Subaru Users Meeting FY2024 (2025/1/28-30)

ULTIMATE-Subaru

すばる広視野補償光学プロジェクト

Overview & Status Report

https://ultimate.naoj.org/index.html

Yusei Koyama (NAOJ/Subaru)

on behalf of ULTIMATE collaboration

Project core / Science core members

- Yosuke Minowa (NAOJ)
- Yusei Koyama (NAOJ)
- Yoshito Ono (NAOJ)
- Tadayuki Kodama (Tohoku)
- Masayuki Akiyama (Tohoku)
- Kentaro Motohara (Tokyo)
- Koki Terao (NAOJ)
- Yuhei Takagi (NAOJ)
- Ichi Tanaka (NAOJ)
- Shin Oya (NAOJ)
- Masahiro Konishi (Tokyo)
- Hirofumi Okita (NAOJ)
- Chihiro Tokoku (NAOJ)
- Kenshi Yanagisawa (NAOJ)
- Takashi Hattori (NAOJ)
- Yutaka Hayano (NAOJ)
- Kosuke Kushibiki (NAOJ)
- Kumiko Morihana (NAOJ)
- Sadman Ali (NAOJ)
- Takamasa Bando (NAOJ)
- Yoko Tanaka (NAOJ)
- Naoyuki Tamura (NAOJ)
- Michitoshi Yoshida (NAOJ)
- Akio Inoue (Waseda)
- Ken-ichi Tadaki (Hokkai-Gakuen)
- Haruka Kusakabe (NAOJ)
- Sakurako Okamoto (NAOJ)
- Shogo Nishiyama (Miyagi Education)
- Daisuke Suzuki (Osaka)
- Takafumi Kamizuka (Tokyo)
- Tsuyoshi Terai (NAOJ)
- Takashi Moriya (NAOJ)

ULTIMATE-Subaru

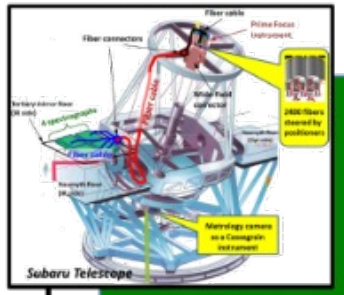
すばる広視野補償光学プロジェクト

Instruments for dark nights

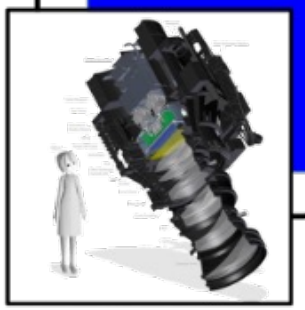
Instruments for bright nights

Spectroscopy

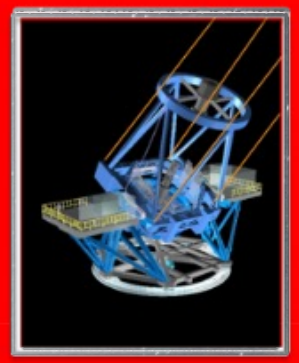
Imaging



PFS
(2025-)



HSC
(2013-)



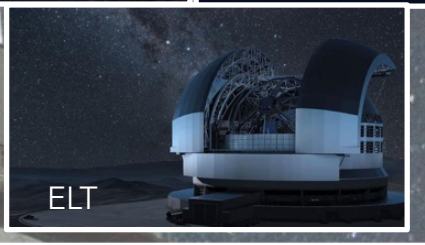
ULTIMATE
(~2028-)

1 2

λ [μm]

Great synergy with future space telescopes

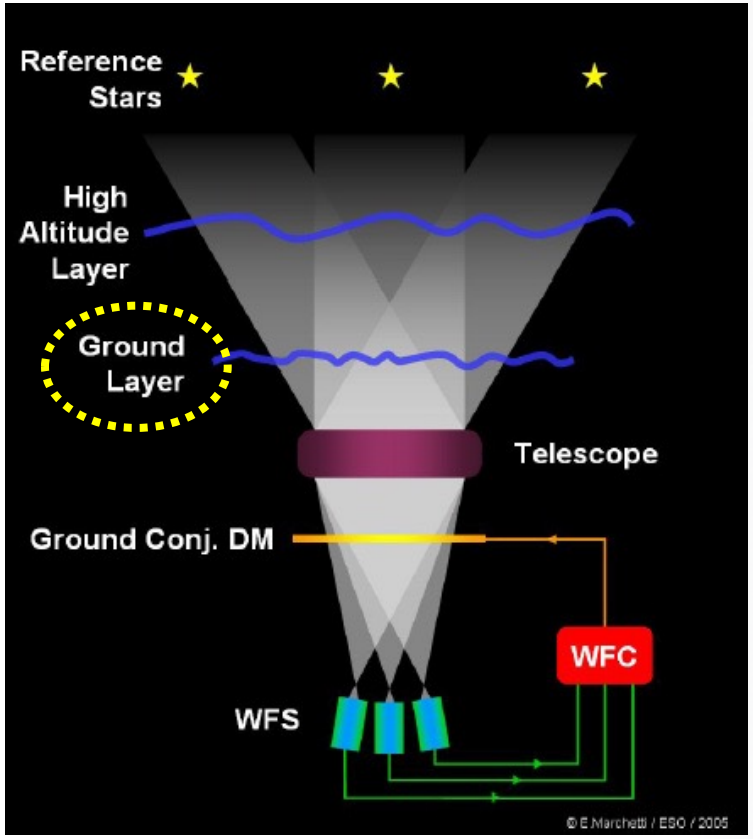
Excellent target provider for 30m -class telescopes



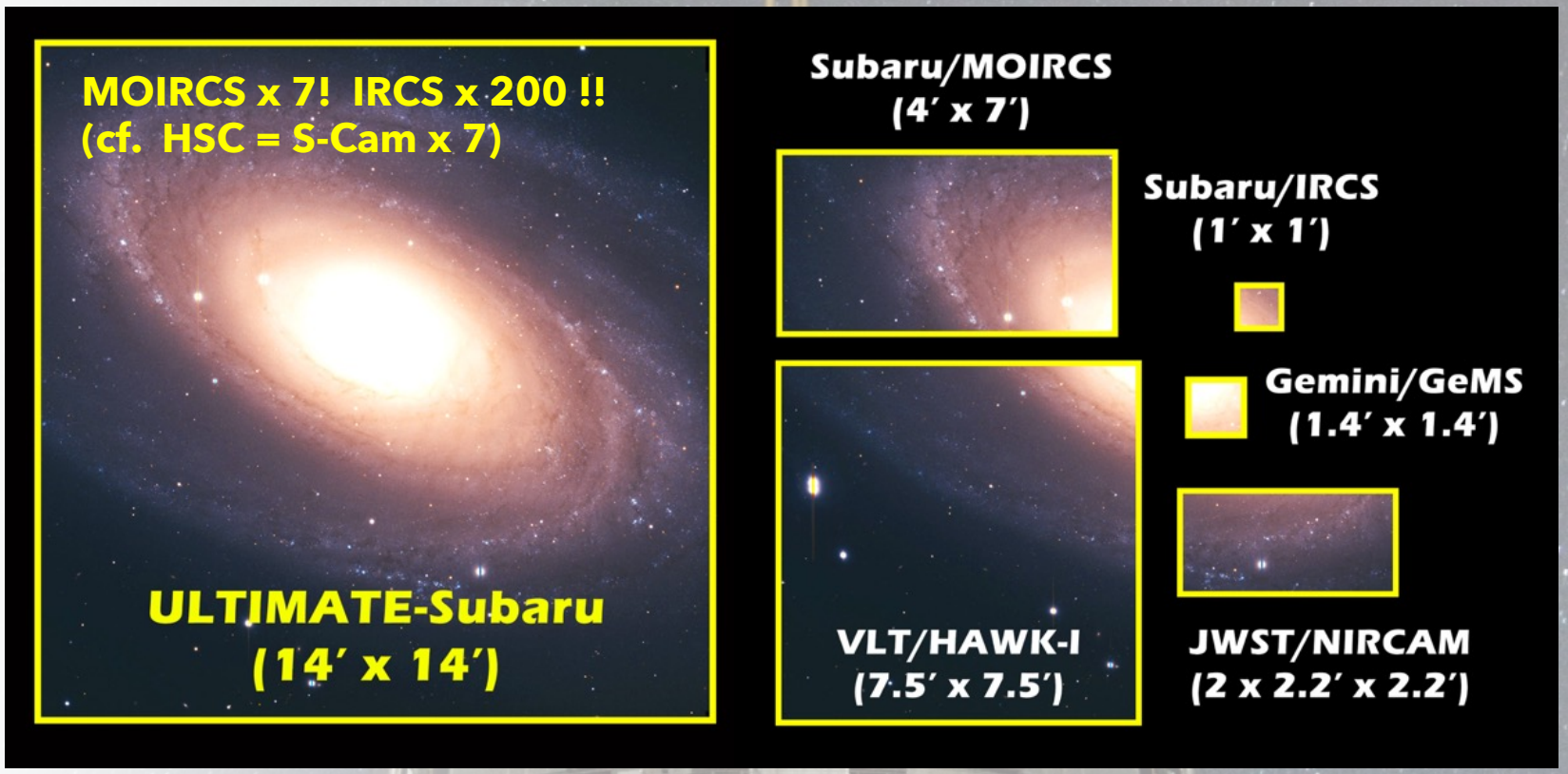
What is ULTIMATE-Subaru ?

すばる広視野補償光学プロジェクト

- Wide-field adaptive optics (**GLAO**) and wide-field IR imager (**WFI**).
- Improved image quality (**FWHM~0.2" in K-band**) over ~20-arcmin FoV.



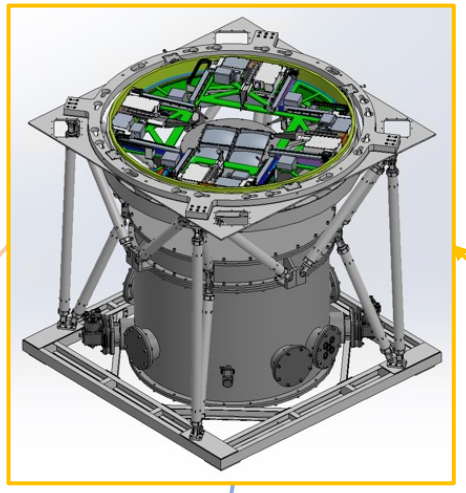
Concept of Ground-Layer AO ©ESO

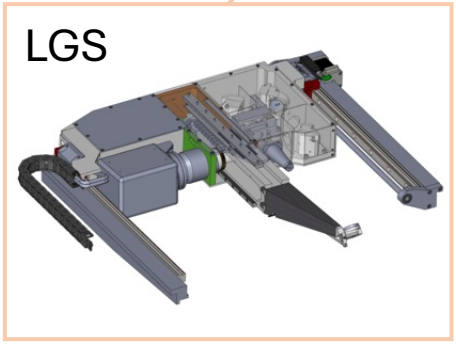


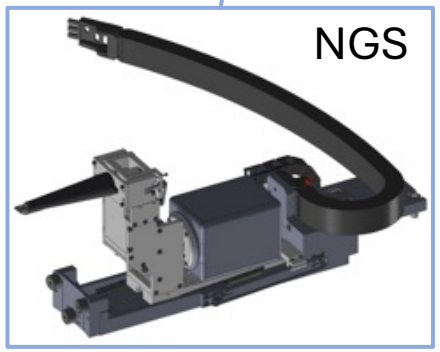
ULTIMATE-Subaru GLAO system

Wide-Field Imager (WFI)

- Cassegrain instrument
- FoV ~ 14' x 14'
- λ: 0.9 – 2.5 um

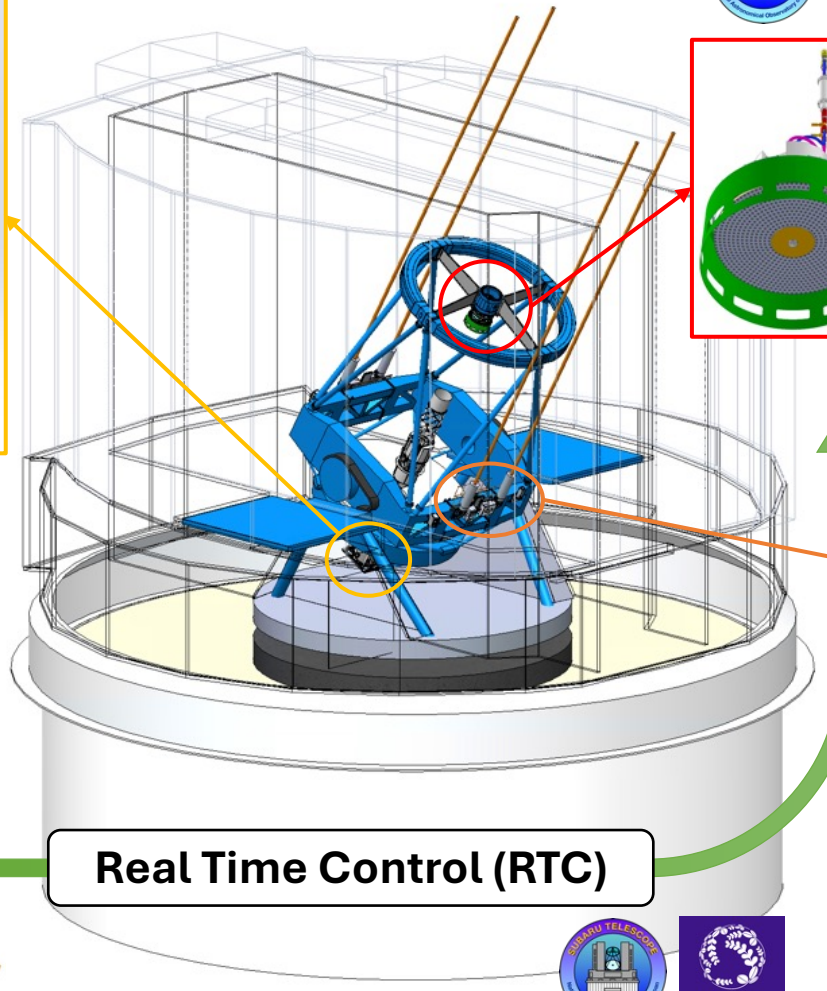




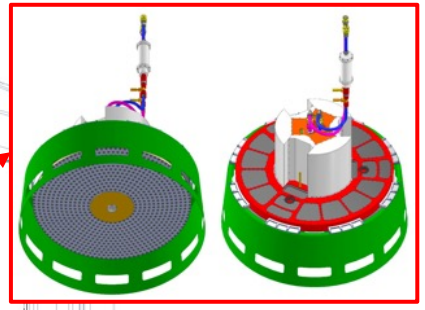


Wavefront Sensor (WFS)

- 4 Laser Guide Star (LGS) WFS
- 4 Natural Guide Star (NGS) WFS

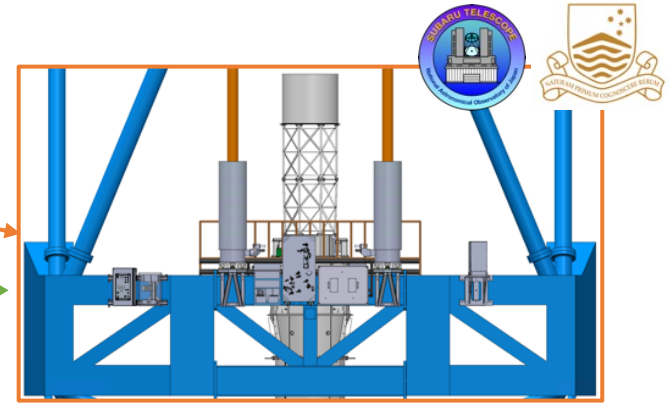


Real Time Control (RTC)



Adaptive Secondary Mirror

- 924 actuators over 1.2 m optical surface
- Control up to 1 kHz (~2 kHz goal)
- Replace the existing IR secondary mirror

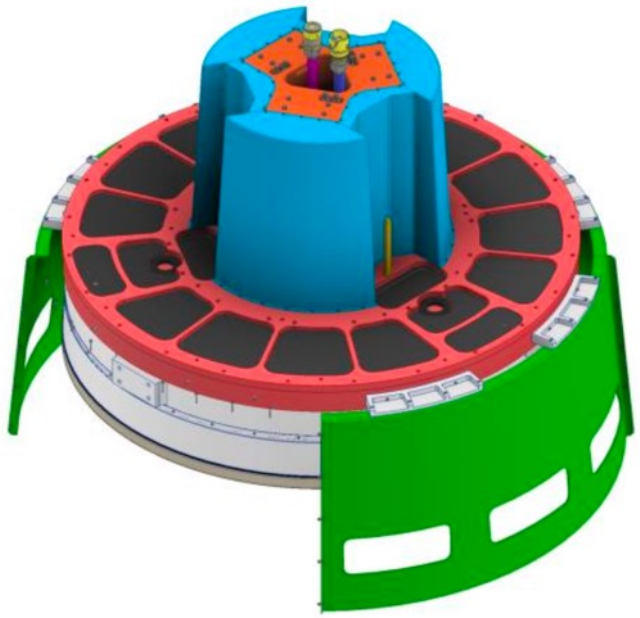


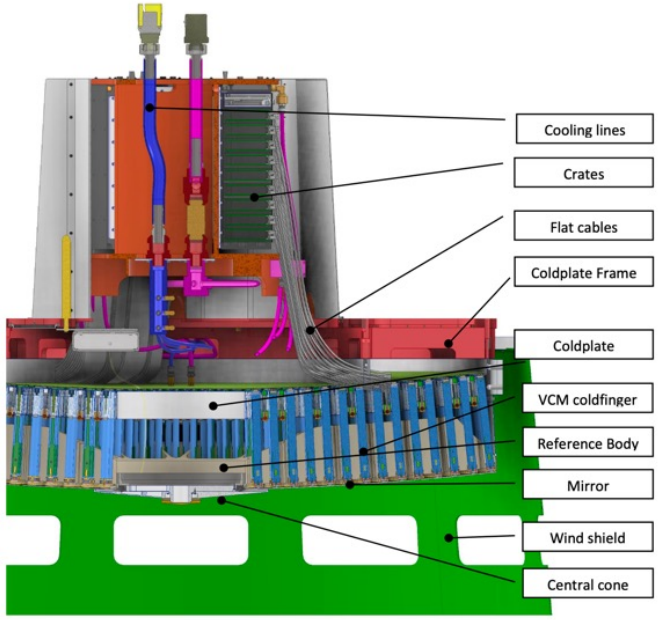
Laser Guide Star Facility

- Launch four laser beams from the side of the telescope.
- Generate 4 LGS constellation within < 20' diameter

Adaptive Secondary Mirror Status

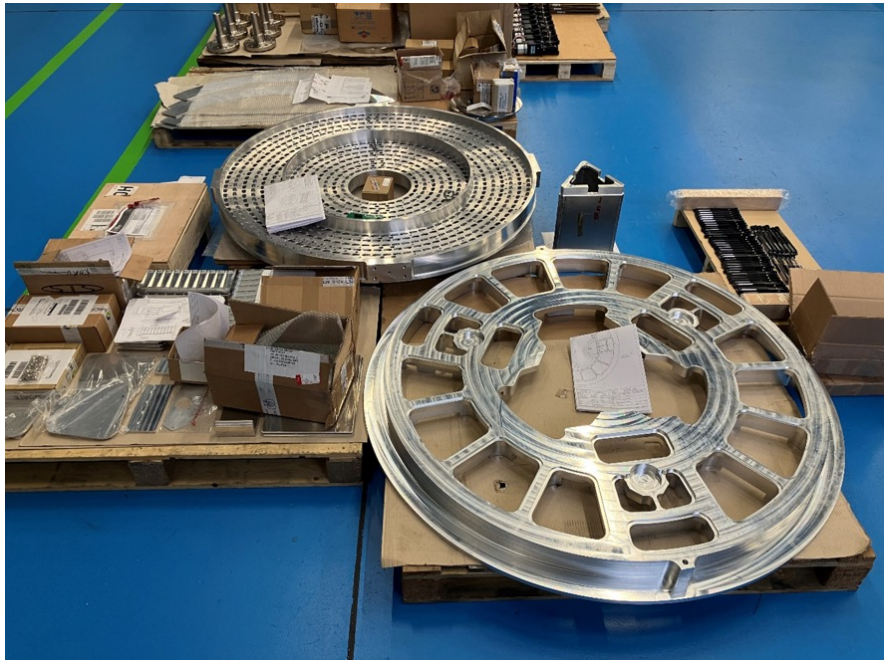
- Adopt a well-established design from AdOptica based on the VLT DSM design.
- Install the ASM in the existing secondary mount hexapod (IRM2) at Subaru.





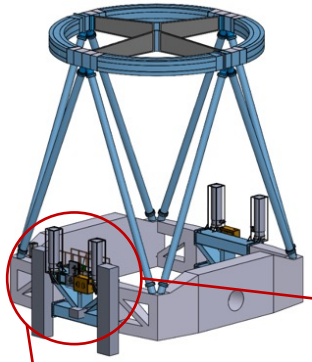
924 actuators over 1.26 m diameter

Fabrication ongoing, some parts are completed

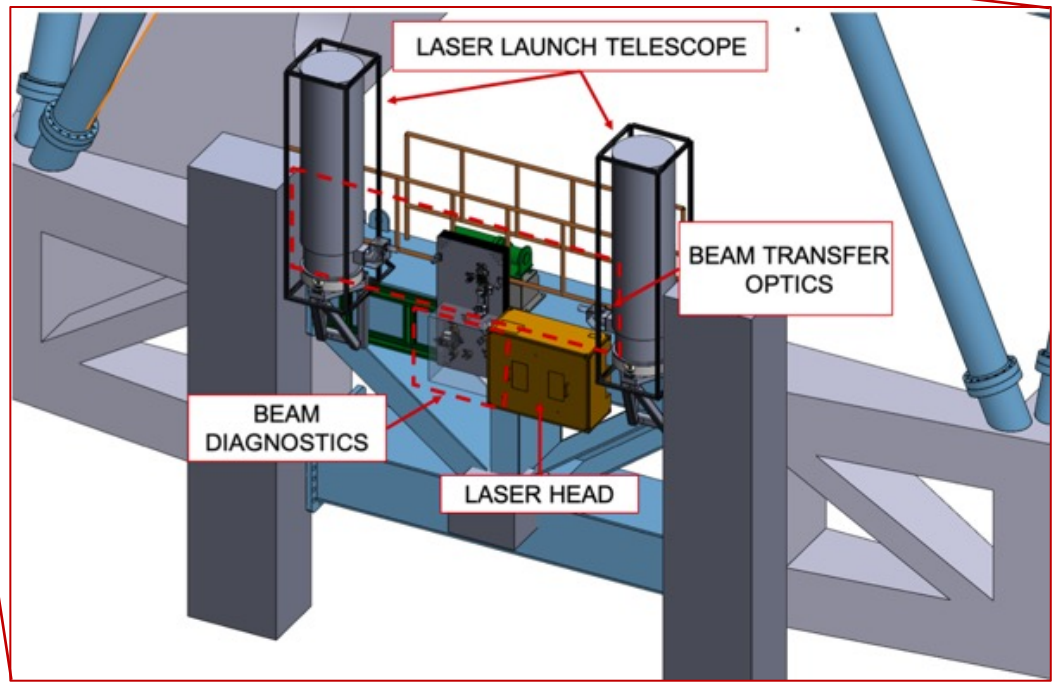


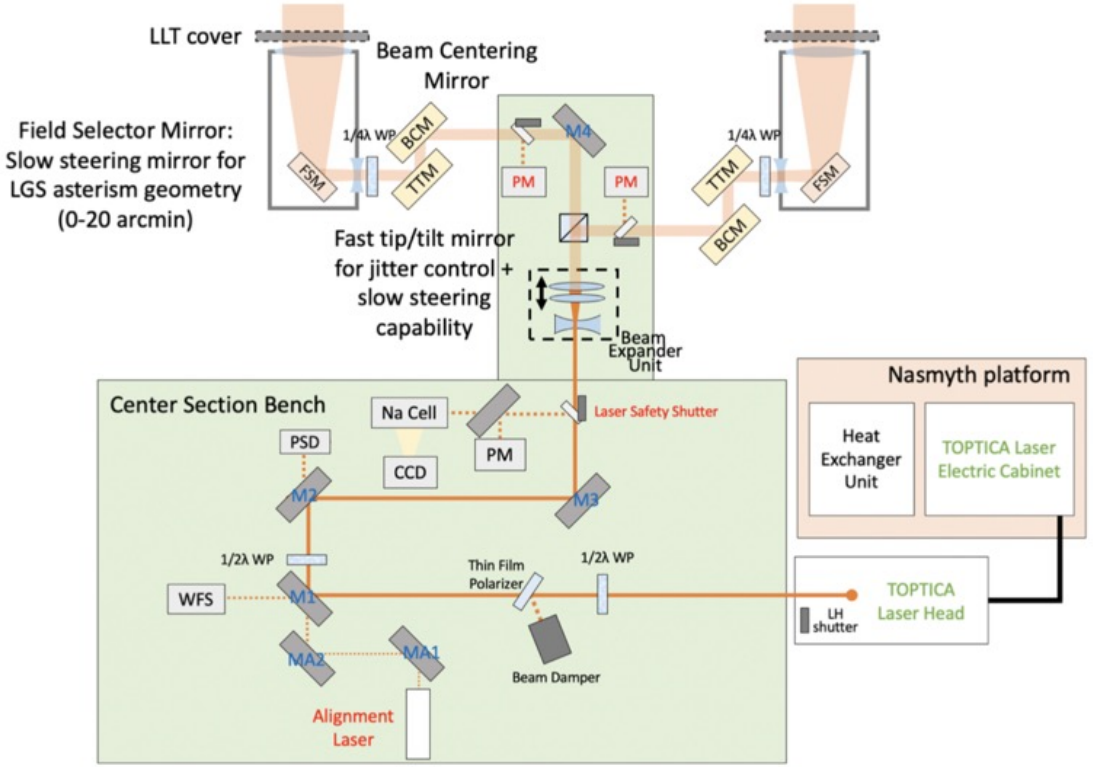
- Optical fabrication to be completed in ~ 1 year
- Assembly, Integration, Test will be in completed in 2025
- System verification in 2026 to be delivered by the end of 2026

Laser Guide Star Facility



- Use two TOPTICA 20W lasers to generate 4 LGSs (~**10W each**)
- The asterism can be configured at **any diameter within 0 – 20 arcmin**.
- Currently in the final design phase.



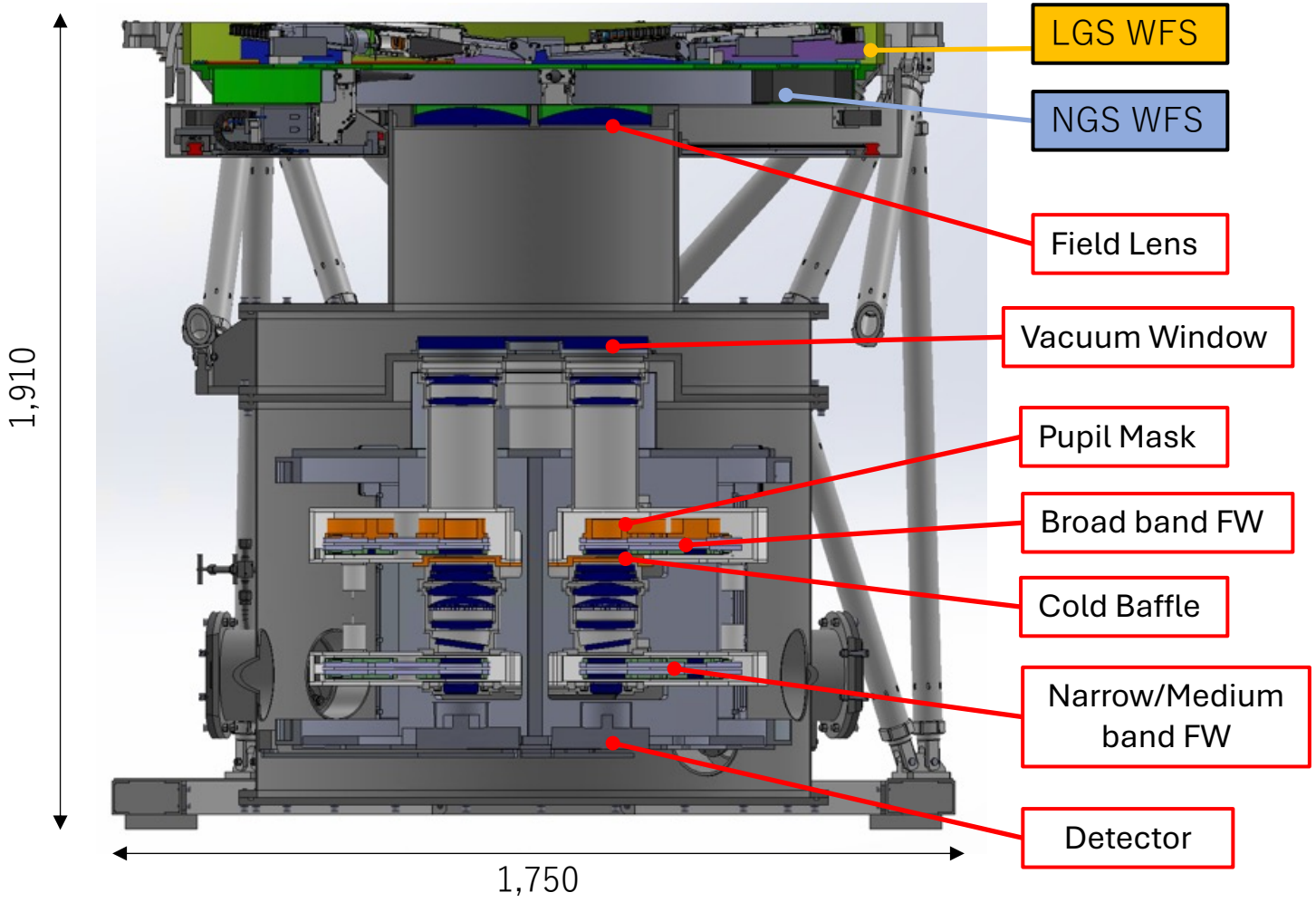


Martinez, N. et al. 2022 Proc. SPIE

Wide-Field Imager (WFI)

See Kushibiki-san's talk for more details on ULTIMATE-WFI

- **Funded (partly) by JSPS grant (PI: T. Kodama at Tohoku Univ.)**
- Detailed design in FY2024, followed by the production phase in FY2025 for ~2 barrels, while continuing the fund raising for the remaining barrels.
- The MAIT schedule will be aligned with the GLAO, start commissioning observations in early 2029 (end of JFY2028).

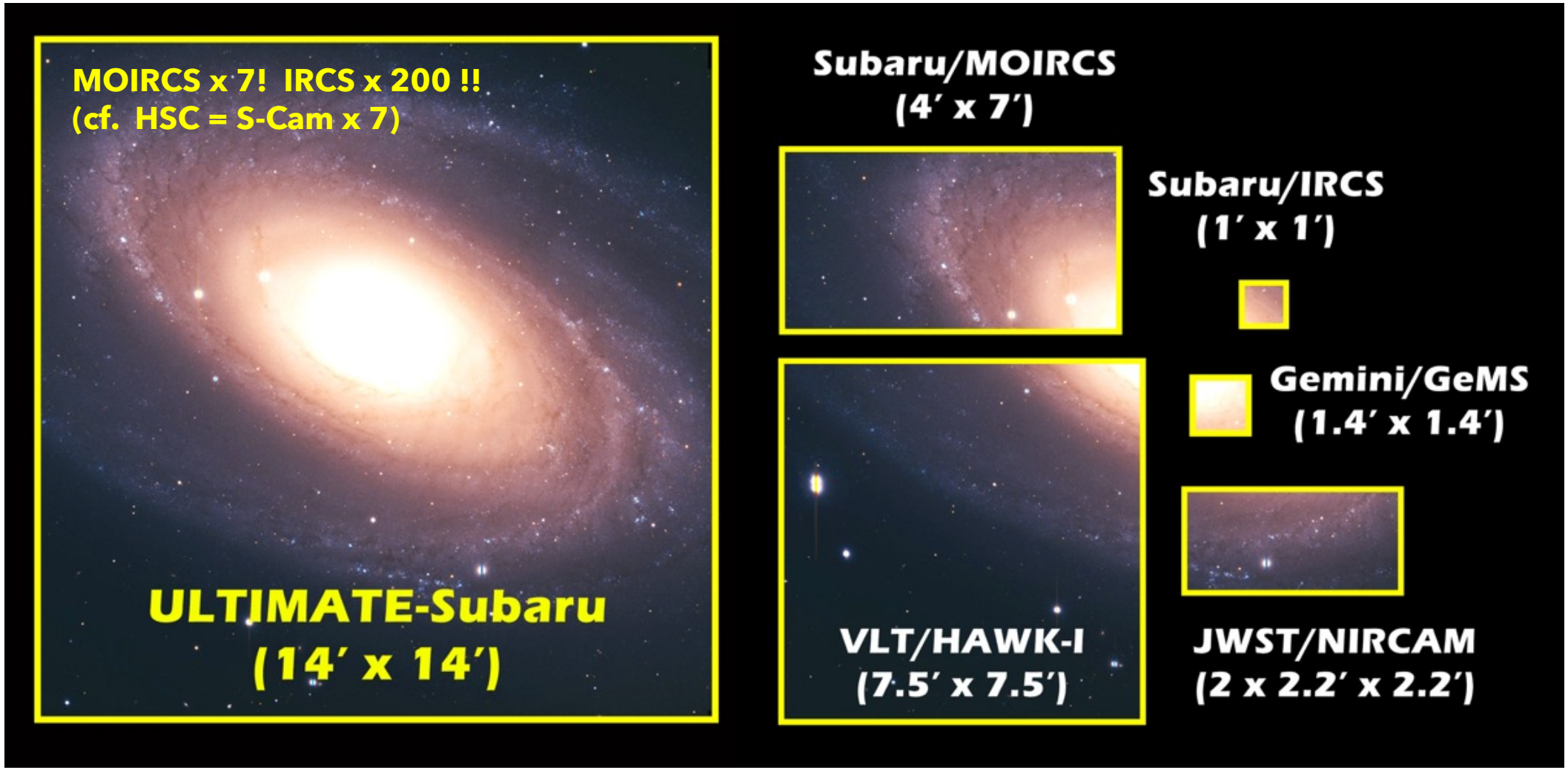


ULTIMATE Subaru

Science Capabilities

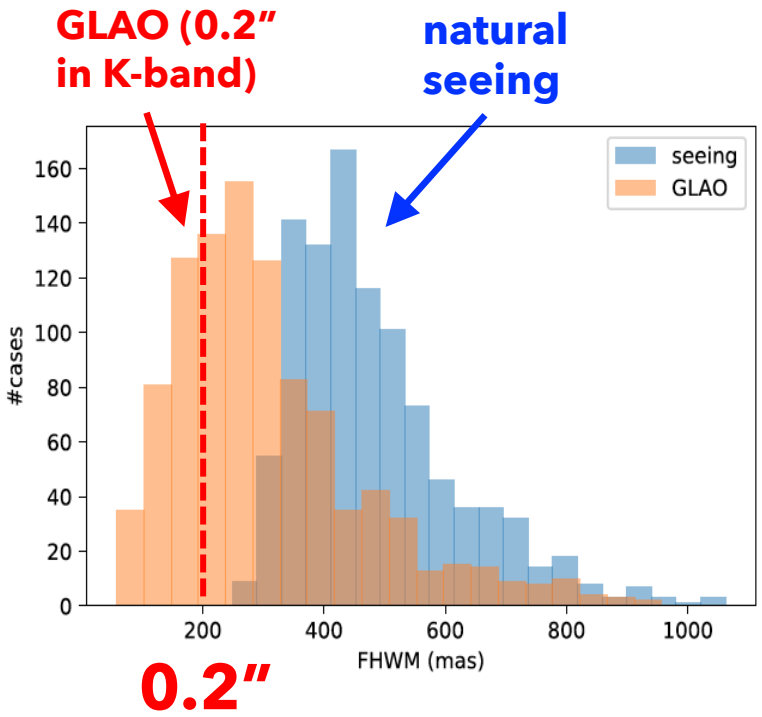
1): Wide Field of View

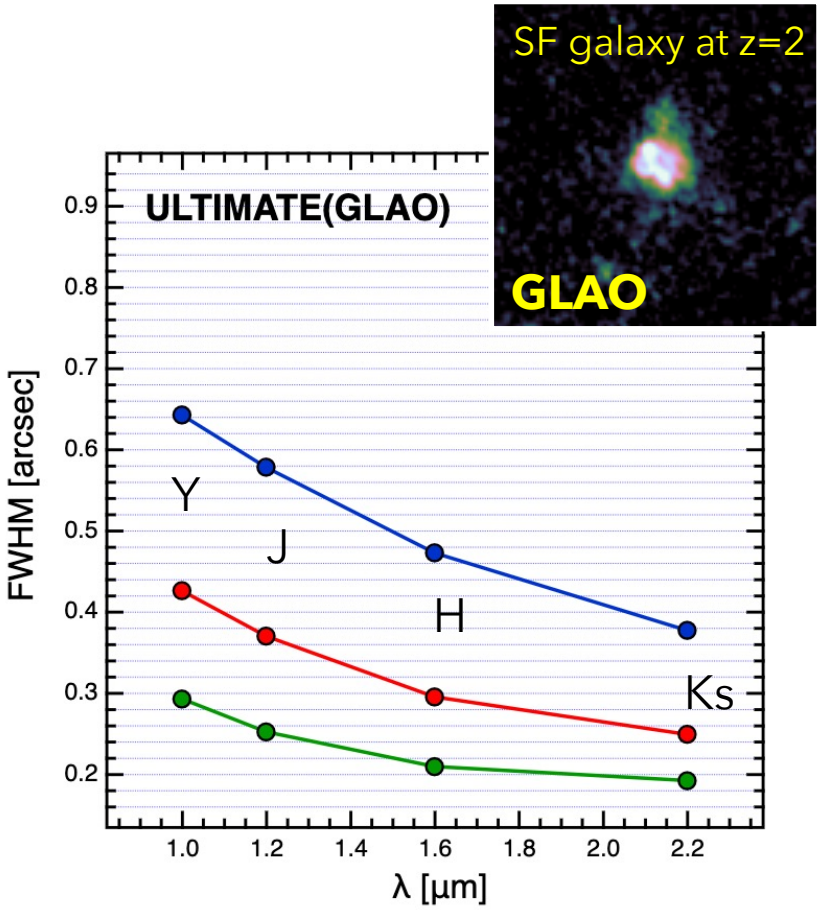
Widest-field AO-assisted imaging among 8-10m class telescopes

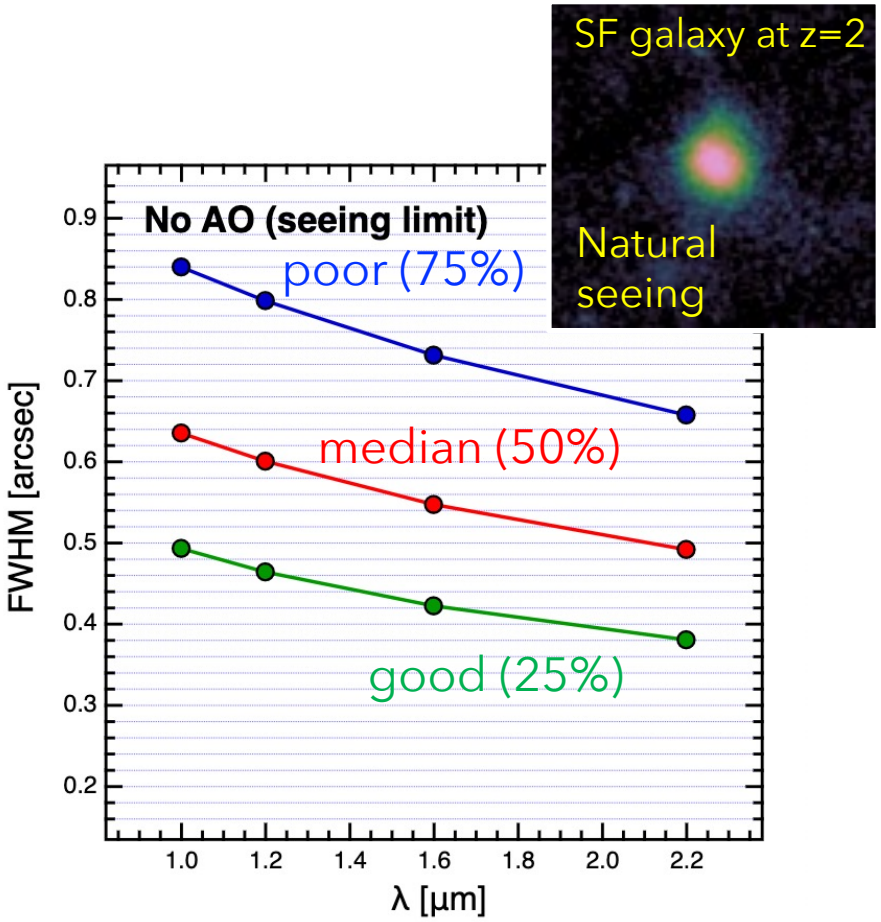


2) Space telescope image quality

- Improve the image quality by a factor of ~2x, comparable to HST, Roman.
- Achieve FWHM~0.2” (in K-band) at moderate conditions of Maunakea

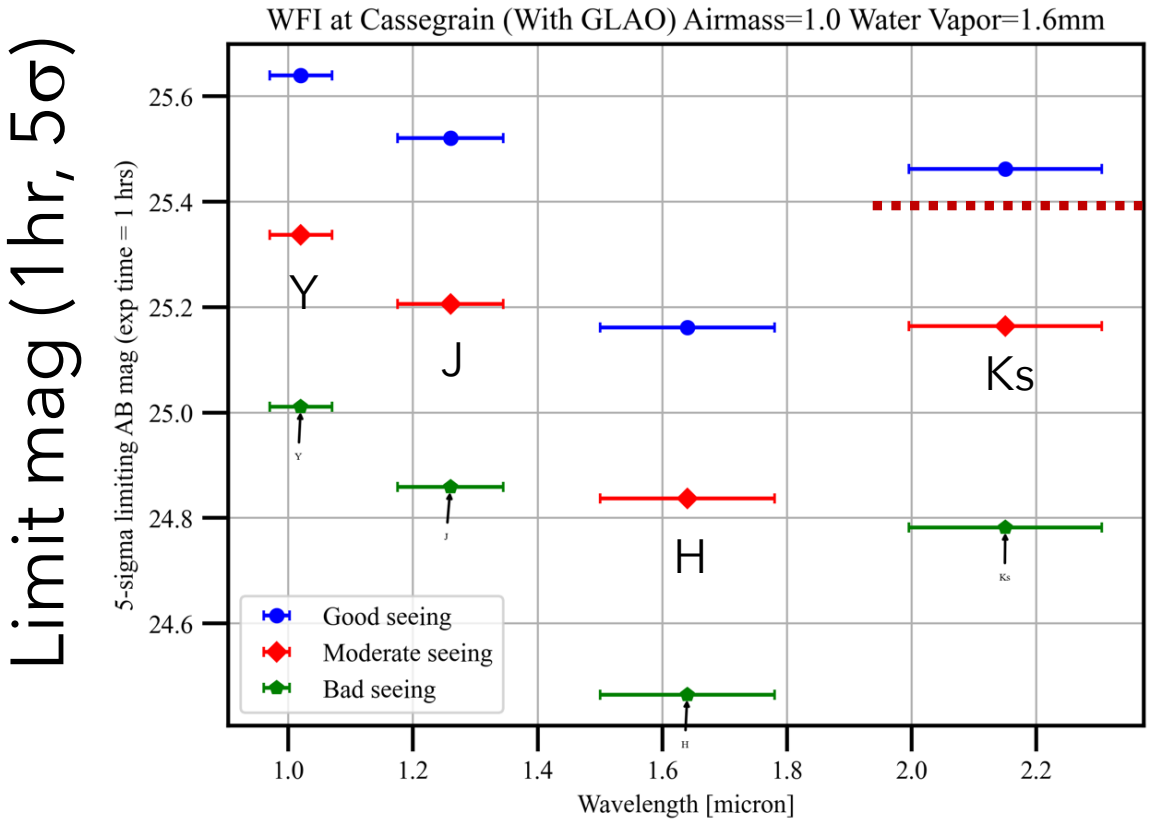




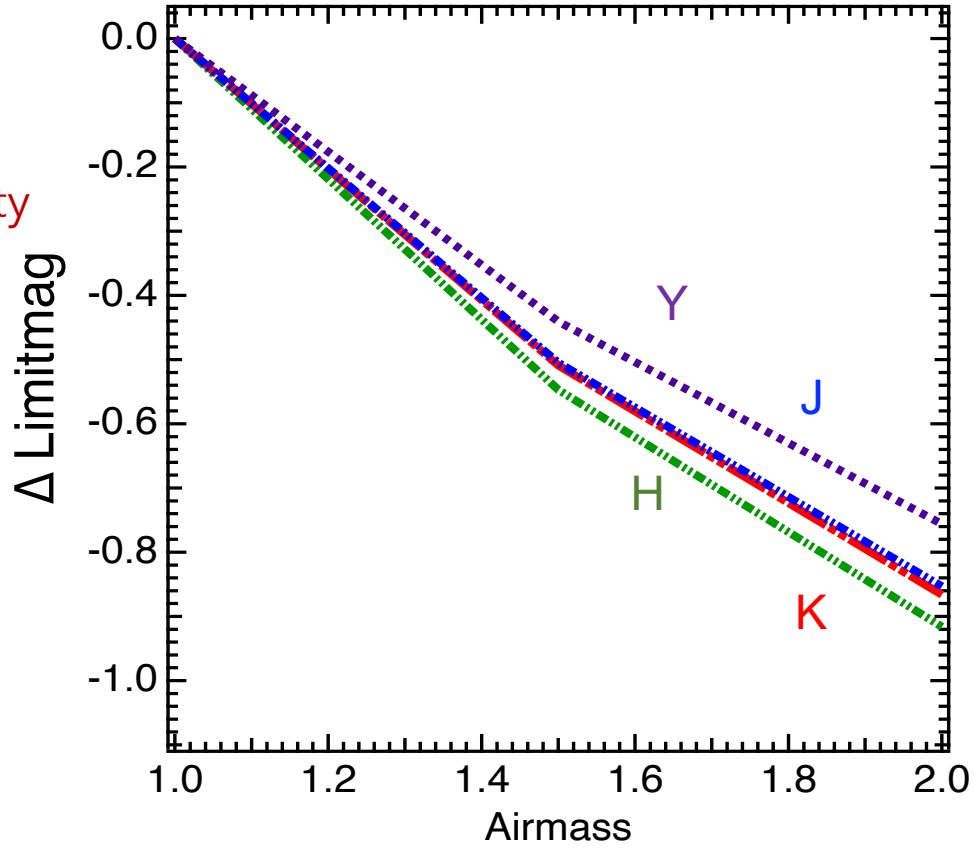


3) No sensitivity loss

- Improved point-source sensitivity thanks to the improved image quality.
- Broad-band sensitivity of ~25-26 mag (AB) in reasonable observing time.



Roman Ks-band sensitivity

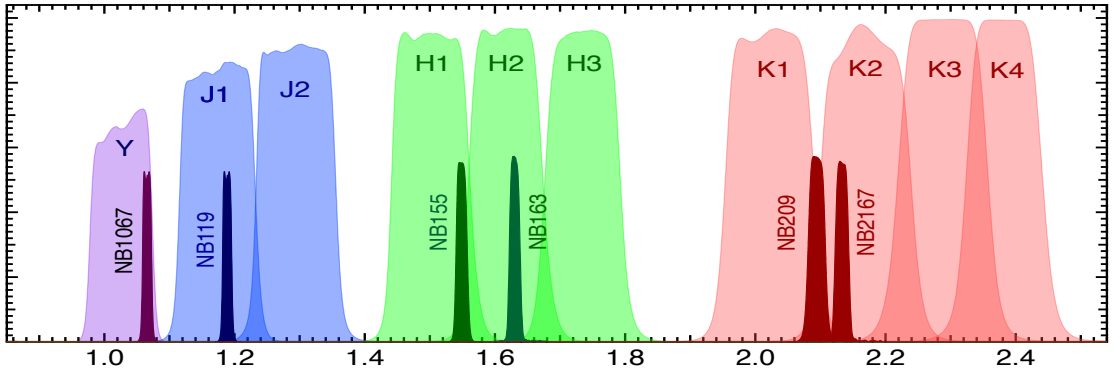


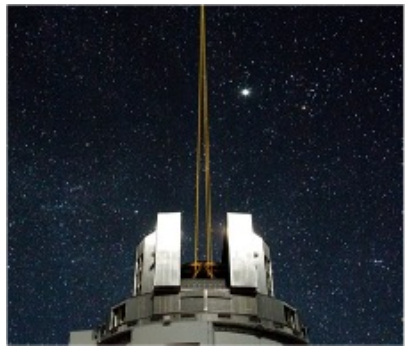
4) Variety of narrow-/medium-band filters

- Improved point-source sensitivity thanks to the improved image quality.
- Broad-band sensitivity of ~25-26 mag (AB) in reasonable observing time.

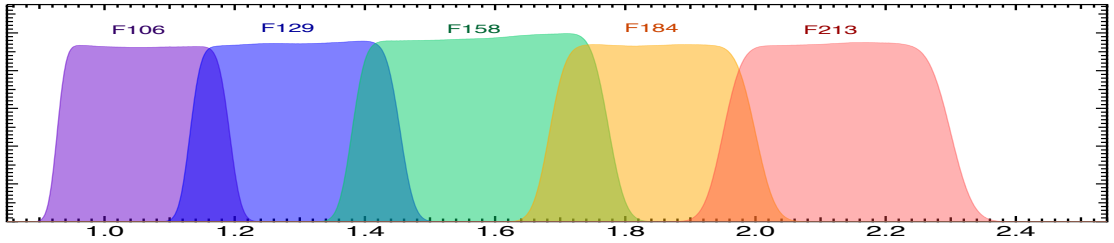
ULTIMATE filters are funded by JSPS Kakenhi (PI: Miyazaki)

ULTIMATE

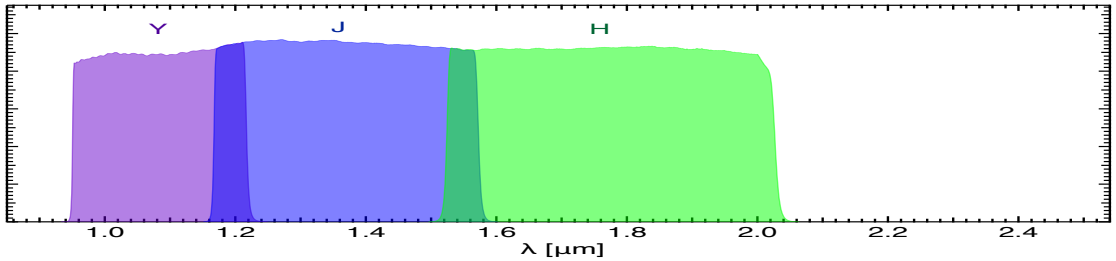


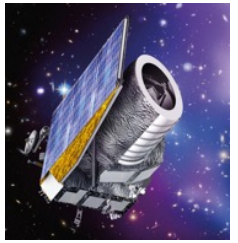


Roman



Euclid



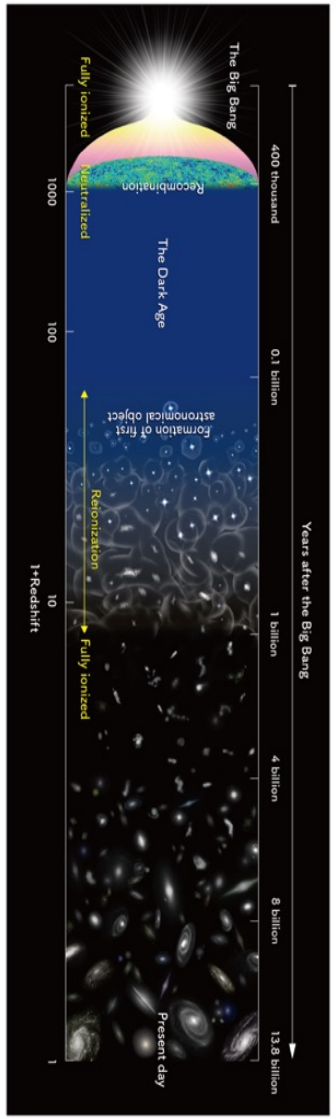


ULTIMATE Subaru

Science Goals

ULTIMATE to explore the *Deep* Universe

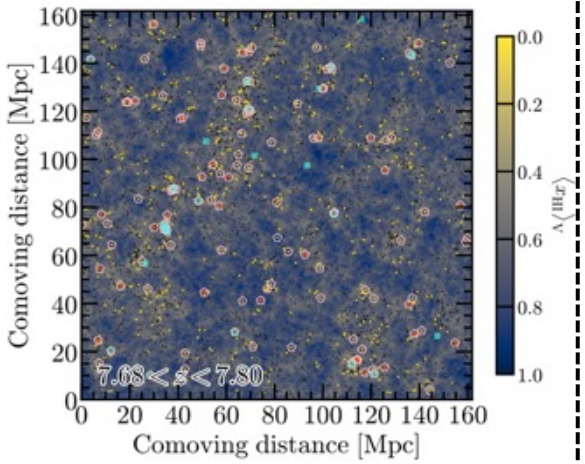
A) High-redshift universe



1) Cosmic Reionization Bubble

Deep & Wide NB

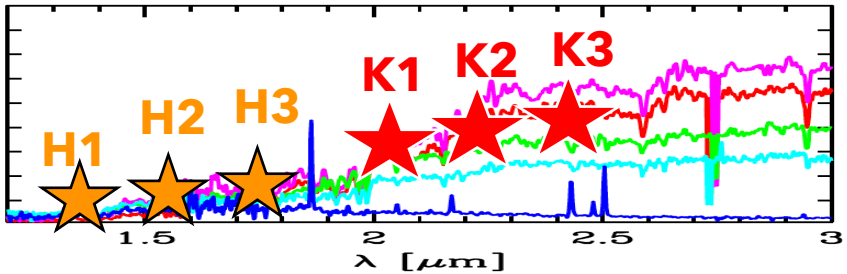
Unprecedentedly deep and wide NB imaging to search Lyα emitters in the epoch of cosmic reionization (at z>>7), to identify ionized bubbles in the very early universe.



2) First Massive Galaxies

Deep & Wide MB

Understand the nature and environment of massive (quenched) galaxies by detecting the most massive galaxies at z~4-5 with deep/wide MB(K) imaging.

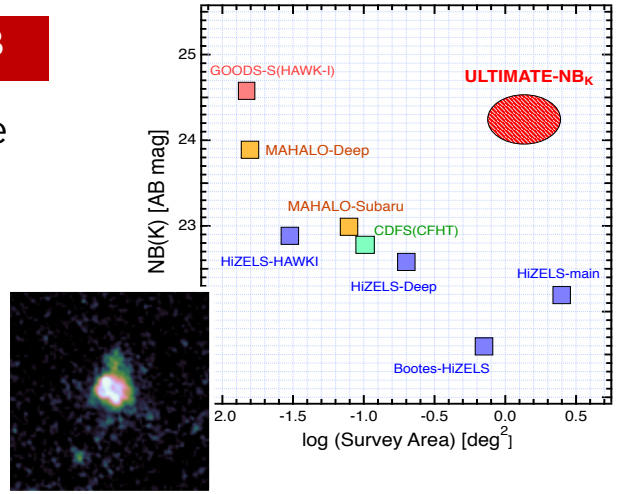


SEDs of z=4 galaxy

3) Early Galaxy Morphologies

Sharp & Wide NB

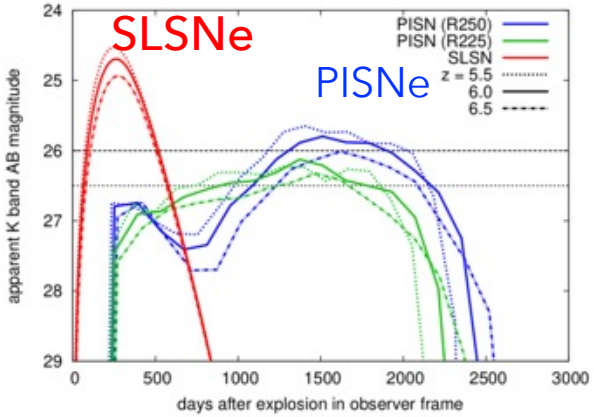
Stellar build-up inside the galaxies at the cosmic noon (z~2-3) epoch with deep and sharp NB(Hα/[OIII]) imaging in K-band.



4) Supernovae Explosion of First Stars

Deep & Wide K/MB

SNe search at z>6 by visiting ~1-deg^2 every 180-days down to K > 26 mag will allow us to detect SNe at z>6.



(Moriya+2019)

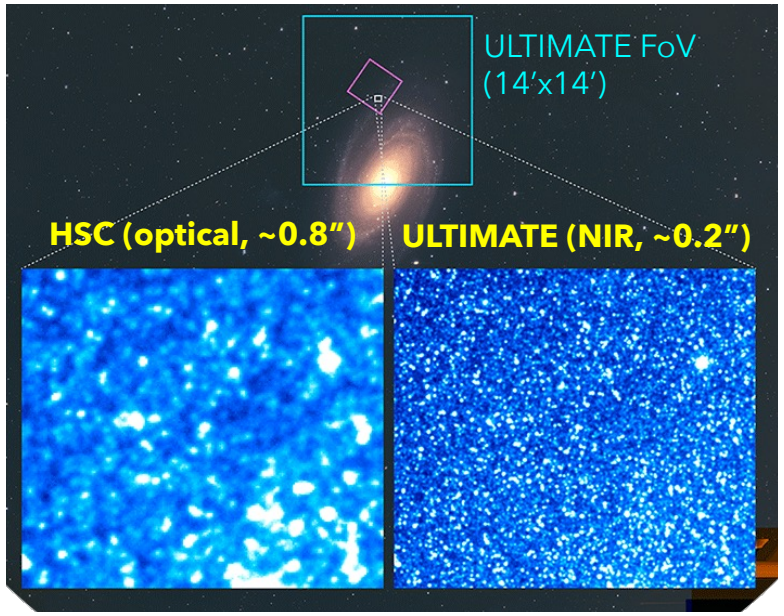
ULTIMATE to explore the *Deep* Universe

B) Dense/Obscured Regions in the Local Universe

1) Nearby Galaxies

Sharp & Wide JHK + NB

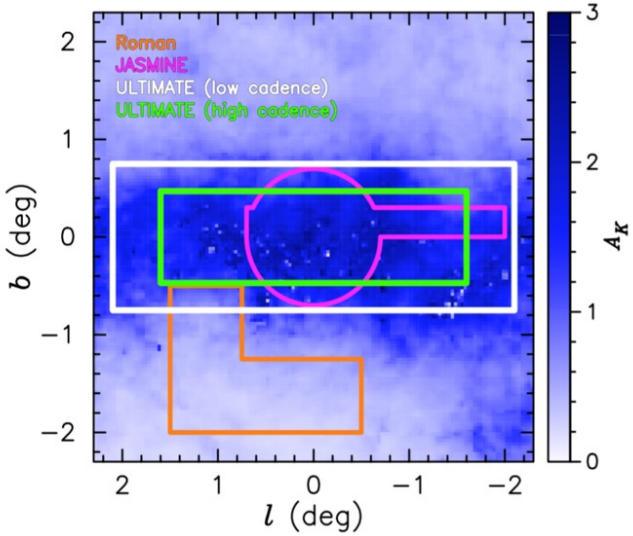
Spatially resolve nearby galaxies (D<10Mpc) into individual stars and star-forming regions, to study galaxy formation history (galactic archaeology) and ISM physics.



2) Galactic Center

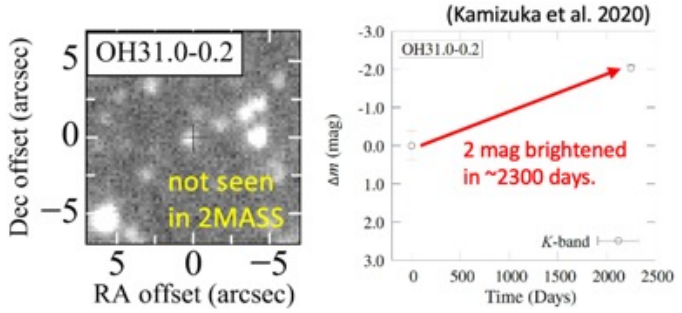
Sharp & Wide JHK + NB

High/low cadence survey toward the Galactic Center with ULTIMATE, to reveal hidden objects (blackholes and free-floating planets) in the Galactic Center with microlensing and astrometric approach.



3) Galactic Plane

- Revealing the Milky Way structure and hidden stellar evolution (e.g. OH/IR stars).
- Paβ/Brγ imaging for cataclysmic variables, to reveal the Galactic Diffuse X-ray Emission

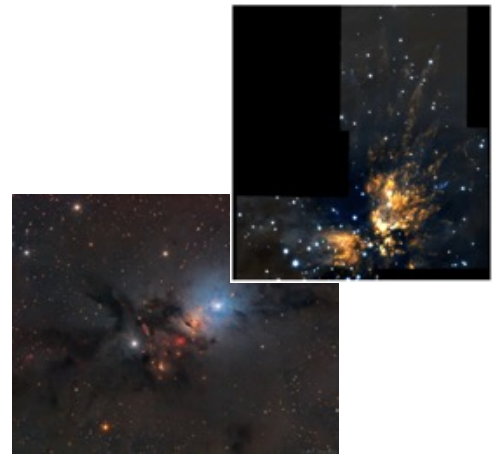


Sharp & Wide NB/MB

4) Star Forming Regions

Sharp & Deep JHK + NB

Sharp/deep imaging of SF regions in a variety of environment within the Milky Way to study the variety/universality of IMF.



ULTIMATE in the world

ULTIMATE promotion in Australia

Supported by Australia-Japan Foundation Grant (FY2024-2025)

May 9-10 at Macquarie University in Sydney

ULTIMATE promotion i

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Published by "Go8" – 8 research universities in Australia – describing successful Australia-Japan collaboration

https://go8.edu.au/partners-in-excellence-the-go8s-long-standing-relationship-with-japan

Table of Contents

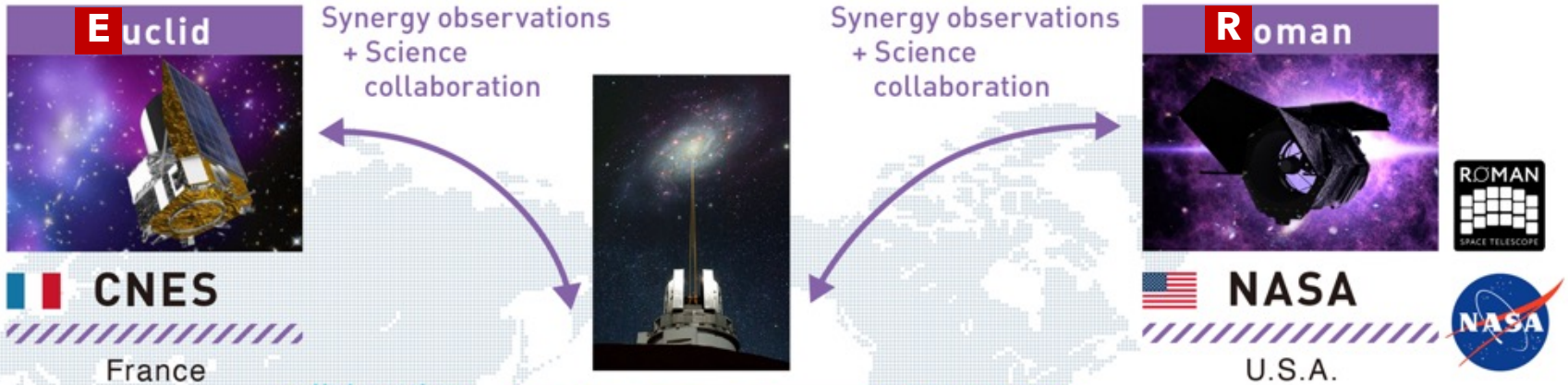
SUPER-IRNET: JSPS Core-to-Core Program

FY2021-FY2025, PI: M. Yoshida (NAOJ), with >200 members

- Online seminar series in FY2021-FY2022 (during pandemic)
- 1st in-person meeting in March 2023 @ NAOJ
- 2nd meeting in July 2024 @ Beppu/Oita

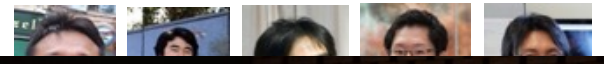
Organizers: M.Yoshida/H. Miyatake/T. Moriya/D. Suzuki/Y.Koyama

"Grade-A" by JSPS mid-term review



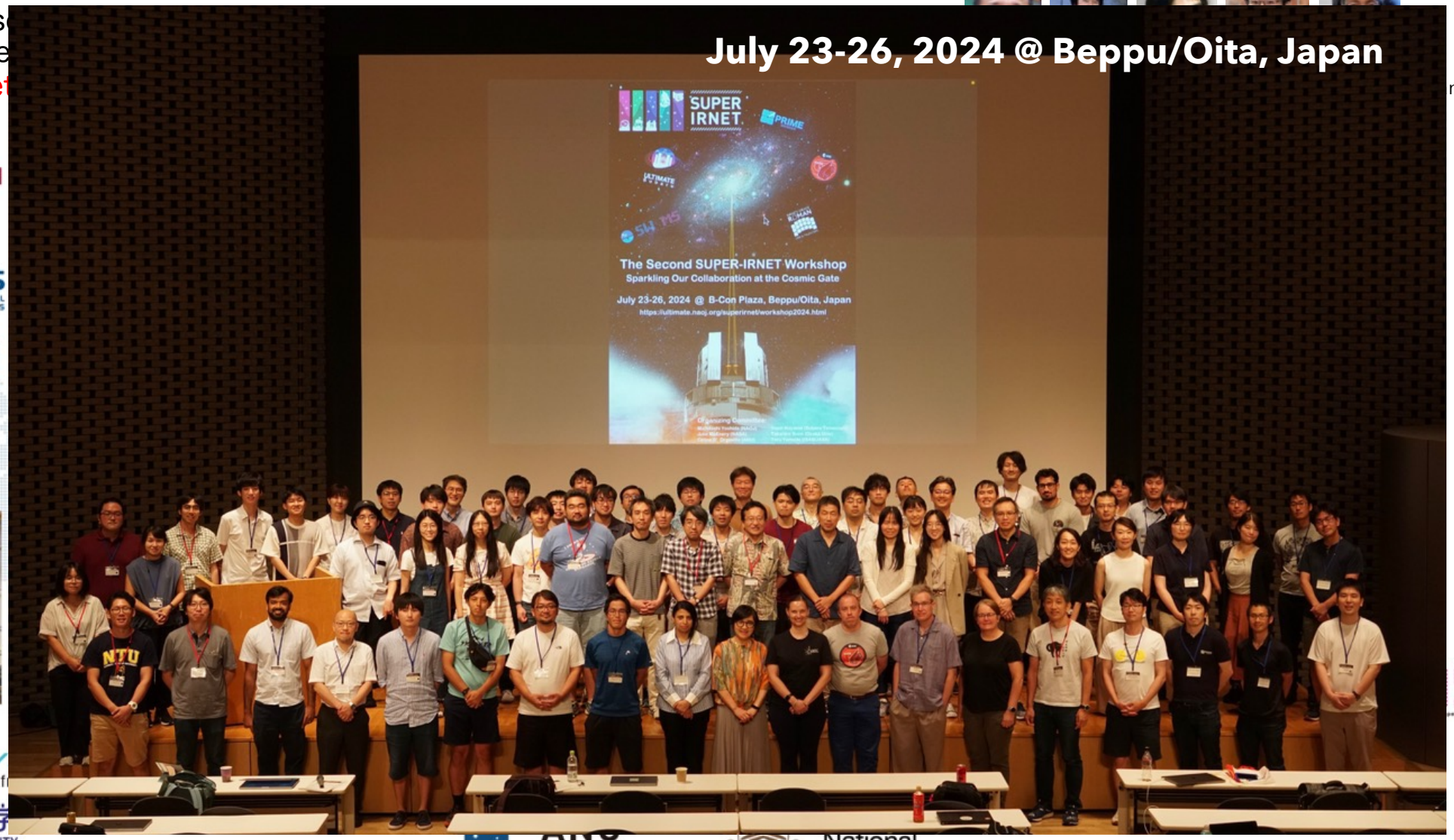
SUPER-IRNET: JSPS Core-to-Core Program

FY2021-FY2025, PI: M. Yoshida (NAOJ), with >200 members



- Online s
- 1st in-pe
- 2nd meet

ma



telescope

PRIME

Osaka Univ./South Af

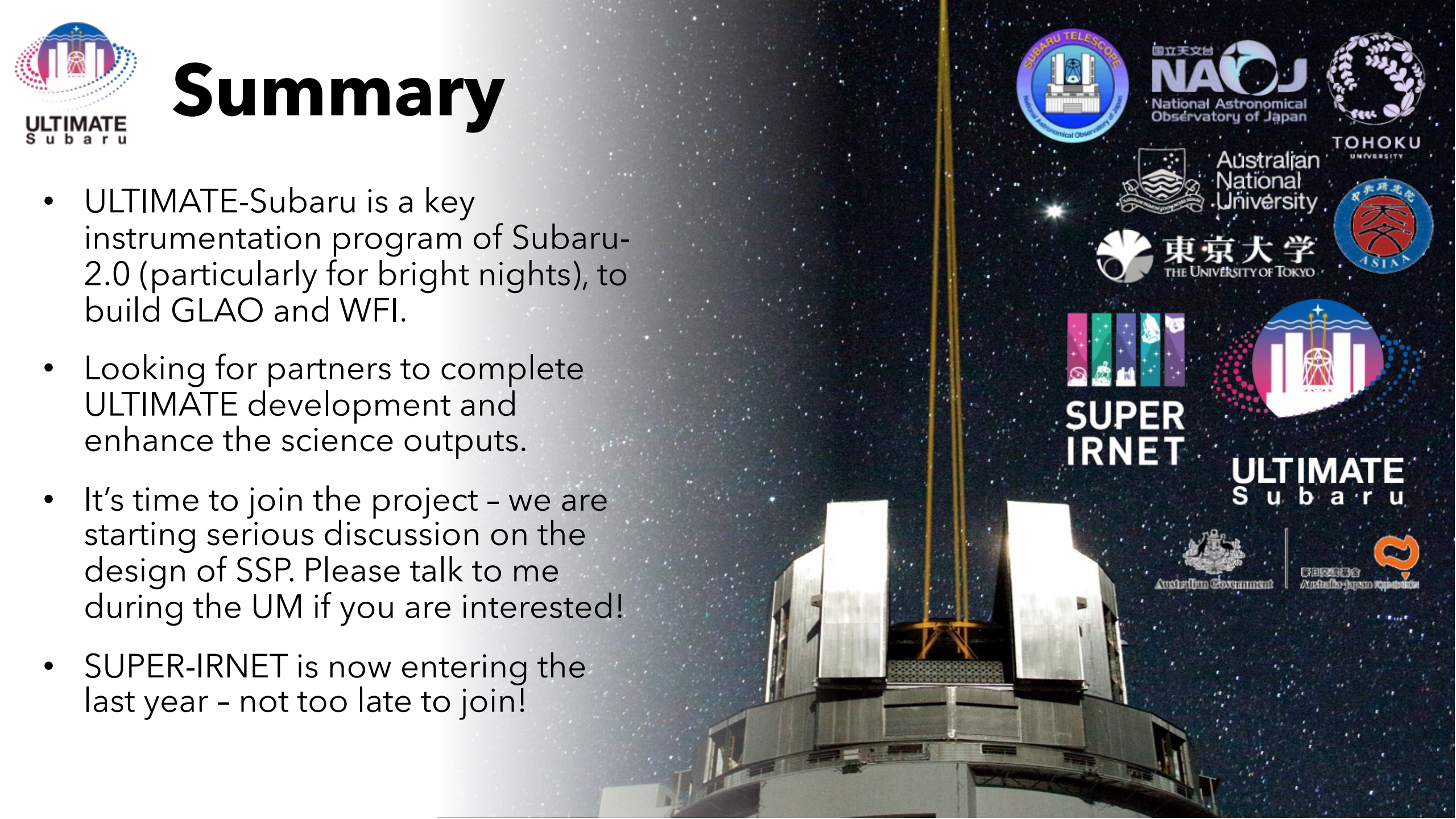
大阪大学
OSAKA UNIVERSITY

ANU
Australia

National University

Summary

- ULTIMATE-Subaru is a key instrumentation program of Subaru-2.0 (particularly for bright nights), to build GLAO and WFI.
- Looking for partners to complete ULTIMATE development and enhance the science outputs.
- It's time to join the project – we are starting serious discussion on the design of SSP. Please talk to me during the UM if you are interested!
- SUPER-IRNET is now entering the last year – not too late to join!



Summary

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Wide-field AO 2025
home
Travel Info.
Wide-field Adaptive Optics
for Astronomy and Astrophysics
March 24 - 28, 2025
National Astronomical Observatory of Japan, Mitaka
https://sites.google.com/view/wfao2025/home
Next generation wide-field adaptive optics systems with multiple laser guide stars will open a new parameter space in the astronomy with ground-based large telescopes. This workshop is to foster collaboration between international AO projects and research through common technical interests, emphasizing opportunities around the Ground-Layer Adaptive Optics (GLAO) project on the Subaru telescope, ULTIMATE-Subaru. Key instrument science and technology areas are covered in the sessions. Each session will consist of an invited introductory review and forefront research presentations, followed by small group discussions. We invite contributed presentations on 1) technical development related to adaptive optics systems, and 2) science cases with wide-field high-resolution observations. The abstract submission form and further information can be found below.
Venue:
National Astronomical Observatory of Japan, Mitaka, Tokyo
Wide-field AO workshop on March 24-28
Registration is now open !!