

Recent progress and future development of Nobeyama 45-m Telescope

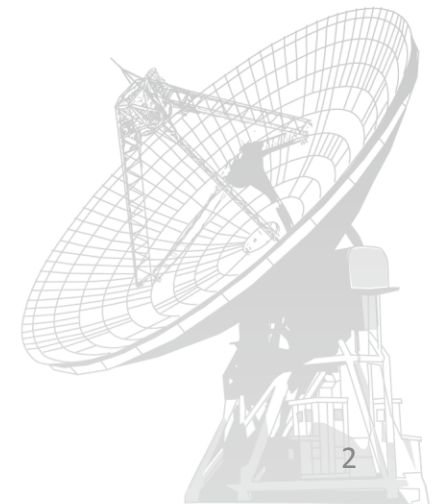
Masao Saito: Director of Nobeyama Radio Observatory

Tetsuhiro Minamidani: Nobeyama Radio Observatory



Outline

- Nobeyama 45-m Telescope
- Recent Progress
- Future Development



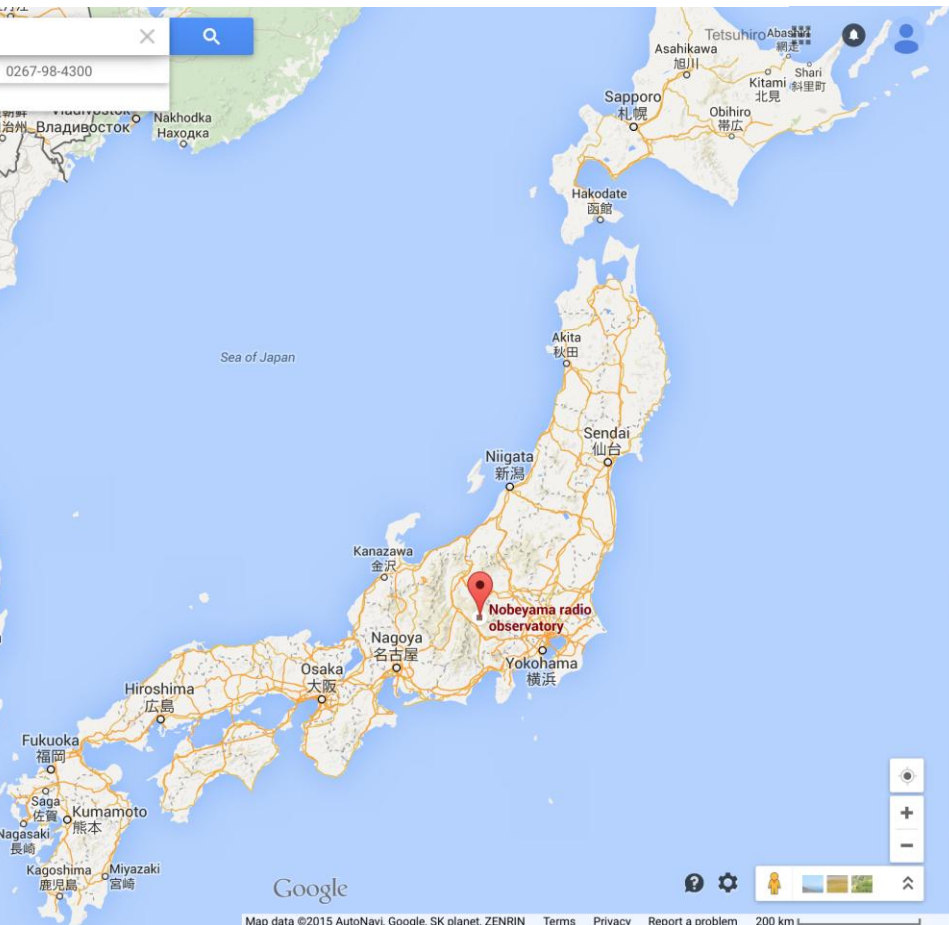
Nobeyama 45-m Telescope



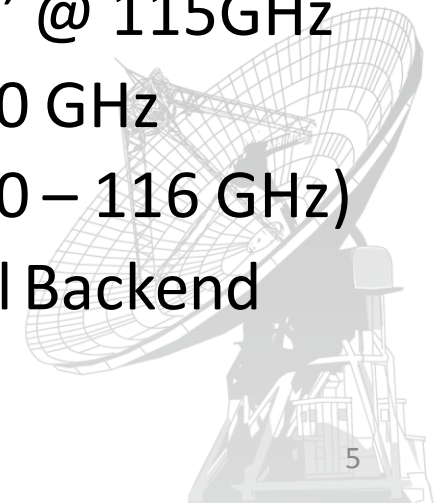


Nobeyama 45-m Telescope

Nobeyama Radio Observatory (NRO)



- 2014 July Spec.
- 1350 m altitude
- 45m Diameter
- Optics: Beam waveguide
- Pointing accuracy: 2-3"
- Surface accuracy: 180 μm
- Beam size: 14" @ 115GHz
- η_A : 0.25 @ 110 GHz
- 9 Receivers (20 – 116 GHz)
- Analog/Digital Backend
- Open-use



2014 July

OPEN USE

Internal Use

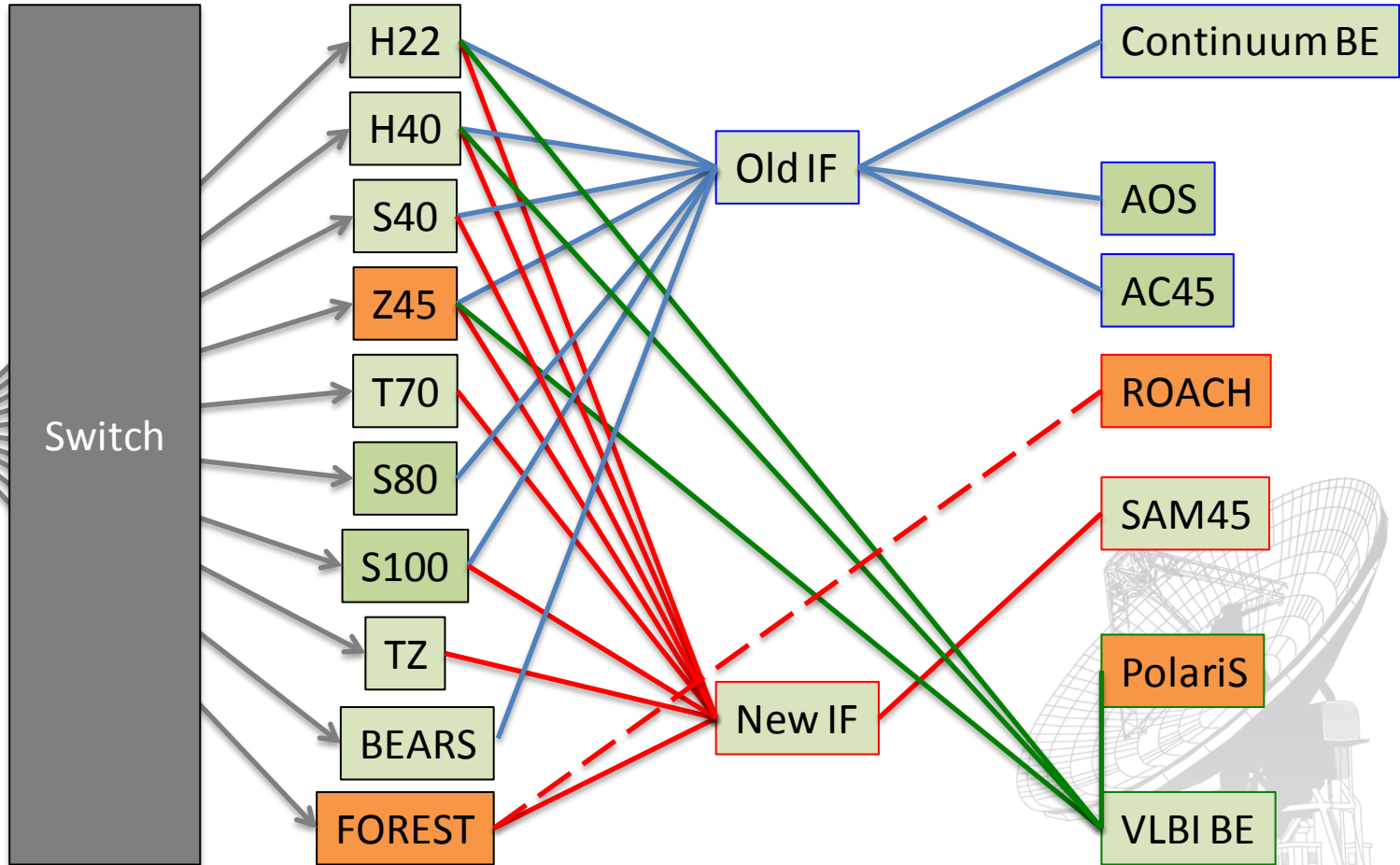
Commissioning

Optics

Receiver

IF chain

Backend



45m

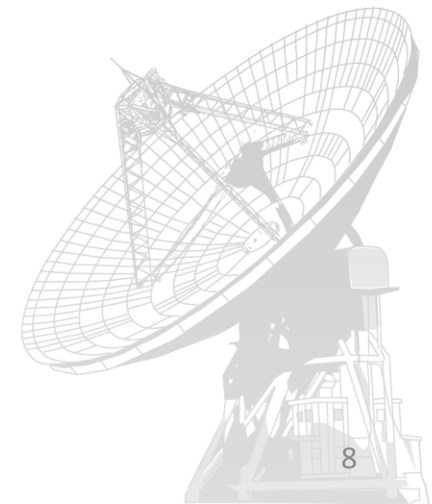
Recent Progress

- Holography
- Optics
- New Multi-beam Receiver



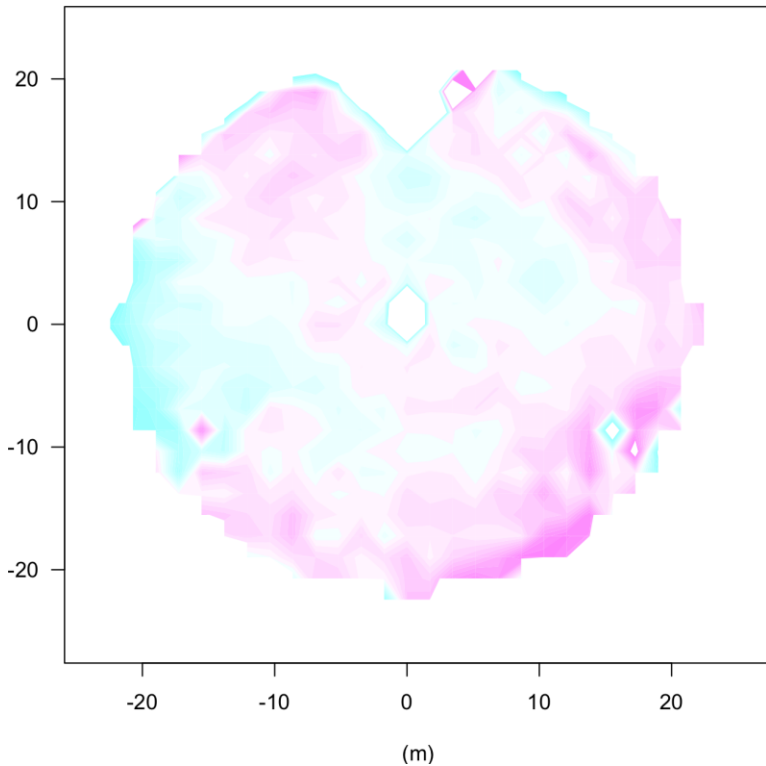
Issues

- Large surface errors : 180 μm rms.
- High antenna noise temperature: 30 K
- Single pixel Rx only
- Too redundant system

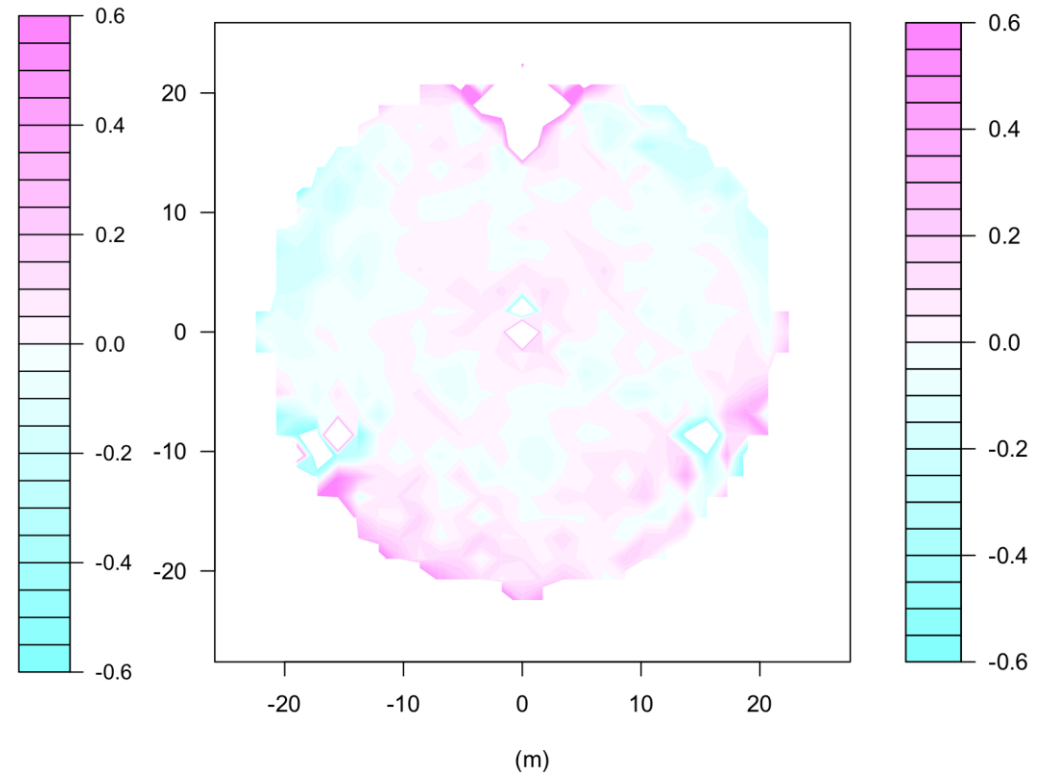


Surface Adjustment

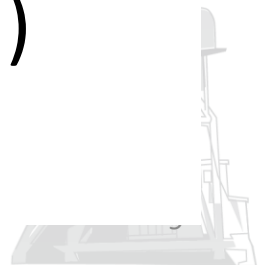
H₀ Before (2015-06-08) .80

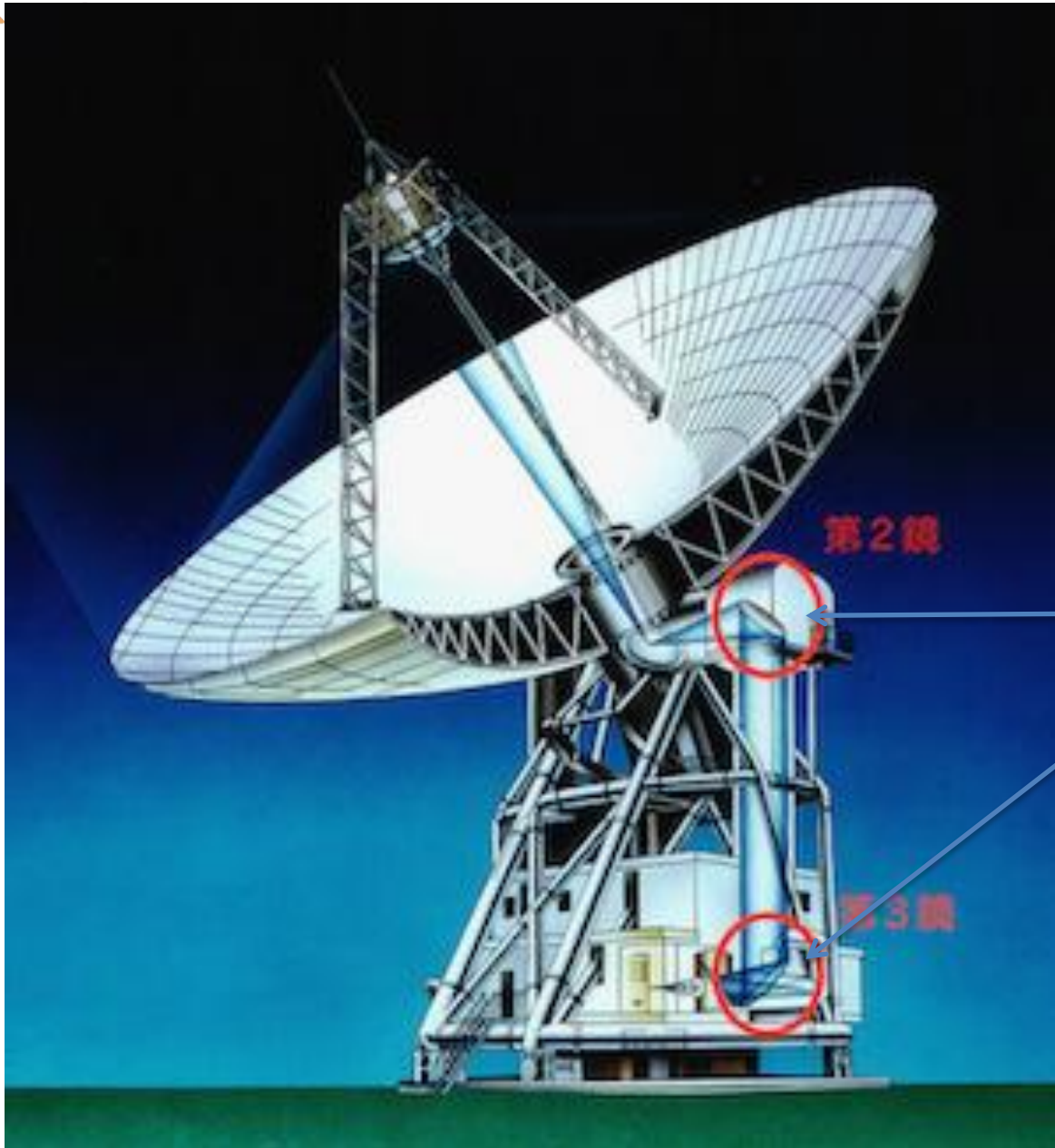


H_{0lg} After (2015-10-05) 20.30

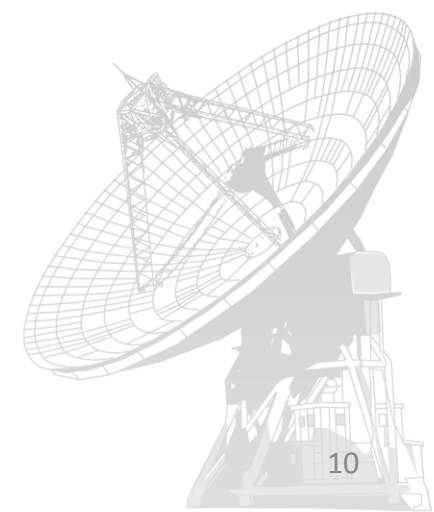


- $180 \mu\text{m rms} \rightarrow 100 \mu\text{m rms}$ (nominal)
- $\eta_A : 0.25 \rightarrow 0.35$ at 110 GHz

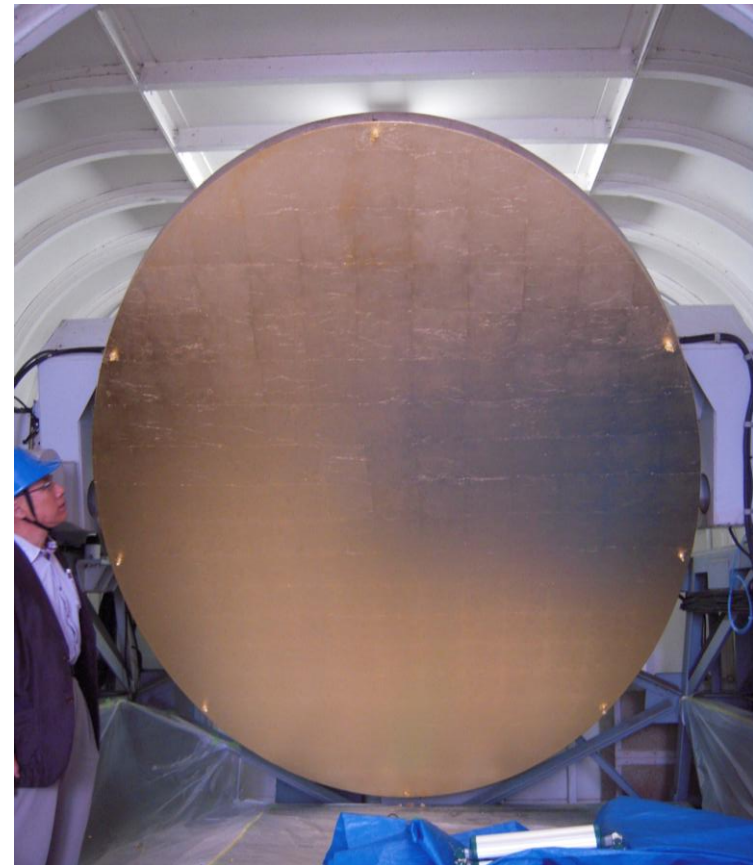




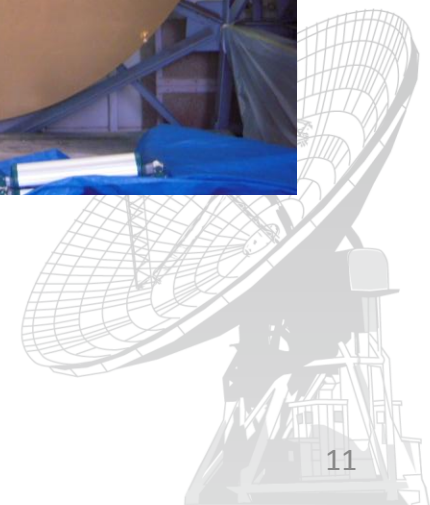
These two mirrors are degraded.



Put (Stick) metal foils to M2 and M3

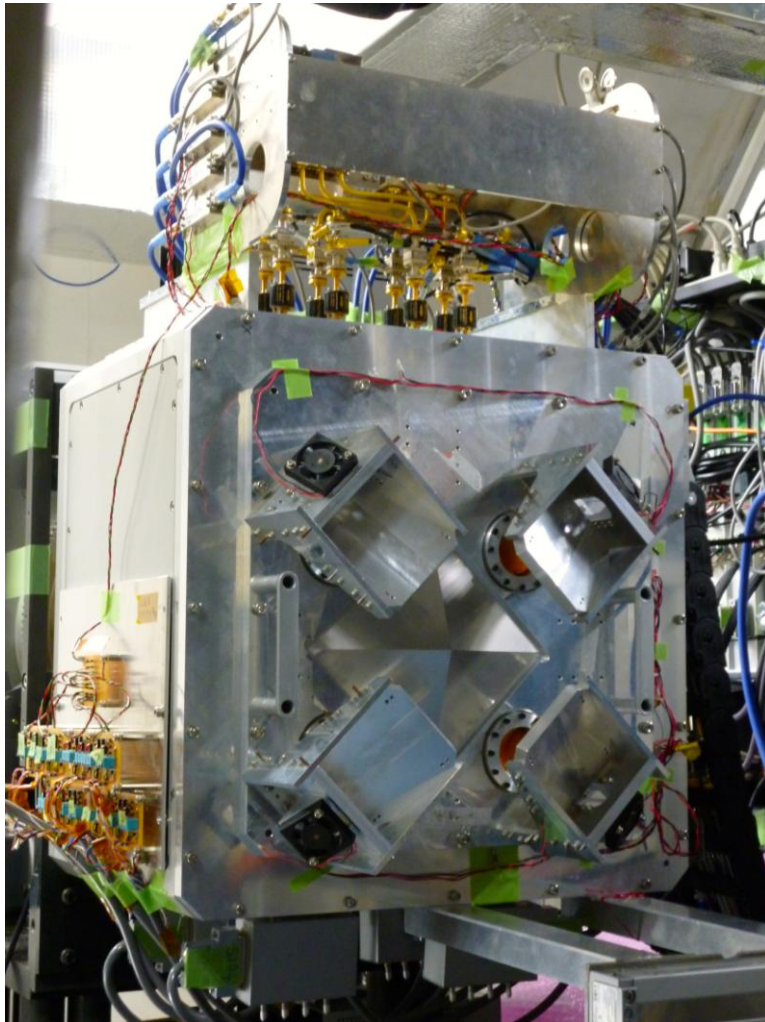


- Put (Stick) metal foils to M2 and M3
- Tsys is reduced by $\sim 11\text{K}$ @ 3mm



“FOREST”

FOur beam REceiver System on 45-m Telescope



- 4-beam x 2-pol.(H/V) x 2-sideband = 16 IFs
- Beam separation $\sim 50''$
- Beam size $\sim 14''$ @ 115GHz
- IF: 4-12 (4-11) GHz \rightarrow simultaneous ^{12}CO , ^{13}CO , C^{18}O observation
- Dewar rotation system to track same sky position

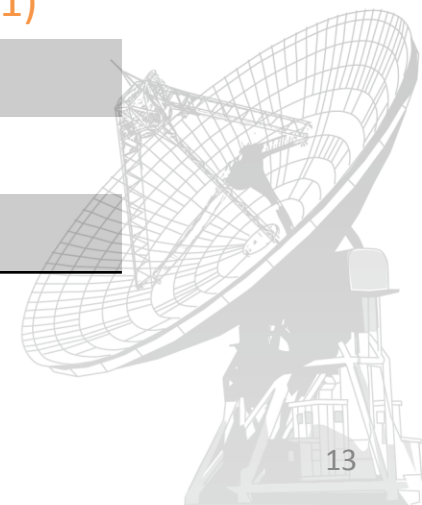
FOREST

FOur beam REceiver System on 45m-Telescope

- 4-beam x 2 pol. x 2SB = 16IF
- Beam separation ~ 50"
- IF 4 – 12 (4-11) GHz

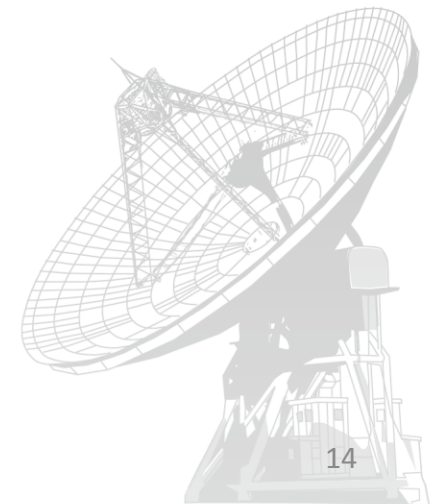
2016, Jan. 06: Started Open Use Observations

Receiver	TZ	FOREST
# of Beams	2 (1)	4
Sidebands	2SB	2SB
Polarization	Dual	Dual
IF freq. [GHz]	4 – 8	4 – 12 (11)
Trx (SSB) [K]	~ 50	~ 50
Tsys (SSB) [K]	~ 150	~ 150
Mapping Eff.	1	4



Decommission old systems

- S80: SSB SIS at 80 GHz
- S100: SSB SIS at 100 GHz
- BEARS: 25 DSB receiver
- AC45: Digital Spectrometer



Issues

- Large surface errors: $180 \mu\text{m}$ ($\eta_{A,110 \text{ GHz}} : 0.25$)
 - Improved to be $100 \mu\text{m}$ ($\eta_{A,110 \text{ GHz}} : 0.35$)
- High antenna noise temperature: 30 K
 - Reduced to be 19 K (w/o atmosphere)
- Single pixel Rx only
 - Expanded to be 4 pixels

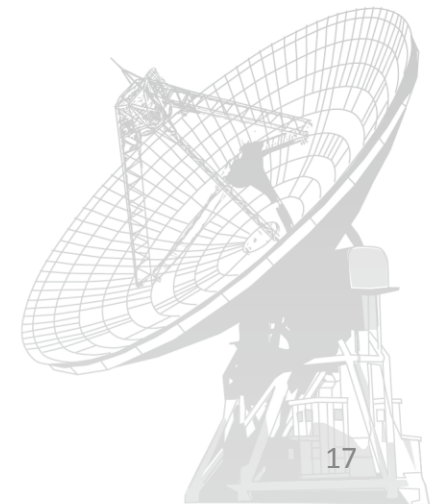
Overall a factor of 10 improvement in 3 mm mapping obs

- Reduce redundancy

Future Development



- Hardware
 - Decommissioning of S40, TZ
 - Providing Z45/Polaris to community
 - Providing SAM45 spectral window mode
 - Developing metrology system (under discussion)
- Software
 - Expand remote observation
 - Move to CASA and single dish pipeline
 - decent archive system



OPEN USE

Internal Use

Commissioning

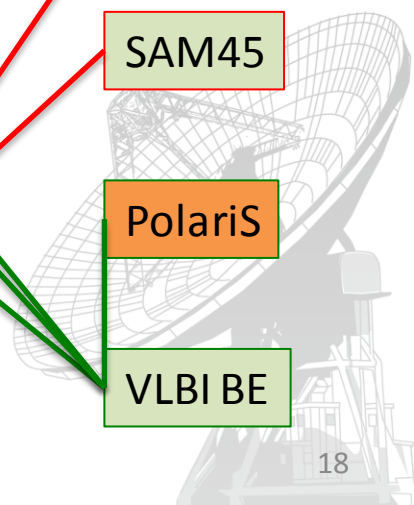
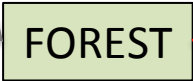
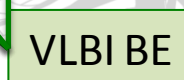
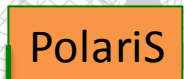
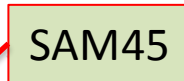
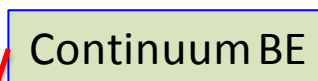
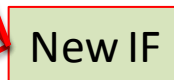
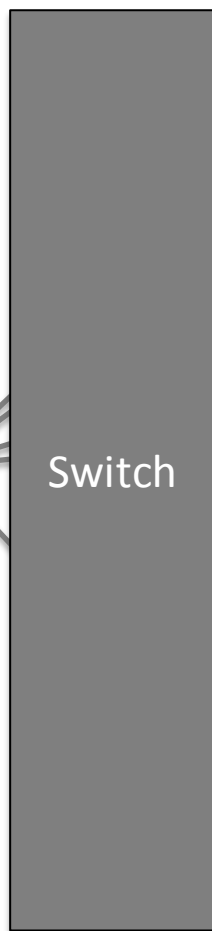
Near Future System

Optics

Receiver

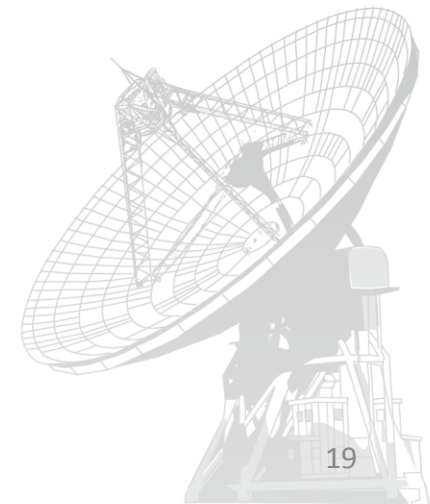
IF chain

Backend

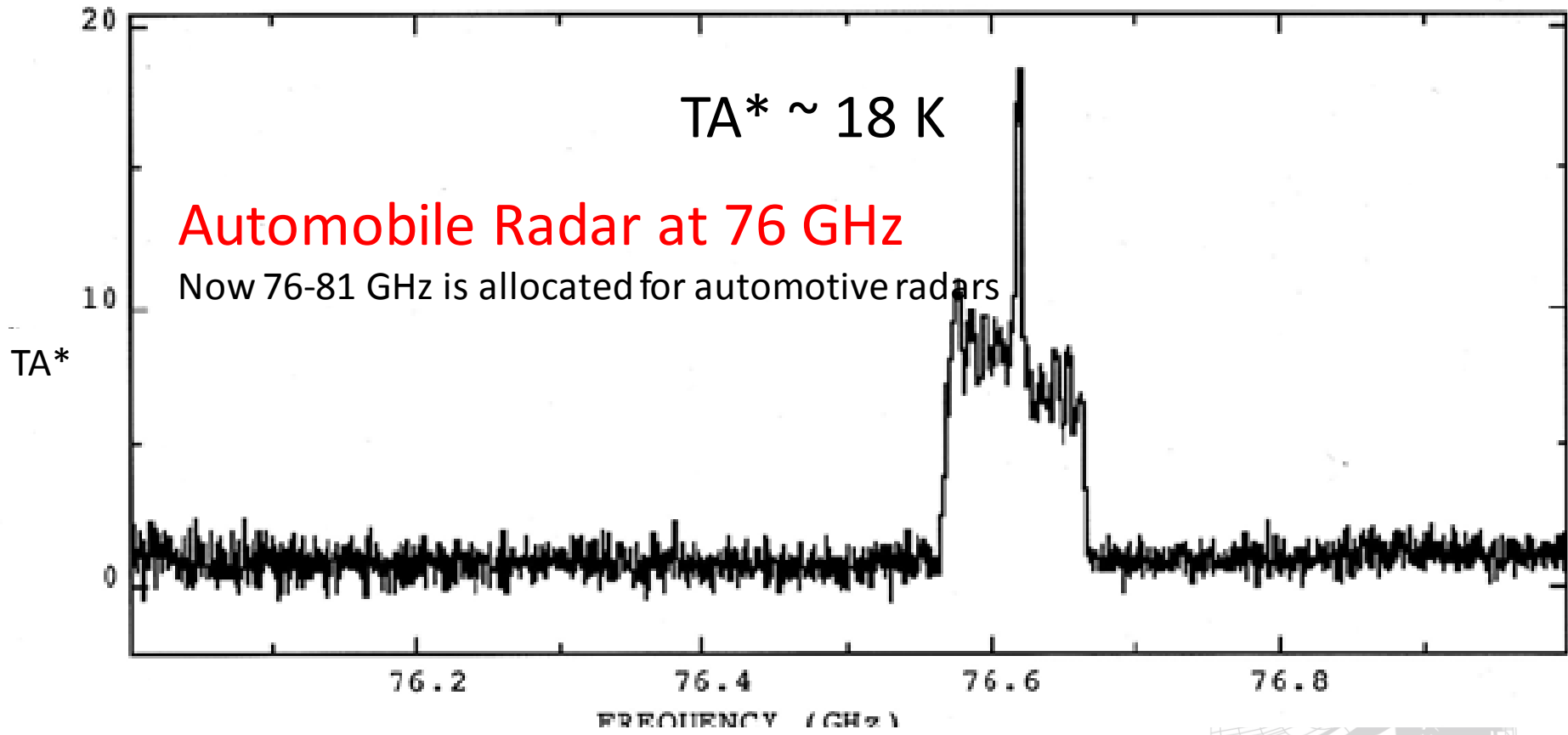


Future Development

- Possible Development Items
 - More beams (pixels)
 - Large Heterodyne Array
 - Wider frequency coverage like Band 2/3
 - More advanced spectrometers (bandwidth/bits)
 - ROACH (FPGA) spectrometer ?
 - GPU spectrometer (KASI) **Iguchi-san' talk**
 - VLBI at millimeter wavelengths



New Discovery?



Summary

- Nobeyama 45-m telescope (34 yrs old)
 - One of the largest single dish antennas operated at 20-116 GHz.
- Recent Progress
 - Surface accuracy improved
 - Optics loss improved
 - Four-beam multi-receiver available for open-use
- Future Developments of the Nobeyama 45-m Telescope
 - On-going/planned updates will be finished in coming 2-3 years
 - Z45 with polarization capability at 7 mm
 - More Flexible Auto-correlator setup
 - Remote Observations
 - Move to CASA and pipeline
 - Future upgrade items
 - More beams (pixels) at 3 mm?
 - Wider bandwidth with more bits spectrometers (bandwidth) ?
 - VLBI in millimeter wavelengths ?

