

# Infrared Space Telescope GREX-PLUS 赤外線宇宙望遠鏡GREX-PLUS

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On behalf of the GREX-PLUS WG

# 1. Summary of the proposal

- GREX-PLUS is a candidate of the ISAS/JAXA's Strategic L-class mission in the 2030s to conduct super wide-field imaging in the wavelength range of 2 to 8  $\mu\text{m}$  for surveys of bright, first galaxies.
  - High resolution spectroscopy in wavelengths of 10-18  $\mu\text{m}$  is an optional capability for revolutionary studies, especially in planetary sciences.
- We hope to have strong supports from NAOJ, as the center of Japanese astronomy.
  - Support for the GREX-PLUS/WFC Japan Team and testing efforts of the telescope and instruments by ATC (+JASMINE+ULTIMATE-WFI)
  - Importing the GREX-PLUS imaging data to the multi-wavelength science platform by ADC
  - Producing world-leading science outputs by DoS

## 2. Science goals

- Space Science and Exploration Roadmap by ISAS/JAXA

『宇宙科学・探査ロードマップ』 2022年4月6日 C改訂

- “Understanding the origin of space and matter in the Universe”  
「宇宙の空間と物質の起源の理解」
- “Exploring the possibility of life in the Universe”  
「宇宙における生命の可能性の探求」

→ Two Science Goals (SGs)

**SG1 | Elucidating the formation and evolution of galaxies**

**銀河形成進化の解明**

**SG2 | Elucidating the formation and evolution of planetary systems**

**惑星系形成進化の解明**

# 3. Scientific objectives

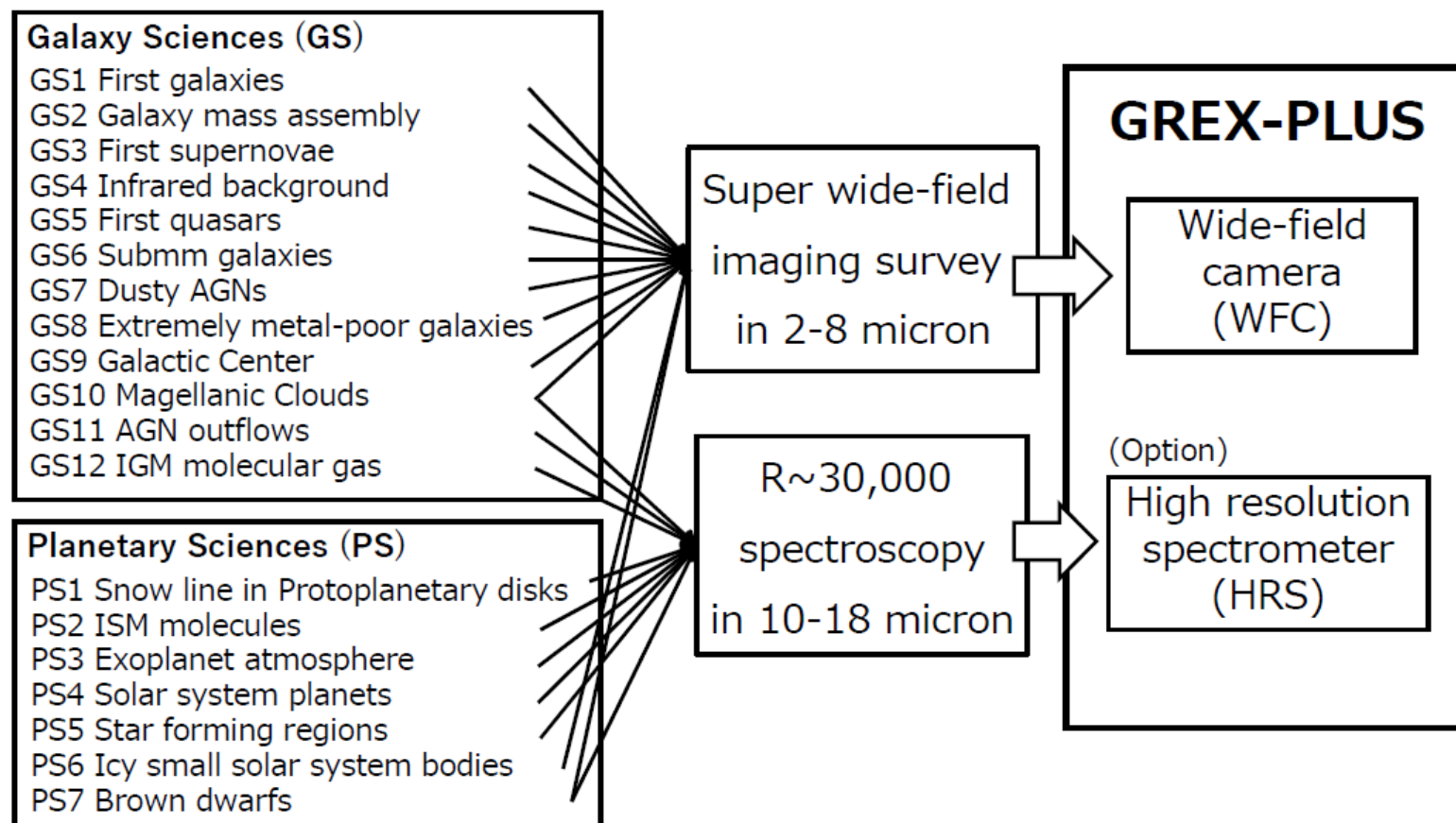
See GREX-PLUS Science Book ([arXiv:2304.08104](https://arxiv.org/abs/2304.08104)) more in detail.

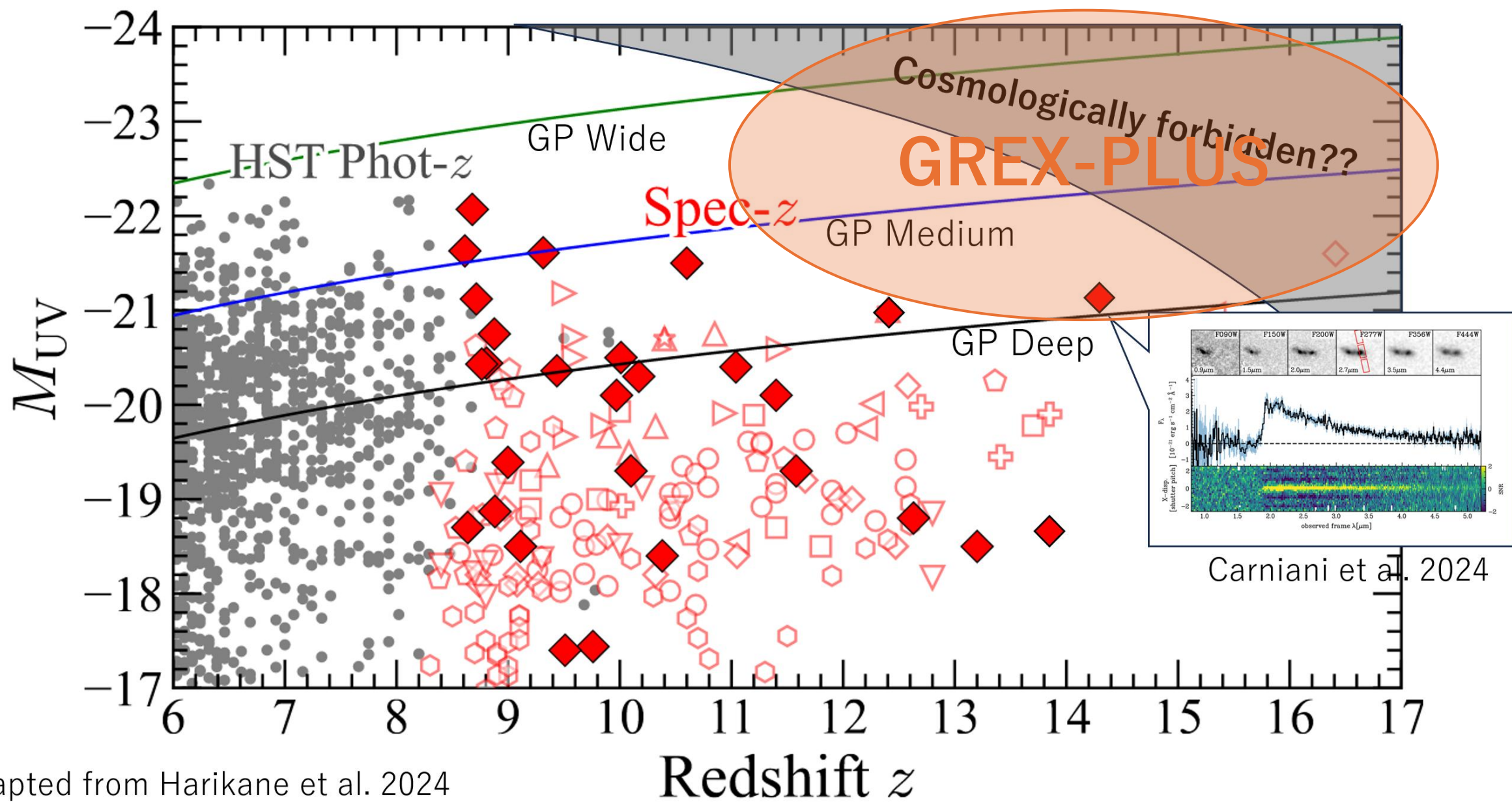
SG1 →

Galaxy Sciences  
(GS)

SG2 →

Planetary Sciences  
(PS)





Adapted from Harikane et al. 2024

2024/12/4

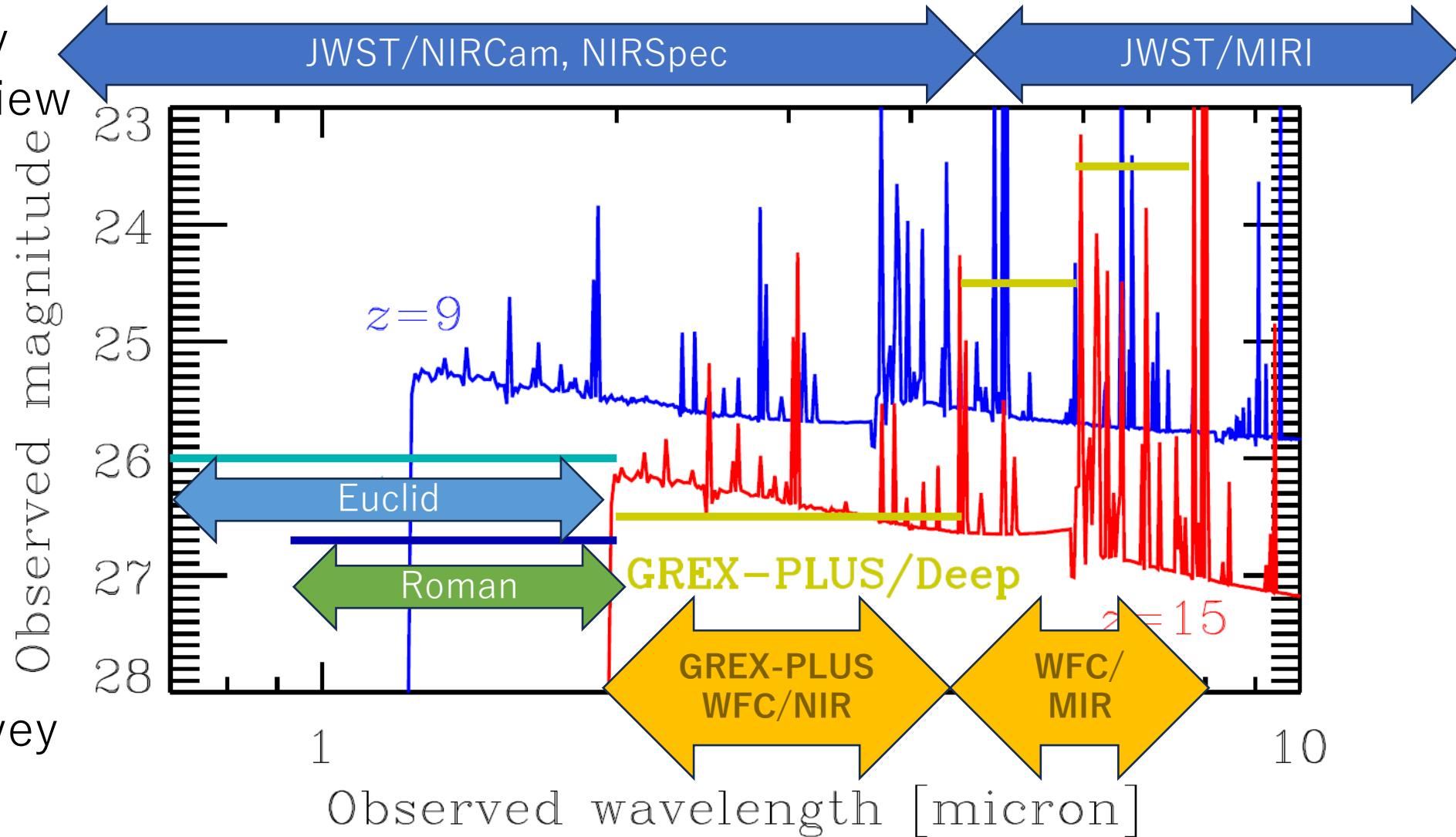
Proposal for NAOJ Science Roadmap

# Advantages over JWST, Euclid, & Roman

Super high sensitivity  
but narrow field-of-view

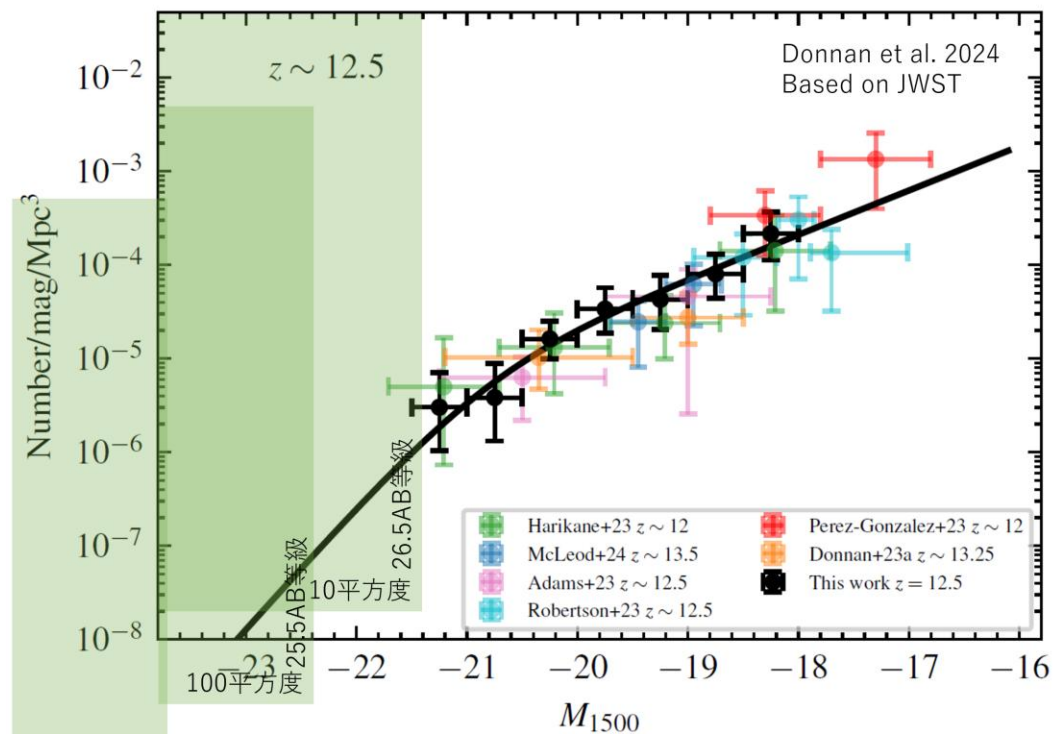
To find rare bright,  
massive galaxies

Super wide-field survey

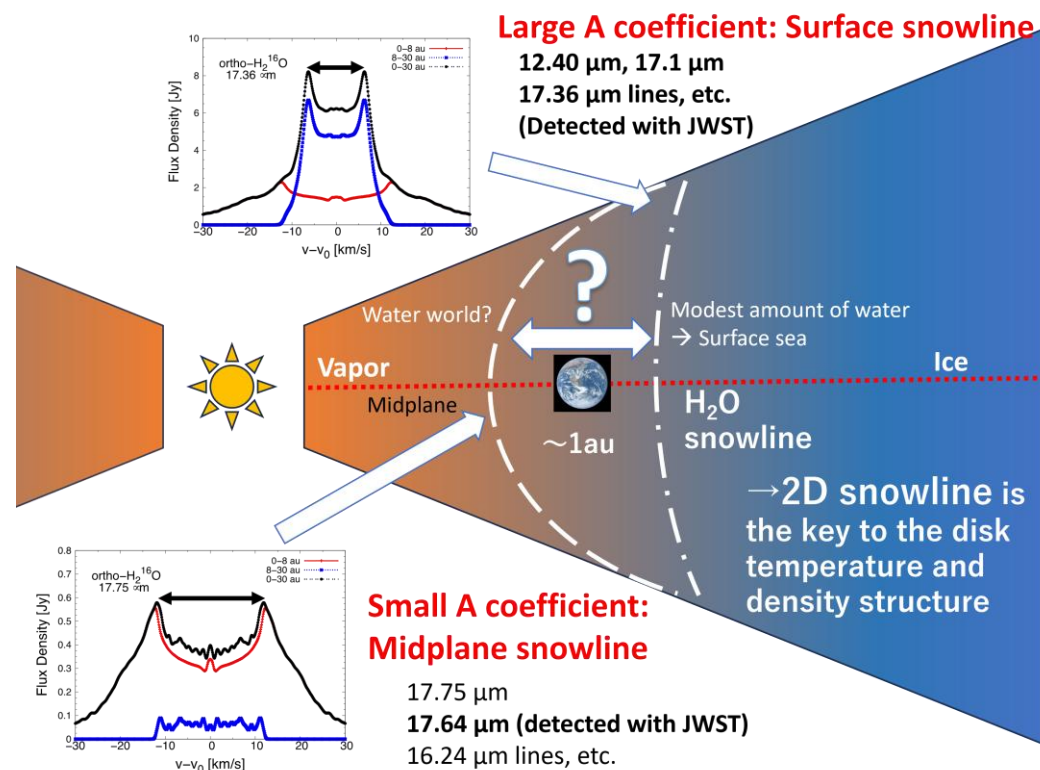


# 4. Science investigations

SG1 > GS1 “First galaxies”  
Measuring UV luminosity functions



SG2 > PS1 “Snowline in PPDs”  
Identifying the snowline position



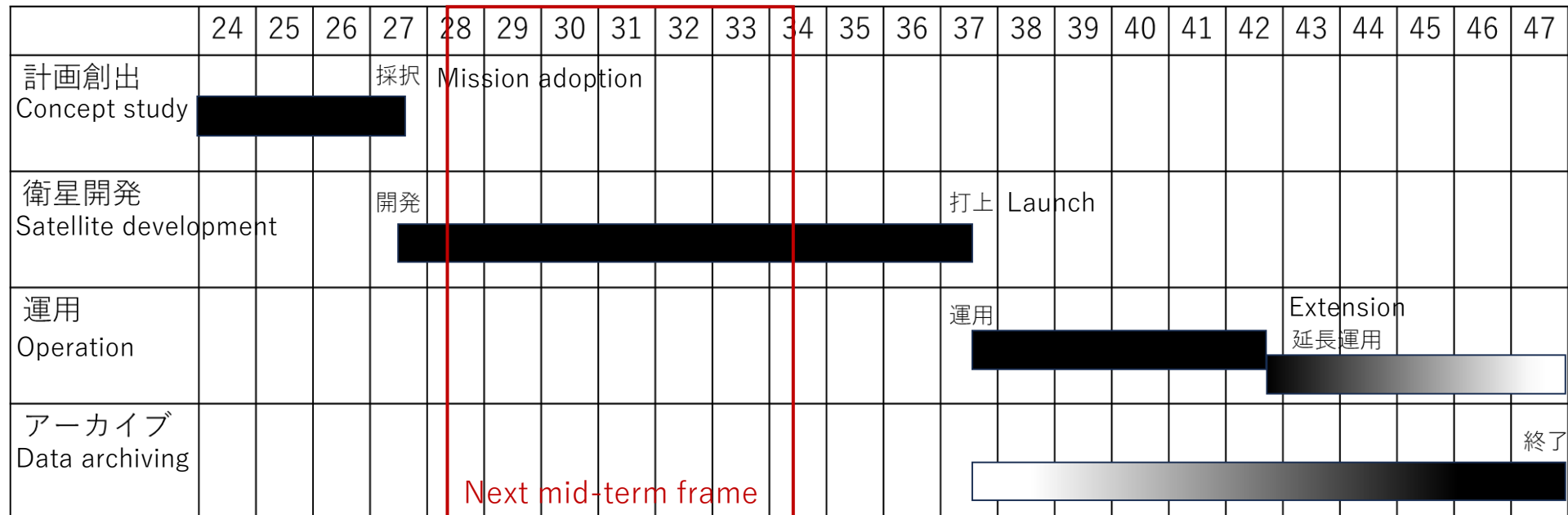


## 4.1 Science investigations until 2033

- Development of the satellite system (JAXA+NAOJ/ATC)
- Preparation of the data analysis and archive (JAXA+NAOJ/ADC)

## 4.2 Science investigations beyond 2034

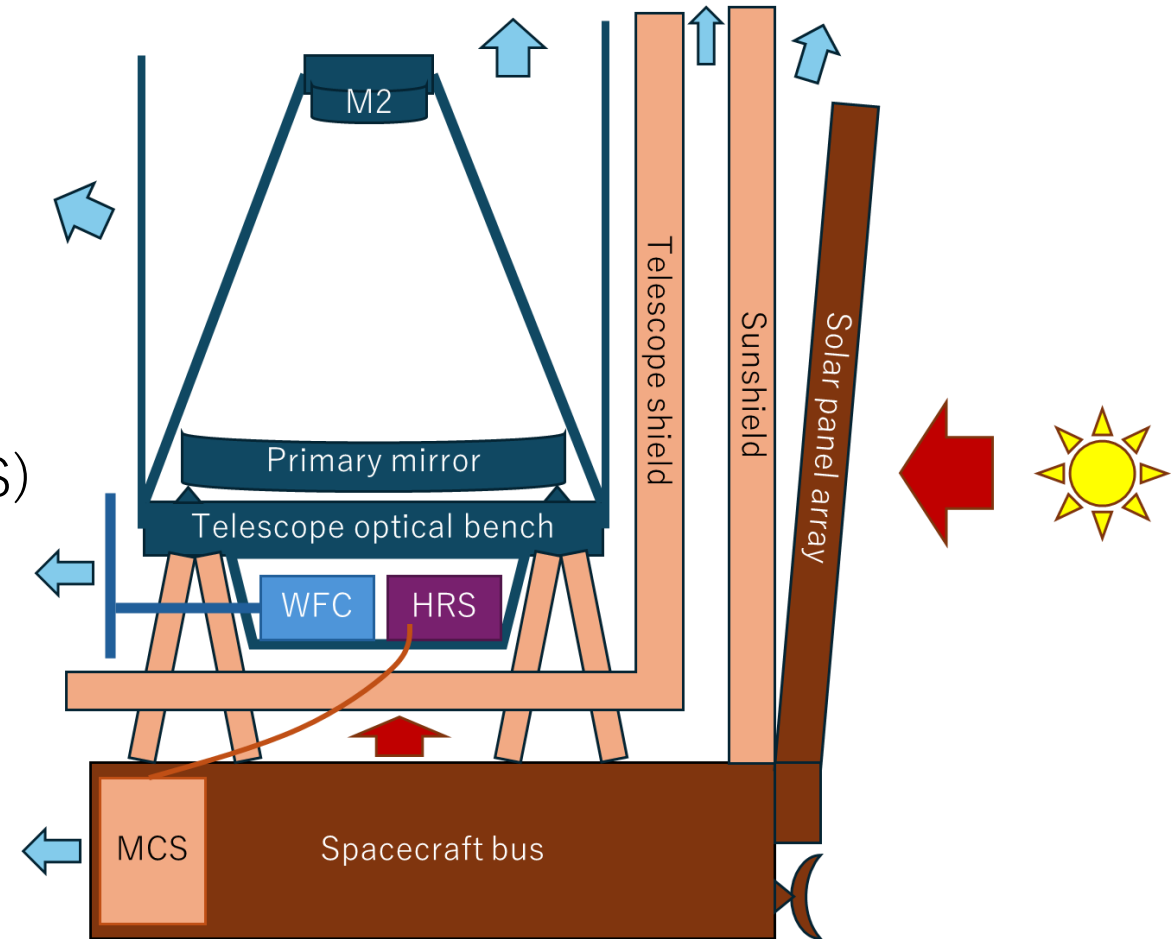
- Continue the above two until the launch, and then,
- Production of scientific outcomes (NAOJ/DoS+OIR Community)
- Observational data archive (JAXA+NAOJ/ADC)





# 5. Instruments and data to be returned

- Telescope
  - $\Phi$  1.0 m
  - $\lambda = 4 \mu\text{m}$  diffraction limited
  - Korsch 3 mirror system
  - $T < 50\text{K}$
- Wide-Field Camera (WFC)
  - FoV 1,792 arcmin<sup>2</sup>
  - NIR 3 bands: F232, F303, F397
  - MIR 2 bands: F520, F680
- (Option) High-Resolution Spectrometer (HRS)
  - $\lambda = 10\text{-}18 \mu\text{m}$
  - $R > 25,000$
- Cooling system
  - Radiative cooling for Telescope and WFC/NIR
  - Mechanical coolers for WFC/MIR and HRS
- Orbit: Sun-Earth L2
- Nominal lifetime: 5 years



# 5. Instruments and data to be returned

- Wide-Field Camera Surveys
  - Deep, Medium, & Wide surveys
  - Magellanic Clouds campaign
  - Galactic Center campaign
- (Option) High-Resolution Spectroscopy
  - “Snowline” observations for >300 PPDs
  - Interstellar hydrocarbon spectroscopy
  - Transit spectroscopy of hot Jupiters
  - Titan atmosphere spectroscopy
  - AGN outflow observations
  - DLA H2 and CMB temperature measurement

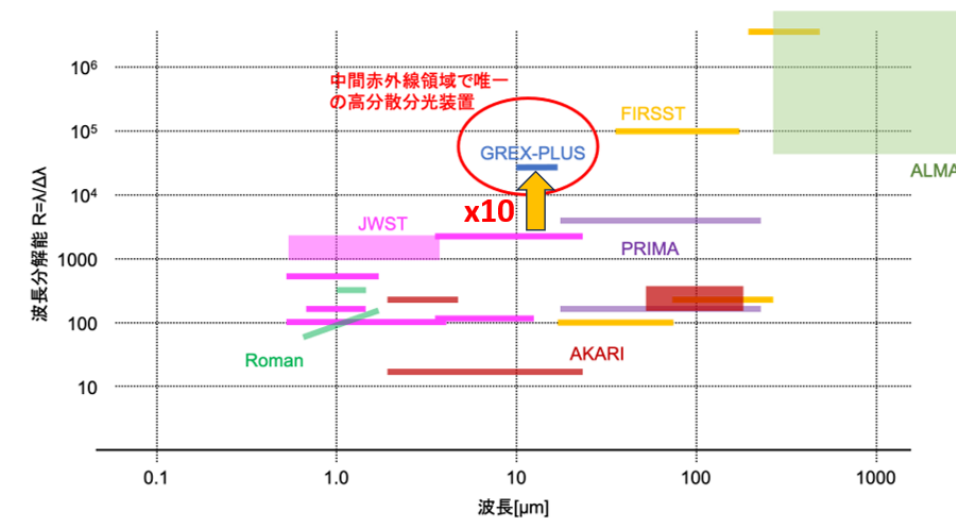
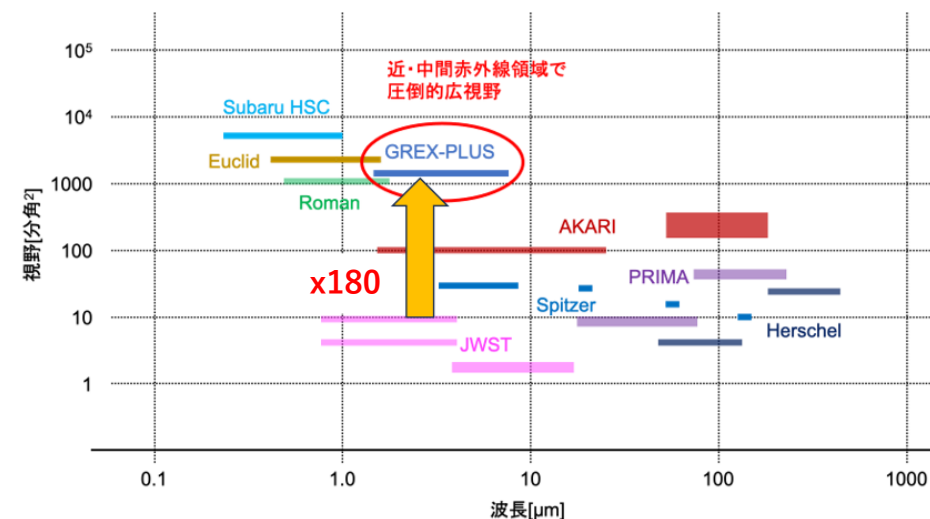
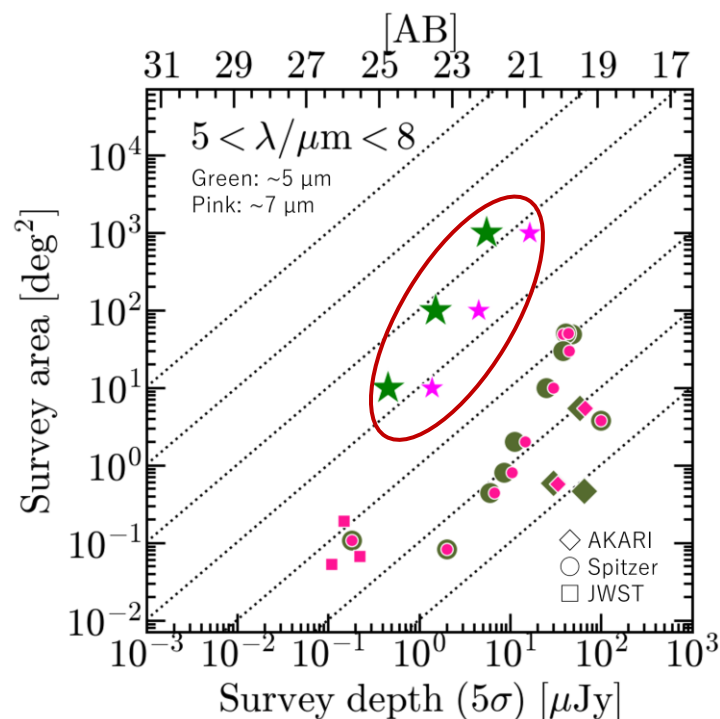
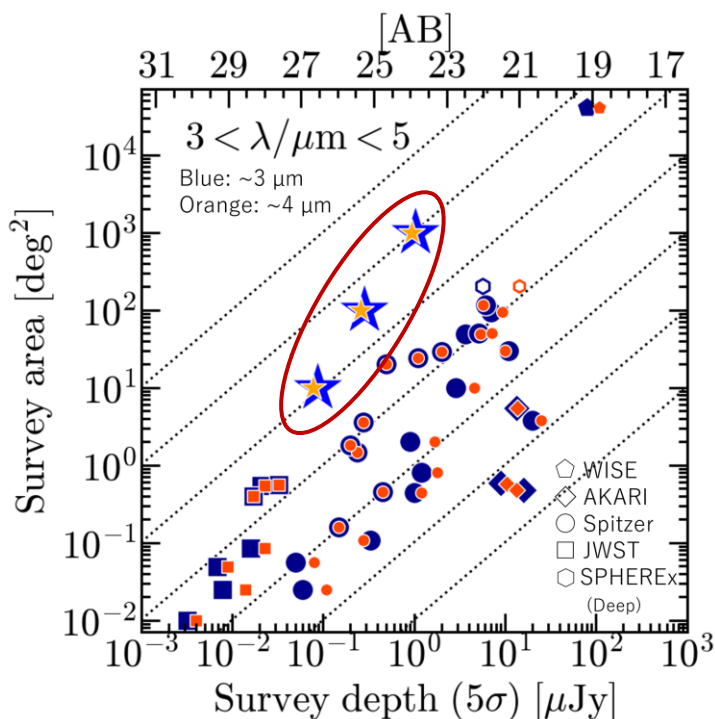
	Deep	Medium	Wide
Area [deg <sup>2</sup> ]	10	100	1,00
F232 [ABmag]	26.5	25.5	24
F303 [ABmag]	26.5	25.5	24
F397 [ABmag]	26.5	25.5	24
F520 [ABmag]	24.5	23.5	22
F680 [ABmag]	23.5	22.5	21

## 4.3 Threshold Science

60 deg<sup>2</sup>, 25.5 AB in F232, F303, F397 (NIR)  
100 times wider area than the current  
JWST widest survey (COSMOS-Web).

## 6. Originality and international competitiveness

- Unique observational capabilities
  - WFC FoV  $\sim 1,800$  arcmin<sup>2</sup> in  $\lambda > 2 \mu\text{m}$
  - HRS R  $\sim 30,000$  in  $10 < \lambda / \mu\text{m} < 18$



## 7. Current status

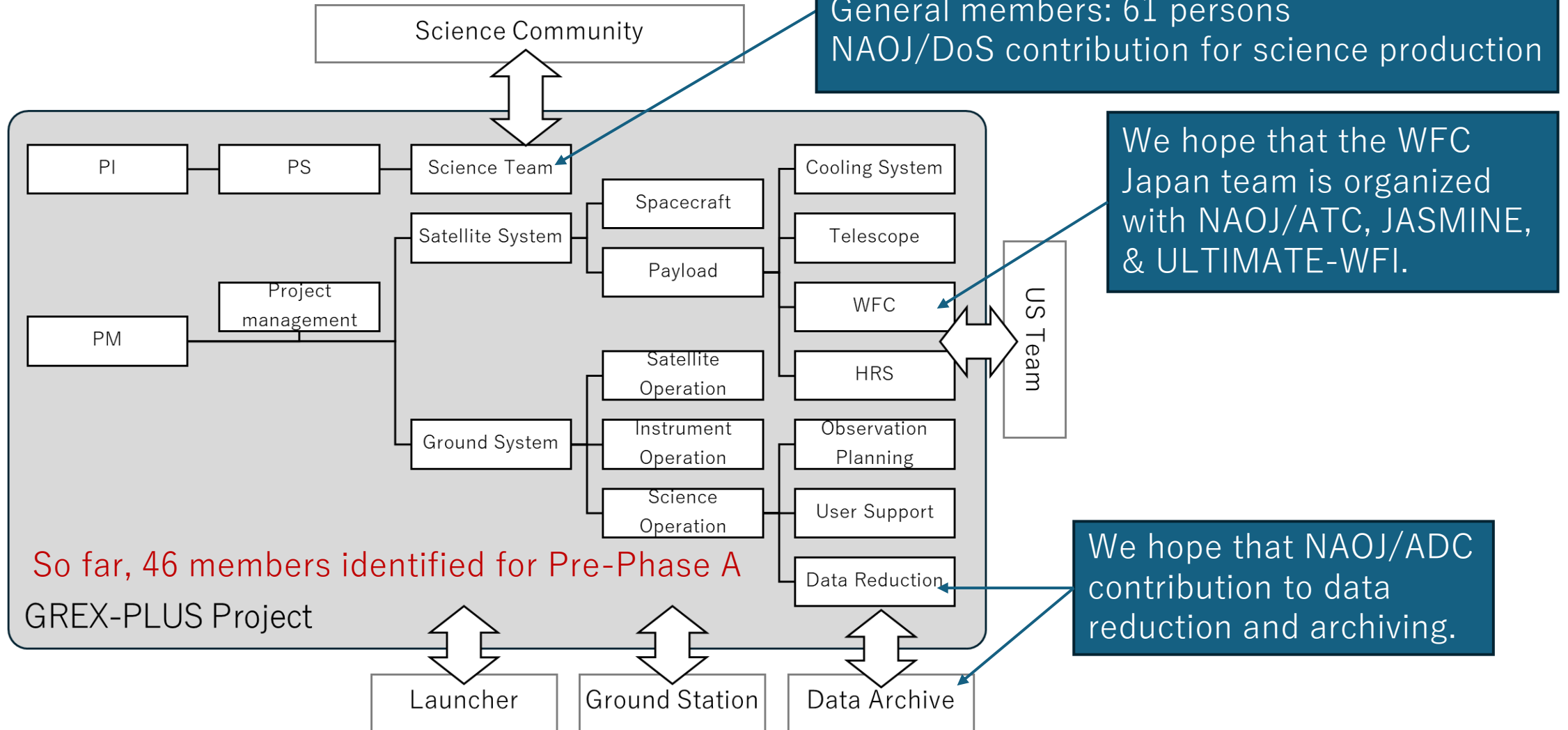
- Working Group under the Astrophysics GDI at ISAS/JAXA
  - Eligible to apply the strategic development budget in ISAS/JAXA
- The final down selection is anticipated in 2027.
  - Another candidate is the next generation sample return mission.

## 8. Cost assessments, budget line and status

- Cost estimate (at the end of FY2020) based on estimates from companies and supervised by ISAS Project Office.
- ISAS/JAXA cost cap is 400 MJPY.
- NAOJ contribution to such as the verification test of science instruments and the ground segment to enhance the capability of data reduction and archiving and production of science outcomes.
  - In-kind contribution, say, ~10 FTE ~ 100 MJPY/year (at the peak)

		Japan	US	Total
Baseline case A1.0new	Φ 1.0, WFC (US contribution), MCS (2x2ST)			
(Baseline + HRS case)	Φ 1.0, WFC (US contribution), HRS (Detectors from US contribution), MCS (3x2ST+1x4KJT)			
Threshold case B1.0	Φ 1.0, WFC/NIR only, no MCS, no US cont.			

# 9. Project organization



# 10. Why NAOJ?

- Without NAOJ's strong support, it would be difficult to realize Japan's flagship optical/infrared space telescope missions such as GREX-PLUS.
- In-kind contribution to the development of observational instruments (e.g., WFC Japan Team), the data reduction and archiving, and the production of science results.
  - ATC: Support to the WFC Japan Team and some test for telescope and instrument developments.
  - ADC: Importing GREX-PLUS imaging data at infrared wavelengths of 2 microns or longer to the science platform that seamlessly handles Subaru HSC and Rubin data in optical, and Roman data at infrared wavelengths less than 2 microns.
  - DoS: Creation of world-leading scientific results under close collaboration with the “Galaxy Formation Research Hub” (PI M. Ouchi), “Revealing the evolution from star and planet forming regions to planetary systems with radio and infrared observations x theory” (PI H. Nomura), and so on.