



中間赤外線装置MIMIZUKU

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



Takashi MIYATA

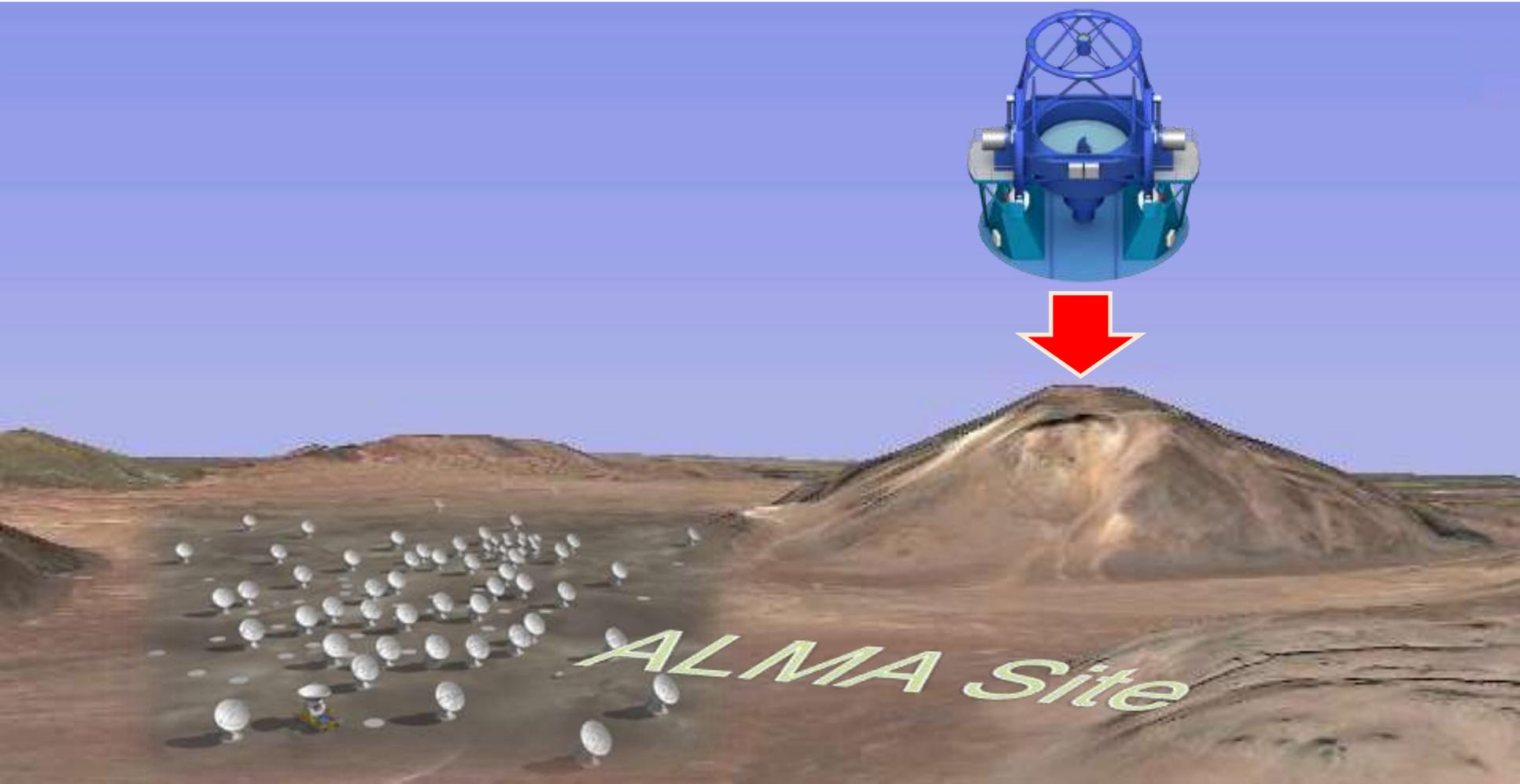
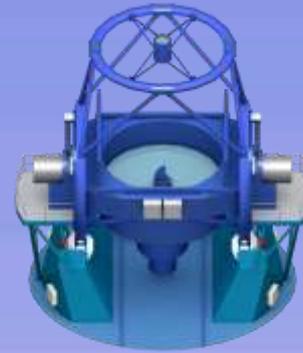
Institute of Astronomy, University of Tokyo

S. Sako, T. Nakamura, K. Asano, M. Uchiyama,
T. Onaka, I. Sakon, H. Kataza, and TAO group



TAO

- a 6.5m infrared/optical telescope
- the highest site in the world (5,640m) at Atacama desert, Chile

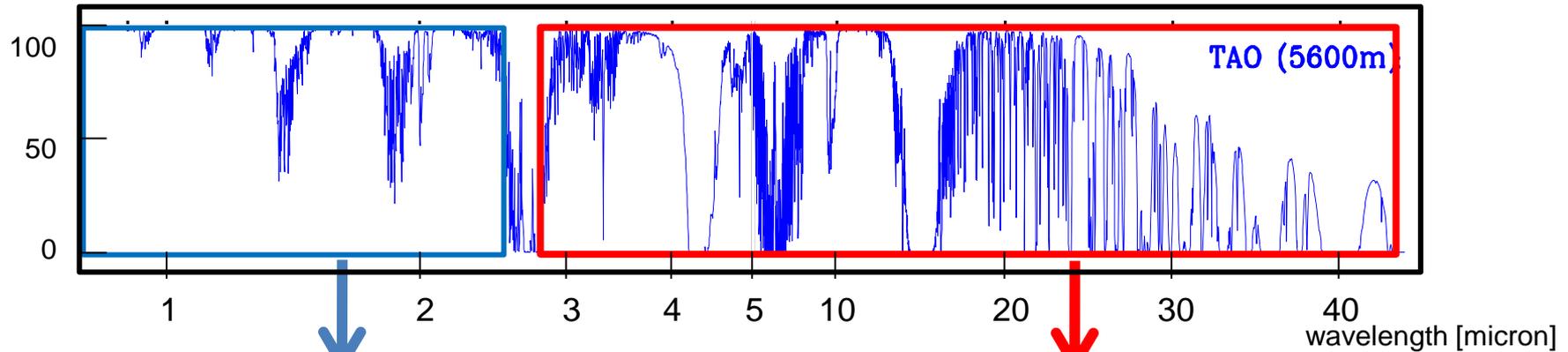


ALMA Site



Excellent sky condition

Transmittance [%]



SWIMS

Motohara+



MIMIZUKU



Two instruments are now under development

→ Can be attached to the SUBARU Cassegrain focus



Mid infrared observations from the ground

Akari and Spitzer achieved excellent results in a number of astronomical fields
very high sensitivity / wide coverage of the sky



Groundbased observations at mid infrared are still important

- high spatial resolution
c.f. COMICS
- monitoring capability

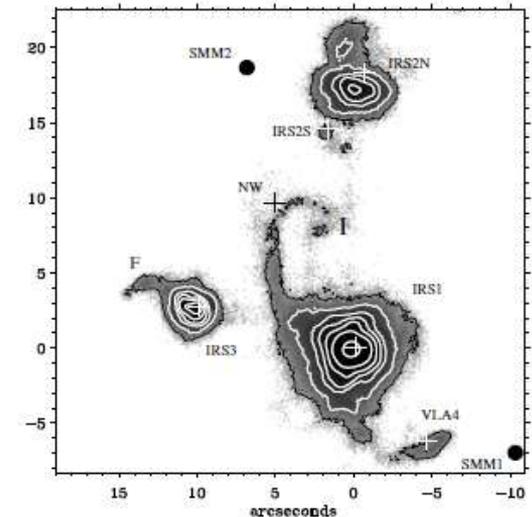


Fig. 3. COMICS 24.5 μm image of the S140 region. The image is linearly scaled. Annotated objects are discussed in the text. Crosses correspond to radio sources (Evans et al. 1989; Tofani et al. 1995). Contour levels are at 0.5%, 1%, 2%, 3%, 5%, 10%, and 40% of peak flux density ($5.9 \times 10^2 \text{ Jy arcsec}^{-2}$). North is up, east is to the left.

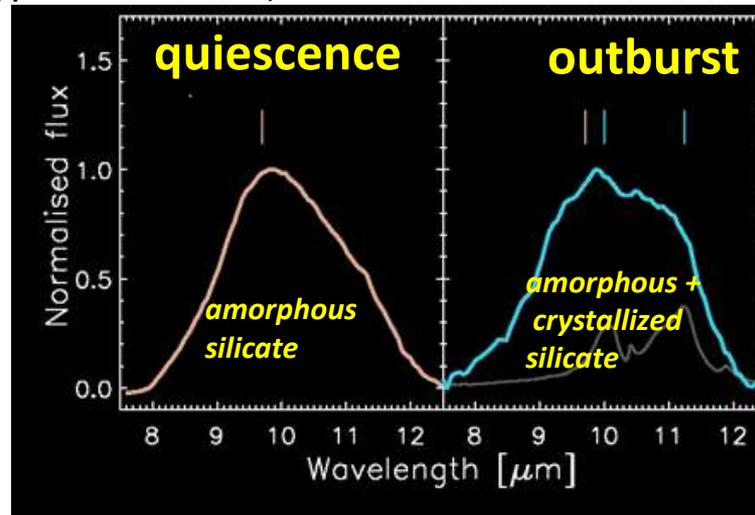


Mid infrared observations from the ground

Many of MIR objects are variables???

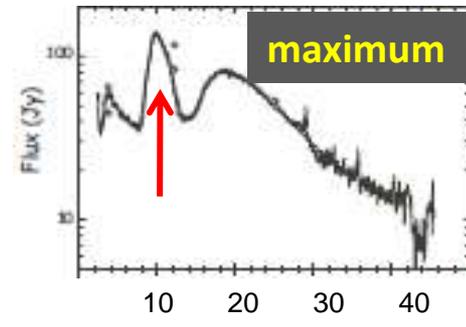
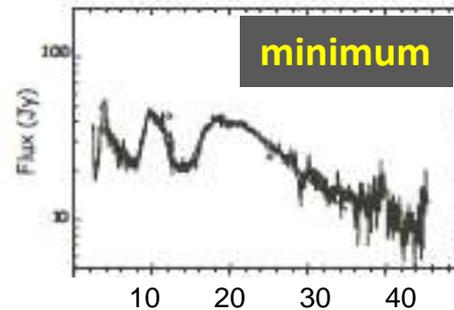
✓ T Tau stars, HAeBe

EX Lupi (FU Ori type, T Tauri star)



Abraham+ 2009

✓ AGB stars, Luminous Blue Variables, WR stars



Onaka+ 2002

✓ Comets....



Accurate monitoring at MIR

Monitoring observations at MIR wavelength are difficult

Satellite telescopes → lifetime is so limited
observing time is very competitive

Ground-based telescopes → accurate monitoring is too difficult

- × Unstable sky condition

- × Limited number of (comparison) stars

 - **Differential photometry** cannot be applied.

c.f. optical / NIR wavelengths....

a lot of stars + wide field of view

→ Stars around a target object can be used

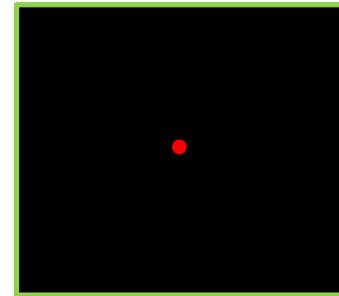
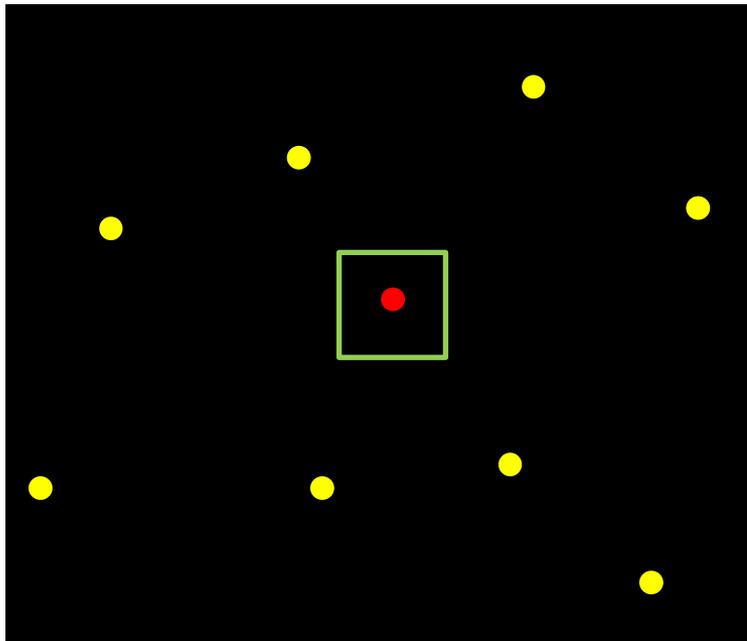
as a standard of comparison



Accurate monitoring at MIR

- Not many stars in MIR sky
- Field of view of current MIR cameras : not so large (< 1 arcmin)

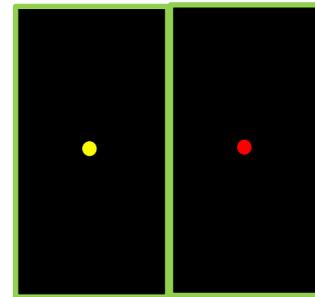
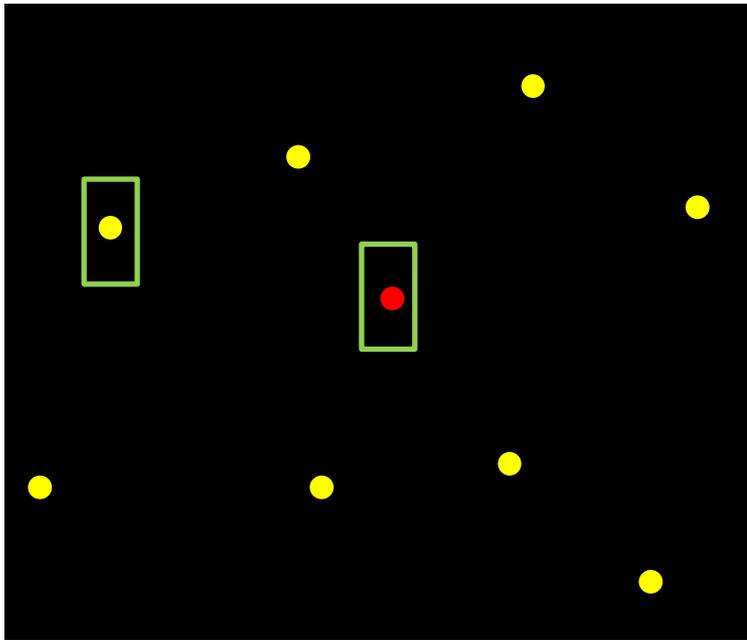
→ Only the target object is observed at once.



Schematics of the mid-infrared sky



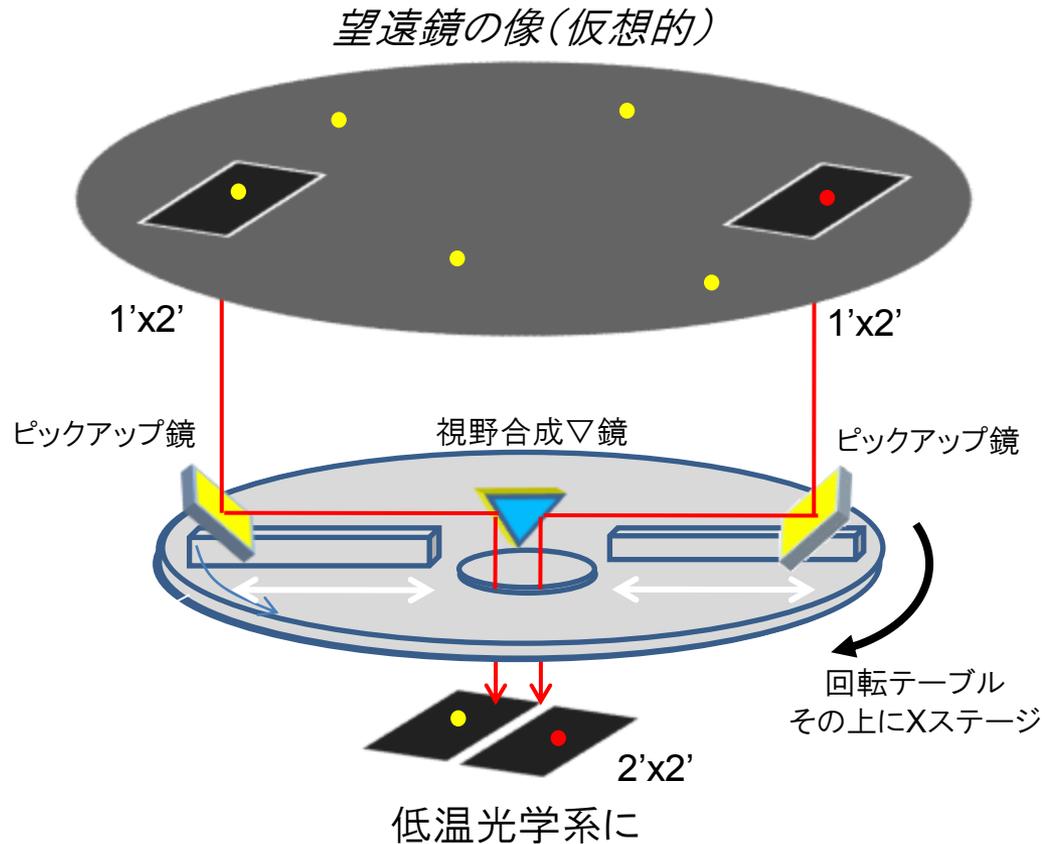
If we can take two (or more) discrete fields simultaneously.....



Differential photometric method can be applied
→ improve precision and reliability dramatically



Field stacker



- consists of two movable pick-up mirrors and a wedge shape mirror
- picks up two discrete fields of the sky
- brings into the instrument field of view

➔ Simultaneous observation of two (or more) stars



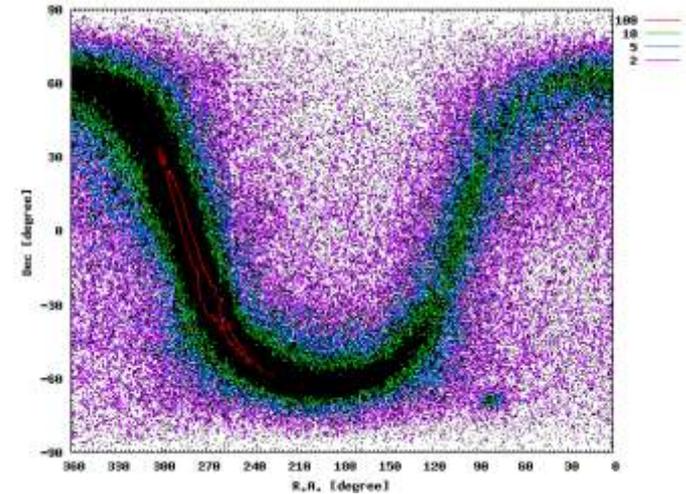
Conceptual studies of the field stacker

There are enough number of MIR stars ??

Fraction of two or more Akari 9um objects in a field

Field of View	> 50mJy	> 300mJy
$\phi 25'$	55%	51%
$\phi 12.5'$	48%	39%
$\phi 5.0'$	23%	13%

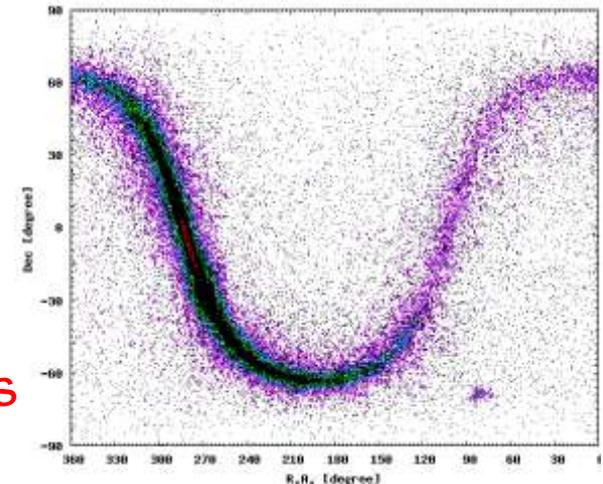
20% of 9um sources



Fraction of two or more Akari 18um objects in a field

Field of View	> 130mJy	> 1000mJy
$\phi 25'$	50%	41%
$\phi 12.5'$	41%	35%
$\phi 5.0'$	15%	0.3%

10% of 18um sources

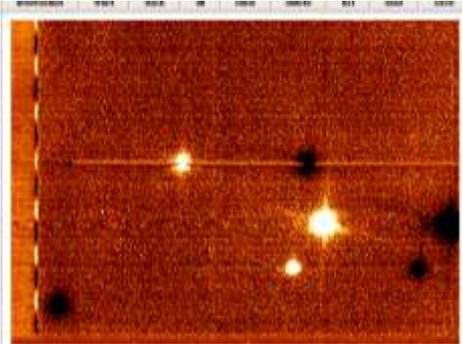




Conceptual studies of the field stacker

Simultaneous observation improves the photometric accuracy?

MIR images of two or more stars taken by COMICS

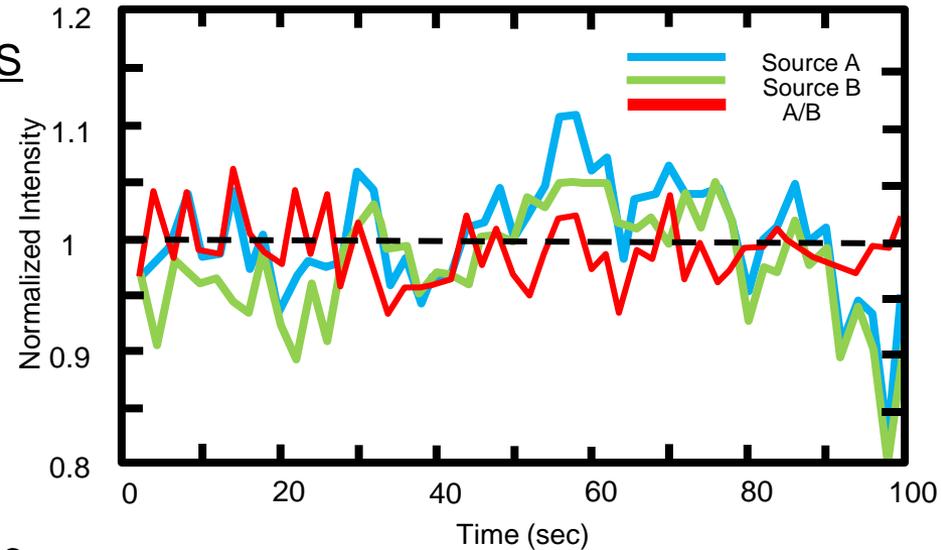


- ✓ Variation of the intensity : 10% within 100 sec.
- ✓ Variations of two stars are synchronized

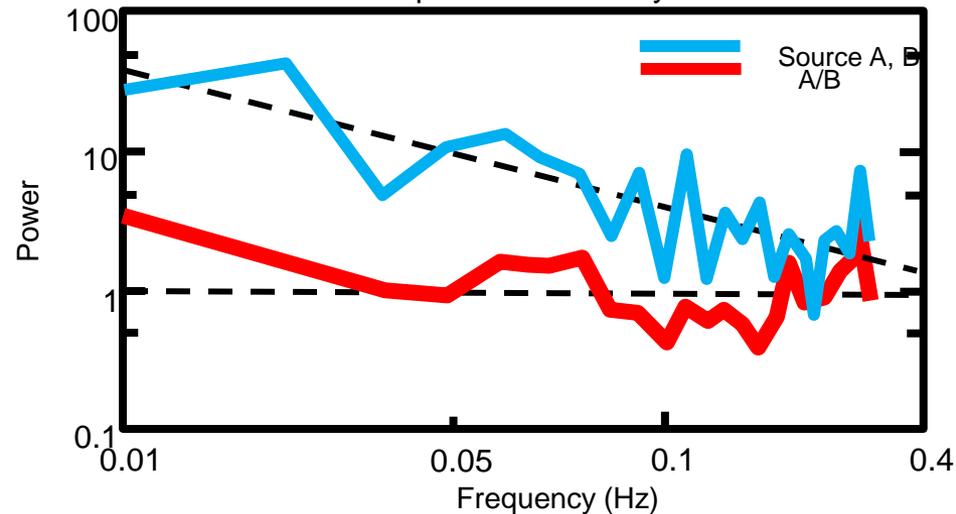


Simultaneous observations are effective (at least within 1 arcmin)

Time variations of star counts



Power spectra of intensity





Field stacker for spectroscopy

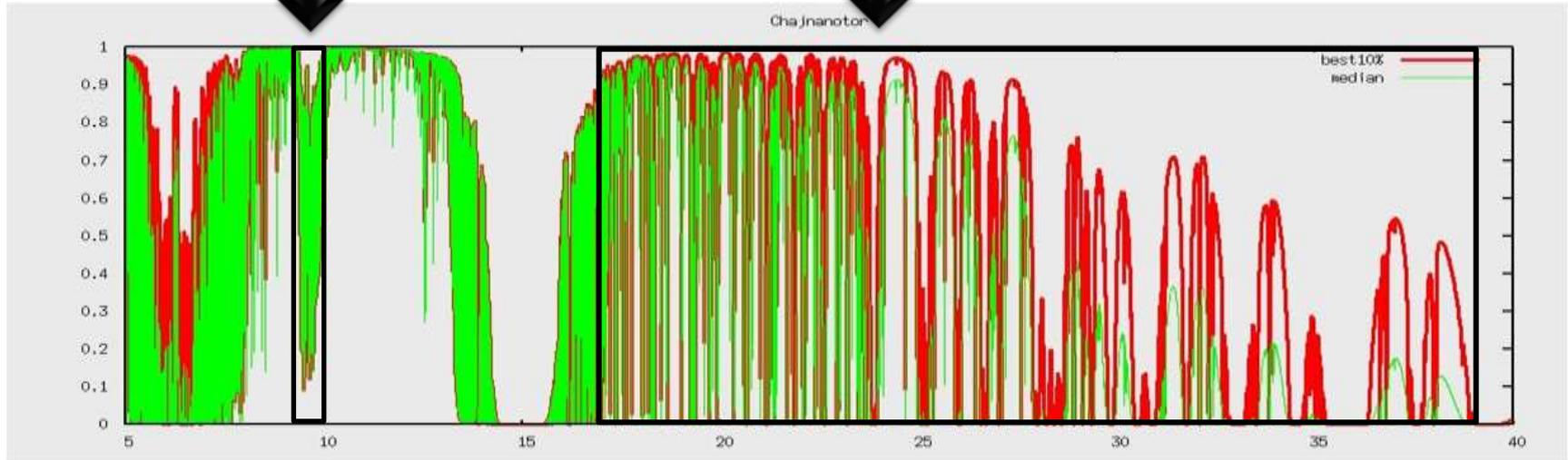
The field stacker is also useful for spectroscopic observations.

Simultaneous observation enable us
accurate calibration of the atmospheric absorptions

especially for

Ozone absorption band
at 10 micron

Q-band or longer
wavelength ranges





Accurate monitoring

with the Field stacker

Wide wavelength coverage

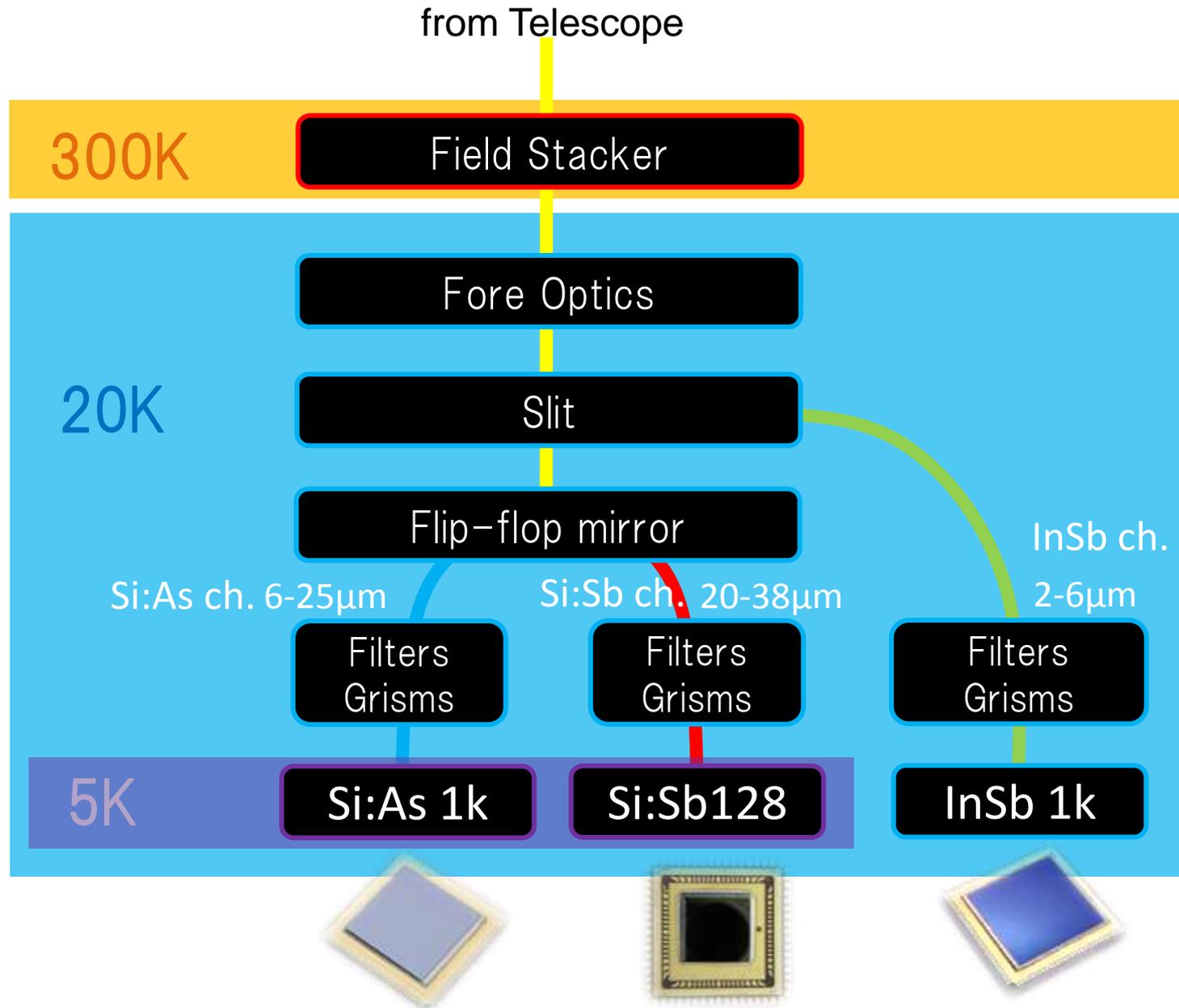
Covers 2-38 micron wavelength region (over 4 octaves!)

High spatial resolution

Achieves diffraction limited spatial resolution

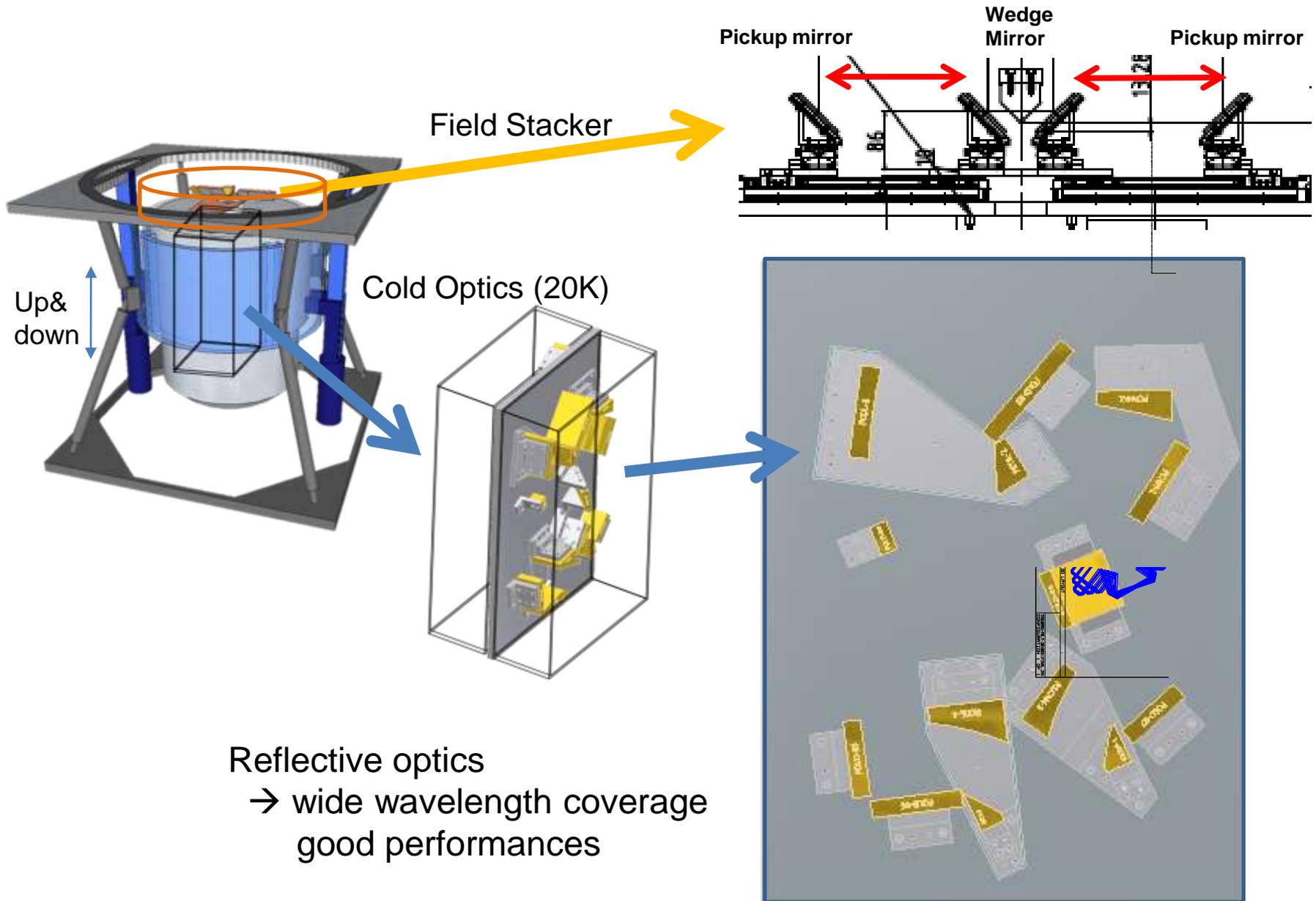


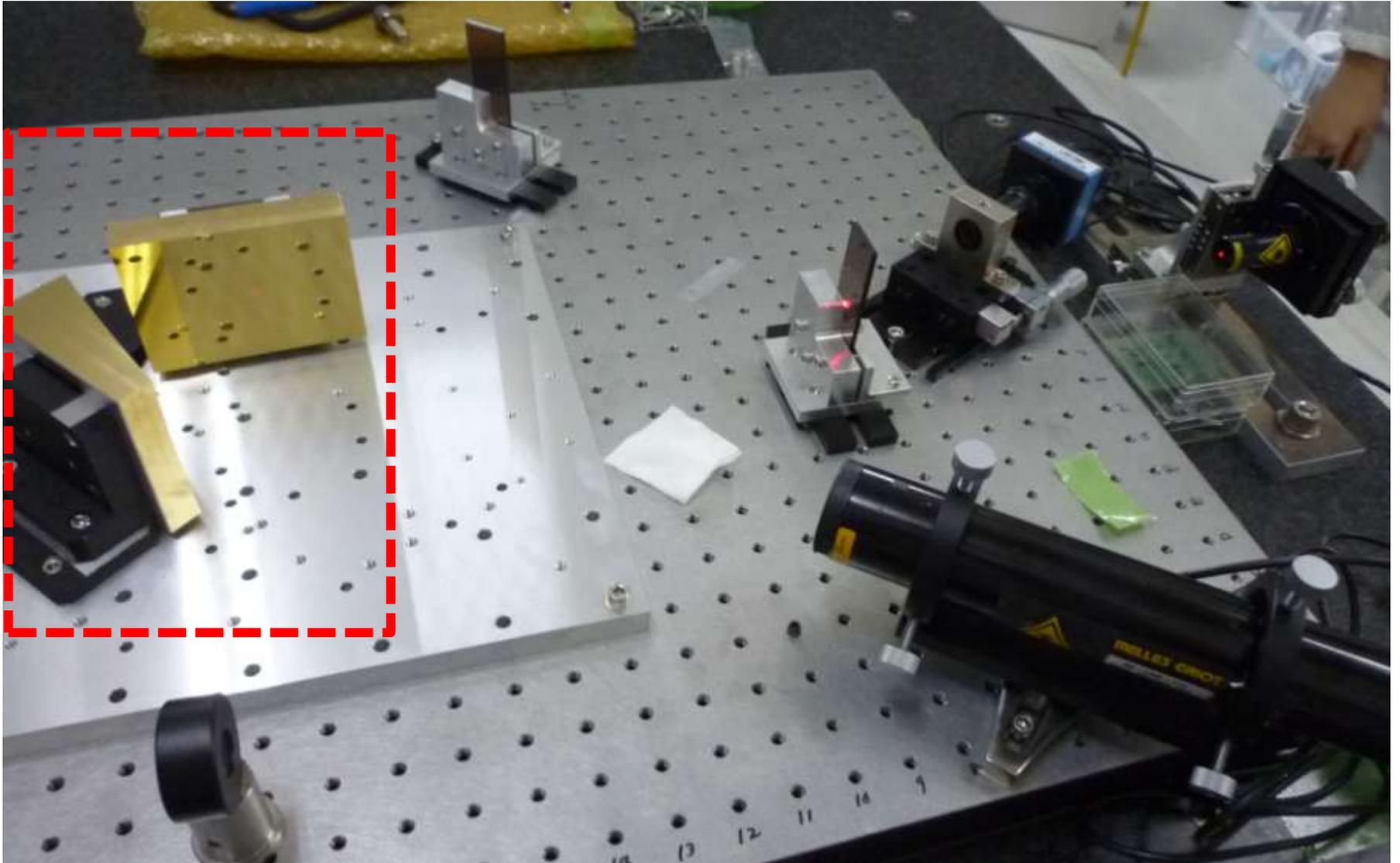
MIMIZUKU : Block diagram





MIMIZUKU : Optics







MIMIZUKU : Specifications

Parameters	Values			Notes
# of channels	3 (Si:As / Si:Sb / InSb)			
Detectors	Si:As 1k x 1k	Si:Sb 128 x 128	InSb 1k x 1k	
Wavelength coverage	6-25um	20-38um	2-6um	
Pixel scale	0.1"/pix	0.4"/pix	0.1"/pix	@SUBARU
Field of view	2' x 2' or 1'x2' x 2fields	1' x 1' or 0.5'x1' x 2fields	2' x 2' or 1'x2' x 2fields	@SUBARU
Filters	10 filtes (6-25um)	7 filtes (20-38um)	13 filtes (2-6um)	
Spectroscopy	R ~400 @Nband R~400 @Qband	R~50 @30um	R~600 @LMband	w/ grism
Sensitivity (Img.) 1sig1sec	40mJy @10um 130mJy @20um	(400mJy @30um?)		for point sources
Instrument size	2m x 2m x 2m , ~ 2ton			
Others	- A cold chopping unit is installed in fore-optics			



MIMIZUKU : Schedule

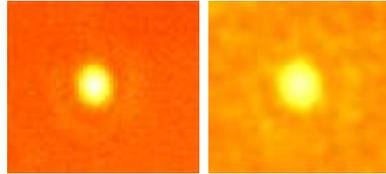
FY 2010 **2011** **2012** **2013** **2014.....**

Prototype instrument

MAX38



Atacama 1m telescope



Point source images @ 31um / 37um
(Diffraction rings can be seen)



MIMIZUKU



Design and Development

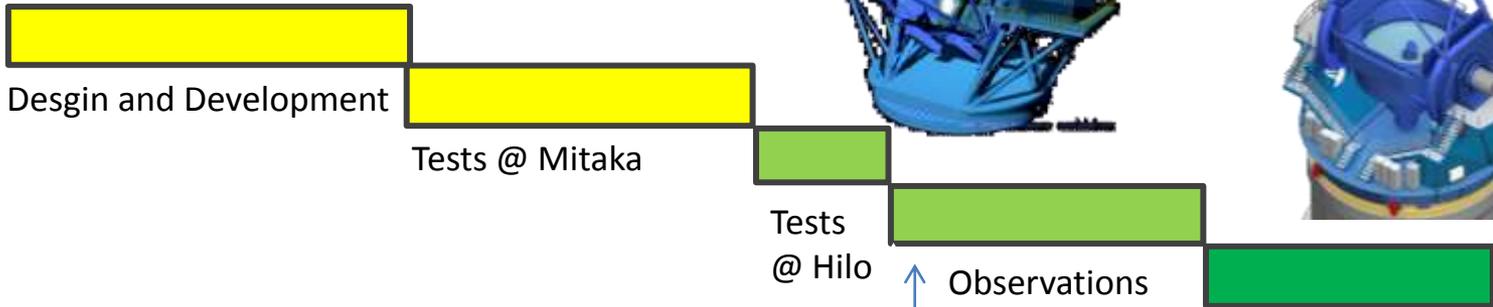
Tests @ Mitaka

Tests @ Hilo

Observations @ SUBARU

Observations @ TAO

first light





MIMIZUKU



- ✓ Wide wavelength coverage (2-38 μ m)
- ✓ High spatial resolution
- ✓ Accurate monitoring w/ Field stacker



adds an unique
“Monitoring Capability”



develops pioneering technology
supplies human resources



....



MIR performances compared with COMICS

	MIMIZUKU	COMICS
Sensitivity	~40mJy @10um 1s1s	~30mJy @10um 1s1s
Spatial resolution	diffraction limited	diffraction limited
Filed of view	120" x 120" or 60"x120" x2filed	~ 40"x30"
Spectral resolution	R~400 @N-band R~400 @Q-band	R~250/2,500/10,000 @N-band R~2,500/5,000 @Q-band
Monitoring Accuracy	Good (w/ ield Stacker)	---

COMICS has advantages of
slightly higher sensitivity (because MIMIZUKU has warm optics)
med/high resolution spectroscopic capabilities



MIMIZUKU will add an unique function of
MIR monitoring observations to the SUBARU telescope