2020 Group 1 GNSS calibration trip (Cal_Id 1001-2020)

Summary

The 2020 visit to Group 1 laboratories is the fourth Group 1 trip and started in June 2020.
The trip is decomposed into several phases, each with closure at the BIPM. Some phases may be run in parallel.

- Phase 1 (June-December 2020). BIPM-NICT-TL-BIPM with the traveling receivers BP1J and BP25;
- Phase 1b (June-December 2020). BIPM-NIM-BIPM with the traveling receivers TS03 and TS04;
- Phase 2 (February-June 2021), BIPM-ROA-PTB-OP-BIPM with the traveling receivers BP1J and BP25.
- Phase 3 (To be continued)

Due to the COVID situation, restrictions in shipping made it imposible to carry out Phase 1 with the three APMP laboratorios in the same trip. Taking advantage of the presence of two NIM receivers at the BIPM, a specific trip was organized, described under Phase 1b.

The full report of the Group 1 trip is split in several sub-reports

All files indexed in this report can be accessed here

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

- 1001-2020-Phase1-cv.pdf
- 1001-2020-Phase1b-cv.pdf
- 1001-2020-Phase2-cv.pdf

- **Excel sheet for differential calibration computations**

- 1001-2020-calcul.xls

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

- 1001-2020-Phase1-report.pdf
- 1001-2020-Phase1b-report.pdf
- 1001-2020-Phase2-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 and Galileo E1/E5a INTDLY values from the 1001-2020 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 or E3) 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 and Galileo E1/E5a INTDLY values from the 1001-2020 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 P1	INTDLY P2	INTDLY C1	INTDLY E1	INTDLY E5a	REFDLY	CABDLY	Note	Implem. date	ΔU_{CAL}
BP21	BP21		28.4	27.3	30.6	30.7	30.9		140.8	(1)		
PHASE 1 (NICT, TL, NIM)												
NC5S	NC5S	2020/08/18	393.4	392.6	395.7	395.8	395.5	266.6	N/A	(2)	59271	0.0
NC5G	NC5G	2020/08/18	-29.9	-18.1	-37.5	-38.5	-38.5	171.3	268.7	(3)	59271	0.0
NC4S	NC4S	2020/08/18	277.4	276.8	278.6	278.2	287.4	315.7	N/A	(2)	59271	0.0
TWTF	TLT0	2020/10/31	60.4	62.7	61.7	61.6	N/A	157.9	119.8		59271	0.0
TLT1	TLT1	2020/10/31	415.0	423.8	414.7	N/A	N/A	N/A	N/A	(4)	59271	0.0
TLT3	TLT3	2020/10/31	-35.6	-32.2	-34.7	N/A	N/A	25.6	143.6	(3)	59271	0.0
TLT5	TLT5	2020/10/31	204.0	202.9	206.1	206.3	204.1	N/A	N/A	(4)	59271	0.0
IM15	IM15	2020/09/20	-27.6	-38.3	-26.5	-27.1	-36.4	119.4	212.4		59271	0.0
IMEJ	IM06	2020/09/20	-31.7	-18.3	-30.8	-31.0	-31.0	121.7	248.7	(3)	59271	0.0
BJNM	IM05	2020/09/20	69.5	76.6	71.1	71.5	N/A	324.8	125.0		59271	0.0
IM21	IM21	2020/09/20	-39.0	-43.0	-37.9	-38.5	-40.8	119.8	212.3		59271	0.0
IMEU	IM03	2020/09/20	-24.6	-11.8	-23.3	N/A	N/A	120.1	250.3		59271	0.0
PHASE 2 (ROA, PTB, OP)												
RO_5	RO_5	2021/03/08	8.0	26.3	4.9			306.8	91.5	(3)	59426	0.0
RO_6	RO_6	2021/03/08	54.3	53.2	55.9			485.1	82.0		59426	0.0
ROAP	RO_7	2021/03/08	54.3	53.9	55.5	55.1	63.8	452.4	89.9		59426	0.0
RO_8	RO_8	2021/03/08	29.2	27.6	31.1	32.5	24.2	20.4	197.1		59426	0.0
RO_9	RO_9	2021/03/08	54.9	54.0	56.3	55.8	64.7	451.8	59.7		59426	0.0
ROAG	RO10	2021/03/08	28.2	25.7	29.9	30.1	29.7	5.1	199.0		59426	0.0

PTBB	PT13	2021/03/30	31.6	29.3	33.6	33.6	33.6	56.2	205.7		59426	0.0
PT07	PT07	2021/03/30	-37.2	-24.9	-35.9			43.4	245.8	(3)	59426	0.0
PT09	PT09	2021/03/30	56.0	55.2	57.4	56.9	65.9	182.9	198.7		59426	0.0
PT10	PT10	2021/03/30	31.4	24.8	33.2	34.7	23.6	36.6	250.0		59426	0.0
OP71	OP71	2021/04/22	54.9	53.8	56.3	55.8	64.9	192.1	128.7		59426	0.0
OP73	OP73	2021/04/22	29.5	26.3	31.7	31.7	31.3	85.2	129.6		59426	0.0
OPMT	OP02	2021/04/22	308.9	320.9	309.3			137.2	156.5		59426	0.0

Notes:
(1) BP21 is included in order to provide reference for BIPM-led specific calibrations.
(2) Results are Systeml Delay values (SYSDLY).
(3) For GTR50/51 the listed INTDLY values are total values. Direct results of the calibration are changes with respect to the values previously entered in the receiver (all values in ns):

BIPM code	**P1**	**P2**	**C1**
NC5G	1.0	0.9	1.0
TLT3	-0.1	0.0	-0.2
IM06	0.1	0.1	0.2
RO_5	-0.4	-0.2	-1.0
PT07	-0.3	-0.3	-0.4

(4) Results are Total Delay values (TOTDLY).

- **Transfer of calibration performed by PTB in March 2022**

In March 2022, the PTB installed for the first time the GNSS receiver PT14. Since it was absent during the 1001-2020 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. 2021/03/30.

Table 2. Final P1/P2/C1/E1/E5a INTDLY values for PT14. 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
PT14	PT14	19/03/2022	19.4	18.5	21.6	21.6	19.1	44.3	208.7		0.5	No plan

Version history

V1.0 2021/02/23: Final APMP results from version V1.0 of the reports 1001-2020-Phase1-report.pdf and 1001-2020-Phase1b-cv.pdf, to be implemented in G1 receivers as coordinated by the BIPM Time Department.

V1.1 2021/05/18: Correction of NC4S E5a SYSDLY value in Table 1 (287.4 ns corrected value).

V1.2 2021/07/12: Final EURAMET results from version V1.0 of the report 1001-2020-Phase2-report.pdf.

V1.3 2022/05/02: Transfer of calibration performed by PTB in March 2022 to include a new receiver PT14.