JAXA VLBIアンテナの現状

村田泰宏（JAXA)

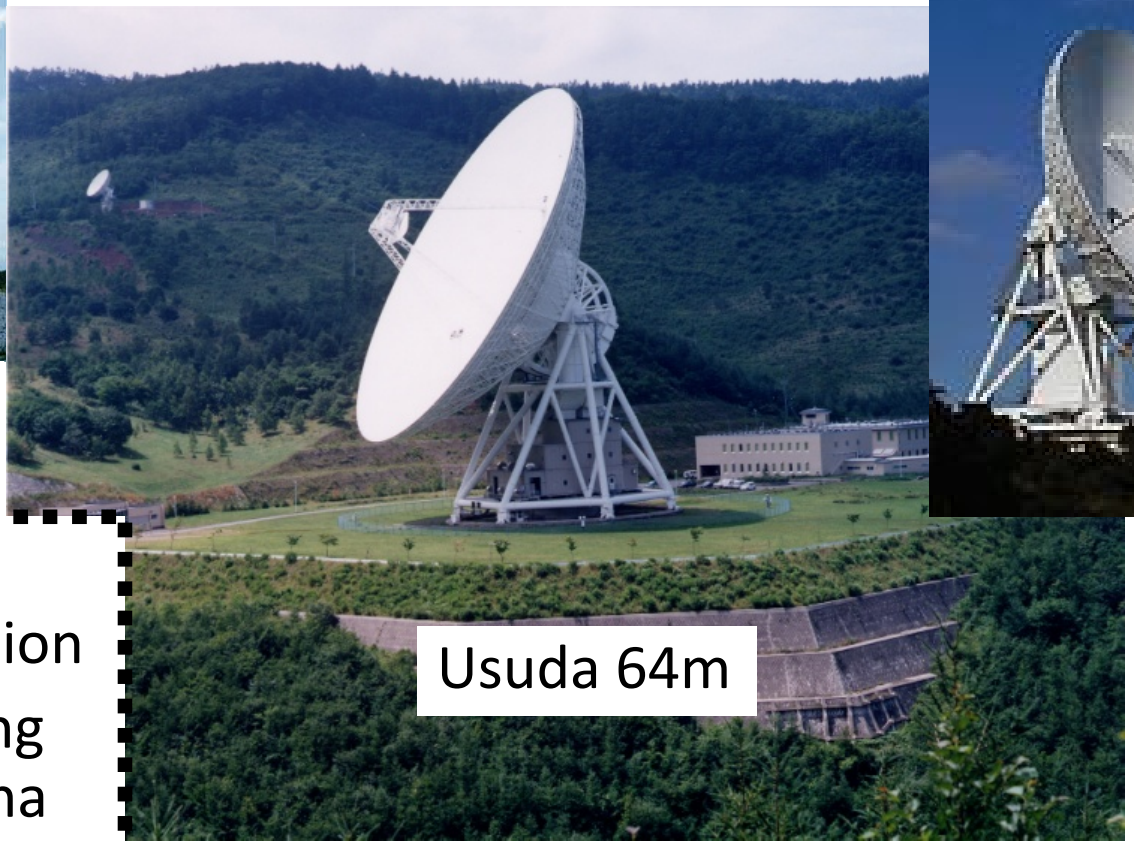
共同研究者・協力者 （敬称略）

VLBI観測システム全般、USC34m：竹内央(JAXA)、望月奈々子(元JAXA)
UDSC 64m:
新X-band 低雑音受信系：坪井昌人（JAXA）、上原顕太（東大）、山口健太郎（元東大）
新X-band Down Converter：坪井昌人、河野裕介、金口政弘、鈴木駿策(NAOJ)
新X-band フリンジ確認：河野裕介、小山友明（NAOJ）
受信性能確認：坪井昌人（JAXA）、上原顕太、石川聡一（東大）、中西裕之、
藏原昂平（鹿児島大）、藤沢健太（山口大）
HI観測中西裕之、齊田智恵（鹿児島大学）、土橋一仁、下井倉ともみ（東京学芸大学）
C帯受信機開発：坪井昌人（JAXA）、石川聡一（東大）、春日隆（法政大学）、
朝木義晴（NAOJ）、小川英夫、木村公洋（大阪府立大）
UDSC 10m:
坪井昌人、上原顕太、石川聡一（東大）、森光智千（元東大）、春日隆（法政大学）
UDSC：サポート 山本善一、中島潔(JAXA)、UDSCのみなさん。

JAXA VLBI Antennas

Uchinoura 34m ~~(& 20m~~)

(Usuda10m)

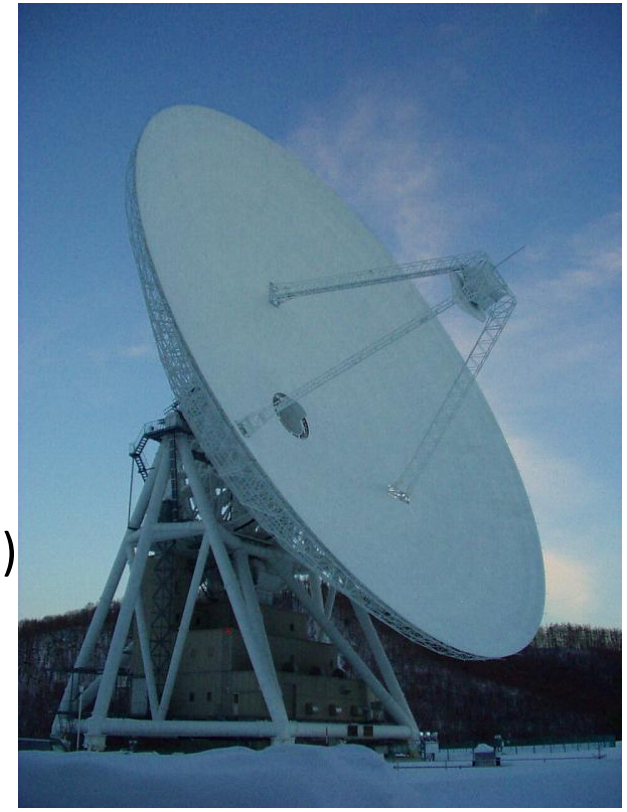


Usuda 64m

Next Generation Tracking Antenna

Status of Usuda 64m

- Tracking Akatsuki (Vinus), IKAROS (Solar Sail), GEOTAIL, Hayabusa-2 (minor planet),
  Procyon (engineering test)
- Observing band C（4.7-5.0, 6.7 GHz）,
  L(1.4, 1.6 GHz, S(2.2), X(8.4))
- Backends (Recorders)
  - K5/VSSP 16ch (IP-VLBI for geodesy）
  - K5/VSI + ADS3000+ (possible Mark 5 compatible)
- Current observation
  - Japanese VLBI network (JVN)
  - Radioastron (under discussion)
  - Single dish observation (Pulsars, Molecular/Atomic Lines)
  - Observation of Atmosphere of Solar system objects.
  - Geodesy (Usuda, Uchinoura (IVS))



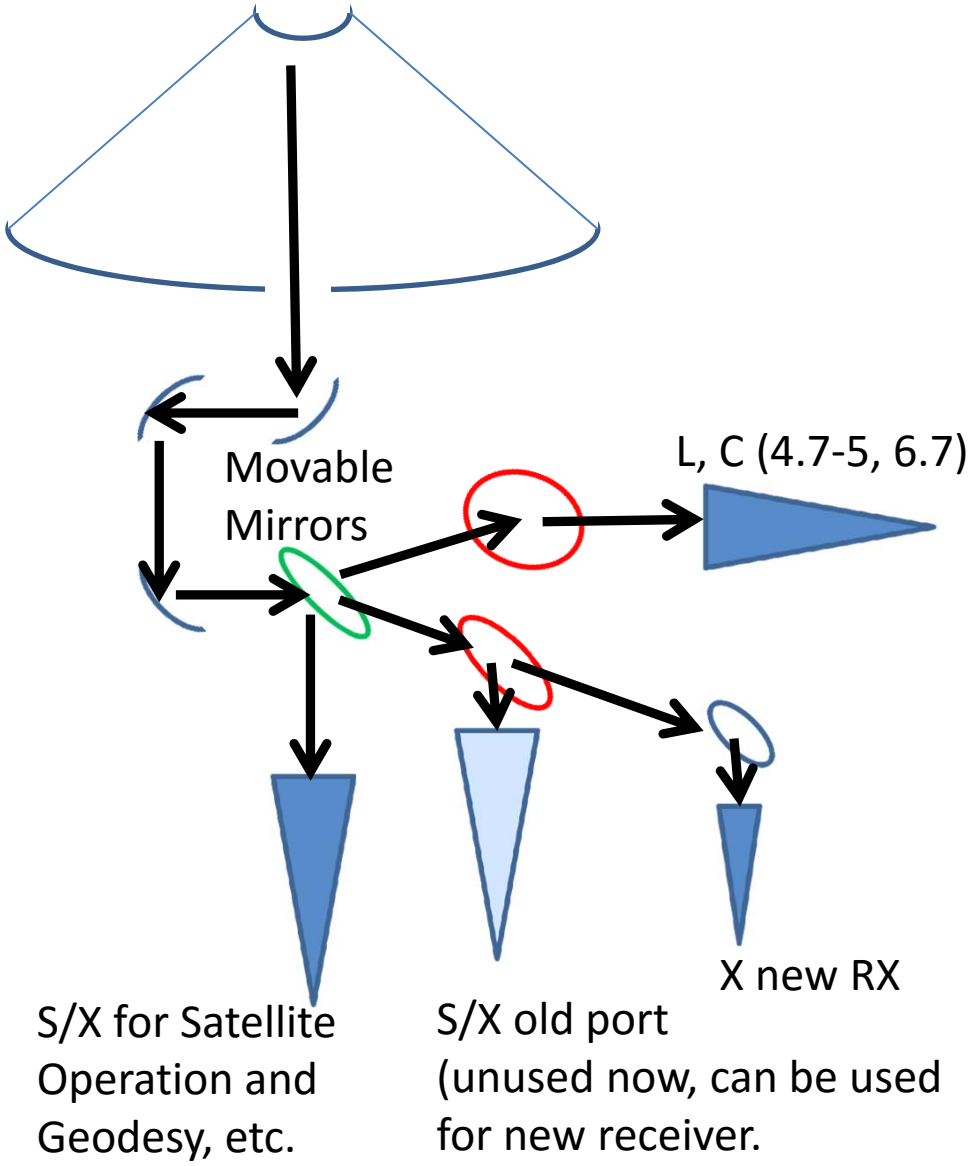
Upgrade of X-band receiver

- X-band receivers for spacecraft need to have diplexer and filters for transmitter, waveguide switch, which rise system temperature (~ 70K), and limit the bandwidth about 300 MHz.
- We installed new wideband X-band receiver at receiving-only feed, and succeeded to achieve 26 K system temperature and more than 512 MHz bandwidth.

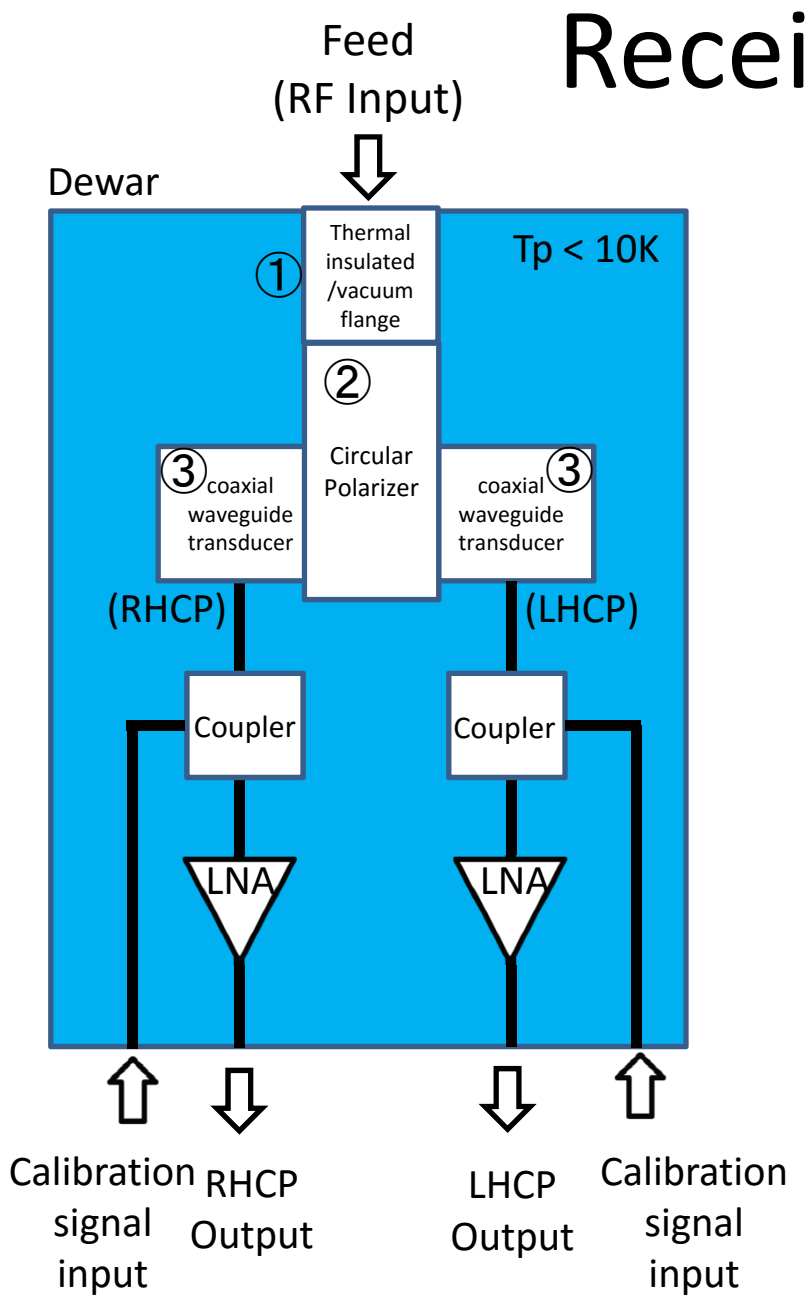
Antenna Efficiency and Beam Size

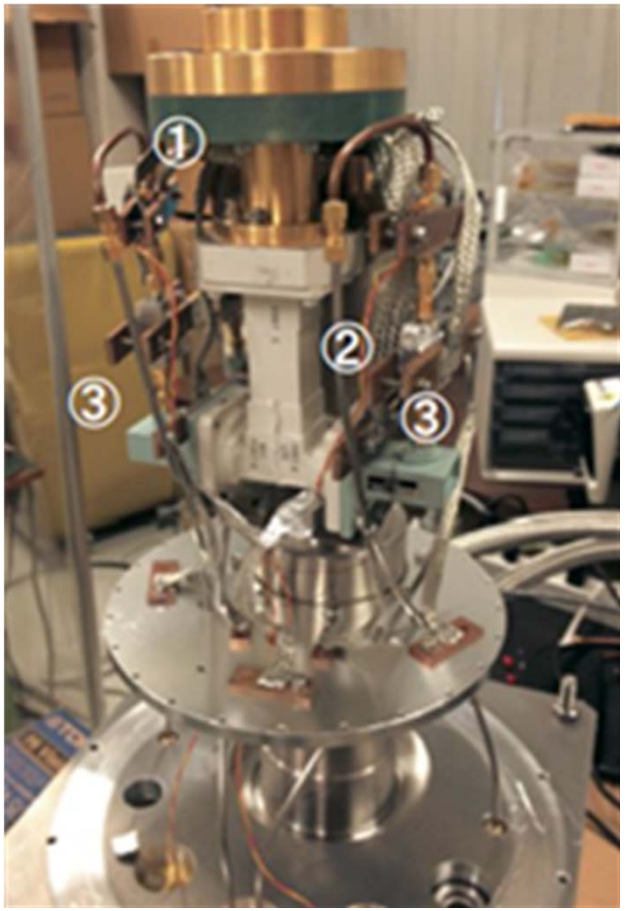
- Antenna Efficiency was measured with observing Planetary Nebula NGC7027.
- We estimate the antenna efficiency of 45±5 % at the #6 horn, which the new X band receiver is attached.
- Beam size using this receiver is derived as 138 arc seconds.

Beam wave guide of Usuda 64m

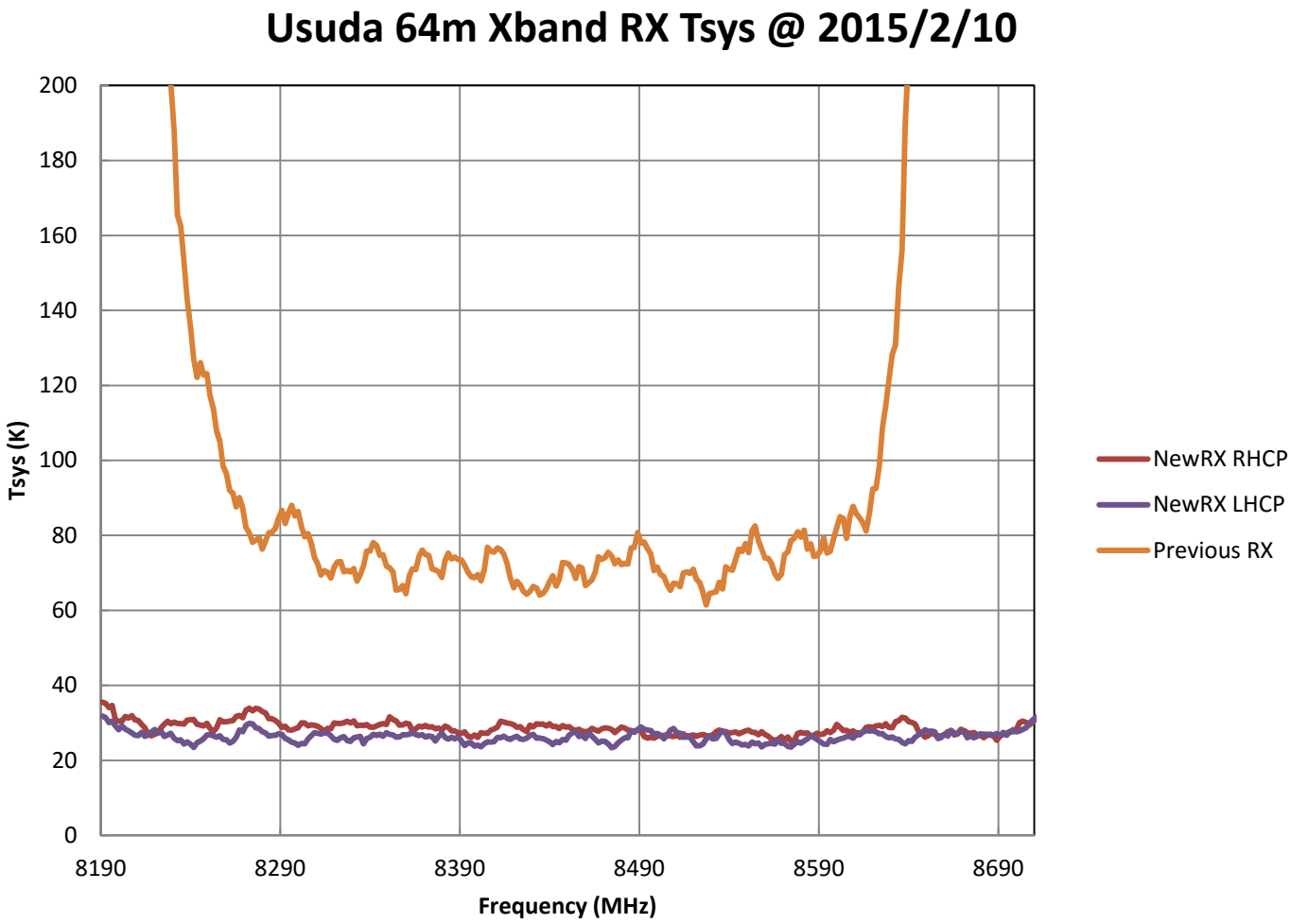


Receiver


Feed
(RF Input)
Dewar
Tp < 10K
①
Thermal insulated /vacuum flange
②
Circular Polarizer
③ coaxial waveguide transducer
③ coaxial waveguide transducer
(RHCP)
(LHCP)
Coupler
Coupler
LNA
LNA
Calibration signal input
RHCP Output
LHCP Output
Calibration signal input


①
②
③
③

System noise @ Zenith



Upgrade new X-band receiver

SEFD of Usuda 64m

<u>Previous</u>

~120 Jy @ Old RX, 32MHz BW

~200 Jy @ Old RX, 512 MHz BW

<u>After Upgrade</u>

First fringe with new RX in May 5th observation (but low (11%) efficiency)

- 50 Jy @ New RX, 512 MHz BW

(from June 24,2015)

VLBI sensitivity @ X-band

Usuda 64m：SEFD ~ 50 Jy、

BW=512 MHz, τ = 5 min, 2-bit sampling

Fringe detection ~ 7σ

Ibaragi 32m SEFD ~ 100 Jy

→ ΔS ~ 1 mJy、ΔT~10,000 K @ 300km baseline

(fringe spacing ~ 25 mas)

Shanghai Tenma 65m SEFD~45 Jy (assumed)

→ ΔS ~ 0.6 mJy、ΔT~210,000 K @ 2000km baseline

(fringe spacing ~ 4 mas)

Measurement of Capability of L-band observation

HI observation comparison with Parkes 64m (Saida et al.)

Tsys ~ 350K (?)

Measurement of Tsys, η @ 1.4 and 1.6 GHz using Moon, lq-N_2, and Noise source.

Tsys (1.4 GHz) ~ 96 +/- 5 K (LHCP, 1415-1425 MHz)

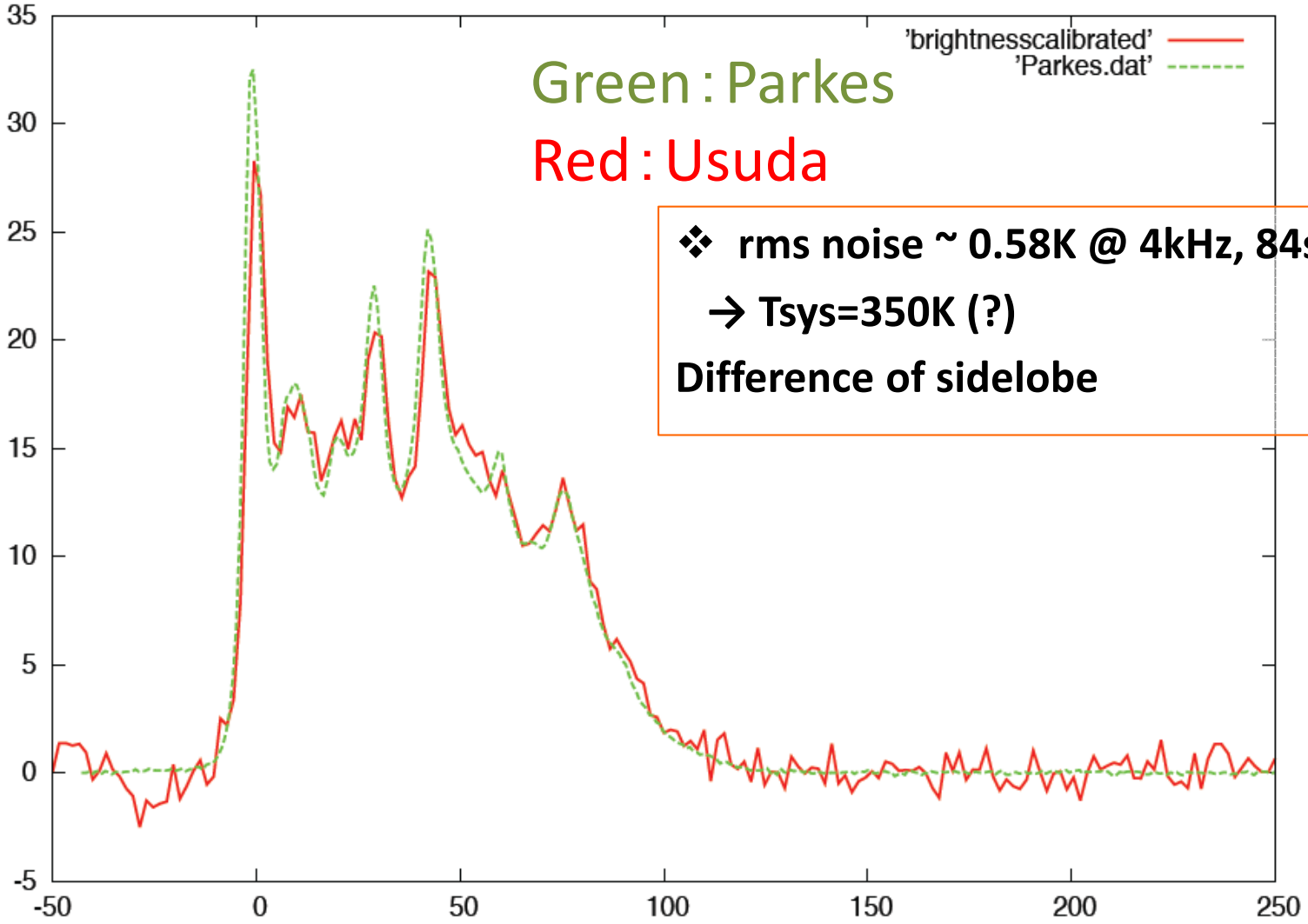
Tsys (1.6 GHz) ~ 85 +/- 1 K (LHCP, 1600-1750 MHz)

(RHCP was broken at this time (end of June, 2015))

η(1.4 GHz) ~ 34 %, η(1.6 GHz) ~ 46 %

Preliminary results, using M87 & Moon.

HI line comparison with Parkes 64m (tentative result)



Green : Parkes

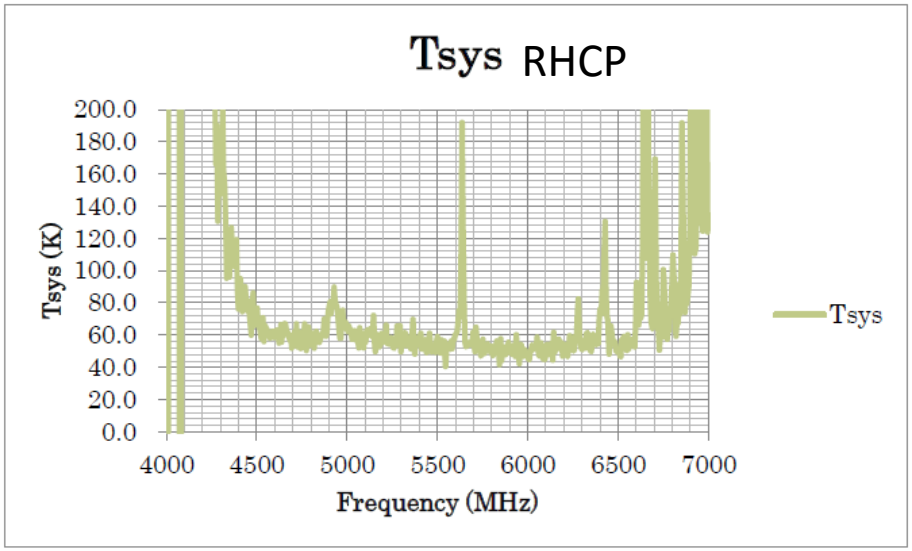
Red : Usuda

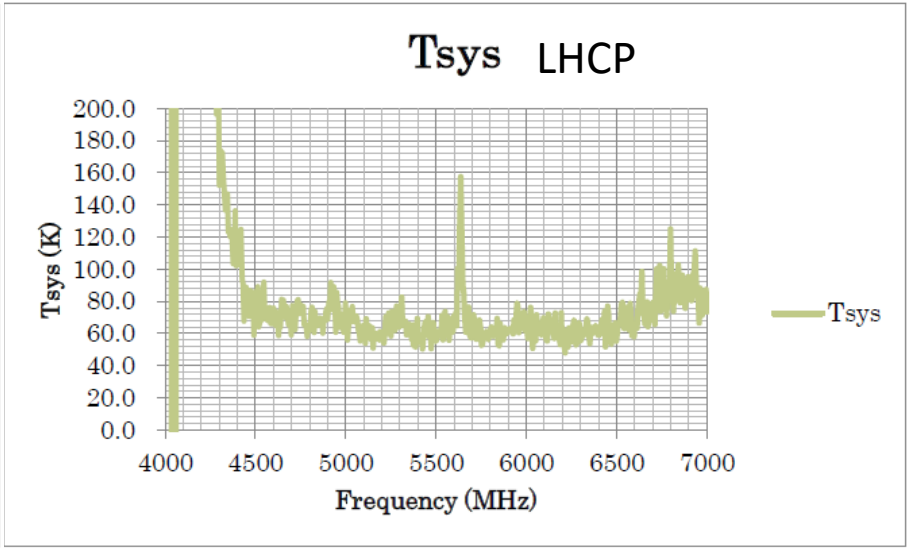
- **rms noise ~ 0.58K @ 4kHz, 84s**
  - **→ Tsys=350K (?)**

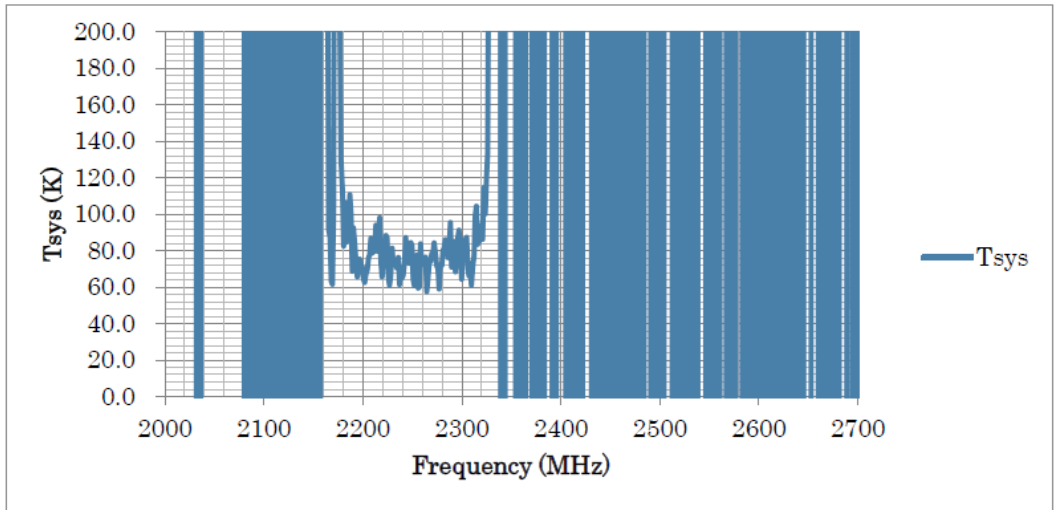
Difference of sidelobe

Saita, Nakanishi et al.

Measurement of Tsys for C-band and S-band







Tsys(4.7-5.1 GHz) ~ 70 K

Tsys(6.7 GHz) ~ 80 K

Tsys(2.2-2.3 GHz) ~ 75 K

Future upgrade plans.

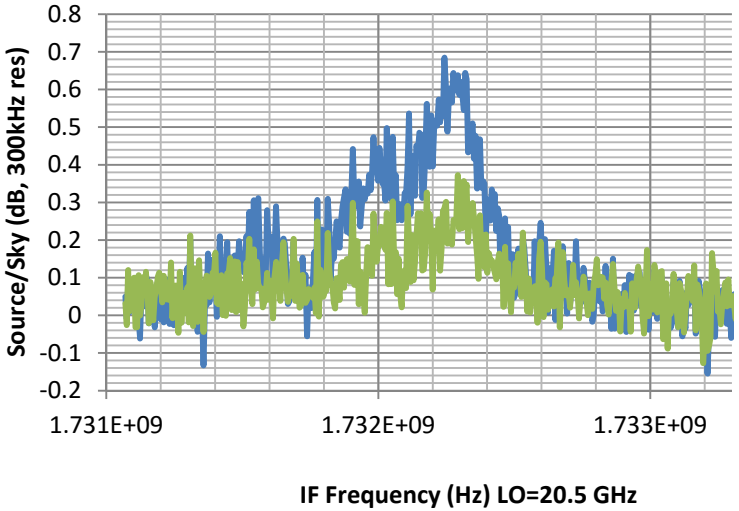
- Not good for sensitive antenna
- Old L-band receiver has Tsys ~ 85-100K, which was used for VSOP-1. It is higher than current top level receiver.
- We are investigating to improve this value for:
  HI and OH observation, Pulsar observation.
  No Upgrade, RX replace, or Feed+RX replace
- C-band Up-grade is also planned.
- Add CH band (3.3 GHz)
- Polarizer for C-band should be cooled.
- Target 20-30 K.

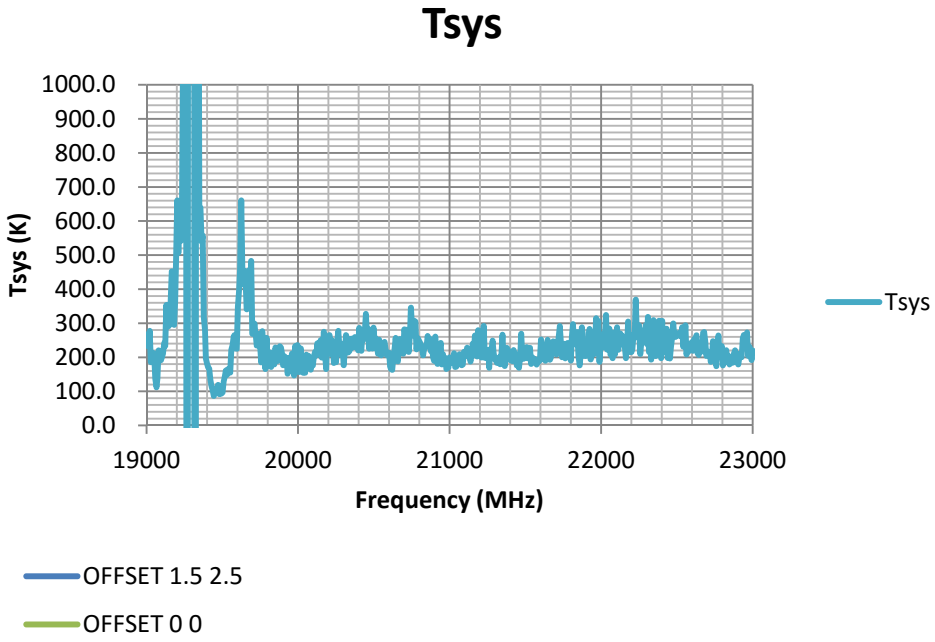
Usuda 10m Antenna

Current Status

- 22 GHz room temperature RX is installed.
- Tsys ~ 300 K, H2O maser from Orion-KL detected.
- Surface accuracy of 0.4 mm rms in 20 years ago
- No need to ask operator and can be controlled from Sagamihara
- Investigating whether it is useful for astronomy or stop operation.
- VLBI could be possible (IPVLBI or ADS-3000 can be connected.)

Usuda 10m Current Status
Tsys measurement, Maser detection





VBW	3000 Hz	RBW	300000 Hz

Uchinoura 34m

- Tracking Suzaku (X-ray), Hinode (Solar telescope)
  Geotail, ocationally backup deep space mission
- Observation Bands ：S, X
- Backends
  - K4 VC, K5/VSSP(IPVLBI) 16ch (for geodesy)
  - K5/VSI + ADS3000+
    （Wide band observation, Navigation）
- Joined IVS observation in 2013 Feb.
- Support Hayabusa Swing-by using IPVLBI