WISH upon a first galaxy:
Wide-Field Imaging Surveyor for High Redshift

wishmission click

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WISH is a newly proposed space science mission whose primary goal is to reveal the first-generation galaxies in the early young universe. We launch a 1.5m-aperture telescope equipped with ~1000-arcmin^2 wide-field NIR camera by middle/late 2010's in order to conduct ultra-deep and wide-area sky survey with the depth that cannot have been achieved by previous ground-base telescopes. WISH should be a very powerful and unique facility not only for the search for first-generation objects but also for study of dark energy, and many other fields in astronomy.

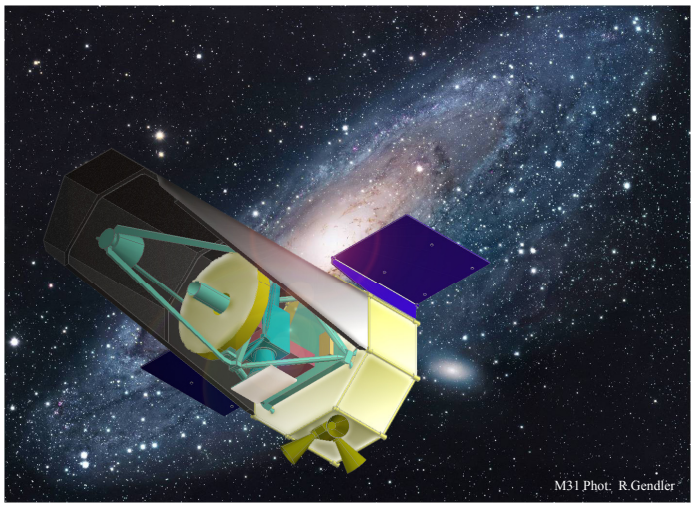
Development of the mission concept including the Preliminary Design of the Optical Layout, Optical Elements, Telescope Structure, Filter-exchanging System, Filters, and FPA Assembly is being proceeded under the JAXA/ISAS WISH Working Group (PI:Toru Yamada).

I. WISH: Wide-field Imaging Surveyor for High-redshift

- Unique new **Deep and Wide-area** space mission in **NIR wavelength** (1-5μm)
- **Exploring the early universe** in the era of reionization to study the 1st generation of galaxies
  → **Ultimate frontier in the history of galaxies**
- **1.5m Primary Mirror, Wide field (~1000 sq. arcmin)**
  Dedicated , Single-task Facility with Simple optics
- **Complementary** with TMT (ELTs), JWST, SPICA, Subaru [HSC]

Survey	Limiting mag.	Number of Filters	Area
Ultra Deep Survey	28 AB	3	100 deg^2
Multi-Band Survey	27-28 AB	5	Sub WISH-UDS
Ultra Wide Survey	24-25 AB	2-3	1000 deg^2

WISH Survey Plan

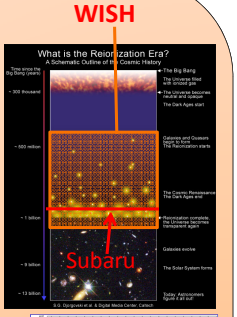


II. WISH Science Goals

[1] Discovery of the First Generation Objects in very distant and early universe.

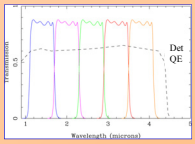
[2] Study of the expansion history of the universe and properties of dark energy by using type-Ia supernovae luminosity at rest-frame NIR wavelength

[3] Extensive study of galaxy formation and evolution utilizing the unique wide-area NIR observations



Expected number of the detected 1st Gen galaxies (in WISH-UDS)
galaxies brighter than 27AB in their rest-frame UV light
(A)No Evolution from z=7 (LF at z=6-7)
(B) Evolution: 1.0-mag luminosity evolution from z>7
(C) Evolution: Proportional to the DM halo evolution
(D) Prediction by a Semi-Analytic Model (Kobayashi, M. WISH SW)

Redshift	(A)	(B)	(C)	(D)
z=7-8	220,000	←	54,000	160,000
z=8-11 (J-drop)	180,000	26,000	1,100	60,000
z=11-14 (H-drop)	68,000	6,300	0	1,000



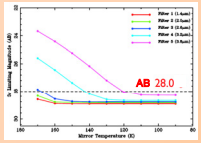
Tentative plan for the WISH band-pass filters

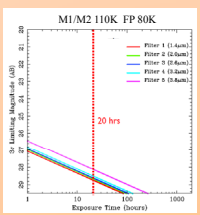
A lot of new exciting science cases were proposed and discussed in WISH Science-WS (2009/04,Japan), including Galactic structure, Exo-planets, Solar system Objects, etc.

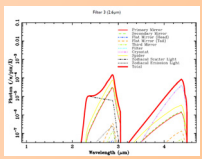
III. WISH Specifications & Sensitivity

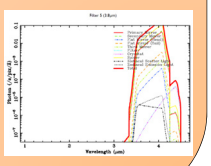
ITEM	Comments
Telescope	
Primary Mirror Diameter	1.5m, 80-100K
Wavelength	1-5μm
Field of View	~1,000 arcmin^2 (or 35' diameter)
Focal Plane Temperature	<80K, Passive Cooling
Wide-Field Near-IR Camera	
Detector	HgCdTe (18μm/pixel is assumed)
Sampling	0.15"/pix
Operation Temperature	40K, Passive Cooling
Filters	5 broad-band filters covering 1μm to 5μm, Narrow-band filters or slitless spectroscopy (TBD)
Spacecraft / Launcher	
Orbit	SE-L2
Rocket	HII-A
Total Weight	1.3t (matched to HII-A dual launch)
Others	
Mission Lifetime	~5 years

The limiting magnitude is calculated considering the ZL and thermal background from various components.



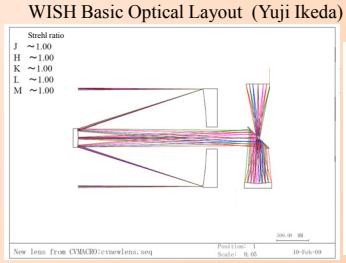


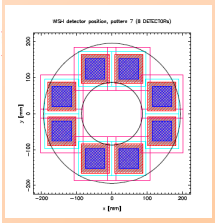




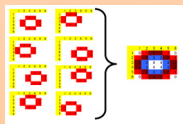
IV. WISH Development

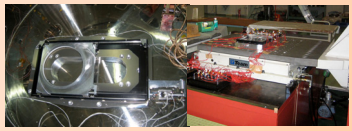
WISH Basic Optical Layout (Yuji Ikeda)



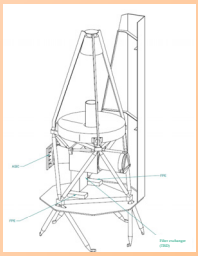


A design of focal plane layout and an example of survey matrix



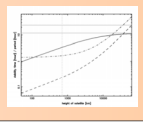


Large-area filter exchange system (warm test for sliding system)

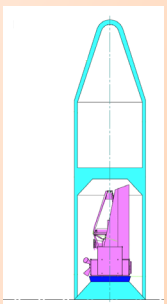


Heritage of the Hinode 50cm Mirror

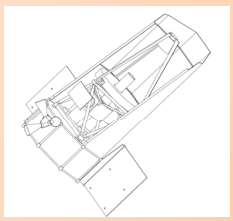
Data production rate r_{DG}	3-4 [Mbps]
Data Downlink rate r_{DL}	<10.0[Mbps]



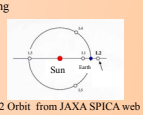
V. WISH Launcher, Orbit, Spacecraft



HIIA rocket is assumed for the Launcher. WISH fits for HIIA Dual Launch



Sun-Earth L2 Orbit is selected for realizing the stable temperature environment for passive cooling



S-E L2 Orbit from JAXA SPICA web page

Weight budget

Mission Instrument	Telescope	M1, M2, lenses	320.0
		Support structures	82.0
		Optical bench	27.0
	Focal Plane Arrays		120.0
	Thermal controls	Sun Shield	52.0
		Radiator	60.0
	Mechanical Cooler		0.0
			661.0
Bus	Battery	Solar Panels	19.0
		others	33.0
	Data Communication Systems		30.3
	Data Analysis Systems		24.3
	Pointing Systems		93.9
	Thruster Systems		82.0
	Body		158.0
	Thermal Control Systems		20.0
	Others		3.0
	Electronics Systems		30.0
			493.5
Dry Weight			1154.5
Fuel			120.0
Weigh at Launch			1274.5