JAWL/TM.123 Sèvres, 13 February 2003

23rd BIPM TWSTFT Report

To: TWSTFT Participating Stations

Dear Colleagues,

This report covers the data for transatlantic, European and Asia/Pacific links from August to December 2002. All TWSTFT links reported here are compared with GPS C/A–code common–view data.

Please note that Section III of this report, describing the equipment of the participating laboratories, has been extensively updated. We invite you to check the information related to your laboratory and to inform us of any errors or omissions. Section IV presents an updated summary of the international time links.

A new permanent X–band link has been established between USNO and PTB and has been calibrated by a portable USNO X–band TWSTFT station. The results of this calibration were applied to USNO/PTB INTELSAT Ku-band link starting from 27 September 2002 (MJD 52544).

A TWSTFT link through INTELSAT at 176° E between AUS (NML, Australia) and CRL (Japan) has been replaced from September 2002 by a link through PAS–8 at 166° E.

Please note that the BIPM TWSTFT Reports are available by ftp (62.161.69.5, see the directory /Publication/), and via the BIPM web site http://www.bipm.org/enus/5_Scientific/c_time/time_ftp.shtml . Computer–readable data for all the TWSTFT links published in these reports are available from the same address. Reports of the two most recent meetings of the CCTF WG on TWSTFT can be found at http://www.bipm.org/pdf/cctf/wg_twstft.html .

Sincerely yours,

Jacques Azoubib and Włodzimierz Lewandowski

23rd BIPM TWSTFT Report

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Section I

Comparison of TWSTFT and GPS CV links computed at the BIPM

Results of the computation for twelve time links are given in Tables 1 to 12. Plots showing the differences between the TWSTFT results and the GPS results are given in Figures 1 to 12.

- TWSTFT links

  Because the TWSTFT data are unevenly spaced by intervals of 2, 3 or 4 days, they are linearly interpolated to give the data for the TAI standard dates at intervals of 5 days.

  When TWSTFT sessions are missing and data are interpolated between TWSTFT sessions more than 5 days apart, results are printed in bold characters. The upper limit for interpolation is 10 days.

- GPS C/A–code common–view links

  GPS C/A–code common–view links are computed using IGS precise ephemerides and IGS ionosphere maps.

Table 1. NIST/PTB link through INTELSAT 307° E.

Date 2002 (MJD)	[*UTC(NIST) – UTC(PTB)*] /ns		(TWSTFT – GPS) /ns
	TWSTFT (*Circular T*)	GPS	
3 August (52489)	19	10	9
8 August (52494)	18	8	10
13 August (52499)	20	9	11
18 August (52504)	14	4	10
23 August (52509)	8	0	8
28 August (52514)	9	3	6
2 September (52519)	9	0	9
7 September (52524)	4	–2	6
12 September (52529)	–1	–8	7
17 September (52534)	–3	–10	7
22 September (52539)	–6	–16	10
27 September (52544)	–10	–18	8
2 October (52549)	–13	–22	9
7 October (52554)	–11	–17	6
12 October (52559)	–13	–21	8
17 October (52564)	–15	–22	7
22 October (52569)	–16	–23	7
27 October (52574)	–18	–19	1
1 November (52579)	–22	–26	4
6 November (52584)	–25	–24	–1
11 November (52589)	–24	–29	5
16 November (52594)	–21	–24	3
21 November (52599)	–20	–23	3
26 November (52604)	–19	–25	6
1 December (52609)	–19	–23	4
6 December (52614)	–21	–24	3
11 December (52619)	–21	–28	7
16 December (52624)	–24	–26	2
21 December (52629)	–16	–19	3
26 December (52634)	–12	–16	4
31 December (52639)	–13	–15	2

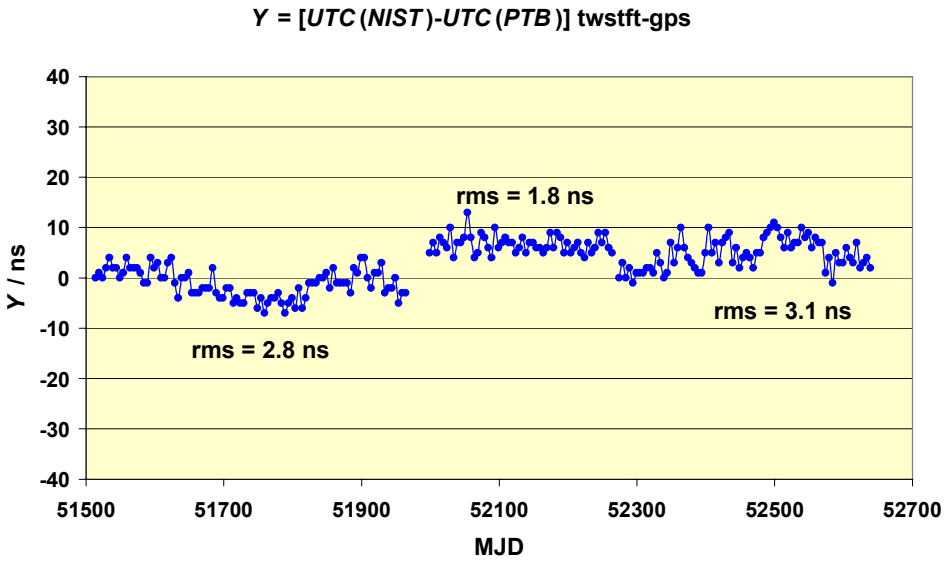

Figure 1. Differences between TWSTFT and GPS C/A–code common–view for NIST/PTB link.

Notes:
- After changes of INTELSAT 307° E transponders from 25 February to 17 March 2001 (MJD 51965 – 51985) causing time steps, a new calibration of the NIST/PTB TWSTFT link derived from *Circular T* was applied starting from 31 December 2001 (MJD 52274).
- Since 5 January 2002 (MJD 52279) the TWSTFT data are used again for the computation of TAI and the corresponding GPS data are computed in parallel and kept as back–up.
- Several changes in PTB earth station hardware in March 2001 ending on 28 March 2001 (MJD 51996).

Table 2. USNO/NPL link with NPL TWSTFT Station 02 through INTELSAT 307° E.

Date 2002 (MJD)	[*UTC(USNO) – UTC(NPL)*] /ns		(TWSTFT– GPS)/ns
	TWSTFT (*Circular T*)	GPS	
3 August (52489)	–4	–17	13
8 August (52494)	–2	–16	14
13 August (52499)	0	–12	12
18 August (52504)	4	–11	15
23 August (52509)	**3**	–10	13
28 August (52514)	2	–11	13
2 September (52519)	1	–13	14
7 September (52524)	**–1**	–13	12
12 September (52529)	–2	–16	14
17 September (52534)	–3	–16	13
22 September (52539)	–5	–18	13
27 September (52544)	–5	–19	14
2 October (52549)	**–5**	–22	17
7 October (52554)	**–4**	–15	11
12 October (52559)	–3	–15	12
17 October (52564)	–2	–14	12
22 October (52569)	–2	–15	13
27 October (52574)	–1	–10	9
1 November (52579)	1	–12	13
6 November (52584)	3	–9	12
11 November (52589)	4	–7	11
16 November (52594)	7	–5	12
21 November (52599)	8	–2	10
26 November (52604)	10	–2	12
1 December (52609)	12	–1	13
6 December (52614)	13	1	12
11 December (52619)	15	2	13
16 December (52624)	18	4	14
21 December (52629)	**19**	5	14

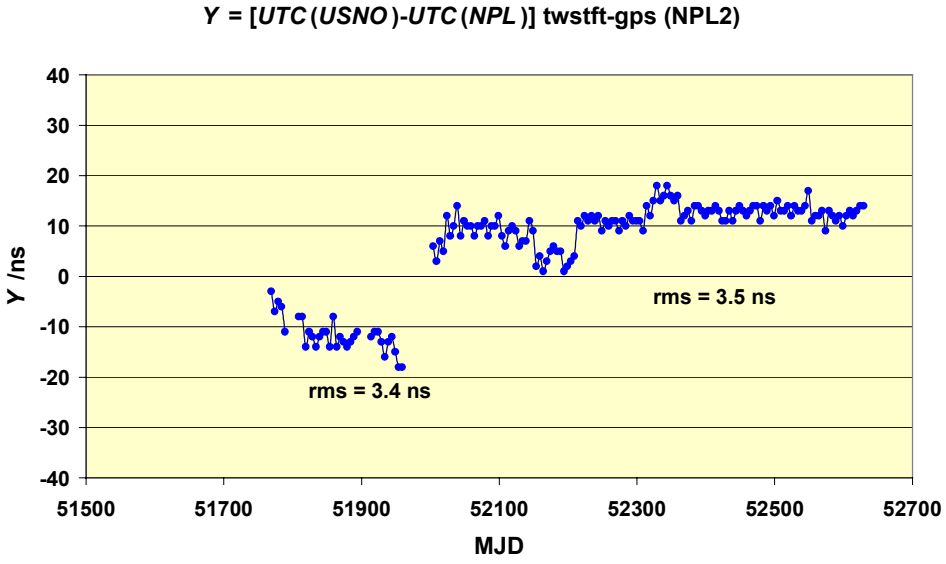

Figure 2. Differences between TWSTFT and GPS C/A–code common–view for USNO/NPL link (NPL station 02).

Notes:
- The USNO/NPL TWSTFT link with NPL TWSTFT Station 02 is used for the computation of TAI. The corresponding GPS multi–channel data are computed in parallel and kept as back–up.
- Changes of INTELSAT 307° E transponders from 25 February to 17 March 2001 (MJD 51965–51985) causing time steps.
- A new calibration of the USNO/NPL02 TWSTFT Ku–band link by the USNO portable X– band station link was applied starting from 19 March 2001 (MJD 51987).
- Change of GPS receiver at the USNO from single–channel to multi–channel on 1 April 2001 (MJD 52000).
- Change of USNO modem from Mitrex to Satre on 4 May 2001 (MJD 52033).
- Change of GPS receiver at the NPL at the beginning of September 2001 (about MJD 52154).
- Change of GPS receiver at the NPL from single–channel to multi–channel at the beginning of August 2002 (about MJD 52489).

Table 3. USNO/PTB Ku–band link through INTELSAT 307° E.

Date 2002 (MJD)	[*UTC(USNO) – UTC(PTB)*] /ns		(TWSTFT – GPS)/ns
	TWSTFT	GPS	
3 August (52489)	28	5	23
8 August (52494)	27	1	26
13 August (52499)	28	2	26
18 August (52504)	24	–3	27
23 August (52509)	23	–4	27
28 August (52514)	27	2	25
2 September (52519)	28	3	25
7 September (52524)	**24**	0	24
12 September (52529)	20	–7	27
17 September (52534)	19	–7	26
22 September (52539)	–	–10	–
27 September (52544)	–4	–12	8
2 October (52549)	–6	–16	10
7 October (52554)	–5	–12	7
12 October (52559)	–6	–14	8
17 October (52564)	–9	–17	8
22 October (52569)	–9	–16	7
27 October (52574)	–10	–15	5
1 November (52579)	–14	–21	7
6 November (52584)	–17	–23	6
11 November (52589)	–18	–26	8
16 November (52594)	–15	–23	8
21 November (52599)	–15	–21	6
26 November (52604)	–17	–25	8
1 December (52609)	–19	–24	5
6 December (52614)	–21	–28	7
11 December (52619)	–23	–31	8
16 December (52624)	–25	–32	7
21 December (52629)	–23	–25	2
26 December (52634)	–23	–20	–3
31 December (52639)	–23	–22	–1

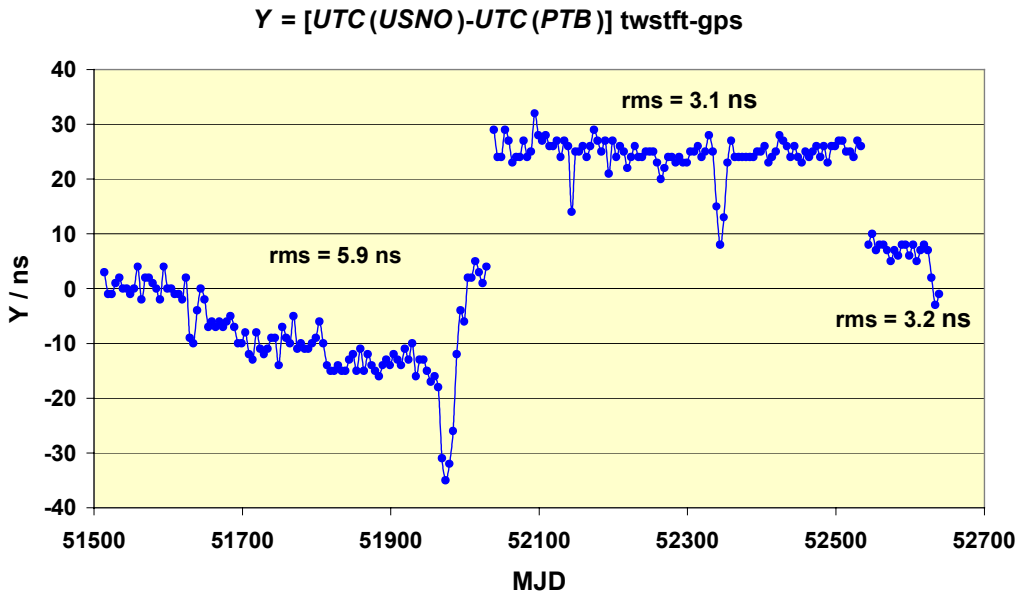

Figure 3. Differences between TWSTFT and GPS C/A–code common–view for USNO/PTB link

Notes:
- A calibration of the USNO/PTB TWSTFT link derived from *Circular T* values from July 1999 was applied starting from 29 November 1999 (MJD = 51511).
- Changes of INTELSAT 307° E transponders from 25 February to 17 March 2001 (MJD 51965–51985) causing time steps.
- Several changes in PTB earth station hardware in March 2001 ending on 28 March 2001 (MJD 51996).
- Change of GPS receiver at the USNO from single–channel to multi–channel on 1 April 2001 (MJD 52000).
- Change of USNO modem from Mitrex to Satre on 4 May 2001 (MJD 52033).
- A calibration of USNO/PTB TWSTFT Ku–band link by USNO/PTB TWSTFT X–band link was applied starting from 27 September 2002 (MJD = 52544).

Table 4. VSL/PTB link through INTELSAT 307° E.

Date 2002 (MJD)	[*UTC(VSL) – UTC(PTB)*] /ns		(TWSTFT – GPS) /ns
	TWSTFT (*Circular T*)	GPS	
3 August (52489)	16	14	2
8 August (52494)	13	9	4
13 August (52499)	11	10	1
18 August (52504)	14	8	6
23 August (52509)	17	11	6
28 August (52514)	27	23	4
2 September (52519)	33	28	5
7 September (52524)	33	29	4
12 September (52529)	21	15	6
17 September (52534)	26	22	4
22 September (52539)	27	21	6
27 September (52544)	21	18	3
2 October (52549)	14	8	6
7 October (52554)	18	9	9
12 October (52559)	15	9	6
17 October (52564)	12	8	4
22 October (52569)	5	2	3
27 October (52574)	3	0	3
1 November (52579)	3	0	3
6 November (52584)	–1	–4	3
11 November (52589)	–5	–10	5
16 November (52594)	0	–5	5
21 November (52599)	–	–3	–
26 November (52604)	6	3	3
1 December (52609)	–4	–8	4
6 December (52614)	**–6**	–15	9
11 December (52619)	**–5**	–9	4
16 December (52624)	–2	–3	1
21 December (52629)	10	7	3
26 December (52634)	20	17	3

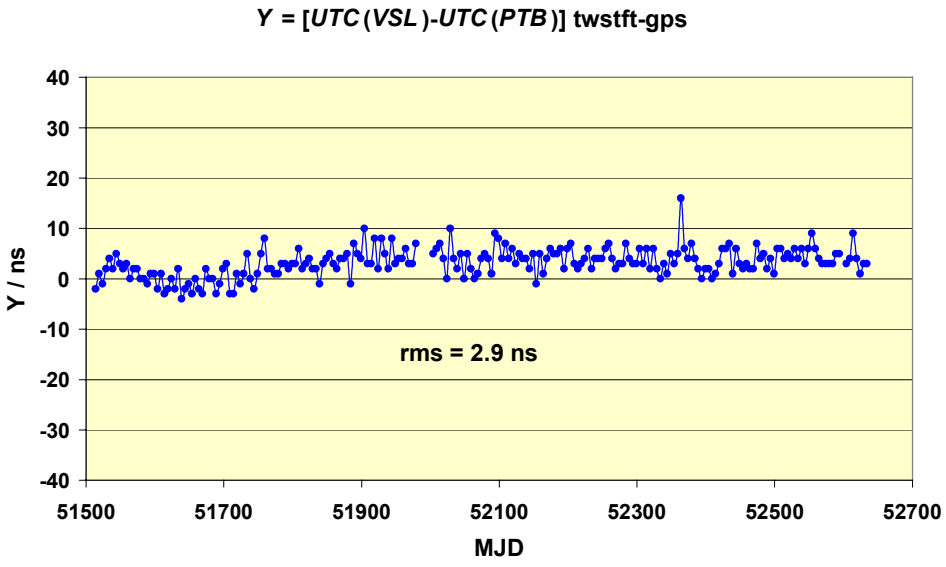

Figure 4. Differences between TWSTFT and GPS C/A–code common–view for VSL/PTB link

Notes:
- The VSL/PTB TWSTFT link was calibrated by *Circular T*.
- The VSL/PTB TWSTFT link has been included in the computation of TAI since 1 January 2000 (MJD = 51544).
- Several changes in PTB earth station hardware in March 2001 ending on 28 March 2001 (MJD 51996).

Table 5. NPL/PTB link with NPL TWSTFT Station 01 through INTELSAT 307° E.

Date 2002 (MJD)	[*UTC(NPL) – UTC(PTB)*] /ns		(TWSTFT–GPS)/ns
	TWSTFT (*Circular T*)	GPS	
3 August (52489)	16	21	–5
8 August (52494)	**13**	18	–5
13 August (52499)	**10**	15	–5
18 August (52504)	5	8	–3
23 August (52509)	3	6	–3
28 August (52514)	8	12	–4
2 September (52519)	11	15	–4
7 September (52524)	9	14	–5
12 September (52529)	5	10	–5
17 September (52534)	5	11	–6
22 September (52539)	6	8	–2
27 September (52544)	3	7	–4
2 October (52549)	0	1	–1
7 October (52554)	1	0	1
12 October (52559)	–2	–2	0
17 October (52564)	–5	–8	3
22 October (52569)	–5	–5	0
27 October (52574)	–8	–6	–2
1 November (52579)	**–14**	–8	–6
6 November (52584)	**–19**	–13	–6
11 November (52589)	–21	–17	–4
16 November (52594)	–20	–17	–3
21 November (52599)	–22	–18	–4
26 November (52604)	–25	–21	–4
1 December (52609)	–29	–23	–6
6 December (52614)	–34	–28	–6
11 December (52619)	–38	–32	–6
16 December (52624)	**–37**	–35	–2
21 December (52629)	**–35**	–28	–7
26 December (52634)	–34	–28	–6
31 December (52639)	–41	–34	–7

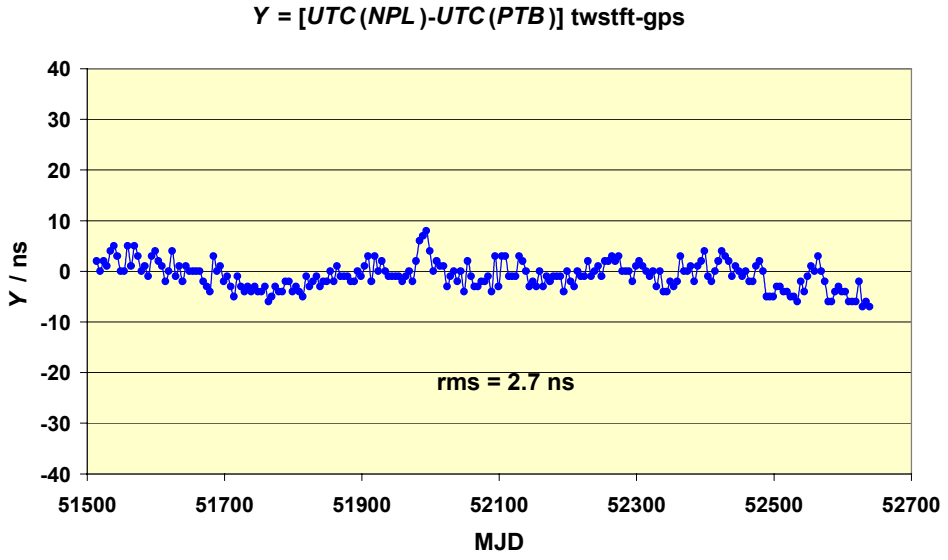

Figure 5. Differences between TWSTFT (NPL station 01) and GPS C/A–code common–view for NPL/PTB link.

Notes:
- A new calibration of the NPL/PTB TWSTFT link using *Circular T* was applied on 29 November 1999 (MJD 51511).
- The NPL/PTB TWSTFT link has been included in the computation of TAI since 4 July 2000 (MJD 51729).
- Several changes in PTB earth station hardware in March 2001 ending on 28 March 2001 (MJD 51996).
- Change of GPS receiver at the NPL at the beginning of September 2001 (about MJD 52154).
- Change of GPS receiver at the NPL from single–channel to multi–channel at the beginning of August 2002 (about MJD 52489).

Table 6. NPL/VSL link with NPL TWSTFT Station 01 through INTELSAT 307° E.

Date 2002 (MJD)	[*UTC(NPL) – UTC(VSL)*] /ns		(TWSTFT – GPS)/ns
	TWSTFT	GPS	
3 August (52489)	–1	8	–9
8 August (52494)	**0**	9	–9
13 August (52499)	**–2**	6	–8
18 August (52504)	–10	1	–11
23 August (52509)	–15	–5	–10
28 August (52514)	–20	–11	–9
2 September (52519)	–24	–13	–11
7 September (52524)	–25	–15	–10
12 September (52529)	–19	–4	–15
17 September (52534)	–22	–11	–11
22 September (52539)	–21	–11	–10
27 September (52544)	–19	–10	–9
2 October (52549)	–14	–6	–8
7 October (52554)	–18	–9	–9
12 October (52559)	–19	–10	–9
17 October (52564)	–18	–14	–4
22 October (52569)	–10	–5	–5
27 October (52574)	–12	–5	–7
1 November (52579)	**–14**	–7	–7
6 November (52584)	**–17**	–9	–8
11 November (52589)	–16	–7	–9
16 November (52594)	–21	–12	–9
21 November (52599)	–	–15	–
26 November (52604)	–30	–24	–6
1 December (52609)	–26	–14	–12
6 December (52614)	**–29**	–15	–14
11 December (52619)	**–34**	–22	–12
16 December (52624)	**–40**	–32	–8
21 December (52629)	**–46**	–35	–11
26 December (52634)	–55	–45	–10

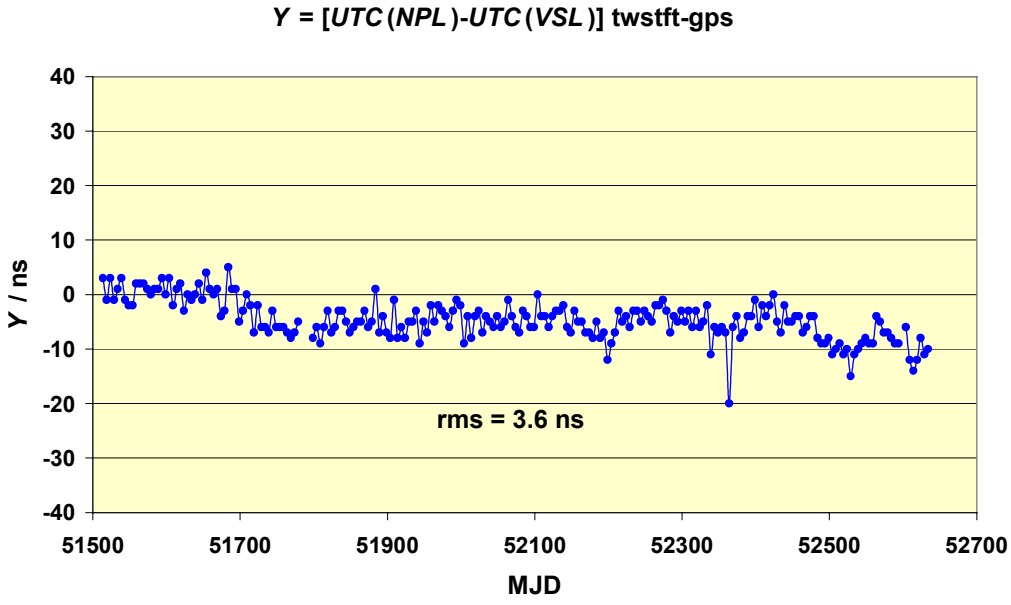

Figure 6. Differences between TWSTFT (NPL station 01) and GPS C/A–code common–view for NPL/VSL link

Notes:
- A new calibration of the NPL/VSL TWSTFT link using *Circular T* was applied on 29 November 1999 (MJD = 51511).
- Change of GPS receiver at the NPL at the beginning of September 2001 (about MJD 52154).
- Change of GPS receiver at the NPL from single–channel to multi–channel at the beginning of August 2002 (about MJD 52489).

Table 7. ROA/PTB link through INTELSAT 307° E.

Date 2002 (MJD)	[*UTC(ROA)– UTC(PTB)*] /ns		(TWSTFT – GPS)/ns
	TWSTFT (*Circular T*)	GPS	
3 August (52489)	**–34**	–28	–6
8 August (52494)	–37	–30	–7
13 August (52499)	–21	–17	–4
18 August (52504)	–22	–19	–3
23 August (52509)	–16	–13	–3
28 August (52514)	–12	–9	–3
2 September (52519)	–18	–16	–2
7 September (52524)	–23	–20	–3
12 September (52529)	–20	–18	–2
17 September (52534)	–19	–17	–2
22 September (52539)	–20	–19	–1
27 September (52544)	–27	–23	–4
2 October (52549)	–37	–34	–3
7 October (52554)	–41	–38	–3
12 October (52559)	–48	–43	–5
17 October (52564)	–42	–34	–8
22 October (52569)	–38	–34	–4
27 October (52574)	–39	–32	–7
1 November (52579)	–37	–34	–3
6 November (52584)	–43	–41	–2
11 November (52589)	–44	–41	–3
16 November (52594)	–37	–33	–4
21 November (52599)	–40	–34	–6
26 November (52604)	–43	–37	–6
1 December (52609)	–44	–36	–8
6 December (52614)	–41	–34	–7
11 December (52619)	–44	–38	–6
16 December (52624)	–55	–49	–6
21 December (52629)	–47	–39	–8
26 December (52634)	–41	–37	–4
31 December (52639)	–45	–38	–7

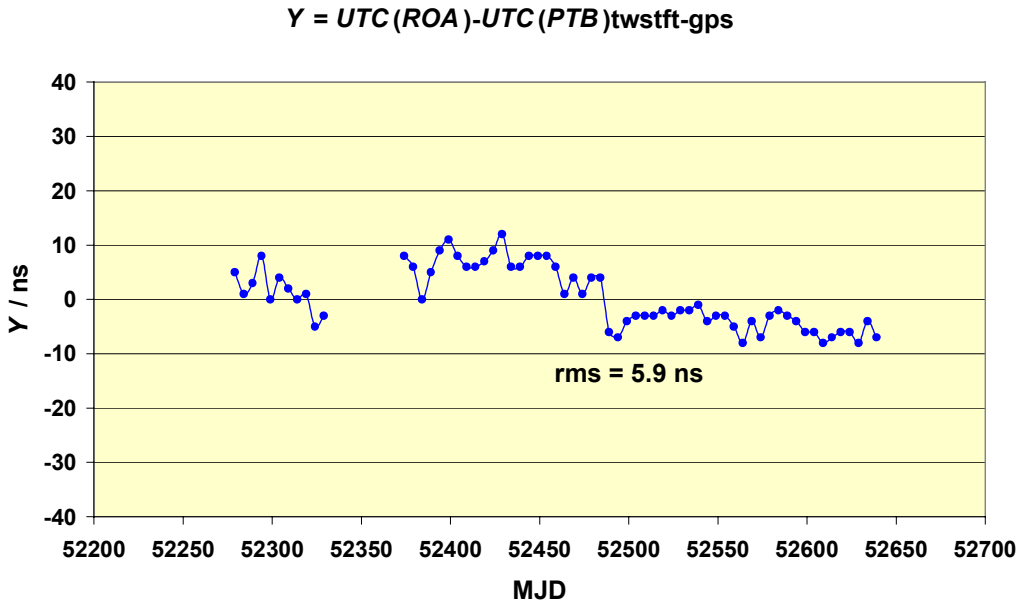

Figure 7. Differences between TWSTFT and GPS C/A–code common–view for ROA/PTB link.

Notes: ● A calibration of the ROA/PTB TWSTFT link derived from *Circular T* values is applied starting from 31 December 2001 (MJD = 52274).

- ROA/PTB TWSTFT link is used for the TAI computation since 5 January 2002 (MJD 52279).
- Due to a thunder damage the ROA TWSTFT station was not operational from 1 to 31 March 2002. For this period the GPS data were used for the computation of TAI.
- Malfunction of ROA reference GPS receiver S/N 253 at the end of July (around MJD 52484).

Table 8. PTB/OCA link through INTELSAT 307° E.

Date 2002 (MJD)	[*UTC(PTB) – OCA clock*] /ns		(TWSTFT – GPS)/ns
	TWSTFT	GPS	
3 August (52489)	**–1072**	–1143	71
8 August (52494)	–1148	–1217	69
13 August (52499)	–1213	–1281	68
18 August (52504)	–1277	–1345	68
23 August (52509)	–1350	–1418	68
28 August (52514)	–1420	–1491	71
2 September (52519)	**–1495**	–1567	72
7 September (52524)	**–1571**	–1642	71
12 September (52529)	–1644	–1717	73
17 September (52534)	–1714	–1787	73
22 September (52539)	–1789	–1858	69
27 September (52544)	–1863	–1938	75
2 October (52549)	–1940	–2017	77
7 October (52554)	**–2015**	–2088	73
12 October (52559)	**–2089**	–2163	74
17 October (52564)	**–2164**	–2236	72
22 October (52569)	–2240	–2315	75
27 October (52574)	–2317	–2397	80
1 November (52579)	–2391	–2466	75
6 November (52584)	–	–2531	–
11 November (52589)	–2533	–2609	76
16 November (52594)	**–2610**	–2682	72
21 November (52599)	**–2684**	–2757	73
26 November (52604)	**–2756**	–	–
1 December (52609)	**–2828**	–2899	71
6 December (52614)	**–2903**	–2974	71
11 December (52619)	–3064	–	–
16 December (52624)	–3310	–3379	69
21 December (52629)	**–3410**	–3481	71
26 December (52634)	**–3504**	–3571	67
31 December (52639)	**–3599**	–3667	68

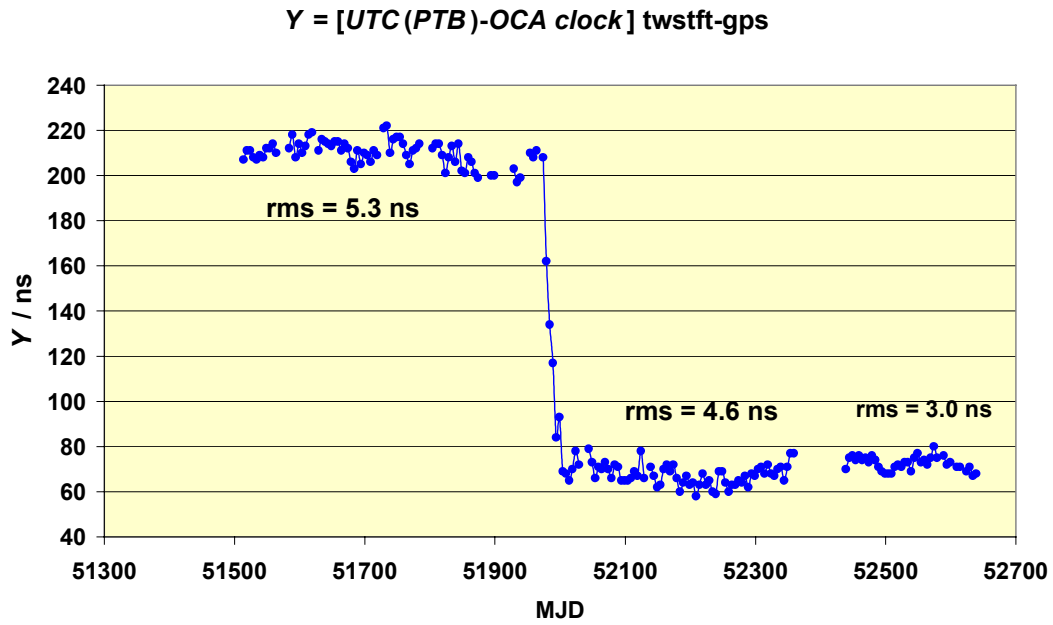

Figure 8. Differences between TWSTFT and GPS C/A–code common–view for PTB/OCA link.

Notes:
- Erronous OCA GPS data due to a mulfunction of a BIPM software were published in BIPM TWSTFT Reports 19 to 22 for the period 4 July (MJD 52094) – 26 March (MJD 52359). Corrected data are reported on the above Figure.
- PTB/OCA TWSTFT link TWSTFT is not calibrated.
- Several changes in PTB earth station hardware in March 2001 ending on 28 March 2001 (MJD 51996).

Table 9. NTSC*/CRL link through JCSAT–1B at 150° E.

Date 2002 (MJD)	[*UTC(NTSC) – UTC(CRL)*] /ns		(TWSTFT – GPS)/ns
	TWSTFT (*Circular T*)	GPS	
23 August (52509)	–34	–49	15
28 August (52514)	–27	–46	19
2 September (52519)	–25	–44	19
7 September (52524)	–25	–36	11
12 September (52529)	–17	–21	4
17 September (52534)	–23	–38	15
22 September (52539)	–31	–45	14
27 September (52544)	–40	–56	16
2 October (52549)	–40	–45	5
7 October (52554)	–42	–55	13
12 October (52559)	–32	–42	10
17 October (52564)	–25	–41	16
22 October (52569)	–22	–37	15
27 October (52574)	–29	–42	13
1 November (52579)	–33	–45	12
6 November (52584)	–37	–49	12
11 November (52589)	–34	–49	15
16 November (52594)	–33	–48	15
21 November (52599)	–32	–49	17
26 November (52604)	–32	–45	13
1 December (52609)	**–33**	–42	9
6 December (52614)	**–31**	–44	13
11 December (52619)	–34	–48	14
16 December (52624)	–34	–46	12
21 December (52629)	**–33**	–44	11
26 December (52634)	**–23**	–37	14
31 December (52639)	**–21**	–28	7

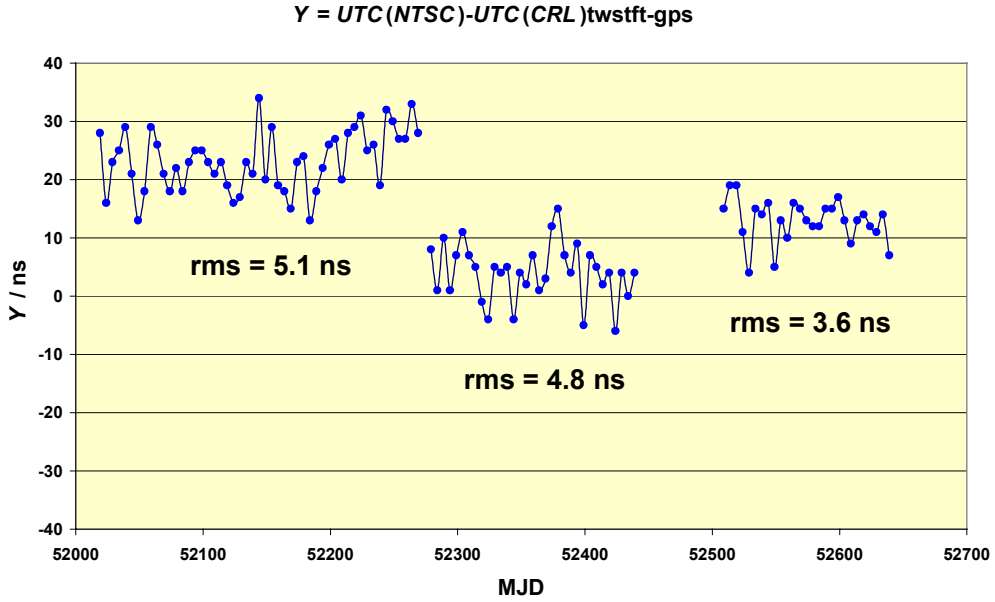

Figure 9. Differences between TWSTFT and GPS C/A–code common–view for NTSC/CRL link.

Notes: * NTSC. National Time Service Center, formerly CSAO.

- The NTSC/CRL TWSTFT link was calibrated from *Circular T* values ranging from 27 September 2001 to 27 October 2001. The calibration results are applied since 5 January 2002 (MJD 52279).
- NTSC/CRL TWSTFT link is used for the TAI computation since 5 January 2002 (MJD 52279).

Table 10. NMIJ/CRL link through JCSAT–1B at 150° E.

Date 2002 (MJD)	[*UTC(NMIJ) – UTC(CRL)*] /ns		(TWSTFT – GPS)/ns
	TWSTFT (*Circular T*)	GPS	
2 October (52549)	**–308**	–303	–5
7 October (52554)	–319	–314	–5
12 October (52559)	–331	–329	–2
17 October (52564)	–340	–337	–3
22 October (52569)	–356	–353	–3
27 October (52574)	–114	–111	–3
1 November (52579)	–118	–113	–5
6 November (52584)	–131	–126	–5
11 November (52589)	–134	–128	–6
16 November (52594)	–146	–141	–5
21 November (52599)	–157	–153	–4
26 November (52604)	**–167**	–167	0
1 December (52609)	–178	–168	–10
6 December (52614)	–186	–184	–2
11 December (52619)	–194	–194	0
16 December (52624)	–205	–198	–7
21 December (52629)	–211	–205	–6
26 December (52634)	–213	–210	–3
31 December (52639)	**–218**	–214	–4

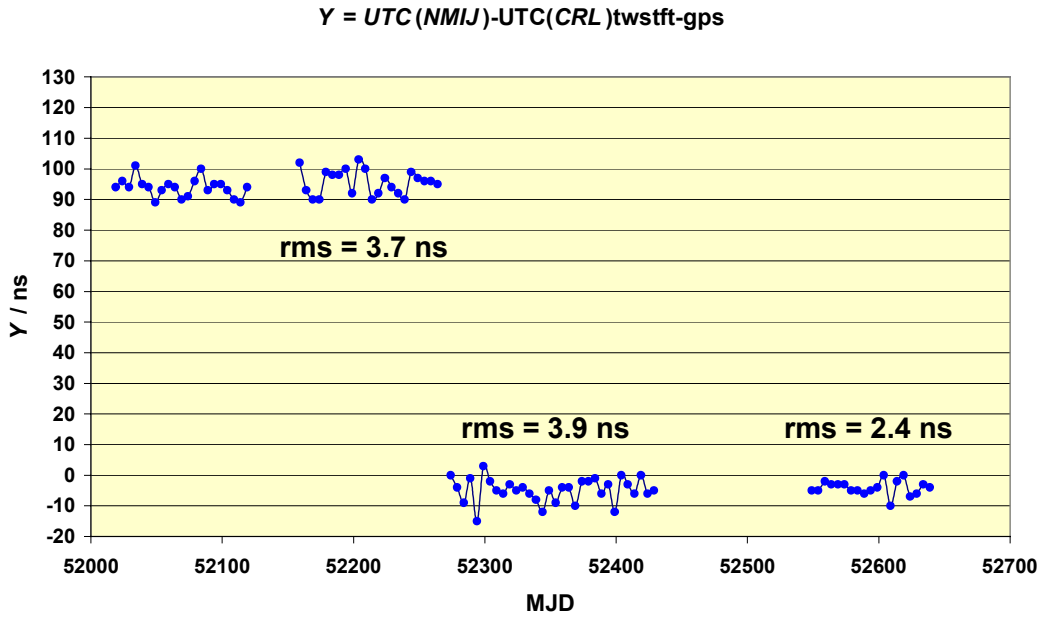

Figure 10. Differences between TWSTFT and GPS C/A–code common–view for NMIJ/CRL link.

Notes:
- The NMIJ/CRL TWSTFT link was calibrated from *Circular T* values ranging from 2 October 2001 to 27 October 2001. The calibration results are applied since 31 December 2001 (MJD 52274).
- NMIJ/CRL TWSTFT link is used for the TAI computation since 5 January 2002 (MJD 52279).

Table 11. TL/CRL link through JCSAT–1B at 150° E.

Date 2002 (MJD)	[*UTC(TL) – UTC(CRL)*] /ns		(TWSTFT – GPS)/ns
	TWSTFT(*Circular T*)	GPS	
3 August (52489)	59	53	6
8 August (52494)	58	55	3
13 August (52499)	56	42	14
18 August (52504)	**46**	32	14
23 August (52509)	**38**	28	10
28 August (52514)	41	26	15
2 September (52519)	32	20	12
7 September (52524)	**29**	21	8
12 September (52529)	28	21	7
17 September (52534)	25	17	8
22 September (52539)	24	22	2
27 September (52544)	21	10	11
2 October (52549)	12	7	5
7 October (52554)	8	–1	9
12 October (52559)	3	8	–5
17 October (52564)	–2	–17	15
22 October (52569)	–8	–15	7
27 October (52574)	–13	–28	15
1 November (52579)	–17	–30	13
6 November (52584)	–23	–27	4
11 November (52589)	–23	–37	14
16 November (52594)	–20	–32	12
21 November (52599)	–16	–22	6
26 November (52604)	–14	–28	14
1 December (52609)	–18	–27	9
6 December (52614)	–18	–26	8
11 December (52619)	–11	–17	6
16 December (52624)	–9	–21	12
21 December (52629)	–12	–19	7
26 December (52634)	–10	–19	9
31 December (52639)	**–9**	–16	7

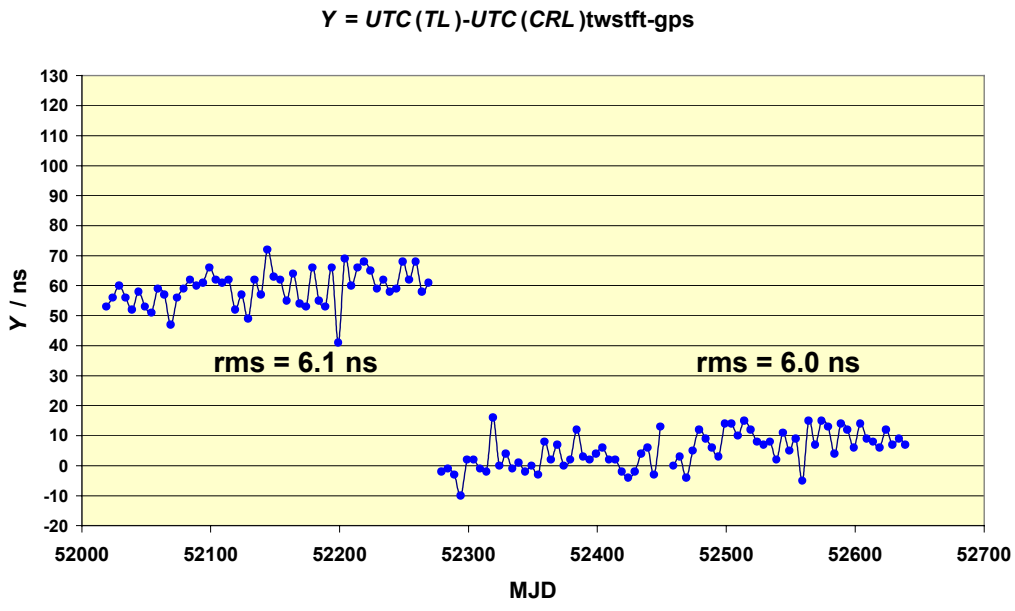

Figure 11. Differences between TWSTFT and GPS C/A–code common–view for TL/CRL link.

Notes:
- The TL/CRL TWSTFT link was calibrated from *Circular T* values ranging from 27 September 2001 to 27 October 2001. The calibration results are applied since 31 December 2001 (MJD 52274).
- The TL/CRL TWSTFT link is used in the computation of TAI since 5 January 2002 (MJD 52279).
- Due to the lack of TWSTFT data at the TL for about two weeks in April, GPS data were used for the TL/CRL link in the computation of TAI for April 2002.

Table 12. AUS/CRL link through PAS-8 at 166° E.

Date 2002 (MJD)	[*UTC(AUS) – UTC(CRL)*] /ns		(TWSTFT – GPS)/ns
	TWSTFT	GPS (*Circular T*)	
17 September (52534)	63	56	7
22 September (52539)	57	59	–2
27 September (52544)	55	50	5
2 October (52549)	79	73	6
7 October (52554)	73	65	8
12 October (52559)	59	58	1
17 October (52564)	49	35	14
22 October (52569)	36	27	9
27 October (52574)	38	29	9
1 November (52579)	46	41	5
6 November (52584)	38	29	9
11 November (52589)	54	48	6
16 November (52594)	52	42	10
21 November (52599)	43	38	5
26 November (52604)	34	26	8
1 December (52609)	39	39	0
6 December (52614)	44	32	12
11 December (52619)	33	17	16
16 December (52624)	30	23	7
21 December (52629)	39	27	12
26 December (52634)	**55**	50	5
31 December (52639)	**62**	53	9

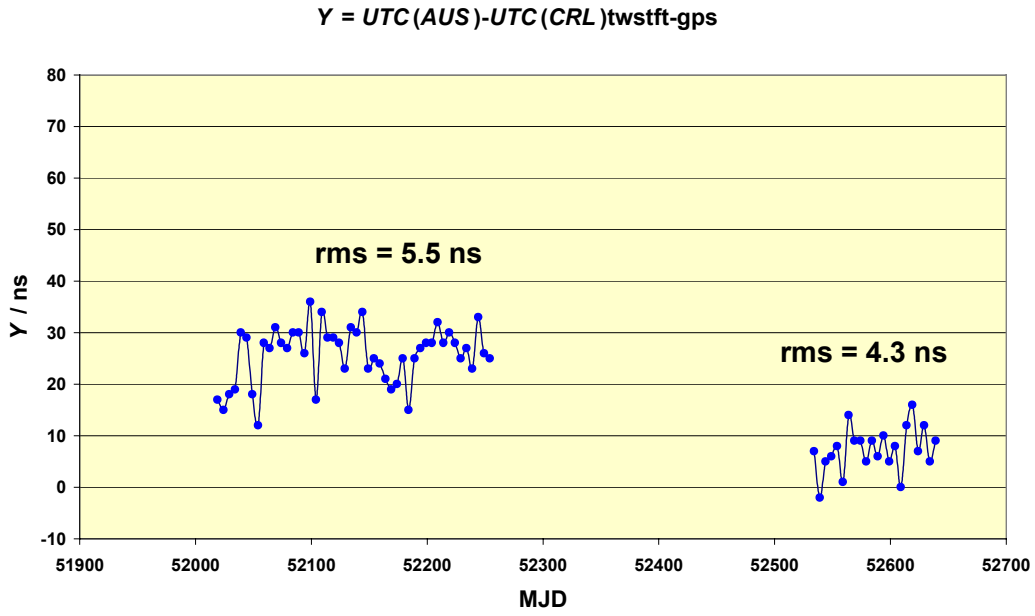

Figure 12. Differences between TWSTFT and GPS C/A-code common-view for AUS/CRL link.

Notes:
- The AUS/CRL TWSTFT link was calibrated from *Circular T* values around 3 August 2002 (MJD 52489). The calibration results are applied since 17 September 2002 (MJD 52534).
- The AUS/CRL TWSTFT is realized through PAS-8 at 166° E. For the period 20 April 2001 (MJD 52019) - 11 December 2001 (MJD 52254) this link was realized through INTELSAT 176° E.

Section II

Frequency stability of some TWSTFT and GPS CV links
reported in Section I

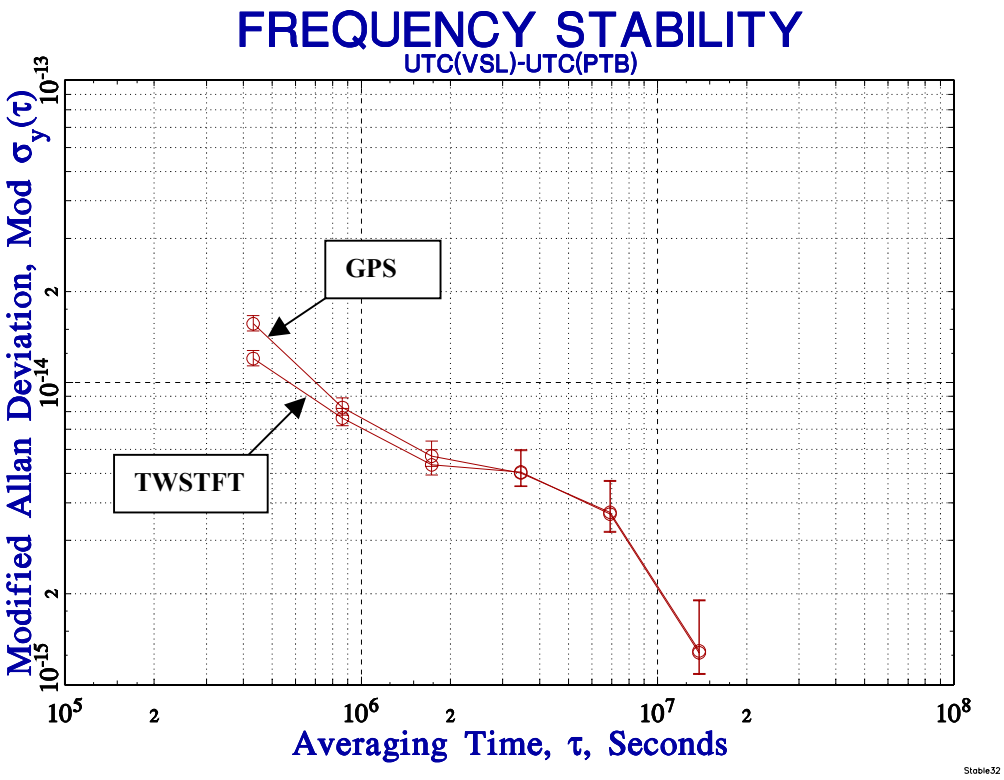

Figure 1. Frequency stability of [*UTC*(*VSL*) – *UTC*(*PTB*)] by GPS CV and by TWSTFT for the MJD period 51269 – 52639.

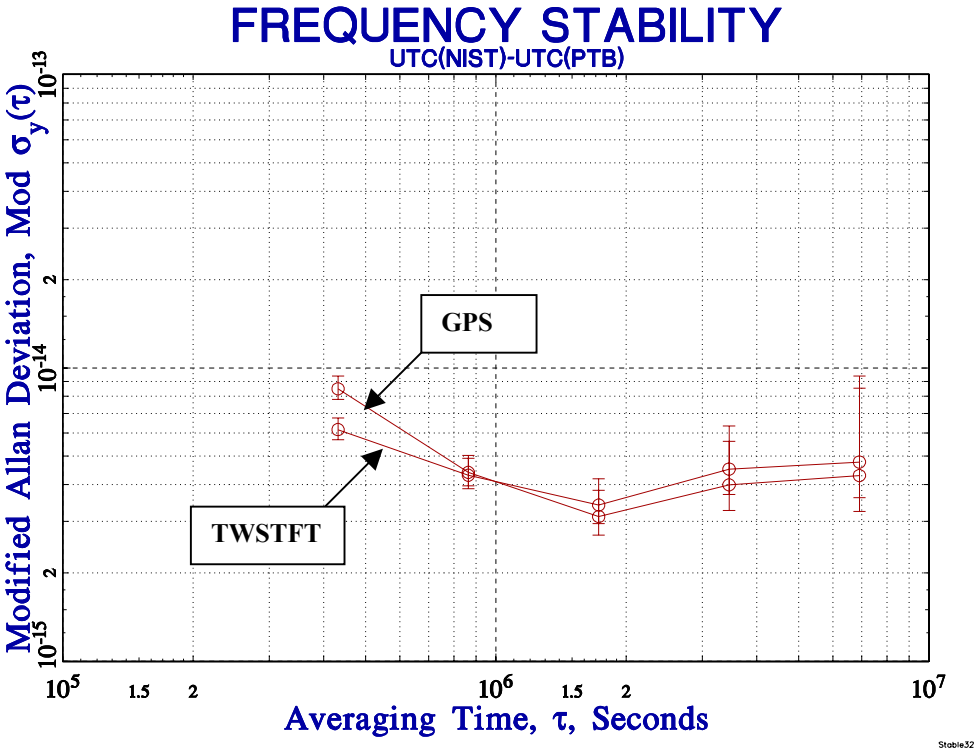

Figure 2. Frequency stability of [*UTC*(*NIST*) – *UTC*(*PTB*)] by GPS CV and by TWSTFT. for the MJD period 52274 – 52639.

Section III a: Description of equipment providing data for the TWSTFT links I Europe and North America (INTELSAT 307° E).

Lab.	GPS CV	TWSTFT (through INTELSAT 307° E)
IEN	Receiver type: NBS/TTR5 Receiver serial no: 31 Internal delay+antena cable delay: 253.0 ns Reference name: UTC(IEN) Reference type: 1 Cs	Modem type: University of Stuttgart/MITREX 2500A Modem serial no: Italy 1 Antenna: 1.8m, VSAT Prodelin Degree of automation: 100% Reference name: UTC(IEN) Reference type: 1 Cs
NIST	Receiver type: NBS/TTR5 Receiver serial no: 010 Internal delay: 53.0 ns Atenna cable delay: 71.9 ns. Reference name: UTC(NIST) Reference type: ensemble of 4 Cs + 5 H–masers	Modem type: University of Stuttgart/MITREX 2500 Modem serial no: Antenna: 3.7 m – steerable Degree of automation: 85 % Reference name: UTC(NIST) Reference type: ensemble of 4 Cs + 5 H–masers
NPL TWSTFT Station 01	Receiver type: NPL/TFS multi–channel Receiver serial No: 101 Internal delay: −31.8 ns Antenna cable delay: 71.9 ns. Reference name: UTC(NPL) Reference type: 1 H–maser	Modem type: TimeTech/SATRE, Serial no 038 Antenna: ERA 2.4 m Up–Converter Miteq (Model: U–9456–1K) Down–Converter Miteq (Model: D9300–3–1K) High Power Amplifier (HPA) Pascal Microwave (Type: PA–14145–2) Low Noise Block downconverter (LNB) (Upper band 12.25–12.75 GHz) Peak Communications Ltd (Model: PL120) Ku/L–Band cables Rhophase Microwave 50 W PTFE (Model No: SPS–1751–10000–SPS) Degree of automation: 70 % Reference name: UTC(NPL) Reference type: 1 H–maser
NPL TWSTFT Station 02	Receiver type: NPL/TFS multi–channel Receiver serial No: 101 Internal delay: −31.8 ns Antenna cable delay: 71.9 ns. Reference name: UTC(NPL) Reference type: 1 H–maser	Modem type: TimeTech/SATRE, Serial no 038 Antenna Channel Master 1.8 m Antenna and earth station are portable, and fitted with a non–penetrating mount. Earth station operates over the whole of the (14.0–14.5) GHz transmit bands and over both the receive bands (10.95–11.7 GHz and 12.25–12.75 GHz). IF input and output frequencies are both at 70 MHz. The up–link high–powered amplifier (HPA) output power is 8 W. All up–link and down–link frequencies are be locked to an external 5/10 MHz reference. Degree of automation: 70 % Reference name: UTC(NPL) Reference type: 1 H–maser
OCA	Receiver type: AOA/TTR5 Receiver serial No: 053 Internal delay+antena cable delay: 194.0 ns Reference name: OCA clock Reference type: 1 Cs	Modem type: University of Stuttgart/MITREX 2500 Modem serial no: Antenna: 1.8 m – VSAT Andrew Degree of automation: Reference name: OCA clock Reference type: 1 Cs
PTB	Receiver type: Rockwell Collins/TTR5 Receiver serial No: PTB01 Internal delay: 77 ns Reference name: UTC(PTB) Reference type: 1 Lab. Cs	Modem type: TimeTech/SATRE (carrier–phase option) Modem serial no: 037 Antenna: 1.8 m – VSAT Degree of automation: Reference name: UTC(PTB) Reference type: 1 Lab. Cs
ROA	Receiver type: AOA/TTR6 Receiver serial no: 253 Internal delay: 50.0 ns Antenna cable delay: 234.0 ns Reference name: UTC (ROA) Reference type: 1 Cs.	Modem type: TimeTech/SATRE Modem serial no: 040 Antenna: 1.8 m VSAT Prodelin Degree of automation: 98 % Automated Reference name: UTC (ROA) Reference type: 1 Cs.
USNO *	Receiver type: AOS/TTS–2 multi–channel Receiver serial no: 014 Internal delay: –47.9 ns Reference name: UTC(USNO MC) Reference type: 1 H–maser + freq. syntent.	Modem type: University of Stuttgart/MITREX 2500 Modem serial no: 85006 From 4 May 2001: TimeTech/SATRE Antenna: 4.6 m – steerable Degree of automation: Reference name: UTC(USNO MC) Reference type: 1 H–maser + freq. syntent.
VSL	Receiver type: VSL/TTR5 Receiver serial no: VSL01 Internal delay: 63.9 ns Reference name: UTC(VSL) Reference type: 1 Cs + micro–phase–stepper	Modem type: Univerity of Stuttgart/MITREX 2500 Modem serial no: 85008 Antenna: 3 m – steerable Degree of automation: 100 % Reference name: UTC(VSL) Reference type: 1 Cs + micro–phase–stepper

Note: * USNO is also equipped with a TWSTFT back–up station.

Section III b: Description of some equipment providing data for the TWSTFT links in Asia/Pacific (JCSAT–1B at 150° E).

Lab.	GPS CV	TWSTFT (through **JCSAT–1B at 150° E**)
CRL	Receiver type: AOA/TTR6 Receiver serial no: 451 Internal delay: 44.8 ns Reference name: UTC(CRL) Reference type: ensemble of 9 Cs	Modem type: Atlantis (AOA) Modem serial no: 29 Antenna: 1.8 m – VSAT Degree of automation: not completed Reference name: UTC(CRL) Reference type: ensemble of 9 Cs
NMIJ	Receiver type: AOA/TTR6 Receiver serial no: 484 Internal delay: 50 ns Reference name: UTC(NMIJ) Reference type: 1 Cs (HP 5071A)	Modem type: Atlantis (AOA) Modem serial no: 133 Antenna: 1.8 m – VSAT Deegree of automation: not completed Reference name: UTC(NMIJ) Reference type: 1 Cs (HP 5071A)
NTSC	Receiver type: 3 S Navigation R100/30T Receiver serial no: 0045 Internal delay: 25.3 ns(uncalibrated) Reference name: UTC(NTSC) Reference type: ensemble 0f 6 Cs	Modem type: Atlantis (AOA) Modem serial no:134 Antenna: 1.8 m – VSAT Degree of automation:not completed Reference name: UTC(NTSC) Reference type: ensemble 0f 6 Cs
TL	Receiver type: AOA Receiver serial no: 479 Internal delay: 50.0ns Reference name: UTC(TL) Reference type: 1 Cs + micro–phase–stepper	Modem type: Atlantis (AOA) Modem serial no: 135 Antenna: 2.4m–VSAT Degree of automation: not completed Reference name: UTC(TL) Reference type: 1 Cs + micro–phase–stepper

Section III c: Description of some equipment providing data for the TWSTFT links in Asia/Pacific (PAS–8).

Lab.	GPS CV	TWSTFT (through PAS–8)
CRL	Receiver type: AOA/TTR6 Receiver serial no: 451 Internal delay: 44.8 ns Reference name: UTC(CRL) Reference type: ensemble of 9 Cs	Modem type: Atlantis (AOA) Modem serial no: 29 Antenna: 1.8 m – VSAT Degree of automation: not completed Reference name: UTC(CRL) Reference type: ensemble of 9 Cs
AUS(NML)	Receiver type: NML/Topcon Euro–80 Receiver serial no: 8RQRFKXT534 Internal delay: 46.5 ns Reference name: UTC(AUS) Reference type: HP5071A (360340)	Modem type: Atlantis (AOA) Modem serial no: 130 Antenna: 1.8 m Degree of automation: None Reference name: UTC(AUS) Reference type: HP5071A (360340)

Section III d: Description of some equipment providing data for the TWSTFT links in Asia/Pacific (INTELSAT 802 at 174 ° E, planned).

Lab.	GPS CV	TWSTFT (through INTELSAT 802 at 174 ° E, planned)
TL	Receiver type: AOA Receiver serial no: 479 Internal delay: 50.0ns Reference name: UTC(TL) Reference type: 1 Cs + micro–phase–stepper	Modem type: TimeTech/SATRE Modem Modem serial no: 066 Antenna: 4.6 m Degree of automation: not completed Reference name: UTC(TL) Reference type: 1 Cs + micro–phase–stepper
AUS(NML)	Receiver type: NML/Topcon Euro–80 Receiver serial no: 8RQRFKXT534 Internal delay: 46.5 ns Reference name: UTC(AUS) Reference type: HP5071A (360340)	Modem type: Univerity of Stuttgart/MITREX 2500 Modem serial no: MTX No. 85007 Antenna: 4.6 m (Andrew ES46–CCP2) Degree of automation: None Reference name: UTC(AUS) Reference type: HP5071A (360340)

Section IV: Summary of the international time links.