G2 Calibration Report for NIST-CENAM-CENAMEP
Cal_Id 1011-2017

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Abstract

This report is a record of the calibration results of cn00, the site receiver of CENAM, and mp1_, the site receiver at CENAMEP using the NIST traveling receiver nb05. Four sets of data were collected between MJD57780-57895(January 27, 2017 and May 22, 2017) by simultaneous operation of a pair of co-located GNSS receivers. The purpose of this campaign was to measure the internal delay of the GPS receiver cn00 and mp1_ and thereby calibrating the links NIST and CENAM, and NIST and CENAMEP for time transfer applications between the labs. The calibration campaign was initiated by NIST in consultation with CENAM and CENAMEP for fulfilling the G2 responsibility as per the guidelines set by BIPM [2].

Contents

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1 List of Acronyms

Table 1: List of acronyms used in this report.

BIPM	Bureau International des Poids et Mesures, Sèvres, France
CCTF	Consultative Committee on Time and Frequency
CGGTTS	CCTF Global GNSS Time Transfer Standard format
CIPM	Comité International des Poids et Mesures
GNSS	Global Navigation Satellite System
ITRF	International Terrestrial Reference Frame
nb05	NIST-owned GPS traveling system
NIST	National Institute of Standards and Technology
nist	4-letter code of NIST's primary GPS receiver
CENAM	Centro Nacional de Metrologia
cn00	CENAM receiver that is to be calibrated
CENAMEP	El Centro Nacional de Metrología de Panamá
mp1_	CENAMEP receiver that is to be calibrated
PPS	Pulse per second
RINEX	Receiver Independent Exchange format
TIC	Time Interval Counter

2 Description of the traveling GNSS receiver

The NIST Traveling System consists of two enclosures containing a rack-mount GPS receiver unit (nb05), a choke-ring antenna and antenna cable, a laptop, a time interval counter and two auxiliary cables (RG223 with BNC connectors) to be used for measuring the REFDLY for the traveling receiver.

The GPS unit nb05 contains a dual-frequency, multi-channel Novatel OEMV Propak-V3 receiver and a NIST-built auxiliary board that conditions the 10MHz and PPS signals to the GPS receiver and measures the time difference between the PPS output and input to the receiver, as well as the time difference between the PPS and 10MHz input signals.

The Novatel GNSS pin-wheel antenna is connected to the receiver with a 50 m long FSJ-50A cable. An HP53132A time interval counter is also provided with nb05.

3 Results

The notation for various delays are consistent with that adopted in the BIPM guidelines[2]. A brief discussion of the various delays and their values for each pair (traveling- and station-receiver) are detailed next, followed by a discussion about computing raw difference of GPS code measurements.

3.1 Computing delays in the measurement setup

The difference of the total delay for a pair of co-located receivers is the sum of the delays incurred in the antenna cable(CABDLY) and the internal delay(INTDLY), minus the time offset at the latching point of the receiver as referenced to a fixed point, usually UTC(k)(REFDLY). The internal delay is comprised of both code- and frequency-dependent delays in the antenna and the receiver. After accounting for the baseline geometry, the difference in pseudoranges between a pair of receivers, say for P1, is given by

$$\mathrm{RAWDIF(P1)}_{\mathrm{A-B}} = \Delta\mathrm{CABDLY}_{\mathrm{A-B}} + \Delta\mathrm{INTDLY}_{\mathrm{A-B}} - \Delta\mathrm{REFDLY}_{\mathrm{A-B}}, \tag{1}$$

where $\mathrm{RAWDIF(P1)}_{\mathrm{A-B}}$ is the raw difference of pseudorange measurements of two receivers. Similarly for P2, $\mathrm{RAWDIF(P2)}_{\mathrm{A-B}}$ is given by using the corresponding set of delays on the right hand side of Eq.(1). The notation for the receivers A and B correspond to the traveling- and station-receiver. $\Delta\mathrm{CABDLY}_{\mathrm{A-B}}$ and $\Delta\mathrm{REFDLY}_{\mathrm{A-B}}$ for nb05(A) and cn00/nist (B) are given in table 2, referenced from Annex 1-3. The various delays used for nist are from the G1 campaign as described in [6].

nb05 setup has provisions to log the REFDLY (both X_{P} and X_{O}) and the procedure is outlined in the operating manual for nb05. Note that in table 2, we provide ΔCABDLY for L1 and L2 because for nb05 the values for CABDLY corresponding to L1 and L2 frequencies were determined separately at NIST. The difference between CABDLY for L1 and L2 are typically of the order of 0.5 ns or less. CABDLY for L1 and L2 are set to the same value if separate measurements are not made available. In Table 2, L1† may be used instead of L2 for calculating RAWDIF(P2), if L2 are not readily available. Similarly C1‡ indicates the values to be used with C1 from CGGTTS files.

Table 2: REFDLY differences between station and traveling receivers

Pair	MJD	Δ REFDLY(ns)	Δ CABDLY(ns)	
			L1	L2†
nb05-nist	57780-57784	393.53 ± 0.36	-69.90	-69.70
nb05-cn00/C1‡	57801-57804	2.30 ± 0.20	66.0	N/A
nb05-mp1_	57856-57861	6.8 ± 0.52	82.34	82.54
nb05-nist	57891-57895	393.54 ± 0.27	-69.90	-69.70

3.2 Computing raw difference of GPS psuedoranges

The RINEX files for a pair of co-located receivers during the data acquisition period, MJD column in table 2, are processed using a script provided by the BIPM which invokes a call to a fortran executable that solves the baseline between the phase centers of the two antennas from L1 and L2 phase differences[1, 4]. Subsequently, the P1 and P2 pseudorange differences are formed after accounting for the previously computed baseline. For both Novatel NIST station receiver(nist) and traveling receiver(nb05), the RINEX files were corrected for C1P1 bias[3].

The results are given in table 3. The values for ΔINTDLY between a given pair of receivers are computed using Eq.(1) and are given in table 4. IF the RINEX files are not made available a common view C1 difference of two receivers, with delays sets to zero, may be used to construct the raw difference (RAWDIF). This was the case for the CENAM part of the trip.

Table 3: Raw P1 and P2 differences between station and traveling receivers. The assigned uncertainties are the first minimum of the TDEV.

Pair	MJD	ΔP1/ΔC1(ns)	ΔP2(ns)
nb05-nist	57780-57784	-396.35 ± 0.10	-409.34 ± 0.10
nb05-cn00/C1	57801-57804	73.7 ± 0.70	N/A
nb05-mp1_	57856-57861	99.5 ± 0.10	89.77 ± 0.10
nb05-nist	57891-57895	-397.01 ± 0.20	-409.37 ± 0.40

Table 4: INTDLY for receiver(s)

Pair	ΔINTDLY(P1/C1)(ns)	ΔINTDLY(P2)(ns)
nb05-nist$\|_{\text{start}}$	67.08	54.09
nb05-cn00/C1	16.98	N/A
nb05-mp1_	23.96	14.23
nb05-nist$\|_{\text{end}}$	66.43	54.07
nb05-nist$\|_{\text{average}}$	66.75	54.08
cn00-nist$\|_{\text{average}}$/C1	49.85	N/A
mp1_-nist$\|_{\text{average}}$	42.79	39.85
MISCLOSURE(nb05-nist)	-0.64	0.02

We have assigned 0.1 ns for $\text{CABDLY}_{\text{nb05}}$ as it was measured fairly recently (less than a year). Similarly, a nominal uncertainty of 0.1 ns is assigned for $\text{CABDLY}_{\text{nist}}$ and $\text{CABDLY}_{\text{cn00}}$.

4 Uncertainty estimates

The overall uncertainty of the differential calibration is the uncertainty of the link between two points(labs) over the duration of the calibration. The uncertainties, both statistical and systematic, associated with the GPS constellation and the traveling-receiver drop out. Therefore for a link comprising a pair of locations(labs), say A and B, the total uncertainty is $u_{A-B} = \left(u_A^2 + u_B^2\right)^{1/2}$, where $u_x = \left(u_{x,a}^2 + u_{x,b}^2\right)^{1/2}$, $x \equiv A, B$. $u_{x,a}$ is the total statistical uncertainty that arise due to the fluctuations in the RAWDIF. We have assumed that the total statistical and systematic uncertainties are orthogonal to each other owing to statistical independence. The total uncertainty for each location are given at the end of tables 6 and 7.

The total systematic uncertainty,$u_{x,b}$ have components that are assumed to be statistically independent and hence orthogonal to each other. Therefore, $u_{x,b}$ is equal to the norm of the vector whose components are the various systematic uncertainties. Misclosure is added to the systematic uncertainty at the closure location (NIST). For the RAWDIF, the values for the uncertainty corresponds to the first minimum of TDEV rounded to nearest 0.1 ns. The final result of the link calibration is given in table 8.

Using the uncertainty estimates from tables 7 and 6 and applying it to the values computed in table 4 the results for ΔINTDLY(P1) and ΔINTDLY(P2) are summarized in table 8. Using the adopted values for the internal delays for nist from the latest BIPM calibration of NIST receiver[6] (also given in Annex

Table 5: Uncertainties for the common-clock, co-located measurements of nb05 at CENAM

quantity	uncertainty	C1(ns)
$\mathrm{RAWDIF}_{\mathrm{nb05-cn00}}$	u_a	0.70
nb05 antenna position	$u_{b,11}$	0.05
cn00 antenna position	$u_{b,12}$	0.05
nb05 multipath	$u_{b,13}$	0.20
cn00 multipath	$u_{b,14}$	0.20
$\mathrm{REFDLY}_{\mathrm{nb05}}$	$u_{b,21}$	0.10
$\mathrm{REFDLY}_{\mathrm{cn00}}$	$u_{b,22}$	0.10
$\mathrm{CABDLY}_{\mathrm{nb05}}$	$u_{b,31}$	0.10
$\mathrm{CABDLY}_{\mathrm{cn00}}$	$u_{b,32}$	0.10
$\Delta\mathrm{INTDLY}_{\mathrm{nb05-cn00}}$	u_{CENAM}	0.90

Table 6: Uncertainties for the common-clock, co-located measurements of nb05 at CENAMEP

<table>
<tr><th>quantity</th><th>uncertainty</th><th>P1(ns)</th><th>P2(ns)</th></tr>
<tr><td>$\mathrm{RAWDIF}_{\mathrm{nb05-mp1\_}}$</td><td>$u_a$</td><td>0.09</td><td>0.12</td></tr>
<tr><td>nb05 antenna position</td><td>$u_{b,11}$</td><td colspan="2">0.05</td></tr>
<tr><td>mp1_ antenna position</td><td>$u_{b,12}$</td><td colspan="2">0.05</td></tr>
<tr><td>nb05 multipath</td><td>$u_{b,13}$</td><td colspan="2">0.20</td></tr>
<tr><td>mp1_ multipath</td><td>$u_{b,14}$</td><td colspan="2">0.20</td></tr>
<tr><td>$\mathrm{REFDLY}_{\mathrm{nb05}}$</td><td>$u_{b,21}$</td><td colspan="2">0.13</td></tr>
<tr><td>$\mathrm{REFDLY}_{\mathrm{mp1\_}}$</td><td>$u_{b,22}$</td><td colspan="2">0.10</td></tr>
<tr><td>$\mathrm{CABDLY}_{\mathrm{nb05}}$</td><td>$u_{b,31}$</td><td colspan="2">0.10</td></tr>
<tr><td>$\mathrm{CABDLY}_{\mathrm{mp1\_}}$</td><td>$u_{b,32}$</td><td colspan="2">0.10</td></tr>
<tr><td>$\Delta\mathrm{INTDLY}_{\mathrm{nb05-mp1\_}}$</td><td>$u_{\mathrm{CENAMEP}}$</td><td>0.50</td><td>0.40</td></tr>
</table>

A for NIST) along with values from table 8, the inferred internal delays for cn00 are given in table 9.

We note the importance of adopting the right procedure for the REFDLY measurement for TTS-4 and perhaps even TTS-5 receivers[7]. The calibration result and its uncertainty for UTC are not affected as long as the receiver set-up doesn't change, even if the REFDLY is assigned incorrectly. This is because the REFDLY is not just the PPS delay from the reference point to the receiver input.

For nb05 at CENAM, it appears that the PPS-in and the reference frequency for nb05 were from asynchronous sources. As a consequence, we see a drift in C1 RAWDIF values as well as the RefDLY (X_O). The value $X_o = \mathrm{PPS}_{\mathrm{out}} - \mathrm{PPS}_{\mathrm{in}}$ for nb05 is measured every 100s and is used for compensating the bias in C1 RAWDIF. The mean of the static component of X_o for nb05 at CENAM is 15.8 ns. The corrected C1 RAWDIF is 73.7 ns, which is obtained by adding the fit values of X_o to the C1 RAWDIF. We have to use the fitted values as the time stamps for X_o and C1 RAWDIF do not match at all times.

Table 7: Uncertainties for the common-clock, co-located measurements of nb05 at NIST

quantity	uncertainty	P1(ns)		P2(ns)	
		begin	end	begin	end
$\mathrm{RAWDIF}_{\mathrm{nb05-nist}}$	u_a	0.10	0.20	0.10	0.40
nb05 antenna position	$\mathrm{u}_{b,11}$	0.05			
nist antenna position	$\mathrm{u}_{b,12}$	0.05			
nb05 multipath	$\mathrm{u}_{b,13}$	0.20			
nist multipath	$\mathrm{u}_{b,14}$	0.20			
$\mathrm{REFDLY}_{\mathrm{nb05}}$	$\mathrm{u}_{b,21}$	0.33	0.21	0.33	0.21
$\mathrm{REFDLY}_{\mathrm{nist}}$	$\mathrm{u}_{b,22}$	0.10	0.10	0.10	0.10
$\mathrm{CABDLY}_{\mathrm{nb05}}$	$\mathrm{u}_{b,31}$	0.10			
$\mathrm{CABDLY}_{\mathrm{nist}}$	$\mathrm{u}_{b,32}$	0.10			
$\Delta\mathrm{INTDLY}_{\mathrm{nb05-nist}}$		0.48	0.45	0.48	0.56
$\Delta\mathrm{INTDLY}_{\mathrm{nb05-nist}}\|_{\mathrm{max}}/\sqrt{2}$		0.34		0.38	
Misclosure/2	$\mathrm{u}_{b,1}$	-0.32		-0.01	
$\Delta\mathrm{INTDLY}_{\mathrm{nb05-nist}}$	$\mathrm{u}_{\mathrm{NIST}}$	0.50		0.40	

Table 8: ΔINTDLY for the two links

Pair	ΔINTDLY(P1/C1) (ns)	ΔINTDLY(P2) (ns)
cn00-nist/C1	49.8 ± 1.0	N/A
mp1_-nist	42.8 ± 0.7	39.8 ± 0.6

Table 9: Estimated INTDLY for the receivers

Rcvr	INTDLY(P1/C1) (ns)	INTDLY(P2) (ns)
cn00/C1	-22.8	N/A
mp1_	-30.0	-32.8

5 Secondary information

1. RAWDIF and TDev plots: Attached separately.
2. Annex A: Attached separately.
3. Data files: ftp//ftp.nist.gov/pub/pml/688gps/GNSS-Calibrations/

References

[1] ftp://ftp2.bipm.org/pub/tai/publication/gnss-calibration/doc-soft/

[2] ftp://ftp2.bipm.org/pub/tai/publication/gnss-calibration/guidelines/

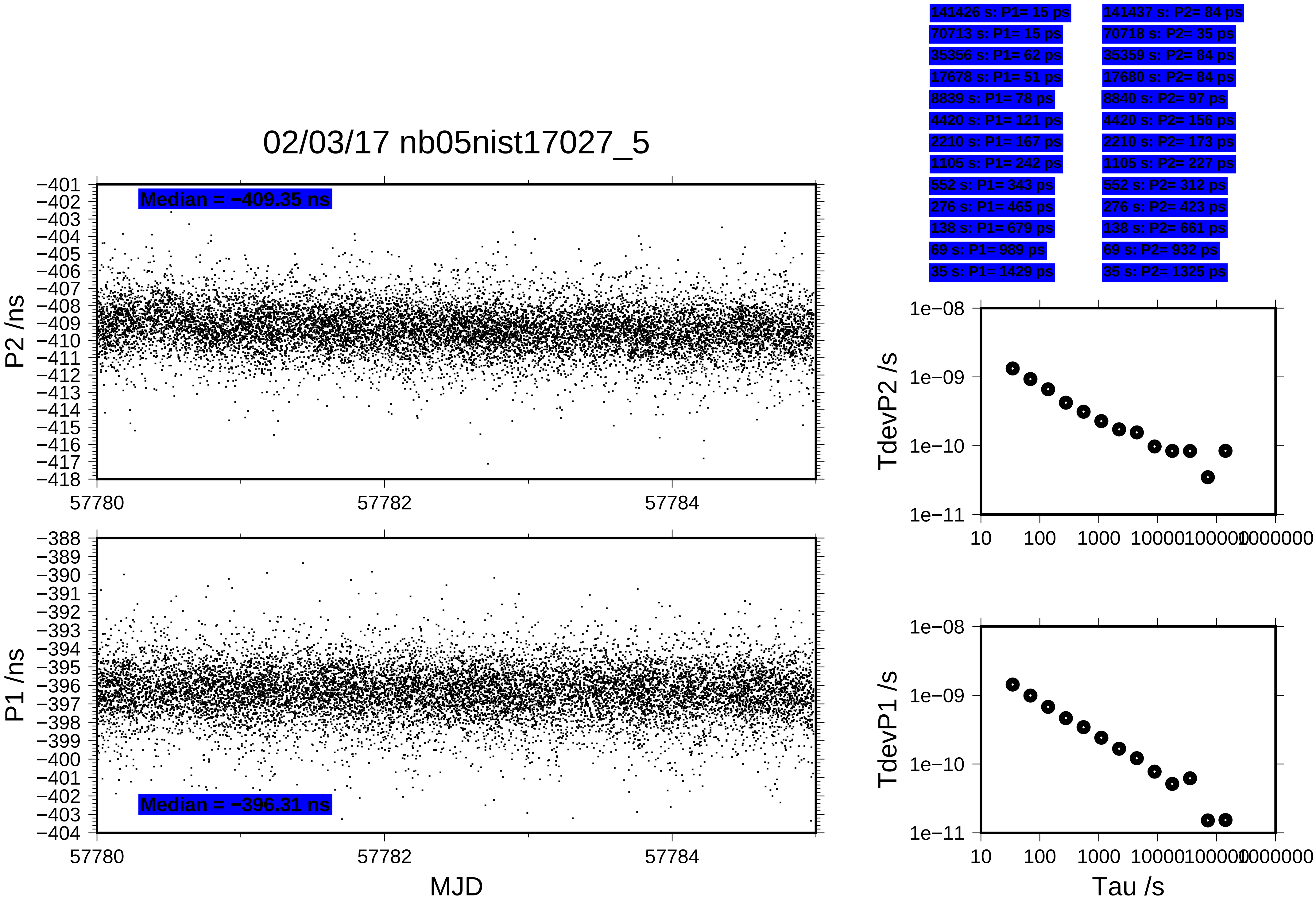
[3] ftp://dgn6.esoc.esa.int/CC2NONCC/

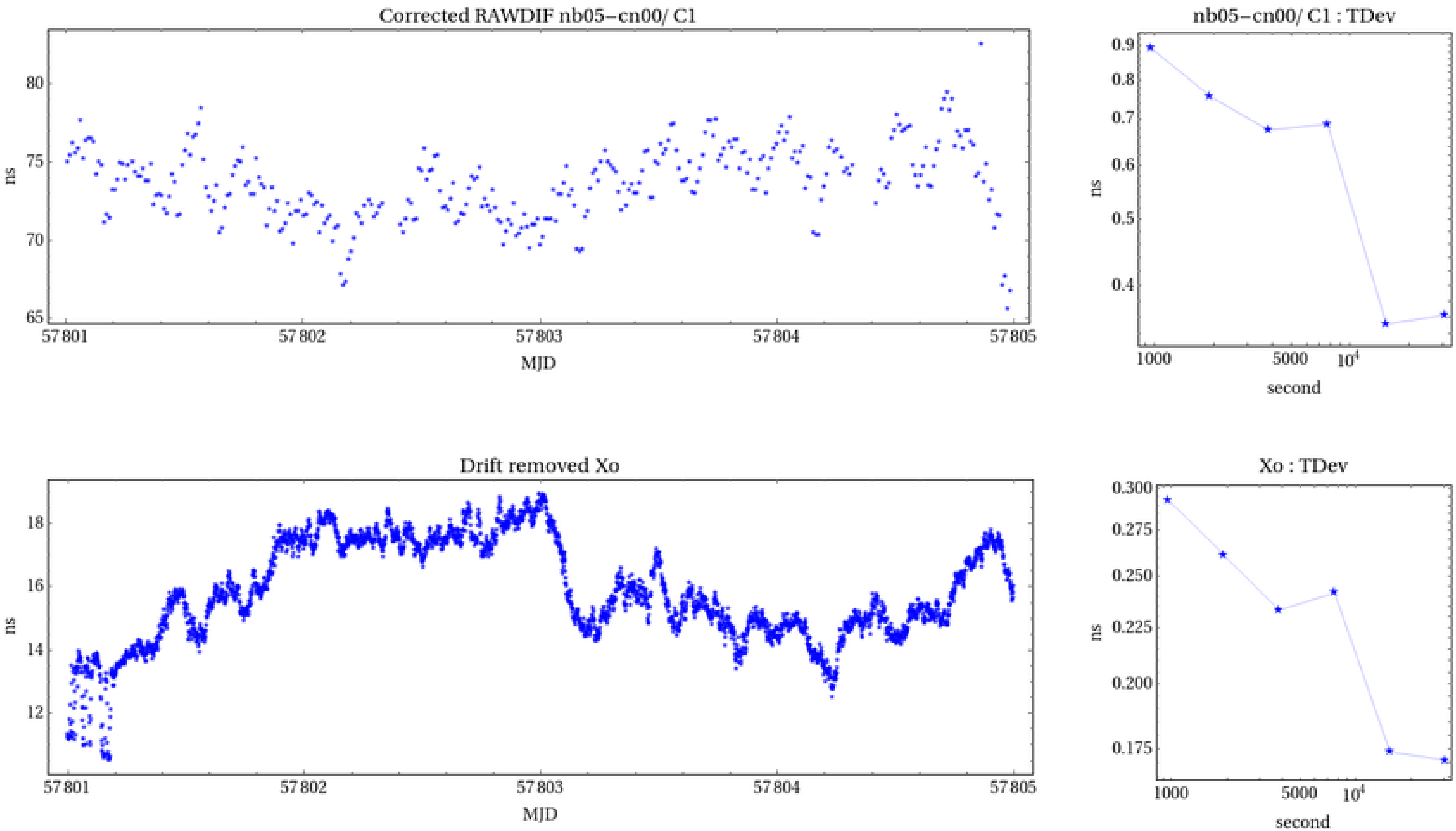
[4] http://www.bipm.org/wg/CCTF/WGGNSS/Allowed/BIPM_guidelines_V3/Annex-3_Computation-procedure-Rinex_V2.pdf

[5] P Defraigne and G Petit, Time transfer to TAI using geodetic receivers, Metrologia, vol. 40, no. 4, pp 184, 2003

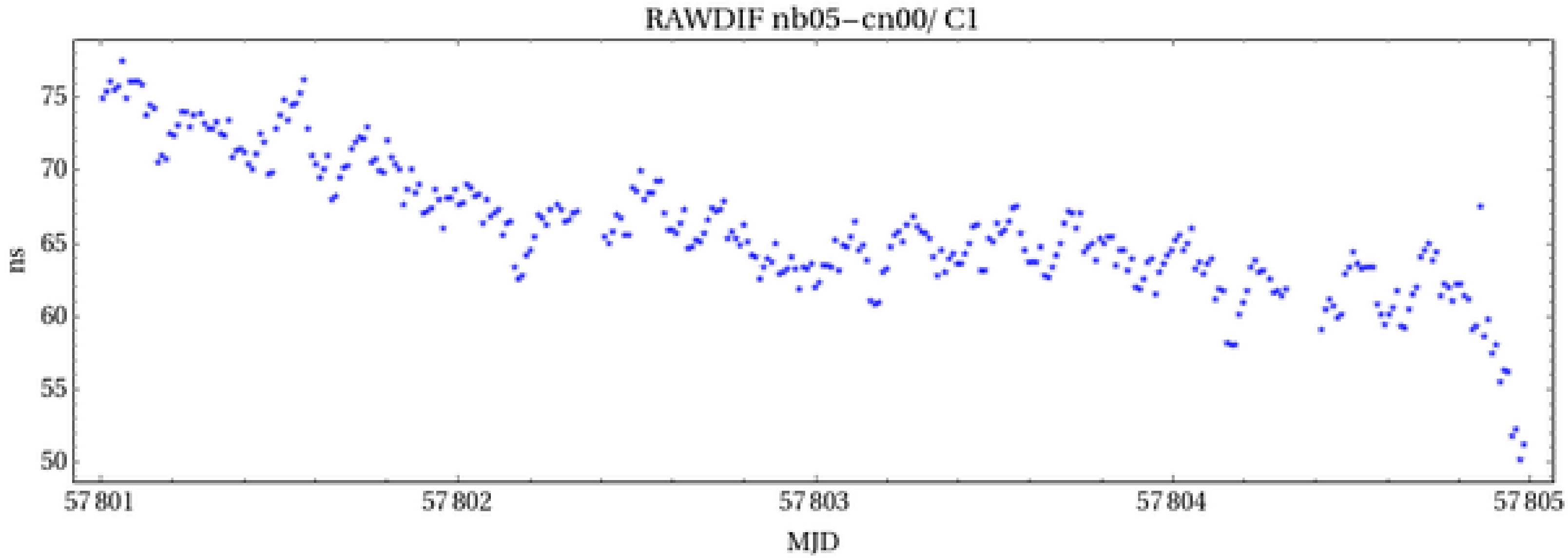
[6] ftp://ftp2.bipm.org/pub/tai/publication/gnss-calibration/group1/1001-2016/1001-2016-phase3-report.pdf

[7] ftp://ftp2.bipm.org/pub/tai/publication/gnss-calibration/guidelines/annex-1_operational-procedures-20190320.pdf

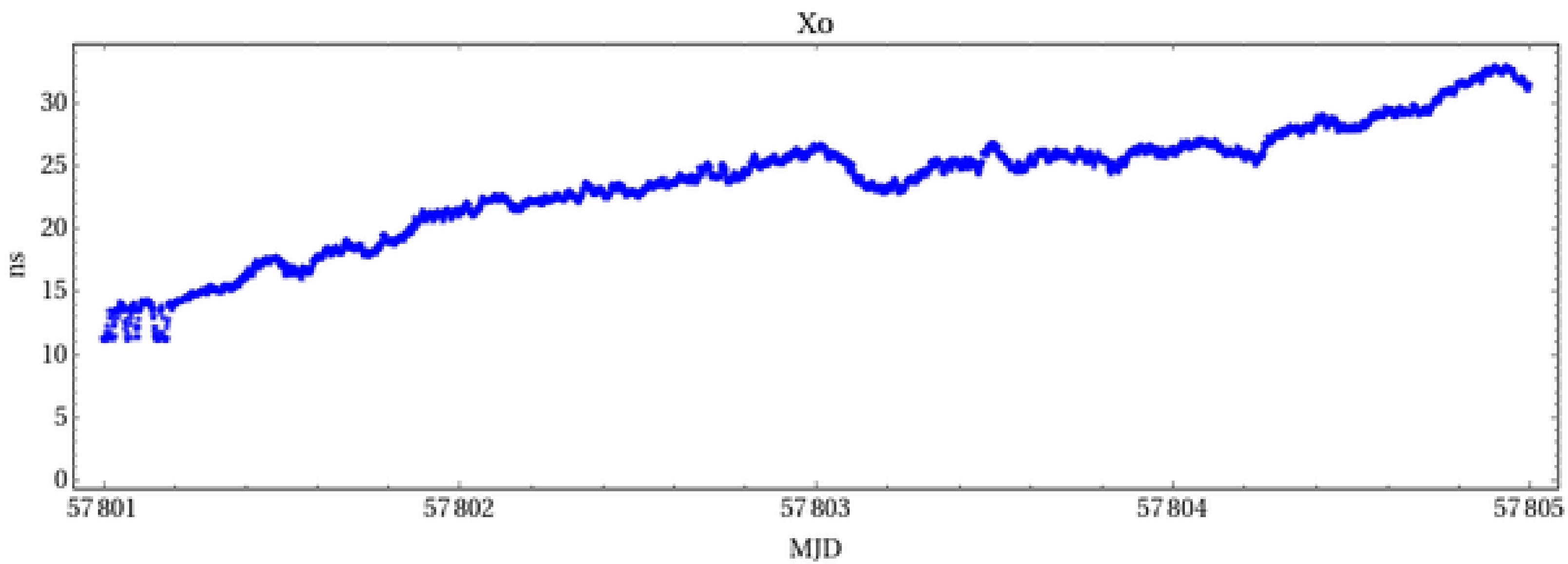

02/03/17 nb05nist17027_5
141426 s: P1= 15 ps
70713 s: P1= 15 ps
35356 s: P1= 62 ps
17678 s: P1= 51 ps
8839 s: P1= 78 ps
4420 s: P1= 121 ps
2210 s: P1= 167 ps
1105 s: P1= 242 ps
552 s: P1= 343 ps
276 s: P1= 465 ps
138 s: P1= 679 ps
69 s: P1= 989 ps
35 s: P1= 1429 ps
141437 s: P2= 84 ps
70718 s: P2= 35 ps
35359 s: P2= 84 ps
17680 s: P2= 84 ps
8840 s: P2= 97 ps
4420 s: P2= 156 ps
2210 s: P2= 173 ps
1105 s: P2= 227 ps
552 s: P2= 312 ps
276 s: P2= 423 ps
138 s: P2= 661 ps
69 s: P2= 932 ps
35 s: P2= 1325 ps
Median = −409.35 ns
P2 /ns
Median = −396.31 ns
P1 /ns
MJD
57780
57782
57784
TdevP2 /s
TdevP1 /s
Tau /s
1e−08
1e−09
1e−10
1e−11
10
100
1000
10000
100000
1000000



Corrected RAWDIF nb05−cn00/ C1
ns
80
75
70
65
57801
57802
57803
57804
57805
MJD
nb05−cn00/ C1 : TDev
ns
0.9
0.8
0.7
0.6
0.5
0.4
1000
5000
10^4
second
Drift removed Xo
ns
18
16
14
12
57801
57802
57803
57804
57805
MJD
Xo : TDev
ns
0.300
0.275
0.250
0.225
0.200
0.175
1000
5000
10^4
second



RAWDIF nb05−cn00/ C1
ns
75
70
65
60
55
50
57801
57802
57803
57804
57805
MJD

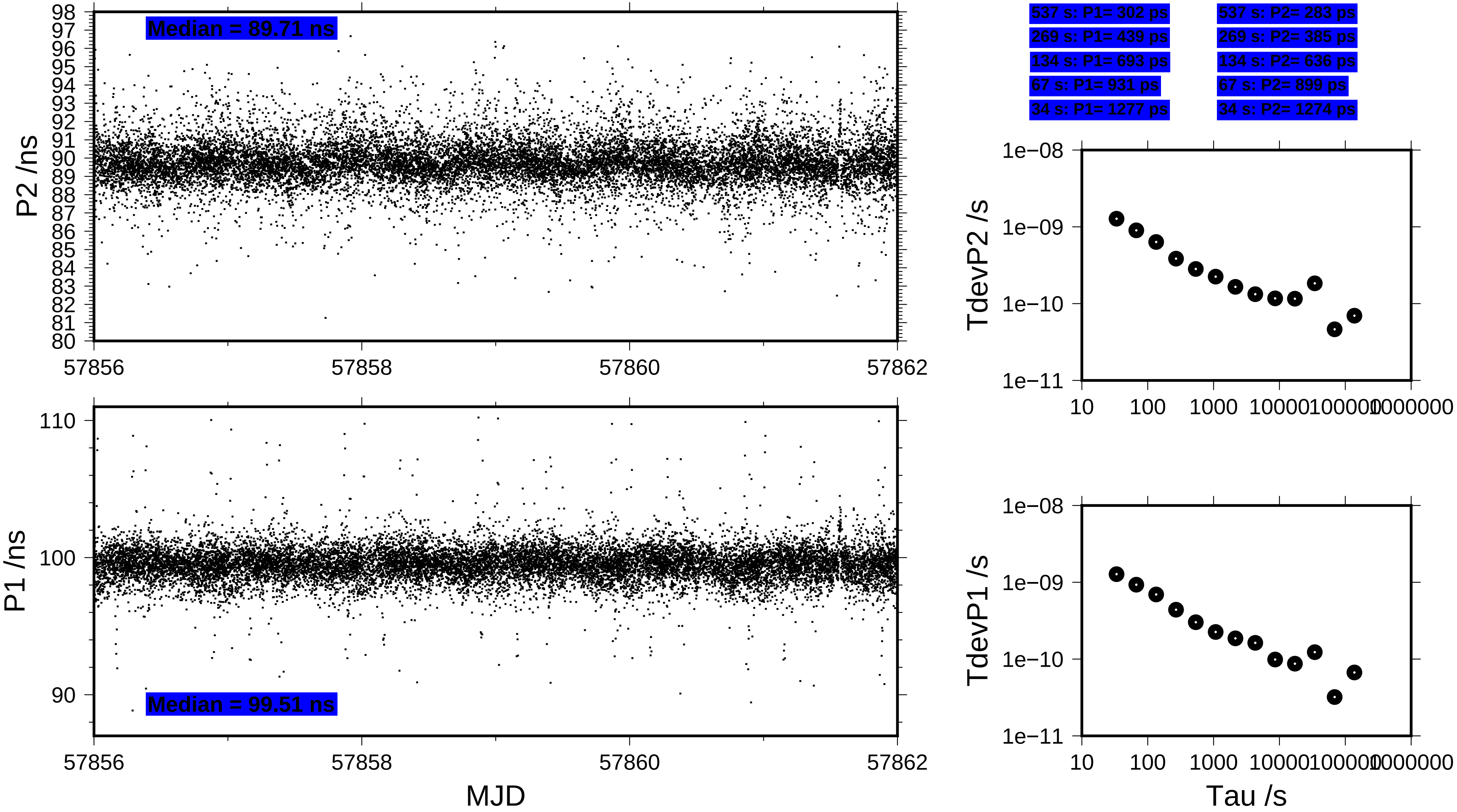


Xo
ns
30
25
20
15
10
5
0
57801
57802
57803
57804
57805
MJD

05/31/17 nb05cnmp17103_6

137596 s: P1= 67 ps
68798 s: P1= 32 ps
34399 s: P1= 123 ps
17199 s: P1= 87 ps
8600 s: P1= 99 ps
4300 s: P1= 163 ps
2150 s: P1= 186 ps
1075 s: P1= 226 ps
537 s: P1= 302 ps
269 s: P1= 439 ps
134 s: P1= 693 ps
67 s: P1= 931 ps
34 s: P1= 1277 ps

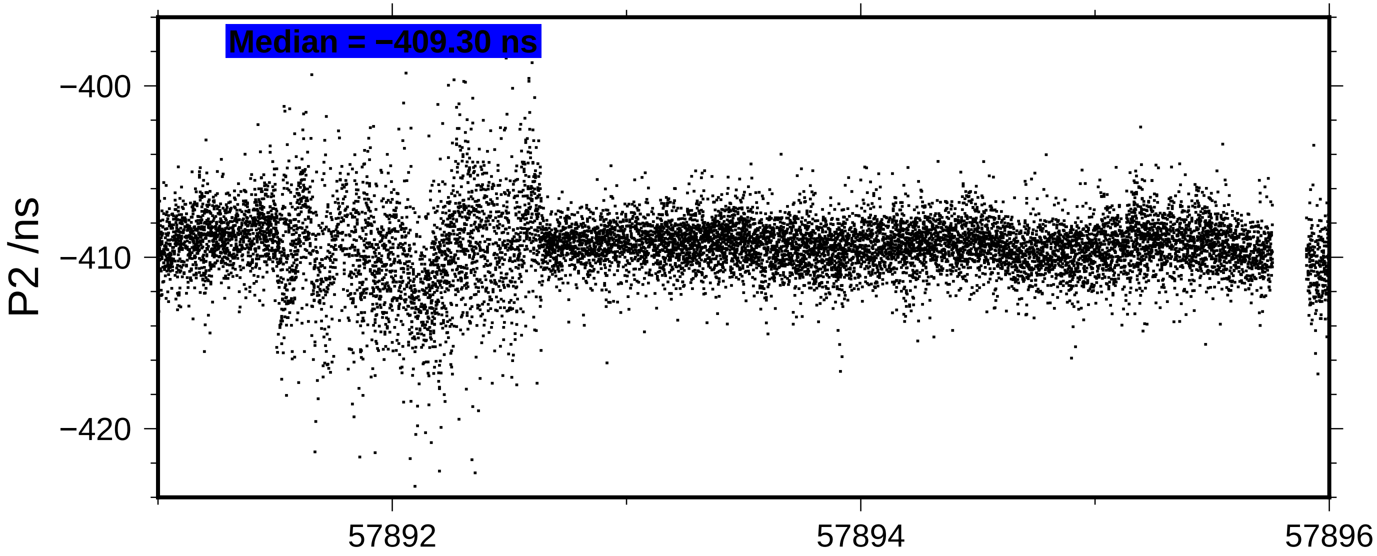
137596 s: P2= 70 ps
68798 s: P2= 46 ps
34399 s: P2= 184 ps
17199 s: P2= 116 ps
8600 s: P2= 117 ps
4300 s: P2= 133 ps
2150 s: P2= 165 ps
1075 s: P2= 225 ps
537 s: P2= 283 ps
269 s: P2= 385 ps
134 s: P2= 636 ps
67 s: P2= 899 ps
34 s: P2= 1274 ps

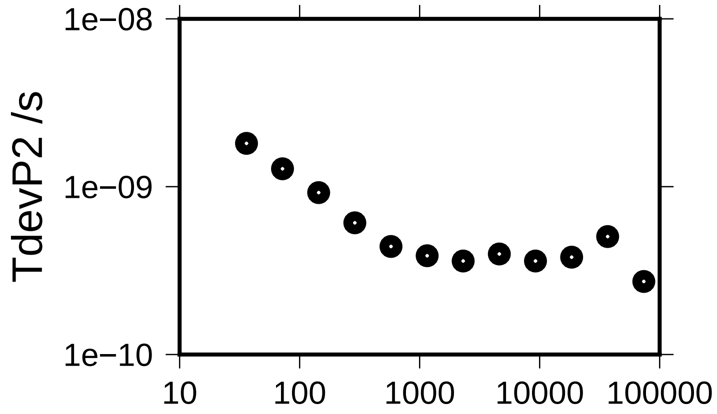


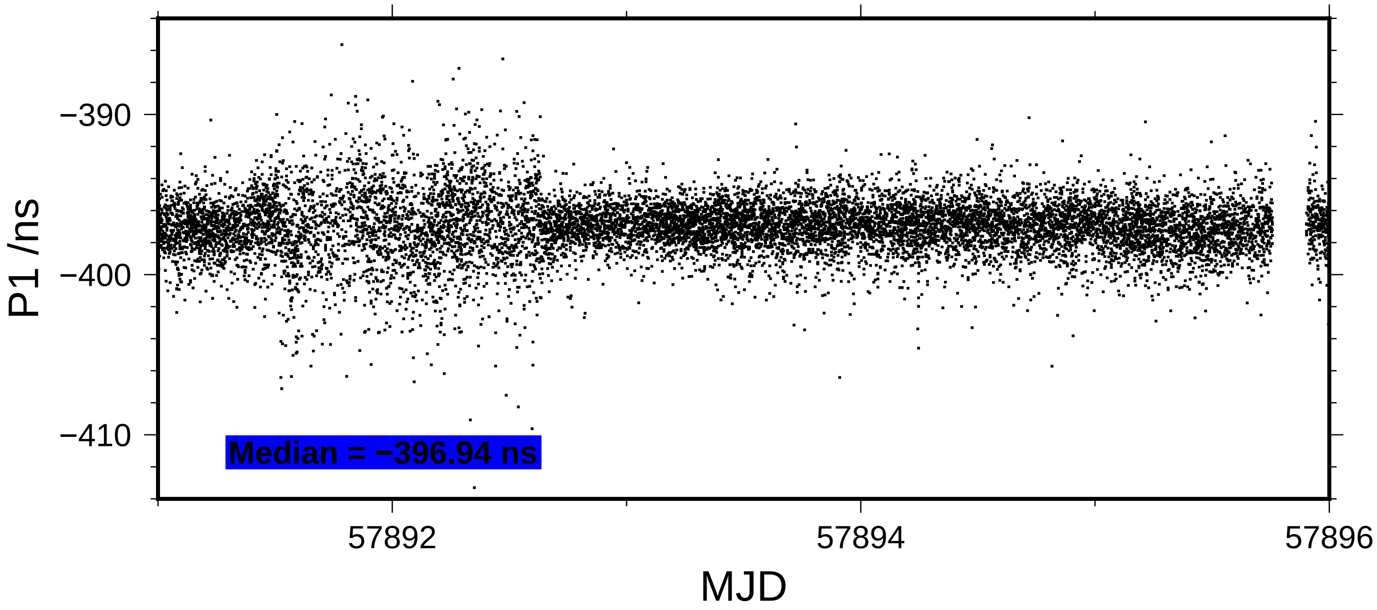
73751 s: P1= 71 ps
36875 s: P1= 78 ps
18438 s: P1= 216 ps
9219 s: P1= 220 ps
4609 s: P1= 243 ps
2305 s: P1= 248 ps
1152 s: P1= 318 ps
576 s: P1= 440 ps
288 s: P1= 636 ps
144 s: P1= 899 ps
72 s: P1= 1234 ps
36 s: P1= 1754 ps

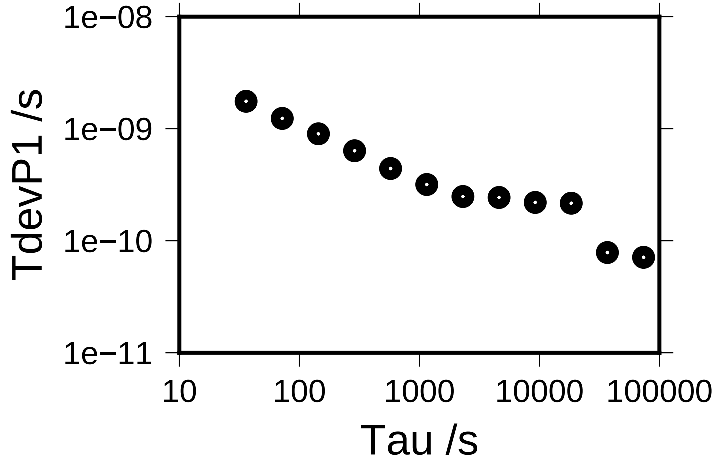
73824 s: P2= 272 ps
36912 s: P2= 504 ps
18456 s: P2= 380 ps
9228 s: P2= 361 ps
4614 s: P2= 397 ps
2307 s: P2= 361 ps
1154 s: P2= 387 ps
577 s: P2= 440 ps
288 s: P2= 610 ps
144 s: P2= 922 ps
72 s: P2= 1279 ps
36 s: P2= 1811 ps

05/31/17 nb05nist17138_5









Annex A - Information Sheet

Laboratory:	NIST
Date and hour of the beginning of measurements:	027, 2017, 00:30:00
Date and hour of the end of measurements:	031, 2017, 23:59:30

Information on the system

	Local:	**Travelling:**
4-character BIPM code	nist	nb05
• Receiver maker and type:	Novatel OEM4-G2	Novatel OEMV
Receiver serial number:		NAP11260003
1 PPS trigger level /V:	1.0	0.5
• Antenna cable maker and type:	Andrea FSJ-50A	Andrea FSJ-50A
Phase stabilised cable (Y/N):	N	N
Length outside the building /m:	65	25
• Antenna maker and type:	Novatel 702	Novatel GNSS 750
Antenna serial number:		NDE 10480003
Temperature (if stabilised) /°C		

Measured delays /ns

(if needed fill box “Additional Information” below)

	Local:	**Travelling:**
• Delay from local UTC to receiver 1 PPS-in, X_P	66.69 ± 0.02 *	465.41 ± 0.11
Delay from 1 PPS-in to internal Reference (if different), X_O	19.70 ± 0.10 *	14.51 ± 0.33
• Antenna cable delay, X_C	275.5	205.6 (L1), 205.8 (L2)
Splitter delay (if any)	N/A	N/A
Additional cable delay (if any)	N/A	N/A

Data used for the generation of CGGTTS files

• INT DLY (GPS) /ns:	-72.8 (P1), -72.3 (P2),-72.6(C1)
• INT DLY (GLONASS) /ns:	
• CAB DLY /ns:	275.5
• REF DLY /ns:	86.4
• Coordinates reference frame:	WGS84
Latitude or X /m:	-1288398.360
Longitude or Y /m:	-4721697.040
Height or Z /m:	4078625.500

General information

• Rise time of the local UTC pulse:	3 ns
• Is the laboratory air conditioned:	yes
Set temperature value and uncertainty:	
Set humidity value and uncertainty:	

* Dec 9, 2015

** averaged over measurement duration

*** 449.72 ± 0.08 added to 15.69 ± 0.14

Annex A - Information Sheet

Laboratory:	**CENAM**
Date and hour of the beginning of measurements	17 FEB 2017 00.00 UTC 57801 (MJD)
Date and hour of the end of measurements	24 FEB 2017 24.00 UTC 57808 (MJD)

Information on the system		
	Local	**Traveling**
4-character BIPM code	**CN00**	**nb05**
Receiver maker and type Receiver serial number	Piktime TTS-3 S/N 024 (AUG 2007)	Novatel OEMV S/N NAP11260003
1 PPS trigger level /V	0.5	0.5
Antenna cable maker and type Phase stabilized cable (Y/N)	Andrew FSJ-50A HELIAX N	Andrew FSJ-50A (cable T2) N
Length outside the building /m:	~ 30	50
Antenna maker and type Antenna serial number	Javad MarAnt+ MA#2847	Novatel GNSS 750 S/N NDE10480003
Temperature (if stabilized) /°C		

Measured delays /ns		
	Local	**Traveling**
Delay from local UTC to receiver 1 PPS-in (X_P)	25.3	11.77 ± 0.14
Delay from 1 PPS-in to internal Reference (if different)(X_O)	N/A	23.61± 1.78
Antenna cable delay (X_C)	146.50	205.6 (L1), 205.8 (L2)
Splitter delay (if any)	N/A	N/A
Additional cable delay (if any)	N/A	N/A

Data used for the generation of CGGTTS files	
INT DLY (or X_R+X_S) (GPS) /ns	-29.30
INT DLY (or X_R+X_S) (GLONASS) /ns	-118.30
CAB DLY (or X_C) /ns	146.50
REF DLY (or X_P+X_O) /ns	25.30
Coordinates reference frame	WGS84
X /m	-1064057.15
Y /m	-5881572.41
Z /m	+2224142.35

General information	
Rise time of the local UTC pulse	
Is the laboratory air conditioned	yes
Set temperature value and uncertainty	22±0.2 ºC
Set humidity value and uncertainty	35±1

Annex A - Information Sheet

Laboratory:	CENAMEP
Date and hour of the beginning of measurements:	103, 2017, 00:30:00
Date and hour of the end of measurements:	108, 2017, 23:59:30

Information on the system

	Local:	Travelling:
4-character BIPM code	mp1_	nb05
• Receiver maker and type:	PIK Time TTS-5	Novatel OEMV
Receiver serial number:	1003	NAP11260003
1 PPS trigger level /V:	0.5	0.5
• Antenna cable maker and type:	Andrea FSJ-50A	Andrea FSJ-50A
Phase stabilised cable (Y/N):	N	N
Length outside the building /m:	7	25
• Antenna maker and type:	Javad choke ring	Novatel GNSS 750
Antenna serial number:	00647	NDE 10480003
Temperature (if stabilised) /°C	N	N

Measured delays /ns

(if needed fill box "Additional Information" below)

	Local:	Travelling:
• Delay from local UTC to receiver 1 PPS-in, X_P	50.6	47.15 ± 0.13
Delay from 1 PPS-in to internal Reference (if different), X_O	N/A	10.25± 0.04
• Antenna cable delay, X_C	123.26	205.6 (L1), 205.8(L2)
Splitter delay (if any)	N/A	N/A
Additional cable delay (if any)	N/A	N/A

Data used for the generation of CGGTTS files

• INT DLY (GPS) /ns:	
• INT DLY (GLONASS) /ns:	
• CAB DLY /ns:	
• REF DLY /ns:	
• Coordinates reference frame:	
Latitude or X /m:	
Longitude or Y /m:	
Height or Z /m:	

General information

• Rise time of the local UTC pulse:	5 ns
• Is the laboratory air conditioned:	yes
Set temperature value and uncertainty:	23 °C ± 3 °C
Set humidity value and uncertainty:	55%RH ± 25%RH

Annex A - Information Sheet

Laboratory:	NIST
Date and hour of the beginning of measurements:	138, 2017, 00:30:00
Date and hour of the end of measurements:	142, 2017, 23:59:30

Information on the system

	Local:	Travelling:
4-character BIPM code	nist	nb05
• Receiver maker and type:	Novatel OEM4-G2	Novatel OEMV
Receiver serial number:		NAP11260003
1 PPS trigger level /V:	1.0	0.5
• Antenna cable maker and type:	Andrea FSJ-50A	Andrea FSJ-50A
Phase stabilised cable (Y/N):	N	N
Length outside the building /m:	65	25
• Antenna maker and type:	Novatel 702	Novatel GNSS 750
Antenna serial number:		NDE 10480003
Temperature (if stabilised) /°C		

Measured delays /ns

(if needed fill box "Additional Information" below)

	Local:	Travelling:
• Delay from local UTC to receiver 1 PPS-in, X_P	66.69 ± 0.02 *	465.36 ± 0.13
Delay from 1 PPS-in to internal Reference (if different), X_O	19.70 ± 0.10 *	14.57± 0.21
• Antenna cable delay, X_C	275.5	205.6 (L1), 205.8 (L2)
Splitter delay (if any)	N/A	N/A
Additional cable delay (if any)	N/A	N/A

Data used for the generation of CGGTTS files

• INT DLY (GPS) /ns:	-72.8 (P1), -72.3 (P2),-72.6(C1)
• INT DLY (GLONASS) /ns:	
• CAB DLY /ns:	275.5
• REF DLY /ns:	86.4
• Coordinates reference frame:	WGS84
Latitude or X /m:	-1288398.360
Longitude or Y /m:	-4721697.040
Height or Z /m:	4078625.500

General information

• Rise time of the local UTC pulse:	3 ns
• Is the laboratory air conditioned:	yes
Set temperature value and uncertainty:	
Set humidity value and uncertainty:	

* Dec 9, 2015

** averaged over measurement duration

*** 449.72 ± 0.08 added to 15.64 ± 0.17