

9th BIPM TWSTFT Monthly Report

To: TWSTFT Participating Stations

Dear Colleagues,

Please find enclosed the 9th BIPM TWSTFT Monthly Report. As usual we present some selected TWSTFT links which are computed and compared to GPS at the time of preparation of *Circular T*. The results of the computation of nine such links are given in Tables 1 to 9 of the Appendix.

1. Introduction of TWSTFT links into TAI

As announced in the previous report, following the recommendations of the last CCTF meeting and meeting of the CCTF WG on TWSTFT at the USNO on December 13 and 14, it was decided to introduce two new TWSTFT links into TAI as from January 2000.

These two TWSTFT links:

- a transatlantic link NPL/USNO,
- a European link PTB/VSL

will be computed in parallel with the best GPS links, which will continue to provide data to be kept in reserve.

In addition it was decided to introduce another transatlantic link (NIST/PTB) into TAI from the same time. For this link, however, the primary technique will remain classical GPS C/A-code common-view, and TWSTFT will be used as a back-up technique.

2. Calibration of TWSTFT links

We are also pleased to inform you that at present all TWSTFT links published in this report are calibrated either by TWSTFT transportable equipment or by the most recent values published in *Circular T*.

The latest adjustment of calibrations by *Circular T* concerns all transatlantic links. Initially, the transatlantic TWSTFT links were calibrated by *Circular T* values published prior to July 1999. Since July 1999 the GPS link between Europe and North America has been corrected for ionospheric delays derived from an IGS map, rather than as previously from direct ionospheric measurements. This is the reason behind the step of about 8 ns at the beginning of July 1999 between the TWSTFT and GPS values as published in *Circular T*. To remove this discrepancy we introduced new calibration values for the transatlantic links, which we derived from *Circular T* values after July 1999.

Since some TWSTFT links not calibrated by TWSTFT also showed a permanent offset from the *Circular T* values, the BIPM also determined new calibration values for these links.

All new calibration values (listed in the table below) have been applied by participating stations as from MJD = 51511 (29 November 1999).

TWSTFT link	CALR/ns	Calib. ID	Calib. Switch	Calib. information for TWSTFT file header		
				Type	MJD	Est. Uncert. /ns
USNO/NPL	295.239	49	1	Circular T	51437	5.0
NPL/USNO	-295.239	49	1	Circular T	51437	5.0
USNO/PTB	710.235	50	1	Circular T	51439	5.0
PTB/USNO	-710.235	50	1	Circular T	51439	5.0
NIST/PTB	747.987	51	1	Circular T	51439	5.0
PTB/NIST	-747.987	51	1	Circular T	51439	5.0
NPL/PTB	413.528	52	1	Circular T	51434	5.0
PTB/NPL	-413.528	52	1	Circular T	51434	5.0
NPL/VSL	211.536	53	1	Circular T	51434	5.0
VSL/NPL	-211.536	53	1	Circular T	51434	5.0

Further refinement of the calibration of TWSTFT links by transportation of a TWSTFT station will be organized in the near future.

We will be pleased to receive your comments on this report.

With our best regards,

Jacques Azoubib and Włodzimierz Lewandowski

**Appendix to
9th BIPM TWSTFT Monthly Report**

TWSTFT links computed at the BIPM

Because the TWSTFT data are unevenly spaced by intervals of 2 or 3 days, they are linearly interpolated to give the data for the TAI standard dates at intervals of 5 days.

Note: When TWSTFT sessions are missing and data are interpolated between TWSTFT sessions more than 5 days apart, results are printed in bold characters. Upper limit for interpolation is 12 days.

Table 1. TUG/PTB link

BIPM Report No.	Date 1999 (MJD)	[UTC(TUG) – UTC(PTB)] /ns		
		TWSTFT	Circular T (GPS)	TWSTFT–Circular T
1	1 April (51269)	110	132	–22
	6 April (51274)	112	133	–21
	11 April (51279)	112	135	–23
	16 April (51284)	129	148	–19
	21 April (51289)	156	180	–24
	26 April (51294)	177	197	–20
2	1 May (51299)	193	217	–24
	6 May (51304)	196	217	–21
	11 May (51309)	205	231	–26
	16 May (51314)	222	242	–20
	21 May (51319)	236	258	–22
	26 May (51324)	248	271	–23
	31 May (51329)	266	288	–22
3	5 June (51334)	286	307	–21
	10 June (51339)	293	314	–21
	15 June (51344)	308	331	–23
	20 June (51349)	322	341	–19
	25 June (51354)	331	352	–21
	30 June (51359)	342	368	–26

Introduction of TUG/PTB TWSTFT link into TAI

BIPM Report No.	Date 1999 (MJD)	[UTC(TUG) – UTC(PTB)] /ns		
		Circular T (TWSTFT)	GPS	Circular T – GPS
4	5 July (51364)	358	360	–2
	10 July (51369)	370	372	–2
	15 July (51374)	379	379	0
	20 July (51379)	385	388	–3
	25 July (51384)	391	390	1
	30 July (51389)	410	411	–1

Note 1: The TUG/PTB TWSTFT link was calibrated by the transport of a TWSTFT station in May-June 1998. Until 30 June 1999 the *Circular T* GPS data for TUG were calibrated using an outdated value; this is the reason for the offset of about –22 ns between the two techniques.

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Table 1. TUG/PTB link (cont.)

BIPM Report No.	Date 1999 (MJD)	[UTC(TUG) – UTC(PTB)] /ns		
		<i>Circular T (TWSTFT)</i>	GPS	<i>Circular T – GPS</i>
5	4 August (51394)	426	431	–5
	9 August (51399)	439	441	–2
	14 August (51404)	454	455	–1
	19 August (51409)	462	462	0
	24 August (51414)	481	485	–4
	29 August (51419)	500	502	–2
6	3 September (51424)	517	521	–4
	8 September (51429)	525	527	–2
	13 September (51434)	550	552	–2
	18 September (51439)	562	565	–3
	23 September (51444)	576	580	–4
	28 September (51449)	588	590	–2
7	3 October (51454)	602	599	3
	8 October (51459)	613	614	–1
	13 October (51464)	624	628	–4
	18 October (51469)	636	637	–1
	23 October (51474)	658	658	0
	28 October (51479)	681	683	–2
8	2 November (51484)	700	697	3
	7 November (51489)	724	726	–2
	12 November (51494)	739	739	0
	17 November (51499)	747	747	0
	22 November (51504)	771	771	0
	27 November (51509)	794	795	–1
9	2 December (51514)	805	806	–1
	7 December (51519)	819	817	2
	12 December (51524)	843	841	2
	17 December (51529)	863	862	1
	22 December (51534)	878	878	0
	27 December (51539)	900	898	2

Note 2: The TUG/PTB TWSTFT link has been included in the computation of TAI since July 1999. This link was calibrated by the transport of a TWSTFT station in May-June 1998. The GPS link between the TUG and the PTB is also computed as a check and the data kept in reserve; this link was calibrated by the transport of a GPS receiver in May-June 1998 (4th BIPM GPS calibration trip).

It is notable that, for the TUG/PTB link, the TWSTFT and GPS techniques were independently calibrated, and the results agree to within the associated uncertainties.

Table 2. PTB/NIST link

BIPM Report No.	Date 1999 (MJD)	[UTC(PTB) – UTC(NIST)] /ns		
		TWSTFT	<i>Circular T</i> (GPS)	TWSTFT– <i>Circular T</i>
4	5 July (51364)	9	16	–7
	10 July (51369)	14	23	–9
	15 July (51374)	16	23	–7
	20 July (51379)	16	24	–8
	25 July (51384)	21	27	–6
	30 July (51389)	23	31	–8
5	4 August (51394)	21	25	–4
	9 August (51399)	26	34	–8
	14 August (51404)	32	38	–6
	19 August (51409)	33	40	–7
	24 August (51414)	37	42	–5
	29 August (51419)	41	46	–5
6	3 September (51424)	42	50	–8
	8 September (51429)	42	51	–9
	13 September (51434)	35	47	–12
	18 September (51439)	40	46	–6
	23 September (51444)	40	45	–5
	28 September (51449)	39	47	–8
7	3 October (51454)	41	48	–7
	8 October (51459)	48	57	–9
	13 October (51464)	48	54	–6
	18 October (51469)	50	58	–8
	23 October (51474)	47	55	–8
	28 October (51479)	46	53	–7
8	2 November (51484)	47	60	–13
	7 November (51489)	46	54	–8
	12 November (51494)	45	53	–8
	17 November (51499)	46	56	–10
	22 November (51504)	44	53	–9
	27 November (51509)	46	51	–5
9	2 December (51514)	50	50	0
	7 December (51519)	45	46	–1
	12 December (51524)	38	38	0
	17 December (51529)	32	34	–2
	22 December (51534)	29	33	–4
	27 December (51539)	30	32	–2

Notes: Since July 1999 the GPS link between Europe and North America has been corrected by ionospheric delays derived from an IGS map rather than, as previously, by direct ionospheric measurements. This is the reason for the step of about 8 ns at the beginning of July 1999 between the TWSTFT and GPS values.

A new calibration of the PTB/NIST TWSTFT link derived from *Circular T* after July 1999 was applied starting from MJD = 51511 (29 November 1999).

Table 3. NPL/USNO link

BIPM Report No.	Date 1999 (MJD)	[UTC(NPL) – UTC(USNO)] /ns		
		TWSTFT	<i>Circular T</i> (GPS)	TWSTFT– <i>Circular T</i>
5	4 August (51394)	–64	–54	–10
	9 August (51399)	–62	–49	–11
	14 August (51404)	–57	–44	–13
	19 August (51409)	–55	–43	–12
	24 August (51414)	–55	–42	–13
	29 August (51419)	–53	–41	–12
6	3 September (51424)	–54	–42	–12
	8 September (51429)	–58	–45	–13
	13 September (51434)	–60	–47	–13
	18 September (51439)	–61	–51	–10
	23 September (51444)	–62	–49	–13
	28 September (51449)	–63	–50	–13
7	3 October (51454)	–62	–52	–10
	8 October (51459)	–62	–49	–13
	13 October (51464)	–64	–54	–10
	18 October (51469)	–65	–57	–8
	23 October (51474)	–67	–56	–11
	28 October (51479)	–71	–64	–7
8	2 November (51484)	–76	–63	–13
	7 November (51489)	–82	–74	–8
	12 November (51494)	–87	–77	–10
	17 November (51499)	–92	–84	–8
	22 November (51504)	–96	–87	–9
	27 November (51509)	–97	–90	–7
9	2 December (51514)	–89	–92	3
	7 December (51519)	–90	–92	2
	12 December (51524)	–95	–98	3
	17 December (51529)	–100	–100	0
	22 December (51534)	–102	–106	4
	27 December (51539)	–101	–107	6

Notes: From 25 July 1999 to 29 November 1999 the NPL/USNO TWSTFT link has been calibrated by a value derived from *Circular T* data of June 1999.

Since July 1999 the GPS link between Europe and North America has been corrected by ionospheric delays derived from an IGS map rather than, as previously, by direct ionospheric measurements. This is the reason for the step of about 8 ns at the beginning of July 1999 between the TWSTFT and GPS values.

A new calibration of the NPL/USNO TWSTFT link derived from *Circular T* after July 1999 was applied starting from MJD = 51511 (29 November 1999).

Table 4. USNO/PTB link

BIPM Report No.	Date 1999 (MJD)	[UTC(USNO) – UTC(PTB)] /ns		
		TWSTFT	<i>Circular T</i> (GPS)	TWSTFT– <i>Circular T</i>
5	4 August (51394)	–18	–24	6
	9 August (51399)	–24	–36	12
	14 August (51404)	–31	–40	9
	19 August (51409)	–31	–43	12
	24 August (51414)	–33	–43	10
	29 August (51419)	–34	–42	8
6	3 September (51424)	–33	–45	12
	8 September (51429)	–30	–41	11
	13 September (51434)	–22	–35	13
	18 September (51439)	–23	–33	10
	23 September (51444)	–25	–34	9
	28 September (51449)	–23	–34	11
7	3 October (51454)	–25	–37	12
	8 October (51459)	–34	–47	13
	13 October (51464)	–36	–44	8
	18 October (51469)	–40	–48	8
	23 October (51474)	–36	–46	10
	28 October (51479)	–33	–41	8
8	2 November (51484)	–33	–46	13
	7 November (51489)	–31	–40	9
	12 November (51494)	–31	–39	8
	17 November (51499)	–31	–40	9
	22 November (51504)	–30	–39	9
	27 November (51509)	–33	–41	8
9	2 December (51514)	–40	–43	3
	7 December (51519)	–43	–42	–1
	12 December (51524)	–38	–37	–1
	17 December (51529)	–34	–35	1
	22 December (51534)	–32	–34	2
	27 December (51539)	–30	–30	0

Notes: Since July 1999 the GPS link between Europe and North America has been corrected by ionospheric delays derived from an IGS map rather than, as previously, by direct ionospheric measurements. This is the reason for the step of about 8 ns at the beginning of July 1999 between the TWSTFT and GPS values.

A new calibration of the USNO/PTB TWSTFT link derived from *Circular T* after July 1999 was applied starting from MJD = 51511 (29 November 1999).

Table 5. PTB/DTAG link

BIPM Report No.	Date 1999 (MJD)	[UTC(PTB) – UTC(DTAG)] /ns		
		TWSTFT	<i>Circular T</i> (GPS)	TWSTFT– <i>Circular T</i>
4	5 July (51364)	–75	–98	23
	10 July (51369)	–64	–83	19
	15 July (51374)	–76	–79	3
	20 July (51379)	–87	–91	4
	25 July (51384)	–99	–100	1
	30 July (51389)	–113	–117	4
5	4 August (51394)	–128	–133	5
	9 August (51399)	–125	–123	–2
	14 August (51404)	–129	–130	1
	19 August (51409)	–142	–149	7
	24 August (51414)	–143	–147	4
	29 August (51419)	–166	–181	15
6	3 September (51424)	–184	–190	6
	8 September (51429)	–198	–206	8
	13 September (51434)	–204	–207	3
	18 September (51439)	–217	–220	3
	23 September (51444)	–234	–237	3
	28 September (51449)	–250	–253	3
7	3 October (51454)	–283	–279	–4
	8 October (51459)	–295	–297	2
	13 October (51464)	–296	–299	3
	18 October (51469)	–306	–309	3
	23 October (51474)	–320	–323	3
	28 October (51479)	–357	–356	–1
8	2 November (51484)	–363	–365	2
	7 November (51489)	–367	–373	6
	12 November (51494)	–373	–377	4
	17 November (51499)	–398	–400	2
	22 November (51504)	–407	–412	5
	27 November (51509)	–421	–423	2
9	2 December (51514)	–427	–427	0
	7 December (51519)	–429	–428	–1
	12 December (51524)	–446	–448	2
	17 December (51529)	–442	–442	0
	22 December (51534)	–442	–443	1
	27 December (51539)	–	–	–

Note: The PTB/DTAG TWSTFT link was calibrated by the transport of a TWSTFT station. The observed discrepancy between the TWSTFT data and the *Circular T* values in this table might be explained by an inaccuracy of the DTAG GPS time-receiving equipment.

Table 6. VSL/PTB link

BIPM Report No.	Date 1999 (MJD)	[UTC(VSL) – UTC(PTB)] /ns		
		TWSTFT	<i>Circular T</i> (GPS)	TWSTFT– <i>Circular T</i>
5	4 August (51394)	–27	–24	–3
	9 August (51399)	–6	–6	0
	14 August (51404)	7	9	–2
	19 August (51409)	14	17	–3
	24 August (51414)	7	7	0
	29 August (51419)	–1	0	–1
6	3 September (51424)	–3	–3	0
	8 September (51429)	–10	–9	–1
	13 September (51434)	–10	–9	–1
	18 September (51439)	–25	–25	0
	23 September (51444)	–37	–33	–4
	28 September (51449)	–47	–46	–1
7	3 October (51454)	–42	–39	–3
	8 October (51459)	–47	–47	0
	13 October (51464)	–54	–55	1
	18 October (51469)	–50	–49	–1
	23 October (51474)	–42	–41	–1
	28 October (51479)	–37	–39	2
8	2 November (51484)	–43	–39	–4
	7 November (51489)	–40	–37	–3
	12 November (51494)	–47	–47	0
	17 November (51499)	–57	–59	2
	22 November (51504)	–61	–58	–3
	27 November (51509)	–55	–55	0
9	2 December (51514)	–54	–52	–2
	7 December (51519)	–48	–49	1
	12 December (51524)	–37	–36	–1
	17 December (51529)	–31	–33	2
	22 December (51534)	–28	–32	4
	27 December (51539)	–29	–31	2

Notes: The VSL/PTB TWSTFT link was calibrated by *Circular T*.

Table 7. NPL/NIST link

BIPM Report No.	Date 1999 (MJD)	[UTC(NPL) – UTC(NIST)] /ns		
		TWSTFT	<i>Circular T</i> (GPS)	TWSTFT– <i>Circular T</i>
5	4 August (51394)	39	–54	93
	9 August (51399)	40	–51	91
	14 August (51404)	44	–46	90
	19 August (51409)	46	–46	92
	24 August (51414)	49	–43	92
	29 August (51419)	52	–37	89
6	3 September (51424)	53	–37	90
	8 September (51429)	–39	–35	–4
	13 September (51434)	–39	–35	–4
	18 September (51439)	–37	–38	1
	23 September (51444)	–38	–38	0
	28 September (51449)	–37	–37	0
7	3 October (51454)	–40	–41	1
	8 October (51459)	–41	–39	–2
	13 October (51464)	–44	–44	0
	18 October (51469)	–47	–47	0
	23 October (51474)	–49	–47	–2
	28 October (51479)	–50	–52	–2
8	2 November (51484)	–54	–49	–5
	7 November (51489)	–59	–60	1
	12 November (51494)	–65	–63	–2
	17 November (51499)	–70	–68	–2
	22 November (51504)	–74	–73	–1
	27 November (51509)	–79	–80	1
9	2 December (51514)	–84	–85	1
	7 December (51519)	–89	–88	–1
	12 December (51524)	–96	–97	1
	17 December (51529)	–103	–101	–2
	22 December (51534)	–108	–107	–1
	27 December (51539)	–103	–105	2

Notes: The NPL/NIST TWSTFT link was calibrated using *Circular T* values dating from July 1999. New calibration value was applied at the beginning of September 1999.

Table 8. NPL/PTB link

BIPM Report No.	Date 1999 (MJD)	[UTC(NPL) – UTC(PTB)] /ns		
		TWSTFT	<i>Circular T</i> (GPS)	TWSTFT– <i>Circular T</i>
6	3 September (51424)	–500	–87	–413
	8 September (51429)	–76	–86	10
	13 September (51434)	–70	–82	12
	18 September (51439)	–72	–84	12
	23 September (51444)	–74	–83	9
	28 September (51449)	–72	–84	12
7	3 October (51454)	–76	–89	13
	8 October (51459)	–84	–96	14
	13 October (51464)	–88	–98	10
	18 October (51469)	–91	–105	14
	23 October (51474)	–91	–104	13
	28 October (51479)	–92	–105	13
8	2 November (51484)	–97	–109	12
	7 November (51489)	–100	–114	14
	12 November (51494)	–106	–116	10
	17 November (51499)	–112	–124	12
	22 November (51504)	–114	–126	12
	27 November (51509)	–122	–131	9
9	2 December (51514)	–133	–135	2
	7 December (51519)	–134	–134	0
	12 December (51524)	–133	–135	2
	17 December (51529)	–134	–135	1
	22 December (51534)	–136	–140	4
	27 December (51539)	–132	–137	5

Note: A new calibration of the NPL/PTB TWSTFT link using *Circular T* was applied on MJD = 51511 (29 November 1999).

Table 9. NPL/VSL link

BIPM Report No.	Date 1999 (MJD)	[UTC(NPL) – UTC(VSL)] /ms		
		TWSTFT	<i>Circular T</i> (GPS)	TWSTFT– <i>Circular T</i>
6	3 September (51424)	–88	–84	–4
	8 September (51429)	–84	–77	–7
	13 September (51434)	–78	–73	–5
	18 September (51439)	–64	–59	–5
	23 September (51444)	– 53	–50	–3
	28 September (51449)	–43	–38	–5
7	3 October (51454)	–51	–50	–1
	8 October (51459)	–54	–49	–5
	13 October (51464)	–51	–43	–8
	18 October (51469)	– 59	–56	–3
	23 October (51474)	–67	–61	–6
	28 October (51479)	–72	–66	–6
8	2 November (51484)	–71	–70	–1
	7 November (51489)	–77	–77	0
	12 November (51494)	–75	–69	–6
	17 November (51499)	–72	–65	–7
	22 November (51504)	–69	–68	–1
	27 November (51509)	–80	–76	–4
9	2 December (51514)	–80	–83	3
	7 December (51519)	–86	–85	–1
	12 December (51524)	–96	–99	3
	17 December (51529)	–103	–102	–1
	22 December (51534)	–107	–108	1
	27 December (51539)	–103	–106	3

Note: A new calibration of the NPL/VSL TWSTFT link using *Circular T* was applied on MJD = 51511 (29 November 1999).