



Research progress of 4" laser interferometer mainframe based on wavelength phase shift technique

Qi Lu, You Zhou, Shijie Liu, Xueke Xu
Shanghai Institute of Optics and Fine Mechanics, CAS

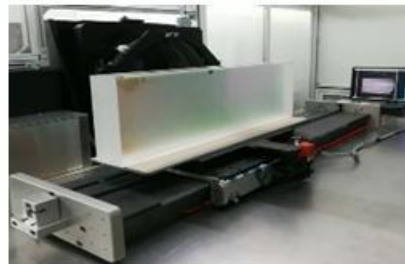
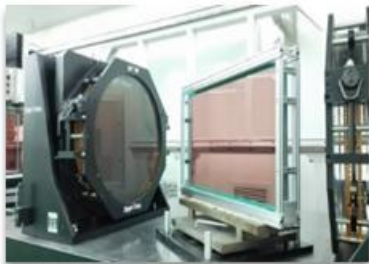
Dmitry Silin, Iliya Kozhevatorov
Institute of Applied physics, RAS

Dec. 1, 2020



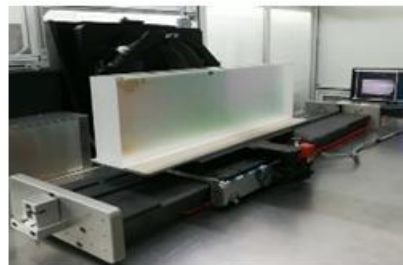
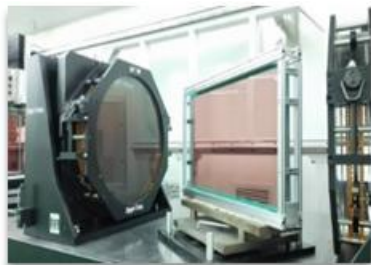
Outline

- **Motivation**
- **Design progress**
- **Current progress**
- **Future works**



Outline

- **Motivation**
- Design progress
- Current progress
- Future works



1. Motivation

Laser optics



In 1960, the first laser by Maiman



Lasers have been widely applied in different fields



SULF

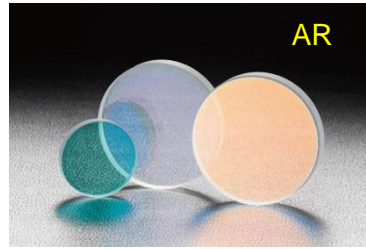
Laser based innovations in the future:

- Miniature beam
- Laser based clock
- Ultrashort lasers
-

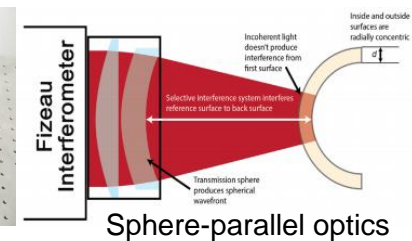
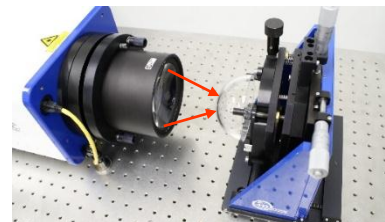
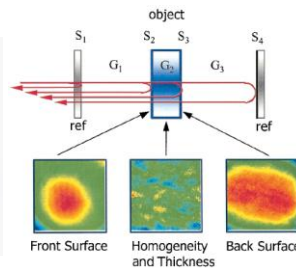
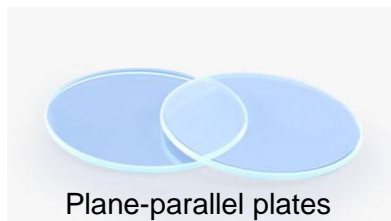
1. Motivation

Requirements

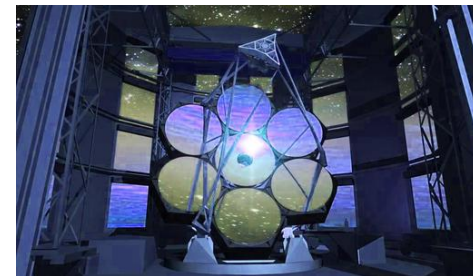
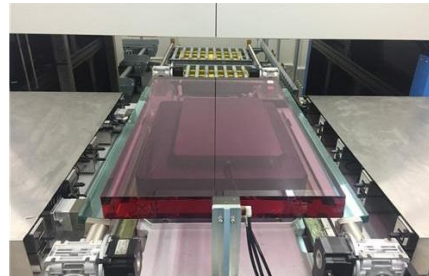
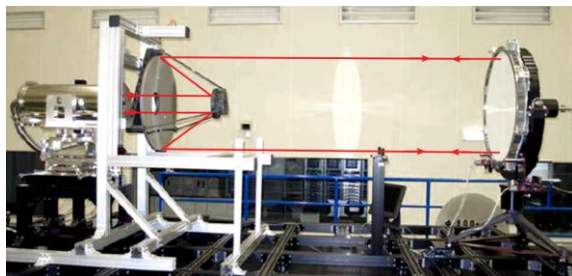
■ Optical coating elements



■ Parallel multi-surface elements



■ Large Optics



1. Motivation

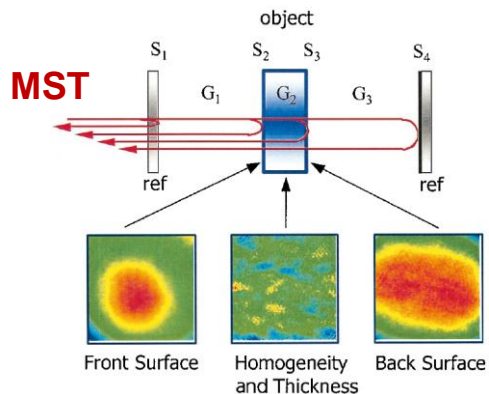
Substitute for similar products

- 4" laser interferometers (mainframe)



Zygo Verifire™ MST (4")

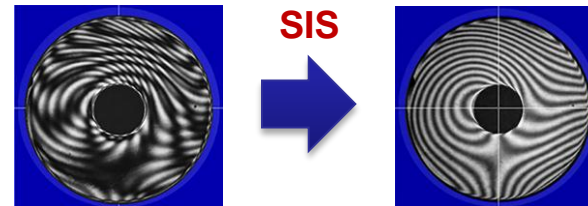
- Wavelength phase-shifting



4D FizCam (4")

... ..

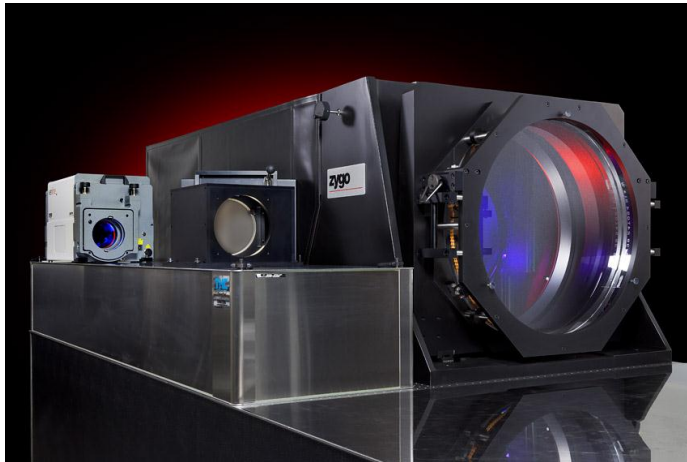
- Common path short-coherence
- Polarization phase-shifting



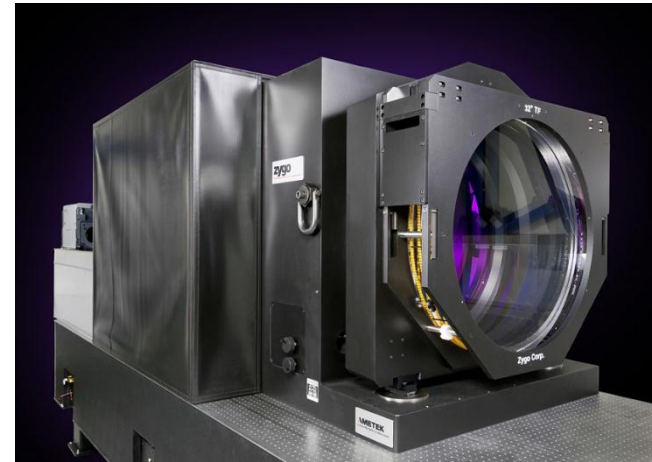
1. Motivation

Substitute for similar products

- Large-aperture interferometers



Zygo Verifire™ (24")



Zygo Verifire™ (32")



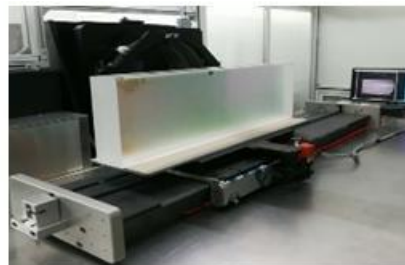
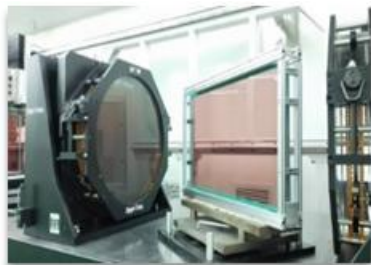
4D Fizcam (18")

Right to left: AccuFiz Fizcam Interferometer, with 100-300 mm Aperture Converter, 300 mm Phase-Shifting Tip/Tilt Mount and 300 mm Tip/Tilt Mount.

.....

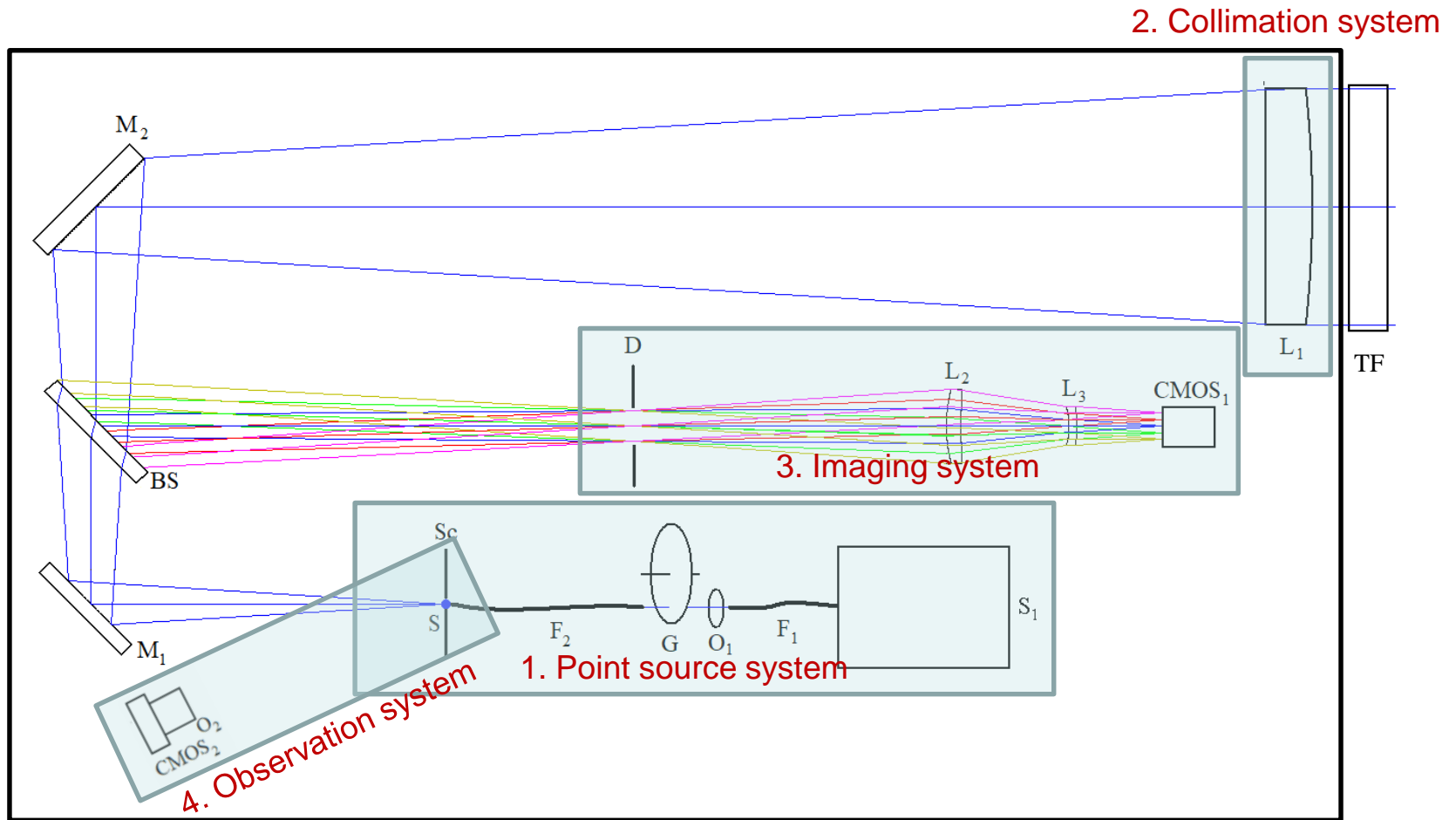
Outline

- Motivation
- **Design progress**
- Current progress
- Future works



2. Principles

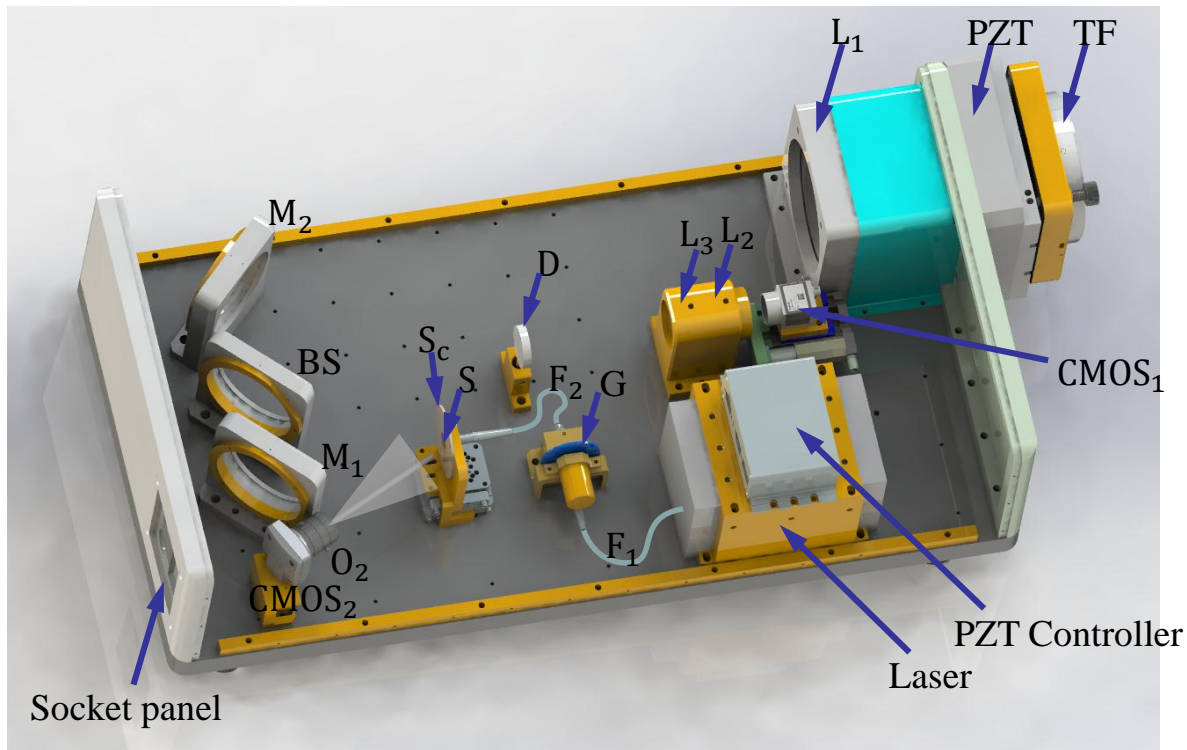
System composition



Scheme of Optical design

2. Principles

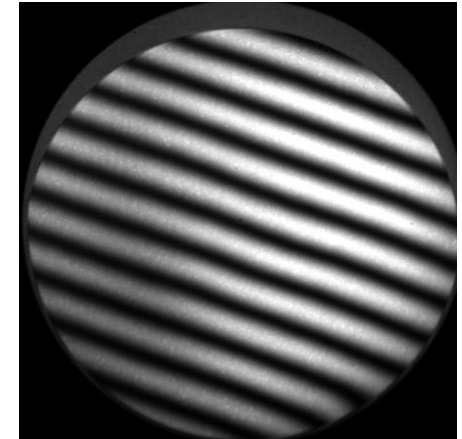
Mechanical design



Scheme of mechanical design

Advantages:

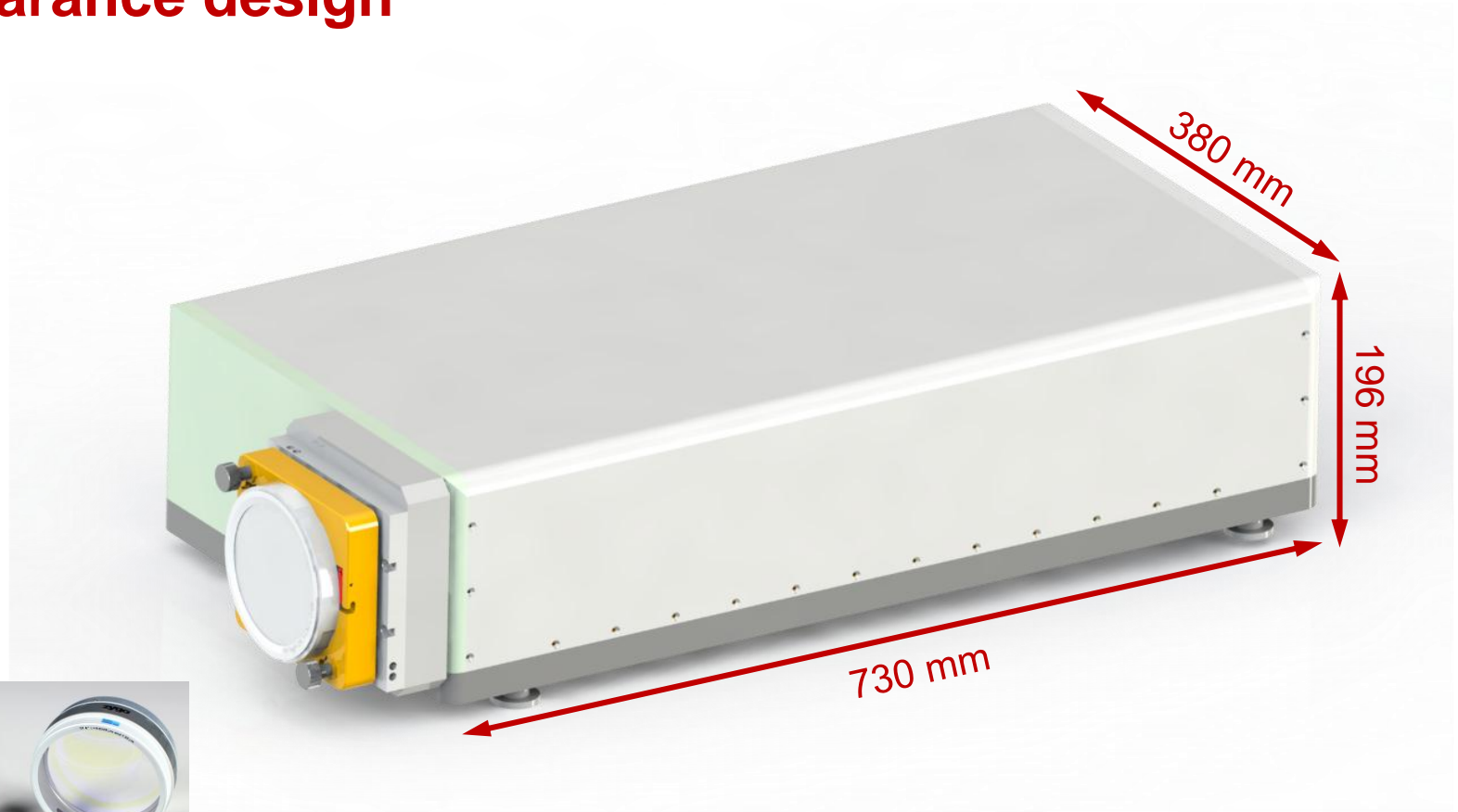
1. Simple structure
2. Compact design
3. Pure interferogram



2048×2048 fringe

2. Principles

Appearance design

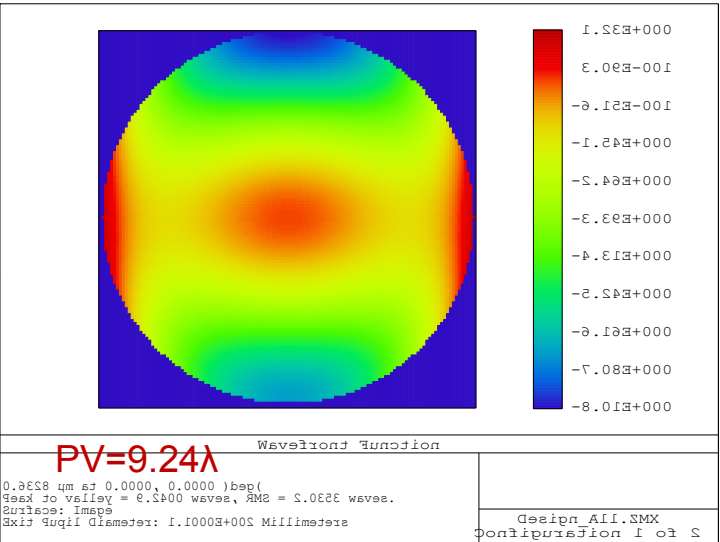
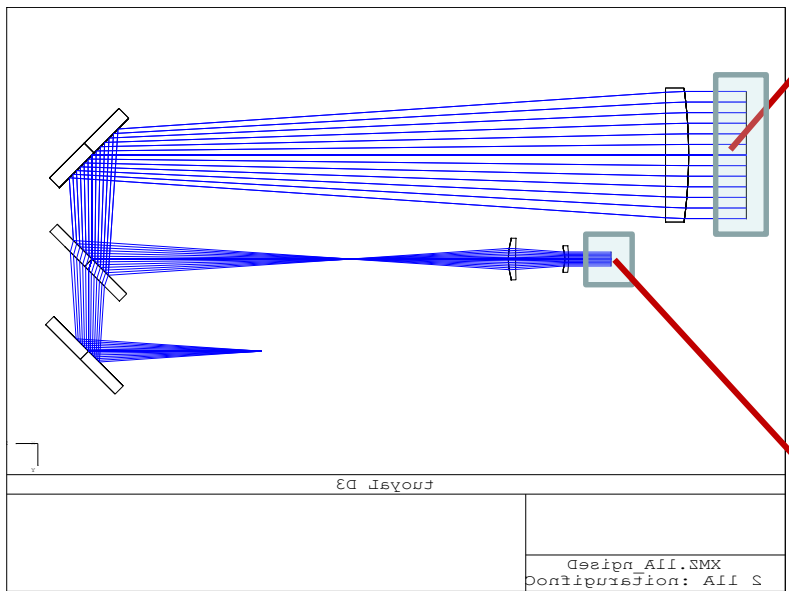


Universal TF mount

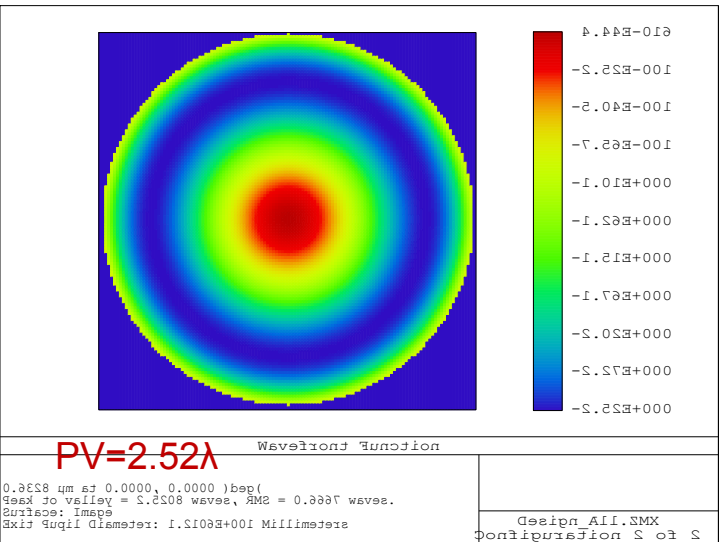
2. Principles

Optical design

1. Collimated wave design



Collimated wavefront after beam expansion

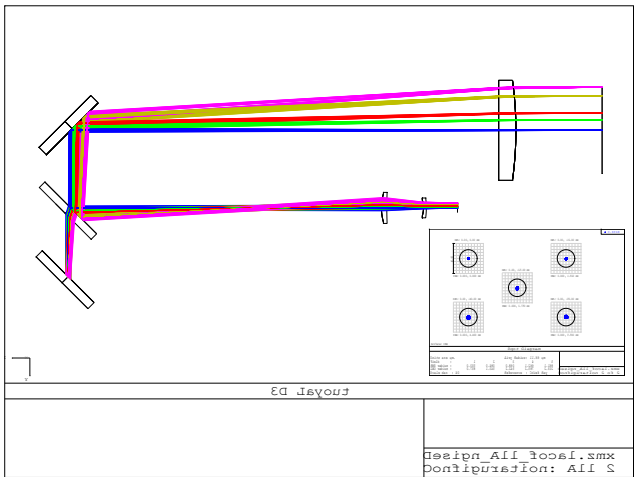


Collimated wavefront after beam contraction

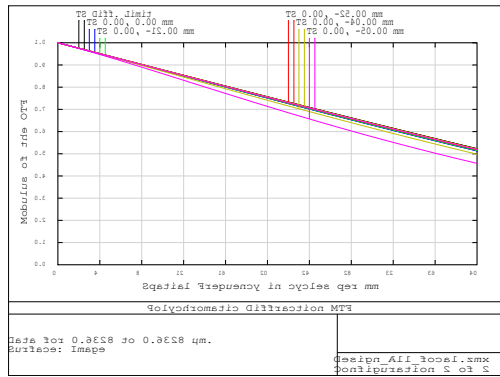
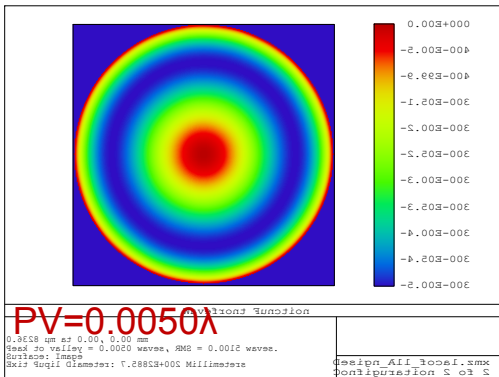
2. Principles

Optical design

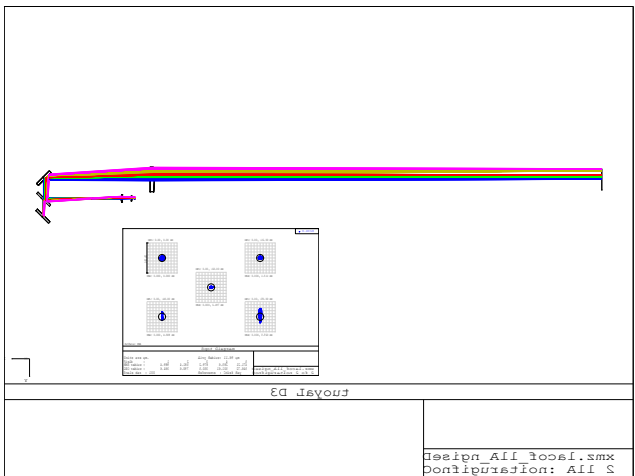
2. Imaging aberration design



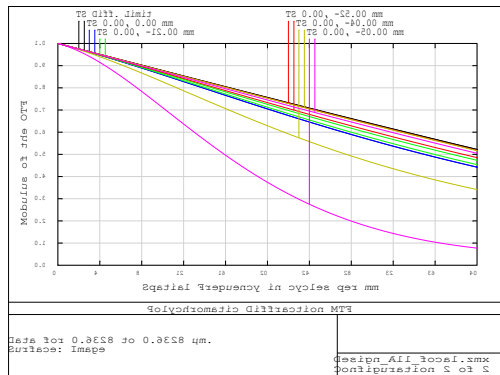
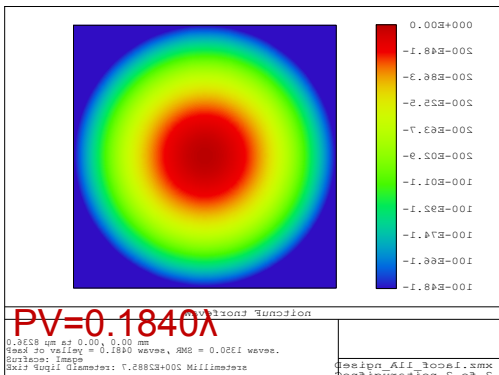
Imaging aberration of near object



Wavefront map and MTF curves



Imaging aberrations of distant object (2 m cavity)

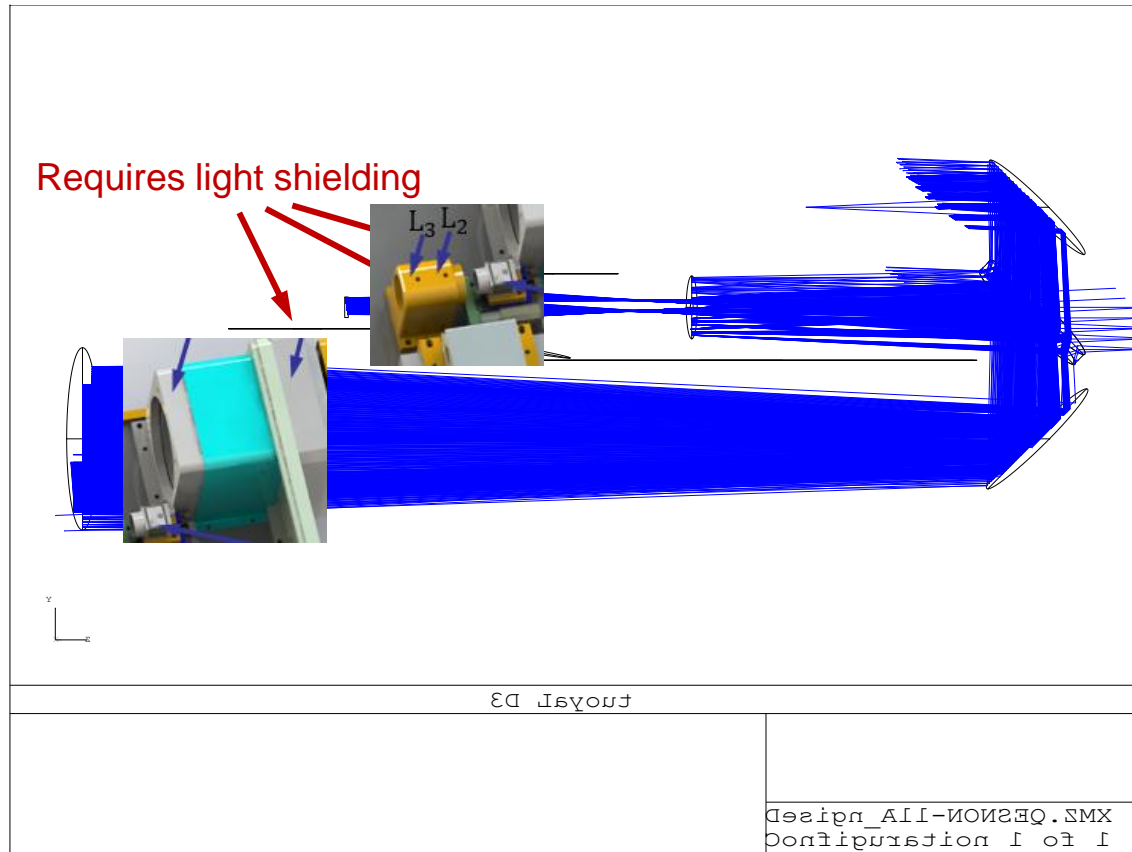


Wavefront map and MTF curves

2. Principles

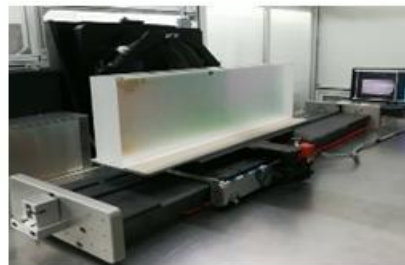
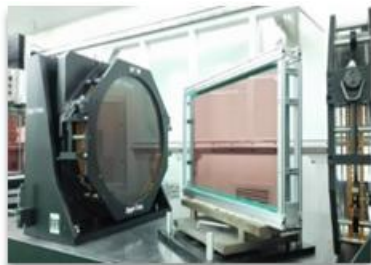
Optical design

3. Stray light shielding design



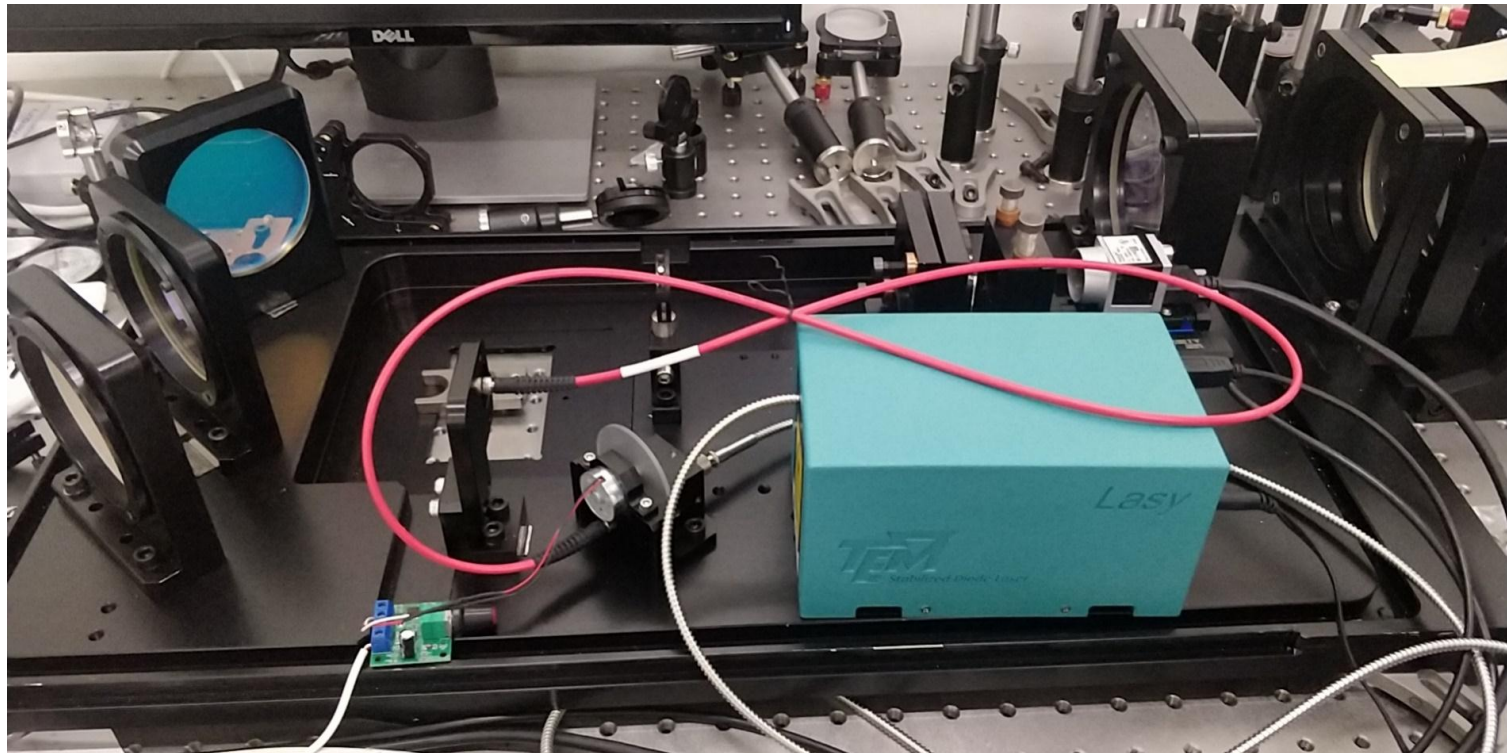
Outline

- Motivation
- Design progress
- **Current progress**
- Future works



3. Current progress

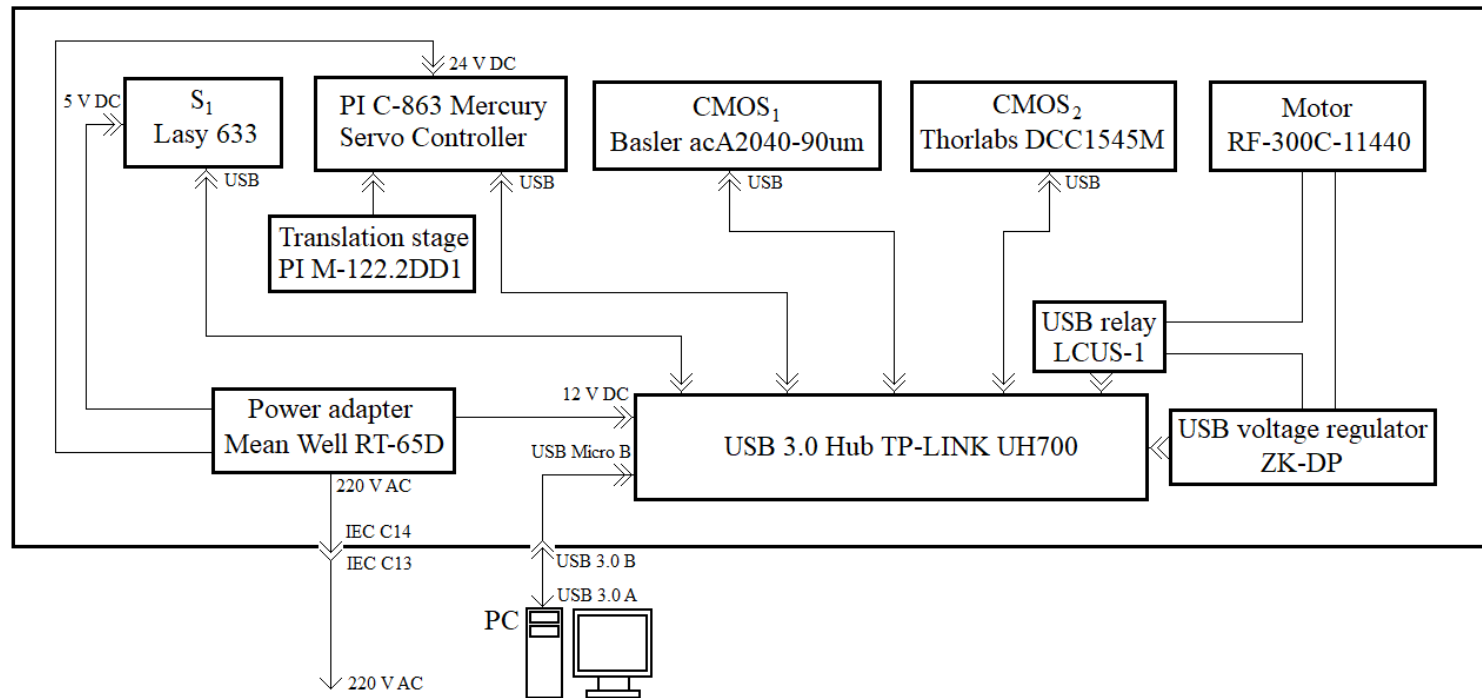
Assembly process



Interior diagram of the 4" laser interferometer mainframe

3. Current progress

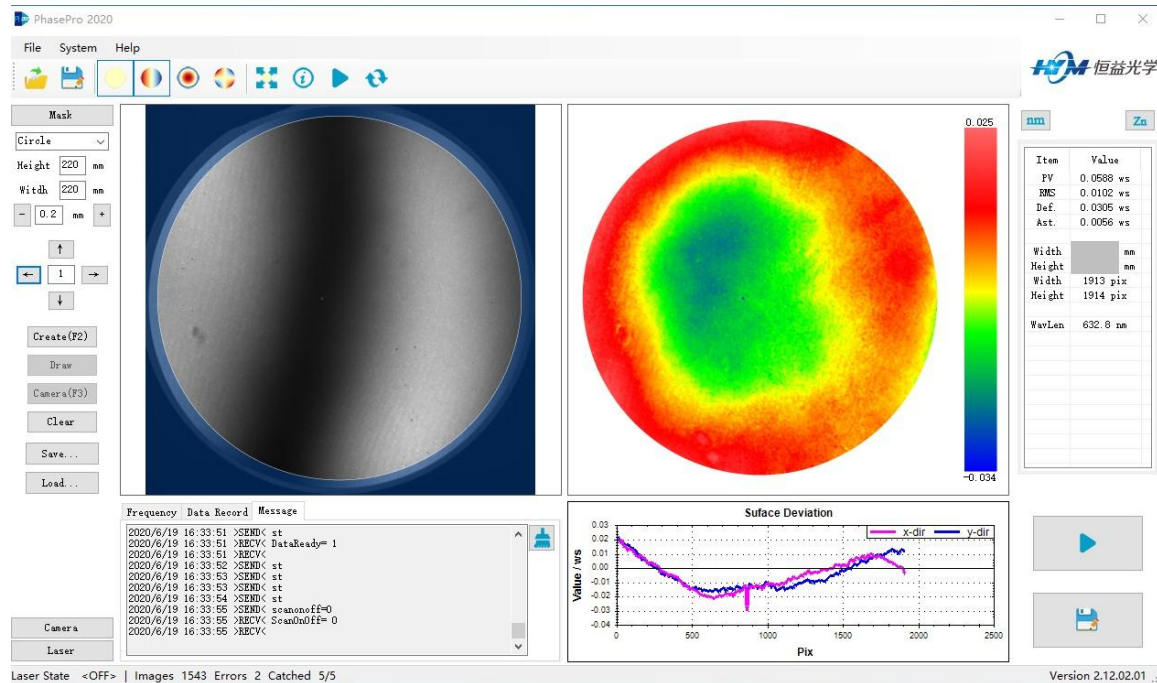
Electric control diagram



Electric control diagram

3. Current progress

Measurement software – “PhasePro”



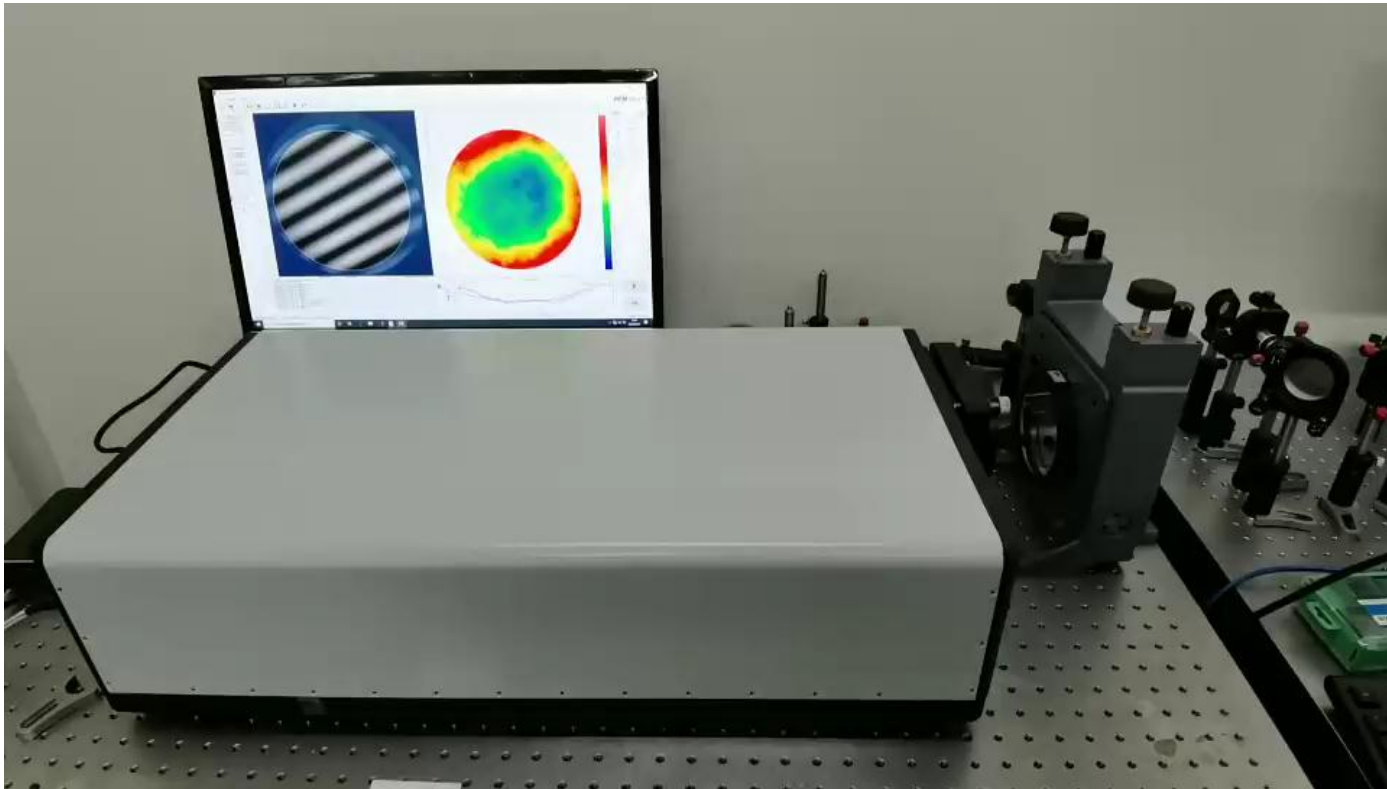
Main functions:

1. Real-time display of the interferogram
2. Mask, Camera, Laser settings
3. Calculation and analysis of PV, RMS, Def., Ast., etc.
4. Zernike polynomial coefficient fitting
5. 2D and 3D surface profile distribution
6. Measurement of optical homogeneity (Δn)

...

3. Current progress

1st China-Russia 4" laser interferometer mianframe

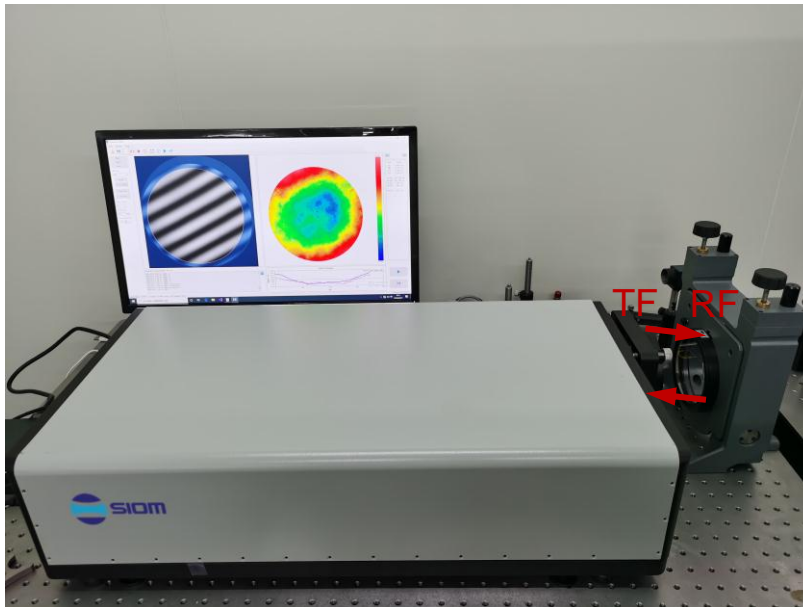


Video recording after installation

3. Current progress

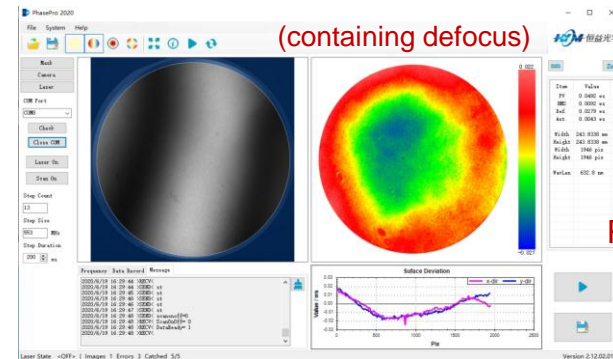
Cavity measurement

- Acceptance criteria: $PV < \lambda/10$

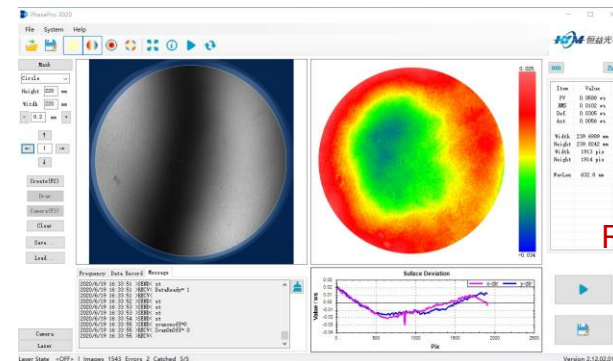


Cavity measurement ($\Phi 100$ mm)

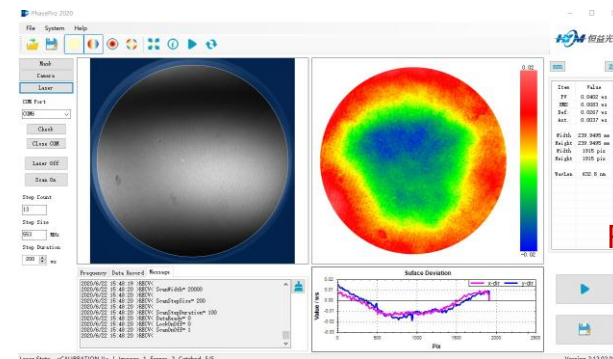
Measurement results



PV=0.0492 λ
RMS=0.0092 λ



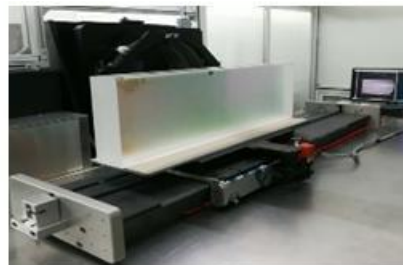
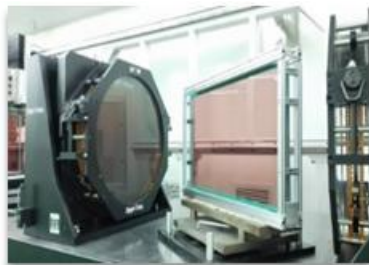
PV=0.0588 λ
RMS=0.0102 λ



PV=0.0402 λ
RMS=0.0083 λ

Outline

- Motivation
- Design progress
- Current progress
- **Future works**

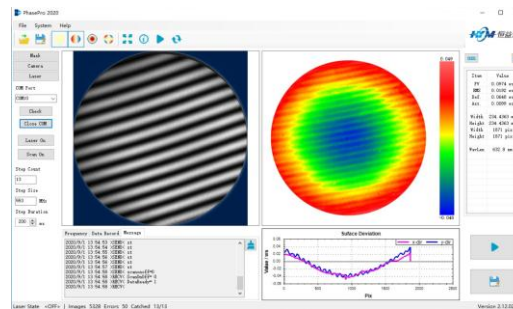


4. Future works

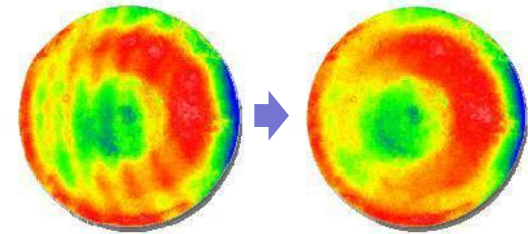
1. Software refinement

2. Anti-vibration

- Acquisition fringes > 5
- Ripple patterns appear



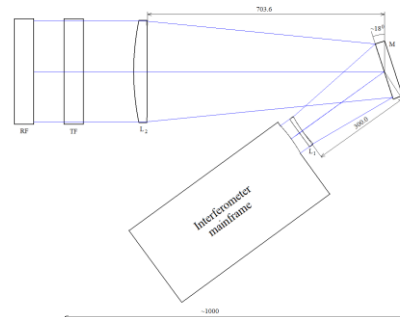
Ripple patterns



Anti-vibration

3. 24" Lage-aperture interferometer

- Component polishing is currently underway



Optical path design



Idea of appearance



Thank you!

Better Optics, Better Laser, Better Life !

CHINESE ACADEMY OF SCIENCES