MIMIZUKUの開発進捗と最新スペック
～Current status and specifications of MIMIZUKU～

Takafumi Kamizuka (IoA/UT)
MIMIZUKU and TAO group

MIMIZUKU Science Workshop　@ IoA　(2013/05/24)

TAO Project

The university of
Tokyo Atacama Obervatory

Next-gen. Observatory of UT (P.I.: Y. Yoshii)

- 6.5-m infrared telescope
- 1st-gen. instruments
  NIR: SWIMS, MIR: MIMIZUKU
- 40%-time for Japanese community

SWIMS

MIMIZUKU

TAO 6.5-m telescope and instruments

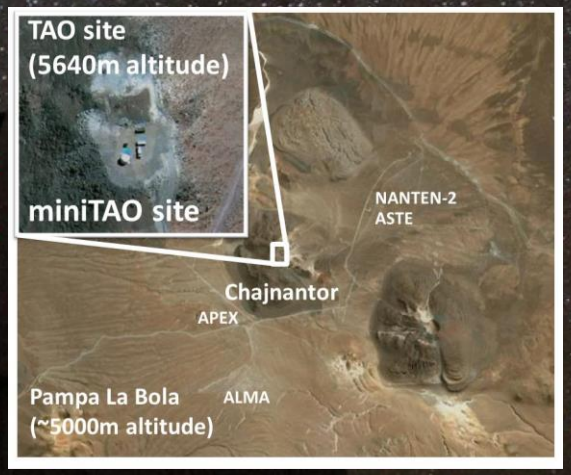
TAO Site

- Summit of Co. Chajnantor
  in the Atacama desert, Chile (5640m alt.)

High altitude + Dry climate

➔ Low PWV (Precipitable Water Vapor)
0.38mm (10%-ile)

➔ Ideal site for infrared astronomy

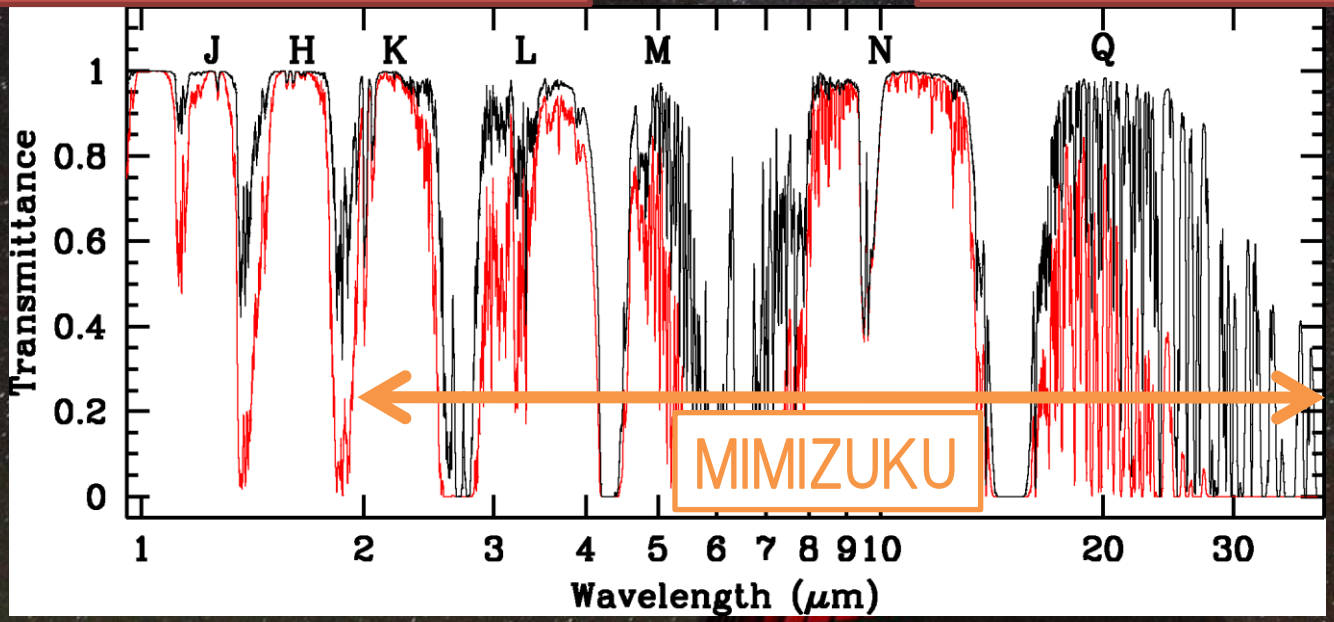


TAO Site

Atmospheric Windows

NIR Water Absorption Bands
➔ Water related matter
Water, Water Ice, Hydrous silicate

30-micron band
➔ Low temperature dust
Crystalline silicate, MgS/FeS

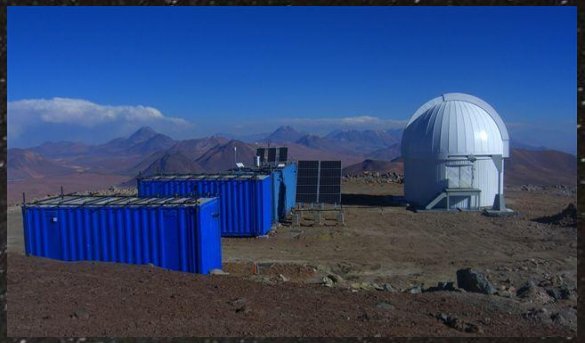


Atmospheric Transmittance
Red : VLT @ 2600m alt., PWV=2.0mm
Black : TAO @ 5640m alt., PWV=0.5mm

MAX38 and ANIR on miniTAO

MAX38
Mid-infrared Astronomical eXplorer

miniTAO Telescope
- 1-m pilot telescope for TAO
- Site evaluation
  - Scientific capability
  - Operation stability



miniTAO Telescope

MAX38 – Mid-infrared Astronomical eXplorer –
- Mid-infrared Imager (λ: 3—38μm)
- First Light : 2009/11

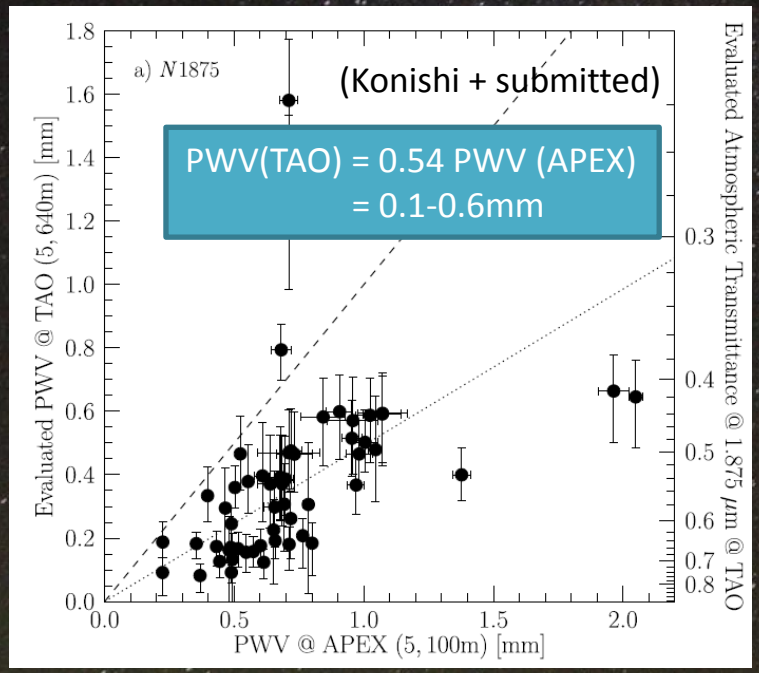
ANIR – Atacama Near InfraRed camera –
- Near-infrared Imager (λ: 1.0—2.1μm)
- First Light : 2009/6

MAX38 and ANIR
on miniTAO Telescope

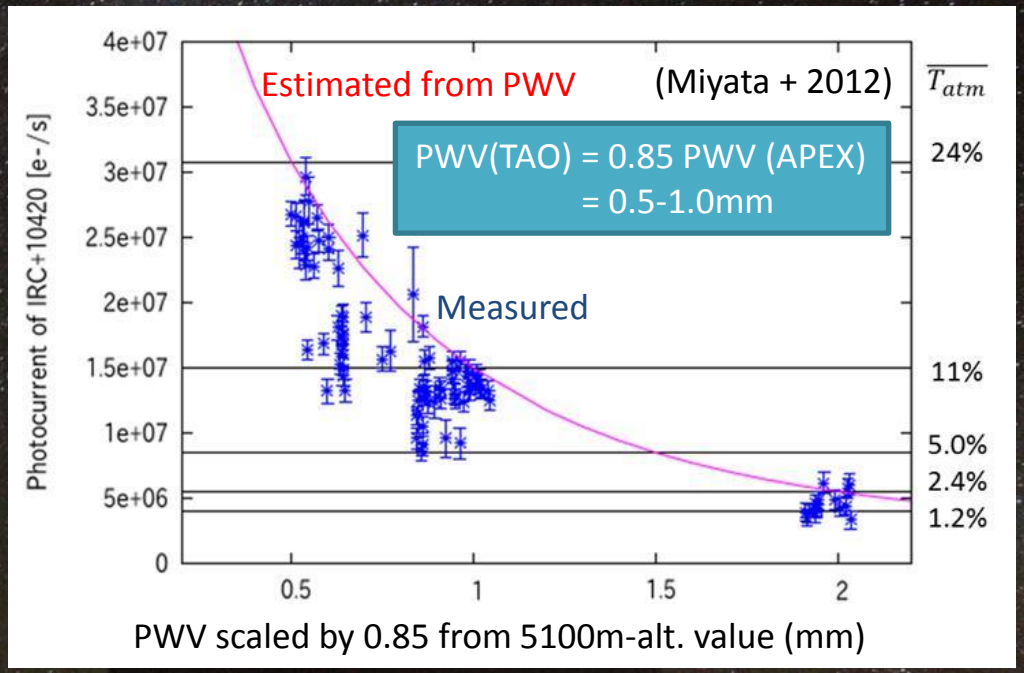
PWV Estimation

MAX38
Mid-infrared Astronomical eXplorer

PWV estimated by infrared observations



PWV estimation in NIR band (1.875um)



PWV estimation in MIR band (31.7um)

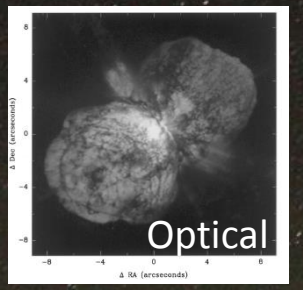
New windows are stably available

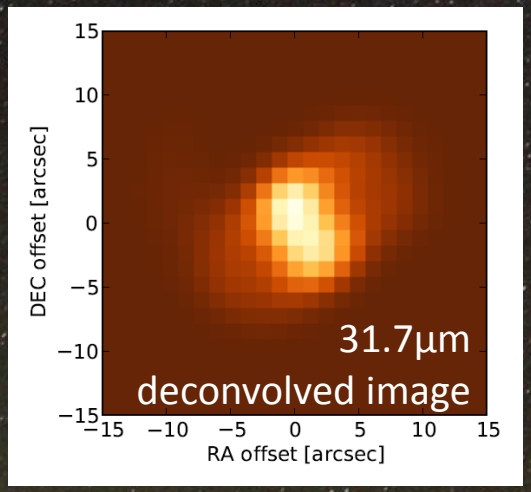
Scientific Results of 30-micron Observations

MAX38
Mid-infrared Astronomical eXplorer

First high-resolution 30-micron images of dying stars
➔New insights of dust formation

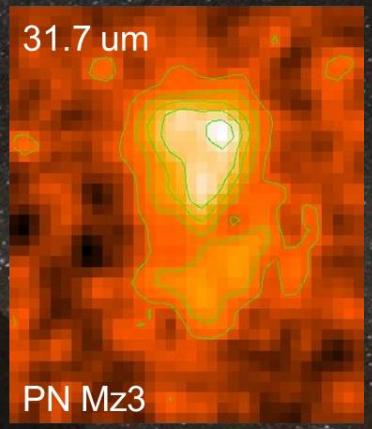
Luminous Blue Variable: η Car (Nakamura D. Thesis)





Dust-formation rate ➔ $7 \times 10^{-5} M_{\odot}$/yr
Greater than conventional estimation by 10^3 !!

Planetary Nebula: Mz3 (Asano in prep.)



Dust in central core ➔ $2 \times 10^{-3} M_{\odot}$
Greater than conventional estimation by 10^3 !!

MIMIZUKU

Mid-Infrared Multi-field Imager for gaZing at the UnKnown Universe

A next-gen. MIR Instrument

- Wide band coverage (λ=2—38 μm)
- High spatial resolution
- 2-beam simultaneous observation
  - Precise photometry / spectroscopy

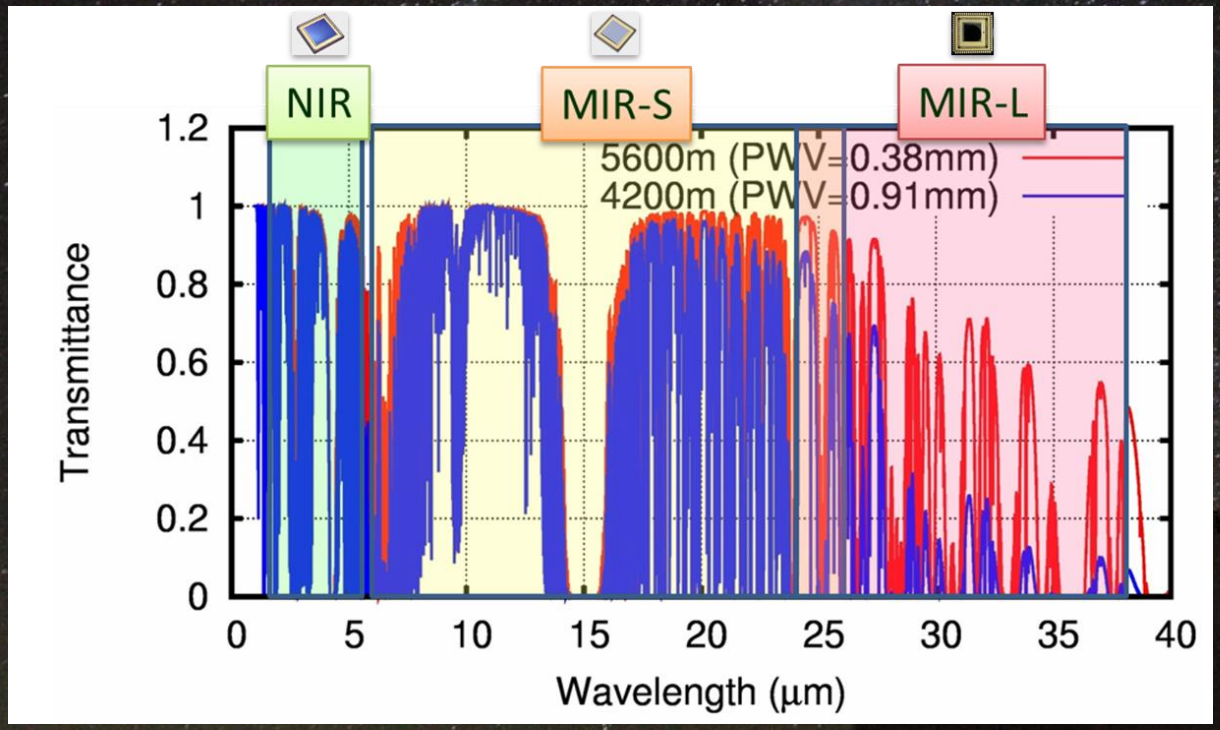
Schedule

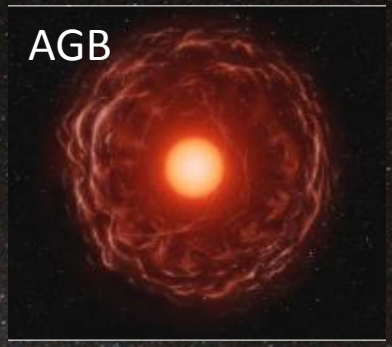
- Development —2014
- Obs. @ Subaru 2015B—2017
- Obs. @ TAO 2018—

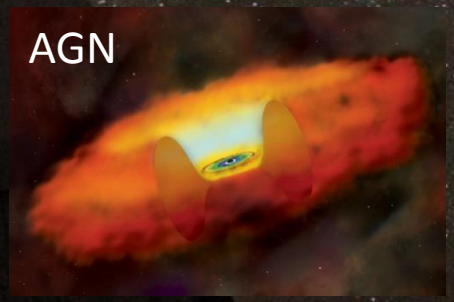
MIMIZUKU
(2m x 2m x 2m; 2.3t)

Wavelength Coverage

2—38 μm covered by 1 instrument







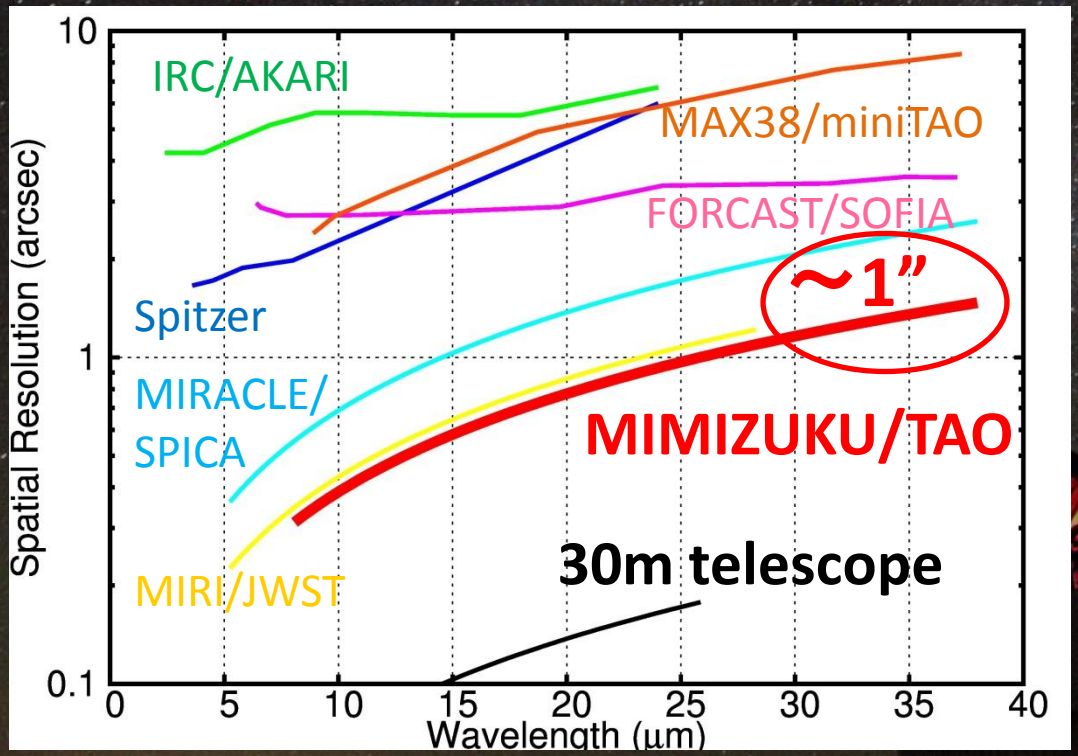
Heating Source

Warm dust

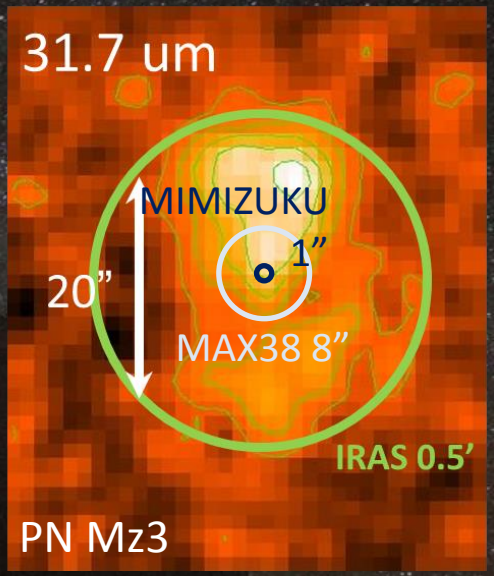
Cold dust

Spatial Resolution

Highest at 30-micron band for a few decades



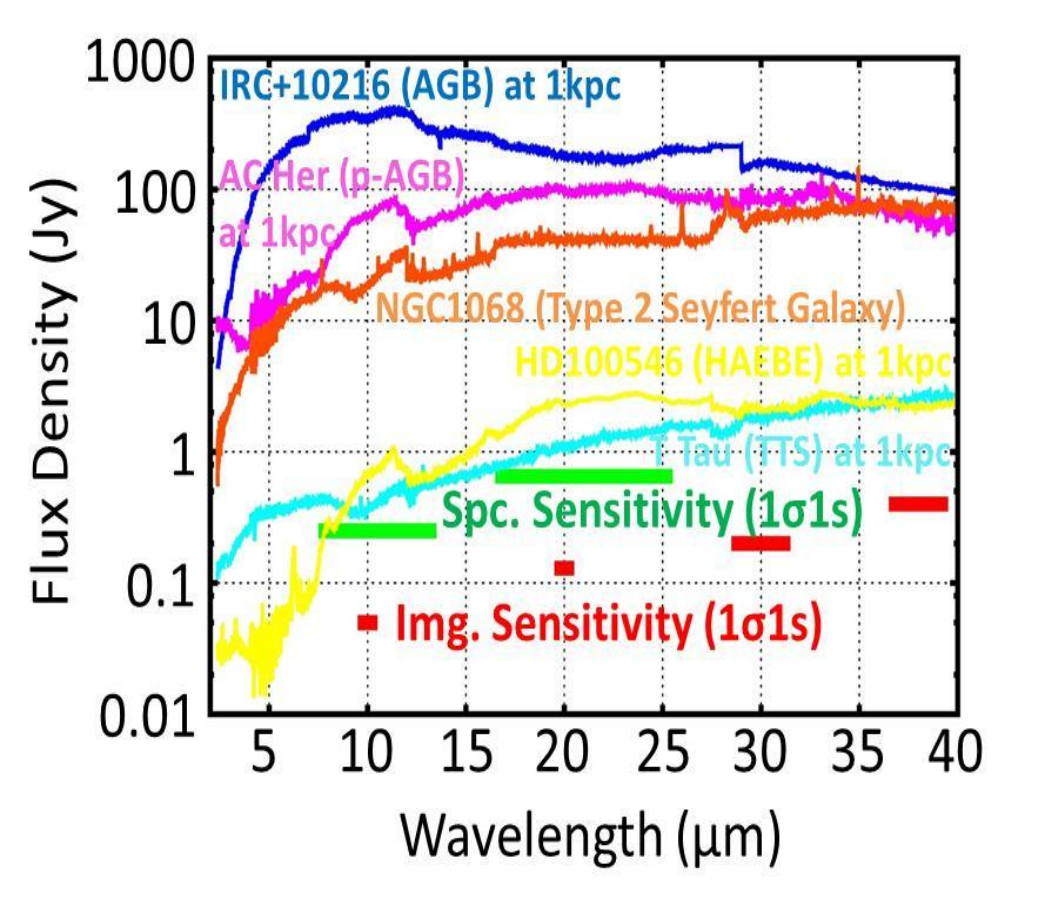
Spatial resolution of MIR instruments



Beam-size comparison

Sensitivity

Various kind objects are observable



Estimated sensitivity compared with spectra of various kind objects

Field Stacker

Equipped on top of MIMIZUKU

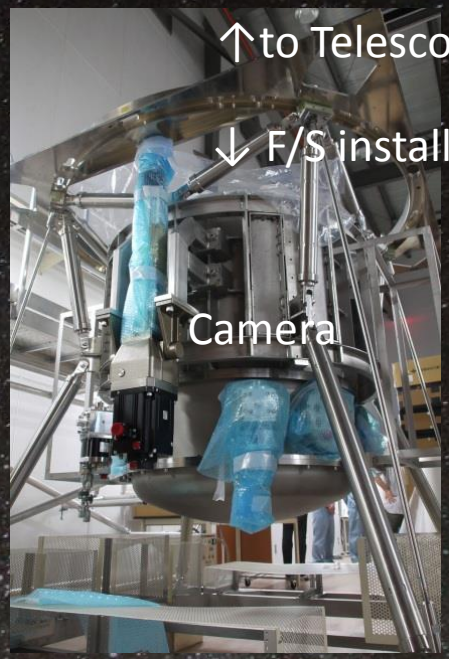
- Picks up 2 fields
- Combines them onto one detector

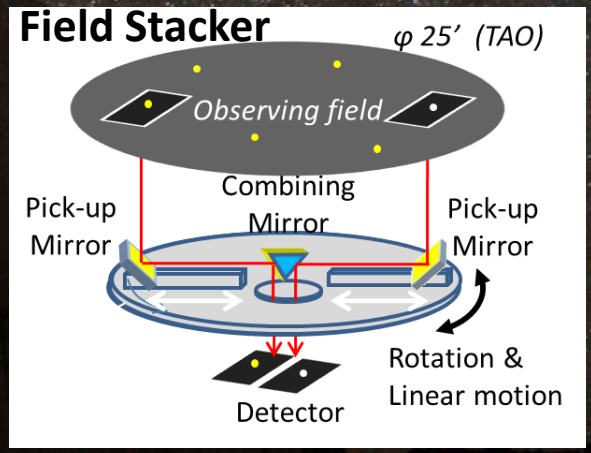
➔Target and Reference object simultaneously observed

➔Atm. variation canceled

➔Precise photometry / spectroscopy

Powerful tool for
Long-term monitoring
Q- and 30-um band spectroscopy





Specifications (prev.)

		NIR ch	MIR-S ch	MIR-L ch
Wavelength		2—5.6μm	6—26μm	24—38μm
Detector		InSb Alladin II 1024x1024	Si:As AQUARIUS 1024x1024	Si:Sb DRS HF-128 128x128 (Opt.: 1024x1024)
Pixel Scale		0.11”/pix	0.11”/pix	0.44”/pix
Field of View	w/o FS	2’x2’	2’x2’	56”x56”
	w/ FS	1’x2’x2fields	1’x2’x2fields	28”x56”x2fields
Imaging Filters		K, L’, M (J, H option)	Med-band filters Narrow-band filters	Med-band filters (Δλ~3μm)
Spectroscopy		2.8—5.5μm R~180	7.5—13.5μm R~230 16.5—25.5μm R~160	26—38μm R~60 (option)
Slit		0.6”x60”	0.3”/0.6” x 60”	1.2”x50”

Specifications (TAO)

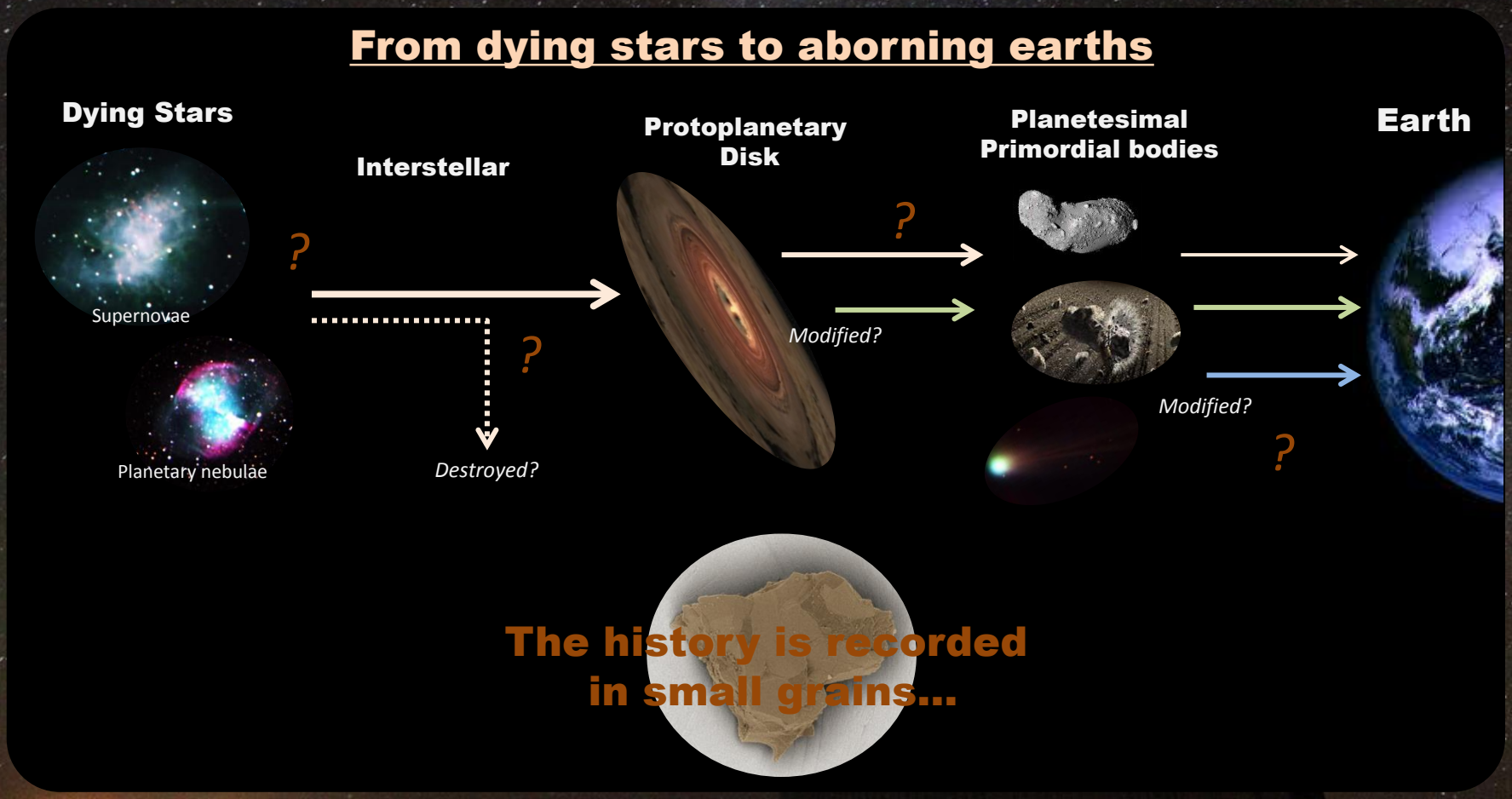
		NIR ch	MIR-S ch	MIR-L ch
Wavelength		2—5.6(?)μm	6—26μm	24—38μm
Detector		H2RG 5um-cut 1024x1024	Si:As AQUARIUS 1024x1024	Si:Sb DRS HF-128 128x128
Pixel Scale		0.07”/pix	0.11”/pix	0.18”/pix
Field of View	w/o FS	1.2’x1.2’	2’x2’	23”x23”
	w/ FS	0.6’x1.2’x2fields	1’x2’x2fields	23”x11”x2fields
Imaging Filters		K, L’, M (J, H option)	Med-band filters Narrow-band filters	Med-band filters (Δλ~3μm)
Spectroscopy		2.8—5.5(?)μm R~180	7.5—13.5μm R~230 16.5—25.5μm R~160	26—38μm R~60 (option)
Slit		0.6”x60”	0.3”/0.6” x 60”	1.2”x50”

Specifications (Subaru)

		NIR ch	MIR-S ch	MIR-L ch
Wavelength		2—5.6(?)μm	6—26μm	24—38μm
Detector		H2RG 5um-cut 1024x1024	Si:As AQUARIUS 1024x1024	Si:Sb DRS HF-128 128x128
Pixel Scale		0.07”/pix	0.11”/pix	0.18”/pix
Field of View	w/o FS	1.2’x1.2’	2’x2’	23”x23”
	w/ FS	0.6’x1.2’x2fields	1’x2’x2fields	23”x11”x2fields
Imaging Filters		K, L’, M (J, H option)	Med-band filters Narrow-band filters	Med-band filters (Δλ~3μm)
Spectroscopy		2.8—5.5(?)μm R~180	7.5—13.5μm R~230 16.5—25.5μm R~160	26—38μm R~60 (option)
Slit		0.6”x60”	0.3”/0.6” x 60”	1.2”x50”

Science Case

Origin of Terrestrial Material
from dying stars to aborning earths

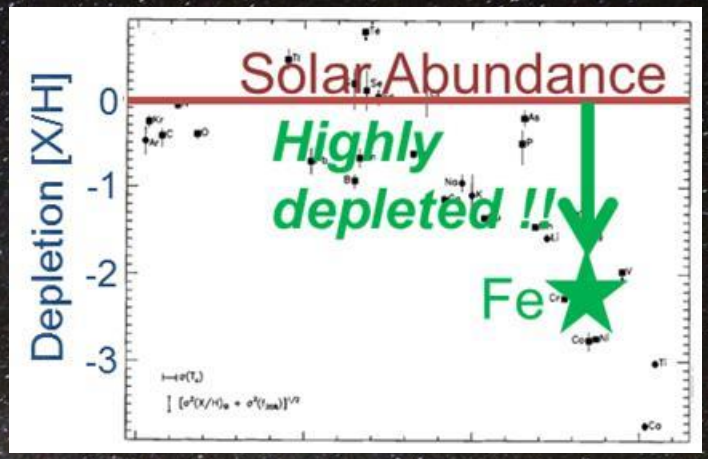


Searching Iron Grains

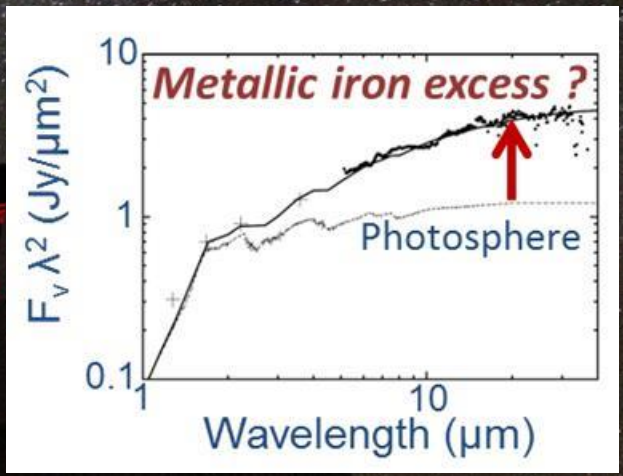
Where are iron grains in the universe?

IR cont. of AGB star can be emission of iron or water vapor.

Separate them by monitoring NIR water bands and IR cont., and investigate iron existence.



Depletion pattern of ζ Oph cloud (Savage & Sembach 1996)

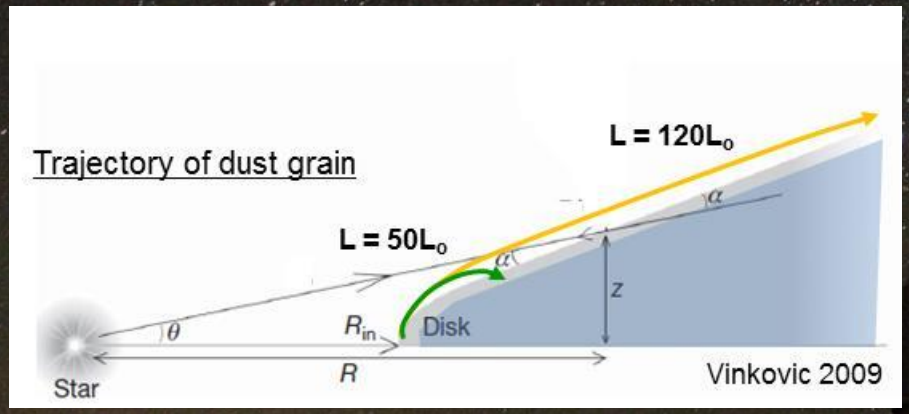


Possible detection of metallic iron emission (McDonald et al. 2010)

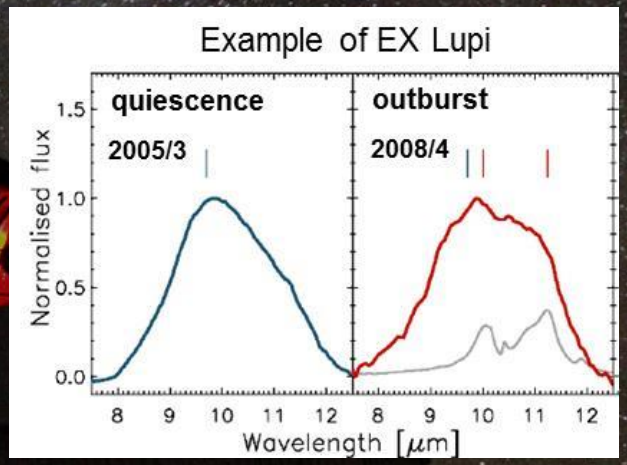
Dust Stream in Protoplanetary Disks

What did cause dust homogenization in the presolar nebula?

Investigate a dust stream by monitoring crystalline silicate feature at 10, 20, 30-micron band.



Outward dust stream on the disk surface

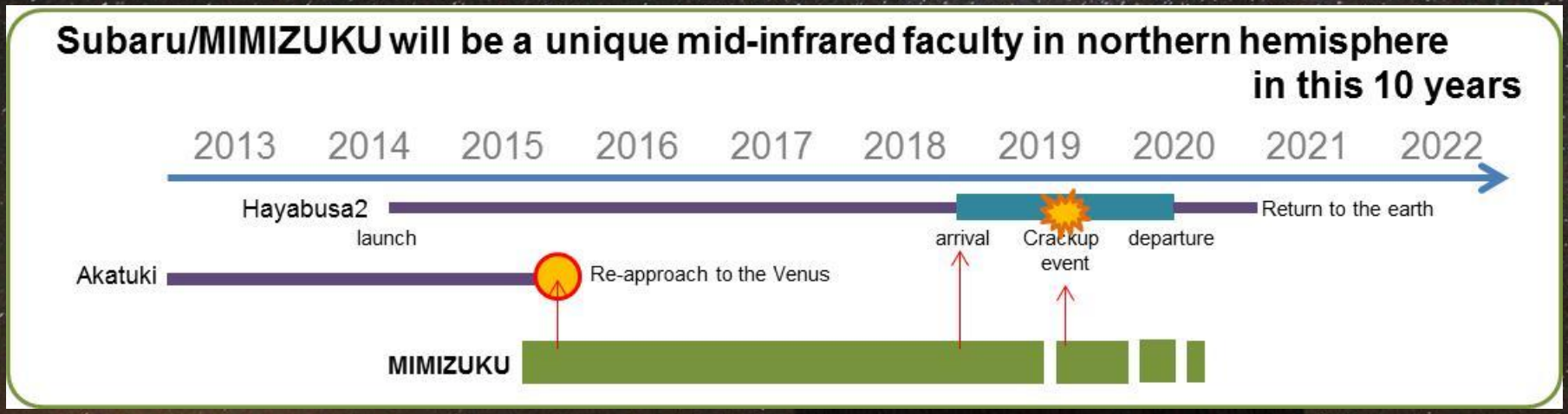


Silicate crystallization observed for EX Lup

Corroboration with Spacecraft Missions

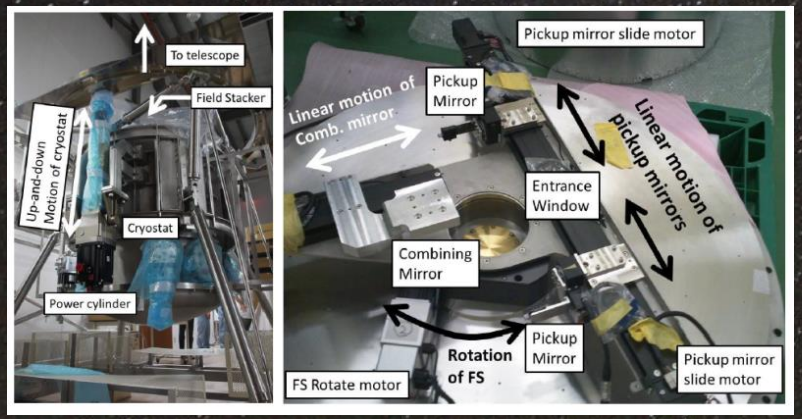
MIMIZUKU can be a strong tool for preliminary or simultaneous obs. of exploration missions.

- Target selection for sample return missions
- Simultaneous obs. of "Crackup" experiments



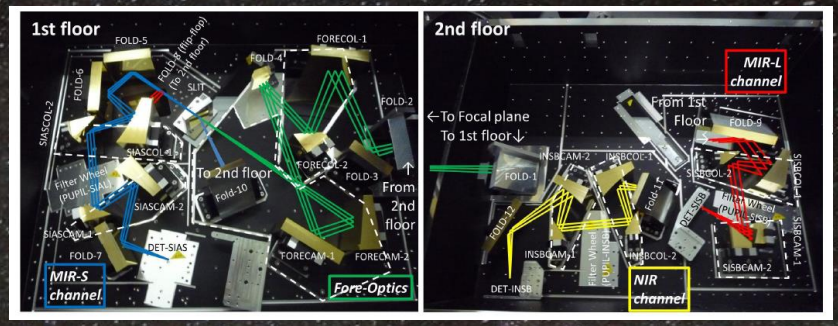
Development

Cryostat & Field Stacker



- Improving cryogenics
- Constructing SW board
- Motion test of F/S

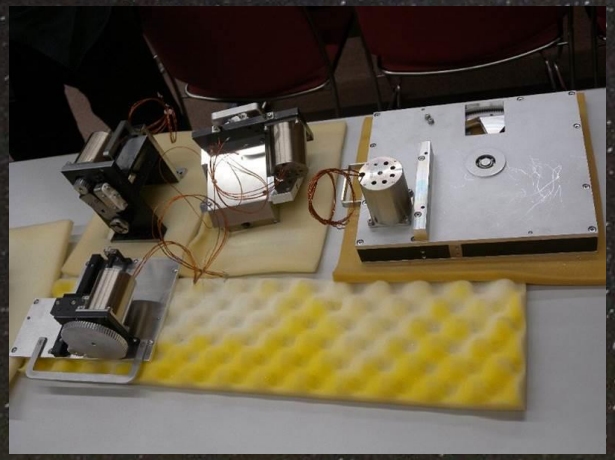
Optics



- Mirror degradation found
- Investigating its cause
- Re-fabrication of mirror

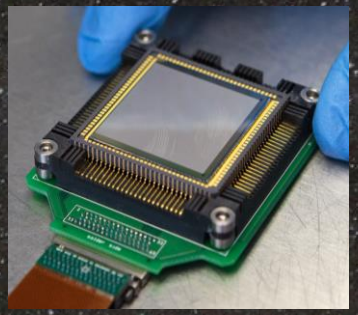
Development

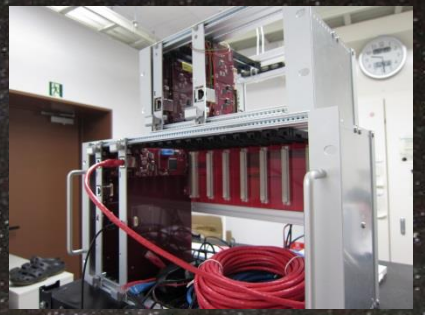
Cryo-mechanics



- Fabrication almost finished
- Cryogenic test
- Development of control system

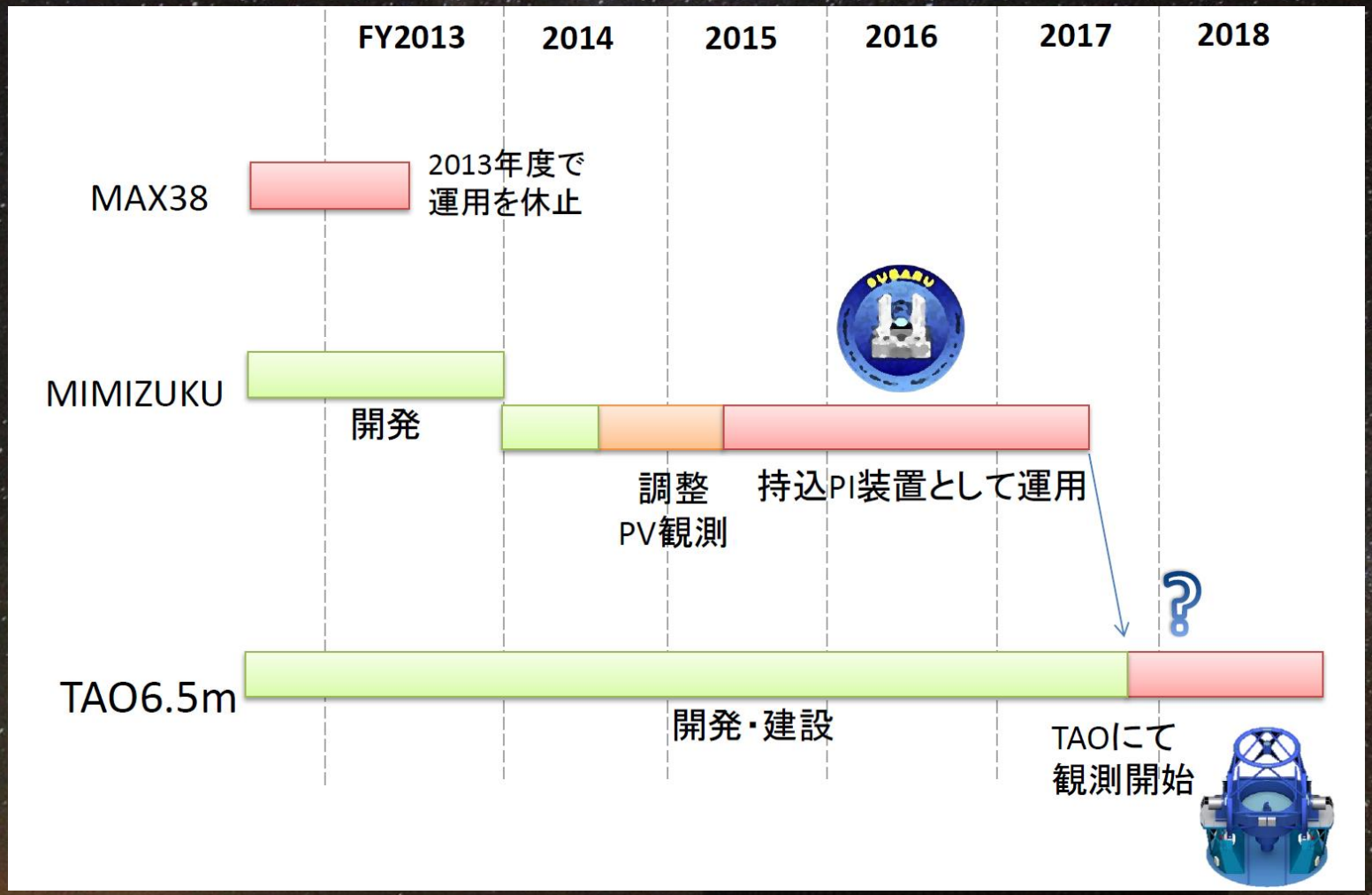
Detector system





- Digital board completed
- Construction of analog board
- Development of cryo-elec. board

Schedule


FY2013
2014
2015
2016
2017
2018
MAX38
2013年度で
運用を休止
MIMIZUKU
開発
調整
PV観測
持込PI装置として運用
?
TAO6.5m
開発・建設
TAOにて
観測開始

Summary

Usefulness of the new atmospheric windows is validated by ANIR and MAX38 on miniTAO

MIMIZUKU is now under development.
Some specifications changed.

Completion of MIMIZUKU : early 2014
Open-use on Subaru : 2015B-2017
MIR-L ch and some functions are limited
Full-MIMIZUKU on TAO : 2018-

We hope MIMIZUKU can contribute to your interesting science.
Let's discuss how to use MIMIZUKU!
Thank you for your participation!