2016 Group 1 GPS calibration trip (Cal_Id 1001-2016)

Summary

The 2016 visit to Group 1 laboratories started in March 2016.
The trip is decomposed into several phases, each separated with closures at the BIPM.

- Phase 1 (March-September 2016). BIPM-TL-NICT-NIM-BIPM with the traveling receivers BP1C and BP0U; In addition, a visit to NTSC was organized to check results of a previous Group 2 trip by NIM.
- Phase 2 (October-December 2016): BIPM-PTB-ROA-OP-BIPM with the traveling receivers BP1C and BP0U;
- Phase 3 (February-May 2017): BIPM-USNO-NIST-BIPM with the traveling receivers BP1C and BP0U;
- Phase 4 (To be continued)

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)**

- 1001-2016-Phase1-cv.pdf
- 1001-2016-Phase2-cv.pdf
- 1001-2016-Phase3-cv.pdf

- **Excel sheet for differential calibration computations**

- 1001-2016-calcul.xls

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

- 1001-2016-Phase1-report.pdf
- 1001-2016-Phase2-report.pdf
- 1001-2016-Phase3-report.pdf

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

TM266_Group1-followon-values.pdf

- **Final results for the visited systems**

Table 1 lists the final values of P1/P2/C1 INTDLY values from the 1001-2016 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
$U_B(A\text{-}B)^2 = (U_{CAL0}{}^2 + \Delta U_{CAL}(A)^2 + \Delta U_{CAL}(B)^2)^{1/2}$ (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 P3 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 P1/P2/C1 INTDLY values from the 1001-2016 Group 1 trip. Values of REFDLY and CABDLY at the epoch of calibration and the resulting P3 Total delay TOTDLY 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	REFDLY	CABDLY	Note	TOTDLY P3	ΔU_{CAL}
	BP0R		222.5	224.4	225.7			(1)		
	BP1J	2016.9	53.0	52.6	54.4			(1)		
PHASE 1 (TL, NICT, NIM, NTSC)										
TLT1	TLT1	2016/03/21	415.0	424.1	414.9	N/A	N/A	(2)	400.9	0.0
TLT2	TLT2	2016/03/21	-35.2	-36.2	-33.4	24.5	140.3	(3)	82.1	0.0
TLT3	TLT3	2016/03/21	-35.7	-32.0	-6.9 (4)	25.5	143.6	(5)	76.7	0.0
NC01	NC01	2016/04/20	218.3	222.4	221.4	407.6	213.4		17.8	0.8
NC5G	NC5G	2016/04/20	5.9	12.7	-1.5	-40.1	-37.0	(4)	-1.5	0.8
NC4C	NC4C	2016/04/20	54.9	53.3	56.4	599.9	157.5		-385.0	0.8
NC4S	NC4S	2016/04/20	276.8	276.3	278.2	314.3	N/A	(6)	-36.7	0.8
IMEJ	IM06	2016/07/07	-31.3	-17.9	-0.6 (4)	122.2	248.7	(5)	74.5	0.0
IMEU	IM03	2016/07/07	-27.5	-14.5	-25.8	112.8	250.3		89.9	0.0
BJNM	IM05	2016/07/07	75.3	82.9	77.1	319.7	125.0		-131.1	0.0
NTP1	NTP1	2016/07/20	55.7	55.1	57.4	373.8	209.0	(7)	-108.2	0.8
NTP2	NTP2	2016/07/20	55.5	54.2	57.3	378.0	221.0	(7)	-99.5	0.8
NTP3	NTP3	2016/07/20	53.1	52.2	54.6	192.6	198.0	(7)	59.9	0.8
PHASE 2 (ROA, PTB, OP)										
RO_5	RO_5	2016/10/28	18.5	32.7	1.5 (4)	36.5	127.5	(5)	87.6	0.0
RO_6	RO_6	2016/10/28	49.6	48.5	51.0	234.4	66.7		-116.4	0.0
RO_7	RO_7	2016/10/28	54.9	53.8	56.2	194.6	81.9		-56.1	0.0
RO_8	RO_8	2016/10/28	-71.9	-75.2	-42.3 (4)	38.0	126.6	(5)	21.8	0.0
RO_9	RO_9	2016/10/28	55.9	55.1	56.6	112.4	118.7		63.4	0.0
PTBB	PT02	2016/10/10	304.5	319.8	305.1	73.9	301.7		508.7	0.0
PTBG	PT03	2016/10/10	301.5	323.9	301.7	46.1	251.4		472.2	0.0
PT07	PT07	2016/10/10	-36.9	-24.3	-35.4	43.3	245.8	(5)	146.1	0.0
PT09	PT09	2016/10/10	56.0	55.2	57.3	161.8	223.7		119.1	0.0
PT10	PT10	2016/10/10	-40.0	-46.6	-37.8	52.0	250.0	(5)	168.2	0.0
OPMT	OP02	2016/11/19	309.0	320.9	309.6	155.9	156.5		291.2	0.0
OP71	OP71	2016/11/19	55.7	54.4	57.1	191.6	128.7		-5.2	0.0
OPM9	OPM9	2016/11/19	-33.7	-37.0	-31.7	60.5	173.3		84.2	0.0
PHASE 3 (USNO, NIST)										
USN6	USN6	2017/03/27	-6.0	-8.8	-5.8	N/A	N/A	(2,4)	-1.7	0.0
USN7	USN7	2017/03/27	-5.4	-8.3	-4.3	N/A	N/A	(2,4)	-0.9	0.0
NIST	NIST	2017/04/20	-72.8	-72.3	-72.6	87.3	275.5		114.6	0.0
NISS	NISS	2017/04/20	44.4	44.8	46.1	1736.9	298.9		-1394.2	0.0
NIS3	NIS3	2017/04/20	-6.3	-17.5	-6.1	1597.0	298.5		-1287.4	0.0
NIS4	NIS4	2017/04/20	-10.2	-21.8	-10.0	1566.4	298.0		-1260.7	0.0

Notes:
(1) BP0R and BP1J are included in order to provide reference for BIPM-led specific calibrations.
(2) Results are Total Delay values (TOTDLY).
(3) The REFDLY value of TLT2 (TTS4) has not been measured in full accordance with the Annex 1 of the calibration guidelines, see the report. Results are expressed as INTDLY for consistency with the CGGTTS V2 format but **care should be taken if the set-up is changed**: Only the "Total delay" (TOTDLY = INTDLY + CABDLY – REFDLY) is a strictly meaningful result.
(4) DLY values are changes with respect to the values previously entered in the receiver.
(5) For these GTR50/51 the listed INTDLY values are total values, unless stated otherwise. 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
TLT3	-5.7	-9.6	-6.9
IM06	0.7	0.9	-0.6
RO_5	-0.1	0.1	1.5
RO_8	-0.3	0.2	-42.3
PT07	-0.6	-0.5	-3.0
PT10	0.3	0.0	-4.0

(6) Results for NC4S are System Delay values (SYSDLY).
(7) Results for Group 2 laboratory, included for completeness.

- **Transfer of calibration performed by ROA in Spring 2018**

In Spring 2018, the ROA installed a new time laboratory with a new realization of UTC(ROA). The GNSS receivers were installed with a new set-up and the transfer of calibration for the five past receivers and for a new one (RO10) involved an ensemble of measurements described in the report by ROA.

Table 2 lists the final values of P1/P2/C1 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 computed from uncertainties given in the report by ROA.

Table 2. Final P1/P2/C1 INTDLY values for ROA receivers. Values of REFDLY with respect to UTC(ROA) 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	REFDLY	CABDLY	Note	ΔU_{CAL}	Impl.date
RO_5	RO_5	2018/04/28	10.3	27.3	8.5	306.6	91.5	(1)	0.7	58254
RO_6	RO_6	2018/04/28	56.7	55.4	58.1	484.9	82.0		0.7	58254
RO_7	RO_7	2018/04/17	56.9	55.7	58.2	452.1	89.9		0.7	58254
RO_8	RO_8	2018/04/28	-20.8	-21.1	-18.9	20.4	202.7	(1)	0.7	58254
RO_9	RO_9	2018/04/17	57.0	55.9	58.3	451.2	59.7		0.7	58254
RO10	RO10	2018/04/17	31.1	29.9	32.4	5.1	204.8		0.7	58254

Notes:
(1) For these GTR50/51 the listed INTDLY values are total values, NOT changes with respect to the values previously entered in the receiver.

Version history
V1.1 2017/01/18: Final results from Reports V1.1 for phases 1 and 2, to be implemented in G1 receivers as coordinated by the BIPM Time Department on MJD 57786.
V1.2 2017/02/10: Results for NC5G and NC4C changed to account for measured CABDLY values. NC5G INTDLY values change by +37.0 ns. NC4C INTDLY values change by -157.5 ns.
V1.3 2017/07/23: Correct info on CABDLY for NIM receivers.
V1.4 2017/10/24: Introduce full INTDLY values for most GTR50/51, instead of changes to the values previously entered in the receiver. Introduce results for SIM laboratories (NIST-USNO).
V1.5 2018/07/12: Transfer of calibration performed by ROA at the installation of the new time laboratory: Replace INTDLY values for RO_5, RO_6, RO_7, RO_8, RO_9 and add values for a new receiver RO10, see the report by ROA.