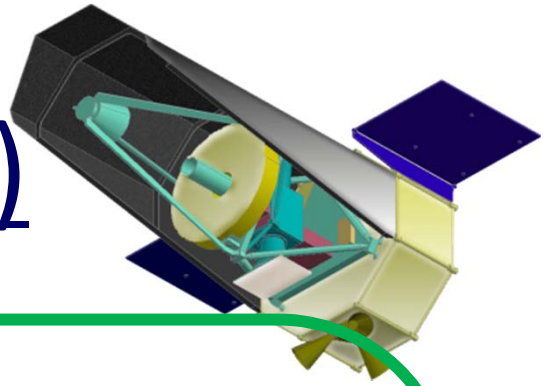

WISH
The Cosmic Dawn Treader
Wide-field Imaging Surveyor for High-Redshift
超広視野初期宇宙探査衛星
WISH Working Group
http://www.wishmission.org/en/index.html

1. WISH Summary
2. Search for Very High-z Galaxies
3. SNe
4. Other Science
5. WISH System

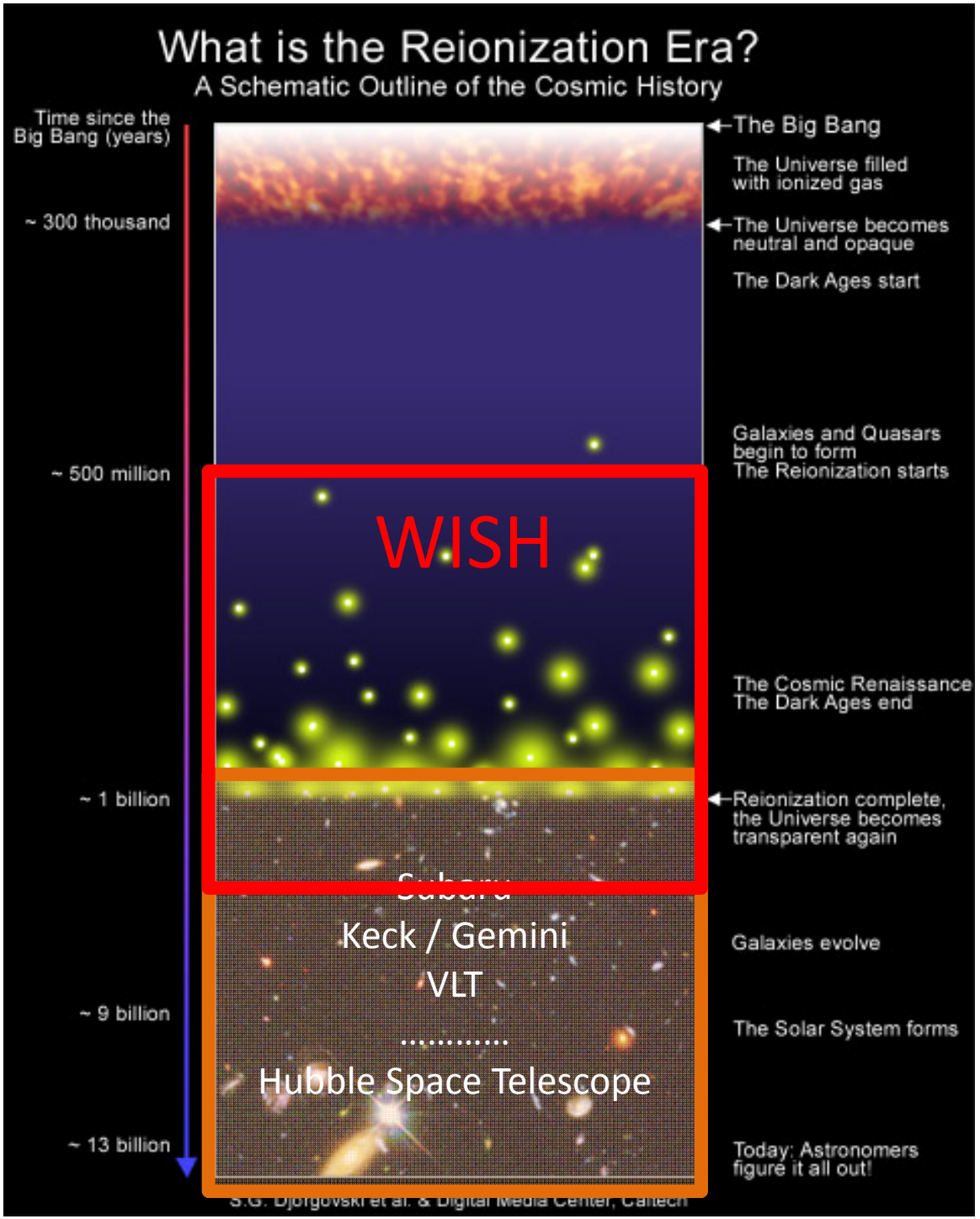
WISH WG Members

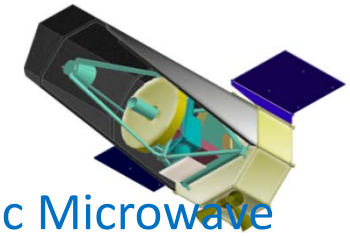
Toru Yamada, K.Mawatari, M.Kubo (Tohoku University)
Ikuru Iwata, S.Tsuneta,
T.Kodama, Y.Komiyama (NAOJ)
H.Matsuhara, T.Wada, Y.Oyabu (JAXA/ISAS)
H.Sugita, Y.Sato, A.Okamoto (JAXA)
K.Ohta, K.Yabe , Tsutsui (Kyoto University)
T.Morokuma, Chihiro Tokoku
M.Doi, N.Yasuda (University of Tokyo)
N.Kawai (TiTEC), Yonetoku (Kanazawa U),
A.Inoue (Osaka Sangyo U.)
Y.Ikeda (Photocoding), S.Iwamura (M.R.J)

WISH Brief Summary (1)



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





Cosmic Microwave Background (CMB)

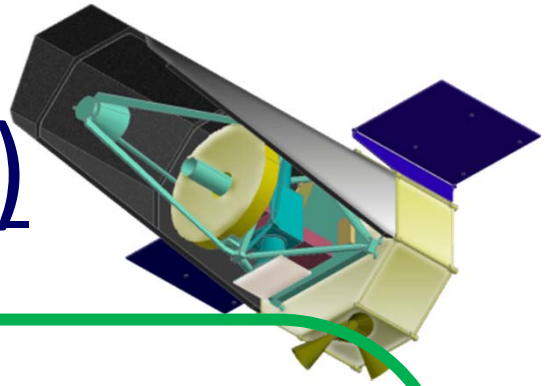
Universe: Neutral

First-Generation Galaxies

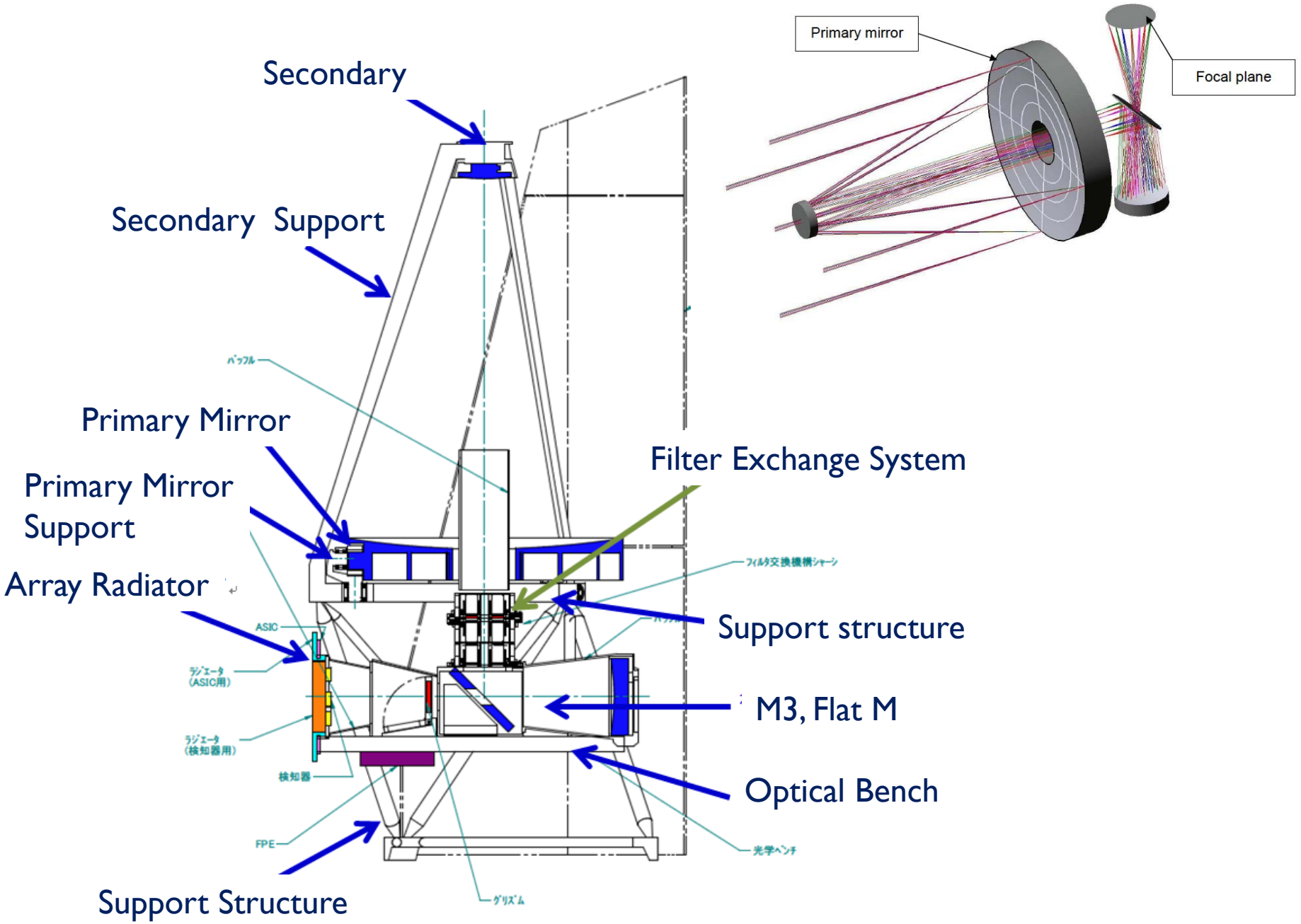
Ultimate Frontier of Galaxies

Universe: Ionized

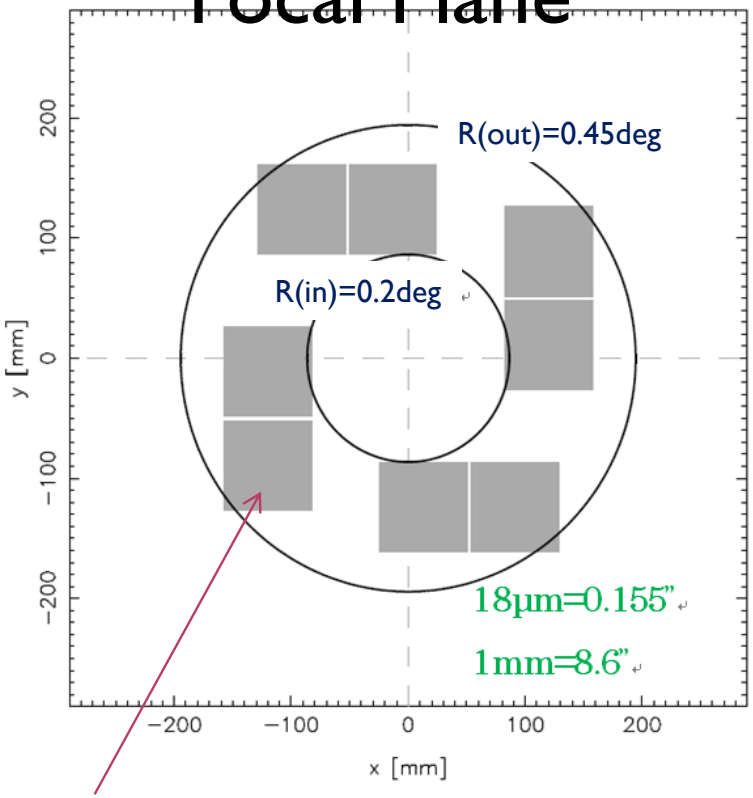
WISH Brief Summary (2)



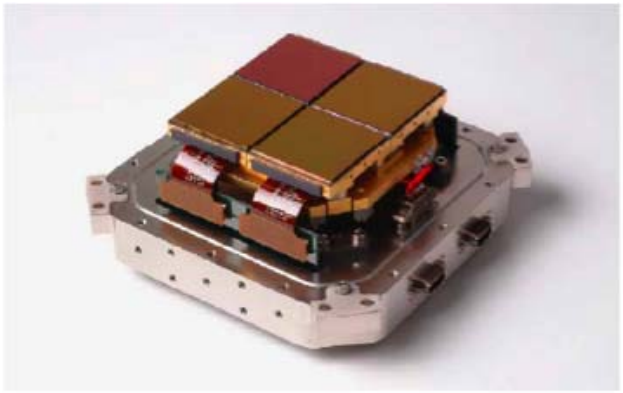
- 1-5 μm wavelength range
- 1.5m diameter telescope
- Very Wide-Field Imager
  ~900 arcmin^2 FoV
- pixel scale: 0.155” / 18μm (f/16)
- Cooled to 90-100K (telescope)
- SE-L2, JAXA HIIA


Primary mirror
Focal plane
Secondary
Secondary Support
Primary Mirror
Primary Mirror Support
Array Radiator
Filter Exchange System
Support structure
M3, Flat M
Optical Bench
Support Structure
バッフル
フィルタ交換機構シャーシ
ASIC
ラジエータ (ASIC用)
ラジエータ (検知器用)
検知器
FPE
光学ベンチ
グリズム

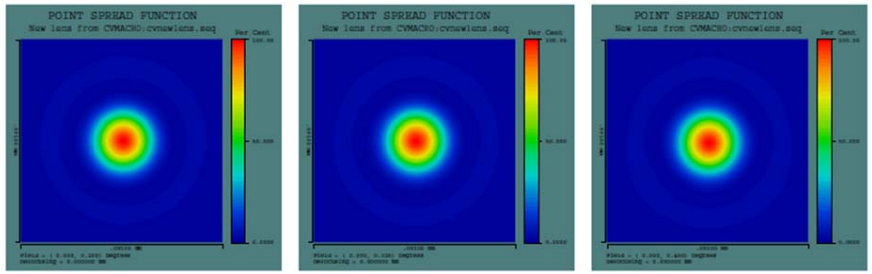
Focal Plane



4 x 2kx2k FPA



R=0.2, 0.325, 0.4 deg @ 1.25um



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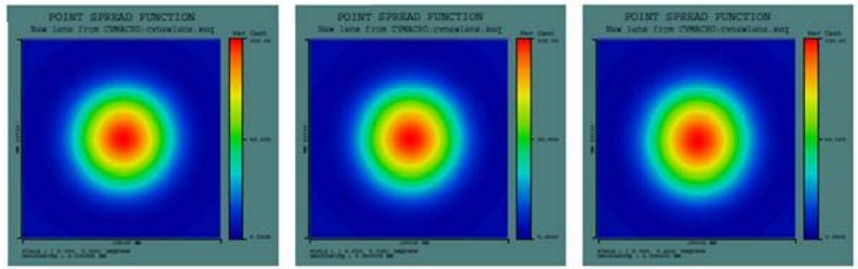
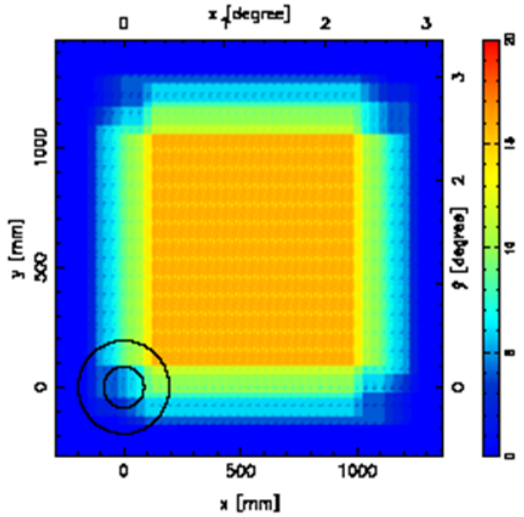


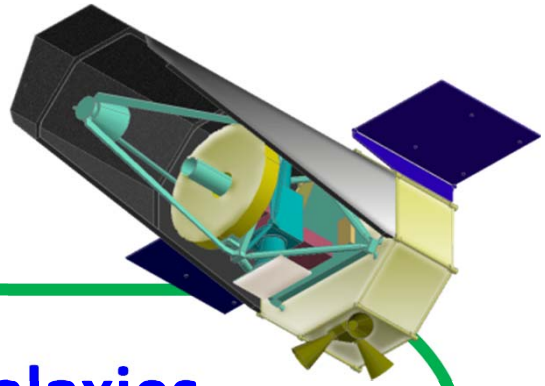


WISH: Survey Strategy

Survey categories

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

WISH Science Goals (1)



- **Exploring the Ultimate Frontier of Galaxies**
  Detection of 1st-generation galaxies and
  studying **cosmic reionization** over **z=7-15**

- **NIR search and light curves for type-Ia SNe**
  History of cosmic expansion and Dark Energy

- Transients: high-z GRB, luminous SNe

- Huge statistics and New discovery

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WISH: Survey Strategy

Surveys achieved within ~1000 days (50% overhead)

WISH can detect

~10^4 galaxies at z=8-9,

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

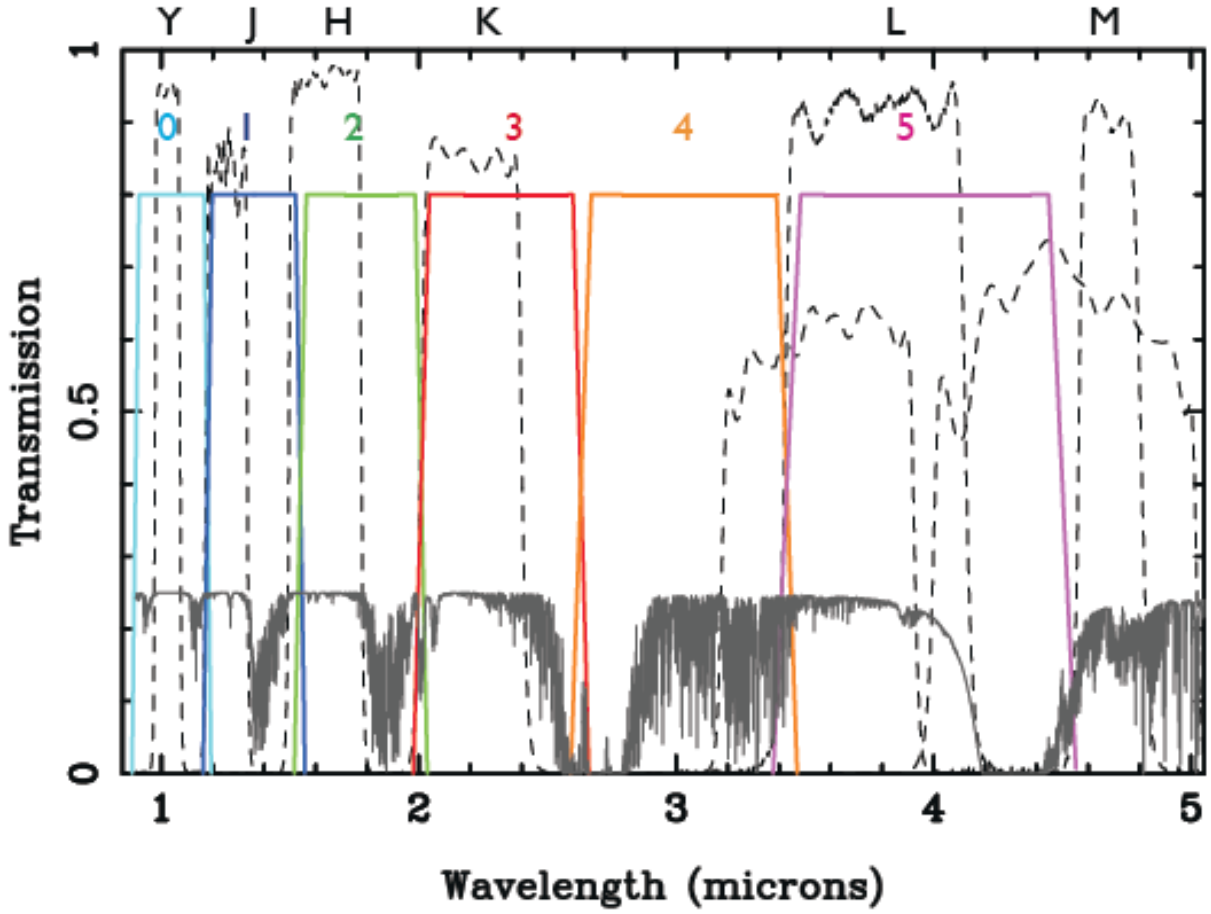
and

~50-100 galaxies at z=14-17

Many of them are feasible spectroscopic targets

WISH: Survey Strategy

set of broad-band filters to select high-z galaxies



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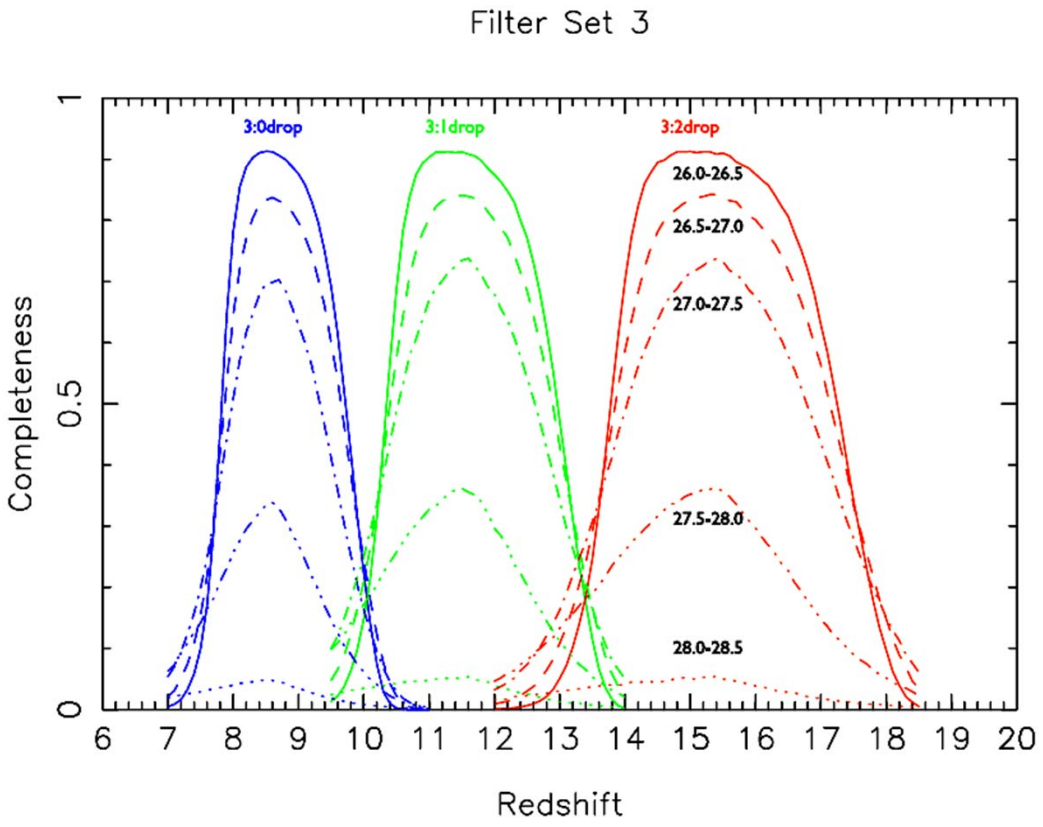
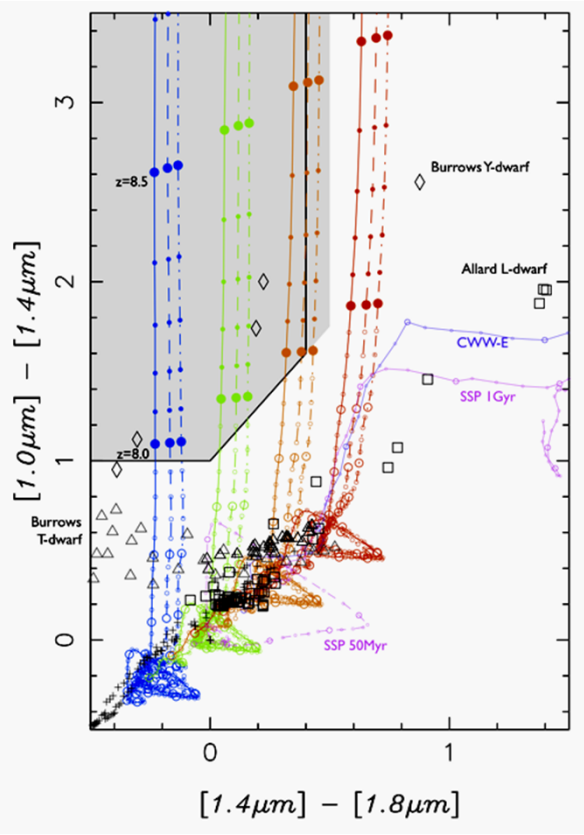
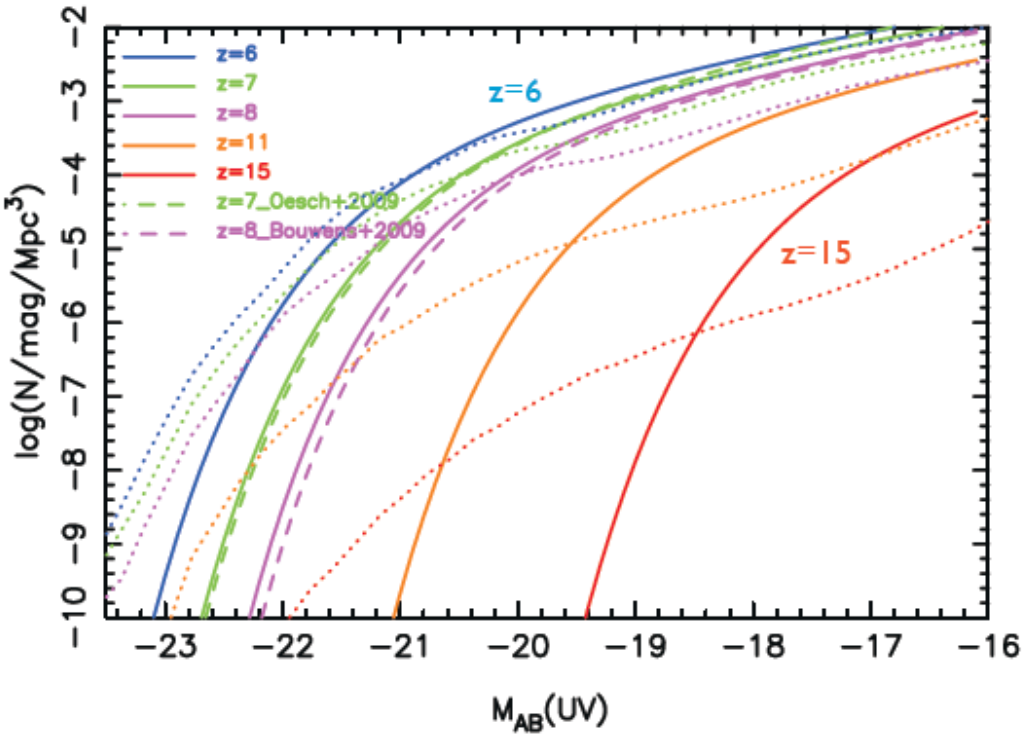




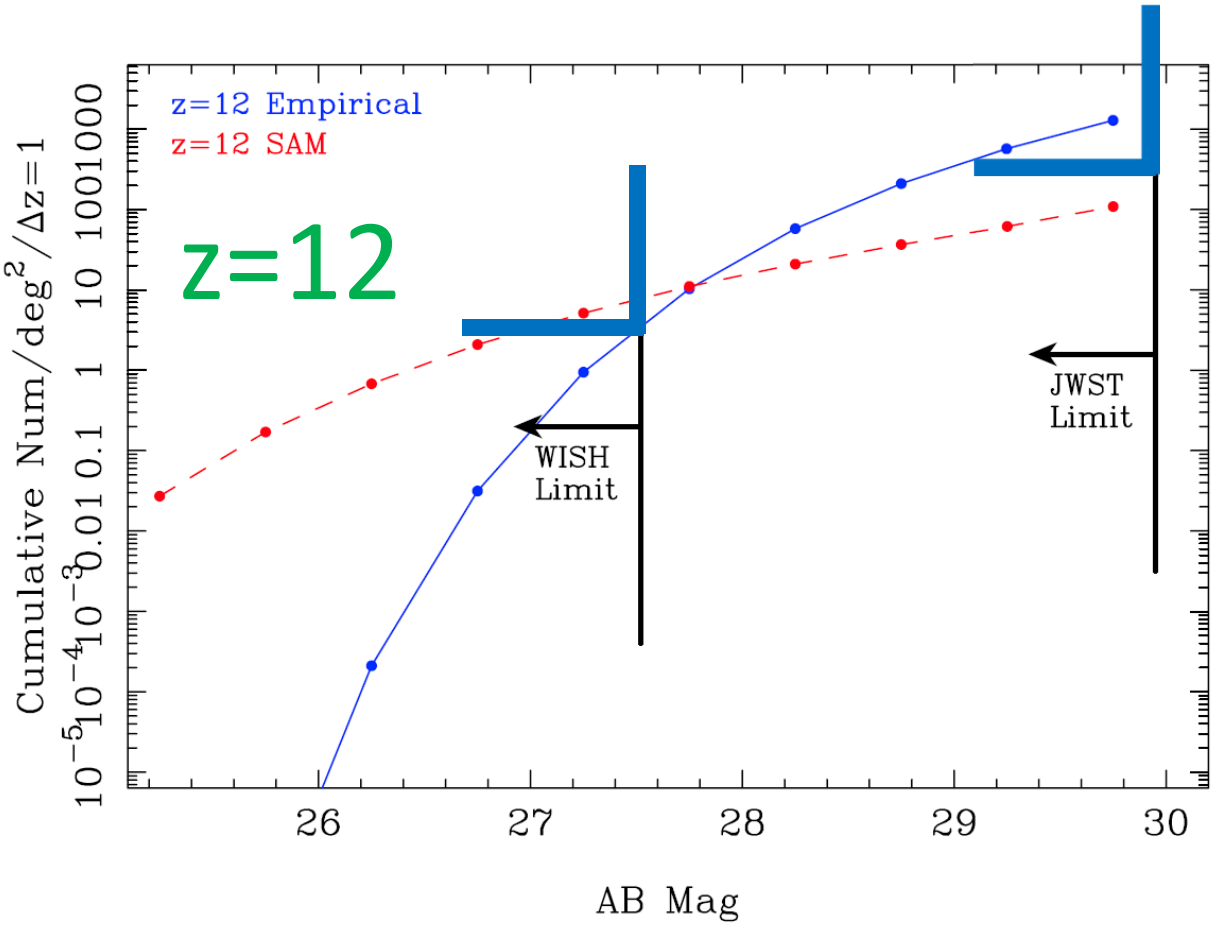
How deep, how large area should we observe?

Observed (z=6-8, HST WFC3 dashed lines) and
Predicted (z=6-15) UV Luminosity Function of Galaxies



Solid lines: empirical expectation (extrapolation) from z=6-8 luminosity function
Dotted lines: expectation based on galaxy models (semi-analytic treatment)

In the observers' frame…



Limit of AB>27-28 is needed

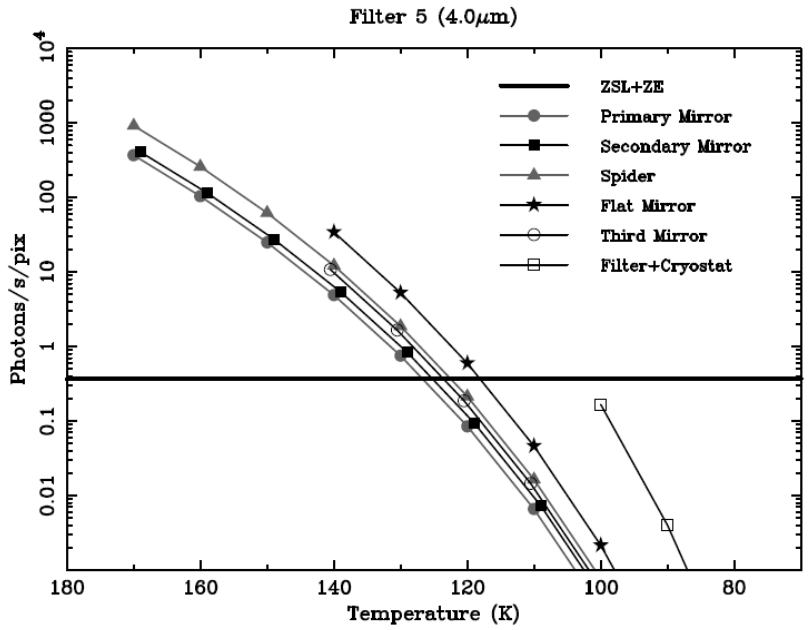
Empirical luminosity evolution

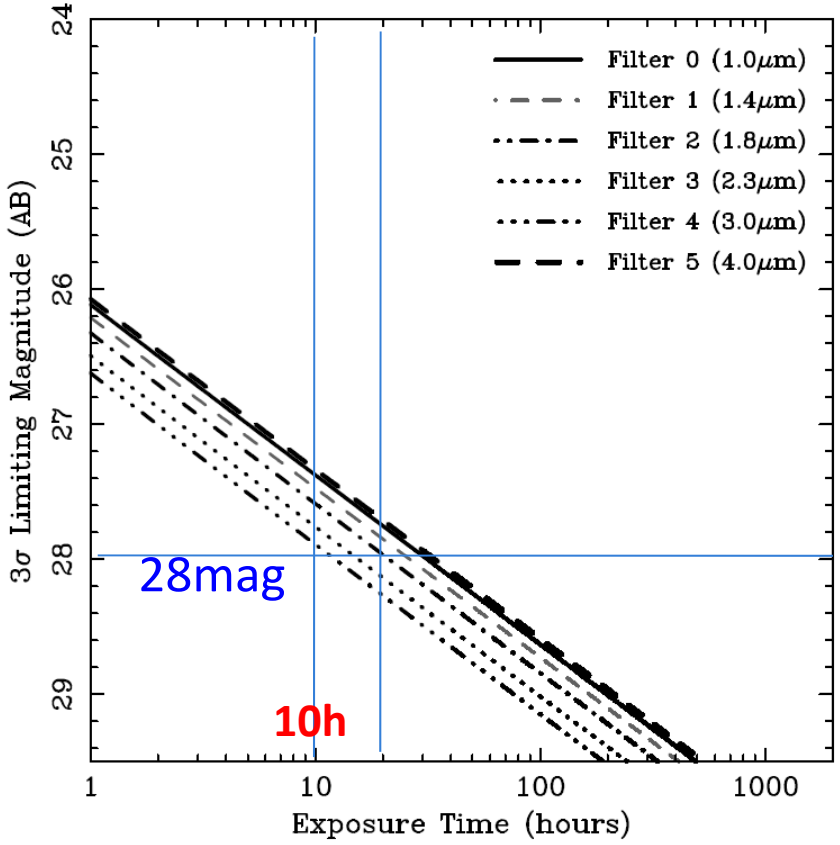
Semi-analytic Model prediction

FoV JWST NIRCam 2.2'x2.2' x 2ch (per filter)
~ 2.8×10^{-3} deg^2

WISH: Survey Strategy

Telescope should be cooled to ~100K (detector to ~40K for 5 µm)





WISH Science Goals

Expected number of the *observed* very high-redshift galaxies

		Number Density [objects per 1 deg^2] for AB < 28.0			
	redshift	No Evolution	Empirical	SAM	DMH
1.0μm-drop	8-9	4,000	1,700	630	850
1.4μm-drop	11-12	2,400	100	50	4.1
1.8μm-drop	14-17	1,200	0.72	1.1	0.003

Numbers for 1 deg^2 , <28AB

Galaxies bright enough for deep spectroscopy with ELT + AO spectrograph

WISH: Survey Strategy

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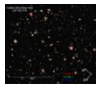
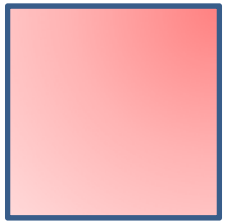
HST UDF





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

WISH 1FoV
(~900arcmin2)

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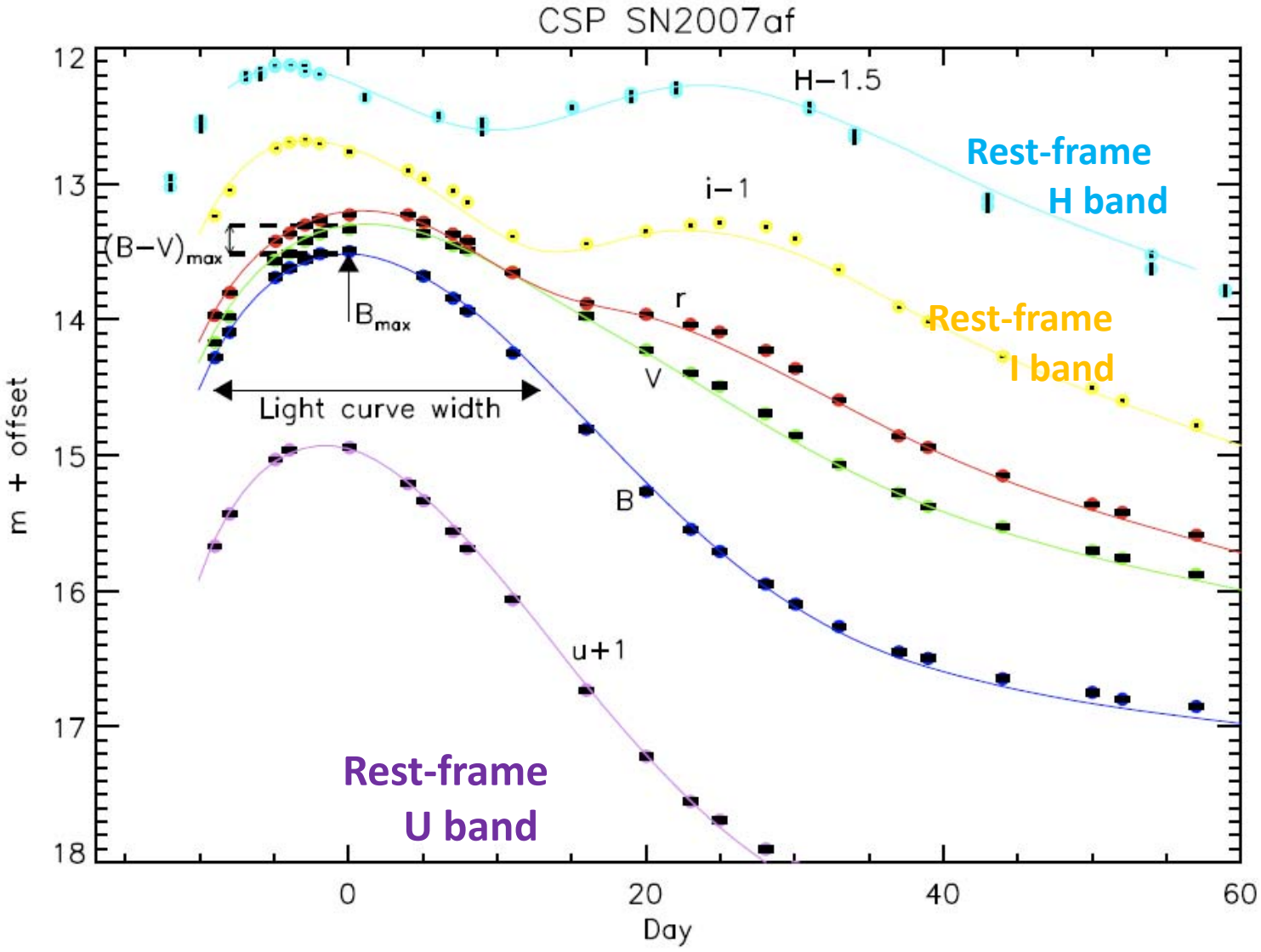
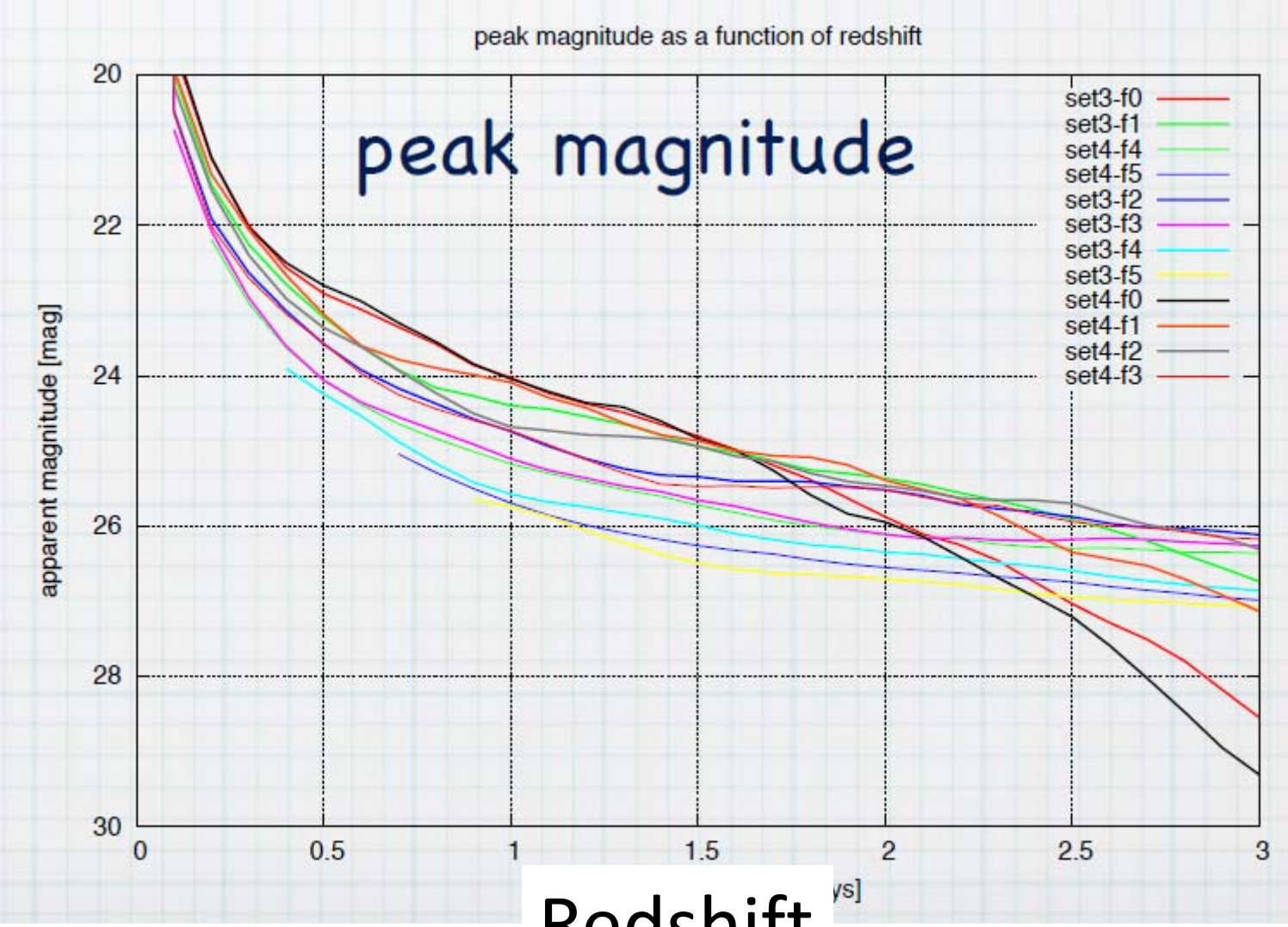
Light Curves of Type Ia SNe



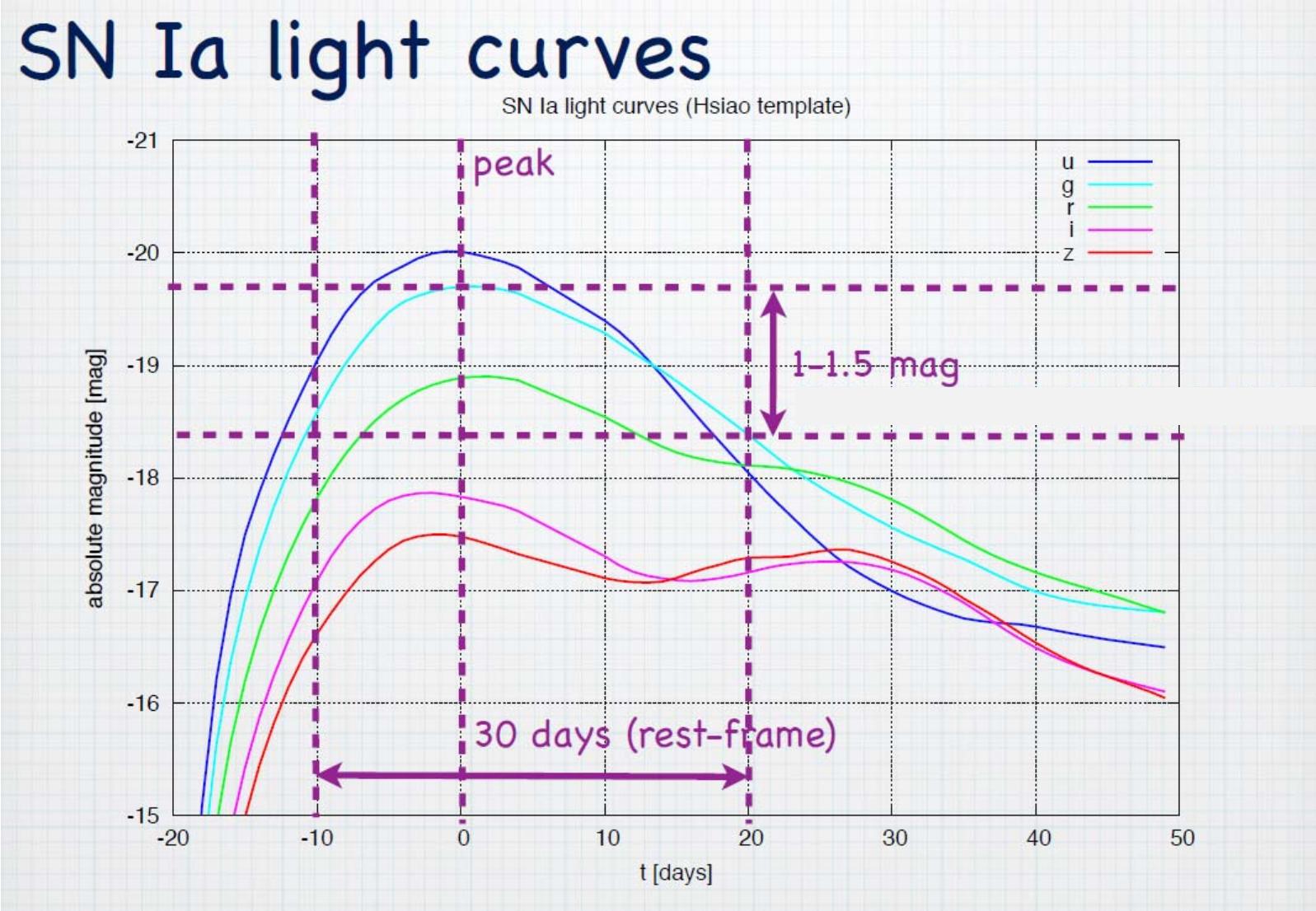
From Goobar and Leibundgut 2011



Redshift

Morokuma、2010

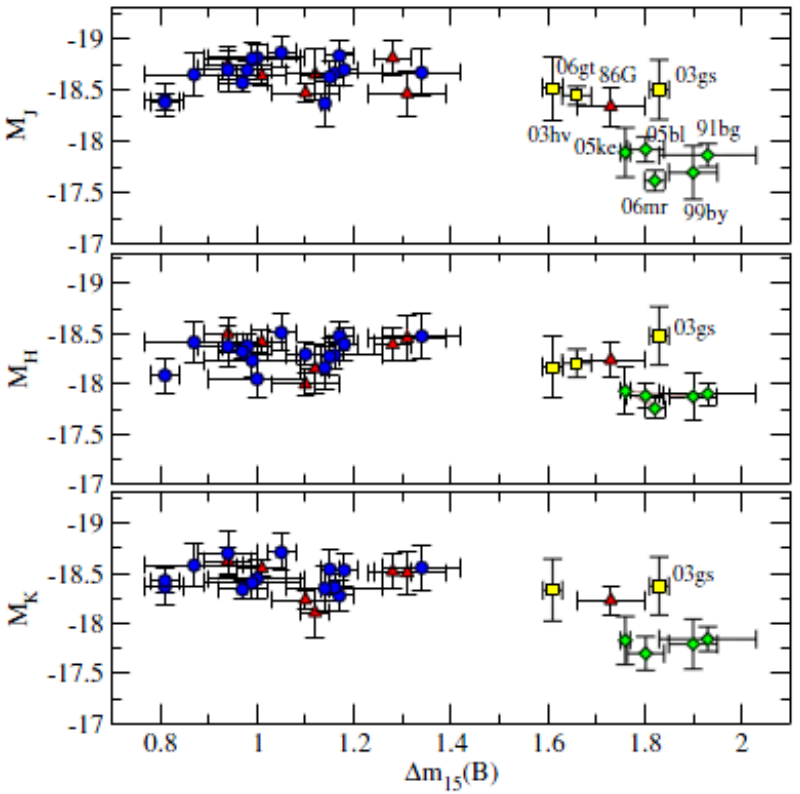
WISH type-Ia SNe

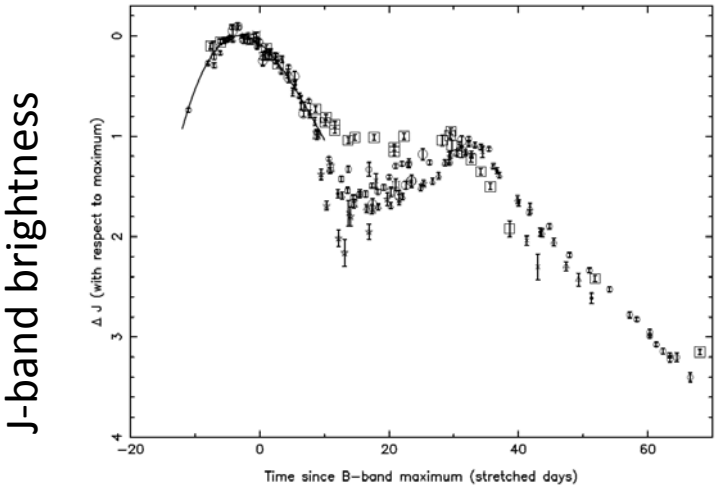


Advantage: rest-frame IR

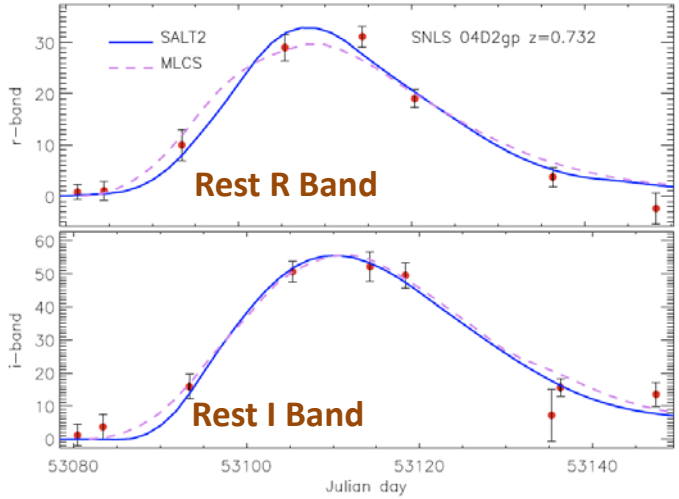
- Small scatter in peak magnitude
  n.b. more dispersion for $T_{peak}(IR)>T_{peak}(B)$
- Double peaks in Light Curve.
  First peak can be fitted by a single template
- Less sensitive to the Fitting Models of LC

Krisciunas et al. 2009





Time from B-band peak



From Goobar and Leibundgut 2011

WISH type-Ia SNe

Ultra Deep Survey 3-4 band AB28mag

N=5-10 times/year (@z~1 … Δt~10 days)

➔ magnitude limit 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 22 deg^2	z=0.-1.0 2000 SNIa in 67 deg^2

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- Galaxy Formation and Evolution
- Transient

  GRB toward z=20, type-IIn SNe
- Variability Survey

  AGN in High-z Galaxies
- Strong Lensing

  Double Einstein Rings

- Quasar toward z=20 (Ultra Wide Survey)
- Weak Lensing Cosmology

  (Ultra Wide Survey)

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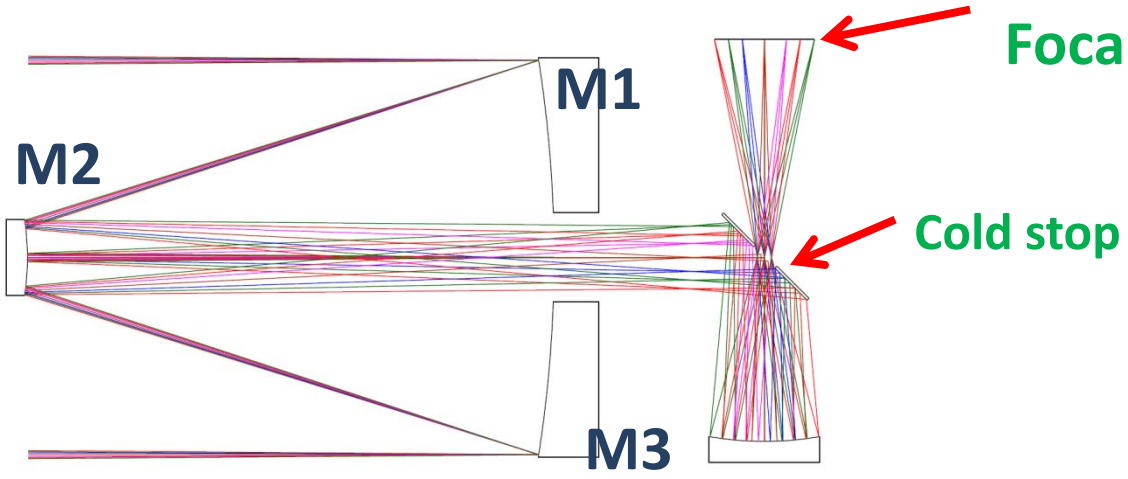
Overall Paremeters		
Launch Date (plan)	NET 2017	Mission Life Time > 5yr
Launcher	H-IIA 4/4D-LC lower case PAF 2360S	Capable to launch 1.5t (dual launch, SE-L2)
Size	φ3.3m x 5.2m	Launch Configuration Including the startracker
Mass	@launch (WET) 1.3t	margin 0.2t
Orbit	Sun Earth L2 Halo	
Power	Max 1.2 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層	SPICA R&D helitage
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	一液触媒式ブローダウン方式 fuel >162kg thruster 3Nx8 23Nx4	Φ504mm tank　4個
Data link Data processing	X-band (Data, 16Mbps), S-band （telemetry） BUS < 50Mbps (Space Wire 使用) DR 48GB x 2	Ka-band (32Mbps): option

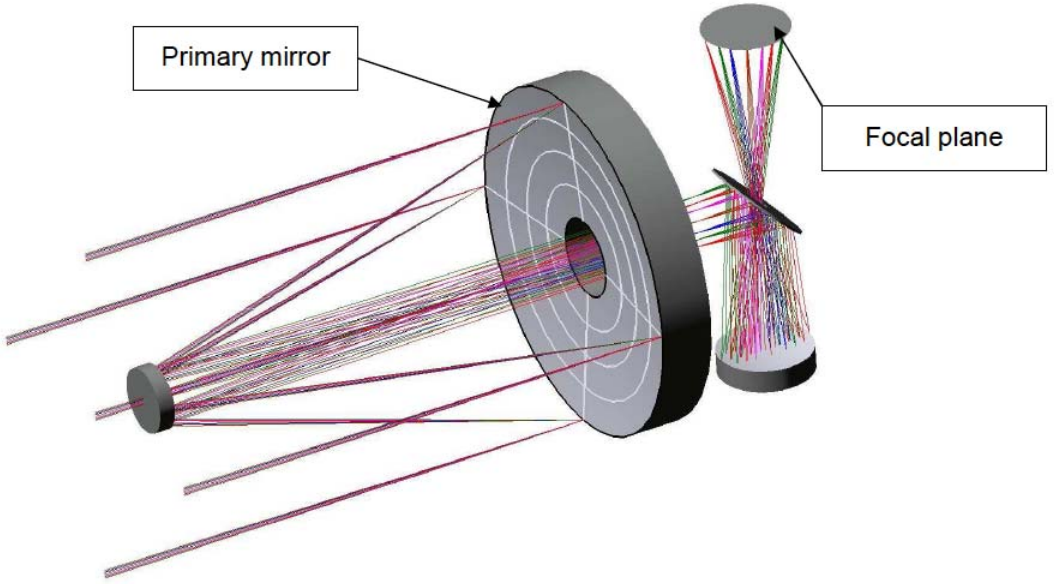
WISH Development: Optical Layout

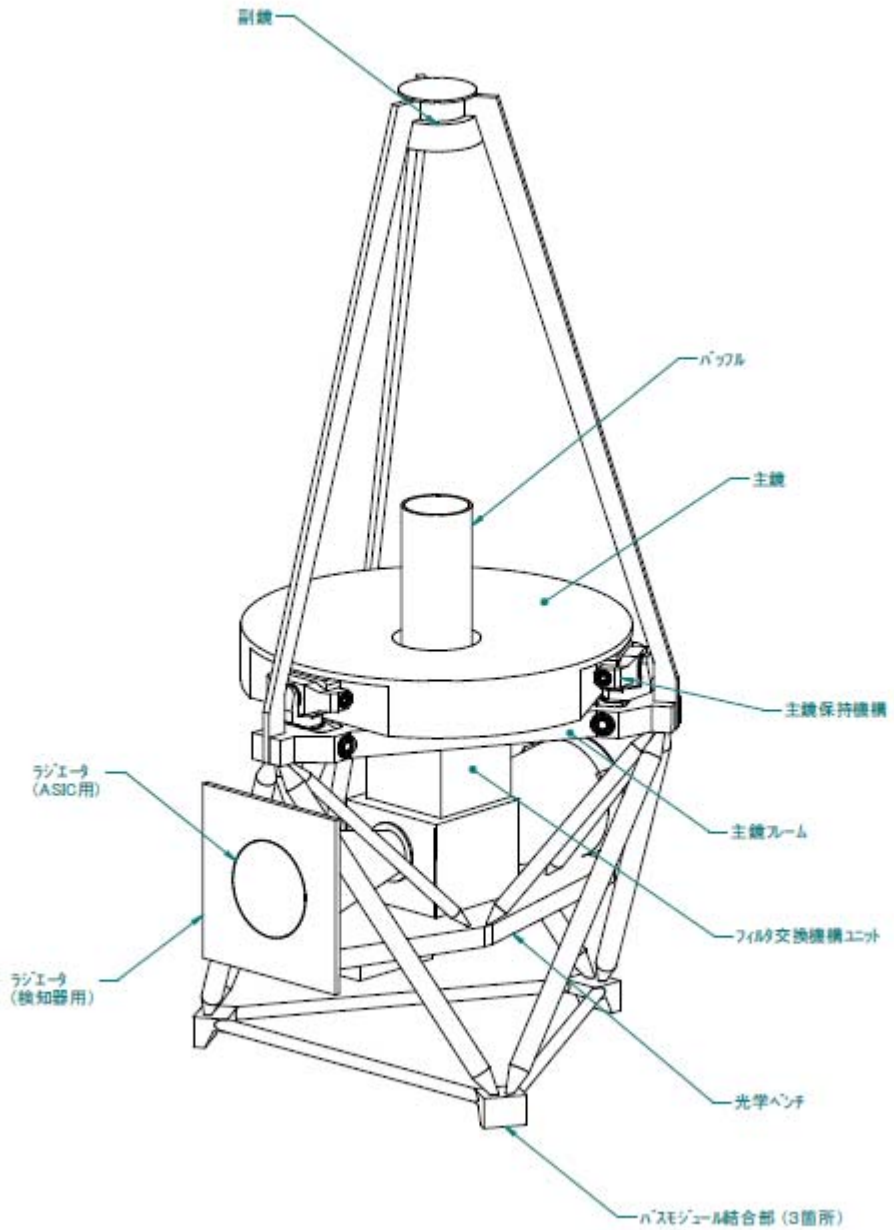


M1: Ellipsoidal
M2: Hyperboloid
M3: Ellipsoidal

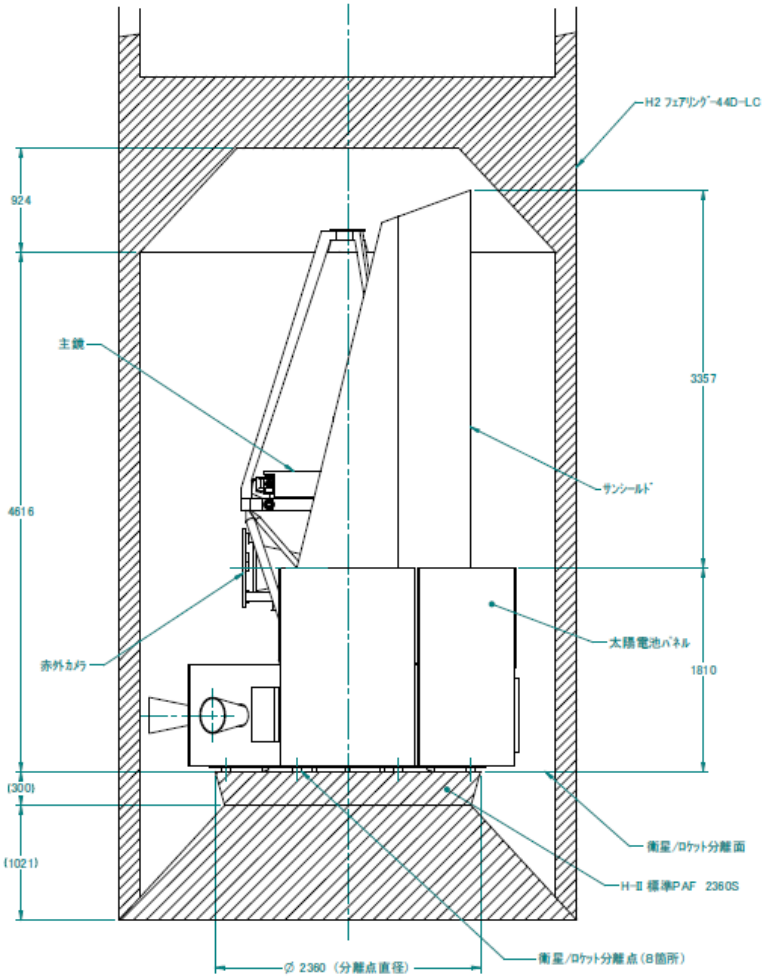
- Very flat focal plane
- Diffraction-limited images to ϕ ~50’ at 1-5 µm

Yuji Ikedaet al. (photocoding)



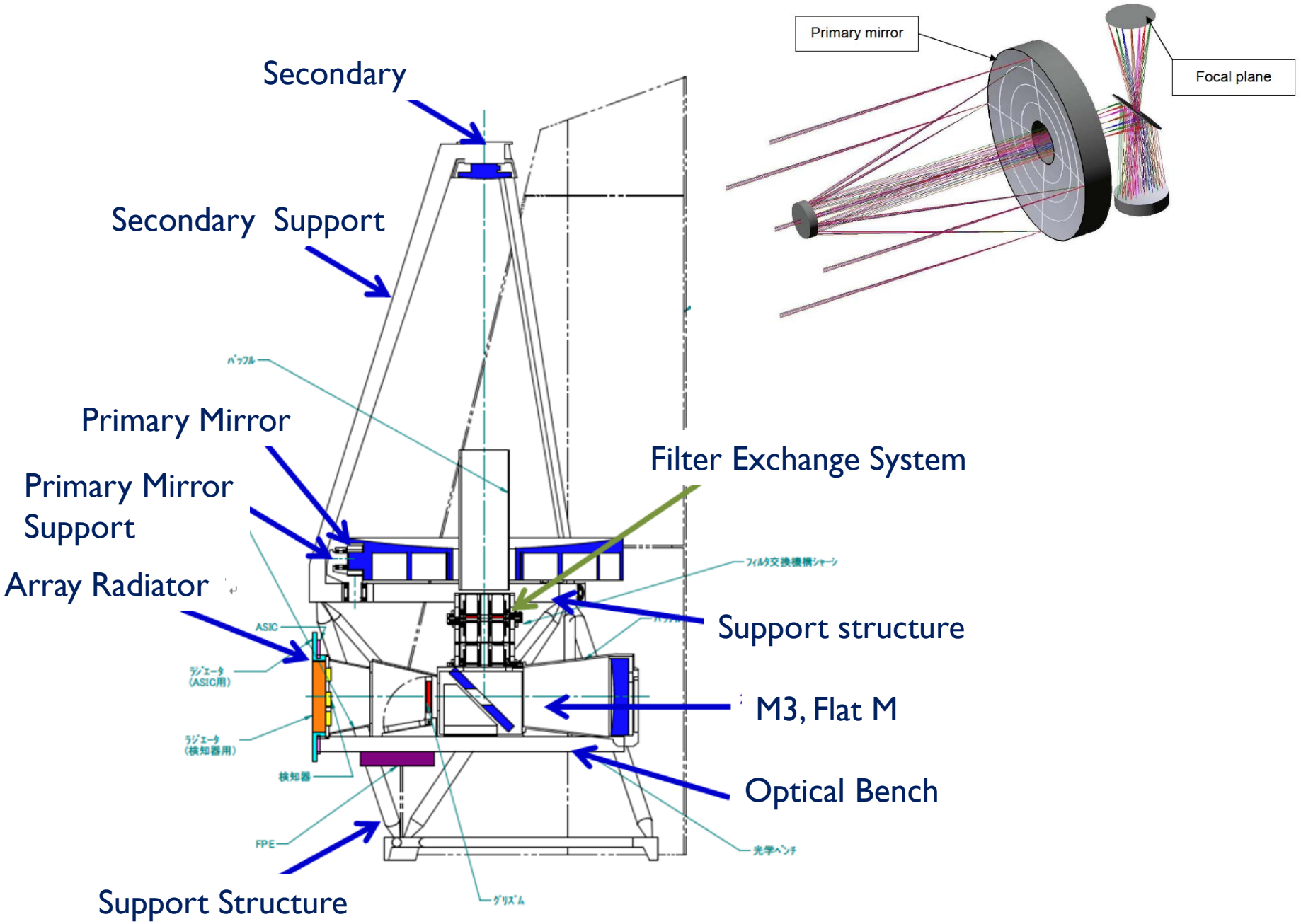


望遠鏡概要



打上時コンフィギュレーション

Launch Configuration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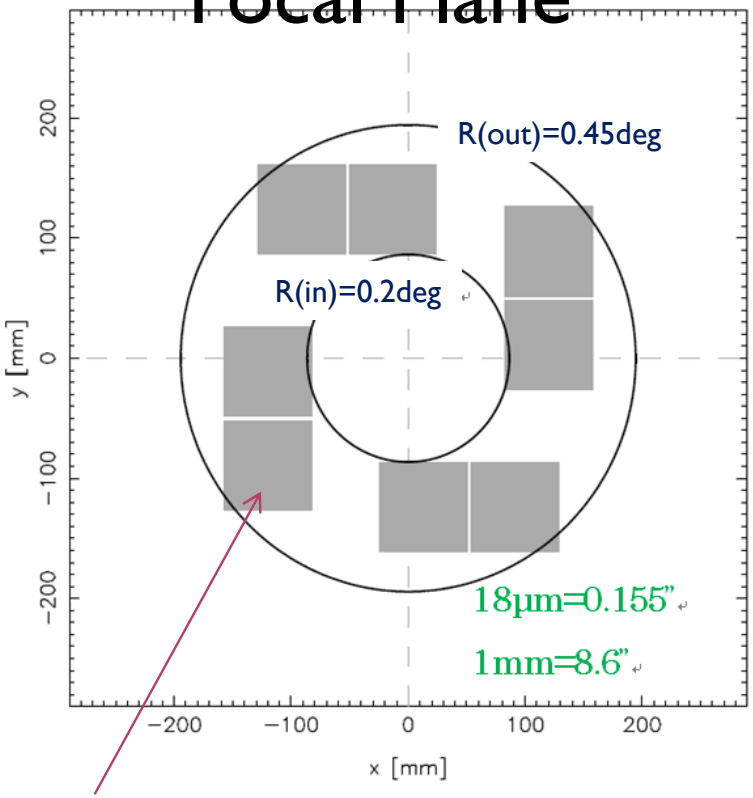
Focal Plane



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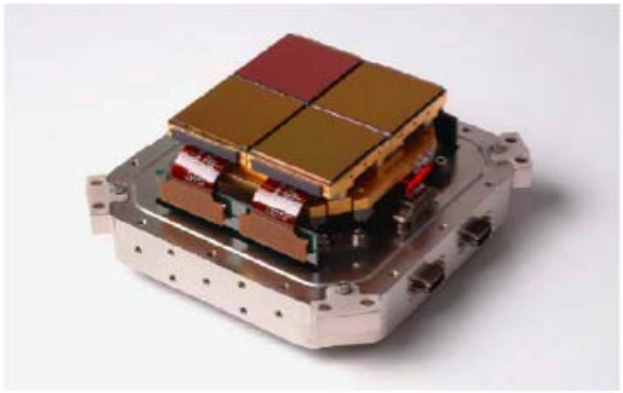

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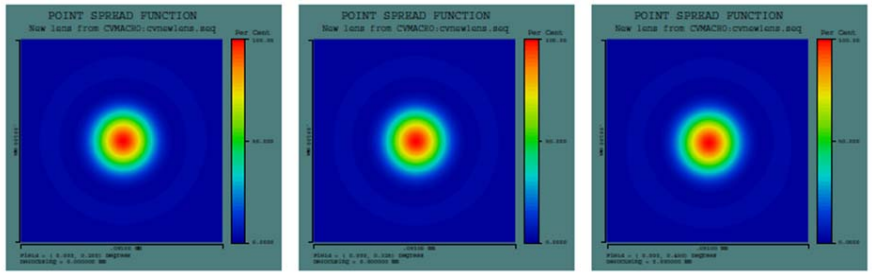
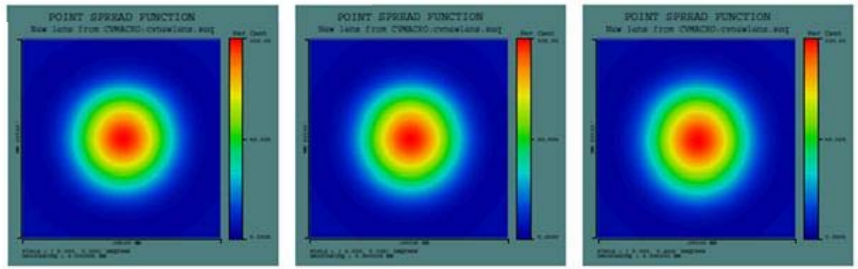
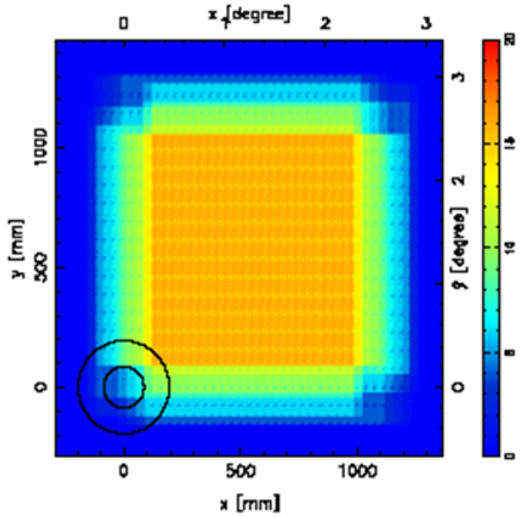
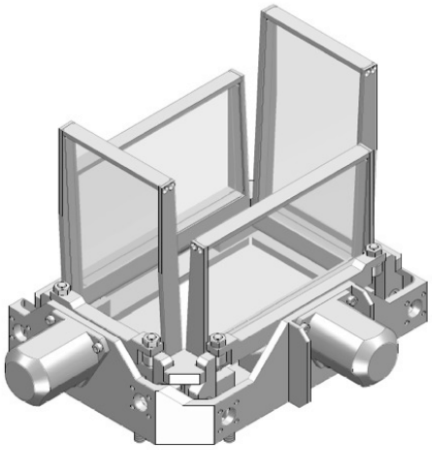


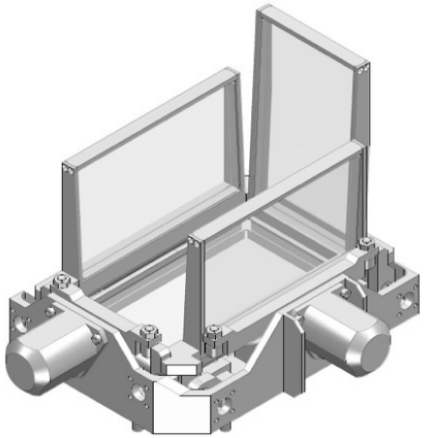
R=0.2, 0.325, 0.4 @ 2.2um

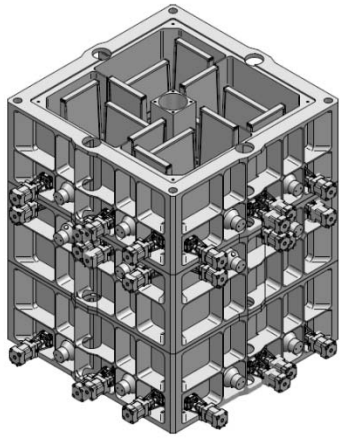


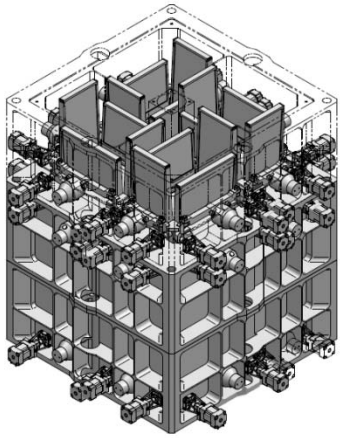


WISH Flip-type Wide-field Filter Exchange System

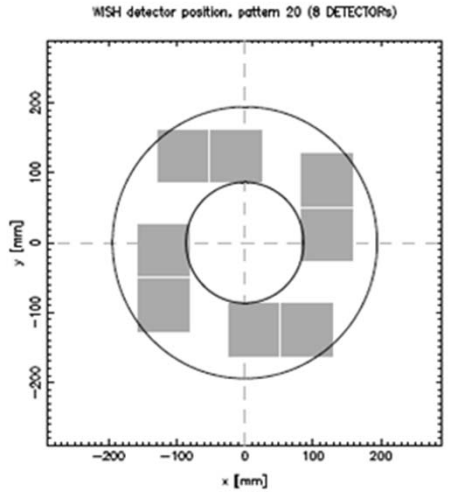


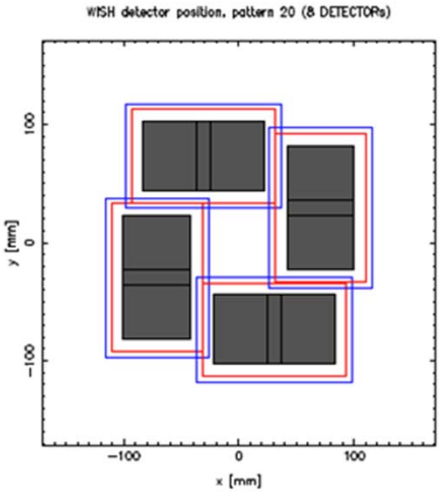


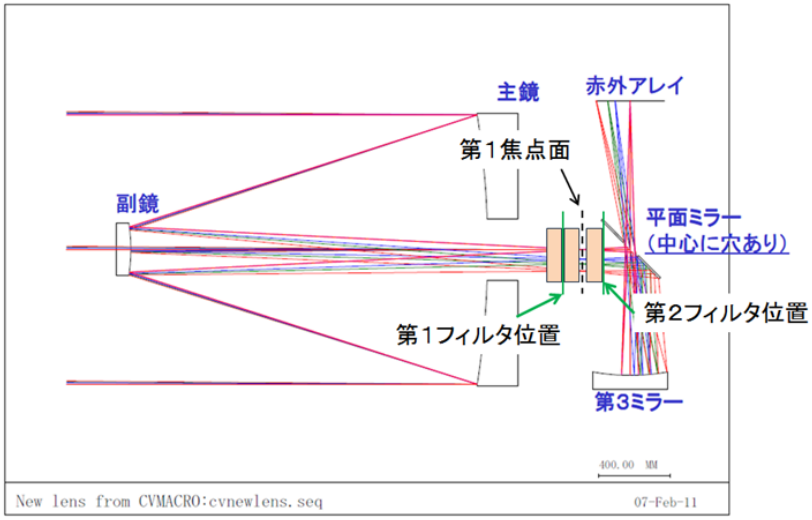




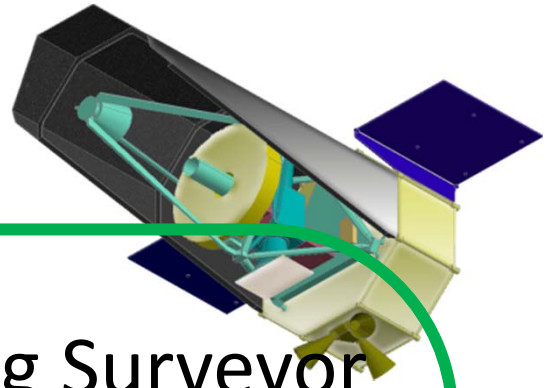
フィルタ交換機構ASSY　概要図







Summary



- NIR Deep and Wide-field Imaging Surveyor
- 1.5m aperture, 0.15”/pix
- Exploring the 1st generation galaxies
- Dedicated, ~100 deg^2, 28AB (~25nJy)
- ~10^4 galaxies at z=8-9, ~3-6x10^3 at z=11-12, and ~50-100 galaxies at z=14-17
- Concept developed under JAXA/ISAS WG to be launched in late 2010’s