

# **BIPM CALIBRATIONS OF GPS TIME EQUIPMENT**

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16th CCTF, 1-2 April 2002

# BIPM differential calibrations of GPS time equipment

Uncertainty 3 ns (1  $\sigma$ )

- In 2001/2004 seven campaigns were carried out
  - 2001: OP, AOS, GUM, LT, TP
  - 2002: OP, NPL, VSL, OCA
  - 2002: OP, IEN, ROA, PTB, USNO, NIST, VSL, NPL
  - 2002: OP, NTSC, CRL, NMIJ, TL, NML
  - 2003: OP, IEN, PTB, NPL, VSL
  - 2003: OP, PTB, AOS, KRIS, CRL, NIST, USNO and APL
  - 2003: OP, CH
- In total 20 laboratories out of the 50 that participate in TAI have been calibrated

## Some past GPS calibrations between NIST and OP

$d$  is the differential time correction to be added to  $[UTC(NIST) - UTC(OP)]$ , and  $u(d)$  is the estimated uncertainty for the period of comparison

Date	$d/ns$	$u(d)/ns$
July 1983	0	2
Sept 1986	1	2
Octo 1986	-1	2
Jan 1988	-4	3
Apr 1988	1	3
Mar 1995	-4	1
May 1996	-1	2
May 2002	-5	3
July 2003	-6	2
Dec 2003	-5	3

# USNO

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Date	UTC(i)–UTC(j)	Differential correction /ns	Estimated uncertainty /ns	Author
Dec. 84	UTC(USNO)–UTC(OP)	+32	10	Buisson
Oct. 86	UTC(USNO)–UTC(OP)	+25	2	Lewandowski, Weiss
Apr. 87	UTC(USNO)–UTC(OP)	+16	5	Oaks
91	UTC(USNO)–UTC(OP)	–14	?	NRL (inf. from Miranian)
Jun. 94	UTC(USNO)–UTC(OP)	–13	2	Lewandowski
Sep. 94	UTC(USNO)–UTC(OP)	–9	1	Weiss
Dec. 94	UTC(USNO)–UTC(OP)	–8	1	Weiss
Mar. 95	UTC(USNO)–UTC(OP)	–20	2	Lewandowski
Jul95–Jun96	UTC(USNO)–UTC(OP)	–14	2	Lewandowski, Moussay
<b>Feb 97</b>	<b>Receiver delay corrected by</b>	<b>+14</b>		

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April 02	UTC(USNO) –UTC(OP)	+9	3	Rapport BIPM –2002/02
December 03	UTC(USNO) –UTC(OP)	+2	3	Rapport BIPM –2004/06



## IEN

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Date	UTC(i)–UTC(j)	Differential correction /ns	Estimated uncertainty /ns	Author
Oct 86	UTC(IEN) –UTC(OP)	–18	2	Lewandowski, Weiss
Feb 95	UTC(IEN) –UTC(OP)	–20	2	Lewandowski, Moussay
July 97	UTC(IEN) –UTC(OP)	–17	3	Lewandowski, Moussay
Dec 97	UTC(IEN) –UTC(OP)	–15	2	Lewandowski, Moussay
Mar 98	UTC(IEN) –UTC(OP)	–21	2	Lewandowski, Moussay
May 98	UTC(IEN) –UTC(OP)	–23	3	Lewandowski, Konate
July 99	<b>Receiver delay corrected by +18</b>			
March 02	UTC(IEN) –UTC(OP)	+6	3	Rapport BIPM –2002/02
June 03	UTC(IEN) –UTC(OP)	–2	3	Rapport BIPM –2003/05

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# PTB

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Date	UTC(i)–UTC(j)	Differential correction	Estimated uncertainty	Author
		/ns	/ns	
Oct 86	UTC(PTB) –UTC(OP)	+9	2	Lewandowski, Weiss
Oct 94	UTC(PTB) –UTC(OP)	+4	2	Lewandowski, Baumont
July 97	UTC(PTB) –UTC(OP)	+2	3	Lewandowski, Moussay
Nov 97	UTC(PTB) –UTC(OP)	+4	2	Lewandowski, Moussay
Mar 98	UTC(PTB) –UTC(OP)	–6	2	Lewandowski, Moussay
June 98	UTC(PTB) –UTC(OP)	+5	3	Lewandowski, Konate
June 03	UTC(PTB) –UTC(OP)	–5	4	Rapport BIPM –2003/05
August 03	UTC(PTB) –UTC(OP)	0	3	Rapport BIPM –2003/06

## NPL

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Date	UTC(i)–UTC(j)	Differential correction /ns	Estimated uncertainty /ns	Author
Oct 86	UTC(NPL) –UTC(OP)	+24	2	Lewandowski, Weiss
Mar 94	UTC(NPL) –UTC(OP)	+6	2	Thomas, Moussay
Oct 94	UTC(NPL) –UTC(OP)	0	3	Lewandowski, Baumont
Jun 97	UTC(NPL) –UTC(OP)	–4	3	Lewandowski, Moussay
Nov 97	UTC(NPL) –UTC(OP)	–2	2	Lewandowski, Moussay
Mar 98	UTC(NPL) –UTC(OP)	+4	2	Lewandowski, Moussay
July 98	UTC(NPL) –UTC(OP)	–	–	Lewandowski, Konate
June 02	UTC(NPL) –UTC(OP)	–6	4	Rapport BIPM –2003/04
May 03	UTC(NPL) –UTC(OP)	–10	3	Rapport BIPM –2003/06

## VSL

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<b>Date</b>	<b>UTC(i)–UTC(j)</b>	<b>Differential correction /ns</b>	<b>Estimated uncertainty /ns</b>	<b>Author</b>
<b>Oct 86</b>	<b>UTC(VSL) –UTC(OP)</b>	<b>–17</b>	<b>2</b>	<b>Lewandowski, Weiss</b>
<b>Oct 94</b>	<b>UTC(VSL) –UTC(OP)</b>	<b>+3</b>	<b>2</b>	<b>Lewandowski, Baumont</b>
<b>May 95</b>	<b>UTC(VSL) –UTC(OP)</b>	<b>+5</b>	<b>2</b>	<b>Lewandowski</b>
<b>Jun 97</b>	<b>UTC(VSL) –UTC(OP)</b>	<b>–2</b>	<b>3</b>	<b>Lewandowski, Moussay</b>
<b>Nov 97</b>	<b>UTC(VSL) –UTC(OP)</b>	<b>–23</b>	<b>2</b>	<b>Lewandowski, Moussay</b>
<b>Feb 98</b>	<b>UTC(VSL) –UTC(OP)</b>	<b>–20</b>	<b>2</b>	<b>Lewandowski, Moussay</b>
<b>July 98</b>	<b>UTC(VSL) –UTC(OP)</b>	<b>–</b>	<b>–</b>	<b>Lewandowski, Konate</b>
<b>June 02</b>	<b>UTC(VSL) –UTC(OP)</b>	<b>+16</b>	<b>4</b>	<b>Rapport BIPM –2003/04</b>
<b>June 03</b>	<b>UTC(VSL) –UTC(OP)</b>	<b>+8</b>	<b>3</b>	<b>Rapport BIPM –2003/95</b>

## CRL

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<b>Date</b>	<b>UTC(i)–UTC(j)</b>	<b>Differential correction /ns</b>	<b>Estimated uncertainty /ns</b>	<b>Author</b>
<b>Nov 96</b>	<b>UTC(CRL) –UTC(OP)</b>	<b>–2</b>	<b>3</b>	<b>Lewandowski, Moussay</b>
<b>Aug 02</b>	<b>UTC(CRL) –UTC(OP)</b>	<b>–14</b>	<b>4</b>	<b>Rapport BIPM –2003/05</b>
<b>Nov 03</b>	<b>UTC(CRL) –UTC(OP)</b>	<b>+5</b>	<b>3</b>	<b>Rapport BIPM–2004/06</b>

## ROA

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Date	UTC(i)–UTC(j)	Differential correction /ns	Estimated uncertainty /ns	Author
Apr 98	UTC(ROA)–UTC(OP)	–8	2	Lewandowski, Moussay
June 98	UTC(ROA)–UTC(OP)	–6	3	Lewandowski, Konate
March 02	UTC(ROA)–UTC(OP)	–2	3	Rapport BIPM –2002/02

# CONCLUSION

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- **BIPM will continue its GPS calibration campaigns; a new temperature-stabilized receiver is now dedicated for this purpose.**
- **A new trip in South and North Americas involving ten laboratoies is now beginning.**
- **BIPM is helping to organize GPS calibration campaigns by the regional metrology organizations.**