BUREAU INTERNATIONAL DES POIDS ET MESURES

BIPM Annual Report on Time Activities

Rapport annuel du BIPM sur les activités du temps

Volume 1

2006

Pavillon de Breteuil

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Foreword

On 1 January 2006 the Time Section of the BIPM became the Time, Frequency and Gravimetry Section. Consequently, the traditional *Annual Report of the BIPM Time Section* has been renamed *BIPM Annual Report on Time Activities*, without modification of its contents.

Avant-propos

Le 1er janvier 2006 la section du temps du BIPM est devenue la section du temps, des fréquences et de la gravimétrie. Par conséquent, le traditionnel Rapport annuel de la section du temps du BIPM *a été rebaptisé* Rapport annuel du BIPM sur les activités du temps, *mais son contenu reste le même.*

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Contents

[1] : Tables also available through the internet network, ftp 62.161.69.5 or http://www.bipm.org

[2] : Tables only available through the internet network, ftp 62.161.69.5 or http://www.bipm.org

Practical information about the BIPM Time, Frequency and Gravimetry Section

The Time, Frequency and Gravimetry Section of the BIPM issues two periodic publications. These are the monthly *Circular T* and the *BIPM Annual Report on Time Activities*. The complete texts of *Circular T* and most tables of the present Annual Report are available from BIPM website, http://www.bipm.org.

La Section temps, fréquences et gravimétrie du BIPM produit deux publications périodiques : la Circulaire T, *mensuelle, et le* Rapport annuel du BIPM sur les activités du temps. *Les circulaires et la plupart des tableaux de ce rapport annuel sont disponibles par utilisation du site internet du BIPM, http://www.bipm.org.*

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Electronic access to the files on BIPM Time Activities

A large number of files related to the BIPM Time Activities are available from the website. (http://www.bipm.org/en/scientific/tai/time_ftp.html)

The files are found in the four subdirectories **data**, **publications**, **scales and links**.
Data, **publications** and **scales** are available by ftp (62.161.69.5 or ftp2.bipm.org, user anonymous, e-mail address as password, cd pub/tai).
Links is available by ftp (62.161.69.131 or tai.bipm.org, user anonymous, e-mail address as password, cd TimeLink/LkC).

Data- Reports of evaluation of primary frequency standards and all clock and time transfer data files used for the computation of TAI, arranged in yearly directories, starting January 2005. See readme.txt for details.

Publication- the latest issues of the Time Section

In the following directories XY represents the last two digits of the year number (19XY or 20XY); ZT equals to 01 for Jan., 02 for Feb. ....12 for Dec.; XX, XXX are ordinal numbers; results of the computation of TAI over the two-month interval Z of the year (Z =1 for Jan.-Feb., 2 for Mar.- Apr., etc...) until Nov.-Dec. 1997.

publications	**filename**
Acronyms of laboratories	acronyms.pdf
Leap seconds	leaptab.txt
Circular T	cirt.XXX
Fractional frequency of EAL from primary frequency standards	etXY.ZT
Weights of clocks participating in the computation of TAI	wXY.ZT
Rates relative to TAI of clocks participating in the computation of TAI	rXY.ZT
Values of the differences between TAI and the local atomic scale of the given laboratory, including relevant notes	TAI - lab
Values of the differences between UTC and its local representation by the given laboratory, including relevant notes	UTC - lab
Values of the differences between TAI and UTC and the respective local scales, evaluated for two-month periods until the end of 1997	TAIXYZ
[UTC(lab1) - UTC(lab2)] obtained by the TWSTFT link, as published in the BIPM TWSTFT reports	lab1 - lab2.tw
BIPM Two-Way Satellite Time and Frequency Transfer Reports (until February 2003)	twstftXX.pdf
Most recent schedules for common-view observations of GPS and	schgps.XX
GLONASS satellites	schglo.XX

Older files can be accessed directly from the ftp site (62.161.69.5 or ftp2.bipm.org).

Scale- time scales data

Content	**filename**
Time Dissemination Services	TIMESERVICES.DOC
Time Signals	TIMESIGNALS.DOC
Rates of clocks contributing to TAI	RTAIXY.ar
Weights of clocks contributing to TAI	WTAIXY.ar
TT(BIPMXY) computed in the year 19XY or 20XY	TTBIPM.XY
Starting 1993:	
Difference between the normalized frequencies of EAL and TAI	EALTAIXY.ar
TAI frequency	FTAIXY.ar (for 1993,1994)
Measurements of the duration of the TAI scale interval	UTAIXY.ar (starting 1995)
Mean duration of TAI scale interval	SITAIXY.ar (1993-1999)
Mean fractional deviation of the TAI scale interval from that of TT duration of TAI scale interval	SITAIXY.ar (starting 2000)
[*TAI - GPS time*] and [*UTC - GPS time*] (until March 2003)	UTCGPSXY.ar
[*TAI - GLONASS time*] and [*UTC - GLONASS time*] (until March 2003)	UTCGLOXY.ar
[*TAI - GPS time*] and [*UTC - GPS time*], [*TAI - GLONASS time*] and [*UTC - GLONASS time*] (starting April 2003)	UTCGPSGLOXY.ar
Local representations of UTC: Values of [*UTC - UTC(lab)*]	UTCXY.ar (1993-1998)
Independent local atomic time scales: values of [*TAI - TA(lab)*]	TAIXY.ar (1993-1998)
Until 1992:	
Local representations of UTC: Values of [*UTC - UTC(lab)*]	UTC.XY
Local values of [*TAI - TA(lab)*]	TA.XY

Links – Results of link comparison, arranged in yearly directories, starting January 2005.
See readme.txt for details.

Starting with the BIPM Time Section Annual Report for 1999, some tables traditionally included in the printed version are only available in electronic form.

For any comment or query send a message to: tai@bipm.org

Leap seconds

Secondes intercalaires

Since 1 January 1988, the maintenance of International Atomic Time, TAI, and of Coordinated Universal Time, UTC (with the exception of decisions and announcements concerning leap seconds of UTC) has been the responsibility of the International Bureau of Weights and Measures (BIPM) under the authority of the International Committee for Weights and Measures (CIPM). The dates of leap seconds of UTC are decided and announced by the International Earth Rotation and Reference Systems Service (IERS), which is responsible for the determination of Earth rotation parameters and the maintenance of the related celestial and terrestrial reference systems. The adjustments of UTC and the relationship between TAI and UTC are given in Tables 1 and 2 of this volume.

Depuis le 1er janvier 1988, l'établissement du Temps atomique international, TAI, et du Temps universel coordonné, UTC (à l'exception de l'annonce des secondes intercalaires de l'UTC), est placé sous la responsabilité du Bureau international des poids et mesures (BIPM) et du Comité international des poids et mesures (CIPM). Le choix des dates et l'annonce des secondes intercalaires de l'UTC constituent quelques-unes des missions du Service international de la rotation terrestre et des systèmes de référence (IERS), qui est responsable de la détermination des paramètres de la rotation terrestre et de la conservation des systèmes de référence terrestre et céleste associés. Les ajustements de l'UTC et la relation entre le TAI et l'UTC sont donnés dans les tableaux 1 et 2 de ce volume.

Further information about leap seconds can be obtained from the IERS:

Des renseignements sur les secondes intercalaires peuvent être obtenus auprès de l'IERS à l'adresse suivante :

IERS Earth Orientation Product Centre
Dr Daniel GAMBIS
Observatoire de Paris
61, avenue de l'Observatoire
75014 Paris, France

Telephone: + 33 1 40 51 22 26
Telefax: + 33 1 40 51 22 91
iers@obspm.fr
http://hpiers.obspm.fr
Anonymous ftp: hpiers.obspm.fr or 145.238.100.28

Establishment of International Atomic Time and of Coordinated Universal Time

1. Data and computation

International Atomic Time (TAI) and Coordinated Universal Time (UTC) are obtained from a combination of data from some 400 atomic clocks kept by about 65 laboratories spread worldwide. The data are regularly reported to the BIPM by about 60 timing centres which maintain a local UTC, UTC(k) (see Table 3). The data are in the form of time differences [*UTC*(*k*) - *Clock*] taken at 5 day intervals at 0 h UTC for Modified Julian Dates (MJD) ending in 4 and 9, at 0 h UTC; these dates are referred here as "standard dates". The equipment maintained by the timing centres is detailed in Table 4.

An iterative algorithm produces a free atomic time scale, EAL (Echelle Atomique Libre), defined as a weighted average of clock readings. The processing is carried out and, subsequently, treats one month blocks of data [1] and [2] (two-month blocks were used before 1998). The weighting procedure and clock frequency prediction are chosen so that EAL is optimized for long-term stability. No attempt is made to ensure the conformity of the EAL scale interval with the second of the International System of Units.

2. Accuracy

The duration of the scale interval of EAL is evaluated by comparison with the data of primary caesium standards, correcting their proper frequency as needed to account for known effects (e.g. general relativity, blackbody radiation). TAI is then derived from EAL by adding a linear function of time with a convenient slope to ensure the accuracy of the TAI scale interval. The frequency offset between TAI and EAL is changed when necessary to maintain accuracy, the magnitude of the changes being of the same order as the frequency fluctuations resulting from the instability of EAL. This operation is referred to as the "steering of TAI". Table 5 gives the normalized frequency offsets between EAL and TAI. Measurements of the duration of the TAI scale interval and estimates of its mean duration are reported in Tables 6 and 7.

3. Availability

TAI and UTC are made available in the form of time differences with respect to the local time scales UTC(k), which approximate UTC, and TA(k), the independent local atomic time scales. These differences, [*TAI* - *TA*(*k*)] and [*UTC* - *UTC*(*k*)], are computed for the standard dates and are available from the BIPM website (see p.5 of this volume).

The computation of TAI is carried out every month and the results are published monthly in *Circular T*. When preparing the Annual Report, the results shown in *Circular T* may be revised taking into account any subsequent improvements made to the data.

4. Time links

The BIPM organizes the international network of time links to compare local realizations of UTC in contributing laboratories and uses them in the formation of TAI. The network of time links used by the BIPM is non-redundant and relies on observation of GPS satellites and on two-way satellite time and frequency transfer (TWSTFT).

Most time links are based on GPS satellite observations. Data from multi-channel dual-frequency GPS geodetic type receivers is regularly used in the calculation of time links, in addition to that acquired by the traditional single-frequency (single or multi-channel) GPS time receivers. For those links performed with more than one technique, one of them is considered as official for TAI and the others are calculated as a back-up. GPS links in TAI with single-frequency receivers are corrected using the ionospheric maps produced by the International GNSS Service (IGS); all GPS links are corrected using the IGS precise operational satellite ephemerides.

Until 31 August 2006, the common-view method had been used for time transfer in TAI via GPS satellites observation; the time links network had the form of local stars within a continent, joined by long-distance links (see p.11 of this volume). Starting on 1 September 2006, GPS links are computed with the method called "GPS all in view" [3], with a network of time links that uses the PTB as a unique pivot laboratory for all the GPS links. This change has not affected the TWSTFT links. The network of GPS all in view time links is shown on page 12 of this volume.

The uncertainty of [$UTC(k_1)$ - $UTC(k_2)$], obtained at the BIPM with these procedures is given in *Circular T*, section 6. The BIPM also publishes an evaluation of [*UTC - GPS time*] which is accessible via the BIPM website.

The BIPM regularly publishes an evaluation of [*UTC - GLONASS time*], also available from the BIPM website, using current observations of the GLONASS system at the Astrogeodynamical Observatory (AOS), Poland.

International GPS tracking schedules are published by the BIPM about every six months, and tracking schedules for GLONASS are also established. The list of the schedules is reported in this volume and their content is available from the website (see p. 5 of this volume).

5. Time scales established in retrospect

For the most demanding applications, such as millisecond pulsar timing, the BIPM issues atomic time scales in retrospect. These are designated TT(BIPMxx) where 19xx or 20xx is the year of computation [4]. The successive versions of TT(BIPMxx) are both updates and revisions: they may differ for common dates. These time scales are available on request from the BIPM or via website (see p. 5 of this volume).

Notes

Tables 8 and 9 of this report give the rates relative to TAI and the weights of the clocks contributing to TAI in 2006.

The yellow pages, at the end of this volume, give indications about time signal emissions and time dissemination services.

The report of the BIPM Time Section for the period July 2005-June 2006, published in the *Director's Report on the Activity and Management of the BIPM*, 2006, **7** is reproduced after the yellow pages. All the publications mentioned in this report are available on request from the BIPM.

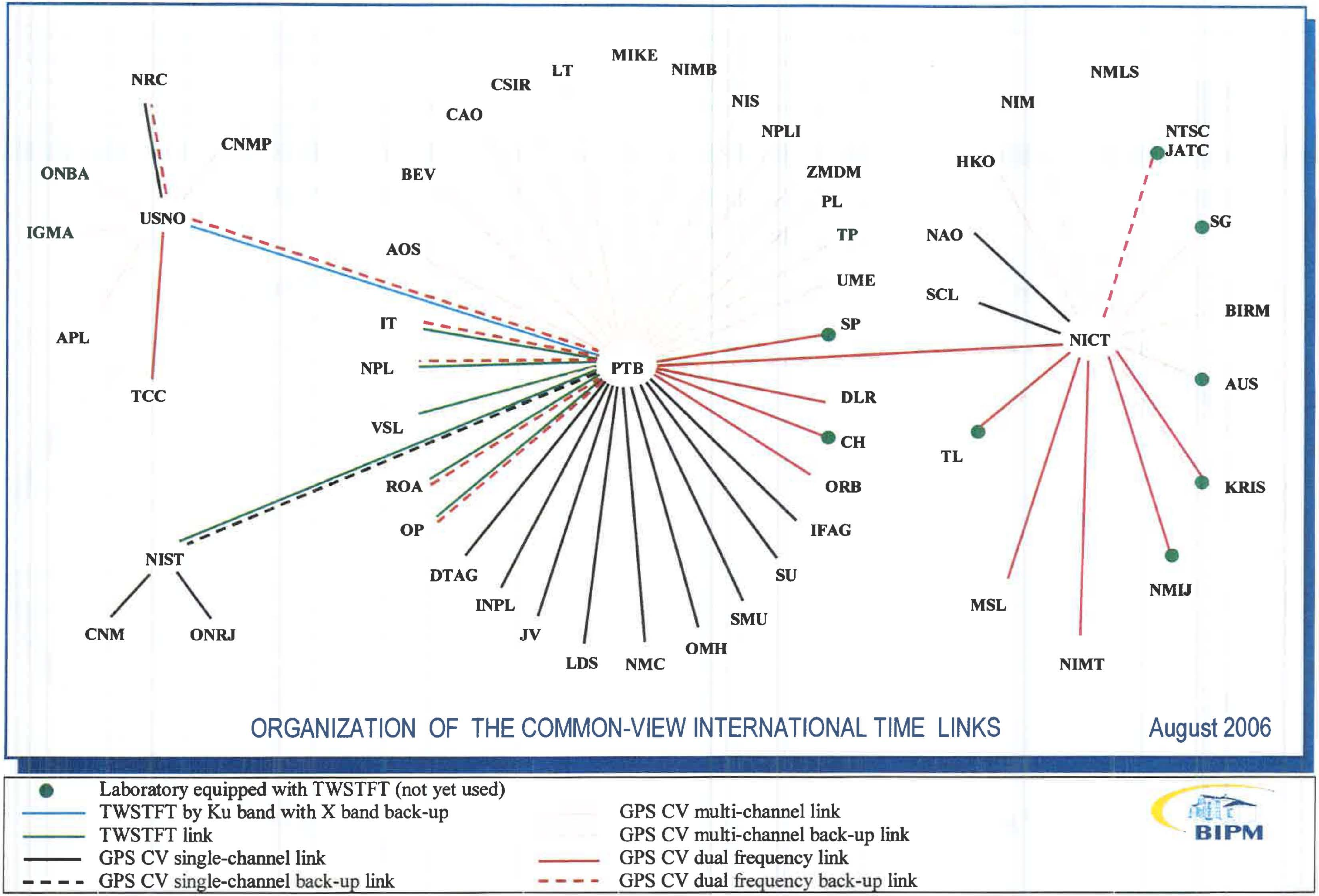
References

[1] Thomas C. and Azoubib J., TAI computation: study of an alternative choice for implementing an upper limit of clock weights, *Metrologia*, 1996, **33**, 227-240.

[2] Azoubib J., A revised way of fixing an upper limit to clock weights in TAI computation, *Report to the 15th meeting of the CCTF*, available on request.

[3] Petit G., Jiang Z., All in View time transfer for TAI computation, *Metrologia*, accepted for publication.

[4] Guinot B., Atomic time scales for pulsar studies and other demanding applications, *Astron. Astrophys.*, 1988, **192**, 370-373.


NRC
CNMP
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NIM
NTSC
JATC
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SG
NAO
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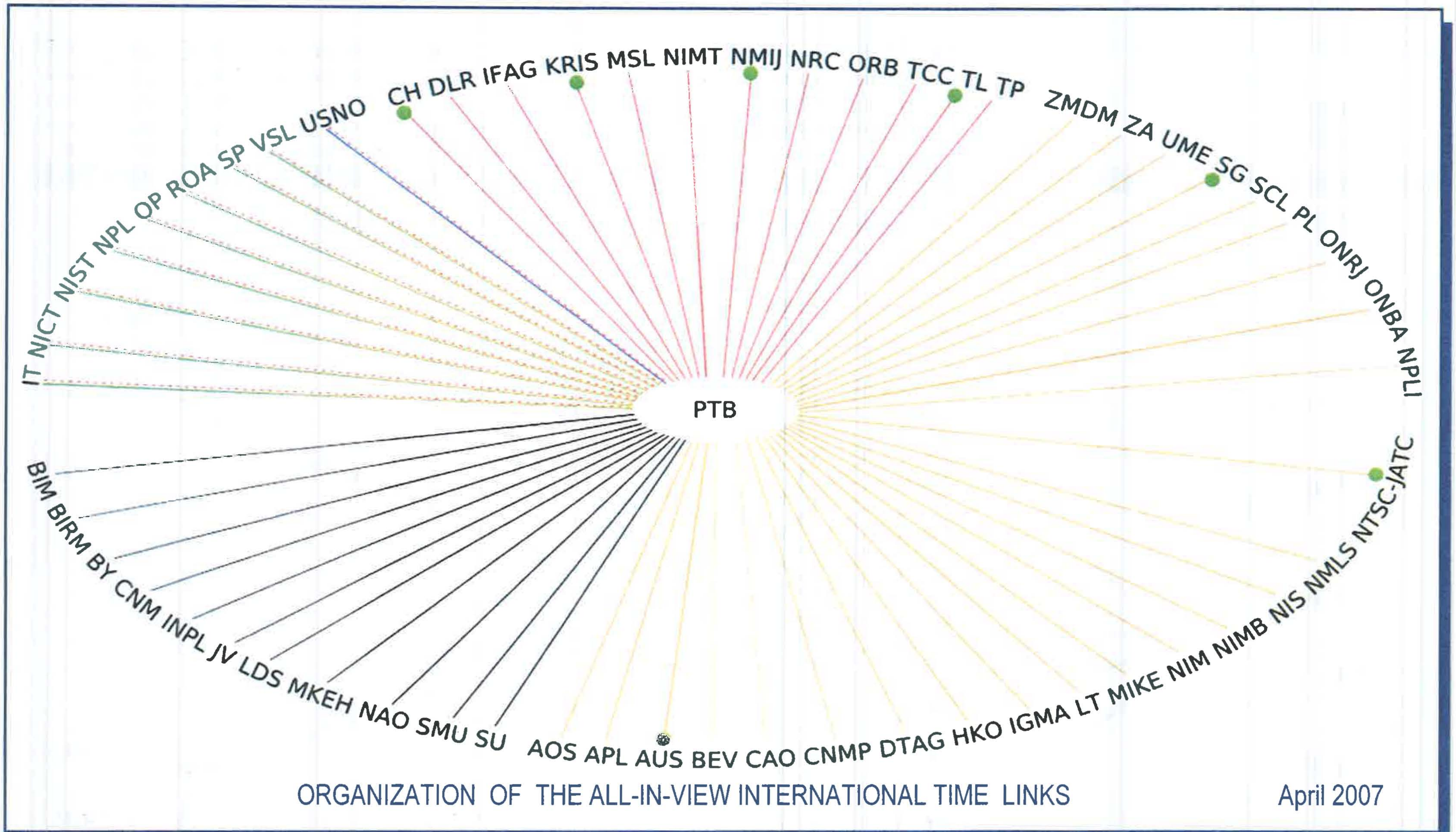
NICT
BIRM
AUS
TL
KRIS
NMIJ
MSL
NIMT
ORGANIZATION OF THE COMMON-VIEW INTERNATIONAL TIME LINKS
August 2006
Laboratory equipped with TWSTFT (not yet used)
TWSTFT by Ku band with X band back-up
TWSTFT link
GPS CV single-channel link
GPS CV single-channel back-up link
GPS CV multi-channel link
GPS CV multi-channel back-up link
GPS CV dual frequency link
GPS CV dual frequency back-up link
BIPM



- Laboratory equipped with TWSTFT (not yet used)
- TWSTFT by Ku band with X band back-up
- TWSTFT link
- GPS AV single-channel link
- GPS AV single-channel back-up link
- GPS AV multi-channel link
- GPS AV multi-channel back-up link
- GPS AV dual frequency link
- GPS AV dual frequency back-up link

BIPM

Etablissement du Temps atomique international et du Temps universel coordonné

1. Données et mode de calcul

Le Temps atomique international (TAI) et le Temps universel coordonné (UTC) sont obtenus par une combinaison de données provenant de quelque 400 horloges atomiques conservées par environ 65 laboratoires répartis dans le monde entier, et fournies régulièrement au BIPM par une soixantaine de laboratoires de temps qui maintiennent un UTC local, UTC(k) (liste donnée dans le tableau 3). Ces données prennent la forme de différences de temps [UTC(k) - Horloge] *enregistrées de 5 jours en 5 jours pour les dates juliennes modifiées (MJD) se terminant par 4 et 9, à 0 hUTC, «dates normales». L'équipement maintenu par ces laboratoires de temps est décrit dans le tableau 4.*

Un algorithme itératif qui traite en temps différé des blocs de un mois de données [1] et [2] produit une échelle atomique libre, EAL, définie comme étant une moyenne pondérée de lectures d'horloges (jusqu'en 1997 des blocs de deux mois étaient utilisés). Le choix de la pondération et du mode de prédiction de fréquence optimise la stabilité de l'EAL à long terme. Il n'est pas tenté d'assurer la conformité de l'intervalle unitaire de l'EAL avec la seconde du Système international d'unités.

2. Exactitude

La durée de l'intervalle unitaire de l'EAL est évaluée par comparaison aux données d'étalons de fréquence à césium primaires, après correction de leur propre fréquence pour tenir compte des effets connus (par exemple relativité générale, rayonnement du corps noir). Ensuite le TAI se déduit de l'EAL par l'addition d'une fonction linéaire du temps dont la pente est convenablement choisie pour assurer l'exactitude de l'intervalle unitaire du TAI. Le décalage de fréquence entre le TAI et l'EAL est changé quand c'est nécessaire pour maintenir l'exactitude, les changements ayant le même ordre de grandeur que les fluctuations de fréquence qui résultent de l'instabilité de l'EAL. Cette opération est désignée par l'expression «pilotage du TAI». Le tableau 5 donne les différences de fréquences normalisées entre l'EAL et le TAI. Des mesures de la durée de l'intervalle unitaire du TAI et des estimations de sa durée moyenne sont données dans les tableaux 6 et 7.

3. Disponibilité

Le TAI et l'UTC sont disponibles sous forme de différences de temps avec les échelles locales de temps UTC(k), approximation de l'UTC, et TA(k), temps atomique local indépendant. Ces différences, [TAI - TA(k)] *et* [UTC - UTC(k)], *calculées pour les dates normales sont disponibles sur le site internet du BIPM (voir p. 5 de ce volume).*

Le calcul du TAI est fait tous les mois et les résultats sont publiés mensuellement dans la Circulaire T *du BIPM. Quand le Rapport annuel est préparé, les résultats de la* Circulaire T *peuvent être révisés, en tenant compte des améliorations de données connues après la publication de la* Circulaire T.

4. Liaisons horaires

Le BIPM organise le réseau international de liaisons horaires dans le but de comparer des réalisations locales de l'UTC dans les laboratoires participants. Le système des liaisons horaires utilisé par le BIPM est non-redondant et repose sur l'observation des satellites du GPS et sur la technique d'aller et retour sur satellite de télécommunications (TWSTFT).

La plupart des liaisons se font par observation des satellites du GPS. Des données acquises avec des récepteurs GPS de type géodésique, multi-canaux et bi-fréquence sont utilisées régulièrement dans le calcul des liaisons horaires, en plus de celles avec des récepteurs mono-fréquence traditionnels (mono et multi-canaux). Dans les cas où plusieurs techniques participent à une liaison horaire, une d'entre elles est considérée comme officielle et les autres sont calculées pour sauvegarde. Les liaisons par GPS mono-fréquence sont corrigées à l'aide des cartes ionosphériques produites par l'IGS; toutes les liaisons par GPS sont corrigées en utilisant des éphémérides précises et opérationnelles des satellites produites par l'IGS.

Jusqu'au 31 août 2006, des observations des satellites du GPS traitées avec la méhode des vues communes ont été utilisées pour les comparaisons horaires, suivant un schéma en étoile au niveau des continents, et en liaisons à longue distance (voir p. 11 de ce volume). Depuis le 1^er^ septembre 2006, les comparaisons horaires par GPS se font par la méthode dite «GPS all in view» [3], dont le réseau a un seul laboratoire central (PTB) pour toutes les comparaisons horaires. Le schéma des comparaisons horaires par la méthode GPS all in view se trouve à la page 12 de ce volume.

L'incertitude de [UTC(k_1) - UTC(k_2)] *est publiée dans la* Circulaire T, *section 6. Le BIPM publie aussi une évaluation de* [UTC - temps du GPS] *dont les valeurs sont disponibles sur le site web du BIPM.*

Le BIPM publie régulièrement une évaluation de [UTC - temps du GLONASS], *accessible sur le site web du BIPM et déduite des observations habituelles du système GLONASS, réalisées à l' Astrogeodynamical Observatory (AOS), Pologne.*

Le BIPM publie tous les six mois des programmes de poursuite des satellites du GPS, ainsi que des programmes pour les satellites du GLONASS. La liste de ces programmes est reproduite dans ce rapport et leur contenu est disponible sur le site web.

5. Echelles de temps établies rétrospectivement

Pour les applications les plus exigeantes, comme le chronométrage des pulsars milliseconde, le BIPM produit des échelles de temps rétrospectivement, désignées par TT(BIPMxx), 19xx ou 20xx étant l'année du calcul [4]. Les versions successives de TT(BIPMxx) ne sont pas seulement des mises à jour, mais aussi des révisions, de sorte qu'elles peuvent différer pour les dates communes. Ces échelles de temps sont disponibles sur demande faite au BIPM ou par utilisation du réseau internet.

Notes

Les tableaux 8 et 9 de ce rapport donnent les fréquences relatives au TAI et les poids des horloges qui ont contribué au calcul en 2006.
Les pages jaunes, à la fin de ce volume, concernent les émissions de signaux horaires et les services de dissémination du temps.

Le rapport (juillet 2005 - juin 2006) de la section du temps du BIPM publié dans le Rapport du directeur sur l'activité et la gestion du Bureau international des poids et mesures (BIPM), 2006, **7**, *est reproduit après les pages jaunes. Toutes les publications qui y sont mentionnées sont disponibles sur demande au BIPM.*

Les références sont données dans le texte anglais, page 10.

Table 1. Relative frequency offsets and step adjustments of UTC, up to 31 December 2007

Date (at 0h UTC)	Offsets	Steps/s
1961 Jan. 1	-150×10^{-10}	
1961 Aug. 1	"	+0.050
1962 Jan. 1	-130×10^{-10}	
1963 Nov. 1	"	-0.100
1964 Jan. 1	-150×10^{-10}	
1964 Apr. 1	"	-0.100
1964 Sep. 1	"	-0.100
1965 Jan. 1	"	-0.100
1965 Mar. 1	"	-0.100
1965 Jul. 1	"	-0.100
1965 Sep. 1	"	-0.100
1966 Jan. 1	-300×10^{-10}	
1968 Feb. 1	"	+0.100
1972 Jan. 1	0	-0.107 7580
1972 Jul. 1	"	-1
1973 Jan. 1	"	-1
1974 Jan. 1	"	-1
1975 Jan. 1	"	-1
1976 Jan. 1	"	-1
1977 Jan. 1	"	-1
1978 Jan. 1	"	-1
1979 Jan. 1	"	-1
1980 Jan. 1	"	-1
1981 Jul. 1	"	-1
1982 Jul. 1	"	-1
1983 Jul. 1	"	-1
1985 Jul. 1	"	-1
1988 Jan. 1	"	-1
1990 Jan. 1	"	-1
1991 Jan. 1	"	-1
1992 Jul. 1	"	-1
1993 Jul. 1	"	-1
1994 Jul. 1	"	-1
1996 Jan. 1	"	-1
1997 Jul. 1	"	-1
1999 Jan. 1	"	-1
2006 Jan. 1	"	-1

Table 2. Relationship between TAI and UTC, up to 31 December 2007

Limits of validity (at 0h UTC)	[*TAI - UTC*] / s
1961 Jan. 1 - 1961 Aug. 1	1.422 8180 + (MJD - 37300) x 0.001 296
1961 Aug. 1 - 1962 Jan. 1	1.372 8180 + " "
1962 Jan. 1 - 1963 Nov. 1	1.845 8580 + (MJD - 37665) x 0.001 1232
1963 Nov. 1 - 1964 Jan. 1	1.945 8580 + " "
1964 Jan. 1 - 1964 Apr. 1	3.240 1300 + (MJD - 38761) x 0.001 296
1964 Apr. 1 - 1964 Sep. 1	3.340 1300 + " "
1964 Sep. 1 - 1965 Jan. 1	3.440 1300 + " "
1965 Jan. 1 - 1965 Mar. 1	3.540 1300 + " "
1965 Mar. 1 - 1965 Jul. 1	3.640 1300 + " "
1965 Jul. 1 - 1965 Sep. 1	3.740 1300 + " "
1965 Sep. 1 - 1966 Jan. 1	3.840 1300 + " "
1966 Jan. 1 - 1968 Feb. 1	4.313 1700 + (MJD - 39126) x 0.002 592
1968 Feb. 1 - 1972 Jan. 1	4.213 1700 + " "
1972 Jan. 1 - 1972 Jul. 1	10 (integral number of seconds)
1972 Jul. 1 - 1973 Jan. 1	11
1973 Jan. 1 - 1974 Jan. 1	12
1974 Jan. 1 - 1975 Jan. 1	13
1975 Jan. 1 - 1976 Jan. 1	14
1976 Jan. 1 - 1977 Jan. 1	15
1977 Jan. 1 - 1978 Jan. 1	16
1978 Jan. 1 - 1979 Jan. 1	17
1979 Jan. 1 - 1980 Jan. 1	18
1980 Jan. 1 - 1981 Jul. 1	19
1981 Jul. 1 - 1982 Jul. 1	20
1982 Jul. 1 - 1983 Jul. 1	21
1983 Jul. 1 - 1985 Jul. 1	22
1985 Jul. 1 - 1988 Jan. 1	23
1988 Jan. 1 - 1990 Jan. 1	24
1990 Jan. 1 - 1991 Jan. 1	25
1991 Jan. 1 - 1992 Jul. 1	26
1992 Jul. 1 - 1993 Jul. 1	27
1993 Jul. 1 - 1994 Jul. 1	28
1994 Jul. 1 - 1996 Jan. 1	29
1996 Jan. 1 - 1997 Jul. 1	30
1997 Jul. 1 - 1999 Jan. 1	31
1999 Jan. 1 - 2006 Jan. 1	32
2006 Jan. 1 -	33

Table 3. Acronyms and locations of the timing centres which maintain a local approximation of UTC, UTC(k), and/or an independent local time scale, TA(k) (updated to May 2007)

AOS	Astrogeodynamical Observatory, Space Research Centre P.A.S. Borowiec, Poland
APL	Applied Physics Laboratory, Laurel, Maryland, USA
AUS	Consortium of laboratories in Australia
BEV	Bundesamt für Eich- und Vermessungswesen, Vienna, Austria
BIM	Bulgarian Institute of Metrology, Sofiya, Bulgary, formerly NMC
BIRM	Beijing Institute of Radio Metrology and Measurement, Beijing, P. R. China
BY	Belarussian State Institute of Metrology, Minsk, Belarus
CAO	Stazione Astronomica di Cagliari (Cagliari Astronomical Observatory), Cagliari, Italy
CH	Swiss Federal Office of Metrology (METAS), Bern-Wabern, Switzerland
CNM	Centro Nacional de Metrología (CENAM), Querétaro, México
CNMP	Centro Nacional de Metrología de Panamá, Panamá
DLR	Deutsche Zentrum für Luft- und Raumfahrt (German Aerospace Centre) Oberpfaffenhofen, Germany
DTAG	Deutsche Telekom AG, Darmstadt, Germany
F	Commission Nationale de l'Heure, Paris, France
GUM	Główny Urząd Miar (Central Office of Measures), Warsaw, Poland
HKO	Hong Kong Observatory, Hong Kong, China
IT	Istituto Nazionale di Ricerca Metrologica (I.N.RI.M.), Italy
IFAG	Bundesamt für Kartographie und Geodäsie (Federal Agency for Cartography and Geodesy), Fundamental station, Wettzell, Kötzting, Germany
IGMA	Instituto Geográfico Militar, Buenos Aires, Argentina
INPL	National Physical Laboratory, Jerusalem, Israel
JATC	Joint Atomic Time Commission, Lintong, P.R. China
JV	Justervesenet, Norwegian Metrology and Accreditation Service, Kjeller, Norway
KRIS	Korea Research Institute of Standards and Science, Daejeon, Rep. of Korea
LDS	University of Leeds, Leeds, United Kingdom
LT	Lithuanian National Metrology Institute, Vilnius, Lithuania
MKEH	Hungarian Trade Licensing Office, Hungary, formerly OMH
MSL	Measurement Standards Laboratory, Lower Hutt, New Zealand
NAO	National Astronomical Observatory, Misuzawa, Japan
NICT	National Institute of Information and Communications Technology, Tokyo, Japan
NIM	National Institute of Metrology, Beijing, P.R. China
NIMB	National Institute of Metrology, Bucharest, Romania
NIMT	National Institute of Metrology, Bangkok, Thailand
NIS	National Institute for Standards, Cairo, Egypt
NIST	National Institute of Standards and Technology, Boulder, Colo., USA
NMIJ	National Metrology Institute of Japan, Tsukuba, Japan
NML	National Measurement Laboratory, Sydney, Australia
NMLS	National Metrology Laboratory of SIRIM Berhad, Shah Alam, Malaysia

Table 3. Acronyms and locations of the timing centres which maintain a local approximation of UTC, UTC(k), and/or an independent local time scale, TA(k) (Cont.) (updated to May 2007)

NPL	National Physical Laboratory, Teddington, United Kingdom
NPLI	National Physical Laboratory, New Delhi, India
NRC	National Research Council of Canada, Ottawa, Canada
NTSC	National Time Service Centre of China, Lintong, P.R. China
ONBA	Observatorio Naval, Buenos Aires, Argentina
ONRJ	Observatório Nacional, Rio de Janeiro, Brazil
OP	Observatoire de Paris (Paris Observatory), Paris, France
ORB	Observatoire Royal de Belgique (Royal Observatory of Belgium), Brussels, Belgium
PL	Consortium of laboratories in Poland
PTB	Physikalisch-Technische Bundesanstalt, Braunschweig, Germany
ROA	Real Instituto y Observatorio de la Armada, San Fernando, Spain
SCL	Standards and Calibration Laboratory, Hong Kong
SG	Standards, Productivity and Innovation Board (SPRING), Singapore
SMU	Slovenský Metrologický Ústav (Slovak Institute of Metrology), Bratislava, Slovakia
SP	Sveriges Provnings- och Forskningsinstitut (Swedish National Testing and Research Institute), Borås, Sweden
SU	Institute of Metrology for Time and Space (IMVP), NPO "VNIIFTRI" Mendeleevo, Moscow Region, Russia
TCC	TIGO Concepción Chile, Chile
TL	Telecommunication Laboratories, Chung-Li, Taiwan
TP	Institute of Photonics and Electronics, Czech Academy of Sciences, Praha, Czech Republic
UME	Ulusai Metroloji Enstitüsü, Marmara Research Center, (National Metrology Institute), Gebze Kocaeli, Turkey
USNO	U.S. Naval Observatory, Washington D.C., USA
VSL	NMi Van Swinden Laboratorium, Delft, the Nederlands
ZA	National Metrology Institute of South Africa, Pretoria, South Africa, formerly CSIR
ZMDM	Bureau of Measures and Precious Metals, Belgrade, Serbia and Montenegro

Note: Most of the timing centres in the table can be accessed through the BIPM website, at "Useful links".

Table 4. Equipment and source of UTC(k) of the laboratories contributing to TAI in 2006

Ind. Cs: industrial caesium standard
Ind. Rb: industrial rubidium standard
Lab. Cs: laboratory caesium standard
H-maser: hydrogen maser
SF: single frequency receiver
DF: dual frequency receiver
* means 'yes'

Lab k	Equipment	Source of UTC(k) (1)	TA(k)	Time Links			
				GPS		GLONASS	Two-Way
				SF	DF		
AOS	1 Ind. Cs	1 Cs + microphase-stepper		*		*	*
APL	3 Ind. Cs 3 H-masers	1 Cs + microphase-stepper		*			
AUS	5 Ind. Cs 4 H-masers 1 Linear Ion Trap Standard (2)	1 Cs		*	*		*
BEV	3 Ind. Cs 2 Ind. Rb	1 Cs		*			
BIRM	2 Ind. Cs 6 H-masers	1 Cs		*			
CAO	2 Ind. Cs	1 Cs		*			
CH	4 Ind. Cs (3) 1 H-maser	all the Cs 1 H-maser	*		*		*
CNM (a)	3 Ind. Cs 1 H-maser	1 Cs		*			
CNMP (a)	2 Ind. Cs	1 Cs		*			
CSIR	2 Ind. Cs	1 Cs		*		*	
DLR	3 Ind. Cs 5 H-masers	1 Cs			*		
DTAG	3 Ind. Cs	1 Cs		*			
HKO	2 Ind. Cs	1 Cs		*			
IFAG (a)	5 Ind. Cs 3 H-masers	1 Cs + microphase-stepper		*	*		
IGMA (a)	3 Ind. Cs	1 Cs + microphase-stepper		*			
INPL	2 Ind. Cs	1 Cs		*			
IT	5 Ind. Cs 2 H-masers 1 Lab. Cs	1 Cs + microphase-stepper (4)	*	*	*	*	*
JATC	9 Ind. Cs (5) 4 H-masers	1 H-maser + microphase-stepper	*	*	*		*
JV	4 Ind. Cs	1 Cs		*			

Table 4. Equipment and source of UTC(k) of the laboratories contributing to TAI in 2006 (Cont.)

Ind. Cs: industrial caesium standard
Ind. Rb: industrial rubidium standard
Lab. Cs: laboratory caesium standard
H-maser: hydrogen maser
SF: single frequency receiver
DF: dual frequency receiver
* means 'yes'

Lab k	Equipment	Source of UTC(k) (1)	TA(k)	Time Links			
				GPS		GLONASS	Two-Way
				SF	DF		
KRIS	5 Ind. Cs 3 H-masers	1 H-maser + microphase-stepper	*	*	*	*	*
LDS	1 Ind. Cs	1 Cs		*		*	
LT	1 Ind. Cs	1 Cs		*			
MIKE	2 Ind. Cs 2 H-masers	1 H-maser + microphase-stepper		*	*	*	
MSL	3 Ind. Cs	1 Cs		*	*		
NAO (a)	4 Ind. Cs 1 H-maser	1 Cs + microphase-stepper		*			
NICT	27 Ind. Cs 7 H-masers 2 Lab. Cs	18 Cs	*	*	*		*
NIM (a)	3 Ind. Cs	1 Cs + microphase-stepper		*			
NIMB	2 Ind. Cs	1 Cs		*			
NIMT (a)	1 Ind. Cs	1 Cs		*	*		
NIS (a)	3 Ind. Cs	1 Cs		*	*	*	
NIST	5 Ind. Cs 1 Lab. Cs 6 H-masers	4 Cs 5 H-masers	*	*	*	*	*
NMC	1 Ind. Cs	1 Cs		*			
NMIJ	5 Ind. Cs 1 Lab. Cs 3 H-masers	1 H-maser + microphase-stepper		*	*		*
NMLS (a)	5 Ind. Cs	1 Cs			*	*	
NPL	2 Ind. Cs 3 H-masers	1 H-maser		*	*		*
NPLI (a)	3 Ind. Cs	1 Cs		*		*	
NRC	2 Ind. Cs 2 Lab. Cs 3 H-masers	1 Ind. Cs + microphase-stepper	*	*	*		
NTSC	14 Ind. Cs 4 H-masers	1 H-maser + microphase-stepper	*	*	*		*

Table 4. Equipment and source of UTC(k) of the laboratories contributing to TAI in 2006 (Cont.)

Ind. Cs: industrial caesium standard
Ind. Rb: industrial rubidium standard
Lab. Cs: laboratory caesium standard
H-maser: hydrogen maser
SF: single frequency receiver
DF: dual frequency receiver
* means 'yes'

Lab k	Equipment	Source of UTC(k) (1)	TA(k)	Time Links			
				GPS		GLONASS	Two-Way
				SF	DF		
OMH (6)	1 Ind. Cs	1 Cs		*			
ONBA	1 Ind. Cs	1 Cs		*			
ONRJ	4 Ind. Cs	1 Cs + microphase-stepper	* (7)	*			
OP	7 Ind. Cs 3 Lab. Cs 4 H-masers	1 Cs + microphase-stepper	* (8)	*	*		*
ORB	3 Ind. Cs 3 H-masers	1 H-maser			*		
PL	9 Ind. Cs 2 H-masers	1 Cs + microphase-stepper (10)	* (9)	*			
PTB	3 Ind. Cs 3 Lab. Cs (11) 3 H-masers	1 Lab. Cs	* (12)	*	*		*
ROA (a)	5 Ind. Cs 1 H-maser	all the Cs		*	*		*
SCL	2 Ind. Cs	1 Cs + microphase-stepper		*			
SG	4 Ind. Cs	1 Cs + microphase-stepper		*			
SMU	1 Ind. Cs	1 Cs + output frequency steering		*			
SP	10 Ind. Cs (13) 4 H-masers	1 Cs + microphase-stepper			*		*
SU	1 Lab. Cs 8 H-masers	4-5 H-masers	* (14)	*	*	*	
TCC	3 Ind. Cs 2 H-masers	1 Cs + microphase-stepper		*	*		
TL	9 Ind. Cs 2 H-masers	1 H-maser + microphase-stepper	* (15)		*		*
TP	4 Ind. Cs	1 Cs + output frequency steering		*	*		
UME	3 Ind. Cs	1 Cs		*	*	*	
USNO	72 Ind. Cs 24 H-masers	1 H-maser + frequency synthesizer steered to UTC(USNO) (16)	(16) *	*	*	*	*
VSL	4 Ind. Cs	1 Cs + microphase-stepper		*	*	*	*
ZMDM	1 Ind. Cs	1 Cs + microphase-stepper		*			

Notes

(1) When several clocks are indicated as source of UTC(k), laboratory k computes a software clock, steered to UTC. Often a physical realization of UTC(k) is obtained using a Cs clock and a micro-phase-stepper.

(2) AUS Some of the standards are located as follows (at the end of 2006):

* National Measurement Institute (NMIA, Sydney)	3 Cs, 2 H-masers

Australian laboratories intercompared by GPS are:

* Canberra Deep Space Communication Complex (CDSCC, Canberra)	1 Cs, 2 H-masers 1 Linear Ion Trap Standard (LITS)

(3) CH All the standards are located in Bern at METAS (Swiss Federal Office of Metrology).

(4) IT H-maser + microphase-stepper since June 2006

(5) JATC The standards are located at National Time Service Centre (NTSC). The link between UTC(JATC) and UTC(NTSC) is obtained by internal connection.

(6) OMH Since 1 January 2007 the National Office of Measures of Hungary (OMH) has merged into the Hungarian Trade Licensing Office (MKEH).

(7) ONRJ The Brazilian atomic time scale TA(ONRJ) is computed by the National Observatory in Rio de Janeiro with data from 4 industrial caesium clocks.

(8) OP The French atomic time scale TA(F) is computed by the LNE-SYRTE with data from 23 industrial caesium clocks located as follows (at the end of 2006) :

* Centre Electronique de l'Armement (CELAR, Rennes)	1 Cs
* Centre National d'Etudes Spatiales (CNES, Toulouse)	4 Cs
* France Telecom Recherche et Developpement (Lannion)	2 Cs
* Agilent Technologies France (Massy)	2 Cs
* Observatoire de la Côte d'Azur (OCA, Grasse)	2 Cs
* Observatoire de Paris (LNE-SYRTE, Paris)	7 Cs
* Observatoire de Besançon (OB, Besançon)	3 Cs
* Direction des Constructions Navales (DCN, Brest)	2 Cs

All laboratories are linked via GPS receivers.

(9) PL The Polish official scale UTC(PL) is maintained by the GUM.

Notes (Cont.)

(10)	PL	The Polish atomic time scale TA(PL) is computed by the AOS and GUM with data from 11 caesium clocks and 2 hydrogen masers located as follows:	
		* Central Office of Measures (GUM, Warsaw)	3 Cs, 1 H-maser
		* Astrogeodynamical Observatory, Space Research Center P.A.S. (AOS, Borowiec)	1 Cs
		* National Institute of Telecommunications (IŁ, Warsaw)	2 Cs
		* Research & Development Centre of the Polish Telecom (CBR, Warsaw)	1 Cs
		* Military Primary Standards Laboratory (CWOM, Zielonka, Warsaw)	1 Cs, 1 H-maser
		* Tele & Radio Research Institute (ITR, Warsaw)	1 Cs
		* Time and Frequency Standard Laboratory of the Semiconductor Physics Institute, a guest laboratory from Lithuania (LT, Vilnius, Lithuania)	2 Cs
		All laboratories are linked via MC GPS-CV receivers.	
(11)	PTB	The laboratory Cs, PTB CS1, PTB CS2 and PTB CS3, are operated continuously as clocks. The uncertainty of PTB CS3 is no longer evaluated, so that PTB CS3 is no longer a primary clock. PTB CSF1 is a fountain frequency standard using laser cooled caesium atoms. It is intermittently operated as a frequency standard. Contributions to TAI are made through comparisons with one of PTB's hydrogen masers. Until further notice, TA(PTB) and UTC(PTB) are derived from PTB CS2, TA(PTB) directly, UTC(PTB) including frequency steering.	
(12)	PTB	*TA(PTB)-UTC(PTB)* and the frequency steering applied to UTC(PTB) are published in PTB Time Service Bulletin.	
(13)	SP	The standards are located as follows (at the end of 2006):	
		* Swedish National Testing and Research Institute (SP, Borås)	4 Cs, 1 H-maser
		* STUPI AB (Stockholm)	5 Cs, 2 H-masers
		* Pendulum Instruments AB (Stockholm)	1 Cs
		* Onsala Space Observatory (Onsala)	1 H-maser
(14)	SU	Starting MJD=53369 time units in TA(SU) and UTC(SU) are different. TA(SU) is a free atomic time scale, while UTC(SU) is steered to UTC.	
(15)	TL	TA(TL) is generated from a 9-caesium-clock ensemble.	
(16)	USNO	The time scales A.1(MEAN) and UTC(USNO) are computed by USNO. They are determined by a weighted average of Cs clocks and H-masers located at the USNO. A.1(MEAN) is a free atomic time scale, while UTC(USNO) is steered to UTC. Included in the total number of USNO atomic standards are the clocks located at the USNO Alternate Master Clock in Colorado Springs, CO.	
(a)		Information based on the Annual Report for 2005, not confirmed by the laboratory.	

Table 5. Differences between the normalized frequencies of EAL and TAI, up to May 2007

(File available on http://www.bipm.org under the name EALTAI06.AR, which contains values since the beginning of the steering)

Date	MJD	$[f(EAL) - f(TAI)] \times 10^{-13}$
1998 Mar 27 - 1999 Feb 25	50899 - 51234	7.130
1999 Feb 25 - 1999 Dec 27	51234 - 51539	7.140
1999 Dec 27 - 2000 May 30	51539 - 51694	7.130
2000 May 30 - 2000 Sep 27	51694 - 51814	7.120
2000 Sep 27 - 2000 Nov 26	51814 - 51874	7.110
2000 Nov 26 - 2001 Jan 30	51874 - 51939	7.100
2001 Jan 30 - 2001 Apr 30	51939 - 52029	7.090
2001 Apr 30 - 2001 Jul 29	52029 - 52119	7.080
2001 jul 29 - 2001 Sep 27	52119 - 52179	7.070
2001 Sep 27 - 2001 Nov 26	52179 - 52239	7.060
2001 Nov 26 - 2002 Jan 30	52239 - 52304	7.050
2002 Jan 30 - 2002 Mar 31	52304 - 52364	7.040
2002 Mar 31 - 2002 Jun 30	52364 - 52424	7.030
2002 Jun 30 - 2002 Jul 29	52424 - 52484	7.020
2002 Jul 29 - 2002 Sep 27	52484 - 52544	7.010
2002 Sep 27 - 2002 Nov 26	52544 - 52604	7.000
2002 Nov 26 - 2003 Jan 30	52604 - 52669	6.990
2003 Jan 30 - 2003 Mar 31	52669 - 52729	6.980
2003 Mar 31 - 2003 May 30	52729 - 52789	6.970
2003 May 30 - 2003 Aug 28	52789 - 52909	6.960
2003 Sep 27 - 2003 Nov 26	52909 - 52969	6.950
2003 Nov 26 - 2004 Jan 30	52969 - 53034	6.940
2004 Jan 30 - 2004 Mar 30	53034 - 53094	6.930
2004 Mar 30 - 2004 May 29	53094 - 53154	6.920
2004 May 29 - 2004 Jun 28	53154 - 53184	6.910
2004 Jun 28 - 2004 Jul 28	53184 - 53214	6.904
2004 Jul 28 - 2004 Dec 30	53214 - 53369	6.899
2004 Dec 30 - 2005 Feb 28	53369 - 53429	6.895
2005 Feb 28 - 2005 Mar 30	53429 - 53459	6.891
2005 Mar 30 - 2005 Apr 29	53459 - 53489	6.888
2005 Apr 29 - 2005 May 29	53489 - 53519	6.886
2005 May 29 - 2005 Jun 28	53519 - 53549	6.884
2005 Jun 28 - 2005 Jul 28	53549 - 53579	6.878
2005 Jul 28 - 2005 Aug 27	53579 - 53609	6.876
2005 Aug 27 - 2005 Sep 26	53609 - 53639	6.870
2005 Sep 26 - 2005 Oct 31	53639 - 53674	6.868
2005 Oct 31 - 2005 Nov 30	53674 - 53704	6.862
2005 Nov 30 - 2005 Dec 30	53704 - 53734	6.856
2005 Dec 30 - 2006 Jan 29	53734 - 53764	6.850
2006 Jan 29 - 2006 Feb 28	53764 - 53794	6.844
2006 Feb 28 - 2006 Mar 30	53794 - 53824	6.838
2006 Mar 30 - 2006 Apr 29	53824 - 53854	6.832
2006 Apr 29 - 2006 May 29	53854 - 53884	6.826
2006 May 29 - 2006 Jun 28	53884 - 53914	6.823
2006 Jun 28 - 2006 Jul 28	53914 - 53944	6.823
2006 Jul 28 - 2006 Aug 27	53944 - 53974	6.820
2006 Aug 27 - 2006 Sep 26	53974 - 54004	6.820
2006 Sep 26 - 2006 Oct 31	54004 - 54039	6.817
2006 Oct 31 - 2006 Nov 30	54039 - 54069	6.817
2006 Nov 30 - 2006 Dec 30	54069 - 54099	6.812
2006 Dec 30 - 2007 Jan 29	54099 - 54129	6.806
2007 Jan 29 - 2007 Feb 28	54129 - 54159	6.802
2007 Feb 28 - 2007 Mar 30	54159 - 54189	6.802
2007 Mar 30 - 2007 Apr 29	54189 - 54219	6.802
2007 Apr 29 - 2007 May 29	54219 - 54249	6.802

As the time scales UTC and TAI differ by an integral number of seconds (see Tables 1 and 2), UTC is necessarily subjected to the same intentional frequency adjustment as TAI.

Table 6. Measurements of the duration of the TAI scale interval

(File available on http://www.bipm.org under the name UTAI06.AR)

TAI is a realization of coordinate time TT. The following tables give the fractional deviation *d* of the scale interval of TAI from that of TT (in practice the SI second on the geoid), i.e. the fractional frequency deviation of TAI with the opposite sign: $d = -y_{TAI}$.

In this table, *d* is obtained on the given periods of estimation by comparison of the TAI frequency with that of the individual primary frequency standards (PFS) IT-CSF1, NICT-O1, NIST-F1, NMIJ-F1, PTB-CS1, PTB-CS2, PTB-CSF1, SYRTE-FO1, SYRTE-FO2, SYRTE-FOM and SYRTE-JPO for the year 2006.
Previous calibrations are available in the successive annual reports of the BIPM Time Section volumes 1 to 18.

Each comparison is provided with the following information:
u_A is the uncertainty originating in the instability of the PFS,
u_B is the combined uncertainty from systematic effects,
Ref(u_B) is a reference giving information on the stated value of u_B,
$u_{link/lab}$ is the uncertainty in the link between the PFS and the clock participating to TAI, including the uncertainty due to dead-time,
$u_{link/TAI}$ is the uncertainty in the link to TAI (For evaluations published since September 2006, this value is computed using the standard uncertainty of [UTC-UTC(k)], following a recommendation of the CCTF Working Group on PFS),
u is the quadratic sum of all four uncertainty values.

In this table, a frequency over a time interval is defined as the ratio of the end-point phase difference to the duration of the interval.

The typical characteristics of the calibrations of the TAI frequency provided by the different primary standards over 2006 are indicated below.

Primary Standard	Type /selection	Type B std. Uncertainty	Operation	Comparison with	Number/typical duration of comp.
IT-CSF1	Fountain	$(0.5 \text{ to } 0.8)\times10^{-15}$	Discontinuous	H maser	3 / 20 to 35 d
NICT-O1	Beam /Opt.	6×10^{-15}	Discontinuous	UTC(NICT)	2 / 20 to 30 d
NIST-F1	Fountain	0.3×10^{-15}	Discontinuous	H maser	3 / 30 to 40 d
NMIJ-F1	Fountain	4×10^{-15}	Discontinuous	H maser	3 / 10 to 15 d
PTB-CS1	Beam /Mag.	8×10^{-15}	Continuous	TAI	12 / 30 d
PTB-CS2	Beam /Mag.	12×10^{-15}	Continuous	TAI	12 / 30 d
PTB-CSF1	Fountain	1.1×10^{-15}	Discontinuous	H maser	2 / 10 to 15 d
SYRTE-FO1	Fountain	0.4×10^{-15}	Discontinuous	H maser	2 / 15 d
SYRTE-FO2	Fountain	0.4×10^{-15}	Discontinuous	H maser	3 / 5 to 15 d
SYRTE-FOM	Fountain	1.2×10^{-15}	Discontinuous	H maser	1 / 15 d
SYRTE-JPO	Beam /Opt.	6×10^{-15}	Discontinuous	H maser	11 / 20 to 30 d

More detailed information on the characteristics and operation of individual PFS may be found in the annexes supplied by the individual laboratories.

Table 6. (Cont.)

Standard	Period of estimation		d (10^{-15})	u_A (10^{-15})	u_B (10^{-15})	Ref(u_B)	$u_{link/lab}$ (10^{-15})	$u_{link/TAI}$ (10^{-15})	u (10^{-15})	Notes
IT-CSF1	53774	53794	4.7	0.8	0.5	[1]	0.2	1.5	1.8	
IT-CSF1	53914	53949	3.7	0.6	0.8		0.3	0.9	1.4	
IT-CSF1	54064	54084	-0.1	1.1	0.5		0.5	0.6	1.4	
NICT-01	53769	53789	10.8	3.7	5.5	[2]	0.8	1.5	6.8	
NICT-01	53839	53869	4.9	4.0	5.5		0.0	1.0	6.9	
NIST-F1	53724	53764	3.7	0.4	0.3	[3]	0.4	0.8	1.0	
NIST-F1	53784	53824	2.6	0.3	0.3		0.3	0.8	0.9	
NIST-F1	54009	54039	3.1	0.4	0.4		0.2	0.3	0.7	
NMIJ-F1	53974	53984	-0.4	1.1	3.9	[4]	0.6	1.9	4.5	
NMIJ-F1	53994	54009	1.7	0.9	3.9		0.5	0.9	4.1	
NMIJ-F1	54024	54034	1.0	1.1	3.9		0.5	1.2	4.3	
PTB-CS1	53734	53764	-5.3	5.0	8.0	[5]	0.0	1.0	9.5	(1)
PTB-CS1	53764	53794	1.8	5.0	8.0		0.0	1.0	9.5	
PTB-CS1	53794	53824	-1.4	5.0	8.0		0.0	1.0	9.5	
PTB-CS1	53824	53854	1.2	5.0	8.0		0.0	1.0	9.5	
PTB-CS1	53854	53884	-4.3	5.0	8.0		0.0	1.0	9.5	
PTB-CS1	53884	53914	2.3	5.0	8.0		0.0	1.0	9.5	
PTB-CS1	53914	53944	-8.8	5.0	8.0		0.0	1.0	9.5	
PTB-CS1	53944	53974	-1.8	5.0	8.0		0.0	1.0	9.5	
PTB-CS1	53974	54004	-5.8	5.0	8.0		0.0	0.3	9.4	
PTB-CS1	54004	54039	4.0	5.0	8.0		0.0	0.2	9.4	
PTB-CS1	54039	54069	-2.3	5.0	8.0		0.0	0.2	9.4	
PTB-CS1	54069	54099	-3.6	5.0	8.0		0.0	0.2	9.4	
PTB-CS2	53734	53764	4.2	3.0	12.0	[6]	0.0	1.0	12.4	(1)
PTB-CS2	53764	53794	3.3	3.0	12.0		0.0	1.0	12.4	
PTB-CS2	53794	53824	-2.6	3.0	12.0		0.0	1.0	12.4	
PTB-CS2	53824	53854	-0.8	3.0	12.0		0.0	1.0	12.4	
PTB-CS2	53854	53884	-3.5	3.0	12.0		0.0	1.0	12.4	
PTB-CS2	53884	53914	1.2	3.0	12.0		0.0	1.0	12.4	
PTB-CS2	53914	53944	4.3	3.0	12.0		0.0	1.0	12.4	
PTB-CS2	53944	53974	0.7	3.0	12.0		0.0	1.0	12.4	
PTB-CS2	53974	54004	5.8	3.0	12.0		0.0	0.3	12.4	
PTB-CS2	54004	54039	-0.6	3.0	12.0		0.0	0.2	12.4	
PTB-CS2	54039	54069	-5.4	3.0	12.0		0.0	0.2	12.4	
PTB-CS2	54069	54099	3.6	3.0	12.0		0.0	0.2	12.4	
PTB-CSF1	53914	53924	2.9	1.0	2.6	[7]	0.1	3.0	4.1	
PTB-CSF1	54079	54094	3.8	1.0	1.1		0.1	0.4	1.5	
SYRTE-FO1	54054	54069	1.1	0.1	0.4	[8]	0.1	0.6	0.8	
SYRTE-FO1	54084	54099	0.6	0.5	0.4		0.3	0.6	0.9	
SYRTE-FO2	53764	53789	1.5	0.2	0.6	[8]	0.1	1.2	1.4	
SYRTE-FO2	54054	54069	1.0	0.2	0.4		0.1	0.6	0.8	
SYRTE-FO2	54069	54079	1.5	0.1	0.4		0.1	0.9	1.0	
SYRTE-FO2	54089	54094	3.1	0.7	0.4		0.2	1.6	1.8	
SYRTE-FOM	54054	54069	-0.1	0.5	1.2	[9]	0.2	0.6	1.5	

Table 6. (Cont.)

Standard	Period of estimation	d (10^{-15})	u_A (10^{-15})	u_B (10^{-15})	Ref(u_B)	$u_{link/lab}$ (10^{-15})	$u_{link/TAI}$ (10^{-15})	u (10^{-15})	Notes
SYRTE-JPO	53739 53764	6.7	0.9	6.3	[10]	0.3	1.2	6.5	
SYRTE-JPO	53764 53794	4.5	0.7	6.3		0.3	1.0	6.4	
SYRTE-JPO	53794 53824	6.4	1.1	6.3		0.3	1.0	6.5	
SYRTE-JPO	53824 53854	5.5	0.7	6.3		0.3	1.0	6.4	
SYRTE-JPO	53859 53884	8.7	0.8	6.3		0.3	1.2	6.5	
SYRTE-JPO	53884 53914	8.0	0.6	6.3		0.3	1.0	6.4	
SYRTE-JPO	53914 53944	10.5	0.6	6.3		0.3	1.0	6.4	
SYRTE-JPO	53984 54004	11.1	0.8	6.3		0.3	0.6	6.4	
SYRTE-JPO	54009 54039	11.1	0.8	6.3		0.3	0.4	6.4	
SYRTE-JPO	54039 54069	10.0	0.7	6.3		0.3	0.3	6.4	
SYRTE-JPO	54069 54099	12.7	0.7	6.3		0.3	0.3	6.4	

Notes:

(1) Continuously operating as a clock participating to TAI.

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Report on the activity of IT-CSF1 Primary Frequency Standard during 2006

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During 2006, three IT-CSF1 frequency evaluations were reported to the BIPM. In the tables below, a summary of the reports and a typical accuracy budget (period MJD 54064-54084) are shown.

CircT	Period (MJD)	Dur.	Local Osc.	yIT-CSF1-yTAI	uA	uB	ulab	uTAI	u
218	53774-53794	20dd	1401102	4.7	0.8	0.5	0.2	1.5	1.8
224	53914-53949	20dd	1401102	3.7	0.6	0.8	0.3	0.9	1.4
228	54064-54084	35dd	1401102	-0.1	1.1	0.5	0.5	0.6	1.4

Effect	Correction ($\times10^{-15}$)	Uncertainty ($\times10^{-15}$)
Quadratic Zeeman (field map)	-45.8	0.1
Blackbody Radiation	29.7	0.2
Collisional (average shift 1.1×10^{-15}) (*)	-	0.1
Gravitational Potential	-26.12	0.01
Microwave related	-	0.4
Total	-41.1	0.5

(*) collisional shift is continuously corrected; here is taken into account just the type B uncertainty [1].

The reference papers for IT-CSF1 evaluations procedure are [1,2]. Some details are reported here.
Quadratic Zeeman shift: before each fountain evaluation, the magnetic field is mapped along the atom flight path, with low frequency spectroscopy ($\Delta F=0$, $\Delta m=\pm1$); the field map is then used to calculate the DC Zeeman shift experienced by the atoms .The AC quadratic Zeeman shift due to the RF cavity heater was measured lower than 4×10^{-17}.
Atomic density shift: IT-CSF1 is operated alternating a low-density state (~9000 s) and a high-density state (~1000 s), then the measured frequency is extrapolated to the zero density condition. The collisional shift uncertainty, mainly of type A, is included in the uncertainty of the final linear fit of the measured frequencies; there is an additional type B uncertainty due to the signal stability and to the assumed linearity between density and signal: it is evaluated to be ≤10% of the weighted averaged density shift [1].
Blackbody radiation shift: as in previous evaluations, the blackbody radiation shift is corrected using the accepted value $\beta = -1.711(.003)\times10^{-14}$; IT-CSF1 is operated around 343 K and the uncertainty on this correction is typically 2×10^{-16}.
Microwave related shifts: before and after each TAI evaluation, the presence of unwanted microwave related shifts (such as microwave leakages, spurious spectrum components, distributed phase shifts) is tested as described in [3,4]. The measured shift is compatible with zero at 4×10^{-16} level.
Gravitational shift: IT-CSF1 is located at (239.43±0.03) m over the Geoid. Thie orthometric height was re-evaluated in 2006 with an accurate measurement of the geodetic height of INRIM GPS antenna with respect to the ellipsoid WGS84, and by the measurement of Geoid undulation at the geodetic INRIM position. INRIM geodetic height is available at millimeter level thanks to its participation to the network IGS (International Global Navigation Satellite System Service) since 2003. The undulation at INRIM has been determined first through the global geodetic model EGM96 [5] (1 m accuracy), then recently using leveling techniques (2 cm accuracy) and by the use of the Italian quasi-Geoid model ITALGEO99 (re-evaluation 2006, 4 cm accuracy) [1]. The three undulation values are in agreement and their weighted average is used. As IT-CSF1 orthometric height is evaluated at a centimetre level, the main uncertainty on the frequency correction is the uncertainty on the Geoid reference potential, assessed to be 10 cm equivalent. The frequency shift for IT-CSF1 is $(26.12\pm0.01)\times10^{-15}$.
Type A uncertainty: IT-CSF1 is generally operated by comparing its frequency to an H-maser (BIPM code 1401102). The short term stability is limited at $3\times10^{-13}\tau^{-1/2}$ by the BVA filter noise.
Laboratory link uncertainty: long term stability measurements show that the H Maser stability (drift removed) is better than fountain stability up to 10^6 seconds. During 2006, IT-CSF1 operated with a dead time uncertainty lower than 5×10^{-16}; a detailed description of its evaluation procedure is reported in [1].

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Operation of the NICT primary clocks in 2006

The first optically pumped cesium primary frequency standard CRL-O1 changed its name to NICT-O1 in April 2004. In 2006, the data of the accuracy evaluation of TAI scale unit have been sent to BIPM twice, in February and May. Type B uncertainty of the standard was estimated as 5.5 x 10^{-15}[1]. In most cases during the evaluation period, the total uncertainties of the standard were less than 1 x 10^{-14}.

Physical Effect	Bias (10^{-15})	Uncertainty (10^{-15})
Second-order Doppler	$\delta\nu_D \sim -266$	2
Second-order Zeeman	$\delta\nu_{QZ} \sim 1.5\times10^5$	0.2
Cavity pulling	$\delta\nu_C \sim 1$	0.6
Cavity phase	$\delta\nu_E \sim \pm136$	3.6
Blackbody	$\delta\nu_B \sim -19.4$	0.5
Gravitation	$\delta\nu_G \sim 8.2$	0.1
Uncorrected biases	0	3.6
Combined Type B Uncertainty		5.5

Table 1: Uncertainty budget for uB

Effect	Uncertainty(10^{-15})
Magnetic Field Inhomogeneity	0.03
Rabi Pulling	0.02
Ramsey Pulling	0.002
Bloch-Siegert Shift	0.3
Fluorescent Light Shift	0.5
Majorana Transitions	1.3
Collisions	1.7
Beam Flux Variation	0.1
Microwave Leakage	1.0
DC Stark Shift	0.01
Spectral Purity	0.1
Modulation Synchronous Effects	
Detector/ Demodulator	1.5
AM on Laser	1.0
Switching Transients	2.0
Combined Type B Uncertainty	3.6

Table 2: Details on the uncertainty of uncorrected biases

The operation of NICT-O1 has stopped since June 2006. From 2007, we plan to operate a new primary frequency standard.

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Operation of NIST-F1 in 2006

NIST-F1, the Cs fountain primary frequency standard at the National Institute of Standards and Technology (NIST), has been in operation since November 1998, and the first formal report to the BIPM was made in November 1999 [1]. Two recent papers updating the operation of NIST-F1 were published in 2005 [2, 3]. During a formal evaluation the average frequency of one of the hydrogen masers at NIST is measured by NIST-F1 and the results, along with all relevant biases and uncertainties, are reported to the BIPM. NIST-F1 is not operated as a clock and is run only intermittently. The standard is constantly evolving, and both hardware and software improvements are continually being made. In most formal evaluations a range of atom densities is used along with a weighted linear least squares fit to determine the frequency at zero density. The typical frequency shift from the lowest measured density to zero density is on the order of 3×10^{-16}. Each formal evaluation also includes mapping the magnetic field, and measuring possible biases due to such things as microwave amplitude and light leaks.

Three formal evaluations were carried out in 2006, including two 40 day report intervals ending in January and March 2006, and a 30 day interval in October 2006. The major event for NIST-F1 in 2006 is that it was moved in July to a different room with better temperature and humidity control, and which is closer to the hydrogen masers of the time scale. The fountain was damaged in the move and as a result the microwave cavities, drift tube, and source region were replaced with nearly identical parts. All of the replaced parts are functionally the same as the originals. Because of the change in location and the repairs, the Zeeman and blackbody corrections changed, along with their uncertainties. There was also a small change in the gravitational red shift since the standard is now one floor lower. There continues to be considerable theoretical and experimental work carried out on biases influenced by the microwave amplitude [4, 5, 6].

The Type B uncertainties for the three runs in 2006 are substantially the same as those given in Table 1 of [2], and are dominated by the blackbody and microwave amplitude shifts. For the January and March runs the total Type B uncertainty was 3.1×10^{-16}. After the move the blackbody uncertainty was increased by 8% since the cavities and drift tube are now operated at a slightly higher temperature. Also the uncertainty on the microwave amplitude shift was increased from 1.4×10^{-16} to 2.2×10^{-16} because the rebuilding of NIST-F1 meant that previous data was no longer valid, and a new set of measurements was required. As more data is collected this uncertainty will decrease. The Type B uncertainty for the October run was 3.6×10^{-16}. The Type A uncertainties ranged from 3.3×10^{-16} to 3.7×10^{-16} for the three runs. The components of the Type A uncertainty from to the spin exchange shift ranged from 2.6×10^{-16} to 2.8×10^{-16}. Total uncertainties, including frequency transfer and dead time uncertainties, ranged from 0.68×10^{-15} to 0.97×10^{-15}.

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Operation of NMIJ-F1 Primary Frequency Standard in 2006

In 2006, we have operated NMIJ-F1 three times to calibrate TAI as the Cs fountain primary frequency standard at the National Metrology Institute of Japan (NMIJ). In order to have better reliability and operationality of NMIJ-F1, some parts of both hardware and soft ware have been upgraded. The frequency difference between the center of the Ramsey fringe and the hydrogen maser is estimated from the control record of the Direct Digital Synthesizer that is a part of the synthesis chain. A new pulse pattern generator was also introduced for sequential control of NMIJ-F1. By using this new pulse pattern generator, parameters such as launch height, sequence cycle in the fountain, and shutter timing, are easily adjustable. Inner/outer type DC blocks have been inserted between microwave synthesizers and cavities to eliminate possible ground loop effect. Before submitting the present report of TAI calibration, we investigated the effect of these modifications on the frequency behavior in NMIJ-F1 during two and a half months. We could confirm the improvement of long-term stability with the above modifications.

Three formal evaluations were carried out September and October in 2006. The microwave power dependence was added as a new evaluation item in the uncertainty budget, as is shown in table 1. The others are the same as the error budget used in 2005[1,2].

Source of uncertainty	Bias ($\times 10^{-15}$)	Uncertainty ($\times 10^{-15}$)
2nd order Zeeman	185.0	0.5
Blackbody radiation	-18.0	1.4
Gravitation	1.6	0.1
Cold collisions	0.0	3.3
Distributed cavity phase	0.0	1.2
Microwave power dependence	0.0	0.7
Total	168.6	3.9

Table 1: Typical uncertainty budget used in 2006

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Operation of the LNE-SYRTE primary clocks in 2006

Uncertainty budget for uB

In 2006 the fountain clock FO2 has transmitted four calibrations to TAI , FO1 two calibrations, FOM one calibration. The caesium beam clock JPO was operational in an almost continuous way between January and December, and has transmitted eleven calibrations to TAI. Modifications were realized on the three SYRTE fountains to improve their accuracy and their stability. For **FO2** and **FO1** a non-dephasing microwave switch has been implemented on the interrogation source to efficiently reduce microwave leaks and the cavity phase shift was investigated **[1]** **[3]**. For **FO1** fountain the optics set-up has been entirely rebuilt and improved in reliability making use of a new laser design **[2]**. The thermal Cs beam for loading has been replaced by a 2D MOT. The 150 m underground link of the reference signal between the cryogenic sapphire oscillator and the fountain now operates at 1GHz instead of 100 MHz. The fountain's microwave synthesis chain has been entirely rebuilt and an ensemble of switches has been installed to allow the symmetric or asymmetric feed of the microwave cavity as well as the interruption of the interrogation signal without significant phase shift, a system identical to that of FO2. For **FOM** fountain the optical set-up and the electronic drivers are new, studies and improvement of the thermal homogeneity along the atomic paths have been made, active magnetic compensation reduces the external fluctuations by a factor of 10, the microwave chain uses the 1 GHz signal provided by the sapphire cryogenic oscillator has been set (same design as the FO1). Systematic effects shifting the frequency of the primary clocks are listed in Table I for the three SYRTE fountains over 2006 and for JPO see ref **[4]**.

Fountain	FO2		FO1		FOM	
Physical origin	Correction	Uncertainty	Correction	Uncertainty	Correction	Uncertainty
2^{nd} order Zeeman	-1920,4	0,1	-1238,5	0,3	-210,2	1,1
Blackbody Radiation	168,7	0,6	165,0	0,6	160,4	0,6
Cold Collisions + cavity pulling	129,3	1,3	211,4	$(1,4)_A$ $(0,8)_B$	39,5	6,7
First Doppler	0,0	3,0		3,2		
Microwave Leaks, spectral purity	0,0	0,5	0,0	0,61	0,0	10,0
Synchronous phase fluctuations			0,0	0.6		
Background gas collisions	0,0	1,0	0,0	0,3	0,0	1,0
Microwave recoil	0,0	1,4	0,0	1,4	0,0	1,4
Ramsey Rabi pulling	0,0	1,0	0,0	0,1	0,0	0,1
Second order Doppler	0,0	0,1	0,0	0,1	0,0	0,1
Red shift	-65,4	1,0	-69,3	1,0	-68,0	1,0
Total (1σ) uncertainty u_B		**4,0**		**4,2**		**12,3**

Table I: Accuracy budget of the FO2-CS, FO1 & FOM fountain involved in the 2006, units 10^{-16}.

Evaluation of uA

The short-term frequency instability of the fountain clocks were evaluated throughout 2006 by comparison with an active H maser locked by a cryogenic oscillator. The relative frequency stability for FO2 was measured to $\sigma_y(\tau) = 1,6\,x\,10^{-14}\,\tau^{-1/2}$, for FO1 $\sigma_y(\tau) = 2,0\,x\,10^{-14}\,\tau^{-1/2}$ and for FOM $\sigma_y(\tau) = 7,3\,x\,10^{-14}\,\tau^{-1/2}$ and for JPO see ref [4].

Evaluation of ul/lab

The uncertainty due to the H maser link lab for FO2, FO1 and FOM was evaluated to 0,1 x 10^{-15} and for JPO was evaluated to 0,3 x 10^{-15}. The dead times uncertainties were included in ul/lab for each fountain clocks measurements with details in LNE-SYRTE reports for TAI calibration.

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Operation of the PTB primary clocks in 2006

PTB's primary clocks with a thermal beam

During 2006, PTB CS1 and CS2 [1] were in continuous clock operation without any modification or (major) disturbance. In the CS1, minor vacuum problems persisted all year so that the beam signal stayed at a lower level than normal. This explains that $\sigma_y(\tau = 1\text{h, CS1}) = (95 - 102)\times10^{-15}$ was measured on several occasions. For PTB CS2, however, $\sigma_y(\tau = 1\text{h, CS2})$ was measured between 57×10^{-15} and 65×10^{-15}. The frequency instability of the clock signals was primarily checked with an active hydrogen maser as the reference. Interestingly, the frequency instability of UTC(PTB), which is directly derived from CS2 and a micro phase stepper, was found to be about 60×10^{-15} at $\tau = 1$ h in international comparisons using TWSTFT and GPS carrier phase with reference to hydrogen masers at NICT and JPL, respectively. A long-term analysis of the frequency instability between CS1 and CS2 over 3200 days (MJD 50800 to 54000) revealed white frequency noise as the dominant noise source for averaging times up to 512 days, which justifies the estimate of the uncertainty contributions u_A as $u_A(\tau = 30\text{d, CS1}) = 5\times10^{-15}$, and $u_A(\tau = 30\text{d, CS2}) = 3\times10^{-15}$.

The clocks' operational parameters were checked periodically and validated to estimate the clock uncertainty. These parameters are the Zeeman frequency, the temperature of the beam tube (vacuum enclosure), the line width of the clock transition as a measure of the mean atomic velocity, the microwave power level, the spectral purity of the microwave excitation signal, and some characteristic signals of the electronics. During 2006, reversals of the beam direction were performed on each clock three times, and the end-to end phase difference determined thereafter exhibited the normal scatter around the long term mean value. No indications were found calling for a modification of the previously stated relative frequency uncertainties, u_B, which are 8×10^{-15} and 12×10^{-15} for CS1 and CS2, respectively [2]. The clocks have been operated continuously, and time differences UTC(PTB) – clock in the standard ALGOS format have been reported to BIPM so that $u_{l/lab}$ is zero.

PTB's caesium fountain clock CSF1

During the past two years we investigated shifts of the CSF1 output frequency – exceeding the formerly stated type B uncertainty – that occurred when the main cavity was operated at increased microwave power. Many possible sources of this effect were investigated, with some concentration on Majorana transitions [3] and microwave leakage [4], and could be excluded.

In 2006 most of the time CSF1 was used to investigate the recent finding of a variable collisional shift depending on the clock state composition after the first interaction with the microwave field in the Ramsey cavity, i.e., the ratio of the atom numbers in the clock states ($F = 4$, $m_F = 0$) and ($F = 3$, $m_F = 0$) [5]. Notably in the case of a small initial atom cloud size associated with the use of a magneto-optical trap (like in CSF1), the expansion of the cloud during its ballistic flight results in position-momentum correlations, which in turn lead to decreasing relative atom velocities in a collision. At these low collisional energies the collisional cross-section is markedly different for atoms in the two clock states [5]. The overall collisional shift therefore depends on the composition of the atomic state after the first Ramsey interaction. Taking this into account we were able to explain the major part of the peculiarities found in CSF1 at increased amplitudes of the microwave in the Ramsey cavity, as confirmed by experiment.

In 2006 we performed two measurements of the TAI scale unit with a systematic uncertainty u_B in the low 10^{-15} range. For the first 10-days measurement, where the new findings were still not considered, we obtained $u_B = 2.5\cdot10^{-15}$ and for the second 15-days measurement, where we accounted for the new findings, we obtained $u_B = 1.1\cdot10^{-15}$. In both cases u_A was conservatively estimated as $1.0\cdot10^{-15}$. The fractional dead times were 0.5% and 0.7%, respectively, so that $u_{l/lab}$ was below $0.1\cdot10^{-15}$.

For 2007 we plan to continue our investigations of potential frequency shifts at increased microwave amplitudes. Several uncertainty contributions will be revised in order to allow for a more up to date uncertainty estimate.

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Table 7. Mean fractional deviation of the TAI scale interval from that of TT

(File available on http://www.bipm.org under the name SITAI06.AR)

The fractional deviation d of the scale interval of TAI from that of TT (in practice the SI second on the geoid), and its relative uncertainty, are computed by the BIPM for all the intervals of computation of TAI, according to the method described in 'Azoubib J., Granveaud M., Guinot B., *Metrologia* 1977, **13**, pp. 87-93', using all available measurements from the most accurate primary frequency standards (PFS) IT-CSF1, NICT-O1, NIST-F1, NMIJ-F1, NPL-CSF1, PTB-CS1, PTB-CS2, PTB-CSF1, SYRTE-FO1, SYRTE-FO2, SYRTE-FOM and SYRTE-JPO consistently corrected for the black-body radiation shift.
In this computation, for the PFS evaluations carried out after Jan. 2005, the uncertainty of the link to TAI has been computed using the standard uncertainty of [UTC-UTC(k)], following the recommendation of the CCTF working group on PFS. The model for the instability of EAL has been expressed as the quadratic sum of three components: a white frequency noise $2.0\times10^{-15}/\sqrt{(\tau)}$, a flicker frequency noise 0.4×10^{-15} and a random walk frequency noise $1.0\times10^{-16}\times\sqrt{(\tau)}$, with τ in days. The relation between EAL and TAI is given in Table 5.

Month	Interval	$d/10^{-15}$	uncertainty/10^{-15}
Jan. 2004	53004-53034	+8.5	0.8
Feb. 2004	53034-53064	+6.4	0.8
Mar. 2004	53064-53094	+5.7	0.9
Apr. 2004	53094-53124	+4.6	0.7
May 2004	53124-53154	+5.3	0.6
Jun. 2004	53154-53184	+5.4	0.9
Jul. 2004	53184-53214	+4.0	1.0
Aug. 2004	53214-53244	+3.3	1.1
Sep. 2004	53244-53274	+3.4	1.2
Oct. 2004	53274-53309	+3.6	1.1
Nov. 2004	53309-53339	+3.9	0.8
Dec. 2004	53339-53369	+4.6	0.9
Jan. 2005	53369-53399	+4.8	0.5
Feb. 2005	53399-53429	+5.9	0.9
Mar. 2005	53429-53459	+5.9	1.1
Apr. 2005	53459-53489	+6.1	1.0
May 2005	53489-53519	+6.5	0.8
Jun. 2005	53519-53549	+6.4	0.7
Jul. 2005	53549-53579	+6.1	0.7
Aug. 2005	53579-53609	+6.0	0.8
Sep. 2005	53609-53639	+5.1	0.8
Oct. 2005	53639-53674	+5.0	0.5
Nov. 2005	53674-53704	+4.5	1.0
Dec. 2005	53704-53734	+4.1	0.9
Jan. 2006	53734-53764	+3.4	0.6
Feb. 2006	53764-53794	+2.7	0.5
Mar. 2006	53794-53824	+2.6	0.6
Apr. 2006	53824-53854	+2.6	1.0
May 2006	53854-53884	+2.6	1.1
Jun. 2006	53884-53914	+2.8	1.1
Jul. 2006	53914-53944	+3.2	0.8
Aug. 2006	53944-53974	+2.9	1.0
Sep. 2006	53974-54004	+2.9	1.0
Oct. 2006	54004-54039	+2.8	0.6
Nov. 2006	54039-54069	+1.6	0.5
Dec. 2006	54069-54099	+1.3	0.5

Independent local atomic time scales

Local atomic time scales are established by the time laboratories which contribute with the appropriate clock data to the BIPM. The differences between TAI and the atomic scale maintained by each laboratory are available on http://www.bipm.org or via anonymous ftp 62.161.69.5. For each time laboratory 'lab' a separate file TAI-lab is provided; it contains the respective values of the differences [*TAI* - *TA*(*lab*)] in nanoseconds, for the standard dates, starting on 1 January 1998.

The file NOTES.TAI provides information concerning the time laboratories contributing to the calculation of TAI since 1 January 1998. This file should be considered as complementary to the individual files TAI-lab.

For dates between April 1996 and December 1997, the values of [*TAI* - *TA*(*lab*)] are given in yearly files, each one giving also values of [*UTC* - *UTC*(*lab*)].

Local representations of UTC

The time laboratories which submit data to the BIPM keep local representations of UTC. The computed differences between UTC and each local representation are available on http://www.bipm.org or via anonymous ftp 62.161.69.5. For each time laboratory 'lab' a separate file UTC-lab is provided; it contains the values of the differences [*UTC* - *UTC*(*lab*)] in nanoseconds, for the standard dates, starting on 1 January 1998.

The file NOTES.UTC provides information concerning the time laboratories since 1 January 1998. This file should be considered as complementary to the individual files UTC-lab.

For dates between April 1996 and December 1997, the values of [*UTC* - *UTC*(*lab*)] are given in yearly files, each one giving also values of [*TAI* - *TA*(*lab*)].

International GPS and GLONASS Tracking Schedules

(Files available on http://www.bipm.org)

GPS Schedule no 46 File SCHGPS.46	implemented on MJD = 53828 (2006 April 3) at 0h UTC	Reference date MJD = 50722 (1997 October 1)
GPS Schedule no 47 File SCHGPS.47	implemented on MJD = 54007 (2006 September 29) at 0h UTC	Reference date MJD = 50722 (1997 October 1)
GLONASS Schedule no 21 File SCHGLO.21	implemented on MJD = 53828 (2006 April 3) at 0h UTC	Reference date MJD = 50722 (1997 October 1)
GLONASS Schedule no 22 File SCHGLO.22	implemented on MJD = 54007 (2006 September 29) at 0h UTC	Reference date MJD = 50722 (1997 October 1)

Relations of UTC and TAI with GPS time and GLONASS time

(File available on http://www.bipm.org under the name UTCGPSGLO06.AR)

[*TAI - GPS time*] and [*UTC - GPS time*]

The GPS satellites disseminate a common time scale designated 'GPS time'. The relation between GPS time and TAI is

$$[TAI - GPS\ time] = 19\ \text{s} + C_0,$$

where the time difference of 19 seconds is kept constant and C_0 is a quantity of the order of tens of nanoseconds, varying with time.

The relation between GPS time and UTC involves a variable number of seconds as a consequence of the leap seconds of the UTC system and is as follows:

From 2006 January 1, 0h UTC until further notice:

$$[UTC - GPS\ time] = -14\ \text{s} + C_0.$$

Here C_0 is given at 0h UTC every day.

C_0 is computed as follows. The GPS data recorded at the Paris Observatory for highest-elevation satellites are first corrected for precise satellite ephemerides and for ionospheric delays derived from IGS maps, and then smoothed to obtain daily values of [*UTC*(*OP*) - *GPS time*] at 0h UTC. Daily values of C_0 are then derived by linear interpolation of [*UTC* - *UTC*(*OP*)].

The standard deviation σ_0 characterizes the dispersion of individual measurements for a month. The actual uncertainty of user's access to GPS time may differ from these values. N_0 is the number of measurements.

Relations of UTC and TAI with GPS time and GLONASS time (Cont.)

(File available on http://www.bipm.org under the name UTCGPSGLO06AR)

[*UTC - GLONASS time*] and [*TAI - GLONASS time*]

The GLONASS satellites disseminate a common time scale designated 'GLONASS time'. The relation between GLONASS time and UTC is

$$[UTC - GLONASS\ time] = 0\text{ s} + C_1,$$

where the time difference 0 s is kept constant by the application of leap seconds so that GLONASS time follows the UTC system, and C_1 is a quantity of the order of several tens of nanoseconds (tens of microseconds until 1997 July 1), which varies with time.

The relation between GLONASS time and TAI involves a variable number of seconds and is as follows:

From 2006 January 1, 0h UTC, until further notice:

$$[TAI - GLONASS\ time] = 33\text{ s} + C_1.$$

Here C_1 is given at 0h UTC every day.

C_1 is computed as follows. The GLONASS data recorded at the Astrogeodynamical Observatory, Borowiec, Poland for the highest-elevation satellites are smoothed to obtain daily values of [*UTC(AOS) - GLONASS time*] at 0h UTC. Daily values of C_1 are then derived by linear interpolation of [*UTC - UTC(AOS)*].

To ensure the continuity of C_1 estimates, the following corrections are applied:

+1285 ns from 1997 January 1 (MJD 50449) to 1999 March 22 (MJD 51259)
+107 ns for 1999 March 23 and March 24 (MJD 51260 and MJD 51261)
0 ns since 1999, March 25 (MJD 51262).

The standard deviation σ_1 characterizes the dispersion of individual measurements for a month. The actual uncertainty of user's access to GLONASS time may differ from these values. N_1 is the number of measurements.

Table 8A. Rates relative to TAI of contributing clocks in 2006

(File available on http://www.bipm.org under the name RTAI06.AR)

Mean clock rates relative to TAI are computed for one-month intervals ending at the MJD dates given in the table. When an intentional frequency adjustment has been applied to a clock, the data prior to this adjustment are corrected, so that Table 8A gives homogeneous rates for the whole year 2006. For studies including the clock rates of previous years, corrections must be brought to the data published in the Annual Report for the previous years. These corrections are given in Table 8B. Unit is ns/day, "   -" denotes that the clock was not used, "*" denotes that the related rate was influenced by a frequency jump.

The clocks are designated by their type (2 digits) and serial number in the type. The codes for the types are:

12 HEWLETT-PACKARD 5061A
13 EBAUCHES, OSCILLATOM B5000
14 HEWLETT-PACKARD 5061A OPT. 4
16 OSCILLOQUARTZ 3200
17 OSCILLOQUARTZ 3000
15 DATUM/SYMMETRICOM Cs III
4x HYDROGEN MASERS
9x PRIMARY CLOCKS AND PROTOTYPES
21 OSCILLOQUARTZ 3210
23 OSCILLOQUARTZ EUDICS 3020
30 HEWLETT-PACKARD 5061B
31 HEWLETT-PACKARD 5061B OPT. 4
34 H-P 5061A/B with 5071A tube
35 H-P/AGILENT 5071A High perf.
36 H-P/AGILENT 5071A Low perf.
50 FREQ. AND TIME SYSTEMS INC. 4065A
51 DATUM/SYMMETRICOM 4065 B
52 DATUM/SYMMETRICOM 4065 C

Lab.	Clock	53764	53794	53824	53854	53884	53914	53944	53974	54004	54039	54069	54099
APL	35 904	4.95	4.76	4.86	4.88	4.02	4.63	3.61	3.68	5.39	4.38	4.00	3.11
APL	35 1264	21.98	22.00	22.30	22.56	22.72	21.95	21.51	22.77	22.57	23.14	23.07	22.84
APL	35 1791	-4.96	-4.42	-4.50	-3.90	-4.48	-4.00	-4.16	-4.67	-4.40	-3.75	-3.95	-4.57
APL	40 3107	33.30	31.92	30.68	29.46	28.50	27.51	26.40	25.37	24.59	23.80	22.81	22.78
APL	40 3108	24.98	31.06	37.18	43.06	49.21	55.37	61.55	67.56	73.65	79.97	86.05	91.76
APL	40 3109	-28.96	-28.67	-28.39	-28.13	-27.82	-27.31	-26.87	-26.62	-26.25	-26.19	-26.15	-25.99
AUS	36 249	-2.51	-3.92	-	-	-7.18	-6.33	-6.03	-	-	-5.02	-4.37	-4.49
AUS	36 340	-0.70	-0.90	0.92	1.96	3.61	2.65	2.83	1.54	3.55	1.21	2.13	1.54
AUS	36 654	-17.84	-18.68	-18.47	-18.29	-18.02	-15.93	-17.13	-17.61	-15.39	-16.48	-15.37	-16.85
AUS	36 1035	4.96	3.78	-	-	-	-	-	-	-	-	-	-

Table 8A. (Cont.)

Lab.	Clock	53764	53794	53824	53854	53884	53914	53944	53974	54004	54039	54069	54099
AUS	36 1141	-	-	-	7.13	6.30	7.13	6.82	7.13	6.78	6.94	7.42	5.94
AUS	40 5401	-	34.38	37.04	38.65	38.13	40.22	37.31	-	34.15	30.66	30.51	29.98
AUS	40 5402	5.57	4.75	-1.83	8.55	9.64	21.90	16.34	13.15	14.66	15.77	-	-
AUS	40 5403	-22.41	10.14	-	-	19.69	24.86	2.98	-12.41	-	-19.41	-19.52	2.05
AUS	99 1	-8.02	-8.52	-	-	-	-	-	-	-	-	-	-
BEV	35 1065	-3.56*	-3.16*	-2.98*	-2.76*	-2.14*	-2.34*	-1.49*	-1.10*	-1.19	-0.84	-1.63	-0.84
BEV	35 1793	-1.03*	-0.64*	-0.93*	-0.69*	0.35*	-0.37*	-0.62*	-0.42*	-0.93	-0.39	-0.59	0.13
CAO	35 939	2.33	2.20	2.92	3.36	3.82	4.73	-	-	2.50	-	-	-1.29
CAO	35 1270	-2.79	-3.53	-2.70	-2.42	-3.07	-4.43	-	-	1.23	-	-	-
CH	35 771	9.12	8.38	9.07	8.76	9.14	10.17	10.42	9.77	8.10	8.80	9.26	10.23
CH	35 2117	0.56	3.33	2.97	2.06	2.54	2.19	0.65	2.34	1.10	1.75	2.20	1.75
CH	36 354	44.61	43.84	44.61	43.22	46.22	44.33	43.46	43.21	42.34	44.16	45.98	43.74
CH	36 413	-12.67	-10.83	-11.11	-11.05	-8.11	-9.02	-10.36	-8.34	-10.55	-8.47	-9.73	-8.63
CH	40 5701	-103.34	-104.53	-105.82	-107.37	-108.97	-109.47	-111.76	-113.04	-114.83	-115.40	-117.60	-120.37
CNM	35 1705	0.13	0.40	0.89	0.28	0.72	0.21	0.68	0.69	0.38	1.69	0.58	0.95
CNM	35 1815	-0.06*	-1.68*	-0.89*	-1.59*	-3.28*	1.30*	1.35*	0.76*	1.65*	1.70*	-0.10*	0.09
CNM	36 1537	-18.98	-17.12	-17.08	-16.73	-17.74	-16.73	-17.85	-14.98	-16.72	-14.89	-14.54	-17.37
CNM	40 7301	-42.20	-38.59	-44.28	-44.42	-48.65	-52.19	-55.20	-53.63	-59.35	-47.49	-53.41	-49.38
CNMP	36 1752	-5.94	-6.25	-6.09	-5.71	-6.36	-5.99	-5.06	-6.63	-6.43	-5.95	104.01	95.37
DLR	35 1714	-	-	-	-	-	-	-	-	-	-	-	-
DTAG	36 136	-4.90	-3.19	-4.39	-5.54	-4.55	6.26	2.50	-5.17	-9.90	-12.39	-	-
DTAG	36 345	-0.40	-2.08	-0.88	-2.71	-1.07	0.17	-1.79	-1.87	-0.96	-3.16	-	-
DTAG	36 465	1.47	-0.43	0.53	-1.25	-0.47	-0.81	-0.68	1.78	5.45	3.98	-	-
F	35 122	27.07	27.97	27.28	27.16	27.14	27.00	26.93	26.93	26.54	26.62	27.72	26.76
F	35 124	8.73	9.92	9.39	9.29	8.69	9.26	8.56	9.53	9.20	8.94	9.43	9.62
F	35 131	11.83	11.73	11.78	11.87	11.92	11.95	11.60	12.02	10.66	11.34	11.68	11.34
F	35 158	5.66	5.14	5.28	5.81	6.79	7.35	7.91	7.90	8.93	8.74	9.29	9.73
F	35 172	7.68	8.48	7.14	7.26	-	-	-	-	-	-	-	-
F	35 198	4.62	3.65	3.73	4.13	4.19	4.08	4.80	5.01	-	-	5.24	4.81
F	35 385	23.13	23.07	23.23	23.78	23.41	24.10	23.06	22.56	24.14	22.71	23.13	23.49
F	35 396	3.50	4.21	5.24	5.27	5.15	5.72	4.98	5.58	6.75	5.27	5.84	5.82
F	35 520	12.66	14.94	16.05	12.53	12.99	13.45	15.07	14.73	15.02	14.65	12.90	14.46
F	35 536	8.57	9.29	8.58	9.15	9.72	10.12	9.48	9.45	8.70	8.94	9.42	8.91
F	35 609	-6.03	-7.49	-9.32	-9.37	-10.51	-9.47	-10.60	-10.73	-10.46	-9.71	-10.32	-10.76
F	35 770	14.94	16.10	16.18	15.50	17.03	16.58	16.60	-	-	-	-	-

Table 8A. (Cont.)

Lab.	Clock	53764	53794	53824	53854	53884	53914	53944	53974	54004	54039	54069	54099
F	35 774	-16.53	-16.65	-16.58	-16.55	-	-	-	-	-	-20.47	-20.26	-19.74
F	35 781	10.68	9.50	9.17	9.92	7.15	8.03	8.20	9.73	-	-	6.68	8.90
F	35 819	-	-	11.13	11.26	11.62	10.27	10.69	-	-	-	-	10.26
F	35 859	1.50	2.37	2.55	3.07	1.56	2.35	2.83	2.20	3.48	3.67	-	-
F	35 1029	14.08	13.32	12.78	13.26	12.28	11.94	12.11	12.52	12.01	11.76	12.24	12.10
F	35 1178	27.82	27.43	27.66	28.45	27.96	28.55	27.60	26.59	26.41	26.56	-	-
F	35 1222	-	-	-	-	-	-	11.42	11.84	-	-	12.81	12.71
F	35 1258	-	-	-	-	1.24	1.45	1.60	1.57	-	-	2.70	1.96
F	35 1321	13.93	-	-	-	-	-	-	4.93	4.12	4.64	-	-
F	35 1556	-16.97	-20.15	-20.20	-21.22	-20.89	-20.59	-21.67	-21.00	-21.67	-21.40	-21.11	-21.03
F	35 2027	5.92	5.05	4.94	4.23	4.65	4.49	4.23	4.04	3.49	2.60	2.37	2.38
F	40 805	-41.75	-37.39	-34.06	-32.24	-31.06	-33.24	-35.35	-37.03	-36.55	-33.96	-33.68	-31.66
F	40 816	-29.23	-28.89	-29.53	-31.05	-34.87	-35.96	-36.90	-37.61	-38.65	-39.70	-39.51	-40.22
F	40 889	46.61	-	-	-	58.84	62.36	66.02	69.79	73.44	77.60	81.73	85.36
F	40 890	15.27	16.00	16.86	17.75	18.43	19.54	20.37	21.53	22.91	26.65	31.44	32.69
HKO	35 1893	0.48	0.11	-	-	-	0.71	-0.87	-1.15	-0.67	-1.31	-0.86	-
IFAG	36 1167	-2.74	-3.34	-4.00	-3.27	-0.67	-3.50	-0.32	2.14	1.40	0.48	-2.62	-2.68
IFAG	36 1173	-5.43	-5.60	-5.73	-5.98	-7.57	-5.60	-3.58	-4.42	-3.32	-5.64	-8.10	-8.45
IFAG	36 1629	5.99	5.64	5.98	7.37	6.61	8.51	8.08	7.11	7.98	7.87	7.08	7.77
IFAG	36 1732	1.01	0.88	1.62	3.16	1.78	3.81	2.68	-	-	-	-	-
IFAG	36 1798	0.12	-0.08	0.07	1.35	0.19	1.15	1.39	0.62	1.52	-0.01	0.59	0.15
IFAG	40 4401	35.65	56.56	59.18	21.11	-8.40	-4.72	-	-	-	-	-	-
IFAG	40 4413	-	-	-	-	44.18	67.91	-	-	-	-	-	-
IFAG	40 4418	8.82	9.87	10.96	12.21	11.74	12.76	12.66	13.29	14.88	15.32	16.48	18.14
IGMA	16 112	-	-	-	-	-	-	-	-	-	21.18	15.81	-36.22
IGMA	35 674	-	-	-	-	-	-	-	-	-	-0.43	-0.49	0.55
IGMA	35 676	-	-	-	-	-	-	-	-	-	0.19	0.25	0.56
INPL	35 1652	3.19	-	-	-	-	-	-	-	-	-	-	-
INPL	35 1653	-	-	1.27	1.02	1.47	0.33	1.11	-0.14	-0.11	-0.60	0.74	0.51
IT	35 219	10.69	10.76	10.64	10.46	10.86	9.99	9.15	9.93	9.99	9.81	9.49	9.94
IT	35 505	-10.21	-9.97	-8.86	-8.77	-8.89	-8.45	-7.85	-8.06	-8.25	-8.13	-8.43	-7.91
IT	35 1115	17.84	17.00	15.37	14.57	13.75	13.65	12.55	13.03	13.29	13.73	13.40	13.59
IT	35 1373	-	-	-7.83	-9.02	-9.28	-9.44	-9.81	-9.56	-10.19	-9.93	-9.61	-10.63
IT	35 2118	13.65	13.54	14.33	14.16	14.28	14.29	14.52	14.08	13.81	13.73	13.83	13.94
IT	40 1101	-	-	-	-	-	94.34	104.93	115.42	125.01	-	-	-

Table 8A. (Cont.)

Lab.	Clock	53764	53794	53824	53854	53884	53914	53944	53974	54004	54039	54069	54099
IT	40 1102	-11.75	-10.66	-9.99	-9.39	-8.29	-7.36	-6.44	-4.94	-3.60	-2.16	-0.56	1.27
JV	21 216	7.08	7.30	11.71	8.00	11.34	10.59	10.96	12.28	11.19	12.62	13.22	14.02
JV	21 387	13.44	18.81	165.14	63.43	126.63	-112.01	-218.75	-10.25	68.88	1.05	-82.80	-43.54
JV	36 1277	-19.56	-19.85	-16.88	-18.88	-18.84	-18.96	-19.52	-17.49	-19.16	-17.71	-20.37	-19.52
JV	51 2040	49.99	46.14	45.06	42.72	-64.23	19.98	26.69	34.19	24.13	-	-	-
KRIS	35 321	10.89	11.51	12.69	11.63	12.97	14.23	15.25	14.48	13.01	12.64	10.38	10.42
KRIS	35 1693	9.25	8.62	8.75	8.80	8.33	7.79	7.91	7.27	7.35	7.17	7.91	-
KRIS	35 1783	13.84	14.35	13.28	15.47	14.26	14.46	14.21	14.84	15.00	14.59	15.84	16.91
KRIS	36 739	-10.96	-11.90	-12.66	-9.99	-11.55	-12.45	-11.90	-11.82	-	-	-	-
KRIS	36 1135	33.70	35.64	36.18	33.02	35.04	36.32	35.80	36.56	34.46	34.67	34.38	34.46
KRIS	40 5623	76.32	82.38	88.20	93.27	97.35	100.73	103.83	106.40	108.12	109.85	110.95	111.75
KRIS	40 5624	155.12	159.59	164.01	168.27	172.52	-	-	184.06	-	-	-	-
KRIS	40 5625	24.46	27.35	30.24	33.28	35.96	38.74	41.62	44.29	46.86	49.91	53.11	56.15
LDS	35 289	5.86	7.05	6.49	6.81	7.30	7.02	6.72	-109.52	8.11	8.72	7.10	6.09
LT	35 1362	-0.24	0.71	1.25	1.90	0.67	0.62	0.05	-1.96	0.92	-1.29	-0.32	0.52
LT	35 1868	-	-	-	-	-	-	-	-	-	-	-	7.84
MIKE	35 1171	14.75	13.40	14.11	25.03	9.69	16.35	14.21	17.54	16.15	18.75	16.24	15.82
MIKE	36 986	2.00	3.40	8.77	5.44	-4.74	-0.39	-0.52	2.00	1.15	1.25	0.92	0.02
MIKE	40 4113	7.09	-	-	-	-	10.34	10.30	14.85	14.21	16.55	17.81	19.16
MIKE	40 4180	0.27*	-0.02*	-0.13*	-0.03*	-0.45*	0.07*	0.04	0.05	-0.18	0.15	-0.15	-0.29
MSL	12 933	4.17	3.78	-9.41	-3.61	-2.24	-7.35	-14.91	-11.46	10.67	11.30	16.49	-
MSL	36 274	4.97	5.32	4.76	5.48	5.62	7.75	6.42	6.78	5.19	3.71	5.99	-
MSL	36 1025	4.33	6.22	6.91	7.84	8.45	7.63	8.20	2.78	-2.24	-0.20	1.38	-
NAO	35 779	5.03	5.08	4.60	4.38	4.71	5.30	5.21	5.31	-	-0.06	-	-5.53
NAO	35 1206	16.72	16.96	16.81	16.05	16.27	16.42	15.98	16.60	-	16.25	14.85	15.69
NAO	35 1214	3.16	2.90	3.39	3.30	3.47	4.01	3.49	3.63	-	4.22	4.52	5.83
NAO	35 1689	-	7.25	6.71	6.73	6.93	7.09	6.99	7.03	-	7.54	7.00	7.11
NICT	35 112	0.54	1.12	1.73	2.36	1.61	1.49	3.22	2.11	2.73	2.41	2.26	2.16
NICT	35 144	-15.69	-15.10	-14.47	-15.33	-11.31	-12.22	-11.99	-13.23	-13.68	-13.44	-13.94	-12.85
NICT	35 332	15.95	16.95	17.15	-	-	-	-	-	-	-	-	-
NICT	35 342	8.72	-	9.22	8.19	7.34	-	-	-	-	-	-	-
NICT	35 343	12.88	12.67	13.38	13.93	13.66	12.99	11.78	12.83	12.83	13.76	13.64	13.36
NICT	35 715	14.97	-	-15.23	-13.54	-14.09	-13.90	-13.80	-14.32	-13.85	-14.42	-14.32	-14.18
NICT	35 732	3.48	3.55	4.03	3.10	4.26	3.89	5.23	4.23	4.22	3.82	4.50	3.66
NICT	35 907	-10.63	-9.30	-6.18	-6.69	-7.04	-6.95	-7.67	-10.89	-11.21	-10.73	-10.87	-11.05

Table 8A. (Cont.)

Lab.	Clock	53764	53794	53824	53854	53884	53914	53944	53974	54004	54039	54069	54099
NICT	35 908	9.61	8.82	8.14	7.15	7.95	6.34	5.27	5.41	5.18	4.01	3.86	4.00
NICT	35 1778	13.60	13.10	13.72	13.89	13.64	13.97	14.29	14.00	13.76	14.23	14.55	14.00
NICT	35 1789	9.82	9.57	9.10	9.08	9.21	8.97	8.41	8.99	8.61	8.63	7.71	7.74
NICT	35 1790	-3.34	-3.92	-3.52	-3.53	-3.14	-2.95	-3.18	-3.11	-3.18	-2.92	-3.15	-2.97
NICT	35 1882	58.58	58.56	58.97	59.03	60.68	60.73	64.21	65.87	66.05	66.40	65.90	64.62
NICT	35 1887	25.06	24.25	24.63	24.52	24.74	24.51	24.13	23.73	24.03	23.77	25.15	29.53
NICT	35 1944	6.09	5.74	5.74	5.05	5.02	4.99	4.79	4.51	4.44	4.07	3.34	3.40
NICT	35 2056	9.11	9.12	9.18	10.00	9.59	9.32	9.91	10.27	10.20	10.61	10.01	10.96
NICT	35 2113	-23.43	-24.10	-23.59	-23.35	-22.66	-22.79	-22.87	-22.72	-22.54	-21.96	-22.51	-22.50
NICT	35 2116	7.51	7.12	7.57	7.84	8.10	8.68	8.84	8.78	9.59	10.06	9.60	9.62
NICT	40 2002	-	-	-	-	-	-	-	-	-	2.83	3.32	4.05
NICT	40 2003	-	-	-	-	-	-	2.31	3.99	5.65	7.48	9.18	11.25
NIM	35 479	2.94	3.45	2.97	2.66	0.63	0.84	-0.06	-0.06	2.08	1.98	1.77	2.44
NIM	35 1239	4.29	3.66	2.71	2.41	3.46	2.55	2.55	1.94	5.43	2.71	0.36	-0.04
NIM	40 4814	8.38	9.79	10.75	-	12.35	7.74	8.83	8.13	7.63	8.80	3.58	-4.90
NIM	40 4832	20.53	21.21	20.94	20.98	21.15	21.32	21.12	20.89	20.86	21.59	21.91	21.45
NIM	40 4835	-	-	-	-	5.42	4.62	5.18	3.90	4.08	6.06	3.04	2.81
NIMB	35 600	-0.98	-0.34	-0.65	-0.23	-1.95	-0.49	-0.89	-2.47	-0.74	-1.68	30.70	-2.24
NIS	35 1126	-0.18	0.06	-	-	-	-0.56	-0.33	-	-	1.96	-1.84	-4.75
NIST	15 9866	13.12	2.26	-7.53	-16.89	-23.98	-28.37	-32.68	-35.67	-37.08	-40.88	-41.91	-44.25
NIST	35 132	-2.55	-2.95	-2.58	-2.39	-3.48	-3.28	-2.94	-3.95	-3.38	-3.71	-3.84	-3.62
NIST	35 182	-10.02	-10.65	-10.17	-10.33	-10.02	-10.98	-11.34	-10.61	-11.19	-10.49	-10.98	-11.13
NIST	35 282	7.82	8.12	6.70	7.65	8.39	7.56	7.36	7.14	7.23	7.64	6.29	7.91
NIST	35 408	-1.00	-0.37	-1.64	-1.14	-1.09	-1.08	-1.44	0.03	-0.79	0.25	-0.54	-0.95
NIST	35 1074	-15.99	-16.02	-16.13	-15.23	-14.87	-15.12	-15.24	-15.03	-14.82	-15.07	-14.93	-15.19
NIST	35 2031	-2.26	-1.53	-2.58	-1.18	-2.01	-2.34	-2.03	-2.50	-2.26	-1.79	-3.72	-1.87
NIST	35 2032	-8.17	-8.71	-8.63	-7.19	-6.40	-7.13	-6.41	-6.78	-6.40	-5.20	-6.47	0.02
NIST	35 2034	-20.70	-20.97	-21.46	-20.80	-20.80	-20.79	-21.06	-21.43	-20.65	-20.40	-22.16	-20.57
NIST	40 201	33.67	34.73	35.78	36.59	37.68	38.63	39.45	40.34	41.02	-	-	-
NIST	40 203	77.88	79.32	80.78	82.00	83.34	84.76	85.96	86.98	87.90	89.18	90.10	90.99
NIST	40 204	17.50	17.79	18.08	18.28	18.43	18.63	18.85	18.98	18.83	19.11	19.26	19.72
NIST	40 205	-26.03	-25.97	-25.94	-26.10	-25.16	-25.83	-25.98	-26.15	-26.09	-26.11	-26.13	-26.13
NIST	40 206	-	-	-	-	-	-62.45	-63.48	-64.32	-65.22	-65.85	-65.57	-66.02
NIST	40 222	2.73	3.48	4.28	5.07	5.88	6.72	7.48	8.33	9.00	9.91	10.90	11.68
NMC	35 1501	-1.46	-2.78	-3.96	-4.09	-0.64	-1.07	-	-	-1.90	-3.22	-1.50	-2.61

Table 8A. (Cont.)

Lab.	Clock		53764	53794	53824	53854	53884	53914	53944	53974	54004	54039	54069	54099
NMIJ	35	224	-12.83	-13.56	-12.82	-12.93	-	-	13.77	11.58	12.33	14.34	12.98	16.43
NMIJ	35	459	0.03	-3.58	-0.44	-0.49	-0.79	-	-	-	-	-	-	-
NMIJ	35	523	10.90	11.50	11.07	11.45	11.42	10.94	9.06	11.11	10.53	10.50	11.28	10.69
NMIJ	35	1466	10.52	-	-	-	-	-	-	13.52	14.17	15.08	15.02	15.37
NMIJ	40	5002	-	-	-	-	-	0.22	0.35	-2.08	-2.56	-0.48	-1.75	0.28
NMIJ	40	5003	-	-	-	-	-	-	-	-3.56	-4.36	-3.56	-5.26	-4.45
NMIJ	40	5014	-1.82	-1.71	-1.65	-1.88	-1.92	-2.01	-2.03	-3.07	-3.03	-3.49	-3.52	-1.15
NMLS	35	1659	0.05	-0.18	-0.13	-1.14	-0.56	-0.41	-1.27	-2.22	-1.08	-1.68	-1.95	-2.42
NPL	35	1275	-	-	-	-	-	-	-	-	-	-	-	10.06
NPL	36	784	0.26	0.19	0.84	0.98	0.57	0.72	1.69	2.45	1.72	1.49	4.30	5.11
NPL	40	1701	-1.41*	-0.95*	-0.55*	-0.84	-0.67	-0.41	-0.26	-0.06	-0.03	0.02	2.21	1.98
NPL	40	1708	-2.56*	-2.25*	-1.30*	-0.97*	-0.69	-0.40	-0.04	-0.07	-0.83	0.05	0.68	0.31
NPLI	35	725	-0.19	2.19	1.25	2.21	2.84	3.66	2.55	1.79	3.50	-4.79	3.11	2.74
NRC	35	234	24.37	24.90	24.81	24.13	24.14	24.21	23.60	24.38	23.80	24.35	23.15	4.85
NRC	35	372	2.08	2.34	2.42	1.56	1.80	1.14	0.43	1.93	2.77	1.50	1.63	0.64
NTSC	35	1007	20.17	20.21	18.89	18.18	18.92	15.85	19.84	-	-	-	-	10.13
NTSC	35	1008	9.52	9.76	9.86	9.75	7.23	5.68	5.27	-	-	4.03	4.36	4.34
NTSC	35	1011	3.97	3.62	3.18	3.38	2.83	3.44	2.53	2.89	3.62	3.37	-	-
NTSC	35	1016	15.53	15.12	16.50	16.45	16.48	16.23	16.01	15.29	15.28	15.34	14.98	14.86
NTSC	35	1017	3.23	2.73	3.17	2.56	3.50	2.24	2.65	2.58	2.16	1.85	-0.46	-0.02
NTSC	35	1018	11.66	11.58	11.47	12.68	13.15	11.57	11.61	-	-	-	-	-
NTSC	35	1818	-28.60	-27.53	-41.40	-31.15	-28.64	-28.35	-	-	-28.51	-28.18	-28.45	-28.47
NTSC	35	1820	-5.71	-6.19	-6.13	-5.14	-4.84	-5.06	-4.29	-4.72	-4.16	-4.07	-3.50	-4.04
NTSC	35	1823	3.70	3.99	2.09	10.29	21.69	23.80	30.23	-	-	-	-	-
NTSC	35	2096	-	-	-	-	-	-	-	-7.02	-7.12	-7.39	-6.40	-7.38
NTSC	35	2098	3.06	3.09	3.47	2.65	3.31	3.51	3.29	3.38	3.38	3.47	3.09	4.33
NTSC	35	2131	6.81	7.06	7.03	6.85	6.73	6.51	6.25	6.36	6.12	6.51	5.57	5.90
NTSC	35	2141	15.19	15.25	13.00	13.91	13.38	12.19	11.90	12.01	10.93	11.16	14.47	31.44
NTSC	35	2142	-13.59	-13.70	-13.30	-13.70	-13.70	-13.37	-13.09	-13.91	-13.21	-13.38	-13.65	-13.36
NTSC	35	2143	-	-	-	-	-	-	-	0.62	1.72	1.18	0.79	2.02
NTSC	35	2144	-6.16	-5.76	-5.88	-6.18	-5.82	-6.09	-6.21	-4.91	-4.88	-5.26	-3.96	-4.40
NTSC	35	2145	-	-	-	-	-	-	-	0.39	0.89	0.72	1.11	1.58
NTSC	35	2146	-	-	-	-	-	-	-	-2.32	-2.14	-1.54	-0.46	-0.88
NTSC	35	2147	-	-	-	-	-	-	-	0.05	0.58	0.66	0.67	1.33
NTSC	40	4926	-38.79	-34.42	-29.90	-25.29	-20.18	-15.18	-10.21	-5.02	0.60	7.09	14.01	20.80

Table 8A. (Cont.)

Lab.	Clock	53764	53794	53824	53854	53884	53914	53944	53974	54004	54039	54069	54099
NTSC	40 4927	99.94	103.55	106.44	109.24	111.80	114.21	117.26	119.70	122.70	125.96	129.90	133.97
NTSC	40 4945	-17.12	-11.36	-11.98	-	-	-	-	-22.97	-21.43	-16.23	-17.29	-24.93
NTSC	40 4946	3.88	27.98	6.85	8.50	3.15	3.35	7.26	15.93	14.76	22.45	28.74	-
OMH	36 849	1.85	2.80	0.71	4.61	1.98	1.01	3.90	4.91	4.51	2.46	0.98	2.23
ONBA	12 1091	-1.82	-	-	-	-	-	-	-	-	-	-	-
ONBA	12 1371	-	-	-	-12.82	-13.75	-14.18	-9.28	-	-	-	11.51	34.98
ONRJ	35 103	-	-	-	-	-	-	7.79	7.20	7.71	7.96	1.10	9.51
ONRJ	35 123	-	-	-	-	-	-	30.64	31.70	31.30	30.96	22.93	31.36
ONRJ	35 129	-	-	-	-	-	-	1.34	1.31	0.97	1.80	-4.47	0.84
ONRJ	35 1942	11.49	11.51	11.35	11.01	10.60	10.78	9.97	10.48	10.30	10.36	2.82	10.20
ORB	35 201	2.09	1.43	0.98	1.02	0.34	3.49	3.47	1.47	2.88	1.00	1.01	1.83
ORB	35 202	7.75	11.12	7.48	8.66	7.48	11.37	5.99	7.31	7.37	5.84	9.03	8.32
ORB	35 593	73.25	74.82	73.00	74.08	74.43	73.87	73.63	73.61	74.74	76.93	77.26	76.77
ORB	40 2601	-0.03	0.26	0.39	-0.09	0.24	0.11	-0.45	0.45	0.55	0.19	-0.94	-0.85
PL	25 124	-2.03	0.47	1.36	-7.83	-11.64	-17.43	-23.94	-	-	-	-	-
PL	35 441	2.41	2.39	3.31	1.64	1.67	1.94	2.18	2.37	1.92	1.99	2.07	2.60
PL	35 502	0.62	0.99	0.69	0.47	1.66	1.62	2.06	1.13	1.41	2.53	1.29	1.75
PL	35 745	-0.20	-0.97	-1.74	-1.40	-1.87	-1.48	-1.26	-2.28	-2.12	-2.35	-1.67	-2.11
PL	35 1120	3.76	3.33	3.07	3.69	3.45	3.47	3.26	3.41	3.18	4.61	4.17	5.14
PL	35 1660	-0.64	-1.89	-1.41	-0.60	-0.70	1.23	0.26	-1.43	0.10	-0.56	-1.10	-1.62
PL	35 1709	1.40	1.47	1.37	0.87	1.19	0.84	1.27	0.59	1.39	1.04	0.38	1.00
PL	35 1746	0.66	0.24	1.46	0.41	0.84	1.24	0.32	0.73	0.96	0.46	0.63	1.13
PL	35 1934	-1.62	-2.05	-1.56	-2.30	-1.59	-1.60	-1.91	-1.97	-1.52	-1.73	-1.78	-1.37
PL	36 1395	-	-8.06	-5.39	-4.94	-7.45	-7.39	-6.57	-8.88	-5.12	-8.04	-7.97	-6.07
PL	40 4002	16.43	15.88	7.62	14.39	5.51	2.52	-	-	6.95	7.66	9.87	10.91
PL	40 4004	-3.27*	2.43*	-0.12*	-4.62*	-10.34	-2.25	-6.01	-3.07	-10.17	-13.34	-16.55	-22.47
PTB	35 128	-1.94	-1.63	-1.46	-1.26	-1.26	-2.17	-0.98	-	-	-	-	-
PTB	35 415	2.92	3.38	2.90	2.83	3.80	4.23	3.47	3.82	3.64	3.19	2.57	3.11
PTB	35 1072	13.50	11.45	11.79	12.22	11.97	12.08	12.12	11.56	11.81	11.53	11.96	12.07
PTB	40 510	-	-	-	-	-	-	-	-	-	-	-	5.43
PTB	40 590	-6.07*	-4.57*	-3.20*	-2.12*	-0.74*	0.70	1.80	3.09	4.28	5.16	6.27	7.49
PTB	92 1	1.90	1.27	1.58	1.30	1.85	1.23	2.39	1.84	2.01	1.18	1.84	1.92
PTB	92 2	1.10	1.21	1.70	1.57	1.75	1.28	1.20	1.52	0.93	1.46	1.99	1.15
PTB	92 3	3.46	4.21	3.90	3.43	4.60	5.23	4.88	5.10	3.27	2.20	1.76	1.80
ROA	31 422	2.37	29.71	24.54	-11.52	-37.42	-5.31	-18.77	-39.24	-43.02	-19.98	-31.75	21.20

Table 8A. (Cont.)

Lab.	Clock		53764	53794	53824	53854	53884	53914	53944	53974	54004	54039	54069	54099
ROA	35	583	2.55*	1.33*	1.11*	0.94*	1.21*	1.60*	1.48*	1.81*	0.28*	-0.01*	-0.75	-0.61
ROA	35	718	-9.52	-8.88	-7.82	-7.87	-8.30	-8.27	-8.02	-7.55	-8.33	-8.53	-7.63	-7.52
ROA	36	1488	11.06	10.82	7.82	10.15	10.00	9.32	8.46	8.90	8.12	8.97	8.31	8.55
ROA	36	1490	7.15	6.24	7.23	8.03	6.40	8.91	8.80	7.64	8.40	7.90	7.41	6.74
ROA	40	1436	-14.77	-	-	-47.57	-54.48	-59.82	-64.29	-67.81	-70.65	-72.63	-73.96	-74.62
SCL	35	621	-3.66	-3.05	-2.78	-2.54	-2.94	-3.10	-2.65	-3.80	-3.08	-3.59	-4.17	-3.65
SCL	35	1745	-0.04	-0.74	-0.78	-0.47	-1.04	-0.61	-1.35	-0.13	-0.61	0.06	-0.63	-0.39
SG	35	1035	5.36	5.93	5.18	5.49	4.77	5.43	-	-	-	4.09	4.38	4.75
SG	35	1127	0.44	0.39	0.40	1.04	0.54	0.02	-	-	-	1.57	0.52	0.86
SG	35	1889	-	-	-	-	-	-	-	-	-	18.90	16.84	16.84
SG	36	522	-4.76	-4.86	-5.15	-2.66	-1.47	-0.20	-	-	-	-1.98	-4.59	-2.84
SMU	36	1193	-	0.24	-1.00	1.09	0.50	1.43	1.35	0.68	-0.53	-0.25	-1.80	-0.88
SP	19	197	-68.25	-70.26	-71.92	-72.80	-73.37	-75.63	-49.97	-36.81	-61.13	-64.44	-86.14	-93.42
SP	35	572	-	-	16.22	15.71	17.05	18.70	18.48	18.50	17.41	18.00	18.58	18.71
SP	35	641	6.93	6.50	7.70	7.12	7.10	7.33	7.68	8.05	8.12	7.59	7.84	7.20
SP	35	1188	28.38	28.78	29.31	29.26	28.81	29.07	29.32	29.85	28.98	29.44	28.33	29.04
SP	35	1531	19.29	20.05	20.38	20.04	19.48	20.40	20.39	20.56	20.10	19.66	19.65	19.89
SP	35	1642	14.21	14.19	13.10	13.91	14.14	13.39	12.77	13.23	14.20	13.41	13.63	13.52
SP	35	2166	-0.23	-0.43	-0.18	-0.76	-0.15	0.05	0.11	-0.62	-0.27	0.16	0.10	0.38
SP	36	1175	1.23	1.38	2.36	2.84	3.01	2.45	3.33	1.67	2.52	2.61	1.27	2.35
SP	36	2068	1.06	-0.44	1.50	2.55	1.70	0.62	0.27	0.30	1.55	1.79	0.84	0.82
SP	36	2218	-	-	-	26.99	24.82	25.57	26.03	25.98	26.12	26.98	27.07	27.57
SP	40	7201	135.09	138.71	142.47	146.32	150.35	156.39	156.98	150.62	-	-	-	-
SP	40	7210	32.87	38.04	43.36	48.75	54.33	60.01	65.52	70.74	75.24	80.64	86.25	91.38
SP	40	7211	25.56	27.41	29.07	30.76	32.65	34.46	36.05	37.73	38.76	40.47	42.46	44.17
SP	40	7218	-113.34	-113.83	-113.52	117.56	115.63	113.02	110.96	109.42	106.62	102.26	99.06	96.80
SU	40	3802	7.66	8.81	8.86	9.30	9.81	10.40	10.70	10.73	11.27	11.56	12.56	12.95
SU	40	3803	-39.64	-	-	-	-	-	-	-	-	-	-	-
SU	40	3804	-	-	-	-	-	-	-5.62	-2.27	-1.58	-1.21	-0.49	-0.08
SU	40	3805	83.50	84.49	84.73	85.15	85.71	86.37	86.55	86.58	87.11	87.43	88.41	88.76
SU	40	3810	61.76	61.83	61.61	61.81	61.89	62.06	62.04	62.10	62.42	62.50	62.95	63.20
SU	40	3822	38.23	39.97	41.07	43.06	44.58	46.77	48.19	49.46	51.56	53.25	54.97	56.53
SU	40	3825	38.07	40.14	39.41	39.42	40.21	40.72	42.38	42.44	44.98	46.49	47.47	48.37
SU	40	3827	67.05	67.20	66.40	66.34	67.34	67.29	68.76	69.02	69.06	-	-	-
SU	40	3831	35.06*	35.71*	35.96*	37.26*	37.91*	38.98*	39.46*	39.97*	40.10*	41.16	42.25	42.91

Table 8A. (Cont.)

Lab.	Clock	53764	53794	53824	53854	53884	53914	53944	53974	54004	54039	54069	54099
SU	40 3837	48.83	48.85	48.94	49.14	49.71	50.39	50.61	50.90	51.24	51.34	51.17	51.31
TCC	35 768	-1.83	-3.05	-5.46	-3.77	-	-4.70	-1.16	-4.69	-6.13	-0.71	-5.31	-3.72
TCC	35 1028	-7.19	-8.88	-8.04	-7.65	-	-8.40	-7.53	-7.22	-8.60	-8.21	-8.32	-9.26
TCC	35 1881	-3.28	-2.70	-2.50	-3.28	-	-3.48	-2.57	-4.42	-3.52	-3.35	-2.06	-3.18
TCC	40 8620	-4.61	-5.87	-5.47	-5.98	-	-6.95	-6.80	-8.13	-8.48	-2.16	-8.81	-9.78
TCC	40 8624	-8.98	-10.11	-9.88	-10.86	-	-11.47	-11.33	-12.50	-12.92	-12.57	-14.12	-14.05
TL	35 160	-5.81	-5.42	-5.41	-5.16	-4.59	-4.93	-4.75	-5.04	-5.50	-4.57	-4.46	-6.13
TL	35 300	6.56	6.91	7.04	6.59	5.28	6.06	7.01	7.43	7.61	6.45	6.96	7.12
TL	35 474	23.08	23.36	23.64	23.43	23.37	23.37	23.07	24.16	22.48	21.23	22.43	18.76
TL	35 809	3.88	4.01	3.67	4.28	4.50	5.03	4.54	4.32	3.99	1.41	2.37	3.12
TL	35 1012	7.48	2.70	6.35	6.99	6.77	5.94	5.88	5.42	5.74	7.43	5.96	6.78
TL	35 1132	-2.72	-1.82	-1.60	-1.31	-1.91	-1.45	-1.21	-1.55	-2.32	-2.05	-2.45	-3.04
TL	35 1498	15.22	16.61	15.69	15.33	15.69	15.91	16.21	16.27	15.93	14.71	16.03	15.23
TL	35 1500	9.84	10.10	10.40	10.34	10.48	10.23	10.49	10.61	11.63	12.12	11.93	12.81
TL	35 1712	1.43	1.52	1.15	1.90	1.94	1.61	1.89	1.42	1.35	1.07	2.30	1.70
TL	40 3052	40.69	41.86	43.24	44.17	45.38	46.72	47.82	48.99	50.05	51.19	52.41	53.65
TL	40 3053	3.01	3.54	3.71	4.05	4.55	5.04	4.80	5.24	5.49	6.05	6.25	6.27
TP	35 163	17.55	17.96	18.56	17.89	17.93	18.89	17.85	-	-	17.90	18.65	18.51
TP	35 326	8.50	6.07	6.96	6.38	5.60	0.99	-1.07	-5.02	-5.19	-4.59	-4.95	-4.90
TP	35 1227	-	7.43	9.31	10.09	10.93	10.81	7.87	7.88	7.61	7.36	8.07	7.77
TP	36 154	13.60	12.08	10.54	11.61	13.34	11.63	12.01	-	-	11.79	12.09	13.65
UME	35 251	-	-	-	-	-	-	-0.82	-0.65	2.72	-	-0.67	0.21
USNO	15 5564	-12.85	-11.89	-13.39	-12.31	-12.30	-11.07	-12.02	-10.86	-12.79	-12.47	-12.79	-
USNO	35 101	-5.84	-4.75	-4.62	-4.56	-5.97	-5.65	-5.20	-5.05	-5.65	-5.37	-5.09	-5.78
USNO	35 104	15.48	15.61	15.65	15.98	15.67	15.75	15.70	16.32	15.82	13.74	14.09	13.85
USNO	35 106	-	-	-	-	-	-	-	-	-	-	-	16.57
USNO	35 108	12.06	11.41	11.73	12.79	11.71	10.81	11.69	11.09	11.74	12.20	3.65	4.98
USNO	35 114	-	-	-	-	-	-	-	-	-	-	-	-6.63
USNO	35 120	1.89	1.45	1.86	1.57	1.38	1.24	0.87	1.26	2.00	0.76	1.25	1.36
USNO	35 142	6.77	6.37	6.79	6.40	6.63	6.76	6.32	6.40	6.33	5.69	6.03	6.64
USNO	35 146	1.19	2.44	0.88	2.40	2.48	1.96	1.68	2.12	2.14	2.61	2.27	2.14
USNO	35 148	11.02	11.40	12.90	11.34	12.61	12.36	12.13	11.12	11.92	10.88	10.69	10.38
USNO	35 150	7.91	8.91	8.60	7.63	8.68	9.24	9.01	8.83	-	-	-	-
USNO	35 152	6.14	5.91	5.06	6.16	7.45	7.33	6.58	7.24	6.67	8.10	6.43	8.17
USNO	35 153	9.34	8.90	9.26	9.41	9.82	10.16	9.30	9.17	8.93	9.08	9.55	9.59

Table 8A. (Cont.)

Lab.	Clock		53764	53794	53824	53854	53884	53914	53944	53974	54004	54039	54069	54099
USNO	35	156	10.67	10.33	10.47	10.62	10.25	10.70	10.52	11.06	10.73	10.41	10.52	10.23
USNO	35	161	-	7.14	7.41	7.06	7.35	6.29	6.79	6.73	6.70	6.28	6.06	6.33
USNO	35	164	9.44	9.71	10.00	8.64	5.50	1.09	0.76	4.35	5.54	-	-	-
USNO	35	165	14.67	15.64	14.82	14.57	14.41	13.94	14.39	14.13	13.58	13.84	13.57	14.16
USNO	35	166	1.52	1.14	1.19	1.78	1.42	1.33	1.21	1.33	1.53	1.50	1.18	1.06
USNO	35	167	4.26	4.23	4.57	4.27	3.24	3.92	4.03	3.92	3.69	3.74	3.26	3.39
USNO	35	169	-5.77	-5.66	-5.19	-5.04	-5.28	-5.40	-4.99	-5.50	-5.06	-5.33	-4.12	-6.23
USNO	35	173	-11.51	-10.97	-10.93	-11.73	-10.63	-10.45	-10.64	-10.09	-10.75	-10.83	-10.76	-10.48
USNO	35	213	1.39	1.60	1.63	1.04	1.82	2.34	2.33	2.22	3.37	3.55	2.99	3.25
USNO	35	217	-10.35	-9.16	-10.03	-10.01	-	-	-	-	-	-	-	-
USNO	35	225	-0.59	-0.21	-0.37	-	-	-	-	-	-	-	-	-
USNO	35	226	21.89	21.98	21.97	21.84	22.97	23.25	23.31	23.50	24.76	23.64	23.69	23.57
USNO	35	227	9.33	9.20	9.19	9.26	8.95	9.76	9.91	9.79	10.32	9.87	10.71	10.71
USNO	35	229	11.38	10.77	11.02	11.29	11.52	11.85	11.83	12.44	12.49	12.54	12.59	12.46
USNO	35	231	-5.96	-6.51	-5.91	-5.77	-5.25	-5.02	-4.82	-5.58	-5.14	-6.27	-5.43	-5.62
USNO	35	233	3.64	4.03	3.91	4.11	4.12	3.90	3.78	4.20	3.81	4.64	4.13	4.54
USNO	35	242	20.88	-	-	-	-	9.90	9.76	11.44	12.09	12.31	12.78	12.78
USNO	35	244	19.36	19.27	19.44	17.95	18.92	19.13	18.32	19.09	18.53	19.47	-	-
USNO	35	249	6.50	5.73	6.13	5.70	5.11	5.68	5.40	5.68	5.60	5.26	4.72	4.56
USNO	35	254	12.95	13.35	13.12	13.32	13.31	13.88	14.08	13.47	14.15	14.44	14.24	14.35
USNO	35	255	7.43	8.25	7.81	8.21	8.45	8.00	8.90	8.91	8.75	8.47	8.29	8.33
USNO	35	256	14.37	14.49	12.97	13.99	13.72	13.38	14.41	13.25	14.42	14.15	13.54	13.86
USNO	35	260	2.97	2.89	3.78	3.92	3.80	2.79	4.23	4.20	3.49	2.75	3.00	2.87
USNO	35	268	1.93	3.08	2.20	2.79	2.49	1.89	2.38	2.91	3.34	2.02	2.64	2.16
USNO	35	270	-10.80	-11.73	-11.56	-12.01	-10.89	-11.63	-11.89	-12.10	-11.66	-11.87	-12.30	-12.32
USNO	35	279	3.14	3.30	3.54	3.84	3.57	3.75	2.84	3.17	3.49	3.28	3.80	3.28
USNO	35	389	-17.78	-18.16	-17.76	-17.04	-16.87	-16.84	-17.06	-16.71	-17.20	-16.68	-16.41	-16.18
USNO	35	392	9.59	10.05	10.13	11.05	10.48	10.67	11.29	10.71	11.15	11.42	11.66	11.45
USNO	35	394	26.37	27.73	26.79	27.46	27.16	27.10	27.66	28.22	27.98	27.69	27.76	27.36
USNO	35	416	-25.69	-26.05	-25.53	-24.52	-24.28	-24.85	-24.92	-24.78	-25.25	-26.24	-25.66	-25.14
USNO	35	417	15.46	15.82	16.23	16.38	15.36	15.59	16.80	15.86	16.57	16.22	16.81	16.32
USNO	35	703	-	-	-	-	-	-	-	-1.36	-1.43	-1.37	-1.47	-0.94
USNO	35	717	-14.72	-15.48	-14.96	-14.43	-15.15	-14.68	-14.30	-14.36	-14.49	-13.65	-13.88	-13.73
USNO	35	762	-3.71	-3.65	-5.27	-6.39	-6.24	-6.09	-5.60	-5.98	-6.37	-6.43	-6.39	-5.97
USNO	35	763	-18.02	-17.88	-17.42	-19.72	-19.61	-19.39	-19.92	-19.63	-19.10	-19.35	-19.77	-19.54

Table 8A. (Cont.)

Lab.	Clock	53764	53794	53824	53854	53884	53914	53944	53974	54004	54039	54069	54099
USNO	35 765	-7.04	-6.22	-7.32	-6.62	-7.59	-7.10	-7.05	-7.52	-7.73	-7.98	-8.75	-7.52
USNO	35 1096	26.65	26.96	27.04	26.43	27.54	26.84	27.64	26.93	28.23	28.57	29.18	28.66
USNO	35 1097	-	-	-	-	-	-	-	-	-	-	-	14.41
USNO	35 1125	18.70	18.53	18.16	18.81	18.03	17.99	18.05	18.28	18.06	18.37	17.65	18.28
USNO	35 1327	-	-	-	-	-	-	-	-	-	-	-	-7.54
USNO	35 1328	6.09	6.35	4.97	-	-	2.81	2.42	3.02	3.30	2.73	1.69	1.39
USNO	35 1331	-41.19	-41.48	-40.47	-40.90	-40.52	-40.24	-40.43	-39.74	-40.15	-39.12	-39.12	-38.49
USNO	35 1438	1.20	0.82	1.43	1.88	0.69	1.33	0.90	1.49	1.64	1.76	1.89	2.15
USNO	35 1459	-4.92	-4.02	-4.98	-5.41	-4.58	-5.10	-5.27	-5.02	-4.67	-4.73	-4.81	-4.77
USNO	35 1462	8.75	8.60	9.23	10.48	9.08	9.04	9.33	8.72	9.30	9.61	9.75	9.28
USNO	35 1463	9.47	9.82	9.69	9.55	9.50	9.23	9.97	9.96	-	-	-	12.49
USNO	35 1468	2.01	2.85	2.88	2.44	2.39	2.74	3.00	2.88	2.95	3.74	3.77	3.17
USNO	35 1481	5.59	5.88	6.45	6.96	6.32	6.41	6.45	6.69	6.76	6.43	7.25	6.85
USNO	35 1543	10.95	11.50	10.92	10.79	11.32	10.69	10.67	10.79	10.69	11.09	10.75	9.85
USNO	35 1573	0.53	0.87	0.91	0.74	0.61	0.91	1.15	0.83	0.16	0.45	0.26	0.64
USNO	35 1575	-3.60	-3.02	-3.12	-2.70	-3.18	-3.15	-3.30	-3.65	-4.07	-3.38	-3.15	-3.55
USNO	35 1655	-11.19	-11.65	-10.98	-11.14	-10.38	-10.98	-10.91	-10.82	-11.55	-10.92	-11.08	-10.91
USNO	35 1692	1.44	2.25	2.83	2.51	2.34	2.17	2.10	2.25	2.25	2.04	2.74	3.10
USNO	35 1694	-2.30	-2.29	-1.99	-2.25	-2.63	-2.13	-1.99	-2.18	-2.97	-2.55	-2.84	-2.72
USNO	35 1696	5.17	5.14	4.89	5.14	6.62	4.90	5.77	5.47	6.08	5.25	5.58	5.49
USNO	35 1697	2.05	2.65	1.73	2.14	2.48	1.98	2.50	2.39	2.33	2.36	2.07	2.22
USNO	40 701	-23.38	-23.17	-23.16	-22.94	-22.68	-22.54	-22.37	-22.23	-22.14	-21.20	-21.38	-21.34
USNO	40 702	-9.79	-9.66	-10.01	-10.08	-10.03	-10.00	-10.02	-10.31	-10.21	-9.91	-10.39	-9.67
USNO	40 704	12.62	13.15	13.34	13.46	13.62	13.86	14.09	12.05	14.90	15.16	15.42	15.49
USNO	40 705	-47.76	-47.73	-47.84	-47.99	-48.25	-48.30	-48.05	-48.20	-48.21	-48.08	-48.49	-48.50
USNO	40 708	30.67	31.27	31.89	31.92	32.64	-	-	-	-	-	-	-
USNO	40 710	57.13	57.72	58.14	58.51	58.87	59.28	59.69	60.02	60.48	61.07	62.04	61.89
USNO	40 711	201.06	203.02	204.90	206.69	208.57	210.53	212.29	213.87	215.84	217.80	219.87	221.68
USNO	40 712	-	47.06	47.23	47.31	47.40	47.51	47.56	47.60	47.56	47.63	47.81	47.71
USNO	40 713	-0.97	-0.51	-0.10	0.23	0.59	0.96	1.25	1.58	1.88	2.26	2.61	3.05
USNO	40 714	-29.62	-29.36	-29.14	-28.90	-28.40	-27.78	-27.49	-27.10	-26.85	-27.33	-26.02	-25.80
USNO	40 715	-	-	-	-	-	-	-	65.94	67.25	67.86	68.40	68.59
USNO	40 716	206.82	207.04	207.13	207.24	207.41	207.51	207.56	207.68	207.67	207.83	207.96	208.06
USNO	40 718	120.37	120.30	120.37	120.39	120.52	120.71	120.90	121.04	121.19	121.43	121.73	121.86
USNO	40 719	-20.76	-19.39	-18.15	-16.93	-15.63	-14.29	-13.05	-11.72	-10.47	-9.05	-7.65	-6.30

Table 8A. (Cont.)

Lab.	Clock	53764	53794	53824	53854	53884	53914	53944	53974	54004	54039	54069	54099
USNO	40 720	-20.23	-18.41	-16.71	-14.77	-12.96	-11.17	-9.28	-7.66	-6.06	-4.09	-1.94	-0.15
USNO	40 721	430.07	436.95	443.71	450.86	459.40	464.74	-	-	-	-	-	-
USNO	40 722	120.04	126.21	131.95	137.41	142.76	148.29	153.81	159.28	164.52	170.20	175.82	181.04
USNO	40 723	-68.89	-68.91	-69.00	-69.17	-69.43	-69.48	-69.69	-69.80	-69.88	-69.92	-69.94	-70.00
USNO	40 724	-	-	-	-	-102.43	-102.37	-102.28	-102.06	-101.76	-101.53	-101.03	-100.83
USNO	40 725	-	-	-	-	-32.55	-33.19	-33.47	-33.67	-33.90	-34.01	-33.93	-34.17
USNO	40 726	50.18	55.51	60.83	66.49	72.21	77.99	83.55	89.33	95.00	101.22	107.59	112.85
USNO	40 728	-	-	-	-	-	-	-	14.64	18.19	22.30	26.67	30.87
USNO	40 730	-	-	-	-	-	-	-	-	-	-	-60.37	-58.13
VSL	35 179	5.38	-	4.96	5.78	6.15	7.92	8.52	6.17	6.18	9.55	6.47	8.90
VSL	35 456	21.18	-	21.94	22.41	22.12	21.28	21.98	22.33	22.02	21.00	20.95	21.96
VSL	35 548	12.00	-	13.17	12.71	13.09	13.36	12.79	10.75	11.76	11.56	11.72	12.52
VSL	35 731	21.59	-	21.78	21.50	21.61	21.42	21.12	21.77	21.56	21.71	21.03	21.10
ZMDM	36 2033	-	6.35	-	-	5.99	5.33	4.50	5.96	5.36	5.65	7.02	6.35

Table 8B. Corrections for an homogeneous use of the clock rates published in the current and previous Annual Reports

Each line refers to the same clock working without interruption.

	clock nø	2005 corr. (ns/d)	2004 corr. (ns/d)	2003 corr. (ns/d)		2002 corr. (ns/d)	
BEV	35 1065	-6.57	-1.13	-1.13	(1)		
BEV	35 1793	-1.12		-1.64	(2)		
CNM	35 1815	-0.60	+0.52	-1.64			
IT	40 1102	-34.55	-34.55	-34.55			
LT	35 1362	-13.13	-13.13	-13.13		-13.13	(3)
NPL	40 1701	-1.00	-4.00	-5.00		-8.00	(4)
NPL	40 1708	-9.85	-9.85	-9.85		-9.85	(5)
NPLI	35 0725	+7.60	+7.60				
ORB	40 2601					-1.73	(6)
PL	35 441					+2.16	
PL	35 1660	+0.52	+0.52	+0.52		+1.10	(7)
PL	35 1746					+4.40	
PTB	40 590	-9.50	-9.50				
ROA	35 583	+0.55	+4.38	+4.38		+2.74	
SU	40 3802			-17.30		-17.30	(8)
SU	40 3803		+5.62	+4.82		-1.68	(9)
SU	40 3810		+0.78	+0.78		-2.22	(10)
SU	40 3825			-66.30		-66.30	(11)
SU	40 3831	-0.86	+1.73	+1.13		+1.13	
TCC	35 0768		+10.00	+10.00			
TCC	40 8620		-23.80	-23.80		-23.80	
TCC	40 8624		+23.20				

(1) A correction of -1.13 ns/d has to be applied for the last 4 months of 2003.
(2) A correction of -1.64 ns/d has to be applied for the last 7 months of 2003.
(3) A correction of -9.85 ns/d has to be applied for the last 5 months of 2001.
(4) A correction of -9.00 ns/d has to be applied in 2001, -9.80 ns/d in 2000, -11.60 ns/d in 1999, -13.20 ns/d in 1998, -16.00 ns/d in 1997, -17.2 ns/d in 1996, -13.55 ns/d in 1995, 1994, 1993 and 1992, and +13.45 ns/d in 1991.
(5) A correction of -9.85 ns/d has to be applied in 2002, 2001, 2000, 1999 and the last 3 months of 1998.
(6) A correction of -6.03 ns/d has to be applied in 2002 and the last four months of 2001.
(7) A correction of +0.08 ns/d has to be applied in 2002 and the last four months of 2001.
(8) A correction of -43.30 ns/d has to be applied in 2002 and the last four months of 2001.
(9) A correction of -1.68 ns/d has to be applied for the last month of 2002.
(10) A correction of -0.22 ns/d has to be applied in 2002 and the last four months of 2001.
(11) A correction of -66.30 ns/d has to be applied for the last six months of 2002.

Table 9A. Relative weights (in percent) of contributing clocks in 2006

(File available on http://www.bipm.org under the name WTAI06.AR)

Clock weights are computed for one-month intervals ending at the MJD dates given in the table.
"-" denotes that the clock was not used

The clocks are designated by their type (2 digits) and serial number in the type. The codes for the types are:

12 HEWLETT-PACKARD 5061A
13 EBAUCHES, OSCILLATOM B5000
14 HEWLETT-PACKARD 5061A OPT. 4
16 OSCILLOQUARTZ 3200
17 OSCILLOQUARTZ 3000
15 DATUM/SYMMETRICOM Cs III
4x HYDROGEN MASERS
9x PRIMARY CLOCKS AND PROTOTYPES
21 OSCILLOQUARTZ 3210
23 OSCILLOQUARTZ EUDICS 3020
30 HEWLETT-PACKARD 5061B
31 HEWLETT-PACKARD 5061B OPT. 4
34 H-P 5061A/B with 5071A tube
35 H-P/AGILENT 5071A High perf.
36 H-P/AGILENT 5071A Low perf.
50 FREQ. AND TIME SYSTEMS INC. 4065A
51 DATUM/SYMMETRICOM 4065 B
52 DATUM/SYMMETRICOM 4065 C
53/Symmetricom 4310

Lab.	Clock	53764	53794	53824	53854	53884	53914	53944	53974	54004	54039	54069	54099
APL	35 904	0.000	0.000	0.000	0.000	0.314	0.435	0.252	0.244	0.262	0.338	0.395	0.302
APL	35 1264	0.000	0.000	0.000	0.000	0.874	0.803	0.476	0.533	0.684	0.646	0.709	0.792
APL	35 1791	0.000	0.000	0.000	0.000	0.574	0.687	0.865	0.893	0.906	0.883	0.887	0.874
APL	40 3107	0.000	0.000	0.000	0.000	0.016	0.014	0.013	0.012	0.012	0.012	0.012	0.012
APL	40 3108	0.000	0.000	0.000	0.000	0.001	0.001	0.000	0.000	0.000	0.000	0.000	0.000
APL	40 3109	0.000	0.000	0.000	0.000	0.476	0.281	0.196	0.171	0.153	0.157	0.171	0.170
AUS	36 249	0.000	0.000	-	-	0.000	0.000	0.000	-	-	0.000	0.000	0.000
AUS	36 340	0.251	0.255	0.211	0.162	0.000	0.059	0.050	0.052	0.045	0.050	0.079	0.087
AUS	36 654	0.169	0.168	0.166	0.166	0.176	0.121	0.118	0.128	0.106	0.104	0.129	0.135
AUS	36 1035	0.002	0.002	-	-	-	-	-	-	-	-	-	-

Table 9A. (Cont.)

Lab.	Clock		53764	53794	53824	53854	53884	53914	53944	53974	54004	54039	54069	54099
AUS	36	1141	-	-	-	0.000	0.000	0.000	0.000	0.462	0.690	0.883	0.887	0.534
AUS	40	5401	-	0.000	0.000	0.000	0.000	0.014	0.020	-	0.000	0.000	0.000	0.000
AUS	40	5402	0.006	0.008	0.006	0.007	0.008	0.000	0.003	0.003	0.003	0.004	-	-
AUS	40	5403	0.000	0.000	-	-	0.000	0.000	0.000	0.000	-	0.000	0.000	0.000
AUS	99	1	0.000	0.000	-	-	-	-	-	-	-	-	-	-
BEV	35	1065	0.120	0.091	0.086	0.082	0.085	0.105	0.102	0.120	0.132	0.166	0.207	0.223
BEV	35	1793	0.095	0.105	0.140	0.191	0.332	0.757	0.766	0.893	0.906	0.883	0.887	0.874
CAO	35	939	0.123	0.108	0.102	0.100	0.172	0.140	-	-	0.000	-	-	0.000
CAO	35	1270	0.377	0.383	0.360	0.463	0.441	0.327	-	-	0.000	-	-	-
CH	35	771	0.936	0.954	0.926	0.906	0.874	0.816	0.494	0.480	0.346	0.345	0.378	0.328
CH	35	2117	0.243	0.147	0.138	0.160	0.168	0.213	0.177	0.181	0.173	0.182	0.228	0.217
CH	36	354	0.134	0.140	0.137	0.140	0.147	0.138	0.166	0.142	0.123	0.142	0.130	0.128
CH	36	413	0.085	0.095	0.095	0.123	0.074	0.066	0.067	0.061	0.064	0.087	0.102	0.092
CH	40	5701	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.006	0.006	0.006	0.006	0.005
CNM	35	1705	0.596	0.729	0.641	0.743	0.708	0.862	0.865	0.893	0.906	0.820	0.887	0.874
CNM	35	1815	0.383	0.357	0.472	0.906	0.676	0.000	0.178	0.161	0.125	0.112	0.123	0.131
CNM	36	1537	0.147	0.186	0.176	0.170	0.163	0.153	0.202	0.135	0.185	0.138	0.109	0.102
CNM	40	7301	0.001	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.003	0.004	0.004	0.004
CNMP	36	1752	0.198	0.189	0.190	0.203	0.184	0.218	0.234	0.207	0.221	0.254	0.000	0.000
DLR	35	1714	-	-	-	-	-	-	-	-	-	-	-	-
DTAG	36	136	0.010	0.009	0.008	0.007	0.006	0.006	0.006	0.005	0.005	0.004	-	-
DTAG	36	345	0.182	0.180	0.244	0.184	0.179	0.156	0.150	0.144	0.177	0.126	-	-
DTAG	36	465	0.079	0.110	0.153	0.160	0.167	0.175	0.179	0.128	0.000	0.036	-	-
F	35	122	0.000	0.000	0.000	0.416	0.486	0.499	0.545	0.616	0.563	0.598	0.700	0.732
F	35	124	0.000	0.000	0.326	0.479	0.444	0.568	0.530	0.641	0.812	0.883	0.887	0.874
F	35	131	0.049	0.051	0.065	0.097	0.821	0.837	0.865	0.893	0.000	0.718	0.827	0.874
F	35	158	0.000	0.000	0.000	0.517	0.254	0.155	0.112	0.109	0.086	0.088	0.087	0.069
F	35	172	0.657	0.675	0.469	0.539	-	-	-	-	-	-	-	-
F	35	198	0.361	0.281	0.249	0.280	0.258	0.256	0.294	0.291	-	-	0.000	0.000
F	35	385	0.739	0.699	0.635	0.758	0.707	0.673	0.616	0.650	0.616	0.550	0.609	0.666
F	35	396	0.209	0.306	0.284	0.349	0.342	0.319	0.319	0.464	0.267	0.287	0.292	0.296
F	35	520	0.100	0.115	0.103	0.096	0.099	0.095	0.095	0.113	0.118	0.131	0.127	0.124
F	35	536	0.936	0.823	0.856	0.906	0.744	0.454	0.505	0.687	0.663	0.707	0.833	0.785
F	35	609	0.000	0.000	0.000	0.000	0.018	0.025	0.028	0.033	0.040	0.052	0.064	0.069
F	35	770	0.074	0.098	0.144	0.448	0.317	0.302	0.283	-	-	-	-	-

Table 9A. (Cont.)

Lab.	Clock	53764	53794	53824	53854	53884	53914	53944	53974	54004	54039	54069	54099
F	35 774	0.895	0.954	0.926	0.906	-	-	-	-	-	0.000	0.000	0.000
F	35 781	0.240	0.223	0.190	0.184	0.000	0.078	0.085	0.087	-	-	0.000	0.000
F	35 819	-	-	0.000	0.000	0.000	0.000	0.198	-	-	-	-	0.000
F	35 859	0.000	0.000	0.000	0.000	0.143	0.206	0.259	0.344	0.302	0.288	-	-
F	35 1029	0.825	0.750	0.481	0.503	0.320	0.217	0.211	0.225	0.217	0.216	0.255	0.263
F	35 1178	0.000	0.000	0.000	0.000	0.526	0.496	0.544	0.249	0.197	0.205	-	-
F	35 1222	-	-	-	-	-	-	0.000	0.000	-	-	0.000	0.000
F	35 1258	-	-	-	-	0.000	0.000	0.000	0.000	-	-	0.000	0.000
F	35 1321	0.325	-	-	-	-	-	-	0.000	0.000	0.000	-	-
F	35 1556	0.061	0.054	0.050	0.046	0.059	0.055	0.047	0.046	0.043	0.048	0.070	0.091
F	35 2027	0.936	0.836	0.533	0.000	0.241	0.240	0.202	0.181	0.164	0.122	0.114	0.111
F	40 805	0.002	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.002	0.003	0.008	0.019
F	40 816	0.046	0.047	0.060	0.072	0.000	0.020	0.016	0.014	0.011	0.009	0.009	0.008
F	40 889	0.000	-	-	-	0.000	0.000	0.000	0.000	0.002	0.002	0.001	0.001
F	40 890	0.017	0.017	0.016	0.016	0.015	0.014	0.013	0.013	0.014	0.011	0.000	0.005
HKO	35 1893	0.049	0.155	-	-	-	0.000	0.000	0.000	0.000	0.100	0.156	-
IFAG	36 1167	0.062	0.060	0.051	0.047	0.047	0.044	0.050	0.040	0.036	0.035	0.042	0.039
IFAG	36 1173	0.030	0.032	0.031	0.030	0.023	0.022	0.030	0.047	0.095	0.114	0.087	0.061
IFAG	36 1629	0.108	0.142	0.172	0.171	0.158	0.148	0.148	0.162	0.189	0.213	0.225	0.222
IFAG	36 1732	0.000	0.926	0.656	0.000	0.173	0.102	0.118	-	-	-	-	-
IFAG	36 1798	0.936	0.954	0.926	0.906	0.874	0.792	0.646	0.661	0.550	0.500	0.529	0.479
IFAG	40 4401	0.000	0.000	0.000	0.000	0.000	0.000	-	-	-	-	-	-
IFAG	40 4413	-	-	-	-	0.000	0.000	-	-	-	-	-	-
IFAG	40 4418	0.025	0.019	0.015	0.012	0.011	0.011	0.012	0.014	0.016	0.021	0.027	0.024
IGMA	16 112	-	-	-	-	-	-	-	-	-	0.000	0.000	0.000
IGMA	35 674	-	-	-	-	-	-	-	-	-	0.000	0.000	0.000
IGMA	35 676	-	-	-	-	-	-	-	-	-	0.000	0.000	0.000
INPL	35 1652	0.008	-	-	-	-	-	-	-	-	-	-	-
INPL	35 1653	-	-	0.000	0.000	0.000	0.000	0.287	0.173	0.177	0.160	0.216	0.260
IT	35 219	0.052	0.081	0.154	0.248	0.346	0.476	0.000	0.431	0.417	0.434	0.416	0.433
IT	35 505	0.120	0.162	0.712	0.616	0.507	0.504	0.331	0.283	0.270	0.280	0.320	0.370
IT	35 1115	0.003	0.003	0.003	0.003	0.030	0.056	0.046	0.043	0.051	0.055	0.056	0.056
IT	35 1373	-	-	0.000	0.000	0.000	0.000	0.093	0.130	0.138	0.173	0.231	0.206
IT	35 2118	0.192	0.199	0.157	0.161	0.164	0.170	0.179	0.283	0.516	0.812	0.887	0.874
IT	40 1101	-	-	-	-	-	0.000	0.000	0.000	0.000	-	-	-

Table 9A. (Cont.)

Lab.	Clock		53764	53794	53824	53854	53884	53914	53944	53974	54004	54039	54069	54099
IT	40	1102	0.009	0.009	0.011	0.012	0.012	0.013	0.013	0.013	0.013	0.013	0.012	0.010
JV	21	216	0.018	0.022	0.000	0.017	0.014	0.012	0.011	0.010	0.010	0.015	0.026	0.034
JV	21	387	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
JV	36	1277	0.226	0.353	0.213	0.209	0.200	0.192	0.194	0.171	0.203	0.211	0.165	0.152
JV	51	2040	0.000	0.000	0.000	0.008	0.000	0.000	0.000	0.000	0.000	-	-	-
KRIS	35	321	0.000	0.000	0.109	0.154	0.155	0.093	0.060	0.065	0.082	0.102	0.080	0.065
KRIS	35	1693	0.837	0.782	0.768	0.824	0.840	0.000	0.378	0.242	0.214	0.192	0.237	-
KRIS	35	1783	0.100	0.091	0.104	0.083	0.094	0.088	0.151	0.209	0.290	0.425	0.360	0.000
KRIS	36	739	0.100	0.111	0.108	0.094	0.122	0.127	0.147	0.188	-	-	-	-
KRIS	36	1135	0.069	0.079	0.082	0.057	0.060	0.059	0.076	0.085	0.125	0.128	0.142	0.137
KRIS	40	5623	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.001	0.001
KRIS	40	5624	0.000	0.000	0.001	0.001	0.001	-	-	0.000	-	-	-	-
KRIS	40	5625	0.000	0.000	0.003	0.003	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002
LDS	35	289	0.174	0.191	0.204	0.201	0.298	0.295	0.295	0.000	0.000	0.000	0.000	0.000
LT	35	1362	0.003	0.002	0.002	0.002	0.002	0.002	0.002	0.003	0.006	0.032	0.132	0.134
LT	35	1868	-	-	-	-	-	-	-	-	-	-	-	0.000
MIKE	35	1171	0.000	0.000	0.000	0.000	0.002	0.003	0.004	0.005	0.007	0.008	0.011	0.012
MIKE	36	986	0.000	0.000	0.000	0.000	0.002	0.003	0.004	0.006	0.008	0.010	0.013	0.014
MIKE	40	4113	0.000	-	-	-	-	0.000	0.000	0.000	0.000	0.009	0.009	0.008
MIKE	40	4180	0.000	0.000	0.000	0.000	0.874	0.862	0.865	0.893	0.906	0.883	0.887	0.874
MSL	12	933	0.007	0.006	0.006	0.006	0.006	0.005	0.004	0.004	0.003	0.002	0.002	-
MSL	36	274	0.000	0.088	0.081	0.103	0.100	0.084	0.083	0.161	0.160	0.149	0.161	-
MSL	36	1025	0.038	0.040	0.037	0.033	0.027	0.056	0.113	0.000	0.000	0.013	0.013	-
NAO	35	779	0.527	0.593	0.763	0.906	0.874	0.794	0.790	0.774	-	0.000	-	0.000
NAO	35	1206	0.936	0.954	0.926	0.906	0.799	0.754	0.560	0.685	-	0.000	0.000	0.000
NAO	35	1214	0.936	0.954	0.926	0.906	0.874	0.862	0.865	0.893	-	0.000	0.000	0.000
NAO	35	1689	-	0.000	0.000	0.000	0.000	0.862	0.865	0.893	-	0.000	0.000	0.000
NICT	35	112	0.936	0.954	0.926	0.627	0.742	0.862	0.000	0.379	0.329	0.339	0.364	0.378
NICT	35	144	0.073	0.083	0.238	0.466	0.000	0.060	0.052	0.056	0.066	0.075	0.087	0.095
NICT	35	332	0.178	0.159	0.162	-	-	-	-	-	-	-	-	-
NICT	35	342	0.936	-	0.000	0.000	0.000	-	-	-	-	-	-	-
NICT	35	343	0.222	0.219	0.251	0.287	0.289	0.294	0.000	0.336	0.392	0.430	0.441	0.464
NICT	35	715	0.034	-	0.000	0.000	0.000	0.000	0.158	0.233	0.327	0.422	0.553	0.667
NICT	35	732	0.235	0.263	0.467	0.654	0.565	0.542	0.375	0.411	0.417	0.437	0.476	0.610
NICT	35	907	0.936	0.567	0.000	0.061	0.052	0.047	0.048	0.047	0.042	0.042	0.041	0.039

Table 9A. (Cont.)

Lab.	Clock		53764	53794	53824	53854	53884	53914	53944	53974	54004	54039	54069	54099
NICT	35	908	0.222	0.215	0.171	0.115	0.095	0.061	0.039	0.032	0.031	0.029	0.033	0.038
NICT	35	1778	0.517	0.925	0.893	0.865	0.874	0.862	0.865	0.893	0.906	0.883	0.887	0.874
NICT	35	1789	0.793	0.754	0.530	0.393	0.336	0.302	0.317	0.366	0.407	0.447	0.392	0.307
NICT	35	1790	0.936	0.954	0.926	0.906	0.874	0.862	0.865	0.893	0.906	0.883	0.887	0.874
NICT	35	1882	0.103	0.092	0.080	0.076	0.059	0.052	0.000	0.000	0.016	0.015	0.015	0.016
NICT	35	1887	0.936	0.954	0.926	0.906	0.874	0.862	0.865	0.630	0.554	0.527	0.618	0.000
NICT	35	1944	0.373	0.303	0.246	0.176	0.178	0.180	0.164	0.169	0.173	0.188	0.182	0.175
NICT	35	2056	0.936	0.954	0.926	0.906	0.874	0.862	0.865	0.893	0.906	0.733	0.764	0.594
NICT	35	2113	0.239	0.283	0.311	0.495	0.337	0.307	0.302	0.350	0.434	0.443	0.638	0.650
NICT	35	2116	0.045	0.052	0.060	0.178	0.566	0.000	0.378	0.317	0.237	0.192	0.207	0.208
NICT	40	2002	-	-	-	-	-	-	-	-	-	0.000	0.000	0.000
NICT	40	2003	-	-	-	-	-	-	0.000	0.000	0.000	0.000	0.010	0.008
NIM	35	479	0.156	0.191	0.219	0.204	0.115	0.091	0.065	0.061	0.064	0.067	0.077	0.104
NIM	35	1239	0.090	0.089	0.082	0.075	0.072	0.065	0.071	0.065	0.061	0.062	0.096	0.067
NIM	40	4814	0.000	0.005	0.006	-	0.000	0.000	0.000	0.000	0.016	0.025	0.015	0.000
NIM	40	4832	0.000	0.954	0.926	0.906	0.874	0.862	0.865	0.893	0.906	0.883	0.887	0.874
NIM	40	4835	-	-	-	-	0.000	0.000	0.000	0.000	0.137	0.117	0.091	0.080
NIMB	35	600	0.117	0.133	0.155	0.173	0.185	0.375	0.393	0.267	0.283	0.306	0.000	0.002
NIS	35	1126	0.043	0.062	-	-	-	0.000	0.000	-	-	0.000	0.000	0.000
NIST	15	9866	0.002	0.001	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
NIST	35	132	0.396	0.367	0.414	0.426	0.288	0.287	0.313	0.264	0.509	0.500	0.444	0.434
NIST	35	182	0.936	0.954	0.926	0.906	0.874	0.862	0.534	0.536	0.449	0.557	0.535	0.577
NIST	35	282	0.008	0.009	0.011	0.013	0.014	0.016	0.019	0.023	0.031	0.063	0.408	0.426
NIST	35	408	0.936	0.954	0.683	0.906	0.874	0.862	0.849	0.665	0.718	0.541	0.587	0.558
NIST	35	1074	0.600	0.709	0.677	0.580	0.497	0.476	0.538	0.689	0.746	0.874	0.887	0.874
NIST	35	2031	0.105	0.152	0.159	0.194	0.230	0.244	0.292	0.315	0.311	0.365	0.000	0.373
NIST	35	2032	0.073	0.090	0.108	0.082	0.061	0.065	0.064	0.071	0.091	0.095	0.123	0.000
NIST	35	2034	0.315	0.459	0.504	0.637	0.782	0.862	0.865	0.893	0.906	0.883	0.000	0.647
NIST	40	201	0.004	0.003	0.003	0.014	0.013	0.013	0.014	0.014	0.015	-	-	-
NIST	40	203	0.007	0.007	0.007	0.007	0.007	0.006	0.006	0.007	0.007	0.008	0.009	0.009
NIST	40	204	0.364	0.315	0.274	0.259	0.235	0.221	0.237	0.282	0.427	0.524	0.624	0.566
NIST	40	205	0.936	0.954	0.926	0.906	0.874	0.862	0.865	0.893	0.906	0.883	0.887	0.874
NIST	40	206	-	-	-	-	-	0.000	0.000	0.000	0.000	0.035	0.047	0.051
NIST	40	222	0.040	0.035	0.032	0.029	0.026	0.023	0.022	0.021	0.022	0.022	0.022	0.020
NMC	35	1501	0.000	0.000	0.000	0.051	0.038	0.043	-	-	0.000	0.000	0.000	0.000

Table 9A. (Cont.)

Lab.	Clock	53764	53794	53824	53854	53884	53914	53944	53974	54004	54039	54069	54099
NMIJ	35 224	0.000	0.000	0.000	0.000	-	-	0.000	0.000	0.000	0.000	0.059	0.029
NMIJ	35 459	0.000	0.000	0.000	0.000	0.031	-	-	-	-	-	-	-
NMIJ	35 523	0.000	0.000	0.000	0.000	0.874	0.862	0.000	0.144	0.184	0.230	0.292	0.332
NMIJ	35 1466	0.000	-	-	-	-	-	-	0.000	0.000	0.000	0.000	0.124
NMIJ	40 5002	-	-	-	-	-	0.000	0.000	0.000	0.000	0.037	0.054	0.062
NMIJ	40 5003	-	-	-	-	-	-	-	0.000	0.000	0.000	0.000	0.132
NMIJ	40 5014	0.000	0.000	0.000	0.000	0.874	0.862	0.865	0.000	0.310	0.243	0.233	0.233
NMLS	35 1659	0.205	0.197	0.232	0.271	0.537	0.760	0.485	0.000	0.252	0.225	0.241	0.187
NPL	35 1275	-	-	-	-	-	-	-	-	-	-	-	0.000
NPL	36 784	0.037	0.181	0.167	0.164	0.167	0.177	0.487	0.279	0.432	0.439	0.000	0.000
NPL	40 1701	0.572	0.357	0.264	0.264	0.267	0.262	0.287	0.321	0.413	0.537	0.000	0.156
NPL	40 1708	0.936	0.954	0.884	0.000	0.328	0.220	0.160	0.150	0.171	0.176	0.172	0.207
NPLI	35 725	0.005	0.007	0.026	0.056	0.051	0.043	0.043	0.044	0.044	0.000	0.033	0.031
NRC	35 234	0.000	0.000	0.013	0.011	0.010	0.009	0.010	0.012	0.014	0.020	0.041	0.000
NRC	35 372	0.000	0.000	0.000	0.000	0.361	0.230	0.138	0.187	0.204	0.257	0.327	0.289
NTSC	35 1007	0.604	0.541	0.505	0.362	0.321	0.000	0.095	-	-	-	-	0.000
NTSC	35 1008	0.208	0.200	0.218	0.221	0.000	0.000	0.033	-	-	0.000	0.000	0.000
NTSC	35 1011	0.382	0.388	0.483	0.549	0.411	0.386	0.441	0.467	0.488	0.532	-	-
NTSC	35 1016	0.452	0.476	0.443	0.424	0.400	0.435	0.703	0.637	0.568	0.555	0.484	0.377
NTSC	35 1017	0.589	0.595	0.590	0.711	0.622	0.495	0.607	0.633	0.570	0.472	0.000	0.098
NTSC	35 1018	0.936	0.954	0.926	0.821	0.486	0.447	0.577	-	-	-	-	-
NTSC	35 1818	0.055	0.048	0.000	0.012	0.012	0.011	-	-	0.000	0.000	0.000	0.000
NTSC	35 1820	0.398	0.396	0.420	0.396	0.349	0.422	0.412	0.443	0.345	0.368	0.279	0.275
NTSC	35 1823	0.021	0.022	0.019	0.016	0.000	0.003	0.002	-	-	-	-	-
NTSC	35 2096	-	-	-	-	-	-	-	0.000	0.000	0.000	0.000	0.401
NTSC	35 2098	0.000	0.000	0.000	0.588	0.843	0.862	0.865	0.893	0.906	0.883	0.887	0.874
NTSC	35 2131	0.000	0.000	0.000	0.432	0.461	0.423	0.376	0.410	0.416	0.511	0.425	0.558
NTSC	35 2141	0.000	0.000	0.000	0.065	0.078	0.060	0.056	0.060	0.055	0.059	0.070	0.000
NTSC	35 2142	0.000	0.000	0.000	0.906	0.874	0.862	0.865	0.893	0.906	0.883	0.887	0.874
NTSC	35 2143	-	-	-	-	-	-	-	0.000	0.000	0.000	0.000	0.200
NTSC	35 2144	0.000	0.000	0.000	0.906	0.874	0.862	0.865	0.661	0.539	0.637	0.000	0.332
NTSC	35 2145	-	-	-	-	-	-	-	0.000	0.000	0.000	0.000	0.385
NTSC	35 2146	-	-	-	-	-	-	-	0.000	0.000	0.000	0.000	0.113
NTSC	35 2147	-	-	-	-	-	-	-	0.000	0.000	0.000	0.000	0.370
NTSC	40 4926	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.000

Table 9A. (Cont.)

Lab.		Clock	53764	53794	53824	53854	53884	53914	53944	53974	54004	54039	54069	54099
NTSC	40	4927	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.001	0.001	0.001	0.002	0.001
NTSC	40	4945	0.001	0.001	0.001	-	-	-	-	0.000	0.000	0.000	0.000	0.005
NTSC	40	4946	0.003	0.000	0.001	0.001	0.001	0.002	0.002	0.002	0.002	0.002	0.002	-
OMH	36	849	0.165	0.181	0.131	0.110	0.124	0.091	0.096	0.082	0.077	0.085	0.075	0.075
ONBA	12	1091	0.001	-	-	-	-	-	-	-	-	-	-	-
ONBA	12	1371	-	-	-	0.000	0.000	0.000	0.000	-	-	-	0.000	0.000
ONRJ	35	103	-	-	-	-	-	-	0.000	0.000	0.000	0.000	0.000	0.010
ONRJ	35	123	-	-	-	-	-	-	0.000	0.000	0.000	0.000	0.000	0.007
ONRJ	35	129	-	-	-	-	-	-	0.000	0.000	0.000	0.000	0.000	0.015
ONRJ	35	1942	0.644	0.727	0.926	0.906	0.810	0.814	0.486	0.521	0.508	0.480	0.000	0.029
ORB	35	201	0.054	0.065	0.074	0.085	0.082	0.071	0.065	0.074	0.082	0.109	0.158	0.155
ORB	35	202	0.098	0.066	0.066	0.085	0.085	0.054	0.047	0.047	0.057	0.050	0.052	0.053
ORB	35	593	0.062	0.076	0.076	0.072	0.073	0.072	0.098	0.100	0.099	0.084	0.087	0.081
ORB	40	2601	0.220	0.227	0.224	0.240	0.465	0.498	0.477	0.509	0.828	0.883	0.837	0.575
PL	25	124	0.000	0.000	0.000	0.000	0.002	0.001	0.001	-	-	-	-	-
PL	35	441	0.726	0.692	0.432	0.402	0.364	0.350	0.352	0.437	0.486	0.508	0.541	0.667
PL	35	502	0.936	0.844	0.878	0.861	0.510	0.375	0.265	0.271	0.291	0.247	0.417	0.544
PL	35	745	0.936	0.509	0.222	0.209	0.173	0.178	0.203	0.164	0.190	0.203	0.281	0.334
PL	35	1120	0.936	0.954	0.926	0.906	0.874	0.862	0.865	0.893	0.906	0.883	0.887	0.000
PL	35	1660	0.337	0.189	0.150	0.142	0.141	0.122	0.139	0.145	0.167	0.213	0.212	0.211
PL	35	1709	0.936	0.954	0.926	0.906	0.874	0.862	0.865	0.831	0.857	0.883	0.887	0.874
PL	35	1746	0.710	0.954	0.926	0.906	0.874	0.862	0.865	0.893	0.906	0.883	0.887	0.874
PL	35	1934	0.936	0.954	0.926	0.906	0.874	0.862	0.865	0.893	0.906	0.883	0.887	0.874
PL	36	1395	-	0.000	0.000	0.000	0.000	0.031	0.047	0.042	0.047	0.057	0.070	0.080
PL	40	4002	0.000	0.000	0.003	0.004	0.004	0.003	-	-	0.000	0.000	0.000	0.000
PL	40	4004	0.000	0.000	0.000	0.000	0.003	0.004	0.005	0.007	0.006	0.005	0.004	0.003
PTB	35	128	0.936	0.952	0.926	0.906	0.874	0.862	0.865	-	-	-	-	-
PTB	35	415	0.274	0.388	0.343	0.305	0.293	0.315	0.443	0.662	0.781	0.823	0.685	0.714
PTB	35	1072	0.000	0.000	0.078	0.063	0.052	0.047	0.047	0.051	0.059	0.079	0.145	0.477
PTB	40	510	-	-	-	-	-	-	-	-	-	-	-	0.000
PTB	40	590	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.002	0.010	0.009	0.009
PTB	92	1	0.936	0.945	0.926	0.808	0.828	0.675	0.609	0.742	0.812	0.776	0.887	0.874
PTB	92	2	0.936	0.954	0.926	0.906	0.874	0.862	0.865	0.893	0.906	0.883	0.887	0.874
PTB	92	3	0.000	0.746	0.926	0.836	0.704	0.399	0.421	0.426	0.393	0.000	0.138	0.102
ROA	31	422	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Table 9A. (Cont.)

Lab.	Clock	53764	53794	53824	53854	53884	53914	53944	53974	54004	54039	54069	54099
ROA	35 583	0.329	0.315	0.327	0.287	0.270	0.260	0.515	0.579	0.391	0.272	0.171	0.144
ROA	35 718	0.181	0.128	0.088	0.069	0.069	0.067	0.075	0.101	0.224	0.283	0.305	0.594
ROA	36 1488	0.183	0.150	0.125	0.117	0.123	0.127	0.127	0.132	0.124	0.130	0.128	0.126
ROA	36 1490	0.340	0.188	0.165	0.165	0.123	0.113	0.139	0.148	0.182	0.191	0.207	0.228
ROA	40 1436	0.000	-	-	0.000	0.000	0.000	0.000	0.001	0.001	0.001	0.001	0.001
SCL	35 621	0.677	0.706	0.897	0.906	0.857	0.851	0.854	0.553	0.765	0.681	0.607	0.539
SCL	35 1745	0.431	0.543	0.669	0.762	0.848	0.862	0.833	0.735	0.891	0.777	0.819	0.874
SG	35 1035	0.000	0.000	0.596	0.866	0.558	0.714	-	-	-	0.000	0.000	0.000
SG	35 1127	0.000	0.000	0.344	0.470	0.564	0.434	-	-	-	0.000	0.000	0.000
SG	35 1889	-	-	-	-	-	-	-	-	-	0.000	0.000	0.000
SG	36 522	0.000	0.000	0.293	0.093	0.048	0.030	-	-	-	0.000	0.000	0.000
SMU	36 1193	-	0.000	0.000	0.000	0.000	0.075	0.097	0.138	0.141	0.170	0.122	0.130
SP	19 197	0.003	0.003	0.004	0.004	0.003	0.005	0.000	0.000	0.001	0.001	0.001	0.001
SP	35 572	-	-	0.000	0.000	0.000	0.000	0.037	0.047	0.069	0.094	0.115	0.126
SP	35 641	0.874	0.655	0.700	0.775	0.874	0.862	0.865	0.893	0.892	0.883	0.887	0.874
SP	35 1188	0.237	0.238	0.232	0.235	0.226	0.234	0.317	0.305	0.321	0.384	0.874	0.874
SP	35 1531	0.134	0.155	0.184	0.205	0.196	0.347	0.505	0.528	0.542	0.578	0.590	0.874
SP	35 1642	0.768	0.954	0.000	0.379	0.357	0.351	0.229	0.238	0.308	0.327	0.410	0.574
SP	35 2166	0.259	0.316	0.389	0.391	0.458	0.527	0.865	0.893	0.906	0.883	0.887	0.874
SP	36 1175	0.409	0.379	0.367	0.328	0.327	0.312	0.332	0.303	0.410	0.424	0.371	0.362
SP	36 2068	0.936	0.000	0.446	0.323	0.322	0.283	0.256	0.240	0.245	0.248	0.259	0.247
SP	36 2218	-	-	-	0.000	0.000	0.000	0.000	0.094	0.144	0.160	0.185	0.170
SP	40 7201	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	-	-	-	-
SP	40 7210	0.001	0.001	0.001	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
SP	40 7211	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.004	0.004	0.004	0.005	0.005
SP	40 7218	0.001	0.001	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
SU	40 3802	0.056	0.047	0.044	0.042	0.039	0.037	0.039	0.044	0.052	0.064	0.074	0.074
SU	40 3803	0.295	-	-	-	-	-	-	-	-	-	-	-
SU	40 3804	-	-	-	-	-	-	0.000	0.000	0.000	0.000	0.018	0.021
SU	40 3805	0.055	0.048	0.044	0.042	0.039	0.037	0.038	0.044	0.051	0.062	0.072	0.074
SU	40 3810	0.936	0.954	0.926	0.906	0.874	0.862	0.865	0.893	0.906	0.883	0.887	0.874
SU	40 3822	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.005	0.005	0.005	0.005
SU	40 3825	0.011	0.008	0.007	0.007	0.007	0.008	0.009	0.012	0.014	0.015	0.016	0.014
SU	40 3827	0.744	0.954	0.657	0.542	0.634	0.744	0.000	0.245	0.193	-	-	-
SU	40 3831	0.067	0.068	0.065	0.054	0.043	0.032	0.029	0.027	0.028	0.028	0.030	0.027

Table 9A. (Cont.)

Lab.	Clock	53764	53794	53824	53854	53884	53914	53944	53974	54004	54039	54069	54099
SU	40 3837	0.160	0.184	0.244	0.313	0.334	0.266	0.241	0.209	0.193	0.175	0.185	0.184
TCC	35 768	0.048	0.048	0.037	0.051	-	0.000	0.000	0.000	0.000	0.012	0.016	0.022
TCC	35 1028	0.000	0.000	0.132	0.184	-	0.000	0.000	0.000	0.000	0.189	0.277	0.196
TCC	35 1881	0.345	0.370	0.370	0.321	-	0.000	0.000	0.000	0.000	0.151	0.127	0.171
TCC	40 8620	0.069	0.054	0.052	0.051	-	0.000	0.000	0.000	0.000	0.000	0.014	0.015
TCC	40 8624	0.038	0.030	0.028	0.025	-	0.000	0.000	0.000	0.000	0.126	0.077	0.074
TL	35 160	0.413	0.396	0.373	0.369	0.320	0.489	0.486	0.492	0.533	0.553	0.887	0.661
TL	35 300	0.252	0.243	0.243	0.249	0.188	0.293	0.306	0.325	0.312	0.325	0.397	0.421
TL	35 474	0.474	0.532	0.563	0.587	0.560	0.862	0.865	0.893	0.853	0.000	0.277	0.000
TL	35 809	0.270	0.235	0.309	0.344	0.392	0.730	0.693	0.740	0.817	0.000	0.161	0.149
TL	35 1012	0.147	0.000	0.063	0.065	0.072	0.076	0.076	0.077	0.079	0.093	0.106	0.105
TL	35 1132	0.326	0.307	0.264	0.281	0.271	0.356	0.323	0.359	0.350	0.414	0.681	0.457
TL	35 1498	0.936	0.000	0.526	0.545	0.562	0.577	0.559	0.734	0.906	0.598	0.626	0.531
TL	35 1500	0.000	0.954	0.926	0.906	0.874	0.862	0.865	0.893	0.000	0.000	0.337	0.214
TL	35 1712	0.936	0.954	0.926	0.906	0.874	0.862	0.865	0.893	0.906	0.883	0.887	0.874
TL	40 3052	0.008	0.008	0.008	0.008	0.007	0.008	0.008	0.008	0.009	0.010	0.010	0.010
TL	40 3053	0.000	0.000	0.327	0.291	0.219	0.162	0.172	0.168	0.166	0.153	0.160	0.165
TP	35 163	0.348	0.421	0.466	0.533	0.869	0.691	0.712	-	-	0.000	0.000	0.000
TP	35 326	0.000	0.000	0.001	0.001	0.001	0.001	0.001	0.001	0.002	0.005	0.005	0.005
TP	35 1227	-	0.000	0.000	0.000	0.000	0.033	0.035	0.041	0.047	0.054	0.069	0.077
TP	36 154	0.133	0.144	0.102	0.108	0.106	0.094	0.092	-	-	0.000	0.000	0.000
UME	35 251	-	-	-	-	-	-	0.000	0.000	0.000	0.000	0.000	0.000
USNO	15 5564	0.055	0.048	0.046	0.047	0.059	0.126	0.190	0.355	0.335	0.350	0.340	-
USNO	35 101	0.500	0.408	0.341	0.321	0.300	0.287	0.419	0.610	0.625	0.667	0.704	0.591
USNO	35 104	0.000	0.000	0.926	0.906	0.874	0.862	0.865	0.893	0.906	0.000	0.273	0.189
USNO	35 106	-	-	-	-	-	-	-	-	-	-	-	0.000
USNO	35 108	0.460	0.453	0.510	0.319	0.383	0.331	0.367	0.360	0.371	0.367	0.000	0.018
USNO	35 114	-	-	-	-	-	-	-	-	-	-	-	0.000
USNO	35 120	0.411	0.382	0.439	0.404	0.410	0.332	0.270	0.254	0.291	0.274	0.520	0.833
USNO	35 142	0.283	0.304	0.304	0.316	0.357	0.365	0.484	0.499	0.906	0.883	0.887	0.874
USNO	35 146	0.473	0.426	0.354	0.362	0.341	0.342	0.356	0.408	0.586	0.601	0.683	0.685
USNO	35 148	0.027	0.026	0.025	0.027	0.036	0.055	0.073	0.222	0.231	0.207	0.205	0.233
USNO	35 150	0.454	0.422	0.514	0.391	0.385	0.361	0.367	0.517	-	-	-	-
USNO	35 152	0.154	0.182	0.238	0.252	0.146	0.129	0.152	0.160	0.175	0.187	0.261	0.228
USNO	35 153	0.070	0.091	0.104	0.120	0.125	0.122	0.148	0.180	0.269	0.489	0.887	0.874

Table 9A. (Cont.)

Lab.		Clock	53764	53794	53824	53854	53884	53914	53944	53974	54004	54039	54069	54099
USNO	35	156	0.806	0.590	0.470	0.404	0.344	0.362	0.351	0.433	0.585	0.882	0.887	0.874
USNO	35	161	-	0.000	0.000	0.000	0.000	0.248	0.341	0.438	0.553	0.539	0.504	0.537
USNO	35	164	0.039	0.042	0.048	0.054	0.053	0.000	0.012	0.011	0.012	-	-	-
USNO	35	165	0.621	0.710	0.532	0.378	0.304	0.221	0.257	0.301	0.266	0.263	0.316	0.369
USNO	35	166	0.505	0.589	0.680	0.593	0.588	0.636	0.640	0.691	0.906	0.883	0.887	0.874
USNO	35	167	0.481	0.468	0.512	0.536	0.401	0.464	0.668	0.893	0.829	0.802	0.634	0.641
USNO	35	169	0.207	0.215	0.269	0.277	0.300	0.319	0.503	0.893	0.906	0.883	0.887	0.650
USNO	35	173	0.936	0.954	0.926	0.906	0.874	0.862	0.865	0.747	0.774	0.883	0.887	0.874
USNO	35	213	0.465	0.569	0.675	0.601	0.695	0.686	0.698	0.707	0.447	0.317	0.324	0.287
USNO	35	217	0.076	0.080	0.096	0.113	-	-	-	-	-	-	-	-
USNO	35	225	0.936	0.954	0.926	-	-	-	-	-	-	-	-	-
USNO	35	226	0.814	0.954	0.926	0.906	0.771	0.557	0.445	0.363	0.000	0.221	0.222	0.232
USNO	35	227	0.926	0.954	0.926	0.906	0.874	0.862	0.865	0.893	0.906	0.883	0.763	0.598
USNO	35	229	0.223	0.325	0.428	0.510	0.542	0.496	0.515	0.417	0.335	0.391	0.527	0.513
USNO	35	231	0.488	0.454	0.447	0.436	0.375	0.347	0.556	0.567	0.737	0.629	0.663	0.748
USNO	35	233	0.767	0.615	0.693	0.738	0.764	0.736	0.786	0.763	0.906	0.883	0.887	0.874
USNO	35	242	0.621	-	-	-	-	0.000	0.000	0.000	0.000	0.048	0.054	0.061
USNO	35	244	0.692	0.704	0.849	0.000	0.380	0.387	0.481	0.492	0.462	0.540	-	-
USNO	35	249	0.000	0.657	0.537	0.548	0.492	0.471	0.488	0.514	0.538	0.586	0.565	0.410
USNO	35	254	0.270	0.220	0.228	0.236	0.248	0.222	0.257	0.389	0.477	0.598	0.668	0.846
USNO	35	255	0.261	0.289	0.361	0.369	0.412	0.462	0.495	0.463	0.644	0.736	0.887	0.874
USNO	35	256	0.936	0.954	0.874	0.906	0.874	0.718	0.674	0.550	0.540	0.574	0.565	0.555
USNO	35	260	0.936	0.954	0.926	0.802	0.749	0.700	0.546	0.473	0.491	0.441	0.573	0.488
USNO	35	268	0.173	0.190	0.174	0.173	0.210	0.259	0.381	0.479	0.784	0.766	0.814	0.718
USNO	35	270	0.936	0.954	0.926	0.826	0.796	0.737	0.622	0.491	0.504	0.562	0.491	0.542
USNO	35	279	0.763	0.860	0.834	0.743	0.720	0.786	0.865	0.893	0.906	0.883	0.887	0.874
USNO	35	389	0.179	0.207	0.240	0.197	0.186	0.160	0.230	0.221	0.300	0.361	0.747	0.668
USNO	35	392	0.936	0.954	0.926	0.906	0.874	0.862	0.794	0.893	0.858	0.741	0.604	0.532
USNO	35	394	0.811	0.702	0.632	0.735	0.756	0.862	0.865	0.657	0.653	0.685	0.760	0.755
USNO	35	416	0.461	0.403	0.436	0.370	0.319	0.326	0.412	0.427	0.442	0.422	0.427	0.469
USNO	35	417	0.598	0.855	0.845	0.854	0.737	0.804	0.651	0.786	0.757	0.786	0.687	0.781
USNO	35	703	-	-	-	-	-	-	-	0.000	0.000	0.000	0.000	0.874
USNO	35	717	0.936	0.879	0.850	0.795	0.874	0.862	0.865	0.893	0.906	0.826	0.850	0.685
USNO	35	762	0.936	0.885	0.546	0.000	0.158	0.122	0.115	0.108	0.103	0.113	0.121	0.140
USNO	35	763	0.000	0.000	0.000	0.000	0.062	0.069	0.072	0.085	0.109	0.134	0.156	0.191

Table 9A. (Cont.)

Lab.	Clock	53764	53794	53824	53854	53884	53914	53944	53974	54004	54039	54069	54099
USNO	35 765	0.643	0.654	0.408	0.522	0.371	0.385	0.368	0.329	0.282	0.297	0.268	0.314
USNO	35 1096	0.936	0.954	0.825	0.830	0.513	0.482	0.401	0.418	0.311	0.280	0.232	0.236
USNO	35 1097	-	-	-	-	-	-	-	-	-	-	-	0.000
USNO	35 1125	0.892	0.811	0.643	0.630	0.465	0.380	0.352	0.529	0.510	0.599	0.887	0.874
USNO	35 1327	-	-	-	-	-	-	-	-	-	-	-	0.000
USNO	35 1328	0.927	0.785	0.604	-	-	0.000	0.000	0.000	0.000	0.649	0.258	0.182
USNO	35 1331	0.000	0.000	0.000	0.498	0.624	0.613	0.771	0.561	0.677	0.441	0.399	0.251
USNO	35 1438	0.936	0.954	0.926	0.906	0.764	0.719	0.865	0.893	0.906	0.883	0.887	0.874
USNO	35 1459	0.936	0.954	0.826	0.498	0.528	0.432	0.389	0.457	0.510	0.715	0.752	0.874
USNO	35 1462	0.276	0.229	0.240	0.228	0.266	0.440	0.620	0.599	0.627	0.632	0.627	0.673
USNO	35 1463	0.125	0.126	0.130	0.142	0.141	0.142	0.163	0.176	-	-	-	0.000
USNO	35 1468	0.636	0.611	0.861	0.857	0.874	0.862	0.830	0.842	0.856	0.883	0.766	0.823
USNO	35 1481	0.729	0.664	0.640	0.576	0.610	0.584	0.586	0.616	0.628	0.883	0.887	0.874
USNO	35 1543	0.936	0.954	0.926	0.906	0.874	0.862	0.865	0.877	0.833	0.883	0.887	0.736
USNO	35 1573	0.333	0.311	0.423	0.489	0.415	0.862	0.865	0.893	0.906	0.883	0.887	0.874
USNO	35 1575	0.601	0.598	0.571	0.677	0.656	0.660	0.865	0.893	0.573	0.678	0.887	0.874
USNO	35 1655	0.516	0.575	0.660	0.664	0.609	0.718	0.833	0.893	0.906	0.883	0.887	0.874
USNO	35 1692	0.539	0.954	0.926	0.906	0.874	0.862	0.865	0.893	0.906	0.883	0.887	0.874
USNO	35 1694	0.369	0.327	0.362	0.340	0.305	0.412	0.459	0.632	0.784	0.883	0.887	0.874
USNO	35 1696	0.936	0.954	0.926	0.906	0.000	0.502	0.503	0.632	0.622	0.691	0.736	0.721
USNO	35 1697	0.936	0.954	0.926	0.906	0.874	0.862	0.865	0.893	0.906	0.883	0.887	0.874
USNO	40 701	0.936	0.954	0.926	0.906	0.874	0.862	0.865	0.893	0.871	0.000	0.414	0.376
USNO	40 702	0.682	0.689	0.825	0.906	0.874	0.862	0.865	0.893	0.906	0.883	0.887	0.874
USNO	40 704	0.626	0.449	0.366	0.326	0.298	0.280	0.282	0.288	0.224	0.190	0.169	0.149
USNO	40 705	0.890	0.905	0.838	0.753	0.643	0.555	0.596	0.644	0.786	0.883	0.887	0.874
USNO	40 708	0.077	0.071	0.061	0.058	0.055	-	-	-	-	-	-	-
USNO	40 710	0.052	0.051	0.049	0.048	0.047	0.049	0.056	0.066	0.081	0.098	0.084	0.073
USNO	40 711	0.004	0.004	0.004	0.004	0.003	0.003	0.003	0.003	0.004	0.004	0.004	0.004
USNO	40 712	-	0.000	0.000	0.000	0.000	0.862	0.865	0.893	0.906	0.883	0.887	0.874
USNO	40 713	0.114	0.106	0.100	0.098	0.095	0.093	0.096	0.099	0.108	0.116	0.125	0.120
USNO	40 714	0.095	0.092	0.092	0.100	0.100	0.094	0.094	0.098	0.107	0.132	0.129	0.117
USNO	40 715	-	-	-	-	-	-	-	0.000	0.000	0.000	0.000	0.063
USNO	40 716	0.936	0.954	0.926	0.906	0.874	0.862	0.865	0.893	0.906	0.883	0.887	0.874
USNO	40 718	0.936	0.769	0.678	0.677	0.651	0.625	0.635	0.649	0.717	0.753	0.776	0.746
USNO	40 719	0.012	0.011	0.010	0.009	0.008	0.008	0.008	0.007	0.008	0.008	0.008	0.008

Table 9A. (Cont.)

Lab.		Clock	53764	53794	53824	53854	53884	53914	53944	53974	54004	54039	54069	54099
USNO	40	720	0.005	0.005	0.005	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004
USNO	40	721	0.001	0.000	0.000	0.000	0.000	0.000	-	-	-	-	-	-
USNO	40	722	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
USNO	40	723	0.936	0.954	0.926	0.906	0.768	0.675	0.617	0.592	0.570	0.581	0.611	0.604
USNO	40	724	-	-	-	-	0.000	0.000	0.000	0.000	0.906	0.713	0.424	0.330
USNO	40	725	-	-	-	-	0.000	0.000	0.000	0.000	0.216	0.253	0.326	0.341
USNO	40	726	0.000	0.000	0.001	0.001	0.001	0.001	0.001	0.000	0.000	0.000	0.000	0.000
USNO	40	728	-	-	-	-	-	-	-	0.000	0.000	0.000	0.000	0.002
USNO	40	730	-	-	-	-	-	-	-	-	-	-	0.000	0.000
VSL	35	179	0.000	-	0.000	0.000	0.000	0.000	0.029	0.043	0.061	0.046	0.061	0.061
VSL	35	456	0.262	-	0.000	0.000	0.000	0.000	0.312	0.431	0.625	0.397	0.364	0.443
VSL	35	548	0.313	-	0.000	0.000	0.000	0.000	0.826	0.000	0.095	0.114	0.144	0.174
VSL	35	731	0.303	-	0.000	0.000	0.000	0.000	0.726	0.893	0.906	0.883	0.887	0.874
ZMDM	36	2033	-	0.000	-	-	0.000	0.000	0.000	0.000	0.173	0.268	0.173	0.203

Table 9B: Statistical data on the weights attributed to the clocks in 2006

Interval		Number of clocks			Number of clocks with a given weight									Max relative weight %
					Weight = 0*			Weight = 0**			Max weight			
		HM	5071A	Total	HM	5071A	Total	HM	5071A	Total	HM	5071A	Total	
2006	Jan.	72	205	321	17	30	55	4	4	11	7	36	47	0.936
2006	Feb.	70	199	315	13	31	53	6	5	14	8	33	43	0.954
2006	Mar.	69	206	317	8	34	47	5	3	11	6	31	41	0.926
2006	Apr.	68	203	316	9	24	40	7	4	15	7	34	43	0.906
2006	May	73	197	317	11	14	32	7	5	17	8	31	41	0.874
2006	June	77	202	326	15	17	37	7	6	17	9	36	46	0.862
2006	July	75	202	323	16	14	36	5	5	14	9	35	45	0.865
2006	Aug.	79	201	321	20	21	43	6	4	15	8	34	43	0.893
2006	Sep.	78	195	313	14	23	37	6	4	16	8	29	38	0.906
2006	Oct.	77	205	326	11	28	44	6	6	16	9	32	43	0.883
2006	Nov.	77	203	321	10	26	41	6	11	22	8	38	49	0.887
2006	Dec.	77	212	326	6	29	40	7	9	21	8	40	50	0.874

Wmax = A/N, here N is the number of clocks, excluding those with a priori null weight, A = 2.50.
* A priori null weight (test interval of new clocks).
** Null weight resulting from the statistics.
HM designates hydrogen masers and 5071A designates H-P/Agilent 5071A units with high performance tube.
Clocks with missing data during a one-month interval of computation are excluded.

TIME SIGNALS

The time signal emissions reported here follow the UTC system, in accordance with the Recommendation 460-4 of the Radiocommunication Bureau (RB) of the International Telecommunication Union (ITU) unless otherwise stated.

Their maximum departure from the Universal Time UT1 is thus 0.9 second.

The following tables are based on information received at the BIPM in February and March 2007.

AUTHORITIES RESPONSIBLE FOR THE TIME SIGNAL EMISSIONS

Signal	Authority
BPM	Time and Frequency Division National Time Service Center, NTSC Chinese Academy of Sciences P.O. Box 18 - Lintong Shaanxi 710600, China
CHU	National Research Council of Canada Institute for National Measurement Standards – Frequency and Time Standards Bldg M-36, 1200 Montreal Road Ottawa, Ontario, K1A 0R6, Canada
DCF77	Physikalisch-Technische Bundesanstalt Time and Frequency Department, WG 4.42 Bundesallee 100 D-38116 Braunschweig Germany
EBC	Real Instituto y Observatorio de la Armada Cecilio Pujazón s/n 11.110 San Fernando Cádiz, Spain
HBG	METAS Swiss Federal Office of Metrology Time and Frequency Laboratory Length, Optics and Time Section Lindenweg 50 CH-3003 Bern-Wabern Switzerland
HLA	Length and Time Metrology Group Division of Physical Metrology Korea Research Institute of Standards and Science P.O. Box 102, Yuseong Daejeon 305-340 Republic of Korea
JJY	Space-Time Standards Group National Institute of Information and Communications Technology 4 -2- 1, Nukui-kitamachi Koganei, Tokyo 184-8795 Japan

Signal	Authority
LDS	School of Electronic and Electrical Engineering Leeds University Leeds LS2 9JT United Kingdom
LOL	Servicio de Hidrografía Naval Observatorio Naval Buenos Aires Av. España 2099 C1107AMA – Buenos Aires, Argentina
MSF	National Physical Laboratory Division for Enabling Metrology Hampton Road Teddington, Middlesex TW11 0LW United Kingdom
RAB-99, RBU, RJH-63, RJH-69, RJH-77, RJH-86, RJH-90,RTZ,RWM	All-Russian Scientific Research Institute for Physical Technical and Radiotechnical Measurements Institute of Metrology for Time and Space Meendeleevo, Moscow Region 141570 Russia
STFS	National Physical Laboratory Dr. K.S. Krishnan Road New Delhi - 110012, India
TDF	FT R et D France Telecom Recherche et Développement Laboratoire RTA/D2M Technopole ANTICIPA 2, avenue Pierre Marzin 22307 - Lannion Cedex, France
WWV, WWVB, WWVH	Time and Frequency Division, 847.00 National Institute of Standards and Technology - 325 Broadway Boulder, Colorado 80305, U.S.A.
YVTO	Dirección de Hidrografía y Navegación Observatorio Naval Cagigal Apartado Postal No 6745 Caracas, Venezuela

TIME SIGNALS EMITTED IN THE UTC SYSTEM

Station	Location Latitude Longitude	Frequency (kHz)	Schedule (UTC)	Form of the signal
BPM	Pucheng China 35° 0'N 109° 31'E	2 500 5 000 10 000 15 000	7 h 30 m to 1 h continuous continuous 1 h to 9 h	Signals emitted in advance on UTC by 20 ms. Second pulses of 10 ms duration with 1 kHz modulation. Minute pulses of 300 ms duration with 1 kHz modulation. UTC time signals are emitted from minute 0 to 10, 15 to 25, 30 to 40, 45 to 55. UT1 time signals are emitted from minute 25 to 29, 55 to 59.
CHU	Ottawa Canada 45° 18'N 75° 45'W	3 330 7 335 14 670	continuous	Second pulses of 300 cycles of a 1 kHz modulation, with 29th and 51st to 59th pulses of each minute omitted. Minute pulses are 0.5 s long. Hour pulses are 1.0 s long, with the following 1st to 9th pulses omitted. A bilingual (Fr. Eng.) announcement of time (UTC) is made each minute following the 50th second pulse. FSK code (300 bps, Bell 103) after 10 cycles of 1 kHz on seconds 31 to 39. Year, DUT1, leap second information, TAI-UTC and Canadian summer time format on 31, and time code on 32-39. Broadcast is single sideband; upper sideband with carrier reinsert. DUT1 : ITU-R code by double pulse.
DCF77	Mainflingen Germany 50° 1'N 9° 0'E	77.5	continuous	The DCF77 time signals are generated by PTB and are in accordance with the legal time of Germany which is UTC(PTB)+1 h or UTC(PTB)+2 h. At the beginning of each second (except in the last second of each minute) the carrier amplitude is reduced to 25% for a duration of 0.1 or 0.2 s corresponding to "binary 0" or "binary 1", respectively, referred to as second marks 0 to 59 in the following. The number of the minute, hour, day of the month, day of the week, month and year are transmitted in BCD code using second marks 20 to the 58, including overhead. Information emitted during minute n is valid for minute n+1. The information transmitted during the second marks 1 to the 14 is provided by third parties. Information on that additional service can be obtained from PTB. To achieve a more accurate time transfer and a better use of the frequency spectrum available an additional pseudo-random phase shift keying of the carrier is superimposed on the AM second markers. No transmission of DUT1.

Station	Location Latitude Longitude	Frequency (kHz)	Schedule (UTC)	Form of the signal
EBC	San Fernando Spain 36° 28'N 6° 12'W	15006 4998	10 h 00 m to 10 h 25 m 10 h 30 m to 10 h 55 m except Saturday, Sunday and national holidays.	Second pulses of 0.1 s duration of a 1 kHz modulation. Minute pulses of 0.5 s duration of 1 250 Hz modulation. DUT1: ITU-R code by double pulse.
HLA	Daejeon Rep. of Korea 36° 23'N 127° 22'E	5 000	continuous	Pulses of 9 cycles of 1 800 Hz modulation. 29th and 59th second pulses omitted. Hour identified by 0.8 s long 1 500 Hz tone. Beginning of each minute identified by a 0.8 s long 1 800 Hz tone. Voice announcement of hours and minutes each minute following the 52nd second pulse. BCD time code given on 100 Hz subcarrier. DUT1: ITU-R code by double pulse.
JJY	Tamura-shi Fukushima Japan 37° 22'N 140° 51'E	40	Continuous	A1B type 0.2 s, 0.5 s and 0.8 s second pulses, spacings are given by the reduction of the amplitude of the carrier. Coded announcement of hour, minute, day of the year, year, day of the week and leap second. Transmitted time refers to UTC(NICT) + 9 h.
JJY	Saga-shi Saga Japan 33° 28'N 130° 11'E	60	Continuous	A1B type 0.2 s, 0.5 s and 0.8 s second pulses, spacings are given by the reduction of the amplitude of the carrier. Coded announcement of hour, minute, day of the year, year, day of the week and leap second same as JJY(40). Transmitted time refers to UTC(NICT) + 9 h.
LDS	Leeds United Kingdom 53 ° 48'N 1° 33'W	5 000	Continuous	Second pulse amplitude = 2.4 V (50 ohm), 5 ns rise time and 20 μs width. Initial clock synchronization: 50 ns of UTC.
LOL(1)	Buenos Aires Argentina 34° 37'S 58° 21'W	10 000	14 h to 15 h except Saturday, Sunday and national holidays.	Second pulses of 5 cycles of 1000 Hz modulation. Second 59 is omitted. Announcement of hours and minutes every 5 minutes, followed by 3 minutes of 1000 Hz or 440 Hz modulation. DUT1: ITU-R code by lengthening.

(1) Information based on the Annual Report 2005, not confirmed by the Laboratory.

Station	Location Latitude Longitude	Frequency (kHz)	Schedule (UTC)	Form of the signal
MSF	Rugby United Kingdom 52° 22'N 1° 11'W	60	Continuous, except for interruptions for maintenance from 10 h 0 m to 14 h 0 m on the first Tuesday of January, May and September. A longer period of maintenance during the summer is announced annually.	Interruptions of the carrier of 100 ms for the second pulses and of 500 ms for the minute pulses. The signal is given by the beginning of the interruption. BCD NRZ code, 1 bit/s (year, month, day of the month, day of the week, hour, minute) from second 17 to 59 in each minute, following the seconds interruption. DUT1: ITU-R code by double pulse.
RAB-99	Khabarovsk Russia 48° 30'N 134° 50'E	25.0 25.1 25.5 23.0 20.5	02 h 06 m to 02 h 40 m 06 h 06 m to 06 h 40 m	A1N type signals are transmitted between minutes 10 and 22 : 0.025 second pulses of 12.5 ms duration are transmitted between minutes 10 and 13; second pulses of 0.1 s duration, 10 second pulses of 1 s duration, 0.1 second pulses of 25 ms and minute pulses of 10 s duration are transmitted between minutes 13 and 22.
RBU	Moscow Russia 55° 44'N 38° 12'E	200/3	Continuous	DXXXW type 0.1 s signals. The numbers of the minute, hour, day of the month, day of the week, month, year of the century, difference between the universal time and the local time, TJD and DUT1+dUT1 are transmitted each minute from the 1^{st} to the 59^{th} second. DUT1+dUT1 : by double pulse.
RJH-63	Krasnodar Russia 44° 46'N 39° 34'E	25.0 25.1 25.5 23.0 20.5	11 h 06 m to 11 h 40 m	A1N type signals are transmitted between minutes 9 and 20 : 0.025 second pulses of 12.5 ms duration are transmitted between minutes 9 and 11 ; 0.1 second pulses of 25 ms duration, 10 second pulses of 1 s duration and minute pulses of 10 s duration are transmitted between minutes 11 and 20.
RJH-69	Molodechno Belarus 54° 28'N 26° 47'E	25.0 25.1 25.5 23.0 20.5	07 h 06 m to 07 h 47 m	A1N type signals are transmitted between minutes 10 and 22 : 0.025 second pulses of 12.5 ms duration are transmitted between minutes 10 and 13; second pulses of 0.1 s duration, 10 second pulses of 1 s duration, 0.1 second pulses of 25 ms and minute pulses of 10 s duration are transmitted between minutes 13 and 22.
RJH-77	Arkhangelsk Russia 64° 22'N 41° 35'E	25.0 25.1 25.5 23.0 20.5	09 h 06 m to 09 h 47 m	A1N type signals are transmitted between minutes 10 and 22 : 0.025 second pulses of 12.5 ms duration are transmitted between minutes 10 and 13; second pulses of 0.1 s duration, 10 second pulses of 1 s duration, 0.1 second pulses of 25 ms and minute pulses of 10 s duration are transmitted between minutes 13 and 22.

Station	Location Latitude Longitude	Frequency (KHz)	Schedule (UTC)	Form of the signal
RJH-77	Arkhangelsk Russia 64° 22'N 41° 35'E	25.0 25.1 25.5 23.0 20.5	09 h 06 m to 09 h 47 m	A1N type signals are transmitted between minutes 10 and 22 : 0.025 second pulses of 12.5 ms duration are transmitted between minutes 10 and 13; second pulses of 0.1 s duration, 10 second pulses of 1 s duration, 0.1 second pulses of 25 ms and minute pulses of 10 s duration are transmitted between minutes 13 and 22.
RJH-86	Bishkek Kirgizstan 43° 03'N 73° 37'E	25.0 25.1 25.5 23.0 20.5	04 h 06 m to 04 h 47 m 10 h 06 m to 10 h 47 m	A1N type signals are transmitted between minutes 10 and 22 : 0.025 second pulses of 12.5 ms duration are transmitted between minutes 10 and 13; second pulses of 0.1 s duration, 10 second pulses of 1 s duration, 0.1 second pulses of 25 ms and minute pulses of 10 s duration are transmitted between minutes 13 and 22.
RJH-90	Nizhni Novgorod Russia 56° 11'N 43° 57'E	25.0 25.1 25.5 23.0 20.5	05 h 06 m to 05 h 47 m	A1N type signals are transmitted between minutes 10 and 22 : 0.025 second pulses of 12.5 ms duration are transmitted between minutes 10 and 13; second pulses of 0.1 s duration, 10 second pulses of 1 s duration, 0.1 second pulses of 25 ms and minute pulses of 10 s duration are transmitted between minutes 13 and 22.
RTZ	Irkutsk Russia 52° 26'N 103° 41'E	50	Winter schedule 22 h 00 m to 24 h 00 m 00 h 00 m to 21 h 00 m Summer schedule 21 h 00 m to 24 h 00 m 00 h 00 m to 20 h 00 m	DXXXW type 0.1 s signals. The numbers of the minute, hour, day of the month, day of the week, month, year of the century, difference between the universal time and the local time, TJD and DUT1+dUT1 are transmitted each minute from the 1st to the 59th second. DUT1+dUT1: by double pulse.
RWM (2)	Moscow Russia 55° 44'N 38° 12'E	4 996 9 996 14 996	The station operates simultaneously on the three frequencies.	A1X type second pulses of 0.1 s duration are transmitted between minutes 10 and 20, 40 and 50. The pulses at the beginning of the minute are prolonged to 0.5 s. A1N type 0.1 s second pulses of 0.02 s duration are transmitted between minutes 20 and 30. The pulses at the beginning of the second are prolonged to 40 ms and of the minute to 0.5 ms. DUT1+dUT1: by double pulse.

(2) RMW is the radiostation emitting DUT1 information in accordance with the ITU-R code and also giving an additional information, dUT1, which specifies more precisely the difference UT1-UTC down to multiples of 0.02 s, the total value of the correction being DUT1+dUT1.
Positive values of dUT1 are transmitted by the marking of p second markers within the range between the 21st and 24th second so that dUT1 = $+p \times 0.02$ s.
Negative values of dUT1 are transmitted by the marking of q second markers within the range between the 31st and 34th second, so that dUT1 = $-q \times 0.02$ s.

Station	Location Latitude Longitude	Frequency (kHz)	Schedule (UTC)	Form of the signal
TDF	Allouis France 47° 10'N 2° 12'E	162	continuous, except every Tuesday from 1 h to 5 h	Phase modulation of the carrier by +1 and -1 rd in 0.1 s every second except the 59th second of each minute. This modulation is doubled to indicate binary 1. The numbers of the minute, hour, day of the month, day of the week, month and year are transmitted each minute from the 21st to the 58th second, in accordance with the French legal time scale. In addition, a binary 1 at the 17th second indicates that the local time is 2 hours ahead of UTC (summer time); a binary 1 at the 18th second indicates that the local time is 1 hour ahead of UTC (winter time); a binary 1 at the 14th second indicates that the current day is a public holiday (Christmas, 14 July, etc...); a binary 1 at the 13th second indicates that the current day is a day before a public holiday.
WWV	Fort-Collins CO, USA 40° 41'N 105° 2'W	2 500 5 000 10 000 15 000 20 000	continuous	Pulses of 5 cycles of 1 kHz modulation. 29th and 59th second pulses omitted. Hour is identified by 0.8 second long 1 500 Hz tone. Beginning of each minute identified by 0.8 second long 1 000 Hz tone. DUT1: ITU-R code by double pulse. BCD time code given on 100 Hz subcarrier, includes DUT1 correction.
WWVB	Fort-Collins CO, USA 40° 40'N 105° 3'W	60	continuous	Second pulses given by reduction of the amplitude of the carrier, coded announcement of the date, time, DUT1 correction, daylight saving time in effect, leap year and leap second.
WWVH	Kauai HI, USA 21° 59'N 159° 46'W	2 500 5 000 10 000 15 000	continuous	Pulses of 6 cycles of 1 200 Hz modulation. 29th and 59th second pulses omitted. Hour is identified by 0.8 second long 1 500 Hz tone. Beginning of each minute identified by 0.8 second long 1 200 Hz tone. DUT1: ITU-R code by double pulse. BCD time code given on 100 Hz subcarrier, includes DUT1 correction.
YVTO	Caracas Venezuela 10° 30'N 66° 55'W	5 000	continuous	Second pulses of 1 kHz modulation with 0.1 s duration. The minute is identified by a 800 Hz tone and a 0.5 s duration. Second 30 is omitted. Between seconds 40 and 50 of each minute, voice announcement of the identification of the station. Between seconds 52 and 57 of each minute, voice announcement of hour, minute and second.

ACCURACY OF THE CARRIER FREQUENCY

Station	Relative uncertainty of the carrier frequency in 10^{-10}
BPM	0.01
CHU	0.05
DCF77	0.02
EBC	0.1
HBG	0.02
HLA	0.02
JJY	0.01
LDS	0.01
LOL	0.1
MSF	0.02
RAB-99,RJH-63	0.05
RBU,RTZ	0.02
RJH-69, RJH-77	0.05
RJH-86, RJH-90	0.05
RWM	0.1
STFS	0.1
TDF	0.02
WWV	0.01
WWVB	0.01
WWVH	0.01

TIME DISSEMINATION SERVICES

The following tables are based on information received at the BIPM in February and May 2007.

AUTHORITIES RESPONSIBLE FOR THE TIME DISSEMINATION SERVICES

AOS	Astrogeodynamical Observatory Borowiec near Poznań Space Research Centre P.A.S. PL 62-035 Kórnik - Poland
AUS	Length, Time and Frequency Section National Measurement Institute PO Box 264 Lindfield NSW 2070 - AUSTRALIA
BelGIM	Belarusian State Institute of Metrology National Standard for Time, Frequency and Time-scale of the Republic of Belarus Minsk, Minsk Region – 220053 Belarus
BEV	Bundesamt für Eich- und Vermessungswesen Arltgasse 35 A-1160 Wien , Vienna - Austria
CENAM	Centro Nacional de Metrología km. 4.5 Carretera a Los Cués El Marqués, Querétaro, C.P. 76241 - México
GUM	Time and Frequency Laboratory Electrical Metrology Division Główny Urząd Miar – Central Office of Measures ul. Elektoralna 2 PL 00 – 950 Warszawa P–10, Poland
HKO	Hong Kong Observatory 134A, Nathan Road Kowloon, Hong Kong
INPL	National Physical Laboratory Danciger A bldg Givat - Ram, The Hebrew university 91904 Jerusalem ISRAEL
INRIM	Istituto Nazionale di Ricerca Metrologica Strada delle Cacce, 91 I – 10135 Torino Italy

KRISS	Length and Time Metrology Group Division of Physical Metrology Korea Research Institute of Standards and Science P.O. Box 102, Yuseong Daejeon 305-340 Republic of Korea
LNE-SYRTE	Laboratoire National de Métrologie et d'Essais Systèmes de Référence Temps-Espace Observatoire de Paris 61, avenue de l'Observatoire, 75014 Paris – France
LT	Time and Frequency Standard Laboratory Semiconductor Physics Institute – State Metrology Service A. Goštauto 11 Vilnius LT01108, Lithuania
METAS	Swiss Federal Office of Metrology Length, Optics and Time Section Lindenweg 50 CH-3003 Bern-Wabern Switzerland
MSL	Measurement Standards Laboratory Industrial Research Gracefield Road PO Box 31-310 Lower Hutt – New Zealand
NICT	Space-Time Standards Group National Institute of Information and Communications Technology 4 -2 -1, Nukui-kitamachi Koganei, Tokyo 184-8795 Japan
NIM	Time & Frequency Laboratory National Institute of Metrology No. 18, Bei San Huan Dong Lu Beijing 100013 - People's Republic of China
NIMB	Time and Frequency Laboratory National Institute of Metrology Sos. Vitan - Barzesti, 11 042122 Bucharest Romania
NIMT	Time & Frequency Laboratory National Institute of Metrology (Thailand) 3/5 Moo 3, Klong 5, Klong Luang, Pathumthani 12120, Thailand
NIST	National Institute of Standards and Technology Time and Frequency Division, 847.00 325 Broadway Boulder, Colorado 80305, USA

NMISA (1)
Time and Frequency Laboratory
National Metrology Institute of South Africa
P.O. Box 395
Pretoria 0001 - South Africa

NMLS
Time and Frequency Laboratory
National Metrology Laboratory
SIRIM Berhad,
Lot PT 4803, Bandar Baru Salak Tinggi,
43900 Sepang - Malaysia

NPL
National Physical Laboratory
Division for Enabling Metrology
Hampton Road
Teddington, Middlesex TW11 0LW
United Kingdom

NPLI
Time and Frequency Section
National Physical Laboratory
Dr.K.S.Krishnan Road
New Delhi 110012 - India

NRC
National Research Council of Canada
Institute for National Measurement Standards
Frequency and Time Standards
Bldg M-36, 1200 Montreal Rd.
Ottawa, Ontario, K1A OR6, Canada

NTSC
National Time Service Center
Chinese Academy of Sciences
P.O. Box 18, Lintong
Shaanxi 710600, China

ONBA
Servicio de Hidrografía Naval
Observatorio Naval Buenos Aires
Servicio de Hora
Av. España 2099
C1107AMA – Buenos Aires, Argentina

ONRJ
Observatorio Nacional (MCT)
Divisão Serviço da Hora
Rua General José Cristino, 77 São Cristovão
20921-400 Rio de Janeiro, Brasil

ORB
Royal Observatory of Belgium
Avenue Circulaire, 3
B-1180 Brussels
Belgium

PTB
Physikalisch-Technische Bundesanstalt
Time and Frequency Department, WG 4. 42
Bundesallee 100
D-38116 Braunschweig
Germany

(1) Change from CSIR to NMISA in May 2007.

ROA	Real Instituto y Observatorio de la Armada Cecilio Pujazón s/n 11.100 San Fernando Cádiz, Spain
SG	National Metrology Centre Standards, Productivity and Innovation Board (SPRING Singapore) 1 Science Park Drive, Singapore 118221 Singapore
SP	SP Swedish National Testing and Research Institute Box 857 S-501 15 BORAS Sweden
TL	National Standard Time and Frequency Laboratory Telecommunication Laboratories Chunghwa Telecom. Co., Ltd. No. 12, Ln.551, Ming-Tsu Road Sec. 5 Yang-Mei, Taoyuan, 326 Taiwan, Rep. of China
TP	Institute of Photonics and Electronics Czech Academy of Sciences Chaberská 57 182 51 Praha 8 Czech Republic
UME	Ulusai Metroloji Enstitüsü Marmara Research Center, National Metrology Institute Gebze Kocaeli, Turkey
USNO	U.S. Naval Observatory 3450 Massachusetts Ave., N.W. Washington, D.C. 20392-5420 USA
VNIIFTRI	All-Russian Scientific Research Institute for Physical Technical and Radiotechnical Measurements Institute of Metrology for Time and Space Mendeleevo, Moscow Region 141570 Russia
VSL	NMi Van Swinden Laboratorium Postbus 654 2600 AR Delft Netherlands

TIME DISSEMINATION SERVICES

AOS

AOS Computer Time Service:
vega.cbk.poznan.pl (150.254.183.15)
Synchronization: NTP V3 primary (Caesium clock), PC Pentium, RedHat Linux
Service Area: Poland/Europe
Access Policy: open access
Contact: Jerzy Nawrocki (nawrocki@cbk.poznan.pl)
Robert Diak (kondor@cbk.poznan.pl)

Full list of time dissemination services is available on:
http://www.eecis.udel.edu/~mills/ntp/clock1.htm

AUS

Network Time Service
Computers connected to the Internet can be synchronized to UTC(AUS) using the NTP protocol. The NTP servers are referenced to UTC(AUS) either directly or via a GPS common view link.
Please see www.measurement.gov.au/time for information on access or contact time@measurement.gov.au

Dial-up Computer Time Service
Computers can also obtain time via a modem connection to our dialup timeserver. For further information, please see our web pages as above.

BelGIM

Internet Time Service:
BelGIM operates one time server Stratum 1 using the "Network Time Protocol" (NTP). The server host name is:
http://www.belgim.by (Stratum 1)

BEV

3 NTP servers are available; addresses:
bevtime1.metrologie.at
bevtime2.metrologie.at
time.metrologie.at
more information on http://www.metrologie.at

Provides a time dissemination service via phone and modem to synchronize PC clocks.
Uses the Time Distribution System from TUG. It has a baud rate of 1200 and everyone can use it with no cost.
Access phone number is +43 (0) 1 49110381
The system will be updated periodically (DUT1, Leap Second…).

CENAM

CENAM operates a voice automatic system that provides the local time for three different time zones for North America; Central Time, Mountain Time and Pacific Time as well the UTC(CNM). The access numbers are:

+52 442 211 0506: Central Time
+52 442 211 0507: Mountain Time
+52 442 211 0508: Pacific Time
+52 442 215 3902: UTC(CNM)

	Telephone Code CENAM provides a telephone code for setting time in computers. More information about this service please contact J. Mauricio López at jlopez@cenam.mx
	Network Time Protocol Operates one time server using the "Network Time Protocol", it is located at the Centro Nacional de Metrología, Querétaro, México. Further information at http://www.cenam.mx/HoraExacta.asp
GUM	Telephone Time Service providing the European time code by telephone modem for setting time in computers. Includes provision for compensation of propagation time delay. Access phone number : +48 22 654 88 72
	Network Time Service Two NTP servers are available: tempus1.gum.gov.pl tempus2.gum.gov.pl with an open access policy. It provides synchronization to UTC(PL). Contact: timegum@gum.gov.pl
HKO	Speaking Clock Service HKO operates an automatic Telephone Information Enquiry System that provides voice announcement of the Hong Kong Standard Time. (=UTC(HKO) + 8 h). Access phone number: + 852 1878200
	Network Time Service HKO operates two Internet time servers using Network Time Protocol. Host name of the server: stdtime.gov.hk Further information at http://www.hko.gov.hk/nts/ntime.htm
INPL	INPL is providing two electronic time dissemination services: 1. via telephone. The user must download a program from INPL ftp site (vms.huji.ac.il) 2. NTS via optic fiber to the Hebrew University which provides time on the internet. For details email clock@vms.huji.ac.il
INRIM	CTD Telephone Time Code Time signals dissemination, according to the European Time code format, available via modem on regular dial-up connection. Access phone numbers : 0039 011 3919 263 and 0039 011 3919 264. Provides a synchronization to UTC(IT) for computer clocks without compensation for the propagation time. Software for the synchronization of computer clocks is available on INRIM home page (www.inrim.it).
	Internet Time Service INRIM operates two time servers using the "Network Time Protocol" (NTP); host names of the servers are ntp1.inrim.it and ntp2.inrim.it. More information on this service can be found on the web pages: www.inrim.it/ntp/index_i.shtml.

KRISS	Telephone Time Service Provides digital time code to synchronize computer clocks to Korea Standard Time (=UTC(KRIS) + 9 h) via modem. Access phone numbers: + 82 42 863 7117, + 82 42 868 5116 Network Time Service KRISS operates three time servers using the NTP to synchronize computer clocks to Korea Standard Time via the Internet. Host name of the server : time.kriss.re.kr (203.254.163.74) Software for the synchronization of computer clocks is available at http://www.kriss.re.kr/time
LNE-SYRTE	LNE-SYRTE operates one primary time server using the "Network Time Protocol" (NTP) : Hostname: ntp-p1.obspm.fr Futher information at: http://lne-syrte.obspm.fr/gen/ntp_infos.html
LT	Network Time Service via NTP protocol NPT v3 DNS: laikas.pfi.lt Port 123 Synchronization from Caesium clock (1pps) System: Datum TymeServe 2100 NTP server Access policy: free Contact: Rimantas Miškinis Mail: Laikas@pfi.lt http://www.pfi.lt/metrology/
METAS	Telephone Time Service The coded time information is referenced to UTC(CH) and generated by a TUG type time code generator using an ASCII-character code. The time protocols are sent in a common format, the "European Telephone Time Code". Access phone numbers: +41 31 323 32 25, +41 31 323 47 00. Network Time Protocol METAS operates a time server using the "Network Time Protocol"(NTP). Host name of the server : ntp.metas.ch Further information available at http://www.metas.ch
MSL	Network Time Service Computers connected to the Internet can be synchonized to UTC(MSL) using the NTP protocol. Access is available for users within New Zealand. Two servers are available at msltime1.irl.cri.nz and msltime2.irl.cri.nz Telephone Time Service A dial up computer time setting service for linking computers to UTC(MSL). The service uses a time code specific to New Zealand. Because it is a pay service, access is restricted to callers within New Zealand. Speaking Clock A speaking clock gives New Zealand time. Because it is a pay service, access is restricted to callers within New Zealand. Further information about these services can be found at http://www.irl.cri.nz/msl/services/time/index.html

NICT	Telephone Time Service (TTS) Provides digital time code accessible by computer at 300/1200/2400 bps, 8 bits, no parity. Access phone numbers: + 81 42 327 7592.
	Network Time Service (NTS) NICT operates a Stratum 1 time server linked to UTC(NICT) using the "Network Time Protocol" (NTP).
	Internet Time Service (ITS) NICT operates four time servers by using NTP. Host name of these servers: ntp.nict.jp (Round robin).
	GPS common view data NICT provides the GPS common view data based on UTC(NICT) to the time business service in Japan.
NIM (2)	Television Time Service The coded time information generated by one time code generator is inserted into the TV signal. It can be obtained by using a decode TV receiver. The time reference is UTC(NIM). Access TV channels of CCTV.
	Telephone Time Service The coded time information generated by NIM time code generator, referenced to UTC(NIM). Telephone Code provides digital time code at 1200 to 9600 bauds, 8 bits, no parity, 1 stop bit. Access phone number: 8610 6422 9086.
	Network Time Service Provides digital time code across the Internet using NTP.
NIMB	2 NTP servers are available: Addresses: ntp.oraoficiala.ro (STRATUM 2) with an open access policy ntp.inm.ro (STRATUM 1) with restricted access policy. Both NTP servers are referenced to UTC (NIMB)
NIMT	2 NTP servers are available: Addresses: 203.158.69.60 203.158.69.61 Both NTP servers are referenced to UTC(NIMT)
NIST	Automated Computer Time Service (ACTS) Provides digital time code by telephone modem for setting time in computers. Free software and source code available for download from NIST. Includes provision for calibration of telephone time delay. Access phone numbers : +1 303 494 4774 (24 phone lines) and +1 808 335 4721 (4 phone lines). Further information at http://tf.nist.gov/service/acts.htm
	Internet Time Service (ITS) Provides digital time code across the Internet using three different protocols: Network Time Protocol, Daytime Protocol, and Time Protocol.
	Geographically distributed set of 16 time servers at 13 locations within the United States of America. Free software and source code available for download from NIST. Further information at http://tf.nist.gov/service/its.htm

(2) Information based on the Annual Report 2005, not confirmed by the Laboratory.

	Web-based time-of-day clock that displays UTC or local time for United States time zones. Referenced to NIST Internet Time Service. Provides snapshot of time with any web browser, but continuously running time display requires web browser with Java plug-in installed. Available at http://www.time.gov (in cooperation with the United States Naval Observatory), and at http://nist.time.gov
	Telephone voice announcement: Audio portions of radio broadcasts from time and frequency stations WWV and WWVH can be heard by telephone: +1 303 499 7111 for WWV +1 808 335 4363 for WWVH
NMISA	Telephone Time Service (TTS) Provides digital time code accessible by computer for setting time in computers. Measurement of telephone transmission delay is included. Access phone numbers: + 27 12 349 1576, + 27 12 349 1577. More information and software for accessing the service is available at http://www.nml.csir.co.za/
	Network Time Service Two NTP servers are available, tick.nml.csir.co.za with restricted access policy and tock.nml.csir.co.za with an open access policy. More information is available at http://www.nml.csir.co.za/time.htm
NMLS (2)	Telephone Time Service The coded time information is referenced to UTC(NMLS) and generated by a TUG type telephone time code generator using an ASCII-character code. The time protocols are sent in the "European Telephone Time Code" format. The service phone number is +60 3 8778 1674. Current service status is free of charge. Fees are made only on the provision of the software for accessing the service via modem dial-up.
	Network Time Protocol Version 3 The NTP time information is referenced to UTC(NMLS) and is currently generated by two Stratum-1 and Stratum-2 NTP servers, made available for public freely. The addresses for the servers are mst.sirim.my, 202.190.27.9 and 202.190.27.10.
NPL	Telephone Time Service A TUG time code generator provides the European Telephone Time Code, referenced to UTC(NPL), by telephone modem. Software for synchronising computers is available from the NPL web site at www.npl.co.uk/time. The service telephone number is 0906 851 6333. Note: this is a premium rate number and can only be accessed from within the UK.
	Internet Time Service Two servers referenced to UTC(NPL) provide Network Time Protocol (NTP) time code across the internet. More information is available from the NPL web site at www.npl.co.uk/time. The server host names are: ntp1.npl.co.uk ntp2.npl.co.uk

(2) Information based on the Annual Report 2005, not confirmed by the Laboratory.

NPLI	Telephone Time Service The coded time information generated by time code generator of NPLI, referenced to UTC(NPLI). Telephone Code provides digital time code (for the current time of Indian standard Time) at 1200 bauds, 8 bits, no parity, 1 stop bit. This service is known as TELECLOCK Service. Accessible by : a. an NPLI-developed Teleclock Receiver already available in the market. b. a Computer through Telephone Modem and NPLI-developed software. One-way Geostationary Satellite Time Service.
NRC	Telephone Code Provides digital time code by telephone modem for setting time in computers. Access phone number : +1 613 745 3900. http://inms-ienm.nrc-cnrc.gc.ca/time_services/computer_timedate_e.html Talking Clock Service Voice announcements of Eastern Time are at ten-second interval followed by a tone to indicate the exact time. The service is available to the public in English at +1 613 745 1576 and in French at +1 613 745 9426. For more information see: http://inms-ienm.nrc-cnrc.gc.ca/time_services/cbc_broadcasts_e.html Web Clock Service The Web Clock shows dynamic clocks in each Canadian Time zone, for both Standard time and daylight saving time. The web page is at: http://time5.nrc.ca/webclock_e.shtml. Network Time Protocol Operates two time servers using the " Network Time Protocol ", each one being on different location and network. Host names : time.nrc.ca and time.chu.nrc.ca Further information at http://inms-ienm.nrc-cnrc.gc.ca/time_services/network_time_protocol_e.html
NTSC	Network Time Service (NTS) Provides a synchronization to UTC(NTSC) computer clocks within China. Software for the synchronization of computer clocks is available on the NTSC Time and Frequency home page : http://time.ntsc.ac.cn Access Policy: free Contact: Shaowu DONG (dongsw@ntsc.ac.cn).
ONBA (2)	Speaking clock access phone number 113 (only accessible in Argentina). Hourly and half hourly radio-broadcast time signal. Internet time service at web site www.hidro.gov.ar/hora/hora.asp
ONRJ	Telephone Voice Announcer (55) 21 25800637. Telephone Code (55) 21 25800677 provides digital time code at 300 bauds, 8 bits, no parity, 1 stop bit (Leitch CSD5300)

(2) Information based on the Annual Report 2005, not confirmed by the Laboratory.

Internet Time Service at the address : 200.20.186.75
SNTP at port 123
Time/UDP at port 37
Time/TCP at port 37
Daytime/TCP at port 13

WEB-based Time Services:
1) A real-time clock aligned to UTC(ONRJ) and corrected for internet transmission delay.
Further information at: http://200.20.186.71/asp/relogio/horainicial.asp
2) Voice Announcer, in Portuguese, each ten seconds, after download of the Web page at: http://200.20.186.71.

ORB

Network Time Service via NTP protocol
Hostname : ntp1.oma.be and ntp2.oma.be
Access policy : free
Synchronization to UTC(ORB)
Contact : f.roosbeek@oma.be
Information on the web pages
http://www.observatoire.be/D1/TIME/ntp_en.htm

ORB provides a time dissemination via phone and modem to synchronize PC clocks on UTC(ORB). The system used is the Time Distribution System from TUG, which produces the telephone time code mostly used in Europe.
The baud rate used is 1200. The access phone number is 32 (0) 2 373 03 20. The system is updated periodically with DUT1 and leap seconds

PTB

Telephone Time Service
The coded time information is referenced to UTC(PTB) and generated by a TUG type time code generator using an ASCII-character code. The time protocols are sent in a common format, the " European Telephone Time Code ". Access phone number : +49 531 51 20 38 .

Internet Time Service
The PTB operates two time servers using the " Network Time Protocol " (NTP). Software for the synchronization of computer clocks is available on the web pages of the PTB
http://www.ptb.de/en/org/q/q4/q42/_index.htm).
Host names of the servers: ptbtime1.ptb.de
ptbtime2.ptb.de

ROA

Telephone Code
The coded time information is referenced to UTC(ROA) and generated by a TUG type time code generator using an ASCII-character code. The time protocols are sent in a common format, the "European Telephone Time Code". Access phone number : +34 956 599 429

Network Time Protocol
Server : hora.roa.es
Synchonized to UTC(ROA) better than 10 microseconds
Service policy : free

Server : ntp0.roa.es
Synchonized to UTC(ROA) better than 10 microseconds
Service policy : restricted
Note : server used as prototype to check new software, hardware, etc.

SG	Website: http://www.SingaporeStandardTime.org.sg. Automated Computer Time Service (ACTS) Transmits digital time code (NIST format) via telephone modem for setting time in computers. The coded time information is referenced to UTC(SG). Includes provision for correcting telephone time delay. Free software available for downloading from the website. Access phone number : +65 67799978. Network Time Service (NeTS) Transmits digital time code via the Internet using three protocols – Time Protocol, Daytime Protocol and Network Time Protocol. Free software available for downloading from the website. Operates two time servers at addresses nets.org.sg and 203.117.180.35. Web-based time service: Displays a real time clock referenced to NeTS. User-selectable display of local time (adjusted for daylight saving) of any major city worldwide and time difference information between any two cities. Further information is available at the website.
SP	Telephone Time Service The coded time information is referenced to UTC(SP) and generated by two TUG type time code generators using an ASCII-character code. The time protocols are sent in a common format, the "European Telephone Time Code". Access phone number: +46 33 41 57 83 Internet Time Service The coded time information is referenced to UTC(SP) and generated by two NTP servers using the Network Time Protocol (NTP). Access host names : ntp1.sp.se and ntp2.sp.se Speaking Clock The speaking clock service is operated by Telia AB in Sweden. The time announcement is referenced to UTC(SP) and disseminated from a computer based system operated and maintained at SP. Access phone number : 90510 (only accessible in Sweden). Access phone number : +4633 90510 (from outside Sweden). More information about these services are found at the web site www.sp.se
TL	Speaking Clock Service Traceable to UTC(TL). Broadcast through PSTN (Public Switching Telephone Network) automatically and provides accurate voice time signal to public users. The Computer Time Service Provides digital time code by telephone modem for setting time in computers. Access phone number : +886 3 4245117. NTP Service TL operates a time server using the "Network Time Protocol (NTP)". Host name of the server : time.stdtime.gov.tw Further information at http://www.stdtime.gov.tw/english/e-home.htm

TP	Internet Time Service IPE operates a time server directly referenced to UTC(TP). Time information is accessible through Network Time Protocol (NTP). Server host name: time.ufe.cz More information at http://www.ufe.cz/time
UME	Telephone Time Service Providing the European time code that is referenced to UTC(UME) by telephone modem for setting computer time. Includes compensation of propagation time delay. More information for this service please contact to eml@ume.tubitak.gov.tr. Access phone number : +90 262 679 50 24 Network Time Service UME operates an NTP server referenced to UTC(UME). Host server name : time.ume.tubitak.gov.tr
USNO	Telephone Voice Announcer +1 202 762-1401 Backup voice announcer: +1 719 567-6742 Telephone Code +1 202 762-1594 provides digital time code at 1200 baud, 8 bits, no parity Automated data service for downloading files +1 202 762-1503 Web site for time and for data files: http://tycho.usno.navy.mil Network Time Protocol (NTP) see http://tycho.usno.navy.mil/ntp.html for software and site closest to you.
VNIIFTRI	Internet Time Service VNIIFTRI operates three time servers Stratum 1and one time server Stratum 2 using the "Network Time Protocol" (NTP). The server host names are: ntp1.imvp.ru (Stratum 1) ntp2.imvp.ru (Stratum 1) ntp3.imvp.ru (Stratum 1) ntp21.imvp.ru (Stratum 2).
VSL	Telephone Time Service The coded time information is referenced to UTC(VSL) and generated by a TUG type time code generator using an ASCII-character code. The time protocols are sent in a common format, the "European Telephone Time Code". The access phone number is 0900 6171819. This is a toll number and therefore can only be accessed in the Netherlands.

Director's Report on the Activity and Management of the BIPM, 2006, T. 7

(July 2005 – June 2006)

BIPM Publication

1 International Atomic Time (TAI) and Coordinated Universal Time (UTC)

The reference time scales, International Atomic Time (TAI) and Coordinated Universal Time (UTC), are computed from data reported regularly to the BIPM by the various timing centres that maintain a local UTC; monthly results are published in *Circular T*. The *Annual Report of the BIPM Time Section for 2005* volume **18**, complemented by computer-readable files on the BIPM website (http://www.bipm.org), provides the definitive results for 2005.

2 Algorithms for time scales

The algorithm used for the calculation of time scales is an iterative process that starts by producing a free atomic scale (*Échelle Atomique Libre* or EAL) from which TAI and UTC are derived. Research into time scale algorithms is conducted in the section with the aim of improving the long-term stability of EAL and the accuracy of TAI.

2.1 EAL stability

Some 85 % of the clocks used in the calculation of time scales are either commercial cæsium clocks of the HP/Agilent 5071A type or active, auto-tuned hydrogen masers. To improve the stability of EAL, a weighting procedure is applied to clocks where the maximum relative weight each month depends on the number of participating clocks. About 14 % of the participating clocks have been at the maximum weight, on average, during 2005. This procedure generates a time scale which relies upon the best clocks.

Since 2003, it is estimated that the stability of EAL, expressed in terms of an Allan deviation, has been about 0.4×10^{-15} for averaging times of one month. Slowly varying long-term drifts limit the stability to around 2×10^{-15} for averaging times of six months.

2.2 TAI accuracy

To characterize the accuracy of TAI, estimates are made of the relative departure, and its uncertainty, of the duration of the TAI scale interval from the SI second, as produced on the rotating geoid, by primary frequency standards. Since July 2005, individual measurements of the TAI frequency have been provided by eight primary frequency standards, including four cæsium fountains (IT CSF1, LNE-SYRTE FO2, NIST F1, and NMIJ F1). Reports on the operation of the primary frequency standards are regularly published in the *Annual Report of the BIPM Time section* and on the BIPM website.

Starting in July 2004, a monthly steering correction of, a maximum, 0.7×10^{-15} is applied as deemed necessary. Since July 2005, the global treatment of individual measurements has led to a relative departure of the duration of the TAI scale unit from the SI second on the geoid ranging from $+1.9 \times 10^{-15}$ to $+5.9 \times 10^{-15}$, with a standard uncertainty of about 1×10^{-15} to 2×10^{-15}. Since October 2005, we have used in this computation a revised estimation of the stability of the free atomic time scale EAL. Over the year, twelve steering corrections have been applied for a total correction of $[f(EAL) - f(TAI)]$ of -6×10^{-15}.

A CCTF Working Group on Primary Frequency Standards has been established to optimize the contribution of the primary frequency standards to the accuracy of TAI.

2.3 Determination of uncertainties in [*UTC* – *UTC*(*k*)]

The values of the uncertainties of [*UTC* – *UTC*(*k*)] have been published in *Circular T*. The original method of calculation has been refined allowing the inclusion of: all available calibration information, more details for the correlation between the links, methods for optimizing the link structure, given uncertainty information, non-Gaussian behaviour, and different correlation properties of uncertainties due to calibration or due to random noise. This work is a cooperation with colleagues of the INRIM and the USNO.

2.4 Independent atomic time scales

TT(BIPM)

Because TAI is computed in "real-time" and has operational constraints, it does not provide an optimal realization of Terrestrial Time TT, the time coordinate of the geocentric reference system. The BIPM therefore computes an additional realization TT(BIPM) in post-processing, which is based on a weighted average of the evaluation of the TAI frequency by the primary frequency standards. We have provided an updated computation of TT(BIPM), named TT(BIPM2005), valid until December 2005. Here, we used all recently available data from the new cæsium fountains and a revised estimation of the stability of the free atomic time scale EAL on which TAI is based.

3 Primary frequency standards and secondary representations of the second

Members of the BIPM Time section are actively participating in the work of the CCTF Working Group on Primary Frequency Standards (PFS), encouraging better documentation, comparison, and use of high accuracy PFS (Cs fountains) for TAI.

In parallel, other microwave and optical atomic transitions (Rb, Hg^+, Yb^+, Sr^+) are being proposed as secondary representations of the second by the CCL/CCTF Joint Working Group on Secondary Representations of the Second. An extensive comparison of measurements from fountain PFS, a Rb fountain, and a Yb^+ optical standard spanning six years has been carried out. BIPM staff continue to participate in the rapidly evolving field of optical frequency standards, addressing, for example, the issue of their comparison at the 10^{-17} uncertainty level or below.

4 Time links

Clock comparisons can presently be made by three independent techniques: satellite common-view based on C/A code measurements from GPS single frequency receivers; satellite common-view obtained with dual-frequency, multi-channel GPS geodetic type receivers (P3); and two-way satellite time and frequency transfer through geostationary telecommunications satellites (TWSTFT). Significant improvement is being made with the growing number of time links with P3 receivers (twelve official links in June 2006, and several more computed as additional links), and with the increase of the frequency of TWSTFT observations (up to twelve per day for links in Europe and with North America). The classical GPS single-channel single-frequency receivers that today represent only 25 % of the time transfer equipment are being replaced to allow multi-channel, single or dual frequency observations. As a result, there has been an improvement in the accuracy for time transfer, and the whole system of time links becomes more reliable.

Testing continues on other time and frequency comparison methods and techniques. Exhaustive analysis has proved that further improvement should be possible, in particular, for clock comparison over long distances by calculating GPS all-in-view solutions instead of the current GPS common-views. The CCTF Working Group on TAI has established two study groups to analyze the benefits of this change, which will be operational before the end of 2006. Results of link comparisons by the different techniques and methods are available on the BIPM website.

4.1 Global Positioning System (GPS) and Global Navigation Satellite System (GLONASS) code measurements

All GPS links are corrected for satellite positions using IGS (International GNSS Service) post-processed, precise satellite ephemerides, and those performed with single-frequency receivers are corrected for ionospheric delays using IGS maps.

4.2 Phase and code measurements from geodetic-type receivers

GPS and GLONASS time and frequency transfer may also be carried out using dual-frequency, carrier-phase measurements in addition to code measurements. This technique, already in common use in the geodetic community, can be adapted to the needs of time and frequency transfer. These studies are conducted in the framework of the IGS working group on clock products, of which a physicist of the section is a member.

The method developed to perform the absolute calibration of the Ashtech Z12-T hardware delays allows us to use this receiver for differential calibrations of similar receivers worldwide. Calibration trips began in January 2001. From July 2005 to June 2006, 12 such calibrations have taken place concerning receivers in seven laboratories. For 2006, calibration results are also issued for the new type of receiver Septentrio PolaRx2, and other types of receivers are being investigated in collaboration with laboratories equipped with such receivers. The BIPM's second Ashtech Z12-T serves as a local reference with which the travelling Ashtech Z12-T is compared between calibration trips.

Data from geodetic-type receivers worldwide are collected for TAI computation, using procedures and software developed in collaboration with the Observatoire Royal de Belgique (ORB). As of June 2005, 17 laboratories regularly provide such P3 data. Time links computed using these data are systematically compared to those generated by other available techniques, notably for two-way time transfer. Geodetic-type receivers also provide raw phase measurements which may be used, along with the code measurements, to compute time links. This is routinely done by the IGS for some time laboratories which are also part of the IGS network. In addition, new Precise Point Positioning (PPP) software, obtained in collaboration with geodetic institutes, allows the BIPM to compute its own solutions for such time links. Comparisons between PPP, IGS, P3 and two-way links lead to insightful results on the stability of each technique.

4.3 Two-way time transfer

Three meetings related to TWSTFT activities have been held since July 2005. The BIPM collects two-way data from 16 operational stations and undertakes treatment of some two-way links. About ten TWSTFT links are routinely used in the computation of TAI; some others are in preparation for their introduction into TAI. The BIPM is also involved in the calibration of two-way time-transfer links by comparison with GPS.

4.4 Uncertainties of TAI time links

The values of the type A and type B uncertainties of TAI time links are published in the *Circular T*, together with the information on the time links used in each monthly calculation.

4.5 Calibration of TAI time links

The BIPM is conducting a series of calibrations of GPS time equipment in time laboratories which contribute to TAI. From July 2005 to June 2006, GPS time equipment in five laboratories and GPS P3 equipment in seven laboratories have been calibrated. In addition, the Time section is developing methods for calibration of GPS/GLONASS time receivers. The BIPM is also taking part in the organization of TWSTFT calibration trips.

5 Key comparisons

Monthly updates of key comparison in time CCTF-K2001.UTC are published after the publication of *Circular T*. Timing centres in laboratories who are participants to the CIPM MRA, from Member States and Associates of the CGPM, are published in the BIPM key comparison database.

6 Pulsars

Collaboration continues with the Observatoire Midi-Pyrénées (OMP), Toulouse and other radio-astronomy groups observing pulsars and analyzing pulsar data to study the potential capability of millisecond pulsars as a means of sensing the very long-term stability of atomic time. The Time section provides these groups with its post-processed realization of Terrestrial Time.

7 Space-time references

A web and ftp site for the *IERS Conventions* has been established at the BIPM (http://tai.bipm.org/iers/) and a user discussion forum has been created (http://tai.bipm.org/iers/forum/) for users to offer comments related to the future updates of the *IERS Conventions*. Updates to the *Conventions* (2003) have been posted on the website (http://tai.bipm.org/iers/convupdt). These updates consider several new models for effects that affect the positions of Earth's points at the mm level, which is now significant. These modifications are studied with the help of the Advisory Board for the *IERS Conventions* updates, including representatives of all groups involved in the IERS.

Activities related to the realization of reference frames for astronomy and geodesy are developed in cooperation with the IERS.

8 Other studies

P. Wolf was on secondment at the Paris Observatory (OP) until August 2005. Part of the work reported below was carried out as a contribution to their programmes.

A novel test of Lorentz invariance using spin polarized atoms in a Cs atomic fountain at the LNE-SYRTE (OP) was carried out and published. It tests for the dependence of the transition frequency of the atoms on the orientation of their spin with respect to a putative preferred frame. The results improve previous limits on the corresponding parameters of a comprehensive test theory by 11 and 13 orders of magnitude.

P. Wolf is supervisor of a doctoral student at OP, on the development, modelling and data analysis of the microwave link (MWL) time transfer system of the future ACES (Atomic Clock Ensemble in Space) mission. The MWL will allow the comparison of distant clocks at an uncertainty of 1×10^{-16} after an integration time of one day, an order of magnitude below the best performance of present systems. This is an essential step towards the comparison of future clocks at or below that uncertainty.

9 Publications, lectures, travel: Time section

9.1 External publications

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