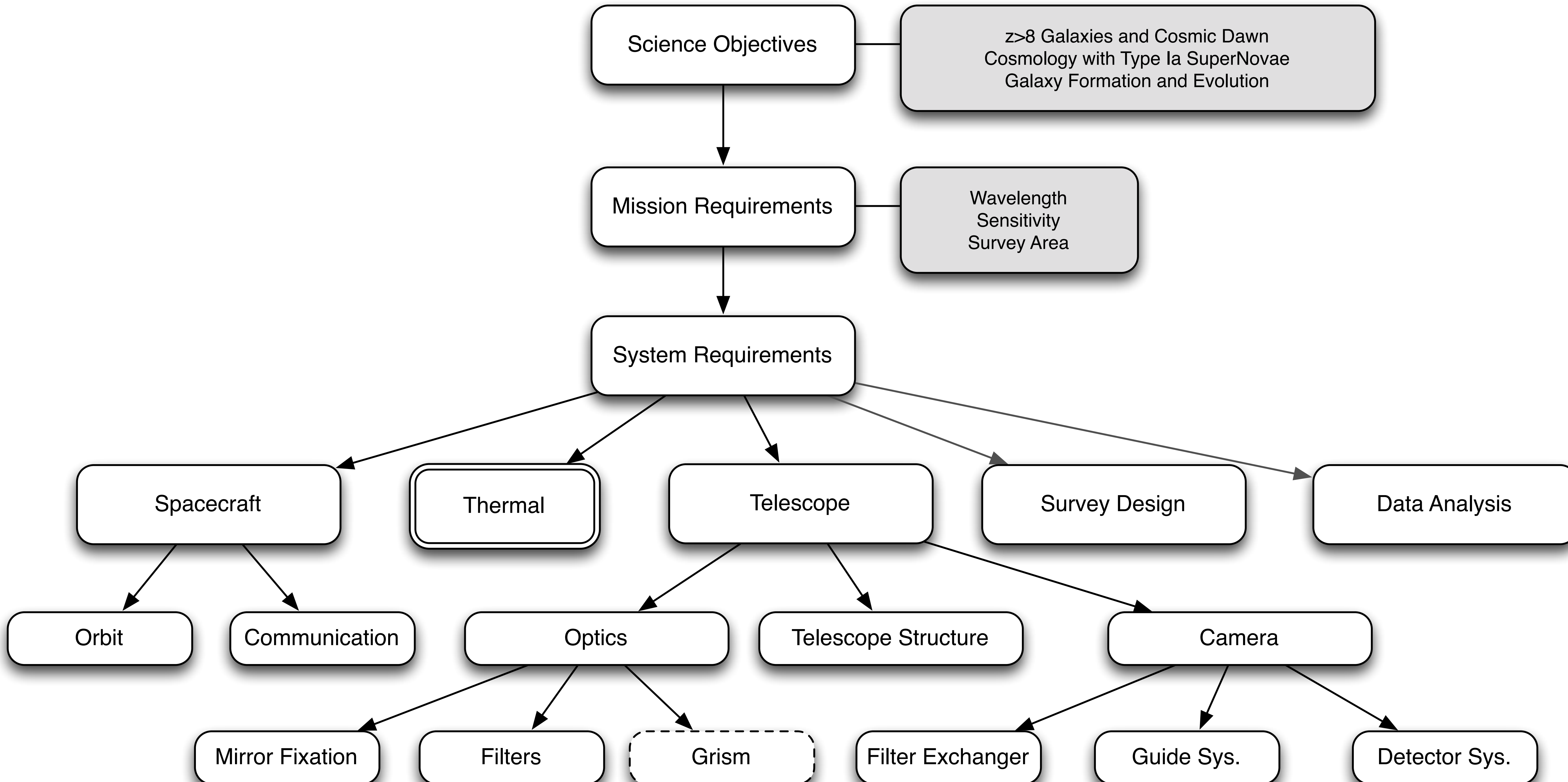
WISH Development Activities

2013/03/27

Ikuru Iwata (NAOJ)

WISH Design Flow



WISH Top-Level System Requirements

- Launcher: HIIA Dual Launch
- Orbit: Sun-Earth L2 Halo Orbit (TBC)
- Cooling: Mirrors < 100K, Detector < 40K
- Primary Mirror: > 1.5m
- Pixel Scale: ~ 0.15”
- Broad-band Filters
- Mission Lifetime: > 5 years
- Pointing Stability: <0.07” for 300 seconds

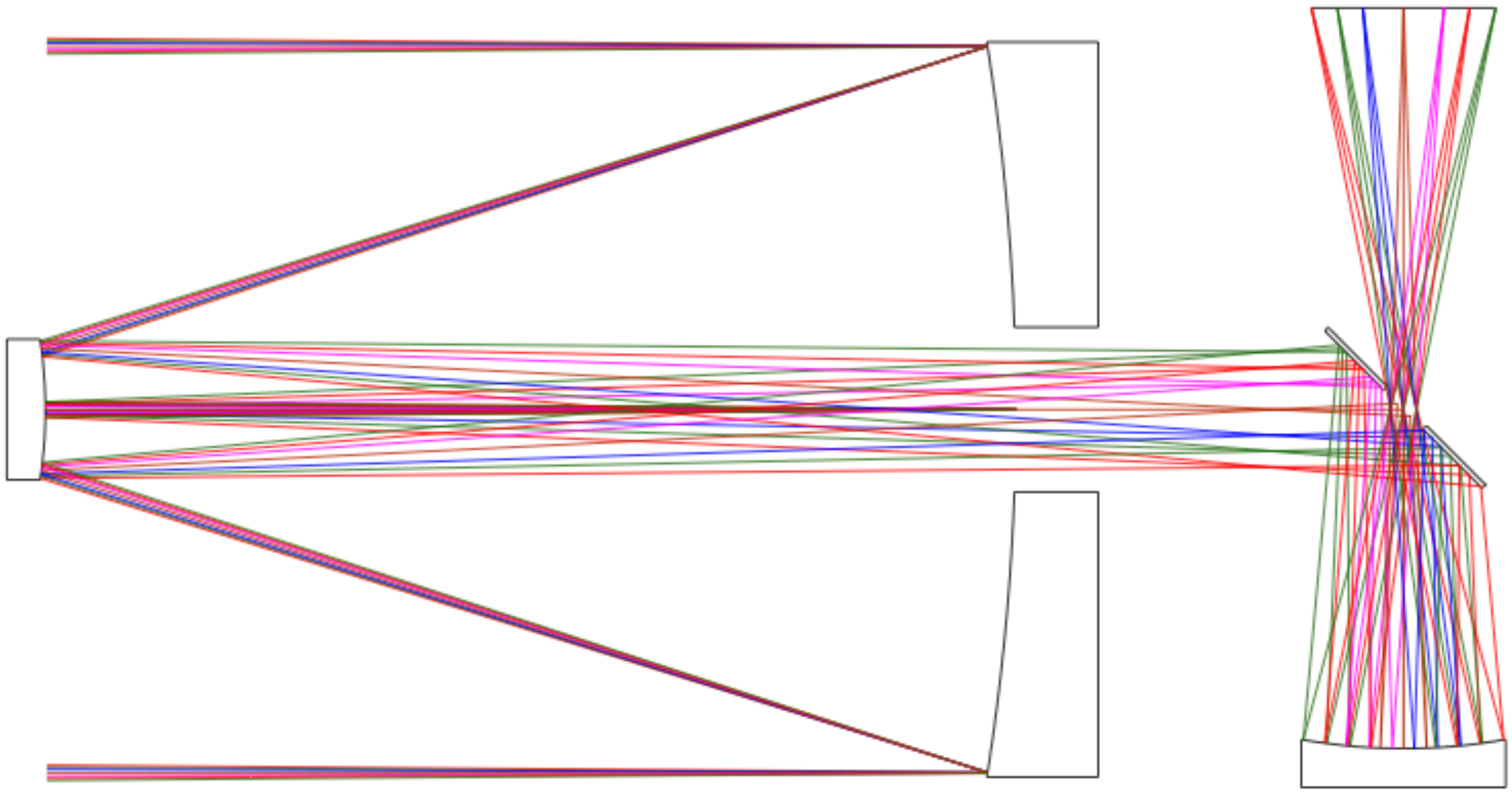
- Electricity
- Data Transfer Rate

Telescope (Mission Payload)

Telescope Optics

Optical Design by Dr. Y. Ikeda (Photocoding)

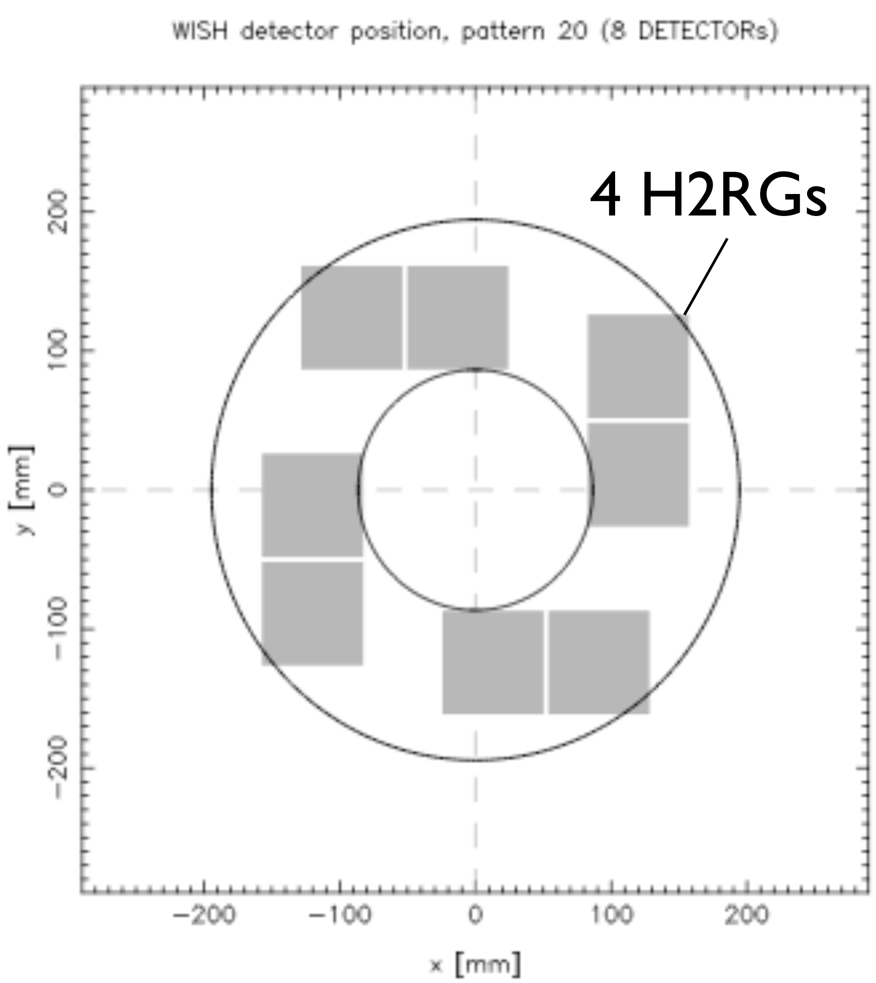
F/16 (18μm=0.155”, 8.6”/mm)



M1: 1.5m
Three Mirror Astigmatism

500.00 MM

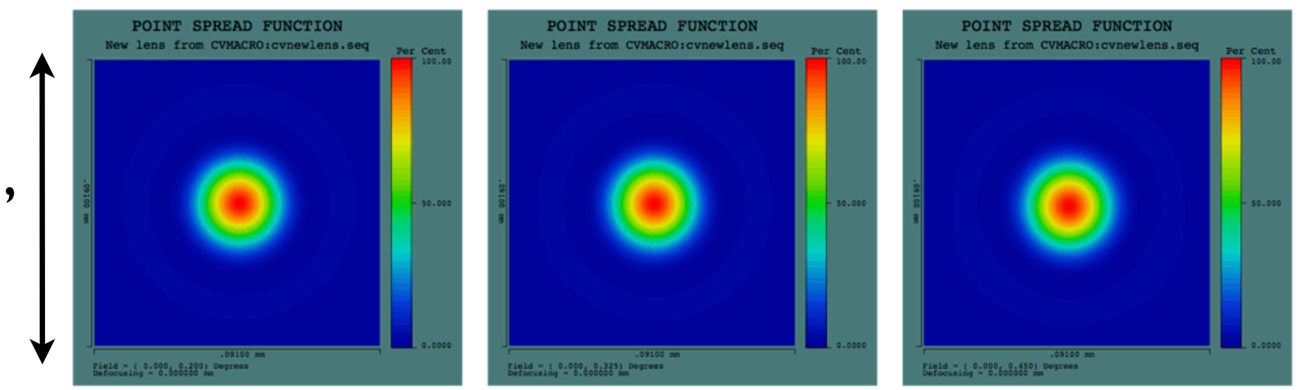
Telescope Optics: Focal Plane



Inner Diameter: ~0.2 deg.
Outer Diameter: ~0.45 deg.
Detector area: ~895 min^2

PSF (1.2µm)

0.77”



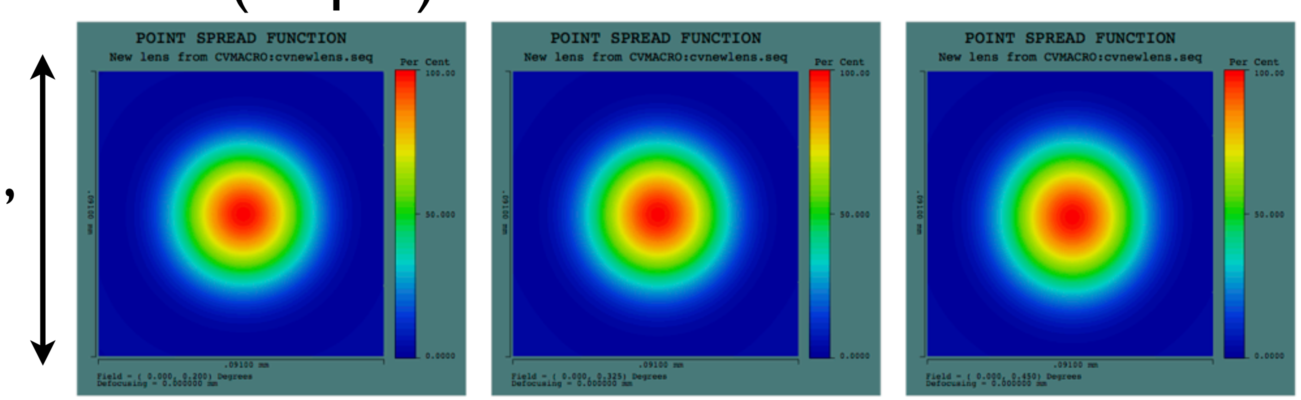
r=0.2deg.
SR=0.997

r=0.325deg.
SR=0.997

r=0.45deg.
SR=0.997

PSF (2.2µm)

0.77”

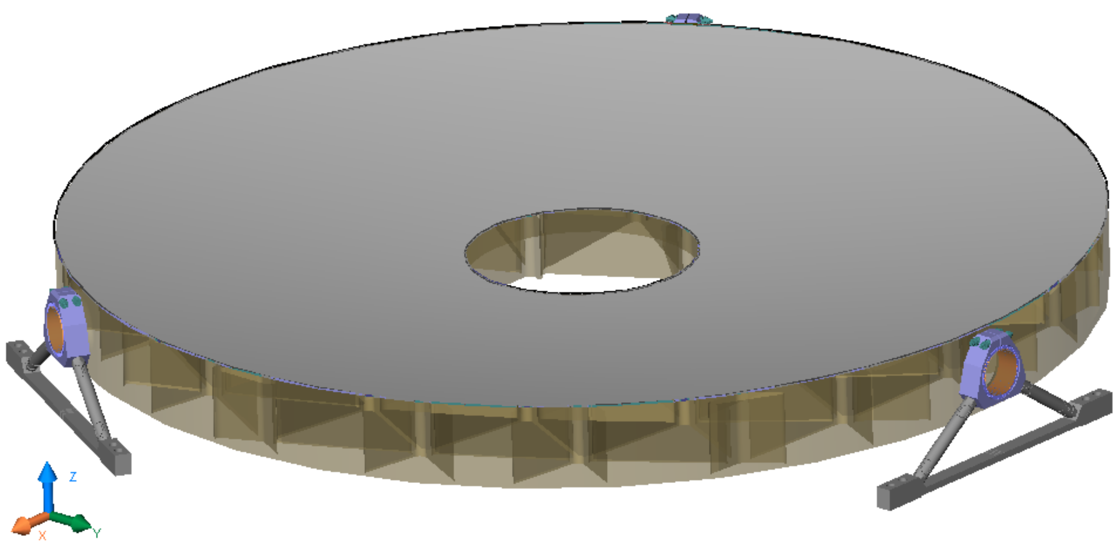


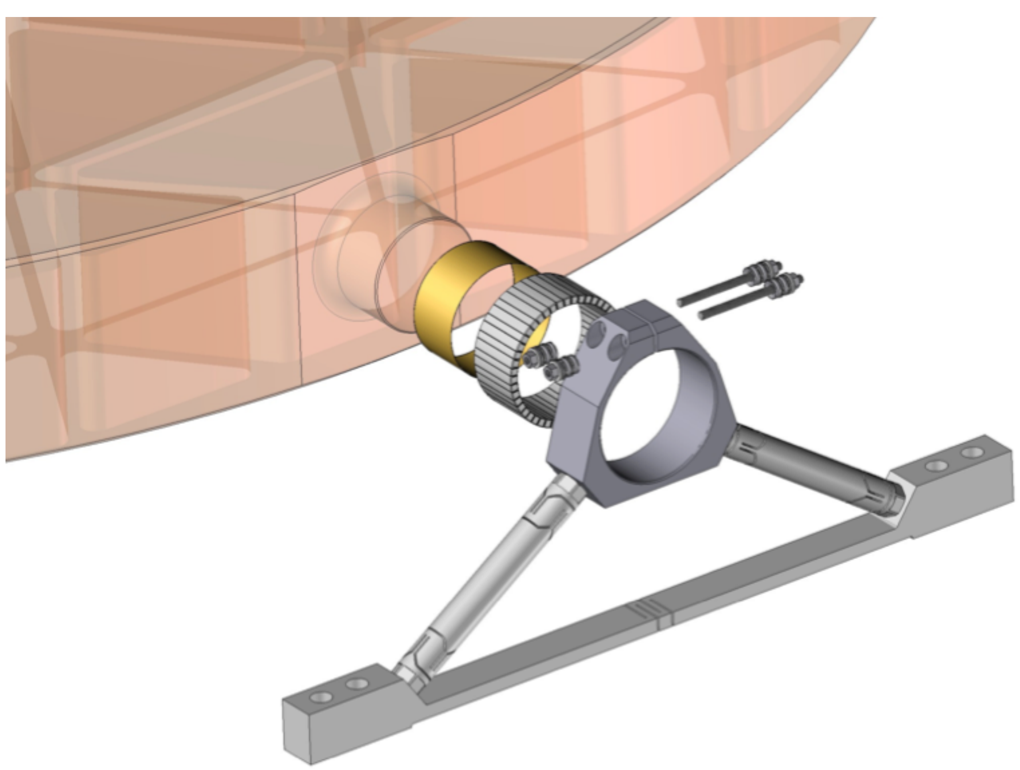
r=0.2deg.
SR=0.999

r=0.325deg.
SR=0.999

r=0.45deg.
SR=0.999

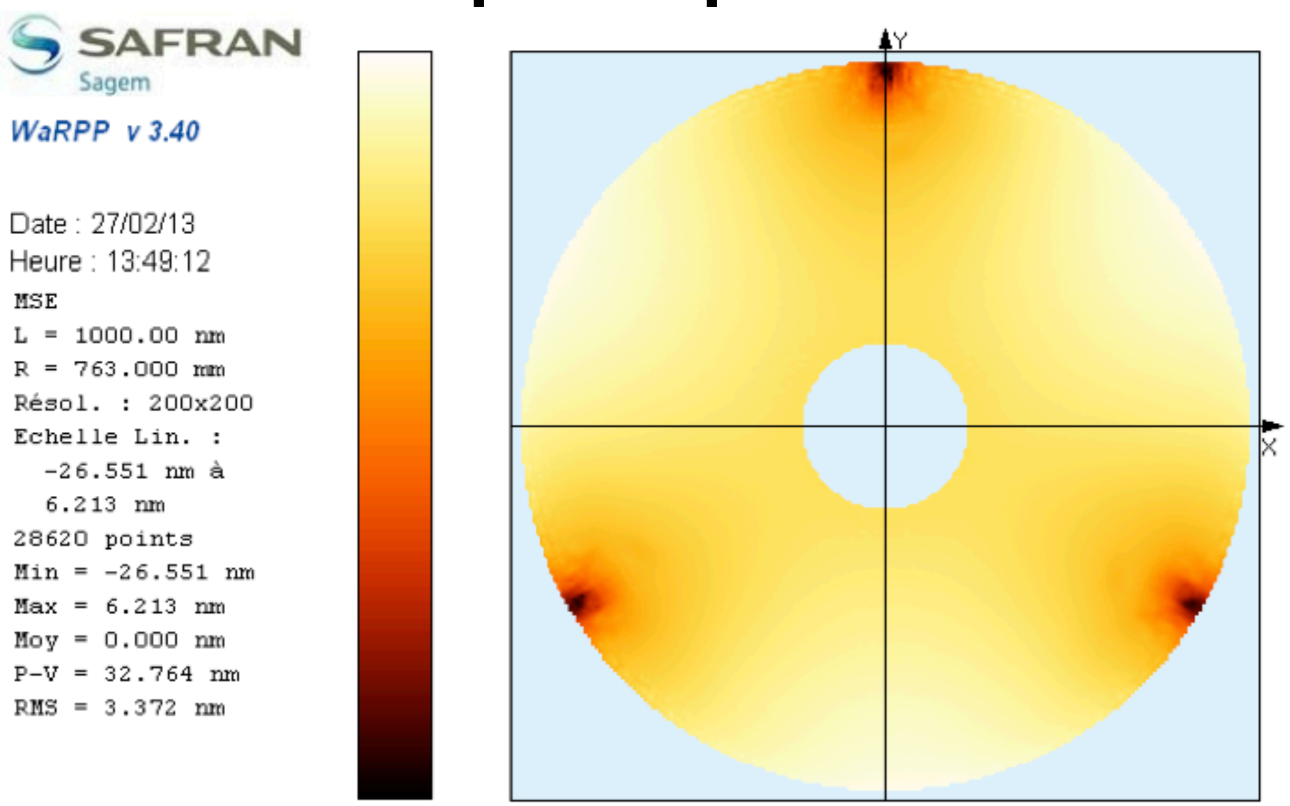
Telescope Optics: Mirror Fixation



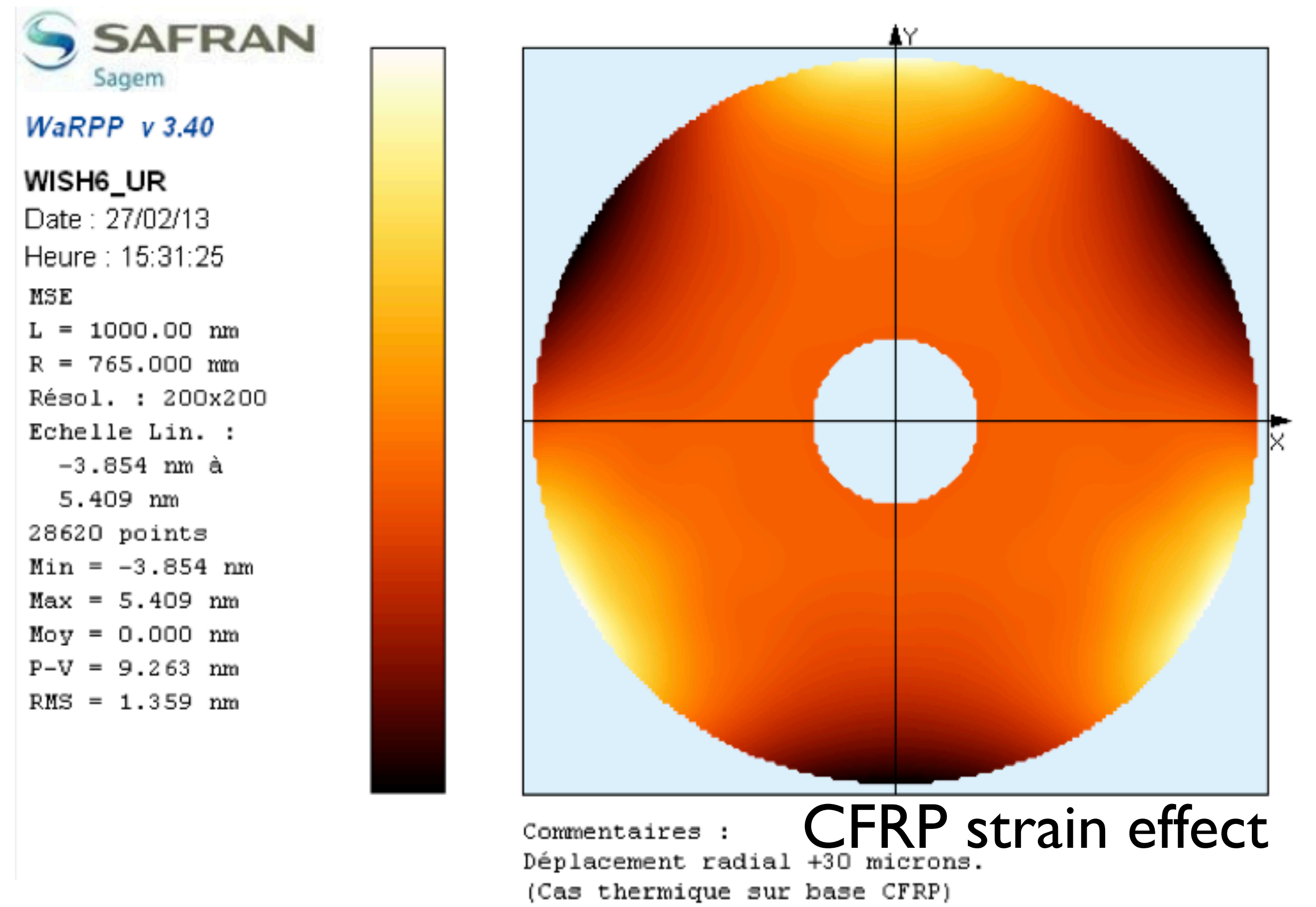


- Mirror Fixation and Preliminary M1 Design by SAGEM / REOSC
- Tenon + Gold Sheet + Clamp to release stress
- Wavefront error analyses to quantify thermal effects, coating effects, load during the launch
- Mechanical load analyses
- Bare mirror weight: 143 kg

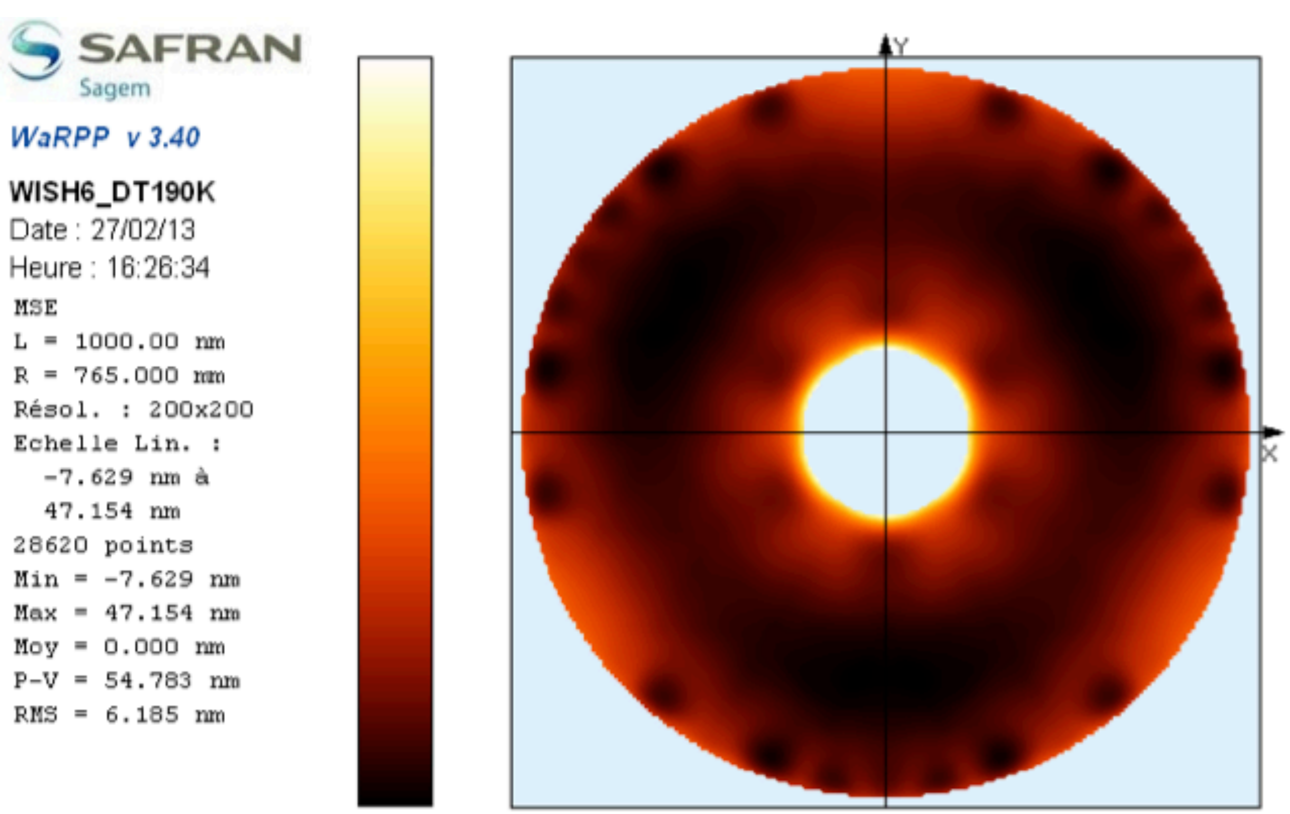
Telescope Optics: Mirror Fixation



Clamping effect

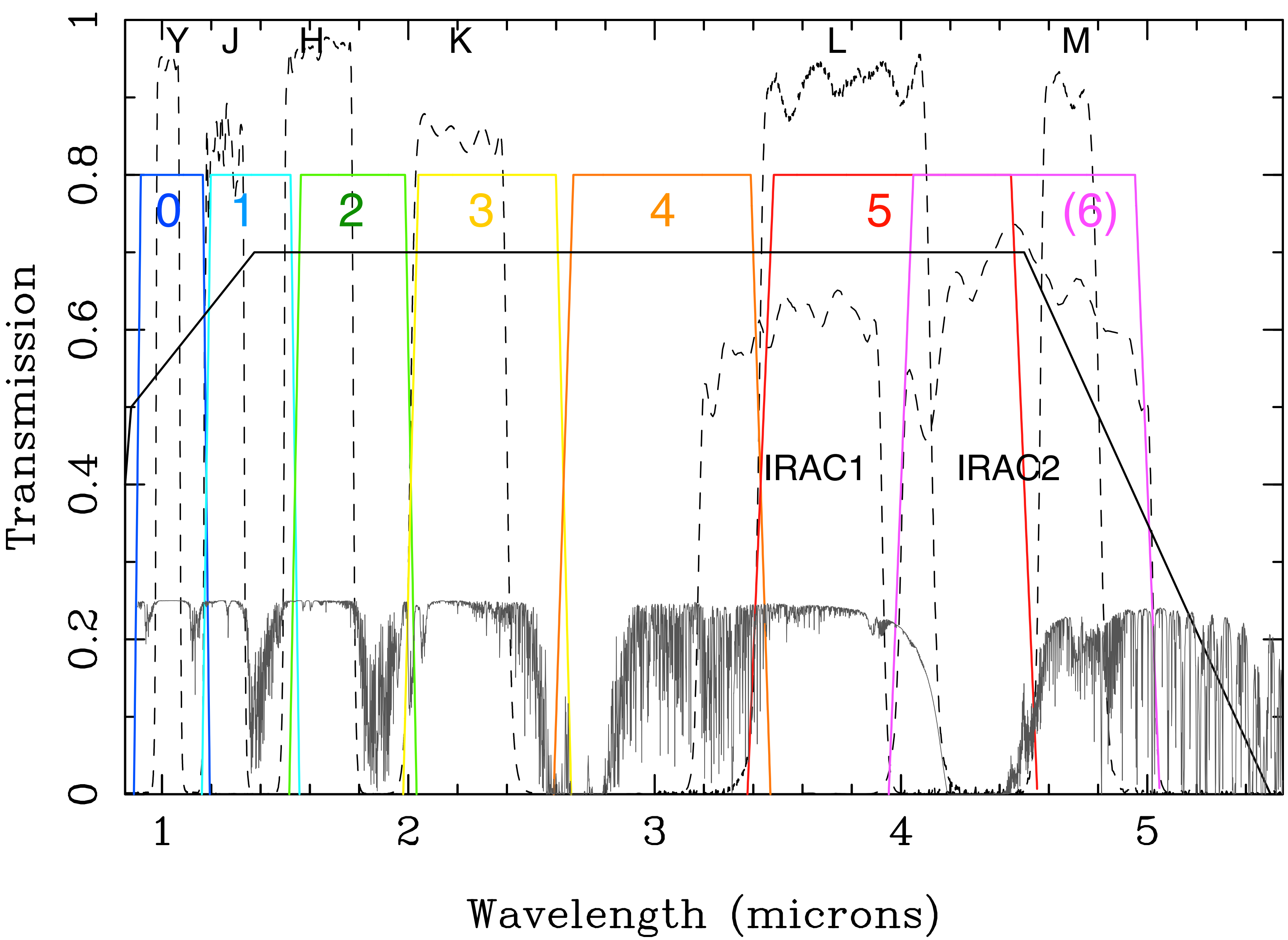


CFRP strain effect



Coating effect

Telescope Optics: Filters



- Broad-band filters for WISH
- Logarithmic band widths along with wavelength
- Some similarity with standard broad-band filters for ground-based telescopes

Telescope Optics: Filters

Name	λcenter [μm]	FWHM [μm]	w0 [μm]	w1 [μm]	R	Diff. Limit [″]	Ref. Name	Notes
Filter 0	1.040	0.280	0.900	1.180	3.714	0.174	WBF0300_00	
Filter 1	1.360	0.360	1.180	1.540	3.778	0.228	WBF0300_01	
Filter 2	1.775	0.470	1.540	2.010	3.777	0.298	WBF0300_02	
Filter 3	2.320	0.620	2.010	2.630	3.742	0.389	WBF0300_03	
Filter 4	3.030	0.800	2.630	3.430	3.788	0.508	WBF0300_04	
Filter 5	3.965	1.070	3.430	4.500	3.706	0.665	WBF0300_05	
Filter 5e	4.215	1.570	3.430	5.000	2.685	0.707	WBF0301_05	オプション
Filter 6	4.500	1.000	4.000	5.000	4.500	0.755	WBF0302_06	オプション

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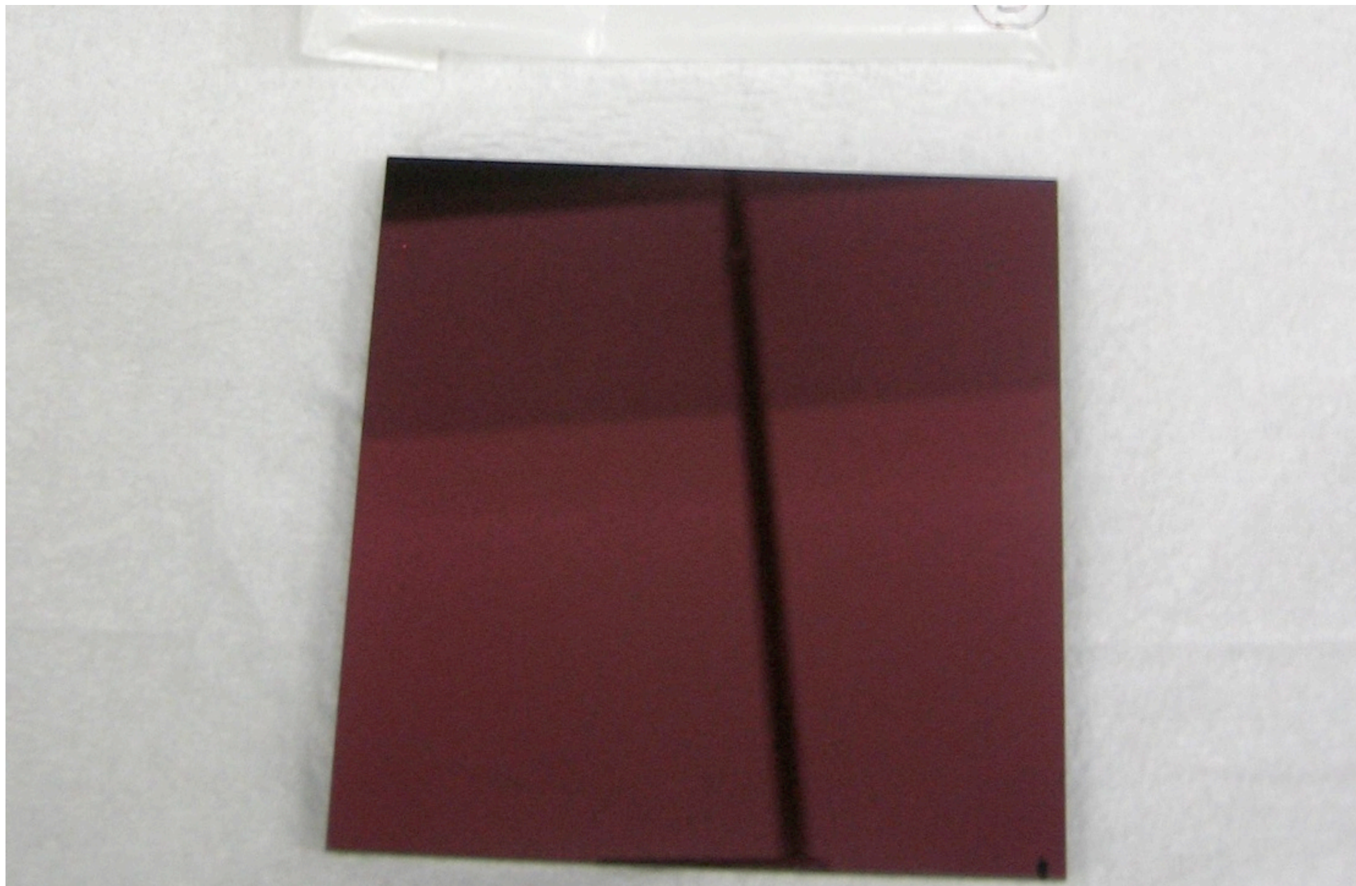
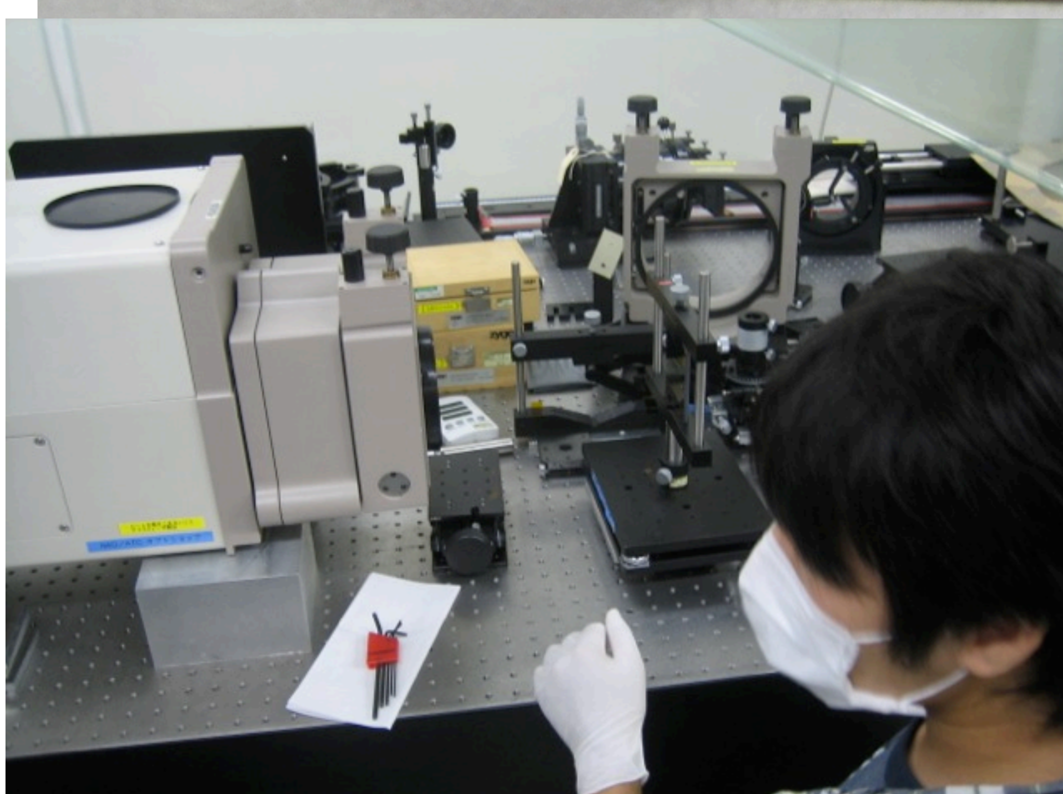
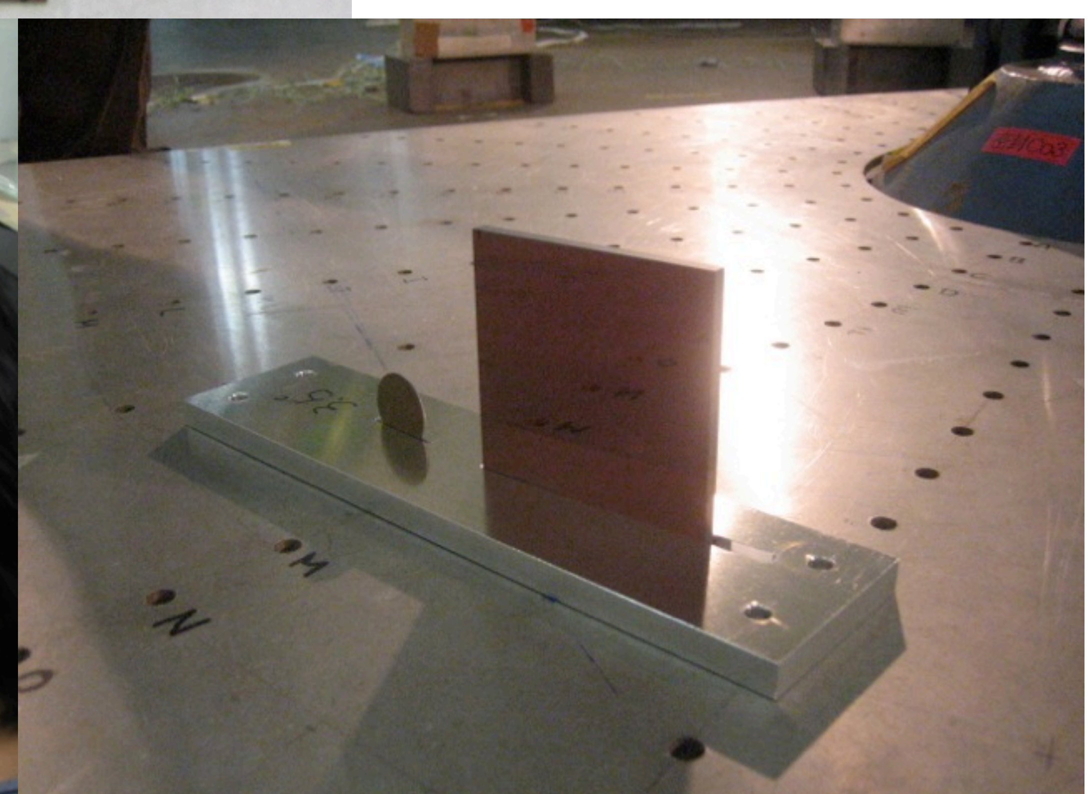
Telescope Optics: Filters

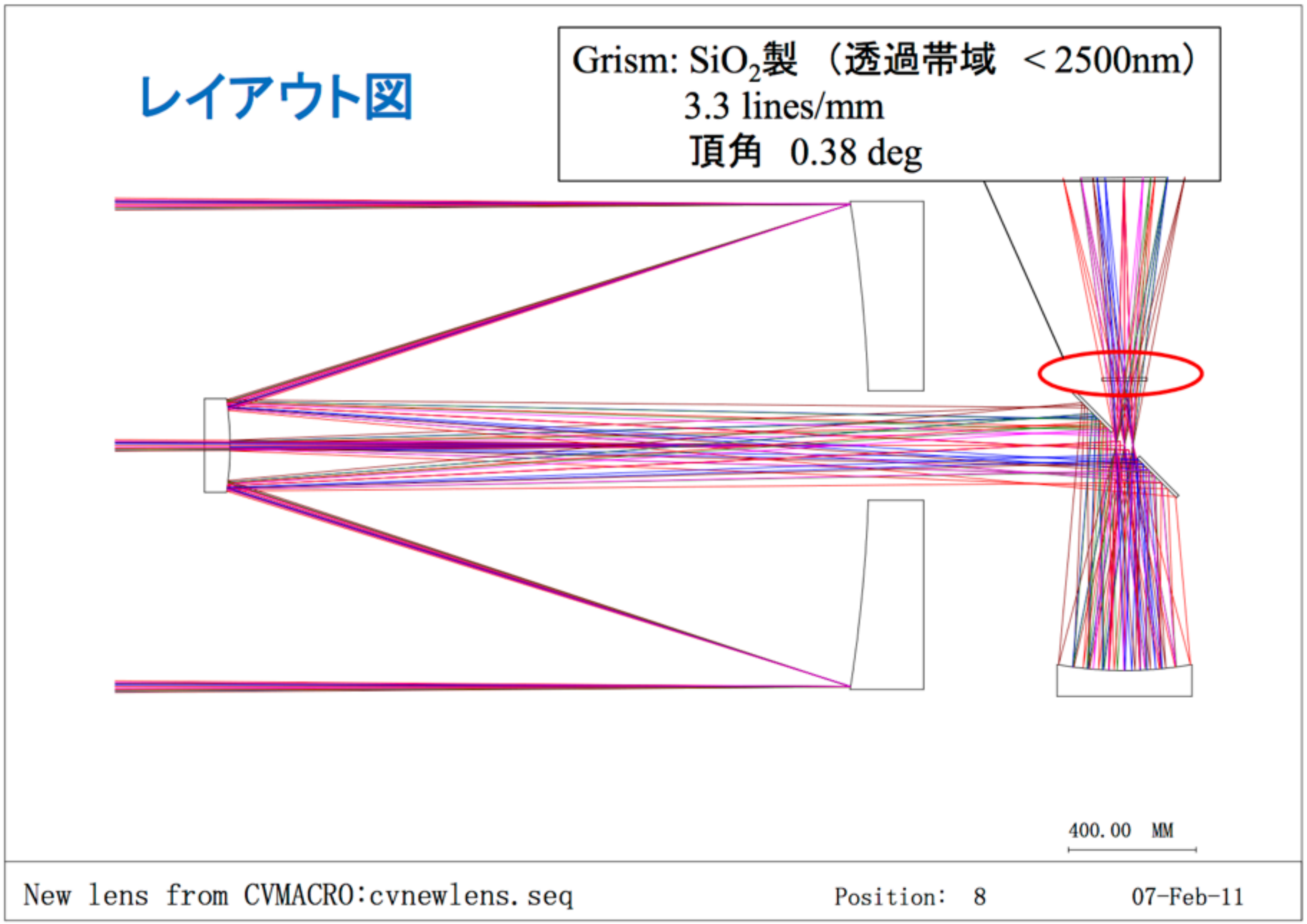


- Test fabrication of large infrared filters in 2009
- Si 80mm x 80mm 3.2μm BPF
- Radiation test - passed
- Cryogenic test - Throughput measurements





Telescope Optics:
Possibility of Slitless Grism Spectroscopy



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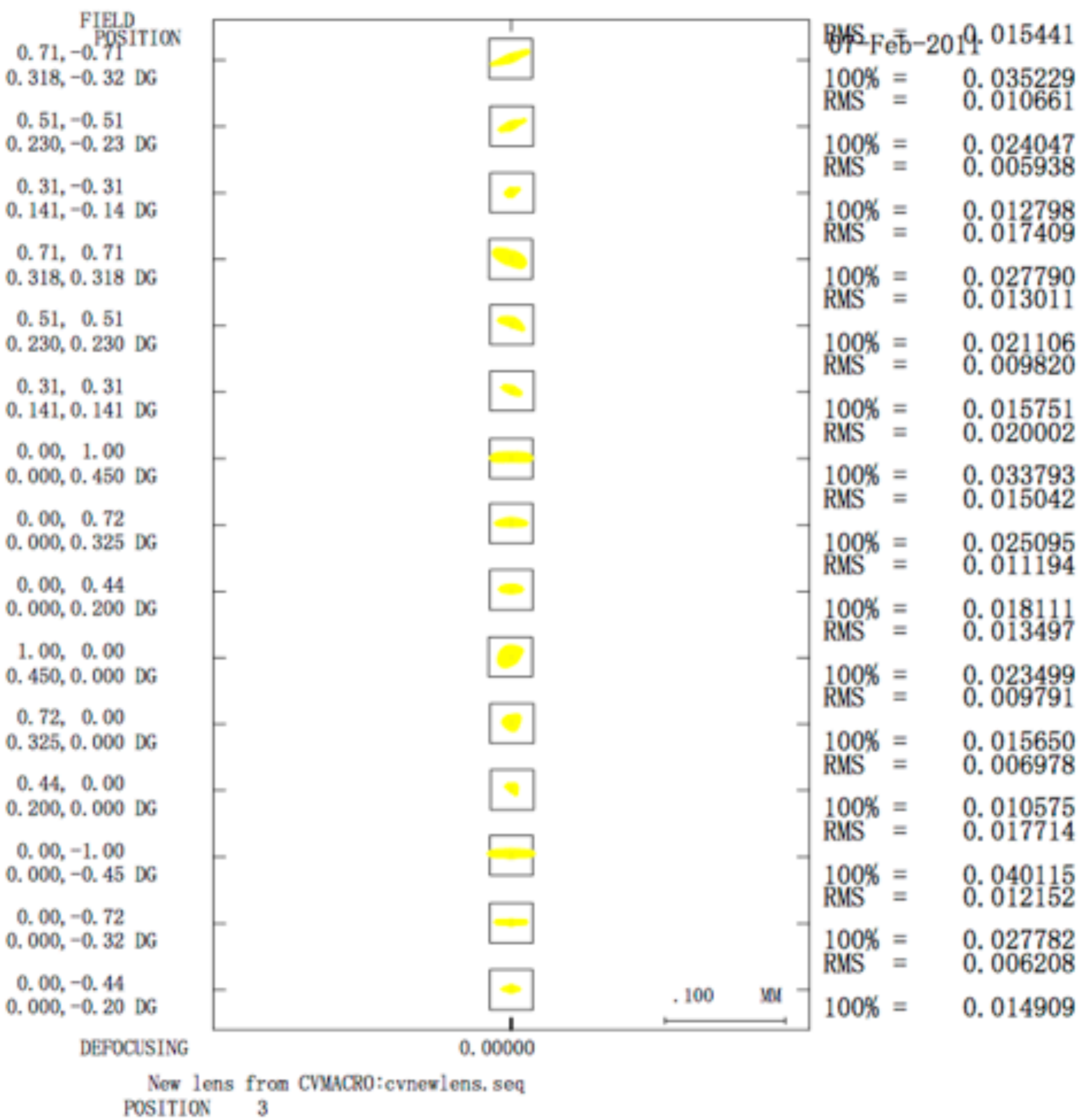
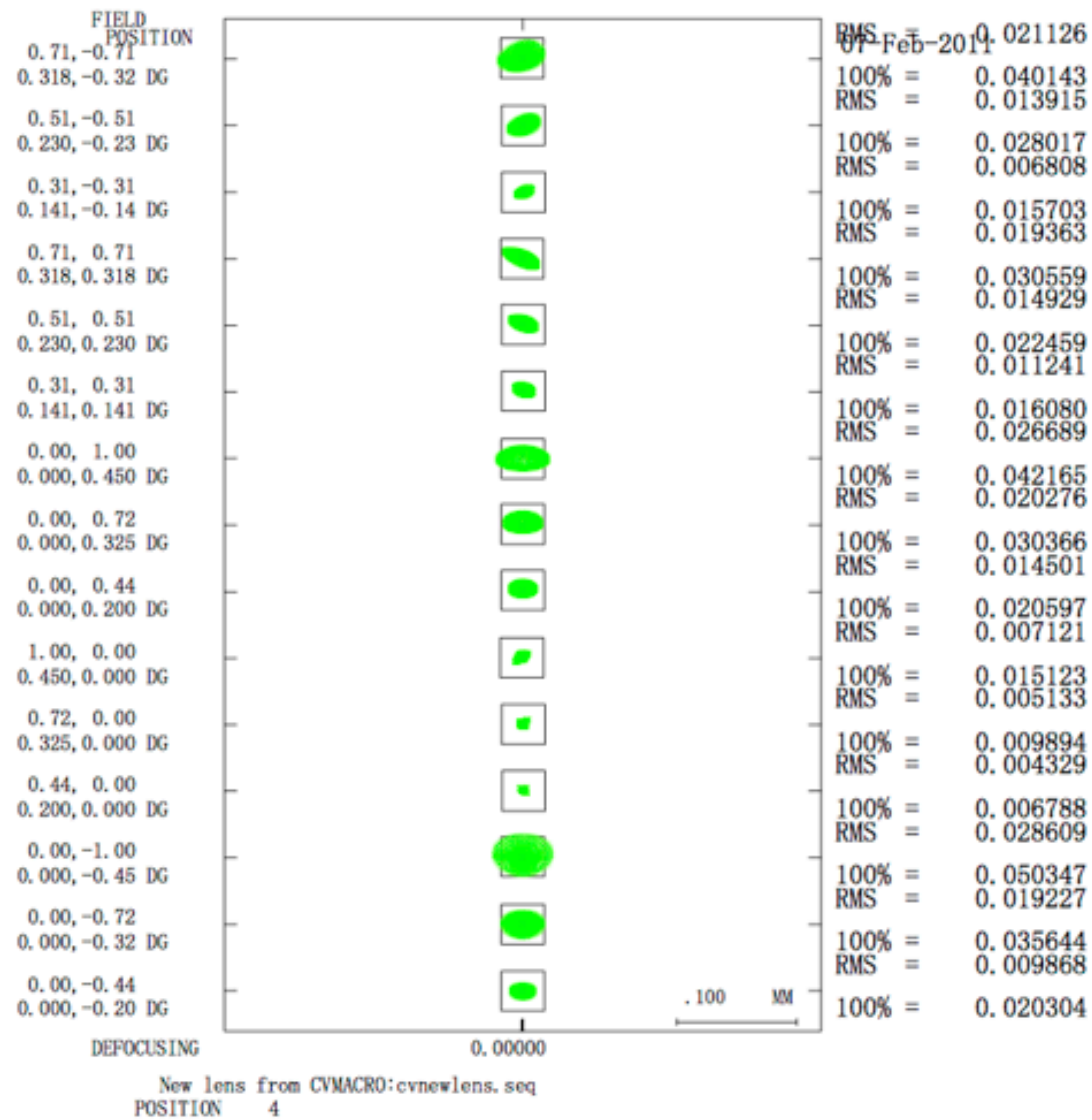
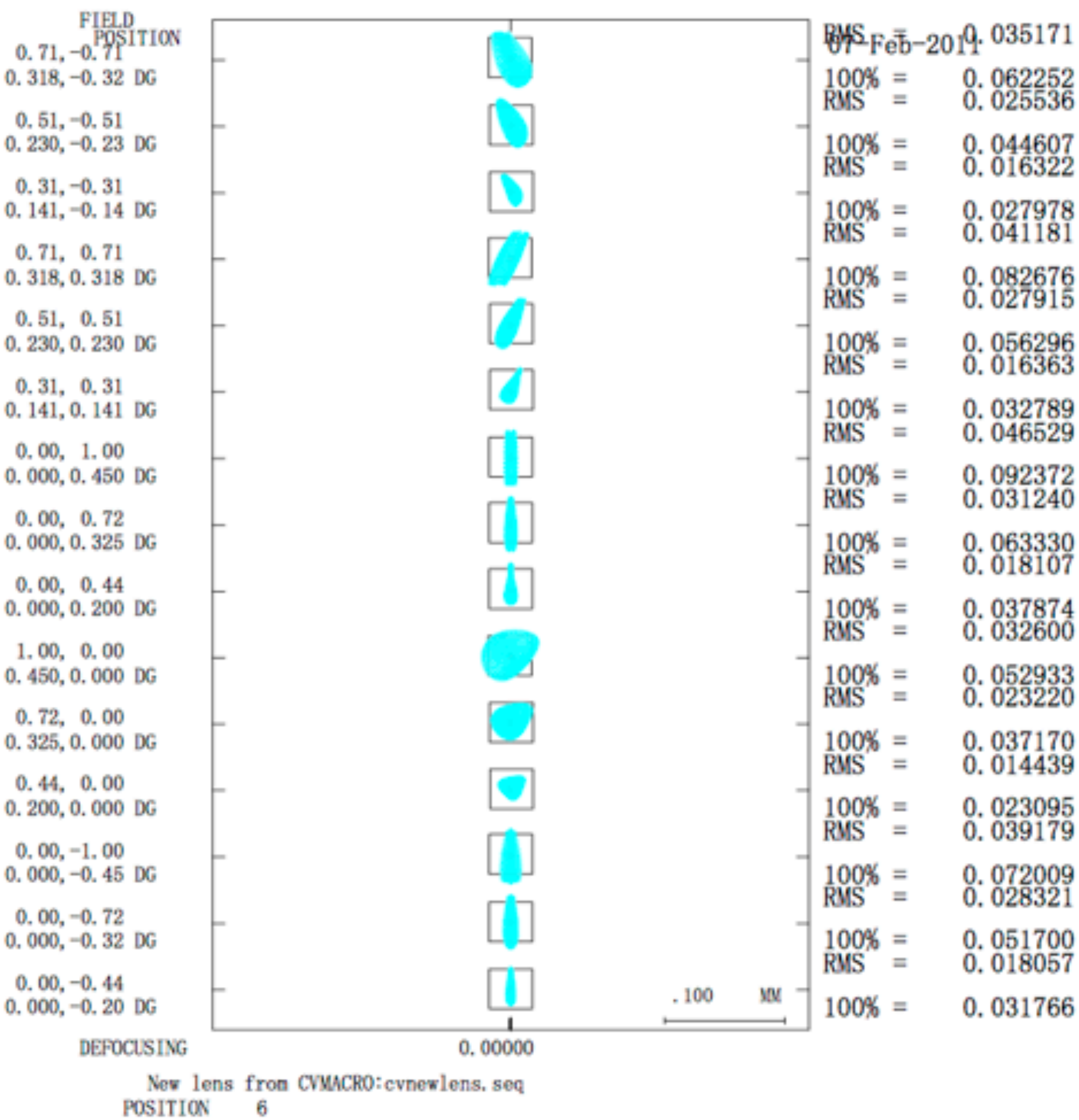


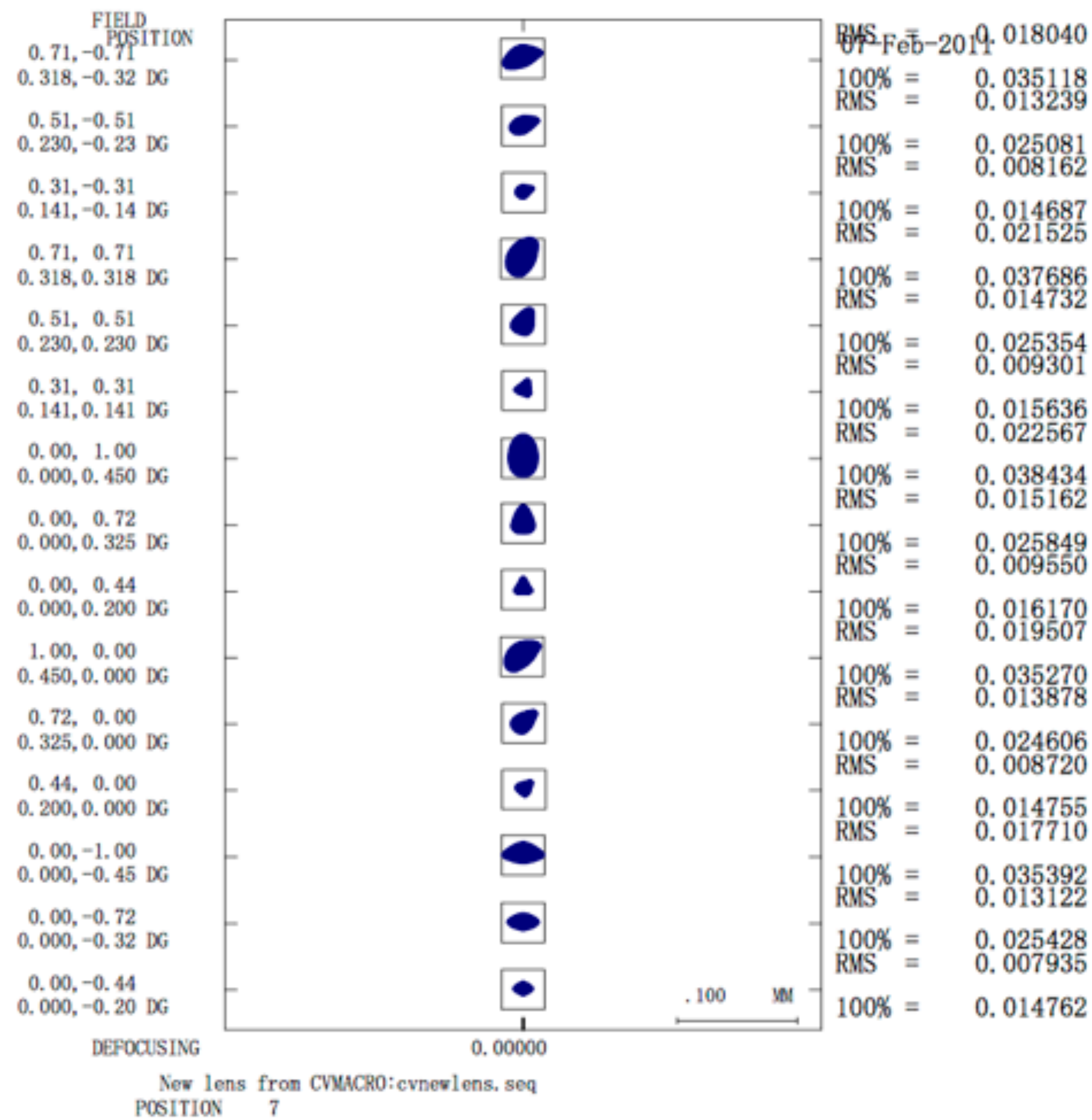


λ=2100nm **λ=1800nm**

Spot diagrams simulated by Dr. Y. Ikeda (Photocoding)

Telescope Optics: Possibility of Slitless Grism Spectroscopy





λ=1500nm

λ=1200nm

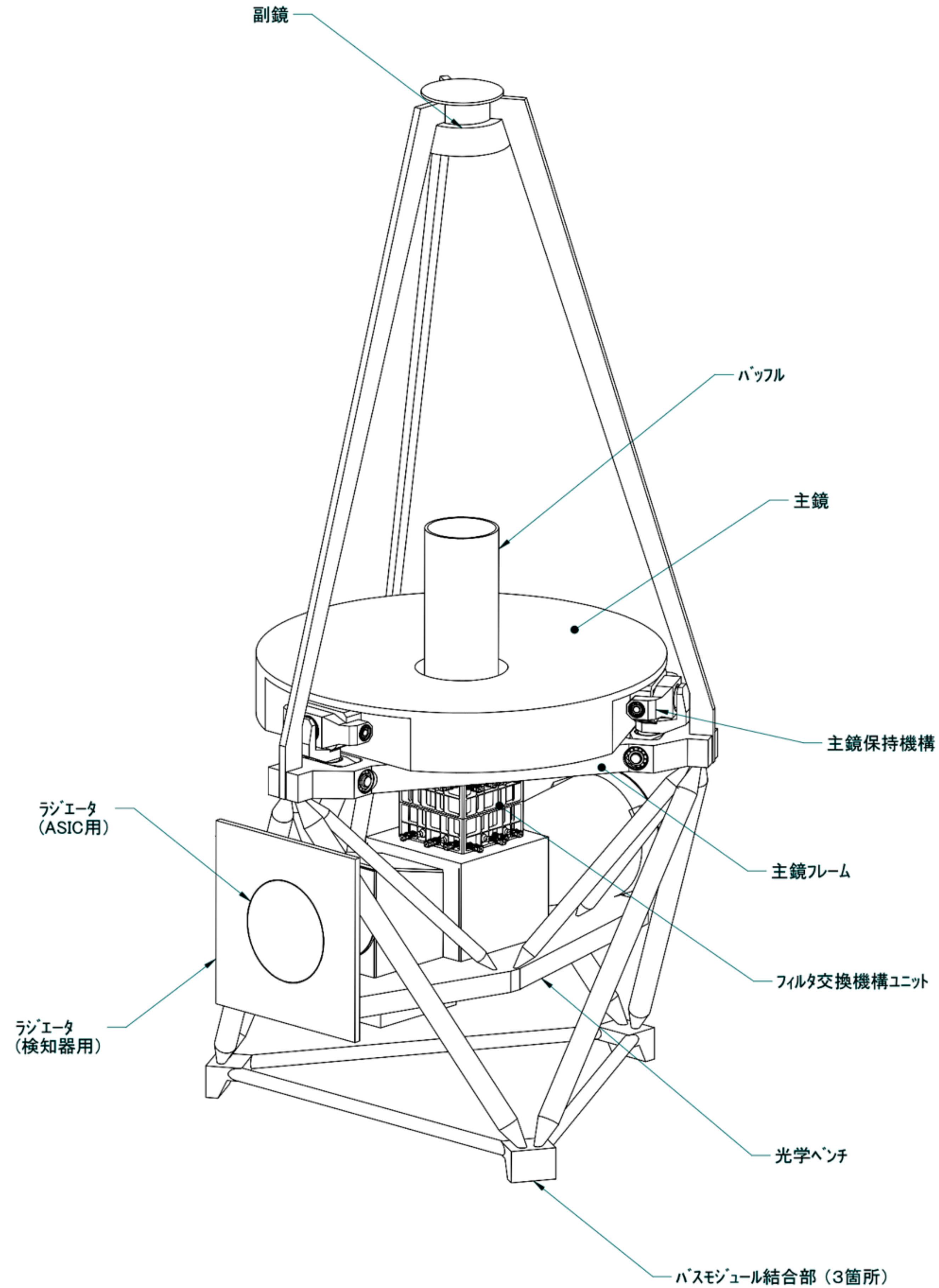
Spot diagrams simulated by Dr. Y. Ikeda (Photocoding)

Telescope Structure

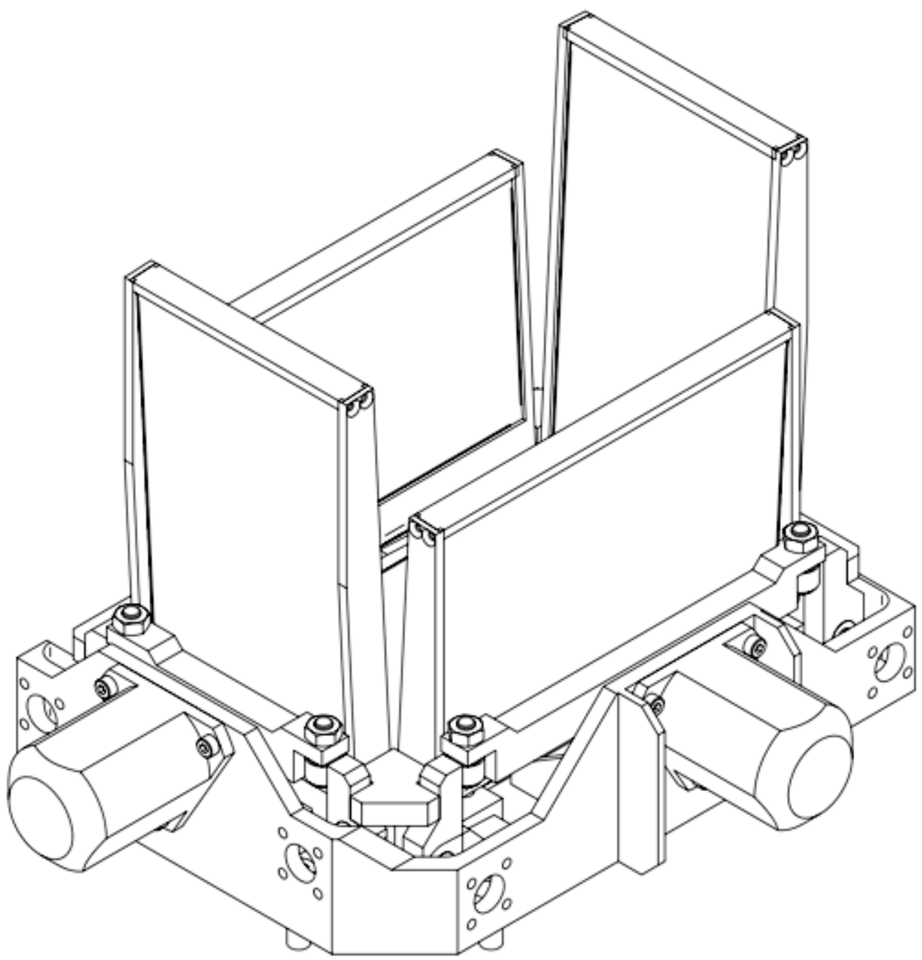
- Basic investigation of properties of CFRP as telescope structure material
  - CTE
  - Degradation of strength with thermal cycles
  - Swelling
- CTEs of materials Low-expansion glass (Ohara CLEAECERAM-Z) and invar
- Properties of adhesive
  - CTE
  - Degradation of strength with thermal cycles
- Telescope structure study is still in preliminary stage (investigation of basic properties of materials). Design study of telescope structure and interface with mirrors are important items for us.

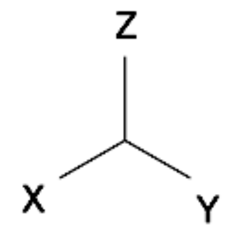
Camera System

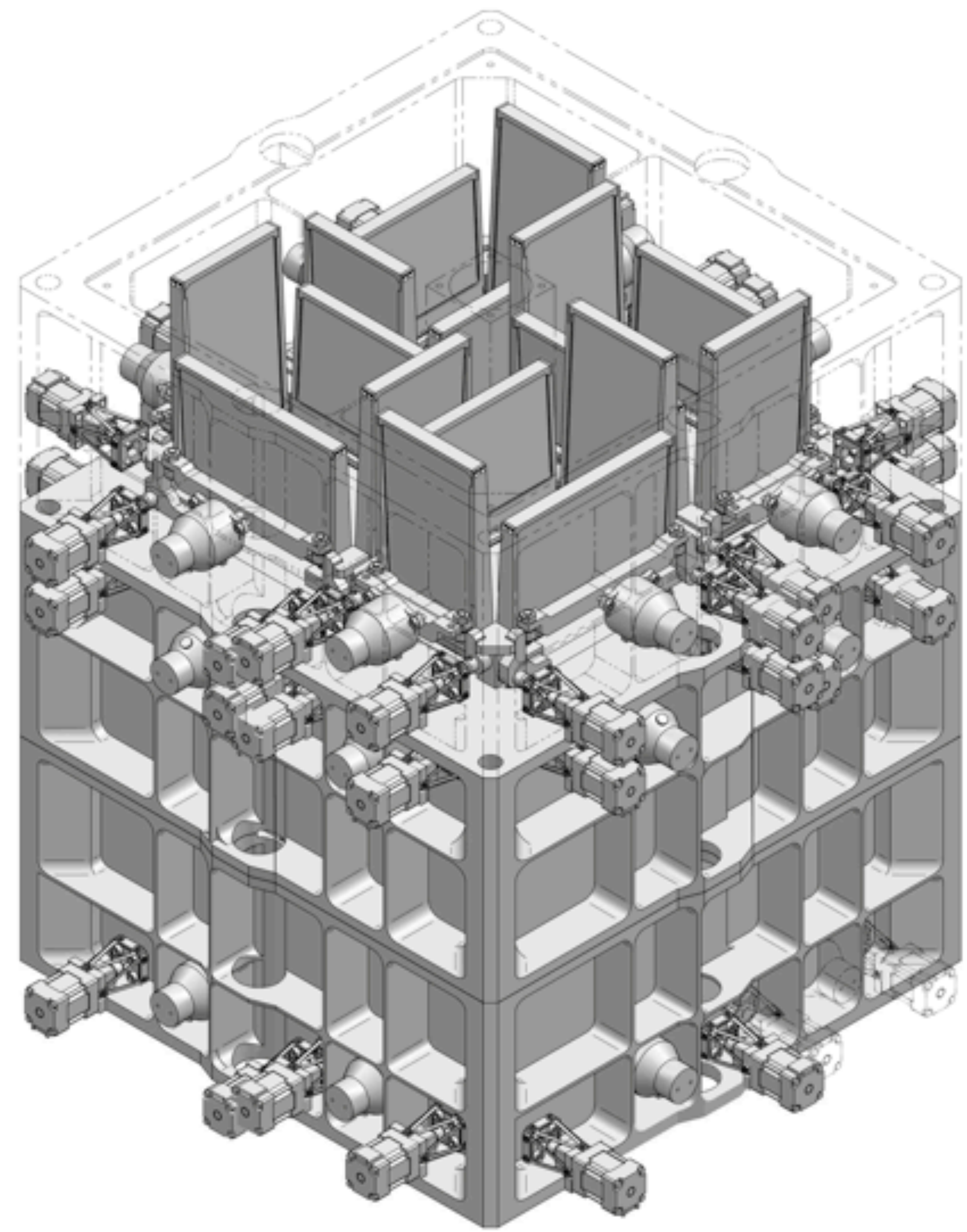
- ‘Optical Bench’
- Filter Exchanger Assembly
- Detector System
  - H2RG + ASIC
  - Read-out Electronics



Camera System: Filter Exchanger

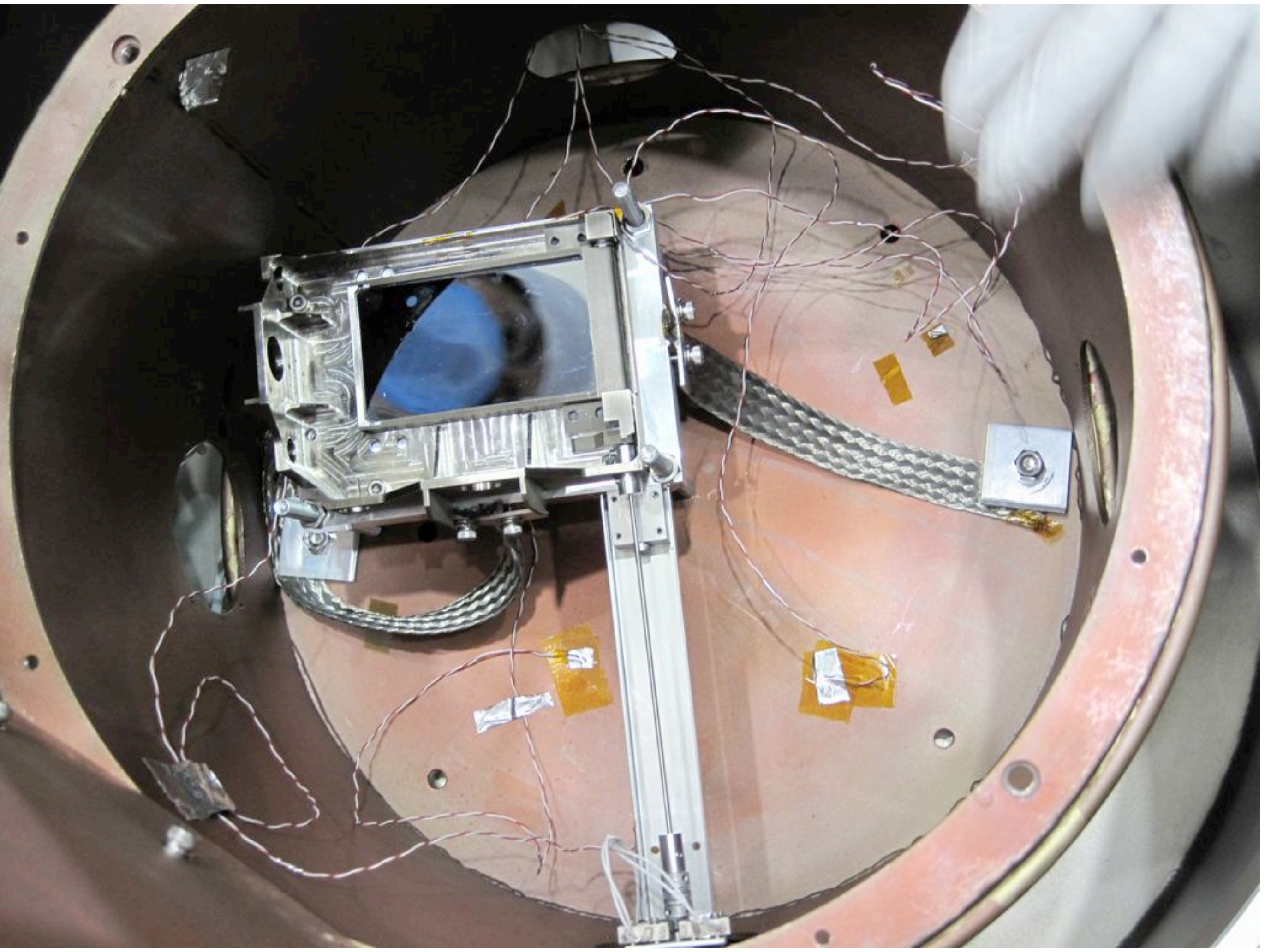






Each 160mm x 80mm filter
covers 8 H2RGs

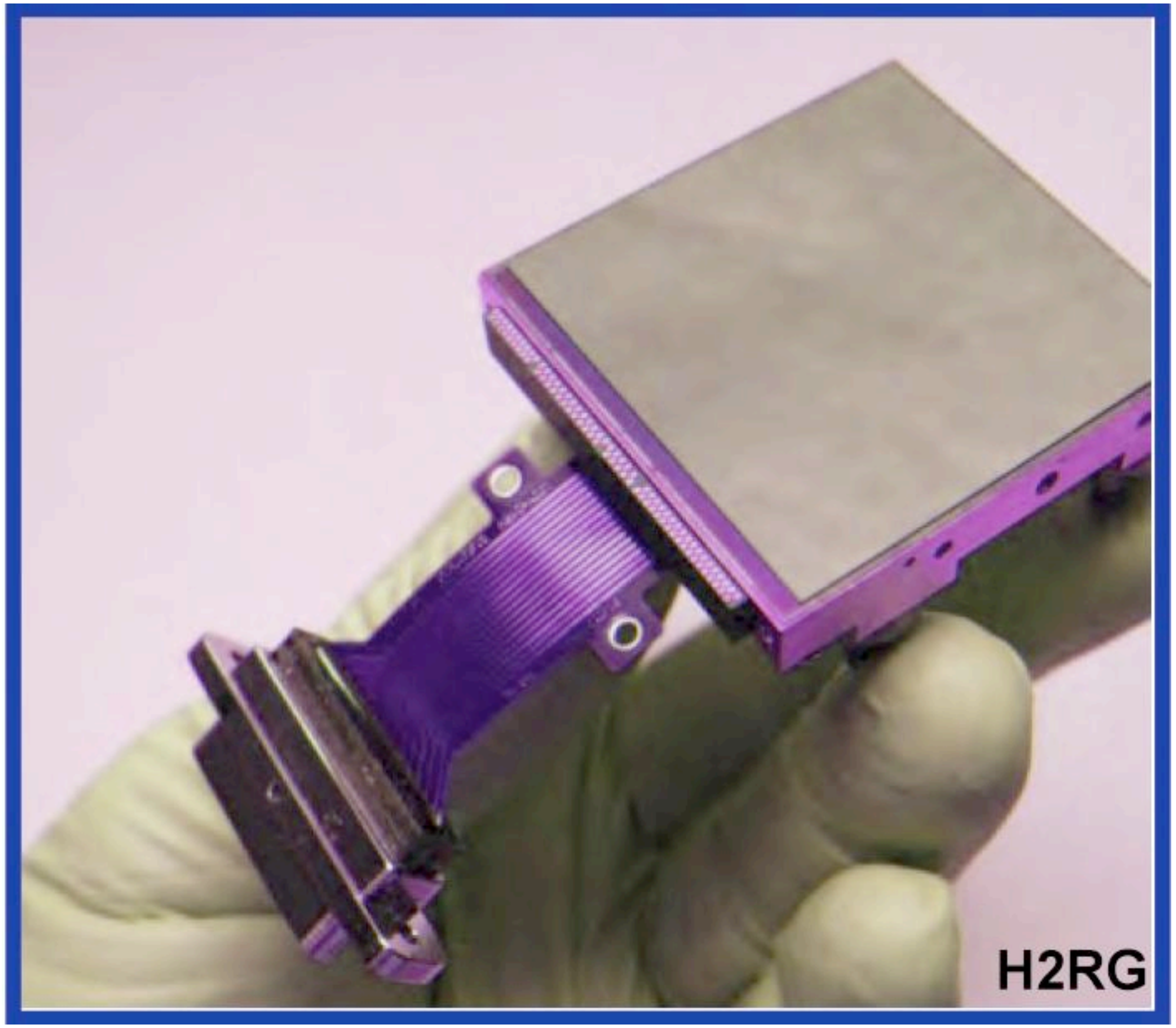
Camera System: Filter Exchanger

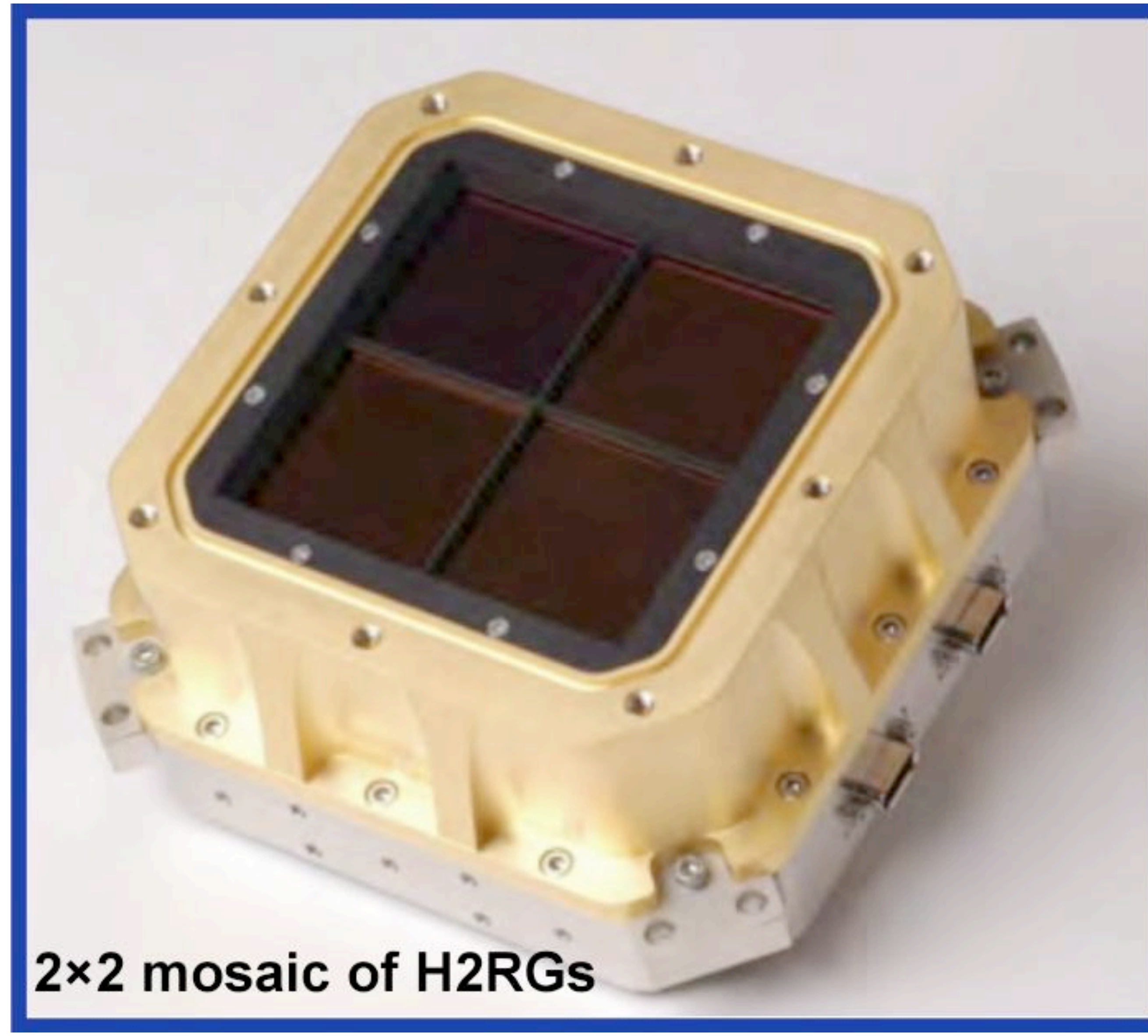


Mechanical reliability test
under cold environment

Cryogenic motor test

Camera System: Detector System





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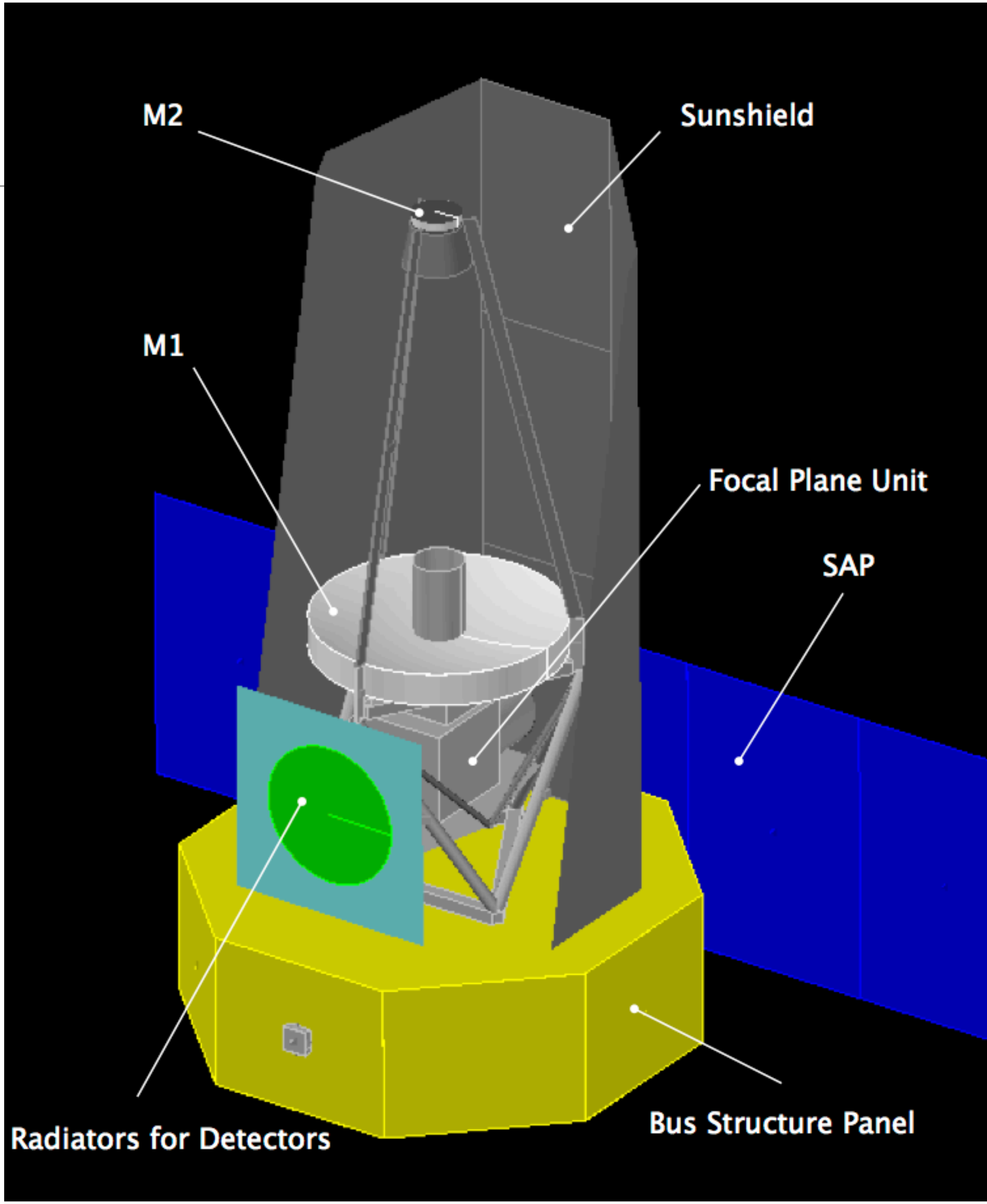
Thermal Design and Analyses

Thermal Model

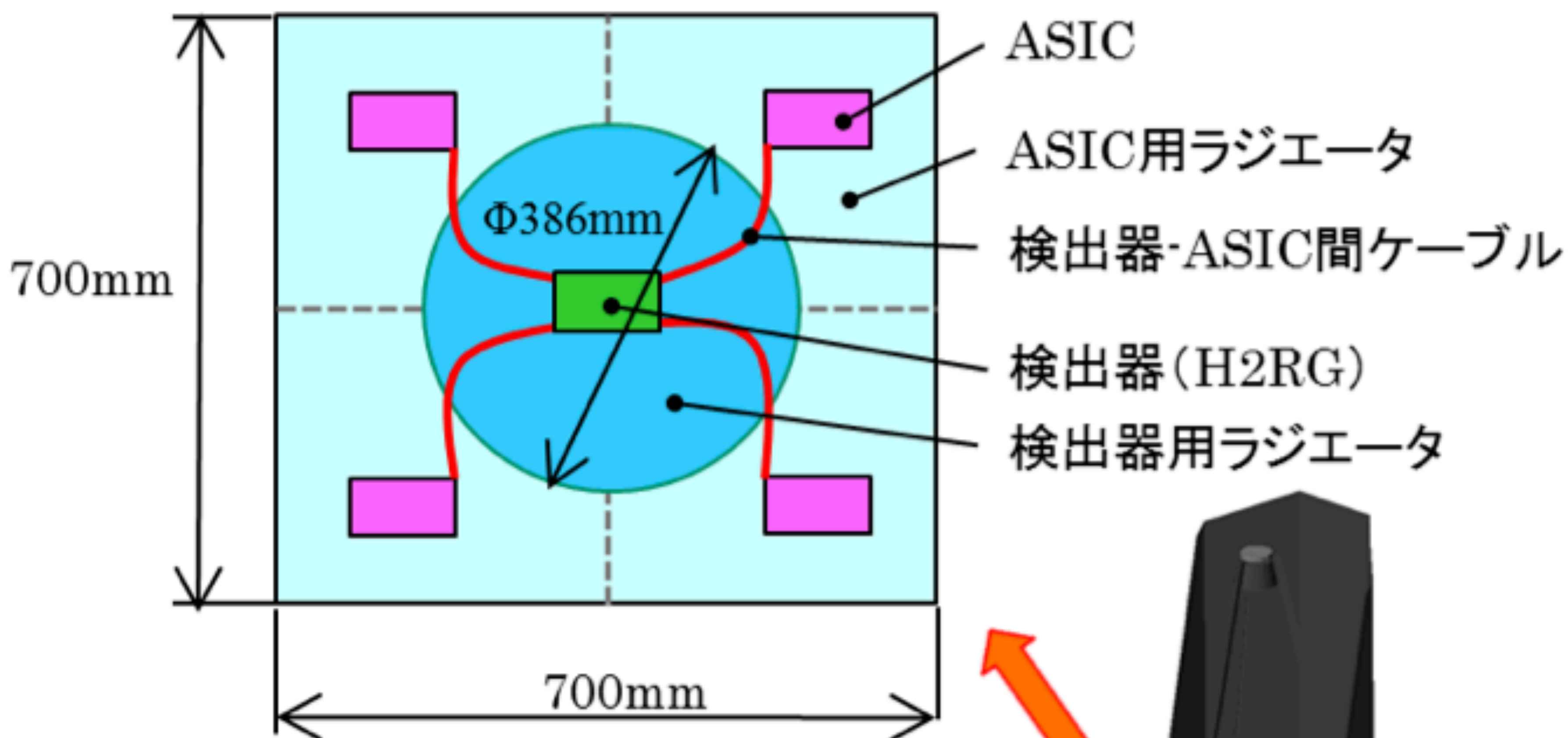
- Sun Shield: 30 layer MLI
- MLI for top-surface of Bus Structure
- CFRP truss
- Step1: thermal model of detector, FEE and radiators
- Step2: thermal model of the entire space craft and calculate static thermal flow

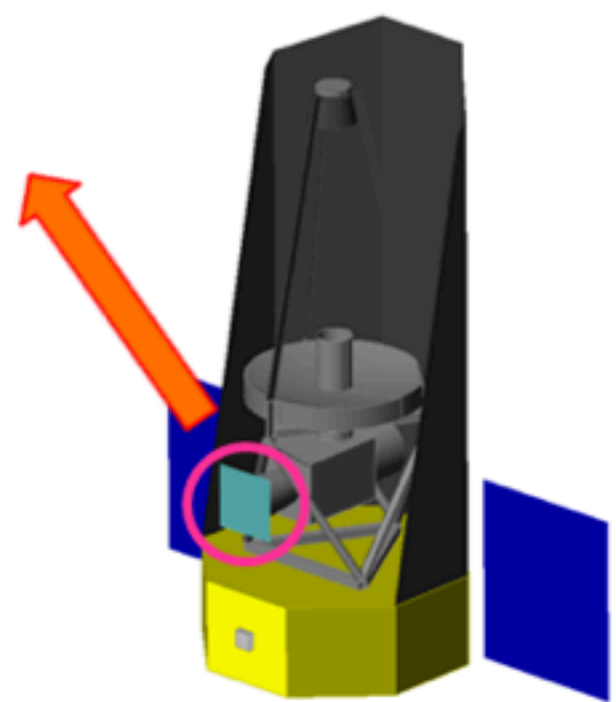


Requirements on Temperature of WISH Components

Components	Requirements
Mirrors (M1, M2, Flat, M3)	100K
Spiders	100K
Filters	80K
Focal Plane Unit	80K
Detectors	40K (Goal)

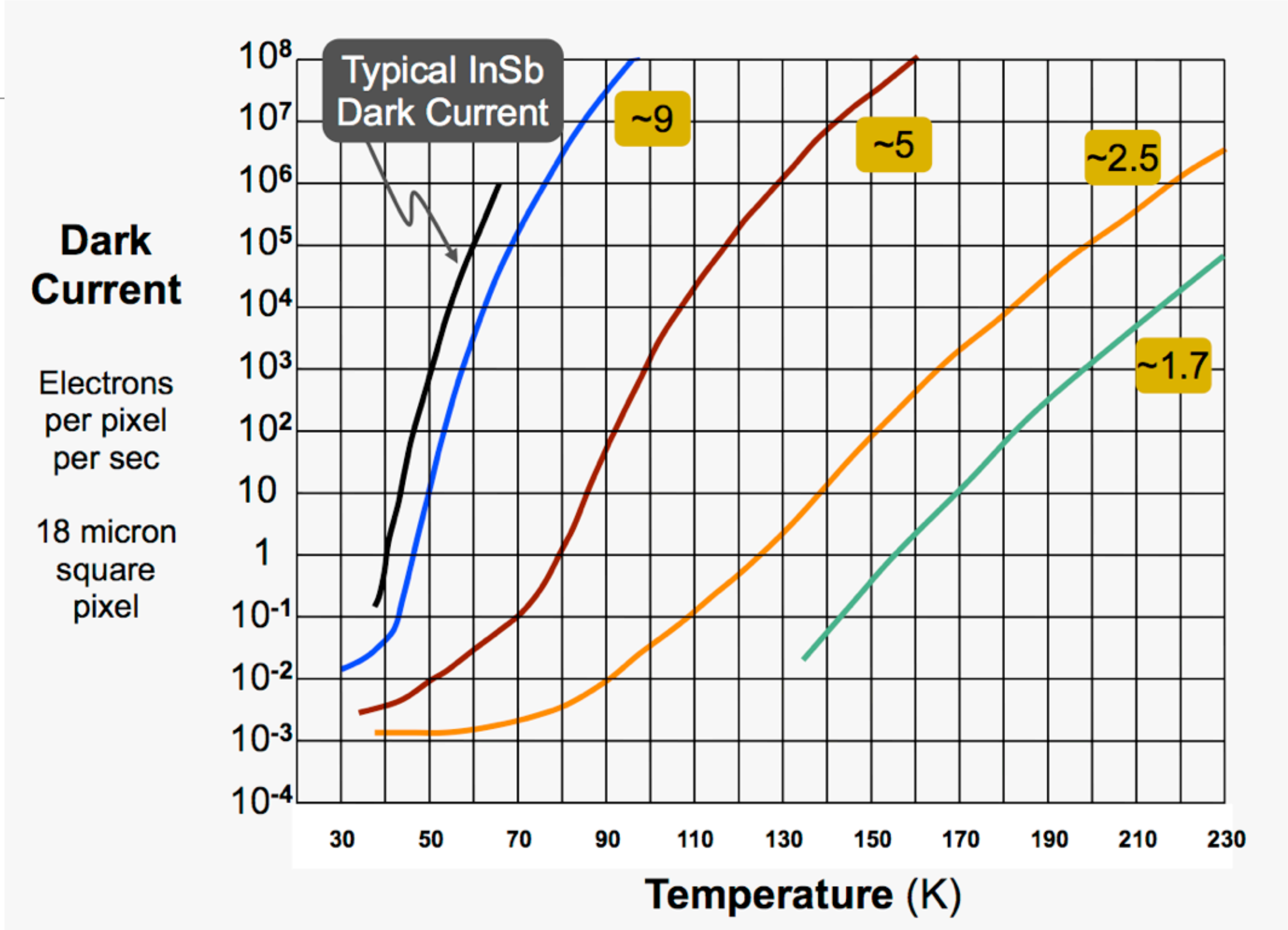
Detector, ASIC (FEE) and Radiators





If we assume 700 x 700mm^2 radiators, H2RG temperature is ~86K.
If the radiator size is 1300 x 1300 mm^2, H2RG will be ~66K and ASIC willl be ~70K.
Need to reduce thermal conductance from ASIC and effective cooling to achieve <50K

Cutoff Wavelengths and Dark Current - from Teledyne



We assume 0.05e-/pix/s for sensitivity calculations.

Current Results of Thermal Analysis by the JAXA Thermal Group

Components	Requirements	Current Results
Mirrors (M1, M2, Flat, M3)	100K	50-70K
Spiders	100K	40-70K
Filters	80K	100K
Focal Plane Unit	80K	70-100K
Detectors	40K (Goal)	65K

Spacecraft (Uncompleted)

- Data Rate: 3- 30 Mbps. 30 - 120 GB / day
- Dry Weight: 1.3t - Tandem launch with H2A
- Electricity: ~1200W
- Orbit: Need to consider possibilities other than S-E L2?

Development of WISH: Primary Issues

- Telescope Structure
- Mirror fixation
- Thermal studies
  - Dynamic study (pointing, stabilization, exposure ..)
- Data analysis and Data archive