中華電信研究院
Chunghwa Telecom Laboratories

2018 Group 2 GPS Calibration Trip
Cal_ID: 1017-2018

Yi-Jiun Huang, Tzi-Yu Chiu, Huang-Tien Lin, Zhang-Jie Huang and

Chia-Shu Liao

National Time and Frequency Standard Lab

Telecommunication Laboratories, Chunghwa Telecom Co., Ltd.

dongua@cht.com.tw

Abstract

One trip for calibrating GPS time transfer equipment of APMP G2 labs was organized by TL, started from August 2018 and ended in April 2019. This trip covered one G1 lab: TL, and two G2 labs: RCM-LIPI and MUSSD. The report describes the details of calibration equipment, method, and result. The annexes contain GPS station information and measurement figures.

Acronyms

APMP	Asia Pacific Metrology Programme
UTC	Coordinated universal time
BIPM	International Bureau of Weights and Measures
TL	Telecommunication Laboratories, Chunghwa Telecom Co., Ltd., Taiwan
RCM-LIPI	Research Center for Metrology - Lembaga Ilmu Pengetahuan Indonesia, Indonesia
MUSSD	Measurement Units, Standards and Services Department, Sri Lanka
NMIA	National Measurement Institute, Australian Government, Australia
GPS	Global positioning system
GPS P3	GPS ionosphere-free combination of P1 and P2
GNSS	Global navigation satellite system
RINEX	Receiver independent exchange format
CGGTTS	Common GNSS generic time transfer standard
INTDLY	Internal delay
TOTDLY	Total delay
CABDLY	Antenna cable delay
REFDLY	Reference delay
SYSDLY	System delay
TIC	Time interval counter
TDEV	Time deviation

History

Version	Date	Note
1.0	2019-04-23	Initial version
1.1	2019-05-14	1. Concerning KI01 (Septentrio PolaRx5 TR Pro), LIPI confirmed the information and TL confirmed the calculation 2. Typos fixed
1.2	2019-05-29	1. Values corrected to represent the total delay for KI01 (PolaRx5TR) 2. Change of the data pool in TL

Table of contents

1. Description of the trip

TL coordinated a calibration trip for GPS time transfer equipment of two G2 laboratories RCM-LIPI in Indonesia and MUSSD in Sri Lanka over nine months during 2018 and 2019. The GPS traveling equipment TRVL was developed by NMIA and prepared by TL. The equipment was sent from TL, circulated among RCM-LIPI and MUSSD, and finally back to TL for closure measurement.

1.1. Traveling equipment

Figure 1 shows the diagram of the traveling equipment TRVL. The equipment contains a GPS receiver, NMIA Topcon/Javad Euro-80, a GPS antenna, and a dedicated for connecting between laboratory 1 PPS and the receiver. If the cable is connected to UTC(k), the REFDLY of TRVL will be considered zero; otherwise, the time delay from UTC(k) to the 1 PPS used should be reported by the visited lab.

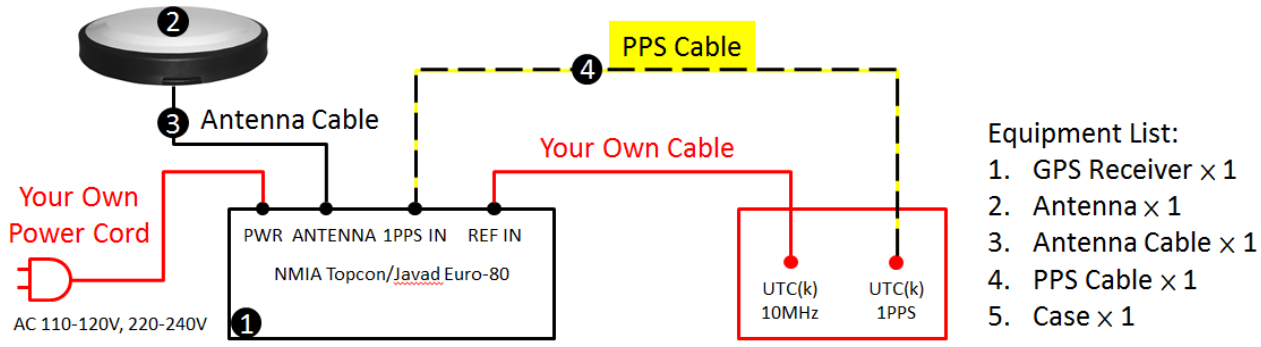


Figure 1 Diagram of the TRVL. The REF IN is connected to a laboratory 10 MHz with an arbitrary coaxial cable. A dedicated cable is supplied to connect UTC(k) 1 PPS and 1PPS IN ports.

According to the BIPM guidelines, the receiver must demonstrate sufficient stability over a time period comparable with the campaign. Due to external constraints, the campaign had to be completed within a strict timeframe which meant that the stability demonstration could not be undertaken for the anticipated duration of the campaign.

However, we do have data spanning about 13 years for this receiver (albeit with two long gaps), showing ± 1 ns scatter in **Table 1**.

Table 1 C1 INTDLY of the traveling equipment, measured by AU01

MJD	53000	53092	53195	53240	53284	53342	53524	53539	53630	53995	55009	57605
C1 delay (ns)	42.3	42.3	43.6	44.3	44.2	42.7	43.4	43.5	43.7	43.6	44.6	42.1

The reference receiver for these measurements was AU01, the NMIA primary receiver up until 2010. Uncertainties are at the ±0.5 ns level, due to a single cable delay measurement. Note that the AU01 C1 delay in these data has not been corrected to the BIPM-provided value.

1.2. Visited equipment

The visited equipment should be able to generate C1, P1 and P2. **Table 2** summarizes the stations. Detailed information on the equipment set-up is given by each labs in the Annex 1 except the reference station which is described in the BIPM calibration report [1].

Table 2 Summary information on the calibration trip

Institute	Status of equipment	MJD period of measurement	Receiver type	BIPM code	RINEX name
TL	Traveling	58356 – 58574	NMIA Topcon/Javad Euro-80	-	TRVL
TL	Reference	58356 – 58365 58565 – 58574	Ashtech Z12T	TLT1	TLT1
RCM-LIPI	Visited	58480 – 58489	Septentrio PolaRx5 TR Pro	KI01	KI01
RCM-LIPI	Visited	58480 – 58489	Piktime TTS3	KI02	KI02
MUSSD	Visited	58540 – 58549	Septentrio PolaRx4 TR Pro	SL01	SL01

2. Data used

The CGGTTS data are used for all analyses. The data of the reference and visited stations are downloaded from the BIPM file server with permission. For traveling equipment, we use a R2CGGTTS to convert RINEX data to CGGTTS files for different codes C1, P1, and P2 [2]. Users can access the RINEX data from TL data pool: ftp://ftp.stdtime.gov.tw/pub/APMP/1017-2018. Precise antenna co-ordinates are obtained via a separate RINEX observation file which contains code and carrier phase observations, but not referenced to the external time standard.

3. Data processing

The data processing starts from the CGGTTS files of two GPS stations A and B. In the CGGTTS file, we use three parameters, INTDLY, CABDLY, and REFDLY in the file header, and three measurements, REFSYS, MDIO, and MDTR, in the contents. We define RAW as an uncorrected measurement and it is expressed by equation (1).

$$\text{RAW} = \text{REFSYS} + \text{MDIO} + \text{MDTR} + \text{INT DLY} + \text{CAB DLY} - \text{REF DLY} \quad (1)$$

We have a RAW value for each GPS station, each code, each satellite, and at each epoch. Then, we define $\text{RAWDIF}_{\text{A-B}}$ as the difference between A's and B's RAW values, averaged over all satellites in view. It is expressed by equation (2).

$$\text{RAWDIF}_{\text{A-B}} = \text{AVG\_OVER\_SATELLITES}\ \{\text{RAW of A - RAW of B}\} \quad (2)$$

Annex 2 shows plots of the RAWDIF for each pair "A–B" and the corresponding time deviation (TDEV). The associated uncertainties are taken as the floor of the TDEV values with a minimum of 0.1 ns. Each value in **Table 3** and **Table 4** is the RAWDIF value averaged over the period which is described in **Table 2**.

Table 3 RAWDIF values for the pairs "Traveling–Reference"

Pair T-R	$\text{RAWDIF}_{\text{T-R}}$ P1 / ns	Unc / ns	$\text{RAWDIF}_{\text{T-R}}$ P2 / ns	Unc / ns	$\text{RAWDIF}_{\text{T-R}}$ C1 / ns	Unc / ns
TRVL-TLT1	-249.43	0.1	-238.14	0.1	-246.76	0.1
TRVL-TLT1	-250.24	0.2	-238.62	0.2	-248.58	0.2

Table 4 RAWDIF values for all "Traveling–Visited" pairs

Pair T-V	$\text{RAWDIF}_{\text{T-V}}$ P1 / ns	Unc / ns	$\text{RAWDIF}_{\text{T-V}}$ P2 / ns	Unc / ns	$\text{RAWDIF}_{\text{T-V}}$ C1 / ns	Unc / ns
TRVL-KI01	96.70	0.2	119.17	0.2	96.36	0.2
TRVL-KI02	111.48	0.2	129.39	0.2	111.76	0.2
TRVL-SL01	48.50	0.2	68.51	0.2	48.41	0.2

We compute SYSDIF, the differences of SYSDLY for all pairs, from equation (3).

$$\text{SYSDIF}_{\text{A-B}} = \text{RAWDIF}_{\text{A-B}} + \text{REFDLY}_{\text{A}} - \text{REFDLY}_{\text{B}} \quad (3)$$

where the values RAWDIF come from **Table 3** and **Table 4**, and the values REFDLY provided by each lab are listed in Annex 1. The SYSDIF values are reported in **Table 5** for the pairs "Traveling–Reference" and in **Table 6** for the pairs "Traveling–Visited".

Table 5 REFDLY and SYSDIF values for all "Traveling–Reference" pairs

Pair T-R	$REFDLY_T$ / ns	$REFDLY_R$ / ns	$RAWDIF_{T-R}$ P1 / ns	$SYSDIF_{T-R}$ P1 / ns	$RAWDIF_{T-R}$ P2 / ns	$SYSDIF_{T-R}$ P2 / ns	$RAWDIF_{T-R}$ C1 / ns	$SYSDIF_{T-R}$ C1 / ns
TRVL-TLT1	0.0	0.0	-249.43	-249.43	-238.14	-238.14	-246.76	-246.76
TRVL-TLT1	0.0	0.0	-250.24	-250.24	-238.62	-238.62	-248.58	-248.58
Misclosure	-	-	-	-0.81	-	-0.48	-	-1.82
Mean	-	-	-	-249.84	-	-238.38	-	-247.67

Table 6 REFDLY and SYSDIF values for all "Traveling–Visited" pairs

Pair T-V	$REFDLY_T$ / ns	$REFDLY_V$ / ns	RAWDIF P1 / ns	$SYSDIF_{T-V}$ P1 / ns	RAWDIF P2 / ns	$SYSDIF_{T-V}$ P2 / ns	RAWDIF C1 / ns	$SYSDIF_{T-V}$ C1 / ns
TRVL-KI01	0.0	0.0	96.70	96.70	119.17	119.17	96.36	96.36
TRVL-KI02	0.0	46.0	111.48	65.48	129.39	83.39	111.76	65.76
TRVL-SL01	0.00	148.90	48.50	-100.40	68.51	-80.39	48.41	-100.49

We compute SYSDIF of the pair "Visited–Reference" for all visited stations.

$$SYSDIF_{V-R} = SYSDIF_{T-R} - SYSDIF_{T-V} \quad (4)$$

We can compute INTDIF of the pair "Visited–Reference" for all visited stations.

$$INTDIF_{V-R} = SYSDIF_{V-R} - CABDLY_V + CABDLY_R \quad (5)$$

where Annex 1 provides the values CABDLY provided by each lab. **Tables 7** reports the $INTDIF_{V-R}$ results for the pairs "Visited–Reference" by applying equations (4) and (5) for the values in **Table 5** and **Table 6**.

Table 7 SYSDIF and INTDIF for all "Visited–Reference" pairs

Pair V-R	$CABDLY_V$ / ns	$CABDLY_R$ / ns	$SYSDIF_{V-R}$ P1 / ns	$INTDIF_{V-R}$ P1 / ns	$SYSDIF_{V-R}$ P2 / ns	$INTDIF_{V-R}$ P2 / ns	$SYSDIF_{V-R}$ C1 / ns	$INTDIF_{V-R}$ C1 / ns
KI01-TLT1	0.0	0.0	-346.54	-346.54	-357.55	-357.55	-344.03	-344.03
KI02-TLT1	143.20	0.0	-315.32	-458.52	-321.77	-464.97	-313.43	-456.63
SL01-TLT1	210.20	0.0	-149.44	-359.64	-157.99	-368.19	-147.18	-357.38

4. Uncertainty

In this section, we use the same method as [1] to determine the uncertainty of INTDLY. We estimate all components that can affect the accuracy and determine a value u_{CAL} that is to be used as the accuracy of all GPS P3 links at the epoch of calibration.

$$u_{CAL} = \sqrt{u_a^2 + u_b^2}$$

with the statistical uncertainty u_a and the systematic uncertainty u_b.

The statistical uncertainty u_a originates from RAWDIF and is given by the time deviation (TDEV) values for "Traveling–Reference" in **Table 3** and "Traveling–Visited" in **Table 4**. We find the minimum for each TDEV curve, and then we choose the largest one among the minimums as the u_a.

The systematic uncertainty is given by

$$u_b = \sqrt{\sum_n u_{b,n}^2}$$

where all possible terms to be considered in the sum are to be listed in **Table 8**. Values appear separately for each code (C1/P1 and P2) so as to compute a value u_{CAL} applicable to GPS P3 links. We choose to compute u_{CAL} using for u_b the uncertainty $u_{b,SYS}$ of $\mathrm{SYSDIF_{V\text{-}R}}$ from equation (4). **Table 8** presents all components of the uncertainty budget along with the uncertainty $u_{b,SYS}$ of $\mathrm{SYSDIF_{V\text{-}R}}$ from equation (4) and the resulting uncertainty value u_{CAL}. The items in **Table 8** are separated into several categories.

4.1. $u_{b,1}$ accounts for possible variation of the delays of the traveling equipment during the trip. This is evaluated by the observed disagreement in **Table 5**. The averaged value 1.0 ns over all codes is selected for single code C1, P1 and P2, and the value 0.3 is for P1-P2.

4.2. $u_{b,11}$ and $u_{b,12}$ account for errors in the antenna coordinates. In general they are estimated to be 3.0 cm (0.1 ns) because the standard uncertainty of the coordinates obtained with the data used for calibration is typically at or below this level.

4.3. $u_{b,13}$ and $u_{b,14}$ account for multipath effect. This is difficult to estimate and 0.2 ns is conventionally used, following a discussion in the CCTF working group meeting on GNSS in 2017.

4.4. $u_{b,21}$ and $u_{b,22}$ account for the measurement between the reference point of the traveling equipment and the local UTC(k). Unless otherwise specified, the values are 0.0 ns since the traveling equipment was connected with UTC(k) in all labs.

4.5. $u_{b,31}$ accounts for the measurement between the reference point of the reference station and the local UTC(k). This values is 0.0 ns since the reference station is connected with UTC(k);

4.6. $u_{b,32}$ accounts for the measurement between the reference point of the visited stations and the local UTC(k). They include at least one measurement with a TIC and are taken to be 0.5 ns.

Table 8 Uncertainty budget.

Item	C1 and P1 / ns	P2 / ns	P1-P2 / ns	P3 / ns	Description
u_a "T–V"	0.2	0.2	-	-	RAWDIF of "Traveling–Visited"
u_a "T–R"	0.2	0.2	-	-	RAWDIF of "Traveling–Reference"
u_a	0.3	0.3	-	[1]0.8	
Misclosure					
$u_{b,1}$	1.0	1.0	0.3	-	RAWDIF disagreement
Systematic components related to RAWDIF					
$u_{b,11}$	0.1	0.1	[2]0.1	-	Position error at TL
$u_{b,12}$	0.1	0.1	[2]0.1	-	Position error at visited labs
$u_{b,13}$	0.2	0.2	[2]0.4	-	Multipath effect at TL
$u_{b,14}$	0.2	0.2	[2]0.4	-	Multipath effect at visited labs
Link of the Traveling system to the local UTC(k)					
$u_{b,21}$	0.0	0.0	[3]0.0	-	$REFDLY_T$ at TL
$u_{b,21}$	0.0	0.0	[3]0.0	-	$REFDLY_T$ at visited labs
$u_{b,TOT}$	1.0	1.0	0.7	[4]1.5	
Link of the Reference system to its local UTC(k)					
$u_{b,31}$	0.0	0.0	[3]0.0	-	$REFDLY_R$ at TL
Link of the Visited system to its local UTC(k)					
$u_{b,32}$	0.5	0.5	[3]0.0	-	$REFDLY_V$ at visited labs
$u_{b,SYS}$	1.2	1.2.	0.7	[4]1.6	Components of equation (4)
u_{CAL}	1.2			1.8	Composed of u_a and $u_{b,SYS}$

[1]The value is computed by $\sqrt{(2.545 \times \mathrm{P1})^2 + (1.545 \times \mathrm{P2})^2}$

[2]The values are computed by $\sqrt{\mathrm{P1}^2 + \mathrm{P2}^2}$ since the P1 and P2 are assumed uncorrelated.

[3]The common effect due to TIC is assumed cancelled out.

[4]The values are computed by $\sqrt{\mathrm{P1}^2 + 1.545^2(\mathrm{P1} - \mathrm{P2})^2}$.

5. Final results for the visited systems

The Final results are presented for each visited system as they need to be entered to produce timing data in the CGGTTS format, i.e. in the form of INTDLY. The value INTDLY for each visited station, $INTDLY_V$, can be obtained by using equation (6).

$$INTDLY_V = INTDIF_{V\text{-}R} + INTDLY_R \quad (6)$$

Using the $INTDLY_R$ values reported in 1001-2018 for the Reference system TLT1 (transferred from the BIPM reference BP0R), **Table 9** then reports $INTDLY_V$ for all visited systems [1]. The uncertainty value u_{CAL} for P3 is obtained from **Table 8**. It is used by the BIPM to assign the value u_b which will apply to all links to which the system participates.

Table 9 INTDLY values for all stations

Reference station	Cal_Id	Date		$INTDLY_R$ P1 /ns	$INTDLY_R$ P2 /ns	$INTDLY_R$ C1 /ns
TLT1	1001-2018	Nov. 30, 2018		415.30	424.30	415.10
Visited stations	Cal_Id	Date	u_{CAL} / ns	$INTDLY_V$ P1 /ns	$INTDLY_V$ P2 /ns	$INTDLY_V$ C1 /ns
KI01	1017-2018	May 31, 2019	1.7	[5]68.76	[5]66.75	[5]71.07
KI02	1017-2018	May 31, 2019	1.7	-43.22	-40.67	-41.53
SL01	1017-2018	May 31, 2019	1.7	55.66	56.11	57.72

[5] Results are total delay (TOTDLY) values [2].

Acknowledgements

The authors appreciate colleagues in RCM-LIPI and MUSSD for their effort on shipment, installation of the traveling equipment and troubleshooting, and they also appreciate the online applications AUSPOS for them to obtain the precise coordinates of the traveling equipment in each lab [3].

Reference

[1] The BIPM, “2018 Group 1 GPS calibration trip”

[2] P. Defraigne and G. Petit, “CGGTTS-Version 2E: an extended standard for GNSS time transfer”, *Metrologia*, **52**, 2015.

[3] AUSPOS - Online GPS Processing, http://www.ga.gov.au/bin/gps.pl

Annex 1. Information provided by each visited laboratory

TL

Laboratory:	TL	TL (closure)
Date and hour of the beginning of measurements:	Aug. 26, 2018 (MJD 58356) 00 h UTC	Mar. 23, 2018 (MJD 58565) 00 h UTC
Date and hour of the end of measurements:	Sep. 04, 2018 (MJD 58365) 23 h UTC	Apr. 01, 2018 (MJD 58574) 23 h UTC

Information on the system

	Local:	Travelling:
4-character BIPM code	TLT1	TRVL
Receiver maker and type: Receiver serial number:	Ashtech Z-XII3T Metronome RT919994504	NMIA Topcon/Javad Euro-80
1 PPS trigger level /V:	1 V	0.5 V
Antenna cable maker and type: Phase stabilized cable (Y/N):	Andrew FSJ1-50A	LMR-400
Length outside the building /m:	~ 30 m	~ 40 m
Antenna maker and type: Antenna serial number:	SEPCHOKE_B3E6 SPKE 5006	Hemisphere A45 A452401000003
Temperature (if stabilised) /°C	23 ± 1 °C	23 ± 1 °C

Measured delays /ns if needed fill box “Additional Information” further below)

	Local:	Travelling:
Delay from local UTC to receiver 1 PPS-in / ns:	0.0	0.0
from 1 PPS-in to internal reference (if different) / ns	N/A	N/A
Antenna cable delay / ns:	N/A	N/A
Splitter delay (if any):	N/A	N/A
Additional cable delay (if any) / ns:	N/A	N/A

Data used for the generation of CGGTTS files

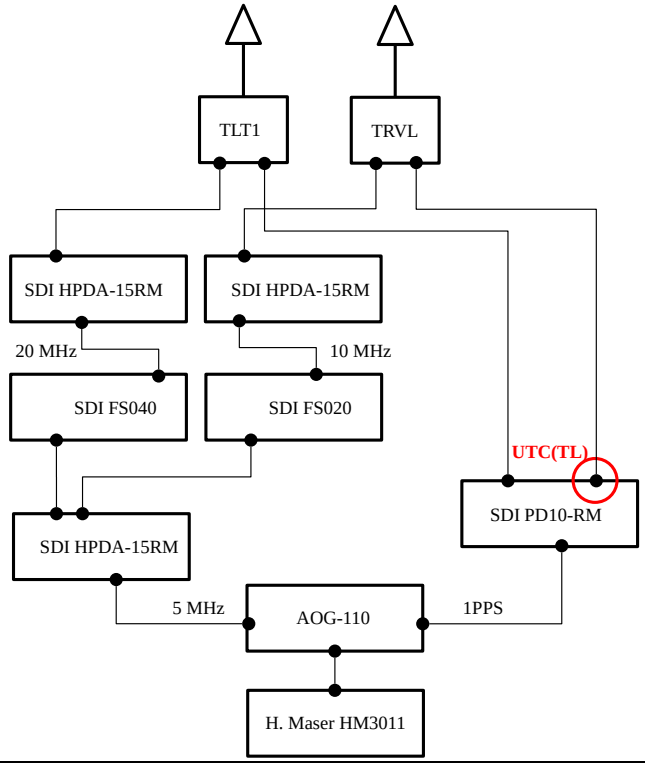
INT DLY (GPS) /ns:	C1: 415.1, P1: 415.3, P2: 424.3
CAB DLY /ns:	0.0
REF DLY /ns:	0.0
Coordinates reference frame:	WGS84

Latitude or X /m:	-2994425.48
Longitude or Y /m:	4951311.89
Height or Z /m:	2674498.36

General information

Rise time of the local UTC pulse:	3 ns
Is the laboratory air conditioned?	Yes
Set temperature value and uncertainty:	23 ± 1 °C
Set humidity value and uncertainty:	-

Diagram of the experiment set-up



The photo below shows the local and traveling stations are co-located.

RCM-LIPI

Laboratory:	RCM-LIPI
Date and hour of the beginning of measurements:	Dec. 28, 2018 (MJD 58480) 00 h UTC
Date and hour of the end of measurements:	Jan. 06, 2019 (MJD 58489) 23 h UTC

Information on the system

	Local:	Travelling:
4-character BIPM code	KI01	TRVL
Receiver maker and type: Receiver serial number:	Septentrio PolaRx5TR	NMIA Topcon/Javad Euro-80
1 PPS trigger level /V:	1 V	0.5 V
Antenna cable maker and type: Phase stabilized cable (Y/N):	RG213	LMR-400
Length outside the building /m:	~ 25 m	~ 40 m
Antenna maker and type: Antenna serial number:	Septentrio SepChoke_B3E6 5438	Hemisphere A45 A45250300100
Temperature (if stabilised) /°C	N/A	23 ± 1 °C

Measured delays /ns if needed fill box “Additional Information” further below)

	Local:	Travelling:
Delay from local UTC to receiver 1 PPS-in / ns:	0.0	0.0
from 1 PPS-in to internal reference (if different) / ns	N/A	N/A
Antenna cable delay / ns:	0.0	N/A
Splitter delay (if any):	N/A	N/A
Additional cable delay (if any) / ns:	N/A	N/A

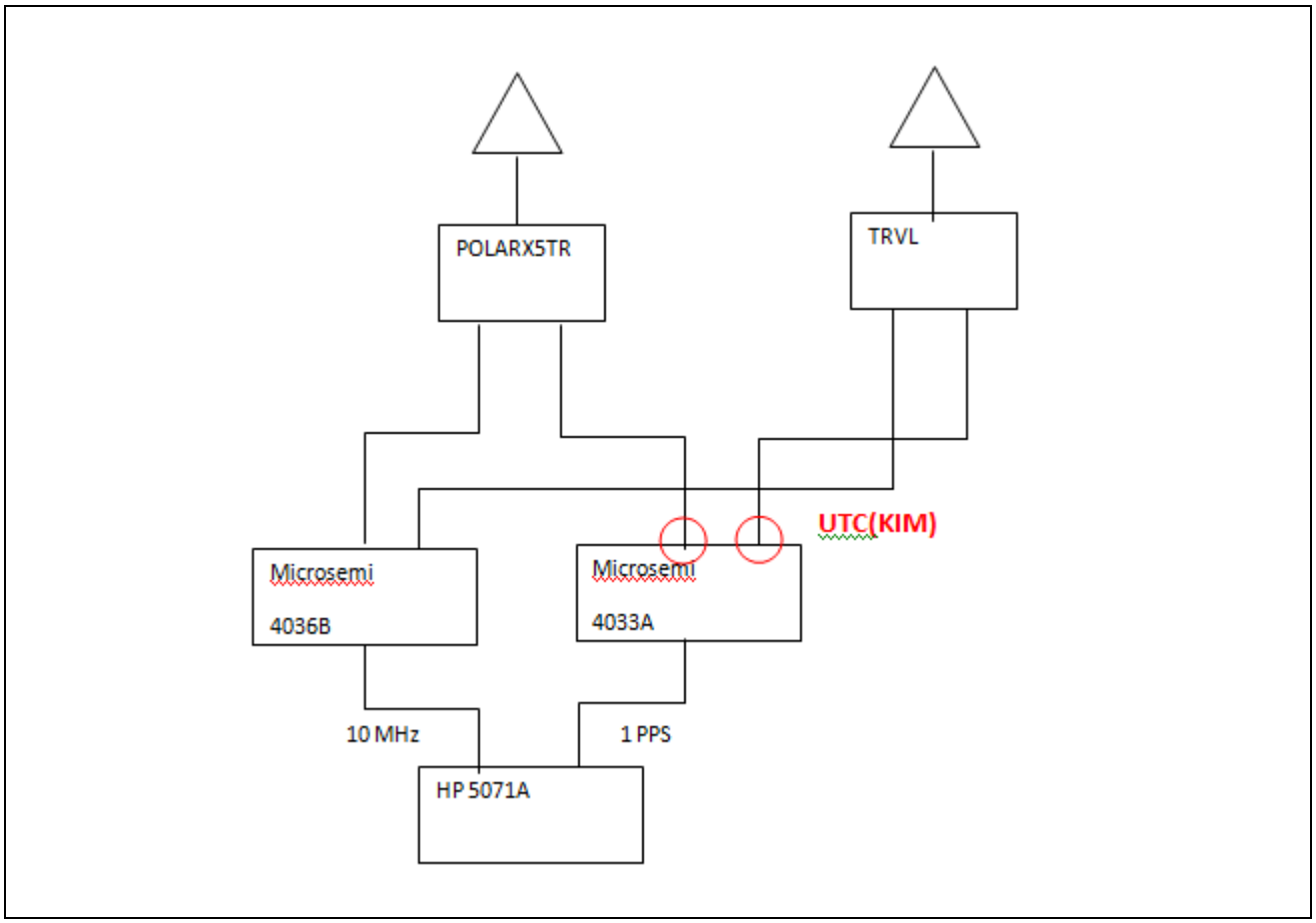
Data used for the generation of CGGTTS files

INT DLY (GPS) /ns:	0.0
CAB DLY /ns:	0.0
REF DLY /ns:	0.0
Coordinates reference frame:	WGS84
Latitude or X /m:	-1817479.138
Longitude or Y /m:	6073153.891
Height or Z /m:	-701358.500

General information

Rise time of the local UTC pulse:	3 ns
Is the laboratory air conditioned?	Yes
Set temperature value and uncertainty:	23± 3 °C
Set humidity value and uncertainty:	60± 10 %

Diagram of the experiment set-up



Information on the system

	Local:	Travelling:
4-character BIPM code	KI02	TRVL
Receiver maker and type: Receiver serial number:	TTS3 026	NMIA Topcon/Javad Euro-80
1 PPS trigger level /V:	1 V	0.5 V
Antenna cable maker and type: Phase stabilized cable (Y/N):	N/A	LMR-400
Length outside the building /m:	~ 35 m	~ 40 m
Antenna maker and type: Antenna serial number:	Javad GrAnt -G3T 01-570200-01	Hemisphere A45 A45250300100
Temperature (if stabilised) /°C	N/A	23 ± 1 °C

Measured delays /ns if needed fill box “Additional Information” further below)

	Local:	Travelling:
Delay from local UTC to receiver 1 PPS-in / ns:	46.0	0.0
from 1 PPS-in to internal reference (if different) / ns	N/A	N/A
Antenna cable delay / ns:	143.2	N/A
Splitter delay (if any):	N/A	N/A
Additional cable delay (if any) / ns:	N/A	N/A

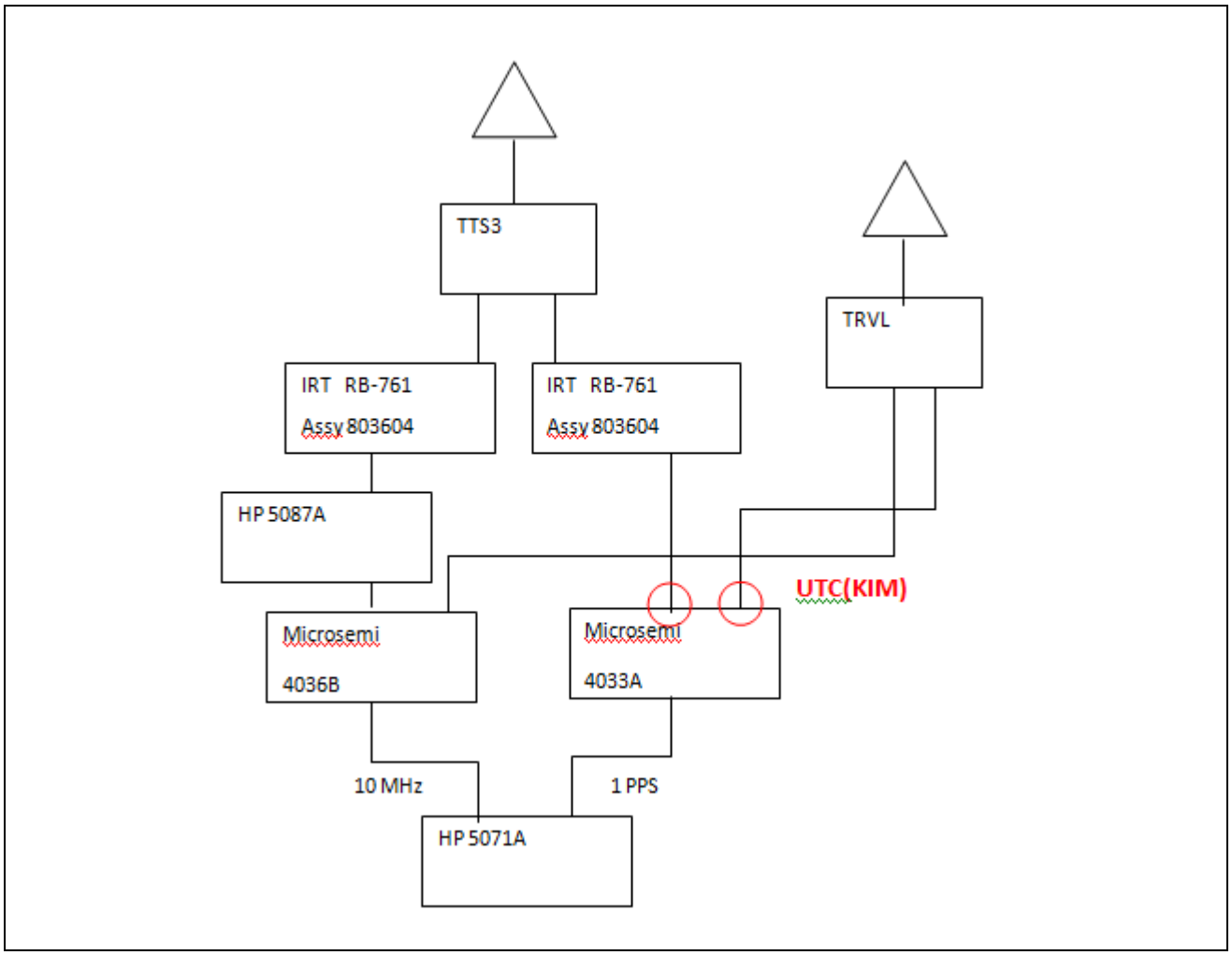
Data used for the generation of CGGTTS files

INT DLY (GPS) /ns:	-25.04
CAB DLY /ns:	143.2
REF DLY /ns:	46.0
Coordinates reference frame:	WGS84
Latitude or X /m:	-1817480.2609
Longitude or Y /m:	6073157.1211
Height or Z /m:	-701365.5999

General information

Rise time of the local UTC pulse:	3 ns
Is the laboratory air conditioned?	Yes
Set temperature value and uncertainty:	23± 3 °C
Set humidity value and uncertainty:	60± 10 %

Diagram of the experiment set-up



The photo below shows the visited and traveling stations are co-located.

MUSSD

Laboratory:	MUSSD
Date and hour of the beginning of measurements:	Feb. 26, 2019 (MJD 58540) 00 h UTC
Date and hour of the end of measurements:	Mar. 07, 2019 (MJD 58549) 23 h UTC

Information on the system

	Local:	Travelling:
4-character BIPM code	SL01	TRVL
Receiver maker and type: Receiver serial number:	Septentrio Polar RX4TR Pro 3102069	NMIA Topcon/Javad Euro-80
1 PPS trigger level /V:	1 V	0.5 V
Antenna cable maker and type: Phase stabilized cable (Y/N):	ANTCAB-001	LMR-400
Length outside the building /m:	~ 40 m	~ 40 m
Antenna maker and type: Antenna serial number:	AT1675-120SW-TNCF-000-RG-39-NM-R (SEPCHOKE_MC_NONE) 5400	Hemisphere A45
Temperature (if stabilised) /°C		

Measured delays /ns if needed fill box “Additional Information” further below)

	Local:	Travelling:
Delay from local UTC to receiver 1 PPS-in:	9.53	0.0
from 1 PPS-in to internal reference (if different)	139.37	N/A
Antenna cable delay:	210.2	N/A
Splitter delay (if any):	N/A	N/A
Additional cable delay (if any):	N/A	N/A

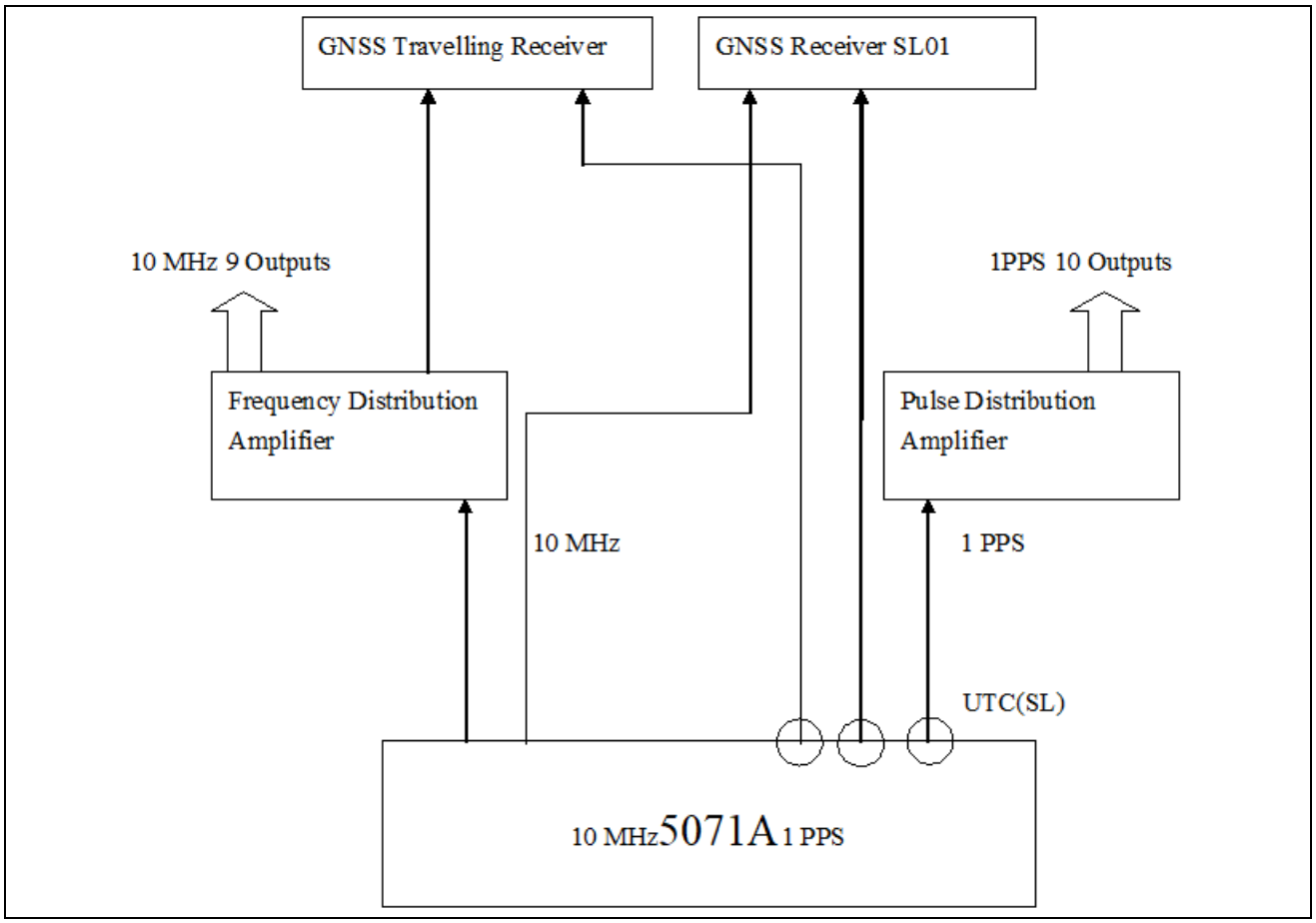
Data used for the generation of CGGTTS files

INT DLY (GPS) /ns:	C1: 0.0, P1: 0.0, P2: 0.0
CAB DLY /ns:	210.2
REF DLY /ns:	156.6
Coordinates reference frame:	ITRF2014
Latitude or X /m:	1095421.10
Longitude or Y /m:	6237724.16
Height or Z /m:	753024.43

General information

Rise time of the local UTC pulse:	3 ns
Is the laboratory air conditioned?	Yes
Set temperature value and uncertainty:	23± 1 °C
Set humidity value and uncertainty:	50± 10 %

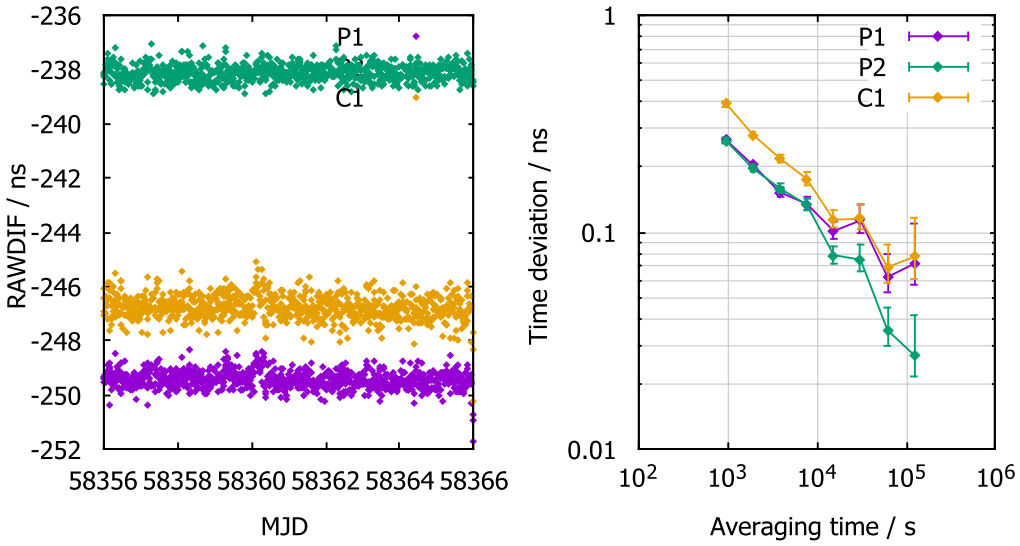
Diagram of the experiment set-up



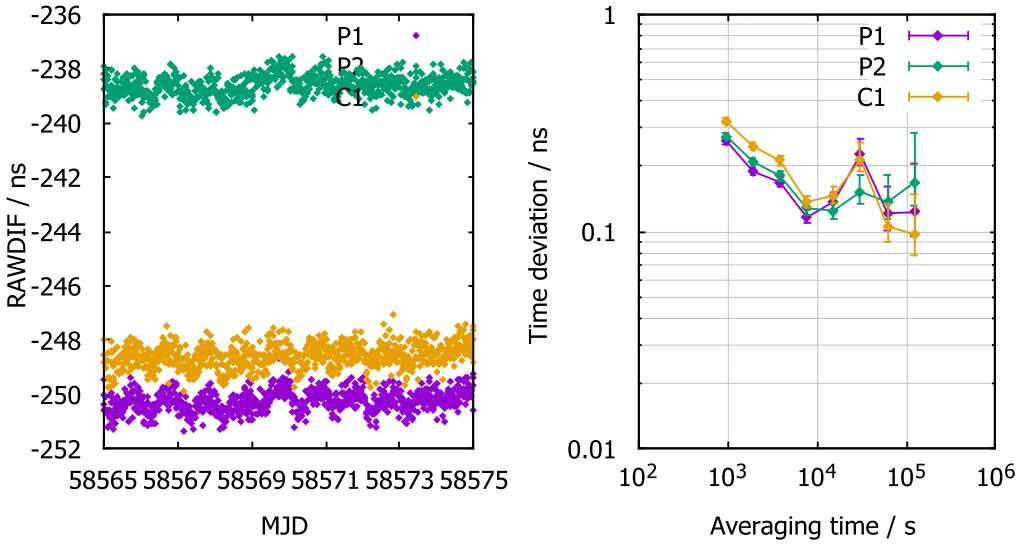
The photo below shows the local and traveling stations are co-located.

Annex 2. RAWDIF values and statistics

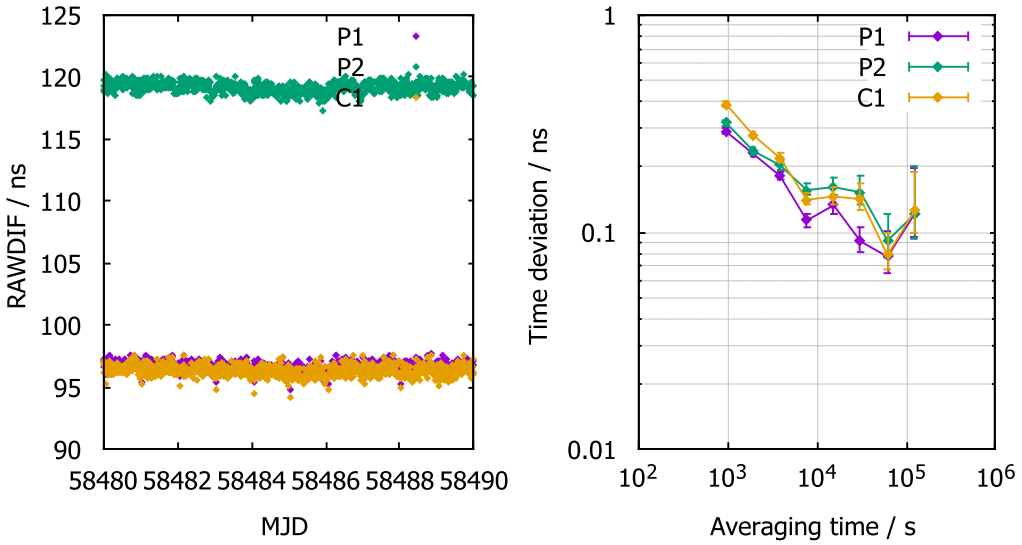
TRVL-TLT1 (Aug. 2018)



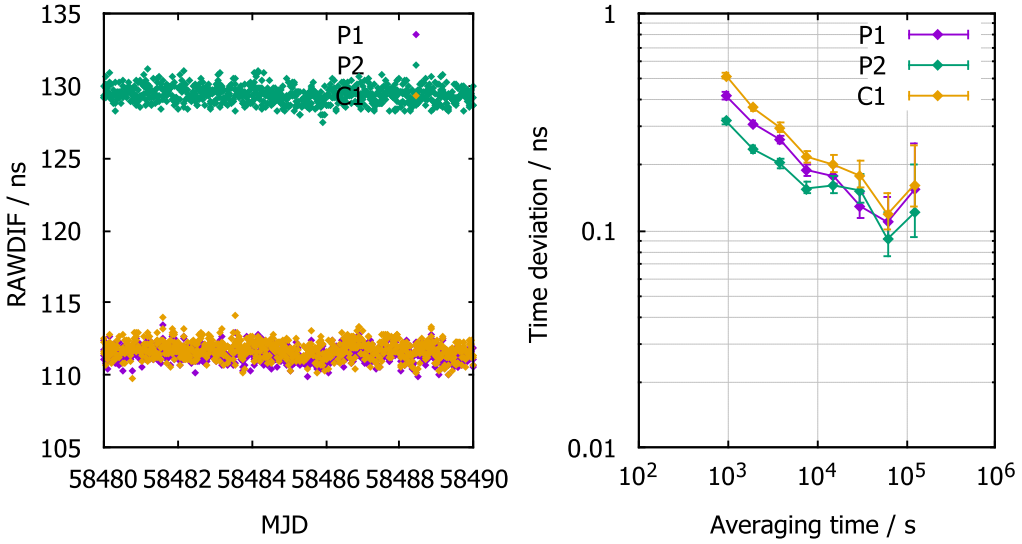
TRVL-TLT1 (Mar. 2019)



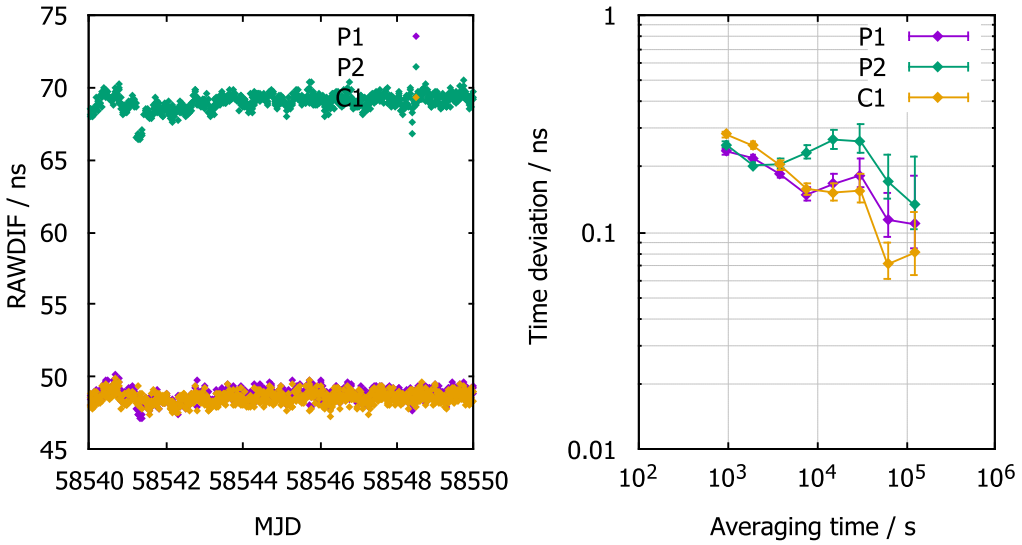
TRVL-KI01



TRVL-KI02



TRVL-SL01


RAWDIF / ns
MJD
P1
P2
C1
75
70
65
60
55
50
45
58540 58542 58544 58546 58548 58550
Time deviation / ns
Averaging time / s
1
0.1
0.01
10^2 10^3 10^4 10^5 10^6