2022 Group 1 GNSS calibration trip (Cal_Id 1001-2022)

Summary

The 2022 visit to Group 1 laboratories is the fifth Group 1 trip and started in July 2022. The trip is decomposed into several phases, each enclosed with closure at the BIPM.

- Phase 1 (July 2022-February 2023). BIPM-NIM-NICT-TL-BIPM with the traveling receivers BP2G and BP25;
- Phase 2 (March-June 2023), BIPM-ROA-PTB-OP-BIPM with the traveling receivers BP2G and BP2D.
- Phase 3 (June 2023 - January 2024), BIPM-USNO-NIST-BIPM with the traveling receivers BP2G and BP2D.

Due to the current situation a trip to COOMET G1 lab SU has been not possible. Since phase 1 of the 2022 Group 1 trip, results are provided for the GPS codes P1, P2 and C1, the Galileo E1 and E5a codes, and the BDS B1C B5 code.

All files indexed in this report can be accessed here

- **Reports of operations and raw data processing (one for each phase)**

- 1001-2022-Phase1-cv.pdf
- 1001-2022-Phase2-cv.pdf
- 1001-2022-Phase3-cv.pdf

- **Reports of differential calibration computations (one for each phase)**

- 1001-2022-Phase1-report.pdf
- 1001-2022-Phase2-report.pdf
- 1001-2022-Phase3-report.pdf

- **Report on selecting reference values to compute final results of this trip**

See TM266_Group1-followon-values.pdf

- **Final results for the visited systems**

Table 1 lists the final values of GPS P1/P2/C1, Galileo E1/E5a INTDLY and BDS BC/B5 INTDLY values from the 1001-2022 Group 1 trip, along with information on the REFDLY and CABDLY values used in the processing of the calibration results.

For any link A-B, the uncertainty resulting from the calibration, U_B(A-B), is computed as

$$U_B(A\text{-}B)^2 = (U_{CAL0}^2 + \Delta U_{CAL}(A)^2 + \Delta U_{CAL}(B)^2)^{1/2} \quad (1)$$

where U_{CAL0} is the conventional value chosen for the whole calibration trip and where ΔU_{CAL} is generally zero, except for some systems for specific reasons. See the reports of differential calibration computations for all information on U_{CAL0} and ΔU_{CAL}. The values ΔU_{CAL} are indicated in Table 1.

For dual-frequency (P3, E3 or B3) links, U_{CAL0} is 1.5 ns.

For single frequency links, U_{CAL0} is 1.2 ns but should be complemented by an additional component to represent systematic errors in the ionospheric model.

Table 1. Final GPS P1/P2/C1, Galileo E1/E5a and BDS BC/B5 INTDLY values from the 1001-2022 Group 1 trip. Values of REFDLY and CABDLY at the epoch of calibration are also indicated for reference (all values in ns). “Meas. Date” refers to the first day of the differential calibration, to which the calibration results can be applied.

System	BIPM code	Meas. Date	INTDLY C1	INTDLY P1	INTDLY P2	INTDLY E1	INTDLY E5	INTDLY BC	INTDLY B5	REFDLY	CABDLY	Note	Implem. Date	ΔUCAL
BP21	BP21		30.60	28.40	27.30	30.70	30.90	30.40	30.30	43.27	140.8	(1)		
PHASE 1 (NICT, NIM, TL)														
NC4S	NC4S	2022/11/17	278.9	277.5	277.2	278.5	287.6			315.5		(2)		0
NC5G	NC5G	2022/11/17	-37.3	-29.6	-18.6					171.3	268.7			0
NC5S	NC5S	2022/11/17	395.3	393.0	392.7	395.5	395.9	395.1	395.3	266.5		(2)		0
IM15	IM15	2022/09/06	-27.0	-28.1	-39.0	-27.5	-38.5			171.7	212.4			0
IM06	IM06	2022/09/06	-30.8	-31.6	-18.6					134.5	248.7			0
IM03	IM03	2022/09/06	-23.7	-25.0	-12.4					131.9	250.3			0
IM09	IM09	2022/09/06	-18.8	-19.7	-14.8					199.9	212.9			0
IM11	IM11	2022/09/06	33.8	32.1	31.7	35.5	31.6			199.9	213.5			0
IM22	IM22	2022/09/06	17.3	14.2	4.8	17.9	9.1			205.7	213.1			0
IM02	IM02	2022/09/06	-3.7	-5.6	-8.6	-3.6	-2.0	-3.7	-2.7	174.6	213.6			0
IM04	IM04	2022/09/06	-3.8	-6.1	-9.5	-3.7	-1.9	-3.9	-2.5	176.3	212.9			0
TLT0	TLT0	2023/01/06	61.4	60.0	62.3	61.2	45.4			157.9	119.8			0
TLT1	TLT1	2023/01/06	414.6	414.9	423.4							(3)		0
TLT3	TLT3	2023/01/06	-34.9	-35.7	-31.9					25.6	143.6			0
TLT5	TLT5	2023/01/06	221.4	219.1	217.9	221.4	219.2	221.2	218.6	14.6		(2)		0
PHASE 2 (ROA, PTB, OP)														
RO_6	RO_6	2023/03/16	56.2	54.6	53.3					485.1	82.0			0
RO_7	RO_7	2023/03/16	55.9	54.5	53.6	55.4	63.9			452.4	89.9			0
RO_8	RO_8	2023/03/16	31.2	29.2	27.3	32.6	24.4			20.4	197.1			0
RO_9	RO_9	2023/03/16	56.3	54.8	53.9	55.8	64.7			451.8	59.7			0
RO10	RO10	2023/03/16	30.0	28.2	25.7	30.1	29.9	30.0	29.3	5.1	199.0			0

PT07	PT07	2023/05/16	-36.0	-37.4	-25.4					43.7	245.8			0
PT09	PT09	2023/05/16	57.0	55.5	54.7	56.5	65.5			182.9	198.7			0
PT10	PT10	2023/05/16	32.7	30.7	24.2	34.0	23.0			36.6	250.0			0
PT13	PT13	2023/05/16	33.1	31.0	28.5	33.2	33.0	33.0	32.5	56.2	205.7			0
OP70	OP70	2023/06/17	29.9	27.7	26.3	30.0	30.3	29.8	29.7	90.6	128.7			0
OP73	OP73	2023/06/17	31.7	29.5	26.0	31.8	31.5	31.6	30.9	85.2	129.6			0
OP75	OP75	2023/06/17	32.5	30.2	25.4	32.6	31.6	32.4	31.0	85.3	129.6			0
OP02	OP02	2023/06/17	309.4	308.7	320.4					137.2	156.5			0
OPM9	OPM9	2023/06/17	39.3	37.4	34.3	40.7	34.6			60.5	173.6			0
PHASE 3 (USNO,NIST)														
US06	US06	2023/07/27	-7.0	-7.8	-9.9							(3)		0
US10	US10	2023/07/27	201.4	199.2	196.4	201.6	203.4					(3)		0
US09	US09	2023/07/27	206.8	204.6	200.8	207.0	208.5	206.8	207.9			(3)		0
NISG	NISG	2023/11/03	33.1	30.8	29.3	33.2	33.2	32.8	32.2	1622.3	298.5			0
NISX	NISX	2023/10/20	31.0	28.8	26.6	31.1	32.0	30.8	31.3	121.8	275.5			0
NISQ	NISQ	2023/10/20	33.5	31.2	22.6	33.6	27.9	33.5	27.3	466.2	199.6			0
NISK	NISK	2023/11/03	26.9	24.3	24.2	27.0	26.1	26.4	25.2	1535.6	298.9			0
NISP	NISP	2023/11/03	35.1	32.7	25.4	35.1	31.1	35.2	30.5	466.2	199.6			0

Notes:
(1) BP21 is included in order to provide reference for BIPM-led specific calibrations.
(2) Results are Systeml Delay values (SYSDLY).
(3) Results are Total Delay values (TOTDLY).

- **Transfer of calibration performed by PTB in July 2024**

In January 2025, the PTB started contributing to UTC with the GNSS receiver PT15. Since it was absent during the 1001-2022 visit, a transfer of calibration with respect to the receiver PT13 was performed, see the report by PTB.

Table 2 lists the final values of P1/P2/C1/E1/E5a INTDLY values obtained from the transfer of calibration, along with information on the REFDLY and CABDLY values used in the processing of the calibration results. The value ΔU_{CAL} for use in equation (1) has been set by default and is in line with the PTB report. For UTC use, the ageing uncertainty will be based on the date of original calibration of PT13 i.e. 2023/05/16.

Table 2. Final P1/P2/C1/E1/E5a INTDLY values for PT15. Values of REFDLY with respect to UTC(k) and of CABDLY at the epoch of calibration are also indicated for reference (all values in ns). “Meas. Date” refers to the first day of the differential calibration, to which the calibration results can be applied. “Impl. Date” is the MJD when the results were implemented in the receiver.

System	BIPM code	Meas. Date	INTDLY P1	INTDLY P2	INTDLY C1	INTDLY E1	INTDLY E5a	REFDLY	CABDLY	Note	ΔU_{CAL}	Impl.date
PT15	PT15	28/07/2024	34.9	28.1	38.6	38.6	31.6	11.0	205.5		0.9	

Version history

V1.0 2024/04/12: First publication of the results.
V1.1 2024/05/16: Note added for TLT1 TOTDLY
V1.2 2025/01/24: Calibration transfer by PTB