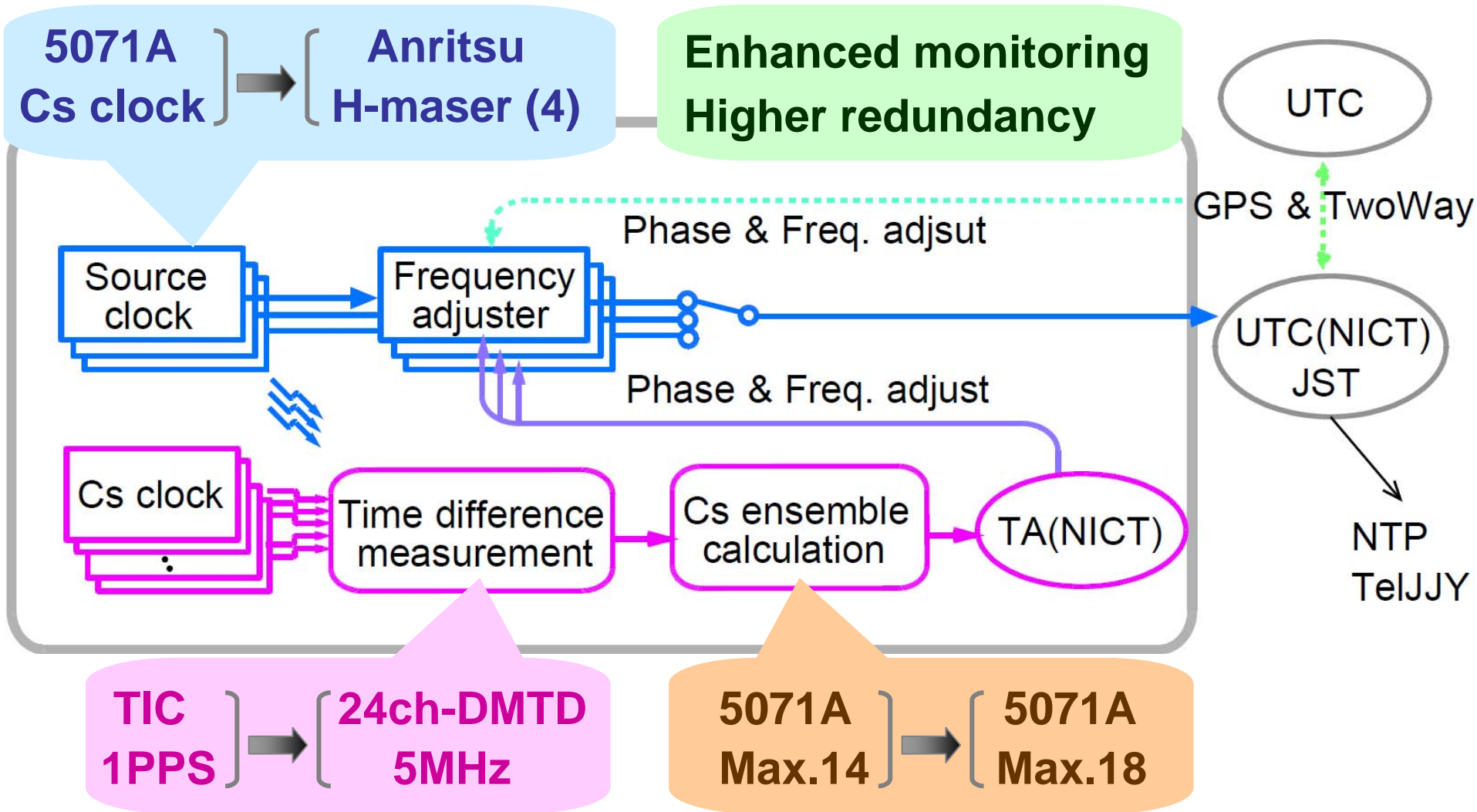


NICT station report

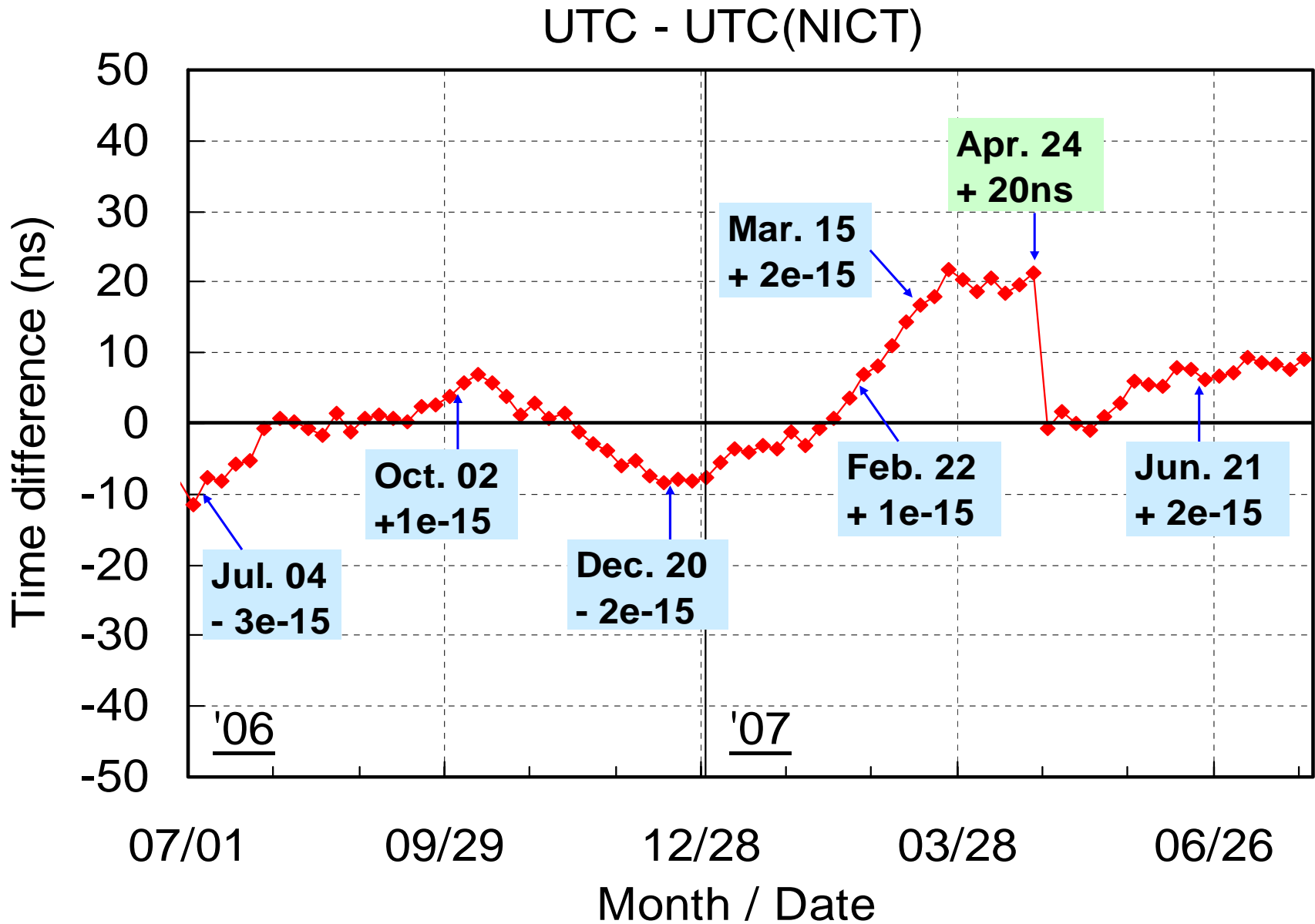
- UTC(NICT)
- TWSTFT
- Research topics on T&F transfer
 - New TWSTFT: Dual PRNs
 - ETS-VIII
 - QZSS

UTC(NICT) status

2006. February : JST system was renewal.



UTC(NICT) status



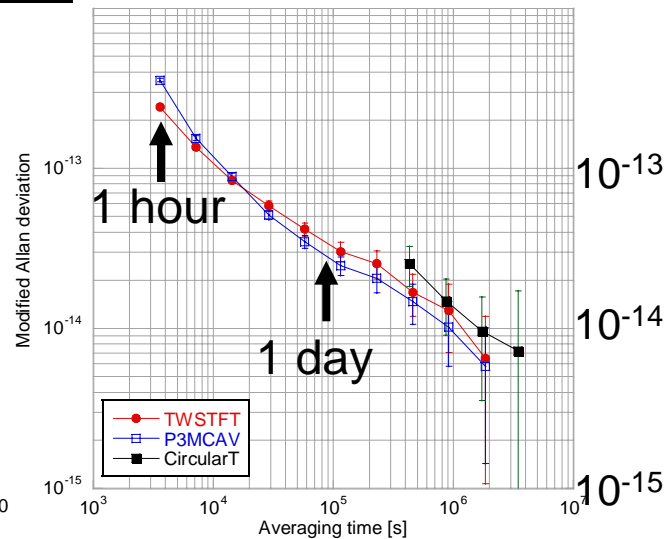
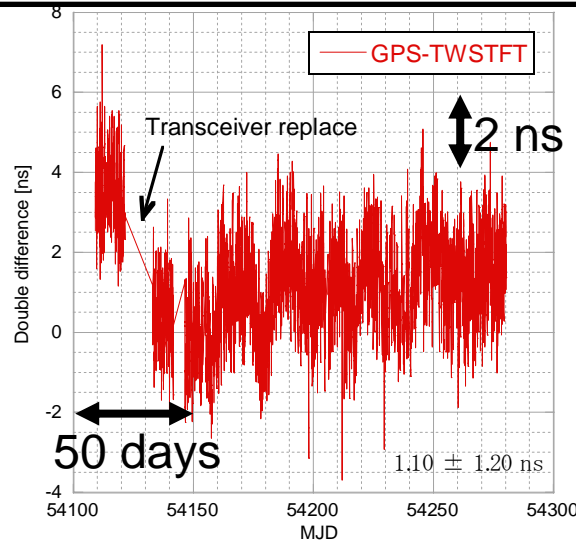
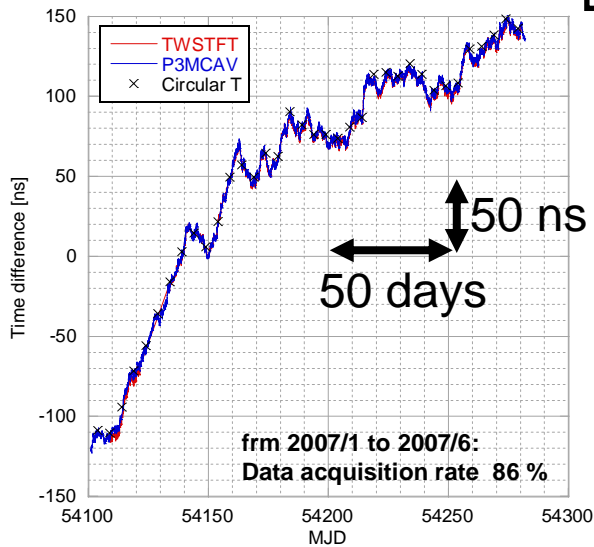
TWSTFT status

Satellite	Participants	Topics
JCSAT-1B	NICT, KRISS, TL, NMIJ, NTSC, SG, NICT LF stations x2	Two Japanese low-frequency stations joined in July 2007.
PAS-8	NICT, KRISS, NMIA, NICT LF stations x2	Regular operation finished in June 2007. Ad hoc usage will be planned.
PAS-4	PTB, NICT, KRISS, (NMIJ)	NICT/PTB link has been adopted for TAI link since May 2007. NMIJ will join near future.

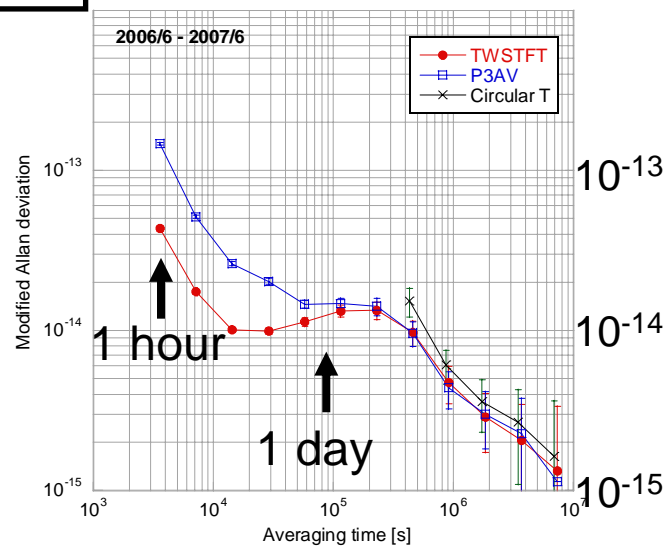
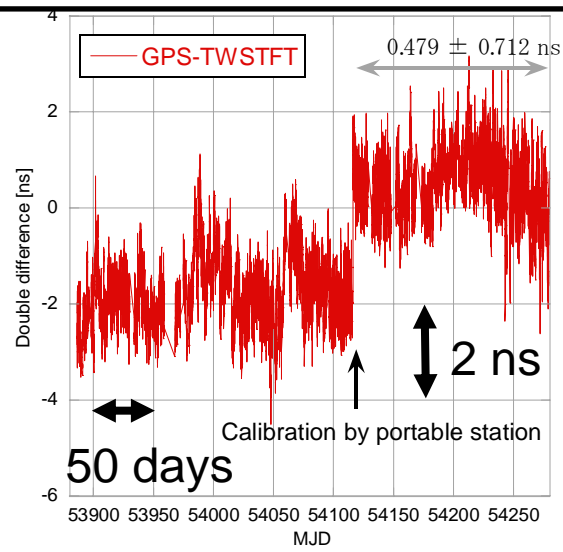
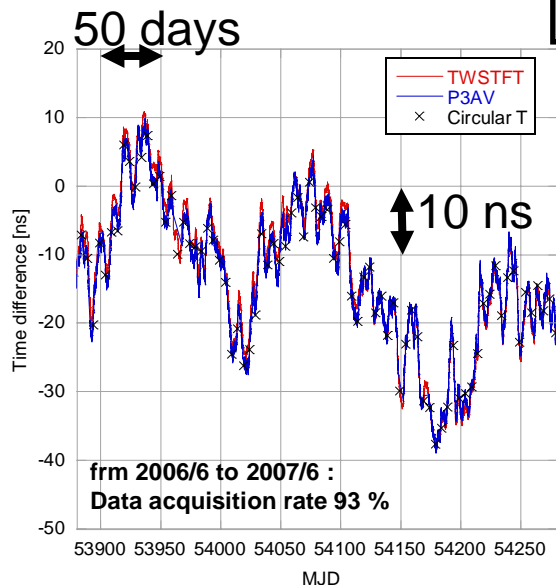
TWSTFT Session: once every hour

TWSTFT status

NICT-AUS: 2007/1 – 2007/6

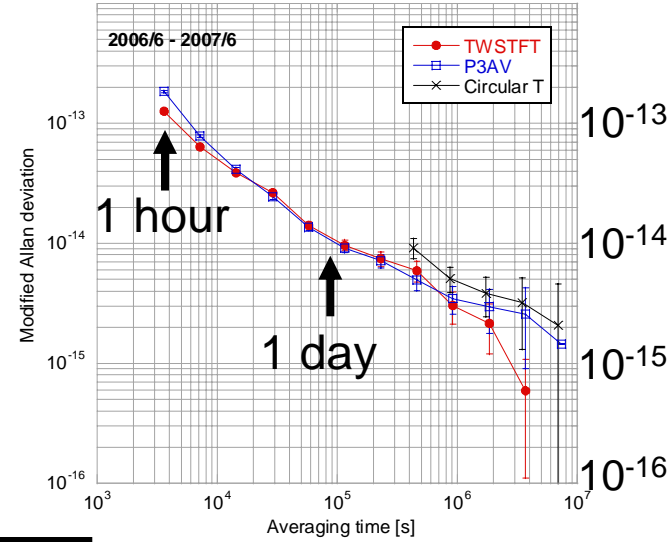
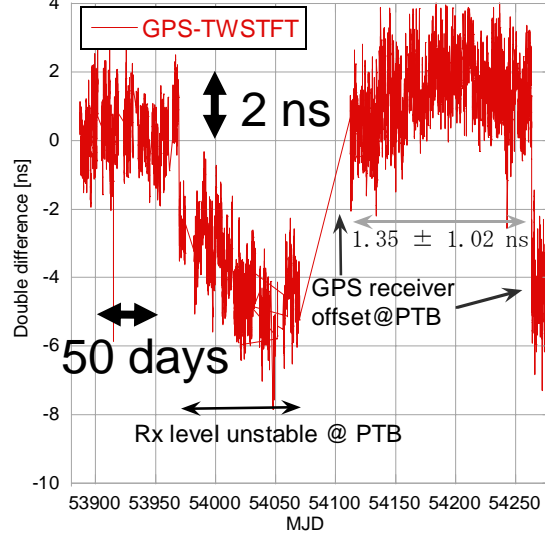
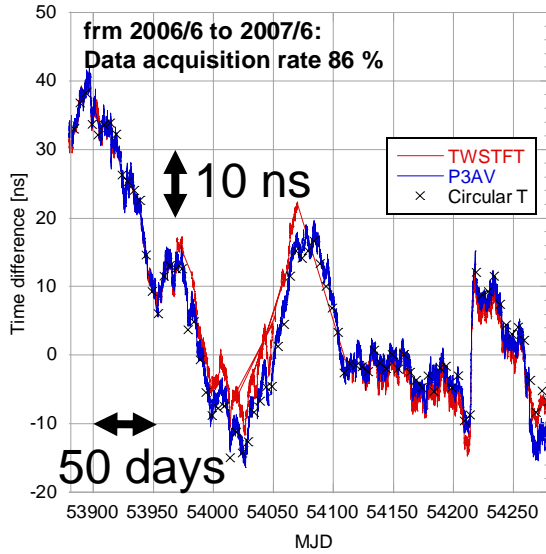


NICT-KRISS: 2006/6 – 2007/6

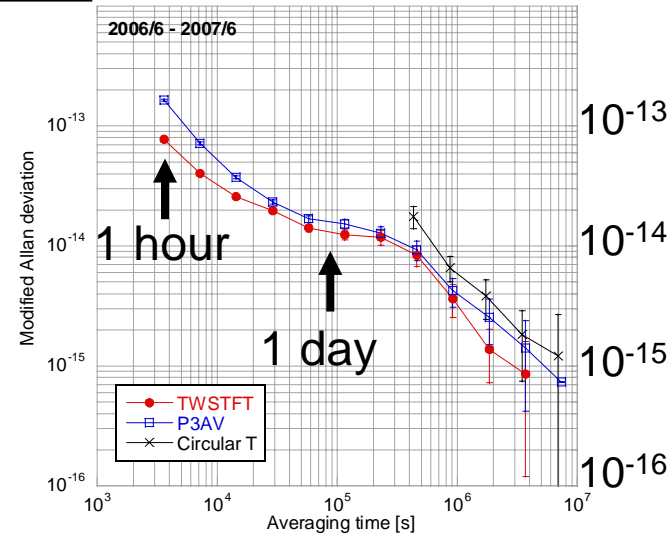
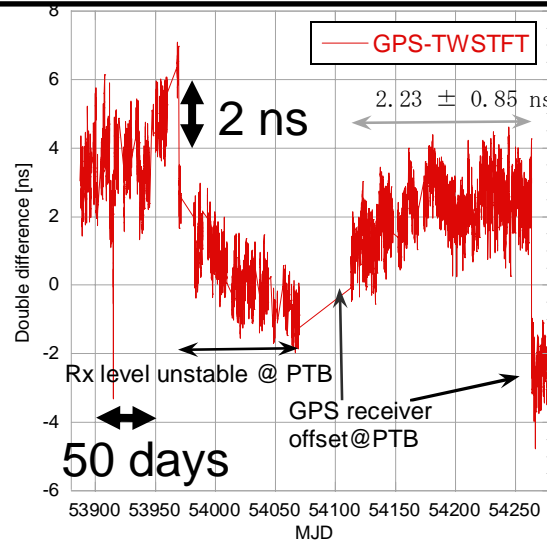
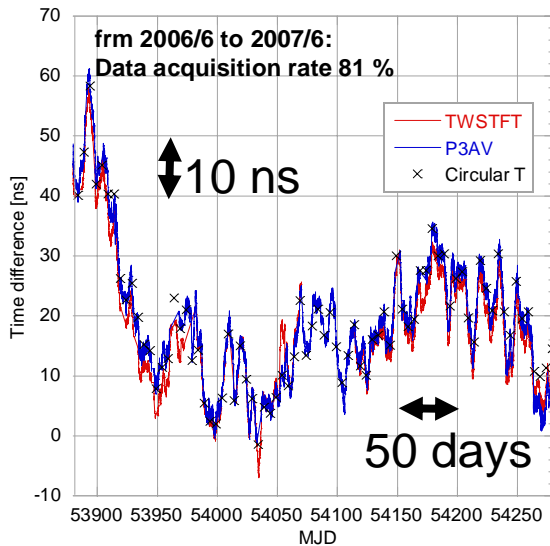


TWSTFT status

NICT-PTB: 2006/6 – 2007/6



KRISS-PTB: 2006/6 – 2007/6



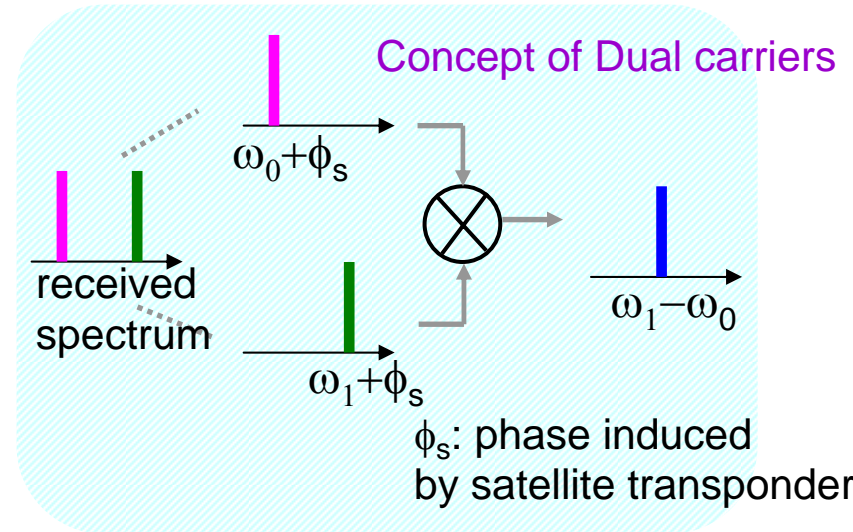
Research topics on T&F transfer

TWSTFT

- First comparison of Cs fountains with PTB succeeded in Dec. 2006.
M. Fujieda et al., EFTF 2007
- Monitor system of earth station delay variation runs well.
M. Fujieda et al., IEEE Trans. Inst. Meas., V. 56, No.2, pp. 346-350, 2007

New TWSTFT

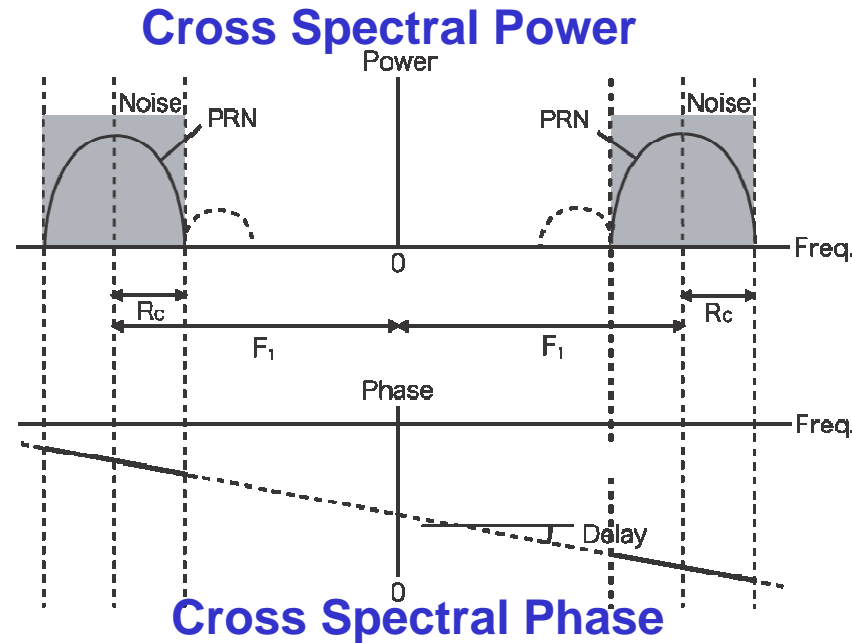
- Dual carriers: Under laboratory test
 - $\omega_1 - \omega_0$: 20 MHz
 - Measurement precision < 0.1 ns
 - Waiting for radio license
- Dual PRNs



Carrier phase two-way frequency transfer with ETS-VIII

QZSS (Quasi-zenith satellite system)

New TWSTFT using dual PRNs



R_c : chip rate
 $2 F_1$: band gap

- Group delay error : σ_τ

$$\sigma_\tau = \frac{1}{4\pi F_1 \sqrt{(T C/N_0/2)}} \quad (\text{for } F_1 \gg R_c)$$

- Necessary condition

Inclination of the cross-spectral phase of each PRN should be on a line.

$$R_c > \frac{4F_1}{3\sqrt{(T C/N_0/2)}} \quad T : \text{Integration time}$$

New TWSTFT using dual PRNs

- **Conditions**

$$2F_1 = 20.24 \text{ MHz}$$

$$C/N_0 = 50 \text{ dBHz.}$$

- **Expected precision and necessary bandwidth**

Delay measurement error

$$\sigma_\tau = 35 \text{ psec}$$

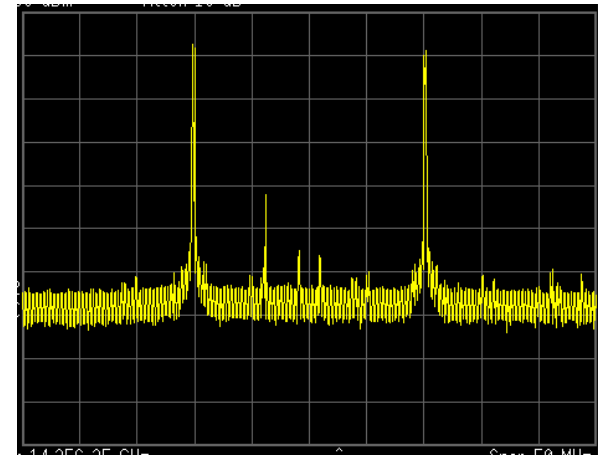
Necessary chip rate ; R_C

$$R_C > 60 \text{ kHz}$$

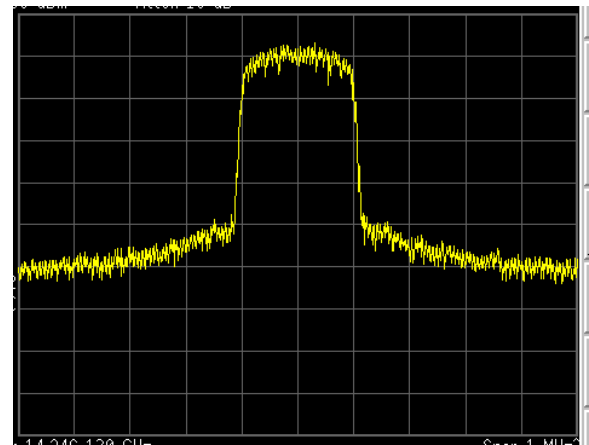
→ **Total bandwidth : 400 kHz**

(1/6 of currently used BW : 2.5 MHz)

- **Now under laboratory test
and waiting for radio license**



14 GHz RF spectrum
Channel space : 20.24 MHz



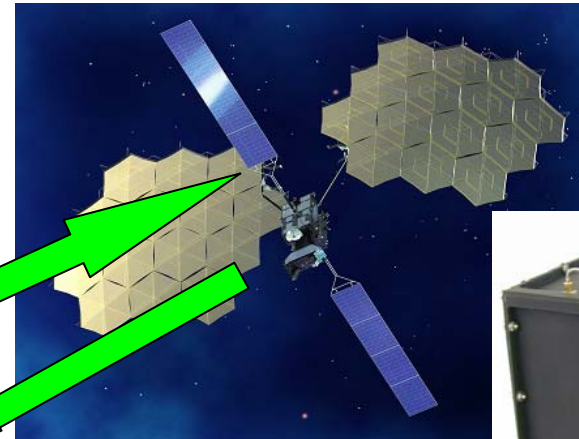
Spectrum of lower channel
Occupied BW : 200 kHz

Carrier phase two-way frequency transfer with ETS-VIII

Satellite positioning experiment

*Time Comparison Equipment
(TCE) developed by NICT

*High Accuracy Clock (HAC)
developed by JAXA



ETS-VIII

launched on 2006/12/18



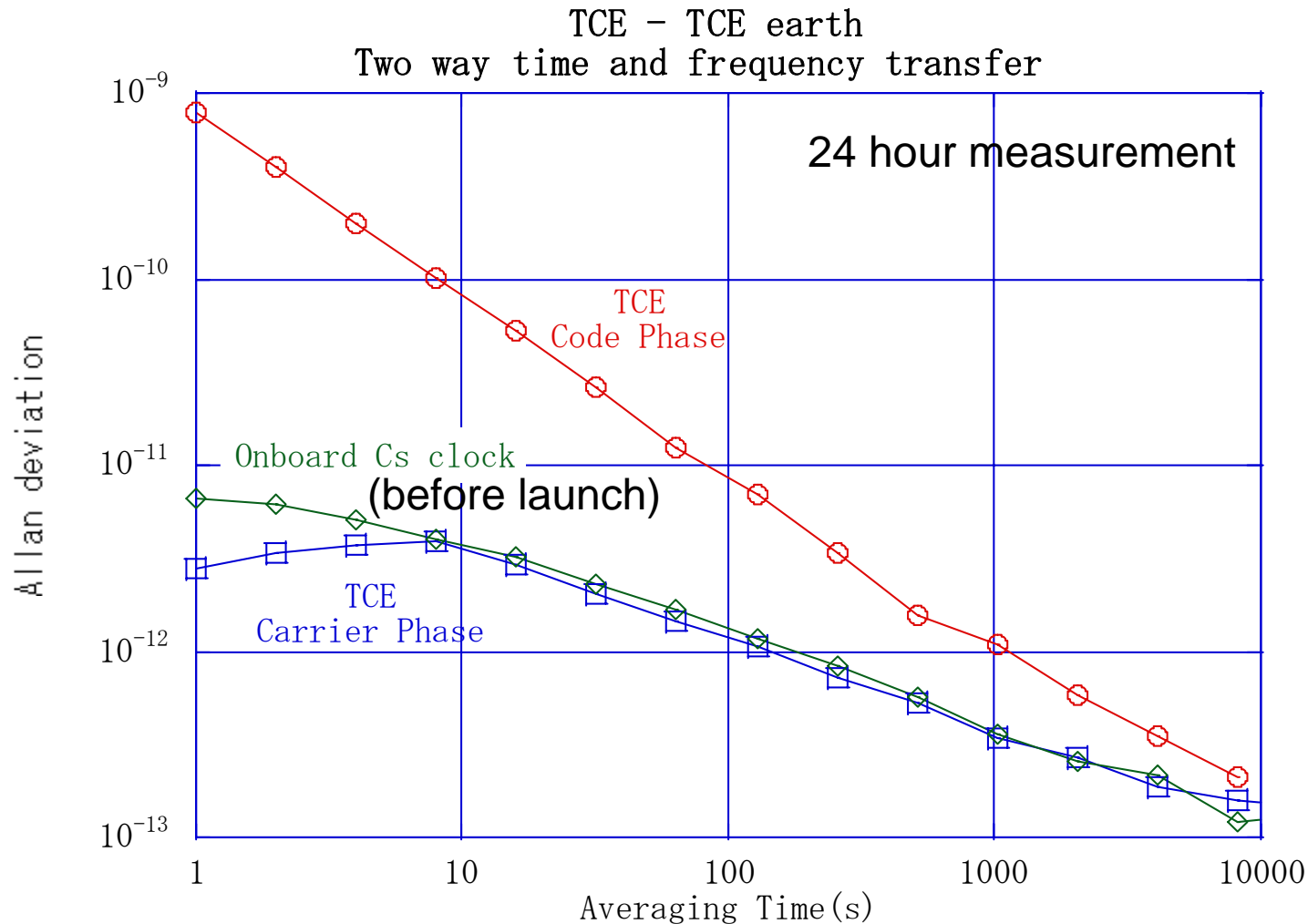
TCE



TCE Earth station

First experiments of two-way carrier phase frequency transfer between the atomic clocks on the satellite and a ground-reference clock to verify the performance of the onboard clock

Carrier phase two-way frequency transfer with ETS-VIII

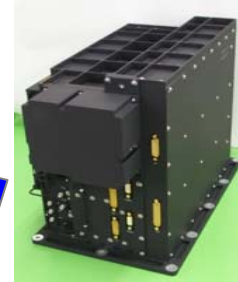


Y. Takahashi et al., ION GNSS 2007
F. Nakagawa et al., PTTI 2007

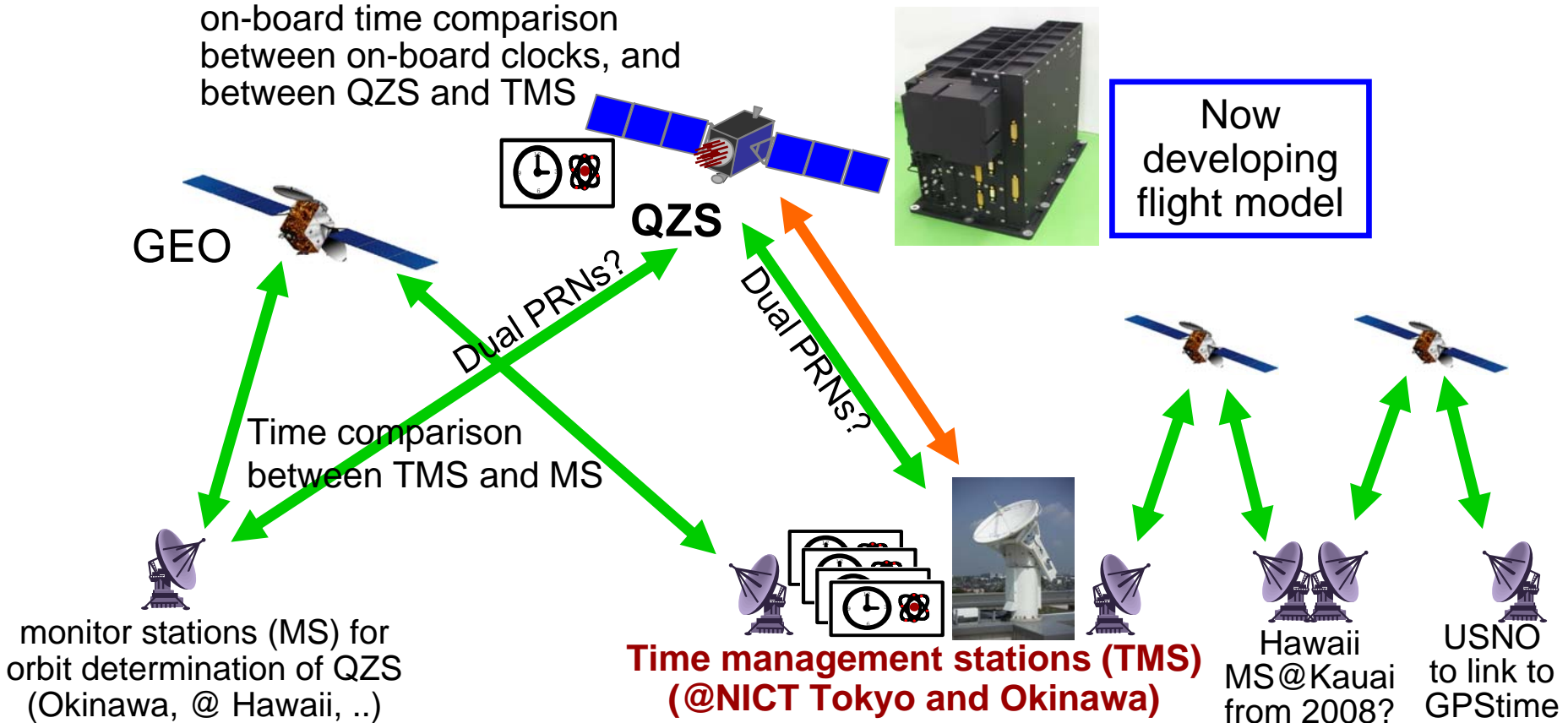
QZSS: Quasi-zenith satellite system

TWSTFT relay station @Hawaii with QZSS MS

on-board time comparison between on-board clocks, and between QZS and TMS



Now developing flight model



- between QZS and TMS (Ku-band)
- between ground stations (Ku-band)

QZS time – GPS time < 3ns

Thank you for your attention!
