



Mid-infrared monitoring imager and spectrograph for TAO 6.5m telescope

Yuki Hirao, Takashi Miyata, Takafumi Kamizuka, Shigeyuki Sako,
Itsuki Sakon, Akira C. Naruse, Riko Senoo, Yuki Kojima

Institute of Astronomy, School of Science, the University of Tokyo

The 11th East-Asian Meeting on Astronomy, 2025/12/8-12 @ TOKI MESSE, Niigata, Japan

MIMIZUKU Overview

MIMIZUKU — **M**id-**I**nfrared **M**ulti-field **I**mager for ga**Z**ing at the **U**n**K**nown **U**niverse



Wide wavelength coverage by 3 optical channels

NIR ch : 1.2 – 5.3 μm
MIR-S ch : 6.8 – 26 μm
MIR-L ch : 24 – 38 μm

Imaging & low-resolution spectroscopy (R~100-600)

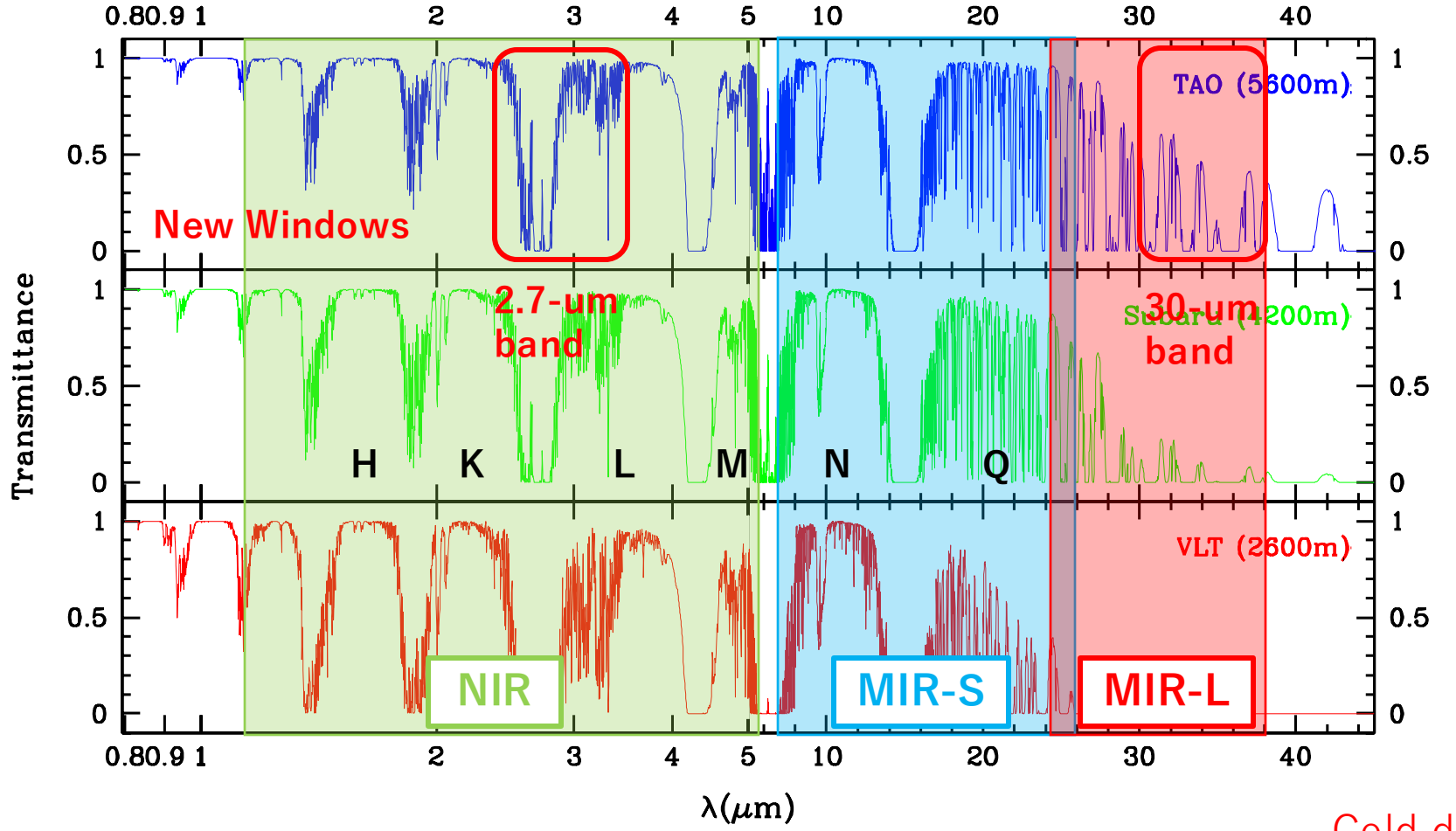
High spatial resolution given by large telescope

NIR : ~ 0.5 arcsec (seeing limit)
10-μm band : ~ 0.6 arcsec (~ diffraction limit)
20-μm band : ~ 0.8 arcsec (diffraction limit)
30-μm band : ~ 1.2 arcsec (diffraction limit)

Accurate monitoring observations

w/ new device “Field Stacker” (details later)

Atmospheric Transmittance & Wavelength Coverage



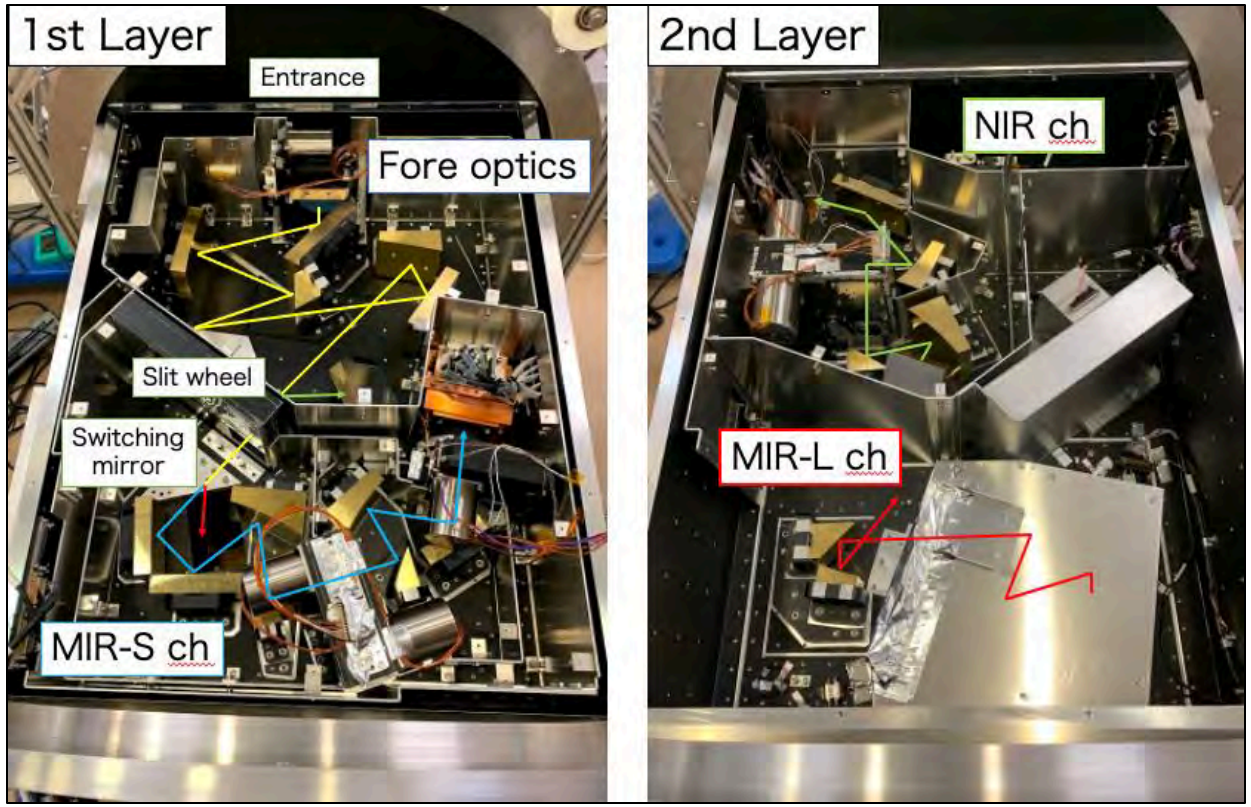


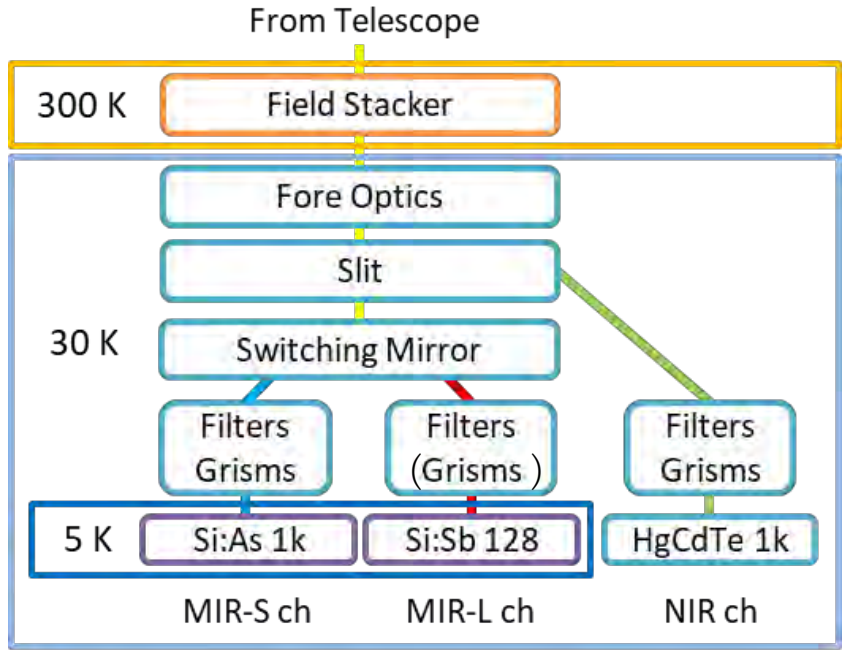
Wide wavelength coverage allows us to:

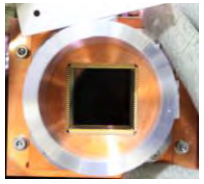
- observe stellar light and hot/cold dust grains surrounding stars
- investigate the amount, temperature, size & chemical composition of dust

Optical Layout & Detectors

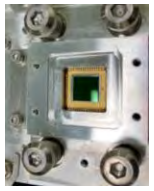
All-reflective optics with three selectable optical channels : NIR, MIR-S, MIR-L







Raytheon Aquarius

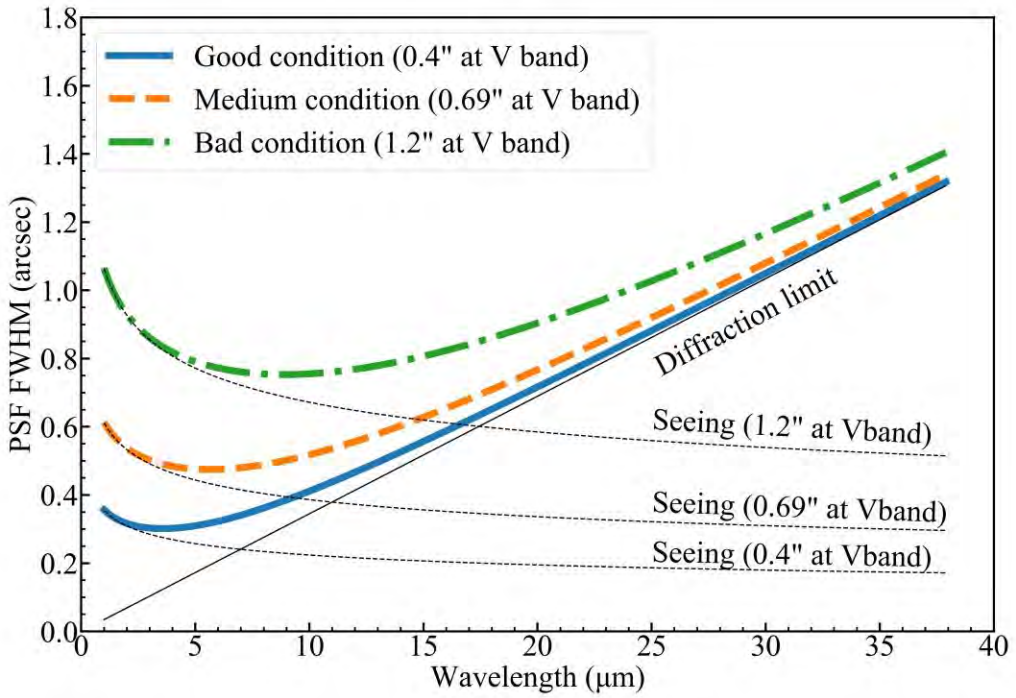


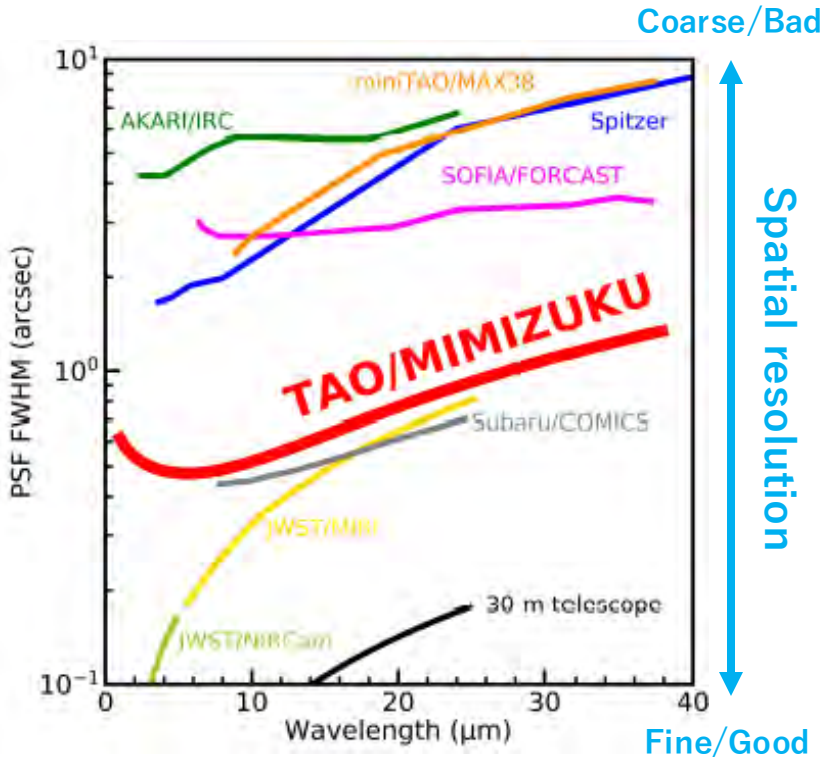
DRS Si:Sb MF-128



Teledyne H1RG

Spatial Resolution

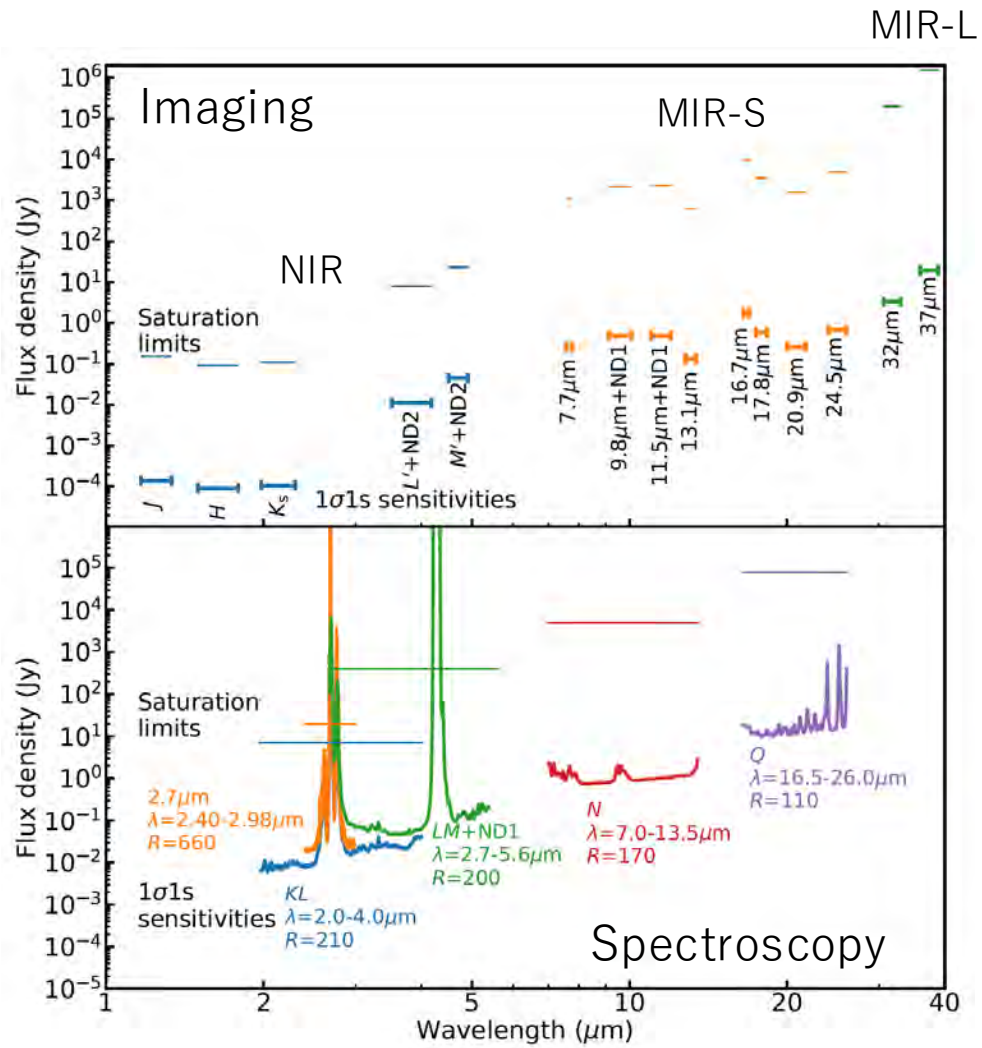




- The spatial resolution is limited by seeing and diffraction
- TAO/MIMIZUKU achieves comparable resolutions to 8-m class telescopes in the MIR
- **In the 30-μm band, TAO/MIMIZUKU achieves the best resolution**

(This will continue for a few decades)

Sensitivity & Saturation Limit



Updated points:

- Window material (Diamond → CsI)
  - Sensitivity in L/M bands improved
- MIR-L ch detector properties
  - updated based on experiments

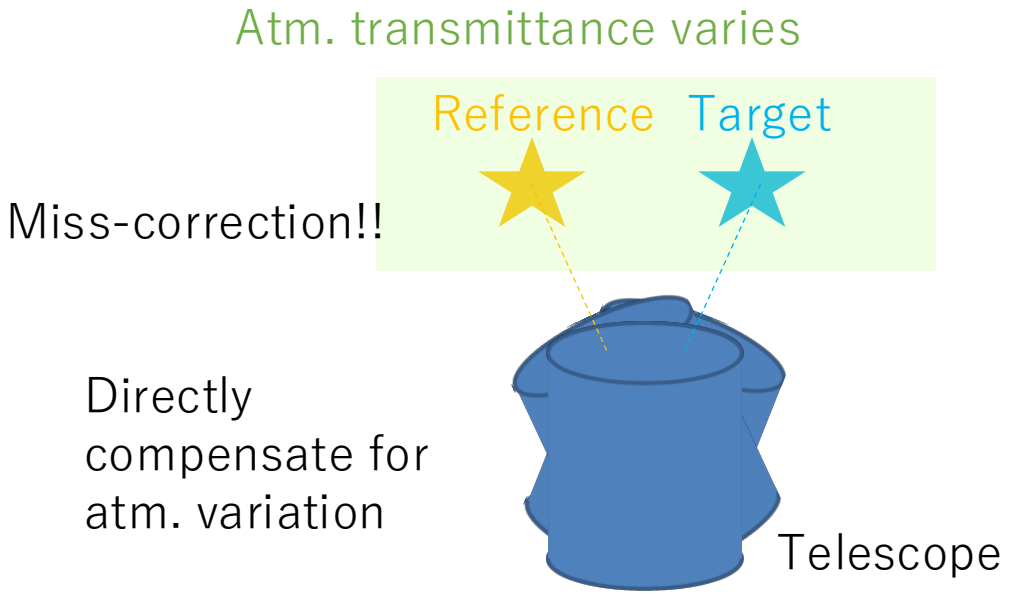
Perspectives of improvements:

- Implementation of short exposure for NIR ch
  - Enables to remove ND filters
  - Improves sensitivities
- Improvement of MIR-L ch sensitivity
  - Adjusting detector bias
  - Changing filter configuration

http://www.ioa.s.u-tokyo.ac.jp/TAO/mimizuku/pub/

Atmospheric Absorption Correction with Field Stacker

Comparison between reference objects and targets is needed for atmospheric absorption correction to determine the brightness or spectrum



Conventional method:

Observe reference object **before/after** observing target, because bright reference objects are sparse in the MIR

➔ Atmospheric variation causes miss-correction…

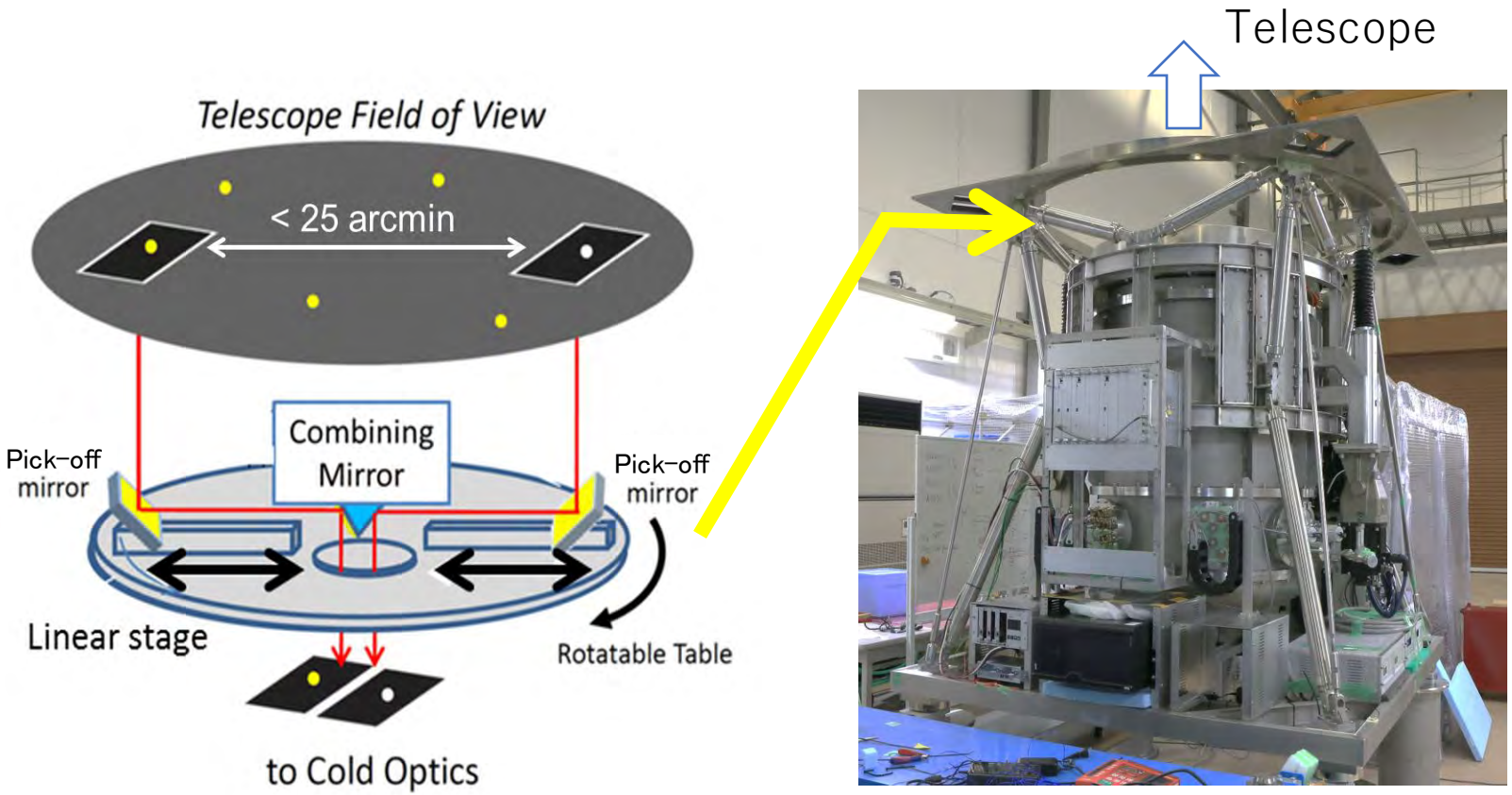
New method by Field Stacker:

Observe reference object and target **simultaneously** even when they are too separated to be observed in a single field of view

➔ **Achieve accurate correction**

Accurate correction leads to improved data reliability & enables precise monitoring observations from the ground

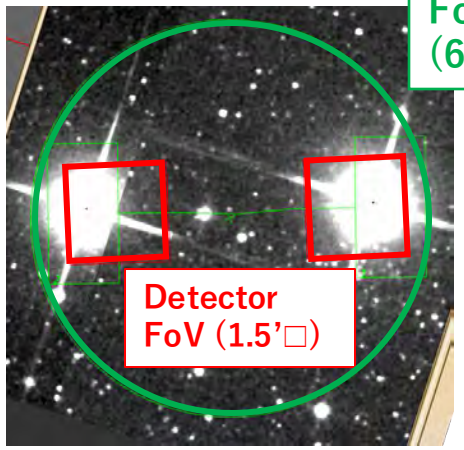
Field Stacker

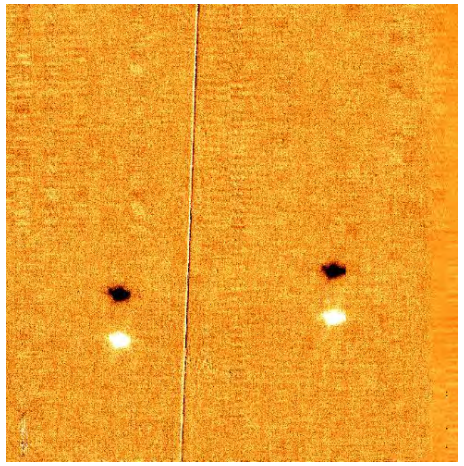


Three movable mirrors on the telescope focal plane enables **simultaneous observations of two arbitrary regions** on the sky (allowed separation < 25 arcmin)

For MIR standard star candidates (K-type giants): see poster **AS-8P** by **Yuki Kojima**

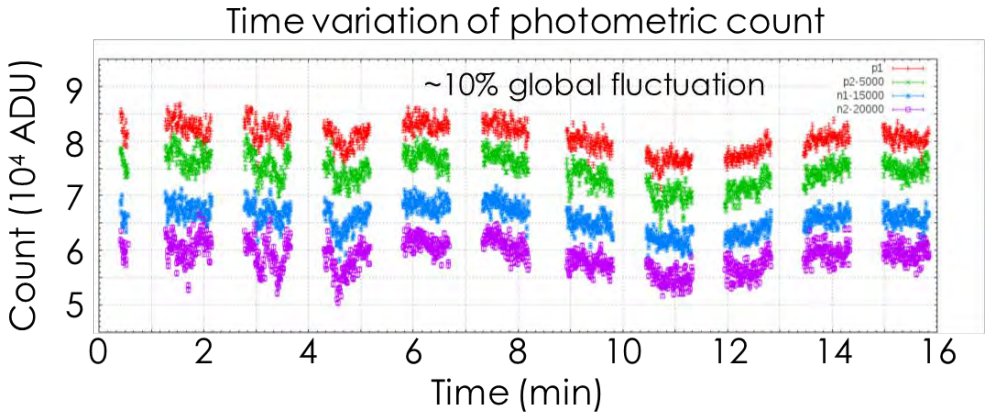
On-sky test @ Subaru telescope in 2018





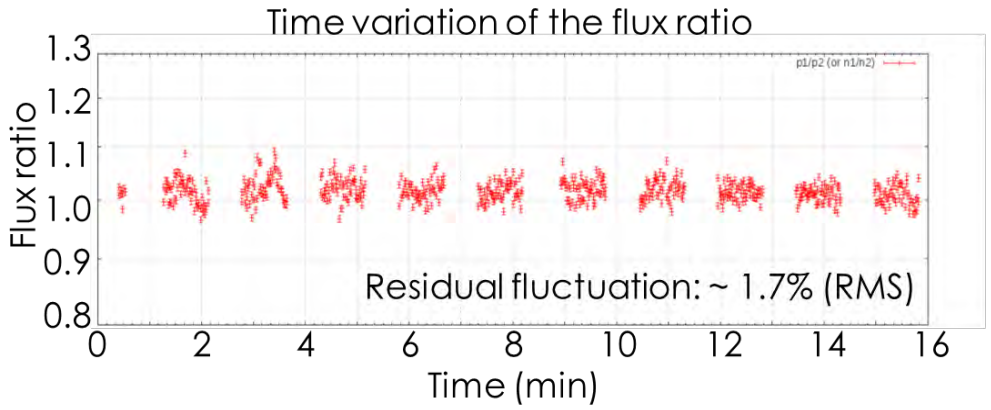
10 μm Field Stacker image (MIR-S Channel)

photometry



Photometric counts showed a 10% variation due to atmospheric variation

Taking ratio

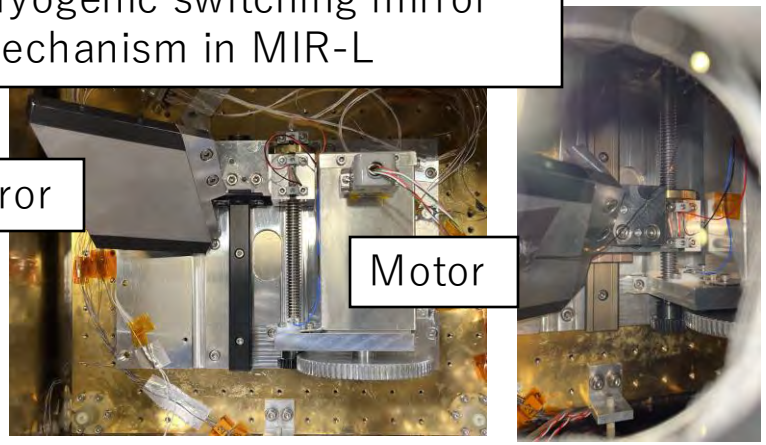


The variations in the count ratio were suppressed to below 2%

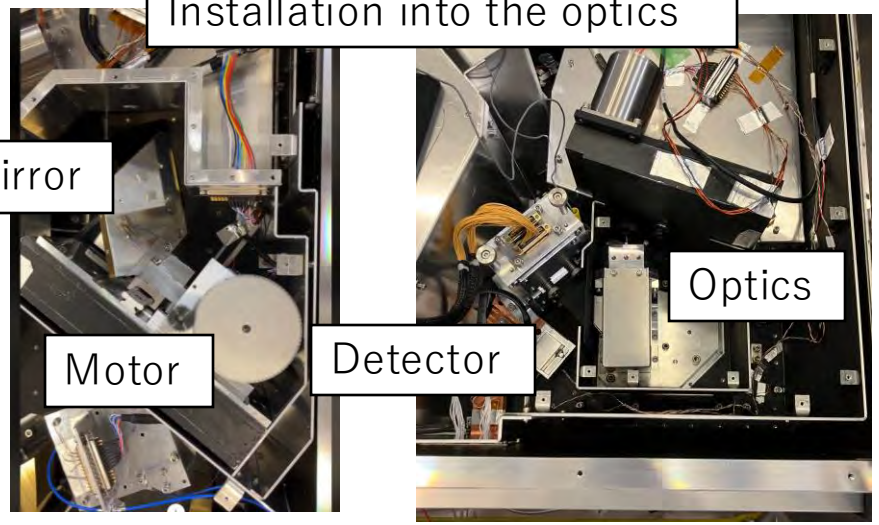
➔ **Field Stacker improves atmospheric correction**

Current Status: Final Integration and Performance Evaluation

Cryogenic switching mirror mechanism in MIR-L



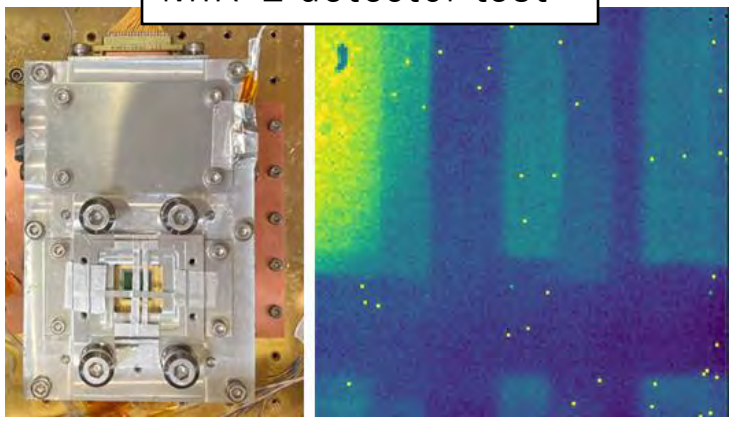
Installation into the optics

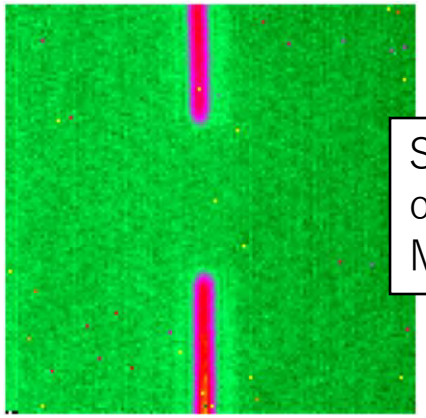


Evaluation of CsI window



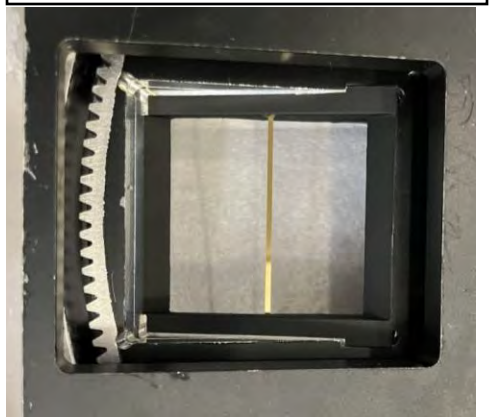
MIR-L detector test





Slit image obtained by the MIR-L

Evaluation of NIR slit



Will be transported to Chile in Mid-2026

Summary

- MIMIZUKU enables imaging and low-resolution spectroscopy in 1.2–38 μm with high spatial resolution

- Field Stacker on MIMIZUKU has a good potential to realize accurate photometric/spectroscopic monitoring observations, which is difficult for other instruments

- After final integration and performance verification in Japan, MIMIZUKU will be transported to Chile in mid-2026 and first light on TAO telescope is expected shortly thereafter

Thank you!

