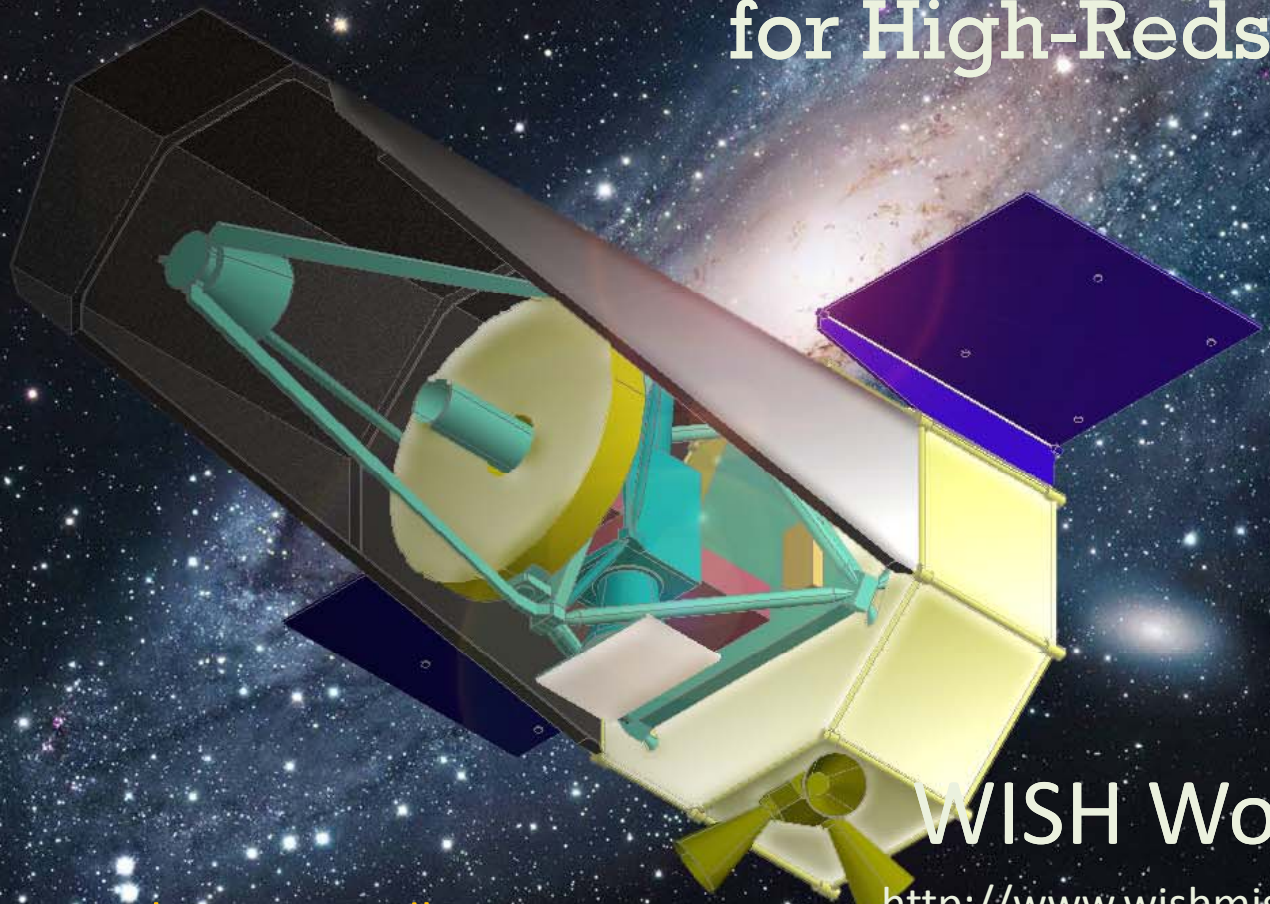
WISH

upon a first galaxy....

WISH

Wide-field Imaging Surveyor for High-Redshift



WISH Working Group

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

M31 Phot: R.Gendler

WISH WG Members

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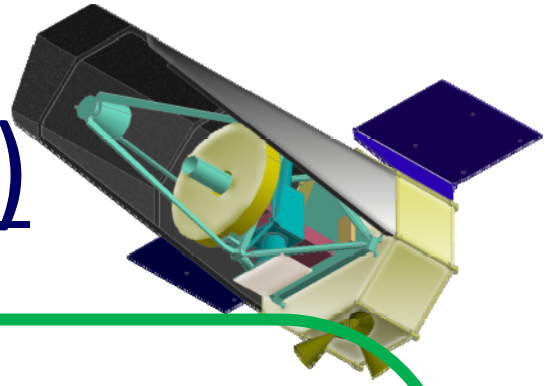
1. WISH: Brief Summary
2. WISH: Science Goals
3. WISH: Survey Strategy
4. WISH: Development

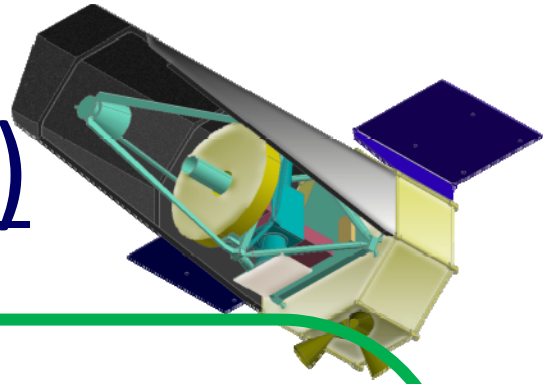
WISH Brief Summary (1)



- NIR Deep and Wide-field Imaging Surveyor
- Exploring the 1st generation galaxies
- Dedicated, ~100 deg^2, 28AB (~25nJy)
- Concept developed under JAXA/ISAS WG

  to be launched in late 2010's (NET2017)

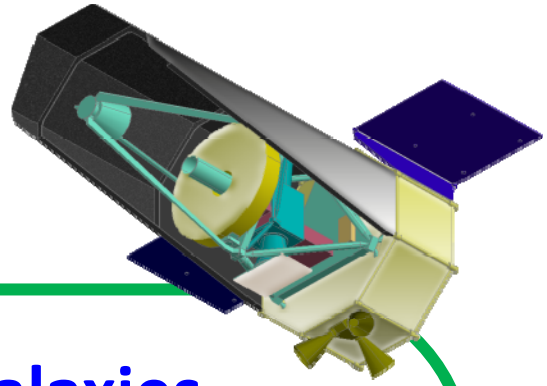
WISH Brief Summary (2)



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

  ~1000 arcmin^2 FoV
- pixel scale: 0.15” / 18μm (f/16)
- Cooled to < 100K (telescope)
- SE-L2, JAXA HIIA

WISH Science Goals (1)

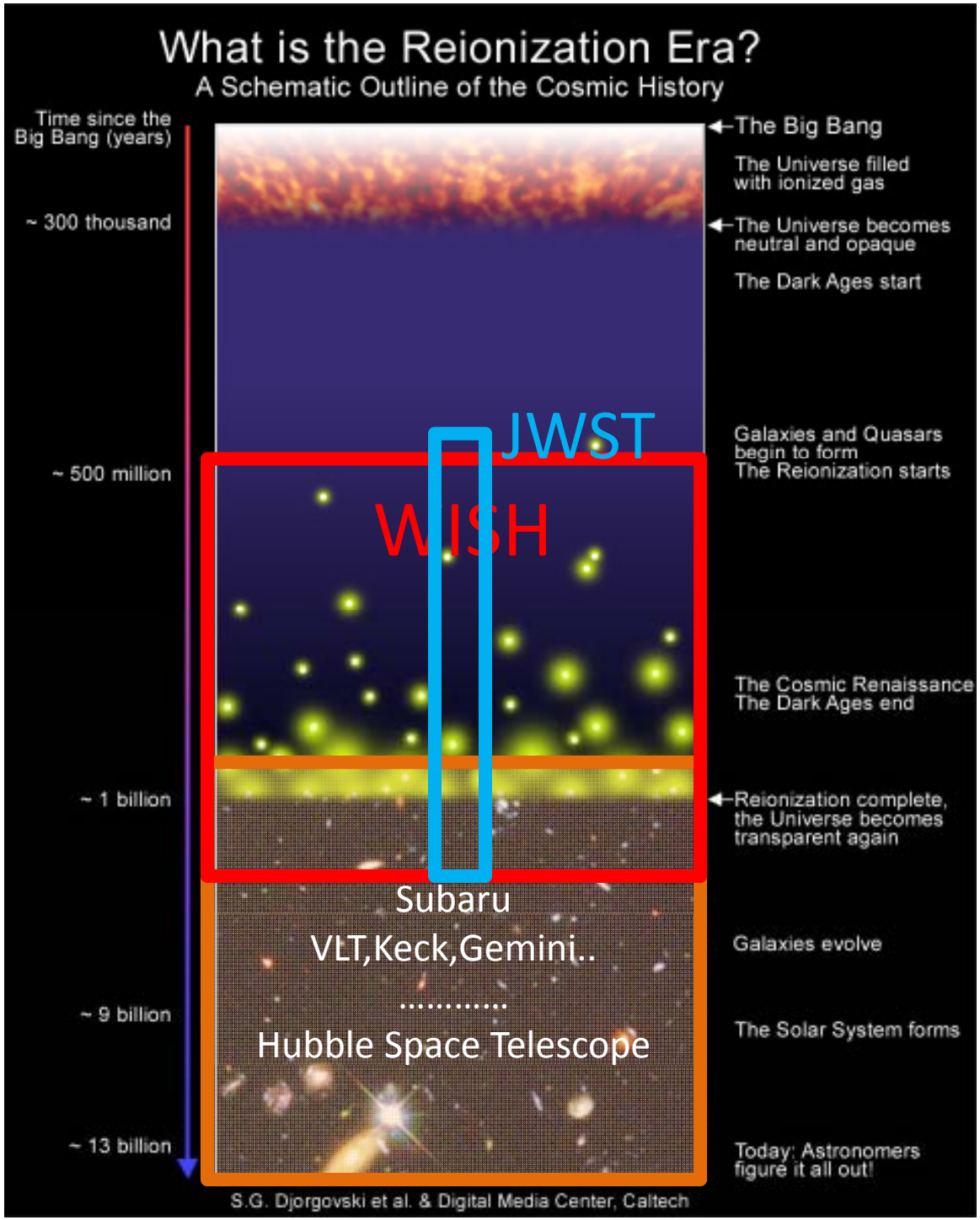


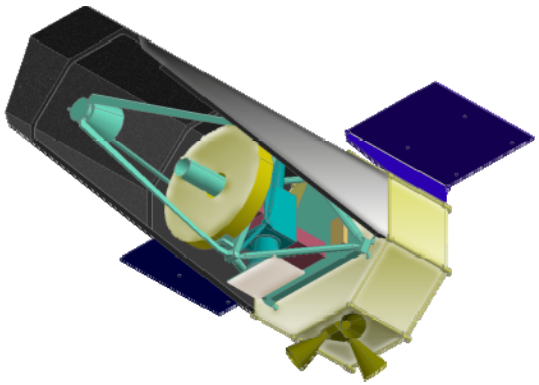
- **Exploring the Ultimate Frontier of Galaxies**
  Detection of 1st-generation galaxies and
  studying **cosmic reionization** over **z=7-15**

- **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





Redshift
z~15

Redshift
z~6

Studying High-redshift (z=7-15) galaxies

Faint

Rare

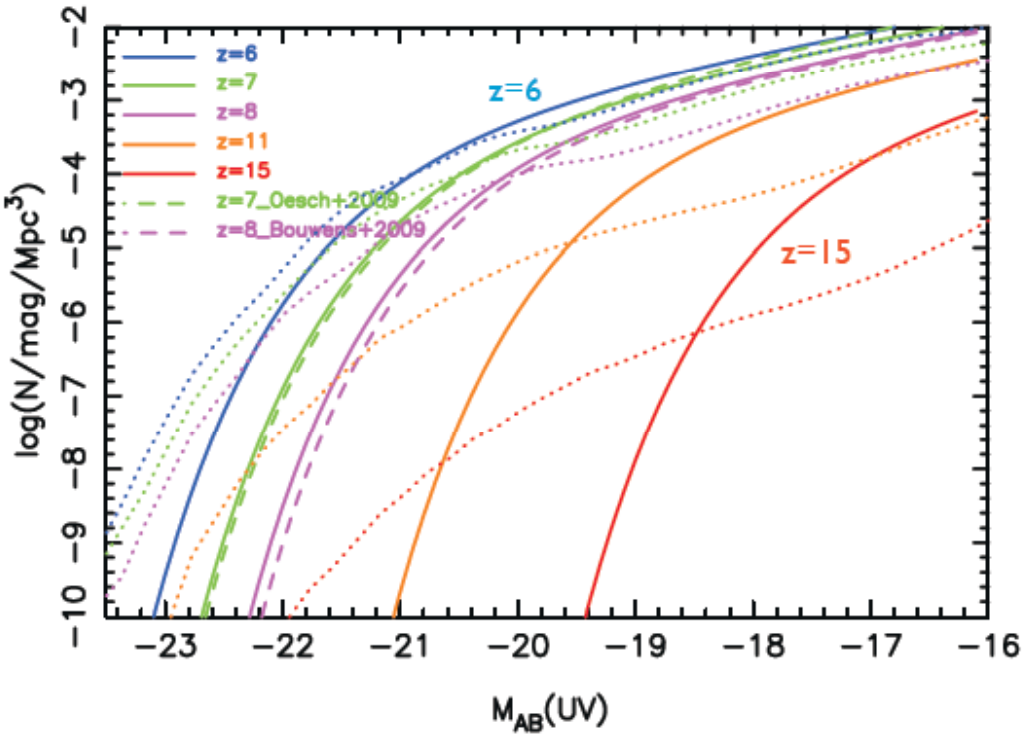
Near Infrared

➔ Space NIR Wide-field Imager

Dedicated Survey Strategy

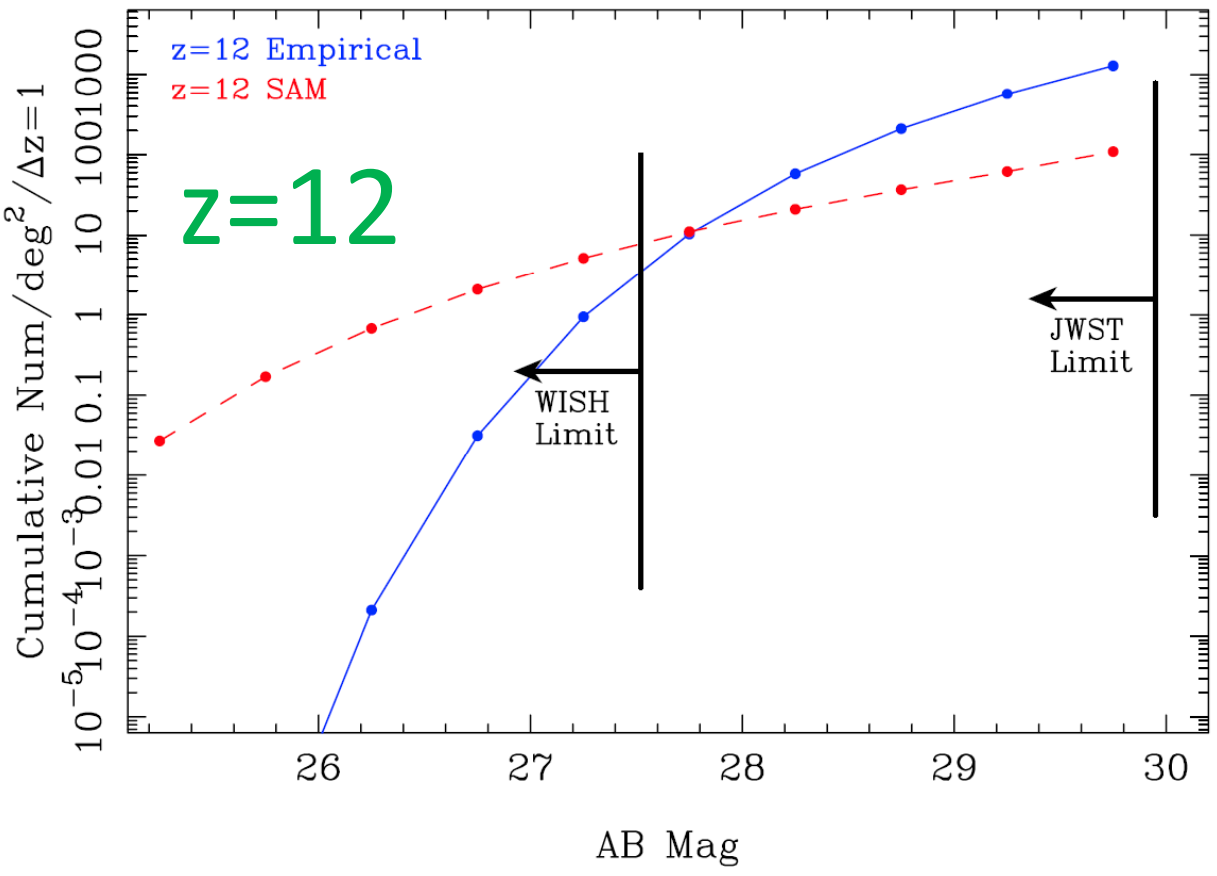
How deep, how large area should we observe?

Observed (z=6-8, HST WFC3) 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 ~ 2.8×10^{-3} deg^2

Only 0.3~3 z=12 galaxies are expected above AB~30 within NIRCam FoV

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

What is your WISH? Requirements

Limiting magnitude

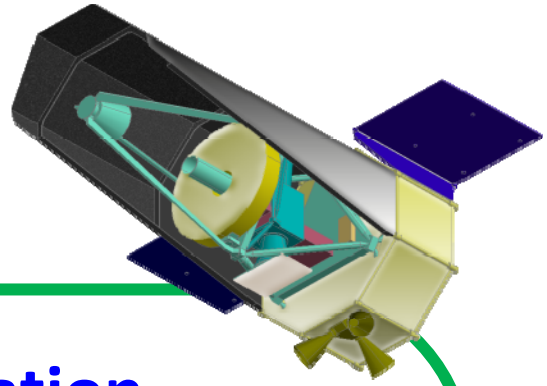
(at least) **AB~28 mag** within a reasonable amount of time

- telescope aperture 1.5m
- image size / pixel scale 0.15” / 18µm pix
  vs. diff. lim. 0.22” at λ =1.5µm
- telescope temperature ~100K
  to achieve ZL-limited observations

Field of View ~1000 arcmin^2 (0.28 deg^2)

survey speed ~2x of JWST NIRCam for extended sources such as Φ~0.2” (resolved for JWST, not resolved for WISH)

WISH Science Goals



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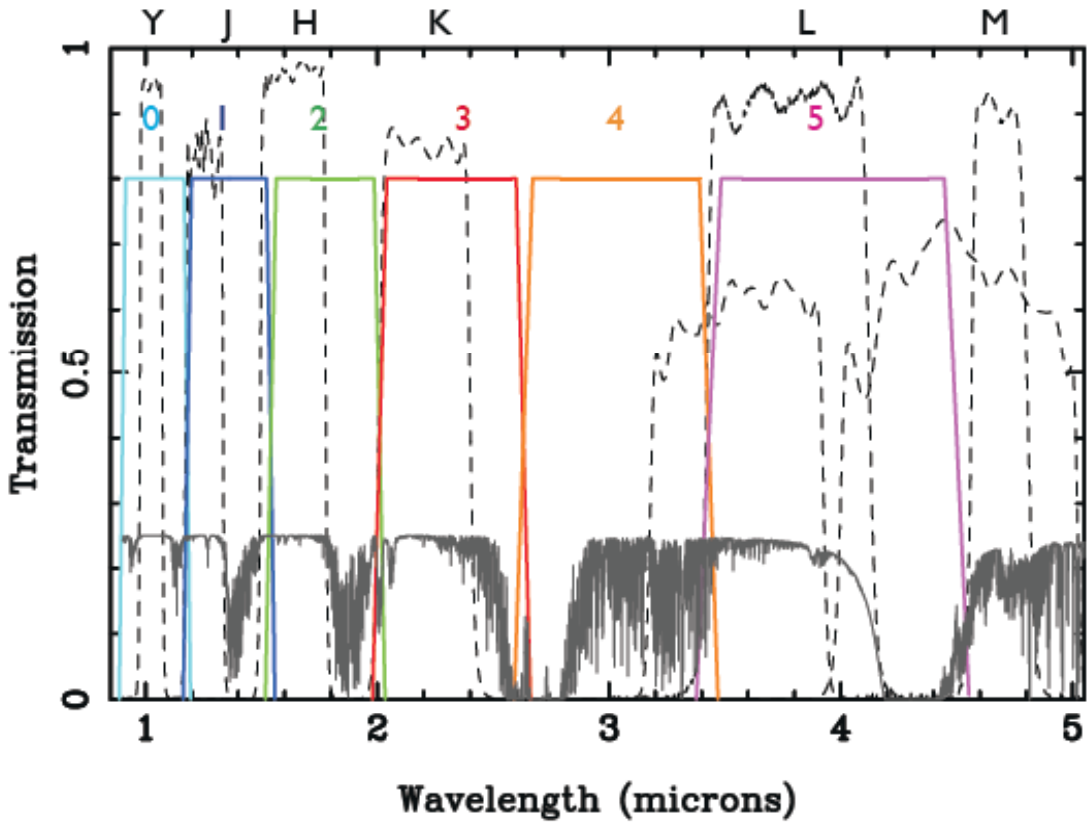
WISH: Survey Strategy

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



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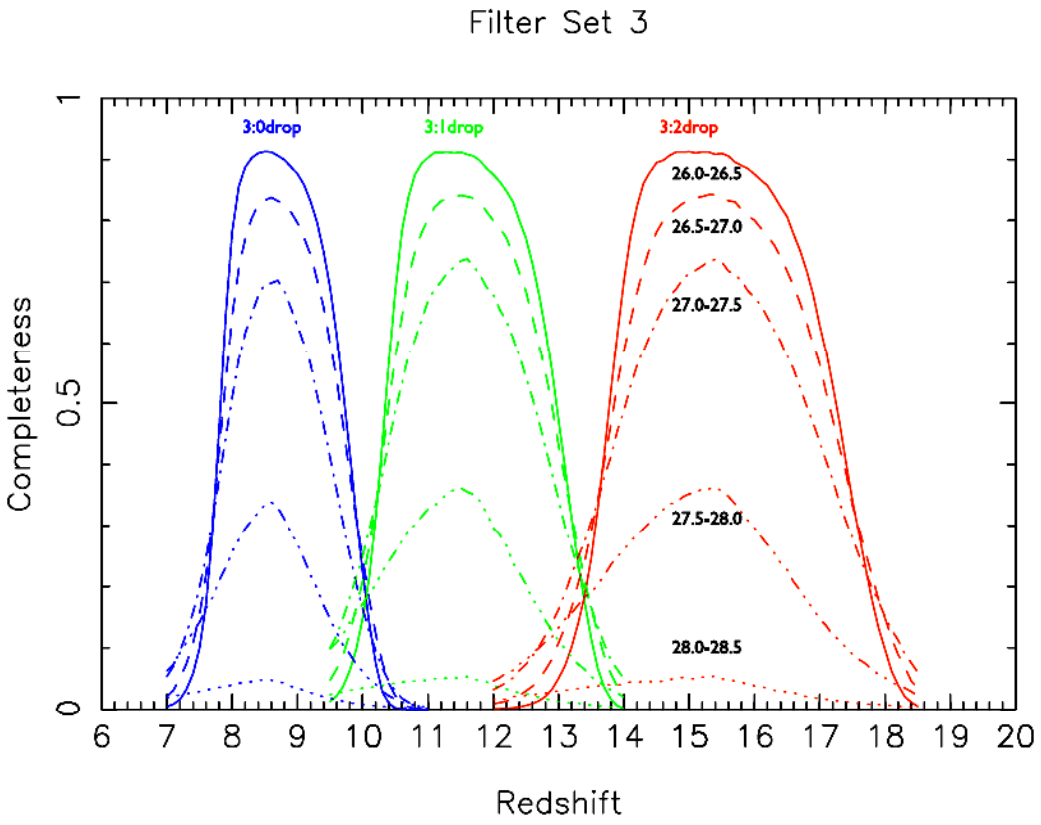
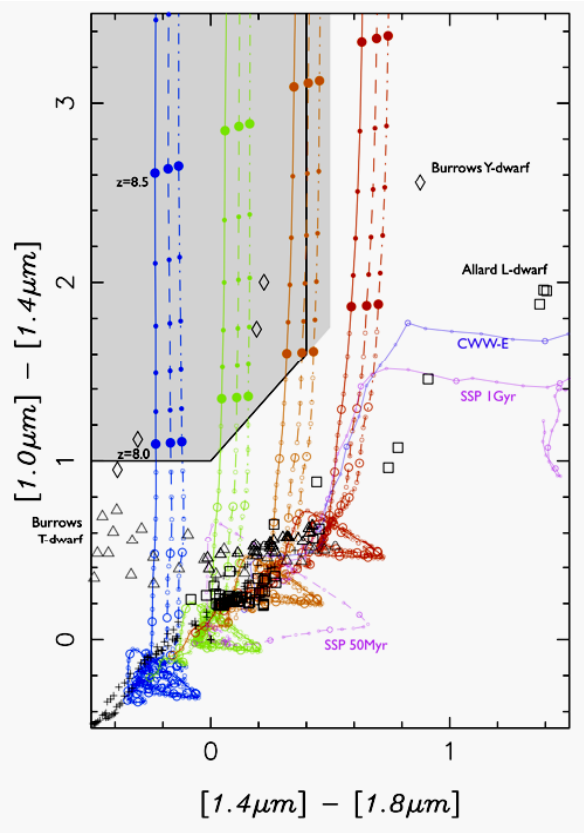
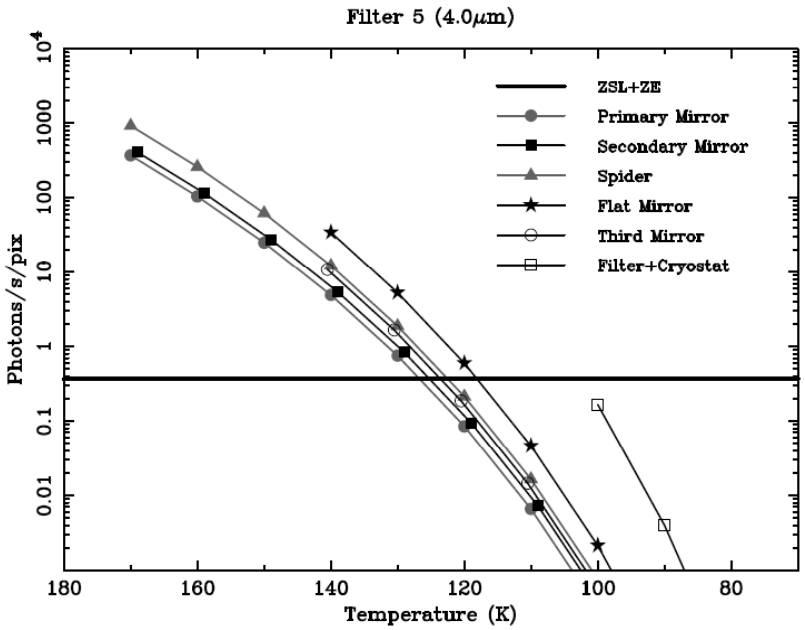
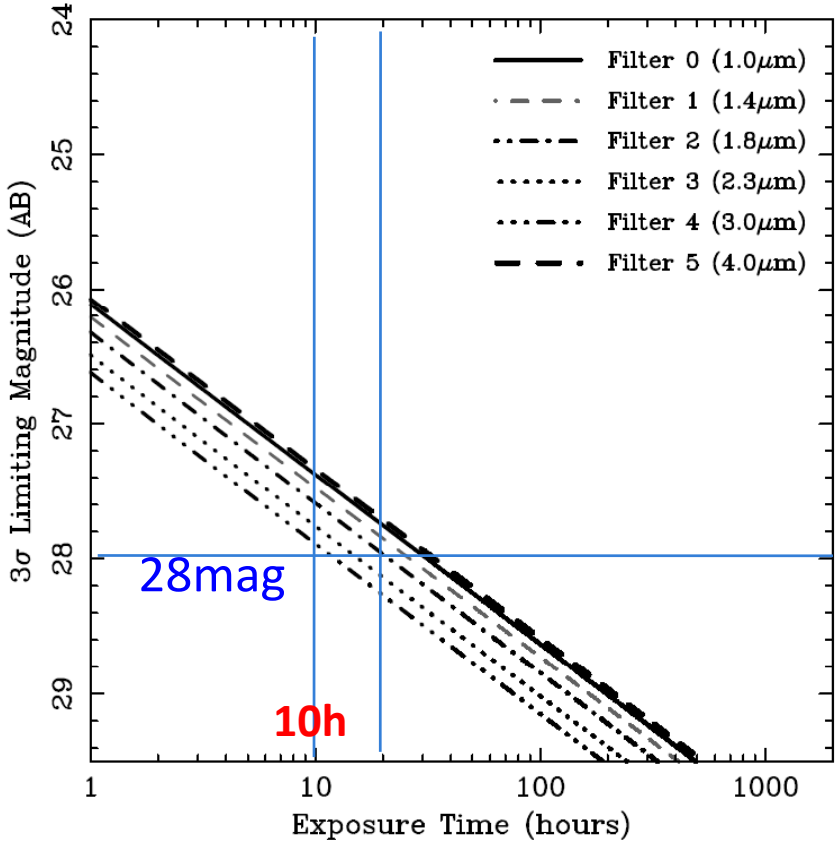




WISH: Survey Strategy

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





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: Survey Strategy

Surveys can be achieved
within ~1000 days (50% overhead)

	WISH UDS		WISH MBS	
	Filter Choice	Area (deg^2)	Filter Choice	Area (deg^2)
Plan 1	1.8, 2.3, 3.0 µm	64	1.0,1.4,4.0 µm	14
Plan 2	1.4, 1.8, 2.3, 3.0 µm	64	1.0,4.0 µm	9

+ Ultra Wide Survey (~1000 deg2 shallow)
+ Extreme Survey (~29 mag narrow field)

WISH: Survey Strategy

WISH can detect

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

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

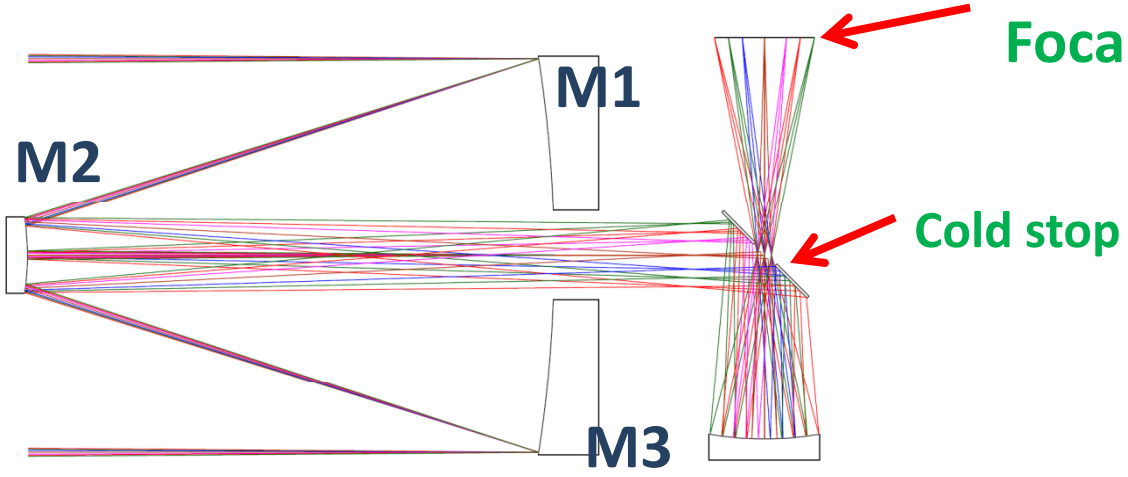
and

~50-100 galaxies at z=14-17

Many of them are feasible spectroscopic targets

WISH Development

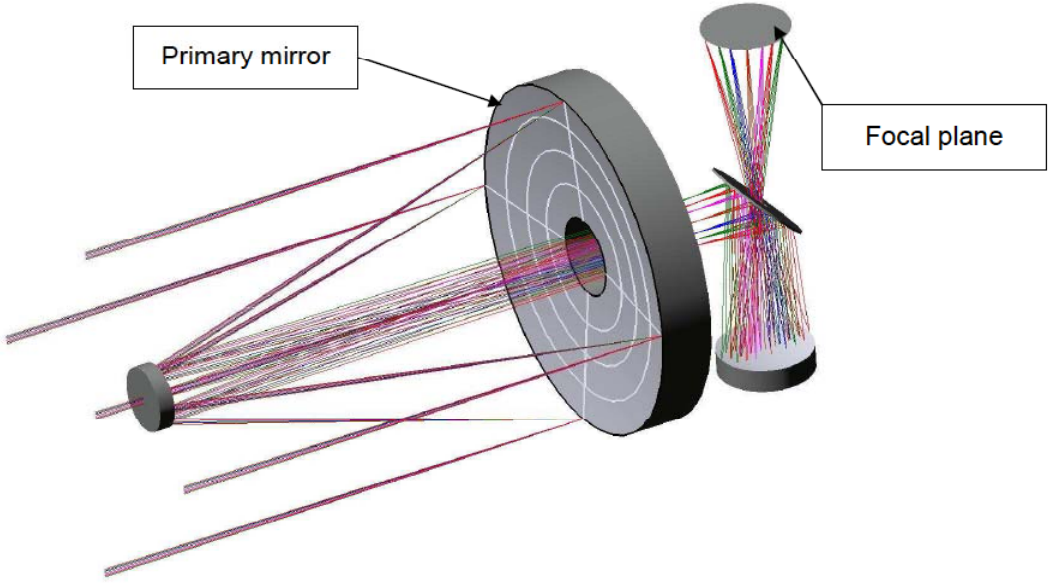
WISH Development: Optical Layout



M1: Ellipsoidal
M2: Hyperboloid
M3: Ellipsoidal

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

Yuji Ikedaet al. (photocoding)



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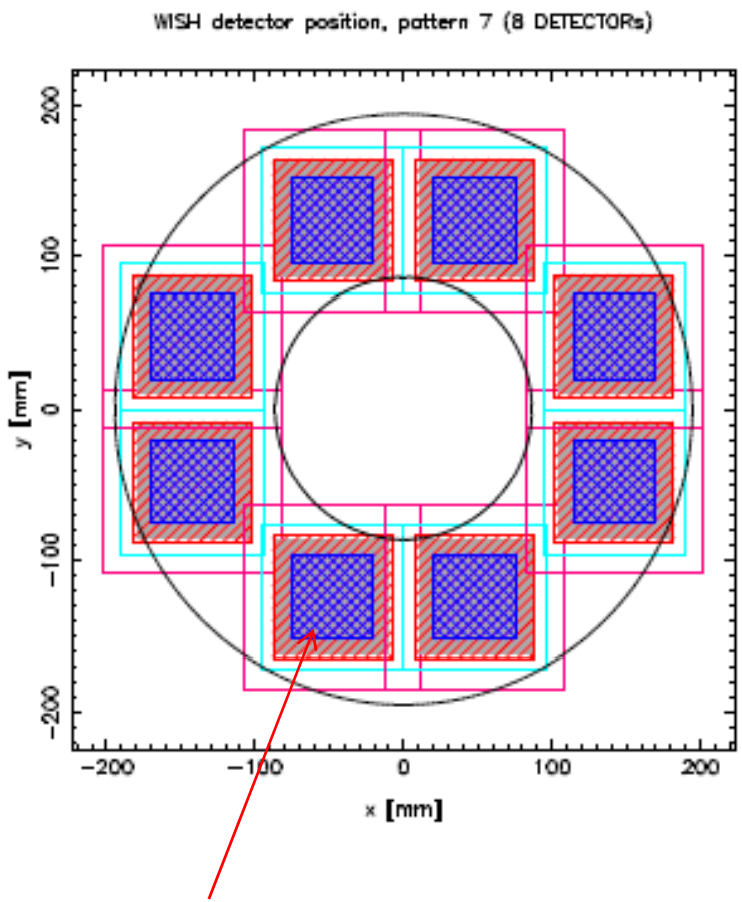
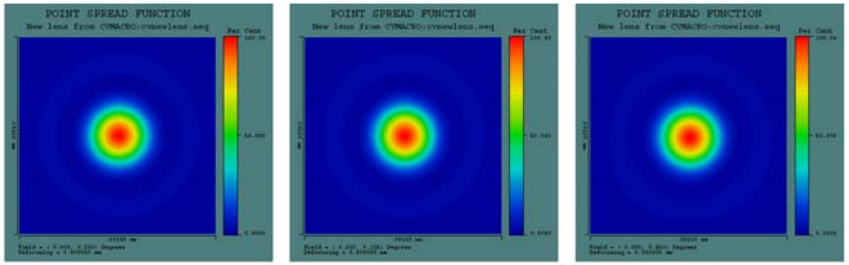


4kx4k (4 x 2k x 2k) array

Simulated Point Spread Function
at radius 0.2, 0.325, and 0.45 deg

at λ ~ 1.3µm SR> 0.99



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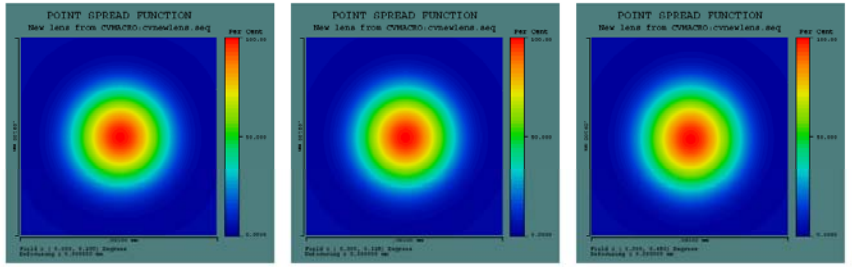
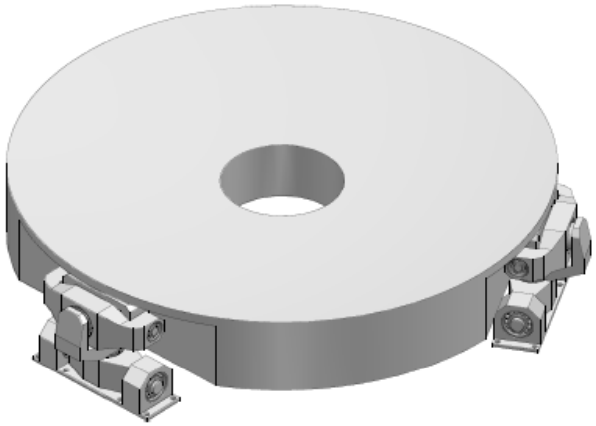
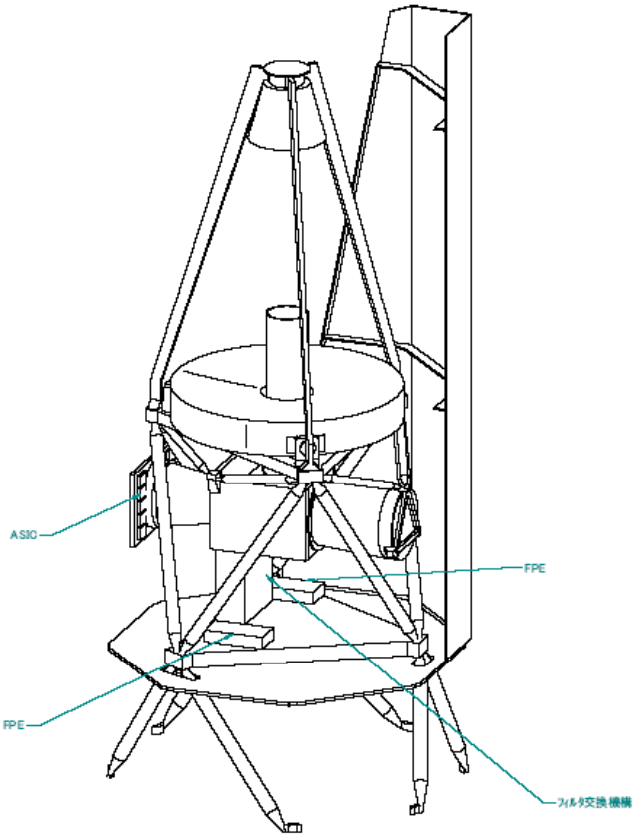


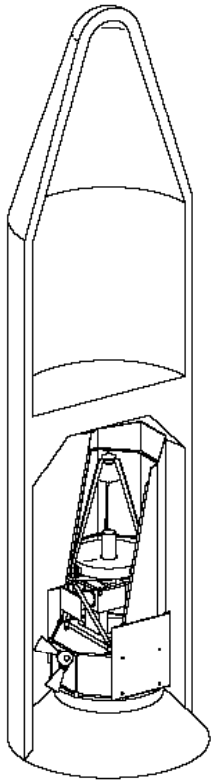
WISH Development: Telescope Structure

1.5m Primary Mirror

- ultra low-expansion glass material
-light weighted (< 200kg)



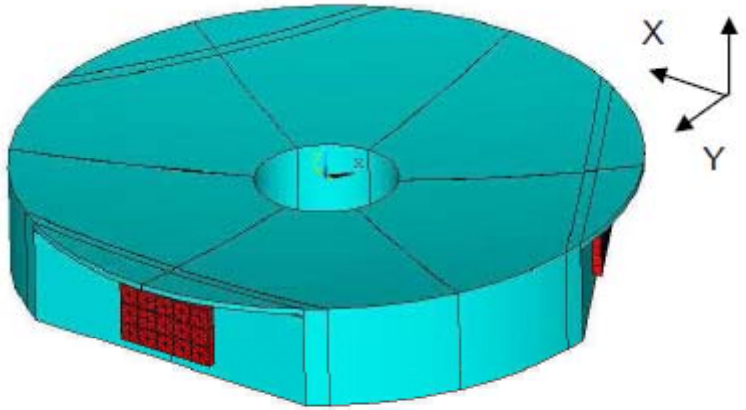




H-IIA (4/4D-LC

Supported by CFRP structure

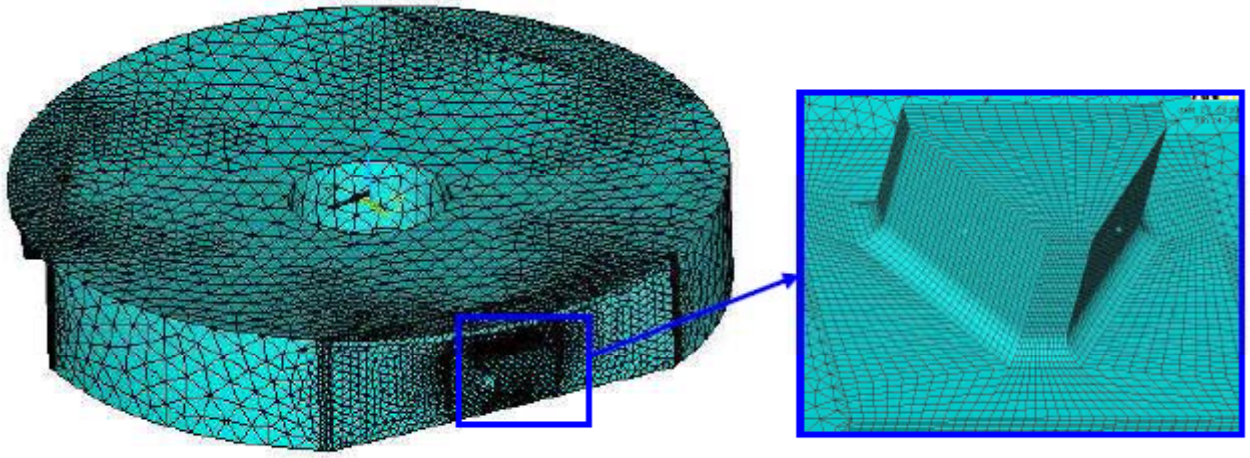
WISH Development: Telescope Structure



Global FEM

Mirror fixation
- launch load
- thermal road (to 100K)

Bonding / clumping solutions studied



w/ SAGEM

WISH Development: Filter Exchanger

Requirements:

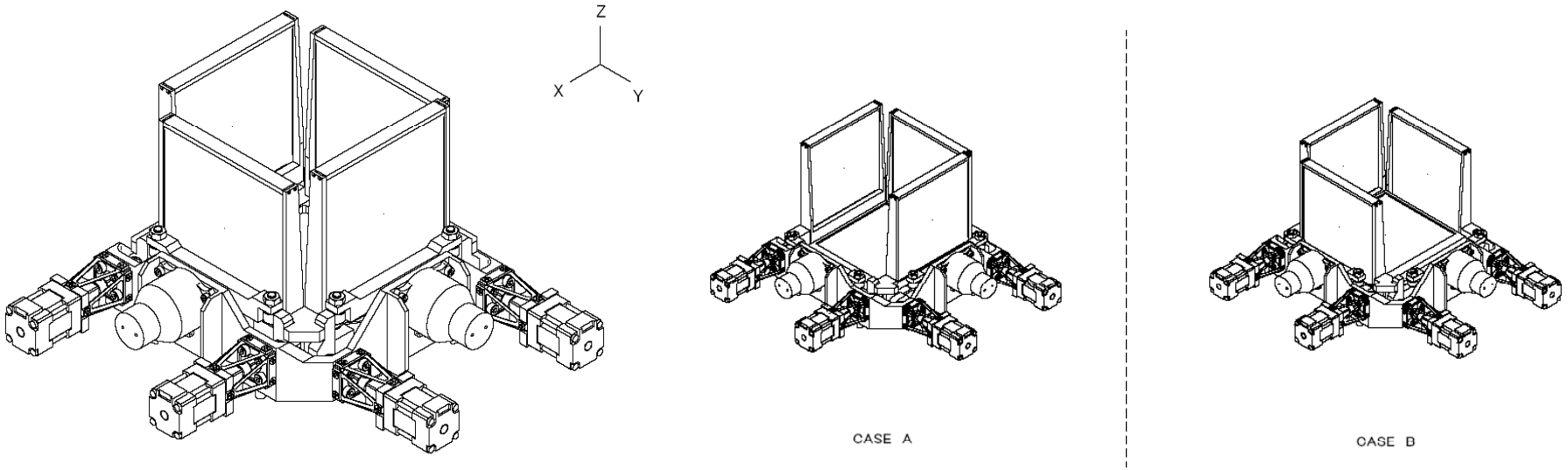
- operate more than 7 filters
  (selection of high-z galaxies)
- large-sky survey in a single filter

➔ Needs for the filter exchanger

Type	Merits/advantage	difficulties
Wheel	heritage	Large beam size, weights
Slider	works in room temperature	Lubrication at 100K
Flip	Less difficulty in lubrication	Gaps between detectors

WISH Development: Filter Exchanger

Flip-type filter exchanger

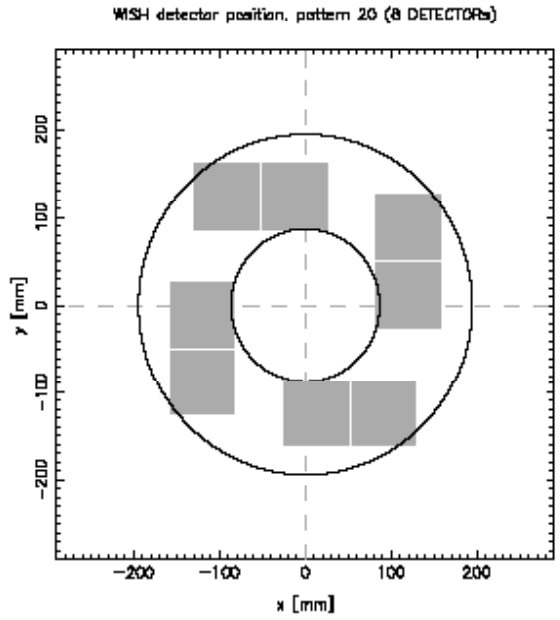


in use

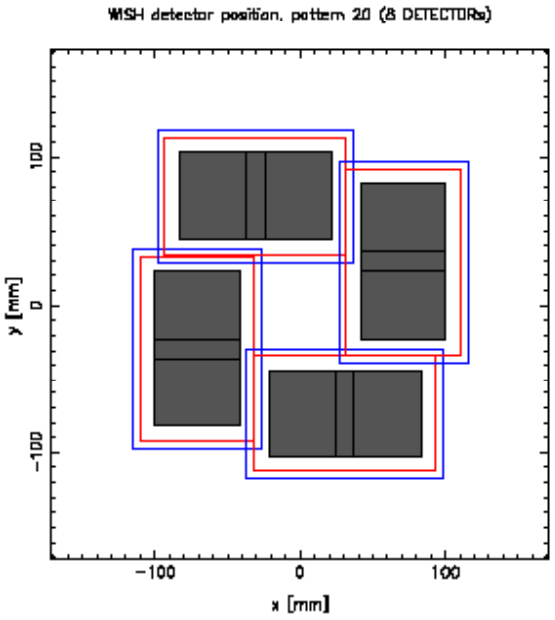
- less difficulty of lubrication at low temperature
- helps thermal design easier
- needs gaps between detectors

WISH Development: Filter Exchanger

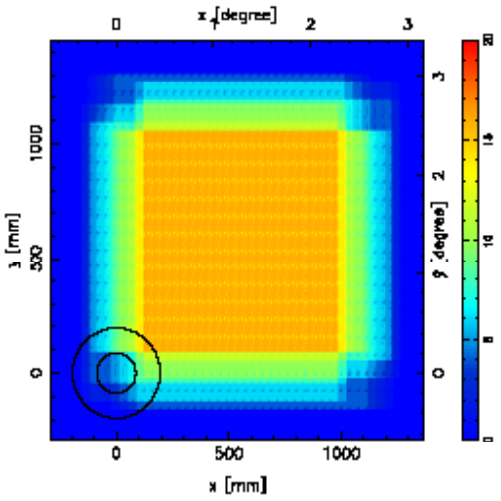
Detector Focal Plane



Filter location

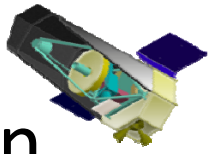


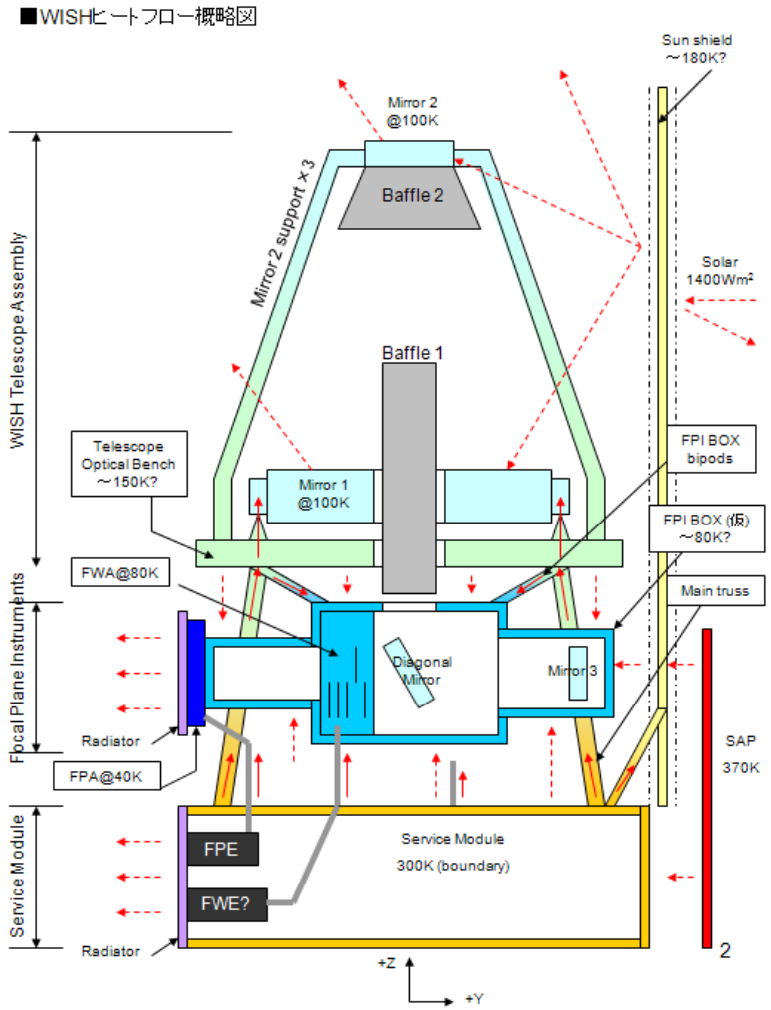
Dithering Pattern



- 1 filter exchanging unit for a two (4k x 4k) arrays
- 8 filters for 1 unit

WISH Development: Preliminary Thermal Design





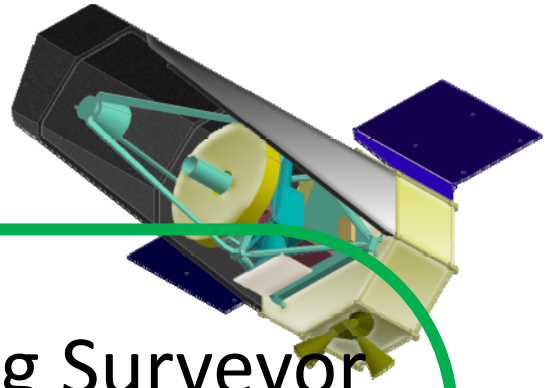
Passive cooling

- Telescope 100K
- FPI Box 80K
- Detector 40K (radiator)

Preliminary Thermal Design On-going

	achieved	requirement
M1	79K	~100K
M2	132K	~100K
FPI BOX	95K	~80K

Summary



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