Current activities of NICT/Kashima as Technical Development Center

Kazuhiro Takefuji
on behalf of NICT/Kashima

Contents

1. Broadband project “GALA-V”
2. Kashima 34m and compact antennas
3. Kashima 34m and Ishioka 13m
4. First Japanese sub-mm VLBI

My motto of broadband VLBI developments

- Wish to distribute our techniques around the VLBI world
- Broadband system makes new science and knowledge
- Cheep, cheep cheep! … but reliable!

High speed samplers

ADS3000+

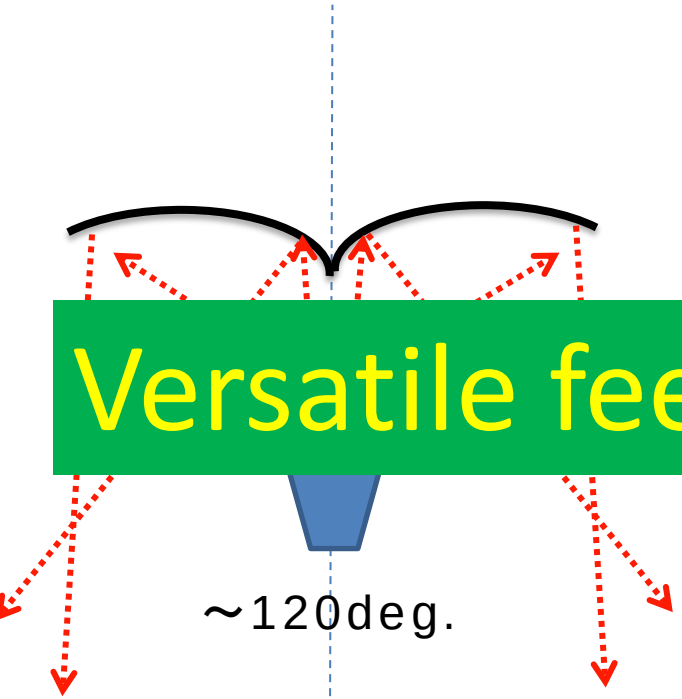
- 16ch DBBC
- Video converters will be replaced
- Installed at O'Higgins

GALAS

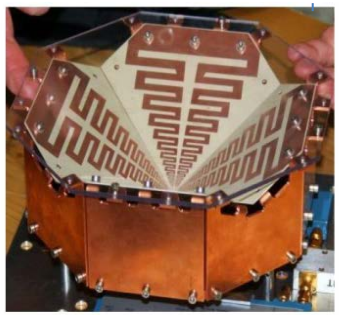
- 16Gsps 3bit
- Direct sampling ~20GHz
- 1GHz BW DBBC

Gala-V Feed

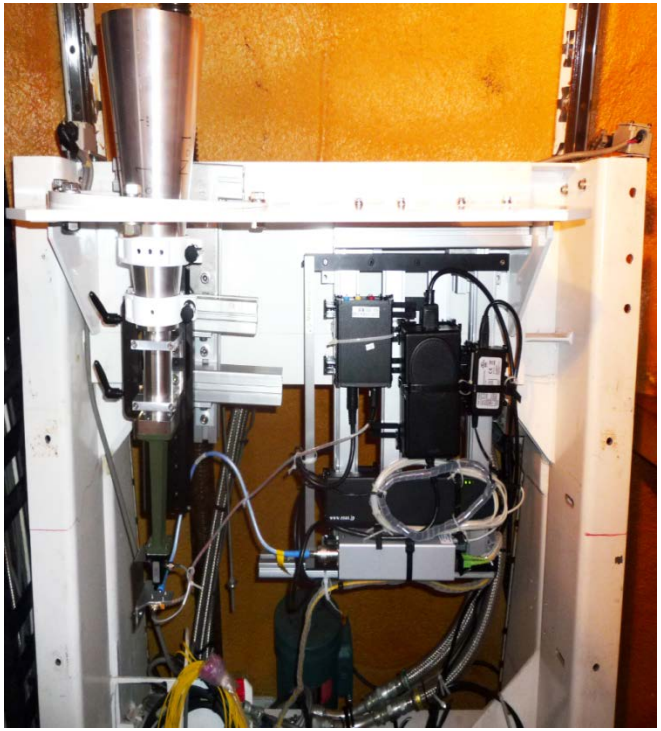
Broadband
and Narrow
beam width



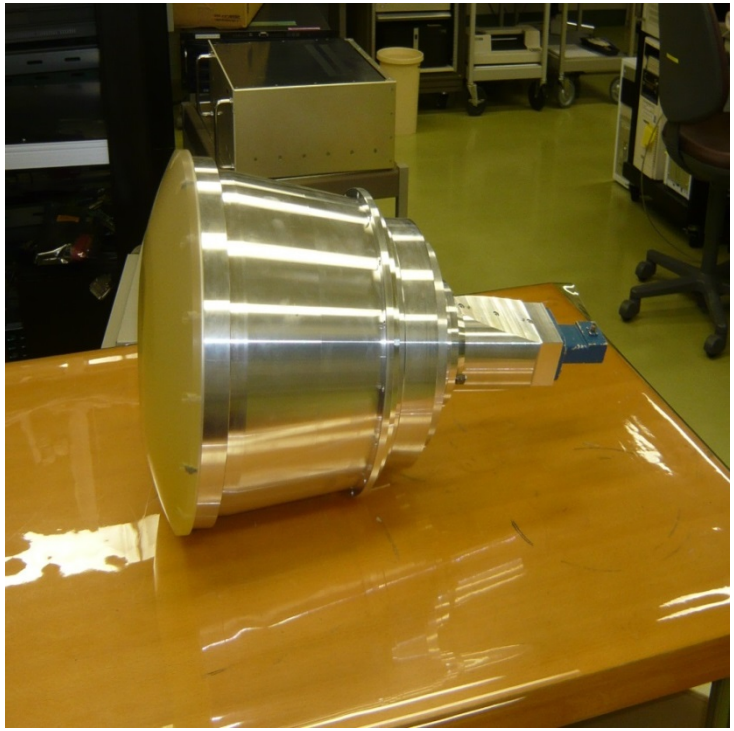
Versatile feed for most antennas



Broadband Feed for Cassegrain optics

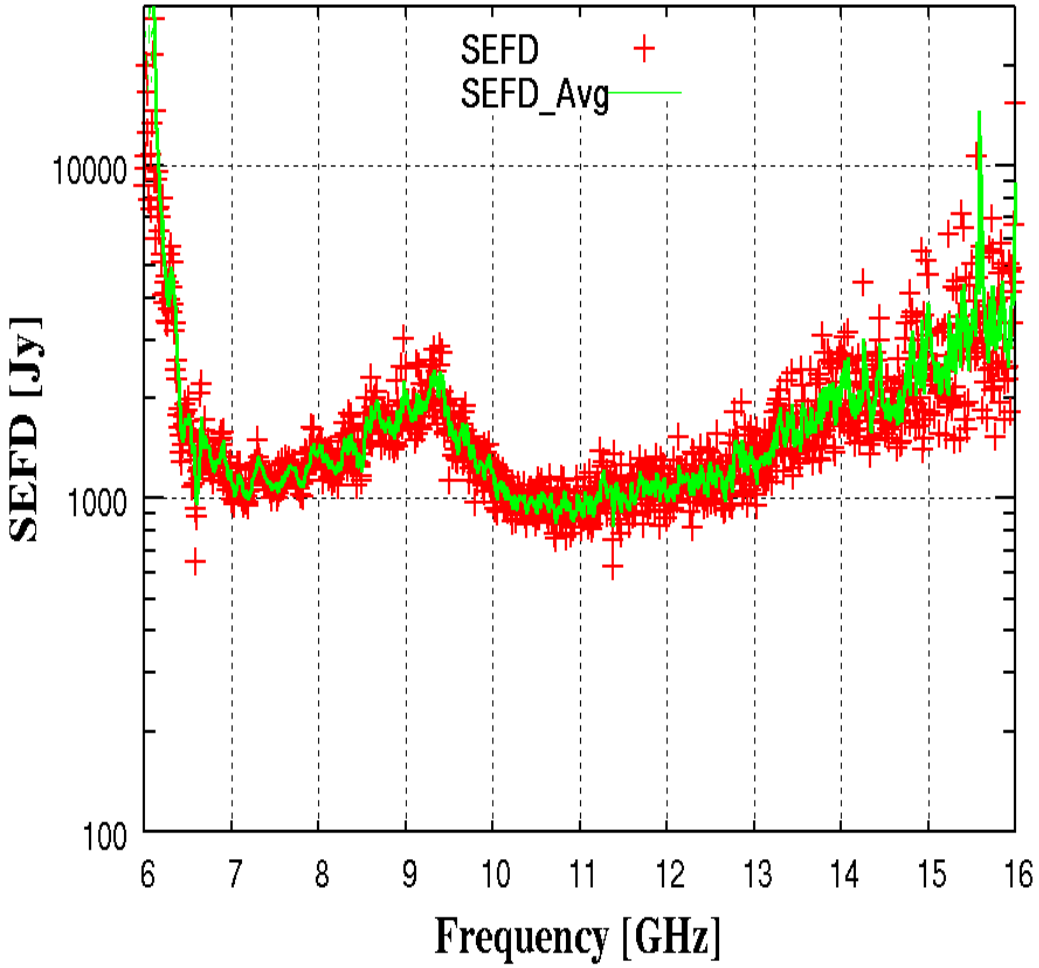


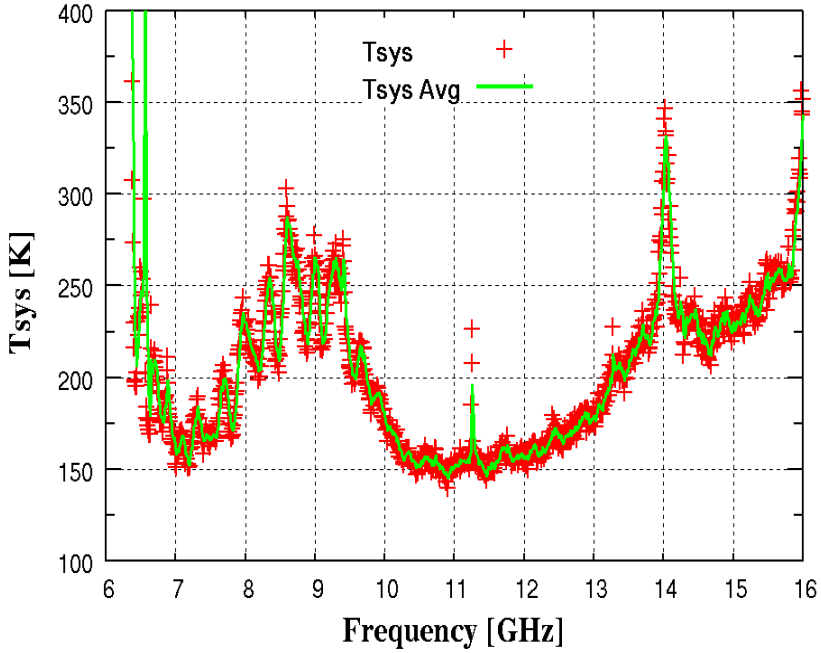
IGUANA Feed (6.5-15GHz)

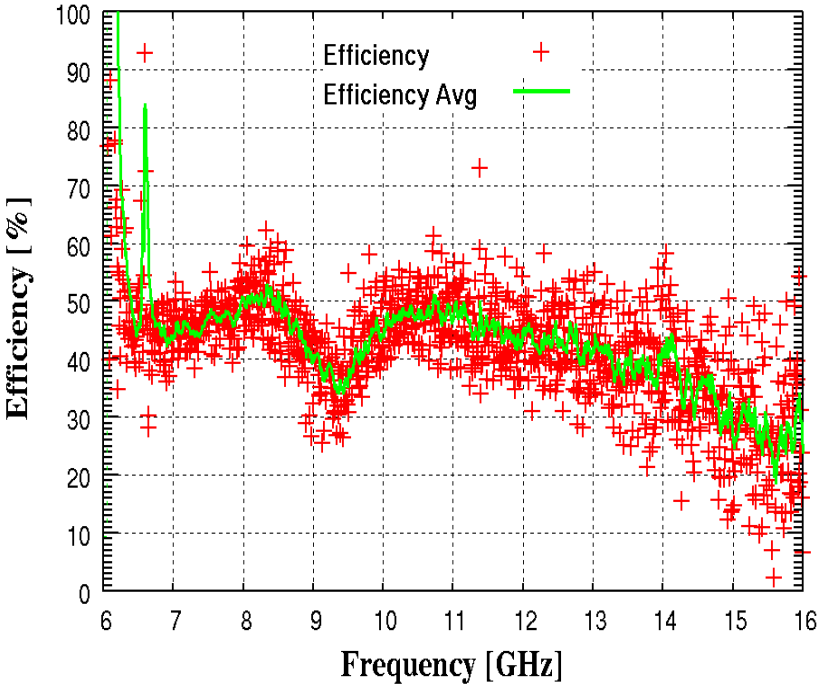


NINJA Feed (3.2-14.4GHz)

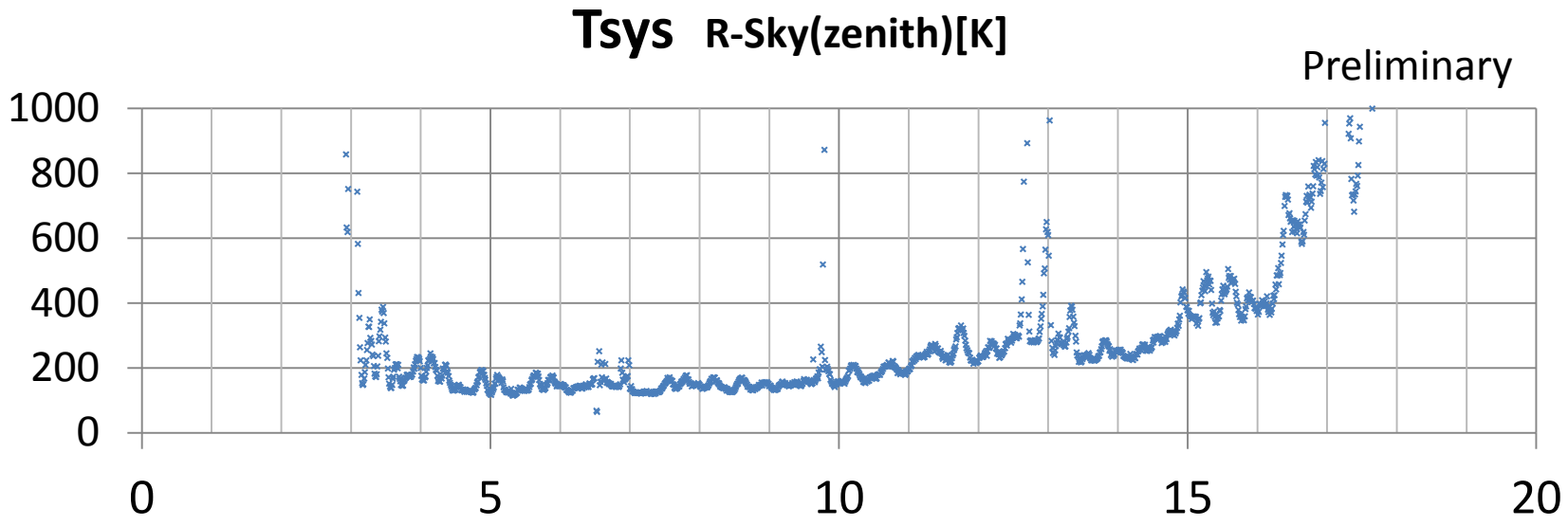
IGUANA feed system

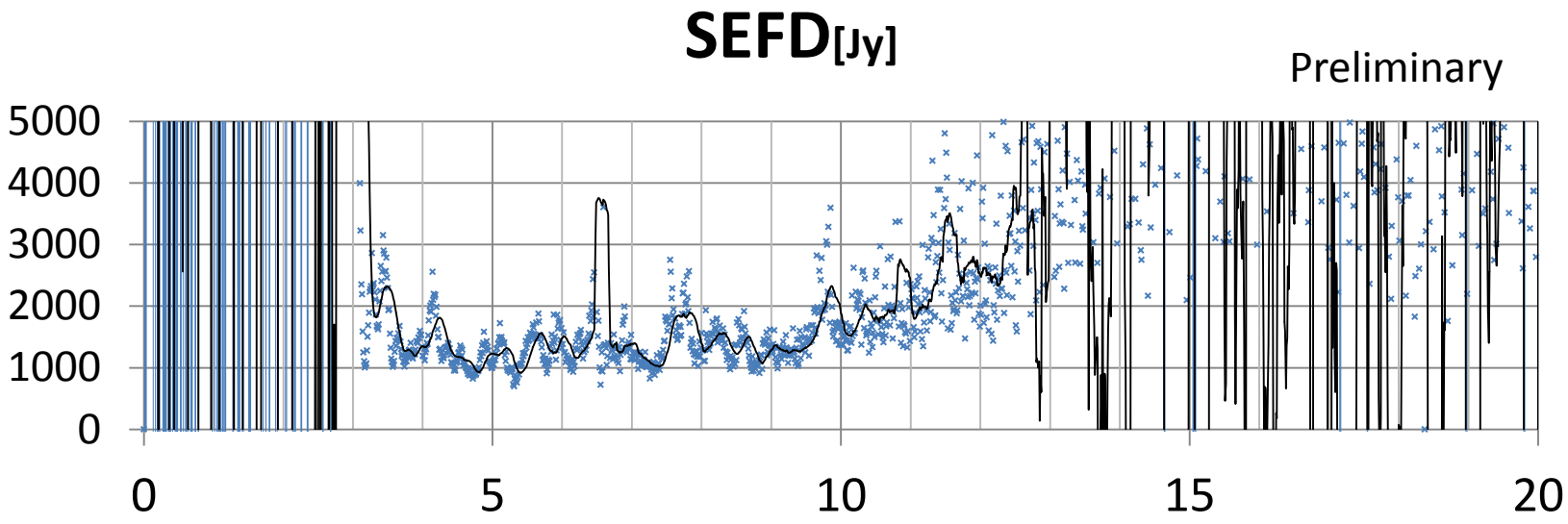






NINJA feed system





VLBI with compact antennas

KASHIMA 34m

34m Kashima

Compact#2

1.5m

UTC(NICT)

Compact#1

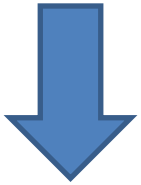
1.6m

UTC(NMI J)

Measurement of frequency difference between two atomic standards!

Re-definition of “second”

- Currently defined by Cs atomic clock
  - (9.2GHz,1.5x10^{-15} @NICT)
- BIPM provides UTC by ensemble average of Cs clock around the world



- Optical lattice clock was invented
- More accurate frequency comparison technique is required (10^{-16})
  - TWSTFT, GNSS, and **VLBI**

NMIJ

50km

AB

NICT/Kashima

100km

NICT/Koganei

Two compact antennas VLBI

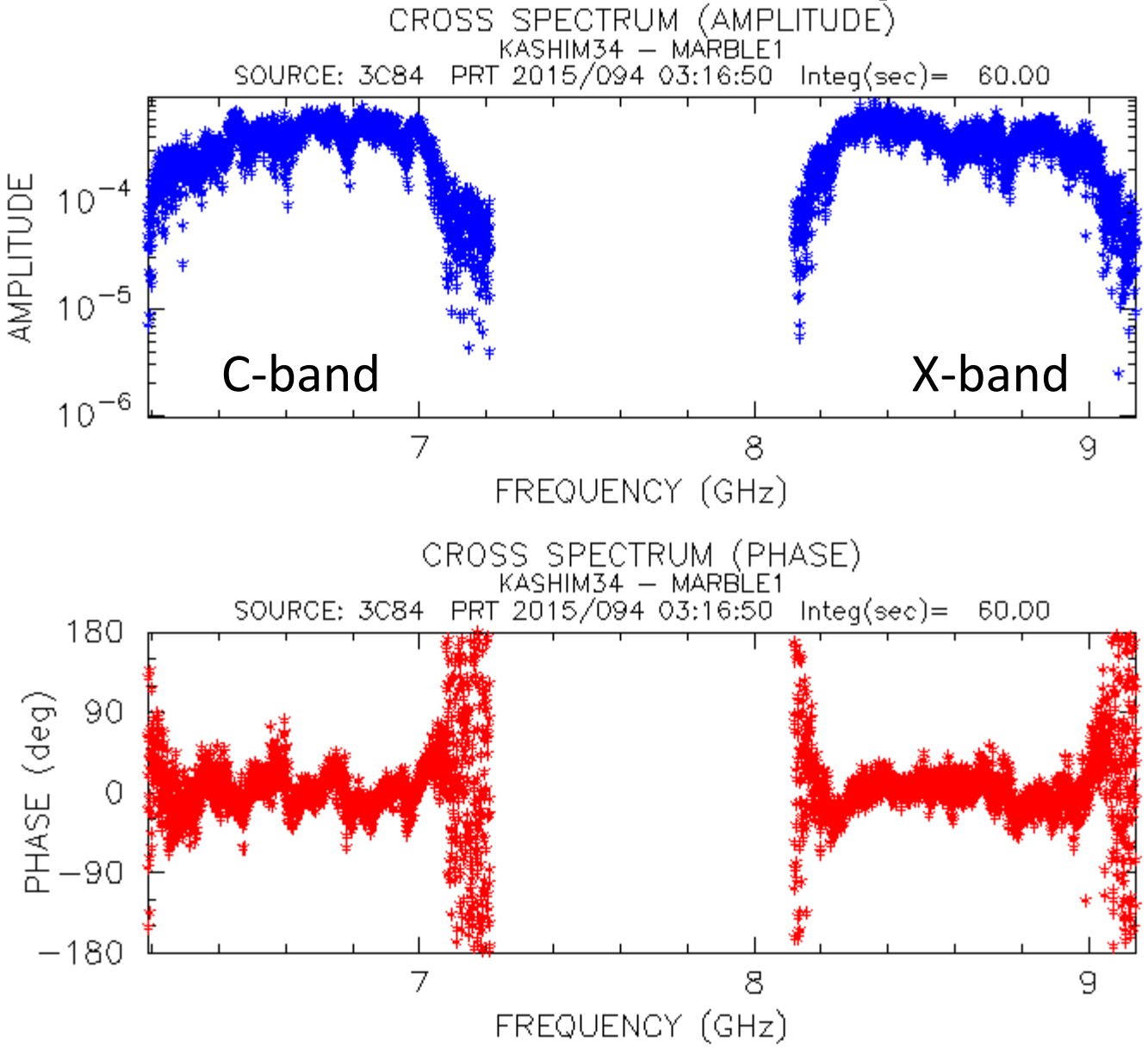
- 26 hours from 2015/094 UT3:00
- Each **1GHz bands** of C and X range
- Bandwidth synthesis after correlation

Fringe detection

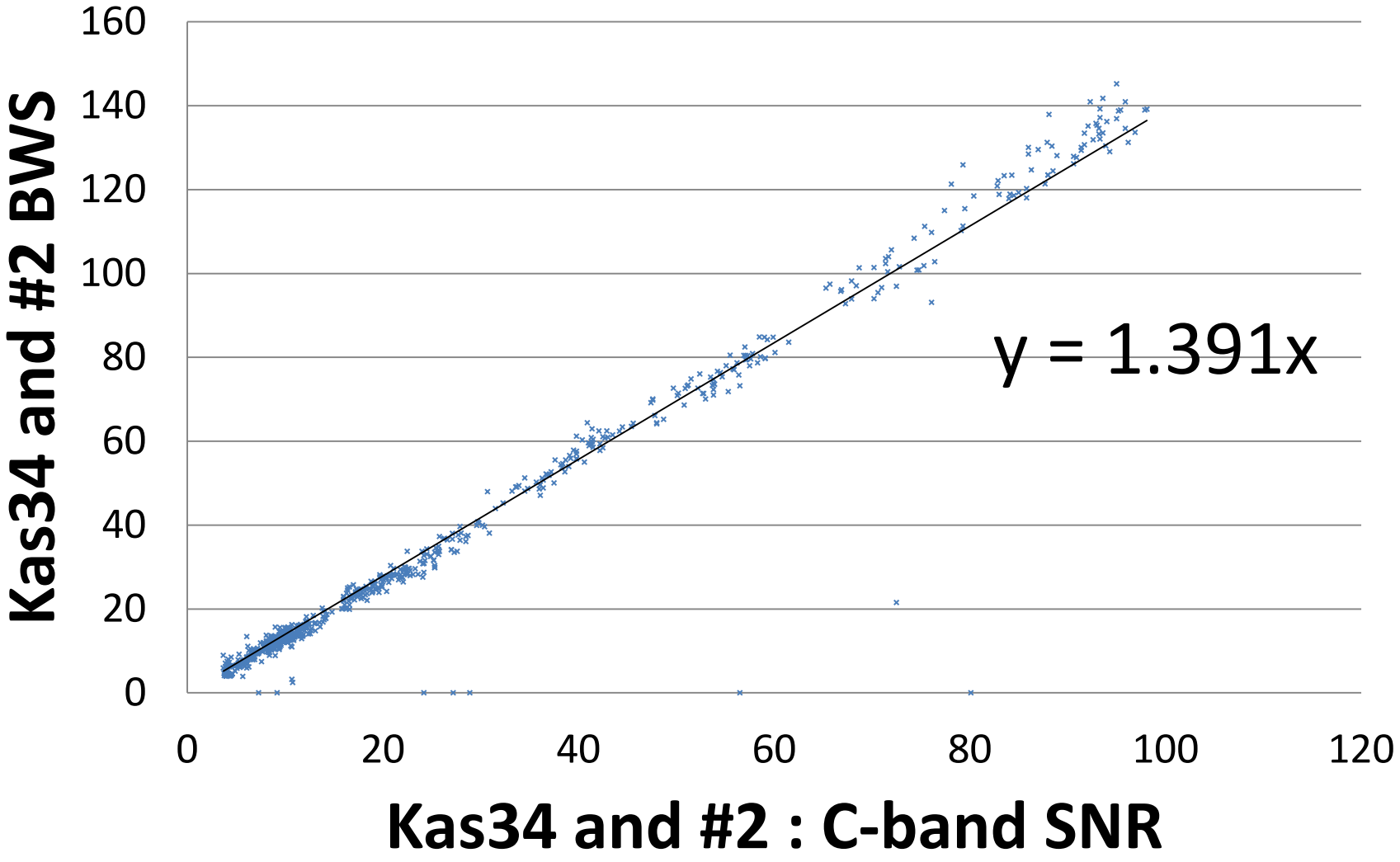
SNR>=5.5	C-band 6.1 to 7.1GHz	X-band 8.1 to 9.1GHz
Kas34 and #1	736/746（98.7%）	730/747（97.7%）
Kas34 and #2	646/747（86.5%）	680/746（91.2%）

Compact #2 has bad detection rate

Performed BWS to C/X band



SNR improved by **a factor of $\sqrt{2}$** after Bandwidth synthesis



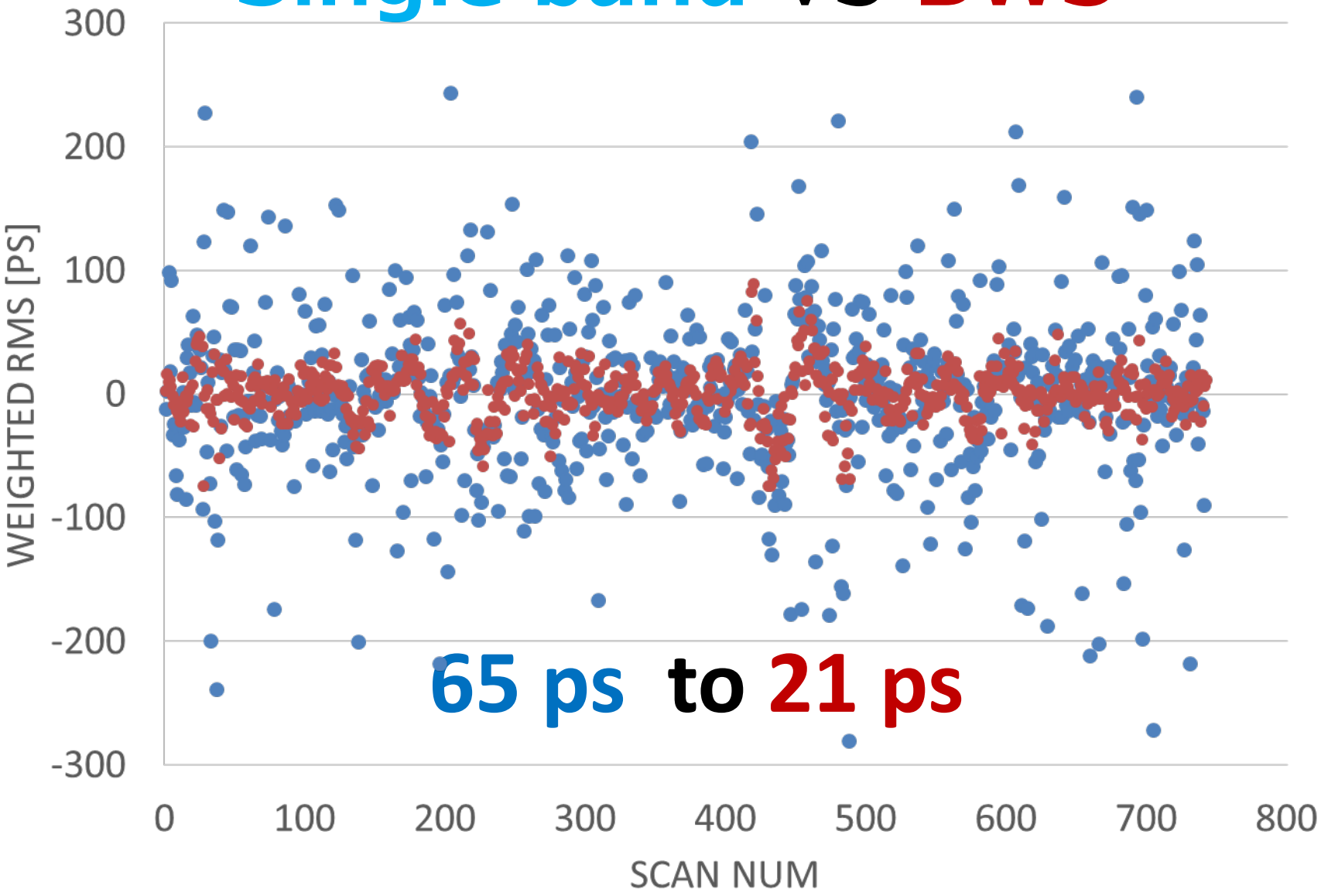
Fringe detection after BWS

SNR>=6.0	After BWS
Kas34 and #1	735/739（99.5%）
Kas34 and #2	**701**/740（**94.7**%）

60 scans (8%) could be recovered!

RMS improved in baseline analysis

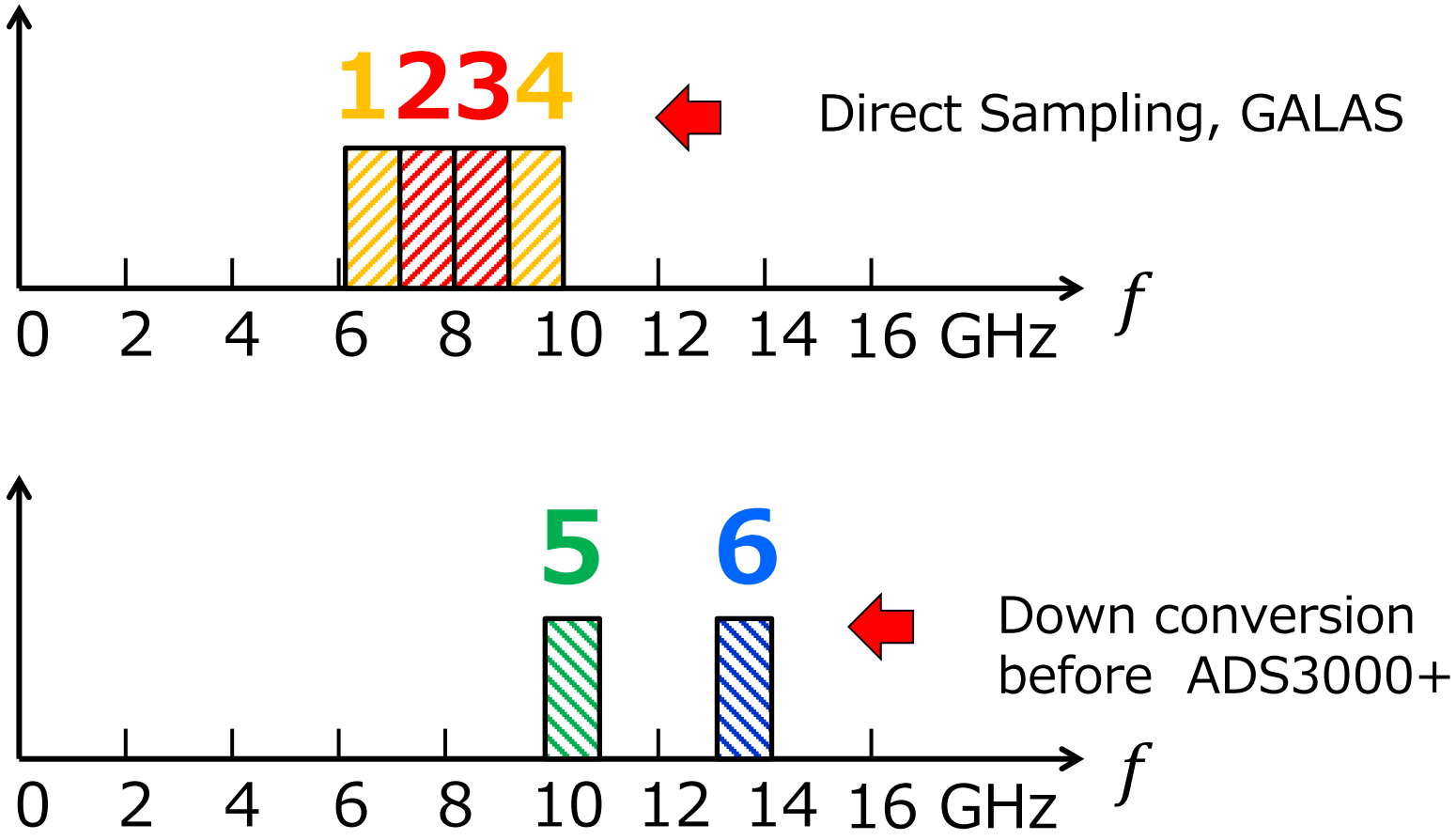
Single band VS BWS



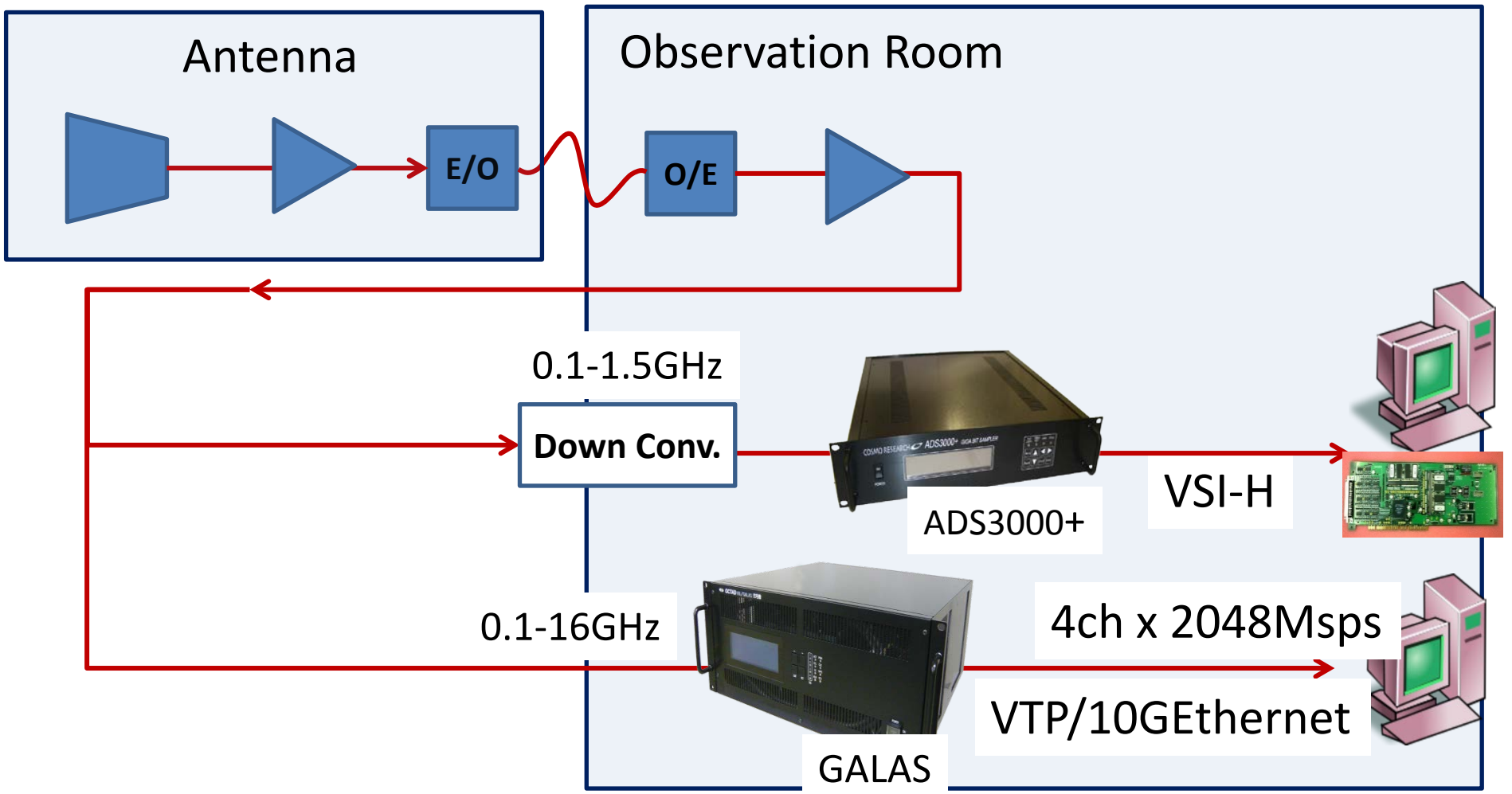
KASHIMA – ISHIOKA
First VLBI session on Jan 2015

Frequency allocation 6GHz to 14GHz

Each 1024MHz BW

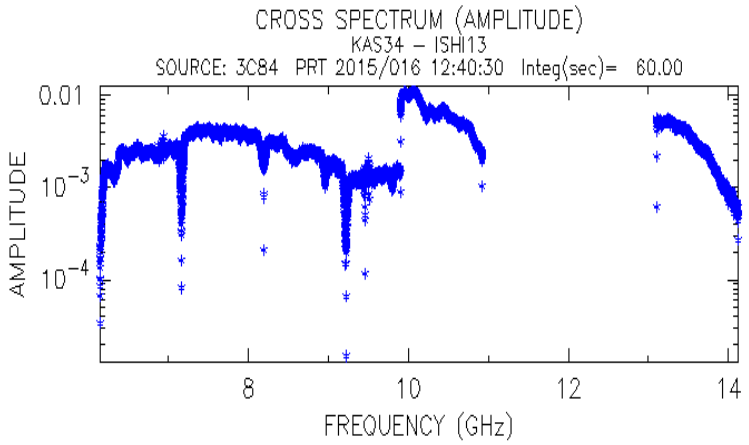


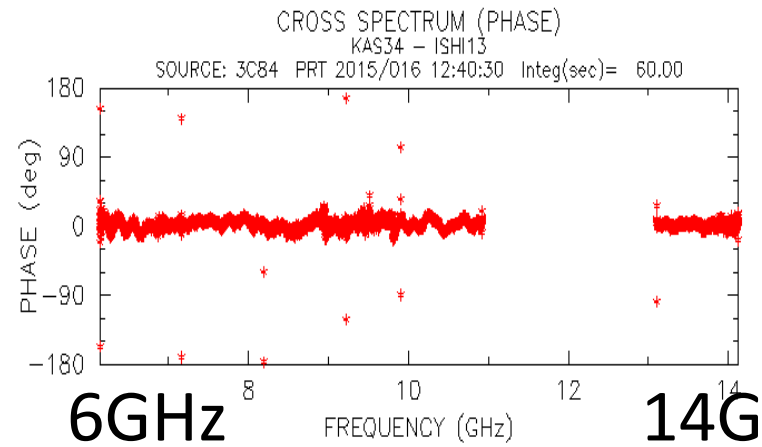
Signal Path and DAS



Bandwidth Synthesis
The first BWS **over 8GHz** bandwidth

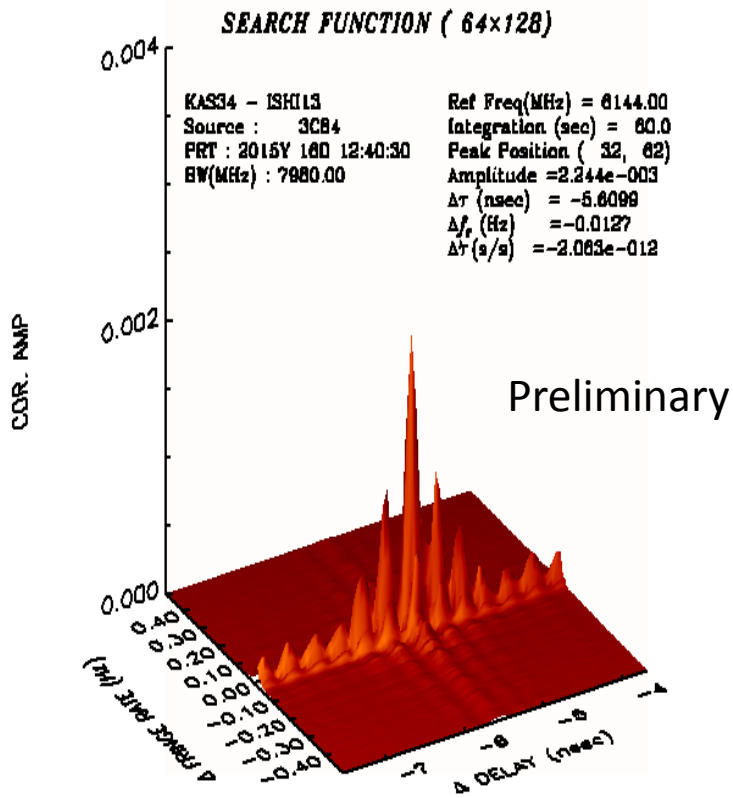
Cross Spectrum





6GHz 14GHz

Delay Resolution Function



Preliminary

Theoretical delay precision is 27 femto sec.

RMS in 1sec

Band width	RMS/sec [ps]	Remark
1GHz	3.08	Band #2
2GHz	2.01	Band #1 and #2
4GHz	1.29	Band #1 to #4
4GHz	0.96	After intra-band correction
8GHz	0.60	All 6 Bands

Preliminary

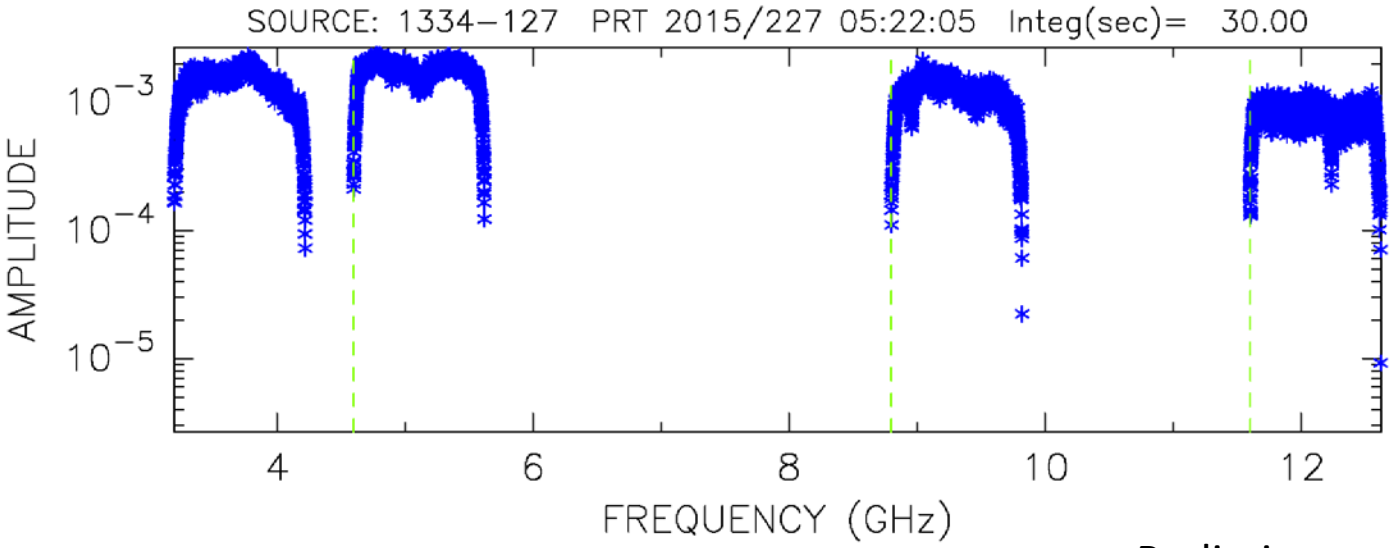
If we perform 7.5sec integration like VGOS,
RMS will become 200 femto second !

KASHIMA – ISHIOKA
Second VLBI session in **summer** 2015

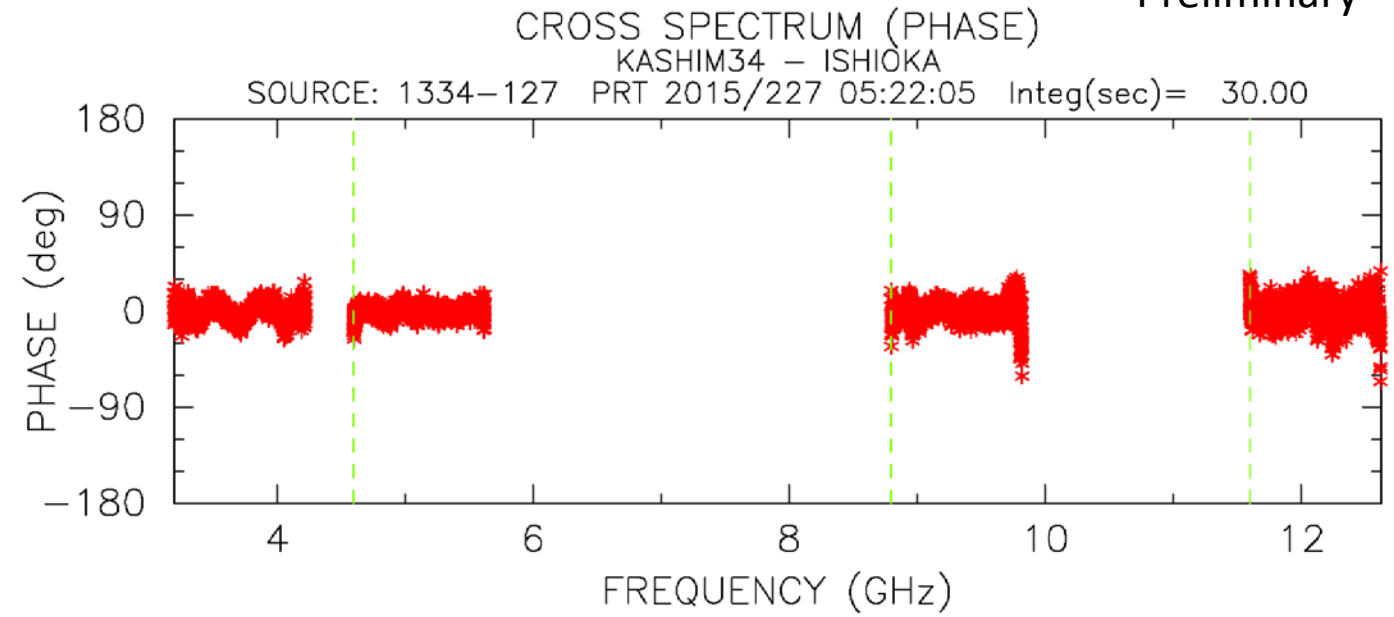
NINJA feed has installed

- 3.2 GHz to 14.4GHz
- Allocated 4 bands
  - 3.2 – 4.6 – 8.8 – 11.6 GHz
  - Almost 10GHz BW
  - Applied zero redundant array
  - Main target is to detect ionospheric delay
- Fully adopted direct sampling unit

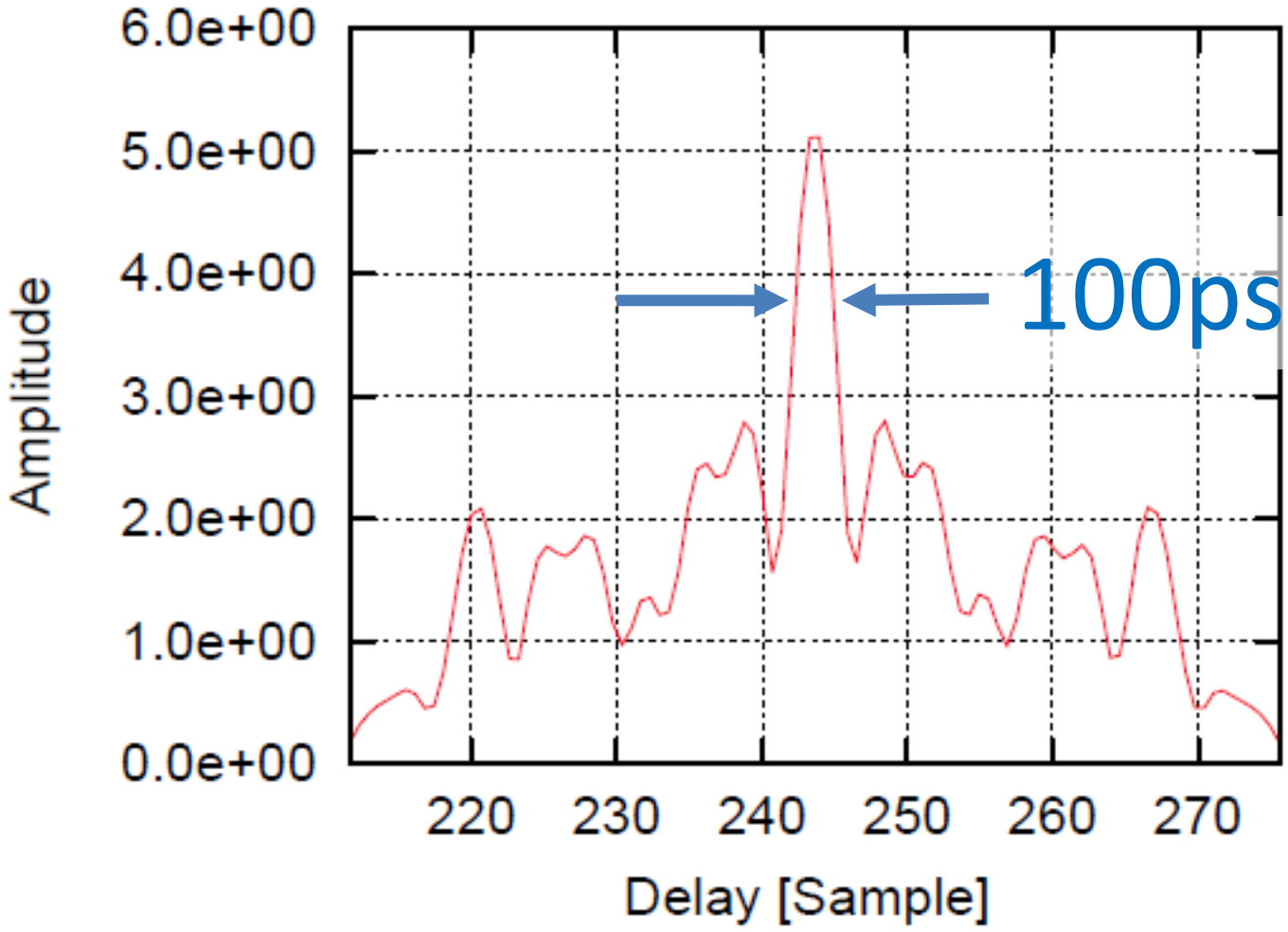
Cross spectrum



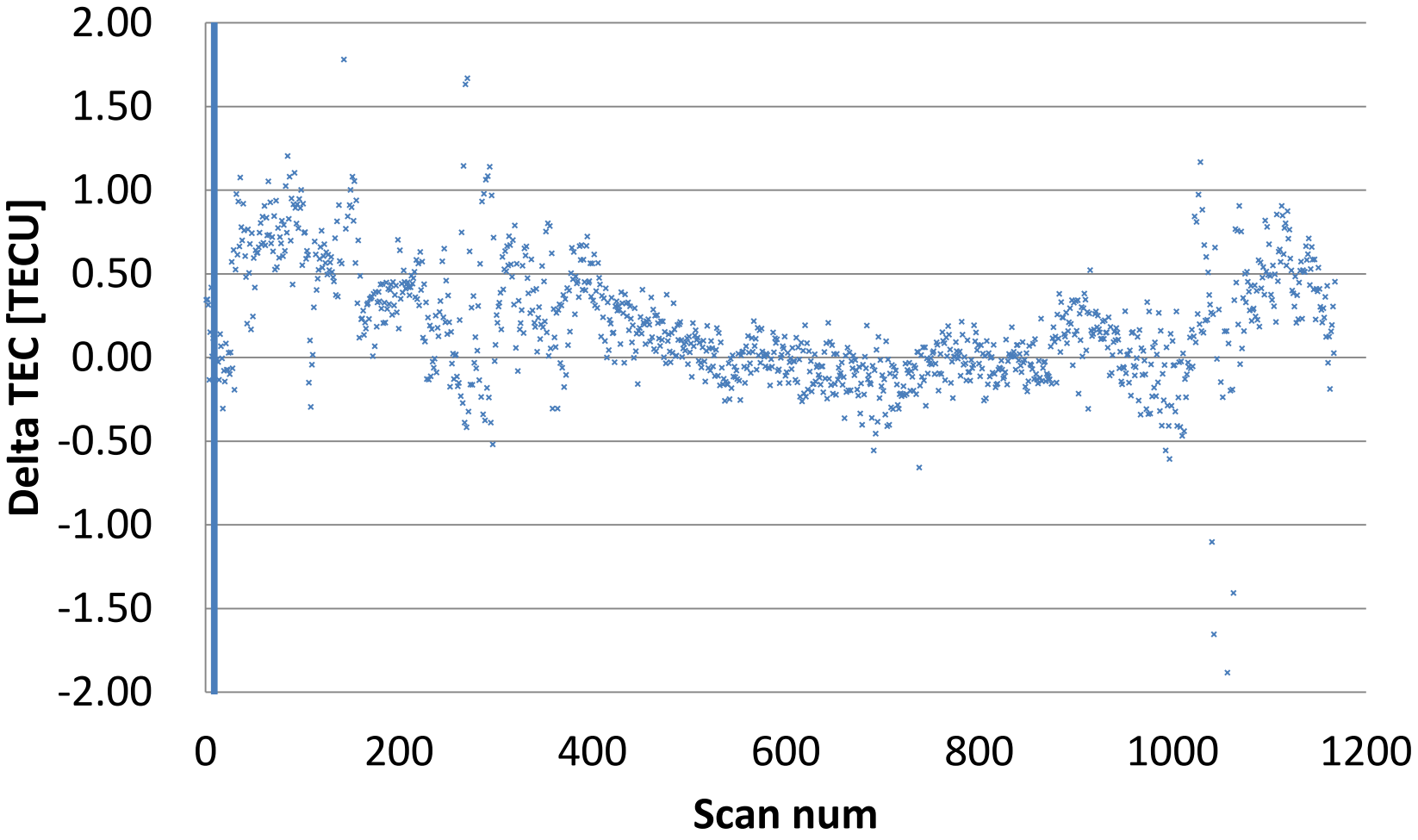
Preliminary



The delay resolution function



ΔTEC estimated by broadband delay



First Sub-mm VLBI in Japan

230 GHz VLBI at Nobeyama

Steady 230 GHz observation as single dishes

But

No VLBI back-ends

Need for building VLBI system temporary!

150 m
(VSBI)

Backend and Optical fiber from Kashima

- No rooms for human…

laying of optical fiber

protection

Pulling out from a duct

Three Reference Signal Modes

[Mode 1] Connected interferometer mode
  – 10 MHz transfer via optical fiber

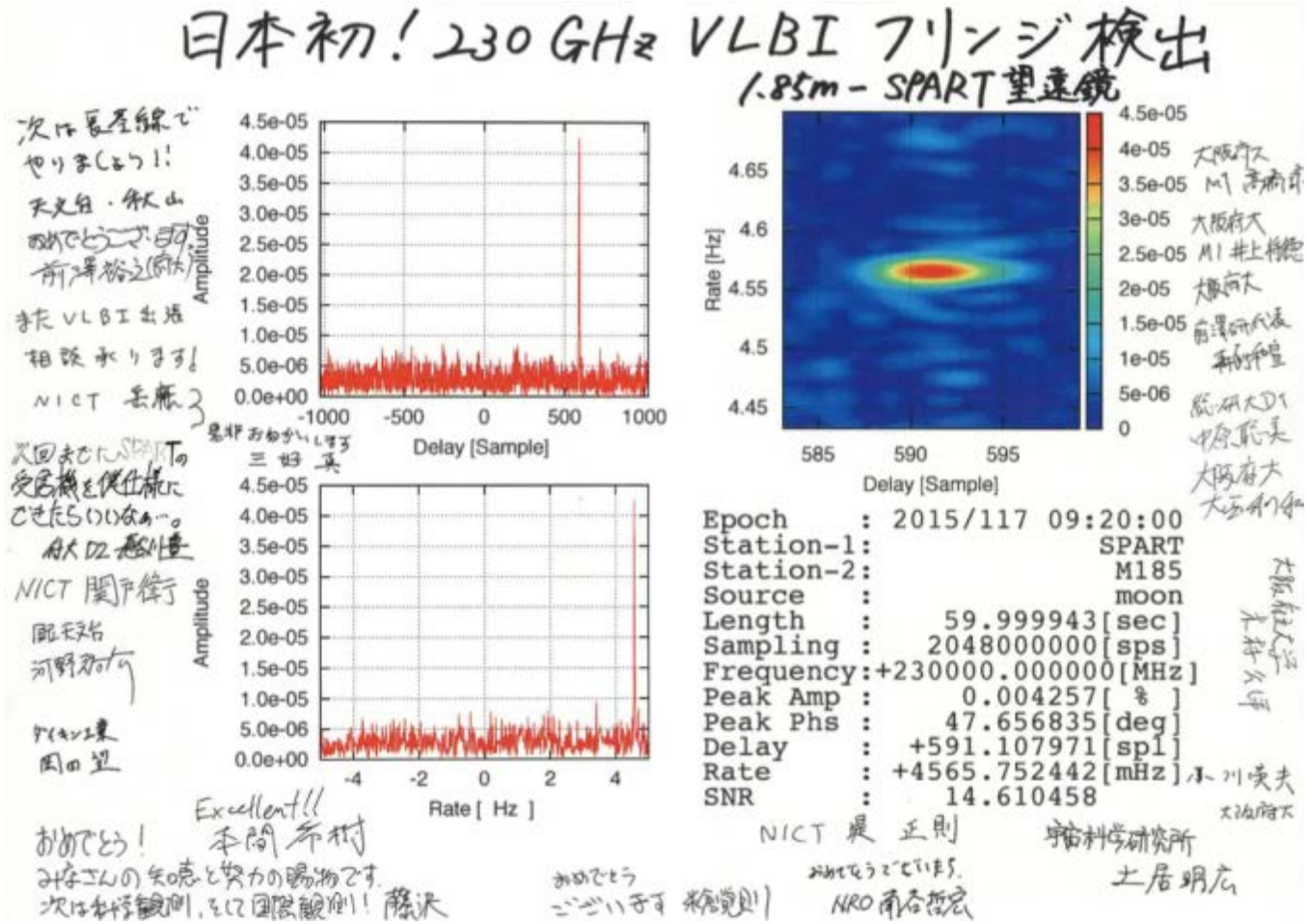
[Mode 2] H-maser VS OCXO

[Mode 3] OCXO VS OCXO

- OCXO
  – Oven Controlled Xtal Oscillator
  – Good Stability at 230 GHz for 10 seconds integration
  – Cheap and compact (transportable)

Back-end for SPART

First 230 GHz fringe in Japan !



16k point / 100 Hz fringe search window

Thank you

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