

FOREST and Future Development of the Nobeyama 45-m Telescope

Tetsuhiro MINAMIDANI

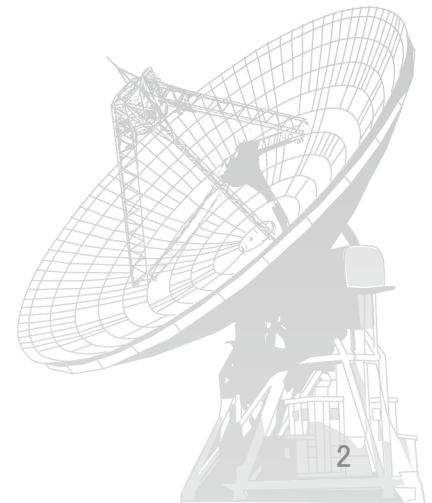
Nobeyama Radio Observatory

National Astronomical Observatory of Japan



Outline

- FOREST
 - Season 2015-2016
 - Preparations for Season 2016+
- Future Development of the Nobeyama 45-m Telescope
 - post FOREST



Nobeyama Radio Observatory (NRO)



- Diameter: 45m
- Surface accuracy: 100um rms
- 9 Receivers
- Frequency coverage: 20 – 116GHz
- Beam size: 15" @ 115GHz
- Pointing accuracy: ~ 3"
- Main beam efficiency: ~ 0.41 @ 115GHz
- Aperture efficiency: ~ 0.36 @ 115GHz

March. 07, 2016

15 (Miramidanu)

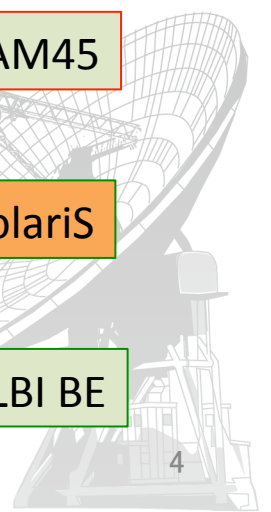
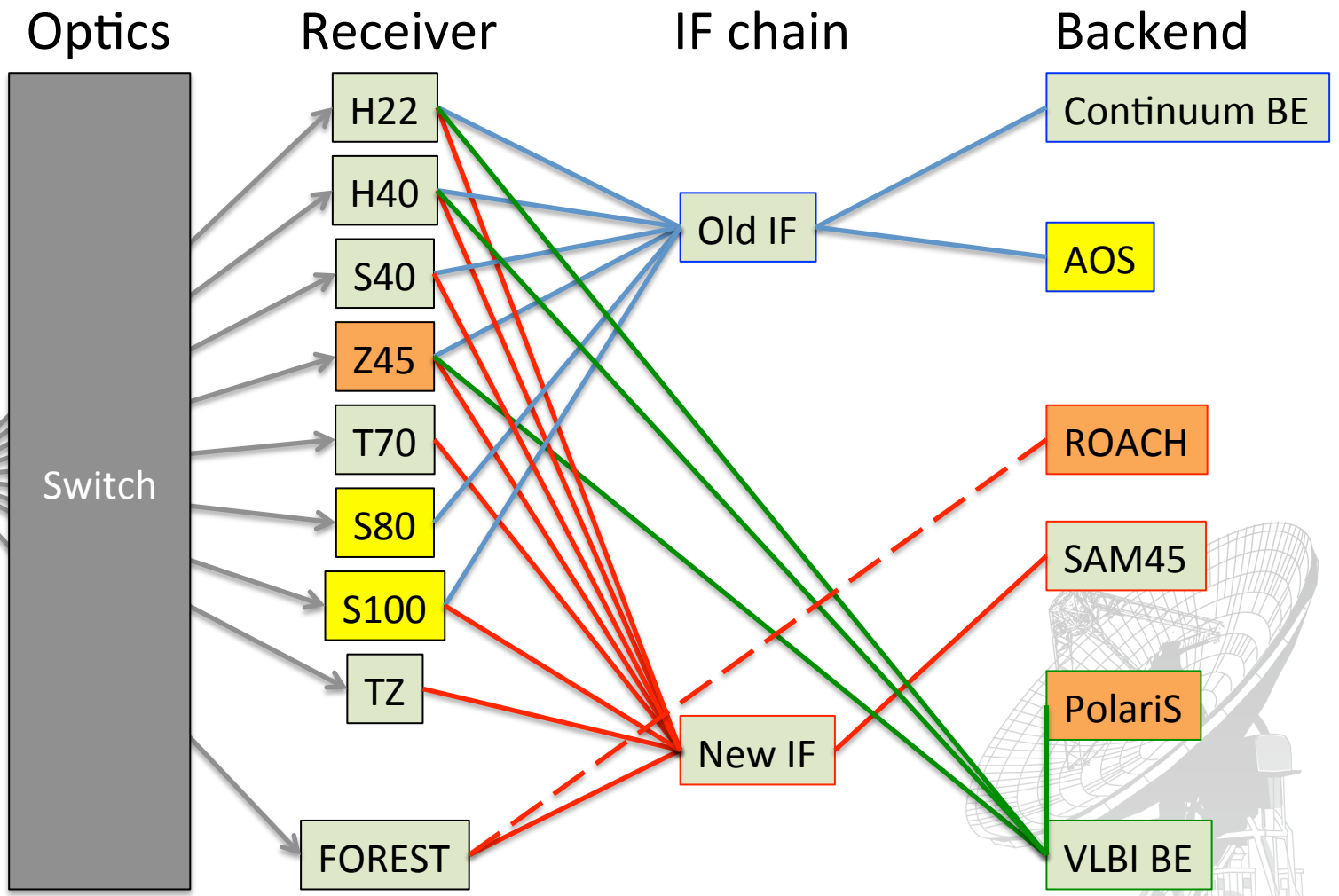
3

OPEN USE

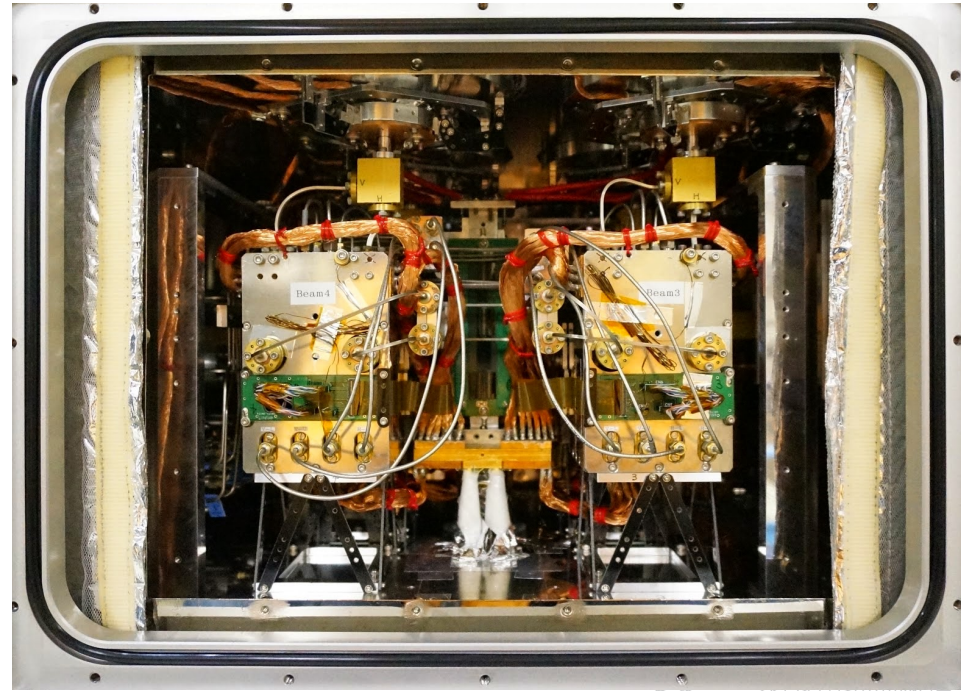
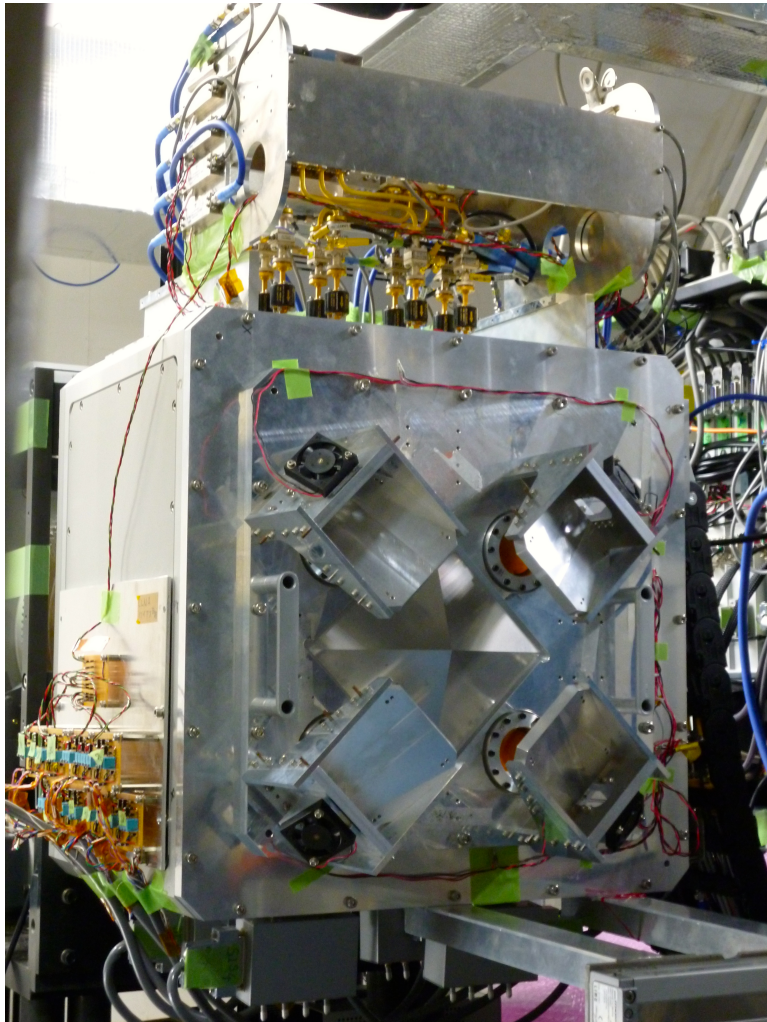
Internal Use

Commissioning

Current System



FOur beam REceiver System on 45-m Telescope



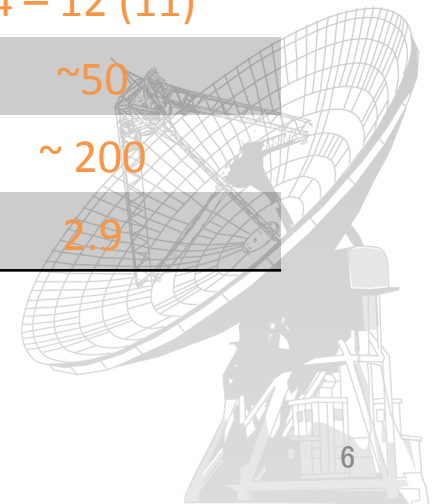
- 4-beam x 2-pol.(H/V) x 2-sideband = 16 IFs
- Beam separation ~ 50"
- Beam size ~ 15" @ 115GHz
- IF: 4-12 (4-11) GHz → simultaneous 12CO, 13CO, C18O observation
- Dewar rotation system to track same sky position

FOREST

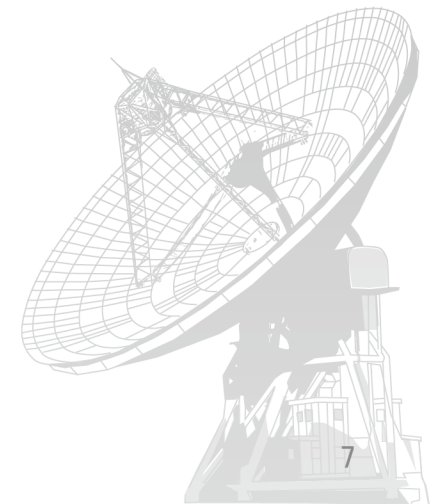
FOur beam REceiver System on 45m-Telescope

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

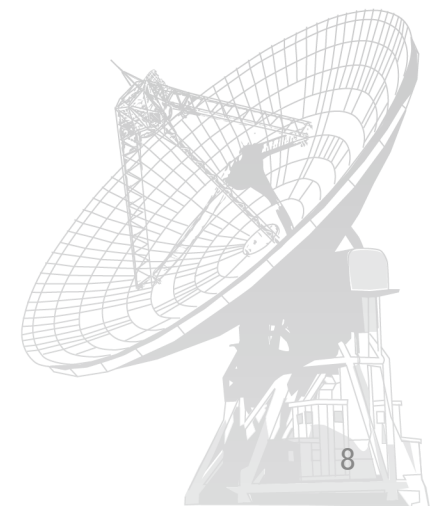
Receiver	BEARS	TZ	FOREST
# of Beams	25	2 (1)	4
Sidebands	DSB	2SB	2SB
Polarization	Single	Dual	Dual
IF freq. [GHz]	2 – 2.6	4 – 8	4 – 12 (11)
Trx (SSB) [K]	~ 160	~ 50	~ 50
Tsys (SSB) [K]	~ 600	~ 200	~ 200
Mapping Eff.	1	0.72	2.9



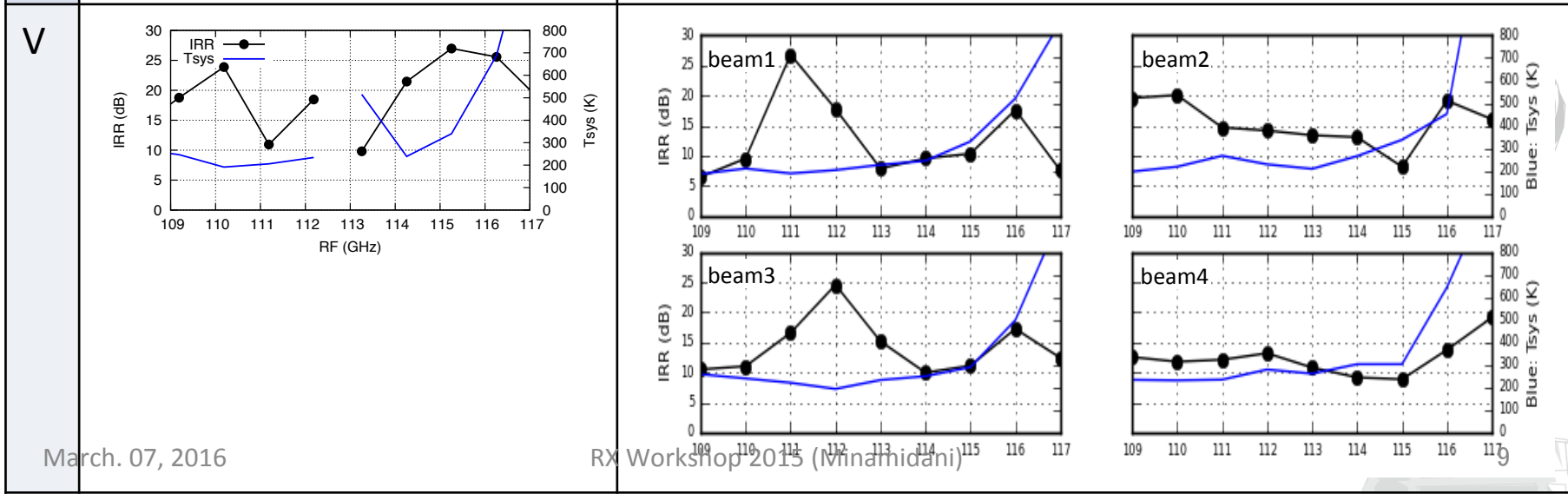
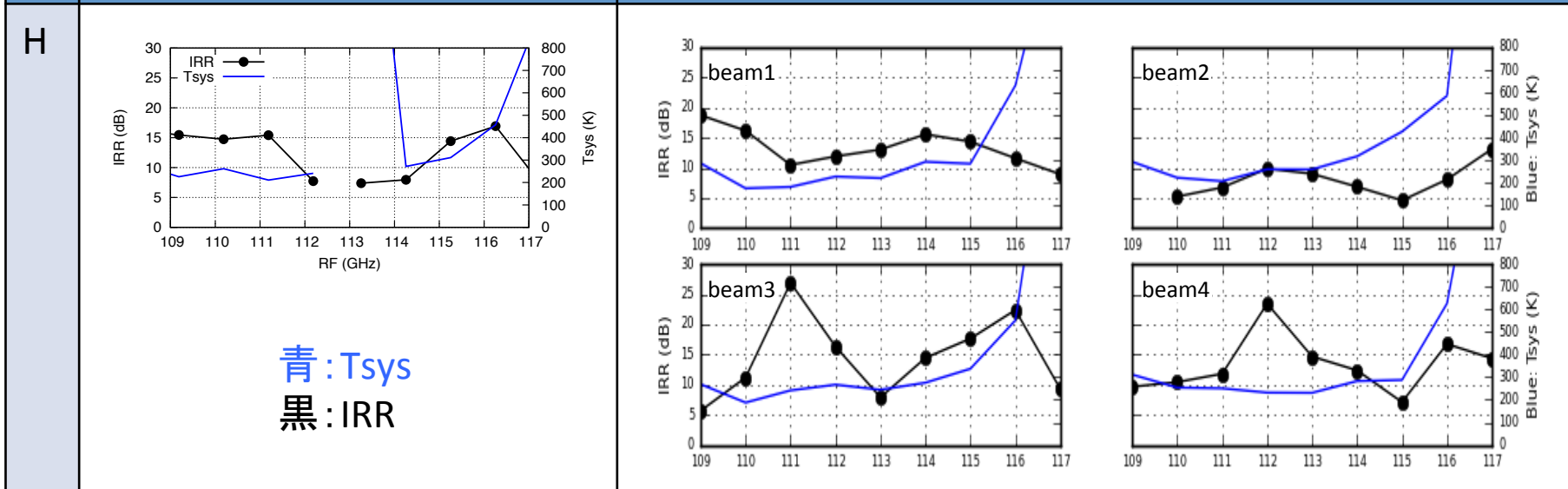
- Updates:
 - Co-axial IF cables in Dewar: Replaced
 - “Dip” is disappeared
 - CLAN Bias circuit: Replaced
 - IF chains: Tuned
 - Control System: Replaced
- Timeline:
 - Oct. 13: Installed to the 45-m Telescope
 - Set-up, Commissioning
 - Dec. 22: Started Legacy Observations
 - Jan. 06: Started Open Use Observations



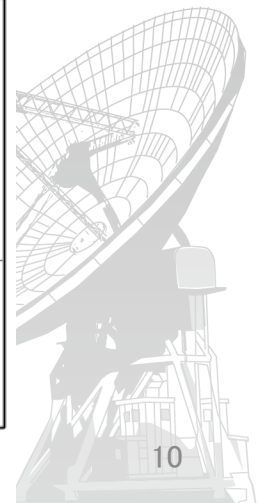
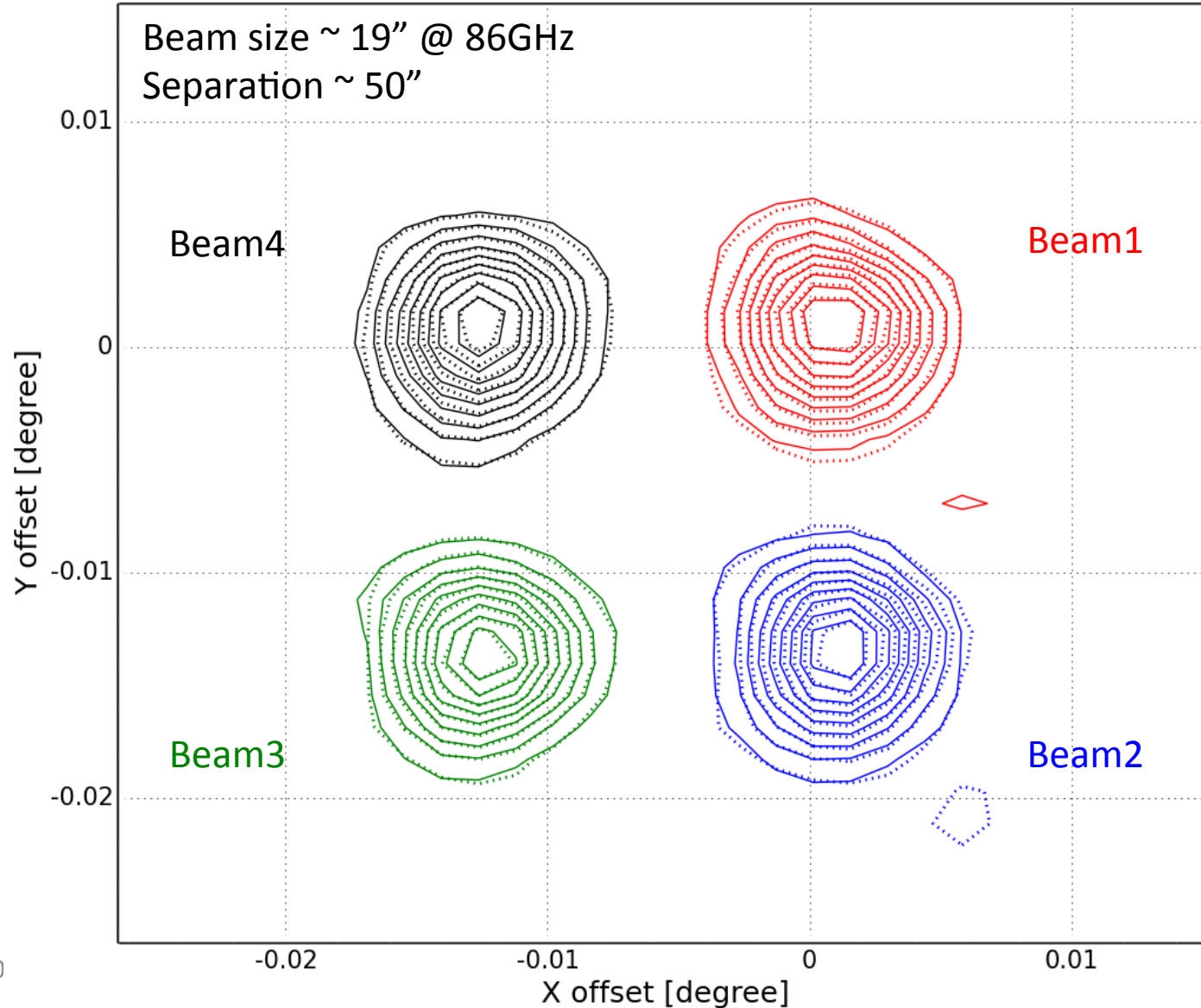
- Status:
 - 45-m Status Report
 - http://www.nro.nao.ac.jp/~nro45mrt/html/prop/status/Status_R15.html
 - FOREST wiki CSV
 - <https://www.nro.nao.ac.jp/~nro-devel/secure/wiki/forest/index.php?FOREST%2FDevelopment%2FCSV>
 - (要 ID/password)
 - Tsys
 - 250 K @ 12CO (~ 115GHz)
 - 150 K @ 13CO, C18O (~ 110GHz)
 - IRR ~ 10 dB



TZ FOREST



Beam Map



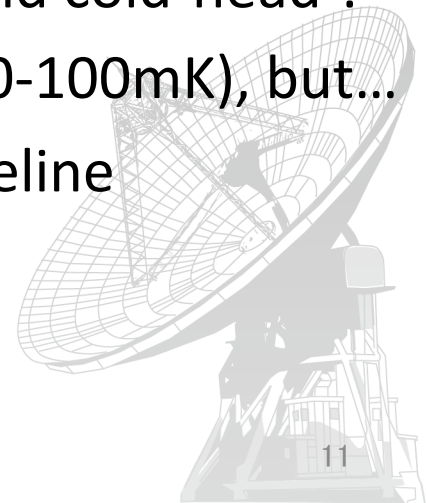
- Issues on Cooling System

- He gas leak

- He lines between compressor and cold-head ?
- Charge He gas every week / every two weeks

- Temperature fluctuation

- depend on combinations of compressor and cold-head ?
- Temperature fluctuation is not so large (50-100mK), but...
- Affected to IF signal level and spectral baseline

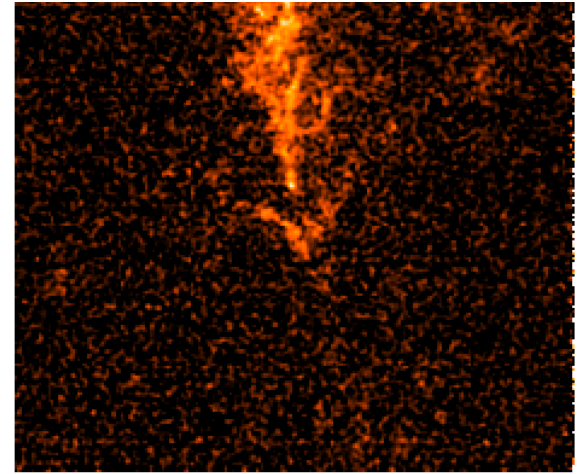
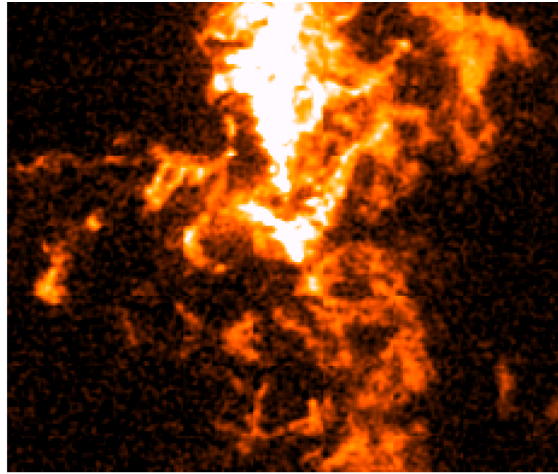
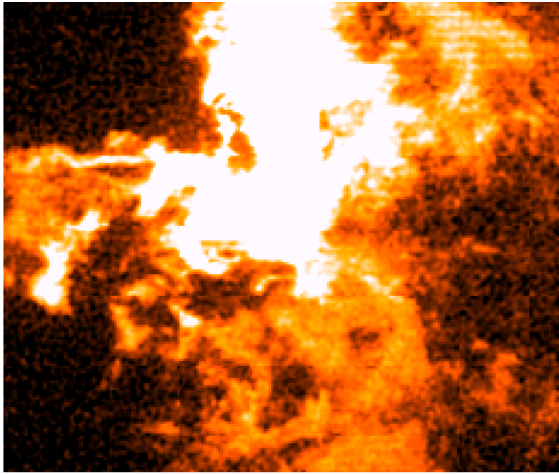


12CO

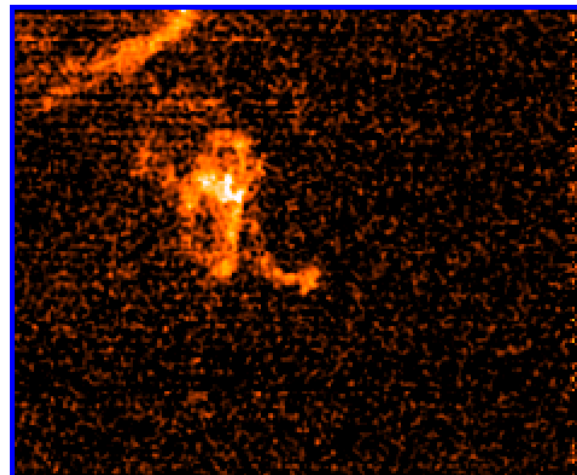
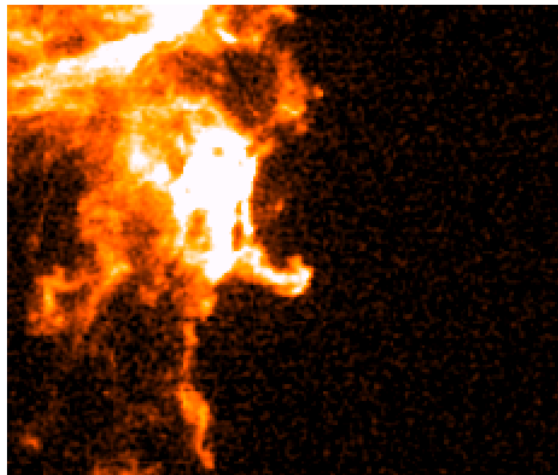
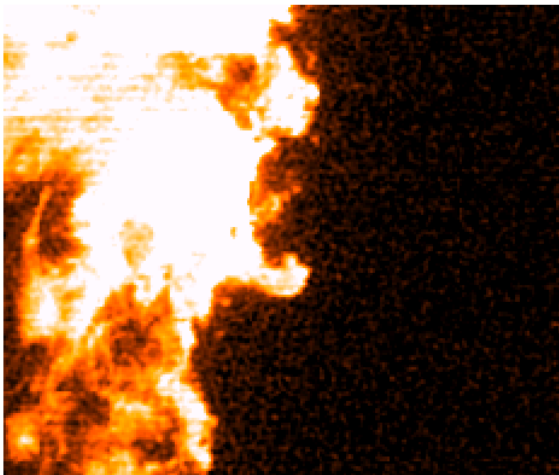
13CO

C18O

Orion A



Horsehead Nebula



1 deg x 1deg x 2 regions ~ 5 hours

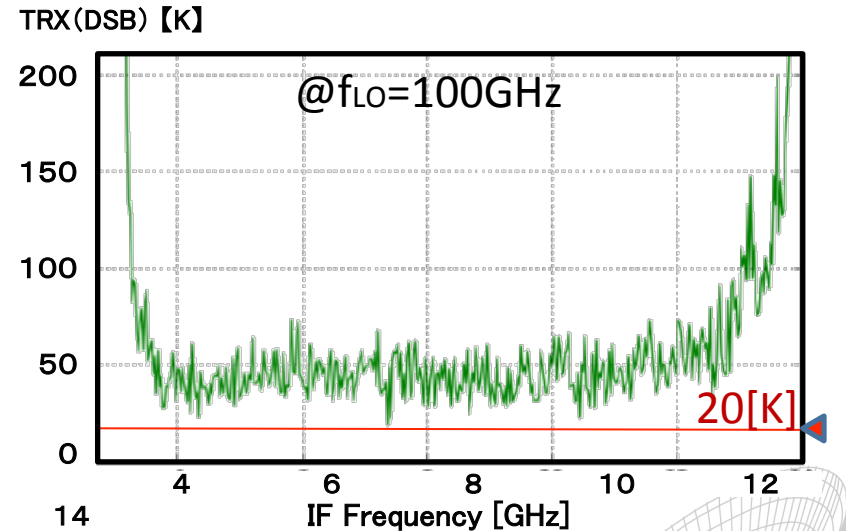
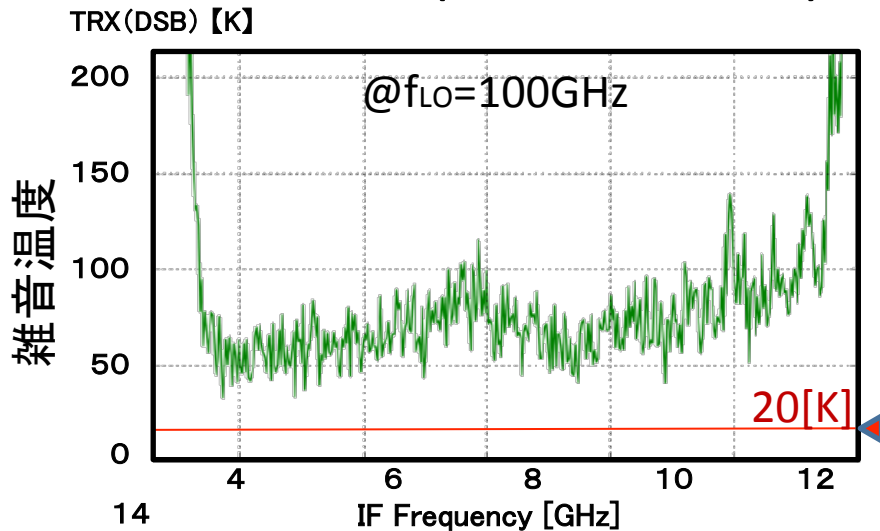
March. 07, 2016

RX Workshop 2015 (Minamidani)

(Minamidani, FOREST CSV Team et al. in prep.)

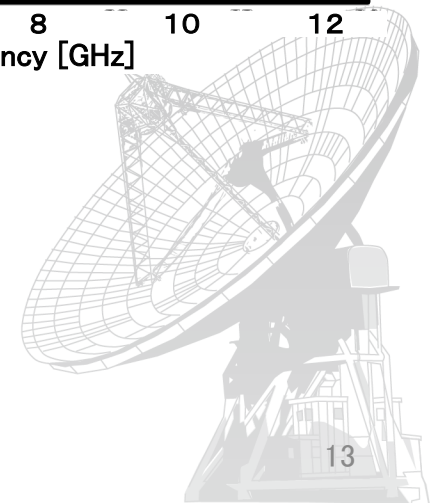
Preparations for Season 2016+NINS

- Development of Wideband SIS Mixers @ ATC
 - OKY100 (Kozuki et al.)



- Replace SIS Mixers next summer

- Replace to 67-116GHz SIS Mixers ?!



Future Development of the Nobeyama 45-m Telescope

Nobeyama Radio Observatory (NRO)



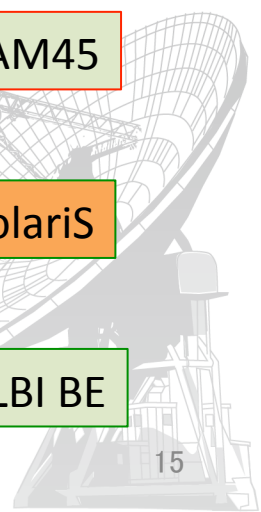
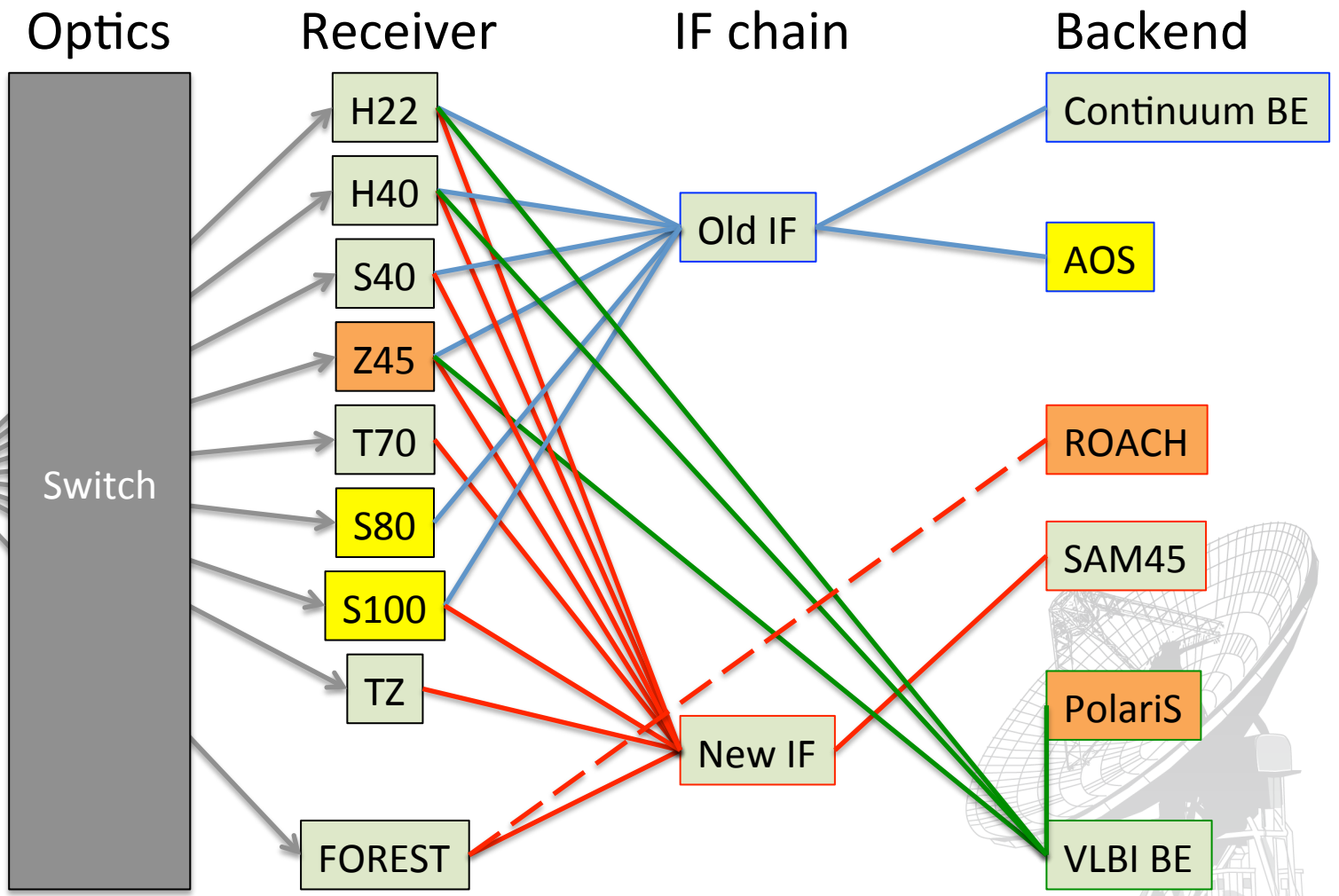
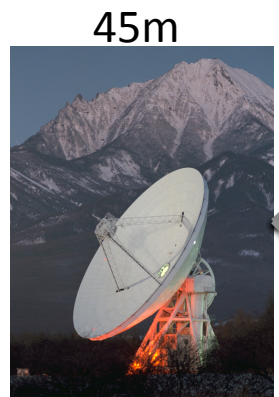
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OPEN USE

Internal Use

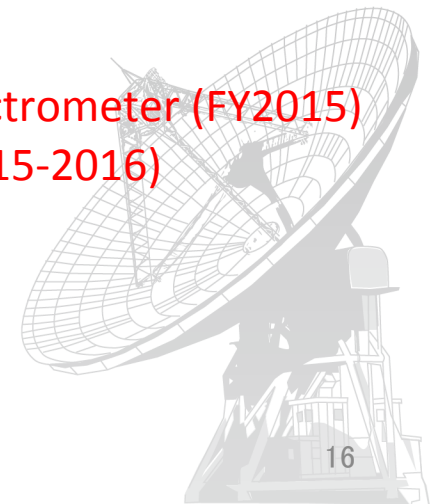
Commissioning

Current System



Recent Issues & Actions

- Antenna
 - Replacing sub-ref. servo system (FY2015 done)
 - Surface adjustment (FY2015 done)
- Optics
 - Put (Stick) metal foils to M2 and M3 (FY2015 done)
 - Replace mirror switching, chopper wheel mechanisms (FY2015 - 2017)
- Receiver – IF - Backend
 - So many frontends → Decommissioning of S40, S80, S100, TZ
 - S40: Low demand(?) / Replace H40/Z45 CLNA to wider one?
 - S80/S100: After checking consistency among 3mm RXs (FY2015-2016)
 - TZ: FOREST covers TZ capability (Deep integration, ON-ON mode) (FY2015-2016)
 - Commissioning of Z45 to open to community (Season2015-2016)
 - Decommissioning of Old IF system
 - Check consistency between AOS and SAM45 (Season2015-2016)
 - New/Relocate Continuum Backend (FY2015 - 2016)
 - Applying 3-bit linearity correction to OCTAD-A + SAM45 spectrometer (FY2015)
 - Commissioning of SAM45 spectral window mode (Season2015-2016)
 - Commissioning of ROACH spectrometer (Season2015-2016)
- Monitor & Control
 - Expand remote observation
 - Metrology system

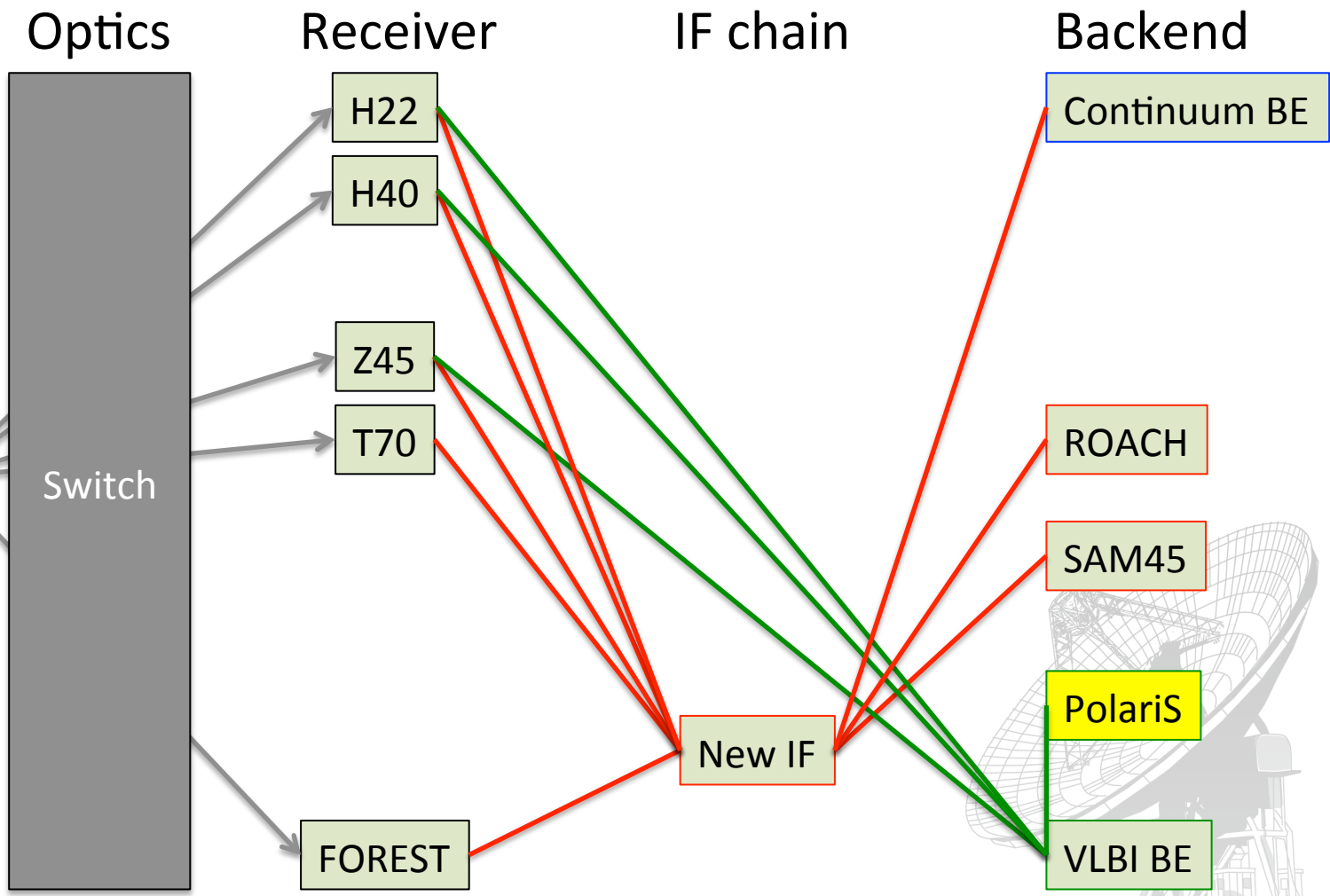
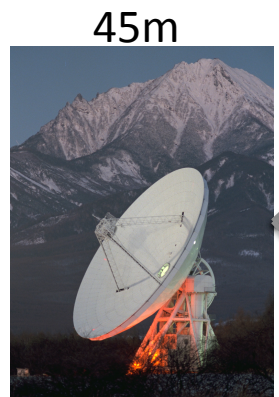


OPEN USE

Internal Use

Commissioning

Near Future System



- Options/Candidates:
 - More beams (pixels) ?
 - Heterodyne Array ?
 - More spectrometers (bandwidth) ?
 - ROACH (FPGA) spectrometer ?
 - GPU spectrometer (e.g., KASI developing) ?
 - Continuum Camera ??
 - VLBI at millimeter wavelengths ?
- Cooperation with other projects and/or universities is essential.



Summary

- FOREST
 - Performance is improved
 - Provided to Open Use Observation
- Future Developments of the Nobeyama 45-m Telescope
 - Nobeyama 45-m Telescope: One of the largest radio telescope which covering 20 – 115GHz.
 - On-going/planned updates will be finished in coming 2-3 years
 - These will improve observing efficiency by factor ~ 7
 - Options/Candidates:
 - More beams (pixels) ?
 - More spectrometers (bandwidth) ?
 - Continuum Camera ??
 - VLBI in millimeter wavelengths ?
 - etc. ?
 - Highly depend on the demands from community.
 - Competitive ?
 - Cooperation with universities and/or other projects in NAOJ is essential.

