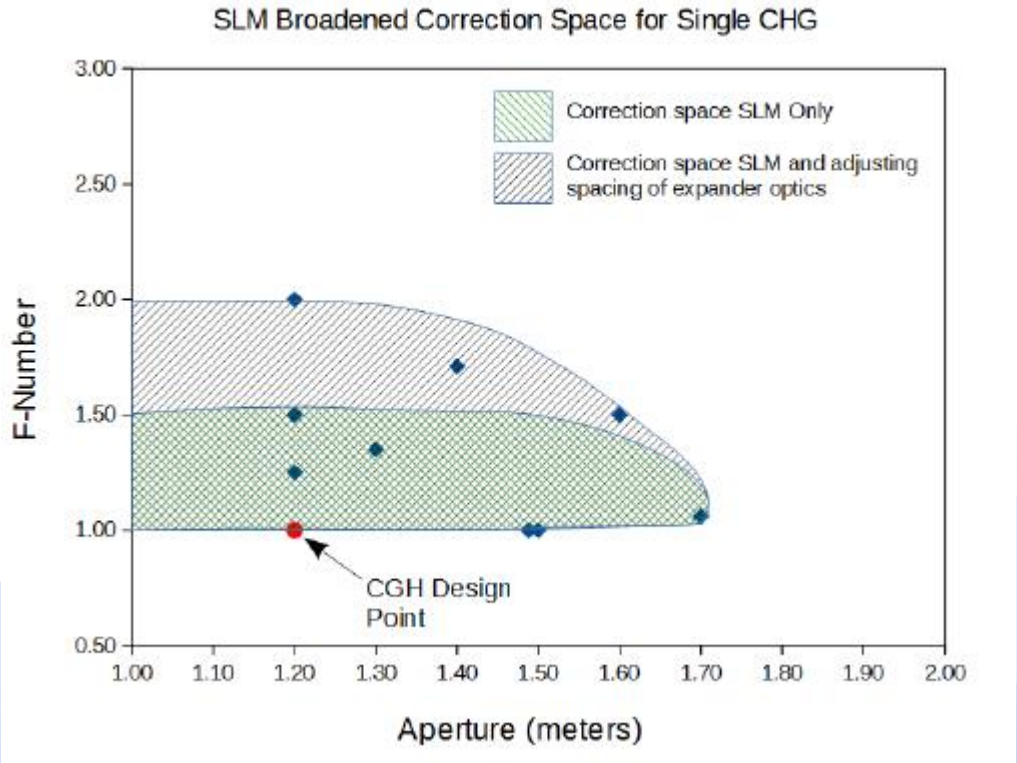


# Use of SLMs to extend CGH range

SLM: 100 wave range




Temperature, gravity, similar segments

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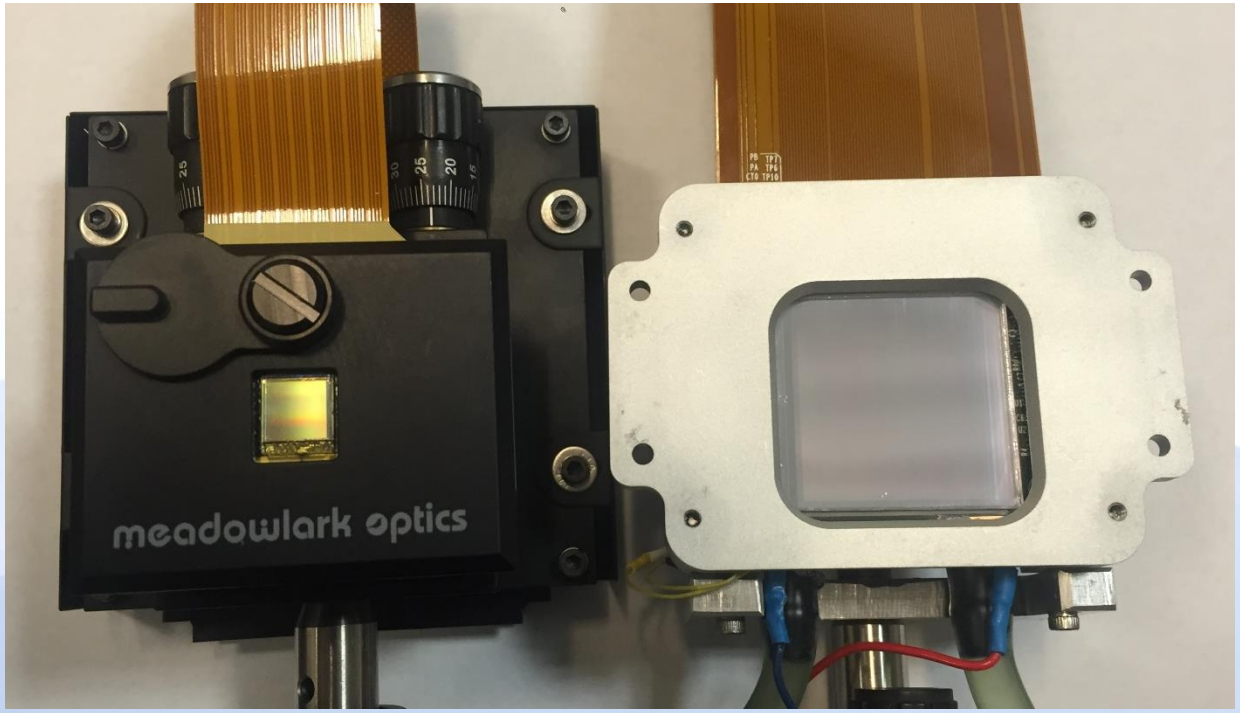
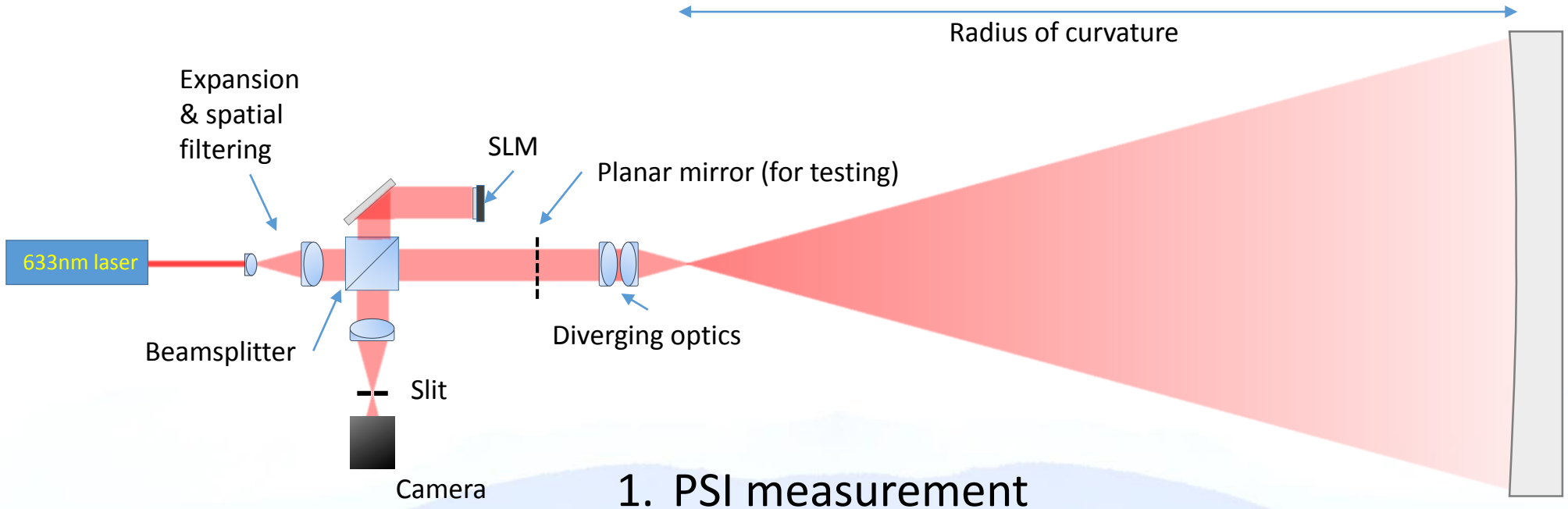


# Optical setup

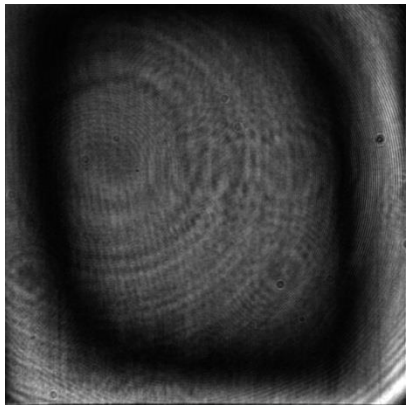



1. PSI measurement
2. Invert measured phase
3. Apply with SLM to null

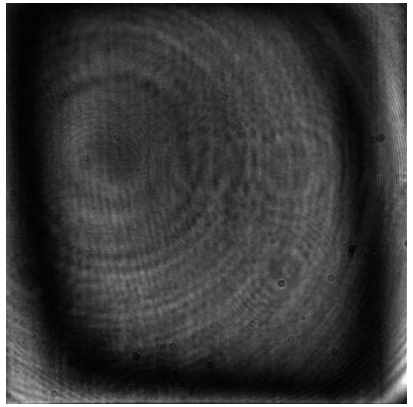
# PSI Measurement: planar mirror

SLM piston applied (4-step PSI):

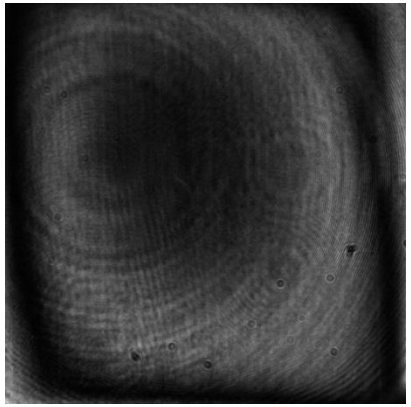
0



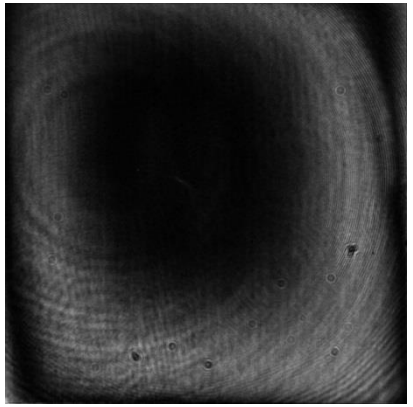
π/2



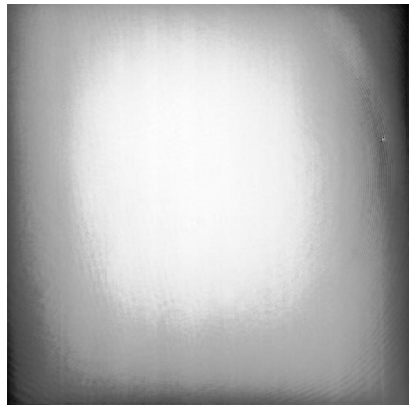
π



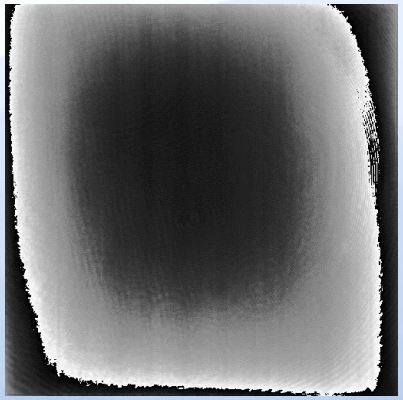
3π/2



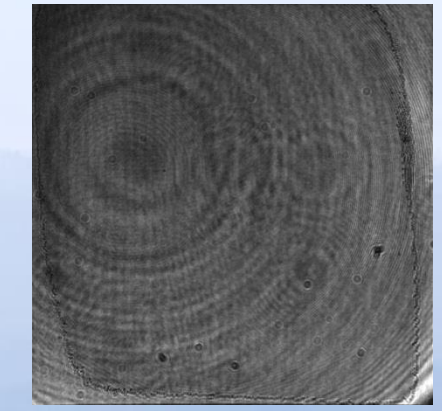
Retrieved phase:

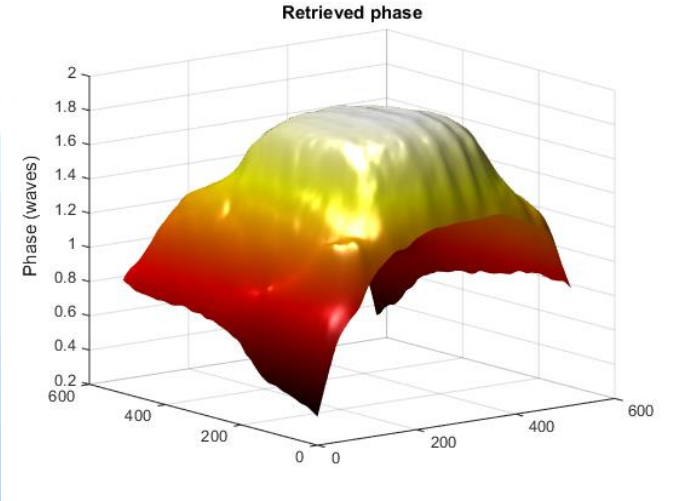


Correction phase:



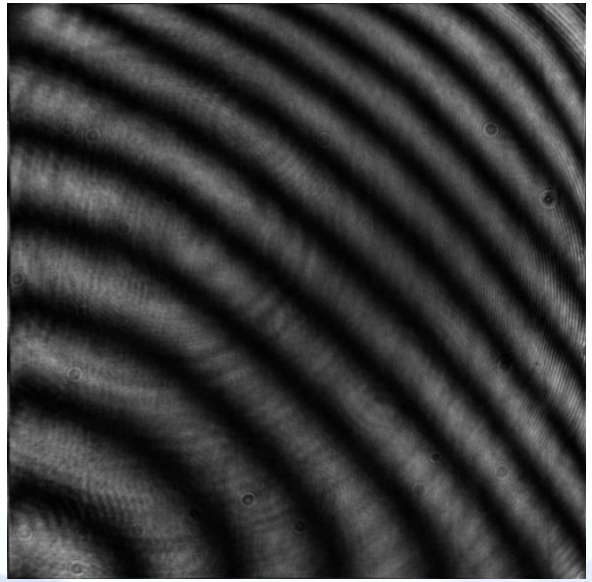
Null

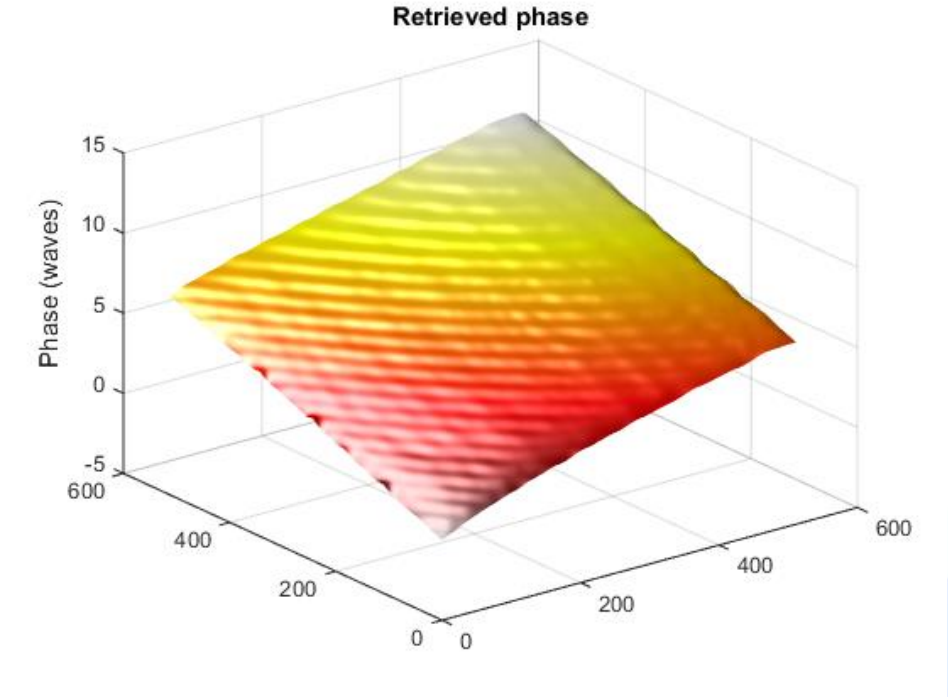




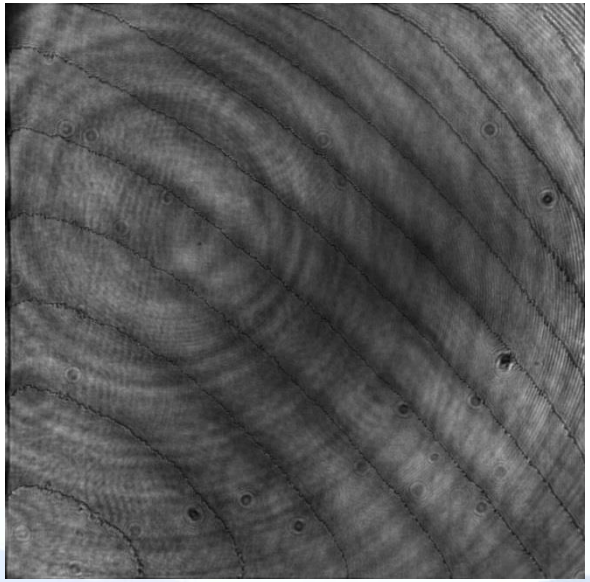
# Nulling results: planar mirror w/ tilt

Interferogram before nulling

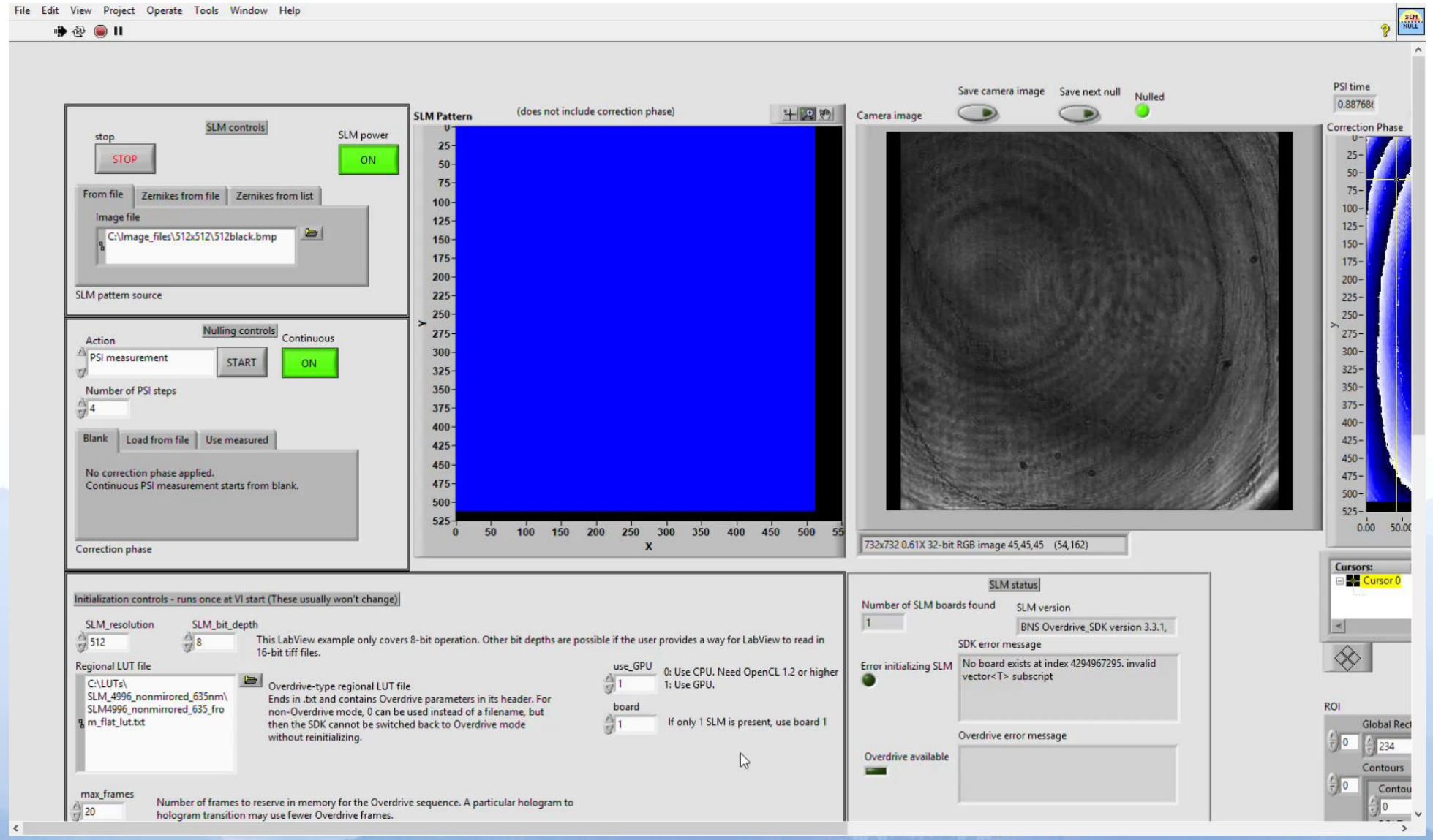





System nulled



# Nulling results: adaptive null



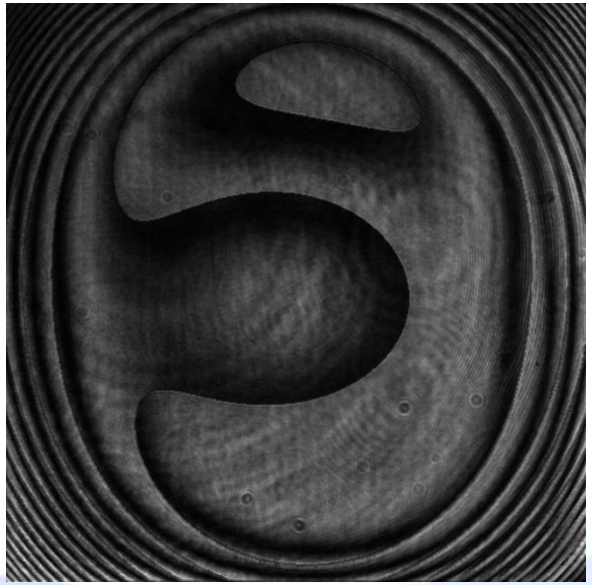

Moving optic in the test arm
Nulling time: 0.9s

SLM rate: 400 Hz
Camera rate: 15 Hz

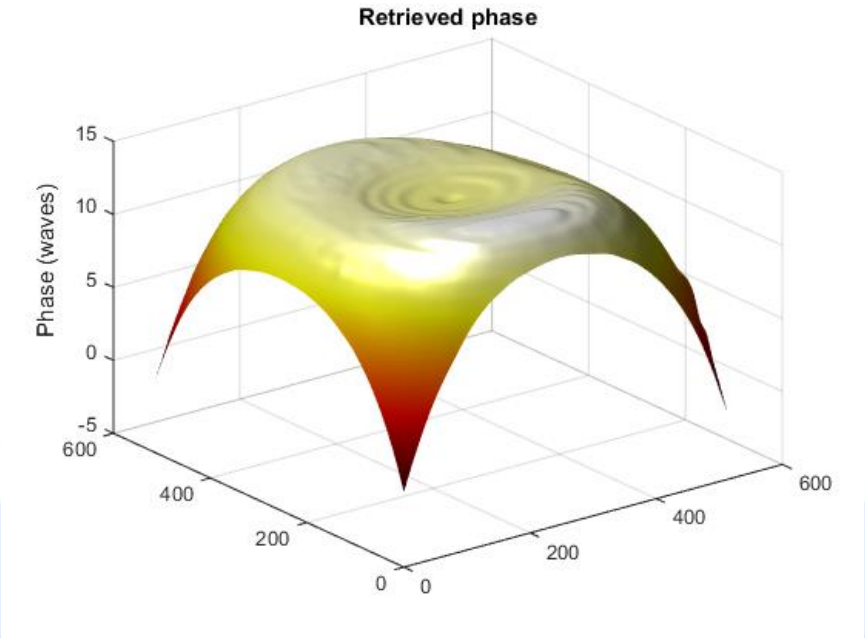
w/ triggered fast camera & GPU accelerated calculation, 100 Hz nulling is possible

# Nulling results: Custom SLM-applied phase

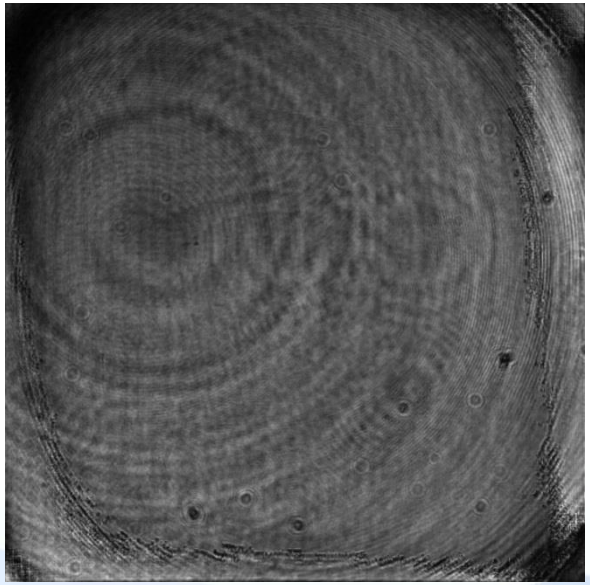
Interferogram before nulling



PSI retrieved phase




System nulled



X tilt: 0.5
Y tilt: 0.25
Oblique astigmatism: 0.25
Defocus: 1
Horizontal coma: 1

# Future work

## Speed

Speed limited by 15fps camera rate
SLM speed: 400fps; 500fps w/next-gen
>100 Hz nulling

## Commercial-grade hardware

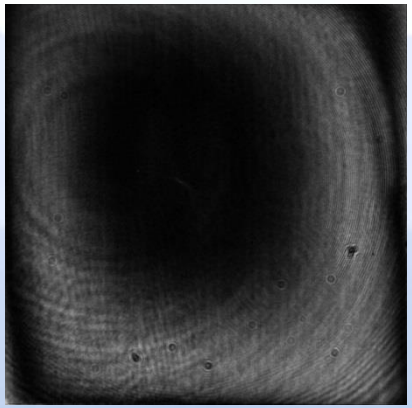
Vibration management
Quality of optics
Integration w/ commercial interferometer

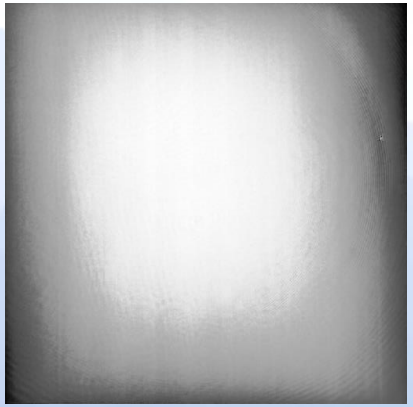
## Characterization

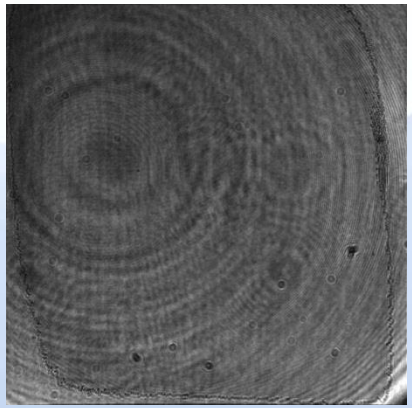
Accuracy, range
Results w/ known optics & CGH

## Regional SLM calibration

Accounts for nonuniform SLM surface

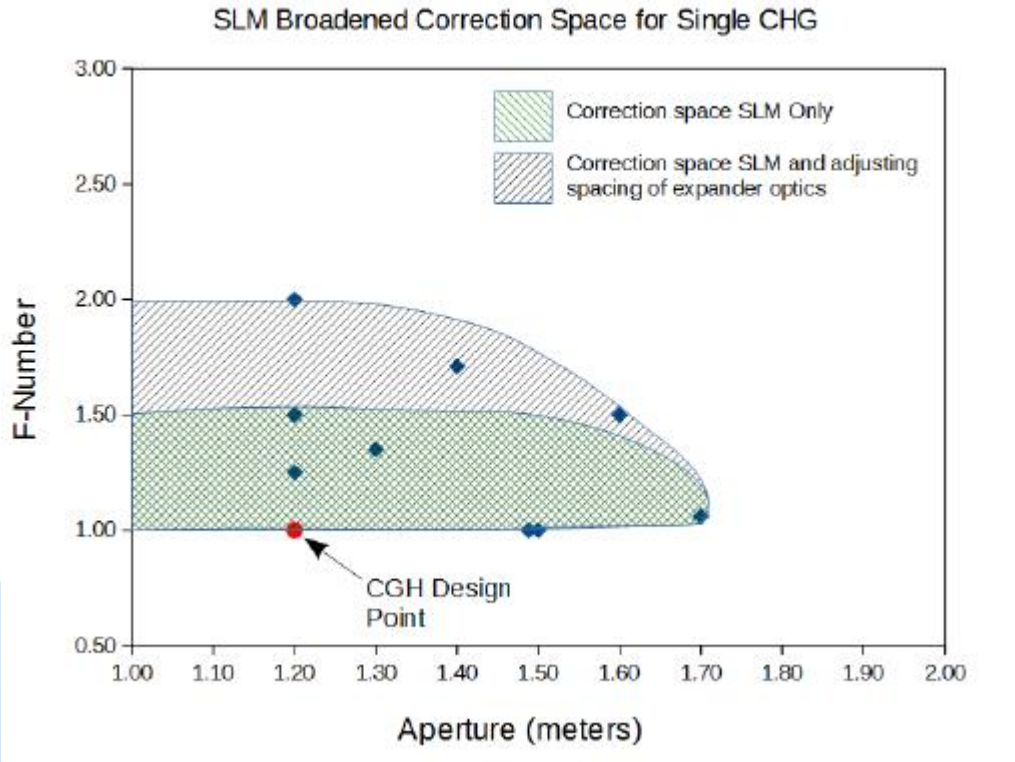






# Future work – expanded range

SLM: 100 wave range

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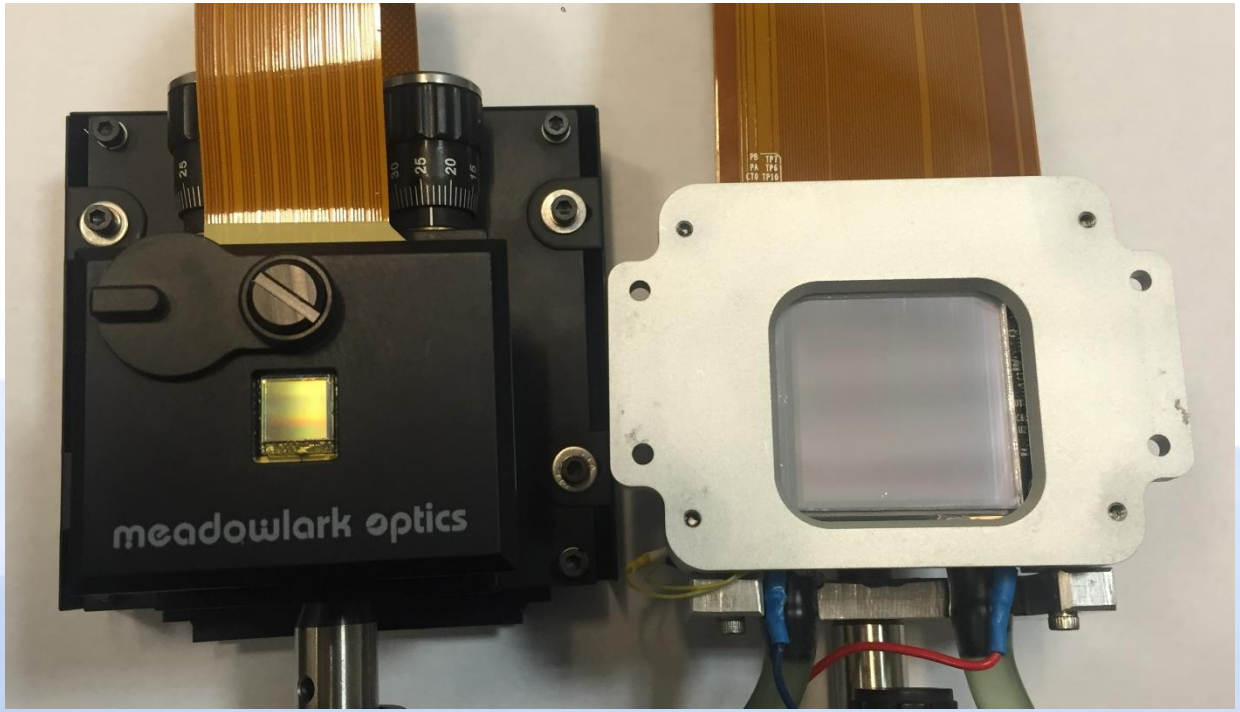
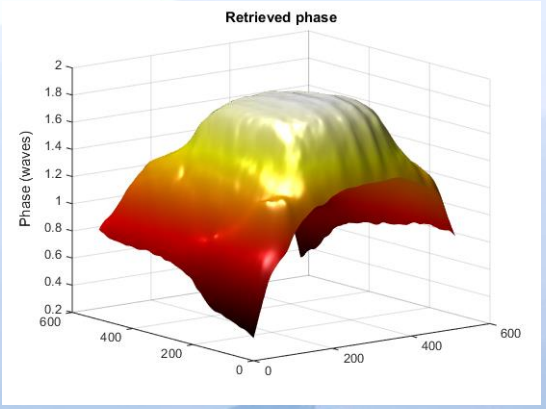
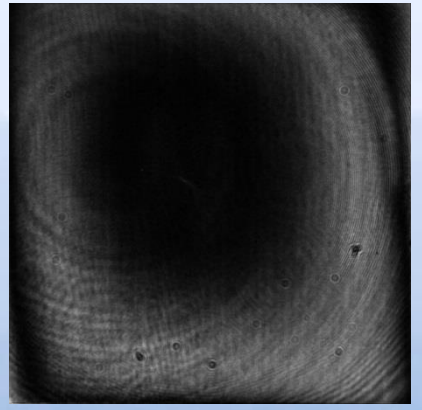
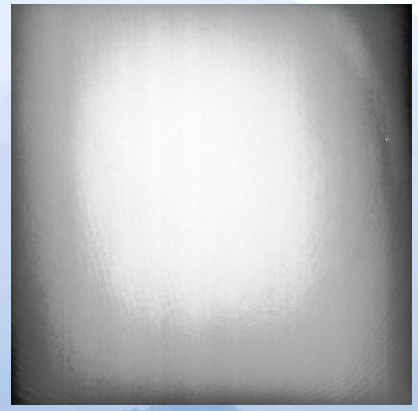
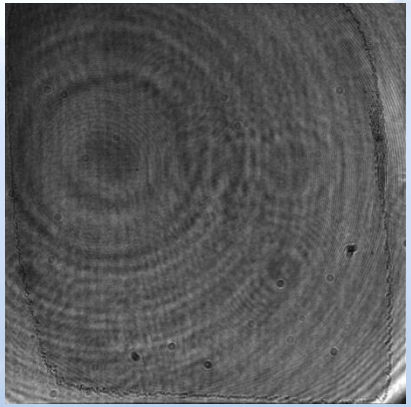


# Conclusions

- LCoS can apply arbitrary phase, incl. piston for PSI
- Can extend the range of a CGH
- 1 Hz nulling shown; 100 Hz nulling likely
- Phase 2: larger SLM, commercial interferometer

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