Calibration transfer from the SU52-PT13 GPS PPP link to SU01-PTB03 and SU51-PTB53 TWSTFT links

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Context

Due to a hardware failure, the TWSTFT link between VNIIFTRI and PTB has been interrupted on day 2026-05-18. After replacement of the failing equipment, a clear step of -2.85 ns has been measured by VNIIFTRI, based on H maser comparisons through that link

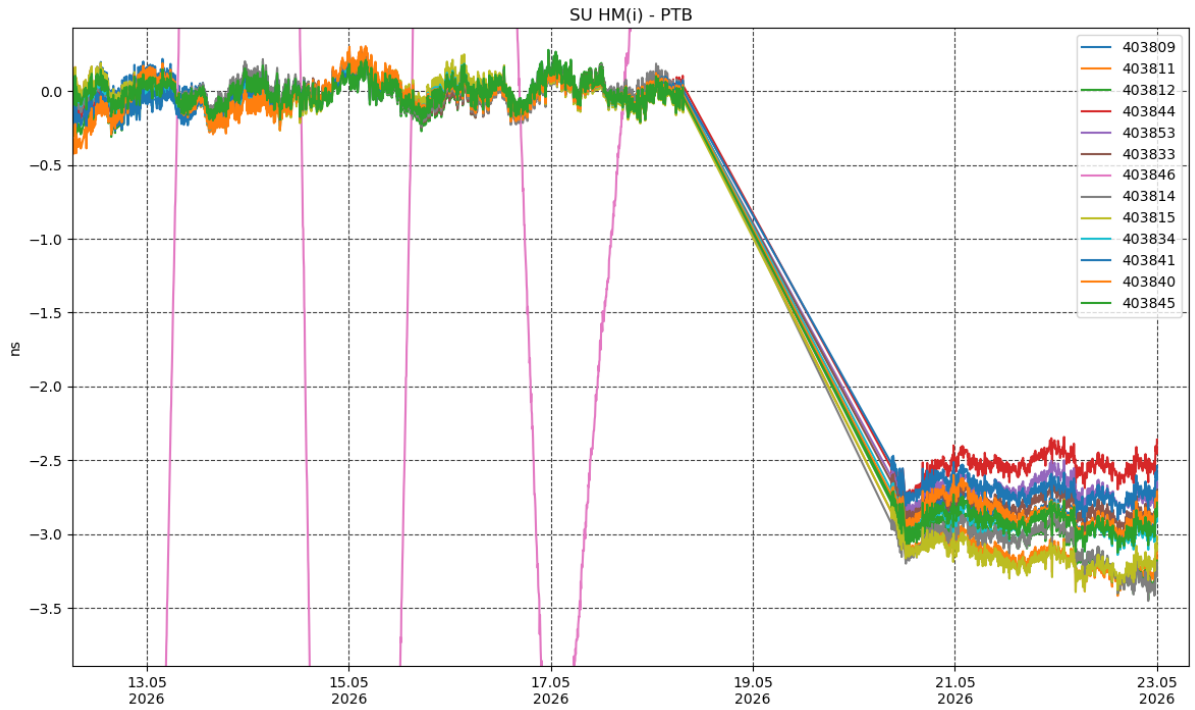


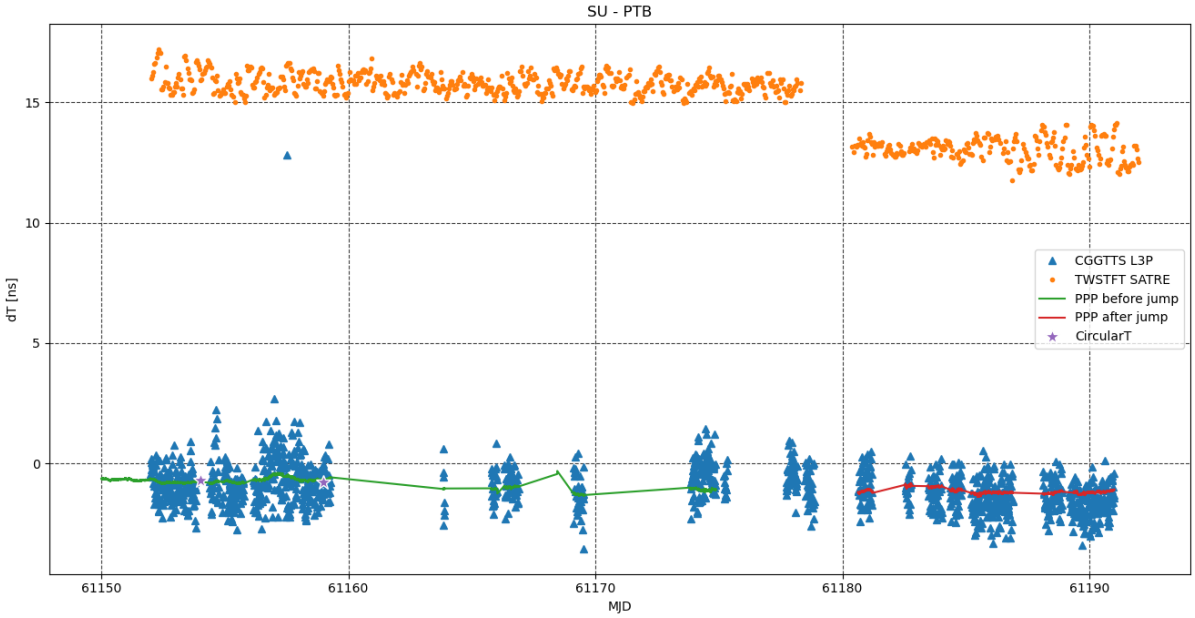
Figure 1 H maser comparison between VNIIFTRI and PTB before and after the link interruption.

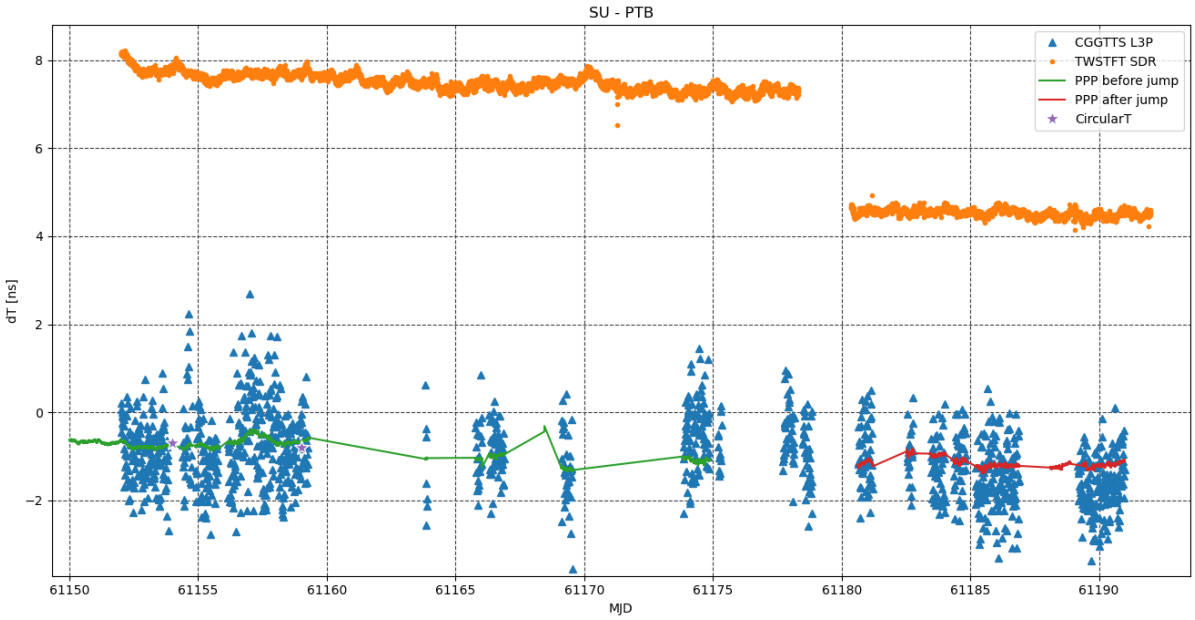
In order to reset any previous alignment estimates, and in the absence of previous calibration values, it has been decided to perform a calibration transfer from one of the available GNSS receivers to recover the calibration of the TW link, after the incident.

Data

All data acquisition and calculation have been performed by VNIIFTRI. SU52 receiver has been chosen because, in a difficult environment with very scarce availability of the GNSS signal, it

offered the best reliability. The two following plots represent the TW data (SATRE = SU01-PTB03, SDR = SU51-PTB53) compared to the SU52-PT13 GPS PPP link, without any calibration applied, before and after the gap on MJD 61180. P3 link has been observed as a comparison.





GNSS receivers used:

Lab	GNSS receiver
SU	SU52
PTB	PT13

RINEX delays applied (for PPP processing):

Receiver	Cal_ID	P1	P2	CAB	REF	P3 TOTAL
SU52	1001-2020	28.7	25.5	149.1	134.8	47.95
PT13	1001-2025	30.8	28.6	205.7	55.7	184.20

CGGTTS P3 delays applied: none

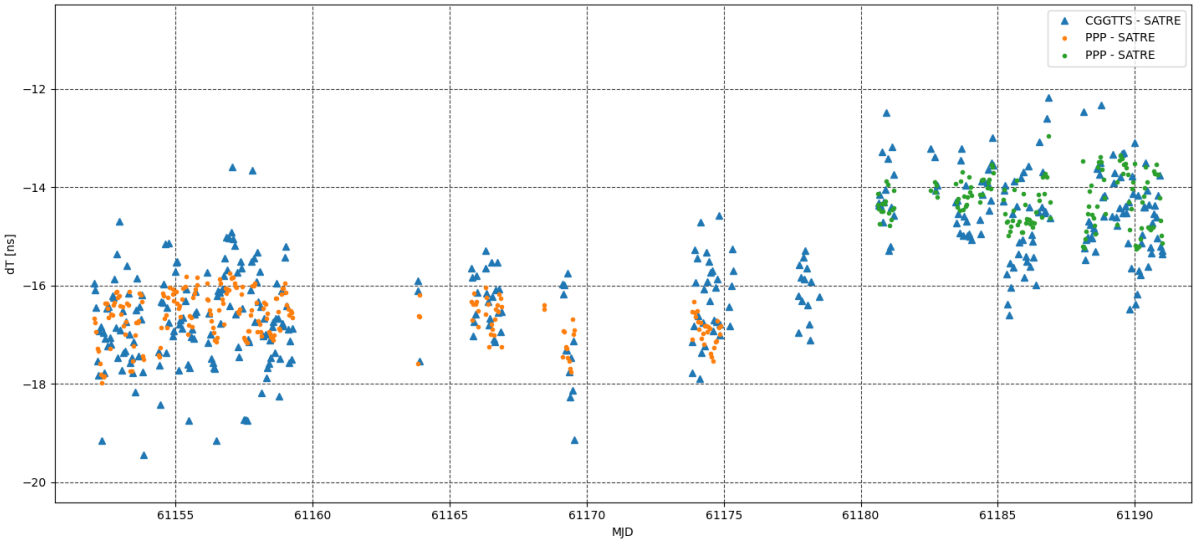
Calibration results (SDR):

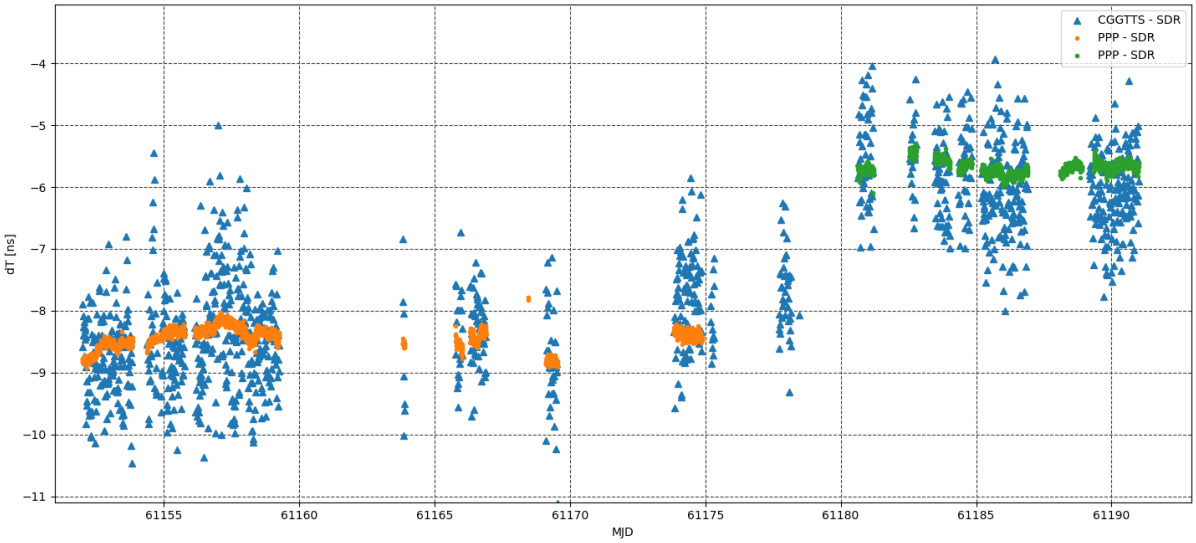
Method	Interval start, MJD	Interval end, MJD	CALR, ns
CGGTTS P3	61152.0	61178.4	-8.37
PPP	61152.0	61178.4	-8.44
CGGTTS P3	61180.5	61191.0	-5.92
PPP	61180.5	61191.0	-5.68

Calibration results (SATRE):

Method	Interval start, MJD	Interval end, MJD	CALR, ns
CGGTTS P3	61152.0	61178.4	-16.59
PPP	61152.0	61178.4	-16.65
CGGTTS P3	61180.5	61191.0	-14.47
PPP	61180.5	61191.0	-14.27

The two following plots represent the TW links with CALR values applied according to the measured difference at the previous step.





Uncertainty calculation

U_{a1} — Uncertainty of the RefDelay of SU01 TWSTFT station measurement;
U_{a2} — Random uncertainty of the SU01 TWSTFT measurements;
U_{b1} — Uncertainty of the SU52 GNSS receiver calibration;
U_{b2} — Uncertainty of the SU52 GNSS receiver calibration ageing (57 months since calibration);
U_{b3} — Uncertainty of the PT13 GNSS receiver calibration;
U_{b4} — Uncertainty of the PT13 GNSS receiver calibration ageing (10 months since calibration).
U : quadratic sum of the above-mentioned values

Uncertainty budget

	SDR	SATRE
U_{a1}	0.5	0.5
U_{a2}	0.15	0.5
U_{b1}	1.5	1.5
U_{b2}	2.02	2.02
U_{b3}	1.5	1.5
U_{b4}	0.24	0.24
U	**2.99**	**3.02**

Calibration values

The retained values, validity date, and the CI designated by the BIPM, are as follows

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* CAL    625 TYPE:  GPS          MJD: 61180 EST. UNCERT.:    3.100 ns
* CAL    626 TYPE:  GPS          MJD: 61180 EST. UNCERT.:    3.000 ns

LOC     REM     CI  S       CALR     ESDVAR  ESIG
SU01    PTB03   625 1    -14.270      0.000 0.000
PTB03   SU01    625 1     14.270      0.000 0.000
SU51    PTB53   626 1     -5.680      0.000 0.000
PTB53   SU51    626 1      5.680      0.000 0.000
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