Introducing WISH: Goals, Design, Proposal

WISH: Wide-field Imaging Surveyor for High-Redshift
超広視野初期宇宙探査衛星

Toru Yamada (Tohoku University)
on behalf of
WISH Working Group

http://www.wishmission.org/en/index.html

WISH WG Members

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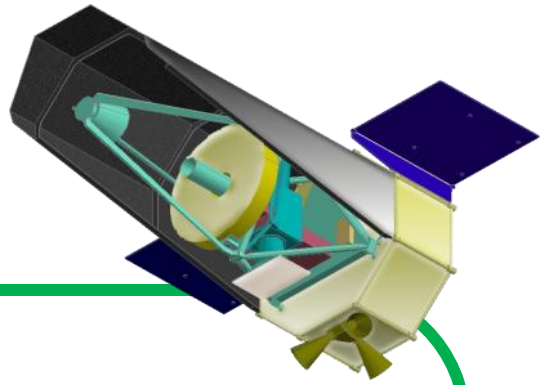
S.Oyabu (Nagoya University)
Y.Ikeda (Photocoding), S.Iwamura (M.R.J)

WISH Science Members

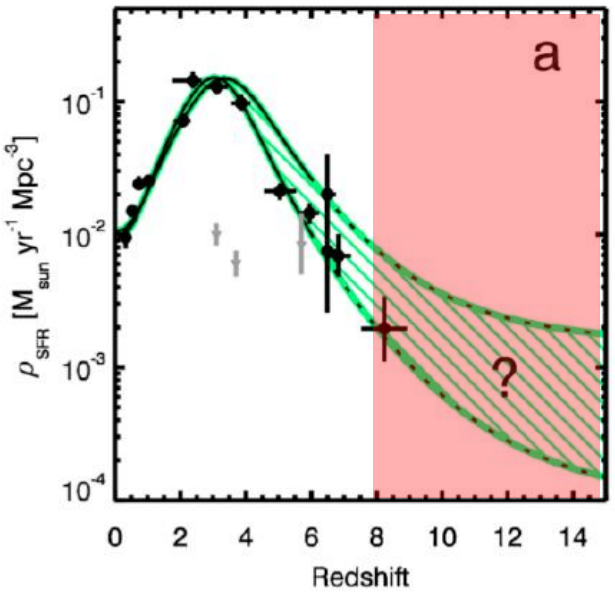
WISH Science Goals

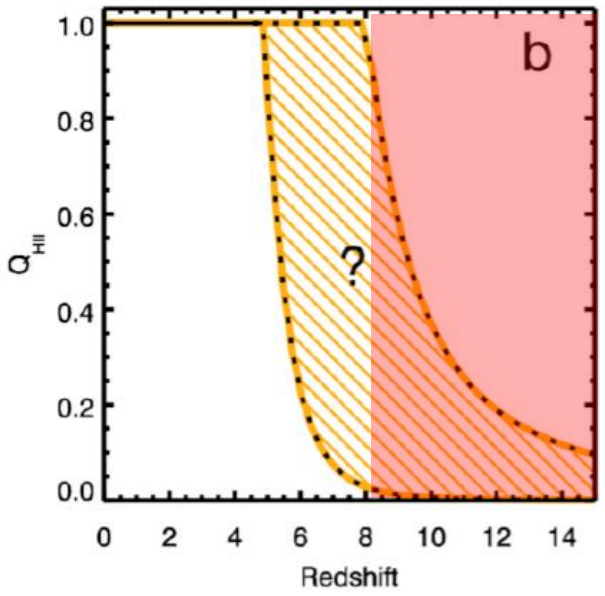


- **Exploring the Galaxies beyond the Epoch of Cosmic Reionization z=7-15**
- **NIR search and light curves of type-Ia SNe History of cosmic expansion and Dark Energy**
- **Deep and Wide NIR Survey**

A schematic picture Robertson et al. 2010

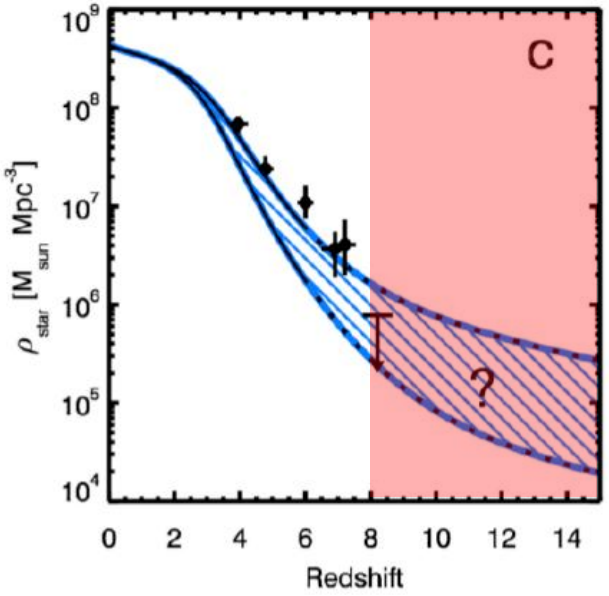
SFR density

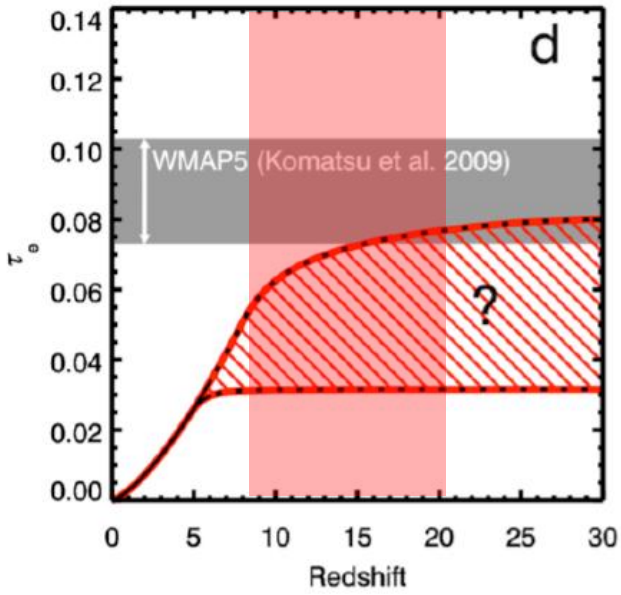




Ionization degree

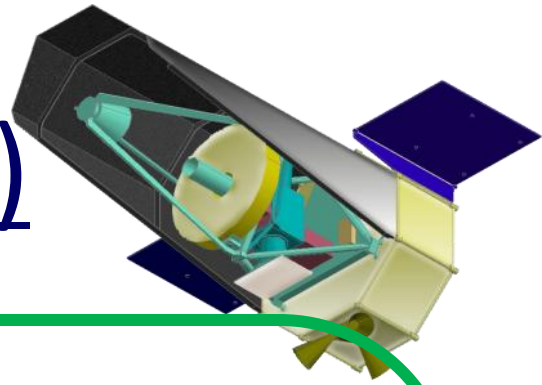
Stellar mass density





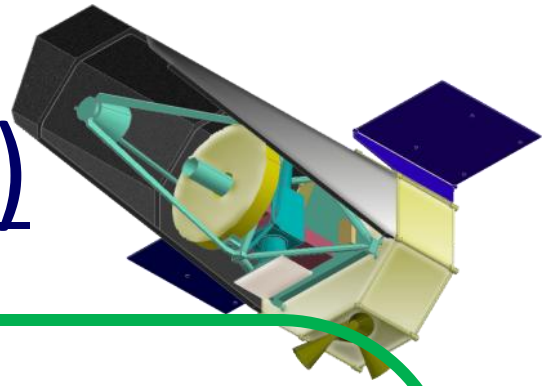
Electron scattering optical depth

WISH Brief Summary (1)



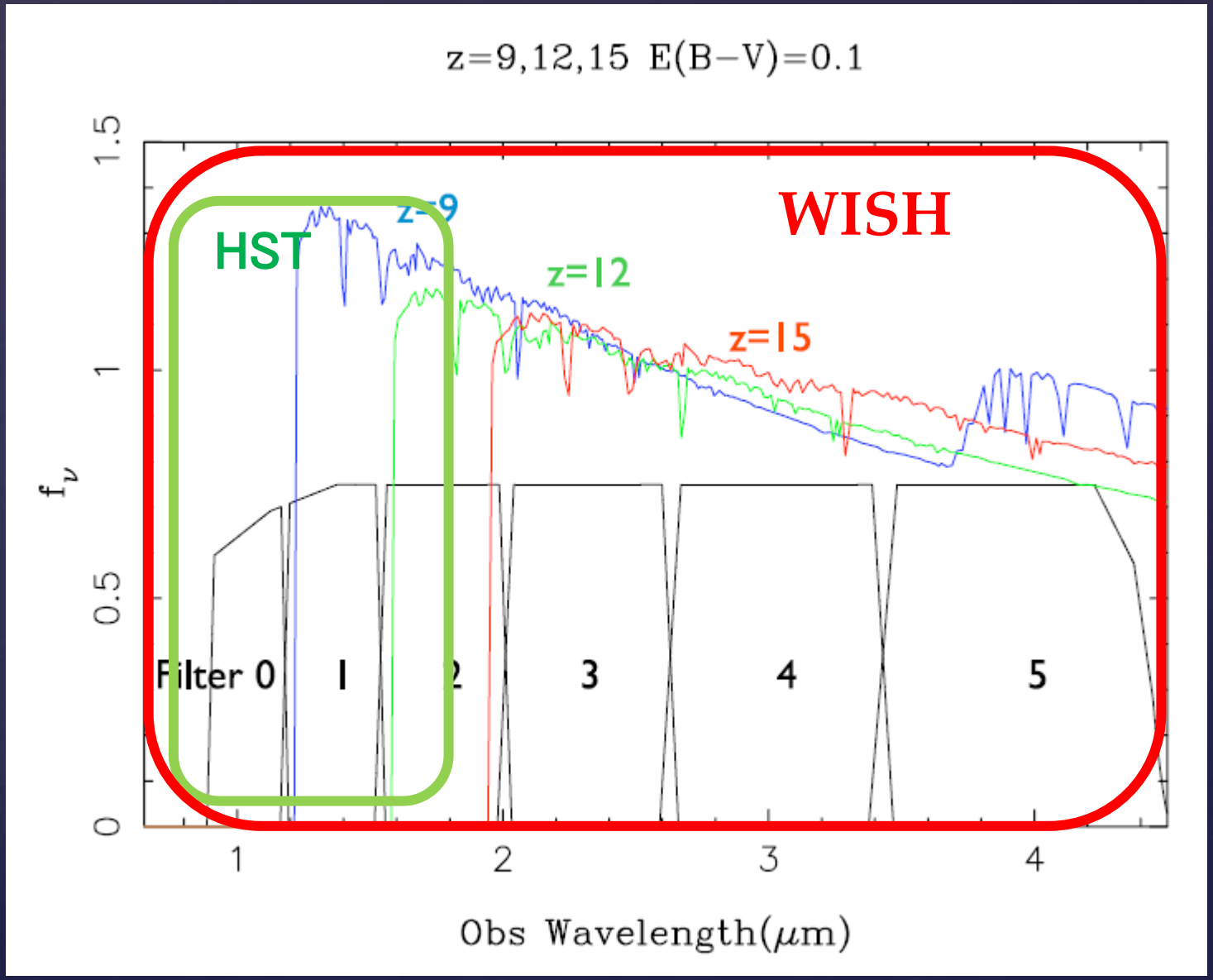
- NIR Deep and Wide-field Imaging Surveyor
- Exploring the 1st generation galaxies
- Dedicated, ~100 deg^2, 28AB (~25nJy)
- Concept being developed under JAXA/ISAS
  (the WG was selected in Sept 2008)
  to be launched in late 2010's (NET2018)
- Utilizing heritage of existing technology

WISH Brief Summary (2)



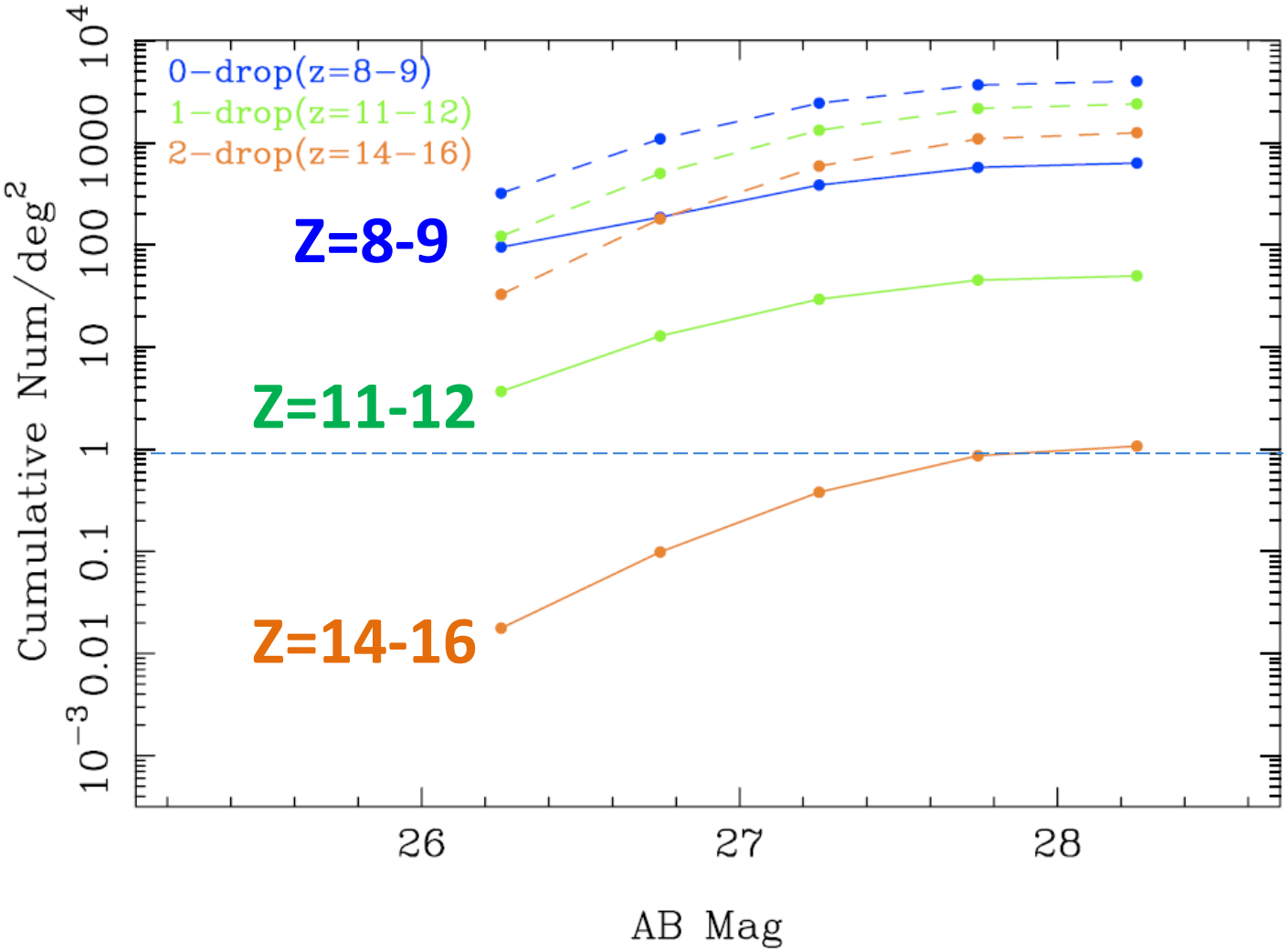
- 1-5 μm wavelength range
- 1.5m diameter telescope
- Very Wide-Field Imager

  ~900 arcmin^2 FoV
- pixel scale: 0.155” / 18μm (f/16)
- Cooled to 90-100K (telescope)
- SE-L2, JAXA HIIA


z=9,12,15 E(B−V)=0.1
WISH
HST
z=9
z=12
z=15
Filter 0
1
2
3
4
5
f_ν
0
0.5
1
1.5
1
2
3
4
Obs Wavelength(μm)

Expected Number of Galaxies in 1deg^2

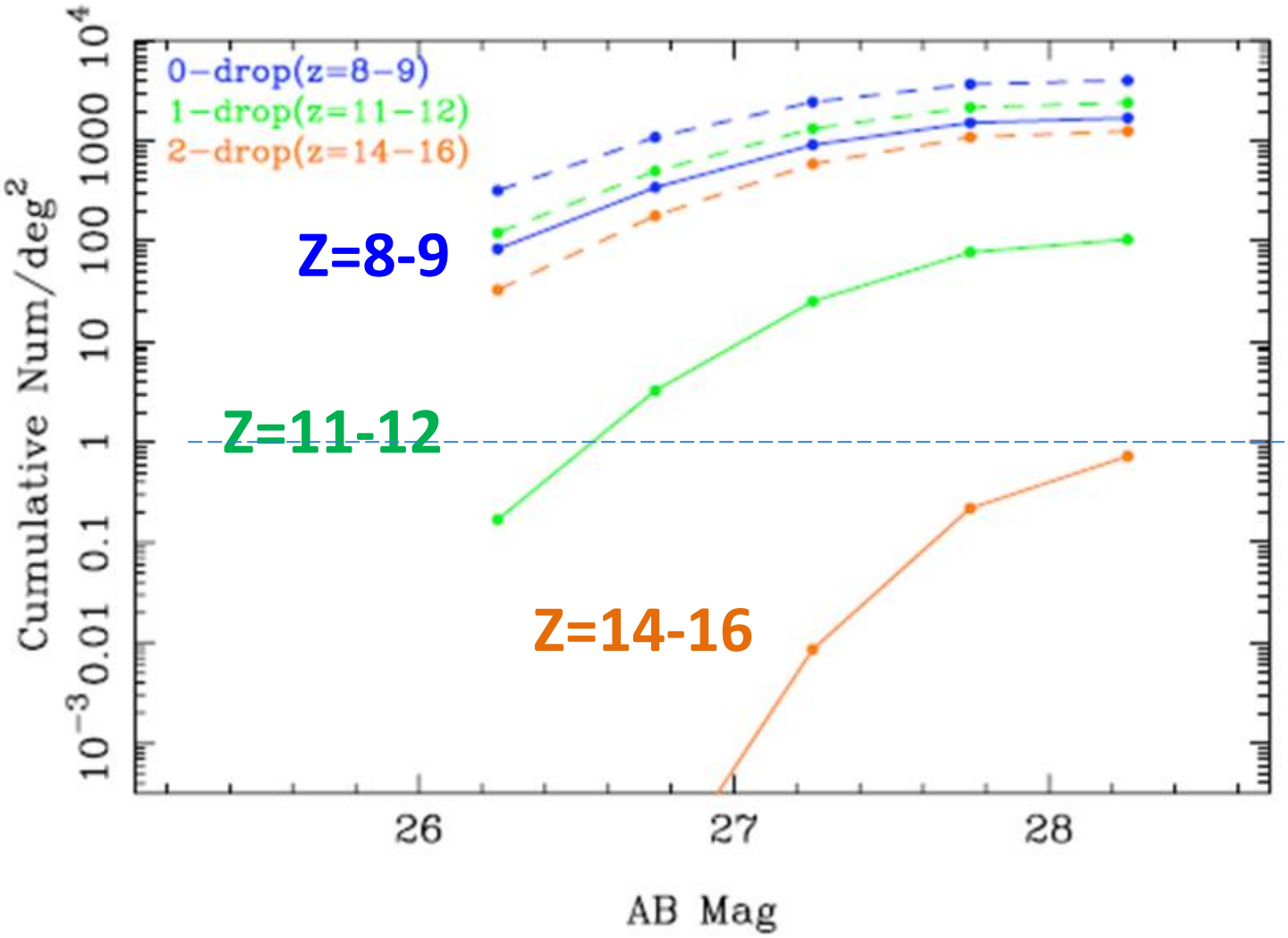
Extrapolation of z=6-8 UV LF by
Luminosity evolution (L*)



Dashed lines
No evolution
from z=8

Expected Number of Galaxies in 1deg^2

Extrapolation of z=6-8 UV LF by
Semianalytic Model by Kobayashi et al.



Dashed lines
No evolution
from z=8

WISH: Survey Strategy

Survey categories

	Depth (3σ) (AB mag)	Area	Example of the Filters (a plan, to be determined)
Ultra Deep Survey (UDS)	28	100 deg^2	1.0,1.4,1.8, 2.3, 3.0 μm
Multi-Band Survey (MDS)	28	10 deg^2	4.0
Ultra Wide Survey (UWS)	24-25	1000 deg^2	1.4, 1.8, 2.3, (3.0, 4.0)
Extreme Survey	29-30	0.25 deg^2	1.0, 1.4, 1.8, (3.0, 4.0)

WISH UDS will bring

~$10^{4\text{-}5}$ galaxies at z=8-9,

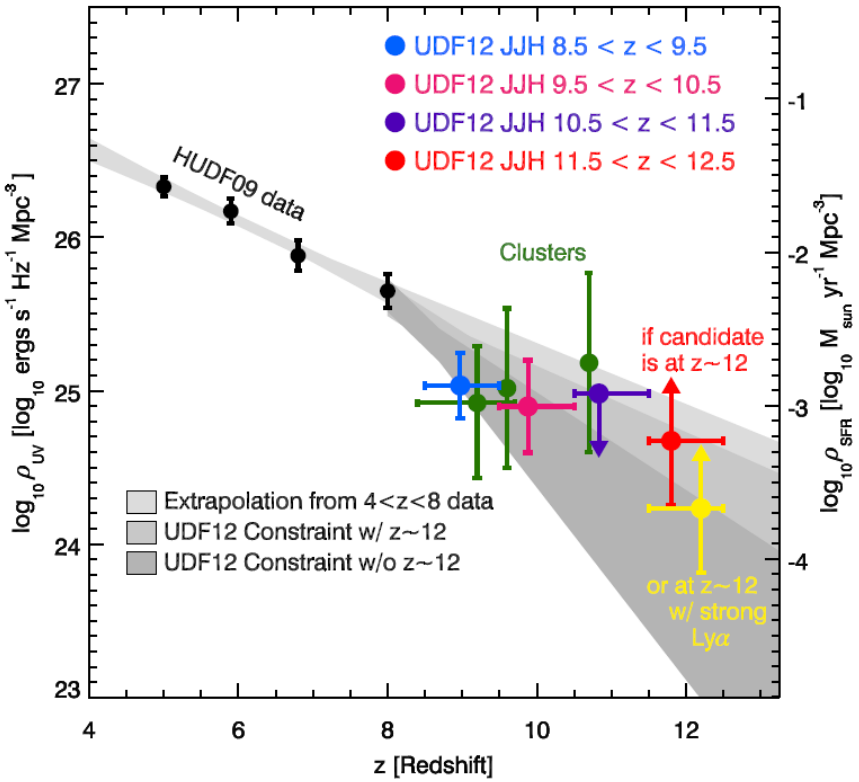
~$10^{3\text{-}4}$ galaxies at z=11-12,

and

~50-100 galaxies at z=14-17

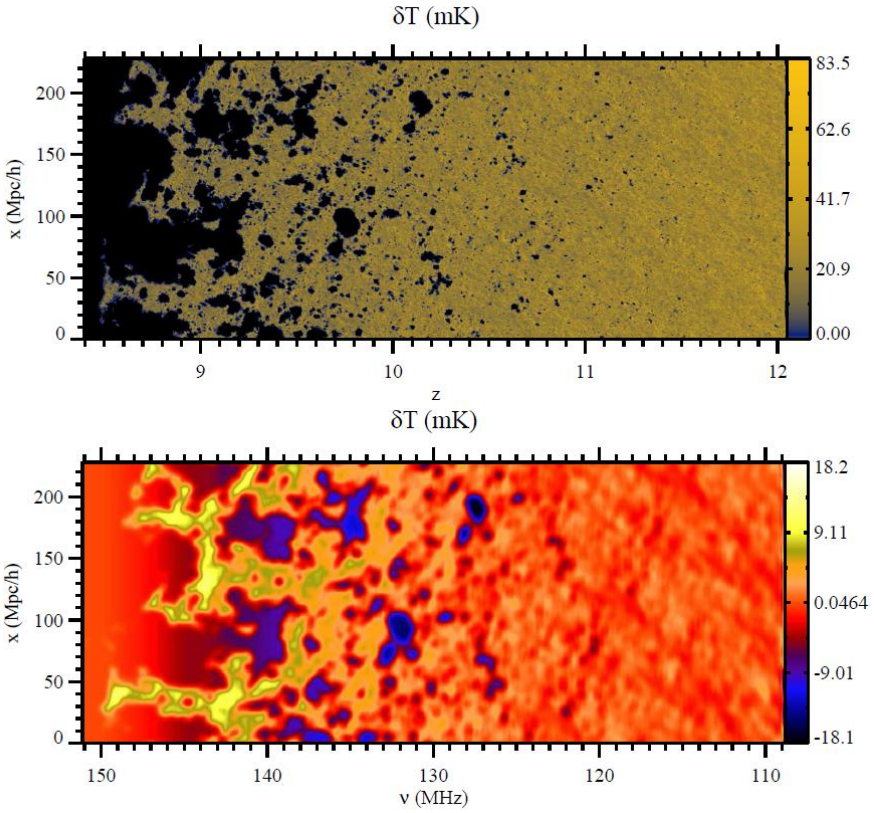
Galaxies beyonf Cosmic Reionization

z=8－15 UV LF evolution
Spatial distribution
Stellar population



From Ellis et al.(2012)

HI21cm fluctuation
by SKA



HI 21cm fluctuation
From Iliev et al.(2012)

Statistical Errors Only

Statistical + Systematic Errors

NIR Hubble Diagram

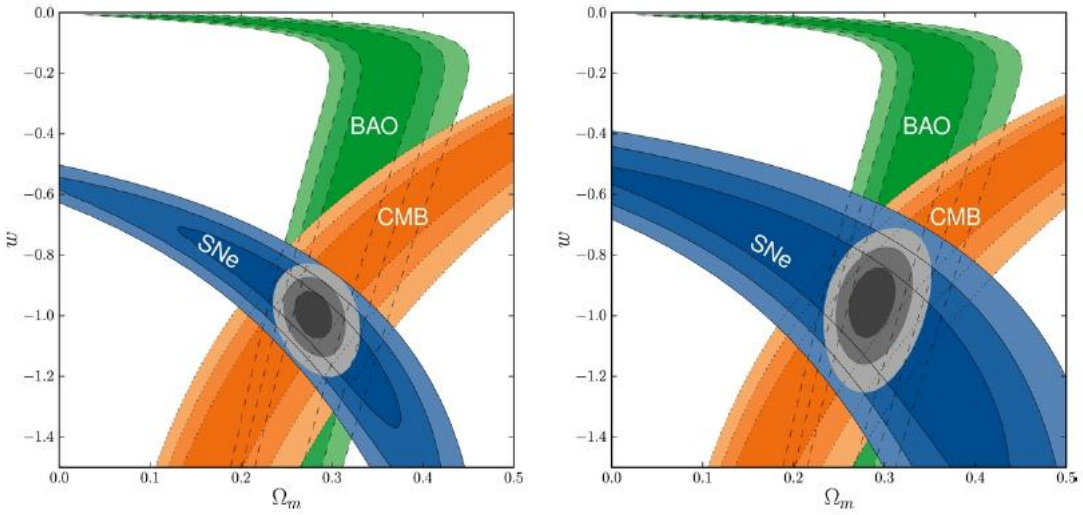


図 2.8.1: Ia 型超新星、バリオン音響振動、宇宙マイクロ波背景放射の観測による宇宙論パラメータ (Ω_M と w) への制限。Confidence Level 68.3%、95.4%、99.7%の範囲を示している。左は統計的誤差のみ考慮した場合、右は系統的誤差も含めた場合。Ia 型超新星による制限は CMB によるものとほぼ直角に交差しており、宇宙論パラメータの制限に有効である。Suzuki et al. (2012) による。

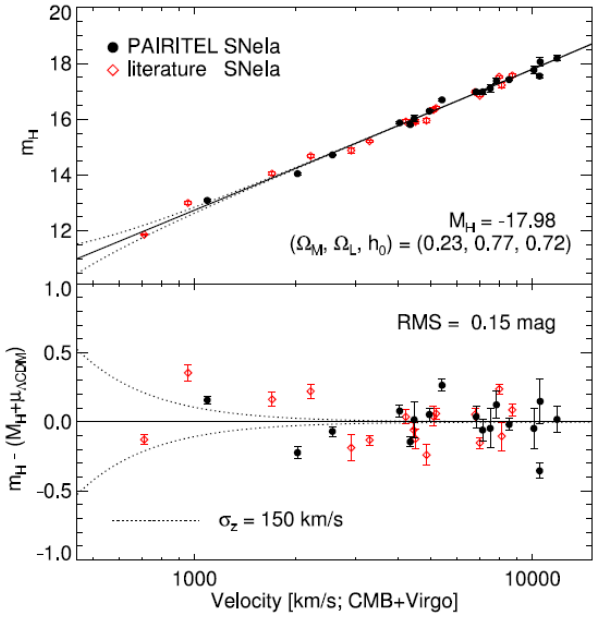


図 2.8.2: *H* バンドでのハッブル図。Wood-Vasey et al. (2008) より抜粋。

From Suzuki et al. 2012

Precision Cosmology by Type-Ia SNe

* reducing "systematic errors"

- High precision photometry from space
- Detection and Light Curve in rest NIR

Type Ia SNe by WISH

Ultra Deep Survey AB28mag

N=5-10 ／year （@z~1 … Δt~10 days）

➔ limiting magnitude 27.1 (N=5) – 26.8 (N=10)

1mag margin： m<26.1(N=5) m<25.8(N=10)

	Rest-frame I Band	Rest-frame H Band
N=5	z=0.2-2.2 2000 SNIa in 80 deg^2	z=0.-1.4 2000 SNIa in 170 deg^2
N=10	z=0.2-1.6 2000 SNIa in 20 deg^2	z=0.-1.0 2000 SNIa in 70 deg^2

Synergy with TMT: Feasibility Matching

e.g., Find z=11-12 galaxies by WISH and obtain their spectra with TMT

WISH Ultra Deep Survey

(100deg^2, 28AB, 1-4um 10-20h integration)

- z=11-12 galaxies ~26.5AB ~27AB
  ~5/deg^2 ~20/deg^2

TMT IRIS

0.1” aperture AO-assisted

Continuum H-band 5hours S/N= 2-3

26-27 AB （R~4000 resolution unit）

Wright et l. 2010

0.1” aperture / point source

0.05”/pix

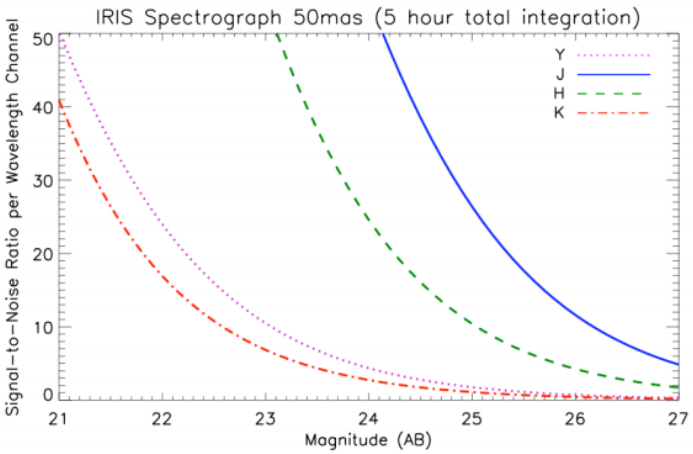


Figure 5: Estimated signal-to-noise ratio per wavelength channel versus a given magnitude (AB) illustrating the sensitivities for the integral field spectrograph at the 0.05” per spatial element scale in each broadband filter (Y, J, H, K) using a fixed aperture size of 0.1” over a single point source. A total integration time of 5 hours was made up of single exposures of 900 seconds stacked 20 times in Y, J, and H, and K. The coarser scale yields a higher background compared to the finer spatial scales and undersamples the PSF, therefore decreasing the signal-to-noise in these simulations.

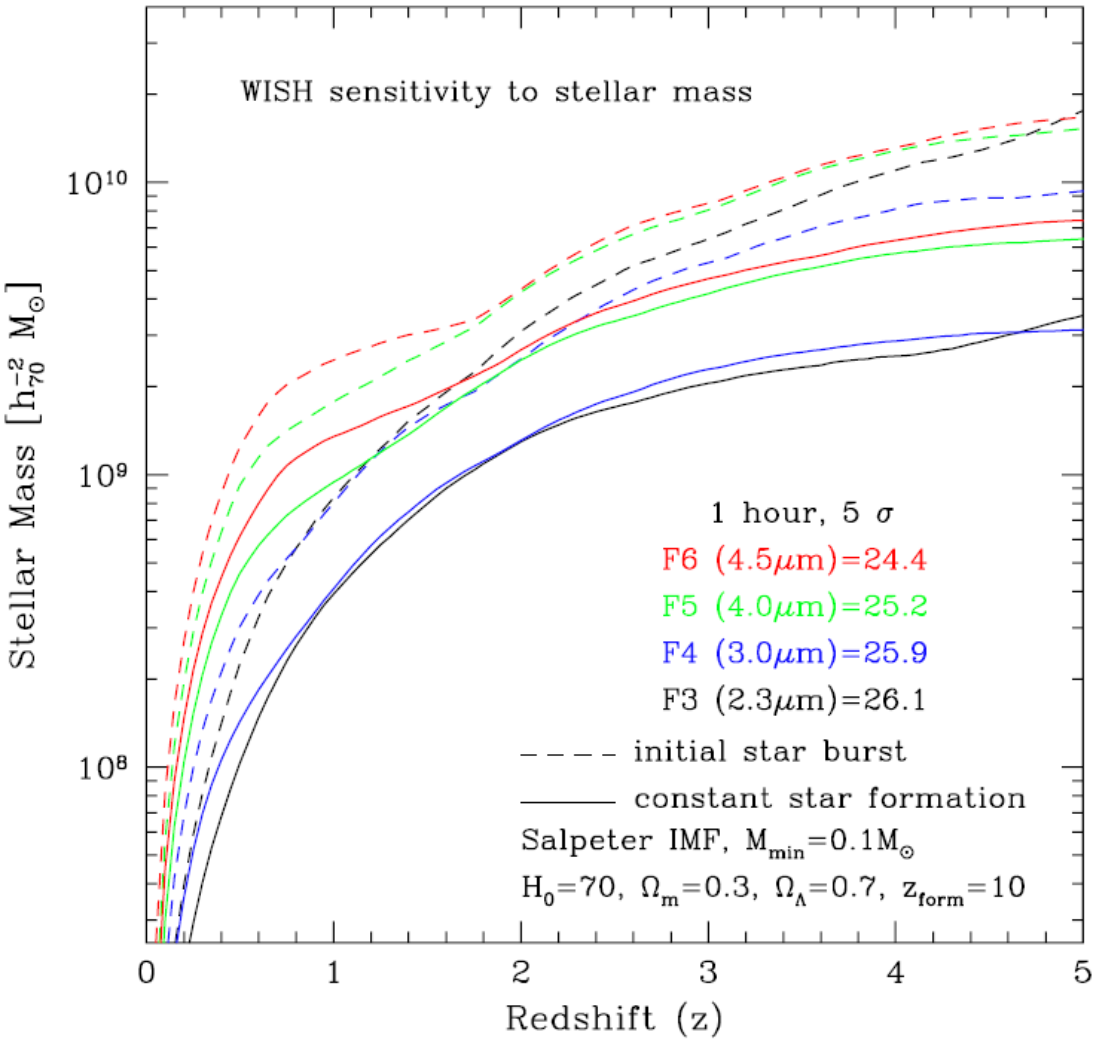
WISH Auxiliary Campaign Science

Base-line:
>80% WISH Surveys (UDS, UWS, ExS)
~20% Auxiliary Science

- Galactic Bulge astrometry in NIR
- Galactic Plane Open clusters, disk structure
- Extrasolar Planets NIR Transit
- Extrasolar Planets microlensing
- Solarsystem H_2O Ice on Kyper-Belt objects

etc....

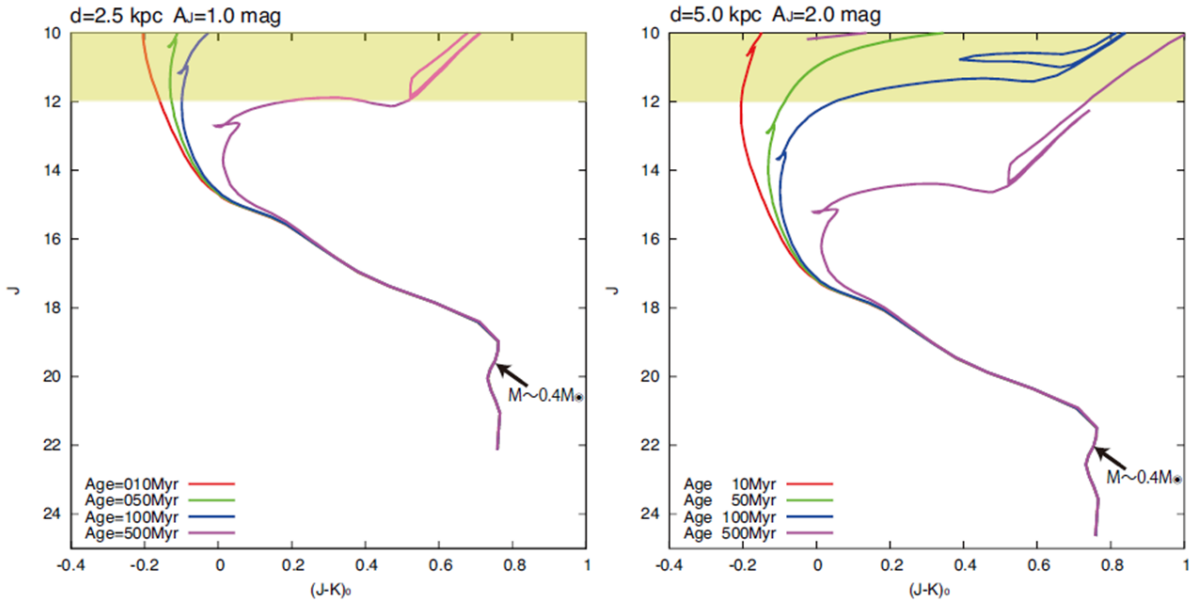
WISH Stellar Mass : 1h integration



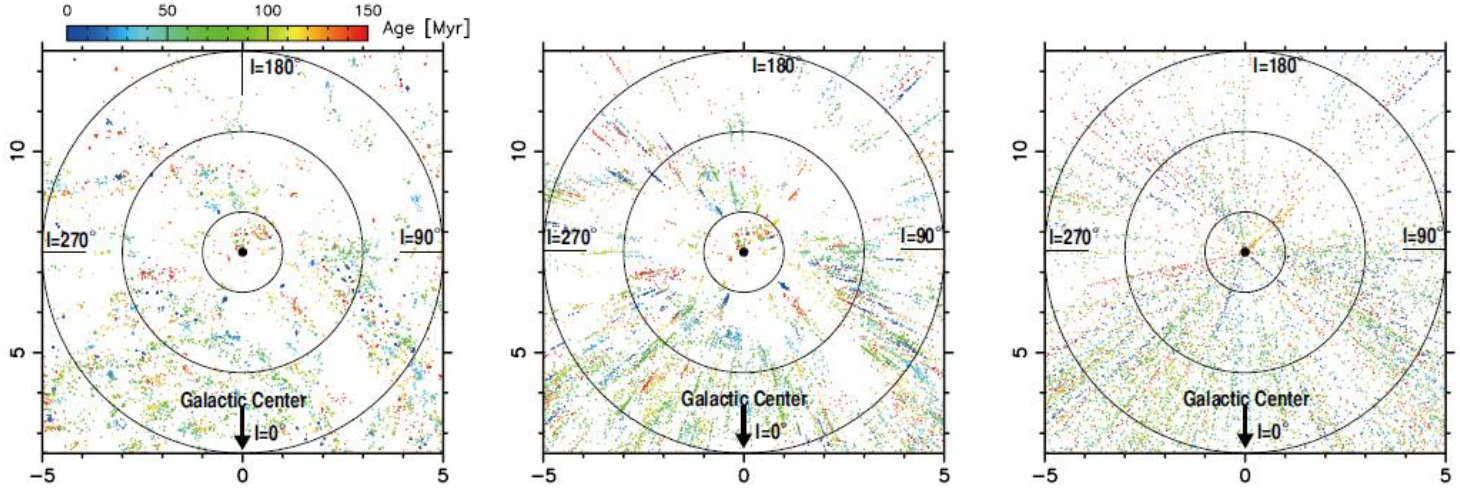
$10^9 M_{sun}$

WISH提案書
児玉、他

Galactic Plane Survey



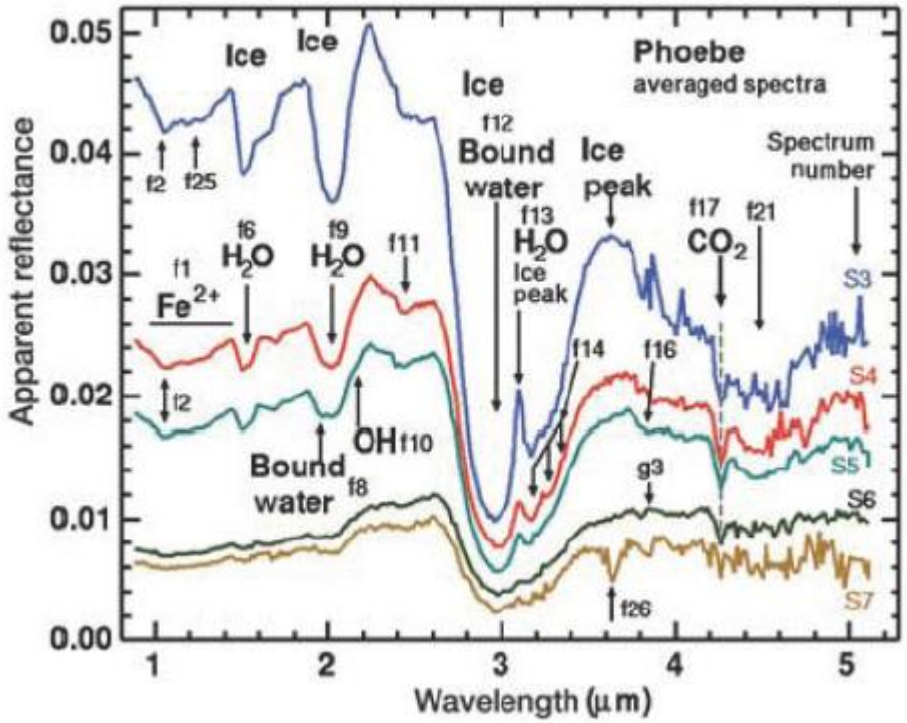
J vs J-K HR-diagram and age

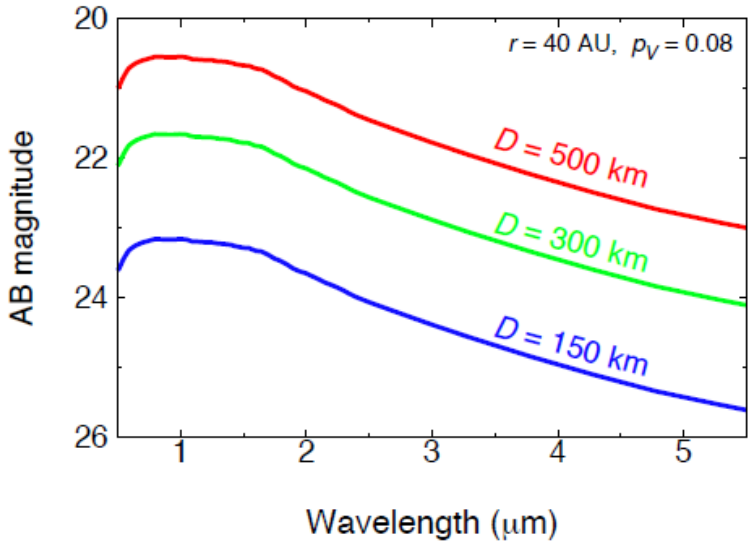


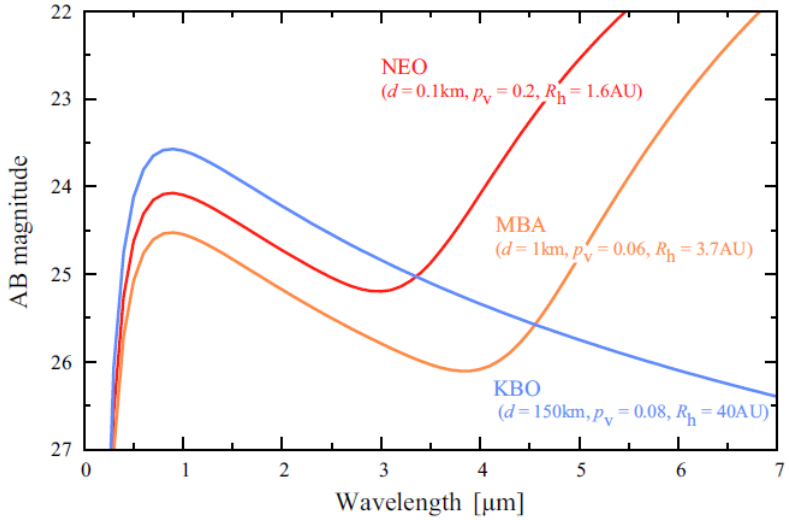
松永、他　WISH提案書

馬場、他によるシミュレーション

H_2O Ice of TNO







寺居、他
WISH 提案書

WISH Project Development (Science)

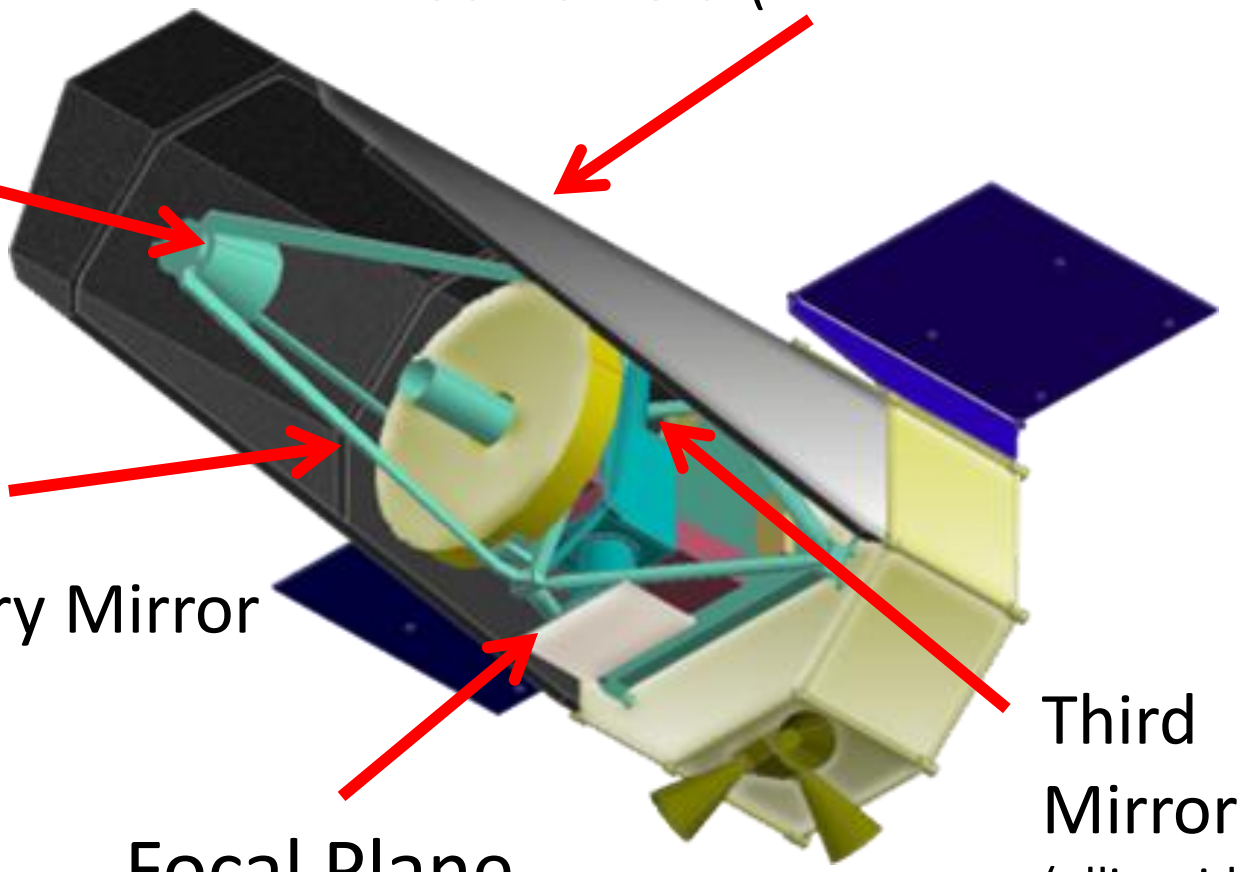
Defining the Main Science Goals
- Search for Galaxies beyond Cosmic Reionization: z=8-15 (+ GRB, QSOs)
- Type-Ia SNe and Acceleration of Cosmic Expansion : rest-frame NIR search and LC
- Deepest and Wide NIR Survey (GRB, Transients, Galaxy Evolution, QSOs, etc.)

Basic Filter set and the Survey Plan
- 6 broad-band filters at 1-5μm
- Mission lifetime: 5 years
- 28AB, 100deg2 (Ultra Deep Survey)
- 25AB, 1000 deg2 (Ultra Wide survey) and 29-30AB, 0.3 deg2 (Extreme Survey)

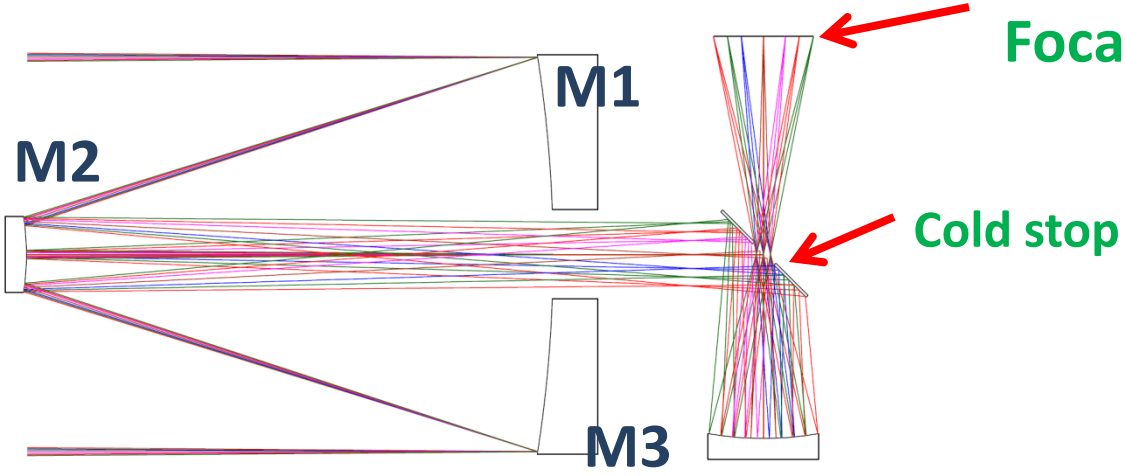
Additional Science Goals
- Narrow-band Imaging (LAE at z~10)
- Grism Slitless Spectroscopy
- Galactic Bulge (astrometry)
- Galactic Plane (open clusters, disk dynamics)
- Extrasolar Planets (transit, microlensing)
- Solar System (H2O Ice on the asteroids)
- Backside Spectrograph

WISH Project Development (Conceptual Design)

- Optical Layout
  ϕ1.5m, f/16, wide-field (~1000deg^2), diff. limit at 1-5μm, flat, cold stop
- Wide-field Imager
  NIR high QE, 0.155”/18μm pitch, arrays operated at ~50K
- Filter Exchange Unit
  Flip Type Exchanger ➔ Focal Plane configulation
- Telescope Structure
  CFRP, torus
- Primary Mirror / Mirror Fixation
  light-weighted glass mirror
- Baffling / Scattered Light
  ray-trace simulation
- Thermal Design
  Static thermal balance at SE-L2, focal plane radiator
- Data Production Rate, Required Data Down-link Rate
  Requirements for communication, ground-base antennas
- Guiding
  science array guiding
- System requirements for the space craft
  1.4t, 1.2kW


Sun shield (for Sun and Earth light)
Secondary Mirror (hyperbolic)
D=1.5m Glass Primary Mirror (ellipsoidal)
Focal Plane
Third Mirror (ellipsoidal)

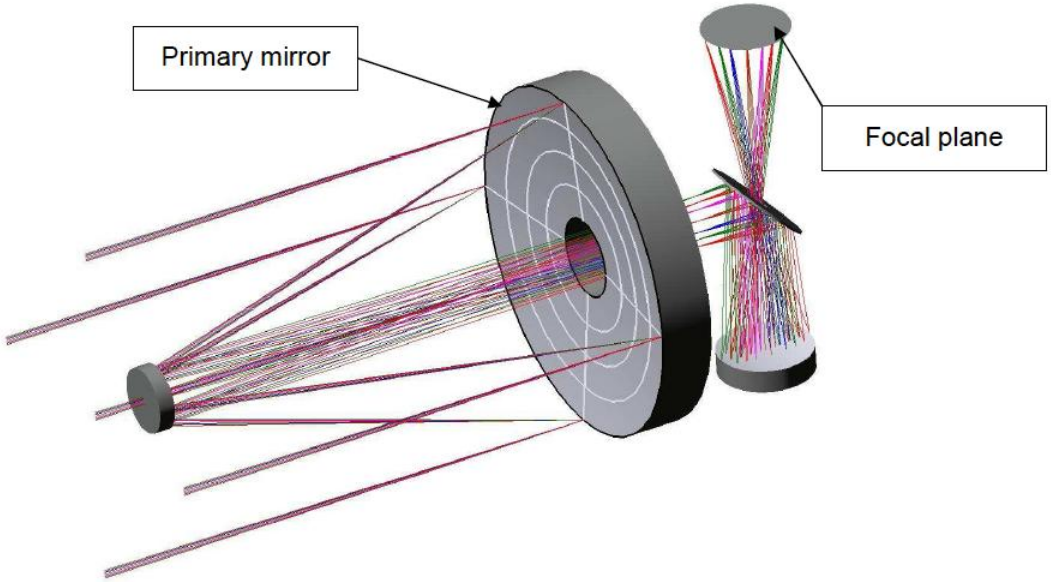
WISH Development: Optical Layout



M1: Ellipsoidal
M2: Hyperboloid
M3: Ellipsoidal

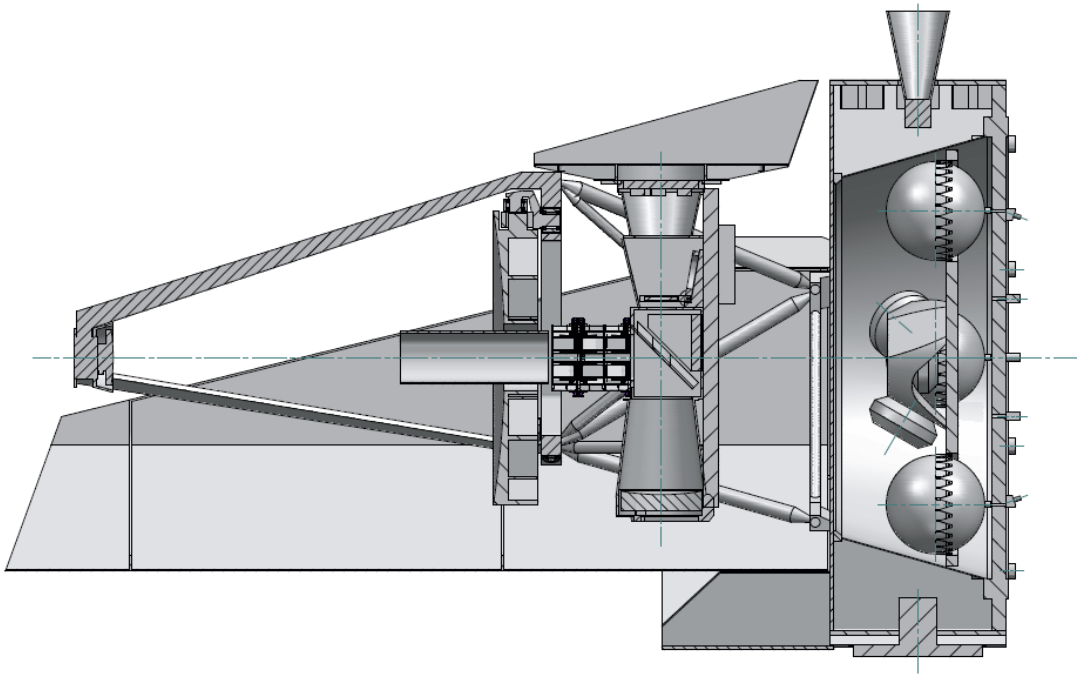
- Very flat focal plane
- Diffraction-limited images to ϕ ~50’ at 1-5 μm

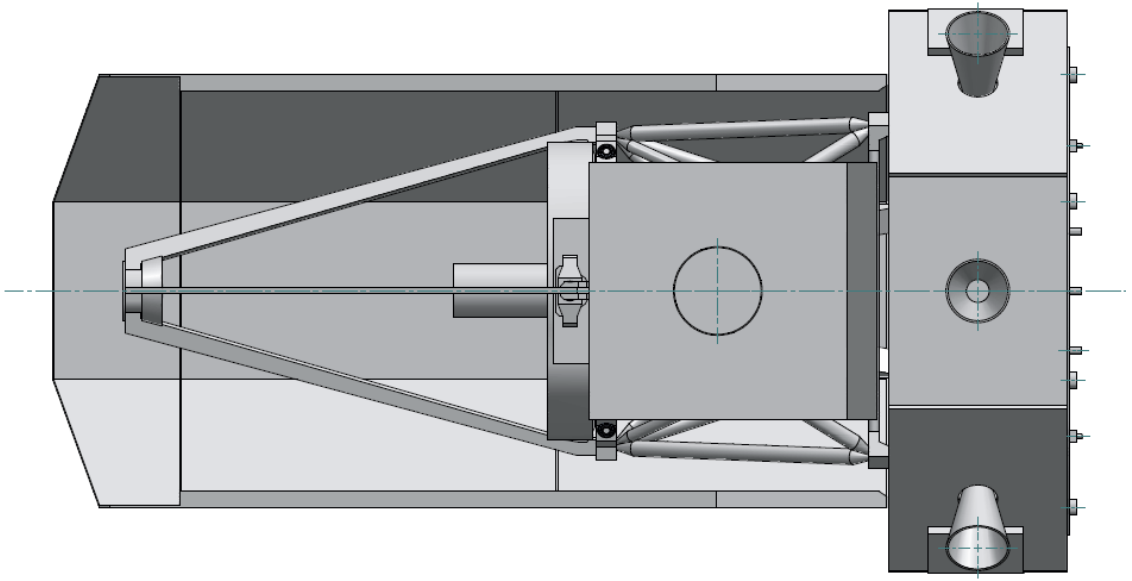
Yuji Ikedaet al. (photocoding)

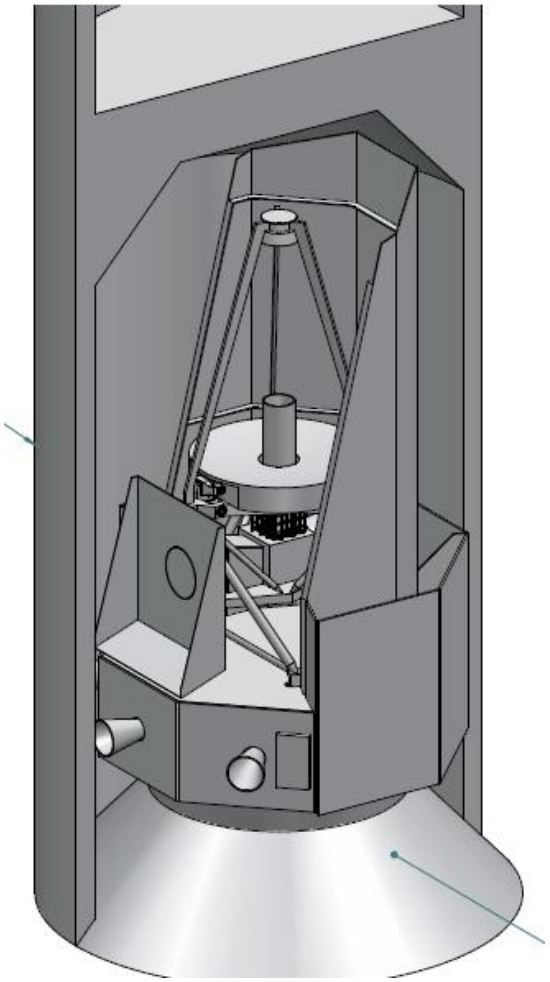


Size : (HII-A) 4/4D-LC (lower)

Mass : ~ 1.4t





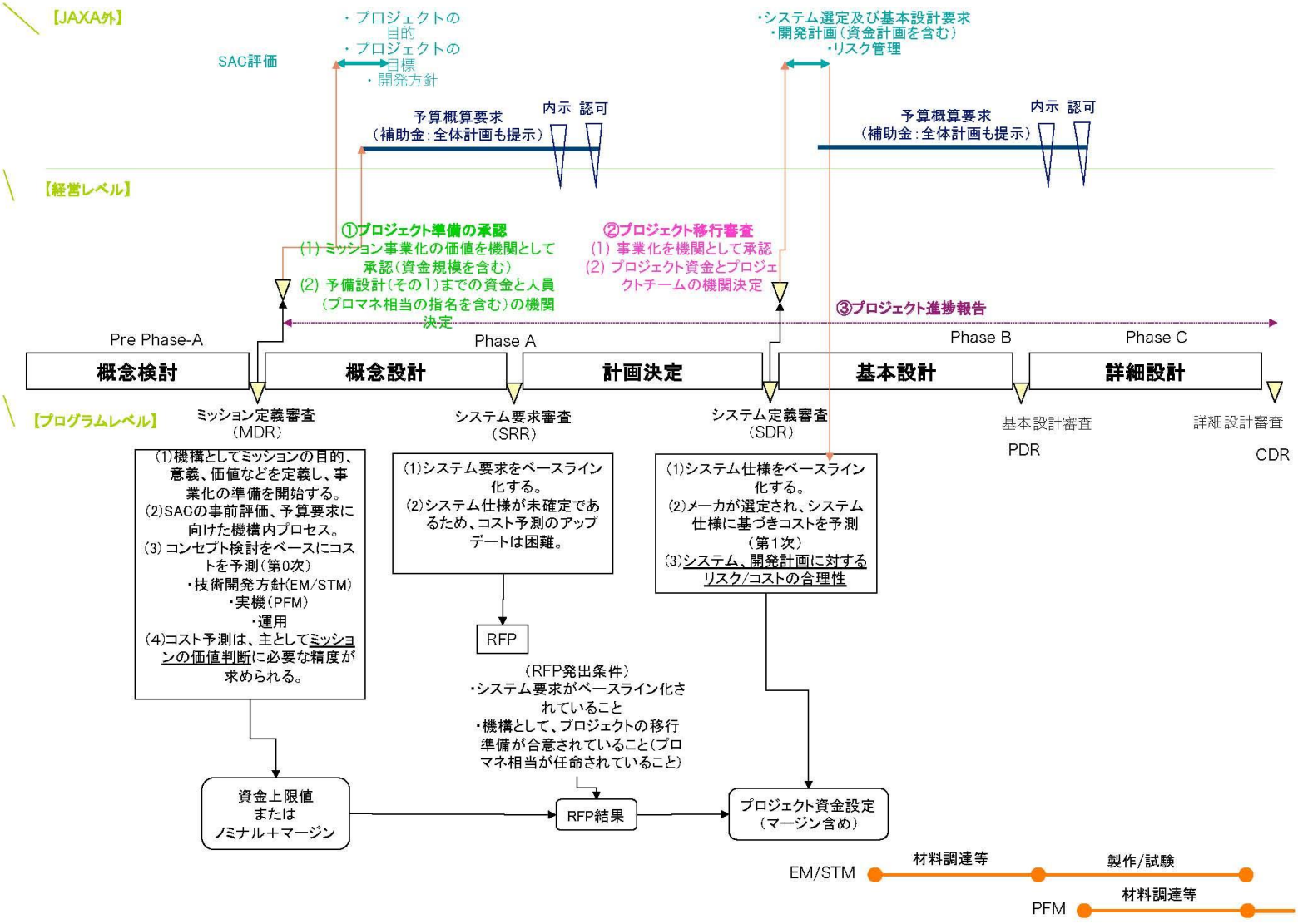


Overall Paremeters		
Launch Date (plan)	NET 2017	Mission Life Time > 5yr
Launcher	H-IIA 4/4D-LC lower case PAF 2360S	Capable to launch 1.5t (dual launch, SE-L2)
Size	φ3.3m x 5.2m	Launch Configuration Including the startracker
Mass	@launch (WET) 1.3t	margin 0.2t
Orbit	Sun Earth L2 Halo	
Power	Max 1.2 kW	SAP power 1.6kW (BOL) 1.4kW (EOL)

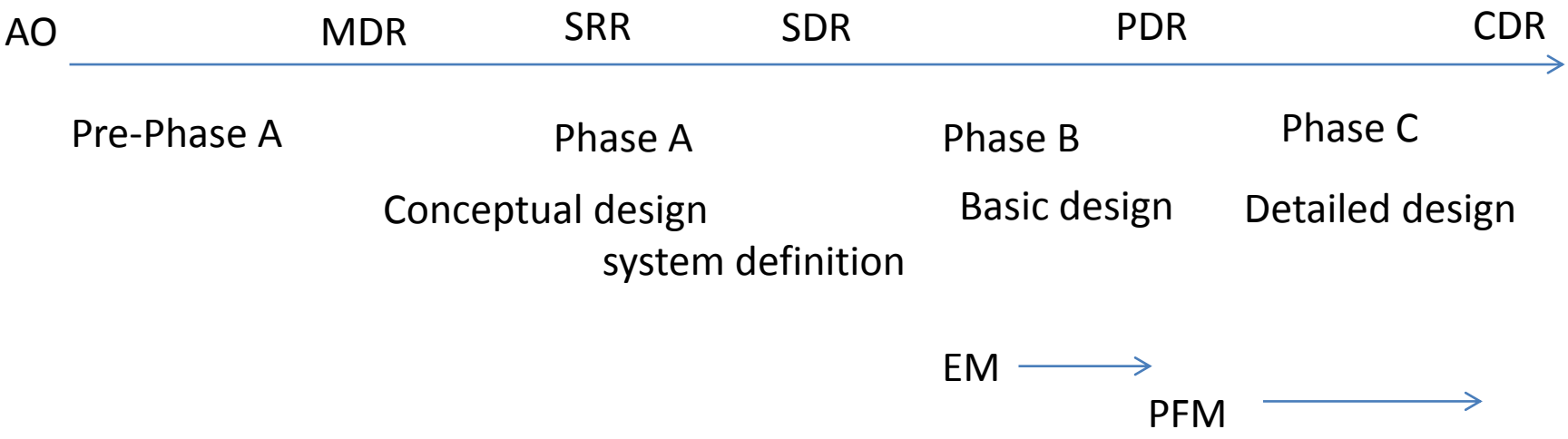
Mission Part		
Optics	M1 φ1.5m ellipsoidal M2 φ0.28m hyperboloid M3 φ0.41m ellipsoidal Deff..limit at 1-5μm Fov φ0.2-0.7deg 0."15／18μm(pixel)	・Cooled to 100K ・flat mirror also works as the cold stop ・light going through the flat mirror hole: option ・slitless grism spectroscopy at 1-2.5μm
Focal Plane Arrays	HgCdTe (HAWAII-2RG) 2K x 2K 32 chips (128Mpix)	0.9-5.3μm 1pixel=18μm
Filter Exchanger	Flip-type exchanger 11 filters + Cold Shutter	Test module pass the robustness test (120K, >100000 moving) and oscillation test
Cooling	M1 100K Other telescope and instrument structure: 80-100K Detector 40-50K Passive radiative cooling	No mechanical cooler

BUS		
SAP	Fixed, 2 wings 1.6kW (BOL) 1.4kW (EOL)	
Sun shield	Al panels ＋MLI 30/30	SPICA R&D heritage
Positional Control	STT-IRU Strap down system RW high accuracy （tork-balance ）	”internal accuracy” (w/o thermal flexure) <0.03” r.m.s. (300sec) Guiding using the science arrays
Thruster	fuel >162kg thruster 3Nx8 23Nx4	Φ504mm tank 4
Data link Data processing	X-band (Data, 16Mbps), S-band （telemetry） BUS < 50Mbps (Space Wire) DR 48GB x 2	Ka-band (32Mbps): option

JAXAにおける審査基本的考え方（図1）



ISAS Phase-Up Process



MDR
= Mission Definition Review
SRR
= System Requirement Review
SDR
= System Definition Review

WISH Schedule (Proposed)

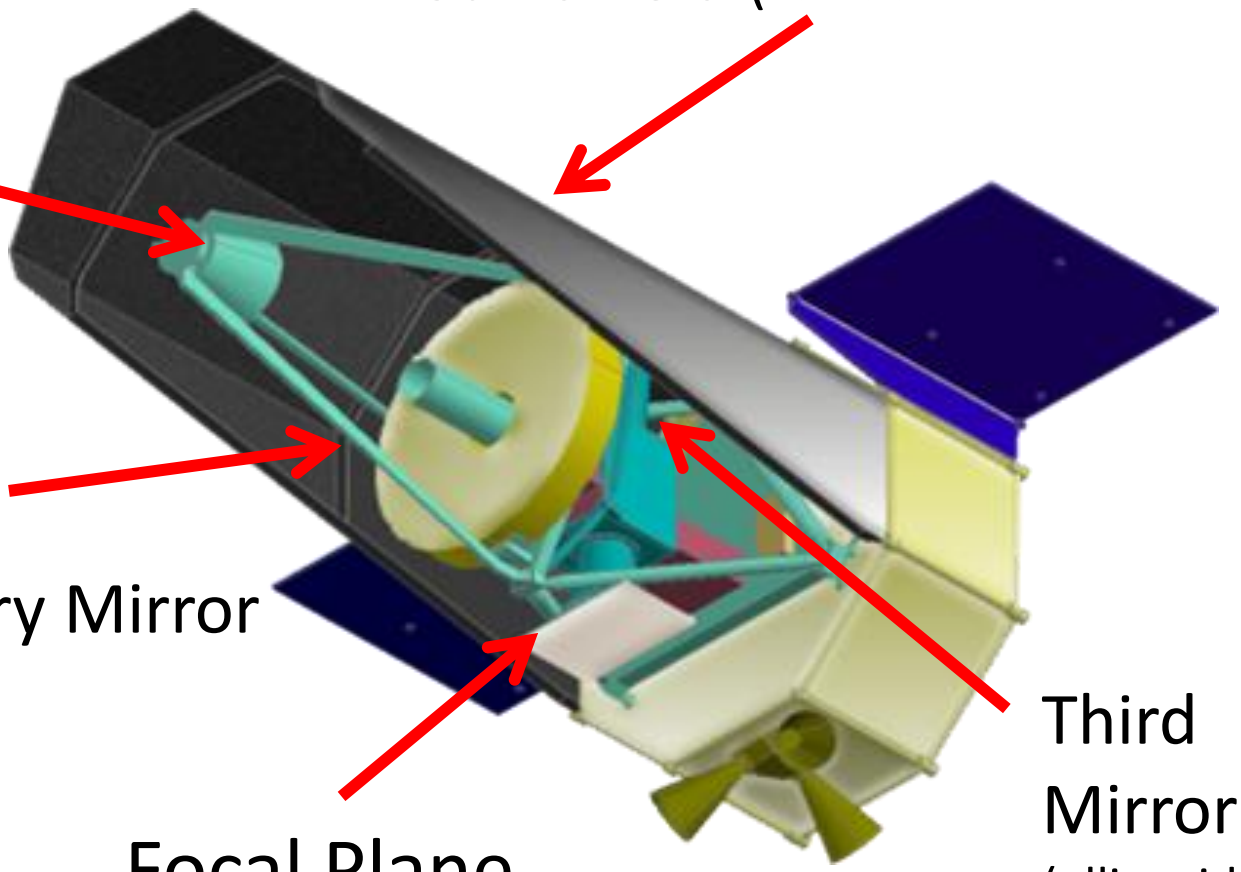
FY	task	Phase
FY0 (2008)	**Project Launch JAXA/ISAS Working Group Conceptual Study**	**Working Group**
FY1-FY4 (2009-2012)	**Conceptual Study, Basic development Preparing the Mission Proposal Early engineering model for some parts / test**	
Mission Proposal Mission Definition Review		
FY4-FY5	Conceptual Design Proto Models, Design and Testing	Phase A
System Requirement Review (SRR)		
FY5-FY6	Conceptual Design, System Definition Proto Model, Testing	Phase A
System Definition Review(SDR)		
FY6-FY8	Preliminary Dedign Preliminary Design Review Procuring M1 and detectors Detailed Design Critical Design Review PFM / FM	Phase B Phase C
Mission Critical Review		
FY9-10	FM, Testing	Phase C
FY10-11 (NET 2019)	Testing Launch	

Comparison of NIR IMAGING Capability

	Euclid	WFIRST	WISH
Mirror	1.2m	1.3m	1.5m
Wavelength Coverage	0.9-2μm	0.8-2μm	1-5μm
FoV	0.5deg^2	0.3deg^2	0.23deg^2
Pixel Scale	0.3arcsec	0.18arcsec	0.155arcsec
Num. Pixels	64Mpix	144Mpix	128Mpix
Filters	YJH	4BB	6BB+NB
Survey Area Deep	40deg^2	?	100deg^2
Survey Depth Deep	26AB	?	28AB
Survey Area Wide	20000deg^2	HL >2500deg^2	>1000deg^2
Survey Depth Wide	24AB	25AB	24-25AB
Primary Science	Dark Energy	Dark Energy Exoplanets QSO	First Galaxies

2011 SDT report

WISH Development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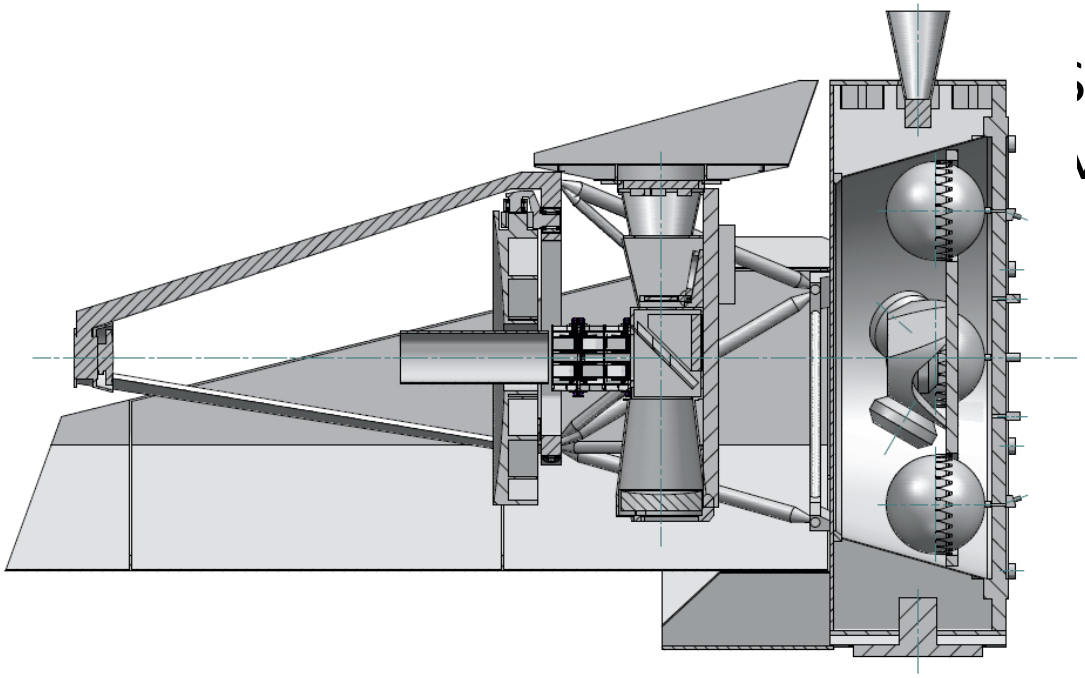

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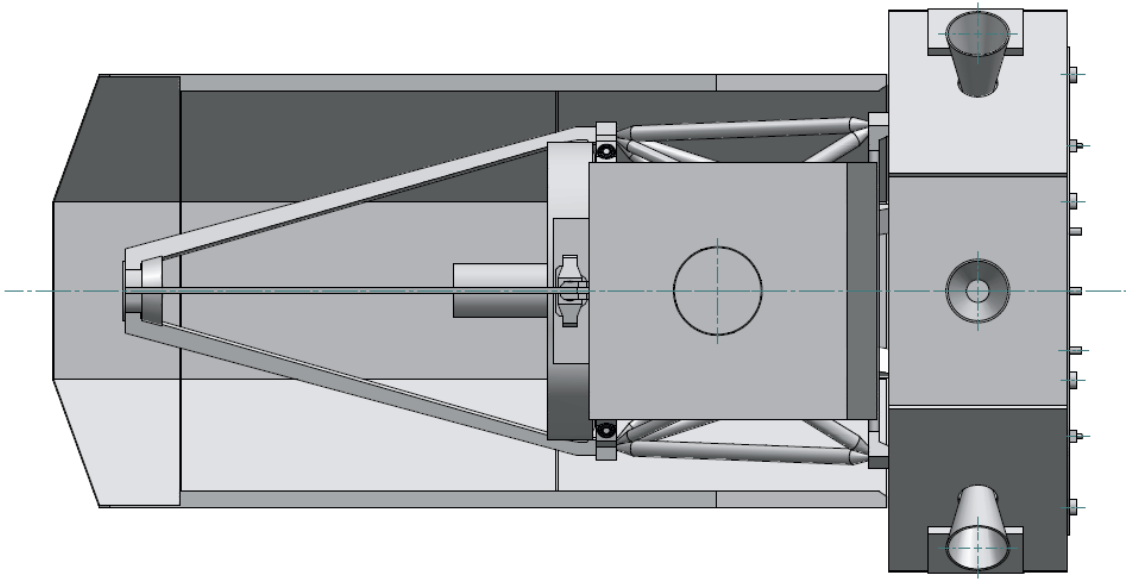
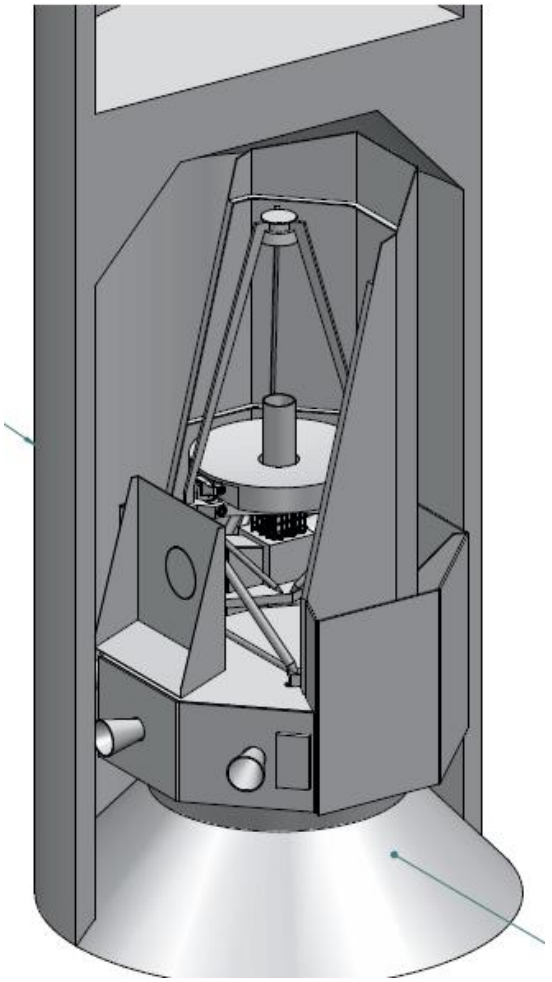
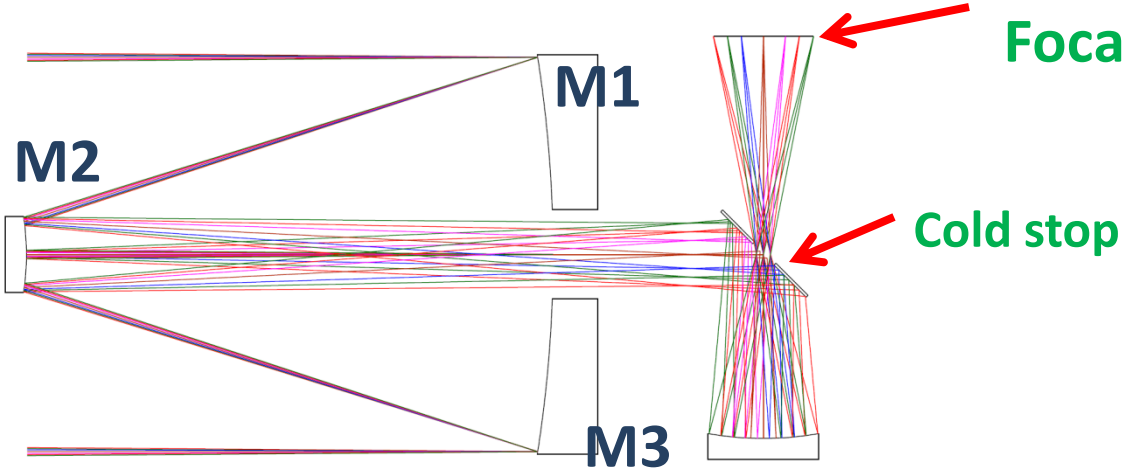
Mass : ~ 1.4t





Optical Layout and Very Wide-Field Imager

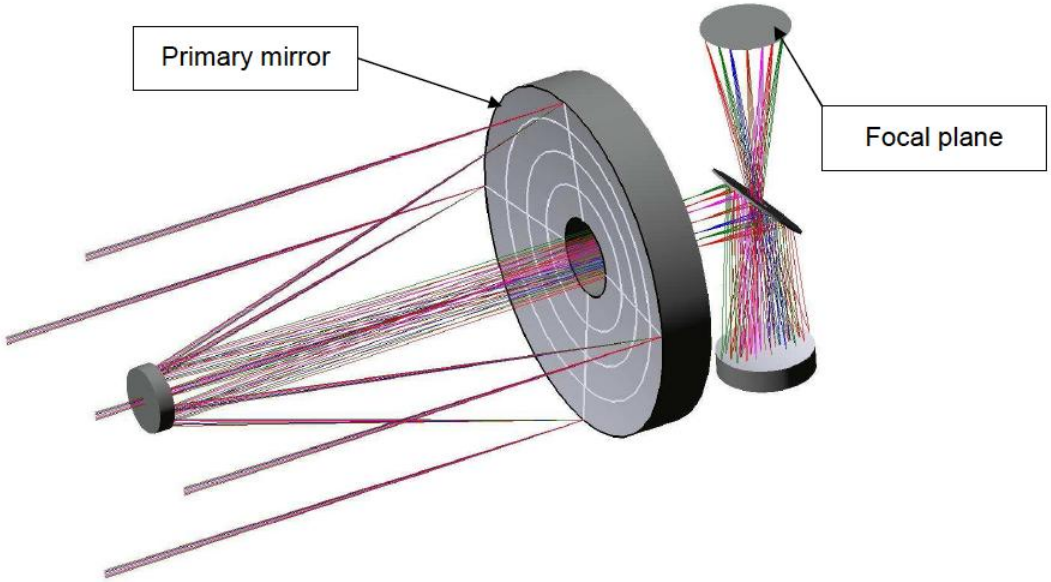
WISH Development: Optical Layout



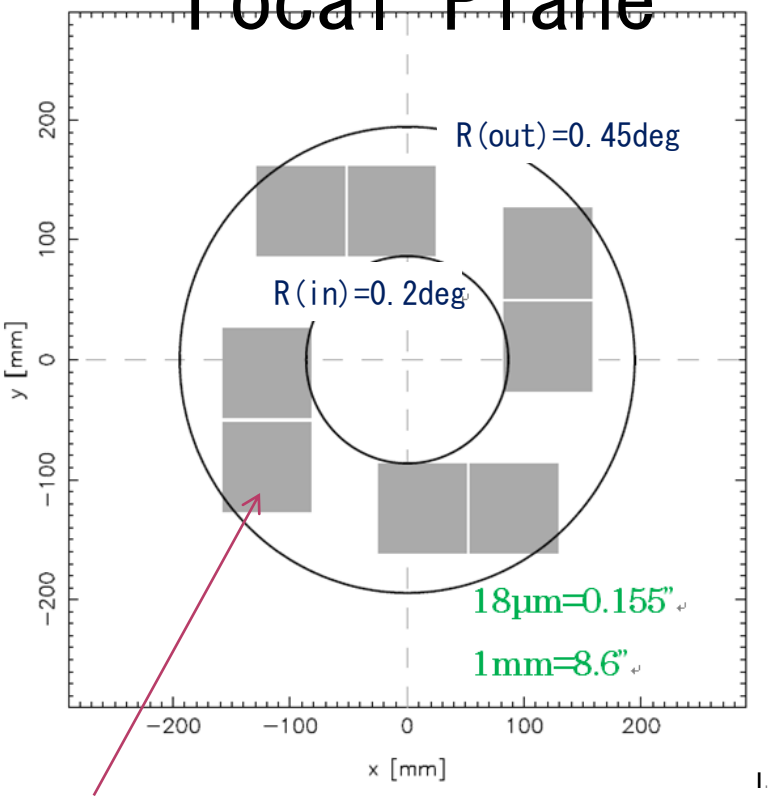
M1: Ellipsoidal
M2: Hyperboloid
M3: Ellipsoidal

- Very flat focal plane
- Diffraction-limited images to ϕ ~50’ at 1-5 μm

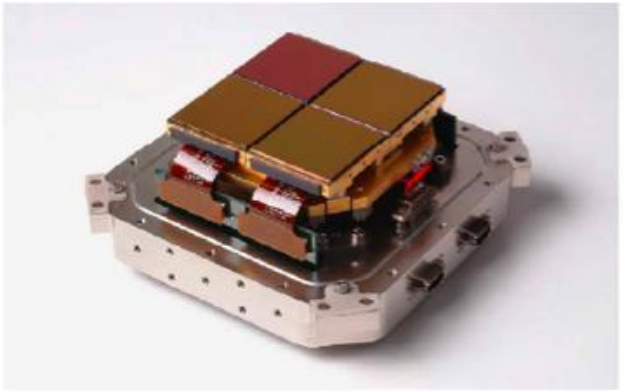
Yuji Ikedaet al. (photocoding)



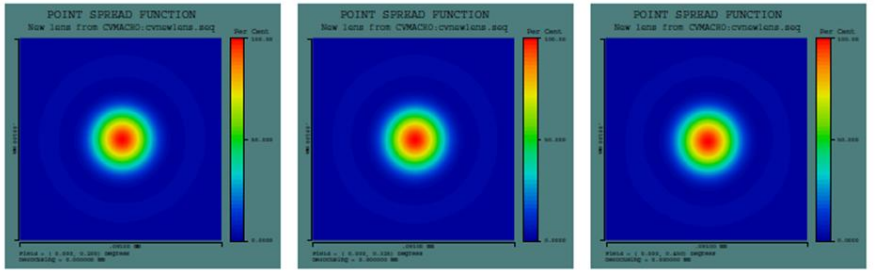
Focal Plane



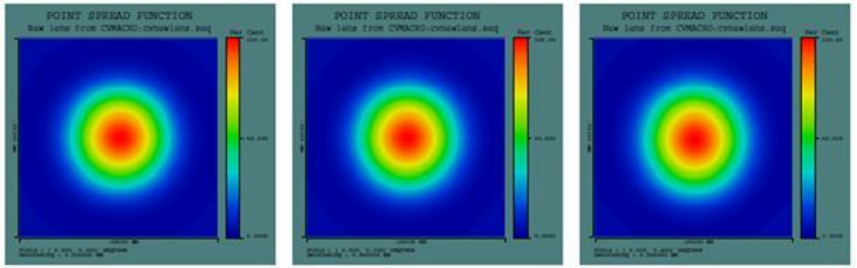
4 x 2kx2k FPA

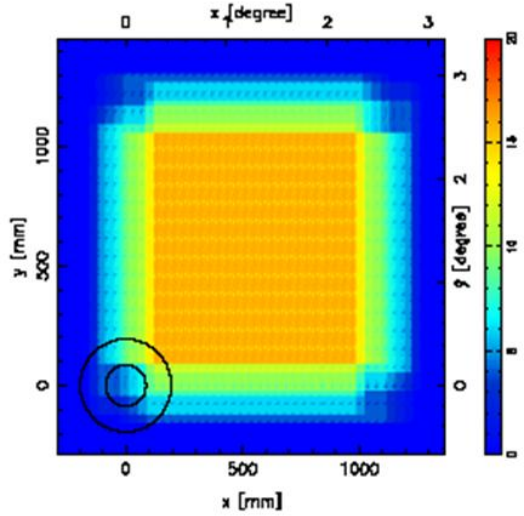


R=0.2, 0.325, 0.4 deg @ 1.25um

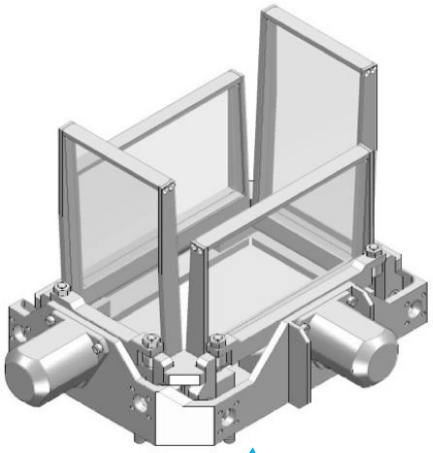


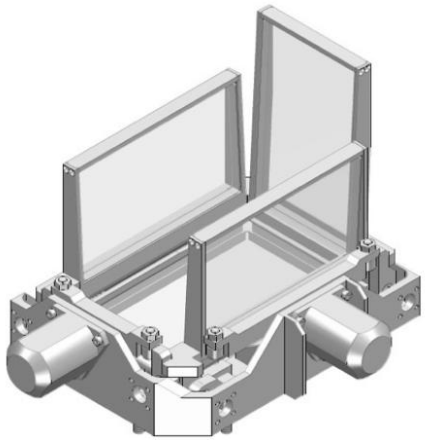
R=0.2, 0.325, 0.4 @ 2.2um

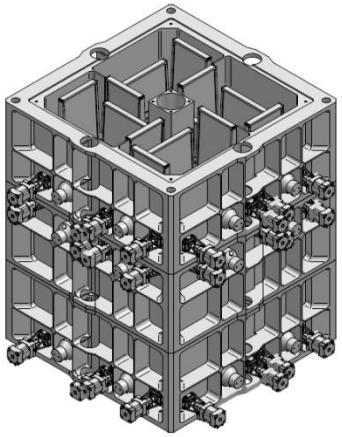


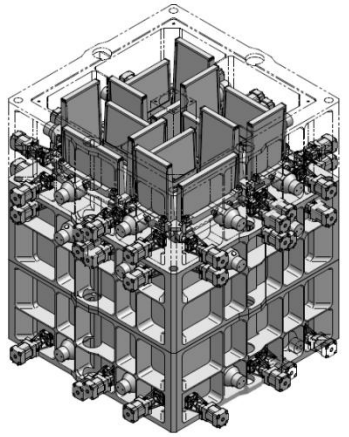


WISH Flip-type Wide-field Filter Exchange Sy

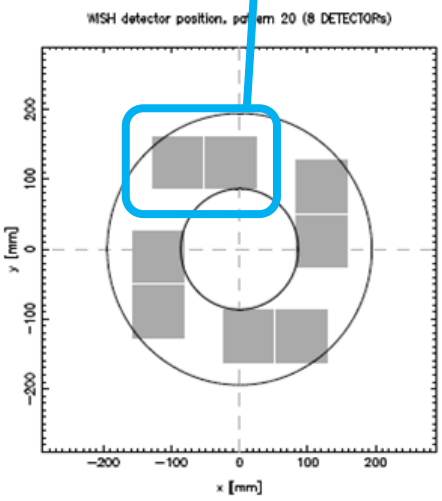


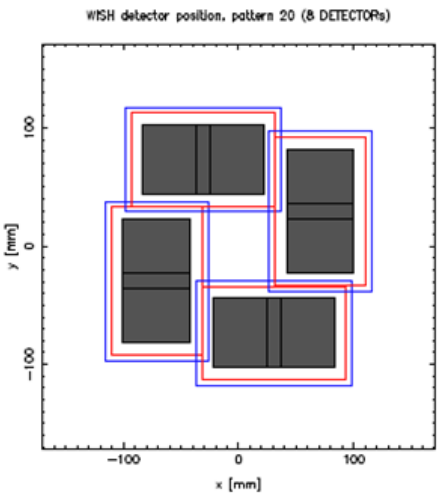


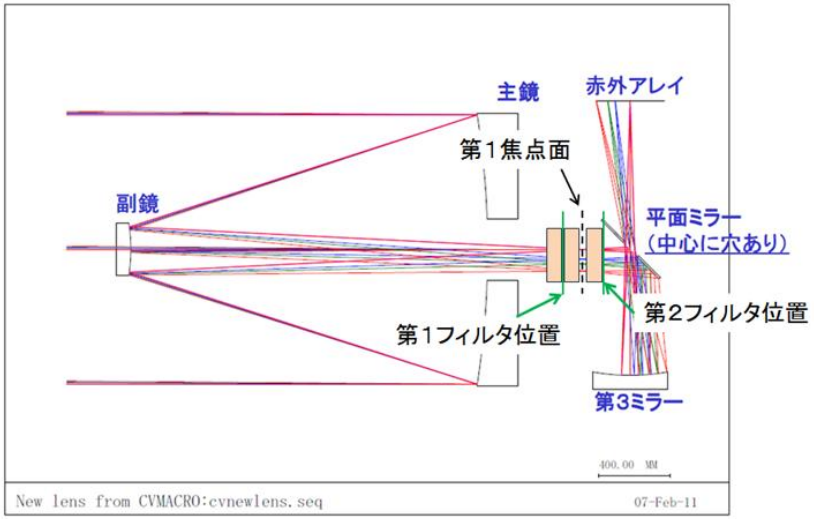




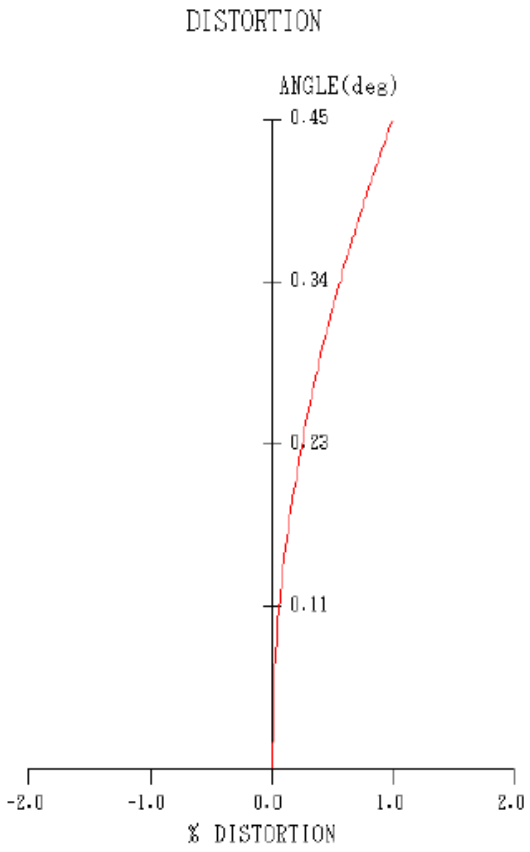
フィルタ交換機構ASSY　概要図

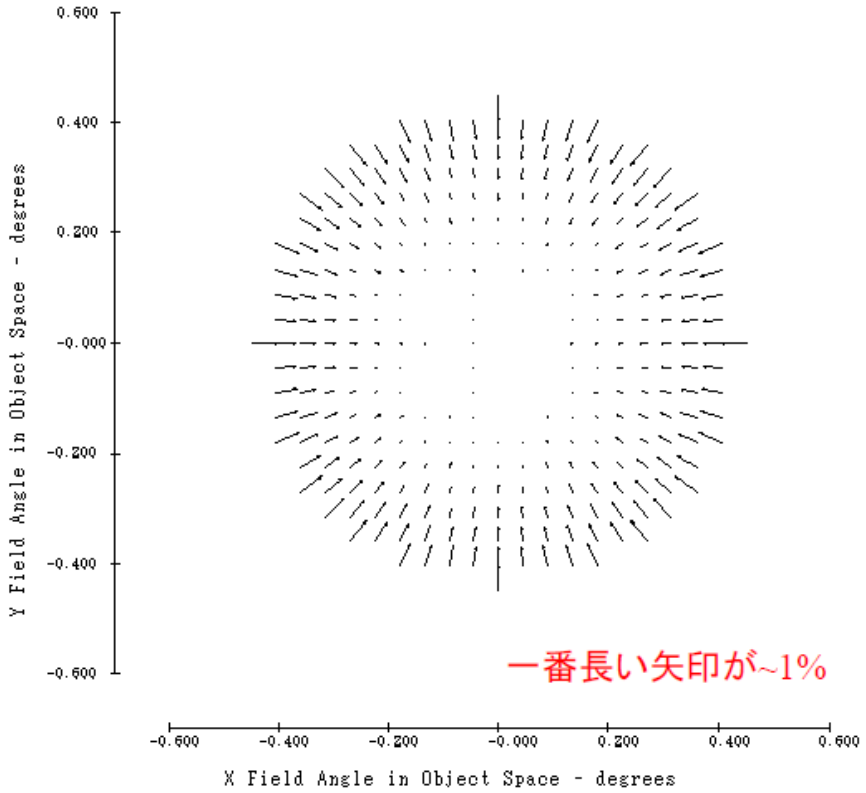






Distortion

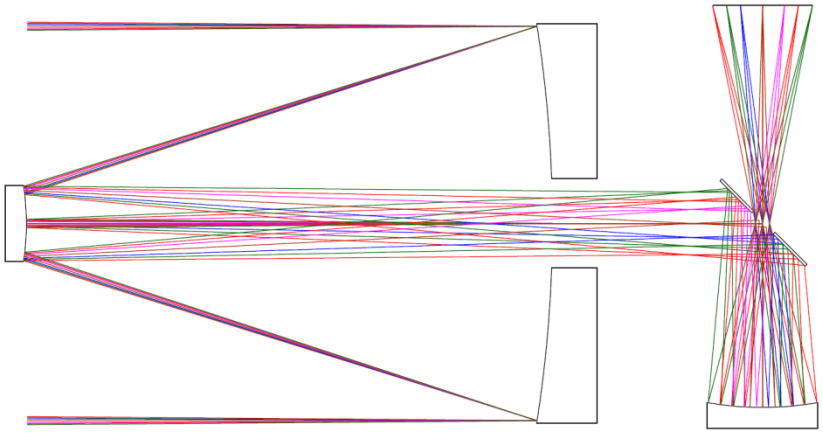




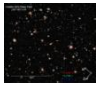
Longest arrow = 1%

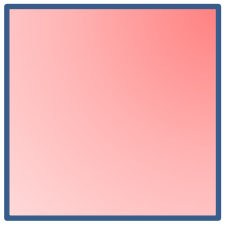
tolerance

	Sag	Irregularity	Centering	Tilt	Thickness
M1	0.3mm	0.5λ@633nm	----------	----------	----------
M2	0.1mm	0.5λ@633nm	0.1mm	1’	1mm
flat	---------	1.0λ@633nm	----------	2’	----------
M3	0.2mm	1.0λ@633nm	0.5mm	2’	----------



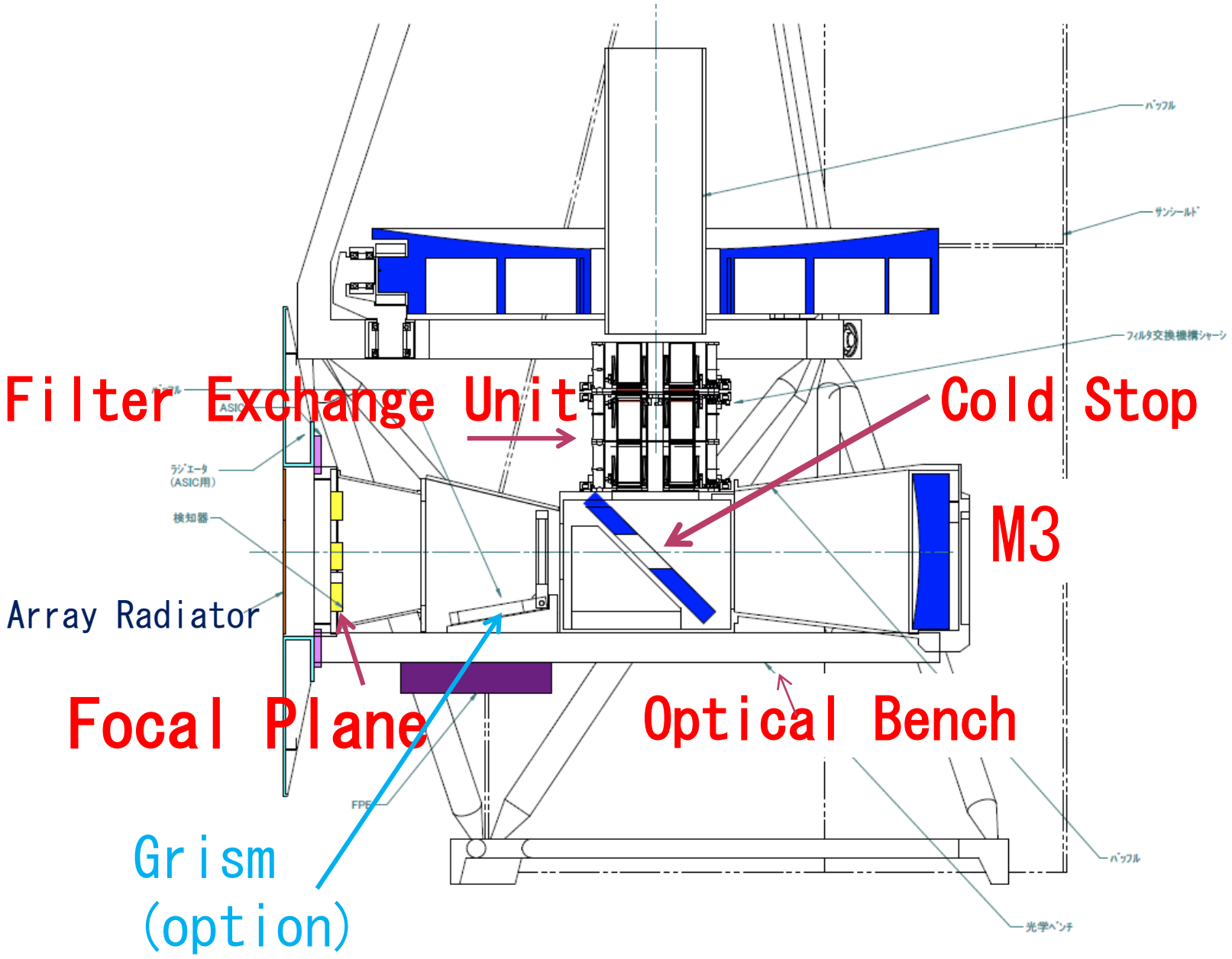
HST UDF





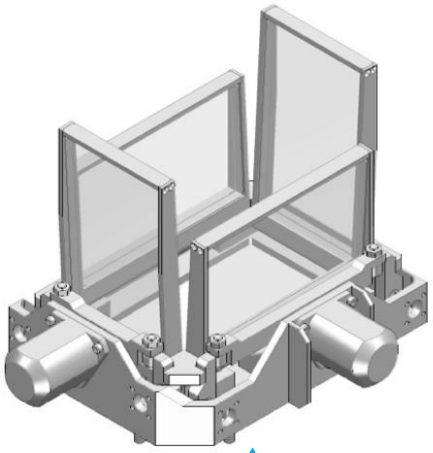
~ JWST
(2x2.2x4.3
=19 arcmin2)
~SPICA
FPC-S
5'x5'=25arcmin2

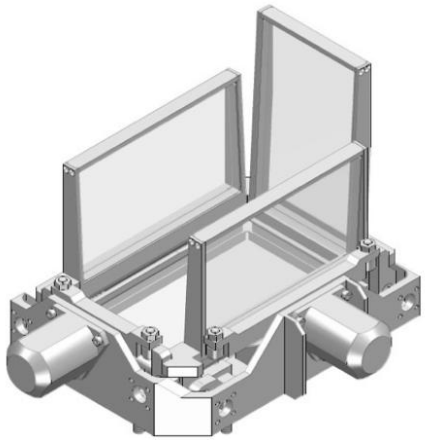
WISH 1FoV
(~900arcmin2)

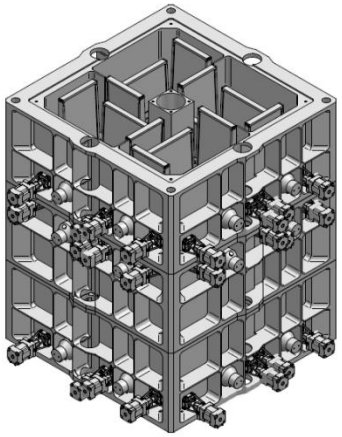

Filter Exchange Unit
Cold Stop
M3
Array Radiator
Focal Plane
Optical Bench
Grism
(option)
バッフル
サンシールド
フィルタ交換機構シャーシ
ラジエータ
(ASIC用)
検知器
FPE
光学ベンチ

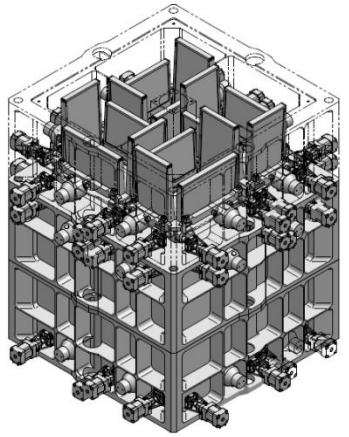
望遠鏡 断面図

WISH Flip-type Wide-field Filter Exchange Sy

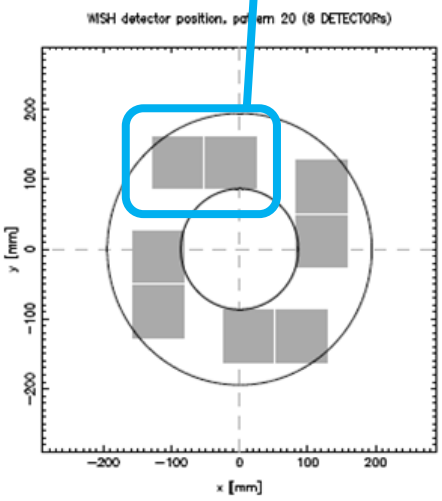


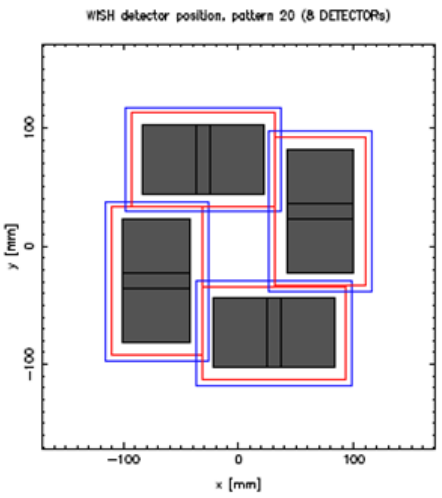


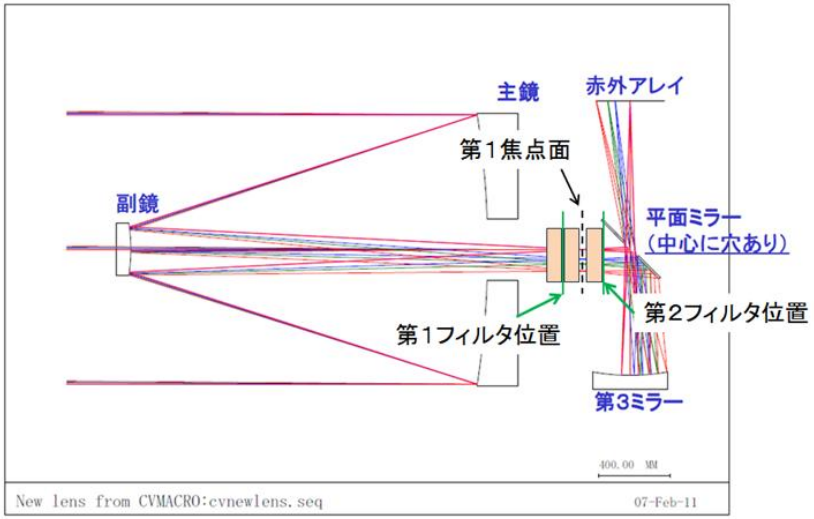




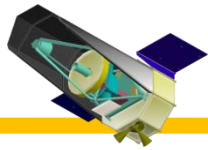
フィルタ交換機構ASSY　概要図







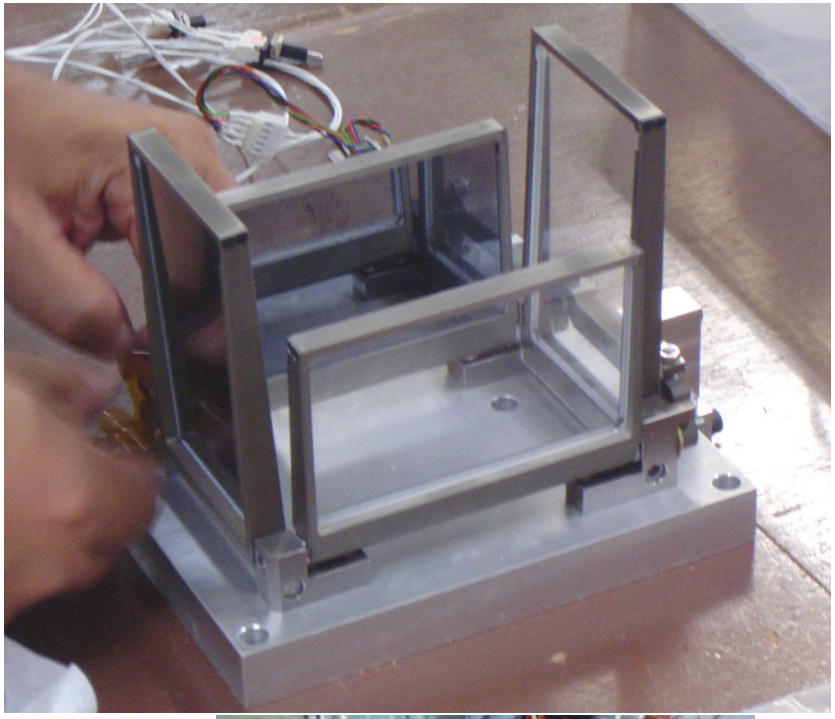
Filter Exchange Unit: Vibration Test

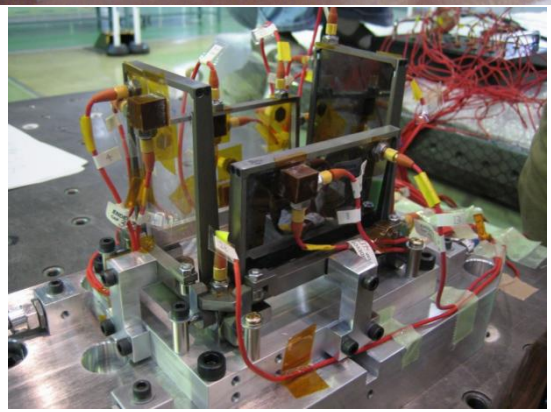


２０１０年１１月１６－１９日
JAXA/ISAS Vibration Test Facility

Dummy Filters
石英
白板ガラス
シリコン

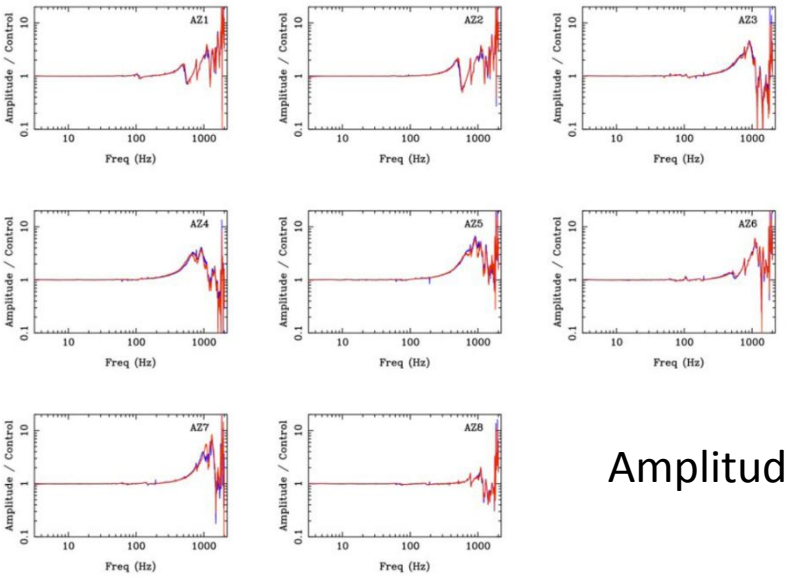
ECSS-E-10-03A
“Testting” guidline
Generic levels of vibration





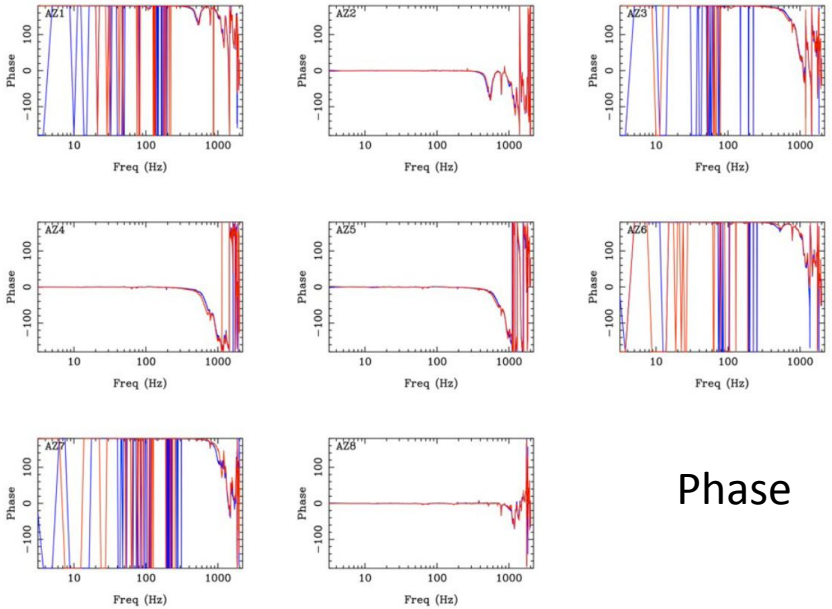
Successfully Passed

Z軸正弦波加振前後



Amplitude

Z軸正弦波加振前後

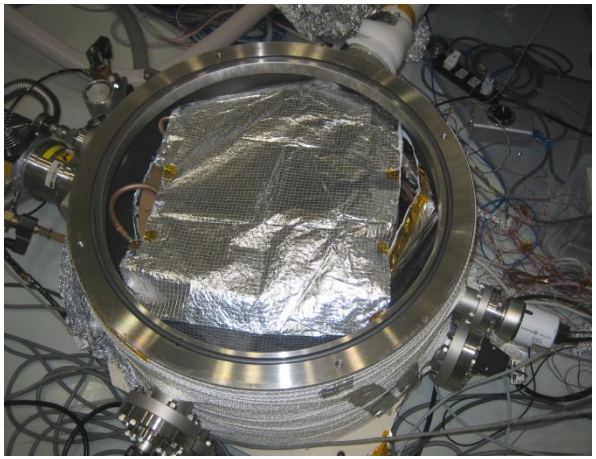


Phase

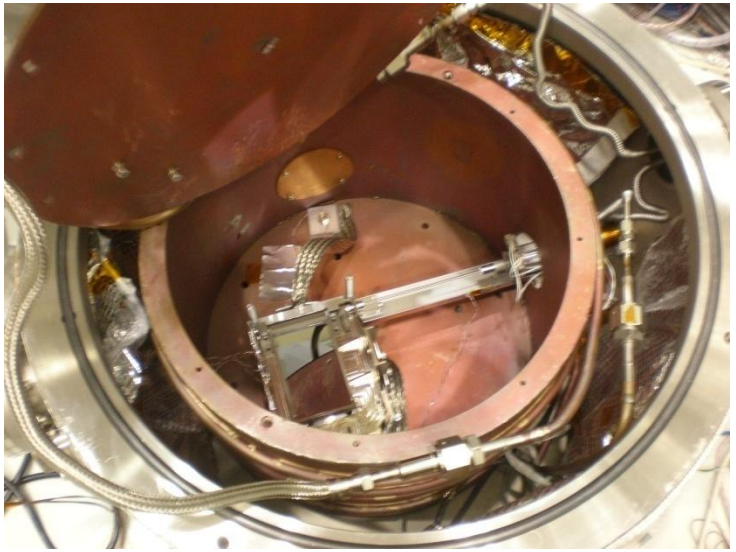
Filter Exchange Unit: Robustness Test

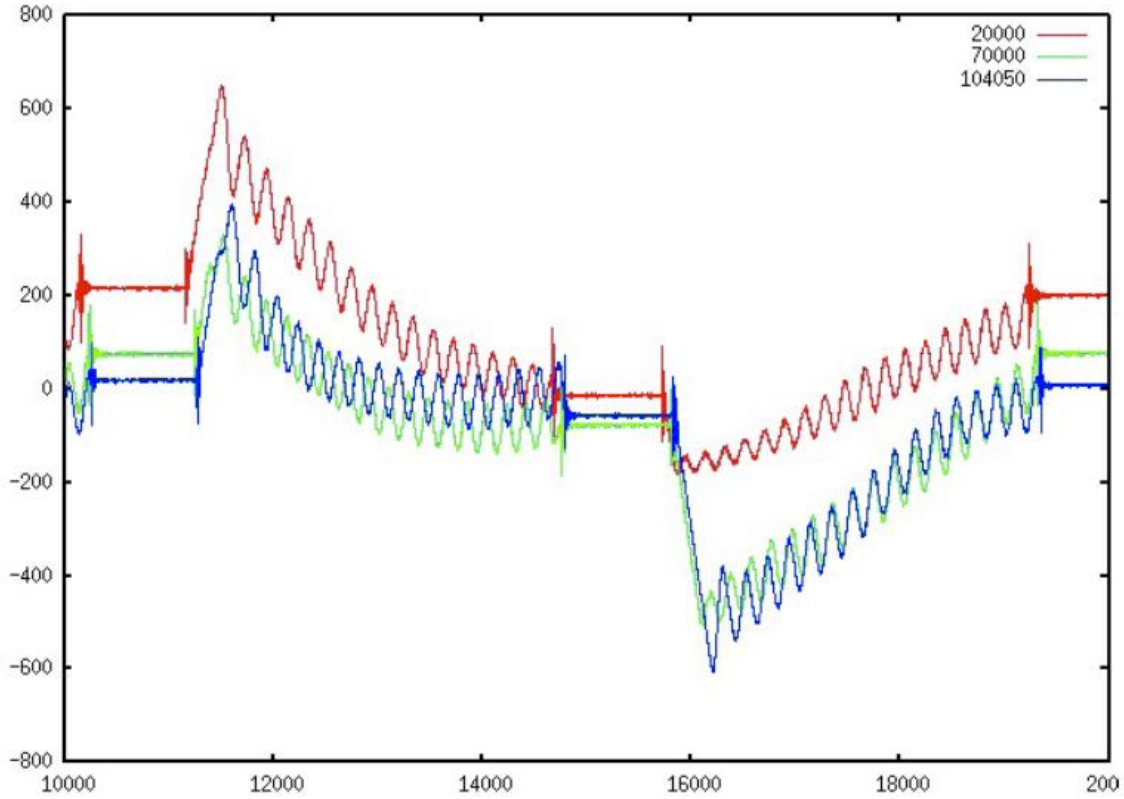
@ NAOJ
Clean Room

Cooloed to 100-120K in a small chamber
Test body temperature 120-150K

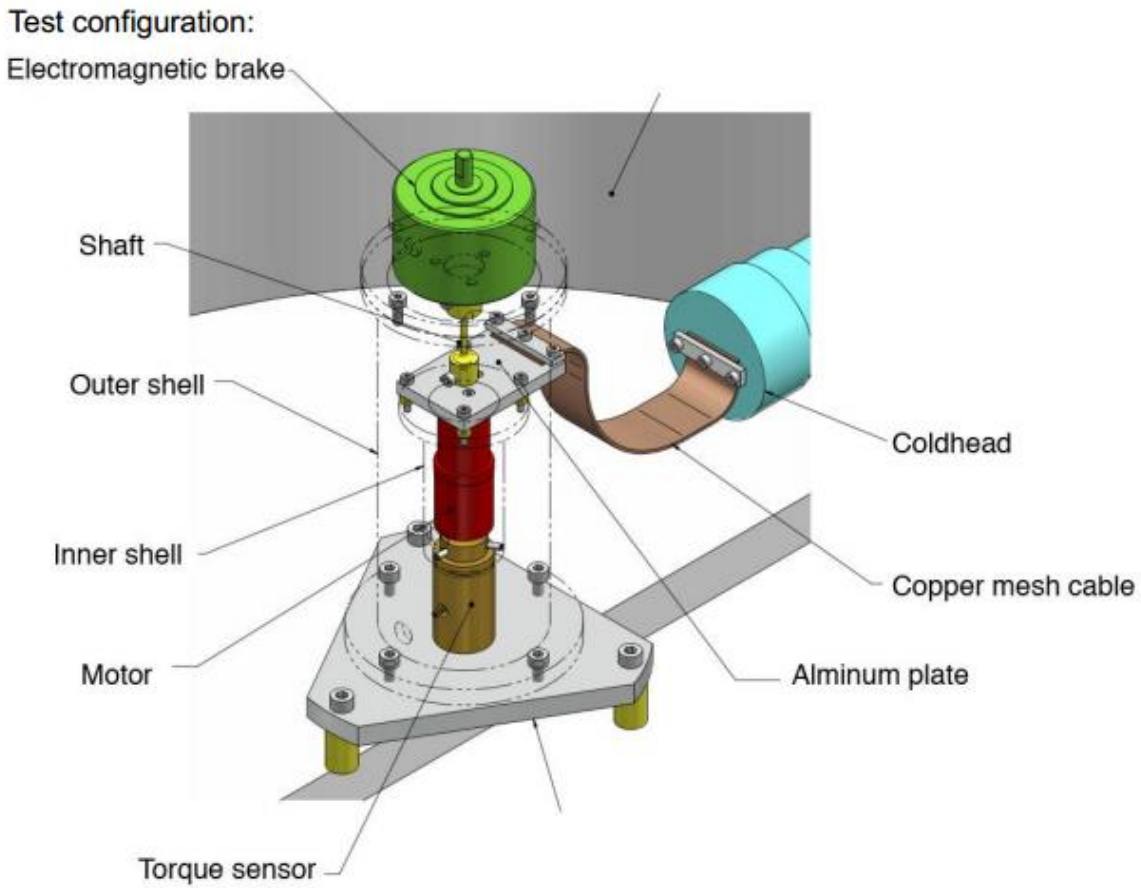


Successfully operated more than 100000 times



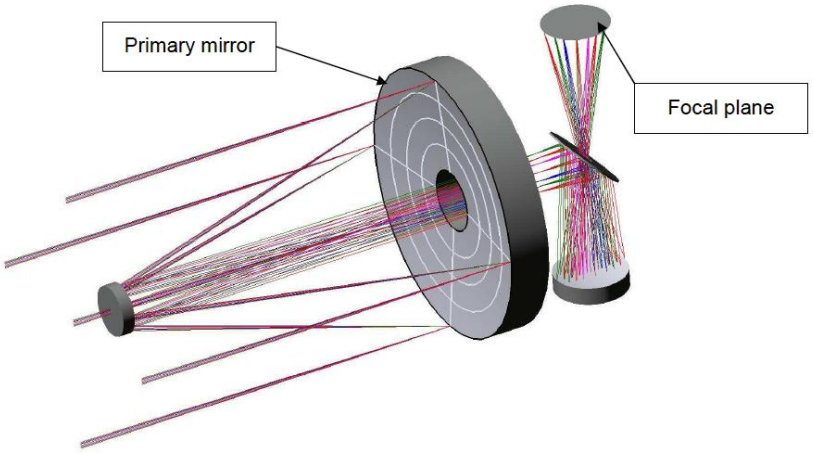


往復回数 20,000回, 70,000回と104,050回



Testing the Phytron cryogenic motor

Primary Mirror
and Telescope Structure



Secondary

Secondary Support

Primary Mirror

Primary Mirror Support

Array Radiator

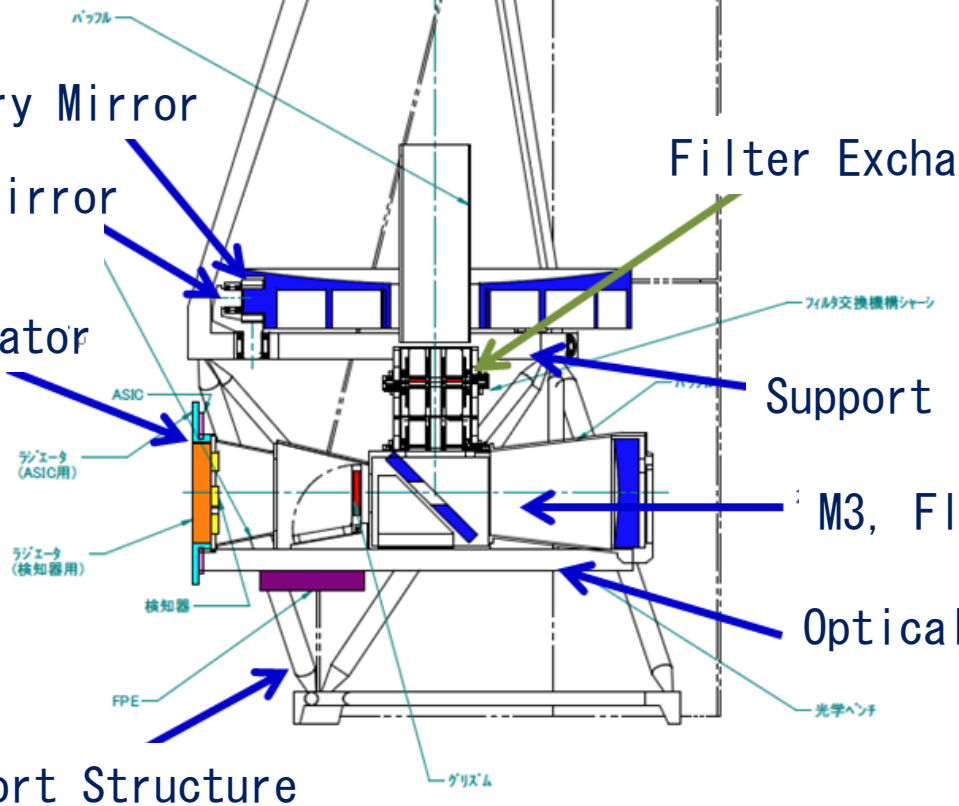
Filter Exchange System

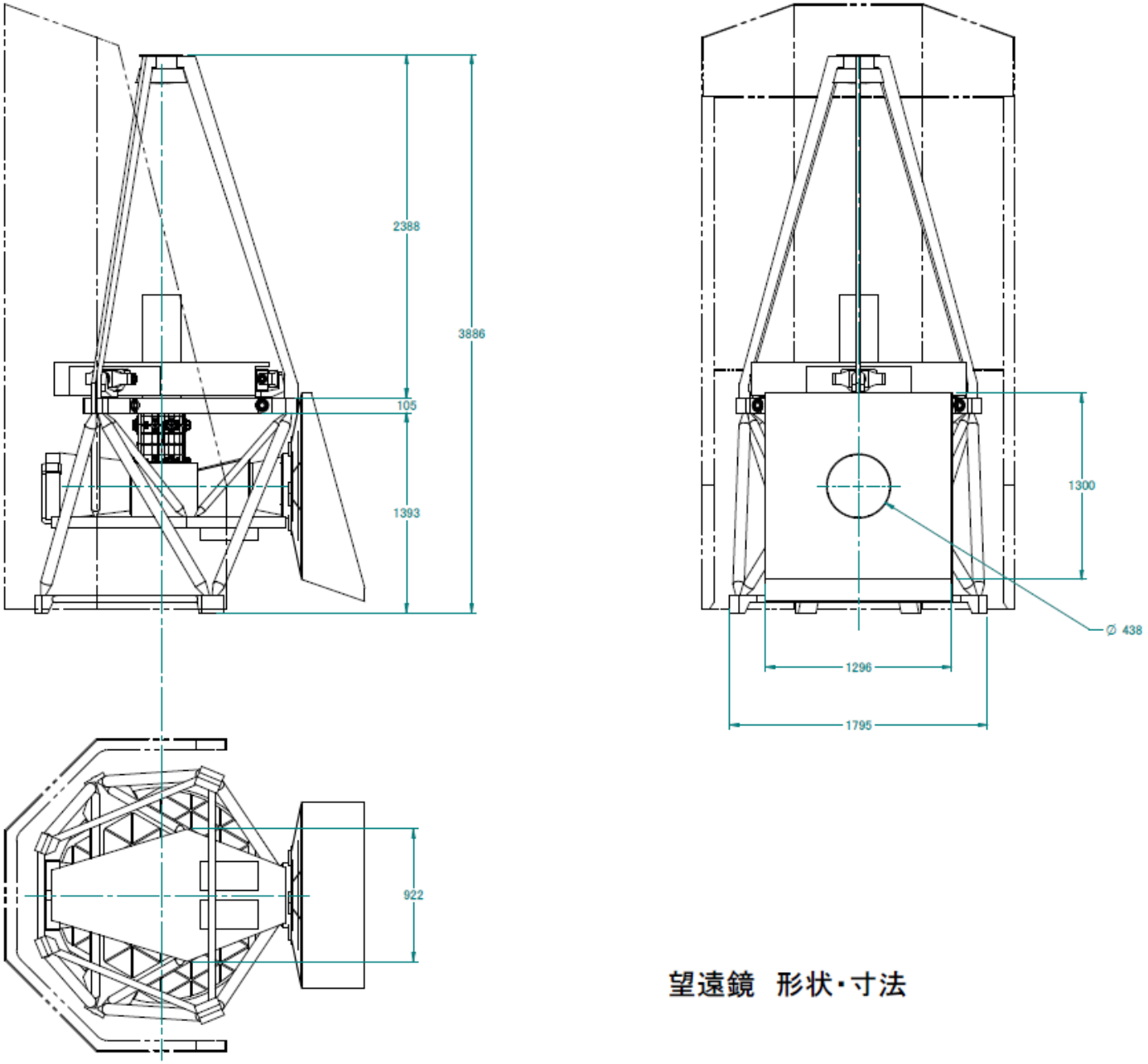
Support structure

M3, Flat M

Optical Bench

Support Structure



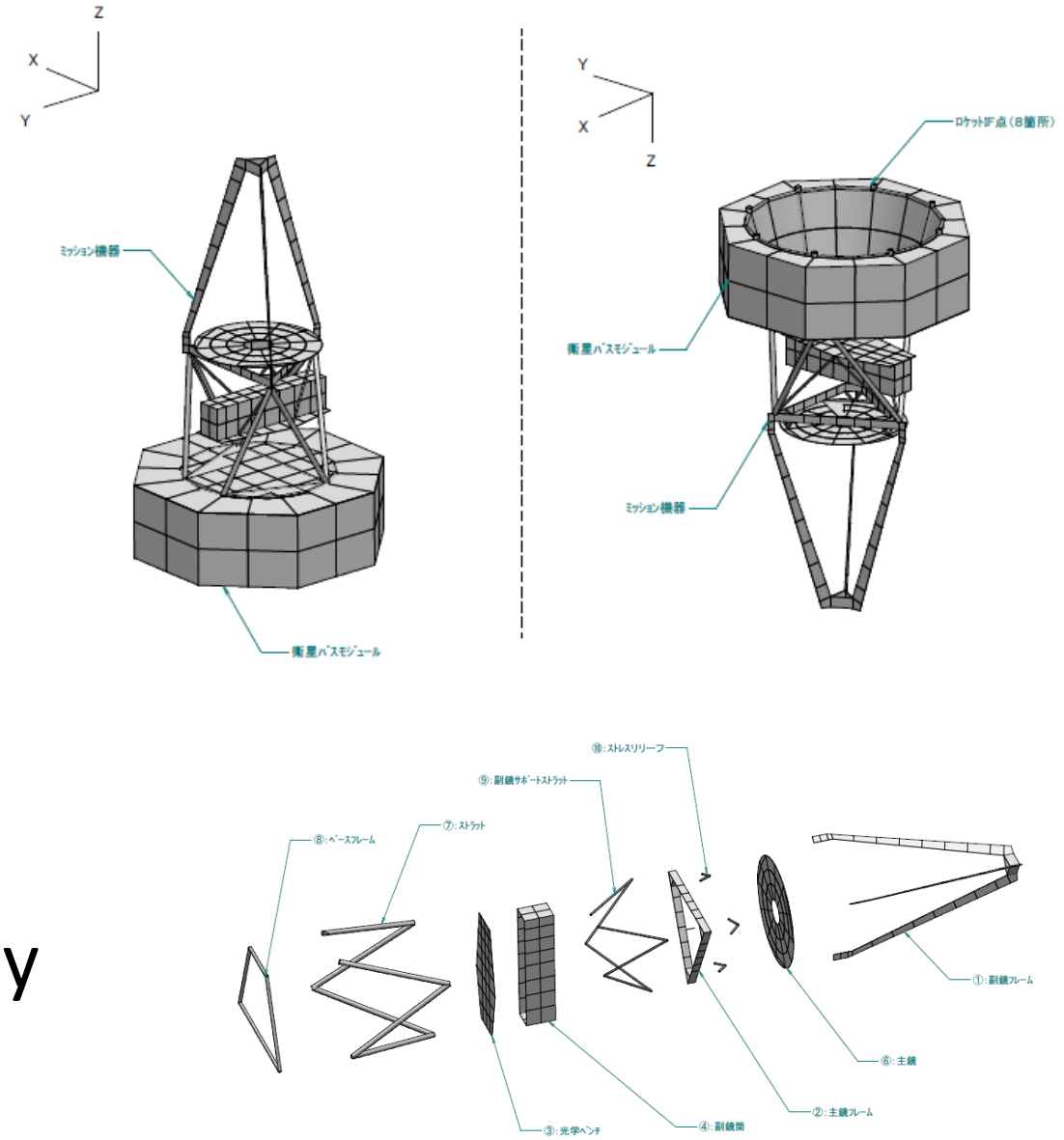


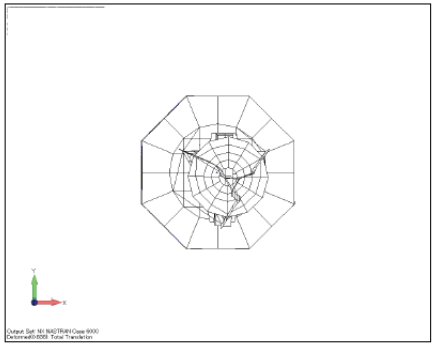
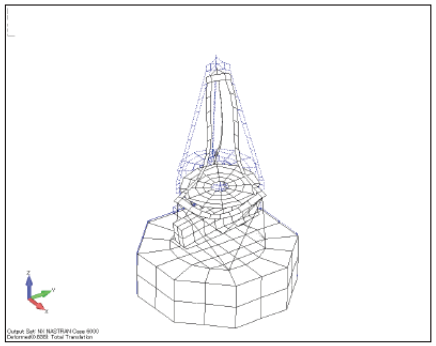
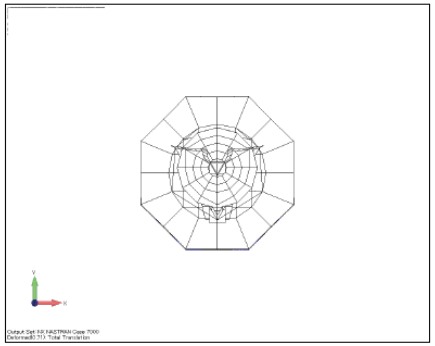
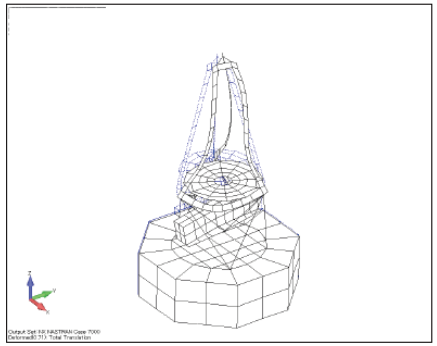
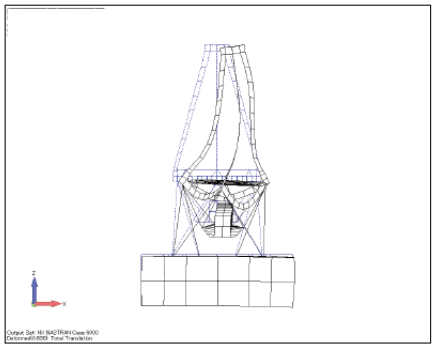
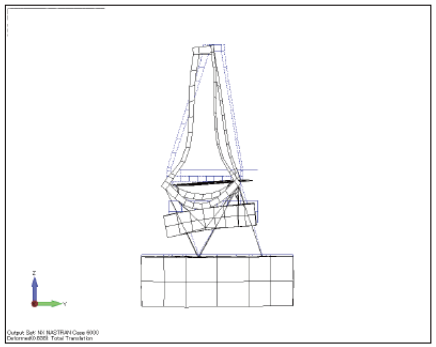
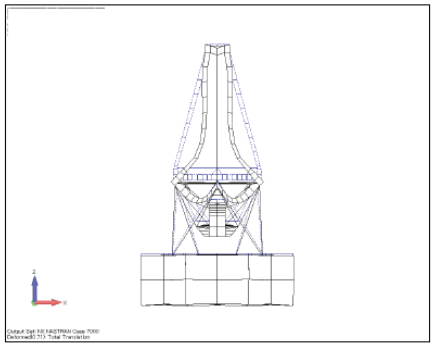
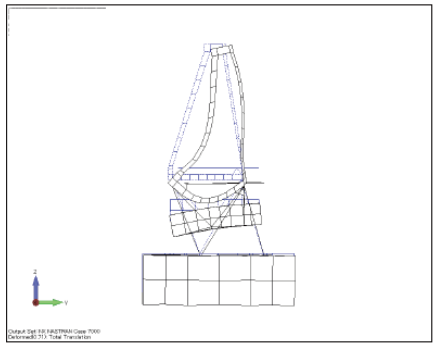
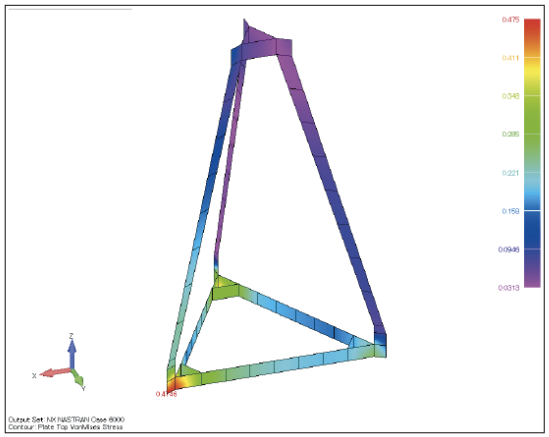
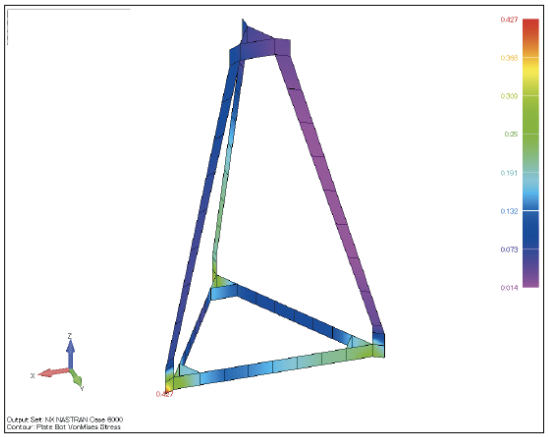
望遠鏡　形状・寸法

Dynamical Analysis of the satellite and the telescope

- Static support
- Launch load

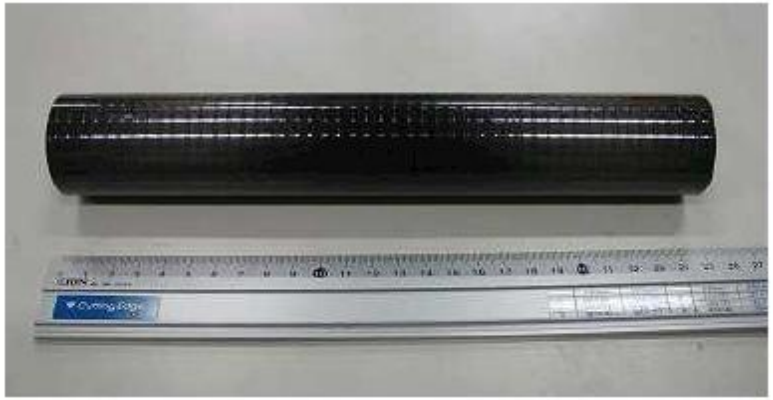
- accerelation
- deformation
- mass center
- proper frequency
- stiffness



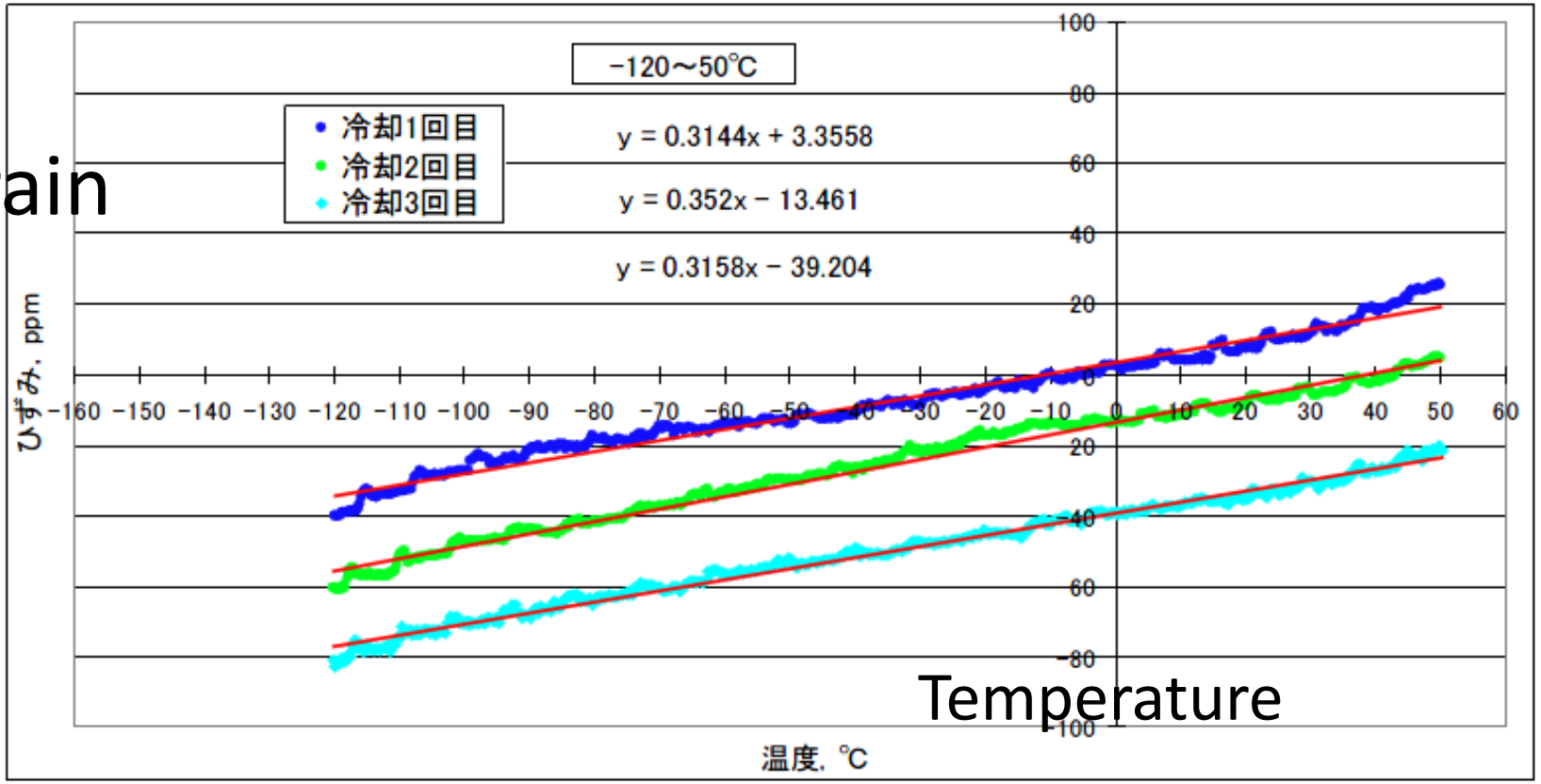









0.475
0.411
0.348
0.285
0.221
0.159
0.0946
0.0313
Output Set: NX NASTRAN Case 6000
Contour: Plate Top VonMises Stress

0.427
0.363
0.299
0.25
0.191
0.132
0.073
0.014
Output Set: NX NASTRAN Case 6000
Contour: Plate Bot VonMises Stress

@ MECO

CFRP Pipe　CTE ~ 0.1 ppm/K

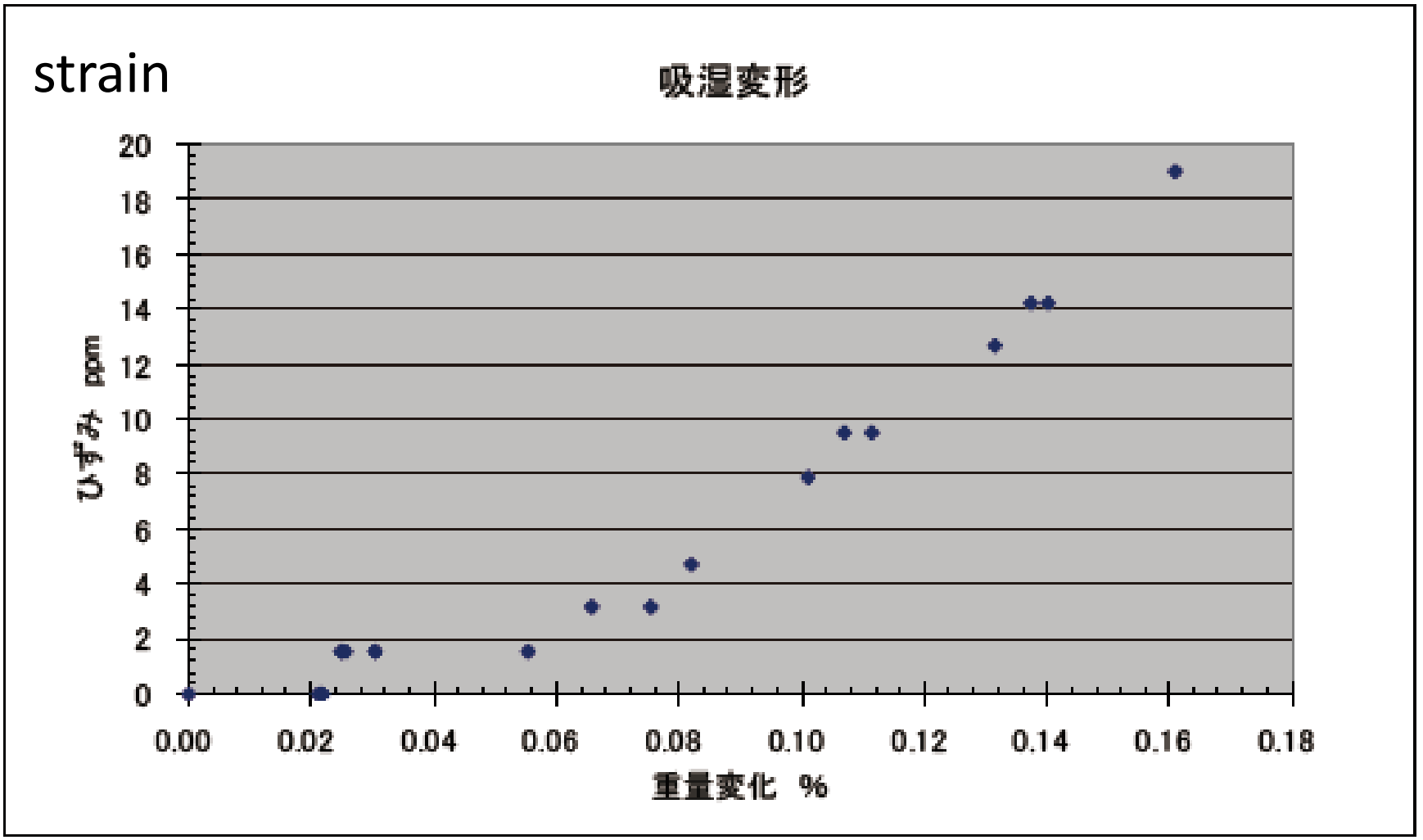


strain



Temperature

Deformation by moisture absorption
(hygroscopic swelling)

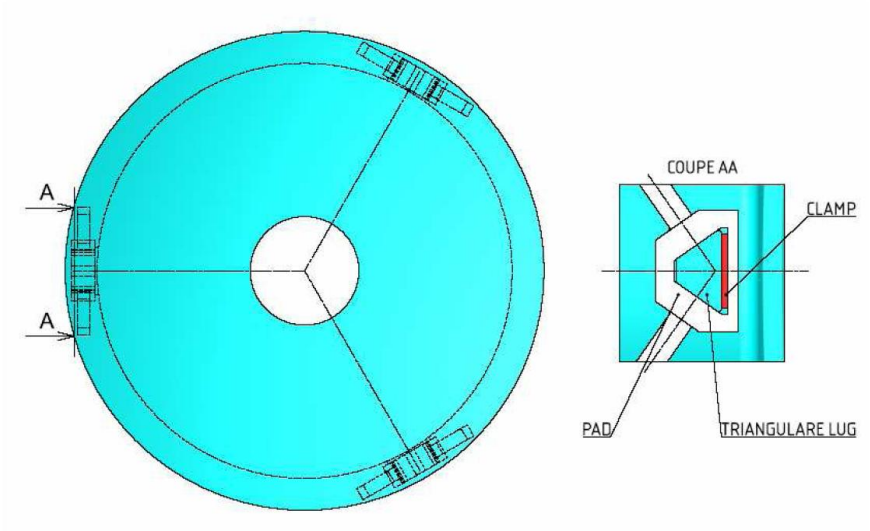


mass

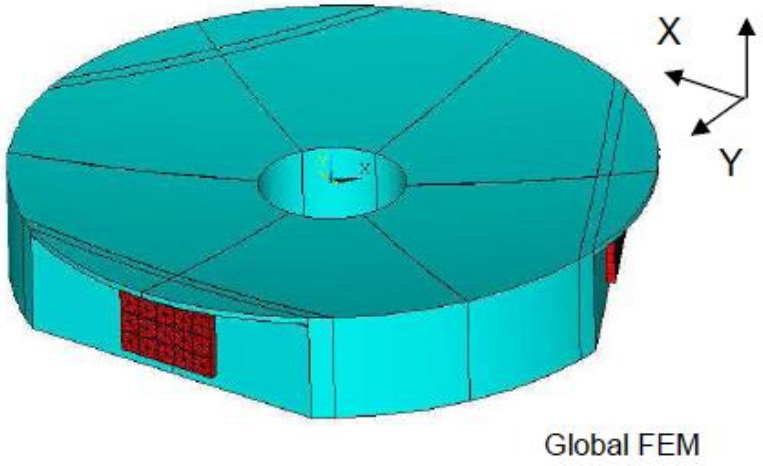
Conceptual Design of the Primary Mirror/Mirror Fixation

1. Previous Study

6.2.6 Sixth solution : clamping by straight block on a triangular lug

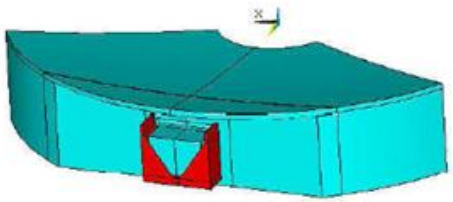


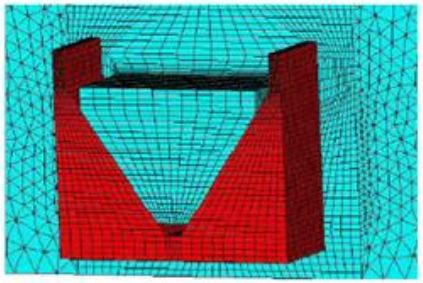
Clump solution
-marginal (2010)



Global FEM

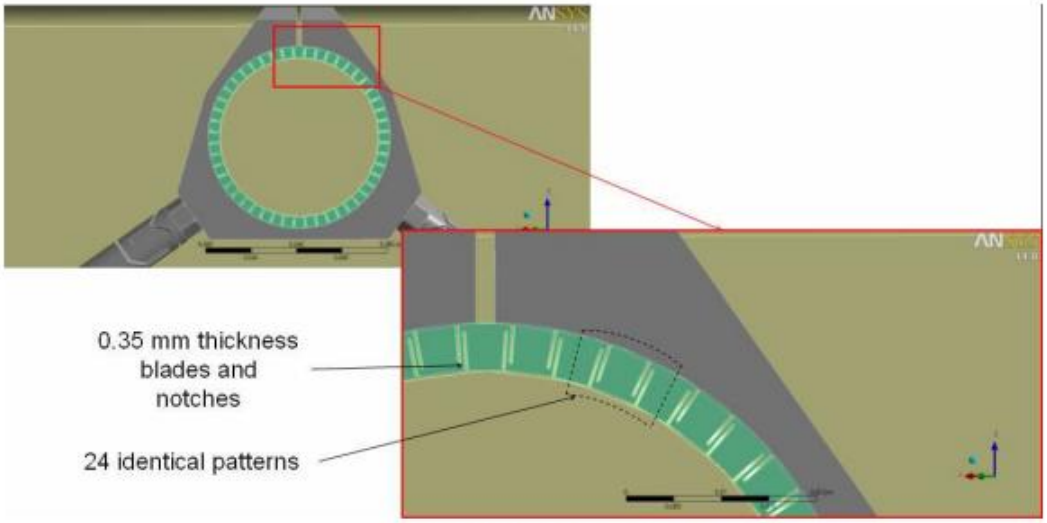
Bonding Solution
INVAR Pad ×
CFRP Pad studied
need to be developed and tested





2. Updated design for Mirror Fixation

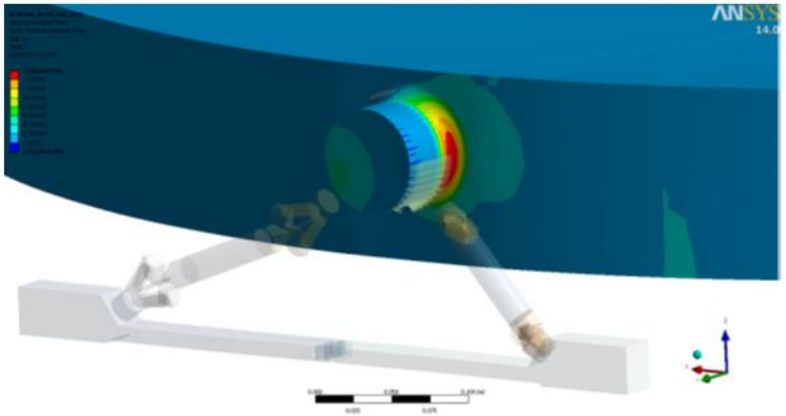
- Thermal Comp structure
- Appropriate Clump force
  to have no gap at max load



Close up on inner ring

vs Launch Load
Stress 33MPa max

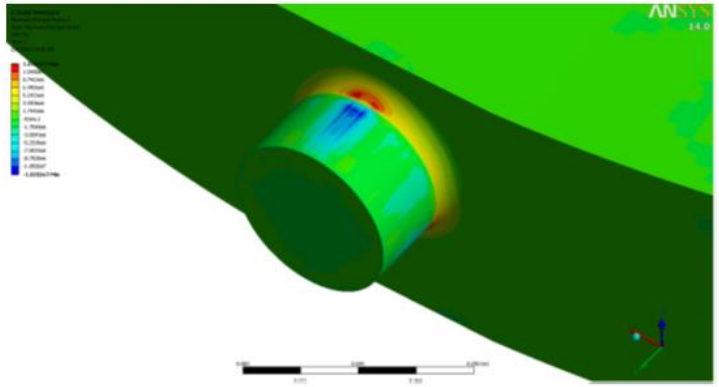
Launch stresses @ RT				
	X Y acceleration 20 g		Z acceleration 20 g	
	Stress (MPa)	MS	Stress (MPa)	MS
Glass, tenon	33	>0	24	>0
Glass, ribs	6	>0	14	>0
Inner ring	180	-0.1	180	-0.1
Outer ring	110	0.9	100	1.1
MFD	700	0.2	450	0.8



Stress in glass @ RT + launch inertial loads

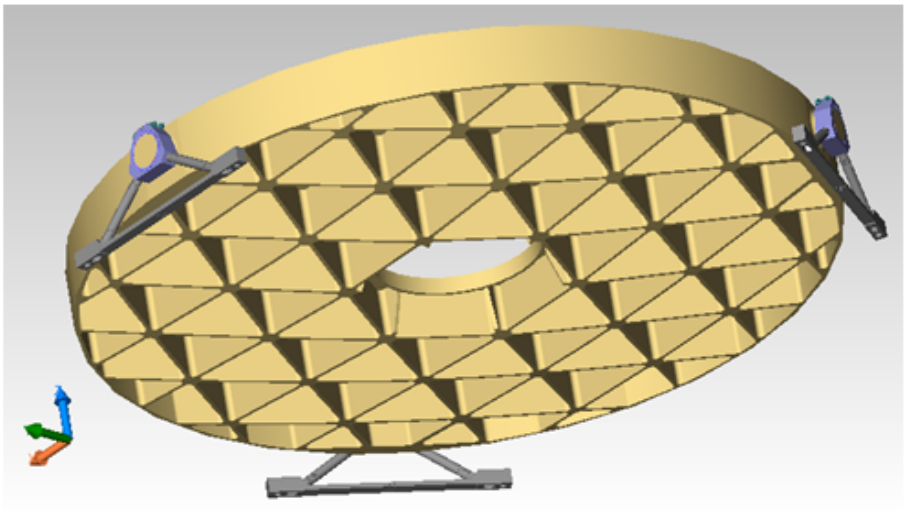
vs Cryogenic Load
Stress 13.1MPa

Permanent stresses @ RT & 80 K				
	RT		80 K	
	Stress (MPa)	MS	Stress (MPa)	MS
Glass	13.1	0.1	12.2	0.15
Inner ring	180	-0.1 (1)	140	0.1
Outer ring	104	1.0	104	1.0



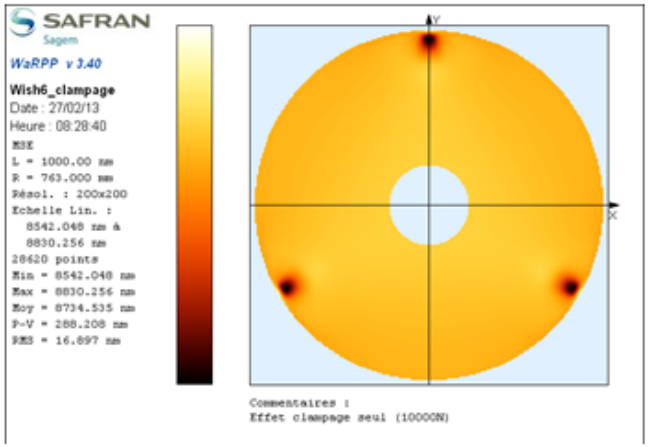
Stress in glass @ 80K

M1 Design 143kg ϕ1530mm

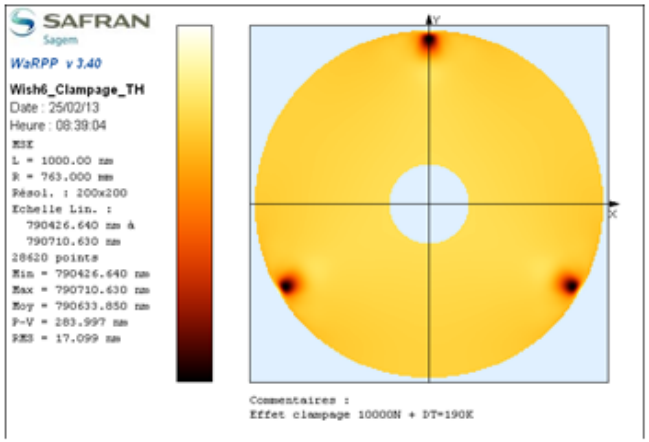


Parameter	Value	Remark
Mirror mechanical diameter	1530 mm	30 mm margin / useful diameter
Hole diameter	340 mm	Useful diameter = 370 mm
Radius of curvature	4808.7419 mm	Radius of conic
Conic constant	-0.986648	
Mirror thickness	115 mm	Constant
Ribs thickness	8 mm	
Radius of pockets corners	10 mm	Min for diamond tool
Tenons diameter	70 mm	Polished
Mass of the bare mirror	143 kg	
Mass of the equipped mirror	153.5 kg	
MFD arms diameter	20 mm	
MFD blades thickness	2 mm	
Athermalisation ring thickness	6.4 mm	

RMS

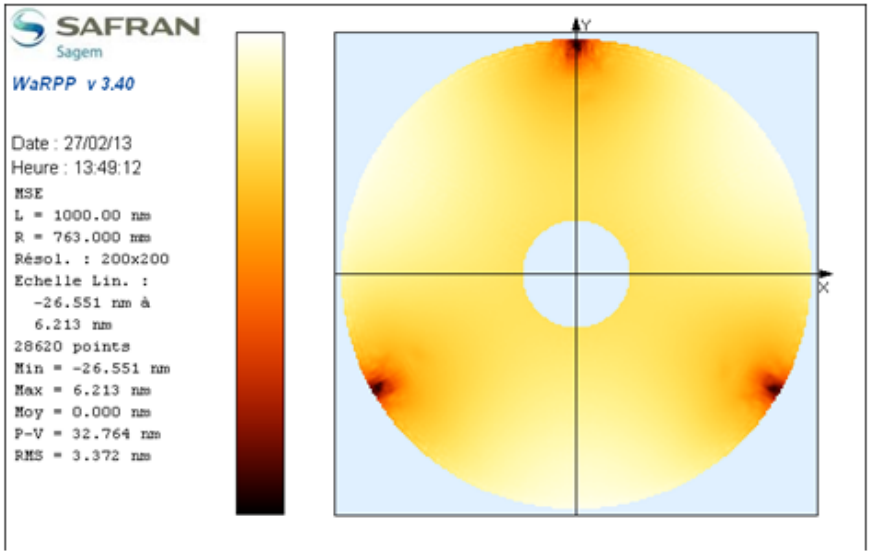


Clamp effect @ 293 K (polished)



Clamp effect @ 80 K

Clamping effects



Residue @ 80 K

Difference RMS 6.6nm in wave-front error
(more detailed optical performance
is being studied with the surface)

Silver Coating

Cryogenic effect is not negligible

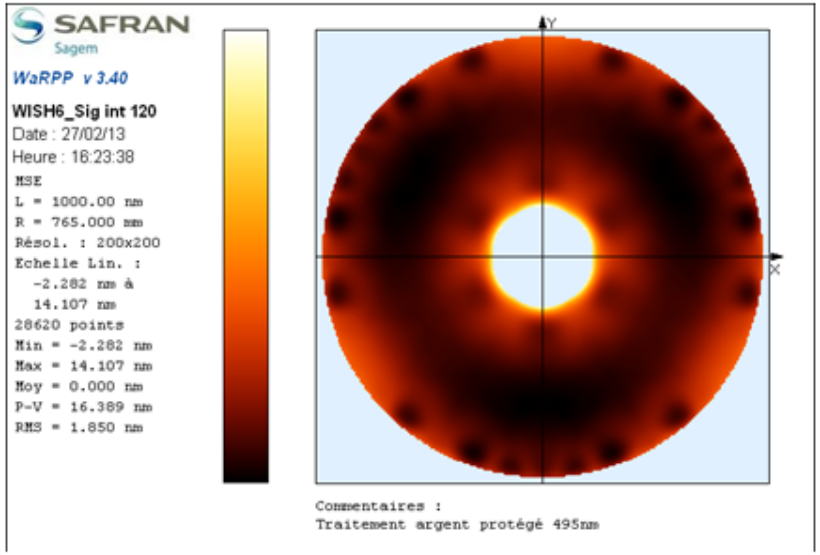
Wave Front Error rms 12nm (dominant in error budget)

Gold?

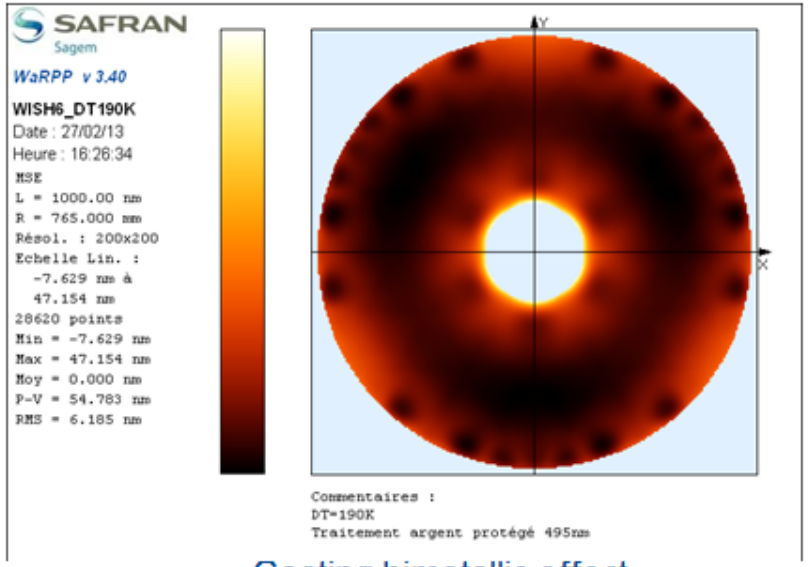
Intermediate?

Coating effects

Protected silver coating	
Thickness	495 nm
Intrinsic stresses	120 MPa
Equivalent CTE of the layers	8.5 ppm/K @ 100 K 13.9 ppm/K @ RT
Equivalent Young modulus of the layers	162 GPa
Equivalent Poisson ratio of the layers	0.304



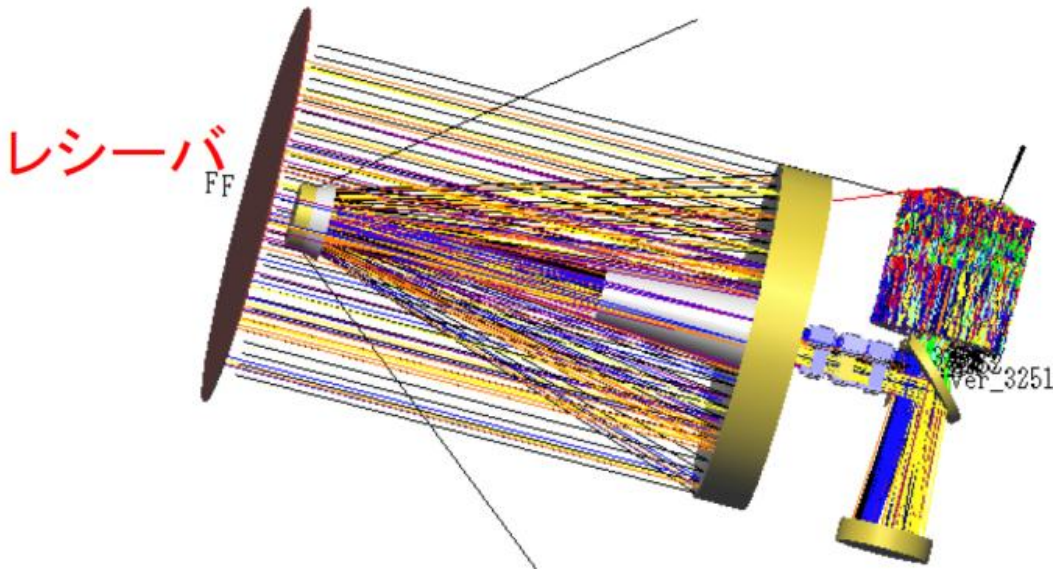
Coating intrinsic stress effect
Focus removed

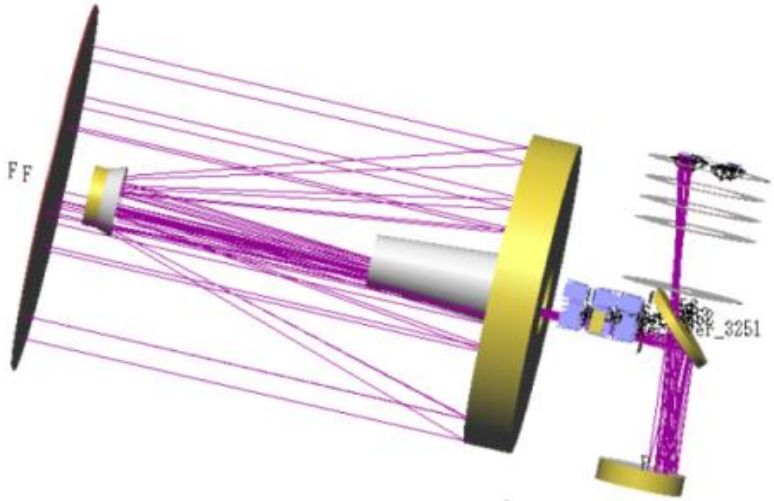


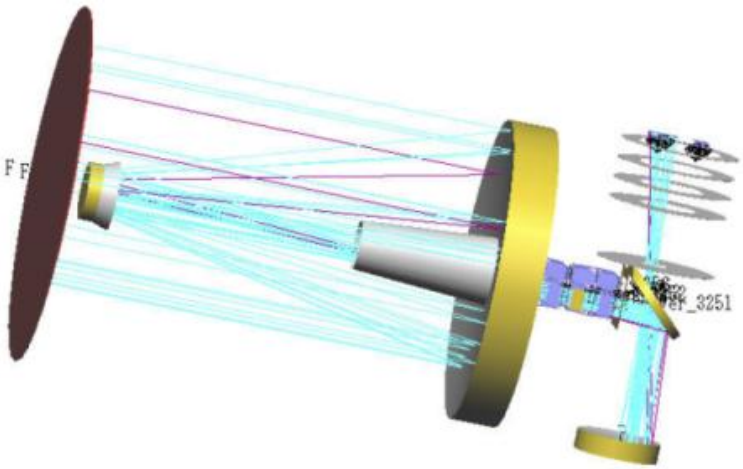
Coating bimetallic effect
Focus removed

Error budget Primary mirror- Focus removed		
	MSE (nm RMS)	Remark
Clamping pressure variation	3.4	@ 80K
Tangential bias 20 µm	0.8	On 3 MFD
Radial bias 10 µm	2.7	On 3 MFD
CFRP strain	1.3	@ 80 K
Z bias 20 µm	1.6	On 3 MFD
Coating intrinsic stress effect	1.85	120 MPa
Coating bimetallic effect	6.1	@80 K
RSS	8.0	
WFE	***16 nm RMS***	

Baffling







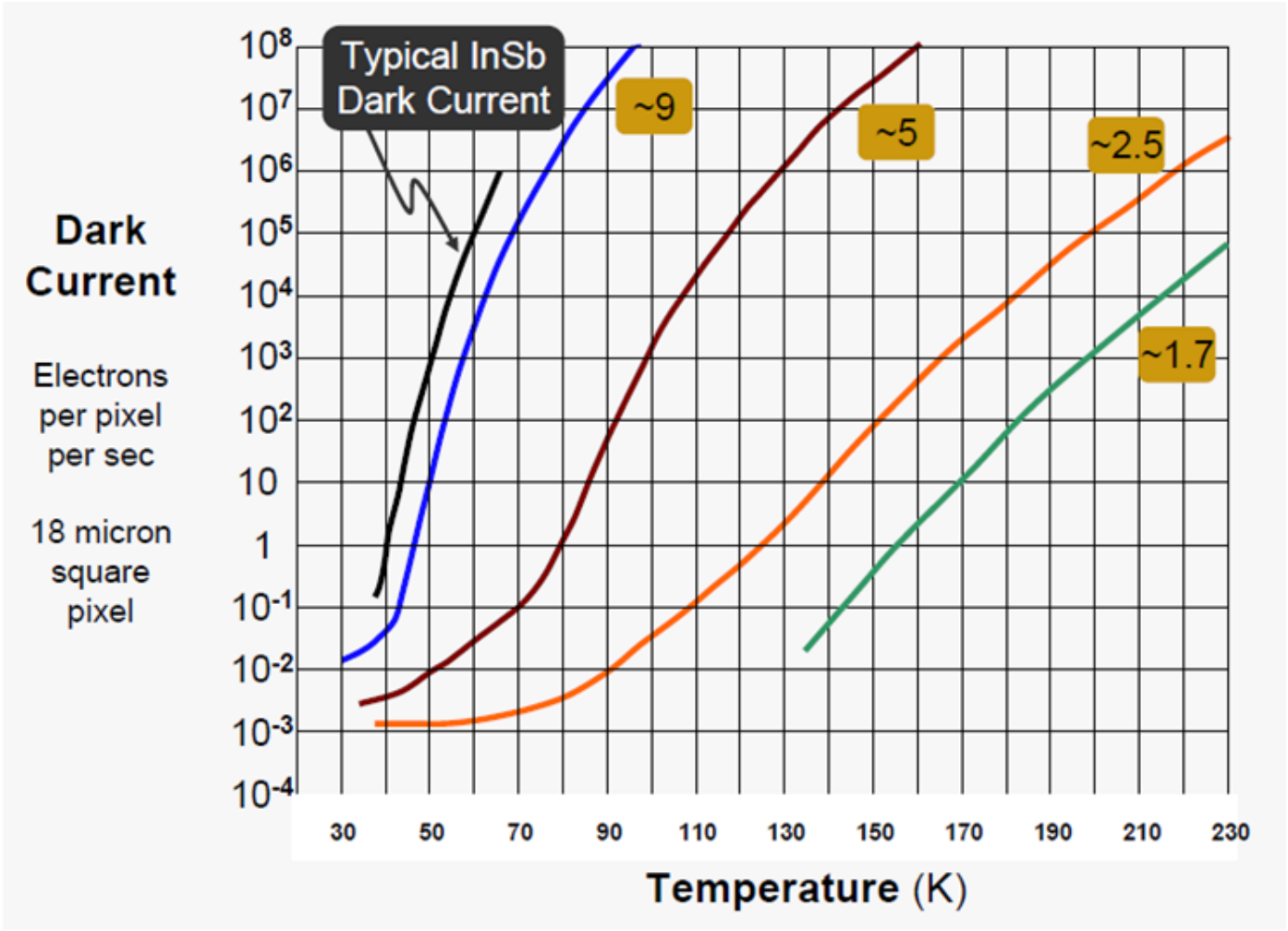
Thermal Design

Components		Temperature	Notes
Telescope Optics	Primary Mirror	100K	Flat mirror and Tertiary are puton the optical bench. The hole in the flat mirroe works as the cold stop.
	Secondary	100K	
	Flat	80K	
	Tertiary	100K	
Very Wide Field Imager	Focal Plane Arrays	40K (goal)	Put at the system focal plane.
	Filter Exchanger	80K	Flip-Type. Put near the first focal plane.
	Array Radiator	<40K	Cooling the detectors

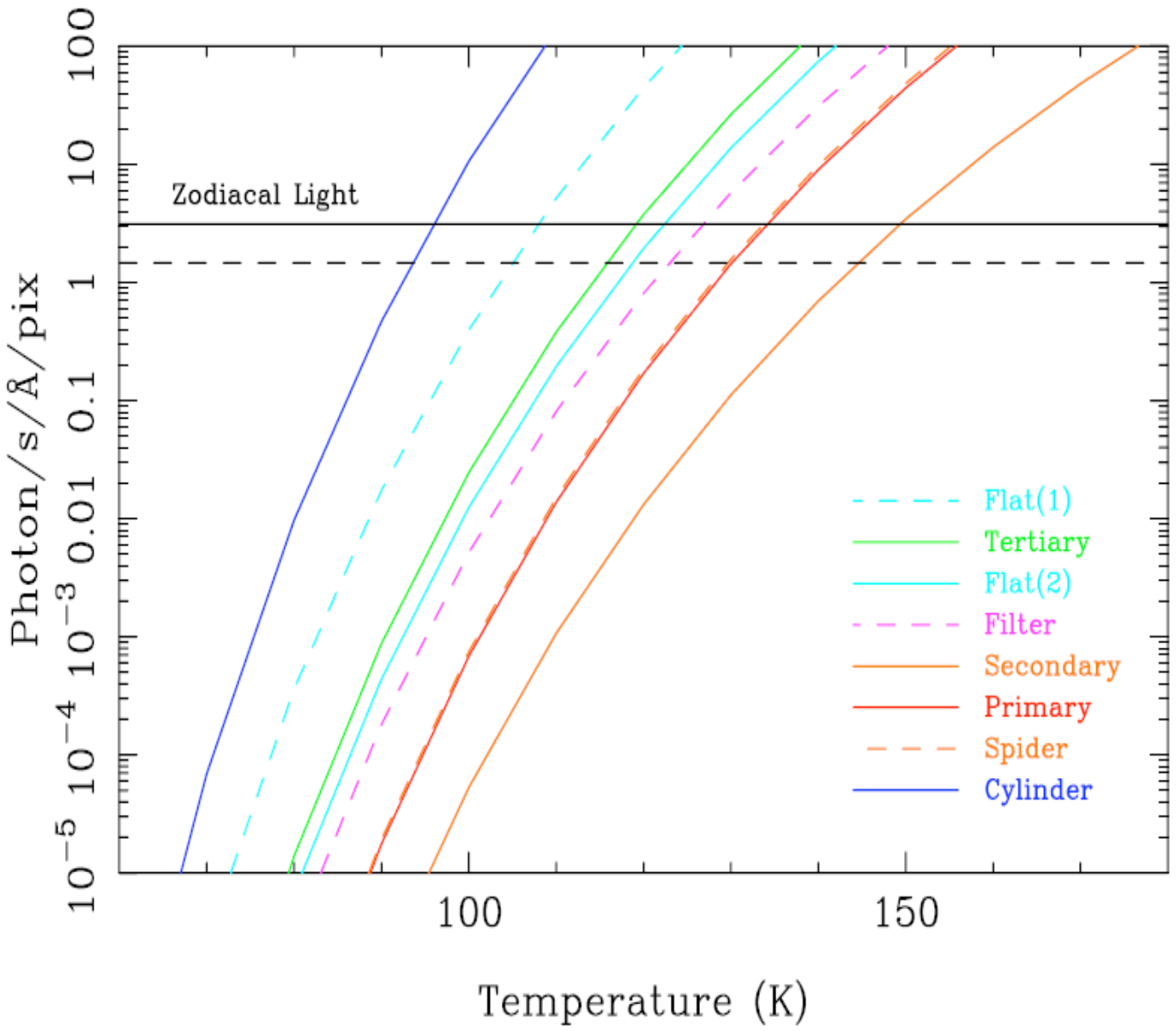
component	Teff	Emissivity	note
Scattered	5800K	3.0×10^{-14}	EP
Thermal	275K	7.1×10^{-8}	EP

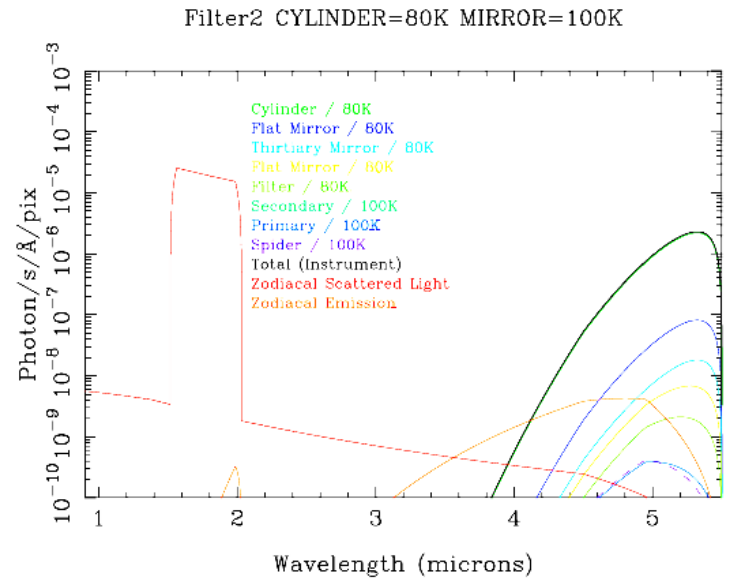
Component	emissivity	立体角 (str)
M1	5%	3.6×10^{-2}
M2	5%	3.6×10^{-2}
Flat（front）	5%	2.3×10^{-2}
Flat（back）	5%	1.6×10^{-2}
M3	5%	5.7×10^{-2}
Filters	10%	2.8
post-optics baffles	10%	2.8
Spiders	90%	4.5×10^{-3}

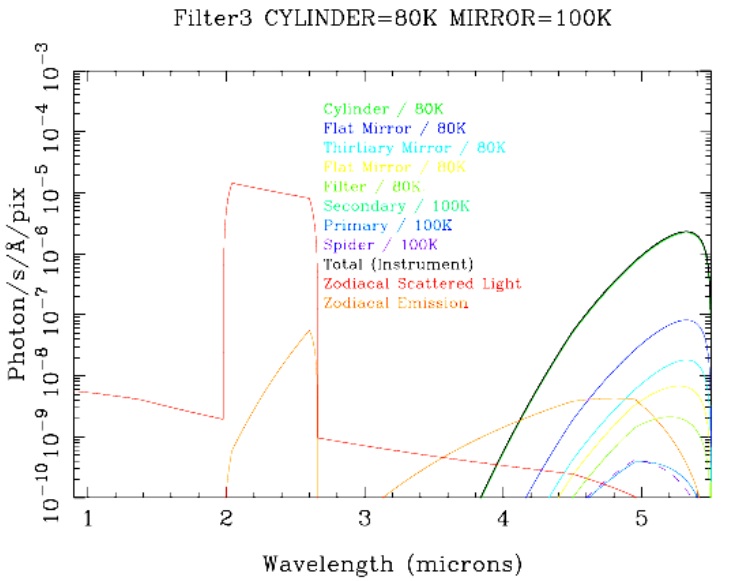
Detector operation temperature

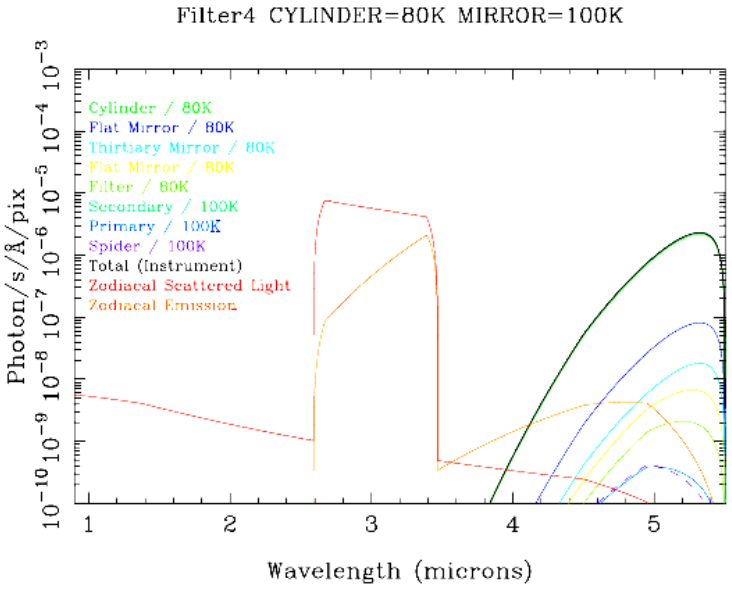


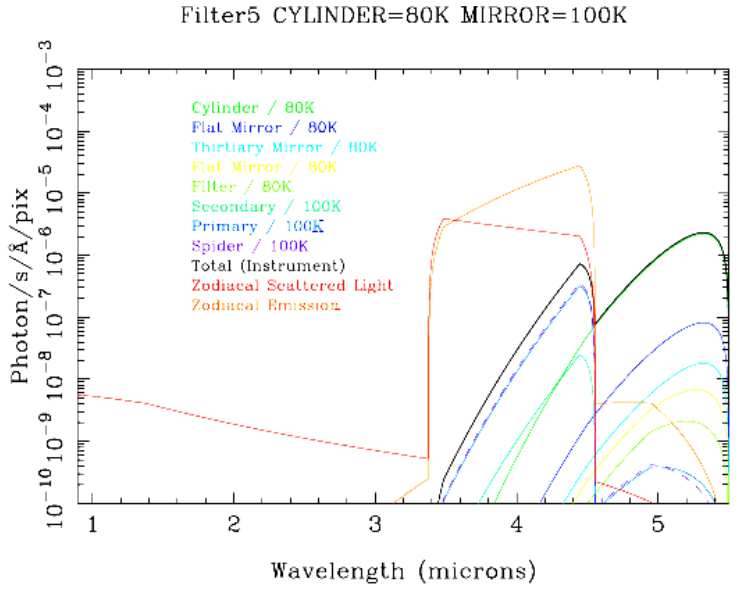
Thermal and natural background



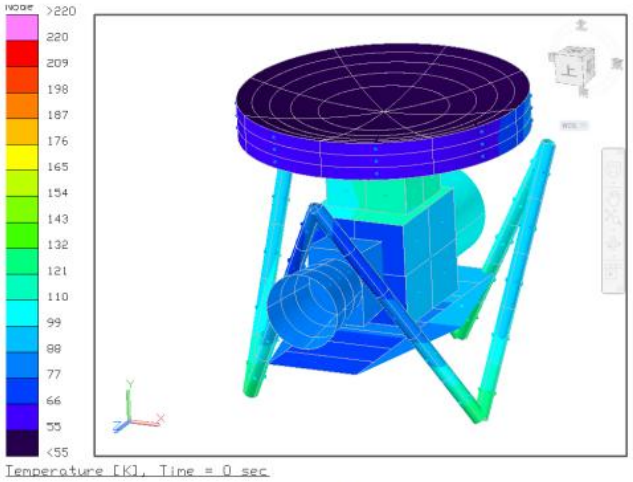








3xEP zodiacal light and thermal radiation from each component



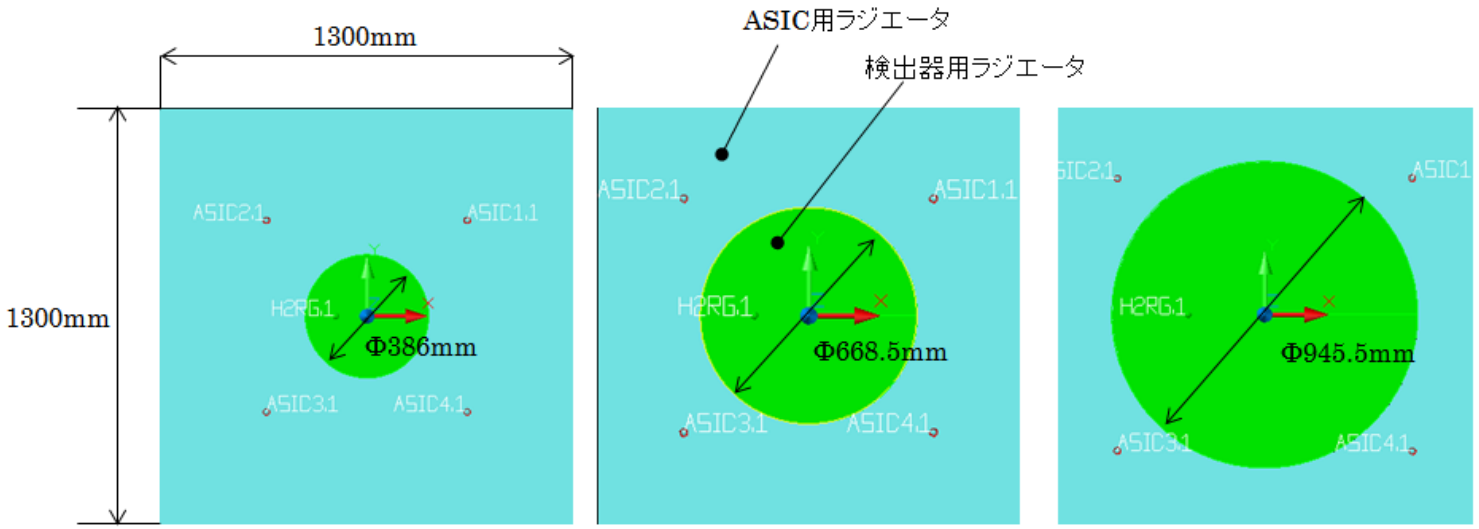
Thermal Design

heat production by filter unit

heat production by ASIC

	Temperature (Analysis)	Allowable temperature range
主鏡 M1	52.7	100K以下
副鏡 M2	64.7 – 70.5	100K以下
Telescope Optical Bench	91.3 – 99.0	
副鏡筒	71.1 – 103.0	80K以下
フィルタ交換機構 Filter unit	95.9 – 100.0	
検出器 Detector arrey	64.7	40K以下
ASIC	77.1 – 80.9	
メイントラス Main torus	70.1 – 125.0	
Optical Bench	67.4 – 113.0	
バスモジュール BUS	300K (boundary)	
主鏡バッフル	54.2 – 76.1	
副鏡バッフル baffles	42.7 – 51.8	
サンシールド	48.9 – 240	
太陽電池パネル	386 – 391	
副鏡筒用バイポッド	74.2 101.0	
フィルタ交換機構用モータドライバ	300K (boundary)	
副鏡焦点調整部用ドライバ	300K (boundary)	

Focal plane radiator



検出器用ラジエータ面積
default値

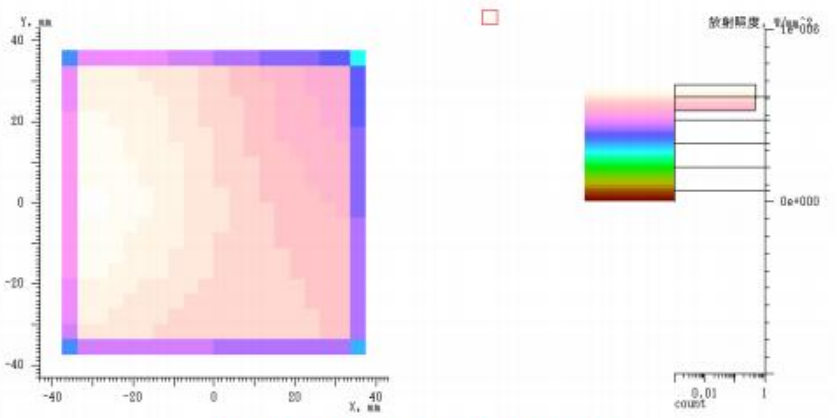
検出器用ラジエータ面積
default値の3倍

検出器用ラジエータ面積
default値の6倍

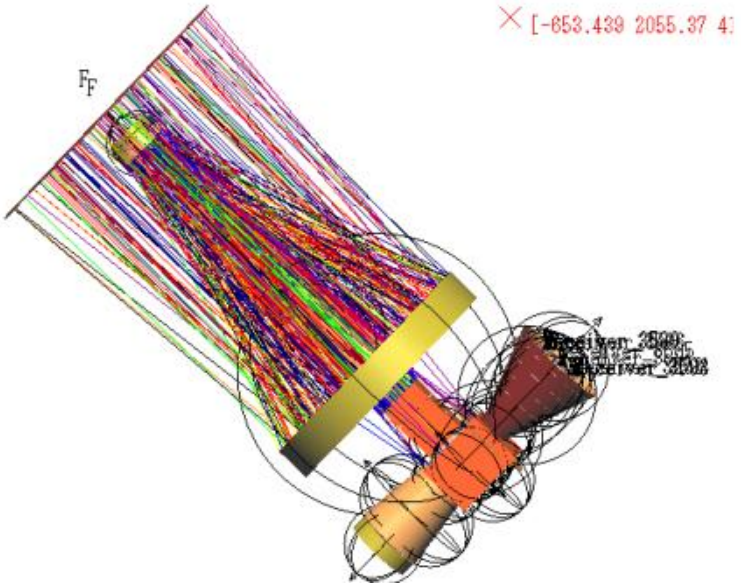
	ASIC用ラジエータの外形サイズ：1300mm × 1300mm					
	ASIC用ラジエータフィン効率η_A=0.5, 検出器用ラジエータフィン効率η_H=0.5					
	ASIC-検出器間ケーブル長さL=100mm					
	ラジエータ表面赤外輻射率ε=0.8					
検出器用ラジエータのサイズ	φ386mm (default)	φ545.8mm (defaultの2倍)	φ668.5mm (defaultの3倍)	φ772mm (defaultの4倍)	Φ863.1mm (defaultの5倍)	φ945.5mm (defaultの6倍)
H2RG temperature [K]	66.86	64.47	62.77	61.05	60.64	59.99
ASIC temperature [K]	71	71.64	72.41	73.45	74.68	76.09
Heat flow from ASIC to H2RG [mW]	53.032	91.32	123.788	151.664	179.04	205.228

Evaluation of Thermal background by ray trace

On-going



検出器上での照度分布例



WISH: System

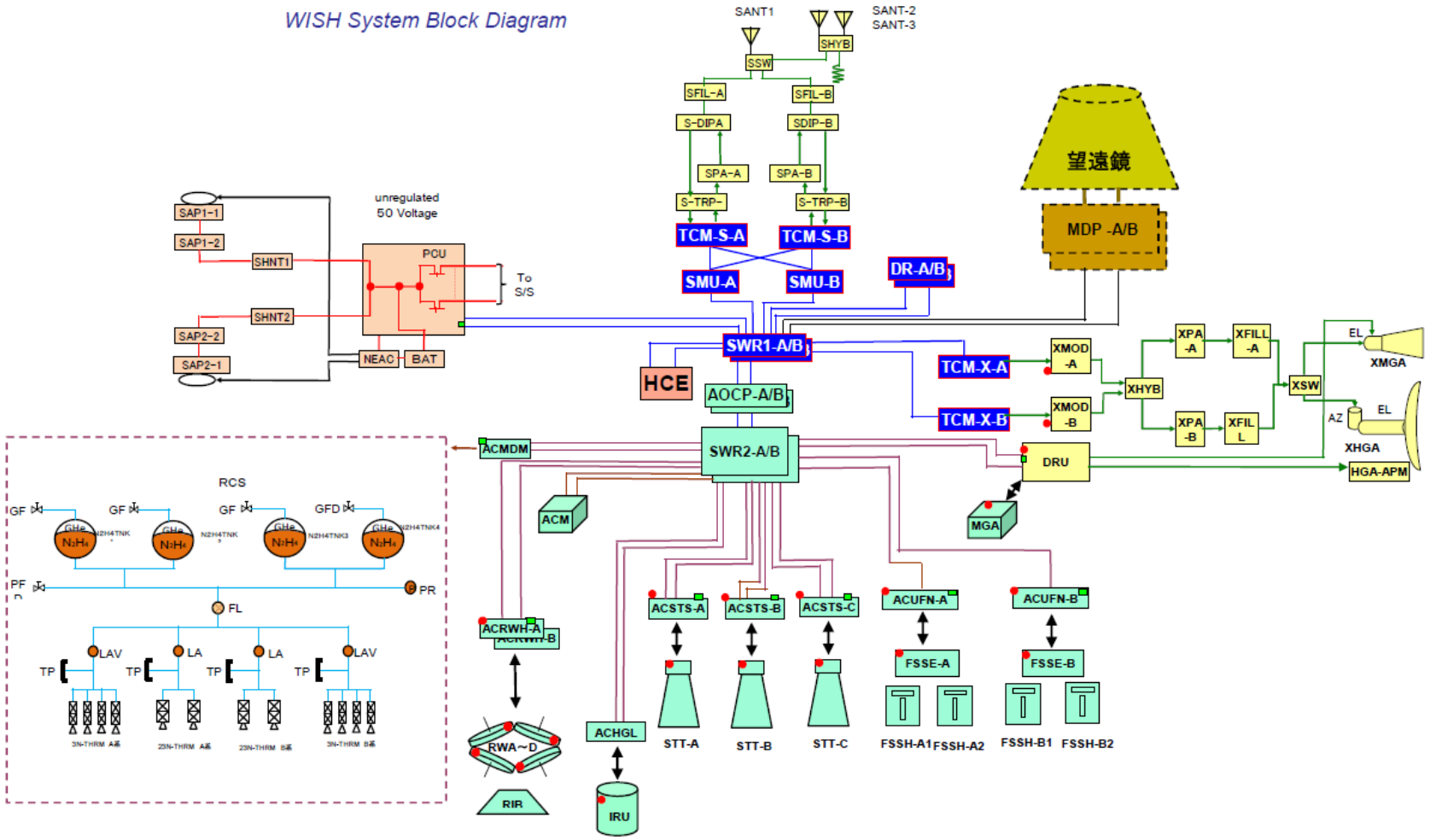
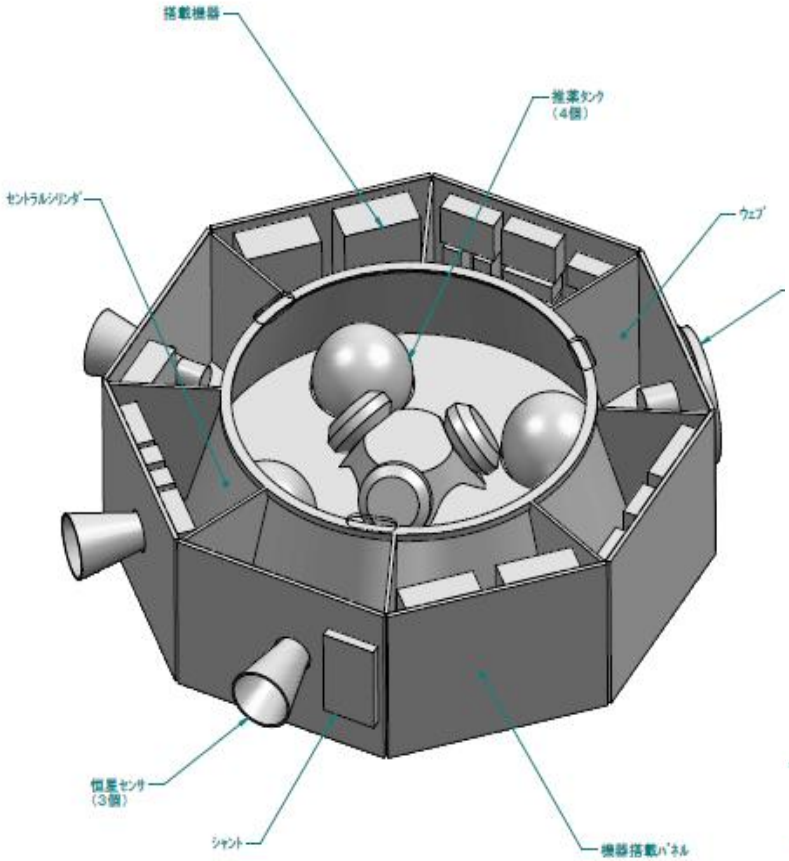
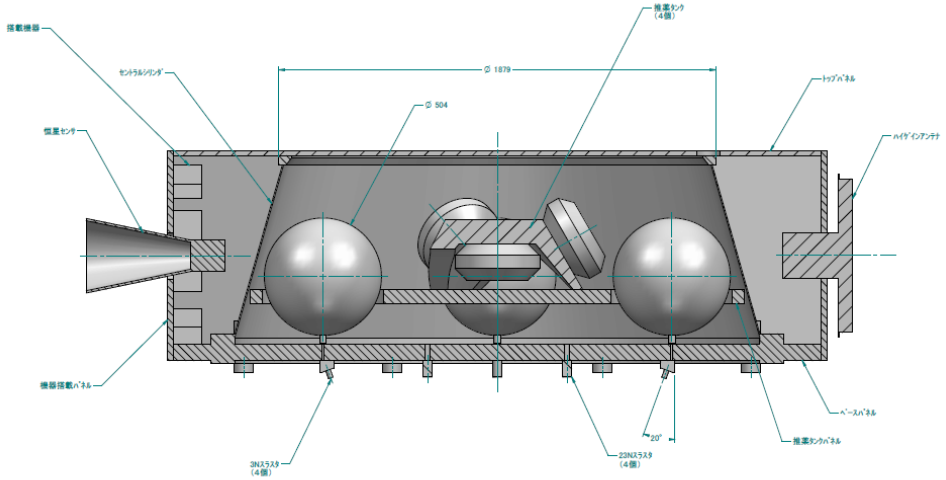


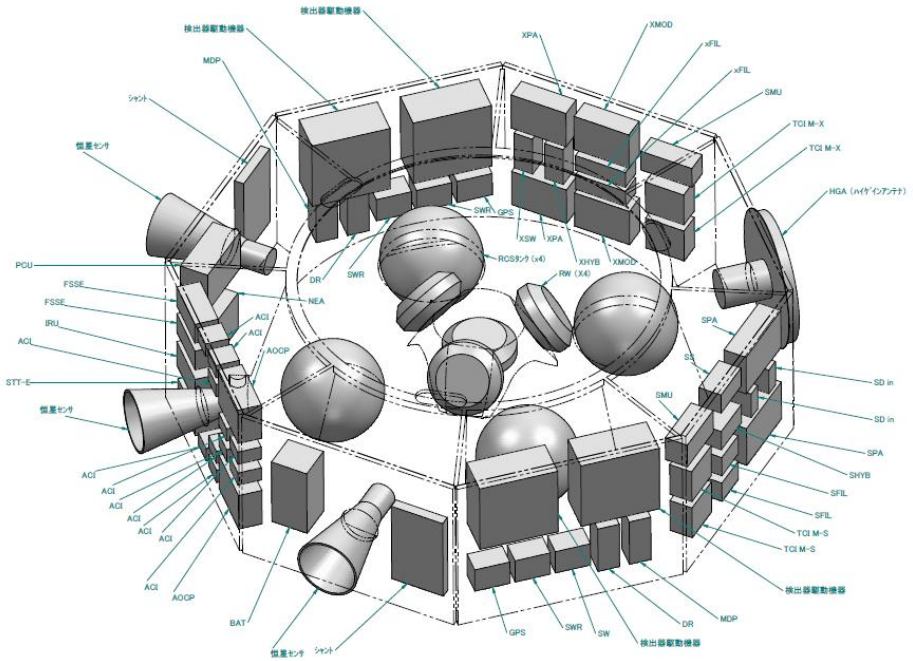
図3.2-1 WISHシステムブロック図 System Block Diagram



バス部　概要



バス部　断面図



バス部　機器配置図

MASS BUDGET

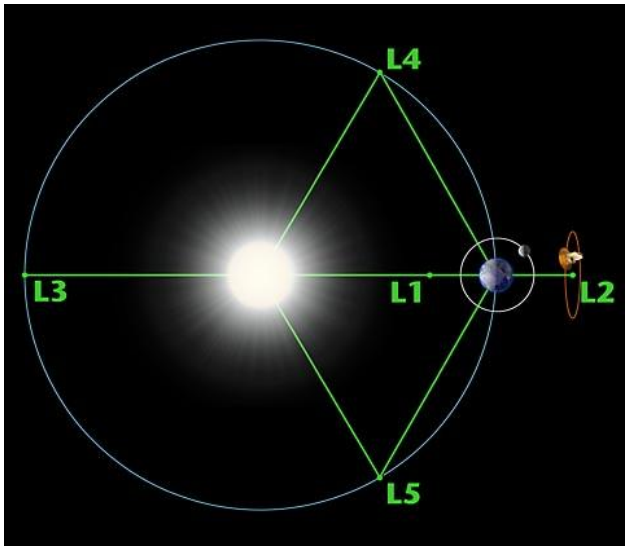
Compoment		Mass (kg)	Notes
Mission Payload		609.00	
BUS		607.00	
	Power	96.60	
	Communication	40.21	
	Data analysis	73.40	
	Pulsation	56.63	
	Orbit adjustment	126.96	
	Electronics	24.00	
	Structure	156.00	
	Thermal	33.20	
Dry mass		1216.00	
Fuel		97.50	
Wet mass at launch		1313.50	
Mergin		186.50	<1500kg

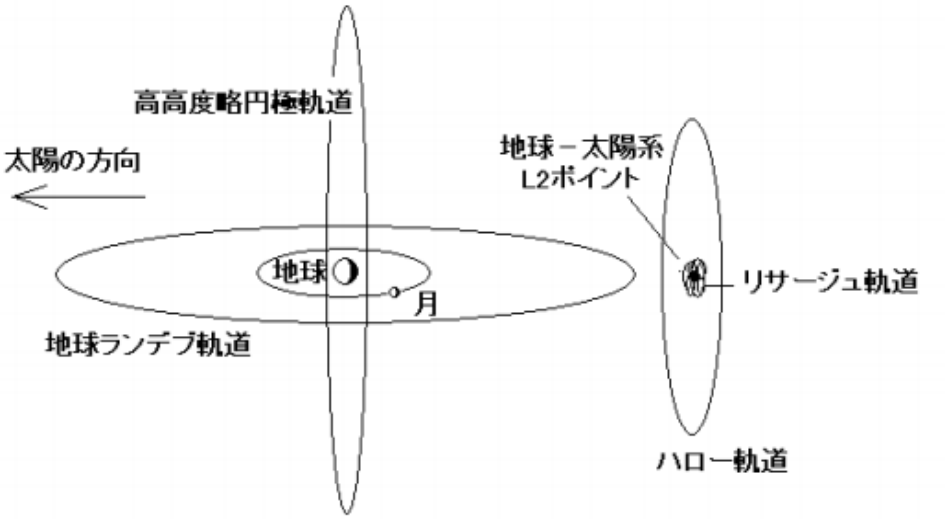
Table 15 : WISH Power budget
（unit W）

POWER BUDGET

components	launch	TRANS L2 Wheel ON	TRANS L2	TRANS L2	operation EOL	operation max	position manuva EOL	Position manuva max	operation orbit
MissionPayload Total	0.0	30.0	30.0	30.0	239.0	239.0	239.0	239.0	0.0
BUS total	480.2	752.2	906.7	752.2	793.7	793.7	793.7	708.7	
Power	30.5	30.5	30.5	30.5	35.0	35.0	35.0	35.0	35.0
communication	85.0	195.3	195.3	195.3	195.3	195.3	195.3	195.3	195.3
Data management	162.0	162.0	162.0	162.0	199.0	199.0	199.0	199.0	192.0
Pulsation	0.0	0.0	150.0	0.0	0.0	0.0	0.0	0.0	150.0
Orbital adjustment	97.7	254.9	259.4	254.9	259.4	259.4	259.4	259.4	254.9
Thermal	105.0	105.0	105.0	105.0	105.0	105.0	105.0	20.0	105.0
Total load	480	782	937	782	1033	1033	1033	948	932
Power used	522	842	1004	842	1104	1104	1104	1015	999
Power used w/ margin	608	956	1126	956	1223	1223	1223	1223	1083
SAP power gen	1625	1625	1625	1625	1462	1462	1462	1462	1462
	(BOL)	(BOL)	(BOL)	(BOL)	(EOL)	(EOL)	(EOL)	(EOL)	(EOL)
SAP margin （w/o margin）	1103	782	621	782	358	358	358	447	463
SAP margin ((w/ margin)	1018	669	499	669	239	239	239	239	379

ORBIT SE-L2 Halo





Item	Value
Center of the orbit	SE-L2 1500000km from the Earth
Period	180days
In the plane	700000km (TBD)
Out of plane	350000km (TBD)

Typical Exposure Time