TAO PROJECT
The University of Tokyo Atacama Observatory

東京大学 大学院
理学系研究科・理学部
SCHOOL OF SCIENCE, THE UNIVERSITY OF TOKYO

東京大学
THE UNIVERSITY OF TOKYO

The University of Tokyo Atacama Observatory Project

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on behalf of miniTAO and TAO Project Team

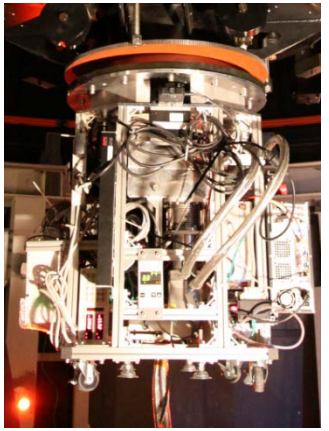
Graduate School of Science, Institute of Astronomy

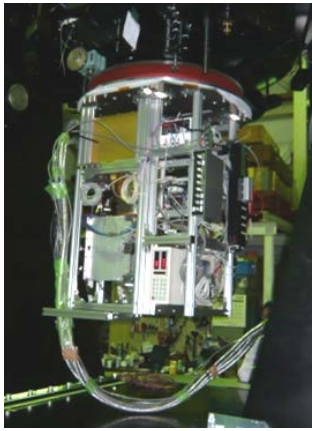
- Since 1988
  - For observational astrophysics and instrumentation
- Location
  - Mitaka : Suburb of Tokyo
  - Next to the NAOJ campus
- People
  - Director : Prof. M. Doi
  - 3 prof., 4 assoc. prof., 5 asssis. prof.
  - 4 technical staffs, 5 postdocs
- Observatories
  - Kiso Observatory (1974 -)
    - 1m Schmidt Telescope
  - Atacama Observatory (2015 -)
    - 1m miniTAO telescope
    - 10m ASTE telescope
    - TAO 6.5m telescope

Instrumentation at IoA

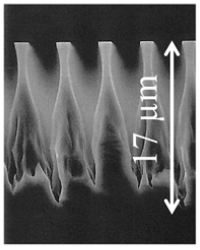
Tomoe Prototype

- Optical
  - miniAO : cheap and fast AO for small telescopes (Minezaki)
  - KISO / Tomoe Gozen Wide-field CMOS Imager (Morokuma's presentation)
  - LISS : Camera/Spectrograph for small telescopes (Doi)
- IR :
  - TAO insruments : SWIMS(NIR : Motohara) / MIMIZUKU (MIR : Miyata)
  - miniTAO instruments : ANIR (NIR : Motohara) / MAX38 (MIR : Miyata)
  - WINERED : High resolution NIR spectrograph (0.9-1.4um) (Kobayashi)
  - NICE : NIR(0.9-2.5um) Echelle spectrograph (Tanaka)
- Radio
  - ASTECAM : STJ two-color camera (Kohno)
- Various element technology
  - Array Readout System for CCD, CMOS, NIR and MIR arrays (Sako)
  - Moth-eye AR structure for Si lens (Miyata)
  - Metal-mesh filter for MIR (Sako)
  - Microshutter array (Toshiyoshi's presentation)
  - Cryogenic chopping mirror system (Kamizuka)
  - Immersion Grating for WINERED (Kobayashi)





miniTAO ANIR(NIR) and MAX38(MIR)

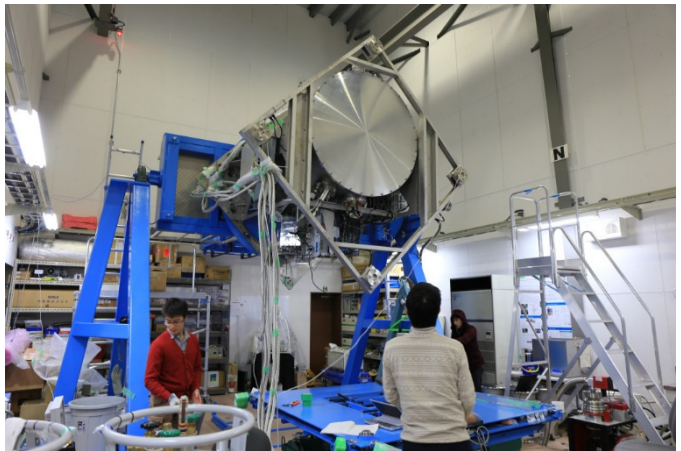


MOTHEYE Lens

Support Facilities

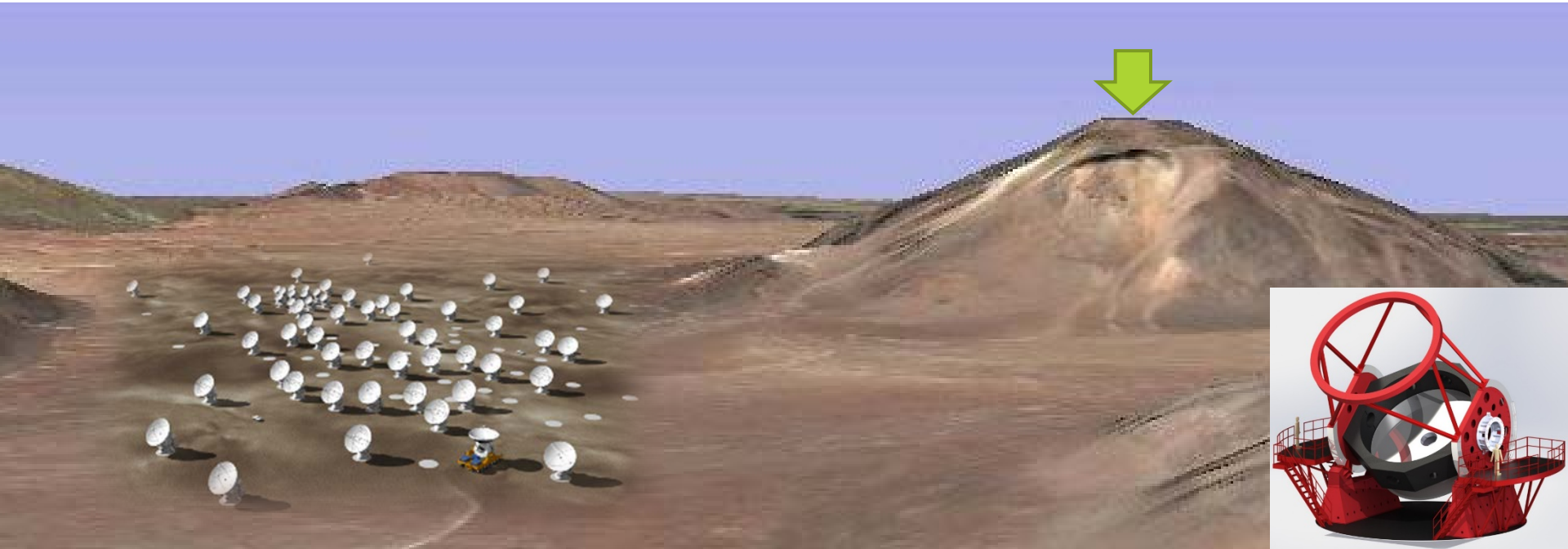
- Large Instrument Lab
- Telescope Simulator
- Clean Room

- Advanced Technology Center of NAOJ



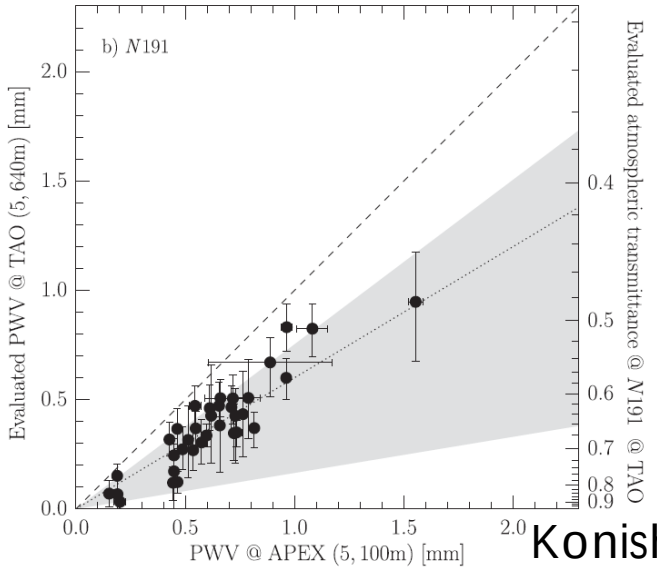
TAO 6.5m Telescope Project

- Install a 6.5m infrared-optimized telescope
- At the summit of Co. Chajnantor (5640m)
- PI : Prof. Yuzuru Yoshii



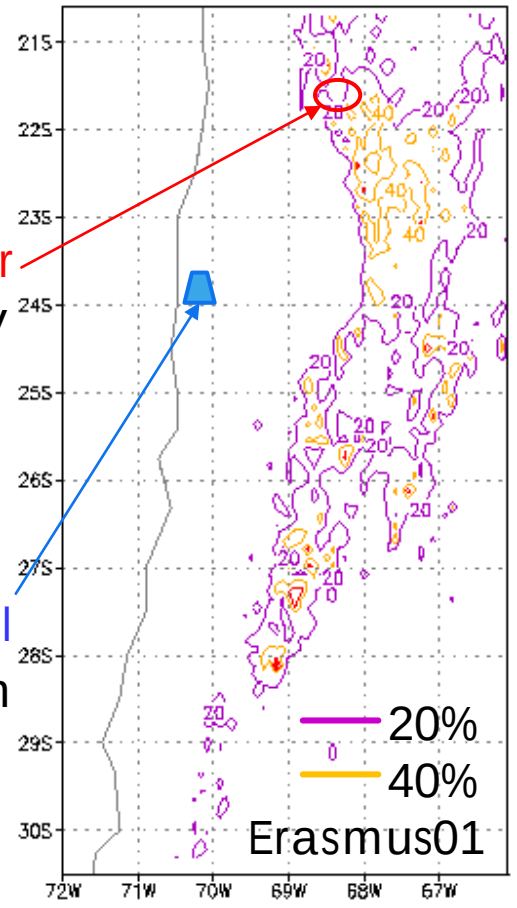
Very Low Water Vapor at Chajnantor

- Median PWV < 0.7mm
  - Constant <0.5mm available at winter – spring
  - Lower than ALMA site by 40-50%
- Clear Fraction > 70%



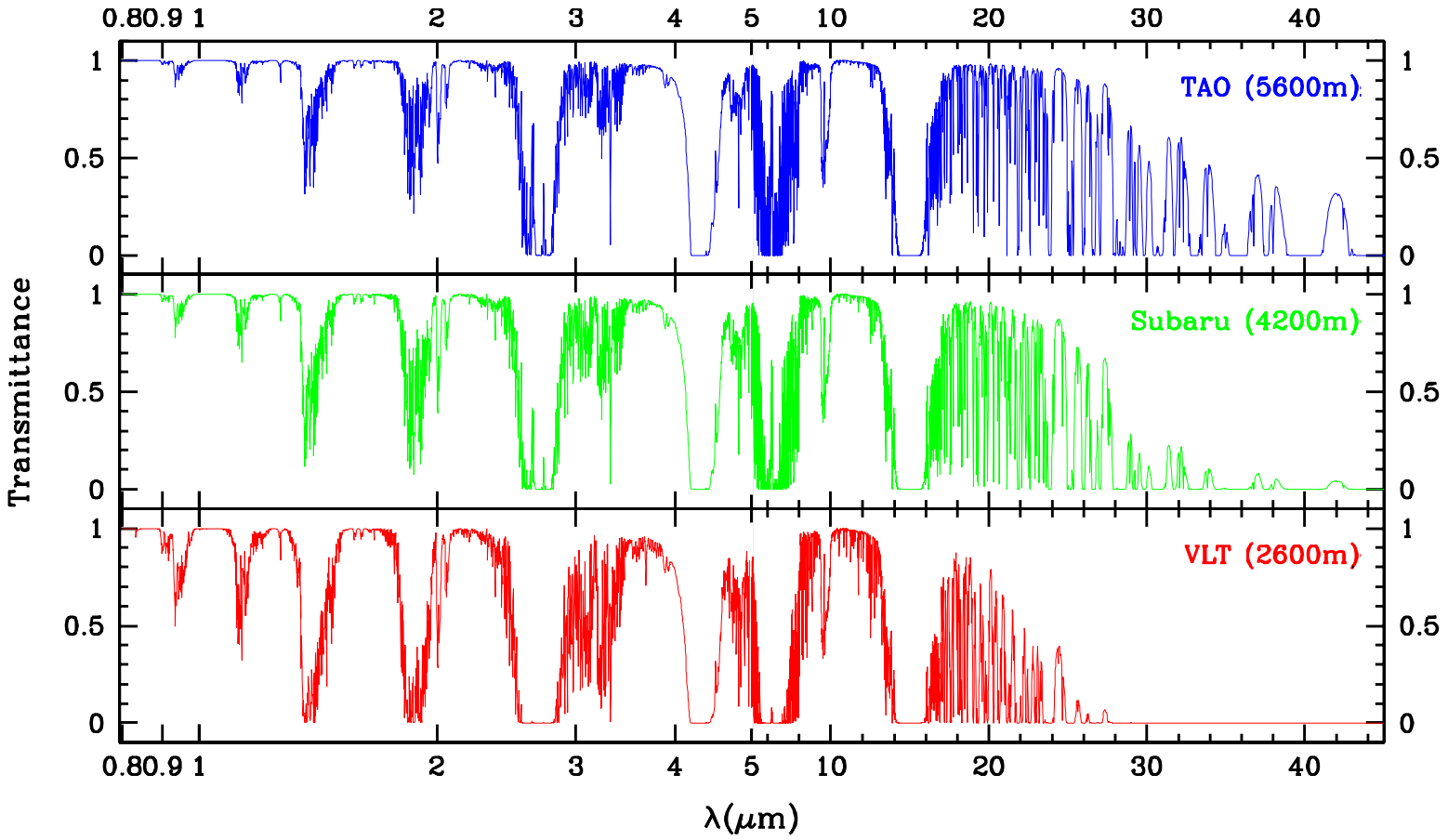
Konishi+15

Frequency of PWV < 1mm

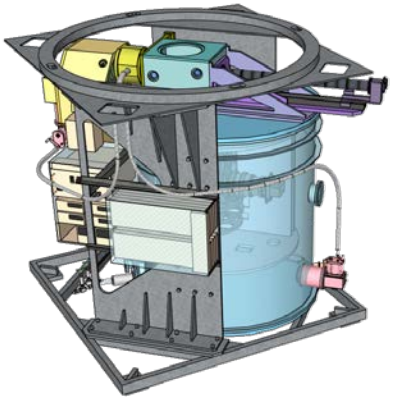


High Atmospheric Transmittance

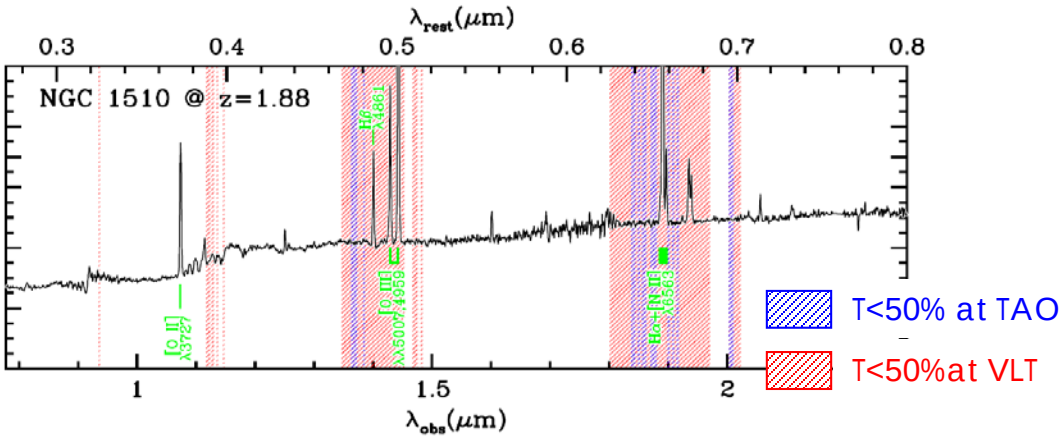
- Continuous window at NIR, New windows at MIR

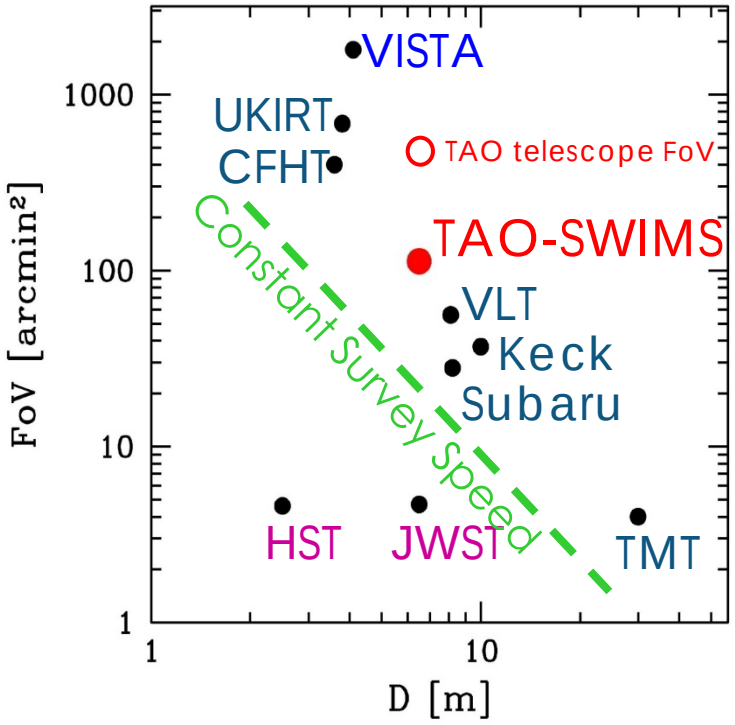


TAO NIR Science



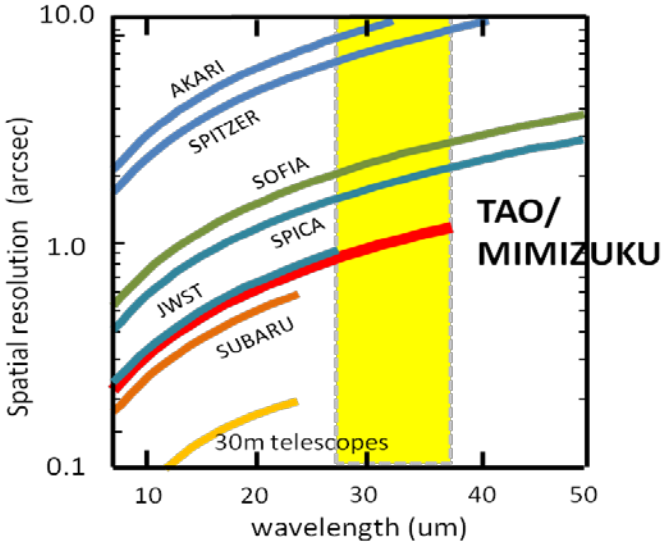
- NIR Features
  - Almost continuous wavelength coverage in 0.9-2.5 μm
  - Good image quality <0.7" (visible)
- Deep & Wide survey
  - Deeper with better image quality than VISTA
  - Spectroscopy covering wide z-range
  - Hi-z galaxies and clusters, QSOs, SNe, ..
- Wide Field Imag./MOS SWIMS (0.042□˚)

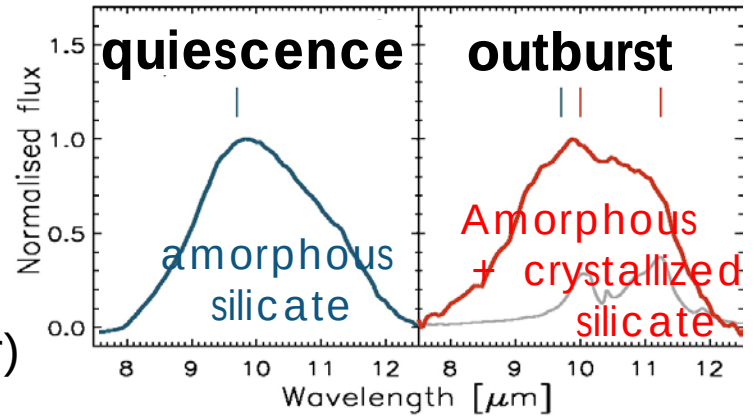




TAO MIR Science

- MIR Features
  - New windows at 30μm, high sensitivity at 10-20μm
  - Diffraction limit PSF with 6.5m aperture
- Pioneering new parameter space
  - Long-term temporal variation monitoring at MIR
  - High spatial resolution imaging (esp. bright objects, not observable with JWST)
  - Proto-planetary disk and planet formation
  - Dust formation around stars and planetary nebulae
- Imag. / Spec. with MIMIZUKU capable of relative photometry in MIR





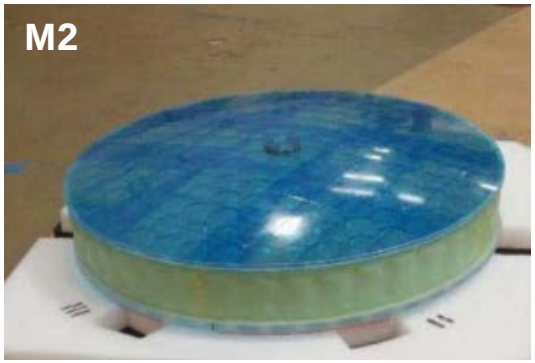
EX Lupi (FU Ori type, T Tauri star)
Abraham+09

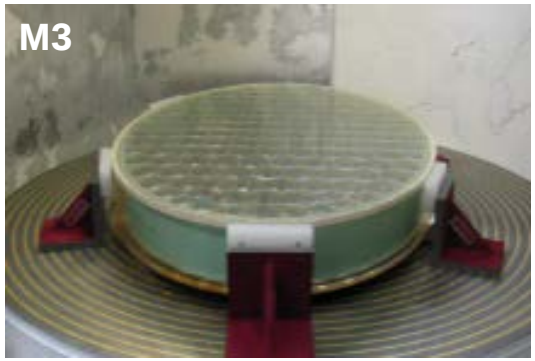
Telescope Structures

- Magellan-like Alt-Az Structure
- 2 Nasmyth foci, 2 bent-Cassegrain foci
- Production by Nishimura Co., Ltd.
- Preassembly underway

Mirrors

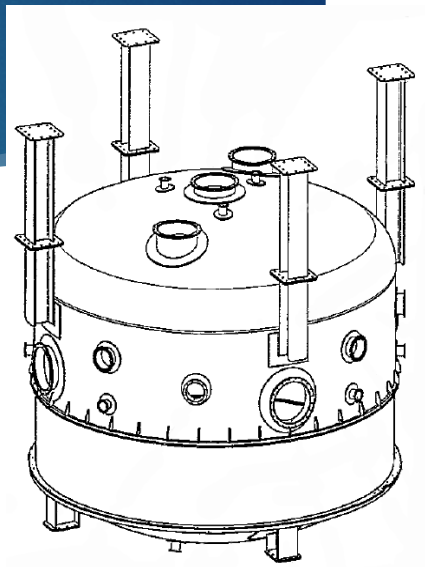
- Borosilicate honeycomb mirror
  - M1 : 6.5m primary
  - M2 : 0.9m secondary
  - M3 : 1.1x0.75m tertiary
- Production by Mirror Lab, University of Arizona





Re-aluminizing Facility

- Washing facility and primary mirror cell carrier are fabricated
- Detail design of main chamber completed

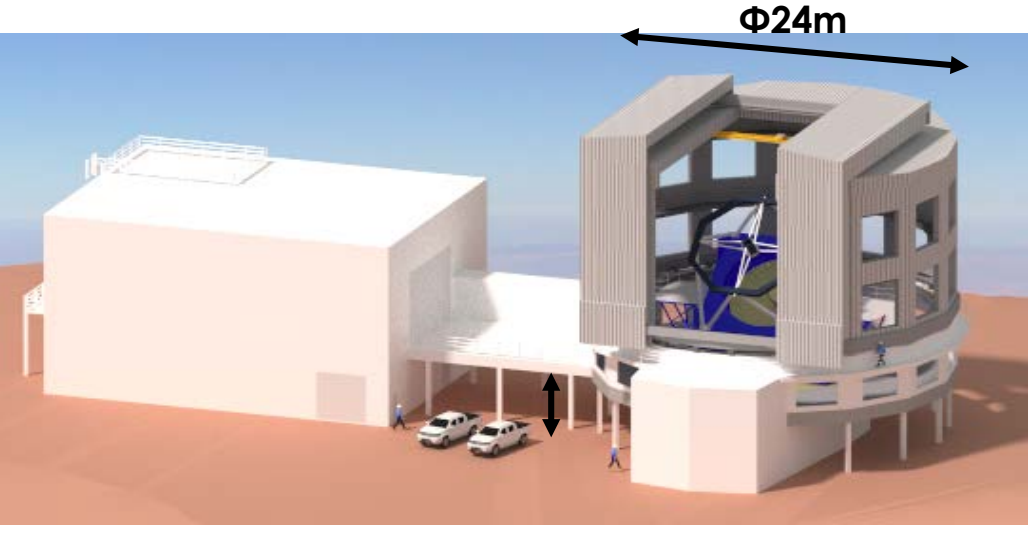


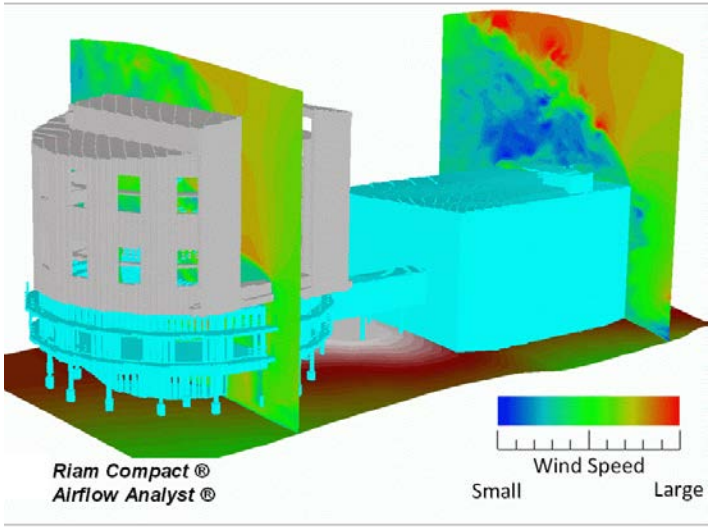
M1 Cleaning System

M1 cell carrier

Enclosure and Summit Building

- Final Design of the summit building underway
- Wind simulation completed
- Pre-assembly of the rotating enclosure started in western Japan

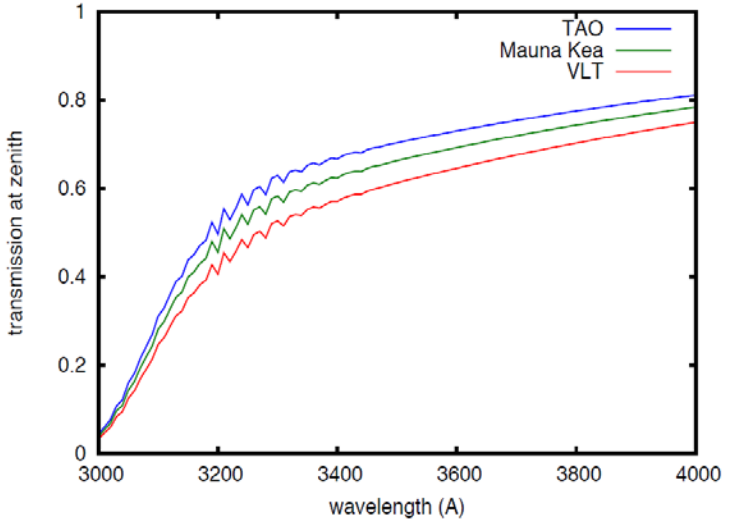




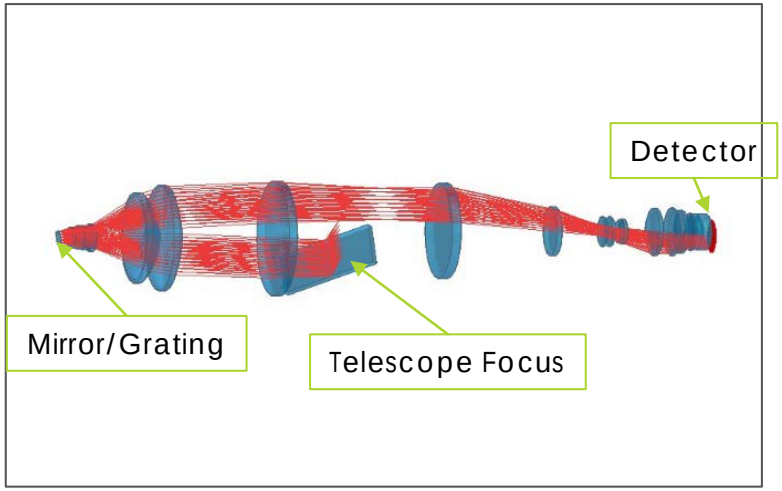
Base Facility at San Pedro de Atacama

- Inauguration Nov.21, 2014
- Land owned by UTokyo ~14000m^2 next to Don Tomas'
- Laboratory, office space, bedrooms (5), kitchen, living room

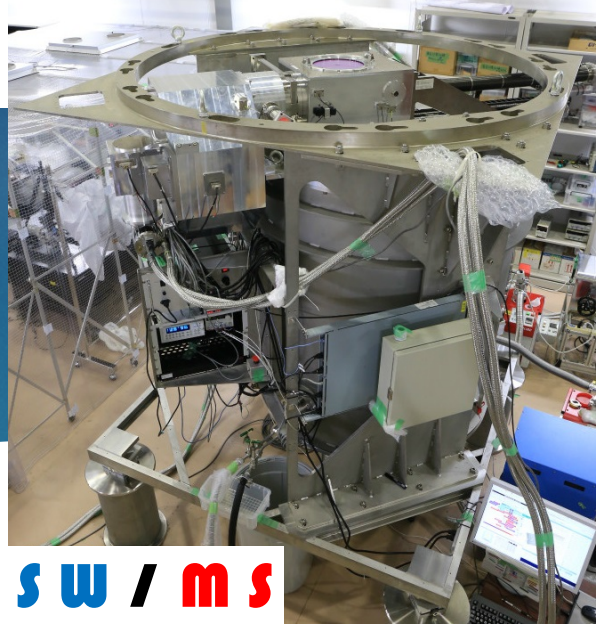
Instruments



- 1st Gen. Instrumens
  - SWIMS (NIR)
  - MIMIZUKU (MIR)
  - Funded in 2010, prior to the telescope
  - Almost completed,and be send to Subaru in 2017 for engineering obs.
- 2nd Gen. Instruments
  - U-band Optimized Camera/Spectrograph
  - TARdYS : Y-band High-dispersion Spectrograph (PI : Vanzi)



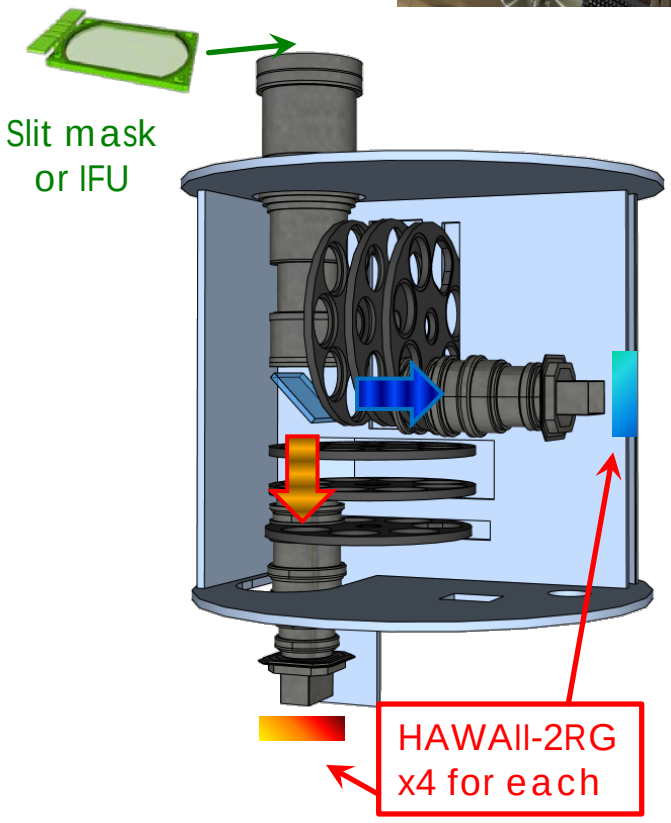
NIR Instrument SWIMS



S W / M S

Simultaneous-band Wide field Infrared MOS Spectrograph

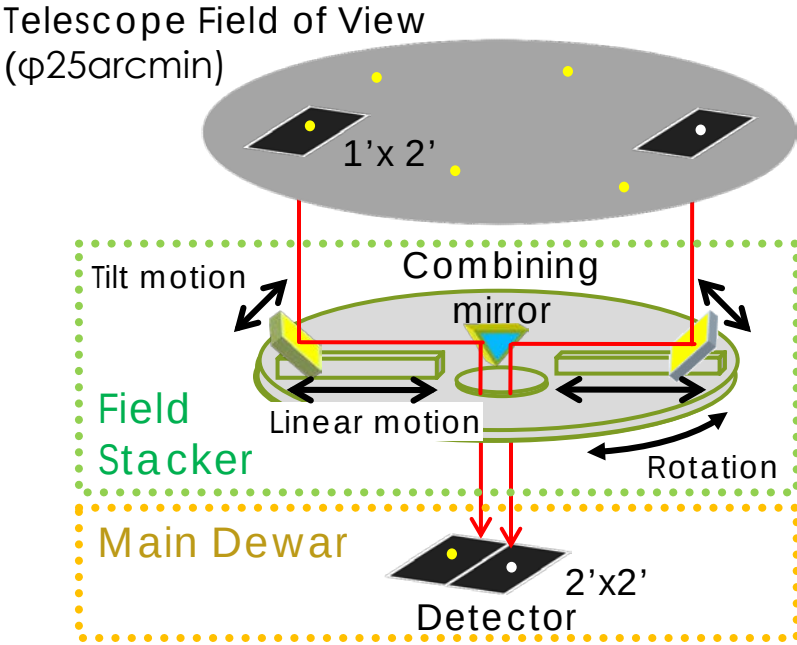
- Simultaneous imaging/spectroscopy in 2 bands (0.9-1.4 μm & 1.4-2.5 μm)
- Wide field of view with good pixel resolution
  9.6' Φ FoV, 0.126"/pix,
  with 4k x 4k pixels
- Multi-object spectroscopy with cooled multi-slit masks
  0.9-2.5 μ m simultaneous spectroscopy for ~30 objects (R~1000)
  IFU module also under development
- 2m x 2m x 2m, 2.4ton



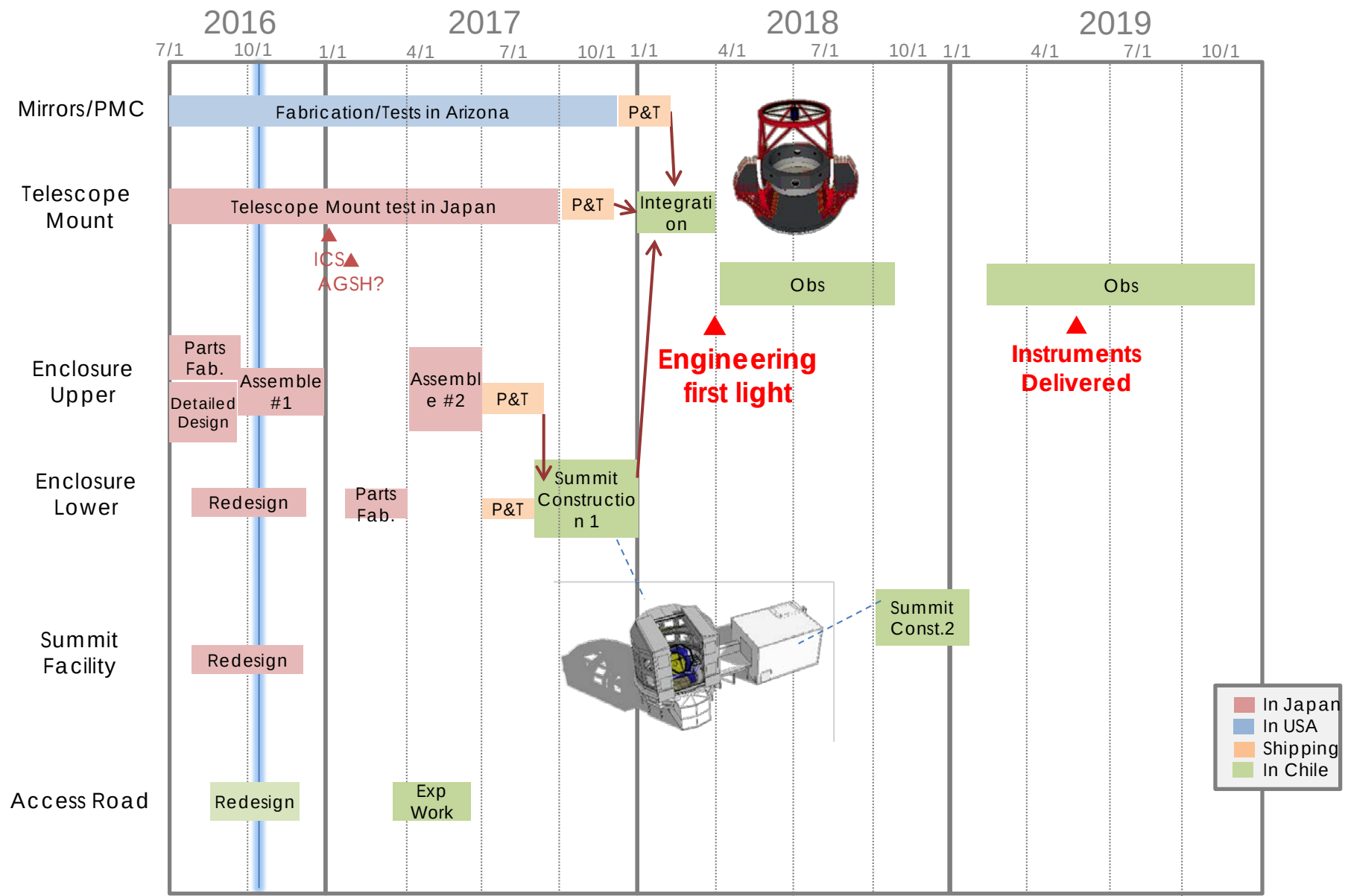
MIR Instrument MIMIZUKU

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

- Wide wavelength coverage with 3 detectors
  - InSb : 2-5.6μm
  - Si:As : 6-26μm
  - Si:Sb : 25-38μm
- Diffraction limited spatial resolution
  - 0.4″ @ 10μm / 1.2″ @ 30μm
- Accurate monitoring observations
  - Simultaneous observations of two discrete fields by the “Field Stacker”
  - Can compensate time variation of atmospheric transmittance
    →High accuracy relative photometry



Schedule


2016
2017
2018
2019
7/1
10/1
1/1
4/1
7/1
10/1
1/1
4/1
7/1
10/1
1/1
4/1
7/1
10/1
Mirrors/PMC
Telescope Mount
Enclosure Upper
Enclosure Lower
Summit Facility
Access Road
Fabrication/Tests in Arizona
P&T
Telescope Mount test in Japan
P&T
Integrati on
ICS▲
AGSH?
Obs
Obs
Engineering first light
Instruments Delivered
Parts Fab.
Detailed Design
Assemble #1
Assembl e #2
P&T
Redesign
Parts Fab.
P&T
Summit Constructio n 1
Summit Const.2
Redesign
Redesign
Exp Work
In Japan
In USA
Shipping
In Chile

UTokyo-Chile Collaboration

- Site testing campaign and concession works
  - Great assist and help from University of Chile DAS
- TAO 2nd Generation Insrument
  - Collaboration with PUC-AIUC
  - High-resolution Y-band spectrograph TARdYS (Rukdee's talk)

Summary

- TAO 6.5m telescope at 5640m altitude
  - Will open new NIR-MIR observation capability
  - Engineering first light in 2018
  - Science first light in 2019
- Two 1st Gen. Instruments
  - NIR wide field imager and MOS : SWIMS
  - MIR imager and spectrograph : MIMIZUKU, capable of relative photometry
  - Both are almost completed, and send to Subaru for engineering observations first