

6th BIPM TWSTT Monthly Report

To: TWSTT Participating Stations

Dear Colleagues,

As usual we present some selected TWSTT links which are computed and compared to GPS at the time of the preparation of *Circular T*. The results of the computation of eight such links are given in Tables 2 to 9 of the Appendix. We have added one new link: NPL/VSL.

Some TWSTT links require better calibration. At the BIPM we intend to perform these calibrations using *Circular T*, and we shall communicate their results to the laboratories concerned as soon as possible.

Following the decisions of the last CCTF, and wishes expressed by the TWSTT Participating Stations during their meeting on 6 October at Geneva, we plan to introduce further TWSTT links into TAI in January 2000. We suggest one transatlantic and two European TWSTT links. All these TWSTT links should be in parallel with the best possible GPS links that will continue to provide data to be kept as reserve. The choice of January for the introduction of the new links facilitates management of TAI data.

We are looking forward to meeting you during the CCTF WG on TWSTT meeting at the USNO in December. This meeting will certainly stimulate further progress in the use of the TWSTT technique.

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

With our best regards,

Jacques Azoubib and Włodzimierz Lewandowski

**Appendix to
6th BIPM TWSTT Monthly Report**

TWSTT links computed at the BIPM

Because the TWSTT 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 TWSTT sessions are missing and data are interpolated between TWSTT sessions more than 5 days apart, results are printed in bold characters.

Table 1. TUG/PTB link

BIPM Report No.	Date 1999 (MJD)	[UTC(TUG) – UTC(PTB)] /ns		
		TWSTT	<i>Circular T</i> (GPS)	TWSTT – <i>Circular T</i>
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

Note 1: The TUG/PTB TWSTT link was calibrated by the transport of a TWSTT 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.)

Introduction of TUG/PTB TWSTT link into TAI

BIPM Report No.	Date 1999 (MJD)	[UTC(TUG) – UTC(PTB)] /ns		
		<i>Circular T</i> (TWSTT)	GPS	<i>Circular T</i> – 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
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

Note 2: The TUG/PTB TWSTT link has been included in the computation of TAI since July 1999. This link was calibrated by the transport of a TWSTT 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 TWSTT 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		
		TWSTT	<i>Circular T</i> (GPS)	TWSTT – <i>Circular T</i>
1	1 April (51269)	41	41	0
	6 April (51274)	38	37	1
	11 April (51279)	36	36	0
	16 April (51284)	30	33	–3
	21 April (51289)	19	16	3
	26 April (51294)	10	12	–2
2	1 May (51299)	3	3	0
	6 May (51304)	1	3	–2
	11 May (51309)	2	1	1
	16 May (51314)	–3	–4	1
	21 May (51319)	–4	–6	2
	26 May (51324)	–7	–9	2
	31 May (51329)	–10	–11	1
3	5 June (51334)	–9	–9	0
	10 June (51339)	–3	–5	2
	15 June (51344)	–1	–3	2
	20 June (51349)	2	2	0
	25 June (51354)	4	2	2
	30 June (51359)	8	7	1
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

Notes: The PTB/NIST TWSTT link was calibrated by *Circular T* prior to July 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 TWSTT and GPS values.

Table 3. NPL/USNO link

BIPM Report No.	Date 1999 (MJD)	[UTC(NPL) – UTC(USNO)] /ns		
		TWSTT	<i>Circular T</i> (GPS)	TWSTT – <i>Circular T</i>
2	26 April (51294)	82	–46	128
	1 May (51299)	83	–48	131
	6 May (51304)	81	–48	129
	11 May (51309)	81	–48	129
	16 May (51314)	77	–51	128
	21 May (51319)	75	–52	127
	26 May (51324)	74	–53	127
31 May (51329)	72	–54	126	
3	5 June (51334)	* 61	–58	* 119
	10 June (51339)	* 40	–59	* 99
	15 June (51344)	* 66	–61	* 127
	20 June (51349)	* 62	–61	* 123
	25 June (51354)	* 63	–63	* 126
	30 June (51359)	* 62	–65	* 127
4	5 July (51364)	* 60	–56	* 116
	10 July (51369)	* 59	–57	* 116
	15 July (51374)	* 58	–61	* 119
	20 July (51379)	* 60	–58	* 118
	25 July (51384)	* –71	–59	* –12
	30 July (51389)	–69	–56	–13
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)	– 62	–50	–12

Notes: The NPL/USNO TWSTT link was not calibrated until 21 July 1999. Since 25 July 1999 this link has been calibrated by *Circular T* using the data of June 1999.

See also the note to Table 2 concerning the time step in the GPS values between 30 June 1999 and 5 July 1999.

* Hardware and automation problems have rendered USNO TWSTT data between 5 June 1999 and 25 July 1999 unreliable. These data were adjusted a posteriori between 16 June 1999 and 25 July 1999.

Table 4. USNO/PTB link

BIPM Report No.	Date 1999 (MJD)	[UTC(USNO) – UTC(PTB)] /ns		
		TWSTT	<i>Circular T</i> (GPS)	TWSTT – <i>Circular T</i>
2	26 April (51294)	–11	–33	22
	1 May (51299)	–7	–28	21
	6 May (51304)	–4	–27	23
	11 May (51309)	–8	–25	17
	16 May (51314)	4	–19	23
	21 May (51319)	8	–16	24
	26 May (51324)	12	–11	23
31 May (51329)	15	–7	22	
3	5 June (51334)	* 25	–6	* 31
	10 June (51339)	* 43	–10	* 53
	15 June (51344)	* 14	–9	* 23
	20 June (51349)	* 15	–12	* 27
	25 June (51354)	* 12	–10	* 22
	30 June (51359)	* 10	–12	* 22
4	5 July (51364)	* 10	–20	* 30
	10 July (51369)	* 7	–26	* 33
	15 July (51374)	* 7	–25	* 32
	20 July (51379)	* 7	–24	* 31
	25 July (51384)	* –14	–27	* 13
	30 July (51389)	–16	–29	13
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

Notes: The USNO/PTB TWSTT link was calibrated using *Circular T* of May 1997. At this time the USNO GPS time-receiving equipment was inaccurate by about 23 ns, which explains the offset between the TWSTT data and the *Circular T* data observed.

See also the note to Table 2 concerning the time step in the GPS values between 30 June 1999 and 5 July 1999

* See note to Table 3.

Table 5. PTB/DTAG link

BIPM Report No.	Date 1999 (MJD)	[UTC(PTB) – UTC(DTAG)] /ns		
		TWSTT	<i>Circular T</i> (GPS)	TWSTT – <i>Circular T</i>
2	26 April (51294)	22	–2	24
	1 May (51299)	–	–15	–
	6 May (51304)	–	–11	–
	11 May (51309)	–1	–22	21
	16 May (51314)	–8	–22	14
	21 May (51319)	–14	–42	28
	26 May (51324)	–33	–57	24
31 May (51329)	–39	–61	22	
3	5 June (51334)	–49	–67	18
	10 June (51339)	–46	–65	19
	15 June (51344)	–65	–82	17
	20 June (51349)	–82	–104	22
	25 June (51354)	–81	–102	21
	30 June (51359)	–78	–99	21
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

Note: The PTB/DTAG TWSTT link was calibrated by the transport of a TWSTT station. The observed discrepancy between the TWSTT 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		
		TWSTT	<i>Circular T</i> (GPS)	TWSTT – <i>Circular T</i>
3	6 May (51304)	–66	–67	1
	11 May (51309)	–77	–73	–4
	16 May (51314)	–79	–78	–1
	21 May (51319)	–83	–80	–3
	26 May (51324)	–84	–82	–2
	31 May (51329)	–83	–80	–3
	5 June (51334)	–78	–77	–1
	10 June (51339)	–77	–74	–3
	15 June (51344)	–85	–84	–1
	20 June (51349)	–85	–85	0
	25 June (51354)	–86	–81	–5
30 June (51359)	–	–67	–	
4	5 July (51364)	–	19	–
	10 July (51369)	–	–107	–
	15 July (51374)	–	–97	–
	20 July (51379)	–	–82	–
	25 July (51384)	–	–61	–
30 July (51389)	–	–35	–	
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

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

The transmitted power of the TWSTT signal from VSL has been suffering from an extra attenuation of up to 6 dB since 30 June 1999. The VSL TWSTT data were not available between 9 July 1999 and 2 August 1999.

Table 7. NPL/NIST link

BIPM Report No.	Date 1999 (MJD)	[UTC(NPL) – UTC(NIST)] /ns		
		TWSTT	<i>Circular T</i> (GPS)	TWSTT – <i>Circular T</i>
3	26 April (51294)	31	–67	98
	1 May (51299)	28	–73	101
	6 May (51304)	27	–72	99
	11 May (51309)	27	–72	99
	16 May (51314)	28	–74	102
	21 May (51319)	28	–74	102
	26 May (51324)	28	–73	101
	31 May (51329)	28	–72	100
	5 June (51334)	29	–73	102
	10 June (51339)	28	–74	102
	15 June (51344)	29	–73	102
	20 June (51349)	28	–71	99
	25 June (51354)	28	–71	99
30 June (51359)	30	–70	100	
4	5 July (51364)	30	–60	90
	10 July (51369)	28	–60	88
	15 July (51374)	31	–63	94
	20 July (51379)	32	–58	90
	25 July (51384)	35	–59	94
	30 July (51389)	38	–54	92
5	4 August (51394)	39	–54	93
	9 August (51399)	41	–51	92
	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

Notes: The NPL/NIST TWSTT link was calibrated on MJD = 51377 using *Circular T*.
See also the note to Table 2 concerning the time step in the GPS values between 30 June 1999 and 5 July 1999.

Table 8. NPL/PTB link

BIPM Report No.	Date 1999 (MJD)	[UTC(NPL) – UTC(PTB)] /ms		
		TWSTT	<i>Circular T</i> (GPS)	TWSTT – <i>Circular T</i>
5	1 April (51269)	–327	–81	–246
	6 (April) (51274)	–331	–84	–247
	11 April (51279)	–334	–87	–247
	16 April (51284)	–333	–91	–242
	21 April (51289)	–328	–77	–251
	26 April (51294)	–324	–79	–245
	1 May (51299)	–321	–76	–245
	6 May (51304)	–320	–75	–245
	11 May (51309)	–322	–73	–249
	16 May (51314)	–316	–70	–246
	21 May (51319)	–315	–68	–247
	26 May (51324)	–311	–64	–247
	31 May (51329)	–310	–61	–249
	5 June (51334)	–308	–64	–244
	10 June (51339)	–315	–69	–246
	15 June (51344)	–316	–70	–246
	20 June (51349)	–321	–73	–248
	25 June (51354)	–321	–73	–248
	30 June (51359)	–324	–77	–247
	5 July (51364)	–325	–76	–249
	10 July (51369)	–331	–83	–248
	15 July (51374)	–332	–86	–246
	20 July (51379)	–331	–82	–249
	25 July (51384)	–332	–86	–246
	30 July (51389)	–331	–85	–246
	4 August (51394)	–327	–78	–249
	9 August (51399)	–330	–85	–245
	14 August (51404)	–334	–84	–250
19 August (51409)	–333	–86	–247	
24 August (51414)	–333	–85	–248	
29 August (51419)	–333	–83	–250	
6	3 September (51424)	–333	–87	–246
	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

Note: The NPL/PTB TWSTT link was calibrated on MJD = 51238 using *Circular T*.

Table 9. NPL/VSL link

BIPM Report No.	Date 1999 (MJD)	[UTC(NPL) – UTC(VSL)] /ns		
		TWSTT	<i>Circular T</i> (GPS)	TWSTT – <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

Note: The NPL/VSL TWSTT link was calibrated on MJD = 51304 using *Circular T*.