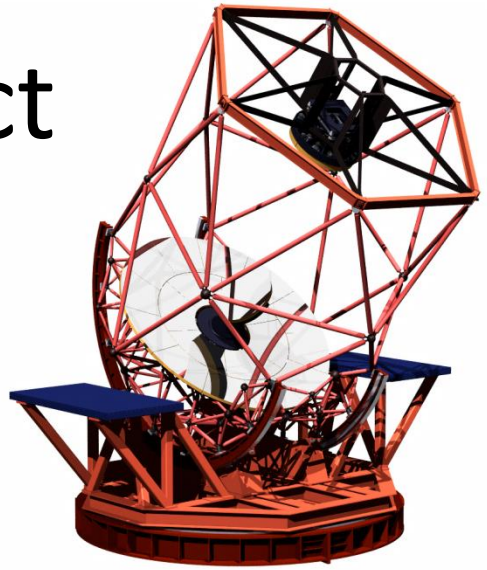
Kyoto Univ. 3.8m New Technology Telescope

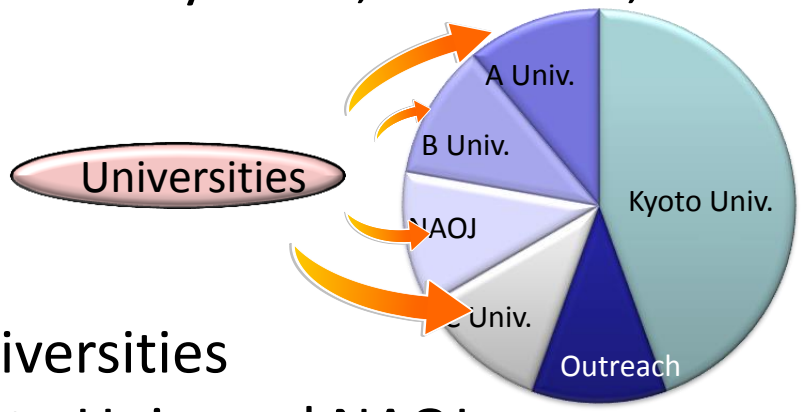
Mikio Kurita（栗田　光樹夫）
(Department of Astronomy, Kyoto University)

April 2010

Outline of the Project



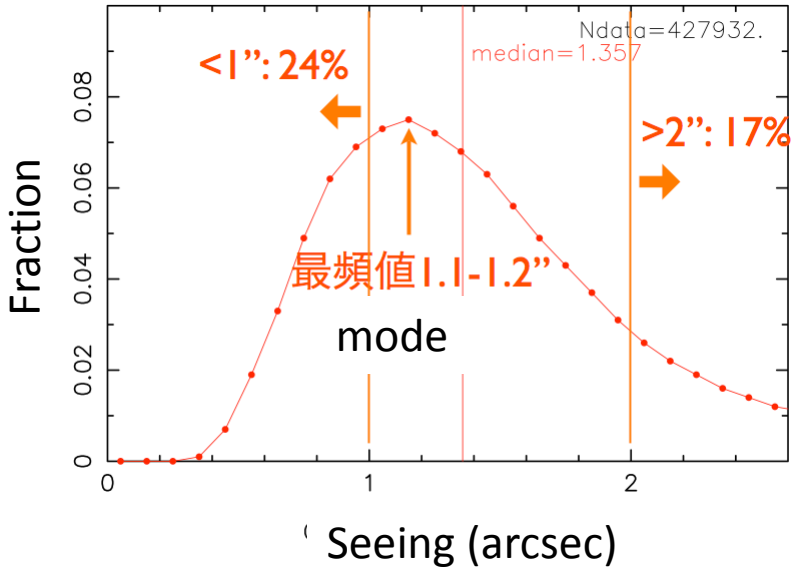
- Telescope
  - 3.8 m telescope
  - 18 petal shape segments
  - Lightweight and high speed drive
- Key Science
  - Time Domain Astronomy (Gamma ray burst, Flare Star, etc.)
  - Exo-planet with EXtreme AO
- Operation
  - By Kyoto Univ. and NAOJ
  - Joint use telescope among universities
  - Budget will be covered by Kyoto Univ. and NAOJ

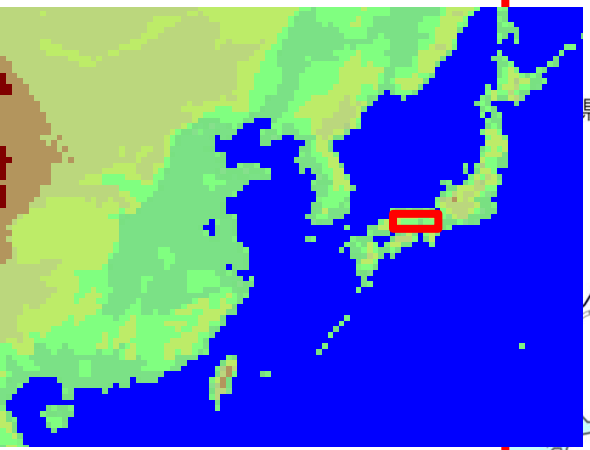


Site

Okayama Astrophysical Observatory, NAOJ

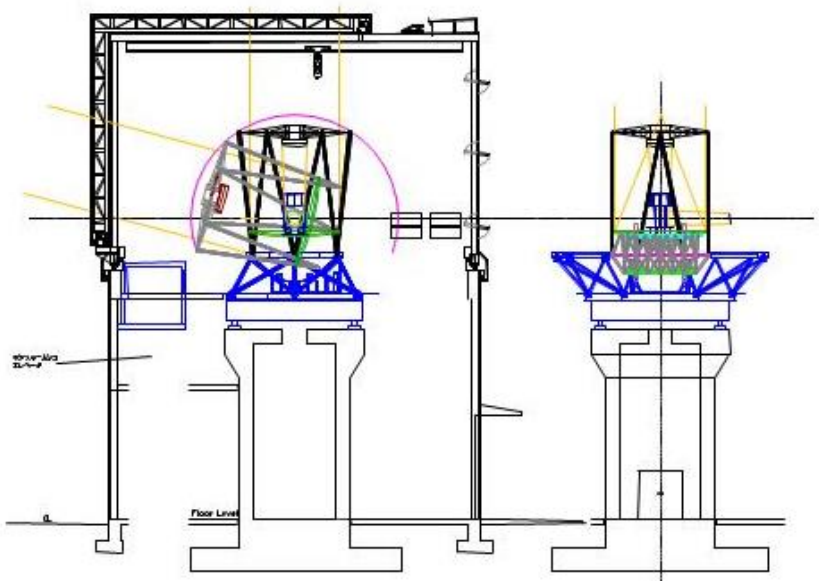
- Clear night = 50 %
- Photometric night < 20 %

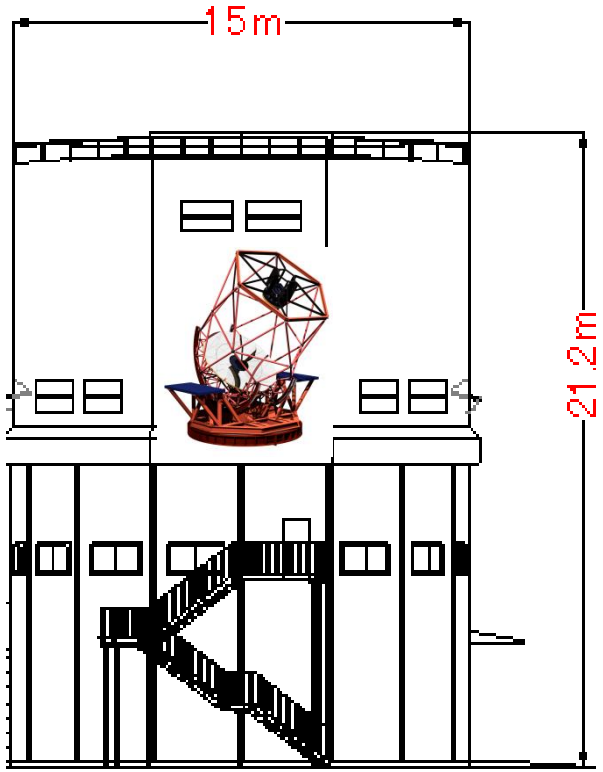




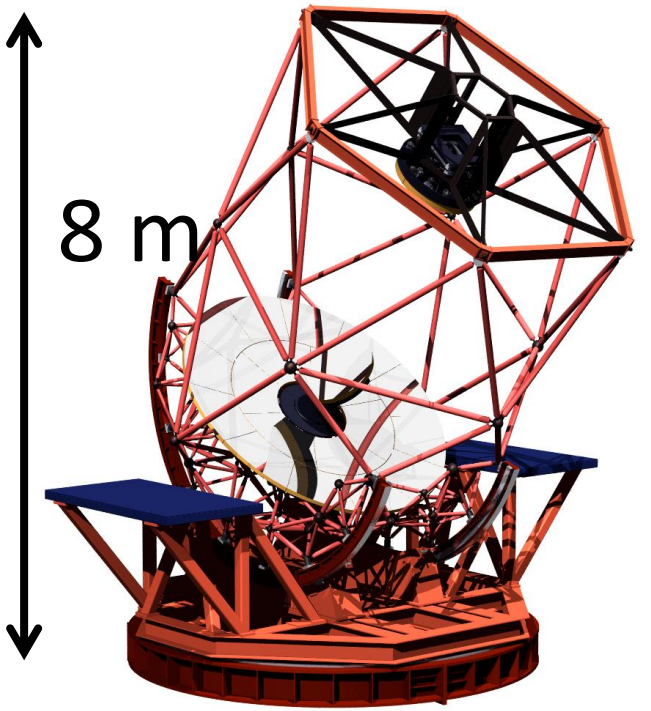
Enclosure

- 15 m pedestal
- Cylindrical dome (Subaru Heritage)

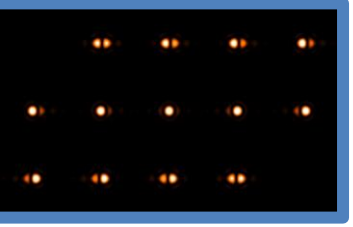




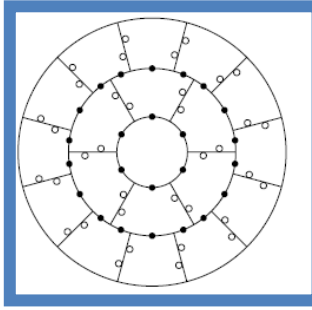
Telescope



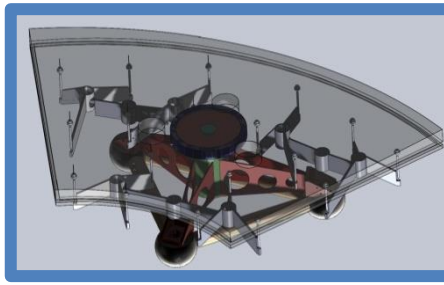
Aperture:	3.8 m
Focus:	Nasmyth × 2 F/6
FoV:	10’, 1°
Wavelength:	0.4 to 4.2 um
AO:	J, H bands
Pointing speed	< 1 min
	El speed 2° /s
	Az speed 3° /s



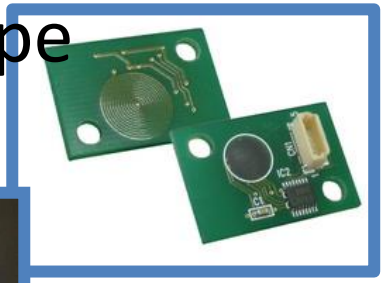
Technology Development

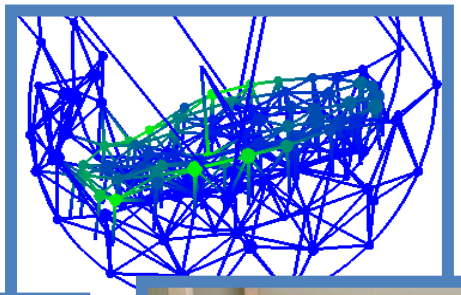


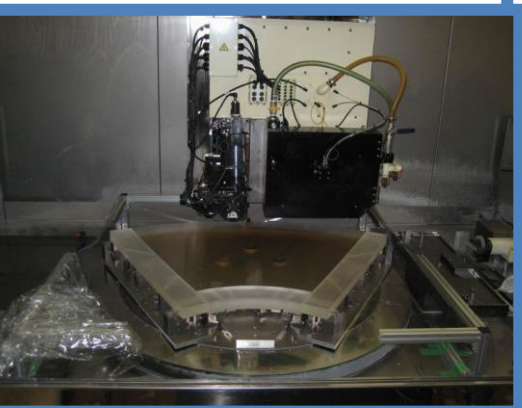
- Quick process for meter size optics by an ultra precision grinder and on-the-machine test system
- Segmented mirror control system
- Compact and ultra-light structure

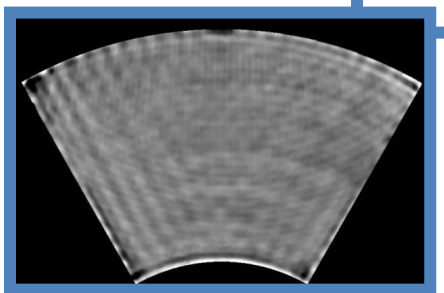


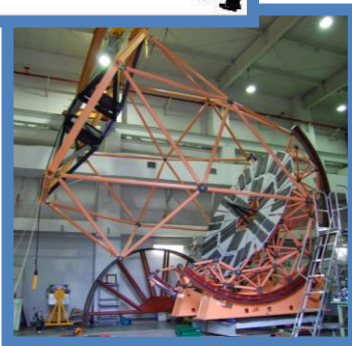
Low cost and moderate performance for medium size telescope











Mirror Factory

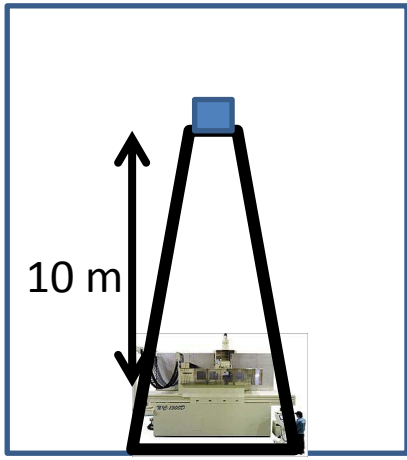
- Quick process for meter size optics ; M1, M2, M3, corrector lens, Grating, and other optics

Facility
（Nano Optonics Energy）

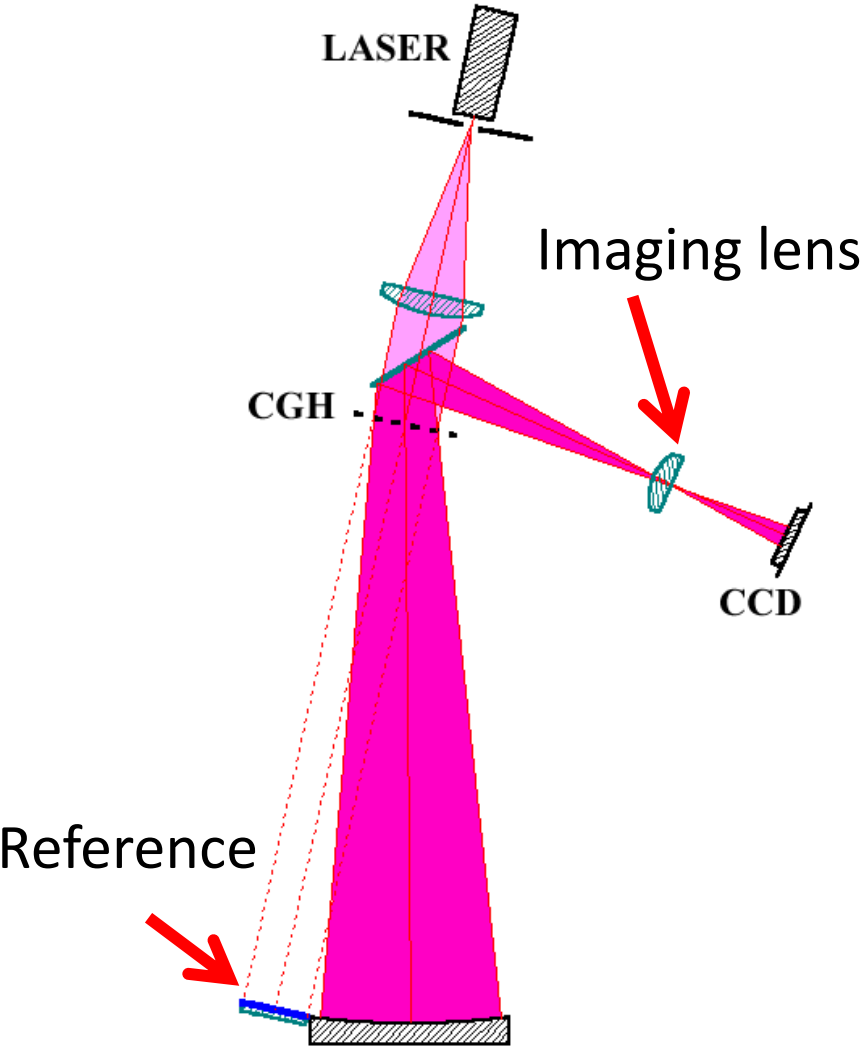
Grinding Machine
（N2C-1300D）

Quick Process for Optical Elements

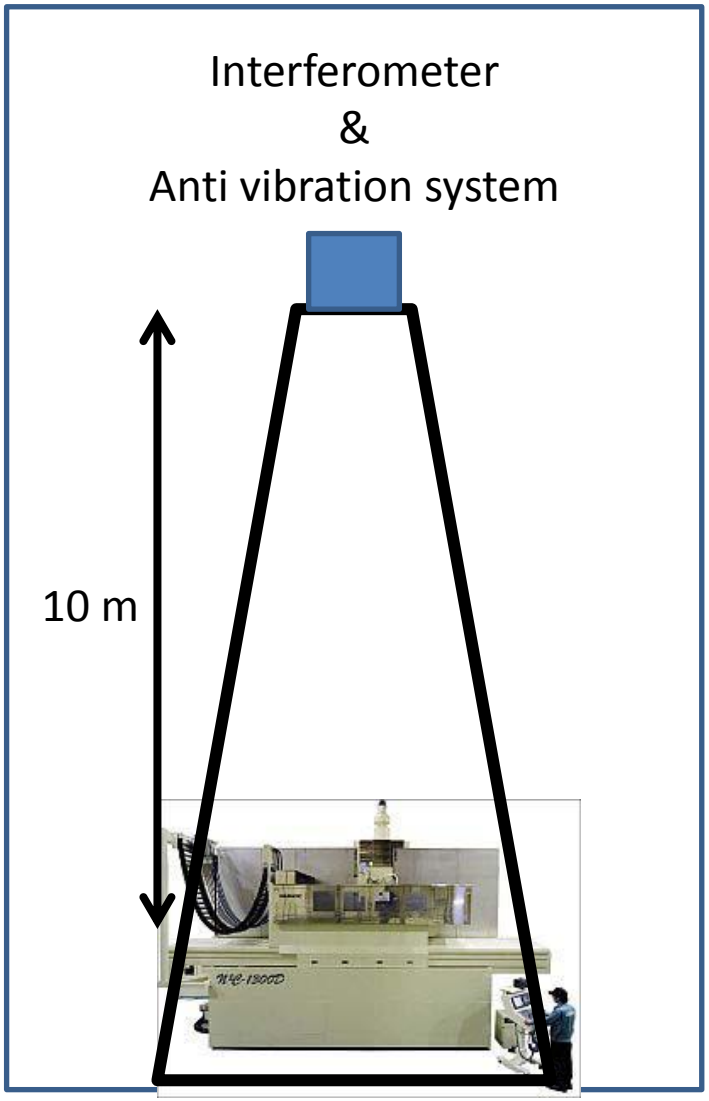
- Accuracy : 1um with open loop
- Processing time: 1 m within 1 month
- Maximum work size : ϕ1.6 m
- Test: CGH and i-Fezeau interferometer
  - Radius of Curvature: < 10 m
  - Test system for convex optics under development



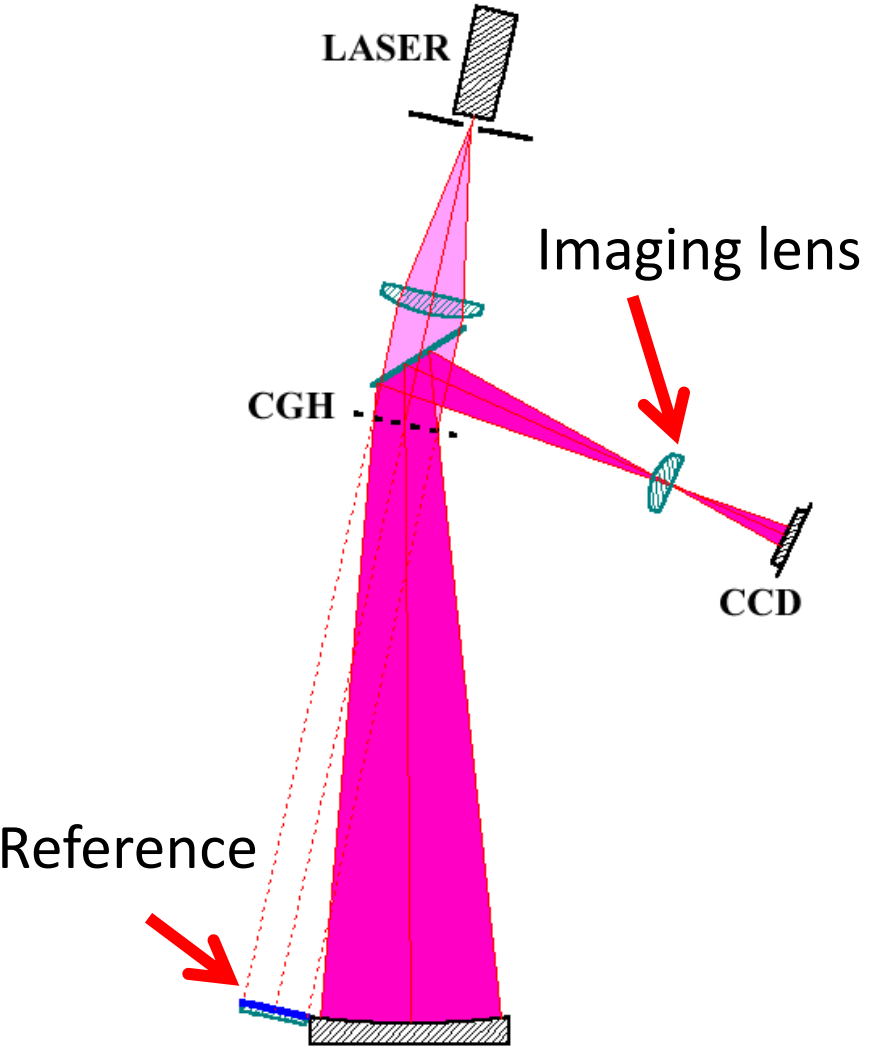
Optical Test



Chamber T:23±0.1 deg



CGH Interferometer



- Semi common pass

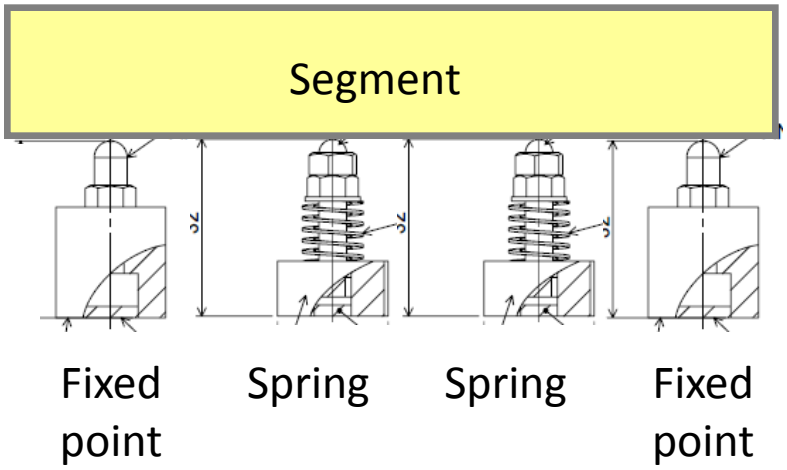
→ Robust against turbulence and vibration

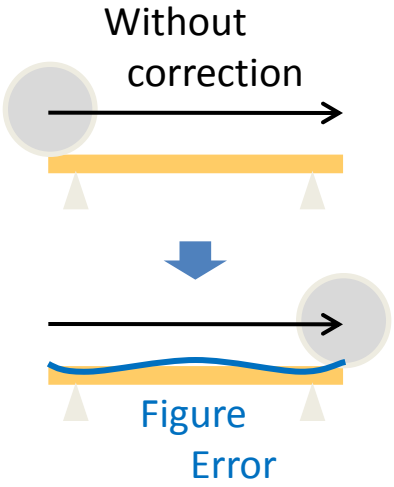
- Reflected test beam passes through the zero power optics

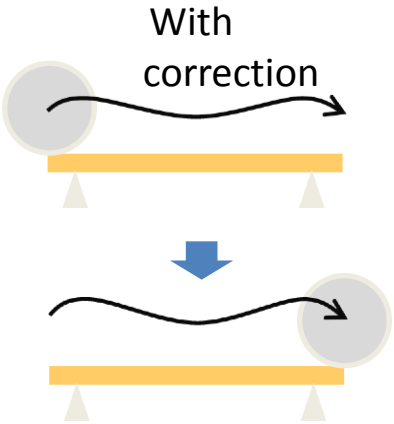
→ High lateral resolution

Kinematic Support Grinding

- Grinding pressure push the glass downward.
- Fixing glass rigidly, footprint error appears.
- The deformation induced by grinding pressure was simulated beforehand, and the stone travels along the corrected trajectory.

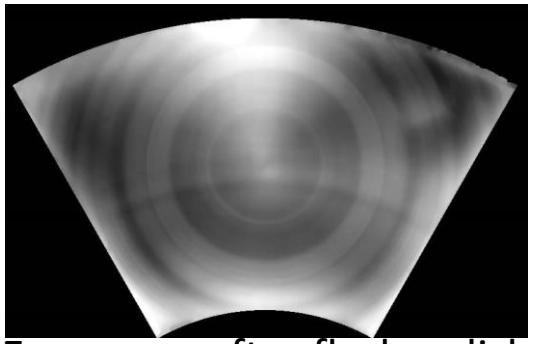




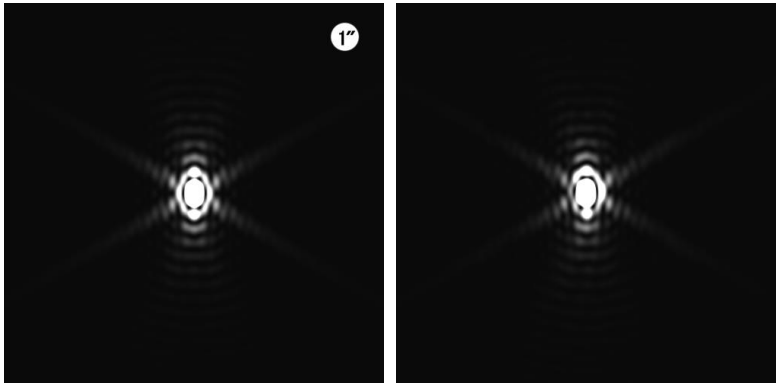


Result

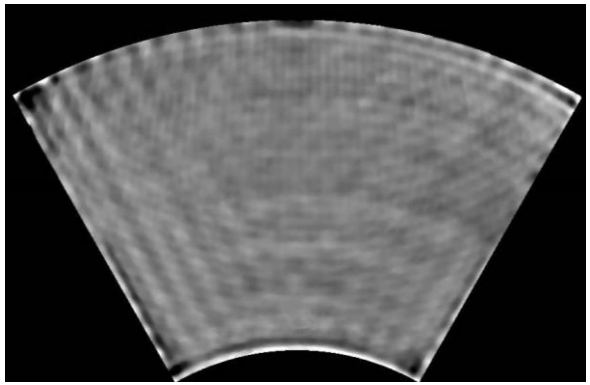
Processing time: 13 days
The time will be reduced to several days by optimization of grinding method already developed.



Error map after flash polish
-1 um to 1 um

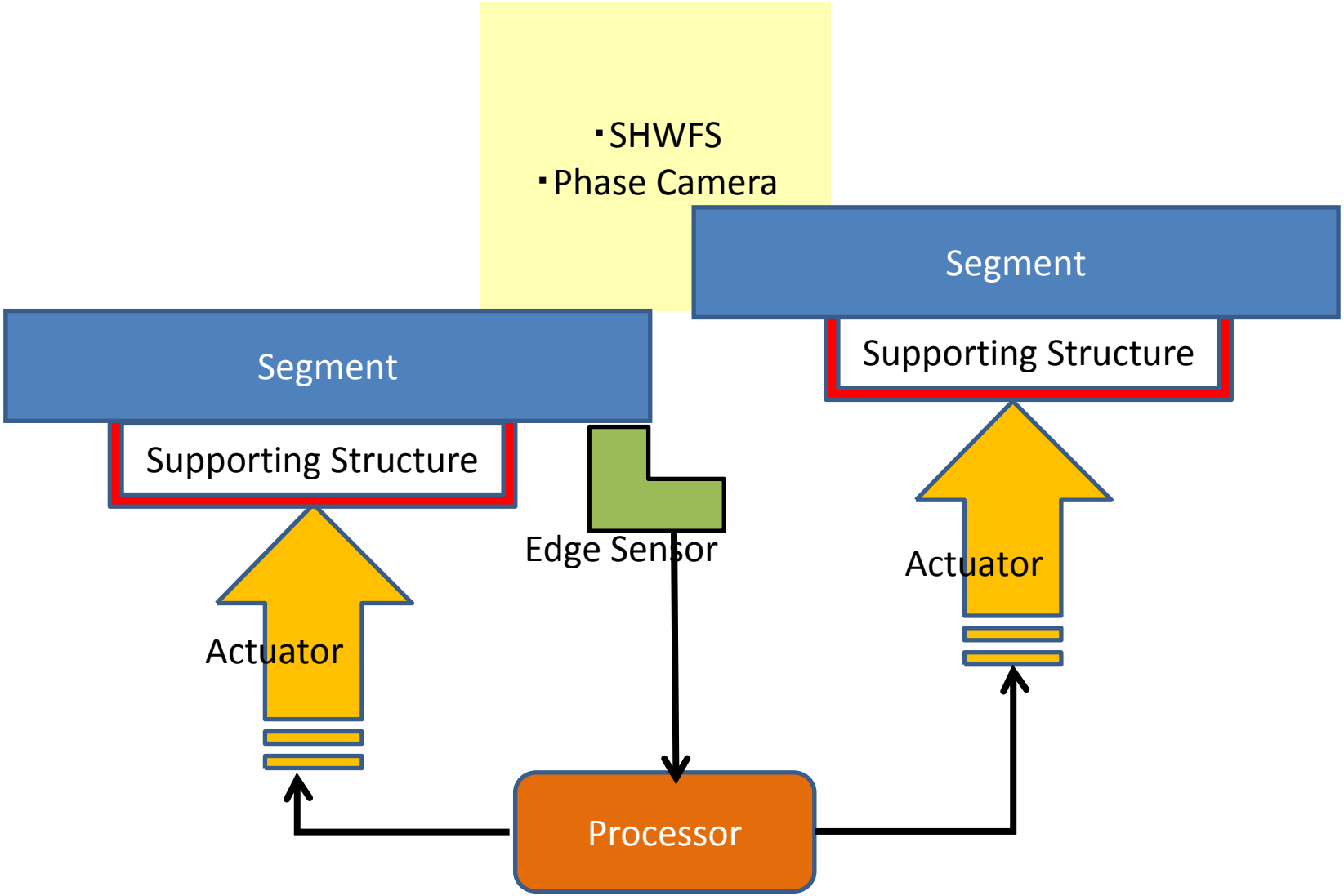


PSF
Left : Ideal mirror shape
Right : 1st mirror

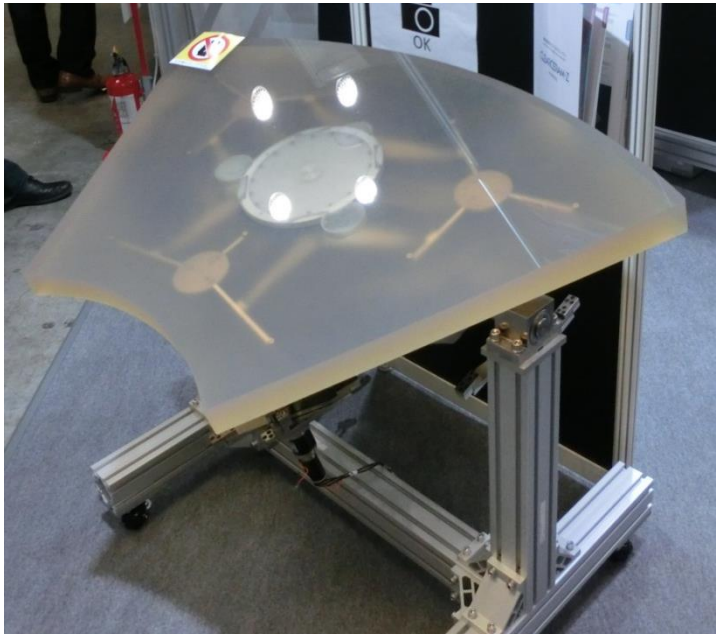


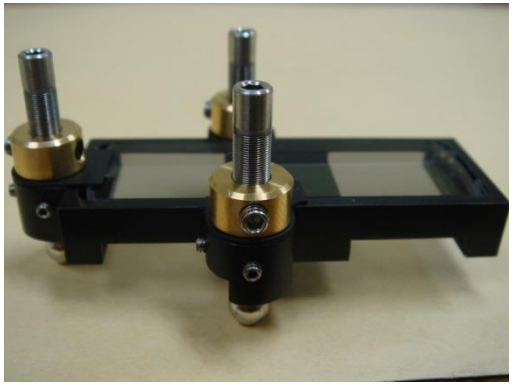
Error map after correcting polish
-0.1 um to 0.1 um

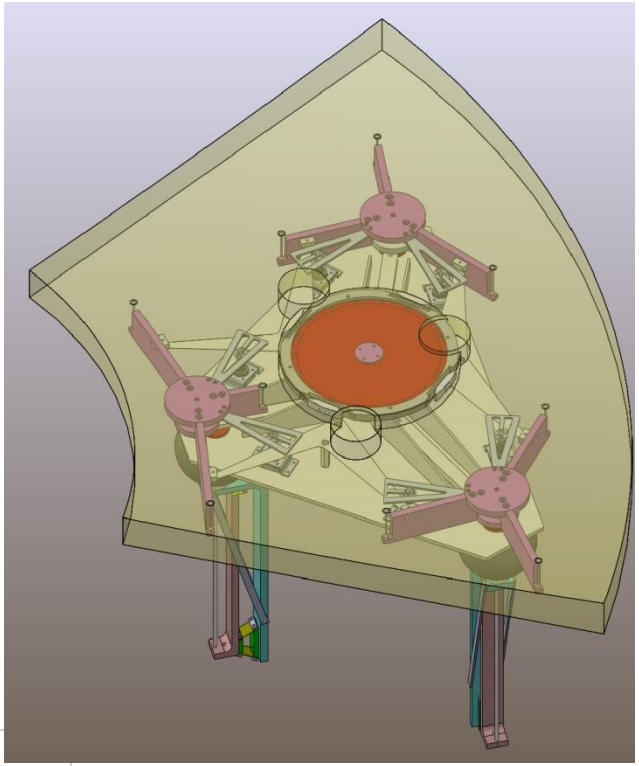
Segment Control System Component

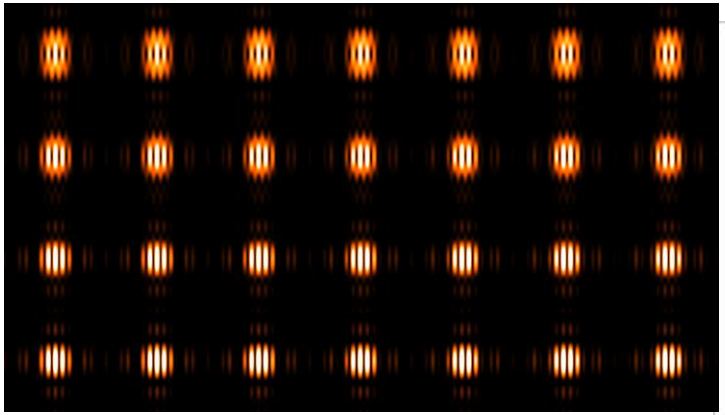


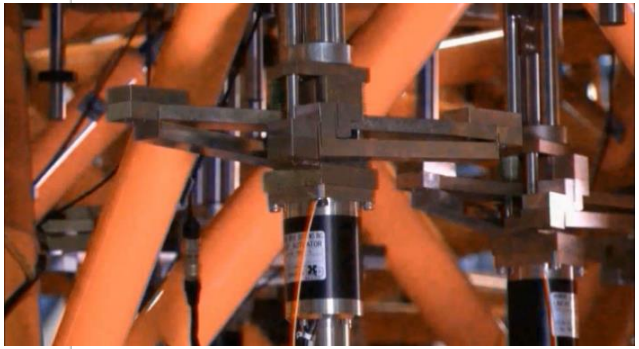
Segment Techniques
Actuator











Lightweight Structure

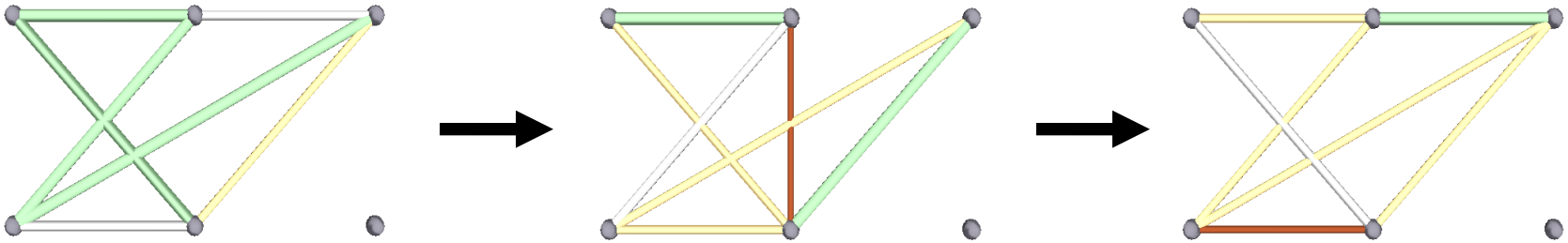
- The primary mirror is directly supported by large elevation rings.
- Whole the telescope tube consists of system truss
- 1/5 of Conventional Telescope weight

- Advantages
  - High speed drive
  - Small cross section and low air drag
  - Low heat capacity
  - Large surface area and low heat inertial

Genetic Algorithm

Selection, Mutation, & Crossover

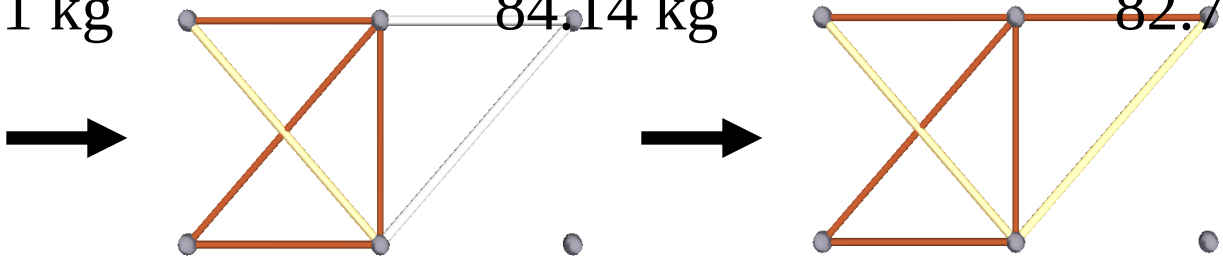
Cantilever example



Parent
88.51 kg

1st Generation
84.14 kg

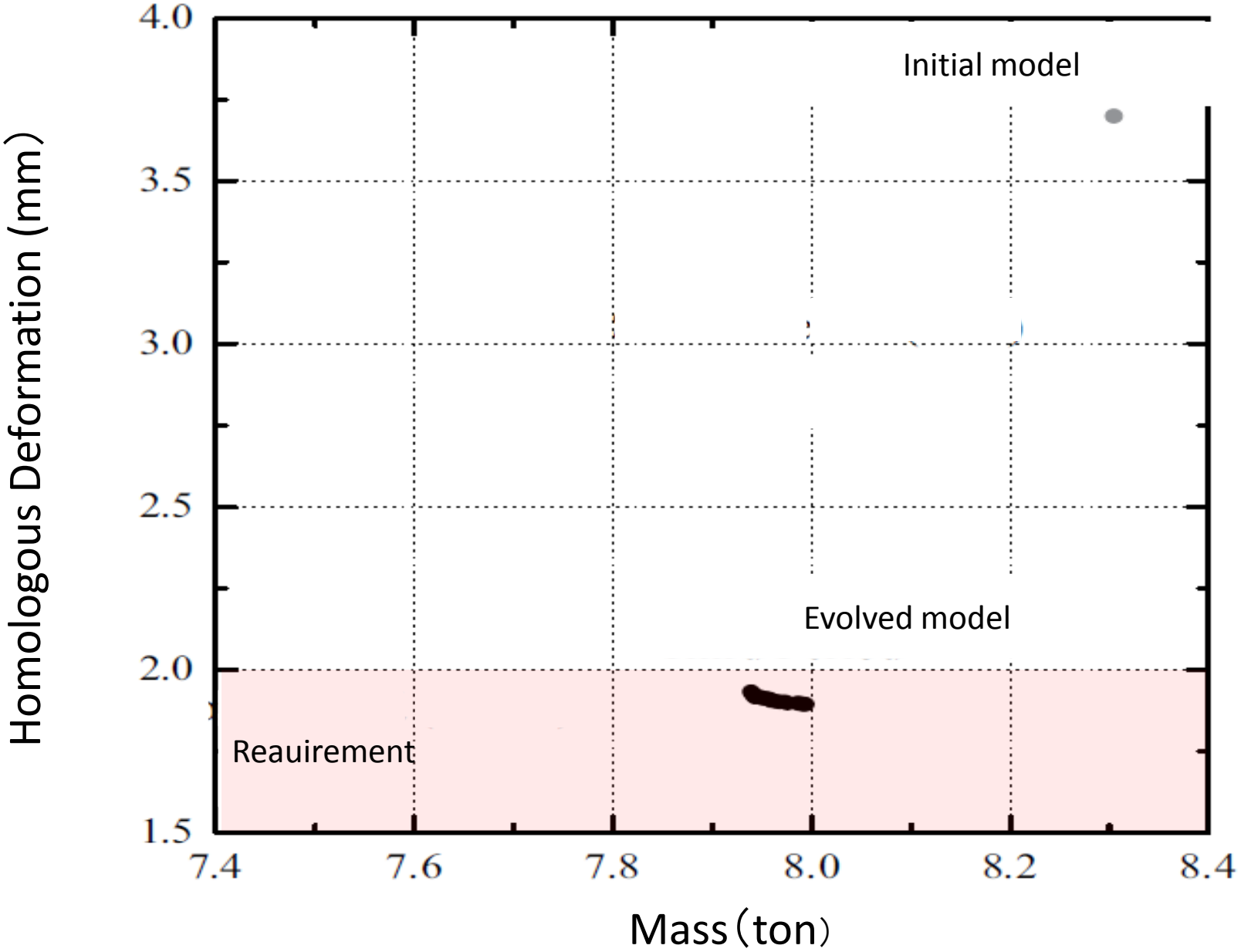
3rd Generation
82.71 kg



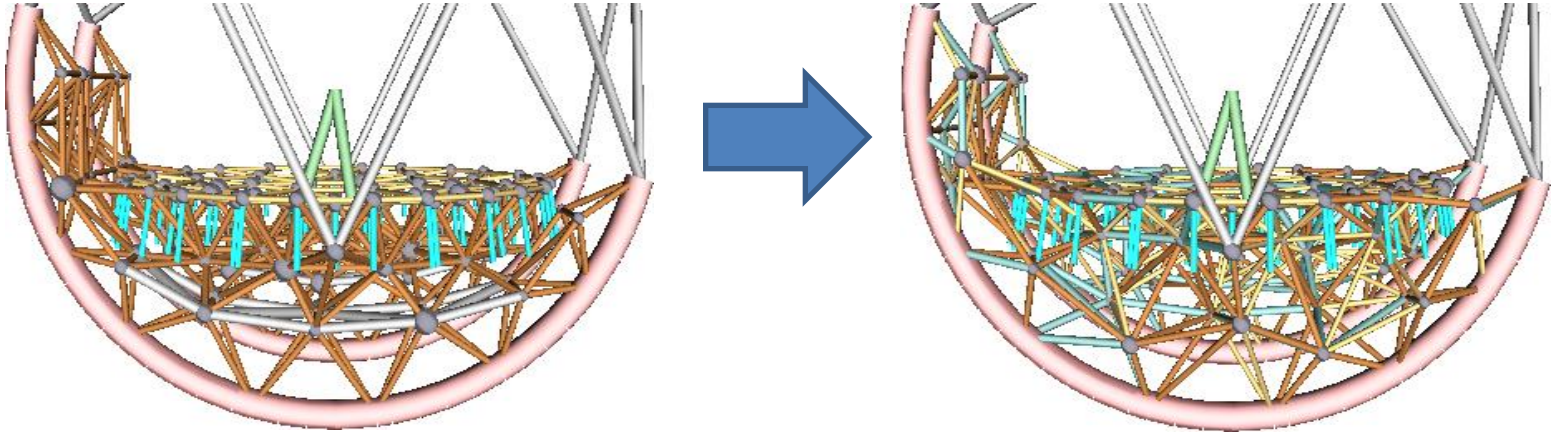
10th Generation
77.52 kg

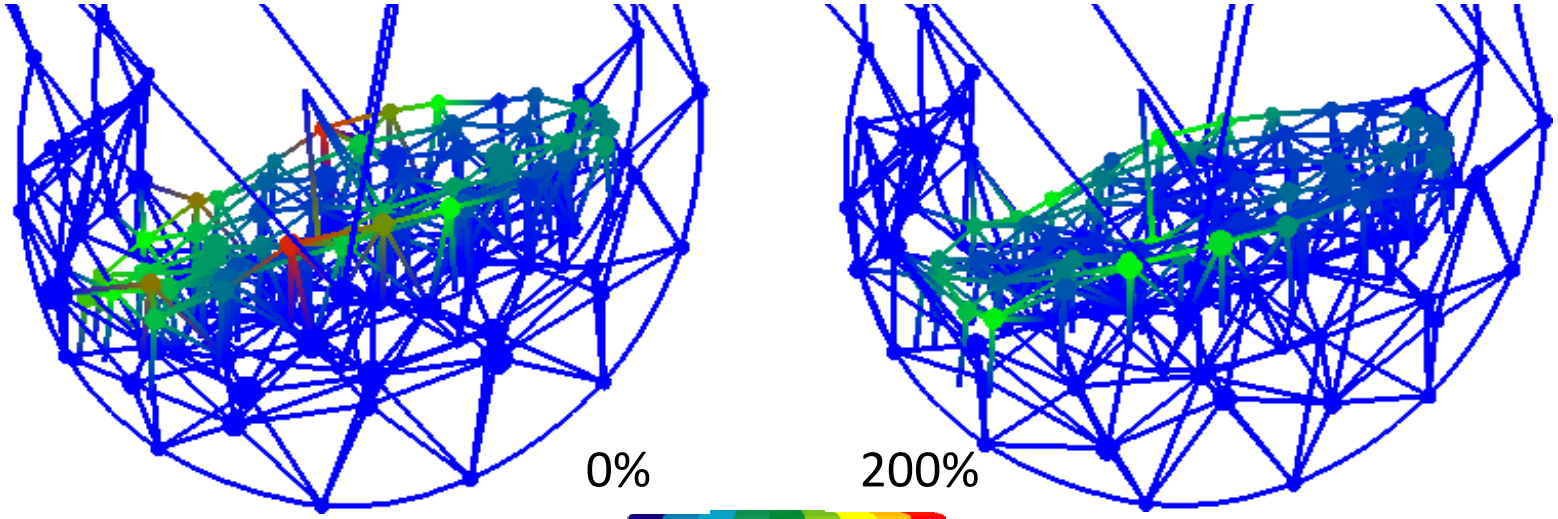
18th Generation
76.22 kg

Evolution


Homologous Deformation (mm)
4.0
3.5
3.0
2.5
2.0
1.5
Initial model
Evolved model
Reauirement
7.4
7.6
7.8
8.0
8.2
8.4
Mass（ton）

Lightweight Structure Optimization by GA

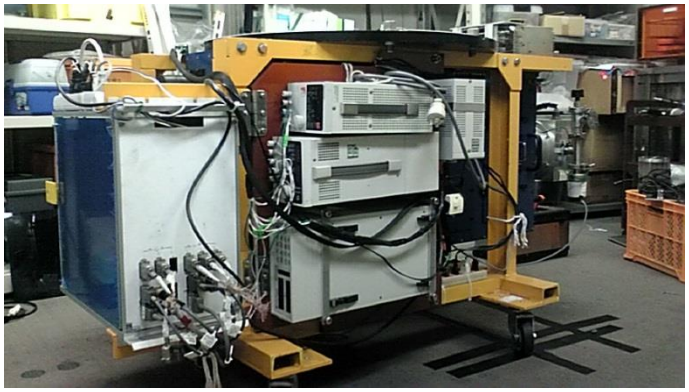




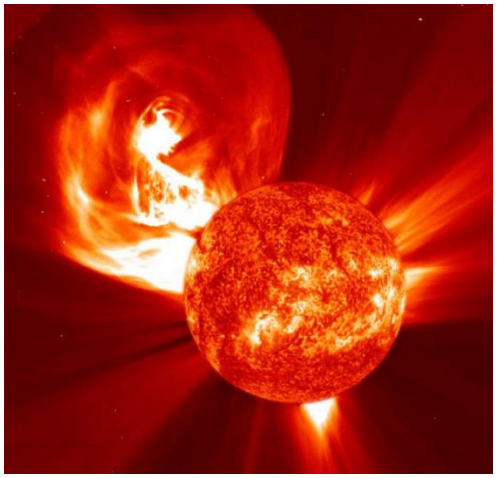
Instrument List

	High Speed Opt. Photometer	High Contrast Camera	Opt IFS	NIR IFS	Opt High Dispersion Spectrograph	High accurate Photometer
Science	Time domain	Exo planet	Time domain	Formation & evolution of QSO	Stellar super flare	Exo planet
FoV	2'□	10″□	10″□	7"Φ	1".5Φ	10' □
Wavelength	0.4-1.0μm	0.95-1.80μm	0.57-0.85μm	0.8-2.4μm	0.39-0.87μm	0.5-2.2μm
λ/Δλ	200	---	600–800	3000–5000	30000–50000	---
Pix. Scale	0″.24	0".066	1″	1″	0″.5	0″.35
Status	Complete	Under development	IFU is under development	Budget request	Budget request	Under development

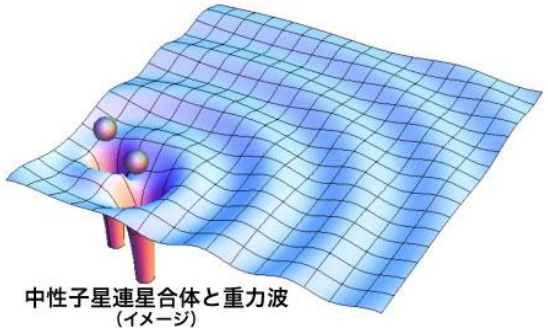
Instruments

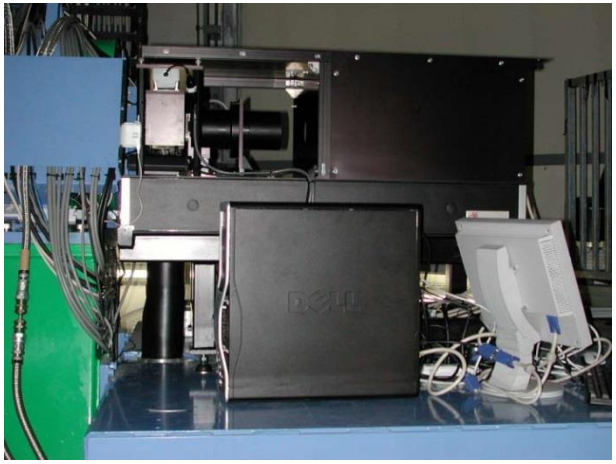


Optical Low-dispersion Spectrograph with IFU



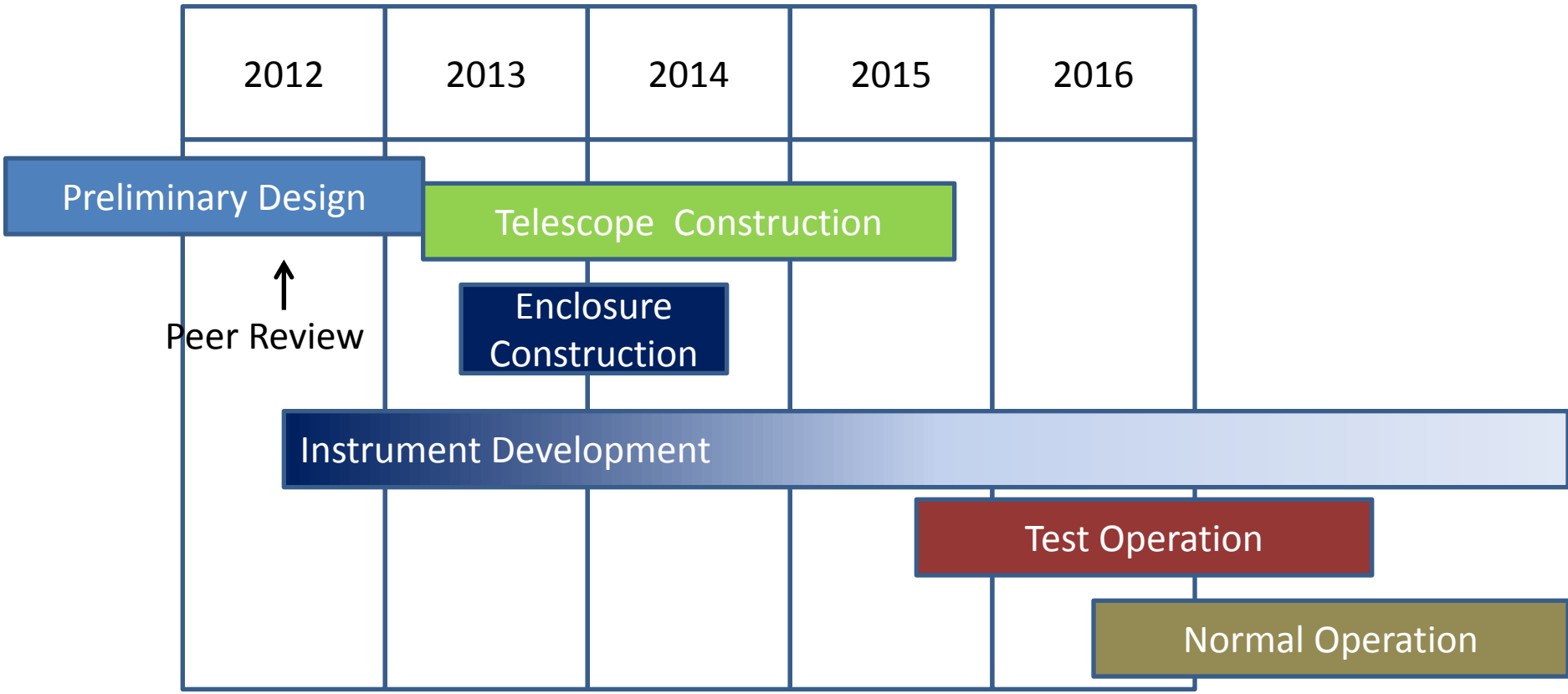
Etreme AO





High speed photo and spectrometer

Schedule


2012
2013
2014
2015
2016
Preliminary Design
Telescope Construction
Peer Review
Enclosure Construction
Instrument Development
Test Operation
Normal Operation

Thank you