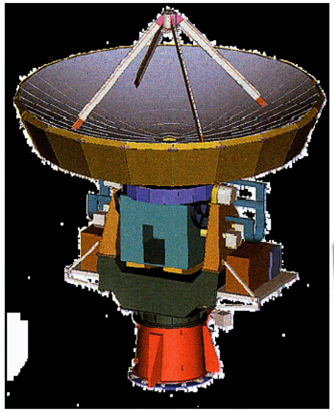
Current status of Japanese activities for astronomy in Antarctica

Takashi Ichikawa & Japanese Consortium

2m Infrared Telescope

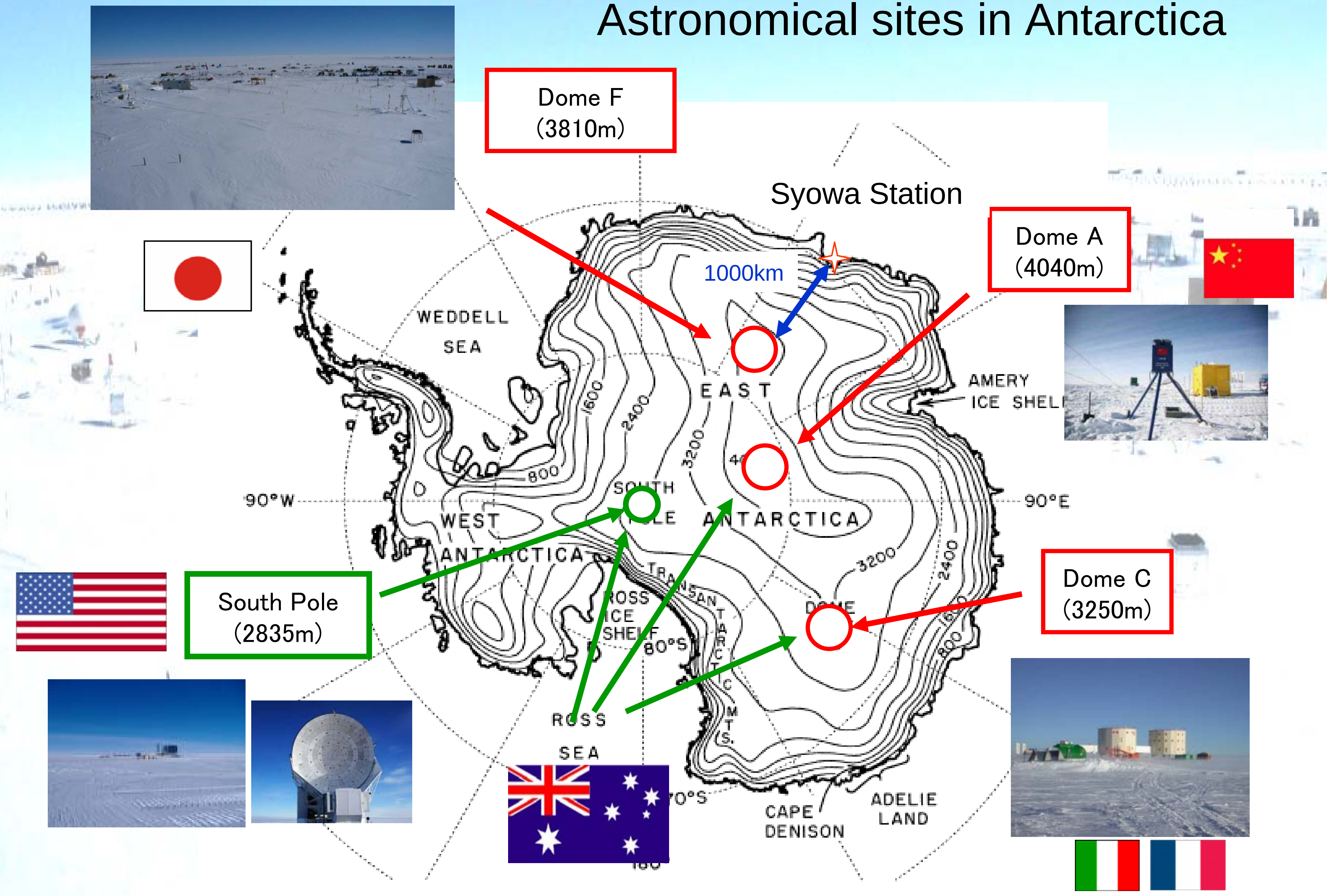


THz Radio Telescope

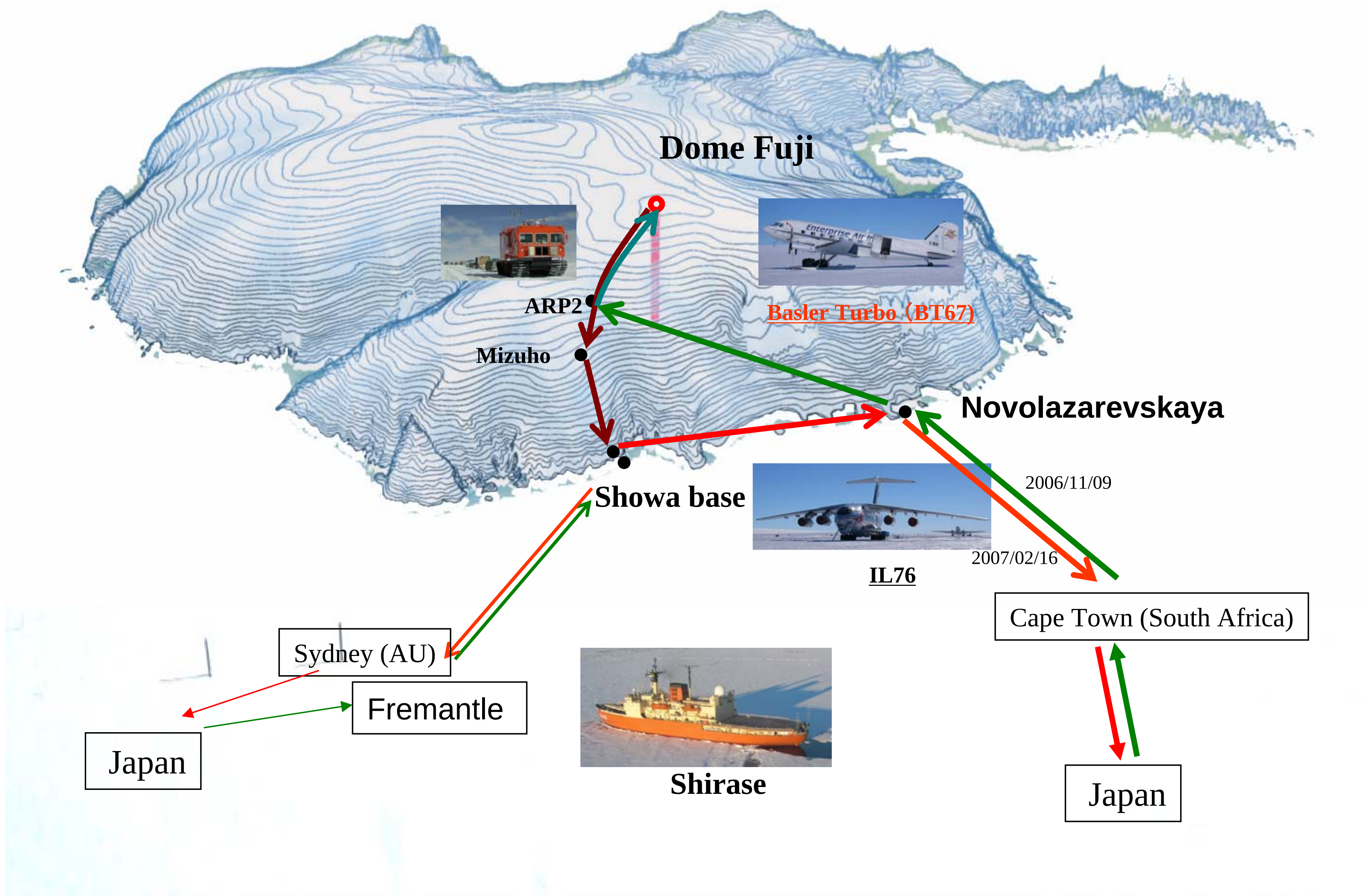
(Chair) Nakai, N., Seta M. (Tsukuba Univ.)
Ichikawa, T., Okano, S., Sakamoi, T. (TohokuUniv.)
Taguchi, M. (Rikyou Univ.)
Takato, N., Uraguchi, H., Iye, M. (NOAJ)
Kurita, M. (Nagoya Univ.)
Motoyama, H. (NIPRJ)

& collaborators

Astronomical sites in Antarctica



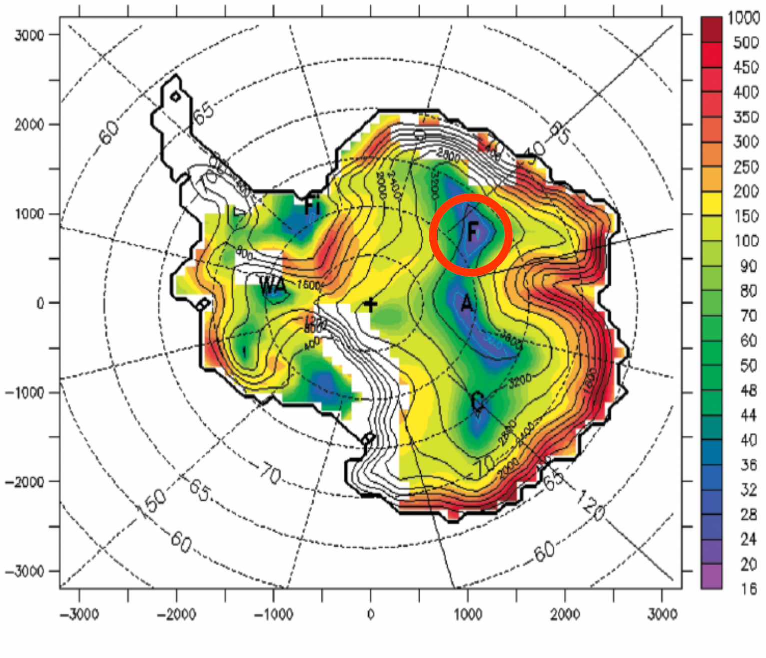
A long way to Dome Fuji



Japan has one of best astronomical sites on earth

Clear sky (photometric day > ~85%)
Low and stable humidity (PWV < 0.6mm)
Low temperature (-70℃ in winter)
Good seeing above boundary layer
weak wind

According to model atmosphere, the surface boundary layer at Dome Fuji is expected to be thinnest in Antarctic inland



Height where the residual boundary layer seeing is 0.1" or better 50% of the time (JJA 2004)

Swain & Gallee (2006)

The seeing above boundary layer (~30m) is ~0.3"-0.4" (λ =0.5μm) in winter at Dome C

Agabi+ (2005)
Lawrence+ (2006)

At Dome Fuji, it is ~0.3"-0.4" at ~20m or above (?)

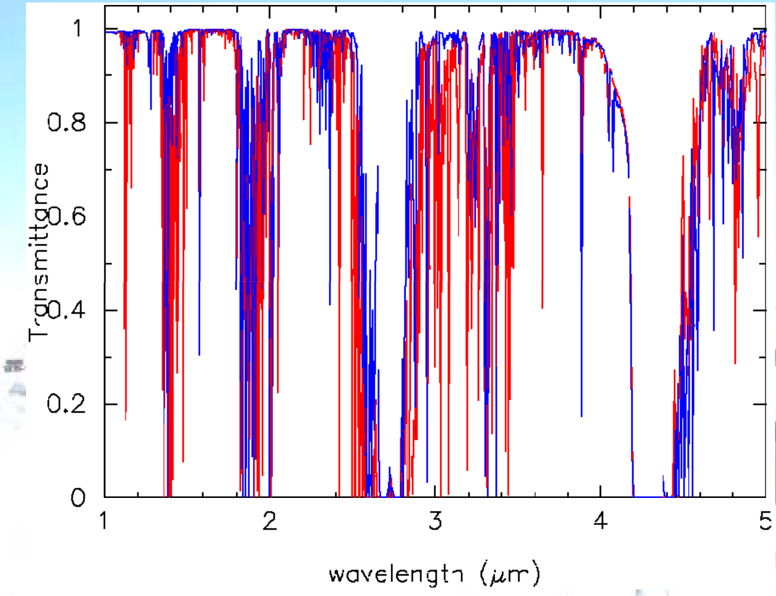
Better seeing in the daytime

Advantages of Antarctica (1)

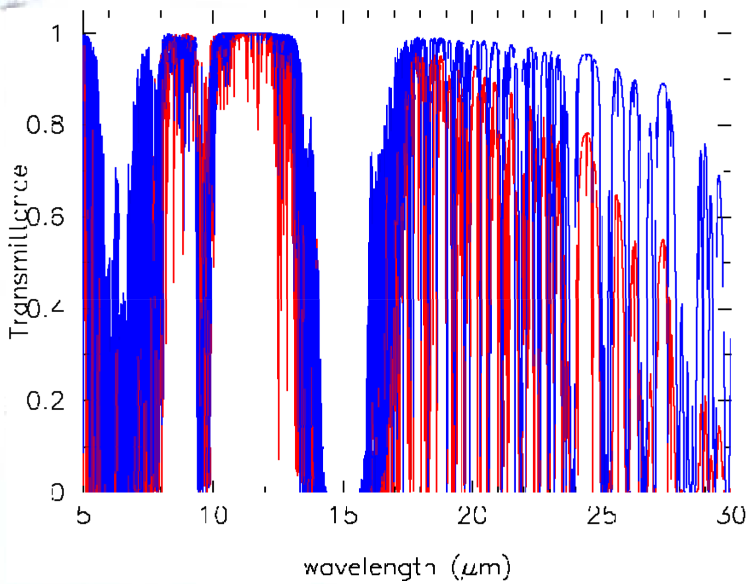
High transmittance

		altitude	temperature	PW
blue	**Dome Fuji**	3810m	-70℃	0.2mm
red	**Mounakea**	4200m	0℃	1.0mm

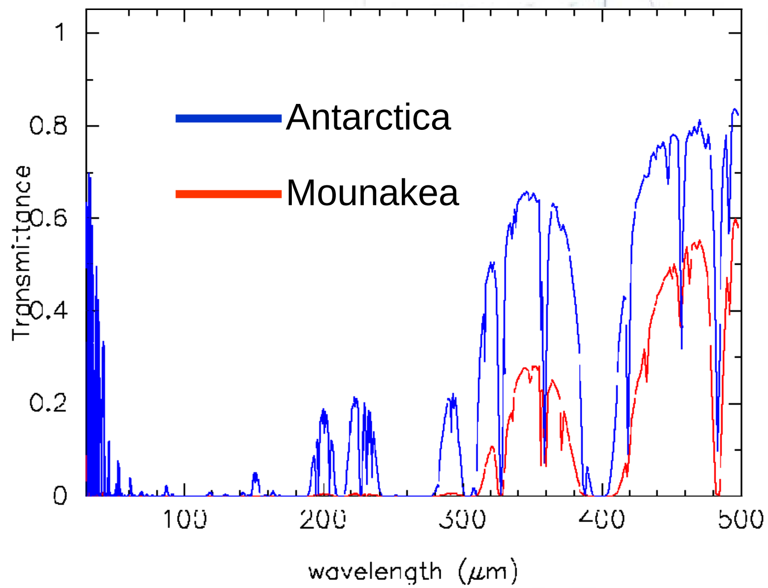
Near-Infrared



Mid-Infrared



Transmittance in THz



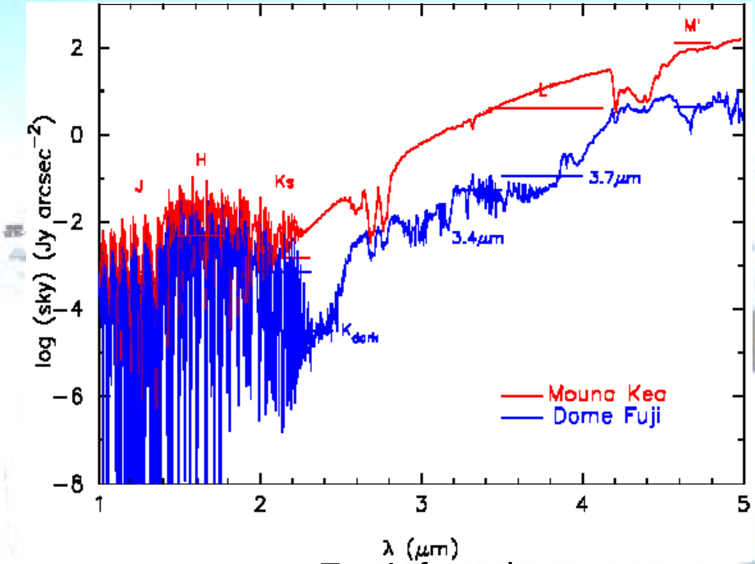
THz Windows are only available in Antarctica

Advantages of Antarctica (2)

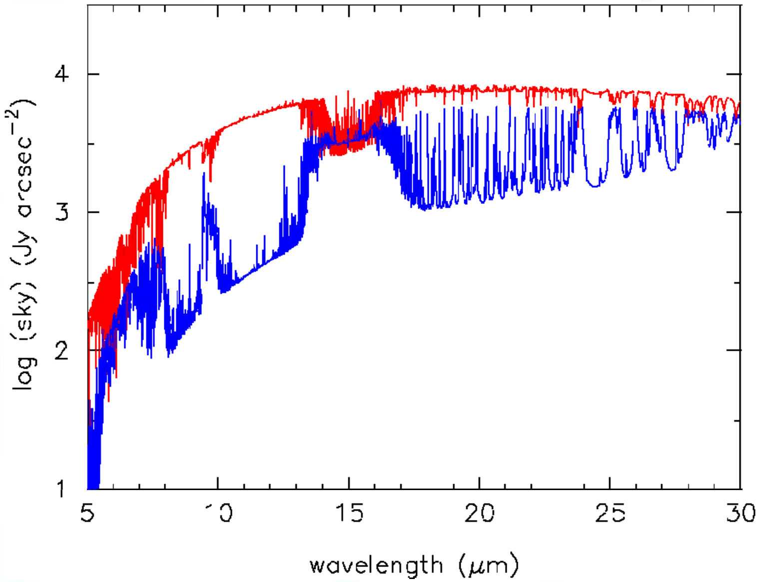
Low sky background

		altitude	temperature	PW
blue	**Dome Fuji**	3810m	-70℃	0.2mm
red	**Mounakea**	4200m	0℃	1.0mm

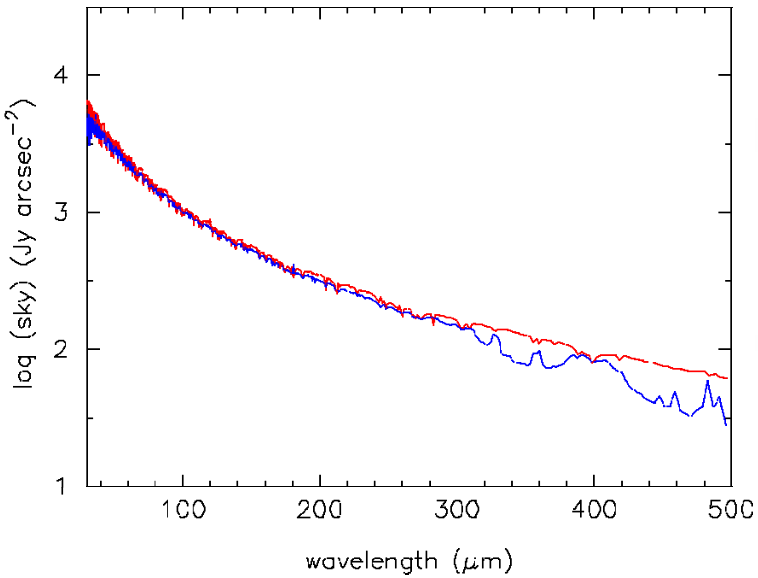
Near-Infrared



Mid-Infrared

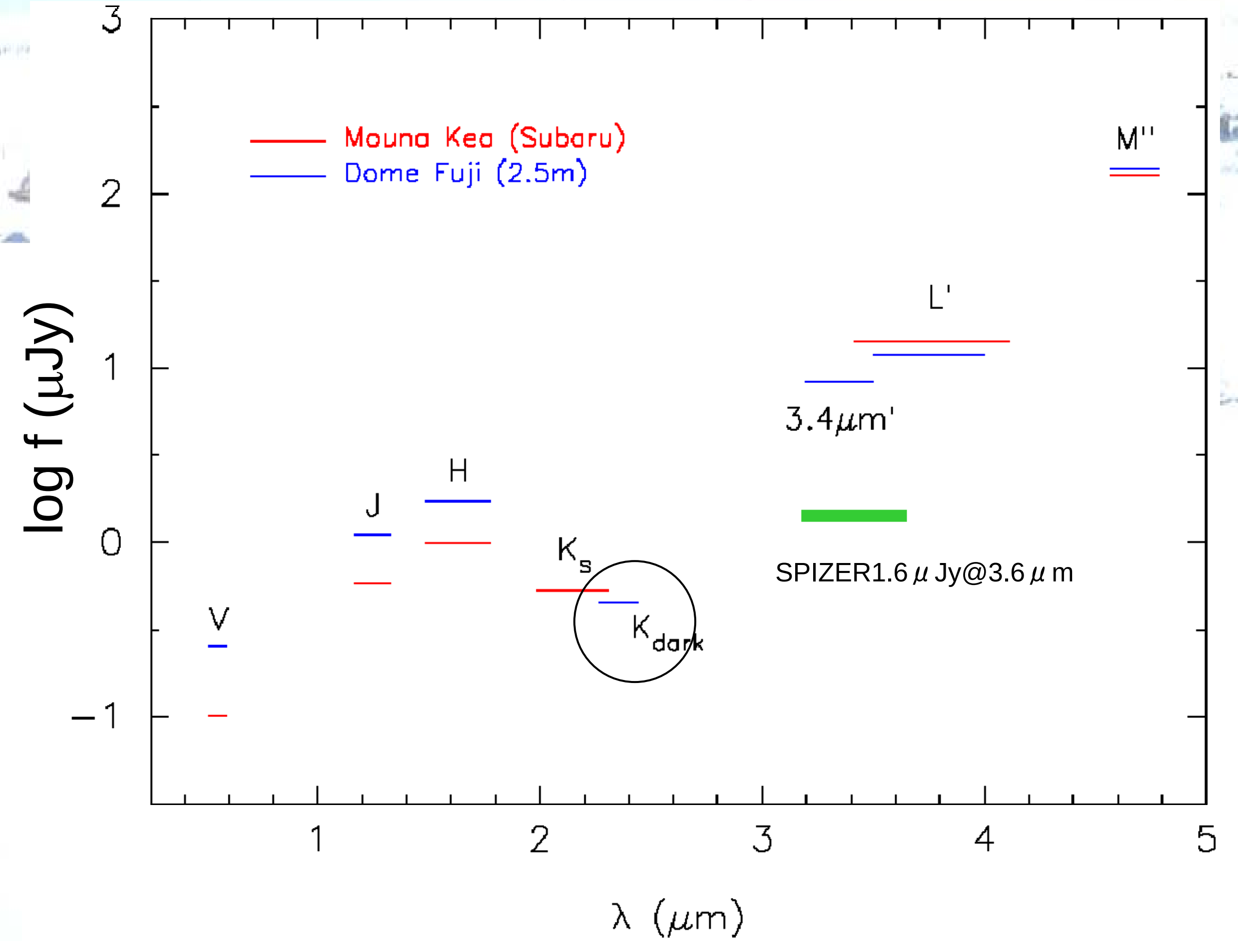


Far-Infrared

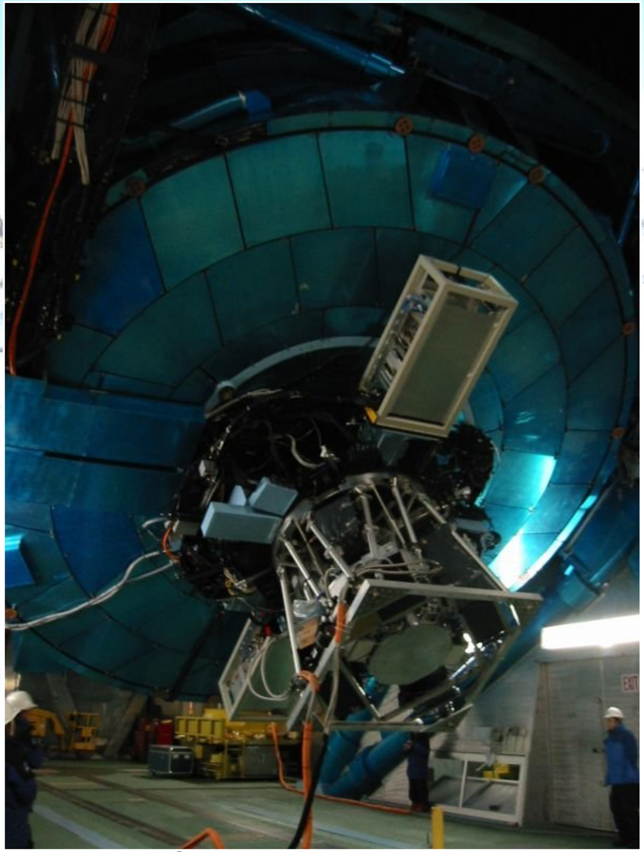


Comparison with Subaru for 2.5m Antarctic Telescope

1 hour integration with S/N=5σ for pint source



Subaru+MOIRCS



Ichikawa et al. (2005)

performance in near-infrared

1:1

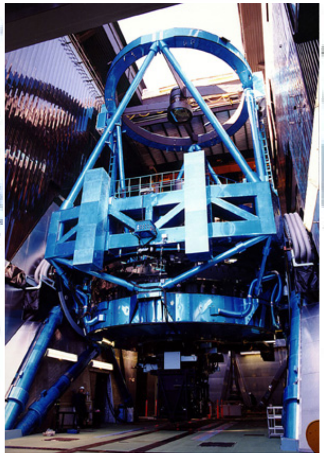
Cost
100 : 1

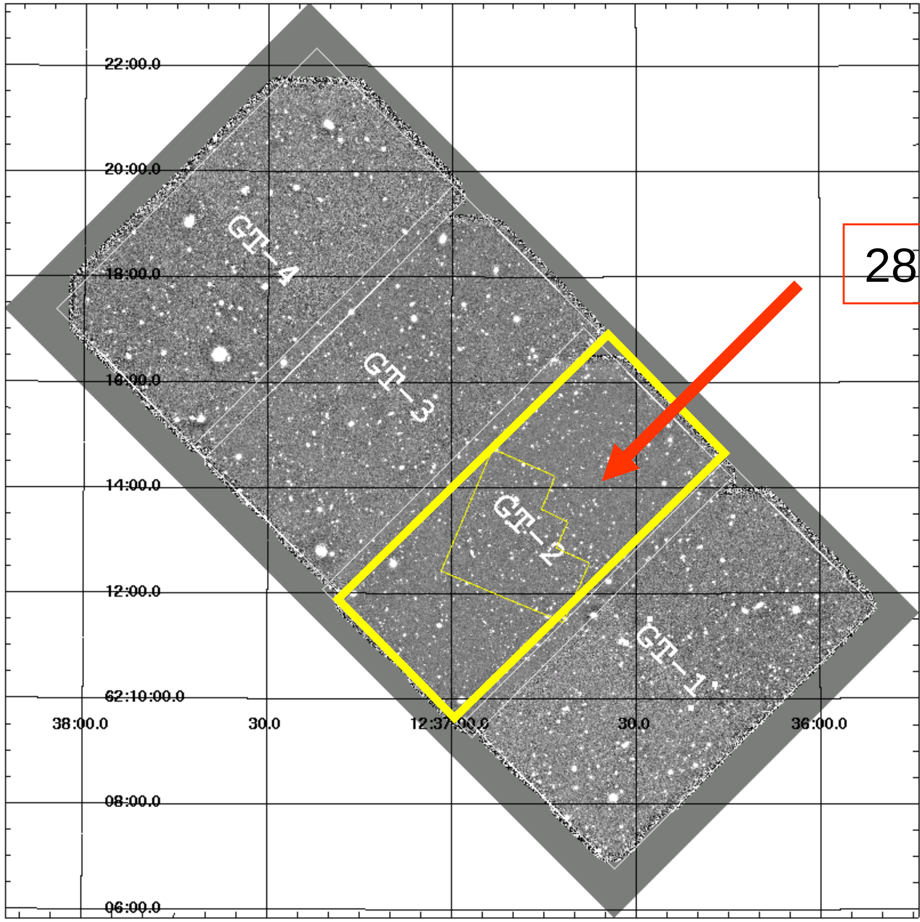
2m telescope in Antarctica

Kurita et al. (2005)

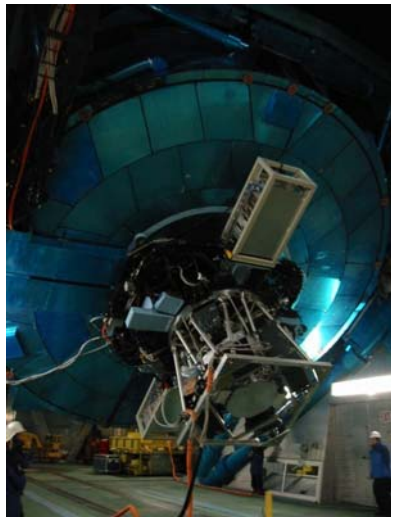
Ultra light weight mount

MOIRCS High Redshift Galaxy Survey
In GOODS region



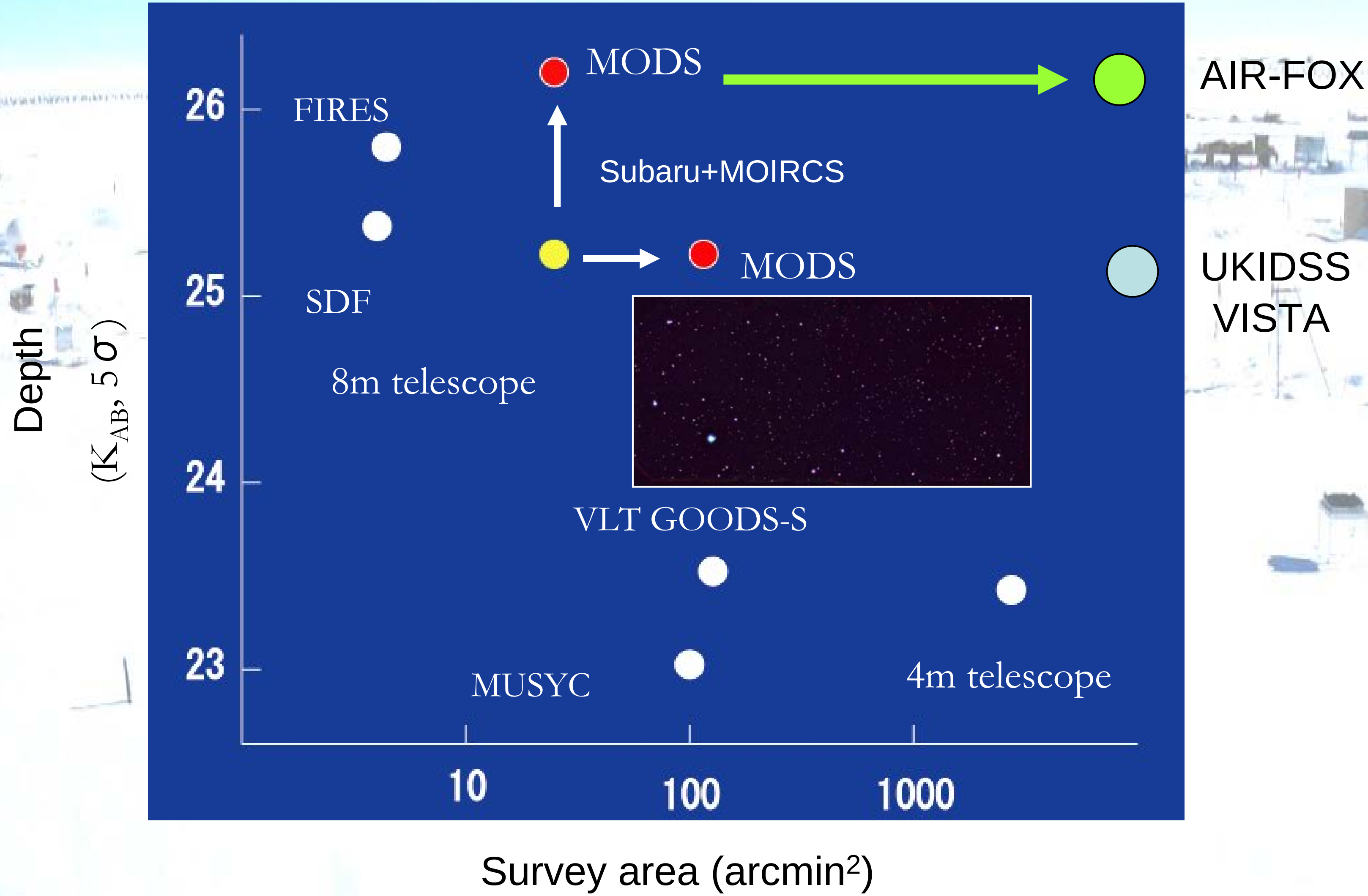


28 hour integration



Widest and Deepest High-Redshift Galxy Survey

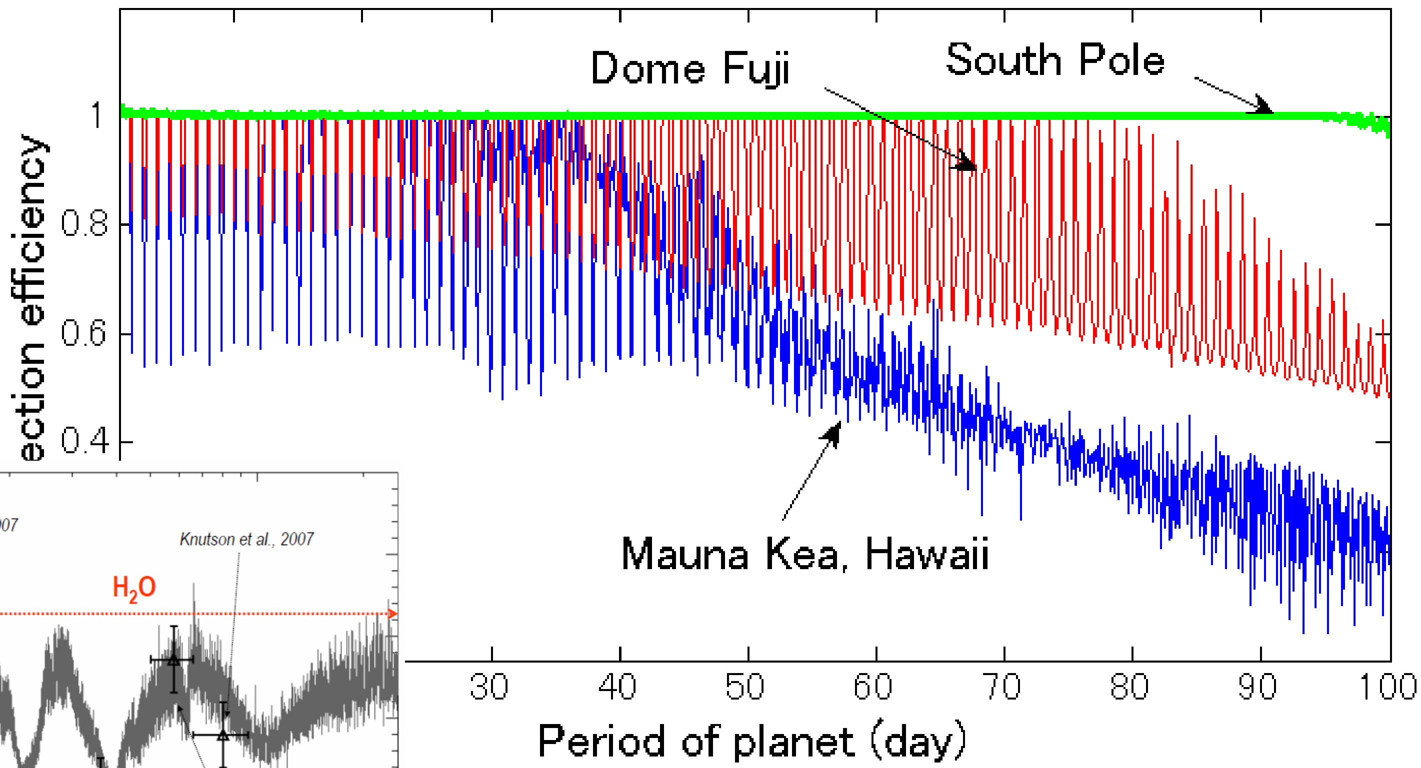
~2m telescope + (K_{dark}、3.4μm) camera

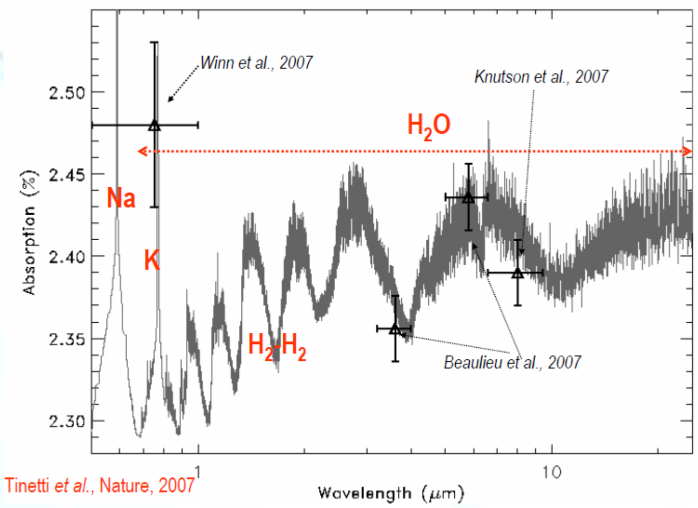


Advantages of Antarctica (3). Polar night

Transit identification of long-period extra-solar planets

Probability of chance for multiple observation of transit (1-year monitoring)





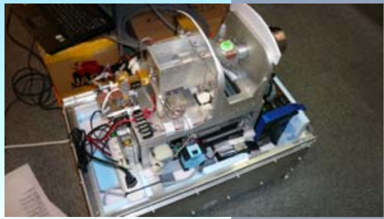
Transit observation with molecule band

CH_4, H_2O, CO_2

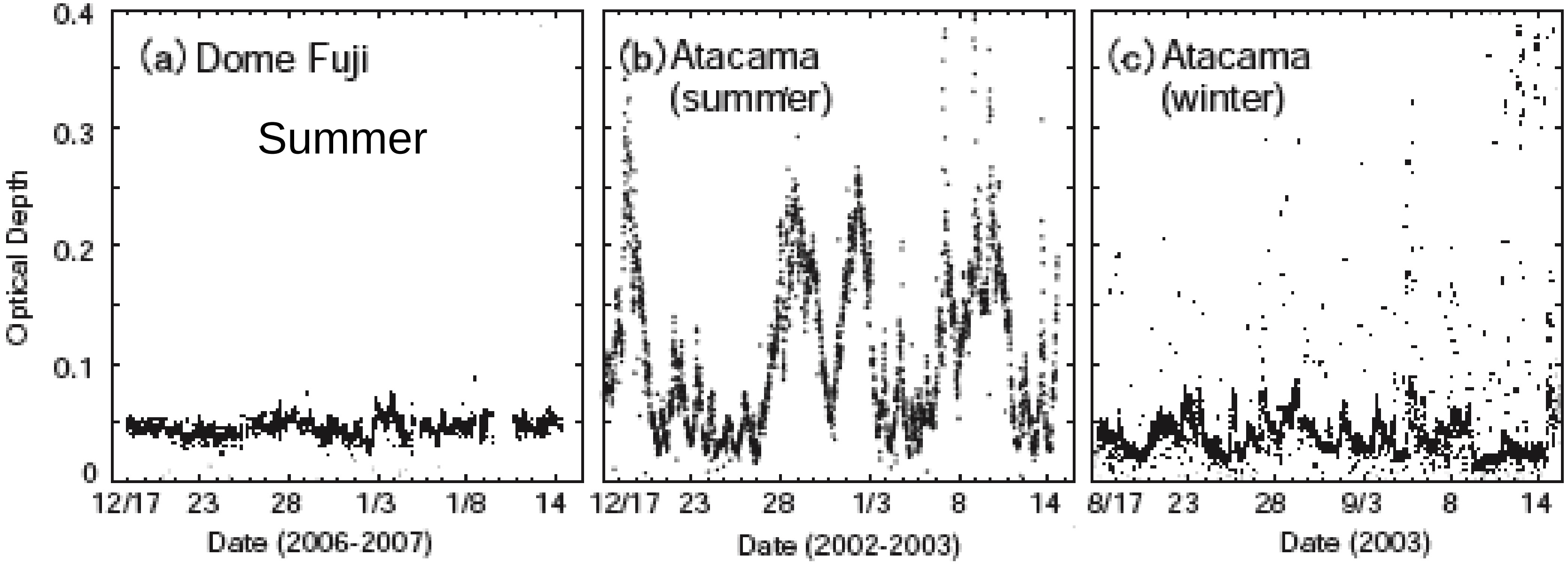
Dome Fuji station

National Institute of Polar Research

Transmittance in 220GHz band



Seta+ 2009

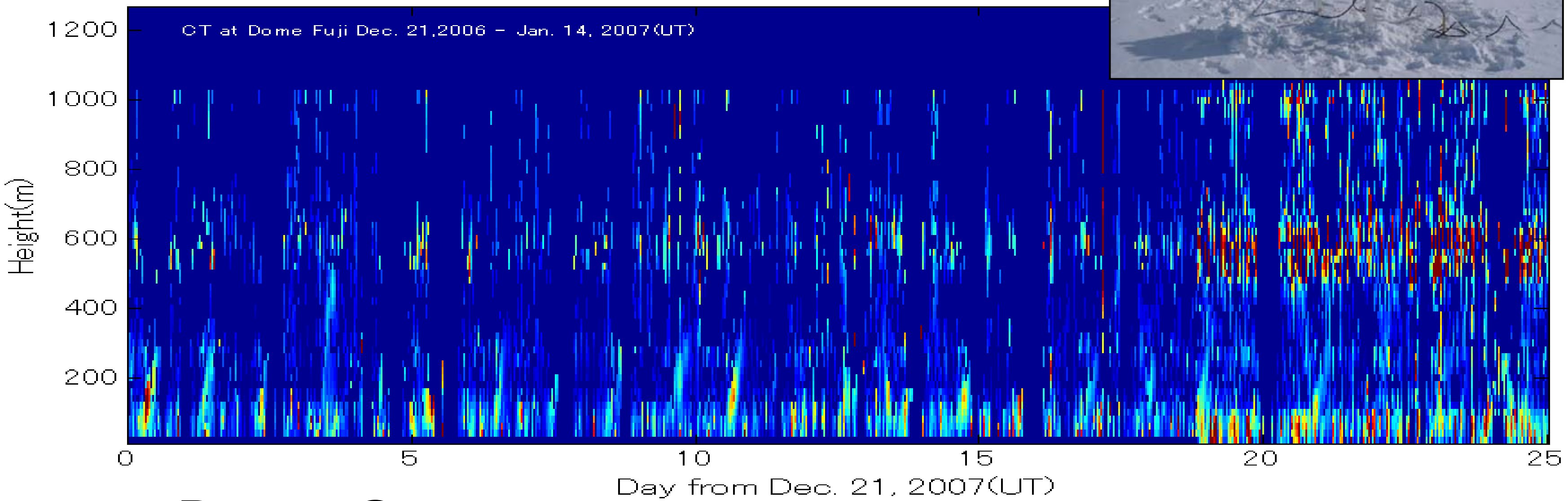


Very stable than Atakama in summer
However, higher transmittance than Atakama in the best days

Turbulence strength

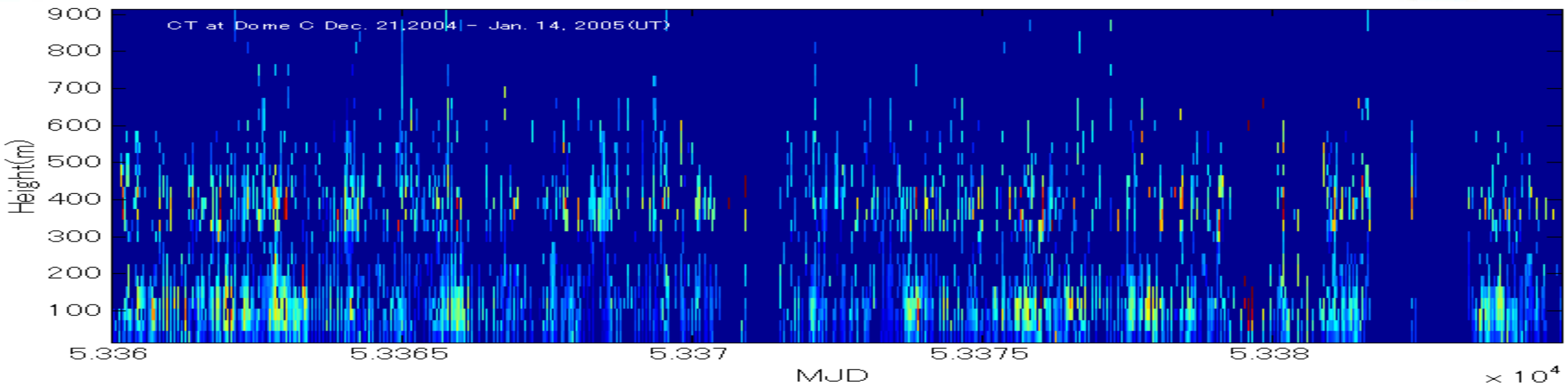
SODAR

Dome Fuji

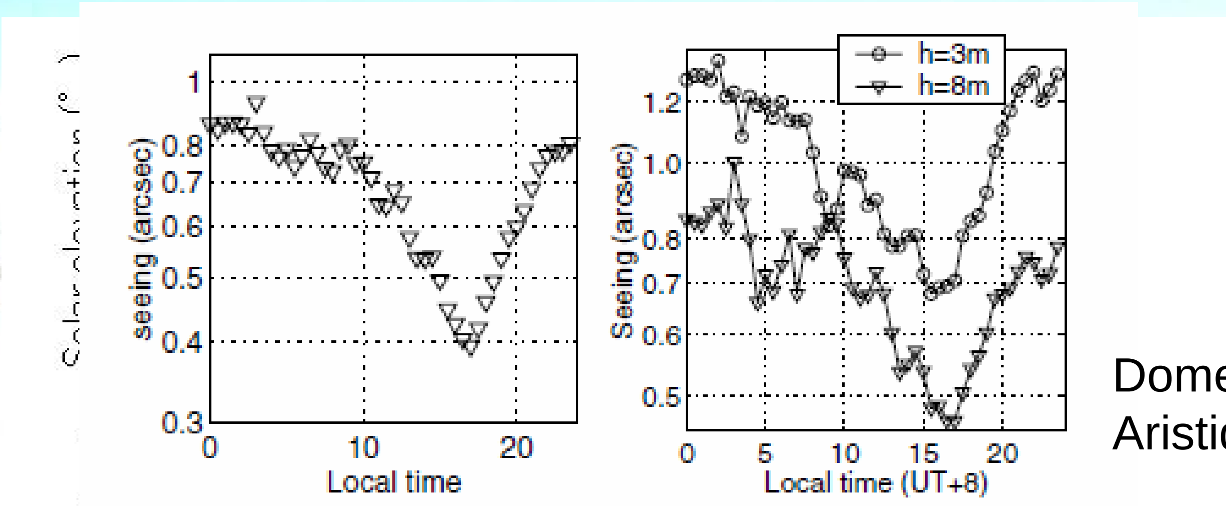


Dome C

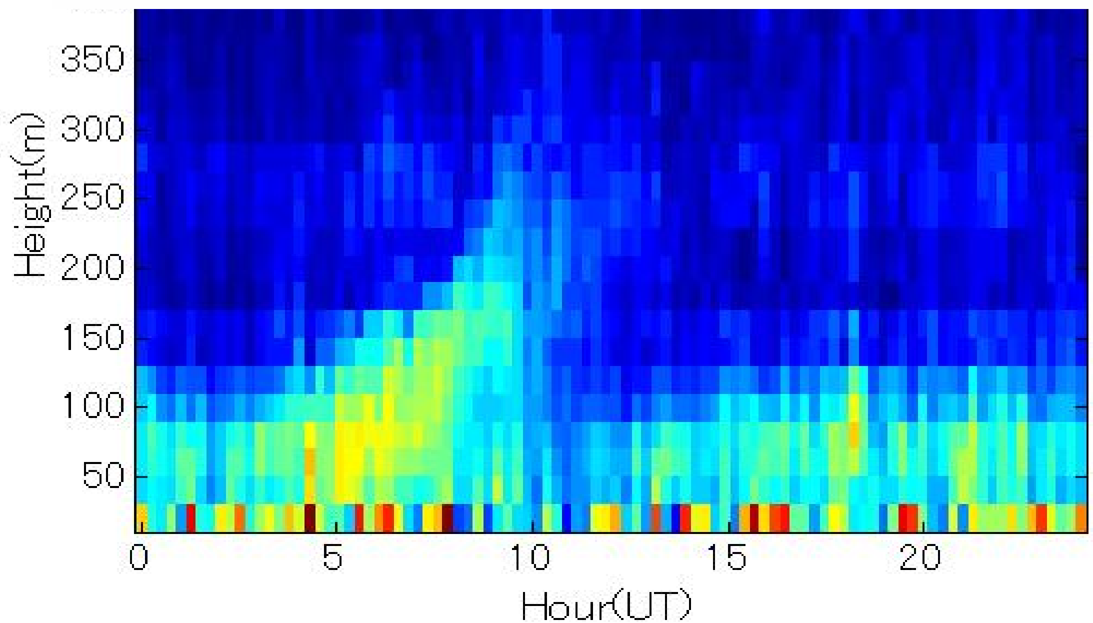
AASTINO



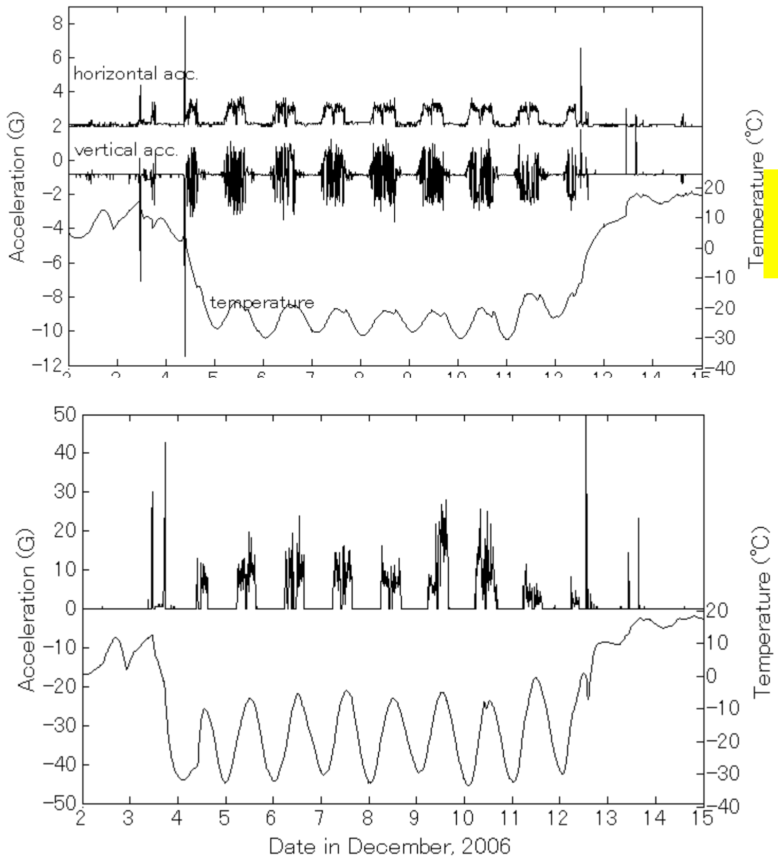
Diurnal variation of turbulence strength



Dome C
Aristidi + 2005



Vibration



±3 G

on the roof of snow vehicle

25 G

on a sledge

Pilot studies with small telescopes

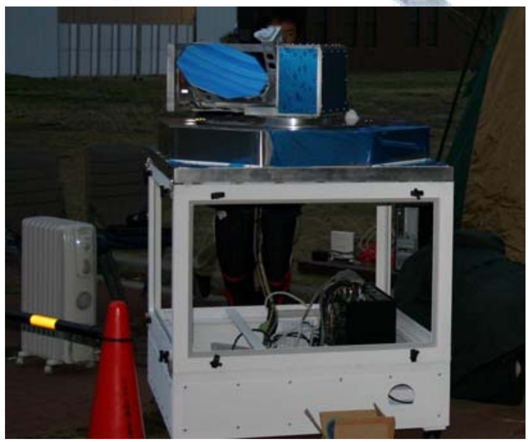
40cm Infrared telescope

J, K_{dark} Camera
AIR-C

for seeing, transmittance, sky background

30cm THz telescope

for transmittance and its stability



Seta +

AIR-T-40
40 cm Antarctic Infra-Red Telescope

+ remote control (under developing)

Specs for the environment at −80℃

Operation at Hokkaido Rikybetsu the coldest place in Japan (2008/2)

Murata et al.

deploy

Operation at -23℃ without no problems except note PC

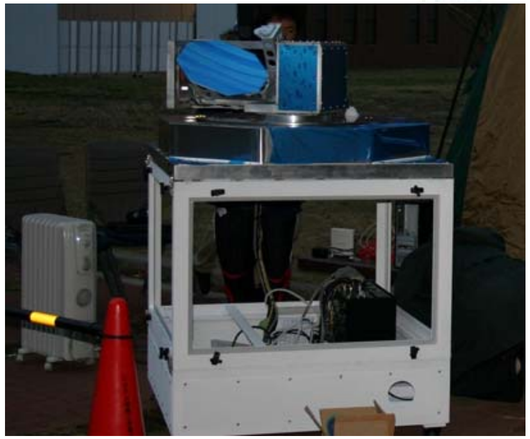
assemble

Operation by wind power

Jungflau in Swiss

- ◆3580m
- ◆-37℃

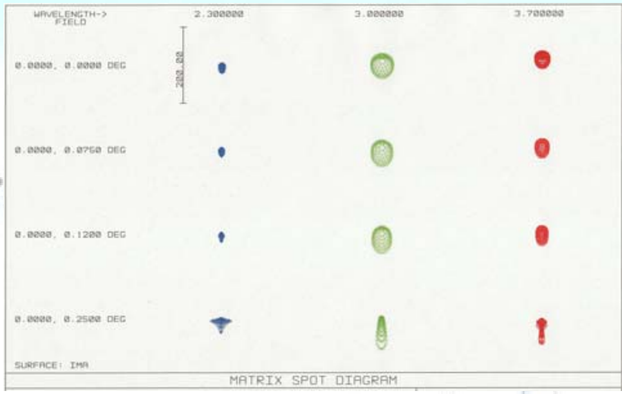
Seta et al.

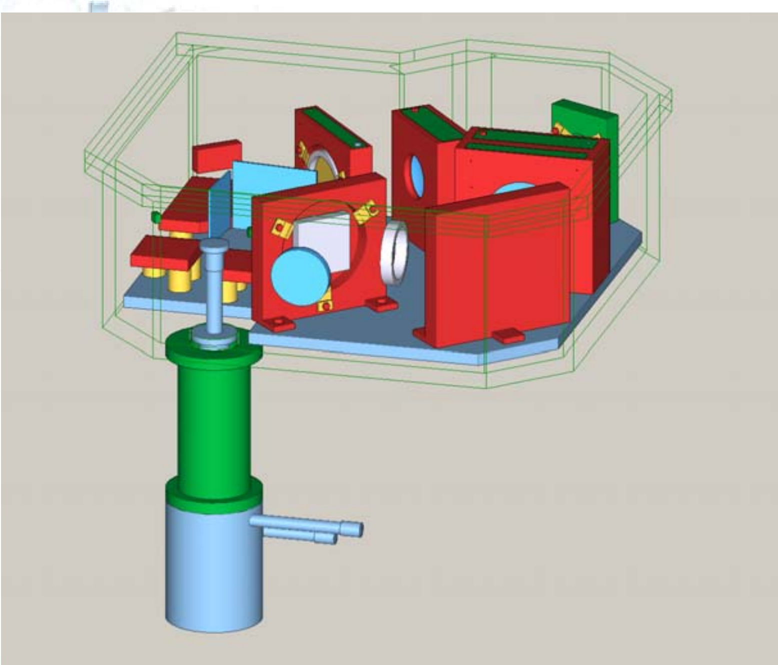


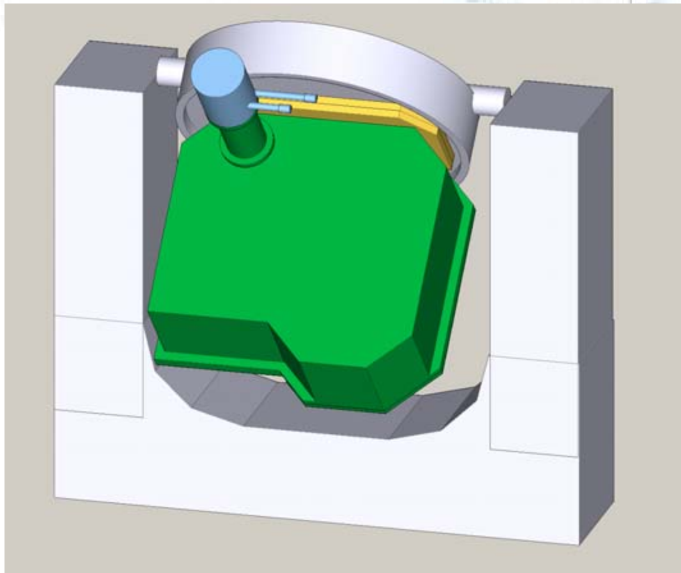
AIR-C3

K_{dark} (2.4 μm)
3.4 μm
L' (3.8 μm)

Lundock+ (2008)







Infrared Astronomy by Japanese group

AIR-FOX

Antarctic InfraRed astronomy at dome Fuji Observatory eXplorer

AIR-T-40 Antarctic InfraRed Telescope (40cm)
AIR-C1 Antarctic InfraRed Camera 1
AIR-C3 Antarctic InfraRed Camera (3 bands)
AIR-T-200 Antarctic InfraRed Telescope (2m)

AIR-Solar Antarctic InfraRed Solar telescope (40cm)
AIR-HET10 Antarctic InfraRed Heterodyne Spectrograph (10 μm)
AIR-Trans Antarctic InfraRed Transit telescope
etc.

$\lesssim$ 500 M yen (Telescope & Instruments) + NIPRJ (logistics)

Collaboration with Australia group at Dome Fuji

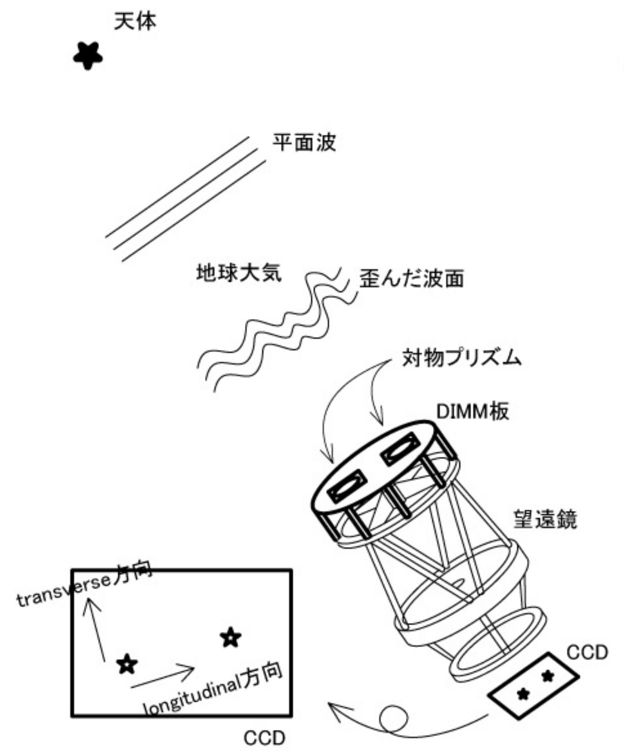
Engine module

Dome A

Storey+

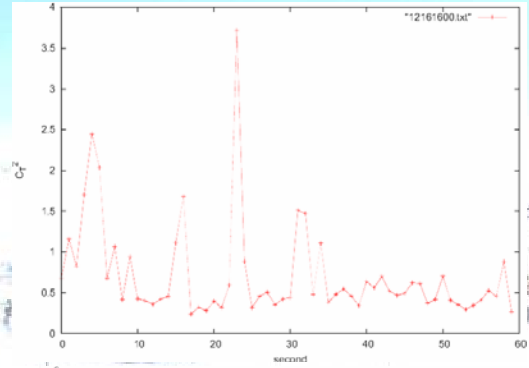
Seeing measurement by DIMM

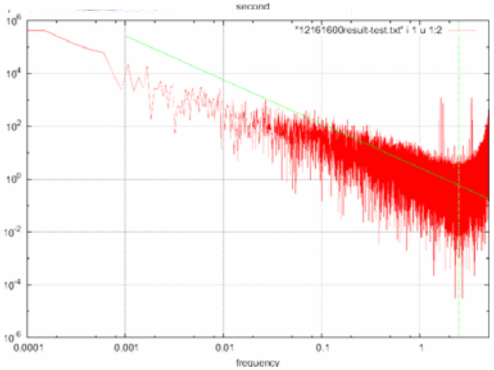
Okita+



Seeing measurement by anemometer

Kurita et al.





Current status and future plane

2005/12 started the discussion with NIPR
2006/ 2 first observations for astronomical test
SODAR
220GHz radio meter
2009/12-2010/2
first step on Dome Fuji by a Japanese astronomer
transmittance by handy infrared spectrograph
transmittance by 200GHz radiometer
2010/12-2011/2
deployment of 40cm-infrared and 30cm-THz telescopes
at Dome Fuji
2010-2014 Construction of overnight facilities by NIPR
2011-2012 deployment of PLATO-Fuji by collaboration with UNSW
Observations with small telescope over winter
(remote operation)
2014?-   Construction of large telescope(?)