

VLBI 周波数比較への応用と GALA-V システムの開発(VIII) -広帯域VLBI観測の長基線観測に向けて-

情報通信研究機構

関戸衛、岳藤一宏、氏原秀樹、近藤哲朗、宮内結花、堤正則、川合栄治、
長谷川新吾、小室純一、寺田健次郎、
難波邦孝、高橋留美、岡本慶大、青木哲郎、池田貴俊

産業技術総合研究所 計量標準センター

渡部謙一、鈴山智也

国土地理院

石本正芳、栗原忍、若杉貴浩、梅井迪子、豊田友夫

GALA-V Project Overview

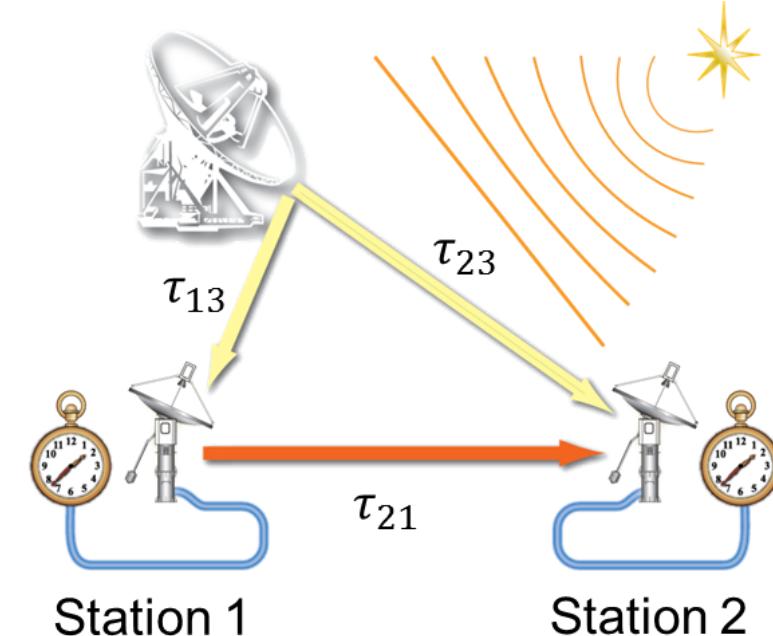
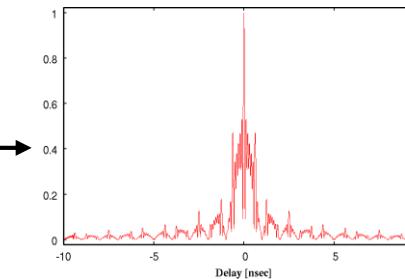
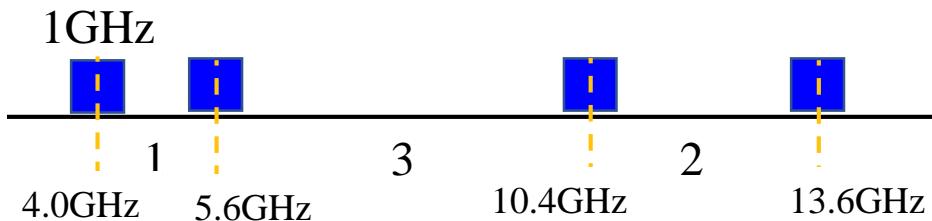
Frequency comparison by using Transportable Broadband telescopes

■ Radio Frequency : 3-14 GHz (VGOS Compatible)

■ Data Acquisition : 4 band (1024 MHz width)

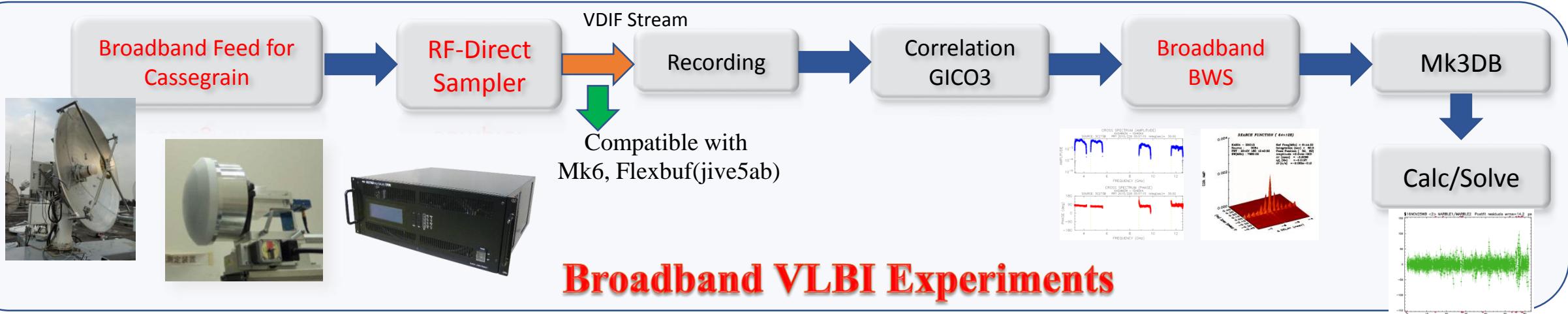
■ Nominal Freq. Array: $F_c = 4.0\text{GHz}, 5.6\text{GHz}, 10.4\text{GHz}, 13.6\text{GHz}$

■ Effective Bandwidth : 3.8GHz (10 times more than Conventional)



$$\tau_{21} = \tau_{13} - \tau_{23}$$

By using closure delay relation.



Broadband VLBI Experiments

Broadband VLBI Stations in Japan

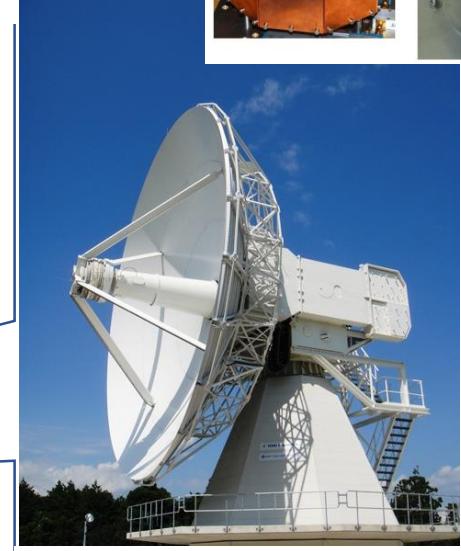


MARBLE1 (2.4m)



NMIJ (Tsukuba)

GSI(Ishioka)



Ishioka 13m

NICT(Koganei)

NICT(Kashima)



MARBLE2(2.4m)

NINJA Feed
For Marble



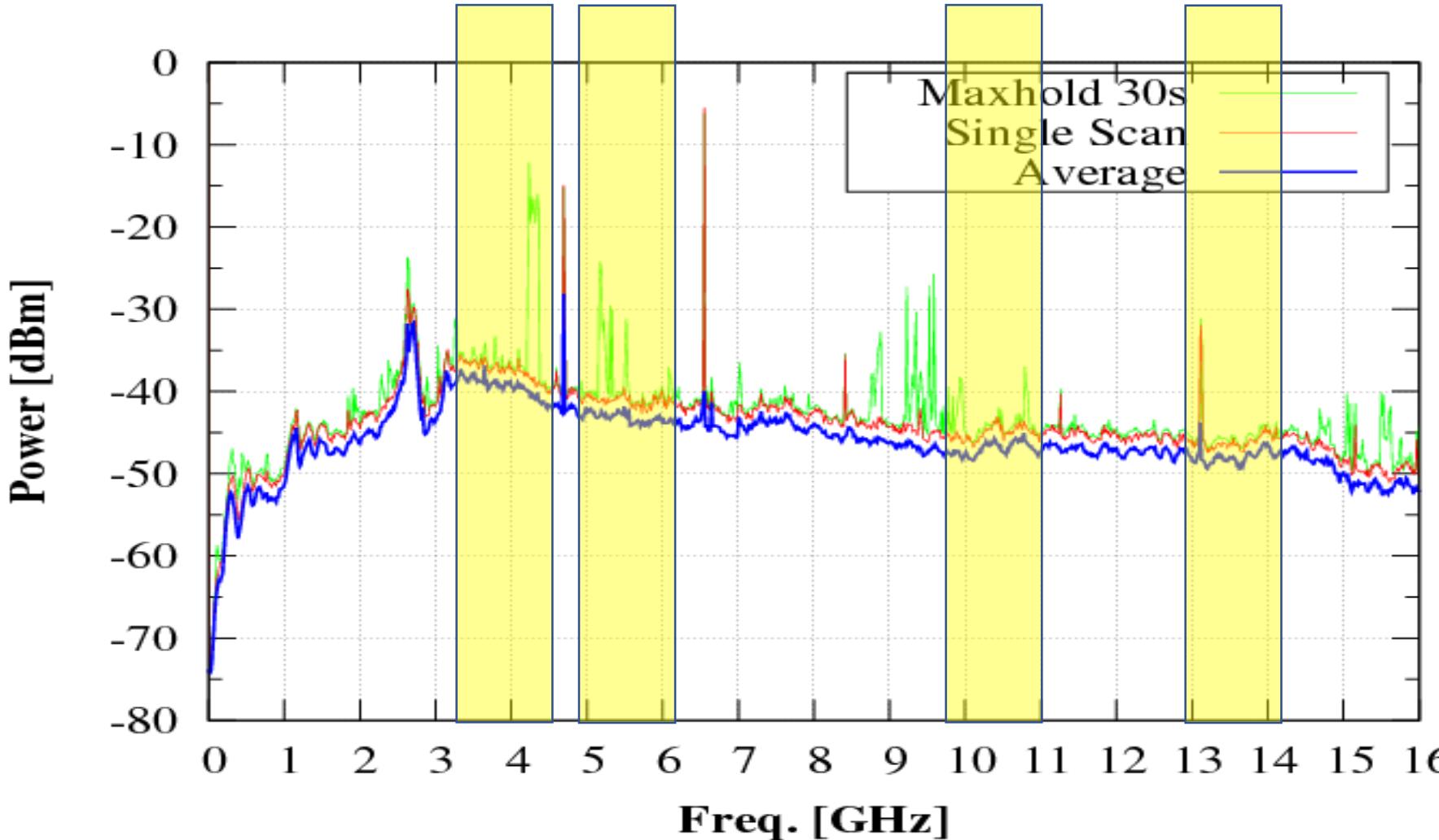
Broadband
NINJA Feed



Kashima 34m

Map data ©2014 Google.

Current State at Kashima 34m Broadband Signal



RBW=3MHz
Whole BW~12GHz

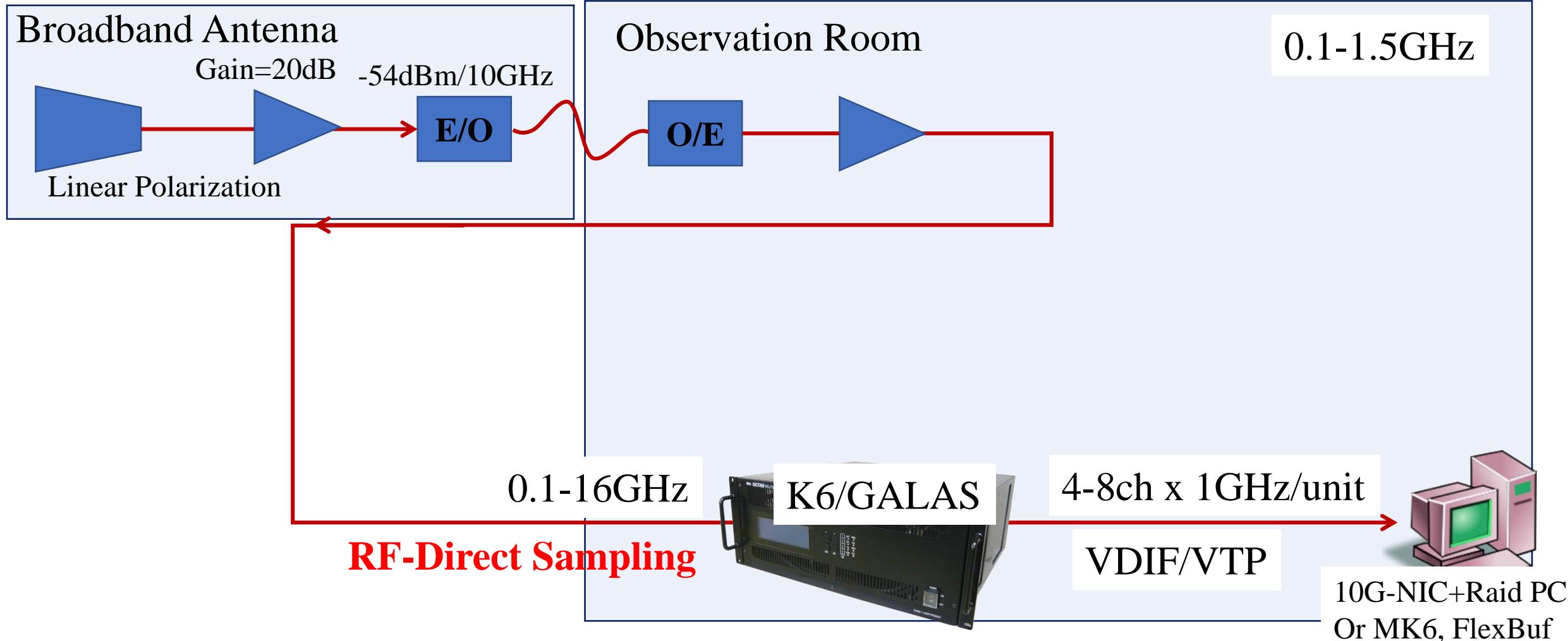
 $N = 12\text{GHz}/3\text{MHz}$
=36dB

Total Powe~ $-45+36$
=-9dBm
< -5dBm (RFI)

Data Acquisition System

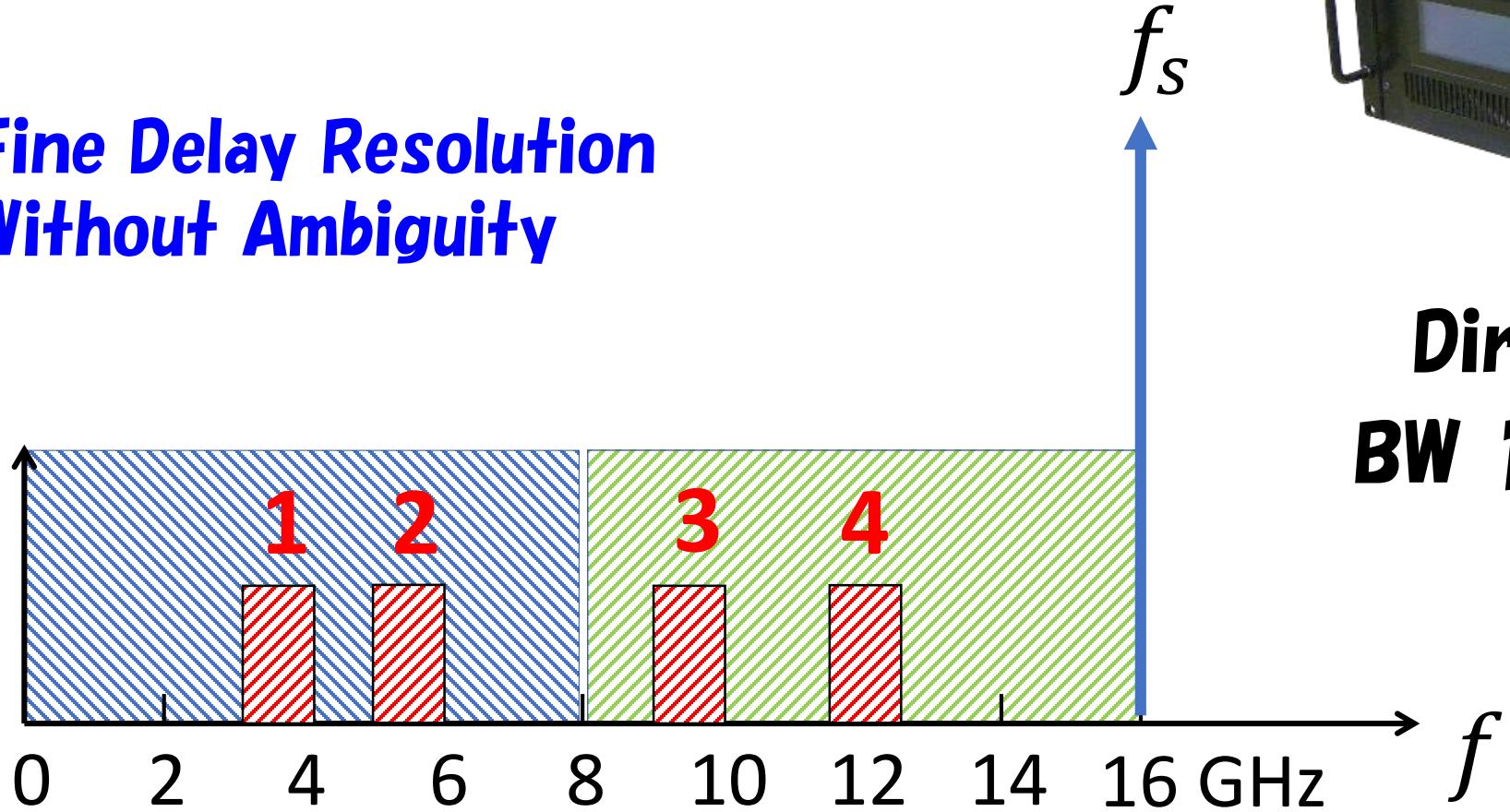
300k=-174 dBm/Hz
-74dBm/10GHz

We have to be careful to compromise (1) avoiding saturation of system and (2) increase of noise figure, as discussed by Chris(2012) .



As close as Zero Redundancy Frequency allocation

**Fine Delay Resolution
Without Ambiguity**

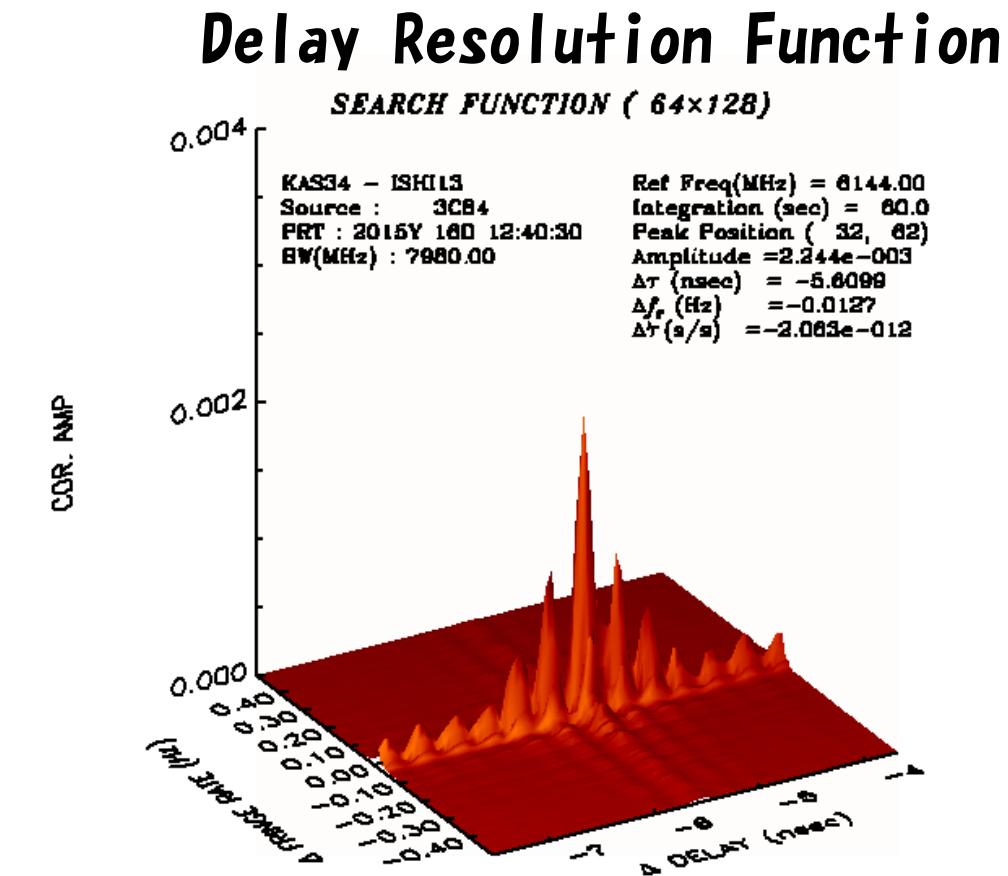
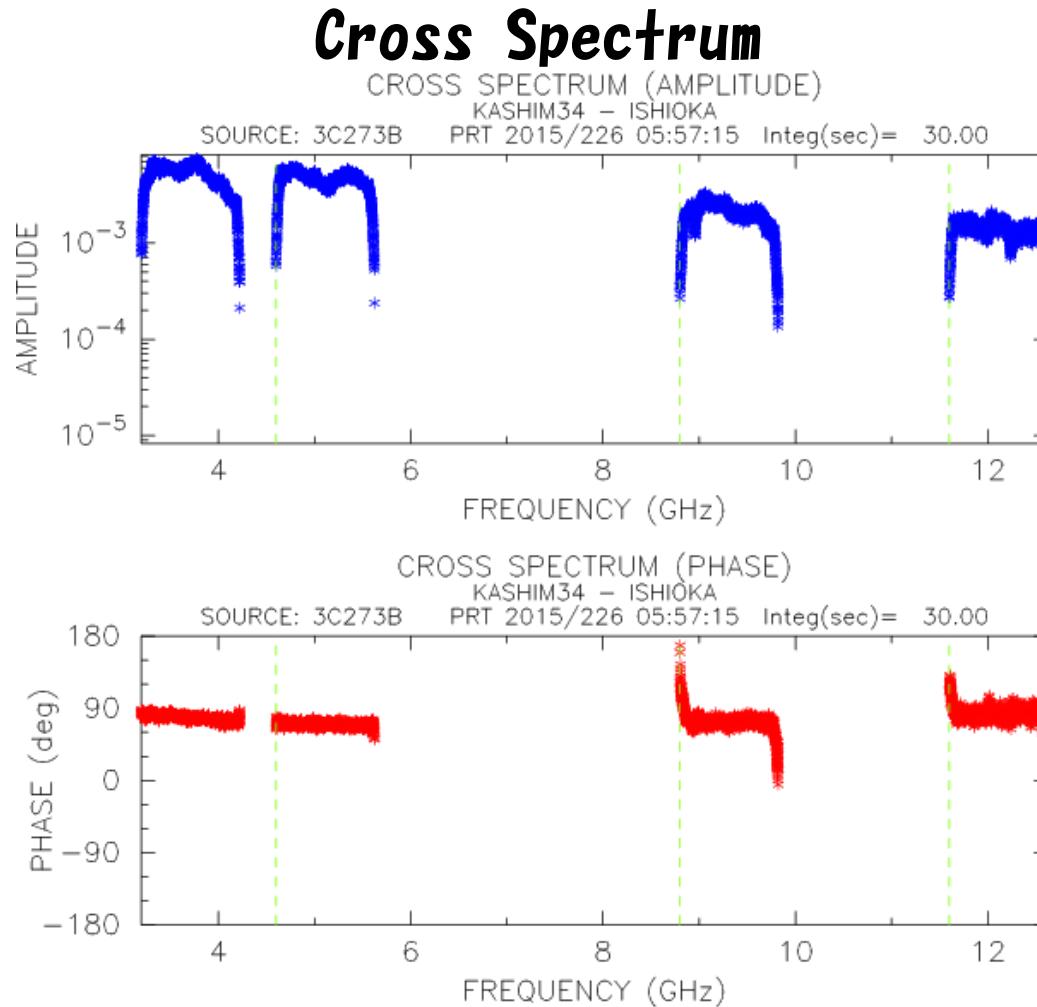


Lower Edge= 3.2, 4.8, 8.8, 11.6GHz



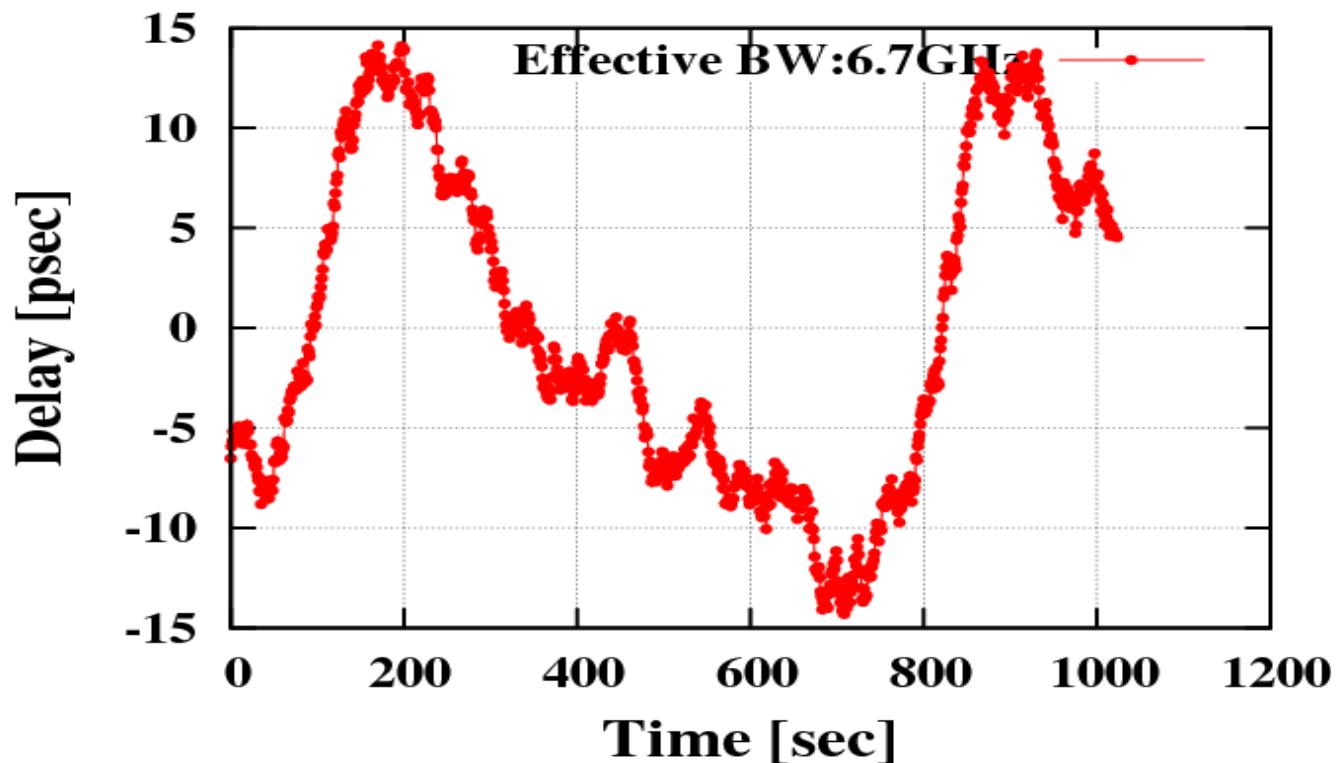
**Direct Sampling
BW 1024MHz each**

Full Bandwidth Synthesis #1-# (6-14GHz) by Phase Calibration with Radio Source

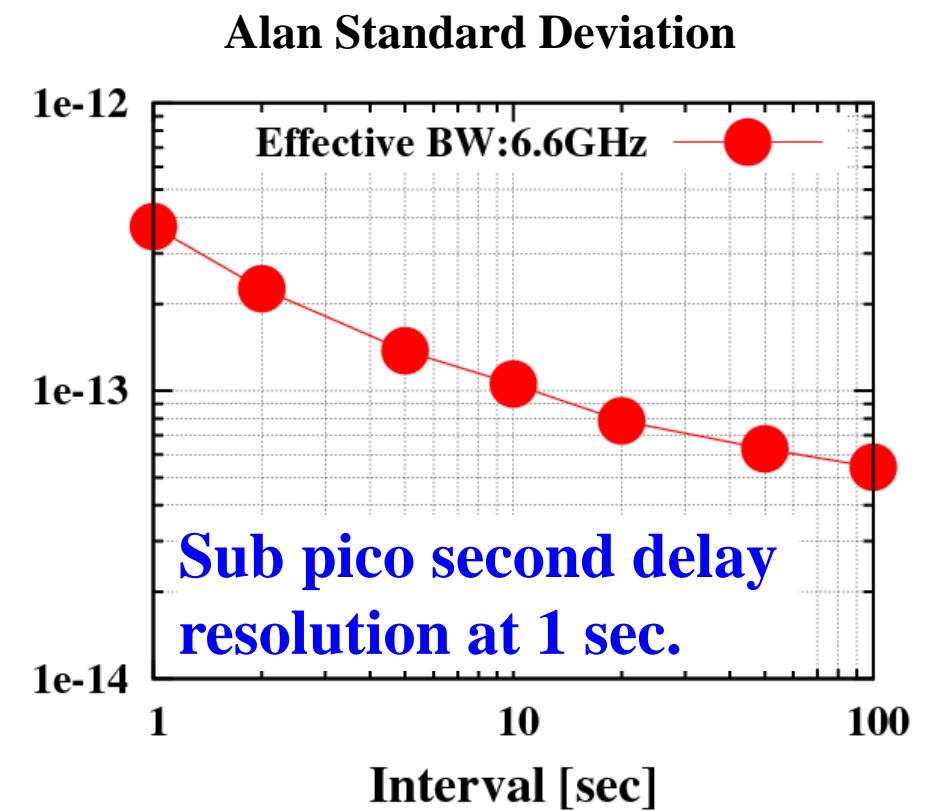


Delay Behavior Broadband Group Delay (3.2-12.6GHz) Kashima34 – Ishioka 13m

Exp. on 14 Aug.2015,
Freq. array=(Lower Edge=3.2, 4.8, 8.8, 11.6GHz)



Alan Std Dev.



‘Small – Small’ Baseline

- Closure delay relation used for ‘small-small’ baseline.

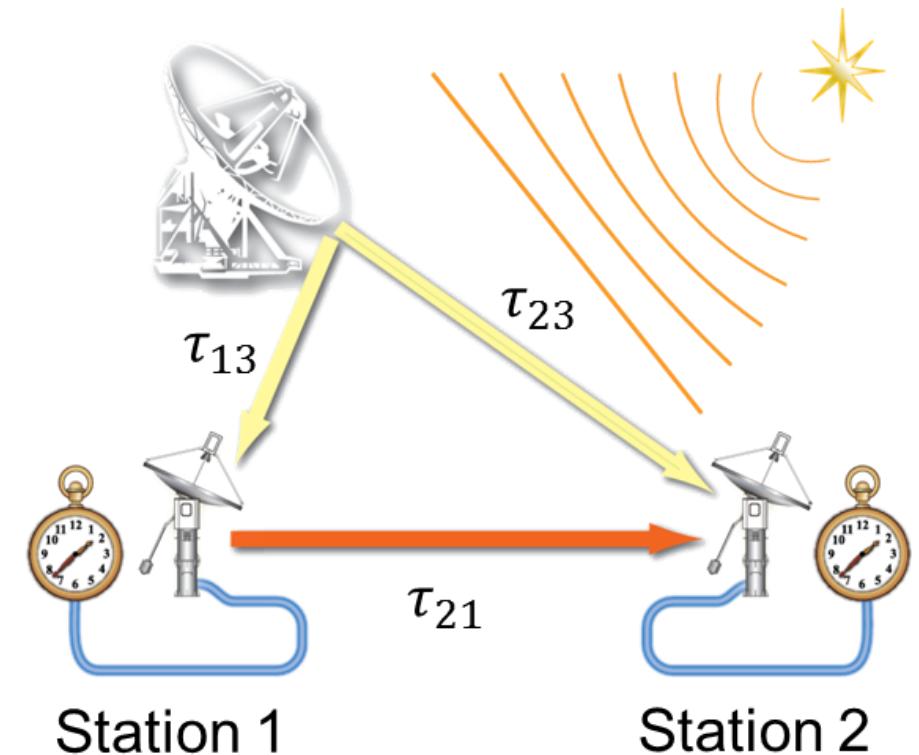
$$\tau_{21}(t_1) = \tau_{23}(t_1) - \tau_{13}(t_1) - \dot{\tau}_{13}(t_1)\tau_{12}$$

- Advantage of Small Antenna:

- Quick Slew and Small Distortion
- Large Diameter’s effects are canceled out.
- Lower Cost

- Disadvantage:

- Lower Sensitivity,
- source structure effect in closure delay.



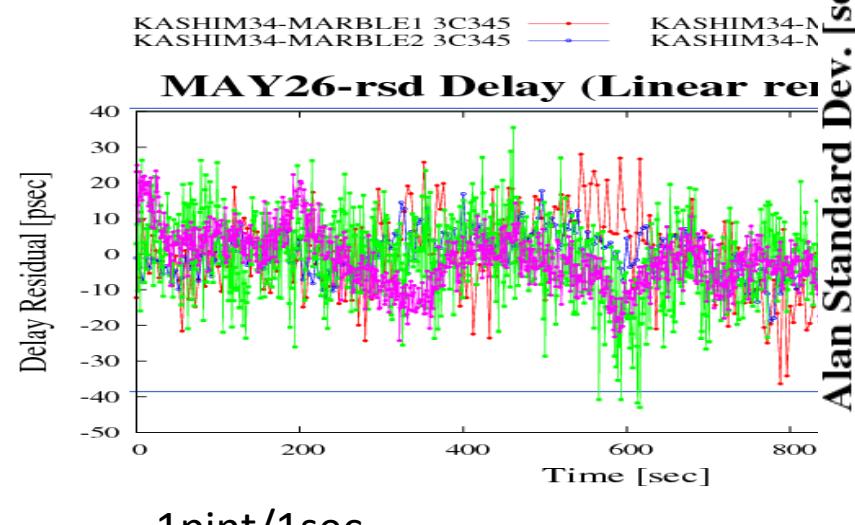


2.4m Diameter



1.6m Diameter

Broadband



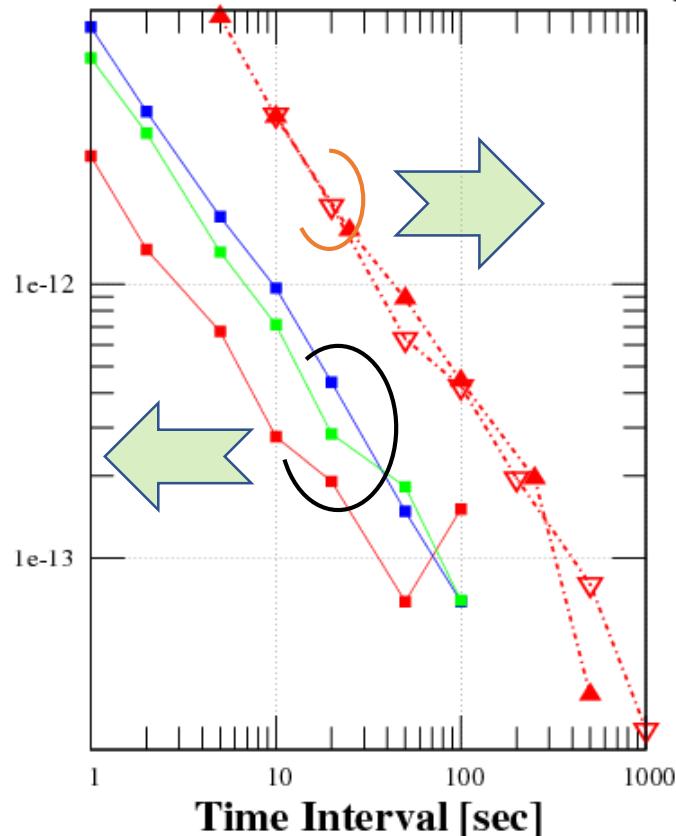
Delay Precision

Broadband(small-small)

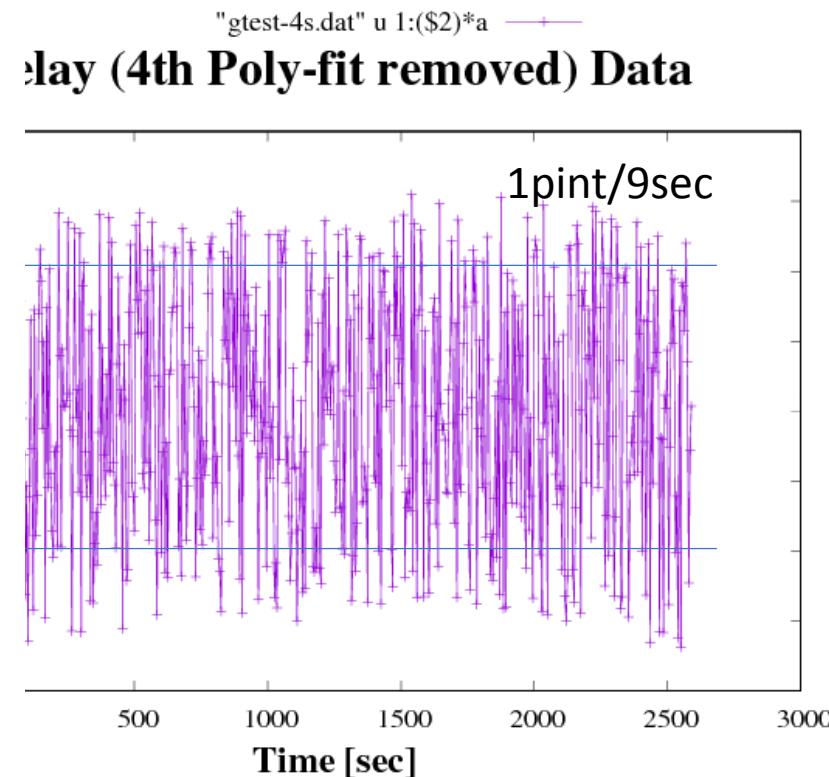
v.s.

Conventional 8180-8680MHz
S/X **500MHz**(T2 session)

2016MBL1-MBL2Dec-cmp

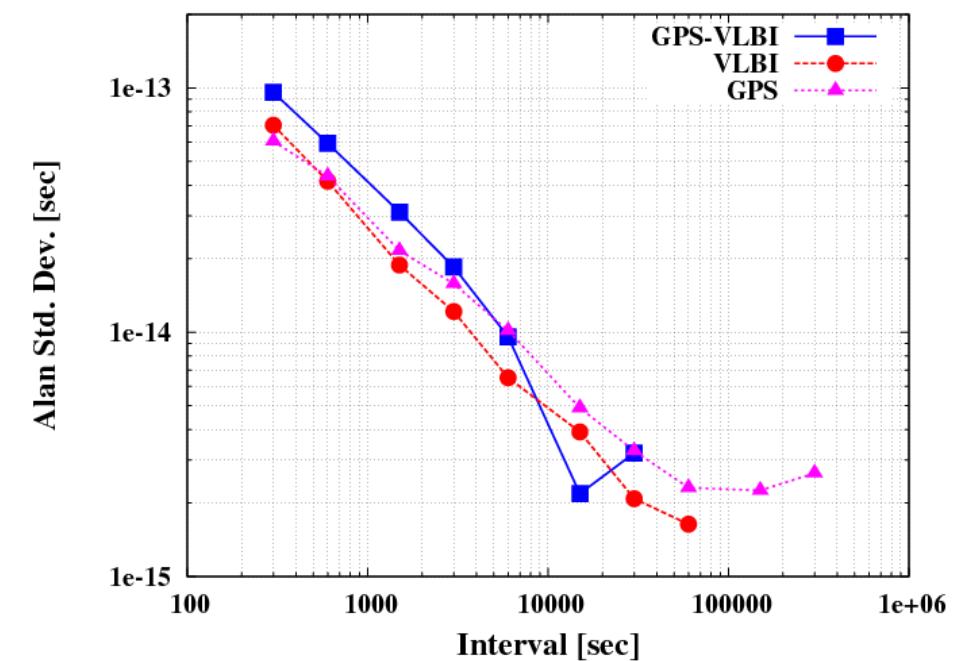
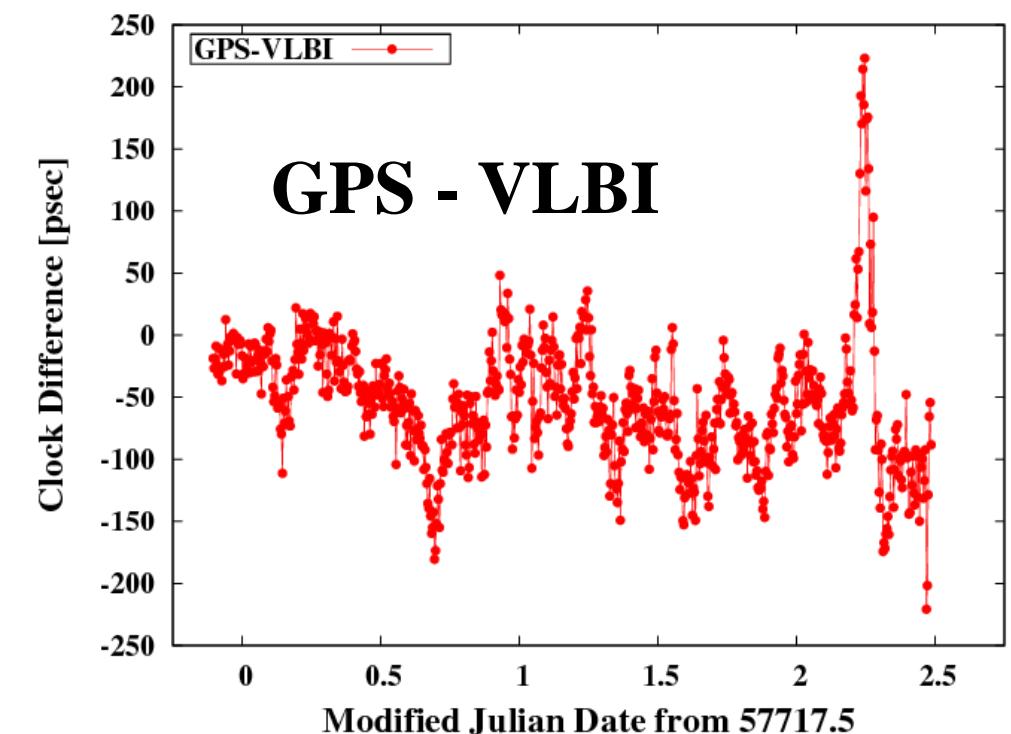
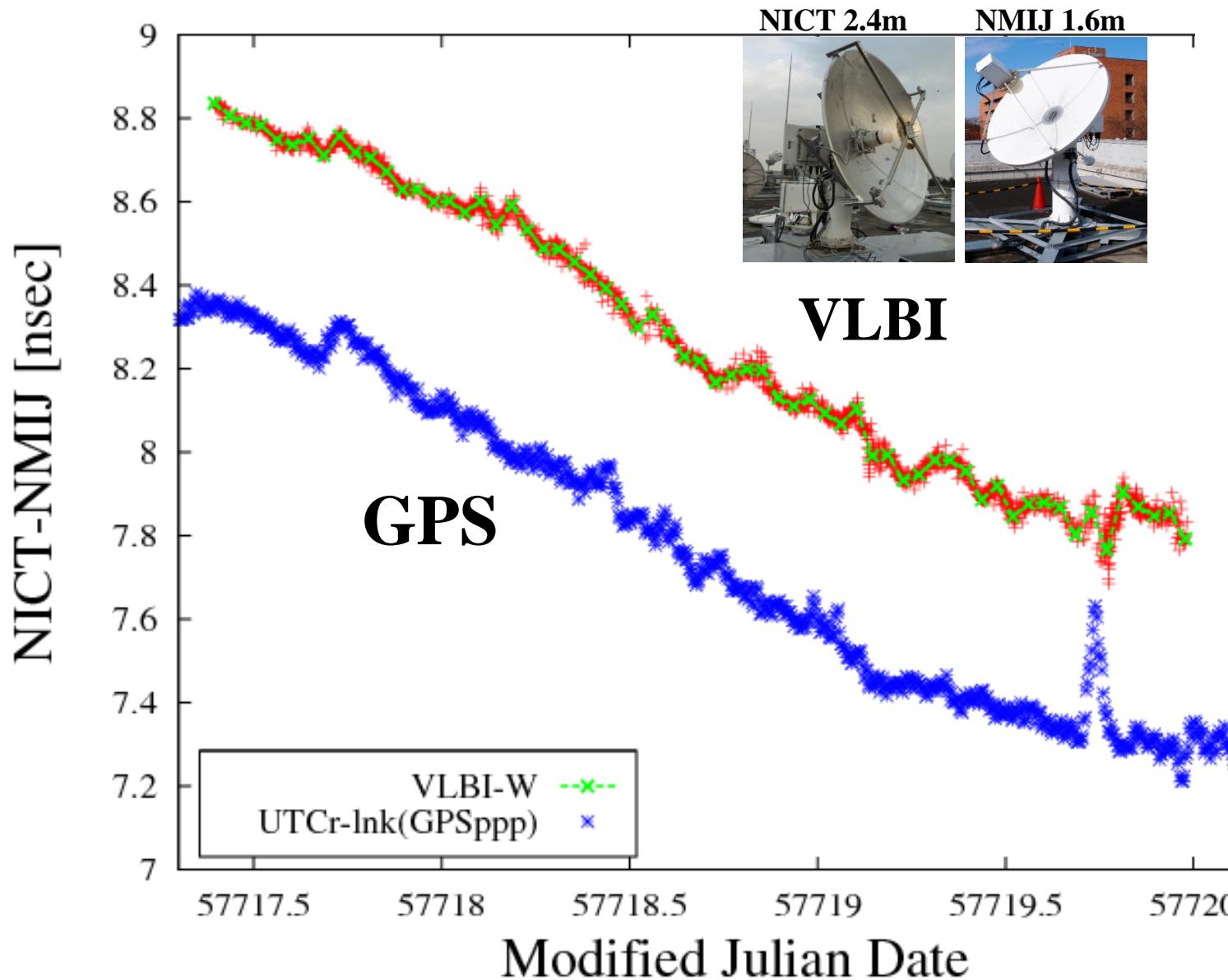


3C273B

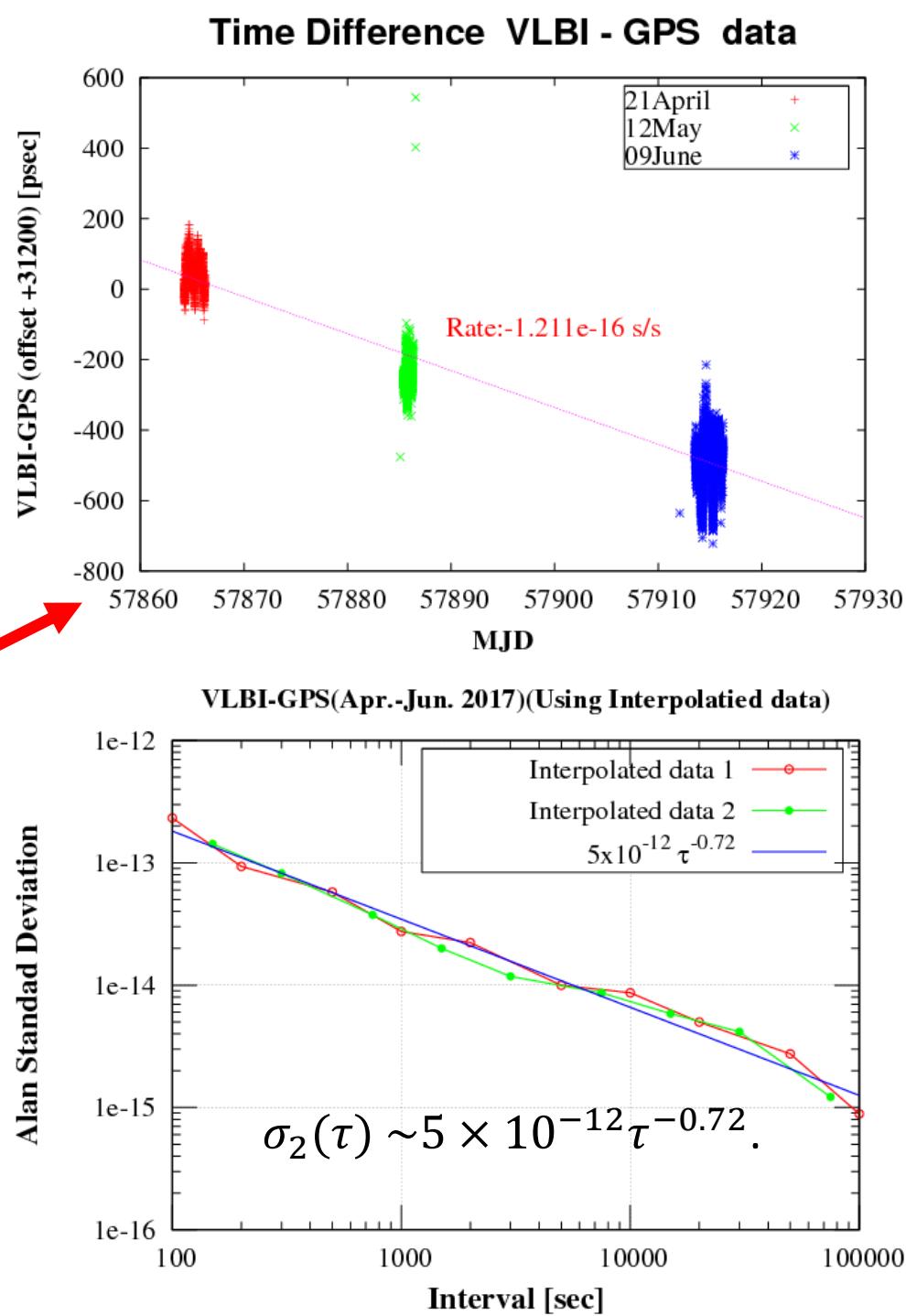
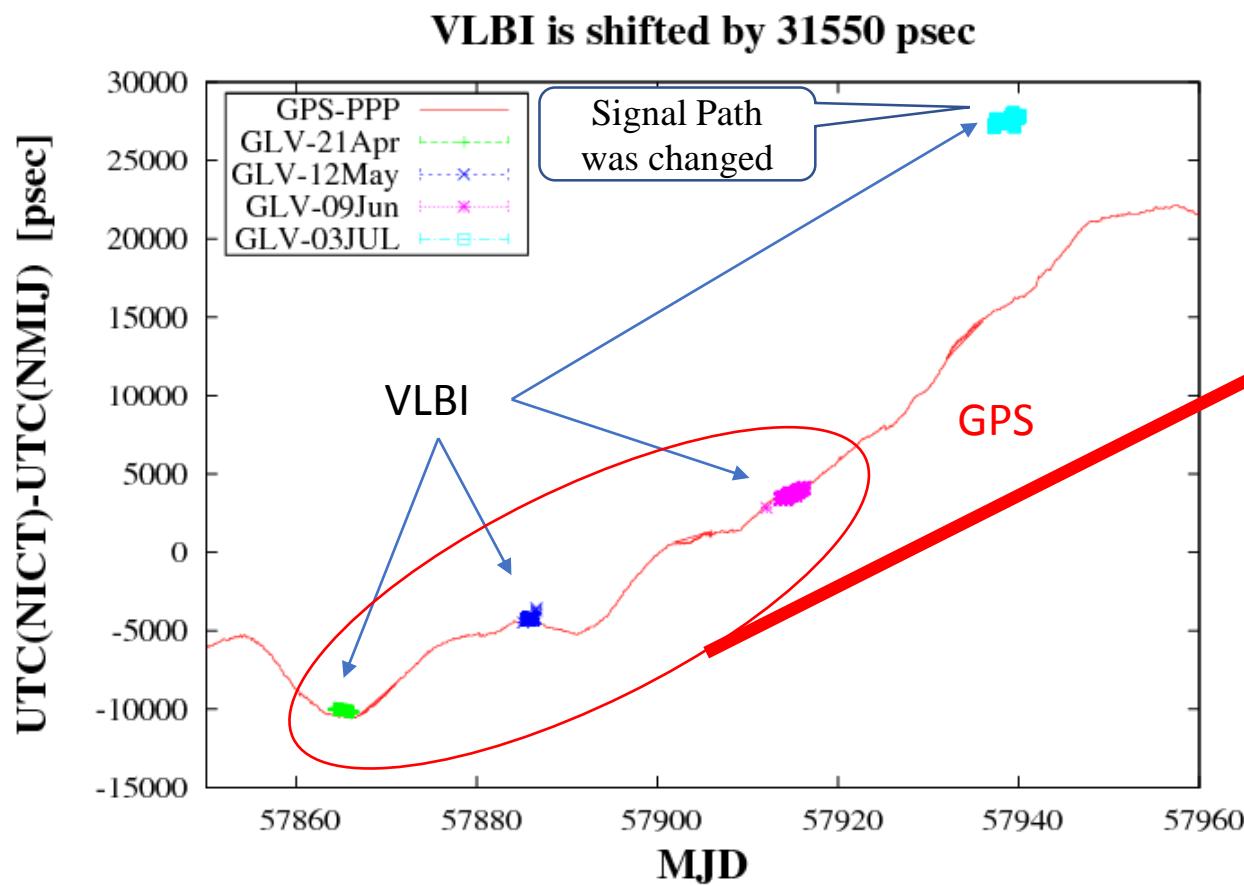


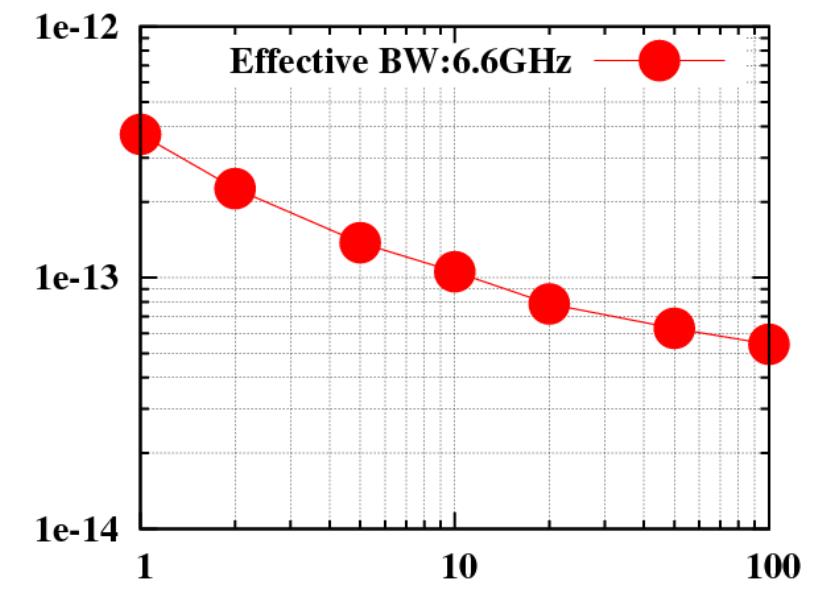
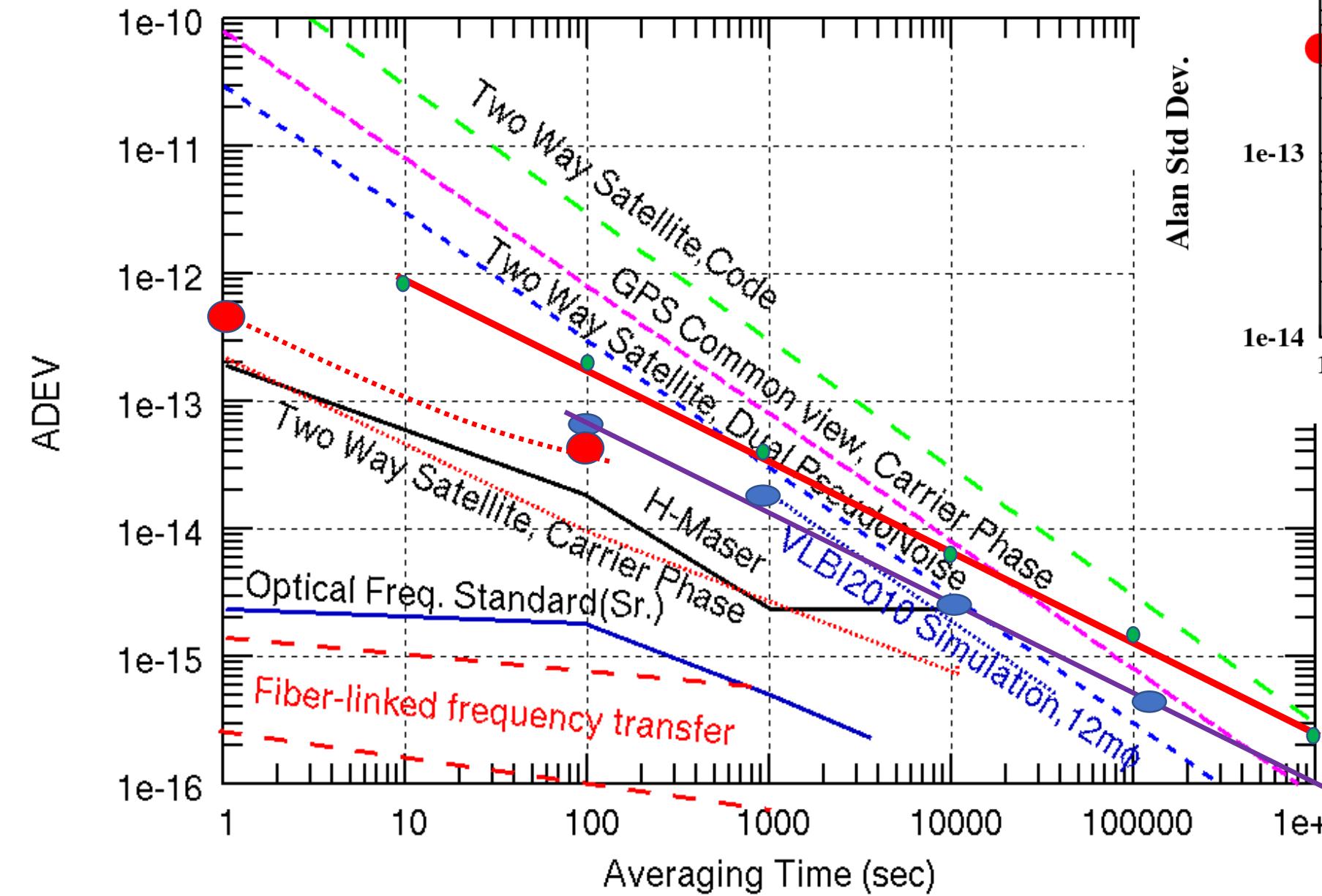
Clock Comparison via VLBI and GPS-ppp

2016Nov25 UTC(NICT) – UTC(NMIJ)



Clock Difference in Long Time Span UTC(NICT)-UTC(NMIJ)





海外標準機関との周波数比較実験を計画中

