Report for Calibration of G2 Laboratory BIRM by NIM

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The report is divided by eight parts. The first part introduces the calibration process briefly. And the second and third parts describe separately the equipments and the operation methods, and the experiment setups during the calibration campaign. Part 4 and 5 separately introduce the data processing of the calibration, and the final calibration results by the computation. Then the sixth part describe the verification for the final results by processing Rinex observation using dclrinex program. In part 7, it is shown how the calibration uncertainties are evaluated. Climate parameters during the calibration is involved in part 8.

From the verification, we can find the discrepancy of less than 1.1 ns between the results by the two methods as shown in part 5 and 6 separately. And the final calibration uncertainties for C1 and P3 codes are evaluated both as 1.8 ns.

1. Introduction

Time link calibration is the premise of time transfer. Since 2012, BIPM has started to draw up the new guideline for GNSS link calibration and assigned several NMIs including NIM as the group 1 laboratories to implement the possibility of calibration of group 2 laboratories in the local RMO (Regional Metrology Organization) that might give some assist to BIPM.

In March 2016, BIRM (in Beijing, China) sent us the calibration request and due to the calibration G2 laboratory NTSC (in Lintong, China) and APMP TCI project with our calibrator, the calibration has been delayed and it was implemented from last October to last November.

2. Description of the equipments and the operation method

We had planned to use our calibrator (NIM cal-001) for BIRM calibration. However, it had been occupied by the APMP TCI project for the verification and demonstration among APMP G1 labs until last December. So another traveling receiver for this calibration as follows in figure 1 and it has been operated in a stable status nearly continuously for a long period as indicated in table 2.

Figure 1. IM20 GNSS time and frequency transfer receiver

Physical Size: 43cm(width)*8.8cm(height)*50cm(depth)
rough weight: 15 kg
List of supplied items:
Receivers:IM20: NIM-TF-GNSS-2J (with antenna Novatel 702GG)

All information about the equipments for the calibrator and the receivers to be calibrated are list in table 1.

Table 1. Sites used for the calibration

Timing lab	Site name	BIPM code	Model	Role	Notes
NIM	IMEJ	IM06	Dicom GTR50	Reference receiver	Master
NIM	IM20	IM20	NIM-TF-GNSS-2J	Traveling receiver	Traveling
BIRM	TTS4	BI01	TTS-4	Receiver to be calibrated	Master
BIRM	BIRM	BI02	BM1308-52	Receiver to be calibrated	Backup

Note: BIRM has given the same code for the two receivers, for discrimination, we just call TTS-4 receiver "BIRM" and the other "BM52" when we processed the data for calibration computation. Finally, BIRM decided to name TTS-4 receiver "BI01" and the other "BI02". However, in the following part of this report, all description and results corresponds to "BIRM" and "BM52".

The whole calibration tour includes start CCD before calibration, calibration on site and closure CCD as shown in table 2.

Table 2. Sites used for the calibration

Time period	Place	Operation	Notes
MJD 57315-MJD 57672	NIM	Start CCD before calibration	Measurements used for computation from MJD 57665-MJD 57671
MJD 57673-MJD 57715	BIRM	Calibration on site	Measurements used for computation from MJD 57703-MJD 57706

MJD 57716 to now	NIM	Closure CCD after calibration	Measurements used for computation from MJD 57716-MJD 57721

We had IM20 installed and operated at BIRM in MJD 57673, and however it was some time for us to remove the possibility of the influence from some interferences transmitted for some other experiments, which made the CCD results very noisy and sometimes the standard deviation of the results approached 2 ns as shown in figure 34 in Annex 5. The data from MJD 57703 to MJD 57706 after the signal transmitting was closed which looks normal are finally used for computation.

The calibration method, the differential calibration with closure of GPS (Global Positioning System) time and frequency transfer receiver, is used.Its principle concept of is addressed in [1],. Here we don't repeat the description of the differential calibration by BIPM.

3. Experiment setups

In the campaign, the receivers used were as follows in table 1. IMEJ (site name for CGGTTS is IM06) is the master GPS time and frequency transfer receiver of NIM for TAI contribution and the reference receiver and has been calibrated in 2012 by NIM and 2014 by BIPM. The calibrator at BIRM was installed as figure 2 and 3 shows. And the setups and the sub-delay information for start and closure experiments at NIM and calibration experiments on site at BIRM were depicted in figure 4 and 5.

Figure 2. Calibrator installed in BIRM

Figure 3. Calibrator installed in BIRM

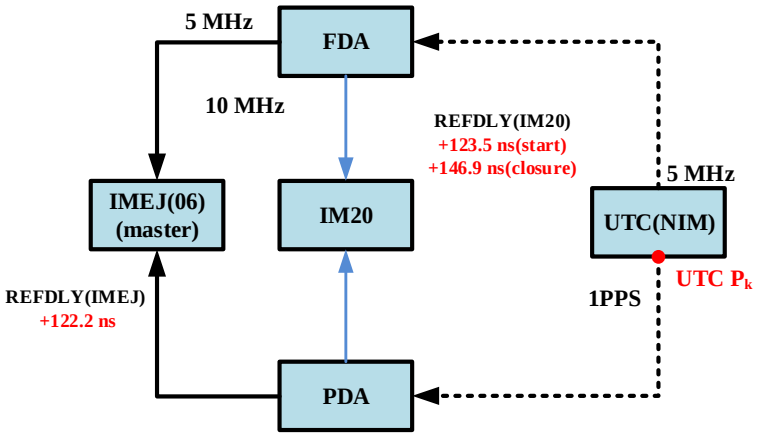

Figure 4. Experiment setup @NIM(for CCD experiments)

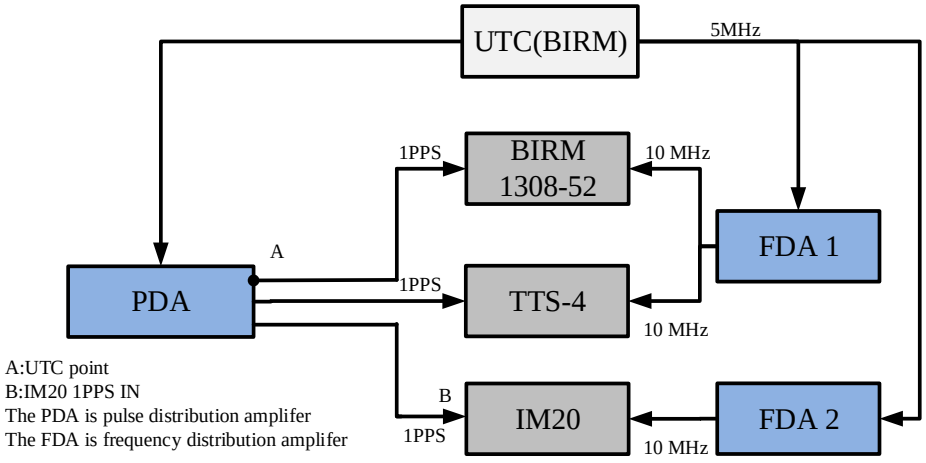

Figure 5. Experiment setup @BIRM(for CCD experiments)

4. Data processing

The calibration tour is divided into three phases including start CCD before calibration, calibration on site and closure CCD after calibration. Thus, data processing results are divided into three sides using GPS C1 and P3 CGGTTS data of the receivers.

4.1. Start CCD before calibration

Table 3. Real measurements of sub-delays for the sites in start experiment at NIM

Receiver	Ref-PPSin(XP) / ns	Meas 3.1(3.3)	Meas 3.2	Ant. Cable (XC+XD) / ns
		Int ref – 1PPSin(XO) / ns		
IM20	123.5	/		205.1
IMEJ	122.2	/		248.7

4.2. Calibration on site

Table 4. Real measurements of sub-delays for the sites in calibration experiment at BIRM

Receiver	Ref-PPSin(XP) / ns	Meas 3.1(3.3)	Meas 3.2	Ant. Cable (XC+XD) / ns
		Int ref – 1PPSin(XO) / ns		
BM52	12.0(11.4)	/		225.4
BIRM	9.4(10.5)	/		218.9
IM20	11.1(10.4)	/		205.1

Note: Due to the very early version of the receiver software and the lack of the factory test cables, the REFDLY value of BIRM has not been measured in full accordance with the Annex 1 of the BIPM calibration guidelines. The Ref-PPSin(XP) data outside and inside the brackets were separately the measurements before and after calibration at BIRM.

4.3. Closure CCD after calibration

Table 5. Real measurements of sub-delays for the sites in closure experiment at NIM

Receiver	Ref-PPSin(XP) / ns	Meas 3.1(3.3)	Meas 3.2	Ant. Cable (XC+XD) / ns
		Int ref – 1PPSin(XO) / ns		
IM20	146.9	/		205.1
IMEJ	122.2	/		248.7

Closure values(the difference between the mean values before calibration and after calibration shown in the figures in the Annex 1.)

IM20:
C1: -47.43+47.19=-0.24 ns
P3: -51.44+51.37=-0.07 ns

5. C1/P3 Calibration computation and calibration values

Algorithm: $(XR+XS)_{RUC}$=CCD(RUC- Calibrator)-original compensation for (RUC- Calibrator) from CGGTTS header-$(XC+XD)_{RUC}$+$(XO+XP)_{RUC}$+$(XC+XD)_{Cal}$+ CCD(Calibrator-Ref)
RUC: Receiver under calibration
Ref: calibration reference receiver, NIM master GPS time and frequency receiver IM06(IMEJ)
C1:
Base on IM20
GM data

$(XR+XS)_{BM52}$ = -18.73+225.0-12.0-225.43+(12.0+11.4)/2+11.1-(11.1+10.4)/2-(47.43+47.19)/2= -66.4 ns
Total_delay= -18.73+225.0-12.0+11.1-(11.1+10.4)/2-(47.43+47.19)/2= 147.3 ns

$(XR+XS)_{BIRM}$=
18.80+218.85-10.0-26.44-218.85+(9.4+10.5)/2+11.1-(11.1+10.4)/2-(47.43+47.19)/2= -54.7 ns
Total_delay= 18.80+218.85-10.0-26.44+11.1-(11.1+10.4)/2-(47.43+47.19)/2=154.3 ns

P3:
Base on IM20
GZ data

$(XR+XS)_{BM52}$ = -2.92+225.0-12.0-225.43+(12.0+11.4)/2+11.1-(11.1+10.4)/2-(51.44+51.37)/2= -54.7 ns
Total_delay= -2.92+225.0-12.0+11.1-(11.1+10.4)/2-(51.44+51.37)/2=159.0 ns

$(XR+XS)_{BIRM}$=
47.12+218.85-10.0-26.44-218.85+(9.4+10.5)/2+11.1-(11.1+10.4)/2-(51.44+51.37)/2= -30.4 ns
Total_delay= 47.12+218.85-10.0-26.44+11.1-(11.1+10.4)/2-(51.44+51.37)/2=178.5 ns
Note: The internal reference delay XO is difficult to be decided due to its very early version of firmware. Thus here XR+XS should include the compensation for the present internal reference

delay.

Calibration values are as follows in terms of the computation according to the above formulaa.

BM52(C1)：-66.4 ns
BIRM(C1)：-54.7 ns

BM52(P3)：-54.7 ns
BIRM(P3)：-30.4 ns

6. Verification using dclrinex

CGGTTS file headers
IM20
MJD 57665-57671
INT DLY = 0.0 ns (GPS P3)
CAB DLY = 205.1 ns (GPS), 205.1 ns (GLONASS)
REF DLY = 115.5 ns (XO+XP)
MJD 57703-57706
INT DLY = 0.0 ns(GPS L1C), 0.0 ns (GPS P3)
CAB DLY = 205.1 ns (GPS), 205.1 ns (GLONASS)
REF DLY = 3.1 ns (XO+XP)
MJD 57716-57721
INT DLY = 0.0 ns (GPS C1) 0.0 ns (GPS P3)
CAB DLY = 205.1 ns (GPS), 205.1 ns (GLONASS)
REF DLY = 138.9 ns (XO+XP)
Note: REF DLY of IM20 in the file header is just the external reference delay(XP). The internal reference delay(XO) is measured automatically and saved in one specific file and compensated in the REFSYS. However, for the unification of definition of REF DLY, the REF DLY values shown above here are the sum of the external reference delay and the internal reference delay by adding the internal reference delay to the original REF DLY value.
BM52
MJD 57703-57706
INT DLY = [ns] 0.0 (GPS C1), 0.0 (GPS C2), 0.0 (GPS P1), 0.0 (GPS P2), 0.0 (GPS L5)
CAB DLY = 225.0 ns
REF DLY = 12.0 ns
BIRM
MJD 57703-57706
INT DLY = [ns] GPS: L1C:-26.44 L2C:-26.44 L1P:-26.44 L2P:-26.44 L5P:0.00, GLO: L1C:0.00 L2C:0.00 L1P:0.00 L2P:0.00
CAB DLY = 218.85 ns (GPS), 218.85 ns (GLONASS)
REF DLY = 10.00 ns (1PPS DLY: 10.00 ns, phase corr: 0.00 ns)

Compensation for P1 and P2 results:
IM20
MJD 57665-57671 -205.1+115.5 = -89.6 ns
MJD 57703-57706 -205.1+3.1 = -202.0 ns
MJD 57716-57721 -205.1+138.9 = -66.2 ns

Note: P3 results are calculated by the formula P3=P1*2.54573-P2*1.54573. In the figures, only the P3 results are compensated by these corresponding values, and P1, P2 and P1-P2 results are not compensated. IM06 has all the delays in CGGTTS header compensated in Rinex data.

6.1. Start CCD before Calibration

Table 6. Results for the sites by dclrinex in start experiment at NIM

Before calibration (ns)	C1		P1		P2		P3	P1-P2	
	Mean	Std	Mean	Std	Mean	Std	Mean	Mean	Std
IM20-IMEJ	-47.85	0.95	-17.91	0.94	4.22	0.86	-52.17	-22.15	0.83

6.2. Calibration on site

Table 7. Results for the sites by dclrinex in calibration experiment at BIRM

On site(ns)	C1		P1		P2		P3	P1-P2	
	Mean	Std	Mean	Std	Mean	Std	Mean	Mean	Std
IM20-BM52	19.06	0.92	12.04	0.81	17.72	0.76	3.24	-5.69	0.74
IM20-BIRM	-18.56	0.89	-36.88	0.90	-29.89	0.96	-47.68	-6.99	0.82

6.3. Closure CCD after calibration

Table 8. Results for the sites by dclrinex in closure experiment at NIM

After Calibration(ns)	C1		P1		P2		P3	P1-P2	
	Mean	Std	Mean	Std	Mean	Std	Mean	Mean	Std
IM20-IMEJ	-47.65	1.48	-17.93	0.93	4.23	0.86	-52.19	-22.16	0.83

6.4. Calibration calculation

We can get the similar all CCD values using dclrinex of BIPM to the ones solved in section 8 by ourselves. The differences between them are smaller than 0.7 ns. So we can think the P3 calibration values from two processing methods should be agreed with each other. Anyway, we calculate the P1, P2 and P3 calibration values using CCD values using dclrinex as follows.

P1 and P2 calculation algorithm: $(XR+XS)_{RUC}$ = CCD(RUC-Calibrator)-compensation of IM20 for P1 and P2-$(XC+XD)_{RUC}$+$(XO+XP)_{RUC}$+ CCD(Calibrator-Ref)
RUC: Receiver under calibration

Ref: calibration reference receiver, NIM master GPS time and frequency receiver IM06(IMEJ)
P3 calculation algorithm is the same to that of section 8.
C1：
Based on IM20

$(XR+XS)_{BM52\_C1}$=
-19.06+225.0-12.0-225.43+(12.0+11.4)/2+11.1-(11.1+10.4)/2+(-47.85-47.65)/2=
-67.2 ns

$(XR+XS)_{BIRM\_C1}$=
18.56+218.85-10.0-26.44-218.85+(9.4+10.5)/2+11.1-(11.1+10.4)/2+(-47.85-47.65)/2
= -55.3 ns

P3:
Based on IM20
$(XR+XS)_{BM52\_P1}$=
-12.04+225.0-12.0-225.43+(12.0+11.4)/2+11.1-(11.1+10.4)/2+(-17.91-17.93)/2=
-30.3 ns
$(XR+XS)_{BM52\_P2}$=
-17.72+225.0-12.0-225.43+(12.0+11.4)/2+11.1-(11.1+10.4)/2+(4.22+4.23)/2= -13.9
ns
$(XR+XS)_{BM52\_P3}$=
-3.24+225.0-12.0-225.43+(12.0+11.4)/2+11.1-(11.1+10.4)/2+(-52.17-52.19)/2= -55.8
ns

$(XR+XS)_{BIRM\_P1}$=
36.88+218.85-10.0-26.44-218.85+(9.4+10.5)/2+11.1-(11.1+10.4)/2+(-17.91-17.93)/2
= -7.2 ns
$(XR+XS)_{BIRM\_P2}$=
29.89+218.85-10.0-26.44-218.85+(9.4+10.5)/2+11.1-(11.1+10.4)/2+(4.22+4.23)/2=
8.0 ns
$(XR+XS)_{BIRM\_P3}$=
47.68+218.85-10.0-26.44-218.85+(9.4+10.5)/2+11.1-(11.1+10.4)/2+(-52.17-52.19)/2
= -30.6 ns

7. Uncertainty Evaluation

Here we evaluated the uncertainty from the sources as follows and got the combined uncertainty as 1.8 ns conservatively for C1 and P3 codes. All the measurements related to the cable and reference delays were done with SR620 on the trigger level 1.0 V. And the uncertainties from position references and multipaths are just referenced to the description of the guideline. The u_a values are from TDEV of the corresponding CCD results shown in the figures in Annex 6.

Table 9. Uncertainty contributions

Unc.	Value P1 (ns)	Value P2 (ns)	Value C1 (ns)	Value P3 (ns)	Description
u_a (T-V)	0.5	0.5	0.8	0.9	RAWDIF (traveling-visited)
u_a (T-R)	0.5	0.5	0.7	0.8	RAWDIF (traveling-reference)
u_a	0.7	0.7	1.1	1.2	
Misclosure					
$u_{b,1}$	0.1	0.1	0.3	0.1	observed mis-closure
Systematic components related to RAWDIF					
$u_{b,11}$	0.05	0.05	0.05	0.05	Position error at reference
$u_{b,12}$	0.05	0.05	0.05	0.05	Position error at visited
$u_{b,13}$	0.3	0.3	0.3	0.3	Multipaths at reference
$u_{b,14}$	0.3	0.3	0.3	0.3	Multipaths at visited
Link of the Traveling system to the local UTC(*k*)					
$u_{b,21}$	0.5	0.5	0.5	0.5	$REFDLY_T$ (at ref lab)
$u_{b,22}$	0.5	0.5	0.5	0.5	$REFDLY_T$ (at visited lab)
$u_{b,TOT}$	0.8	0.8	0.8	0.8	
Link of the Reference system to its local UTC(*k*)					
$u_{b,31}$	0.5	0.5	0.5	0.5	$REFDLY_R$ (at ref lab)
Link of the Visited system to its local UTC(*k*)					
$u_{b,32}$	0.5	0.5	0.5	0.5	$REFDLY_V$ (at visited lab)
$u_{b,SYS}$	1.1	1.1	1.1	1.1	Components of equation (2)
uCAL	1.5	1.5	1.7	1.8	Composed of u_a and $u_{b,SYS}$
Antenna cable delays					
$u_{b,41}$	0.5	0.5	0.5	0.5	$CABDLY_R$
$u_{b,42}$	0.5	0.5	0.5	0.5	$CABDLY_V$
Combined Uncertainty: 1.8 ns					

8. Climate parameters

8.1. Temperature and humidity

23.3°C~24.3°C ±0.5°C
32.1%~42.3% ±3%

8.2. Reference signal

Rise time of the local UTC pulse: 2 ns

References:

[1] BIPM. BIPM guidelines for GNSS calibration(V3.2). 05, 02, 2016.

Annex 1. CCD results (C1/P3 code) for calculation

1. Start CCD before calibration

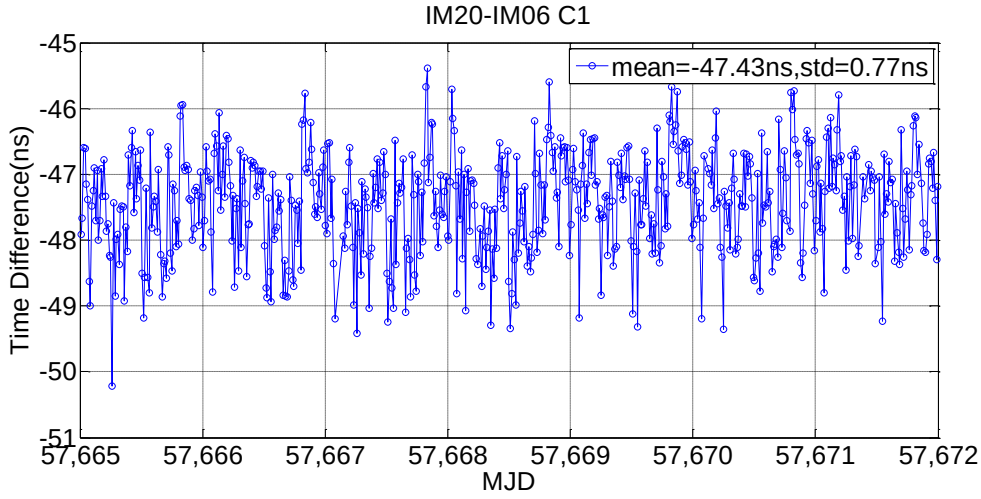

Figure 6. CCD between IM20 and IM06 at NIM

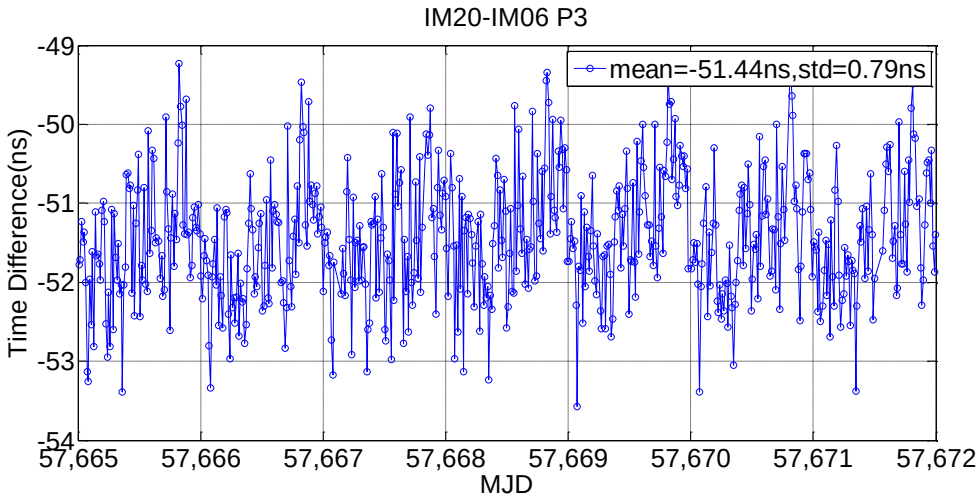

Figure 7. CCD between IM20 and IM06 at NIM

2. Calibration on site

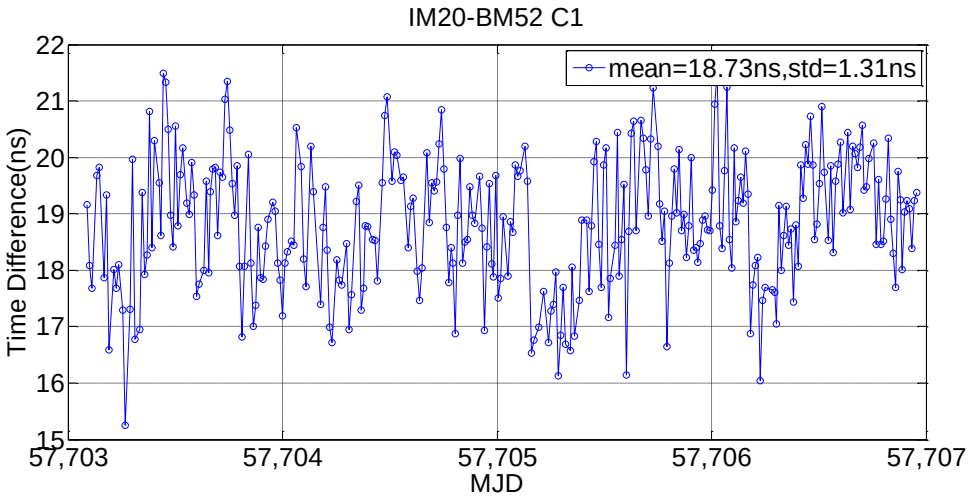

Figure 8. CCD between IM20 and BM52 at BIRM

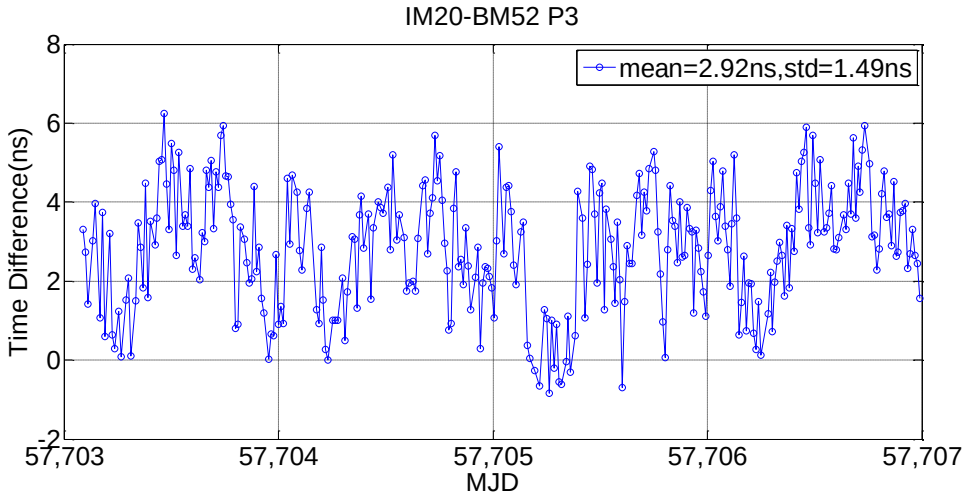

Figure 9. CCD between IM20 and BM52 at BIRM

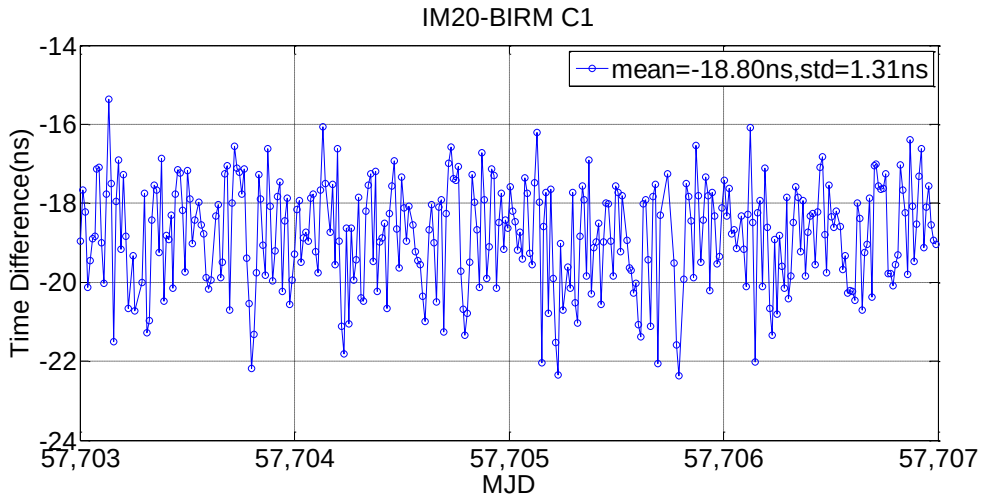

Figure 10. CCD between IM20 and BIRM at BIRM

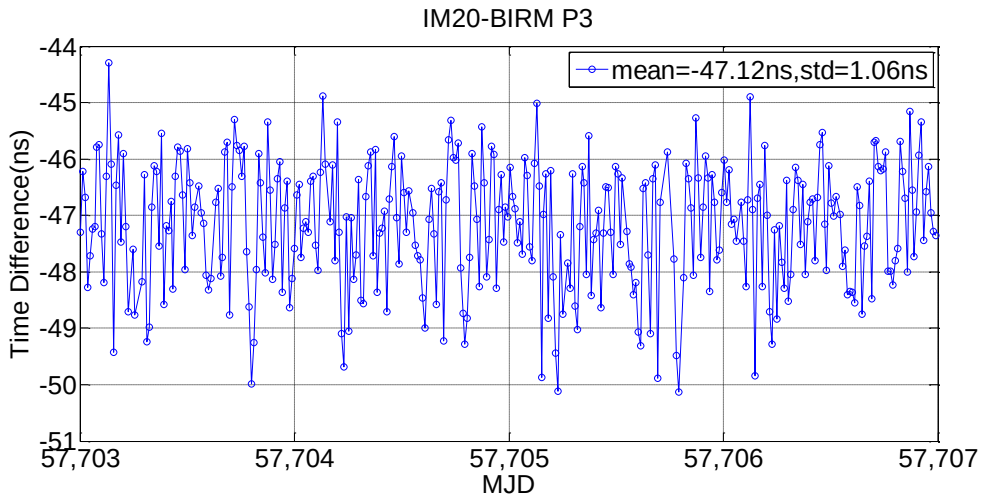

Figure 11. CCD between IM20 and BIRM at BIRM

3. Closure CCD after calibration

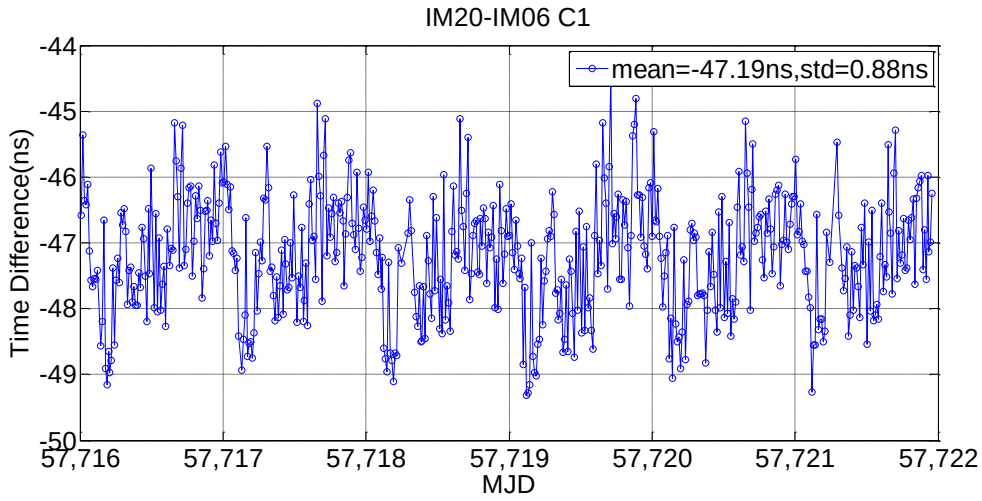

Figure 12. CCD between IM20 and IM06 at NIM

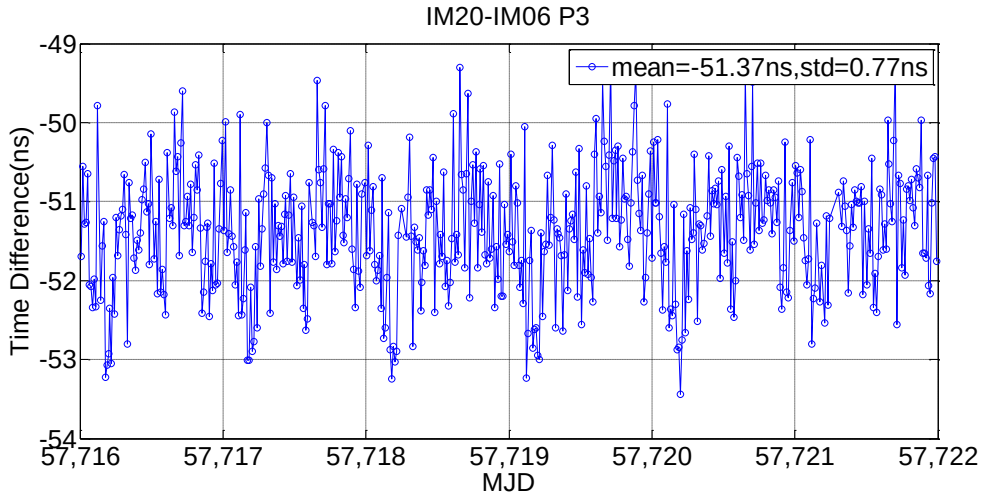

Figure 13. CCD between IM20 and IM06 at NIM

Annex 2. CCD results using dclrinex

1. Start CCD before calibration

IM20-IM06

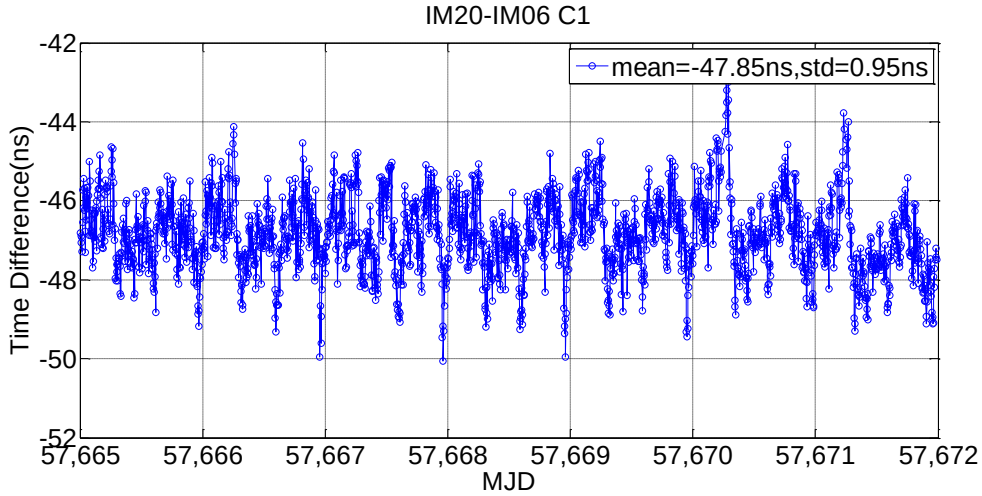

Figure 14. CCD between IM20 and IM06 at NIM(C1)

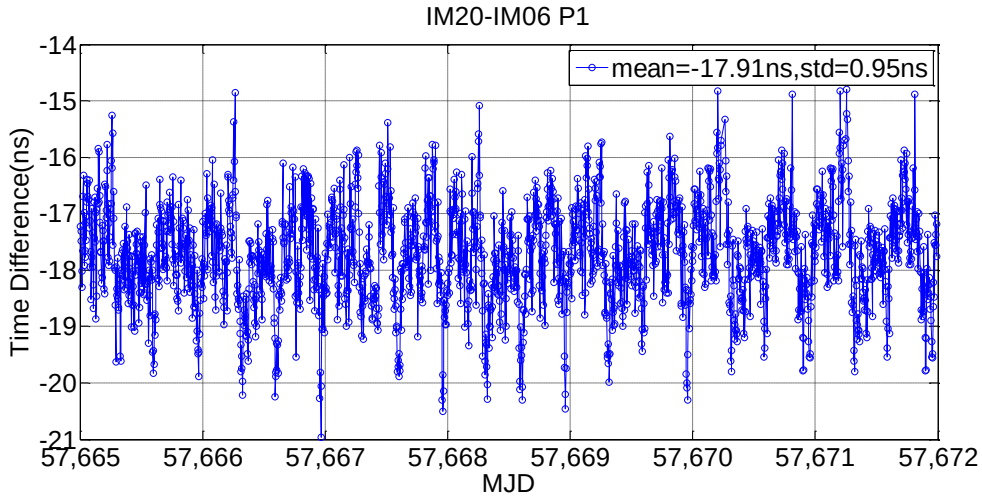

Figure 15. CCD between IM20 and IM06 at NIM(P1)

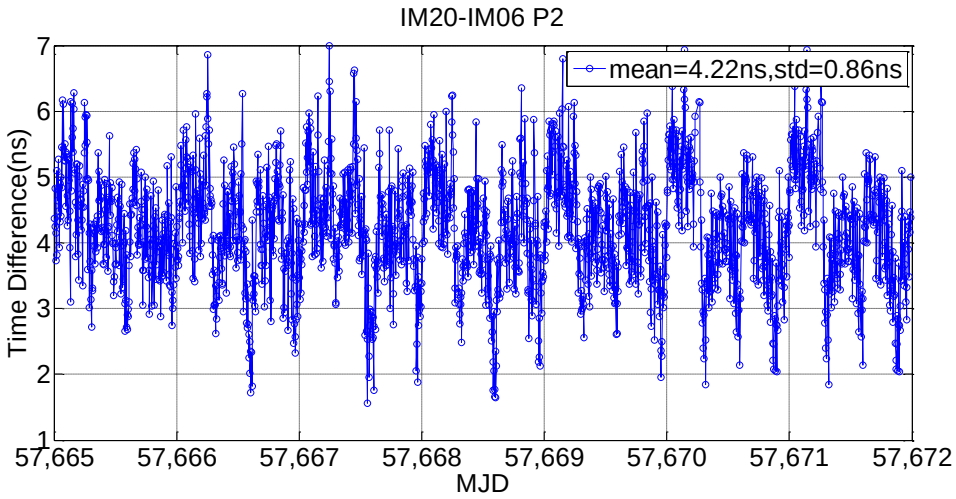

Figure 16. CCD between IM20 and IM06 at NIM(P2)

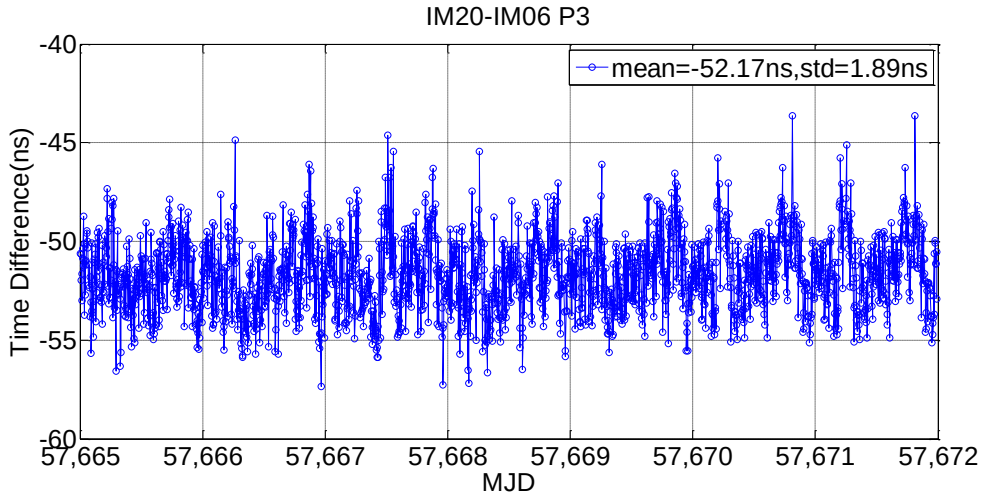

Figure 17. CCD between IM20 and IM06 at NIM(P3)

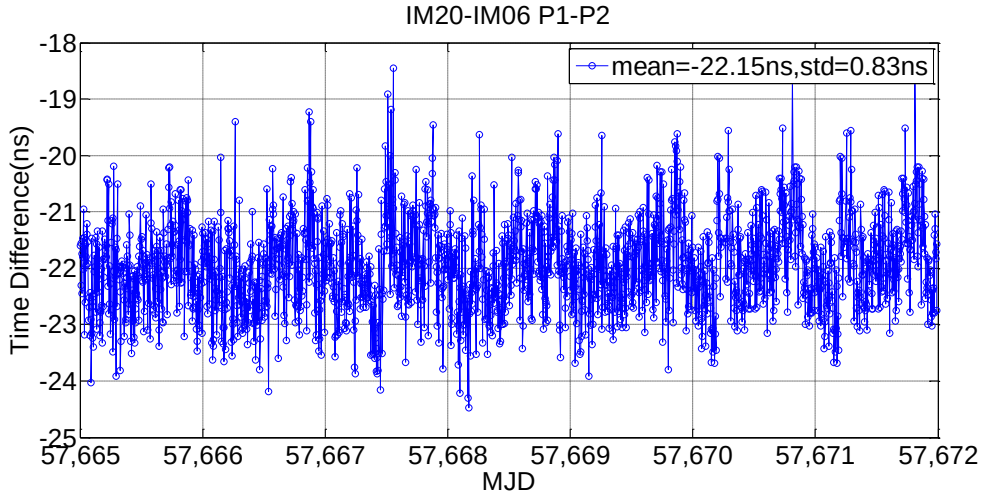

Figure 18. CCD between IM20 and IM06 at NIM(P1-P2)

2. Calibration on site

IM20 – BM52

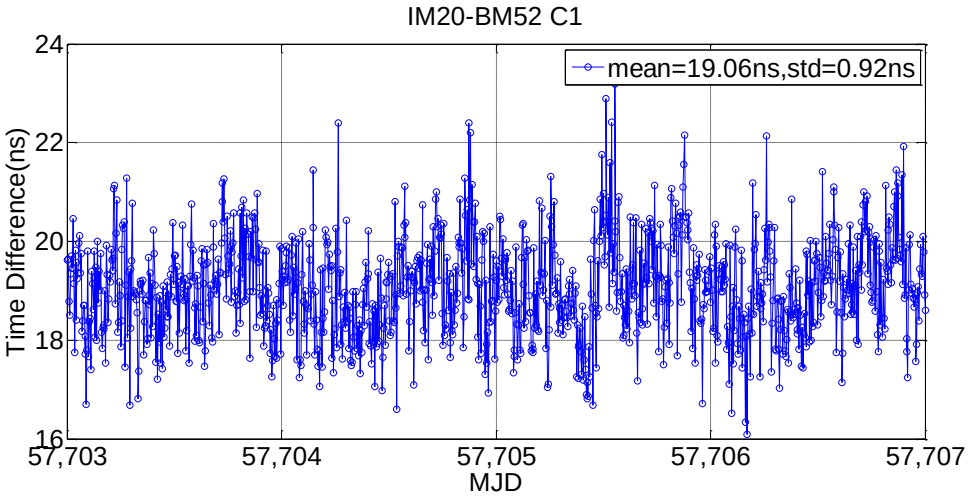

Figure 19. CCD between IM20 and BM52 at BIRM (C1)

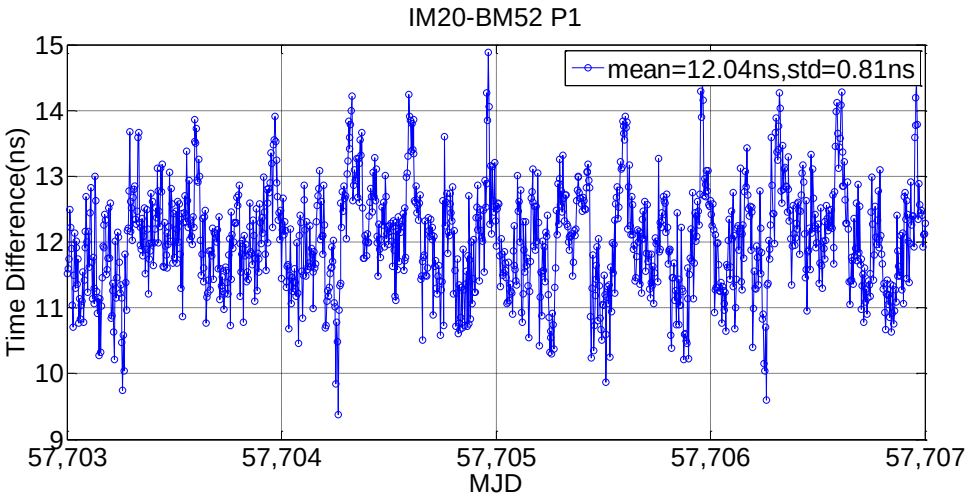

Figure 20. CCD between IM20 and BM52 at BIRM(P1)

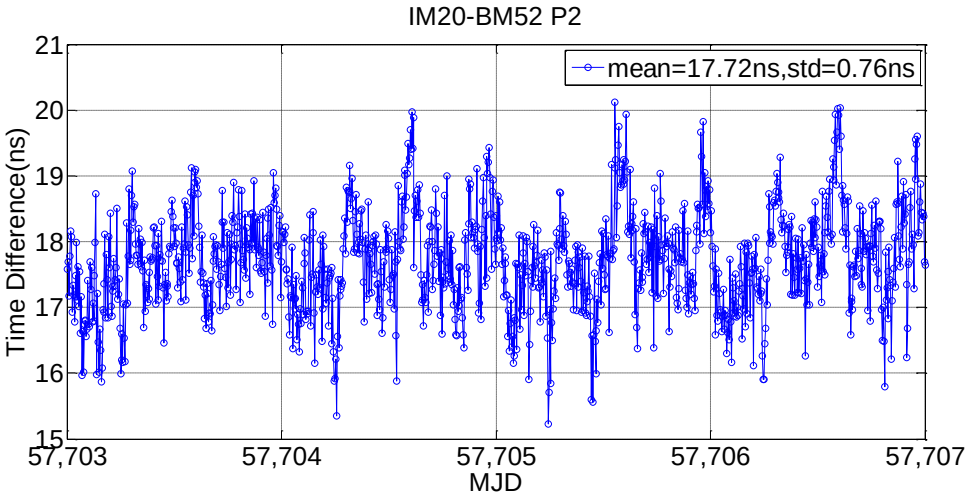

Figure 21. CCD between IM20 and BM52 at BIRM(P2)

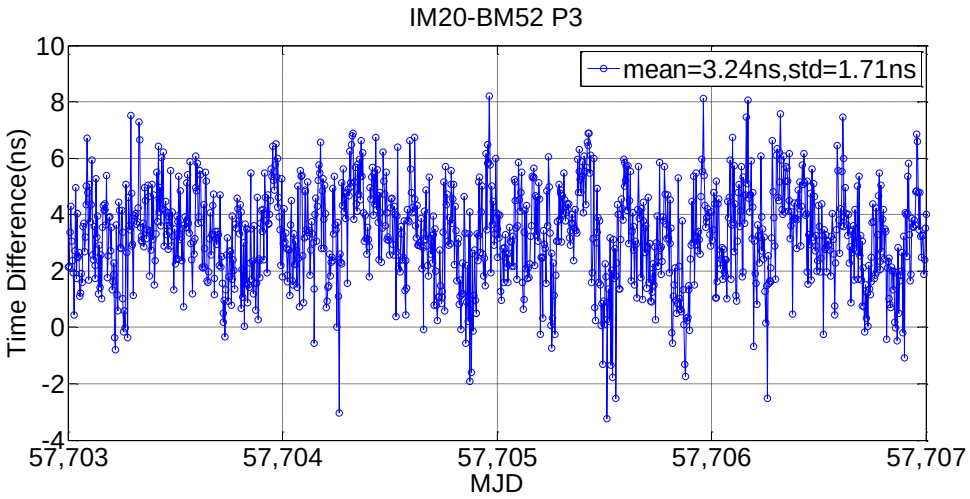

Figure 22. CCD between IM20 and BM52 at BIRM(P3)

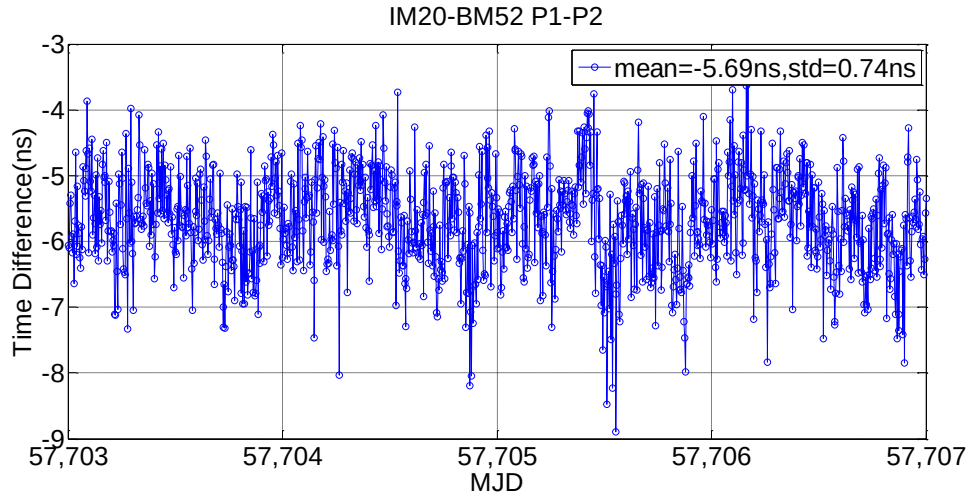

Figure 23. CCD between IM20 and BM52 at BIRM(P1-P2)

IM20 - BIRM

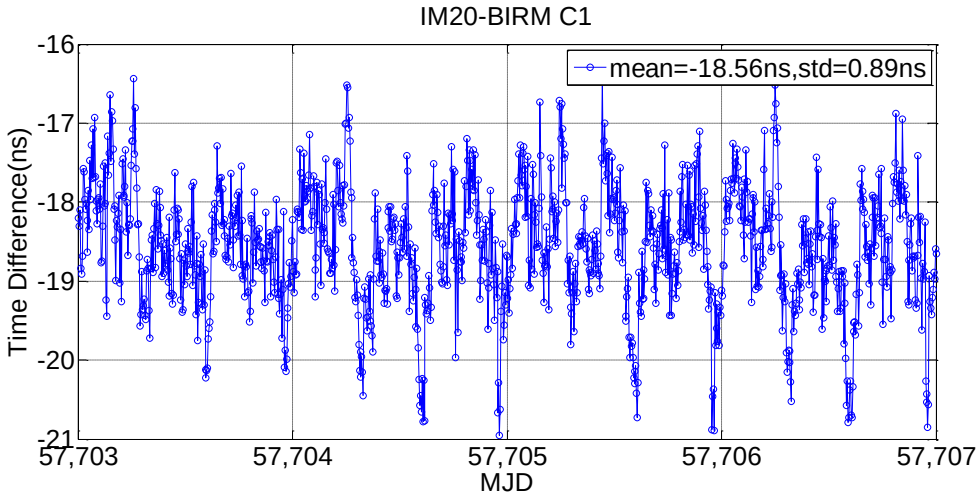

Figure 24. CCD between IM20 and BIRM at BIRM(C1)

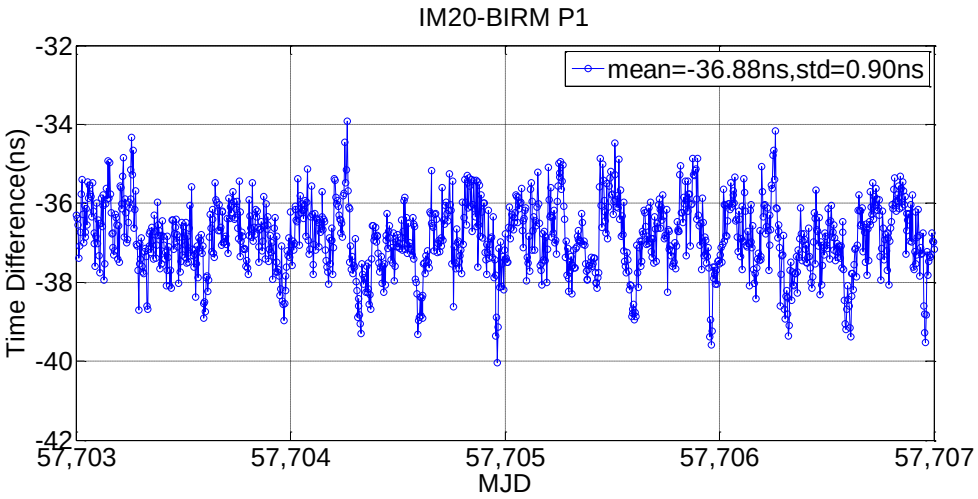

Figure 25. CCD between IM20 and BIRM at BIRM(P1)

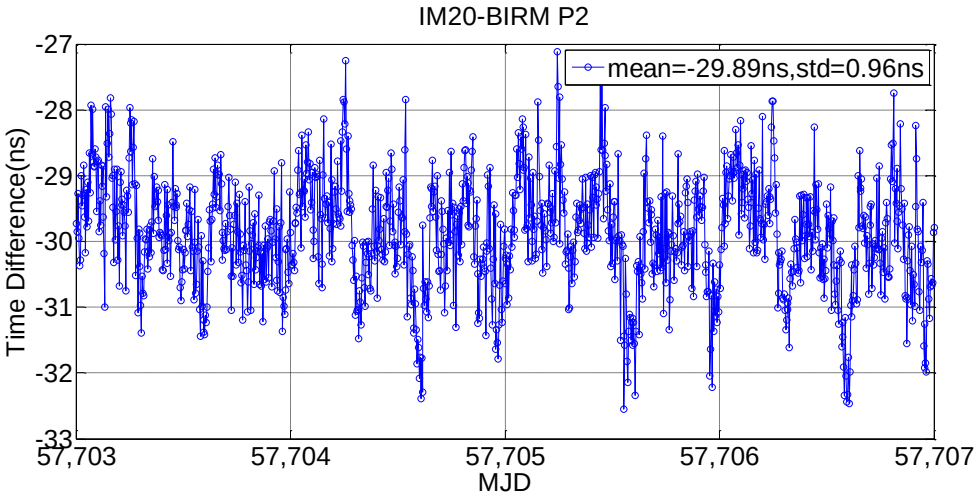

Figure 26. CCD between IM20 and BIRM at BIRM(P2)

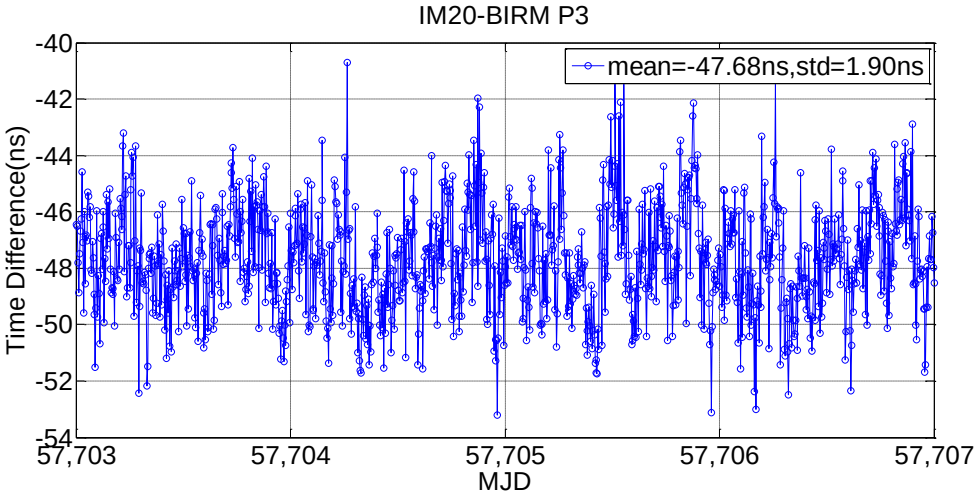

Figure 27. CCD between IM20 and BIRM at BIRM(P3)

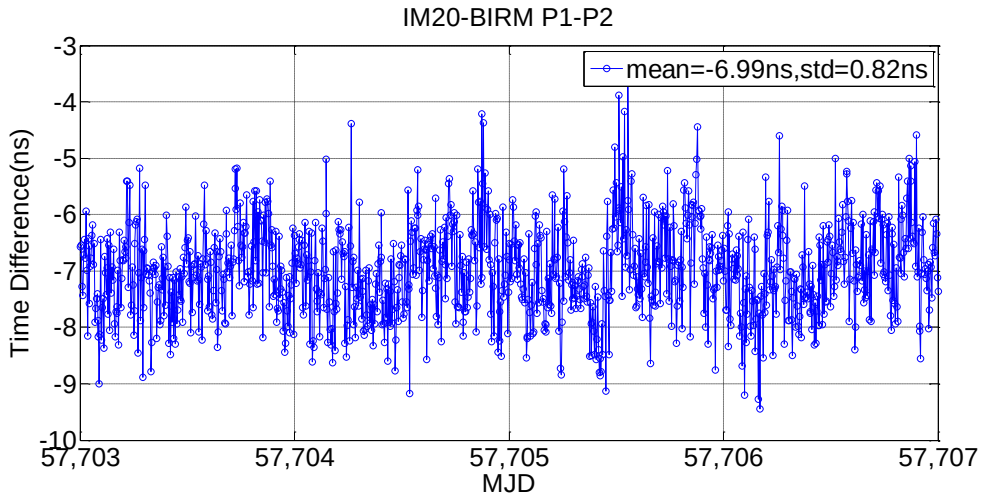

Figure 28 CCD between IM20 and BIRM at BIRM(P1-P2)

3. Closure CCD after calibration

IM20-IM06

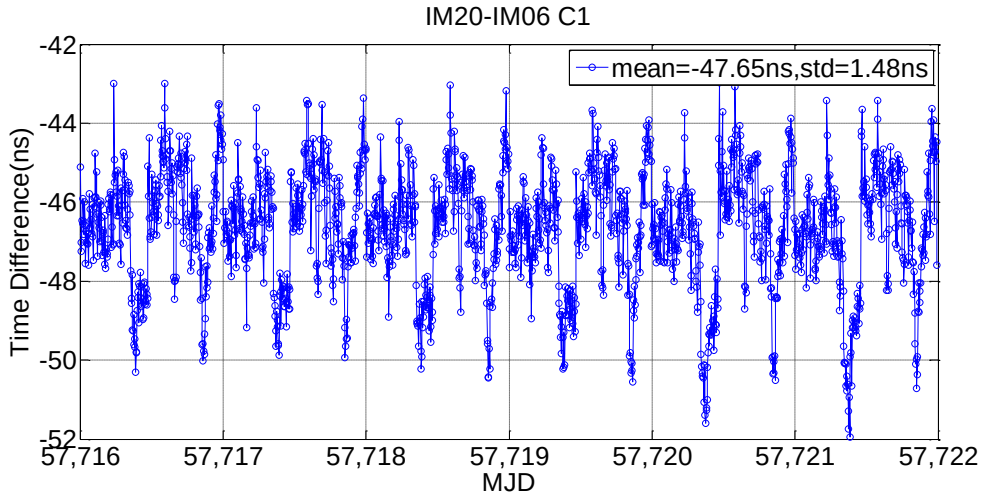

Figure 29. CCD between IM20 and IM06 at NIM(C1)

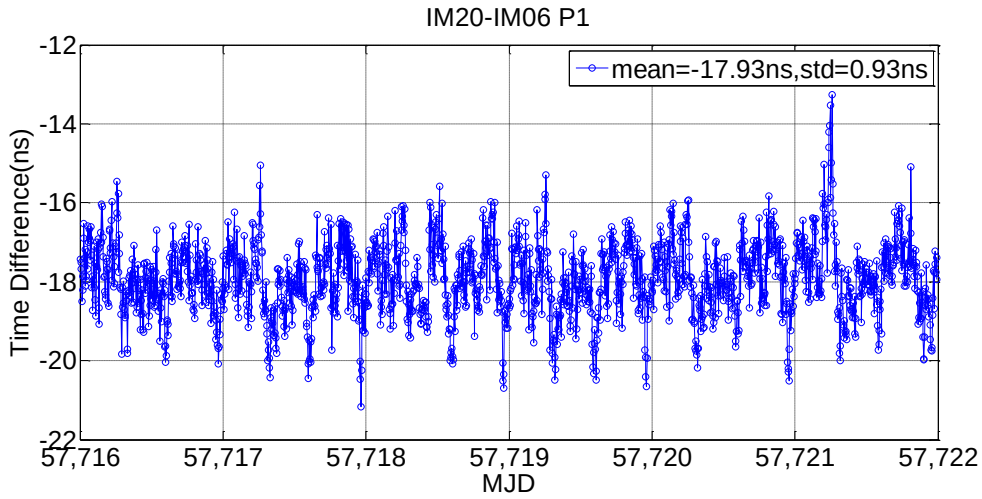

Figure 30. CCD between IM20 and IM06 at NIM(P1)

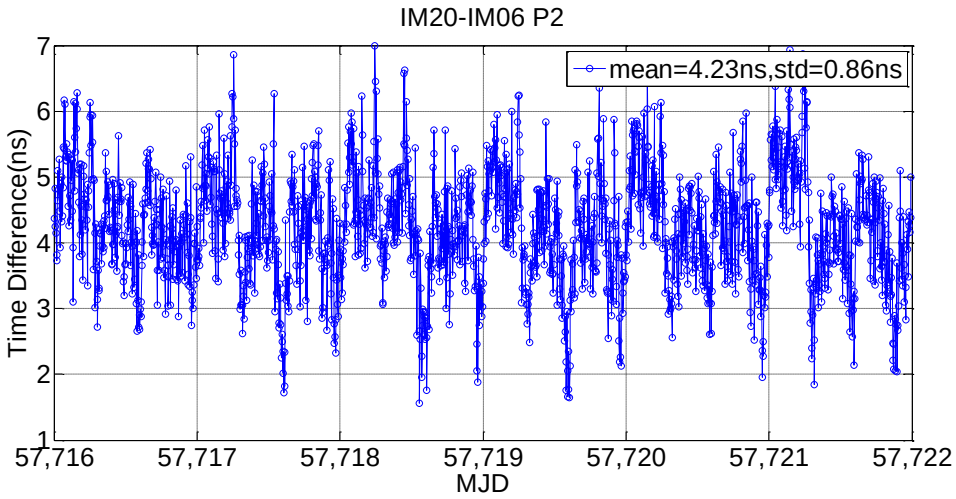

Figure 31. CCD between IM20 and IM06 at NIM(P2)

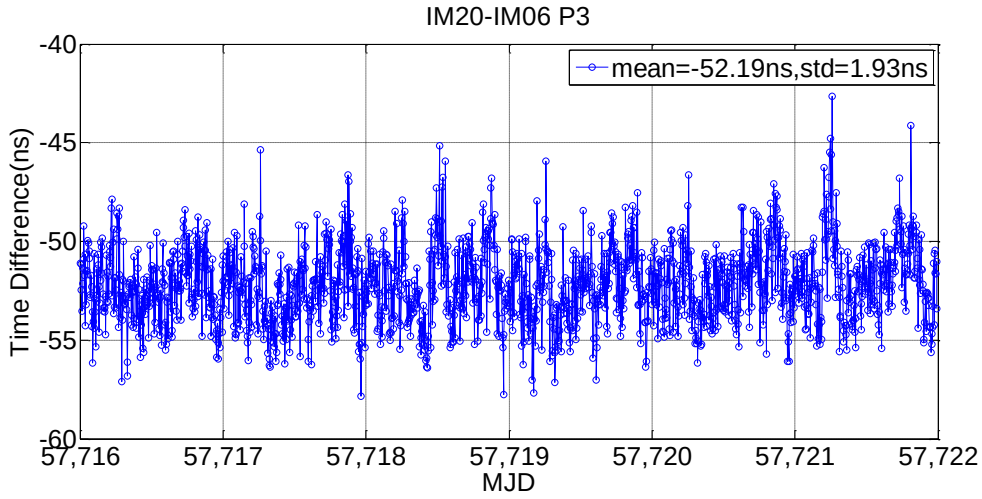

Figure 32. CCD between IM20 and IM06 at NIM(P3)

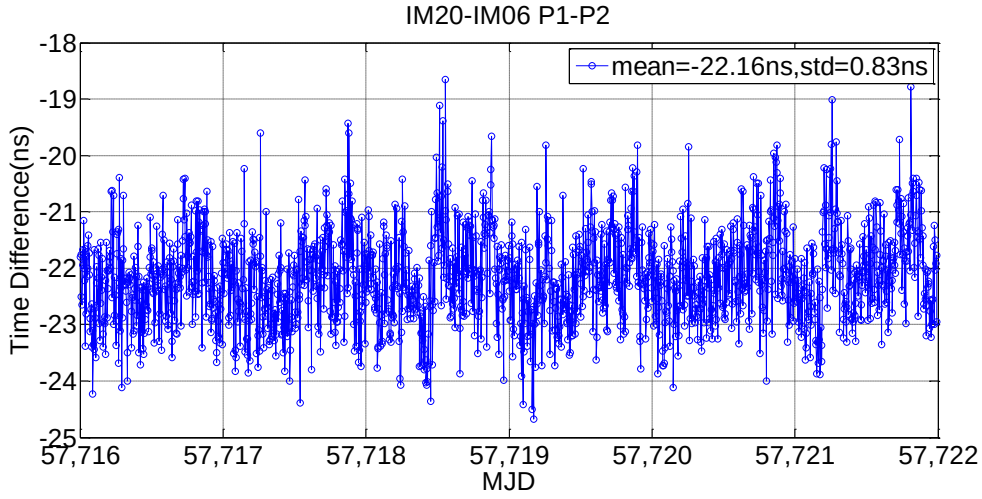

Figure 33. CCD between IM20 and IM06 at NIM(P1-P2)

Annex 3 - Information Sheet

(to be repeated for each calibrated system)

Laboratory：	BIRM
Date and hour of the beginning of measurements:	UTC time 0:00 am November 11,2016
Date and hour of the end of measurements:	UTC time 0:00 am November 15,2016

Information on the system

	Local:	**Travelling:**
4-character BIPM code	BIRM	IM20
Receiver maker and type: Receiver serial number：	maker: PIKTIME type: TTS-4 serial number:140	maker: NIM type: NIM-TF-GNSS-2J serial number:2016005
1 PPS trigger level /V:	0~2	1
Antenna cable maker and type: Phase stabilised cable (Y/N):	maker:JiangXiLiangChuang type: 5D-FB Phase stabilised cable:N	maker: Pasternack type: RG223/U Phase stabilised cable:N
Length outside the building /m:	4.4	3.0
Antenna maker and type: Antenna serial number:	maker: PIKTIME type: Javad RingAnt-G3T serial number: 00635	maker: Novatel type: NOV702GG serial number: nae16270022
Temperature (if stabilised) /°C		

Measured delays /ns

	Local:	**Travelling:**
Delay from local UTC to receiver 1 PPS-in:	9.4(10.5)	11.1(10.4)
Delay from 1 PPS-in to internal Reference (if different):		
Antenna cable delay:	218.85	205.1
Splitter delay (if any):		
Additional cable delay (if any):		

Data used for the generation of CGGTTS files

INT DLY (GPS) /ns:	-26.44
INT DLY (GLONASS) /ns:	0

CAB DLY /ns:	218.85
REF DLY /ns:	10
Coordinates reference frame:	WGS84
Latitude or X /m:	-2167479.18
Longitude or Y /m:	4393380.27
Height or Z /m:	4070639.00

General information

Rise time of the local UTC pulse	2ns
Is the laboratory air conditioned	Yes
Set temperature value and uncertainty:	23.3°C~24.3°C ±0.5°C
Set humidity value and uncertainty:	32.1%~42.3% ±3%

(1) For a trip with closure, not needed if the traveling equipment is used in the same set-up throughout.

Diagram of the experiment set-up

Please see the report.

Log of Events / Additional Information

Annex 4 - Information Sheet

(to be repeated for each calibrated system)

Laboratory：	BIRM
Date and hour of the beginning of measurements:	UTC time 0:00 am October 13,2016
Date and hour of the end of measurements:	UTC time 0:00 am October 19,2016

Information on the system

	Local:	**Travelling:**
4-character BIPM code	BIRM	IM20
Receiver maker and type: Receiver serial number：	maker: BIRM type: BM1308-52 serial number:1501004	maker: NIM type: NIM-TF-GNSS-2J serial number:2016005
1 PPS trigger level /V:	0~2	1
Antenna cable maker and type: Phase stabilised cable (Y/N):	maker:JiangXiLiangChuang type: 5D-FB Phase stabilised cable:N	maker: Pasternack type: RG223/U Phase stabilised cable:N
Length outside the building /m:	4.2	3.0
Antenna maker and type: Antenna serial number:	maker: COMTECH type: CRG-2D serial number: 160405021	maker: Novatel type: NOV702GG serial number: nae16270022
Temperature (if stabilised) /°C		

Measured delays /ns

	Local:	**Travelling:**
Delay from local UTC to receiver 1 PPS-in:	12.0(11.4)	11.1(10.4)
Delay from 1 PPS-in to internal Reference (if different):		
Antenna cable delay:	225.43	205.1
Splitter delay (if any):		
Additional cable delay (if any):		

Data used for the generation of CGGTTS files

INT DLY (GPS) /ns:	0
INT DLY (GLONASS) /ns:	0

CAB DLY /ns:	225.4
REF DLY /ns:	12.0
Coordinates reference frame:	WGS84
Latitude or X /m:	-2167478.947
Longitude or Y /m:	4393378.742
Height or Z /m:	4070640.118

General information

Rise time of the local UTC pulse	2ns
Is the laboratory air conditioned	Yes
Set temperature value and uncertainty:	23.3°C~24.3°C ±0.5°C
Set humidity value and uncertainty:	32.1%~42.3% ±3%

(1) For a trip with closure, not needed if the traveling equipment is used in the same set-up throughout.

Diagram of the experiment set-up

Please see the report.

Log of Events / Additional Information

Annex 5 –the Noisy CCD results on Calibration

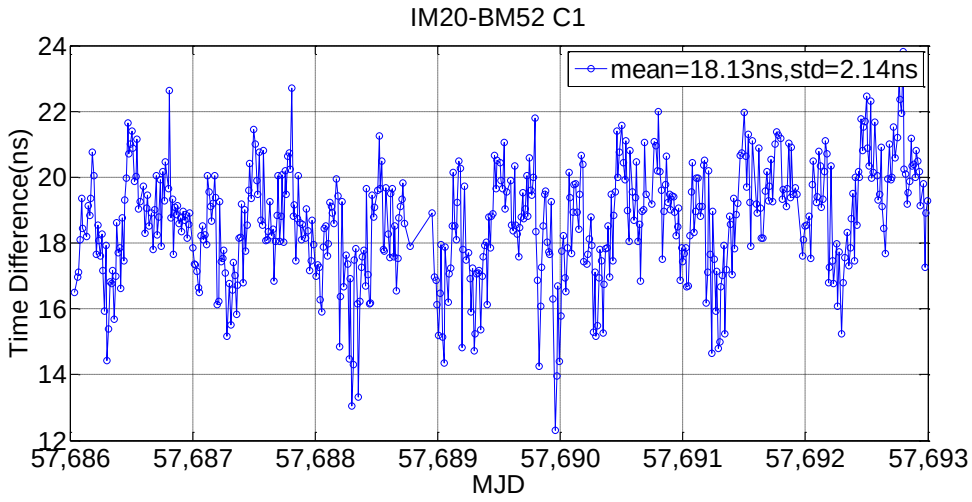

Figure 34. CCD between IM20 and BM52 at BIRM(C1)

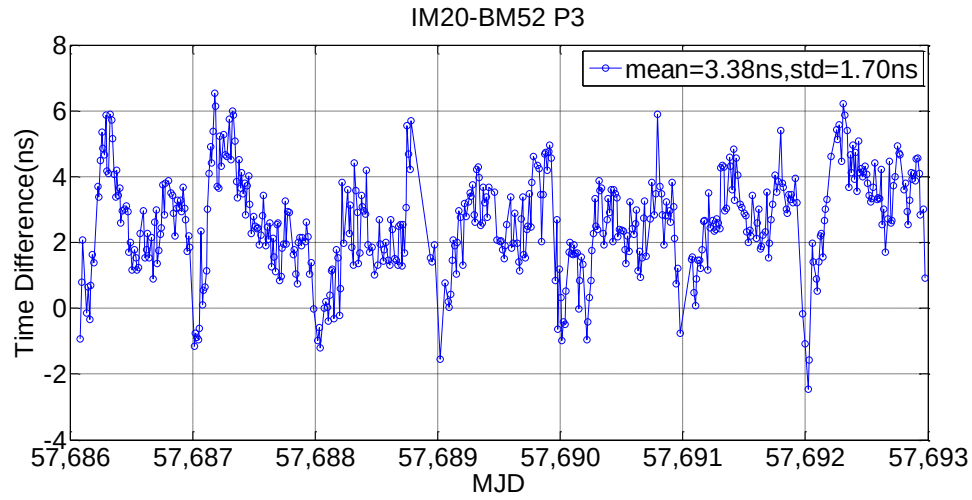

Figure 35. CCD between IM20 and BM52 at BIRM(P3)

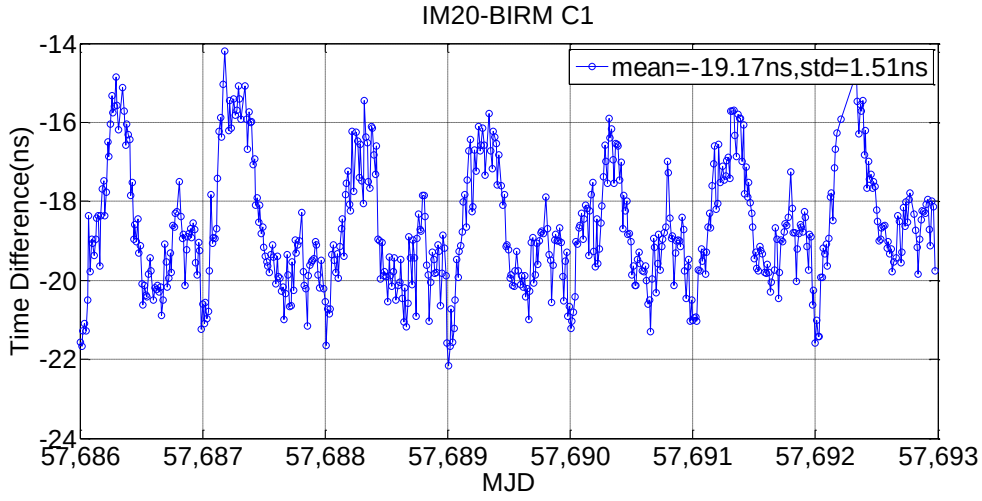

Figure 36. CCD between IM20 and BIRM at BIRM(C1)

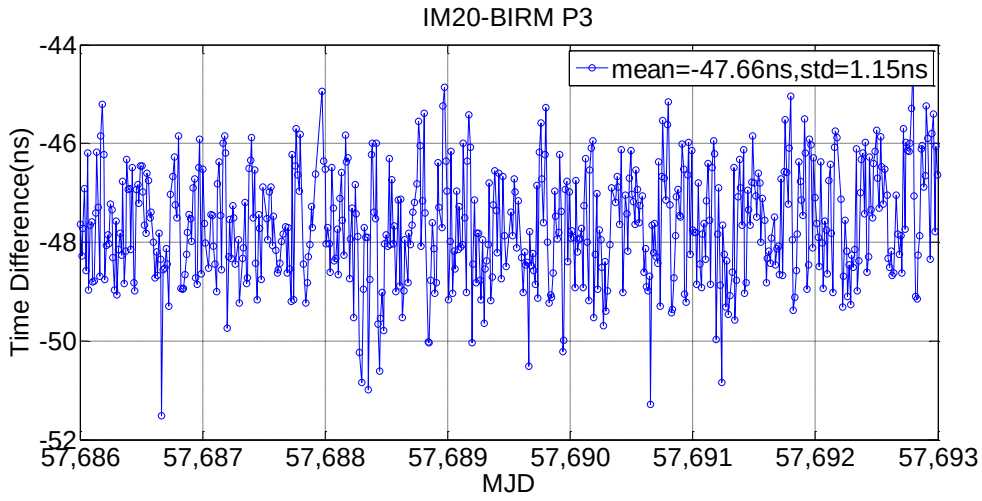

Figure 37. CCD between IM20 and BIRM at BIRM(P3)

Annex 6 – TDEV for CCD results

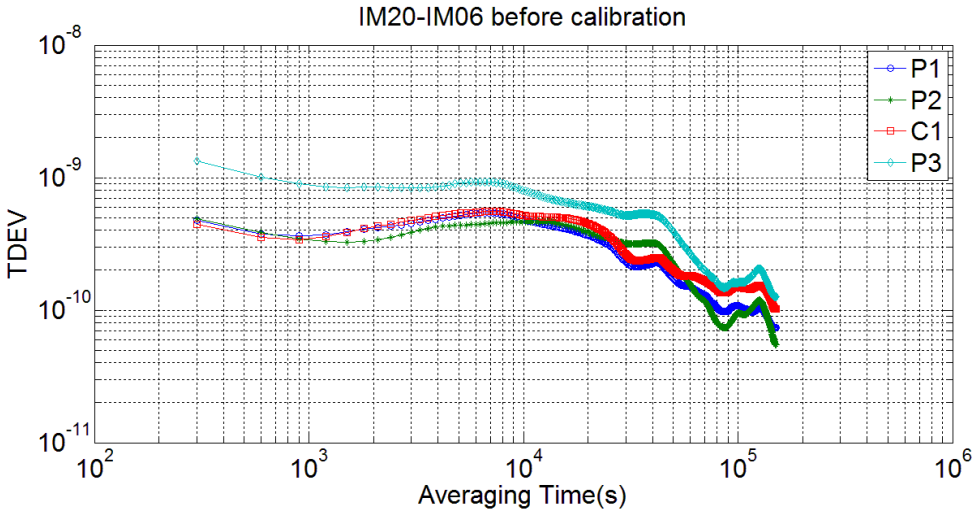

Figure 38. TDEV between IM20 and IM06 receivers at NIM before calibration

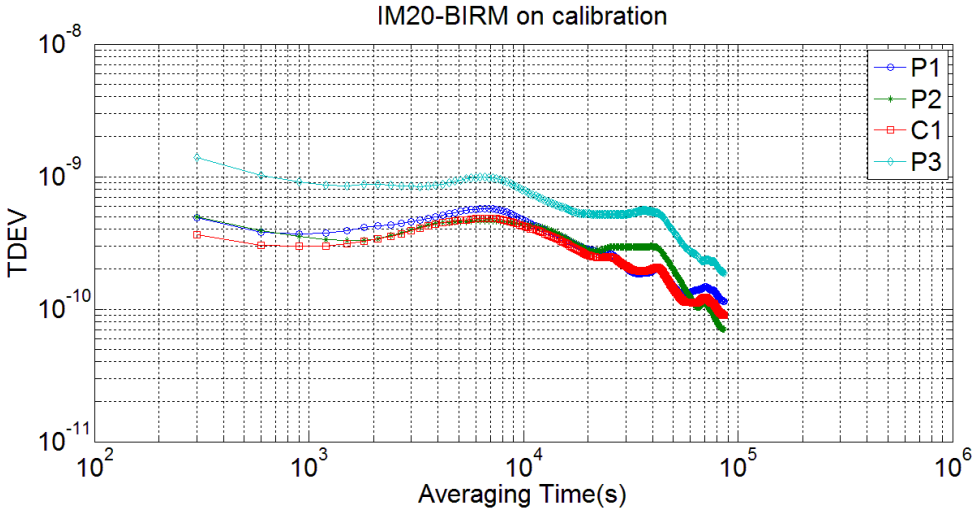

Figure 39. TDEV between IM20 and BIRM receivers at BIRM during calibration

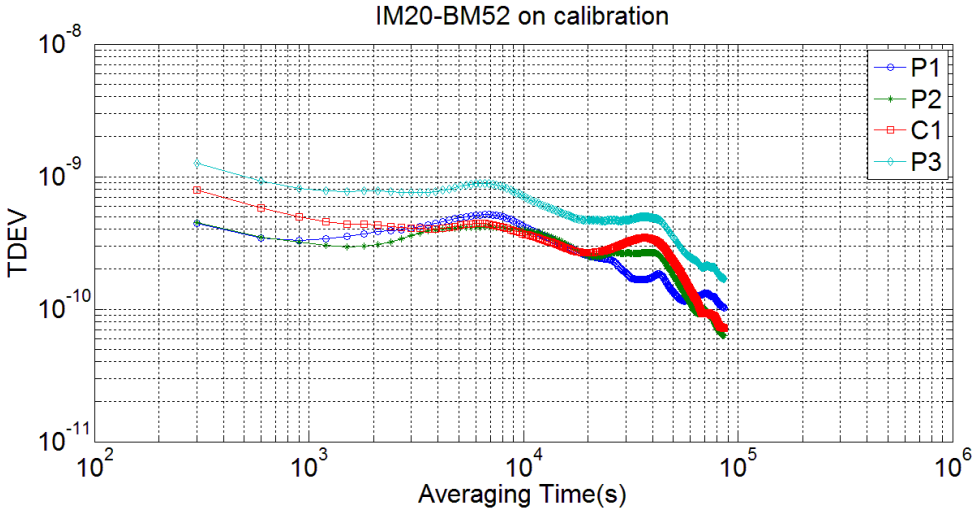

Figure 40. TDEV between IM20 and BM52 receivers at BIRM during calibration

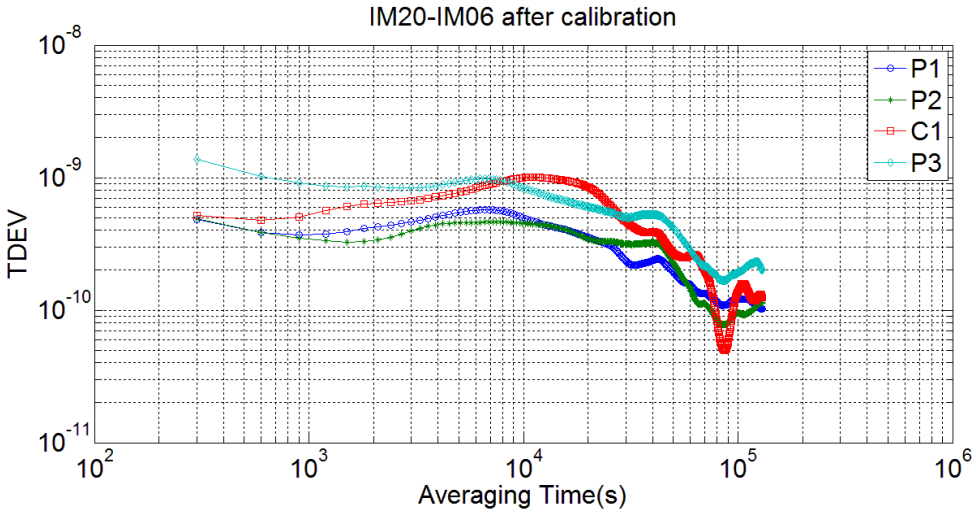

Figure 41. TDEV between IM20 and IM06 receivers at NIM after calibration