Report on Receivers Delays

(on recent changes by NPLI during March 2018)

1. **Receiver Delays before the changes made by NPLI:** NPLI have been sending the data of two receivers, LITI and LITF to BIPM for more than five years till date. Table-1 shows the delays in these receivers before the configuration changes were made. The delays shown in the Table-1 are entered at the time of installation of LITI and LITF. The delays in LITI receiver were entered based on information received from manufacturer. For LITF receiver, only C1 delay were provided by the manufacturer. As P1 and P2 internal delay cannot be zero, they were assigned the same value of delay as C1. As mentioned in Table-1, no "receiver input to output delay" (X_O) was incorporated for these two receivers.

Table-1 NPLI GNSS Rx configuration delays till March 10, 2018

S. N.	Receiver Name	Receiver Delays (ns)						
		RefDelay			Cable Delay	IntDelay		
		UTC(NPLI) to Receiver Input#X_P	Receiver Input to Output#X_O	Total Delay $X_P + X_O$	X_C	C1#X_S + X_R	P1#X_S + X_R	P2#X_S + X_R
1	PolaRx3eTR PRO(NPLI), LITI	109.8	0.0	109.8	150.0	See Note 1	-125.0	-113.0
2	TTS4, LITF	115.5	0.0	115.5	142.2	-14.96	-14.96	-14.96

Note 1:, No option to enter C1 delay in PolaRx3eTR, RxTools v16.2.0 and previous versions. The receiver generates CGGTSS files only for P3.

2. **Present Receiver Delays:**

Table-2 NPLI GNSS Rx configuration delays since March 10, 2018

S. N.	Receiver Name	Receiver Delays (ns)						
		RefDelay			Cable Delay	IntDelay		
		UTC(NPLI) to Receiver Input#X_P	Receiver Input to Output# X_O	Total Delay $X_P + X_O$	X_C	C1#X_S + X_R	P1#X_S + X_R	P2#X_S + X_R
1	PolaRx3eTR PRO(NPLI), LITI	96.1	188.0	284.1	150.0	59.8	59.8	63.0
2	TTS4, LITF	96.5	-6.4	90.1	142.2	-14.96	-14.96	-14.96
3	GTR51A, LIAA	96.5	0.0	96.5	132.9	-23	-25.9	-26.9
4	GTR51B, LIAB	96.7	0.0	96.7	132.2	-21.5	-26.1	-29.5
5	PolaRx4TR PRO, LIAF	96.8	150.3	247.1	168.9	0.0	0.0	0.0

a) The reference delays of LITI and LITF were changed as shown in Table-2 on March 10, 2018. The "receiver input to output delay" (X_0) of LITI and LITF were also incorporated as shown in Table-2 as per BIPM guidelines.
b) Three more receivers LIAA, LIAB and LIAF were commissioned by NPLI recently.
c) The LIAA was pre-calibrated by the UFE as per the report at Annexure-1. The calibrated values of internal delays of LIAA are as shown in Table-2**.**
d) The internal delay of LITI changed to new value as shown in Table-2 on the differential calibration w.r.t. LIAA.
e) LIAB was also pre calibrated as shown in Appendix-2 by UFE and the calibrated values of internal delays of LIAB are as shown in Table-2.
f) For LIAF, no internal delay values were received from the manufacturer and we used the default value of internal delay as shown in Table-2.
g) On March 10, 2018 reference cables and distribution amplifiers were replaced, resulting in new values of Ref delay Xp, which are shown Table-2. The measured "receiver input to output" (Xo) is as per Table-2.

Annexure-1

ÚFE Institute of Photonics and Electronics
The Czech Academy of Sciences

Calibration Report No. 2003-2017/UFE

Laboratory of the National Time and Frequency Standard
(Designated Institute of the Czech Metrology Institute)

Instrument:	Name:	**GNSS Time Transfer Receiver**
	Type:	GTR 51
	SN:	1704141
Antenna:	Type:	NOV-703-GGG
	SN:	NEG17070062
Antenna Cable:	Type:	Belden 50Ω LOW LOSS H155 PVC
	Length:	30 m
Reference:	Signal:	1 PPS and 10 MHz signals of UTC(TP) generated from the Cesium clock 5071A SN 1227
	Receiver:	GPS Time Transfer Receiver GTR 50, SN 002, calibrated by BIPM
Measurement Date:		14 May 2017, 00:00:00–23:59:59 UTC

Measurement Results:

1. Internal Receiver Delays:

GPS L1 C/A:	(-23.0 ± 0.5) ns
GPS L1P:	(-25.9 ± 1.0) ns
GPS L2P:	(-26.9 ± 1.0) ns

Measurement performed by: Alexander Kuna, Ph.D.

Attachment: Graphs with measured values.

Prague, 15 May 2017

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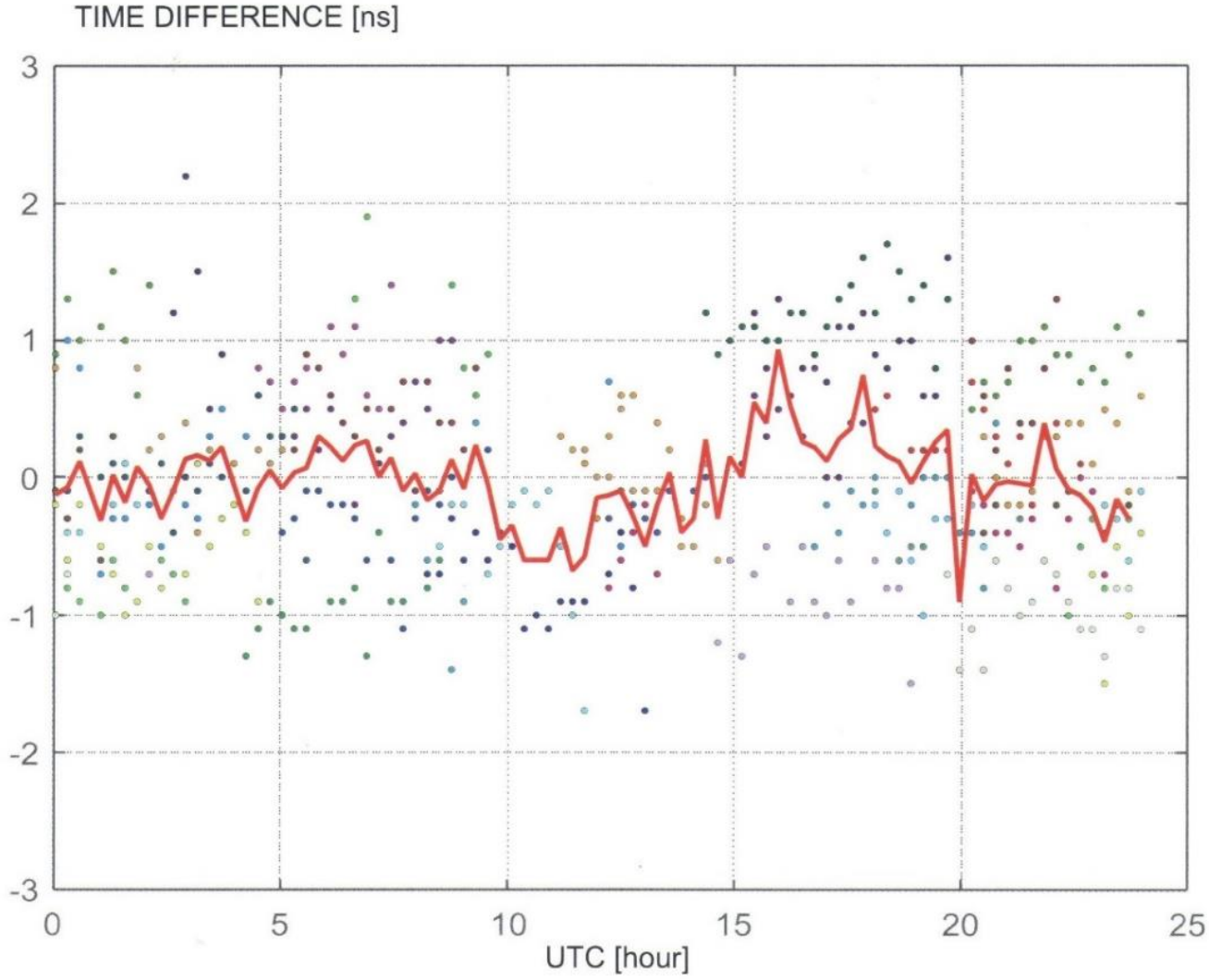
TEST MEASUREMENT

TESTED RECEIVER: GTR51 S/N 1704141
ANTENNA: NOV-703-GGG S/N NEG17070062
REFERENCE RECEIVER: GTR50 S/N: 002

DATE: 2017-05-14
SITE: PRAGUE
BASELINE: 8 m
SATELLITES: ALL IN VIEW
OUTPUT DATA: **CGGTTS**

SIGMA = 290 ps



POINTS = TRACKS
COLOR = SATELLITE

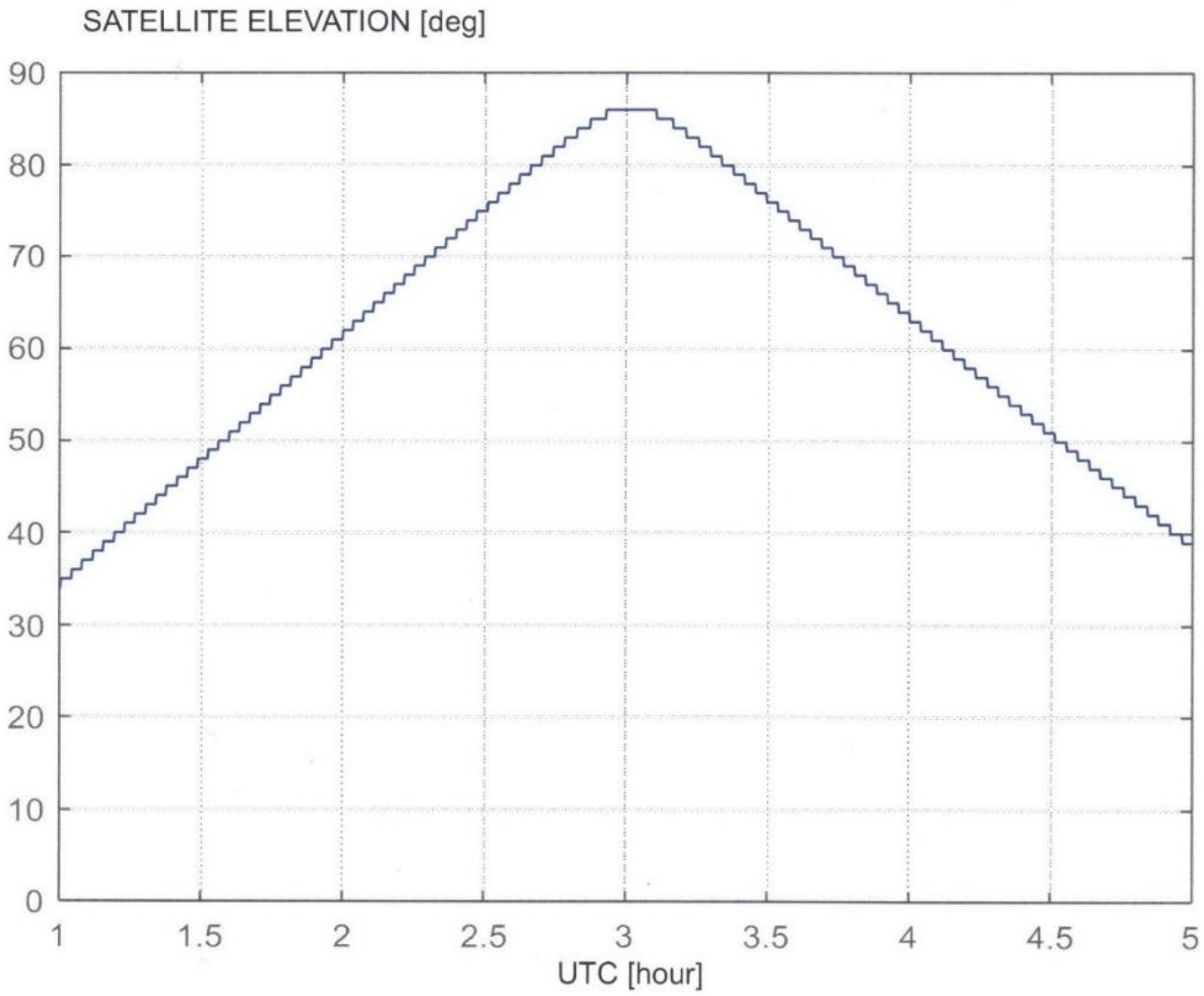
RED LINE = AVERAGE OVER ALL SATELLITES IN VIEW

TEST MEASUREMENT

TESTED RECEIVER: GTR51 S/N 1704141
ANTENNA: NOV-703-GGG S/N NEG17070062
REFERENCE RECEIVER: GTR50 S/N: 002

DATE: 2017-05-14
SITE: PRAGUE
BASELINE: 8 m
SATELLITE: PRN 09
OUTPUT DATA: **RAW**

SATELLITE ELEVATION



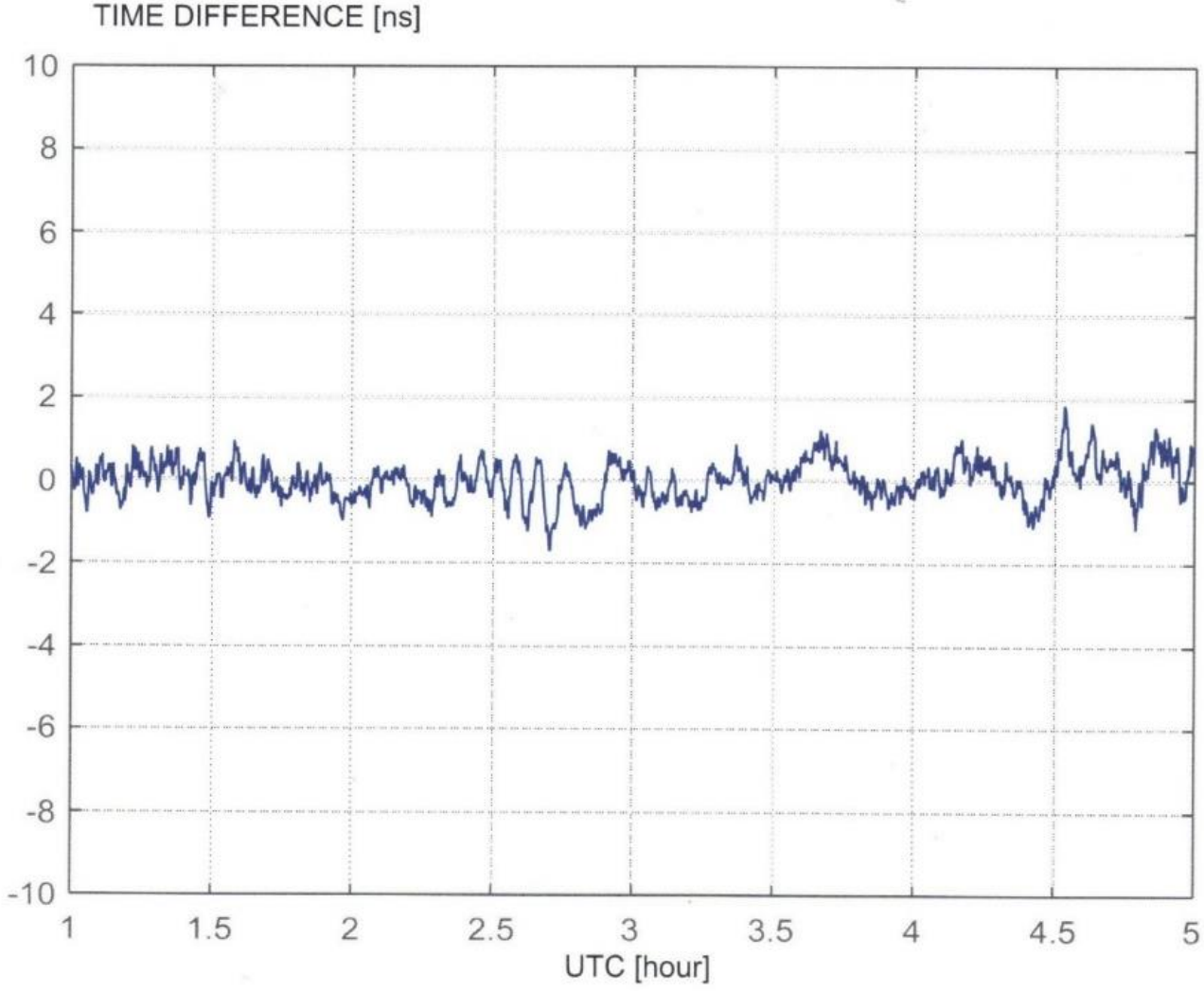
TEST MEASUREMENT

TESTED RECEIVER: GTR51 S/N 1704141
ANTENNA: NOV-703-GGG S/N NEG17070062
REFERENCE RECEIVER: GTR50 S/N: 002

DATE: 2017-05-14
SITE: PRAGUE
BASELINE: 8 m
SATELLITE: PRN 09
OUTPUT DATA: **RAW**

CODE MEASUREMENT

SIGMA = 0.5 ns



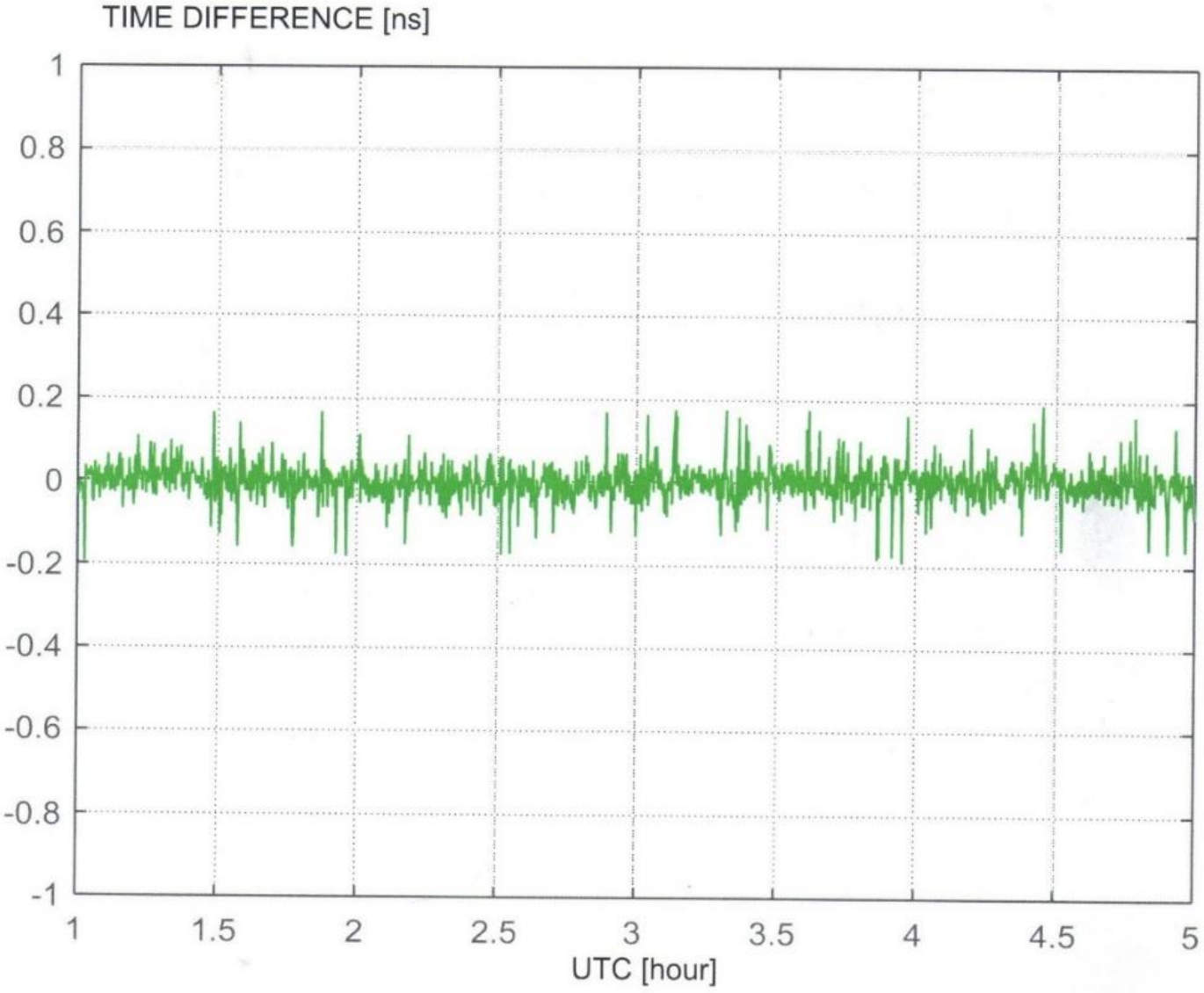
TEST MEASUREMENT

TESTED RECEIVER: GTR51 S/N 1704141
ANTENNA: NOV-703-GGG S/N NEG17070062
REFERENCE RECEIVER: GTR50 S/N: 002

DATE: 2017-05-14
SITE: PRAGUE
BASELINE: 8 m
SATELLITE: PRN 09
OUTPUT DATA: **RAW**

PHASE MEASUREMENT

SIGMA = 48 ps



Annexure-2

ÚFE Institute of Photonics and Electronics
The Czech Academy of Sciences

Calibration Report No. 2004-2017/UFE

Laboratory of the National Time and Frequency Standard
(Designated Institute of the Czech Metrology Institute)

Instrument:	Name:	**GNSS Time Transfer Receiver**
	Type:	GTR 51
	SN:	1704142
Antenna:	Type:	NOV-703-GGG
	SN:	NEG17130019
Antenna Cable:	Type:	Belden 50Ω LOW LOSS H155 PVC
	Length:	30 m
Reference:	Signal:	1 PPS and 10 MHz signals of UTC(TP) generated from the Cesium clock 5071A SN 1227
	Receiver:	GPS Time Transfer Receiver GTR 50, SN 002, calibrated by BIPM
Measurement Date:		17 May 2017, 00:00:00–23:59:59 UTC

Measurement Results:

Internal Receiver Delays:

GPS L1 C/A:	(-21.5 ± 0.5) ns
GPS L1P:	(-26.1 ± 1.0) ns
GPS L2P:	(-29.5 ± 1.0) ns

Measurement performed by: Alexander Kuna, Ph.D.

Attachment: Graphs with measured values.

Prague, 18 May 2017

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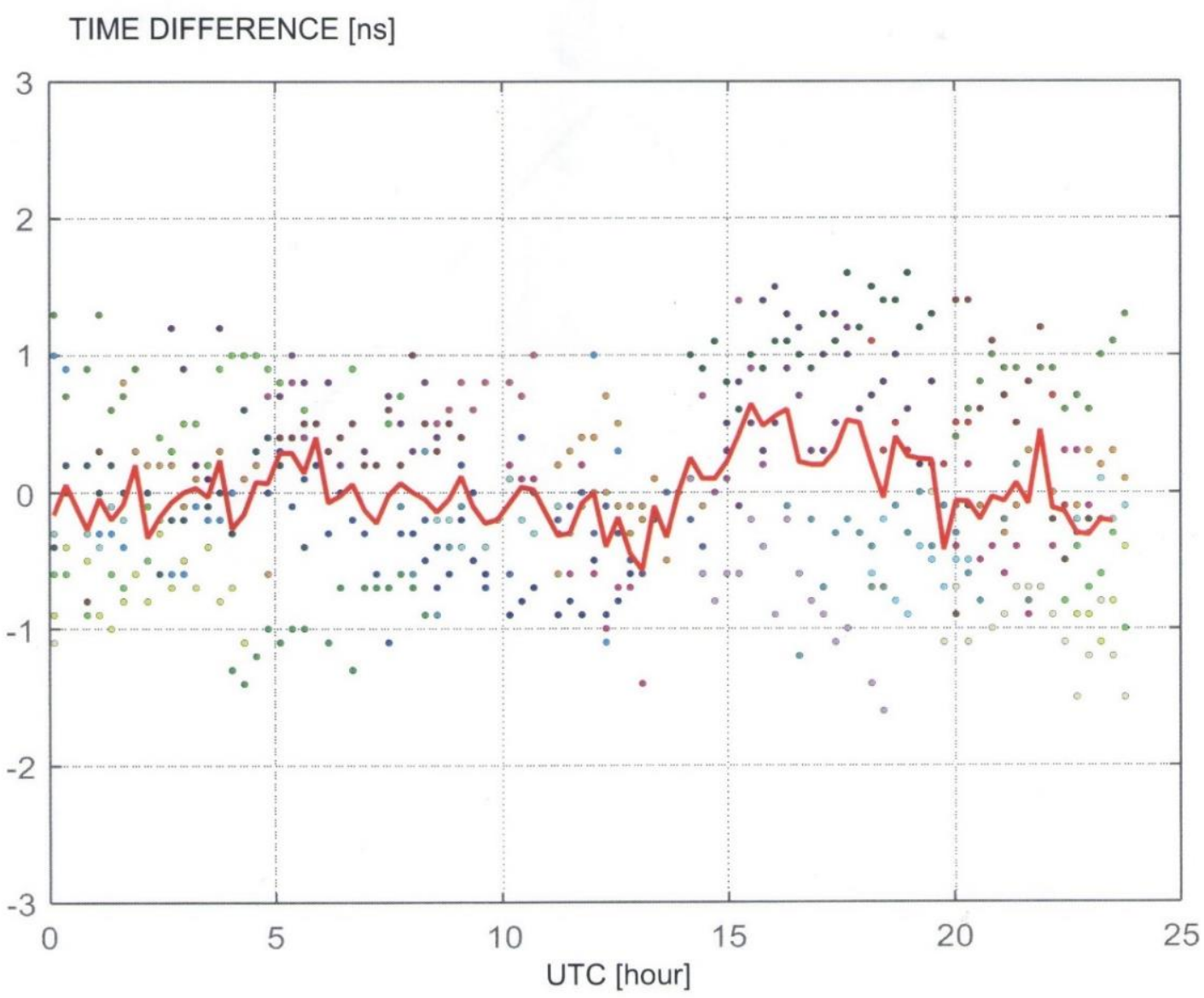
TEST MEASUREMENT

TESTED RECEIVER: GTR51 S/N 1704142
ANTENNA: NOV-703-GGG S/N NEG17130019
REFERENCE RECEIVER: GTR50 S/N: 002

DATE: 2017-05-17
SITE: PRAGUE
BASELINE: 8 m
SATELLITES: ALL IN VIEW
OUTPUT DATA: **CGGTTS**

SIGMA = 260 ps



POINTS = TRACKS
COLOR = SATELLITE

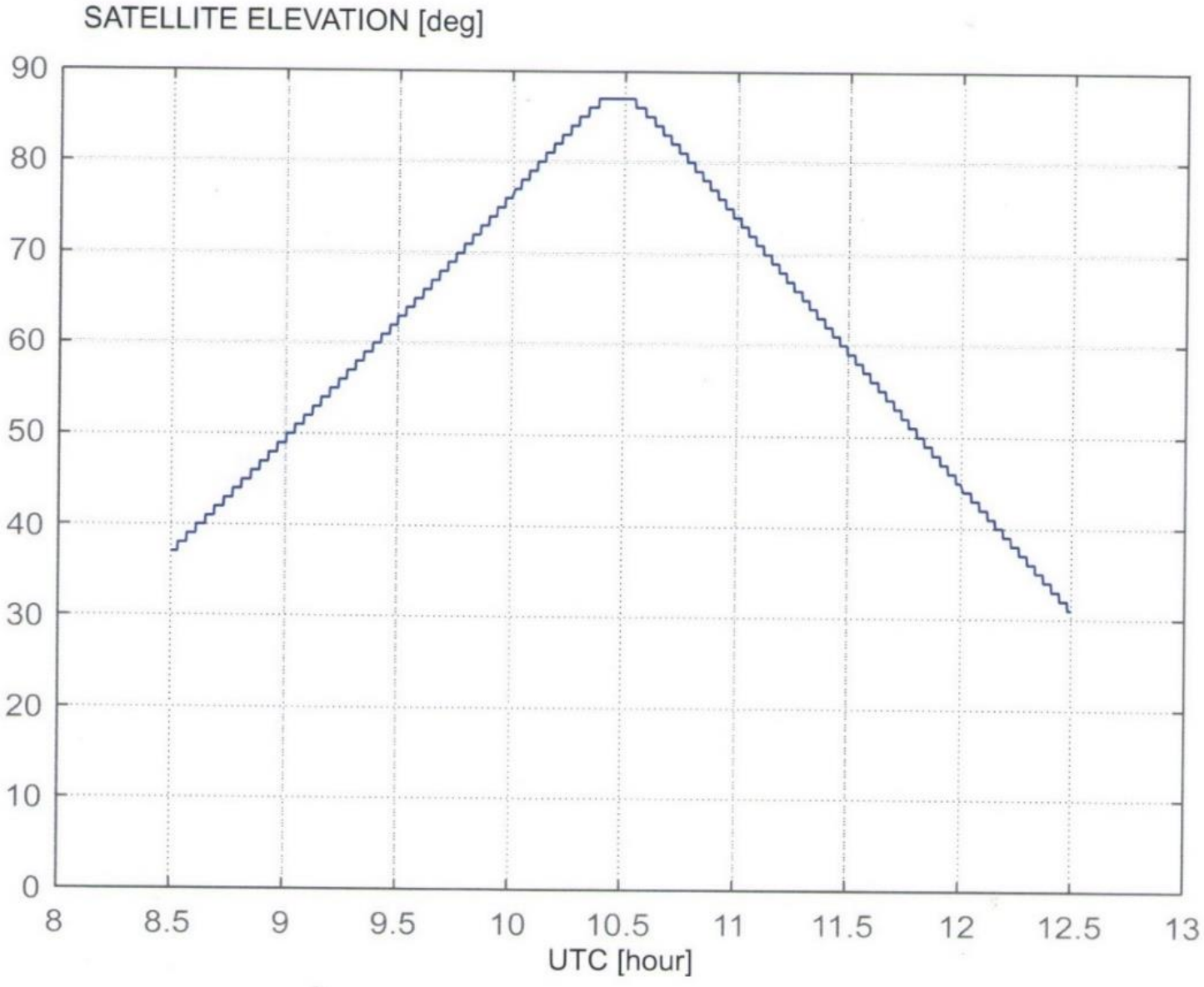
RED LINE = AVERAGE OVER ALL SATELLITES IN VIEW

TEST MEASUREMENT

TESTED RECEIVER: GTR51 S/N 1704142
ANTENNA: NOV-703-GGG S/N NEG17130019
REFERENCE RECEIVER: GTR50 S/N: 002

DATE: 2017-05-17
SITE: PRAGUE
BASELINE: 8 m
SATELLITE: PRN 24
OUTPUT DATA: **RAW**

SATELLITE ELEVATION



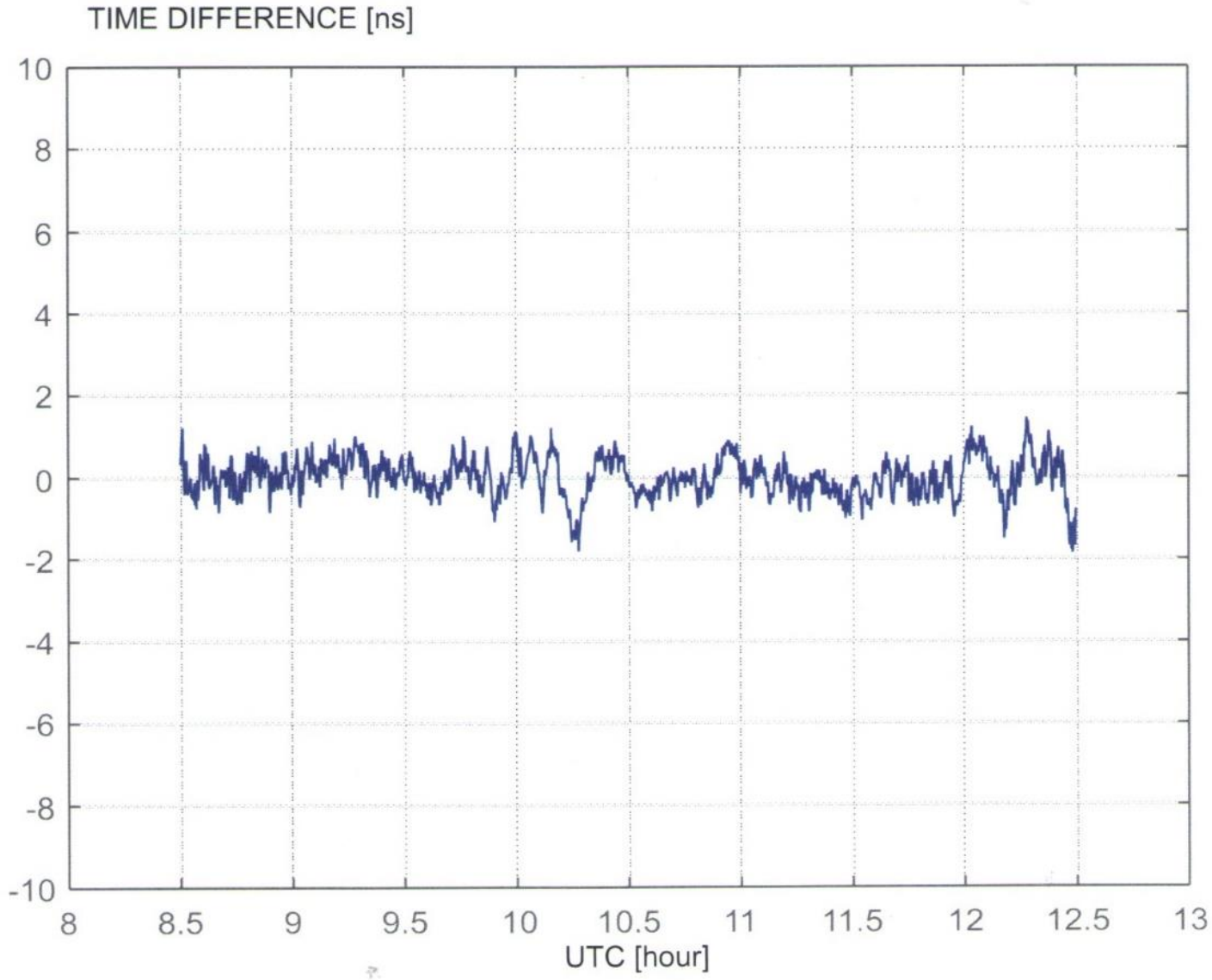
TEST MEASUREMENT

TESTED RECEIVER: GTR51 S/N 1704142
ANTENNA: NOV-703-GGG S/N NEG17130019
REFERENCE RECEIVER: GTR50 S/N: 002

DATE: 2017-05-17
SITE: PRAGUE
BASELINE: 8 m
SATELLITE: PRN 24
OUTPUT DATA: **RAW**

CODE MEASUREMENT

SIGMA = 0.5 ns



TEST MEASUREMENT

TESTED RECEIVER: GTR51 S/N 1704142
ANTENNA: NOV-703-GGG S/N NEG17130019
REFERENCE RECEIVER: GTR50 S/N: 002

DATE: 2017-05-17
SITE: PRAGUE
BASELINE: 8 m
SATELLITE: PRN 24
OUTPUT DATA: **RAW**

PHASE MEASUREMENT

SIGMA = 50 ps