

# Calibration report for IM21&TF11

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The report is divided by five parts. The first part introduces the receivers to be calibrated. The second part describes the calibration principles briefly. The third and fourth parts describe the measurement results from the CCD experiments and data processing and calculation of the calibration. In part 5, it is shown how the calibration uncertainties are evaluated. Annex 1 includes all the related measurement plots. Annex 2 includes the TDEV plots for the CCD results. Annex 3 includes all the information sheets.

## 1. Receiver information

IM21 and TF11 (BIPM code IM31) are NIM-TF-GNSS-3 receivers including GPS, BDS(BeiDou), GLONASS and Galileo measurements and are also used for BDS and GPS time observation to get REFUTC and DUTC with the modified CGGTTS file as [1] describes.

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 | Station name | BIPM code | Model         | Role                      | Notes  |
|------------|--------------|-----------|---------------|---------------------------|--------|
| NIM        | IM06         | IM06      | Dicom GTR50   | Reference receiver        | Master |
| NIM        | IM15         | IM15      | NIM-TF-GNSS-3 | Reference receiver        |        |
| NIM        | IM21         | IM21      | NIM-TF-GNSS-3 | Receiver to be calibrated |        |
| NIM        | TF11         | IM31      | NIM-TF-GNSS-3 | Receiver to be calibrated |        |

## 2. Calibration principles

The basic calibration principles are described in [2]. The raw differences  $RAWDIF(B1/B2)_{A-B}$  between two receivers such as A and B, in the CCD experiments during the calibration, are given by

$$RAWDIF(B1/B2)_{A-B} = \Delta CABDLY_{A-B} + \Delta INTDLY(B1/B2)_{A-B} - \Delta REFDLY_{A-B} \quad (1)$$

where  $RAWDIF(B1/B2)_{A-B}$  are the differences of code measurements from Rinex or CGGTTS files without compensation of the antenna cable delay( $CABDLY$ ), the internal delay( $INTDLY$ ), and reference delay( $REFDLY$ ) from CGGTTS header.

$\Delta CABDLY_{A-B}$ , and  $\Delta REFDLY_{A-B}$  are the differences of  $CABDLY$  and  $REFDLY$  between the station to be calibrated and the reference station separately, given in table 2.

**Table 2. REF DLY and CAB DLY differences between stations**

| Pair      | MJD         | $\Delta$ REF DLY (ns) | $\Delta$ CAB DLY (ns) |
|-----------|-------------|-----------------------|-----------------------|
| IM21-IM15 | 58828-58834 | -36.3                 | 2.6                   |
| IM21-IM15 | 58852-58860 | 12.9                  | -0.1                  |
| IM21-IM15 | 58896-58902 | -36.3                 | -0.1                  |
| TF11-IM15 | 58828-58834 | -25.3                 | 2.6                   |
| TF11-IM15 | 58896-58902 | -25.3                 | 2.6                   |
| IM21-IM06 | 58828-58834 | -1.9                  | -33.7                 |
| IM21-IM06 | 58852-58860 | 47.3                  | -36.4                 |
| IM21-IM06 | 58896-58902 | -1.9                  | -36.4                 |
| TF11-IM06 | 58828-58834 | 9.1                   | -33.7                 |
| TF11-IM06 | 58896-58902 | 9.1                   | -33.7                 |

### 3. Raw difference

Raw B1I, B2I, L3B, C1, P1 and P2 differences calculated between stations are given in table 3-4.

**Table 3. Raw differences of BeiDou between stations**

| Pair      | MJD         | $\Delta$ B1I (ns) | $\Delta$ B2I (ns) | $\Delta$ L3B (ns) |
|-----------|-------------|-------------------|-------------------|-------------------|
| IM21-IM15 | 58828-58834 | 41.1              | 44.8              | 35.6              |
| IM21-IM15 | 58852-58860 | -24.2             | -22.5             | -26.7             |
| IM21-IM15 | 58896-58902 | 25.1              | 26.9              | 22.4              |
| TF11-IM15 | 58828-58834 | 29.8              | 26.1              | 35.3              |
| TF11-IM15 | 58896-58902 | 30.4              | 26.3              | 36.5              |

**Table 4. Raw differences of GPS between stations**

| Pair      | MJD         | $\Delta$ C1 (ns) | $\Delta$ P1 (ns) | $\Delta$ P2 (ns) |
|-----------|-------------|------------------|------------------|------------------|
| IM21-IM06 | 58828-58834 | -26.4            | -26.7            | -48.4            |
| IM21-IM06 | 58852-58860 | -90.7            | -90.9            | -109.3           |
| IM21-IM06 | 58896-58902 | -41.4            | -41.5            | -59.7            |
| TF11-IM06 | 58828-58834 | -38.8            | -39.2            | -64.5            |
| TF11-IM06 | 58896-58902 | -38.9            | -39.3            | -64.5            |

### 4. Calibration calculation

Table 5-6 shows *INTDLY* of station IM15 for BeiDou and *INTDLY* of station IM06 for GPS separately.  $\Delta$ *INTDLY*<sub>A-B</sub> values of *INTDLY* between the station to be calibrated and the reference station separately are computed using Eq.(1) and given in table 7-8. The *INTDLY* values of the stations to be calibrated are given in table 9-10.

#### BeiDou CCGTTS file headers

**IM21**

**MJD 58828-58834**

INT DLY = 0.0 ns (BDS B1), 0.0 ns (BDS B2)

CAB DLY = 215.0 ns

REF DLY = 119.8 ns

**MJD 58852-58860**

INT DLY = 0.0 ns (BDS B1), 0.0 ns (BDS B2)

CAB DLY = 212.3 ns

REF DLY = 169.0 ns

**MJD 58896-58902**

INT DLY = -34.6 ns (BDS B1), -35.3 ns (BDS B2)

CAB DLY = 212.3 ns

REF DLY = 119.8 ns

**TF11**

**MJD 58828-58834, 58896-58902**

INT DLY = -2.5 ns (BDS B1), -8.1 ns (BDS B2)

CAB DLY = 215.0 ns

REF DLY = 130.8 ns

**IM15 Header**

**MJD 58828-58834**

INT DLY = -23.4 ns (BDS B1), -25.8 ns (BDS B2)

CAB DLY = 214.5 ns

REF DLY = 156.1 ns

**MJD 58896-58902**

INT DLY = -23.4 ns (BDS B1), -25.8 ns (BDS B2)

CAB DLY = 212.4 ns

REF DLY = 156.1 ns

**GPS CGGTTS file headers**

**IM21**

**MJD 58828-58834**

INT DLY = -12.4 ns (GPS C1), -25.9 ns (GPS P1), -33.4 ns (GPS P2)

CAB DLY = 215.0 ns

REF DLY = 119.8 ns

**MJD 58852-58860**

INT DLY = 0.0 ns (GPS C1), 0.0 ns (GPS P1), 0.0 ns (GPS P2)

CAB DLY = 212.3 ns

REF DLY = 169.0 ns

**MJD 58896-58902**

INT DLY = -29.4 ns (GPS C1), -39.0 ns (GPS P1), -44.0 ns (GPS P2)

CAB DLY = 212.3 ns

REF DLY = 119.8 ns

**TF11**

**MJD 58828-58834, 58896-58902**

INT DLY = -6.6 ns (GPS C1), -10.6 ns (GPS P1), -10.6 ns (GPS P2)

CAB DLY = 215.0 ns

REF DLY = 130.8 ns

**IM06****MJD 58828-58834, 58896-58902**

INT DLY = -31.0 ns (GPS C1), -31.8 ns (GPS P1), -18.4 ns (GPS P2)

CAB DLY = 248.7 ns

REF DLY = 121.7 ns

**Table 5. INTDLY of BeiDou for station IM15**

| Rcvr | B1I (ns) | B2I (ns) |
|------|----------|----------|
| IM15 | -23.4    | -25.8    |

**Table 6. INTDLY of GPS for station IM06 from 1001-2018**

| Rcvr | C1 (ns) | P1 (ns) | P2 (ns) |
|------|---------|---------|---------|
| IM06 | -31.0   | -31.8   | -18.4   |

**Table 7. INTDLY differences of BeiDou between stations**

| Pair      | MJD         | $\Delta$ INTDLY(B1I) (ns) | $\Delta$ INTDLY(B2I) (ns) |
|-----------|-------------|---------------------------|---------------------------|
| IM21-IM15 | 58828-58834 | 2.2                       | 5.9                       |
| IM21-IM15 | 58852-58860 | -11.2                     | -9.5                      |
| IM21-IM15 | 58896-58902 | -11.1                     | -9.3                      |
| TF11-IM15 | 58828-58834 | 1.9                       | -1.8                      |
| TF11-IM15 | 58896-58902 | 2.5                       | -1.6                      |

**Table 8. INTDLY differences of GPS between stations**

| Pair      | MJD         | $\Delta$ INTDLY(C1) (ns) | $\Delta$ INTDLY(P1) (ns) | $\Delta$ INTDLY(P2) (ns) |
|-----------|-------------|--------------------------|--------------------------|--------------------------|
| IM21-IM06 | 58828-58834 | 5.4                      | 5.1                      | -16.6                    |
| IM21-IM06 | 58852-58860 | -7.0                     | -7.2                     | -25.6                    |
| IM21-IM06 | 58896-58902 | -6.9                     | -7.0                     | -25.2                    |
| TF11-IM06 | 58828-58834 | 4.0                      | 3.6                      | -21.7                    |
| TF11-IM06 | 58896-58902 | 3.9                      | 3.5                      | -21.7                    |

**Table 9. IM21&TF11 INTDLY values for BeiDou referenced to IM15**

| Rcvr | Data used       | B1I (ns) | B2I (ns) |
|------|-----------------|----------|----------|
| IM21 | MJD 58828-58834 | -21.2    | -19.9    |
|      | MJD 58852-58860 | -34.6    | -35.3    |
|      | MJD 58896-58902 | -34.5    | -35.1    |
| TF11 | MJD 58828-58834 | -21.5    | -27.6    |
|      | MJD 58896-58902 | -20.9    | -27.4    |

Note: The hardware of IM21 was upgraded in MJD 58864.

**Table 10. IM21&TF11 INTDLY values for GPS referenced to IM06**

| Revr | Data used       | C1 (ns) | P1 (ns) | P2 (ns) |
|------|-----------------|---------|---------|---------|
| IM21 | MJD 58828-58834 | -25.6   | -26.7   | -35.0   |
|      | MJD 58852-58860 | -38.0   | -39.0   | -44.0   |
|      | MJD 58896-58902 | -37.9   | -38.8   | -43.6   |
| TF11 | MJD 58828-58834 | -27.0   | -28.2   | -40.1   |
|      | MJD 58896-58902 | -27.1   | -28.3   | -40.1   |

**5. Uncertainty evaluation**

Here we evaluated the uncertainty from the sources as follows and got the combined uncertainty as 1.5 ns conservatively for B codes, C1 and P 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 2. The misclosure values of IM21 calibration are the differences between the calibration values from the data of MJD 58852-58861 and MJD 58896-58902; the misclosure values of TF11 calibration are the differences between the calibration values from the data of MJD 58828-58834 and MJD 58896-58902.

**Table 9. Uncertainty contributions**

| Unc.   | Value B1 (ns) | Value B2 (ns) | Value C1 (ns) | Value P1 (ns) | Value P2 (ns) | Description                       |
|--|---------------|---------------|---------------|---------------|---------------|-----------------------------------|
| $u_a$ (T-V)  | 0             | 0             | 0             | 0             | 0             | RAWDIF (traveling-visited)        |
| $u_a$ (T-R)  | 0.2           | 0.2           | 0.2           | 0.2           | 0.2           | RAWDIF (traveling-reference)      |
| $u_a$  | 0.2           | 0.2           | 0.2           | 0.2           | 0.2           |                                   |
| Misclosure   |               |               |               |               |               |                                   |
| $u_{b,1}$  | 0.6           | 0.2           | 0.1           | 0.2           | 0.4           | observed mis-closure              |
| Systematic components related to RAWDIF              |               |               |               |               |               |                                   |
| $u_{b,11}$   | 0.05          | 0.05          | 0.05          | 0.05          | 0.05          | Position error at reference       |
| $u_{b,12}$   | 0             | 0             | 0             | 0             | 0             | Position error at visited         |
| $u_{b,13}$   | 0.2           | 0.2           | 0.2           | 0.2           | 0.2           | Multipaths at reference           |
| $u_{b,14}$   | 0             | 0             | 0             | 0             | 0             | Multipaths at visited             |
| Link of the Traveling system to the local UTC( $k$ ) |               |               |               |               |               |                                   |
| $u_{b,21}$   | 0.5           | 0.5           | 0.5           | 0.5           | 0.5           | $REFDLY_T$ (at ref lab)           |
| $u_{b,22}$   | 0             | 0             | 0             | 0             | 0             | $REFDLY_T$ (at visited lab)       |
| $u_{b,TOT}$  | 0.8           | 0.6           | 0.6           | 0.6           | 0.7           |                                   |
| Link of the Reference system to its local UTC( $k$ ) |               |               |               |               |               |                                   |
| $u_{b,31}$   | 0.5           | 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             | 0             | 0             | 0             | 0             | $REFDLY_V$ (at visited lab)       |
| $u_{b,SYS}$  | 1.0           | 0.8           | 0.7           | 0.8           | 0.9           | Components of equation (2)        |
| $u_{CAL}$  | 1.0           | 0.8           | 0.8           | 0.8           | 0.9           | Composed of $u_a$ and $u_{b,SYS}$ |
| Antenna cable delays                                 |               |               |               |               |               |                                   |
| $u_{b,41}$   | 0.5           | 0.5           | 0.5           | 0.5           | 0.5           | $CABDLY_R$                        |
| $u_{b,42}$   | 0             | 0             | 0             | 0             | 0             | $CABDLY_V$                        |
| <b>Combined Uncertainty: 1.1 ns</b>                  |               |               |               |               |               |                                   |

## **References:**

- [1]. BIPM.TM 272-Definition and format of GNSS time monitoring data.
- [2]. BIPM. BIPM guidelines for GNSS calibration(V3.2). 05, 02, 2016.

## Annex 1: CCD results

### IM21

BeiDou using CGGTTS

MJD 58828-58834

IM21 Header

INT DLY = 0.0 ns (BDS B1), 0.0 ns (BDS B2)

CAB DLY = 215.0 ns

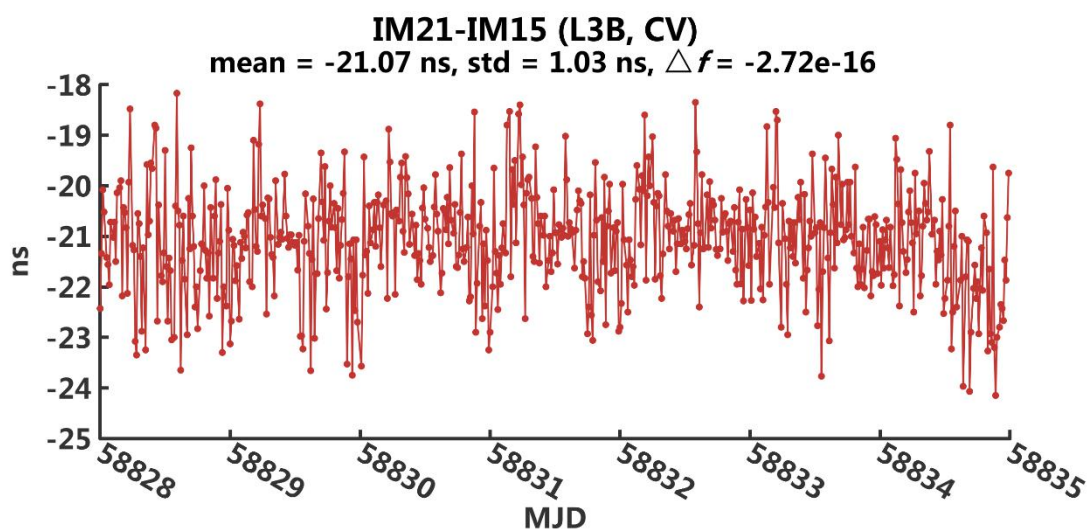
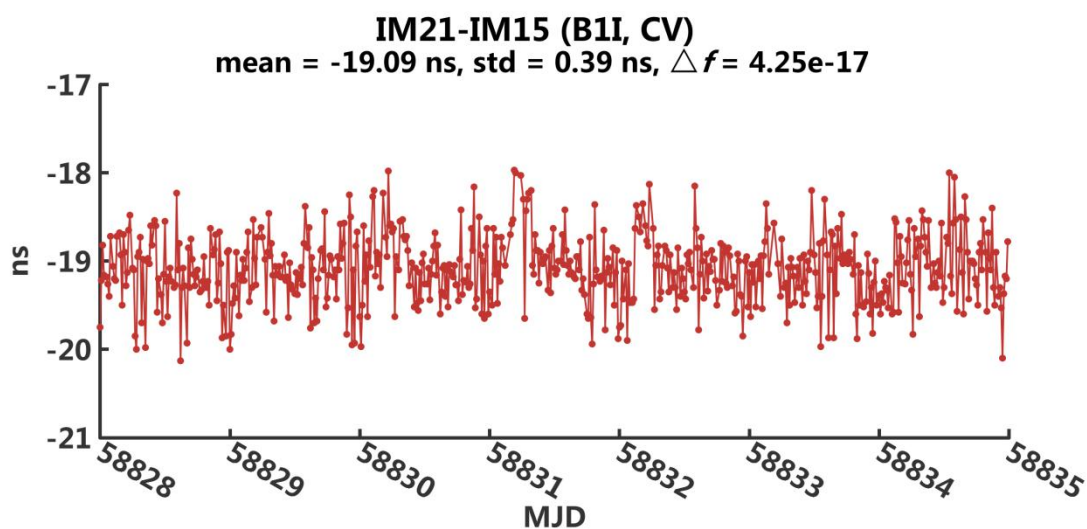
REF DLY = 119.8 ns

IM15 Header

INT DLY = -23.4 ns (BDS B1), -25.8 ns (BDS B2)

CAB DLY = 214.5 ns

REF DLY = 156.1 ns



MJD 58852-58860

IM21 Header

INT DLY = 0.0 ns (BDS B1), 0.0 ns (BDS B2)

CAB DLY = 212.3 ns

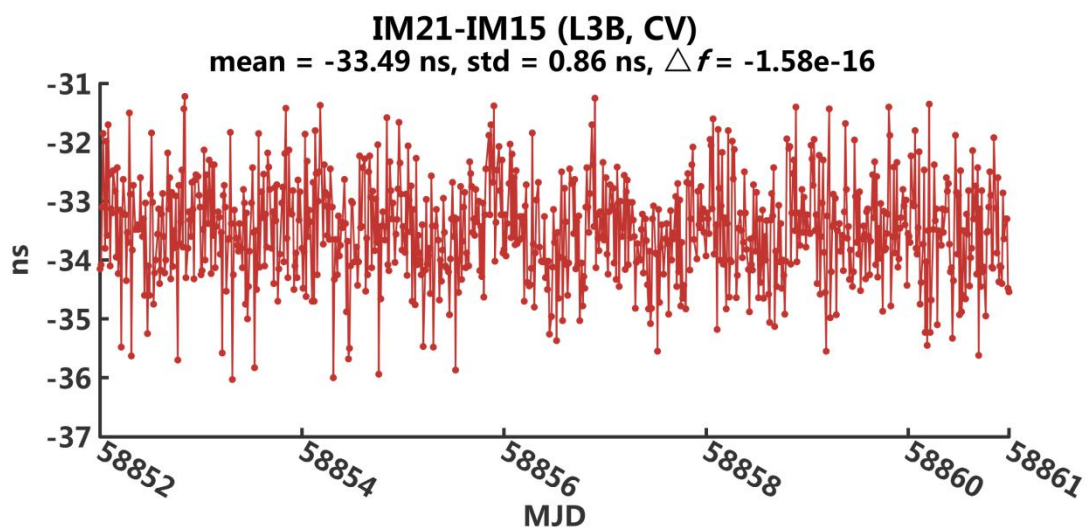
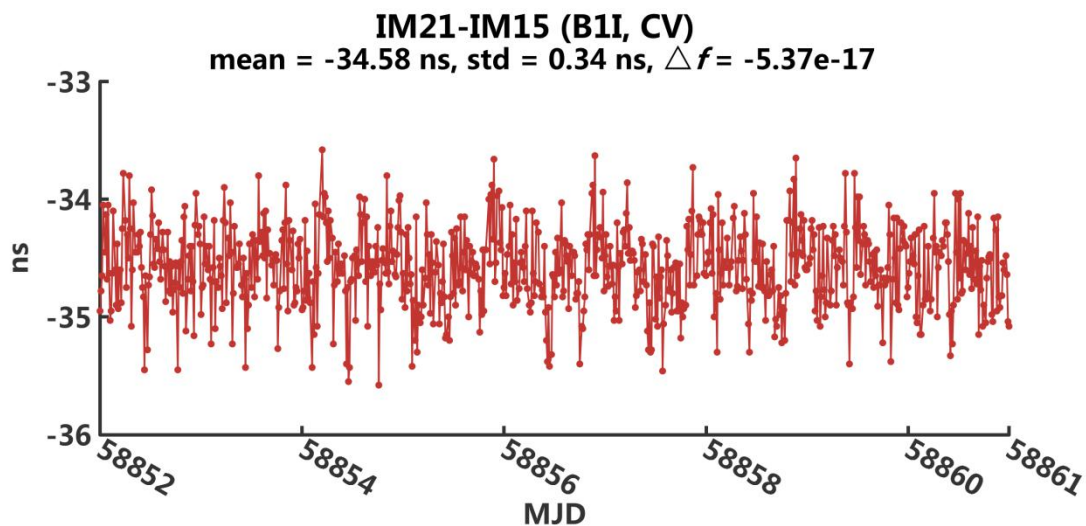
REF DLY = 169.0 ns

**IM15 Header**

INT DLY = -23.4 ns (BDS B1), -25.8 ns (BDS B2)

CAB DLY = 212.4 ns

REF DLY = 156.1 ns



**MJD 58896-58902**

**IM21 Header**

INT DLY = -34.6 ns (BDS B1), -35.3 ns (BDS B2)

CAB DLY = 212.3 ns

REF DLY = 119.8 ns

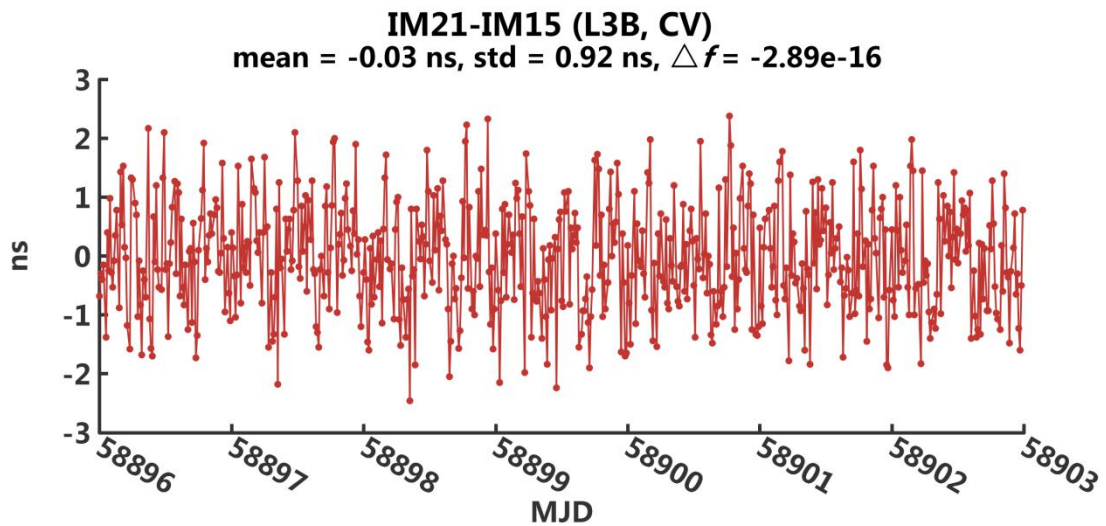
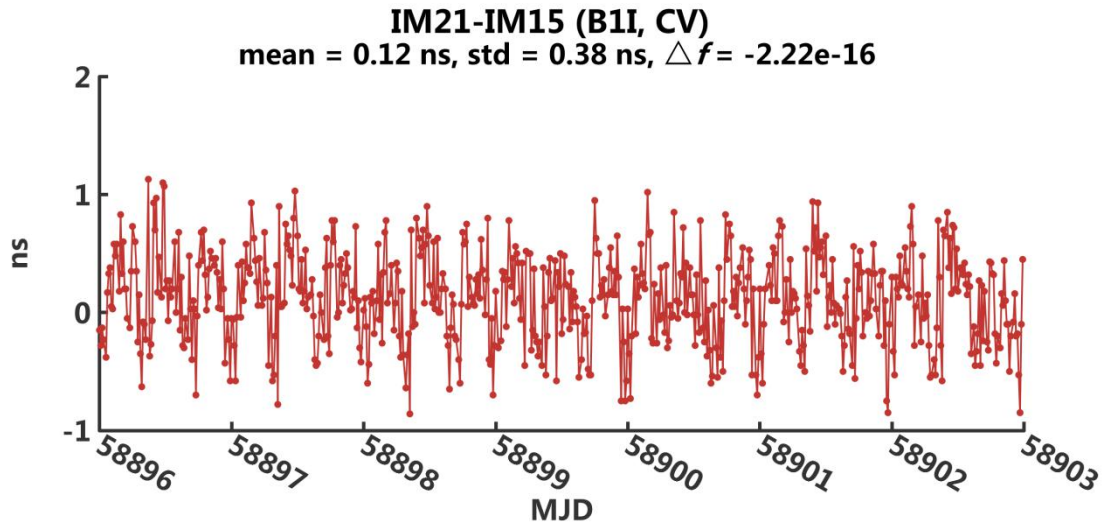
**IM15 Header**

INT DLY = -23.4 ns (BDS B1), -25.8 ns (BDS B2)

CAB DLY = 212.4 ns

REF DLY = 156.1 ns





**GPS using Rinex**

**MJD 58828-58834**

**IM21 Header**

INT DLY = -12.4 ns (GPS C1), -25.9 ns (GPS P1), -33.4 ns (GPS P2)

CAB DLY = 215.0 ns

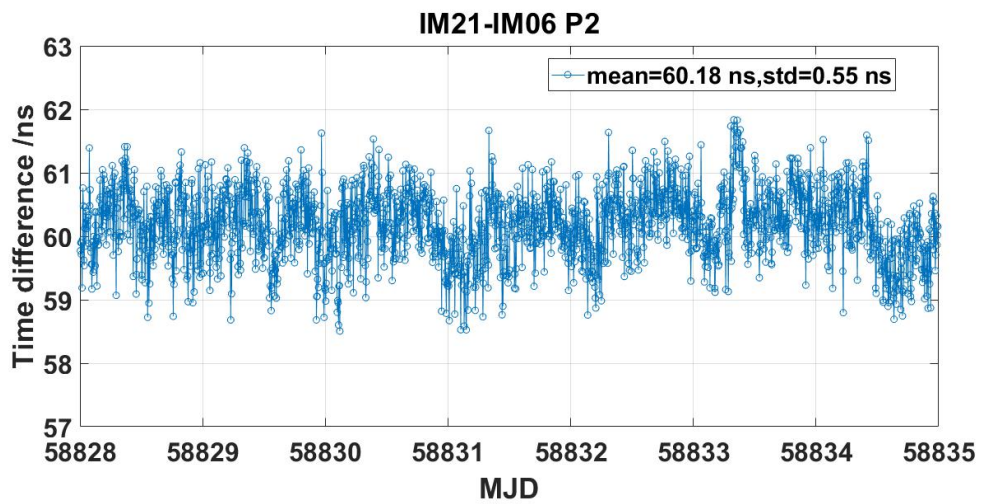
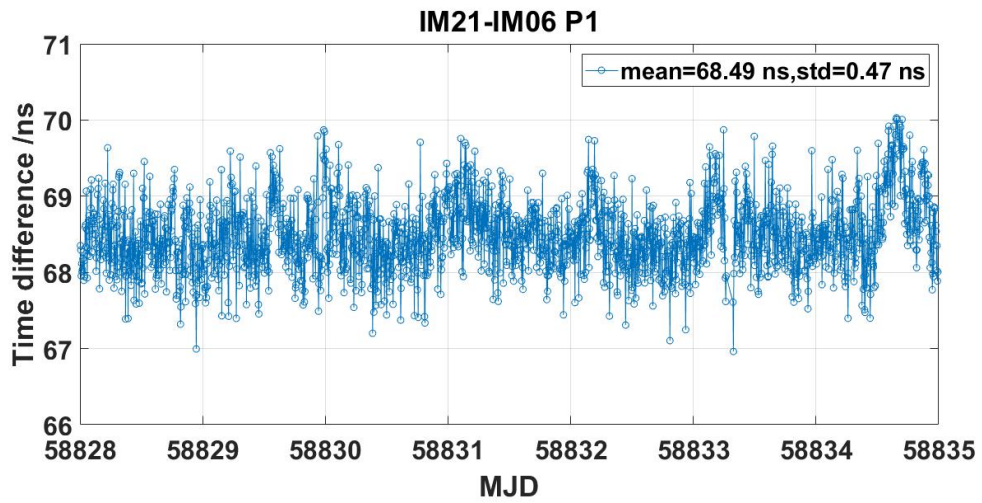
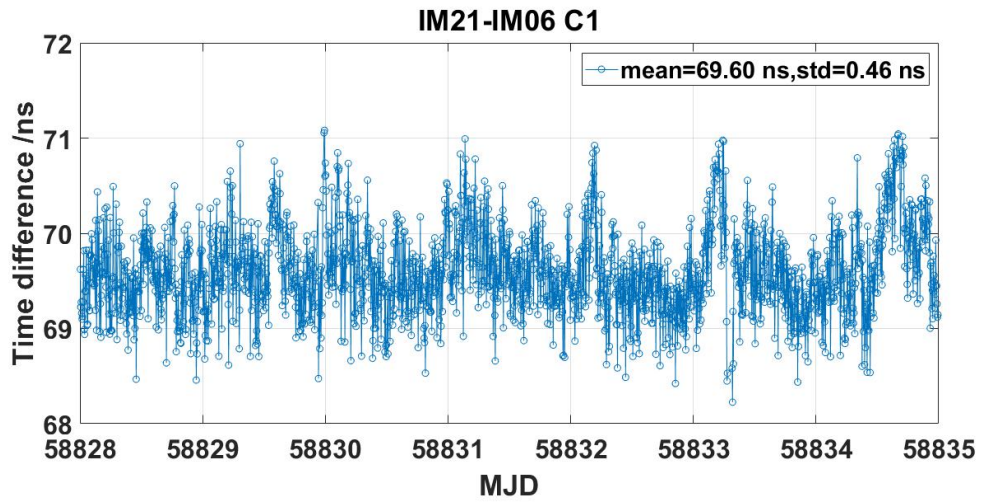
REF DLY = 119.8 ns

**IM06 Header**

INT DLY = -31.0 ns (GPS C1), -31.8 ns (GPS P1), -18.4 ns (GPS P2)

CAB DLY = 248.7 ns

REF DLY = 121.7 ns



**MJD 58852-58860**

**IM21 Header**

INT DLY = 0.0 ns (GPS C1), 0.0 ns (GPS P1), 0.0 ns (GPS P2)

CAB DLY = 212.3 ns

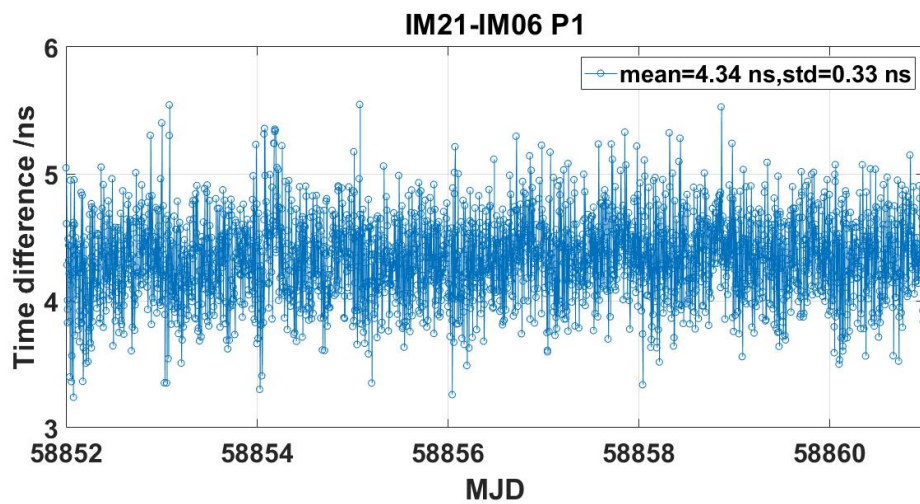
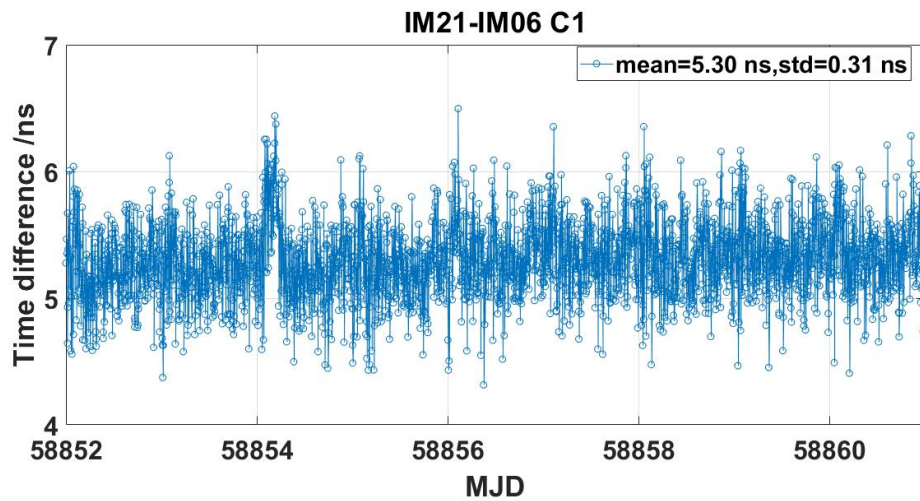
REF DLY = 169.0 ns

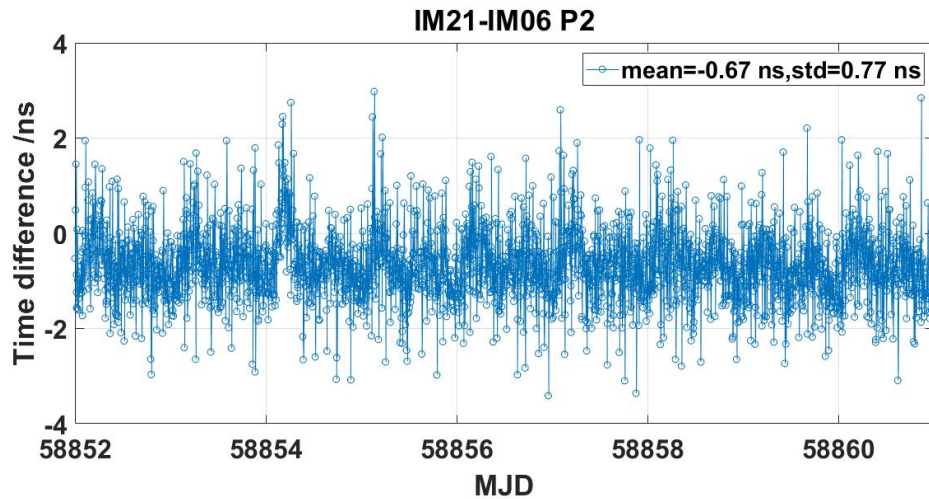
**IM06 Header**

INT DLY = -31.0 ns (GPS C1), -31.8 ns (GPS P1), -18.4 ns (GPS P2)

CAB DLY = 248.7 ns

REF DLY = 121.7 ns





**MJD 58896-58902**

**IM21 Header**

INT DLY = -29.4 ns (GPS C1), -39.0 ns (GPS P1), -44.0 ns (GPS P2)

CAB DLY = 212.3 ns

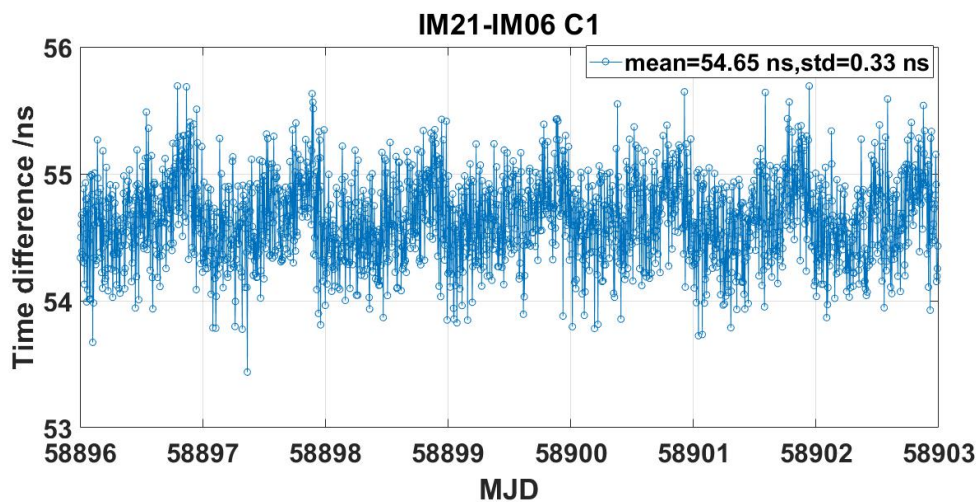
REF DLY = 119.8 ns

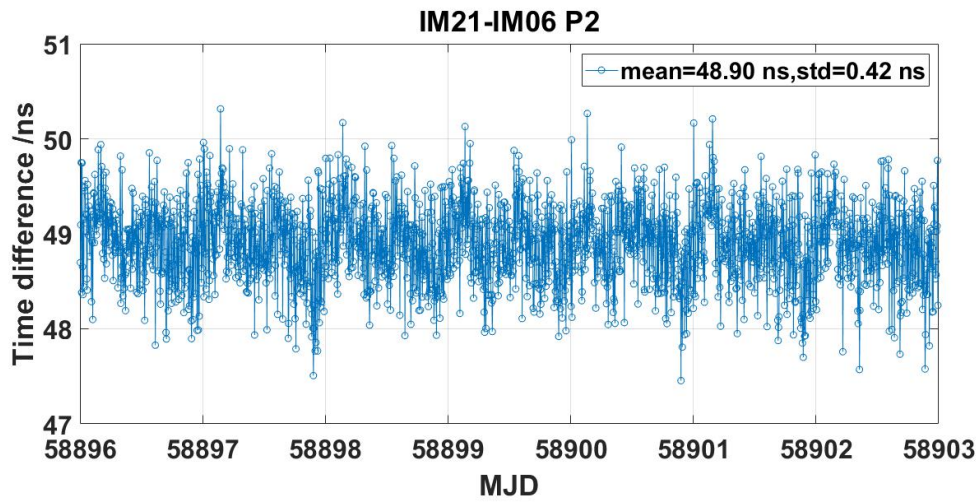
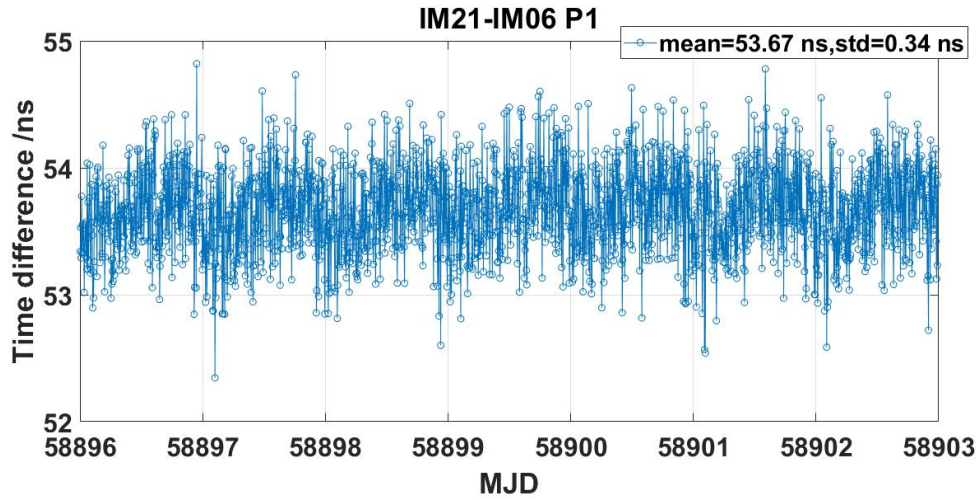
**IM06 Header**

INT DLY = -31.0 ns (GPS C1), -31.8 ns (GPS P1), -18.4 ns (GPS P2)

CAB DLY = 248.7 ns

REF DLY = 121.7 ns





## TF11

**BeiDou using CGGTTS**

**MJD 58828-58834**

**TF11 Header**

INT DLY = -2.5 ns (BDS B1), -8.1 ns (BDS B2)

CAB DLY = 215.0 ns

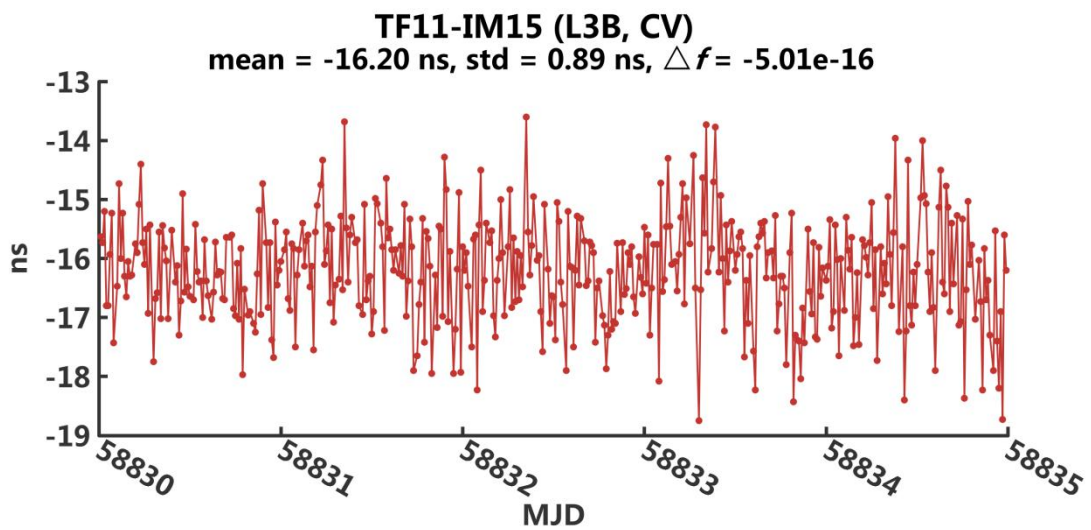
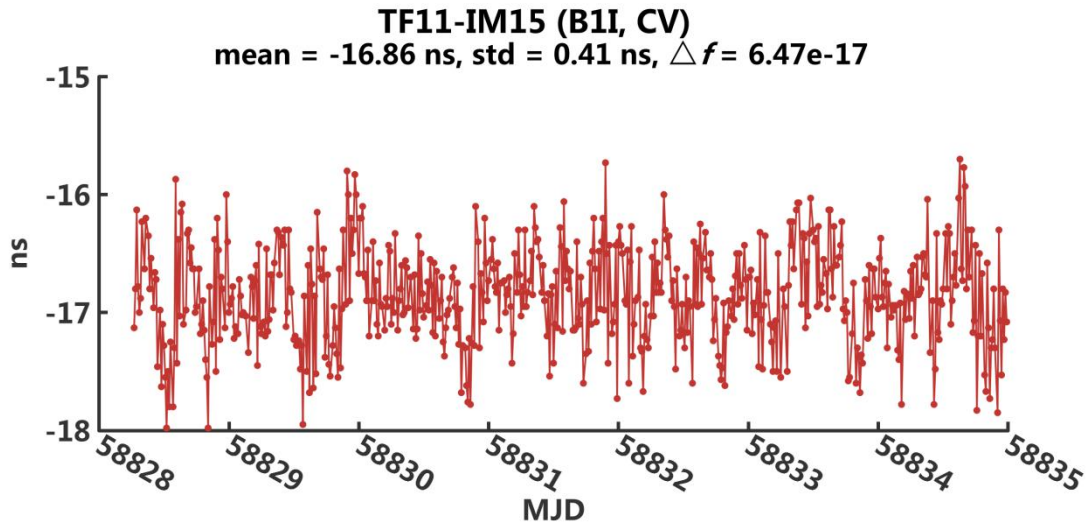
REF DLY = 130.8 ns

**IM15 Header**

INT DLY = -23.4 ns (BDS B1), -25.8 ns (BDS B2)

CAB DLY = 214.5 ns

REF DLY = 156.1 ns



**MJD 58896-58902**

**TF11 Header**

INT DLY = -2.5 ns (BDS B1), -8.1 ns (BDS B2)

CAB DLY = 215.0 ns

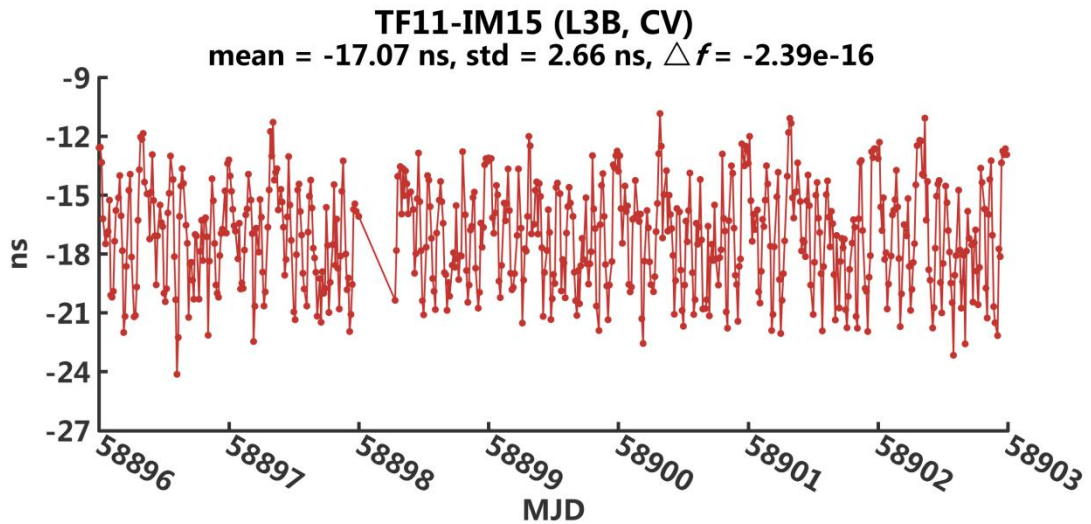
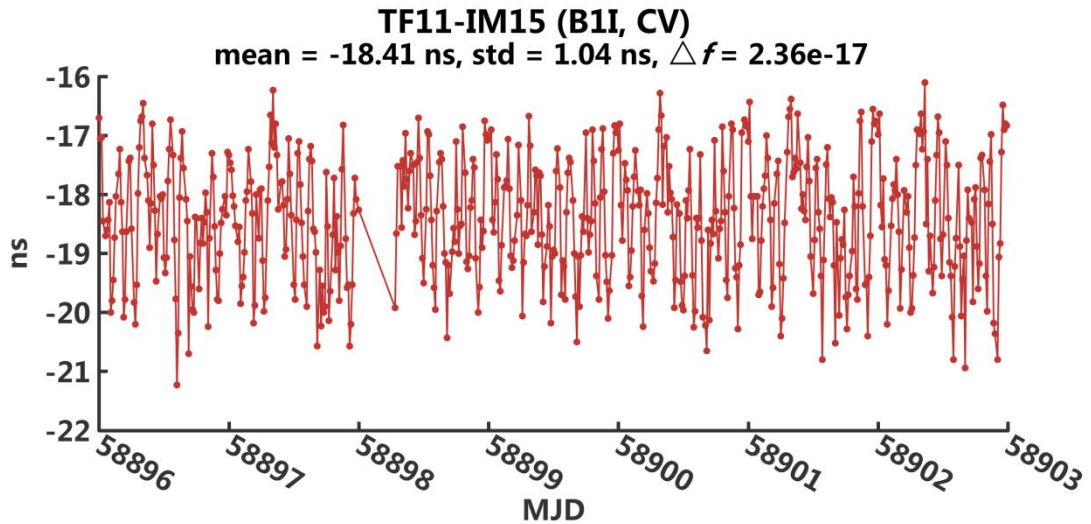
REF DLY = 130.8 ns

**IM15 Header**

INT DLY = -23.4 ns (BDS B1), -25.8 ns (BDS B2)

CAB DLY = 212.4 ns

REF DLY = 156.1 ns



**GPS using Rinex**

**MJD 58828-58834**

**TF11 Header**

INT DLY = -6.6 ns (GPS C1), -10.6 ns (GPS P1), -10.6 ns (GPS P2)

CAB DLY = 215.0 ns

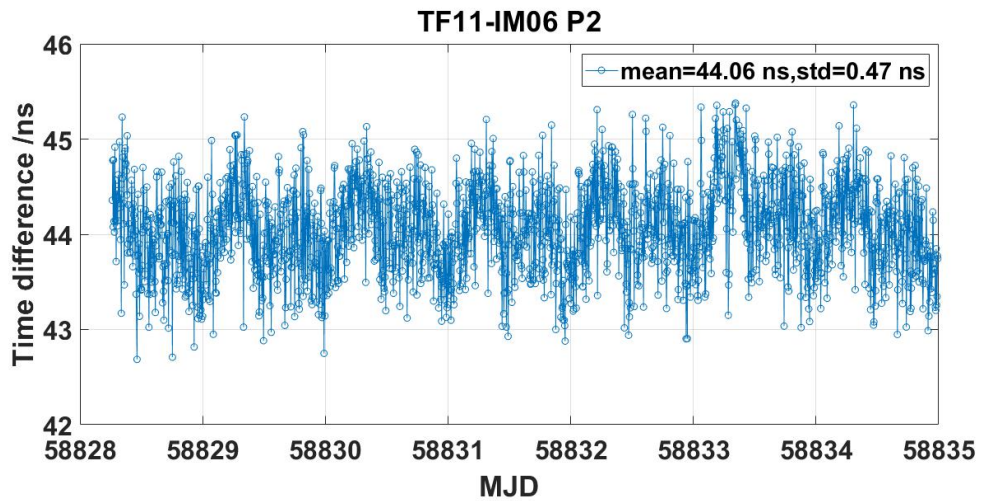
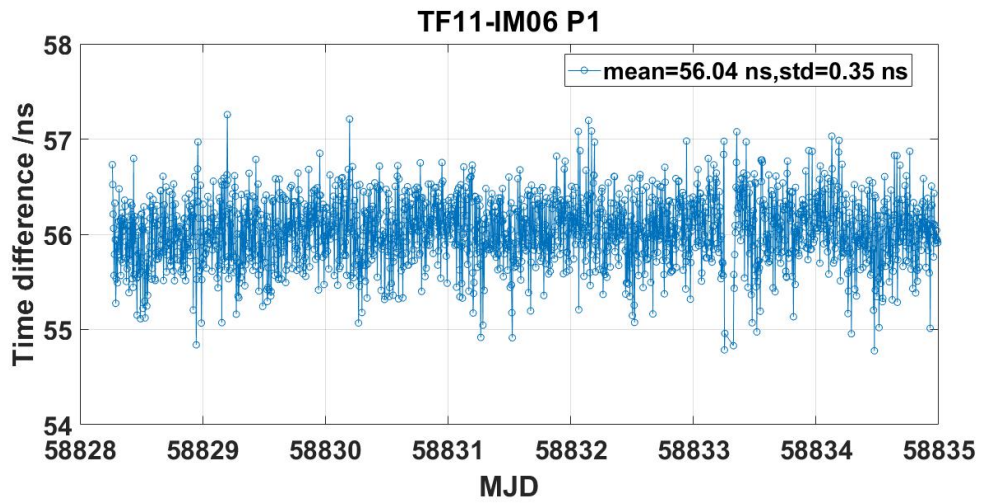
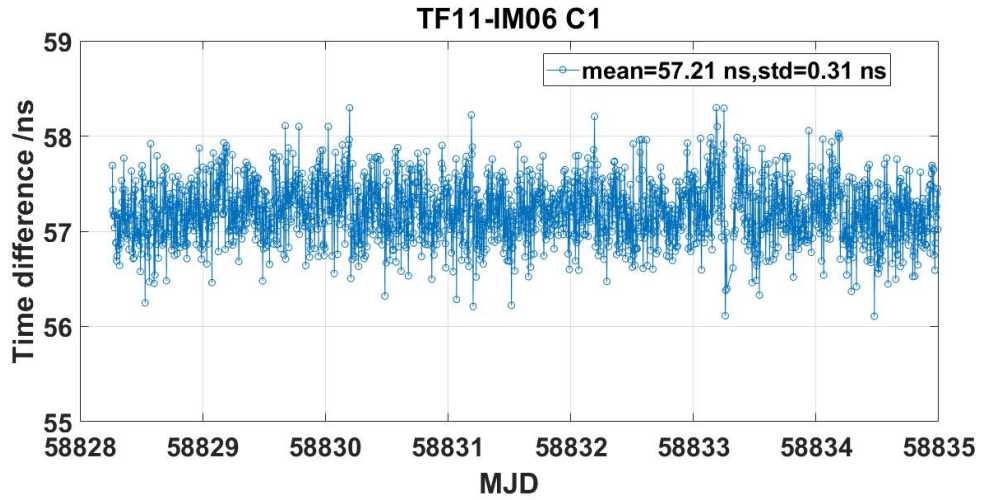
REF DLY = 130.8 ns

**IM06 Header**

INT DLY = -31.0 ns (GPS C1), -31.8 ns (GPS P1), -18.4 ns (GPS P2)

CAB DLY = 248.7 ns

REF DLY = 121.7 ns



**MJD 58896-58902**

**TF11 Header**

INT DLY = -6.6 ns (GPS C1), -10.6 ns (GPS P1), -10.6 ns (GPS P2)

CAB DLY = 215.0 ns



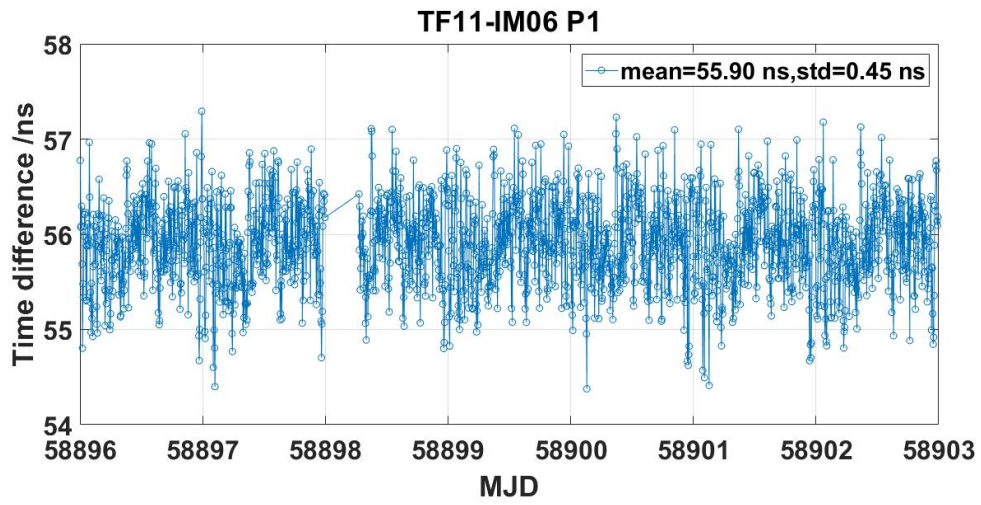
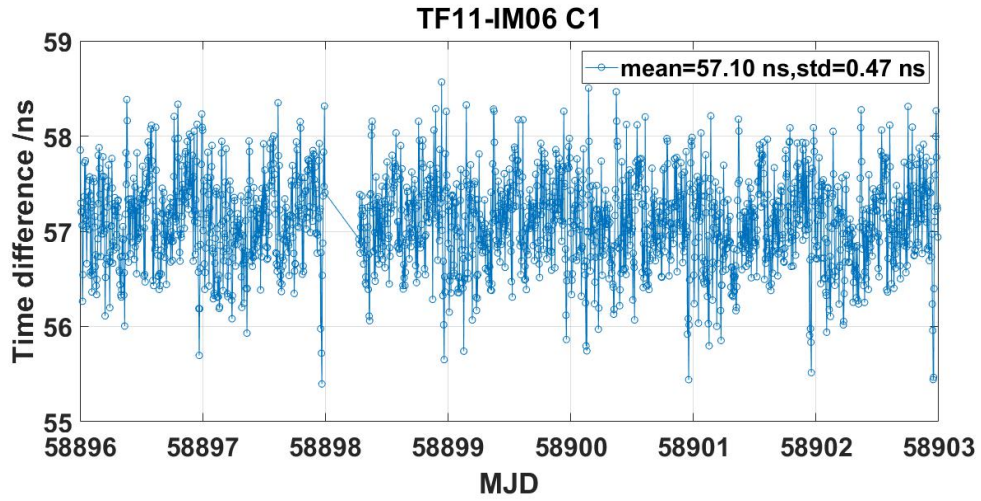
REF DLY = 130.8 ns

**IM06 Header**

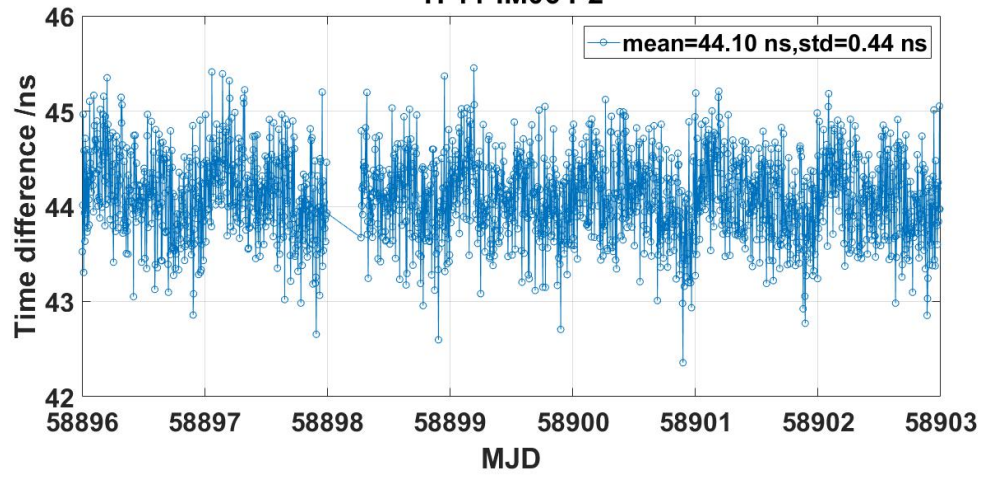
INT DLY = -31.0 ns (GPS C1), -31.8 ns (GPS P1), -18.4 ns (GPS P2)

CAB DLY = 248.7 ns

REF DLY = 121.7 ns

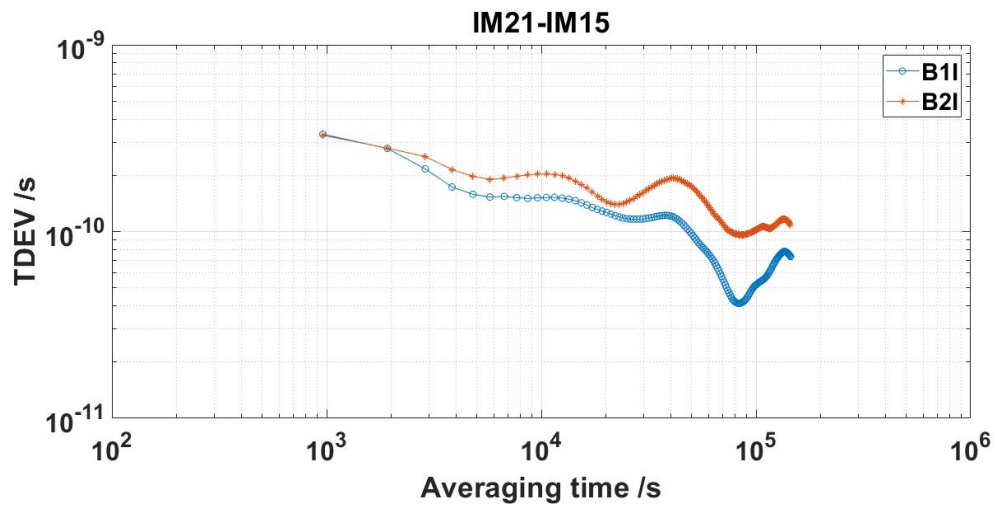


### TF11-IM06 P2

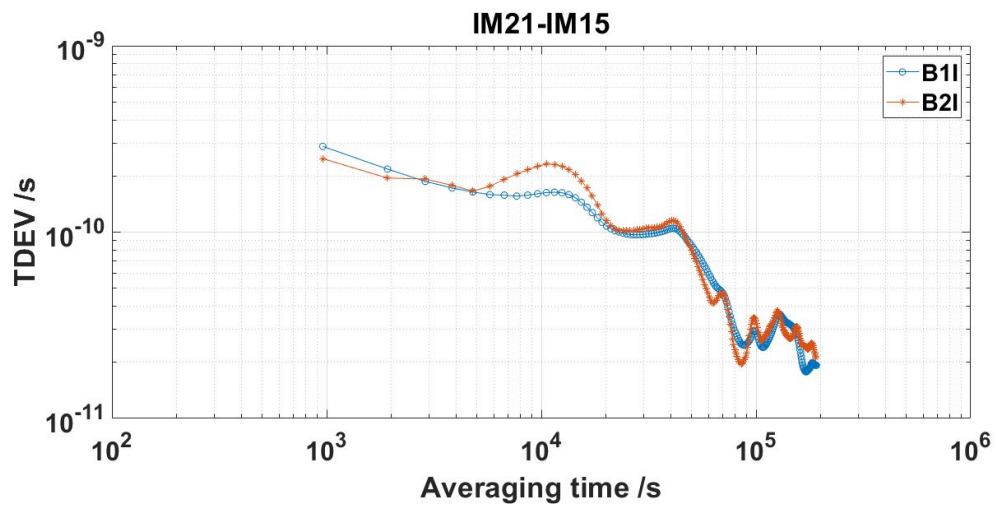


## Annex 2: TDEV for CCD results:

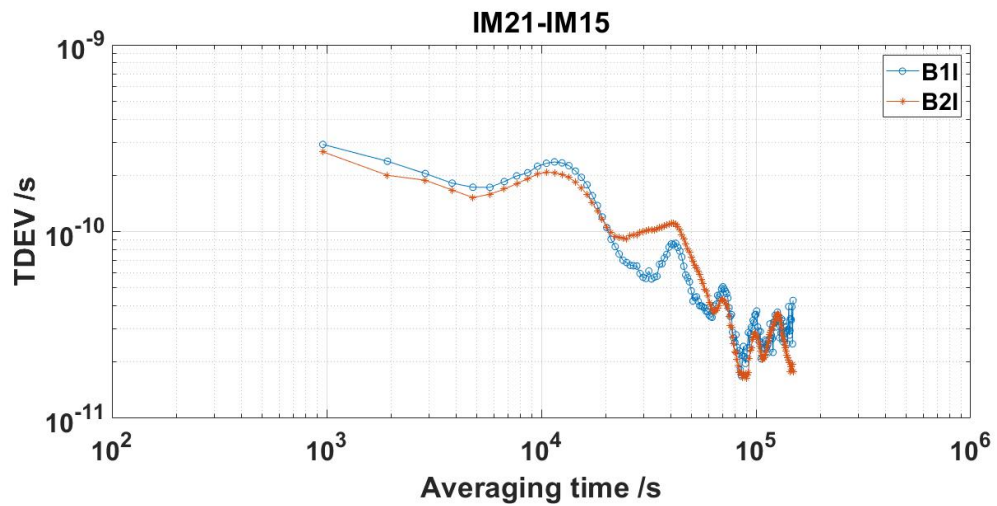
MJD 58828-58834:



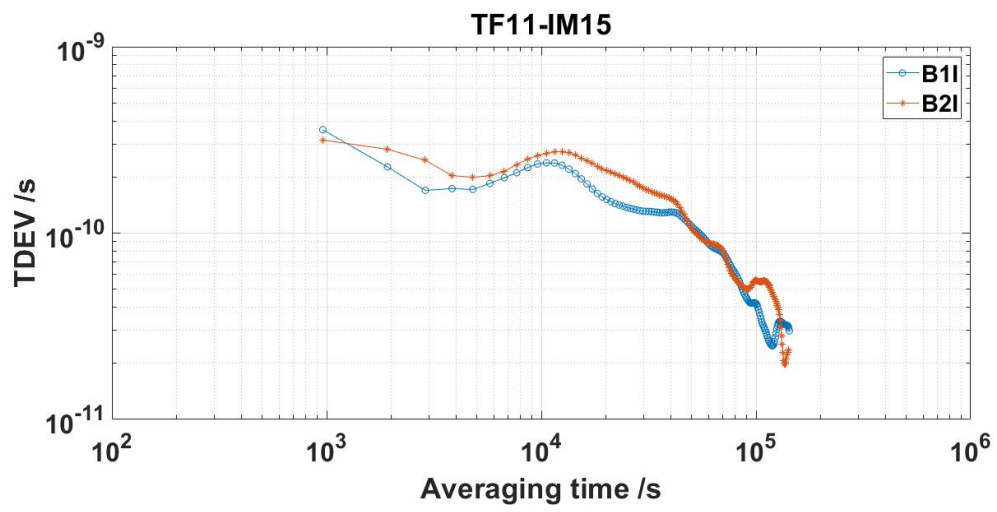
MJD 58852-58860:



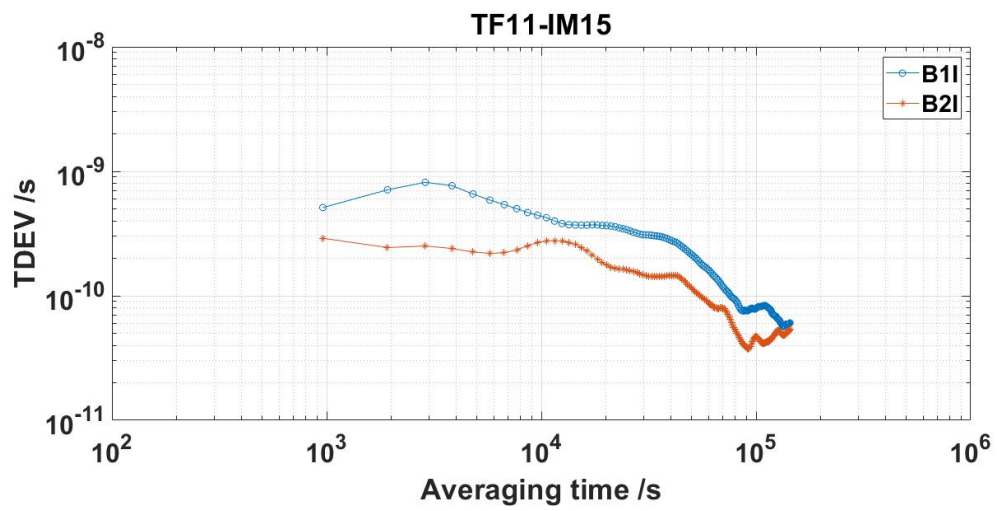
MJD 58896-58902:



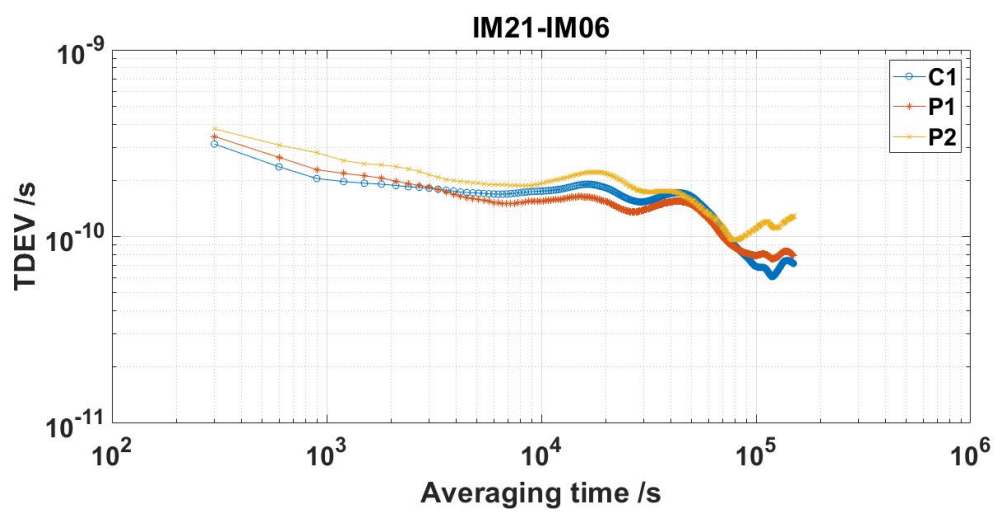
MJD 58828-58834:



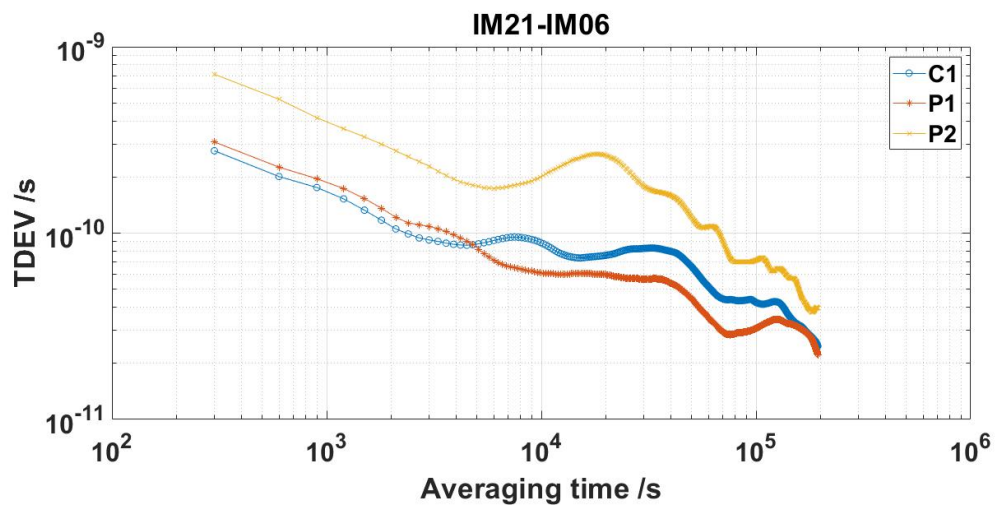
MJD 58896-58902:



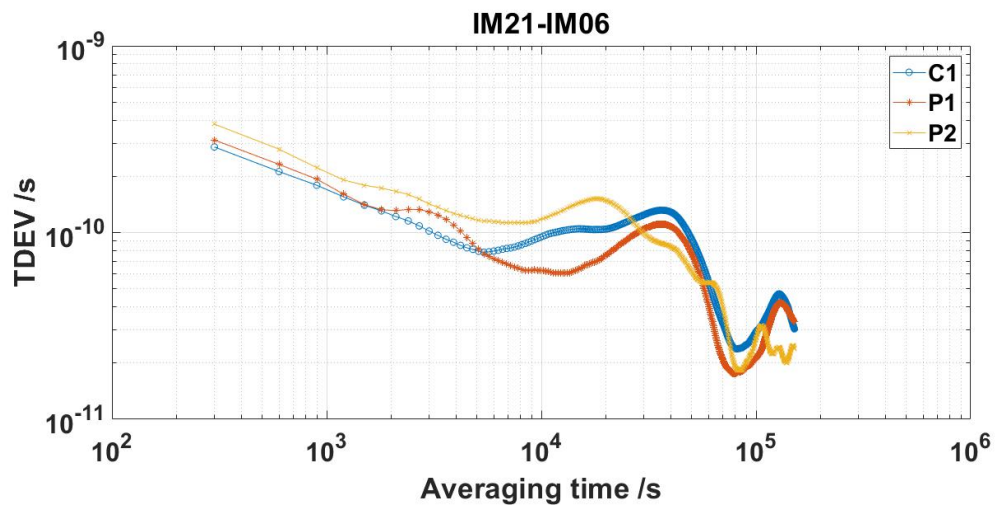
MJD 58828-58834:



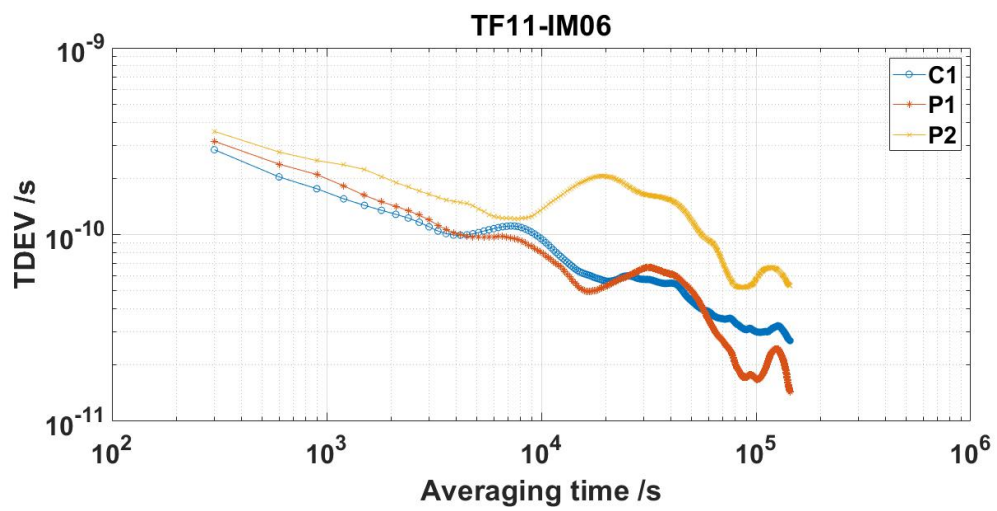
MJD 58852-58860:



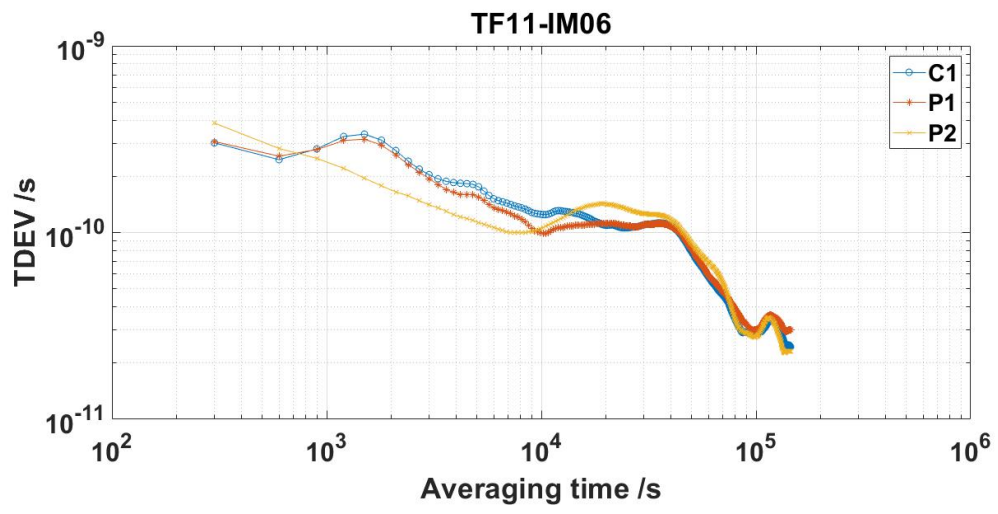
MJD 58896-58902:



MJD 58828-58834:



MJD 58896-58902:



## Annex 3: Information Sheets

### Information Sheet

(to be repeated for each calibrated system)

| Laboratory:  | NIM   |  |
|--|---|--|
| Date and hour of the beginning of measurements:                | UTC time 0:00 am Dec. 11, 2019  |  |
| Date and hour of the end of measurements:                      | UTC time 0:00 am Dec. 18, 2019  |  |
| Information on the system                                      |   |  |
|  | Local:  | Receiver to be calibrated:   |
| 4-character BIPM code  | (1)IM15<br>(2)IM06  | (1)IM21<br>(2)TF11   |
| Receiver maker and type:<br>Receiver serial number:            | (1)maker: NIM<br>type: NIM-TF-GNSS-3<br>serial number: 2016016<br>(2)maker:Dicom<br>type: GTR50<br>serial number:1007011                    | (1)maker: NIM<br>type: NIM-TF-GNSS-3<br>serial number: 2016006<br>(2)maker: NIM<br>type: NIM-TF-GNSS-3<br>serial number: 2016011             |
| 1 PPS trigger level /V:  | 0~2   | 0~2  |
| Antenna cable maker and type:<br>Phase stabilised cable (Y/N): | maker:<br>type:<br>Phase stabilised cable:N   | maker:<br>type:<br>Phase stabilised cable:N  |
| Length outside the building /m:                                | (1) 5 m<br>(2) 5 m  | (1) 5 m<br>(2) 5 m   |
| Antenna maker and type:<br>Antenna serial number:              | (1)maker: Harxon<br>type: HXCCSX601A<br>Serial number:<br>2016016<br>(2)maker:Novatel<br>type: GPS-702-GGG<br>Serial number:<br>NAE10220060 | (1)maker: Harxon<br>type: HXCCSX601A<br>Serial number:<br>2016050147<br>(2)maker: Harxon<br>type: HXCCSX601A<br>Serial number:<br>2016050150 |
| Temperature (if stabilised) /°C                                |   |  |
| Measured delays /ns  |   |  |
|  | Local:  | Receiver to be calibrated:   |
| Delay from local UTC to receiver 1 PPS-in:                     | (1)156.1<br>(2)121.7  | (1)119.8<br>(2)130.8   |

|   |                      |                      |
|---|----------------------|----------------------|
| Delay from 1 PPS-in to internal Reference (if different): |                      |                      |
| Antenna cable delay:                                      | (1)212.4<br>(2)248.7 | (1)215.0<br>(2)215.0 |
| Splitter delay (if any):                                  |                      |                      |
| Additional cable delay (if any):                          |                      |                      |

### **Data used for the generation of CGGTTS files (IM15)**

|                              |                                |
|------------------------------|--------------------------------|
| INT DLY (BDS) /ns:           | -23.4 (BDS B1), -25.8 (BDS B2) |
| INT DLY (GLONASS) /ns:       | 0.0                            |
| CAB DLY /ns:                 | 214.5                          |
| REF DLY /ns:                 | 156.1                          |
| Coordinates reference frame: | ITRF                           |
| Latitude or X /m:            | -2154286.895                   |
| Longitude or Y /m:           | +4373440.505                   |
| Height or Z /m:              | +4098885.481                   |

### **Data used for the generation of CGGTTS files (IM06)**

|                              |  |
|------------------------------|--|
| INT DLY (GPS) /ns:           | -31.8 (GPS P1), -18.4 (GPS P2), -31.0 (GPS C1) |
| INT DLY (GLONASS) /ns:       | 0.0  |
| CAB DLY /ns:                 | 248.7  |
| REF DLY /ns:                 | 121.7  |
| Coordinates reference frame: | ITRF   |
| Latitude or X /m:            | -2154288.06                                    |
| Longitude or Y /m:           | +4373440.56                                    |
| Height or Z /m:              | +4098884.94                                    |

### **Data used for the generation of CGGTTS files (IM21)**

|                              |  |
|------------------------------|--|
| INT DLY (GPS) /ns:           | -12.4 (GPS C1), -25.9 (GPS P1), -33.4 (GPS P2) |
| INT DLY (BDS) /ns:           | 0.0 (BDS B1), 0.0 (BDS B2)                     |
| CAB DLY /ns:                 | 215.0  |
| REF DLY /ns:                 | 119.8  |
| Coordinates reference frame: | ITRF   |
| Latitude or X /m:            | -2154288.053                                   |
| Longitude or Y /m:           | +4373443.586                                   |
| Height or Z /m:              | +4098881.631                                   |

### **Data used for the generation of CGGTTS files (TF11)**

|                    |   |
|--------------------|---|
| INT DLY (GPS) /ns: | -6.6 (GPS C1), -10.6 (GPS P1), -10.6 (GPS P2) |
| INT DLY (BDS) /ns: | -2.5 (BDS B1), -8.1 (BDS B2)                  |
| CAB DLY /ns:       | 215.0   |

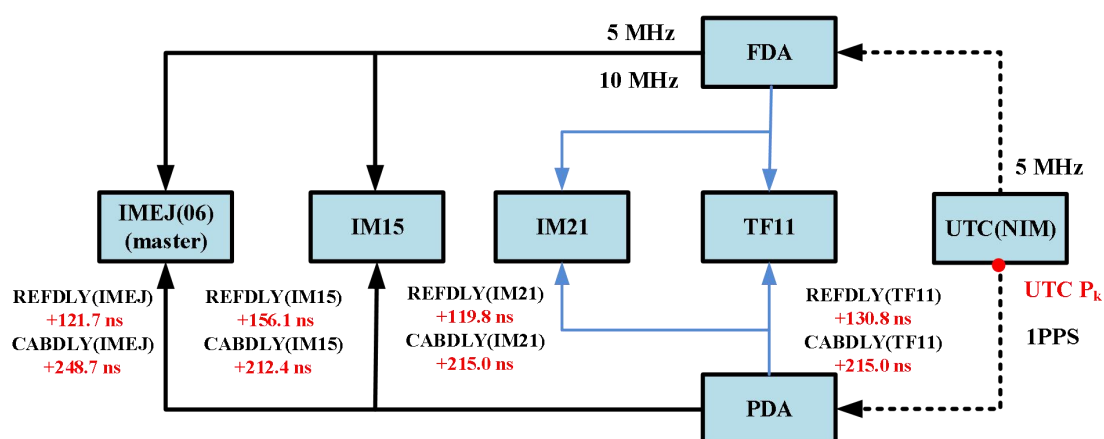


|                              |              |
|------------------------------|--------------|
| REF DLY /ns:                 | 130.8        |
| Coordinates reference frame: | ITRF         |
| Latitude or X /m:            | -2154289.455 |
| Longitude or Y /m:           | +4373442.114 |
| Height or Z /m:              | +4098882.718 |

### General information

|  |                |
|--|----------------|
| Rise time of the local UTC pulse       | unknown        |
| Is the laboratory air conditioned      | Yes            |
| Set temperature value and uncertainty: | 26.0°C ±0.2 °C |
| Set humidity value and uncertainty:    | 21% ± 1%       |

### Diagram of the experiment set-up



### Log of Events / Additional Information

## Information Sheet

(to be repeated for each calibrated system)

|   |                               |
|---|-------------------------------|
| Laboratory:                                     | NIM                           |
| Date and hour of the beginning of measurements: | UTC time 0:00 am Jan. 4,2020  |
| Date and hour of the end of measurements:       | UTC time 0:00 am Jan. 13,2020 |

### Information on the system

|                          | Local:  | Receiver to be calibrated:                    |
|--------------------------|---|---|
| 4-character BIPM code    | (1)IM15<br>(2)IM06                            | IM21  |
| Receiver maker and type: | (1)maker: NIM                                 | maker: NIM                                    |
| Receiver serial number:  | type: NIM-TF-GNSS-3<br>serial number: 2016016 | type: NIM-TF-GNSS-3<br>serial number: 2018001 |

|  |   |  |
|--|---|--|
|  | (2)maker:Dicom<br>type: GTR50<br>serial number:1007011  |  |
| 1 PPS trigger level /V:  | 0~2   | 0~2  |
| Antenna cable maker and type:<br>Phase stabilised cable (Y/N): | maker:<br>type:<br>Phase stabilised cable:N   | maker:<br>type:<br>Phase stabilised cable:N                    |
| Length outside the building /m:                                | (1) 5 m<br>(2) 5 m  | 5.0  |
| Antenna maker and type:<br>Antenna serial number:              | (1)maker: Harxon<br>type: HXCCSX601A<br>Serial number:<br>2016016<br>(2)maker:Novatel<br>type: GPS-702-GGG<br>Serial number:<br>NAE10220060 | maker: Harxon<br>type: HXCCSX601A<br>Serial number:<br>0000000 |
| Temperature (if stabilised) /°C                                |   |  |

### Measured delays /ns

|   | Local:               | Receiver to be calibrated: |
|---|----------------------|----------------------------|
| Delay from local UTC to receiver 1 PPS-in:                | (1)156.1<br>(2)121.7 | 169.0                      |
| Delay from 1 PPS-in to internal Reference (if different): |                      |                            |
| Antenna cable delay:                                      | (1)212.4<br>(2)248.7 | 212.3                      |
| Splitter delay (if any):                                  |                      |                            |
| Additional cable delay (if any):                          |                      |                            |

### Data used for the generation of CGGTTS files (IM15)

|                              |                                |
|------------------------------|--------------------------------|
| INT DLY (BDS) /ns:           | -23.4 (BDS B1), -25.8 (BDS B2) |
| INT DLY (GLONASS) /ns:       | 0.0                            |
| CAB DLY /ns:                 | 212.4                          |
| REF DLY /ns:                 | 156.1                          |
| Coordinates reference frame: | ITRF                           |
| Latitude or X /m:            | -2154286.895                   |
| Longitude or Y /m:           | +4373440.505                   |
| Height or Z /m:              | +4098885.481                   |

### Data used for the generation of CGGTTS files (IM06)

|                              |  |
|------------------------------|--|
| INT DLY (GPS) /ns:           | -31.8 (GPS P1), -18.4 (GPS P2), -31.0 (GPS C1) |
| INT DLY (GLONASS) /ns:       | 0.0  |
| CAB DLY /ns:                 | 248.7  |
| REF DLY /ns:                 | 121.7  |
| Coordinates reference frame: | ITRF   |
| Latitude or X /m:            | -2154288.06                                    |
| Longitude or Y /m:           | +4373440.56                                    |
| Height or Z /m:              | +4098884.94                                    |

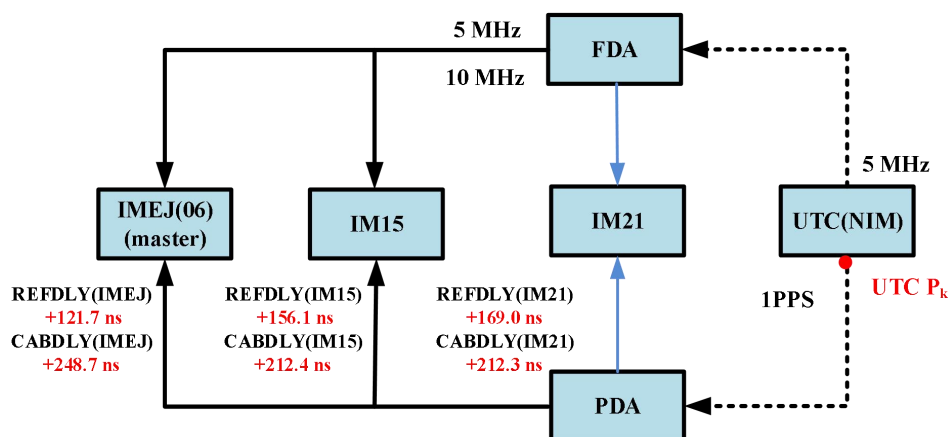
### Data used for the generation of CGGTTS files (IM21)

|                              |  |
|------------------------------|--|
| INT DLY (GPS) /ns:           | 0.0 (GPS C1), 0.0 (GPS P1), 0.0 (GPS P2) |
| INT DLY (BDS) /ns:           | 0.0 (BDS B1), 0.0 (BDS B2)               |
| CAB DLY /ns:                 | 212.3                                    |
| REF DLY /ns:                 | 169.0                                    |
| Coordinates reference frame: | ITRF                                     |
| Latitude or X /m:            | -2154284.865                             |
| Longitude or Y /m:           | +4373434.794                             |
| Height or Z /m:              | +4098892.720                             |

### General information

|  |                |
|--|----------------|
| Rise time of the local UTC pulse       | unknown        |
| Is the laboratory air conditioned      | Yes            |
| Set temperature value and uncertainty: | 26.0°C ±0.2 °C |
| Set humidity value and uncertainty:    | 21% ± 1%       |

Diagram of the experiment set-up



### Log of Events / Additional Information

|   |                               |
|---|-------------------------------|
| Laboratory:                                     | NIM                           |
| Date and hour of the beginning of measurements: | UTC time 0:00 am Feb. 17,2020 |
| Date and hour of the end of measurements:       | UTC time 0:00 am Feb. 24,2020 |

### Information on the system

|  | Local:  | Receiver to be calibrated:   |
|--|---|--|
| 4-character BIPM code  | (1)IM15<br>(2)IM06  | (1)IM21<br>(2)TF11   |
| Receiver maker and type:<br>Receiver serial number:            | (1)maker: NIM<br>type: NIM-TF-GNSS-3<br>serial number: 2016016<br>(2)maker:Dicom<br>type: GTR50<br>serial number:1007011                    | (1)maker: NIM<br>type: NIM-TF-GNSS-3<br>serial number: 120101<br>(2)maker: NIM<br>type: NIM-TF-GNSS-3<br>serial number: 2016011                |
| 1 PPS trigger level /V:  | 0~2   | 0~2  |
| Antenna cable maker and type:<br>Phase stabilised cable (Y/N): | maker:<br>type:<br>Phase stabilised cable:N   | maker:<br>type:<br>Phase stabilised cable:N  |
| Length outside the building /m:                                | (1) 5 m<br>(2) 5 m  | (1) 5 m<br>(2) 5 m   |
| Antenna maker and type:<br>Antenna serial number:              | (1)maker: Harxon<br>type: HXCCSX601A<br>Serial number:<br>2016016<br>(2)maker:Novatel<br>type: GPS-702-GGG<br>Serial number:<br>NAE10220060 | (1)maker: Harxon<br>type: HXCCSX601A<br>Serial number:<br>C18050106111<br>(2)maker: Harxon<br>type: HXCCSX601A<br>Serial number:<br>2016050150 |
| Temperature (if stabilised) /°C                                |   |  |

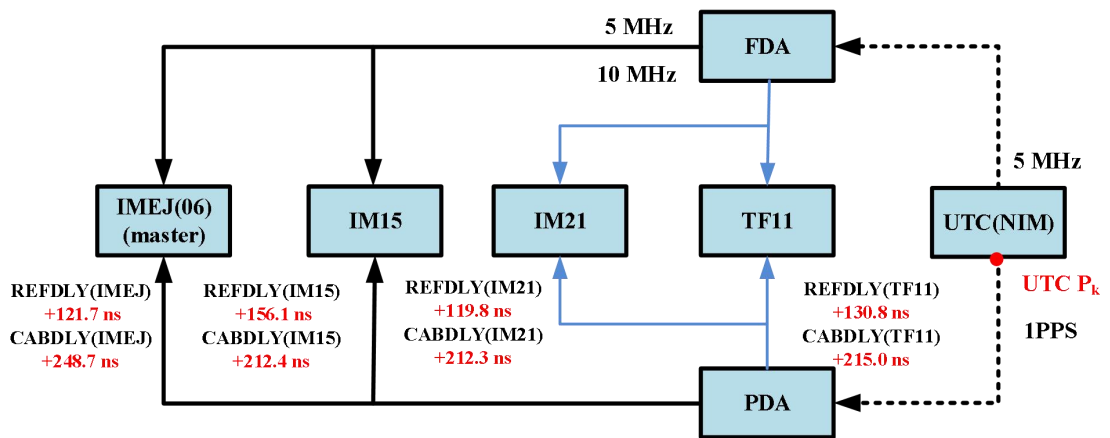
### Measured delays /ns

|   | Local:               | Receiver to be calibrated: |
|---|----------------------|----------------------------|
| Delay from local UTC to receiver 1 PPS-in:                | (1)156.1<br>(2)121.7 | (1)119.8<br>(2)130.8       |
| Delay from 1 PPS-in to internal Reference (if different): |                      |                            |
| Antenna cable delay:                                      | (1)212.4<br>(2)248.7 | (1)212.3<br>(2)215.0       |
| Splitter delay (if any):                                  |                      |                            |

|  |  |
|--|--|
| Additional cable delay (if any):                           |  |
| <b>Data used for the generation of CGGTTS files (IM15)</b> |  |
| INT DLY (BDS) /ns:   | -23.4 (BDS B1), -25.8 (BDS B2)                 |
| INT DLY (GLONASS) /ns:                                     | 0.0  |
| CAB DLY /ns:   | 212.4  |
| REF DLY /ns:   | 156.1  |
| Coordinates reference frame:                               | ITRF   |
| Latitude or X /m:  | -2154286.895                                   |
| Longitude or Y /m:   | +4373440.505                                   |
| Height or Z /m:  | +4098885.481                                   |
| <b>Data used for the generation of CGGTTS files (IM06)</b> |  |
| INT DLY (GPS) /ns:   | -31.8 (GPS P1), -18.4 (GPS P2), -31.0 (GPS C1) |
| INT DLY (GLONASS) /ns:                                     | 0.0  |
| CAB DLY /ns:   | 248.7  |
| REF DLY /ns:   | 121.7  |
| Coordinates reference frame:                               | ITRF   |
| Latitude or X /m:  | -2154288.06                                    |
| Longitude or Y /m:   | +4373440.56                                    |
| Height or Z /m:  | +4098884.94                                    |
| <b>Data used for the generation of CGGTTS files (IM21)</b> |  |
| INT DLY (GPS) /ns:   | -29.4 (GPS C1), -39.0 (GPS P1), -44.0 (GPS P2) |
| INT DLY (BDS) /ns:   | -34.6 (BDS B1), -35.3 (BDS B2)                 |
| CAB DLY /ns:   | 212.3  |
| REF DLY /ns:   | 119.8  |
| Coordinates reference frame:                               | ITRF   |
| Latitude or X /m:  | -2154284.865                                   |
| Longitude or Y /m:   | +4373434.794                                   |
| Height or Z /m:  | +4098892.720                                   |
| <b>Data used for the generation of CGGTTS files (TF11)</b> |  |
| INT DLY (GPS) /ns:   | -6.6 (GPS C1), -10.6 (GPS P1), -10.6 (GPS P2)  |
| INT DLY (BDS) /ns:   | -2.5 (BDS B1), -8.1 (BDS B2)                   |
| CAB DLY /ns:   | 215.0  |
| REF DLY /ns:   | 130.8  |
| Coordinates reference frame:                               | ITRF   |
| Latitude or X /m:  | -2154289.455                                   |
| Longitude or Y /m:   | +4373442.114                                   |

|  |                |
|--|----------------|
| Height or Z /m:                        | +4098882.718   |
| <b>General information</b>             |                |
| Rise time of the local UTC pulse       | unknown        |
| Is the laboratory air conditioned      | Yes            |
| Set temperature value and uncertainty: | 26.0°C ±0.2 °C |
| Set humidity value and uncertainty:    | 21% ± 1%       |

**Diagram of the experiment set-up**



**Log of Events / Additional Information**