BUREAU INTERNATIONAL DES POIDS ET MESURES

BIPM Annual Report on Time Activities

Rapport annuel du BIPM sur les activités du temps

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[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 sur le 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 ftp://ftp2.bipm.org, user anonymous, e-mail address as password, cd pub/tai).
Links is available by ftp://62.161.69.131 or ftp://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 on time activities

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	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 (until April 2008)	schglo.XX

Older files can be accessed directly from the ftp site ftp://62.161.69.5 or ftp://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) computation ending in 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 ftp://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 almost 70 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 (Échelle 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]. 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. Single-frequency GPS data are corrected using the ionospheric maps produced by the Center for Orbit Determination in Europe (CODE); all GPS data are corrected using precise satellite ephemerides and clocks produced by the International GNSS Service (IGS).

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. The network of time links is shown on page 11 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. Tracking schedules for GLONASS have been interrupted since October 2008 as all GLONASS time receivers in operation are multi-channel, not requiring schedule. 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, 5]. 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 2008.

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

The report on the scientific work of the BIPM on time activities for the period July 2007-June 2008, published in the *Director's Report on the Activity and Management of the BIPM*, 2008, **9** is reproduced after the yellow pages. All the publications mentioned in this report are available on request from the BIPM.

References

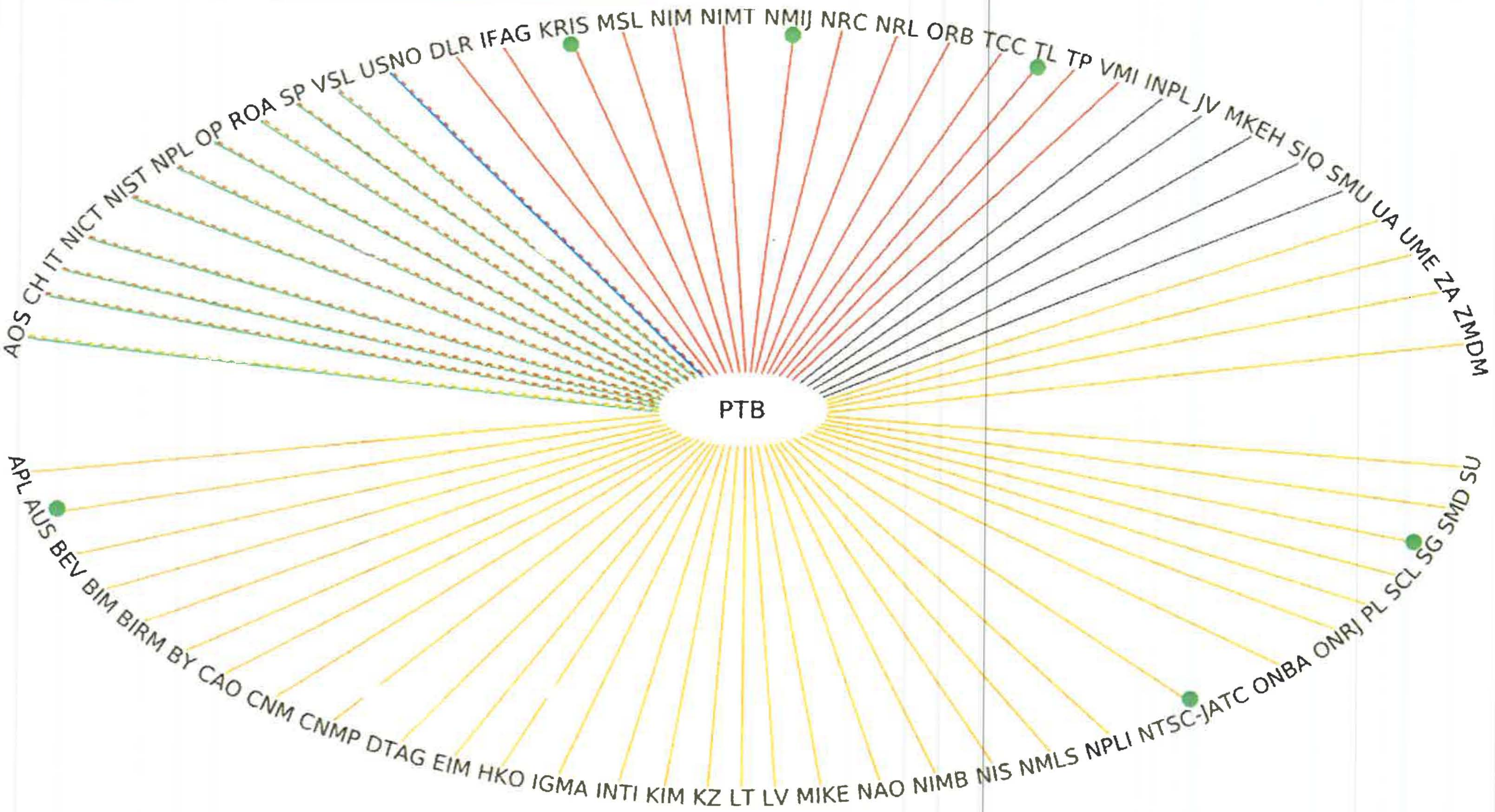
[1] Thomas C. and Azoubib J., TAI computation: study of an alternative choice for implementing an upper limit of clock weights, *Metrologia*, 1996, **33**, 227-240.

[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., GPS All in View time transfer for TAI computation, *Metrologia*, 2008, **45** (1), 35-45.

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

[5] Petit G., A new realization of Terrestrial Time, Proc. 35th PTTI, 2003, 307-317.



ORGANIZATION OF THE ALL-IN-VIEW INTERNATIONAL TIME LINKS

March 2009

- 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 70 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 h UTC, « 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. 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 données GPS mono-fréquence sont corrigées à l'aide des cartes ionosphériques produites par le CODE; toutes les données GPS sont corrigées en utilisant des éphémérides et valeurs d'horloges précises des satellites produites par l'IGS.

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 se trouve à la page 11 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' Astrogeo-dynamical Observatory (AOS), Pologne.*

Le BIPM publie tous les six mois des programmes de poursuite des satellites du GPS. La publication des programmes pour les satellites du GLONASS a été interrompue depuis octobre 2008 puisque tous les récepteurs de temps GLONASS en opération sont multicanaux. La liste de ces programmes est reproduite dans ce rapport et leur contenu est disponible sur le site web (voir p. 5 de ce volume).

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, 5]. 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 (voir p. 5 de ce volume).

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 2008.
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 2007 - juin 2008) du travail scientifique du BIPM sur les activités du temps publié dans le Rapport du directeur sur l'activité et la gestion du Bureau international des poids et mesures (BIPM), 2008, **9**, *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 2009

Date (at 0 h 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
2009 Jan. 1	"	-1

Table 2. Relationship between TAI and UTC, up to 31 December 2009

Limits of validity (at 0 h 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 - 2009 Jan. 1	33
2009 Jan. 1 -	34

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 April 2009)

AMC	Alternate Master Clock station, Colorado Springs, Colo., USA
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, Switzerland (METAS)
CNM	Centro Nacional de Metrología, Querétaro, Mexico (CENAM)
CNMP	Centro Nacional de Metrología, de Panamá, Panamá
DLR	Deutsche Zentrum für Luft- und Raumfahrt (German Aerospace Centre) Oberpfaffenhofen, Germany
DTAG	Deutsche Telekom AG, Frankfurt/Main, Germany
EIM	Hellenic Institute of Metrology, Thessaloniki, Greece
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
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
INTI	Instituto Nacional de Tecnologia Industrial, Buenos Aires, Argentina
IPQ	Instituto Português da Qualidade, Monte de Caparica, Portugal
IT	Istituto Nazionale di Ricerca Metrologica (I.N.RI.M.), Italy
JATC	Joint Atomic Time Commission, Lintong, P.R. China
JV	Justervesenet, Norwegian Metrology and Accreditation Service, Kjeller, Norway
KIM	Research Centre for Calibration, Instrumentation and Metrology The Indonesian Institute of Sciences, Serpong-Tangerang, Indonesia
KRIS	Korea Research Institute of Standards and Science, Daejeon, Rep. of Korea
KZ	Kazakhstan Institute of Metrology, Astana, Kazakhstan
MIKE	Center for Metrology and Accreditation, Finland
MKEH	Hungarian Trade Licensing Office, Hungary
LDS	University of Leeds, Leeds, United Kingdom
LT	Lithuanian National Metrology Institute, Vilnius, Lithuania
LV	SA Latvian National Metrology Centre, Riga, Latvia
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

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 April 2009)

NMIA	National Measurement Institute, Australia, Sydney, Australia
NMIJ	National Metrology Institute of Japan, Tsukuba, Japan
NMLS	National Metrology Laboratory of SIRIM Berhad, Shah Alam, Malaysia
NPL	National Physical Laboratory, Teddington, United Kingdom
NPLI	National Physical Laboratory, New Delhi, India
NRC	National Research Council of Canada, Ottawa, Canada
NRL	U.S. Naval Research Laboratory, Washington D.C., USA
NTSC	National Time Service Center 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, Singapore (SPRING)
SIQ	Slovenian Institute of Quality and Metrology, Ljubljana, Slovenia
SMD	Metrology Division of the Quality and Safety Department - Scientific Metrology Brussels, Belgium
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
UA	National Science Center "Institute of Metrology", Kharkhov, Ukraine
UME	Ulusai Metroloji Enstitüsü, Marmara Research Centre, (National Metrology Institute), Gebze Kocaeli, Turkey
USNO	U.S. Naval Observatory, Washington D.C., USA
VMI	Vietnam Metrology Institute, Ha Noi, Vietnam
VSL	Van Swinden Laboratorium, Delft, the Nederlands
ZA	National metrology Institute of South Africa, Pretoria, South Africa
ZMDM	Bureau of Measures and Precious Metals, Belgrade, Serbia

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 2008

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	3 Ind. Cs 2 H-masers	1 H-maser (2) + microphase-stepper		*	*	*	*
APL	3 Ind. Cs 3 H-masers	1 Cs + microphase-stepper		*			
AUS	4 Ind. Cs 2 H-masers	1 Cs		*	*		
BEV	3 Ind. Cs 1 H-maser	1 Cs		*			
BIM	1 Ind. Cs	1 Cs		*			
BIRM	2 Ind. Cs 6 H-masers	1 Cs		*	*		
BY	6 H-masers	3-4 H-masers		*			
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	2 Ind. Cs	1 Cs		*			
DLR (a)	3 Ind. Cs 5 H-masers	1 Cs			*		
DTAG	3 Ind. Cs	1 Cs		*			
EIM	4 Ind. Cs	1 Cs		*			
HKO	2 Ind. Cs	1 Cs		*			
IFAG	5 Ind. Cs 2 H-masers	1 Cs + microphase-stepper		*	*		
IGMA (a)	3 Ind. Cs	1 Cs + microphase-stepper		*			
INPL	2 Ind. Cs	1 Cs		*			
INTI	1 Ind. Cs	1 Cs		*			

Table 4. Equipment and source of UTC(k) of the laboratories contributing to TAI in 2008 (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		
IT	5 Ind. Cs 2 H-masers 1 Lab. Cs	1 H-maser + microphase-stepper	*	*	*	*	*
JATC	18 Ind. Cs (4) 4 H-masers	1 Cs + microphase-stepper	*	*	*		*
JV (a)	4 Ind. Cs	1 Cs		*			
KIM	1 Ind. Cs	1 Cs		*	*	*	
KRIS	5 Ind. Cs 4 H-masers	1 H-maser + microphase-stepper	*	*	*	*	*
KZ	1 Ind. Cs	1 Cs			*	*	
LDS (a)	1 Ind. Cs	1 Cs		*		*	
LT	2 Ind. Cs	1 Cs		*			
LV	2 Ind. Cs	1 Cs		*			
MIKE	2 Ind. Cs 3 H-masers	1 H-maser + microphase-stepper		*	*	*	
MKEH	1 Ind. Cs	1 Cs		*			
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 (5) 1 Lab. Cs	18 Cs	*	*	*		*
NIM	3 Ind. Cs 2 H-masers	1 Cs + microphase-stepper		*	*		
NIMB	2 Ind. Cs	1 Cs		*			
NIMT	2 Ind. Cs	1 Cs		*	*		
NIS	3 Ind. Cs	1 Cs		*	*	*	

Table 4. Equipment and source of UTC(k) of the laboratories contributing to TAI in 2008 (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		
NIST	8 Ind. Cs 2 Lab. Cs 6 H-masers	4 Cs 6 H-masers + microphase-stepper	*	*	*	*	*
NMIJ	4 Ind. Cs 1 Lab. Cs 3 H-masers	1 H-maser + microphase-stepper		*	*		*
NMLS (a)	5 Ind. Cs	1 Cs			*		
NPL	3 Ind. Cs 4 H-masers	1 H-maser		*	*		*
NPLI	3 Ind. Cs	1 Cs		*			
NRC	6 Ind. Cs 2 Lab. Cs 3 H-masers	1 Ind. Cs + microphase-stepper	*		*		
NRL	2 Ind. Cs 4 H-masers	1 H-maser + microphase-stepper			*	*	*
NTSC	18 Ind. Cs 4 H-masers	1 Cs + microphase-stepper	*	*	*		*
ONBA	1 Ind. Cs	1 Cs		*			
ONRJ	6 Ind. Cs	1 Cs + microphase-stepper	* (6)	*			
OP	8 Ind. Cs 3 Lab. Cs 4 H-masers	1 Cs + microphase-stepper	* (7)	*	*	*	*
ORB	3 Ind. Cs 3 H-masers	1 H-maser			*		
PL	11 Ind. Cs 4 H-masers	1 Cs (8) + microphase-stepper	* (9)	*			
PTB	3 Ind. Cs 3 Lab. Cs (10) 3 H-masers	1 Lab. Cs	* (11)	*	*	*	*
ROA	5 Ind. Cs 1 H-maser	all the Cs		*	*		*
SCL	2 Ind. Cs	1 Cs + microphase-stepper		*			
SG	2 Ind. Cs (12) 1 H-maser	1 Cs + microphase-stepper		*	*		*

Table 4. Equipment and source of UTC(k) of the laboratories contributing to TAI in 2008 (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 SF	Time Links GPS DF	GLONASS	Two-Way
SIQ	1 Ind. Cs	1 Cs		*			
SMU	1 Ind. Cs	1 Cs + output frequency steering		*			
SP	13 Ind. Cs (13) 6 H-masers	1 H-maser + microphase-stepper			*		*
SU	1 Lab. Cs 8 H-masers	3-4 H-masers	* (14)	*		*	
TCC	2 Ind. Cs 3 H-masers	1 Cs		*	*		
TL	14 Ind. Cs 2 H-masers	1 H-maser + microphase-stepper	* (15)		*		*
TP	4 Ind. Cs	1 Cs + output frequency steering		*	*		
UA	5 H-masers	3 H-masers + microphase-stepper		*			
UME (a)	3 Ind. Cs	1 Cs		*	*	*	
USNO	72 Ind. Cs 24 H-masers	1 H-maser + frequency synthesizer steered to UTC(USNO) (16)	* (16)	*	*		*
VMI	3 Ind. Cs	1 Cs		*	*		
VSL	4 Ind. Cs	1 Cs + microphase-stepper			*		*
ZA	4 Ind. Cs	1 Cs		*		*	
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)	AOS	The UTC(AOS) is formed technically using 1H-maser and microstepper, it is steered using TA(PL) data as a reference.
(3)	CH	All the standards are located in Bern at METAS (Federal Office of Metrology). Since November 2007, UTC(CH) is defined in real time by a hydrogen maser steered to the paper time scale UTC(CH.P) which is defined as a weighted average of all the clocks, steered to UTC. TA(CH) is also a weighted average of all the clocks, but free running.
(4)	JATC	The standards are located at National Time Service Centre (NTSC). The link between UTC(JATC) and UTC(NTSC) is obtained by internal connection.
(5)	NICT	The standards are located as follows (at the end of 2008):

* Koganei Headquarters	20 Cs, 7 H-masers
* Ohtakadoya-yama LF station	3 Cs
* Hagane-yama LF station	3 Cs
* Kobe Advanced ICT Research Center	2 Cs

(6)	ONRJ	The Brazilian atomic time scale TA(ONRJ) is computed by the National Observatory in Rio de Janeiro with data from 6 industrial caesium clocks.
(7)	OP	The French atomic time scale TA(F) is computed by the LNE-SYRTE with data from 27 industrial caesium clocks located as follows (at the end of 2008) :

* Centre Electronique de l'Armement (CELAR, Rennes)	1 Cs
* Centre National d'Etudes Spatiales (CNES, Toulouse)	5 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)	8 Cs
* Observatoire de Besançon (OB, Besançon)	3 Cs
* Direction des Constructions Navales (DCN, Brest)	4 Cs

All laboratories are linked via GPS receivers.

The TA(F) frequency steering, based on the LNE-SYRTE PFS data, is published in OP Time Service Bulletin.

(8)	PL	The Polish official timescale UTC(PL) is maintained by the GUM.

Notes (Cont.)

(9)	PL	The Polish atomic timescale TA(PL) is computed by the AOS and GUM with data from 14 caesium clocks and 4 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)	2 Cs, 2 H-maser
		* National Institute of Telecommunications (IŁ, Warsaw)	2 Cs
		* Polish Telecom (TPSA, Warsaw)	2 Cs
		* Military Primary Standards Laboratory (CWOM, Warsaw)	1 Cs, 1 H-maser
		* Tele & Radio Research Institute (ITR, Warsaw)	1 Cs
		and additionally	
		* Time and Frequency Standard Laboratory of the Semiconductor Physics Institute, a guest laboratory from Lithuania (LT, Vilnius, Lithuania)	2 Cs
		* Time and Frequency Laboratory of Latvian National Metrology Centre, a guest laboratory from Latvia (LV, Riga, Latvia)	1 Cs
		All laboratories are linked via MC GPS-CV receivers, except for one clock of TPSA linked via two-way optical fibre connection.	
(10)	PTB	The laboratory Cs, PTB CS1 and PTB CS2 are operated continuously as clocks. 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.	
(11)	PTB	*TA(PTB)-UTC(PTB)* and the frequency steering applied to UTC(PTB) are published in PTB Time Service Bulletin.	
(12)	SG	3 Ind. Cs, 1 Ind. Cs failed at MJD=54535. H-maser was the reference clock between MJD=54536 and MJD=54654.	
(13)	SP	The standards are located as follows (at the end of 2008):	
		* SP Technical Research Institute of Sweden (SP, Borås)	4 Cs, 2 H-masers
		* STUPI AB (Stockholm)	7 Cs, 3 H-masers
		* Pendulum Instruments AB (Stockholm)	1 Cs
		* Onsala Space Observatory (Onsala)	1 CS, 2 H-masers
(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 2007, not confirmed by the laboratory.	

Table 5. Differences between the normalized frequencies of EAL and TAI, up to April 2009

(File available on http://www.bipm.org under the name EALTAI08.AR, which contains values since the beginning of the steering)

Date	MJD	[f(EAL) - f(TAI)] x 10^{-13}
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
2007 May 29 - 2007 Jun 28	54249 - 54279	6.799
2007 Jun 28 - 2007 Jul 28	54279 - 54309	6.796
2007 Jul 28 - 2007 Aug 27	54309 - 54339	6.793
2007 Aug 27 - 2007 Sep 26	54339 - 54369	6.790
2007 Sep 26 - 2007 Oct 31	54369 - 54404	6.787
2007 Oct 31 - 2007 Nov 30	54404 - 54434	6.784
2007 Nov 30 - 2007 Dec 30	54434 - 54464	6.779
2007 Dec 30 - 2008 Jan 29	54464 - 54494	6.776
2008 Jan 29 - 2008 Feb 28	54494 - 54524	6.772
2008 Feb 28 - 2008 Mar 29	54524 - 54554	6.769
2008 Mar 29 - 2008 Apr 28	54554 - 54584	6.766
2008 Apr 28 - 2008 May 28	54584 - 54614	6.763
2008 May 28 - 2008 Jun 27	54614 - 54644	6.758
2008 Jun 27 - 2008 Jul 27	54644 - 54674	6.753
2008 Jul 27 - 2008 Aug 31	54674 - 54709	6.750
2008 Aug 31 - 2008 Sep 30	54709 - 54739	6.747
2008 Sep 30 - 2008 Oct 30	54739 - 54769	6.742
2008 Oct 30 - 2008 Nov 29	54769 - 54799	6.739
2008 Nov 29 - 2008 Dec 29	54799 - 54829	6.736
2008 Dec 29 - 2009 Jan 28	54829 - 54859	6.731
2009 Jan 28 - 2009 Feb 27	54859 - 54889	6.726
2009 Feb 27 - 2009 Mar 29	54889 - 54919	6.721
2009 Mar 29 - 2009 Apr 28	54919 - 54949	6.716

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 UTAI08.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-CSF1, NIST-F1, NMIJ-F1, PTB-CS1, PTB-CS2, PTB-CSF1, SYRTE-FO1, SYRTE-FO2, SYRTE-FOM and SYRTE-JPO for the year 2008.
Previous calibrations are available in the successive annual reports of the BIPM Time Section volumes 1 to 18 and in the BIPM annual report on time activities volume 1 and 2.

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, computed using the standard uncertainty of [UTC-UTC(k)],
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 2008 are indicated below. Reports of individual PFS evaluations may be found at http://www.bipm.org in the subdirectory named 'data'.

Primary Standard	Type /selection	Type B std. Uncertainty	Operation	Comparison with	Number/typical duration of comp.
IT-CSF1	Fountain	$(0.5 \text{ to } 0.7)\times10^{-15}$	Discontinuous	H maser	6 / 10 to 20 d
NICT-CSF1	Fountain	$(0.8 \text{ to } 1.5)\times10^{-15}$	Discontinuous	UTC(NICT)	2 / 10-15 d
NIST-F1	Fountain	0.3×10^{-15}	Discontinuous	H maser	5 / 15 to 25 d
NMIJ-F1	Fountain	3.9×10^{-15}	Discontinuous	H maser	7 / 15 to 25 d
PTB-CS1	Beam /Mag.	8×10^{-15}	Continuous	TAI	10 / 30 d
PTB-CS2	Beam /Mag.	12×10^{-15}	Continuous	TAI	12 / 30 d
PTB-CSF1	Fountain	0.9×10^{-15}	Discontinuous	H maser	2 / 25 d
SYRTE-FO1	Fountain	$(0.4 \text{ to } 0.6)\times10^{-15}$	Discontinuous	H maser	8 / 10 to 30 d
SYRTE-FO2	Fountain	$(0.4 \text{ to } 0.6)\times10^{-15}$	Discontinuous	H maser	9 / 10 to 30 d
SYRTE-FOM	Fountain	$(0.7 \text{ to } 0.9)\times10^{-15}$	Discontinuous	H maser	6 / 10 to 30 d
SYRTE-JPO	Beam /Opt.	6.3×10^{-15}	Discontinuous	H maser	12 / 10 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	54604 54614	1.7	1.1	0.5	[1]	0.4	0.9	1.5	
IT-CSF1	54614 54634	2.5	1.0	0.5		0.2	0.5	1.2	
IT-CSF1	54649 54669	4.5	0.9	0.5		0.2	0.5	1.1	
IT-CSF1	54709 54729	2.7	0.7	0.7		0.2	0.6	1.2	
IT-CSF1	54754 54769	1.6	0.7	0.4		0.2	0.6	1.0	
IT-CSF1	54774 54789	4.3	0.8	0.7		0.2	0.6	1.2	
NICT-CsF1	54534 54544	2.9	1.0	1.5	[2]	0.3	0.9	2.0	
NICT-CsF1	54709 54724	-0.1	1.0	0.8		0.3	0.9	1.6	
NIST-F1	54469 54494	3.0	0.3	0.3	[3]	0.3	0.4	0.6	
NIST-F1	54554 54569	4.9	0.3	0.3		0.5	0.6	0.9	
NIST-F1	54654 54674	4.1	0.3	0.3		0.3	0.5	0.7	
NIST-F1	54774 54799	6.1	0.1	0.3		0.1	0.4	0.5	
NIST-F1	54814 54829	4.1	0.4	0.3		0.5	0.6	0.9	
NMIJ-F1	54504 54519	3.2	0.9	3.9	[4]	0.4	0.9	4.1	
NMIJ-F1	54529 54549	1.3	0.8	3.9		0.3	0.7	4.0	
NMIJ-F1	54559 54584	-0.1	0.7	3.9		0.3	0.5	4.0	
NMIJ-F1	54594 54614	1.2	0.8	3.9		0.3	0.7	4.0	
NMIJ-F1	54679 54704	2.9	0.7	3.9		0.3	0.5	4.0	
NMIJ-F1	54714 54739	1.6	0.7	3.9		0.3	0.5	4.0	
NMIJ-F1	54774 54789	-0.1	0.9	3.9		0.3	0.9	4.1	
PTB-CS1	54464 54494	-6.7	5.0	8.0	[5]	0.0	0.1	9.4	(1)
PTB-CS1	54494 54524	-9.7	5.0	8.0		0.0	0.1	9.4	
PTB-CS1	54524 54554	3.7	5.0	8.0		0.0	0.1	9.4	
PTB-CS1	54554 54584	2.6	5.0	8.0		0.0	0.1	9.4	
PTB-CS1	54584 54614	5.0	5.0	8.0		0.0	0.1	9.4	
PTB-CS1	54614 54644	0.4	5.0	8.0		0.0	0.1	9.4	
PTB-CS1	54644 54674	-5.7	5.0	8.0		0.0	0.1	9.4	
PTB-CS1	54674 54709	-2.1	5.0	8.0		0.0	0.1	9.4	
PTB-CS1	54709 54739	-13.1	5.0	8.0		0.0	0.2	9.4	
PTB-CS1	54739 54769	-12.5	5.0	8.0		0.0	0.2	9.4	
PTB-CS2	54464 54494	1.7	3.0	12.0	[6]	0.0	0.1	12.4	(1)
PTB-CS2	54494 54524	7.5	3.0	12.0		0.0	0.1	12.4	
PTB-CS2	54524 54554	1.2	3.0	12.0		0.0	0.1	12.4	
PTB-CS2	54554 54584	7.2	3.0	12.0		0.0	0.1	12.4	
PTB-CS2	54584 54614	0.8	3.0	12.0		0.0	0.1	12.4	
PTB-CS2	54614 54644	-1.2	3.0	12.0		0.0	0.1	12.4	
PTB-CS2	54644 54674	-1.1	3.0	12.0		0.0	0.1	12.4	
PTB-CS2	54674 54709	-3.1	3.0	12.0		0.0	0.1	12.4	
PTB-CS2	54709 54739	0.9	3.0	12.0		0.0	0.2	12.4	
PTB-CS2	54739 54769	4.7	3.0	12.0		0.0	0.2	12.4	
PTB-CS2	54769 54799	4.1	3.0	12.0		0.0	0.1	12.4	
PTB-CS2	54799 54829	4.3	3.0	12.0		0.0	0.2	12.4	
PTB-CSF1	54644 54669	6.7	0.1	0.9	[7]	0.0	0.2	0.9	
PTB-CSF1	54679 54704	6.1	0.1	0.9		0.0	0.2	0.9	

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-F01	54484 54494	2.4	0.4	0.4	[8]	0.1	0.9	1.1	
SYRTE-F01	54554 54584	3.8	0.3	0.6		0.1	0.3	0.8	
SYRTE-F01	54589 54599	3.9	0.7	0.6		0.1	0.9	1.3	
SYRTE-F01	54614 54644	3.0	0.4	0.4		0.3	0.3	0.7	
SYRTE-F01	54644 54669	2.5	0.3	0.4		0.1	0.4	0.7	
SYRTE-F01	54734 54754	4.8	0.2	0.5		0.2	0.5	0.7	
SYRTE-F01	54779 54794	3.8	0.3	0.4		0.1	0.6	0.8	
SYRTE-F01	54799 54829	4.6	0.6	0.5		0.1	0.3	0.8	
SYRTE-F02	54554 54584	4.4	0.9	0.4	[8]	0.1	0.3	1.1	
SYRTE-F02	54589 54614	5.2	0.2	0.4		0.3	0.4	0.6	
SYRTE-F02	54614 54644	3.9	0.3	0.4		0.2	0.3	0.6	
SYRTE-F02	54644 54669	2.7	0.3	0.4		0.1	0.4	0.7	
SYRTE-F02	54674 54694	3.9	0.3	0.4		0.2	0.5	0.7	
SYRTE-F02	54714 54729	3.1	0.6	0.4		0.2	0.6	1.0	
SYRTE-F02	54759 54769	3.6	0.3	0.5		0.2	0.9	1.1	
SYRTE-F02	54779 54794	4.5	0.2	0.6		0.1	0.6	0.9	
SYRTE-F02	54799 54829	4.9	0.6	0.5		0.1	0.3	0.8	
SYRTE-FOM	54464 54494	3.0	0.2	0.9	[9]	0.1	0.4	1.0	
SYRTE-FOM	54499 54524	3.4	0.2	0.7		0.1	0.4	0.8	
SYRTE-FOM	54544 54554	4.4	0.5	0.7		0.1	0.9	1.2	
SYRTE-FOM	54554 54584	3.5	0.3	0.7		0.1	0.3	0.8	
SYRTE-FOM	54589 54614	4.6	0.2	0.7		0.2	0.4	0.9	
SYRTE-FOM	54614 54639	2.8	0.2	0.7		0.1	0.4	0.8	
SYRTE-JPO	54484 54494	2.2	1.2	6.3	[10]	0.3	0.9	6.5	
SYRTE-JPO	54494 54524	2.9	1.0	6.3		0.3	0.3	6.4	
SYRTE-JPO	54544 54554	0.7	1.0	6.3		0.3	0.9	6.4	
SYRTE-JPO	54554 54584	-1.3	0.6	6.3		0.3	0.3	6.3	
SYRTE-JPO	54589 54614	1.3	0.7	6.3		0.3	0.4	6.4	
SYRTE-JPO	54614 54644	2.7	0.6	6.3		0.3	0.3	6.3	
SYRTE-JPO	54644 54674	2.5	0.5	6.3		0.3	0.3	6.3	
SYRTE-JPO	54674 54694	1.5	0.7	6.3		0.5	0.5	6.4	
SYRTE-JPO	54714 54734	-0.1	0.6	6.3		0.5	0.5	6.4	
SYRTE-JPO	54744 54769	4.0	0.9	6.3		0.3	0.4	6.4	
SYRTE-JPO	54769 54794	2.0	1.1	6.3		0.3	0.4	6.4	
SYRTE-JPO	54799 54814	6.7	1.3	6.3		0.3	0.6	6.5	

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 2008

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During 2008, IT-CsF1 reported six frequency evaluation to the BIPM. In the tables below, a summary of the report and a typical accuracy budget is shown.

CircT	Period (MJD)	Dur.	Local Osc.	yITCsF1-yTAI	uA	uB	ulab	uTAI	u
245	54604-54614	10	1401102	1.7	1.1	0.5	0.4	0.9	1.5
246	54614-54634	20	1401102	2.5	1	0.5	0.2	0.5	1.2
247	54649-54669	20	1401102	4.5	0.9	0.5	0.2	0.5	1.2
249	54709-54729	20	1401102	2.7	0.7	0.7	0.2	0.6	1.2
250	54754-54769	15	1401102	1.6	0.7	0.4	0.2	0.6	1.0
251	54774-54789	15	1401102	4.3	0.8	0.7	0.2	0.6	1.2

Effect	Correction ($x10^{-15}$)	Uncertainty ($x10^{-15}$)
Quadratic Zeeman (field map)	-45.8	0.2
Blackbody Radiation	28.5	0.3
Collisional (average shift $1.1x10^{-15}$) (*)	-	0.1
Gravitational Potential	-26.10	0.01
Microwave related	-	0.3
Total	-44.0	0.5

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

The reference papers for IT-CsF1 evaluations procedure are [1,2]. Some details are reported here.

Atomic density shift: IT-CsF1 is operated alternating a low-density state (~20000 s) and a high-density state (~5000 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 and then accounts for the type A uncertainty part; uncertainty accounted as the type B is due to the signal stability and to the linearity assumption between density and signal is ≤10% of the weighted averaged density shift [1].

Quadratic Zeeman shift: the magnetic field is mapped along the atom flight path before each fountain evaluation, 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 $4x10^{-17}$. As in previous evaluations, the C-field map showed a long term stability for the Zeeman shift of few parts in 10^{16} .

Blackbody radiation shift: the blackbody radiation shift is corrected using the accepted value $\beta=-1.711(.003)x10^{-14}$; IT-CsF1 is operated around 343 K and the uncertainty on this correction is typically $2\text{-}3\times10^{-16}$.

Gravitational shift: At the end of 2007, IT-CsF1 orthometric height has been evaluated to be (239.43±0.03) m over the Geoid [4]. The frequency shift for IT-CsF1 is $(26.10\pm0.01)\times10^{-15}$.

Microwave related shifts: the presence of unwanted microwave related shifts (such as microwave leakages, spurious spectrum components, distributed phase shifts) is tested as described in [3] before and after each TAI evaluation. The measured shift is compatible with zero at $4\text{-}5\times10^{-16}$ level.

Other tests: Some null-shift tests are performed before each evaluation. Typically, they include a light shift test, e.g. a check of the mechanical shutters, and tests on synchronous effects.

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 $3x10^{-13}\tau^{-1/2}$ 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 the evaluation in 2008, IT-CsF1 was operated with a dead time uncertainty lower than $3x10^{-16}$; a detailed description of its evaluation procedure is reported in [1].

Bayesian analysis of PFS data: at the end of 2008, Bayesian techniques has been studied for the analysis of the collisional shift correction [5,6]. This leads to the rigorous embedding of the theoretical information concerning the sign of the collisional shift in a differential measurement technique as used on fountains, reducing the type A uncertainty of about 30%.

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Operation of Cs atomic fountain NICT-CsF1 in 2008

Since 2006, the cesium atomic fountain primary frequency standard NICT-CsF1 at National Institute of Information and Communications Technology has been operated to contribute to the determination of TAI [1]. In 2008, we have performed accuracy evaluations with NICT-CsF1 twice, over 10-days period of MJD 54534-54544 and over 15-days period of MJD 54709-54724 [2, 3].

Basically, the evaluation way of systematic shifts and their uncertainties is the same as that described in the previous report circulated to the working group on primary frequency standard (CCTF-WGPFS) in 2007. At the latest evaluation campaign of MJD 54709-54724, we set the atomic number density lower than the previous campaigns to reduce the collisional shift. We have confirmed that in the operation with one third density of previous case, the stability was kept within the stated Type A uncertainty, 1.0×10^{-15}. Thanks to the lower density, straightforwardly, the averaged value of the shift was reduced to -1.8×10^{-15} and then the associated uncertainty was 0.4×10^{-15} (20% of the frequency bias). As for the deviation associate to the measurement of the collisional shift, it was consistent within the Type A uncertainty. We summarize the corrected biases and their uncertainties below.

Physical Effect	Bias	Uncertainty
2nd Zeeman	74.4	<0.1
Collision (averaged)	-1.8	0.4
Blackbody Radiation	-16.9	0.4
Gravity Potential	8.4	0.1
MW-PW dependence	-2.0	0.3
Cavity Pulling	0.0	<0.1
Rabi Pulling	0.0	<0.1
Ramsey Pulling	0.0	<0.1
Spectral impurities	0.0	<0.1
Light Shift	0.0	<0.1
Distributed cavity phase	0.0	0.3
Majorana	0.0	<0.1
Background Gas	0.0	0.3
Total (Type B)		0.8

units are fractional frequency in 10^{-15}

Table 1. Frequency shifts and their uncertainties in 2008 measurement (MJD54709-54724)

The total uncertainty including both Type A and B is 1.3×10^{-15}.

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Operation of NIST-F1 in 2008

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 more 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. These improvements now tend to be aimed more at increasing the fountain run time and reliability, rather than decreasing the uncertainty. 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 4×10^{-16}. Each formal evaluation also includes mapping the magnetic field, and measuring possible biases due to such things as microwave amplitude and light leaks. In 2008, two of the five evaluations were full evaluations using a range of atomic densities while three were conducted using only historical data for the density dependent shift.

Five formal evaluations were carried out in 2008, in January, April, July, November and December. Work is in progress in the laboratory calibrating various optical frequency standards against the SI second.

The Type B uncertainties for the five runs in 2008 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 run the total Type B uncertainty was 3.1×10^{-16}, dominated by the Blackbody shift with an uncertainty of 2.8×10^{-16}. The Type B uncertainty for the November run was 3.3×10^{-16}. The Type A uncertainties ranged from 1.5×10^{-16} to 3.6×10^{-16} for the five runs. The uncertainty due to the spin exchange shift ranged from 0.7×10^{-16} to 1.1×10^{-16}. Total uncertainties, including frequency transfer and dead time uncertainties, ranged from 0.54×10^{-15} to 0.93×10^{-15}.

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Operation of NMIJ-F1 Primary Frequency Standard in 2008

In 2008, we have operated NMIJ-F1 officially seven times for 15 to 25 days of one campaign to calibrate TAI. The operation time during a year was 145 days in total, which will be increased in the future. The uncertainty evaluation was the same as the one we have ever used [1,2], which is shown in Table 1.

Source of uncertainty	Bias ($x10^{-15}$)	Uncertainty ($x10^{-15}$)
2^{nd} 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 2008

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Operation of the PTB primary clocks in 2008

PTB's primary clocks with a thermal beam

During 2008 PTB CS1 and CS2 [1] could not be operated as undisturbed as we were used to in the past. We briefly explain the observations and consequences for each clock after a short report of what has been common to both.

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.

CS2 has been operated continuously during 2008, whereas CS1 has been operated continuously during 10 months only (see below). For both clocks time differences UTC(PTB) - clock in the standard ALGOS format have been reported to BIPM, so that $u_{l/lab}$ is zero.

CS1

During 2008, the CS1 beam signal gradually decreased and in consequence the frequency instability increased. Analysis was made with reference to one of PTB's active hydrogen maser. For CS1 values $\sigma_y(\tau = 1\text{h, CS1})$ between 93×10^{-15} and 115×10^{-15} were recorded. We tried to bring the beam signal back to a higher level by opening the vacuum, cleaning the oven nozzle and the magnet bore in front of the oven, and improving the quality of vacuum gaskets of the CS1 chamber. The repair lasted much longer than anticipated, and thus CS1 could not serve as a primary clock during the months of November and December 2008. The repair, fortunately, was very successful: The beam signal now is at a much higher level than at any time during 2008, $\sigma_y(\tau = 1\text{h, CS1})$ is currently at about 75×10^{-15}. The value $u_A(\tau = 30\text{d, CS1}) = 5\times10^{-15}$ stated in CircularT can still be considered a correct estimate during the months of operation in 2008.

During 2008, reversals of the beam direction were performed on CS1 three times, and the beam reversal frequency shift determined thereafter exhibited the normal scatter around the long term mean value. No findings call for a modification of the previously stated relative frequency uncertainty u_B, which is 8×10^{-15} for CS1 [2].

CS2

CS2 has been operated with two 5 gram charges of caesium in the two ovens since the mid eighties. So it was no real surprise that one oven ran empty in summer 2008. The signal drop was slow enough and lasted a couple of hours so that the quartz remained locked all time. Since then the second beam has been in operation, and we will continue in that mode until its end of life. Then a major refurbishment will be undertaken. Except of these few hours in summer, values of about 60×10^{-15} were found for $\sigma_y(\tau = 1\text{h, CS2})$. This data confirms the findings of previous years and justifies the estimate of the uncertainty contributions u_A as $u_A(\tau = 30\text{d, CS2}) = 3\times10^{-15}$.

Obviously, no beam reversal can be performed now. This has an impact on the statement of u_B related to the contribution of the end-to-end cavity phase difference. The respective uncertainty contribution amounts to 1×10^{-14} and dominates the CS2 uncertainty budget [2]. In Figure 1, the results of all determinations of the beam-reversal frequency F_{BR} shift since May 1997 are shown. The individual points show a standard deviation of 7.4×10^{-15} around the mean value of 505.6×10^{-15}. This standard deviation is fully explainable by the CS2 frequency instability. The linear trend is described by $\delta F_{BR} / \delta t = (-0.18 \pm 0.10)\times10^{-18}$/d. The currently applied correction is based on the mean over the eight most recent data points whose standard uncertainty is 2.5×10^{-15}. We have not changed the correction applied in real time operations unless the mean value had changed by more than its standard uncertainty. Thus, the correction applied may be in error by that amount. As long as beam reversals are made periodically this error cancels, now it is an additional contribution to the uncertainty component. For 2008, however, no change in the stated uncertainty u_B (CS2) = 12×10^{-15} is necessary.

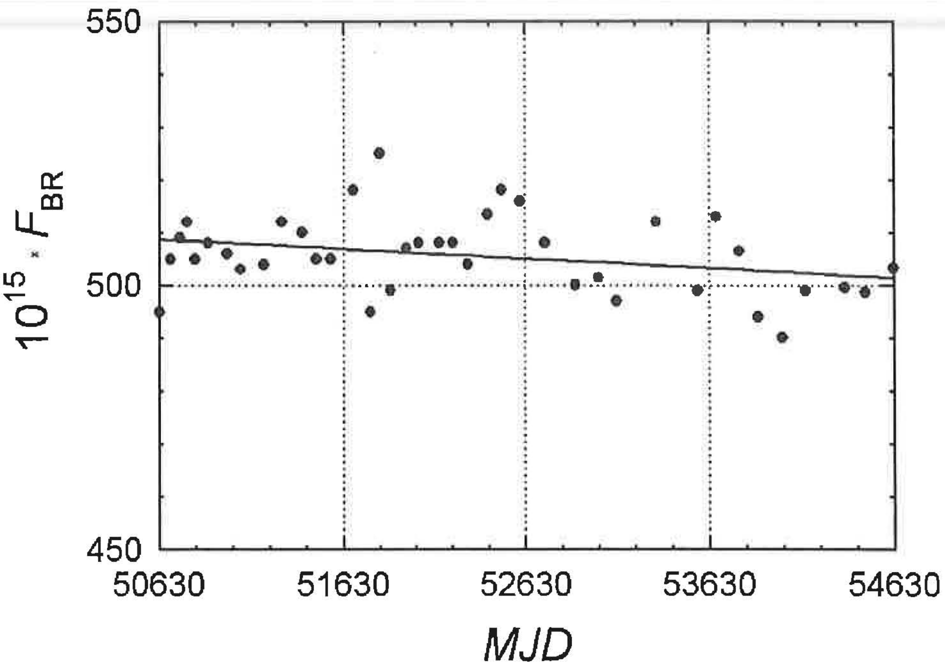

Figure 1: CS2 frequency difference F_{BR} recorded after beam reversal at the indicated dates. Each point is based on 10-day averages of the CS2 frequency with respect to the available frequency standards in PTB.

PTB's caesium fountain clock CSF1

A detailed description of the PTB fountain CSF1 is given in Refs. [3] and [4]. In 2008 some significant progress was made with respect to the instability and the resulting statistical uncertainty for measurements of the TAI scale unit. Improvements of the setup for the detection of the atoms, the master laser frequency stabilisation and the timing of the fountain cycle resulted in significant improvements of the signal-to-noise ratio. For operation with two $\pi/4$-pulses it is now quantum projection noise limited up to the maximum currently achievable detected atom number. For normal operation for TAI scale unit measurements, where CSF1 is operated with reduced atom number, the improvements result in an instability of $1.4 \cdot 10^{-13}$ $(\tau/\mathrm{s})^{-1/2}$, if a magneto-optical trap is used for loading the atoms.

For the two TAI scale unit measurements in 2008 a new microwave frequency synthesis [5] was used. Before, it had been demonstrated that this new synthesis setup is capable of providing instabilities below the 10^{-16} level [5]. By a recent measurement of the single ytterbium ion clock transition frequency, where the Allan standard deviation was dominated by the white frequency noise of CSF1, a $\tau^{-1/2}$-dependence down to $4 \cdot 10^{-16}$ at 10^5 s averaging time could be demonstrated. Therefore - in contrast to previous TAI scale measurements - the statistical uncertainty of CSF1 was calculated with the assumption of white frequency noise for the total measurement interval, arriving at statistical uncertainties $u_A(\tau = 25\ \mathrm{d}) = 0.1 \cdot 10^{-15}$ for the two measurements in 2008. For both measurements the fractional dead time was at 0.1%, so that $u_{l/lab}$ was evaluated to be far below $0.1 \cdot 10^{-15}$.

Compared to the operation of CSF1 in 2007 no significant changes of the systematic uncertainty u_B (CSF1) = 0.9×10^{-15} have been obtained. Below we compile typical corrected biases and the uncertainty budget of CSF1, valid for the 2008 TAI scale unit measurements.

Physical effect	Bias / 10^{-15}	Type B uncertainty / 10^{-15}
Second order Zeeman shift	46.1	0.1
Black body radiation shift	- 16.6	0.1
Cold collisions	- 2.2	0.3
Gravitational red shift	8.6	0.1
Cavity phase		0.5
Majorana transitions		0.1
Rabi and Ramsey pulling		0.1
Microwave leakage		0.1
Electronics		0.2
Light shift		0.1
Background gas collisions		0.1
Microwave power dependence		0.6
Total type B uncertainty		0.9

Table 1: Typical frequency biases and type B uncertainties of PTB-CSF1 in 2008

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Operation of the SYRTE primary clocks in 2008

SYRTE-JPO Thermal Beam

During 2008 SYRTE-JPO was in continuous clock operation except for disturbances. 12 calibrations were transmitted to TAI. The operational parameters are measured periodically and taken into account for each calibration. They are the Zeeman frequency, the microwave power, the amplitude and the symmetry of the neighbouring lines, the cavity detuning, and the optical power. The last complete accuracy evaluation was performed in 2005 and gave the same value as in [1]: u_B = 6.3x10^{-15}. The mean stability is $\sigma_y(\tau)$=8 x 10^{-13} $\tau^{-1/2}$, its deterioration compared to [1] is due to a lower oven temperature in order to increase the lifetime of the cesium loads. The u_A uncertainty is computed for each calibration from the dispersion of the frequency measurements compared to the reference maser.

SYRTE Fountain clocks

In 2008 the 3 SYRTE fountains FO1, FO2 and FOM have transmitted respectively 8, 9 and 6 calibrations to TAI.
No major modifications have been performed on the fountains operation. The microwave synthesizers are referenced to the signal provided by a cryogenic sapphire oscillator (CSO) phase locked to a hydrogen Maser, to take the benefit of the ultra-low phase noise of the CSO.
FO1 had an almost continuous operation since April 2008. The long term stability of the laser source has been improved by implementing an automatic alignment system based on motorized mirrors.
FOM operated continuously between January and June 2008 in Paris observatory. Afterwards, it has been moved to CNES, the French spatial agency, in Toulouse. The transportable fountain currently serves as a frequency reference for the ground tests of the PHARAO/ACES space clocks. It is connected to the CNES time and frequency facilities that include a cryogenic sapphire oscillator, a hydrogen maser, and a GPS time transfer link. This link is used to connect FOM in Toulouse to FO1 and FO2 in Paris. There are ongoing tests to evaluate the performances of this link.
On FO2 [2], the cesium source previously based on an atomic beam slower has been replaced by a 2D-MOT. This improves the cold atoms number stability and reduces the cesium consumption. The FO2 operation with cesium was almost uninterrupted since March 2008. On the rubidium part, the capture optical amplifiers have been replaced due to their aging. This increased by a factor of 3 the number of cold atoms which implied to re-evaluate the frequency shift due to cold collisions and to the cavity pulling. Since mid-November 2008 FO2 operates, for the first time, synchronously with the 2 atomic species. Since many systematic effects are correlated in this dual configuration, their fluctuations are reduced in the Rb/Cs frequency comparison. The 1st order Doppler shift, which depends on the verticality of the 2 interrogation cavities, has been re-examined in dual operation. A new measurement of the Rb hyperfine splitting has been performed in the dual clock operation of FO2. During the same period, FO2-Rb was also compared to FO1. The results, which include an additional correction associated with the Rb atom number, are in agreement within the error bars. They agree as well with the FO2-Rb/FOM comparison realized by the end of 2007 [2]. FO2-Rb is thus a good candidate to contribute, as a secondary representation of the SI second, to the steering of TAI.

Table 1 gives the typical uncertainty budgets for the three SYRTE fountain clocks in 2008. The value and the uncertainty of the frequency shifts, which depend on the operation parameters, are updated for each TAI contribution. The performances of FO1 and FO2 operating with cesium are almost the same as last year. For FOM, the uncertainty on the cold collisions and cavity pulling frequency shifts has been reduced by a factor of 2. This update stems from the analysis of measurement data accumulated over 90 days.
The short-term frequency instability of the fountain clocks were evaluated by comparison to a cryogenic oscillator phase locked on an active H maser. The typical relative frequency instabilities are respectively $\sigma_y(\tau)$=4 x 10^{-14} $\tau^{-1/2}$ for FO1, $\sigma_y(\tau)$=4.5 x10^{-14} $\tau^{-1/2}$ for FO2, and $\sigma_y(\tau)$=8 x 10^{-14} $\tau^{-1/2}$ for FOM. Based on local frequency comparisons, the 3 fountains are in agreement within the combined error bars. We reach a resolution of 10^{-16} for averaging times of several 10^6 seconds. These comparisons are limited by the type B uncertainty.

Fountain	FO1		FO2-Cs		FOM	
Physical origin	Correction	Uncertainty	Correction	Uncertainty	Correction	Uncertainty
2^{nd} order Zeeman	-1276.5	0.2	-1914.9	0.2	-305.4	1.1
Blackbody Radiation	+164.7	0.6	+166.8	0.6	+162.6	0.6
Cold Collisions + cavity pulling	+61.0	1.5	+255	1.7	+27.9	2.8
First Doppler + Synchronous phase fluctuations	0	<3.2	0	3	0	6
Microwave Leaks, spectral purity	0	<1	0	0.5		
Background gas collisions	0	<0.3	0	<1	0	<1
Microwave recoil	0	<1.4	0	<1.4	0	<1.4
Ramsey & Rabi pulling	0	<1	0	<0.1	0	<0.1
Second order Doppler	0	<0.1	0	<0.1	0	<0.1
Red shift	-69.3	1	-65.4	1	-68.7	1
Total (1σ) uncertainty u_B		**4.2**		**4.1**		**7.1**

Table 1 : Accuracy budgets for the 3 SYRTE atomic fountains. (Values given in units of 10^{-16})

References

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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 SITAI08.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-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, 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 $1.7\times10^{-15}/\surd(\tau)$, a flicker frequency noise 0.35×10^{-15} and a random walk frequency noise $1.0\times10^{-16}\times\surd(\tau)$, with τ in days. The relation between EAL and TAI is given in Table 5.

Month	Interval	$d/10^{-15}$	uncertainty/10^{-15}
Jan. 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	0.9
Sep. 2006	53974-54004	+2.9	1.0
Oct. 2006	54004-54039	+2.7	0.5
Nov. 2006	54039-54069	+1.5	0.5
Dec. 2006	54069-54099	+1.5	0.5
Jan. 2007	54099-54129	+1.3	0.8
Feb. 2007	54129-54159	+1.0	0.6
Mar. 2007	54159-54189	+1.9	0.8
Apr. 2007	54189-54219	+2.7	0.3
May 2007	54219-54249	+3.4	0.5
Jun. 2007	54249-54279	+2.5	0.5
Jul. 2007	54279-54309	+2.7	0.5
Aug. 2007	54309-54339	+3.7	0.4
Sep. 2007	54339-54369	+4.0	0.5
Oct. 2007	54369-54404	+3.3	0.4
Nov. 2007	54404-54434	+3.3	0.6
Dec. 2007	54434-54464	+3.9	0.6
Jan. 2008	54464-54494	+3.1	0.4
Feb. 2008	54494-54524	+3.2	0.6
Mar. 2008	54524-54554	+3.6	0.6
Apr. 2008	54554-54584	+4.0	0.4
May 2008	54584-54614	+4.3	0.4
Jun. 2008	54614-54644	+3.4	0.4
Jul. 2008	54644-54674	+3.7	0.3
Aug. 2008	54674-54709	+4.1	0.5
Sep. 2008	54709-54739	+3.3	0.5
Oct. 2008	54739-54769	+3.7	0.5
Nov. 2008	54769-54799	+4.8	0.4
Dec. 2008	54799-54824	+4.6	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 50 File SCHGPS.50	implemented on MJD = 54586 (2008 April 30) at 0 h UTC	Reference date MJD = 50722 (1997 October 1)
GPS Schedule no 51 File SCHGPS.51	implemented on MJD = 54770 (2008 October 31) at 0 h UTC	Reference date MJD = 50722 (1997 October 1)
GLONASS Schedule no 25 File SCHGLO.25	implemented on MJD = 54586 (2008 April 30) at 0 h UTC	Reference date MJD = 50722 (1997 October 1)
The publication of GLONASS tracking schedules has been stopped as all operational GLONASS time receivers are multi-channel.		

Relations of UTC and TAI with GPS time and GLONASS time

(File available on http://www.bipm.org under the name UTCGPSGLO08.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, 0 h UTC until 2009 January 1, 0 h UTC:

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

From 2009 January 1, 0 h UTC until further notice:

$$[UTC - GPS\ time] = -15\ \text{s} + C_0.$$

Here C_0 is given at 0 h 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 0 h 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 UTCGPSGLO08.AR)

[*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

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

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, 0 h UTC, until 2009 January 1, 0 h UTC:

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

From 2009 January 1, 0 h UTC, until further notice:

$$[TAI - GLONASS\ time] = 34\ \mathrm{s} + C_1$$

Here C_1 is given at 0 h 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 0 h 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 8. Rates relative to TAI of contributing clocks in 2008

(File available on http://www.bipm.org under the name RTAI08.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 8 gives homogeneous rates for the whole year 2008. 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 available from the TFG section under request. 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	21 OSCILLOQUARTZ 3210	51 DATUM/SYMMETRICOM 4065 B
13 EBAUCHES, OSCILLATOM B5000	23 OSCILLOQUARTZ EUDICS 3020	52 DATUM/SYMMETRICOM 4065 C
14 HEWLETT-PACKARD 5061A OPT. 4	30 HEWLETT-PACKARD 5061B	
16 OSCILLOQUARTZ 3200	31 HEWLETT-PACKARD 5061B OPT. 4	
17 OSCILLOQUARTZ 3000	34 H-P 5061A/B with 5071A tube	
15 DATUM/SYMMETRICOM Cs III	35 H-P/AGILENT/SYMMETRICOM 5071A High perf.	
4x HYDROGEN MASERS	36 H-P/AGILENT/SYMMETRICOM 5071A Low perf.	
9x PRIMARY CLOCKS AND PROTOTYPES	50 FREQ. AND TIME SYSTEMS INC. 4065A	

Lab.	Clock	54494	54524	54554	54584	54614	54644	54674	54709	54739	54769	54799	54829
APL	35 904	5.72	5.46	4.07	4.55	4.25	3.62	2.75	3.42	3.77	3.83	3.85	3.35
APL	35 1264	19.56	20.08	21.71	21.49	21.58	22.15	21.50	22.00	21.29	21.41	20.57	19.37
APL	35 1791	-3.98	-4.54	-3.83	-3.51	-3.50	-4.00	-4.58	-3.93	-4.62	-4.08	-3.57	-4.40
APL	40 3107	19.09	18.96	15.53	16.42	18.88	18.69	18.65	18.37	18.07	17.36	17.27	17.78
APL	40 3108	163.03	168.02	173.08	178.14	183.37	188.58	193.72	199.13	204.64	209.34	214.08	218.62
APL	40 3109	-20.68	-20.03	-19.19	-18.19	-16.54	-15.64	-14.58	-13.31	-11.69	-10.15	-8.34	-6.52
AUS	35 2269	0.59*	0.15*	0.09*	0.39*	0.22	1.54	0.85	2.71	3.49	4.05	4.44	5.02
AUS	36 340	-0.50	0.93	0.01	0.65	0.85	-0.04	0.77	2.29	0.29	0.82	0.72	0.39
AUS	36 654	-	-	-	-	-14.09	-13.25	-13.64	-13.06	-13.47	-14.23	-13.48	-13.55
AUS	36 1141	8.79	4.58	4.53	5.56	6.95	4.20	5.49	5.60	4.29	4.23	4.32	6.26

Table 8. (Cont.)

Lab.	Clock	54494	54524	54554	54584	54614	54644	54674	54709	54739	54769	54799	54829
AUS	40 5402	-5.99	2.00	-1.25	-4.71	-	-6.01	-	-	7.12	10.17	14.62	-
BEV	35 1065	-0.92*	0.57*	-0.34*	-0.46*	-0.50*	-0.48*	-0.81*	-3.16	-2.37	-2.73	-1.97	-2.00
BEV	35 1793	-5.97*	-0.25*	-1.13*	-0.71*	-0.56*	-1.21*	-0.09*	1.62*	0.50*	1.06*	-0.02	-0.53
BEV	40 3452	-	-	-	-20.48*	-12.14*	-1.87*	7.93*	-30.38*	-17.86*	-7.62	2.94	13.53
BIM	35 1501	0.10	-4.32	-2.64	-4.07	-2.80	-2.91	-2.15	-2.98	-	-1.19	-4.11	-3.52
BY	40 4209	-5.11*	-2.52*	0.15*	5.26*	4.00*	4.33*	-3.26*	7.58*	0.45	7.30	4.29	4.35
BY	40 4227	-	-	-	-	-	-	-	6.30	-2.52	4.00	3.88	4.28
BY	40 4260	-16.07*	-9.46*	-13.07*	-7.00*	-10.69*	-5.30*	-8.32*	0.97*	-10.62*	-0.84*	0.59	2.97
BY	40 4278	-15.98	-14.21	-12.00	-5.94	-7.77	-89.38	19.05	22.96	13.80	21.08	21.62	24.01
CAO	35 939	-3.03	-3.48	-4.25	-3.58	-4.01	-1.49	-2.37	-	-3.10	-2.55	-2.28	-3.69
CAO	35 1270	0.70	1.89	1.55	1.53	2.46	2.25	2.10	-	2.04	3.09	2.18	2.62
CH	35 771	9.28	8.29	-	-	-	-	-	-	-	-	-	0.01
CH	35 2117	1.71	1.53	1.54	1.76	3.35	1.34	2.24	1.82	3.04	1.91	1.96	2.57
CH	36 354	42.42	43.12	43.31	44.82	43.10	43.27	44.84	44.42	44.26	43.07	43.39	43.83
CH	36 413	-6.52	-8.65	-5.76	-5.44	-3.26	-4.74	-1.12	-4.51	-7.40	-7.49	-9.56	-5.55
CH	40 5701	-134.99	-135.81	-136.80	-137.73	-138.61	-139.38	-140.39	-141.39	-142.20	-143.24	-144.30	-148.27
CNM	35 1705	0.32	-0.02	-3.04	-1.73	-2.67	-4.30	-4.44	-4.97	-3.47	-3.38	-3.06	-3.72
CNM	35 1815	-0.25*	-0.26*	-0.15*	0.24*	0.21	-0.33	-0.68	0.13	-0.02	0.47	0.23	-0.28
CNM	36 1537	-6.07*	-5.15*	-3.78*	2.17*	0.09	0.95	0.07	0.24	-1.11	2.18	1.20	1.50
CNM	40 7301	-125.81*	-277.95*	-161.31*	-161.29*	-161.72*	-162.27*	-162.49*	-164.96*	-167.92*	-148.55	-4.38	-4.32
CNM	53 6038	-	-	-	-	-	-	1.69	0.77	0.58	2.11	3.07	2.09
CNMP	36 1806	7.55*	8.22*	9.89*	7.97*	7.23*	8.59*	7.99*	5.29*	-0.77	-0.40	1.55	1.27
DLR	35 1714	0.32	1.20	0.84	-0.18	-0.40	0.05	0.10	-	-	-0.29	-0.47	-1.15
DTAG	36 136	-12.82*	-8.39*	-6.48*	-4.68*	-0.54	-1.28	-1.85	0.94	6.63	8.45	-	-
DTAG	36 345	-1.14	-2.17	-0.76	-1.35	-0.12	-2.45	-1.66	-1.91	-0.92	-1.82	-0.98	-1.59
DTAG	36 465	0.17	-1.47	0.07	-1.33	-0.98	-1.19	0.80	-1.31	-0.06	0.62	-0.23	-1.19
DTAG	36 2370	-	-	-	-	-	-	-	-	-	-	0.53	-0.23
EIM	35 716	-	12.89	12.67	12.60	-	-	-	-	-	13.85	14.26	17.97
EIM	35 1431	-	10.84	10.07	9.65	-	-	-	-	-	-241.30	-	-6.61
EIM	35 2060	-	-	0.11	0.05	-	-	-	-	-	-	-0.18	-0.36
F	35 122	26.34	26.06	26.24	-	-	25.33	26.10	25.92	25.64	24.95	25.52	24.89
F	35 124	10.29	10.52	10.85	10.36	10.56	11.10	10.53	10.95	11.05	10.97	11.99	11.61
F	35 131	11.18	11.29	11.61	11.46	11.82	11.33	11.47	11.41	11.42	10.61	10.54	11.54
F	35 157	-	-	12.69	12.67	12.24	12.99	12.73	13.00	12.34	12.37	12.70	-
F	35 158	12.23	12.36	12.97	13.20	12.13	13.42	12.80	13.75	12.64	13.90	14.37	13.68

Table 8. (Cont.)

Lab.	Clock	54494	54524	54554	54584	54614	54644	54674	54709	54739	54769	54799	54829
F	35 198	-	-	6.21	6.42	6.66	6.32	-	-	-	-	-	-
F	35 385	20.93	20.14	19.55	21.12	21.89	21.51	20.09	20.18	20.35	18.53	19.75	18.88
F	35 396	-	-	-	-	-	2.55	1.94	1.75	1.11	0.68	0.09	-0.25
F	35 469	-	-	-0.04	0.06	-2.69	-2.98	-4.22	-4.60	-4.71	-4.58	-5.00	-
F	35 520	-	-	-	-	2.84	2.19	3.23	3.18	3.81	5.44	4.83	-
F	35 536	-	-	-	-	1.45	1.34	1.98	-	-	-	-	-
F	35 609	-9.96	-10.50	-9.78	-10.62	-10.17	-10.07	-10.43	-10.54	-10.23	-10.36	-11.25	-
F	35 770	-9.42	-9.19	-8.94	-8.85	-8.73	-8.97	-8.89	-8.19	-7.94	-8.10	-8.21	-7.55
F	35 774	-	-	-	-	-	-	-	-	-	-13.58	-13.94	-13.02
F	35 781	-	-	8.95	7.61	8.95	8.44	6.66	6.64	6.78	5.79	6.77	7.82
F	35 819	-	-	11.40	10.98	12.43	12.18	12.65	10.53	13.32	11.60	11.49	11.65
F	35 859	-	-	-	-	3.06	3.09	4.35	3.11	2.77	1.61	2.06	1.78
F	35 1029	11.20	-	-	-	-	-	-	-	-	-	-	-
F	35 1068	-	-	-	-	-	-	-	-	-	-17.09	-17.41	-17.29
F	35 1178	29.25	29.29	27.56	28.29	27.24	26.37	26.32	28.81	27.78	28.62	27.97	28.58
F	35 1222	-	-	11.01	11.06	10.95	10.85	10.83	11.86	11.98	11.91	10.64	11.24
F	35 1258	4.93	4.42	5.55	5.01	5.54	5.13	5.10	5.07	4.80	4.57	5.04	4.62
F	35 1321	2.38	2.43	2.87	2.71	2.94	2.90	3.29	2.47	1.88	2.53	2.91	3.53
F	35 1556	-21.35	-22.63	-	-	-4.91	-4.59	-3.81	-3.77	-	-	-5.43	-5.26
F	35 1644	-	-	-	8.68	8.56	8.83	7.43	8.76	8.30	7.91	7.85	-
F	35 2027	0.85	0.63	0.51	-0.09	-0.20	-0.39	-0.36	-0.39	-0.64	-1.35	-0.95	-1.87
F	35 2388	-	-	-	1.88	1.11	0.92	1.52	1.42	1.67	1.57	1.49	1.59
F	40 805	-18.61	-16.32	-15.08	-13.61	-12.78	-10.81	-9.16	-9.67	-9.49	-4.47	-3.19	-1.08
F	40 816	-44.62	-44.38	-44.87	-45.17	-45.64	-47.45	-48.40	-48.51	-48.12	-48.23	-48.04	-45.91
F	40 889	131.52	134.86	-	-	3.26	6.82	10.27	-	-	20.77	24.08	27.31
F	40 890	41.82	42.83	-	-	-0.42	0.69	1.84	-	-	5.14	6.14	7.02
F	53 6385	-19.52	-17.37	-15.60	-10.68	-9.32	-6.31	-5.61	-5.35	-3.79	-3.64	-3.72	-1.51
HKO	35 358	-	-	-	-	-	-	-	-	-3.81	-4.85	-4.69	-4.82
HKO	35 1893	-0.54	-0.73	-0.47	-0.77	-0.31	-1.46	-0.40	-0.06	0.05	-0.27	0.12	-0.11
IFAG	36 1167	-4.04	-4.93	-4.45	-3.97	-0.43	1.99	1.34	-0.16	1.35	-0.01	-0.56	-2.16
IFAG	36 1173	-8.79	-8.71	-7.15	-5.50	-1.78	-0.44	0.45	2.36	5.41	4.77	1.60	0.32
IFAG	36 1629	5.98	6.21	6.66	7.31	-	-	-	-	-	10.83	11.37	11.38
IFAG	36 1732	13.33	13.21	13.58	13.65	13.11	12.73	13.01	13.08	13.05	12.08	12.55	12.87
IFAG	36 1798	-4.49	-4.84	-4.97	-4.45	-3.83	-3.25	-3.47	-3.25	-3.13	-3.23	-2.57	-2.48
IFAG	40 4418	0.58	0.56	0.92	1.13	1.31	1.34	1.27	1.63	2.39	3.71	4.44	5.41

Table 8. (Cont.)

Lab.	Clock	54494	54524	54554	54584	54614	54644	54674	54709	54739	54769	54799	54829
IFAG	40 4439	-1.79	-3.77	-5.08	-7.03	-8.27	-9.20	-11.13	-13.37	-15.14	-17.94	-19.38	-20.92
INTI	35 2377	-	-	-	-	-	-	-	-	-	-	-1.43	-1.95
IT	35 219	9.59	8.69	9.29	9.00	8.90	9.97	-	-	-	-	-	-
IT	35 505	-8.43	-8.14	-8.08	-7.77	-7.48	-7.65	-8.27	-6.65	-7.48	-7.37	-8.30	-8.13
IT	35 1115	17.18	16.70	17.31	17.06	17.98	16.60	17.75	18.34	18.19	16.55	16.82	17.44
IT	35 1373	-8.75	-8.77	-7.97	-7.85	-7.46	-8.58	-7.79	-6.83	-7.06	-6.52	-6.77	-6.41
IT	35 2118	8.45	8.05	8.33	8.25	7.70	8.32	8.08	9.07	9.33	8.30	8.87	8.58
IT	40 1102	17.55	18.37	19.55	21.35	22.70	23.92	25.65	27.94	30.40	32.73	37.17	42.84
JV	21 216	25.87	25.13	-	-	22.76	27.30	30.76	25.50	21.89	18.44	22.38	19.28
JV	21 387	-149.23	-132.63	-	-	-320.38	-386.60	-254.31	-414.26	-457.57	-413.74	-535.75	-468.03
JV	36 1277	-18.38	-18.50	-	-	-17.81	-16.22	-15.77	-16.95	-18.24	-17.30	-20.21	-18.81
KIM	36 618	-	-	-1.25	0.92	-1.72	-1.39	0.30	1.09	-0.31	-0.85	-2.35	-
KRIS	35 321	13.69	10.13	10.17	10.09	9.53	11.14	11.59	9.86	10.37	10.59	10.42	9.78
KRIS	35 739	-	-	-	-	-	-4.67	-4.23	-4.35	-4.65	-4.34	-3.77	-4.28
KRIS	35 1693	7.16	7.19	7.43	7.15	6.76	6.46	6.93	7.15	6.15	7.16	6.24	6.51
KRIS	35 1783	19.09	18.25	17.26	17.77	16.66	18.23	18.41	18.38	18.26	18.77	18.00	19.67
KRIS	36 739	-	-	-5.04	-4.71	-	-	-	-	-	-	-	-
KRIS	36 1135	36.88	42.33	41.80	39.14	38.86	42.09	39.43	37.56	40.10	38.04	39.04	38.51
KRIS	40 5623	116.48	116.40	117.97	118.17	114.02	118.62	118.65	118.52	117.45	116.95	116.84	116.62
LT	35 1362	-0.12	1.23	-0.10	0.32	4.17	0.22	0.91	-	-	-	-	-
LT	35 1868	5.71	5.46	5.25	4.90	4.91	5.58	4.83	-	-	-	-	-
LV	35 2335	12.13	11.78	5.48	4.25	4.21	4.56	4.44	4.53	4.47	4.70	4.69	4.13
MIKE	35 1171	-0.81*	0.44*	0.13*	-0.68*	0.68*	-0.72	0.37	0.42	0.99	1.11	-2.09	-0.28
MIKE	36 986	0.86	0.54	0.30	0.74	2.47	-0.03	0.32	1.60	1.85	3.56	2.20	1.17
MIKE	40 4108	-	-	-	-	0.21*	0.25*	-1.72*	-1.66*	-1.47*	-1.05	-0.40	-0.24
MIKE	40 4113	39.34	41.29	43.33	44.89	46.80	47.24	49.00	51.24	54.28	56.44	56.89	59.65
MIKE	40 4180	-0.02*	-0.10	0.05	-	-	-	-	-	-	-	-	-
MKEH	36 849	-	-39.25	-39.55	-40.43	-40.66	-40.93	-40.82	-43.23	-41.96	-40.25	-40.26	-41.16
MSL	12 933	33.26*	35.76*	15.70*	0.15*	3.05*	8.20*	23.93*	17.06*	4.80	12.81	2.85	10.97
MSL	36 274	17.25*	16.99*	20.51*	18.19*	18.61*	17.58*	21.53*	20.08*	6.17	4.56	5.61	2.56
MSL	36 1025	23.89*	16.88*	11.82*	15.08*	10.65*	10.51*	8.96*	3.29*	5.15	6.04	6.31	5.84
NAO	35 779	2.48	2.39	2.15	2.12	2.05	2.91	-	-	-	-	-	-3.39
NAO	35 1206	15.13	15.20	14.84	14.55	14.76	15.26	-	-	-	-	-	14.22
NAO	35 1214	6.93	6.83	5.82	6.32	6.41	6.65	-	-	-	-	-	4.38
NAO	35 1689	3.19	2.86	2.33	1.78	1.56	1.15	-	-	-	-	-	0.84

Table 8. (Cont.)

Lab.	Clock	54494	54524	54554	54584	54614	54644	54674	54709	54739	54769	54799	54829
NICT	35 112	-	-	-	-	-	-	-	-6.17	-6.48	-7.06	-7.09	-6.99
NICT	35 144	-13.32	-12.96	-12.77	-12.50	-11.70	-12.51	-14.15	-13.70	-13.07	-12.36	-13.88	-15.10
NICT	35 332	9.71	10.20	9.50	8.87	9.65	9.29	9.14	9.06	9.34	9.41	9.22	9.90
NICT	35 342	41.32	42.13	41.85	42.04	42.64	41.37	41.89	42.04	42.21	42.51	43.40	43.30
NICT	35 343	4.95	4.82	5.45	5.77	5.51	5.69	6.31	6.47	5.91	7.40	6.21	6.44
NICT	35 715	-11.93	-12.14	-12.24	-11.38	-11.33	-11.29	-11.25	-10.81	-10.73	-10.28	-10.47	-11.10
NICT	35 732	5.11	5.27	4.91	4.20	4.93	5.32	5.89	4.92	5.46	-	-	-
NICT	35 907	-7.75	-8.19	-7.67	-8.09	-8.78	-8.38	-8.49	-8.94	-7.93	-8.90	-8.86	-9.10
NICT	35 908	1.99	2.61	2.59	3.42	3.74	2.99	2.43	1.75	1.81	3.00	3.01	4.29
NICT	35 913	-	-	-	-16.95	-17.40	-18.09	-17.92	-18.82	-18.04	-19.39	-19.04	-18.96
NICT	35 916	-11.35	-	-	-	-	-	-	-	-	-	-	-
NICT	35 1225	-2.73	-2.15	-3.06	-2.25	-3.11	-3.74	-3.25	-2.54	-2.76	-2.82	-3.01	-2.32
NICT	35 1778	13.49	14.05	14.26	13.57	14.26	13.57	13.61	13.29	13.88	12.62	13.18	13.43
NICT	35 1789	6.85	6.92	7.13	7.12	5.94	6.96	6.28	6.62	6.63	6.54	6.87	7.40
NICT	35 1790	-2.49	-2.12	-2.82	-2.71	-2.00	-2.66	-2.76	-2.52	-3.54	-2.67	-2.45	-3.27
NICT	35 1866	13.48	11.87	12.47	12.11	12.92	11.85	13.10	12.44	13.26	12.74	12.96	13.77
NICT	35 1882	66.90	67.08	66.98	66.40	66.89	66.67	67.08	68.44	69.41	68.78	69.15	43.06
NICT	35 1887	27.01	27.55	28.23	26.40	26.82	26.66	25.80	26.42	29.81	31.12	31.47	-
NICT	35 1944	3.46	2.53	3.23	3.45	2.74	2.66	2.97	3.09	3.25	2.98	3.60	3.36
NICT	35 2010	4.90	4.98	4.71	4.44	4.16	4.02	3.67	3.26	4.14	3.66	3.64	3.69
NICT	35 2011	5.12	4.70	4.88	4.55	4.65	5.02	4.21	4.17	3.75	3.56	3.74	4.04
NICT	35 2056	12.75	12.79	12.14	12.95	12.74	13.26	12.87	13.28	12.94	13.34	13.71	13.64
NICT	35 2113	-27.98	-26.81	-26.92	-27.40	-27.11	-27.23	-26.31	-26.33	-26.18	-25.36	-26.52	-26.16
NICT	35 2116	13.33	12.95	13.33	13.89	14.37	13.57	14.12	14.35	13.97	14.87	13.81	13.73
NICT	36 1217	5.24	3.11	3.80	3.26	3.99	3.11	2.66	3.96	3.43	3.39	5.18	2.68
NICT	36 1226	25.87	25.81	24.66	26.41	26.12	24.90	-	-	-	-	-	-
NICT	36 1611	9.96	9.03	9.36	7.21	8.63	7.62	8.38	9.61	7.81	-	-	-
NICT	40 2002	11.97	12.66	13.36	14.48	14.99	-	-	-	-	-	-	-
NICT	40 2003	19.20	19.41	19.41	19.02	18.28	18.09	20.02	20.29	20.54	20.66	20.73	20.82
NICT	40 2004	-3.37	-3.66	-3.04	-	-	-	-	-	-	-	-	-
NICT	40 2005	-	-	-	-	-	0.41	1.66	3.28	4.61	5.54	7.11	8.80
NIM	35 479	4.34	4.20	7.04	5.63	3.90	-0.44	-	-	-	-	-	-
NIM	35 1235	-3.94	-3.65	-1.06	-1.66	0.44	3.14	4.95	2.24	4.10	4.32	3.68	3.92
NIM	35 1239	4.09	4.07	6.94	5.83	3.88	3.28	2.69	0.29	5.14	2.13	10.26	16.18
NIM	35 2239	-	-	-	-	-	-	-	-1.53	1.99	1.96	0.61	1.29

Table 8. (Cont.)

Lab.	Clock	54494	54524	54554	54584	54614	54644	54674	54709	54739	54769	54799	54829
NIM	40 4832	20.98	20.86	23.58	22.94	21.09	55.64	61.93	74.22	83.20	91.14	100.01	100.95
NIM	40 4835	4.76	4.38	6.87	6.34	9.16	-	-	-	-	-	35.06	39.44
NIMB	35 600	-1.38	-3.24	-	-	0.72	0.81	1.34	0.85	0.77	0.31	1.26	-1.02
NIS	35 1126	0.21	-1.01	0.32	0.92	-	-	-0.30	-	-	1.59	-	-
NIST	35 132	-4.87	-4.13	-4.36	-5.00	-4.66	-5.68	-4.94	-	-	-	-	-
NIST	35 282	6.10	6.42	6.39	7.04	6.35	6.26	5.93	5.43	-	-	-	5.92
NIST	35 408	-0.78	0.26	-0.51	-0.78	0.35	0.08	0.93	-0.47	-0.13	-	-	-
NIST	35 1074	-15.12	-14.55	-15.10	-14.53	-15.06	-14.78	-14.78	-14.58	-15.06	-14.72	-14.40	-14.48
NIST	35 2031	-7.35	-6.93	-7.57	-7.52	-7.78	-7.19	-7.84	-7.45	-7.62	-7.26	-7.71	-8.16
NIST	35 2032	-2.95	-3.72	-2.79	-2.95	-3.45	-3.49	-2.76	-3.33	-1.99	-2.26	-2.60	-2.48
NIST	35 2034	-9.42	-10.32	-9.48	-9.45	-8.89	-8.41	-7.94	-8.16	-7.88	-7.81	-5.78	-6.99
NIST	40 203	106.74	108.03	109.31	110.52	111.67	113.05	114.25	115.63	116.94	118.23	119.46	120.66
NIST	40 204	22.54	22.86	23.00	23.33	23.51	23.64	23.91	24.09	24.38	24.51	24.65	24.90
NIST	40 205	-26.41	-26.57	-26.59	-26.39	-26.29	-26.28	-26.32	-26.35	-26.27	-26.31	-26.39	-26.39
NIST	40 206	-68.18	-68.18	-68.01	-67.83	-67.50	-67.30	-67.08	-67.12	-67.20	-66.72	-66.47	-66.25
NIST	40 222	20.18	20.58	20.99	21.52	21.75	22.55	22.89	23.31	23.79	24.02	24.24	24.55
NMIJ	35 224	-13.40	-14.30	-13.39	-13.55	-14.35	-14.37	-13.58	-14.07	-13.92	-	-	-
NMIJ	35 523	11.17	11.87	11.63	11.28	10.61	10.42	11.35	11.13	10.40	11.04	10.43	10.35
NMIJ	35 1273	-	-	-	-	-	-	-	-	-	-	22.73	22.82
NMIJ	40 5002	-10.22	-9.46	-	-	-	-	-	-	-1.45	-3.22	-20.77	-16.84
NMIJ	40 5014	-1.33	-1.40	-1.29	-2.90	-2.50	-2.09	-0.67	-2.40	-3.49	-	-	-
NMIJ	40 5015	-	-	-	-	-	-	-	-	-	9.23	12.53	15.32
NMLS	35 1659	0.90	1.73	1.49	1.02	0.02	-0.33	-0.54	-	-0.54	-1.30	-	-
NPL	35 1275	-	8.51	9.06	9.32	9.65	8.38	8.28	8.70	8.15	8.64	8.48	7.50
NPL	36 784	-	6.23	7.44	7.06	7.71	7.24	7.22	5.46	4.28	6.63	6.04	6.95
NPL	40 1701	-	3.87	4.38	4.66	5.24	5.32	5.20	5.35	5.54	6.40	5.87	6.11
NPL	40 1708	-	-0.23*	0.15*	0.30*	-0.29*	-0.29*	0.03*	-0.22	-0.11	0.41	-0.17	0.25
NPLI	35 2257	0.51	-0.58	-0.34	-0.55	1.77	-0.85	-1.16	-0.04	1.44	-0.13	-0.51	-1.02
NRC	35 234	0.90	0.93	1.02	1.05	1.31	1.33	1.65	-	-	-	-	-
NRC	35 372	1.36	0.70	2.11	1.88	2.23	1.94	2.89	3.28	2.70	2.57	1.14	2.68
NRC	35 2148	-	-	-	-	3.31	2.75	3.33	3.38	3.41	3.52	1.23	3.40
NRC	35 2150	-	-	-	-	-3.02	-3.42	-4.13	-2.74	-1.45	-2.22	-4.00	-2.80
NRC	35 2151	-	-	-	-	16.15	14.54	13.74	13.20	13.25	13.37	11.42	13.42
NRC	35 2152	-	-	-	-	-10.58	-10.83	-10.26	-10.01	-9.49	-9.63	-10.80	-9.74
NRL	35 714	-	2.38	2.06	1.08	1.58	1.56	1.48	-	1.59	1.60	1.52	0.85

Table 8. (Cont.)

Lab.	Clock	54494	54524	54554	54584	54614	54644	54674	54709	54739	54769	54799	54829
NRL	35 719	-	2.25	2.43	1.83	2.76	3.50	2.68	-	3.10	2.89	3.14	4.10
NRL	40 1001	-	7.34	10.35	13.13	15.47	18.18	20.71	-	26.01	28.29	30.54	32.70
NRL	40 1003	-	2.20	2.45	2.75	3.12	3.50	3.89	-	4.50	4.76	5.09	5.21
NRL	40 1004	-	0.23	-3.04	-	-	-	-	-	-	-	-	-
NRL	40 1009	-	-0.45	-1.72	-	-1.56	-4.33	-7.61	-	-12.27	-13.78	-16.61	-19.84
NRL	40 1010	-	-	-	-	-	-	-	-	-	-	0.63	1.77
NTSC	35 1007	9.13	10.77	8.26	8.84	6.58	6.59	7.52	7.69	8.64	9.17	10.38	11.80
NTSC	35 1008	4.22	4.41	4.12	3.98	4.33	4.29	4.53	4.12	4.65	4.26	4.98	4.18
NTSC	35 1011	-1.03	-0.76	-1.02	-0.92	-1.03	-0.62	-0.43	-1.29	-0.84	-1.16	-0.72	-0.90
NTSC	35 1016	15.01	14.45	13.93	14.53	15.26	14.71	14.52	14.96	15.01	13.27	14.72	13.78
NTSC	35 1017	-0.58	0.16	0.70	0.21	0.73	1.21	0.50	1.40	1.15	0.25	0.07	-0.82
NTSC	35 1818	-21.48	-20.98	-22.64	-22.35	-22.21	-23.77	-23.81	-23.82	-23.85	-23.15	-22.81	-23.62
NTSC	35 1820	-2.92	-2.88	-0.44	-1.95	-0.85	-0.82	-0.48	0.12	0.34	-1.83	-0.14	-0.02
NTSC	35 1823	9.54	10.29	12.07	11.43	12.14	11.56	10.83	11.21	11.12	11.94	11.72	10.55
NTSC	35 2096	-6.32	-5.98	-5.72	-5.47	-5.64	-6.51	-5.65	-5.74	-5.92	-5.15	-5.53	-5.78
NTSC	35 2098	6.37	6.95	7.17	6.76	7.54	7.74	7.38	7.57	7.98	8.04	8.03	8.14
NTSC	35 2131	1.97	1.47	0.59	0.37	0.11	-0.48	-0.71	-1.09	-1.44	-2.12	-2.55	-2.97
NTSC	35 2141	34.31	43.29	38.98	34.23	39.16	42.91	39.66	38.90	35.17	33.42	34.82	35.93
NTSC	35 2142	-12.05	-11.67	-11.78	-11.29	-11.81	-11.43	-11.11	-11.00	-9.57	-9.09	-9.34	-9.78
NTSC	35 2143	2.71	2.69	3.01	2.88	3.03	2.27	2.90	3.17	3.07	3.51	3.30	4.00
NTSC	35 2144	-3.59	-3.69	-4.37	-3.47	-2.61	-5.17	-4.47	-4.55	-5.01	-3.41	-4.16	-5.29
NTSC	35 2145	1.28	1.81	1.29	1.56	2.17	2.02	2.29	1.53	1.99	1.83	1.80	1.53
NTSC	35 2146	2.68	3.26	3.23	3.42	3.08	3.36	3.49	3.60	3.22	3.11	3.54	3.95
NTSC	35 2147	6.71	6.39	5.78	7.26	7.16	7.28	7.94	7.94	8.09	7.86	8.45	10.00
NTSC	40 4926	134.45	187.21	190.95	194.73	200.01	205.74	212.10	219.74	228.63	234.90	241.01	246.56
NTSC	40 4927	202.18	208.22	214.48	219.70	226.00	231.82	237.47	243.50	249.73	-	-	-
NTSC	40 4933	-43.94	-57.04	-40.54	-31.48	-25.94	-22.62	-23.56	-30.06	-28.29	-25.24	-27.76	-28.48
NTSC	40 4945	-149.79	-115.79	-93.84	-89.25	-	-	-124.34	-	-	-	-	-
NTSC	40 4946	18.82	-	-	-	-	-	-	-	-	-	-	-
ONBA	36 2228	-	-2.21	-1.30	-	-	-2.84	-2.64	-	-1.75	-2.14	-3.52	-3.29
ONRJ	35 102	-	-	-	-	-	-	-	-	-4.52	-6.83	-7.07	-6.36
ONRJ	35 103	8.25	8.38	7.16	7.79	7.81	7.94	7.87	7.59	7.37	7.53	6.92	7.31
ONRJ	35 123	31.43	32.04	31.71	31.81	31.03	30.23	30.53	30.02	31.06	31.27	29.43	30.06
ONRJ	35 129	0.57	0.88	0.66	1.28	0.62	0.88	1.02	0.90	1.07	1.90	1.27	0.91
ONRJ	35 1942	8.65	8.31	8.21	8.14	7.91	8.61	8.56	8.01	8.33	8.30	7.53	8.27

Table 8. (Cont.)

Lab.	Clock		54494	54524	54554	54584	54614	54644	54674	54709	54739	54769	54799	54829
ONRJ	52	125	-15.50	-15.08	-20.90	-25.42	-28.33	-31.30	-32.27	-34.63	-41.70	-43.85	-43.48	-41.74
ORB	35	201	2.03	0.94	-0.13	0.01	-	0.09	1.98	1.19	0.30	1.34	1.10	1.71
ORB	35	202	7.37	8.45	8.10	8.59	-	8.89	7.09	8.23	10.88	8.67	4.73	6.27
ORB	35	593	77.56	78.28	77.40	76.98	-	77.68	79.00	78.08	80.96	79.49	80.07	79.15
ORB	40	2601	-0.34	-0.26	-1.01	0.57	-	-0.04	0.40	0.54	0.55	-0.10	-0.61	-0.67
PL	25	124	21.04	20.69	19.15	17.16	16.28	12.10	7.56	5.81	8.84	10.83	12.77	12.83
PL	35	441	2.70	3.37	3.26	3.35	3.35	3.73	3.59	2.66	3.44	3.61	2.96	4.07
PL	35	502	-0.68	-0.17	-0.42	-1.61	-1.84	-2.43	-	-	-	-	-	-
PL	35	745	-0.50	-1.00	-0.52	-0.07	-0.70	0.04	0.38	-0.04	0.02	-0.94	-0.20	0.59
PL	35	1120	-0.55	-0.25	0.24	-0.31	-0.39	0.40	0.56	-0.35	-0.76	-0.26	-1.43	-1.28
PL	35	1660	12.98	12.67	13.12	13.68	13.12	13.00	12.88	12.76	13.32	12.45	12.90	13.08
PL	35	1709	-0.60	-0.33	-0.39	-1.14	-0.43	-1.16	-1.28	-1.48	-1.36	-1.46	-2.04	-2.31
PL	35	1746	1.48	1.26	1.05	0.99	0.87	1.10	2.55	1.14	1.39	1.09	1.64	0.77
PL	35	1934	-1.15	-0.51	-0.70	-1.21	-0.40	-0.04	0.12	-1.45	-0.74	-0.49	0.64	-0.10
PL	35	2394	-	-	-	-	8.27	6.52	-0.84	-1.11	-0.51	-0.53	-0.94	-0.45
PL	36	1395	-6.34	-5.69	-7.79	-5.49	-	-	-	-	-	-	-	-
PL	40	4002	36.33	33.91	-	-	-28.09	-27.60	-27.59	-34.03	-31.87	-27.34	-28.37	-28.27
PL	40	4004	4.74	-0.56	7.77	2.44	-2.04	-2.42	-2.37	-3.67	-8.50	-9.71	-8.81	-13.71
PL	40	4601	-	-0.20*	0.03*	0.56*	0.98*	1.51*	1.90*	2.14*	2.72*	3.10*	3.07	4.19
PL	40	4602	-	-	-	-	-	-	-	-	-	-	-0.17	5.72
PTB	35	128	-2.41	-2.25	-1.72	-2.19	-1.97	-1.40	-1.09	-1.68	-1.39	-1.50	-1.39	-1.86
PTB	35	415	4.45	5.48	4.47	4.60	4.57	-	-	-	-	-	-	-
PTB	35	1072	10.19	10.13	10.32	9.86	9.85	11.15	10.27	10.30	10.41	10.14	10.05	10.25
PTB	40	506	-10.52*	-5.98*	-4.14*	-3.53*	-0.40	3.08	6.61	10.29	14.22	17.75	17.98	24.07
PTB	40	510	1.51	-14.25	-	-	-	-	-	-	-	-	-	-
PTB	40	590	-11.26*	-10.28*	-9.37*	-9.13*	-7.55*	-5.80*	-5.18*	-4.01*	-3.21*	-2.53*	-2.03	-2.03
PTB	92	1	2.11	2.26	0.92	1.27	1.00	1.40	2.07	1.79	2.49	2.38	-	-
PTB	92	2	1.43	0.98	1.37	0.89	1.40	1.58	1.60	1.76	1.44	1.10	1.12	1.01
ROA	35	583	-0.28*	-1.06*	-0.15*	0.63*	0.35*	-0.23*	-0.46*	-0.45*	-0.89*	-0.85*	-0.39*	-0.94
ROA	35	718	-6.16	-6.53	-6.61	-6.27	-6.55	-5.87	-7.08	-6.37	-6.43	-5.95	-5.26	-5.56
ROA	35	1699	2.78	2.75	3.92	2.94	3.21	3.18	3.47	3.04	2.80	3.46	3.49	3.62
ROA	36	1488	9.18	9.30	8.35	7.82	7.72	9.19	10.73	8.82	8.74	8.95	9.59	9.20
ROA	36	1490	8.94	8.25	6.34	6.60	4.62	7.08	7.08	8.39	8.22	6.60	6.86	9.10
ROA	40	1436	2.65	4.56	6.62	8.65	11.13	13.63	16.24	18.95	21.93	24.74	26.91	29.81
SCL	35	1745	0.36	-0.85	-0.79	-0.32	-0.04	-0.80	-0.81	-0.55	-1.25	-1.67	-0.90	-1.64

Table 8. (Cont.)

Lab.	Clock	54494	54524	54554	54584	54614	54644	54674	54709	54739	54769	54799	54829
SCL	35 2178	0.83	0.66	0.14	0.54	0.62	1.23	0.98	1.07	0.99	1.73	1.89	1.77
SG	35 1127	0.37	0.72	-	-	-	-	-	-	-	-	-	-
SG	35 1889	13.71	14.83	13.20	14.11	13.67	13.47	13.23	12.54	12.13	11.97	12.41	12.35
SG	36 522	2.11	3.06	2.72	4.68	2.36	1.30	3.15	4.65	3.35	2.83	2.89	2.95
SG	40 7701	-	-	-	-15.99	-18.85	-21.11	-	-	-	-	-	-
SIQ	36 1268	2.69*	-1.82*	4.55*	1.84*	3.29*	3.10	1.79	0.71	-4.45	-5.46	-4.43	-6.04
SMU	36 1193	-0.83	-1.15	2.71	2.44	3.20	2.45	1.90	-0.37	-0.35	0.19	0.24	0.05
SP	19 197	-67.24	-64.70	-	-	-54.91	-49.39	-50.96	-52.43	-44.99	-45.25	-	-58.61
SP	35 572	19.05	18.76	19.72	19.88	16.57	15.95	16.77	16.11	16.17	16.51	16.83	17.25
SP	35 641	6.56	6.89	5.65	4.96	4.76	4.80	5.04	4.26	4.73	4.59	4.05	4.03
SP	35 1188	29.20	28.89	29.40	28.78	28.37	28.36	27.93	27.92	27.33	26.71	27.07	27.39
SP	35 1531	19.95	21.43	21.26	20.51	23.27	22.88	22.39	22.46	22.43	22.76	22.19	23.61
SP	35 1642	11.20	10.69	-	-	-	-	-	-	-	-	-	-
SP	35 2166	1.57	1.46	1.63	1.98	1.61	2.02	2.12	2.43	2.71	2.99	2.54	2.50
SP	36 1175	3.06	1.41	1.42	2.43	2.45	1.81	1.83	2.72	2.06	2.08	2.05	1.88
SP	36 2068	0.85	1.38	1.62	2.02	1.03	-0.16	0.82	0.61	-0.98	0.55	1.36	1.85
SP	36 2218	26.67	26.91	25.86	26.54	26.62	26.74	26.36	26.40	26.37	26.18	25.33	25.40
SP	36 2297	-7.66	-7.01	-7.58	-6.68	-7.70	-7.77	-6.43	-7.18	-6.92	-7.47	-7.09	-6.02
SP	40 7201	31.80	34.40	36.42	37.13	39.43	41.86	44.14	46.51	49.01	51.14	53.16	55.37
SP	40 7203	10.16	11.20	12.28	13.46	14.69	15.90	17.11	18.54	20.05	21.23	22.39	23.76
SP	40 7210	-23.58	-	-	4.43	0.66	-0.05	3.49	7.32	11.50	14.71	18.18	22.07
SP	40 7211	-	-	-	-	-	-	-	-	-	-	-	17.18
SP	40 7212	-2.84	-2.26	-1.62	-1.11	-0.72	-0.18	0.11	0.54	1.15	1.15	1.38	1.71
SU	40 3802	3.99	4.03	4.67	5.35	5.78	6.10	6.41	6.46	6.98	7.14	8.20	8.49
SU	40 3804	-	23.86	24.87	26.31	28.95	31.40	33.14	33.18	33.84	35.66	37.69	-
SU	40 3805	94.97*	95.44	96.03	96.61	96.85	97.15	97.05	97.04	97.35	97.72	98.32	98.79
SU	40 3810	66.60*	66.91*	67.58	66.19	65.04	64.08	63.00	61.64	60.67	59.58	58.94	58.51
SU	40 3811	-	-	-	-	-	-	-	-	-	-	-	24.06
SU	40 3812	-	-	-	-	-	-	-	-	-	-	-	0.32
SU	40 3822	77.79*	77.63*	79.43*	81.94*	83.27*	84.89*	85.88*	86.71*	88.53*	86.60*	89.40	91.80
SU	40 3831	48.62*	48.37*	48.90*	49.75*	50.16*	51.84*	52.18*	49.09*	49.33	50.04	50.30	51.18
SU	40 3837	51.08*	51.36*	51.62*	51.98*	52.09*	52.37*	52.77*	52.60*	52.97	53.48	52.66	52.76
TCC	35 768	-3.45	-5.37	-4.52	-1.45	-6.26	-4.21	-	-	-	2.89	3.48	3.95
TCC	35 1881	15.23	16.21	15.97	15.80	16.23	15.86	-	-	-	1.14	0.53	0.74
TCC	40 8620	-	-	37.45*	27.80*	13.93*	-16.55*	-	-	-	-0.24	2.88	5.87

Table 8. (Cont.)

Lab.	Clock	54494	54524	54554	54584	54614	54644	54674	54709	54739	54769	54799	54829
TCC	40 8624	-14.86	-15.88	-16.57	-15.39	-17.45	-18.07	-	-	-	-1.61	-2.25	-2.90
TCC	40 8650	-	-	-	-	-	-	-	-	-	-0.51	-2.67	-5.15
TL	35 160	-5.11	-4.27	-5.07	-5.61	-5.44	-5.03	-5.53	-7.59	-9.91	-9.56	-9.96	-10.41
TL	35 300	8.99	10.00	9.13	8.92	9.27	8.93	8.75	12.50	14.98	14.61	15.08	15.17
TL	35 474	14.30	15.31	14.54	14.77	13.56	15.48	13.86	12.97	12.50	12.35	13.09	14.00
TL	35 809	1.29	2.05	0.71	1.08	1.24	1.35	-3.55	-3.42	-3.21	-4.38	-3.36	-1.04
TL	35 1012	-2.09	-2.17	-1.99	-2.42	-1.38	-1.33	0.59	-3.21	-3.87	-3.84	-4.19	-4.00
TL	35 1104	8.78	9.30	9.26	9.01	9.61	10.98	11.60	11.73	12.45	13.24	12.94	14.28
TL	35 1132	-4.55	-5.41	-6.89	-6.28	-5.97	-6.19	-6.09	-7.17	-7.70	-7.68	-7.30	-7.60
TL	35 1498	15.47	15.79	14.85	15.82	16.88	-	-	-	-	-	-	-
TL	35 1500	17.48	16.92	16.88	16.25	17.14	17.63	17.74	18.67	18.63	18.64	18.95	19.27
TL	35 1712	1.51	1.04	0.44	0.60	1.11	0.97	1.36	0.74	0.56	0.32	0.44	1.27
TL	35 2365	-	5.01	4.59	5.08	4.69	4.08	4.64	4.20	4.68	4.23	4.22	4.00
TL	35 2366	-	-8.28	-8.14	-8.45	-8.05	-8.16	-7.69	-7.60	-7.41	-7.39	-7.80	-7.87
TL	35 2367	-	10.03	10.24	10.44	10.05	10.41	10.45	10.31	9.78	10.33	10.59	10.30
TL	35 2368	-	-0.86	-1.00	-0.20	-1.05	-0.46	1.10	1.50	1.20	1.17	1.39	1.16
TL	40 3052	63.08	63.98	63.97	63.61	63.93	63.96	63.99	63.61	63.25	63.68	64.02	63.79
TL	40 3053	9.67	9.56	9.27	9.30	9.34	9.59	9.61	9.13	9.62	9.28	9.26	9.60
TP	35 163	18.61	18.78	17.84	18.61	19.73	20.09	20.18	20.38	20.31	20.08	20.40	19.64
TP	35 326	-52.12	-51.43	-51.59	-54.85	-56.99	-56.83	-58.93	-58.30	-58.47	-60.64	-61.90	-61.26
TP	35 1227	9.00	8.59	10.73	12.22	11.96	12.38	13.59	13.00	11.26	-	-	-
TP	36 154	12.26	10.85	10.43	11.58	9.89	12.09	11.81	10.40	11.00	11.44	11.39	12.47
UA	40 7871	-	-	-	-	-	-	-2.43	-1.43	0.05	0.46	5.49	5.74
UA	40 7881	-	-	-	-	-	-	1.87	3.43	6.29	5.14	1.96	-2.24
UA	40 7882	-	-	-	-	-	-	15.83	13.07	1.47	-2.26	-1.19	-1.81
UME	35 872	-1.48	-2.18	-1.92	-2.26	-2.28	-2.28	-1.91	-0.91	42.16	-0.51	-1.26	-1.00
USNO	35 101	-3.34	-4.19	-4.13	-4.14	-5.09	-4.52	-5.23	-4.04	-3.93	-4.07	-4.30	-4.25
USNO	35 104	18.21	18.23	18.11	19.21	19.09	19.14	19.70	19.18	19.68	20.35	19.60	19.43
USNO	35 106	16.47	16.47	15.92	16.23	16.25	16.33	15.93	16.79	17.00	16.10	16.70	16.48
USNO	35 108	0.79	0.49	0.84	-	-	-	-	-	-	-	-	-
USNO	35 114	-5.88	-6.08	-5.58	-5.30	-4.66	-4.68	-4.68	-4.67	-4.70	-4.32	-4.65	-4.74
USNO	35 120	1.35	0.88	1.13	-	-	-	-	-	-	-	-	-
USNO	35 142	-12.00	-11.08	-11.23	-11.19	-10.72	-11.10	-11.55	-10.21	-10.49	-10.32	-9.82	-9.73
USNO	35 145	19.06	19.44	19.01	15.17	15.68	-	-	-	-	21.69	21.06	19.75
USNO	35 146	1.04	-0.11	0.45	-0.03	-0.25	-0.30	0.37	0.86	-0.53	0.23	0.46	0.29

Table 8. (Cont.)

Lab.	Clock		54494	54524	54554	54584	54614	54644	54674	54709	54739	54769	54799	54829
USNO	35	148	8.83	8.33	8.55	8.58	8.56	7.99	8.02	-	-	-	-	-
USNO	35	150	0.10	-0.52	-0.03	0.15	-0.02	0.25	0.21	-0.20	-0.42	-0.83	-0.50	-0.25
USNO	35	152	-	3.74	3.89	4.04	4.98	4.35	4.55	4.39	5.26	3.82	4.35	4.16
USNO	35	153	14.69	14.14	15.04	15.17	14.71	15.65	15.73	15.41	15.18	15.71	15.72	15.80
USNO	35	156	11.23	11.44	12.27	12.48	12.20	11.86	10.90	11.78	12.24	12.50	11.78	12.12
USNO	35	161	9.39	8.38	8.70	10.24	8.86	10.18	9.71	9.43	9.02	9.88	10.29	9.91
USNO	35	164	2.75	3.89	4.46	6.17	5.18	5.65	5.34	5.80	5.53	5.49	5.78	4.85
USNO	35	165	13.53	12.90	13.07	13.76	12.65	13.24	-	-	13.64	13.96	13.89	14.28
USNO	35	166	-0.20	-0.36	-0.08	-0.30	-0.61	-0.13	-0.87	-1.09	-0.19	-0.06	-0.88	-1.40
USNO	35	167	1.19	0.44	0.58	0.25	0.25	0.07	1.10	0.42	-0.11	-0.37	-0.35	-0.83
USNO	35	173	-5.88	-6.09	-7.08	-6.37	-6.94	-6.78	-7.48	-7.21	-7.16	-7.83	-7.79	-7.90
USNO	35	213	3.16	3.74	4.36	4.53	3.94	4.66	4.90	5.34	5.34	5.31	6.17	6.20
USNO	35	217	-	-	-	-	-	-	-	-	-	-16.59	-16.91	-16.51
USNO	35	226	-	-	-	-	-	-	-	-	-	8.28	7.95	7.57
USNO	35	227	9.10	8.62	6.87	6.12	5.50	5.40	5.28	5.69	5.02	4.90	5.00	5.35
USNO	35	231	-14.45	-14.80	-15.35	-14.96	-14.01	-14.45	-14.39	-14.67	-14.53	-14.10	-13.88	-13.79
USNO	35	233	17.40	17.81	17.76	17.06	16.99	17.04	17.68	16.91	17.46	17.26	17.40	17.32
USNO	35	242	11.95	13.33	12.96	12.21	12.67	12.00	12.63	12.57	13.05	12.60	12.56	12.03
USNO	35	244	5.43	5.65	6.26	6.44	6.22	6.75	6.78	6.72	6.99	6.70	7.15	6.68
USNO	35	249	2.40	5.40	5.12	6.61	6.58	-	-	-	-	-	-	-
USNO	35	253	-31.80	-30.64	-29.48	-28.73	-28.27	-28.23	-27.80	-27.28	-25.03	-24.47	-25.15	-24.64
USNO	35	254	-	-	-	-	-	-	-	-	-	3.00	2.69	3.21
USNO	35	255	8.46	7.50	8.38	7.94	9.18	8.62	8.93	-	-	-	-	-
USNO	35	256	13.03	13.46	13.12	12.35	13.12	12.19	12.42	12.43	12.37	13.38	12.56	-
USNO	35	260	2.42	4.10	6.49	4.69	2.12	-	-	-	-	2.21	1.64	-0.51
USNO	35	279	2.85	2.37	3.66	-	-	-	-	-	-	-	-	-
USNO	35	389	-17.45	-17.55	-16.96	-17.69	-18.48	-17.86	-17.72	-18.33	-17.83	-19.65	-17.17	-17.85
USNO	35	392	28.01	29.43	28.72	29.97	29.81	29.66	30.07	30.58	30.80	30.64	29.96	30.01
USNO	35	394	-	-	50.27	55.63	58.05	59.23	60.67	57.78	59.28	64.41	-	-
USNO	35	416	-11.86	-10.95	-12.12	-11.95	-10.84	-10.78	-11.16	-11.31	-11.32	-10.52	-11.62	-11.66
USNO	35	417	11.37	10.21	10.38	9.33	9.83	10.34	10.07	10.20	10.27	10.73	10.05	10.14
USNO	35	703	-0.06	-1.25	-2.23	0.63	-0.56	0.08	-0.27	0.16	-0.64	0.43	-1.41	-1.38
USNO	35	717	-12.80	-12.76	-12.82	-12.27	-11.82	-12.06	-12.40	-11.81	-12.12	-11.54	-12.40	-12.21
USNO	35	762	-3.78	-3.25	-2.93	-4.18	-3.81	-3.20	-4.07	-3.61	-2.95	-3.01	-2.69	-2.42
USNO	35	763	-18.00	-18.38	-17.84	-18.07	-17.76	-17.44	-17.21	-17.45	-17.22	-17.28	-17.34	-16.69

Table 8. (Cont.)

Lab.	Clock	54494	54524	54554	54584	54614	54644	54674	54709	54739	54769	54799	54829
USNO	35 765	-9.34	-9.28	-10.03	-9.80	-9.88	-10.14	-10.45	-11.00	-10.80	-11.23	-10.42	-9.37
USNO	35 1096	30.09	29.34	30.40	30.11	29.61	29.47	29.53	30.23	28.95	-	-	-
USNO	35 1097	12.58	13.35	12.67	12.26	12.59	11.93	11.18	11.33	11.54	12.58	11.72	11.78
USNO	35 1125	-	-	-	-	-	-	-	-	-13.86	-12.89	-12.65	-11.70
USNO	35 1327	-5.65	-5.52	-5.05	-5.12	-4.09	-4.32	-4.62	-4.32	-3.66	-4.15	-4.02	-3.98
USNO	35 1328	5.54	5.71	5.80	5.86	5.71	6.36	5.53	5.53	6.07	6.18	6.15	6.04
USNO	35 1331	-38.56	-38.49	-38.88	-38.30	-38.85	-38.68	-38.87	-38.64	-38.60	-39.76	-38.90	-38.93
USNO	35 1438	-4.16	-3.69	-3.12	-3.64	-2.97	-2.47	-1.76	-2.99	-3.23	-3.23	-3.32	-3.25
USNO	35 1459	-	-	-	-	-	-	-	-	-	-7.13	-6.69	-6.21
USNO	35 1462	-4.50	-4.99	-5.06	-5.15	-5.29	-4.86	-5.07	-4.26	-4.60	-4.35	-3.72	-3.86
USNO	35 1463	10.86	10.93	11.59	10.98	11.49	11.75	11.23	11.51	12.09	12.18	11.93	12.04
USNO	35 1468	2.74	3.22	2.72	-	-	-	-	-	-	-	-	-
USNO	35 1543	-	-	-	-	-	-	-	-	4.37	3.26	3.48	3.02
USNO	35 1575	-4.25	-3.97	-4.56	-4.42	-4.29	-	-	-	-	-	-	-
USNO	35 1655	-11.46	-11.07	-10.13	-10.29	-11.21	-9.83	-10.01	-10.08	-9.94	-9.48	-10.41	-10.10
USNO	35 1692	3.89	4.95	3.95	5.25	4.76	4.84	4.77	4.62	5.24	5.63	5.17	5.08
USNO	35 1694	-3.67	-4.69	-4.14	-3.98	-4.06	-3.89	-4.40	-3.53	-4.16	-4.39	-4.39	-4.82
USNO	35 1696	4.89	5.03	5.06	4.41	4.58	5.49	3.27	5.31	4.24	4.88	4.63	4.51
USNO	35 1697	2.32	2.36	2.19	2.47	2.73	2.07	1.77	2.99	1.82	1.96	1.52	1.29
USNO	40 701	-9.84	-9.92	-8.57	-7.68	-8.86	-8.95	-9.64	-10.02	-10.30	-10.01	-	-
USNO	40 702	-10.50	-10.51	-10.93	-10.93	-10.94	-10.85	-10.91	-10.86	-10.95	-11.01	-10.96	-10.97
USNO	40 704	16.94	16.98	17.13	17.33	17.66	18.04	18.21	18.38	18.64	18.78	18.98	19.20
USNO	40 705	-48.59	-48.55	-47.96	-47.68	-48.73	-48.86	-49.01	-48.81	-48.78	-48.49	-47.46	-46.02
USNO	40 708	63.84	63.95	64.02	64.23	64.64	64.97	65.29	65.71	66.14	66.63	67.20	67.79
USNO	40 710	-558.14	-557.74	-556.91	-556.36	-555.82	-555.20	-554.70	-554.20	-553.65	-553.14	-552.71	-552.31
USNO	40 711	245.46	247.24	249.04	250.92	252.70	254.74	256.33	258.35	260.40	262.27	264.12	265.92
USNO	40 712	47.55	47.57	47.53	47.62	47.64	47.87	47.75	47.74	47.80	47.91	47.91	47.50
USNO	40 713	7.34	7.56	7.98	8.33	8.69	9.09	9.37	9.78	10.12	10.49	10.85	11.29
USNO	40 714	-23.06	-22.70	-22.18	-22.54	-22.40	-21.21	-21.28	-21.16	-21.00	-20.85	-20.81	-20.30
USNO	40 715	74.49	74.88	75.13	75.79	76.25	76.87	77.27	77.83	78.15	78.62	79.08	79.53
USNO	40 716	208.31	208.33	208.46	208.37	208.41	209.08	209.03	209.10	209.17	209.38	209.34	209.42
USNO	40 718	128.79	129.51	130.02	130.60	131.10	131.77	132.36	133.18	134.10	135.19	136.28	137.39
USNO	40 719	13.64	15.21	16.76	18.33	19.81	-	-	24.37	26.00	27.44	28.85	30.34
USNO	40 720	26.79	28.66	30.69	32.91	35.00	37.49	39.49	41.77	44.22	46.64	48.83	50.90
USNO	40 722	244.39	248.84	253.45	257.75	262.37	267.06	270.93	275.75	280.45	284.77	289.11	293.32

Table 8. (Cont.)

Lab.	Clock	54494	54524	54554	54584	54614	54644	54674	54709	54739	54769	54799	54829
USNO	40 723	-69.94	-69.99	-70.06	-70.15	-70.28	-70.18	-70.19	-70.31	-70.22	-70.18	-70.18	-70.23
USNO	40 724	-100.32	-100.59	-100.70	-100.89	-100.95	-100.94	-101.54	-99.91	-98.18	-97.28	-96.61	-96.13
USNO	40 725	-32.73	-32.72	-32.73	-32.74	-32.57	-32.21	-32.14	-31.36	-31.06	-30.77	-30.62	-30.29
USNO	40 726	188.10	195.71	203.71	209.99	217.33	224.06	229.68	235.60	240.57	245.52	248.65	255.53
USNO	40 728	-	-	116.64	121.12	125.62	130.31	134.92	139.74	144.79	149.05	153.23	157.57
USNO	40 729	99.21	105.85	112.58	119.17	126.96	-	-	-	-	-	-	-
USNO	40 730	-15.98	-12.44	-8.91	-5.78	-1.81	-	-	-	-	-	-	-
USNO	40 731	-144.23	-143.31	-142.34	-141.61	-140.81	-140.18	-139.54	-138.95	-138.48	-138.18	-138.05	-137.87
VMI	35 2230	-	-	-17.44	-17.38	-16.28	-19.63	-20.41	-21.09	-	-21.15	-19.66	-20.08
VMI	36 1233	-	-	1.29	1.40	4.13	2.44	-1.73	-1.49	-	-1.67	2.69	0.26
VMI	36 2314	-	-	25.12	26.20	27.14	25.17	23.40	21.82	-	22.02	25.26	24.66
VSL	35 179	9.07	9.80	8.60	7.99	8.09	10.04	8.57	7.83	8.09	8.67	-	-
VSL	35 456	18.68	19.58	17.83	18.08	18.13	18.39	17.80	18.03	17.87	19.10	18.23	18.73
VSL	35 548	11.91	12.34	12.70	11.90	11.96	11.53	11.68	11.45	10.34	-	-	-
VSL	35 731	20.72	20.95	19.18	18.77	18.16	18.42	18.33	17.64	18.60	18.60	19.51	18.75
ZMDM	36 2033	5.21	6.81	-	6.70	6.23	6.48	5.55	5.55	5.84	5.55	5.54	6.21

Table 9A. Relative weights (in percent) of contributing clocks in 2008

(File available on http://www.bipm.org under the name WTAI08.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/SYMMETRICOM 5071A High perf.
36 H-P/AGILENT/SYMMETRICOM 5071A Low perf.
50 FREQ. AND TIME SYSTEMS INC. 4065A
51 DATUM/SYMMETRICOM 4065 B
52 DATUM/SYMMETRICOM 4065 C

Lab.	Clock		54494	54524	54554	54584	54614	54644	54674	54709	54739	54769	54799	54829
APL	35	904	0.282	0.283	0.331	0.407	0.471	0.359	0.210	0.188	0.187	0.194	0.192	0.177
APL	35	1264	0.048	0.058	0.072	0.086	0.102	0.092	0.093	0.315	0.319	0.326	0.279	0.176
APL	35	1791	0.842	0.836	0.842	0.831	0.847	0.833	0.836	0.859	0.831	0.833	0.839	0.783
APL	40	3107	0.214	0.237	0.000	0.058	0.071	0.077	0.090	0.090	0.099	0.107	0.110	0.124
APL	40	3108	0.001	0.001	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
APL	40	3109	0.053	0.044	0.040	0.034	0.027	0.021	0.019	0.015	0.013	0.011	0.009	0.008
AUS	35	2269	0.186	0.267	0.395	0.514	0.673	0.393	0.463	0.000	0.000	0.075	0.058	0.051
AUS	36	340	0.109	0.170	0.245	0.251	0.246	0.325	0.325	0.218	0.336	0.371	0.363	0.357
AUS	36	654	-	-	-	-	0.000	0.000	0.000	0.000	0.488	0.359	0.490	0.656
AUS	36	1141	0.078	0.070	0.070	0.094	0.105	0.089	0.092	0.094	0.085	0.081	0.076	0.076

Table 9A. (Cont.)

Lab.	Clock	54494	54524	54554	54584	54614	54644	54674	54709	54739	54769	54799	54829
AUS	40 5402	0.000	0.000	0.000	0.000	-	0.000	-	-	0.000	0.000	0.000	-
BEV	35 1065	0.242	0.239	0.242	0.320	0.304	0.273	0.302	0.000	0.091	0.074	0.072	0.102
BEV	35 1793	0.445	0.000	0.036	0.027	0.023	0.021	0.019	0.018	0.020	0.023	0.031	0.045
BEV	40 3452	-	-	-	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
BIM	35 1501	0.077	0.072	0.076	0.070	0.077	0.072	0.100	0.100	-	0.000	0.000	0.000
BY	40 4209	0.012	0.011	0.010	0.006	0.006	0.005	0.006	0.006	0.006	0.005	0.007	0.009
BY	40 4227	-	-	-	-	-	-	-	0.000	0.000	0.000	0.000	0.006
BY	40 4260	0.001	0.002	0.002	0.002	0.003	0.003	0.003	0.003	0.003	0.002	0.002	0.002
BY	40 4278	0.001	0.001	0.001	0.001	0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.000
CAO	35 939	0.059	0.063	0.074	0.080	0.121	0.119	0.144	-	0.000	0.000	0.000	0.000
CAO	35 1270	0.046	0.052	0.061	0.068	0.106	0.182	0.236	-	0.000	0.000	0.000	0.000
CH	35 771	0.500	0.463	-	-	-	-	-	-	-	-	-	0.000
CH	35 2117	0.629	0.688	0.734	0.744	0.000	0.392	0.573	0.582	0.425	0.460	0.451	0.444
CH	36 354	0.178	0.218	0.569	0.358	0.407	0.419	0.368	0.335	0.315	0.291	0.277	0.282
CH	36 413	0.241	0.226	0.137	0.094	0.000	0.042	0.025	0.025	0.025	0.027	0.025	0.029
CH	40 5701	0.010	0.008	0.007	0.007	0.007	0.007	0.007	0.008	0.009	0.010	0.012	0.010
CNM	35 1705	0.082	0.085	0.084	0.095	0.106	0.067	0.048	0.038	0.036	0.036	0.039	0.052
CNM	35 1815	0.248	0.308	0.342	0.457	0.559	0.537	0.512	0.561	0.549	0.588	0.580	0.853
CNM	36 1537	0.149	0.187	0.157	0.104	0.107	0.109	0.140	0.157	0.135	0.125	0.118	0.133
CNM	40 7301	0.002	0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
CNM	53 6038	-	-	-	-	-	-	0.000	0.000	0.000	0.000	0.067	0.099
CNMP	36 1806	0.000	0.000	0.017	0.026	0.036	0.043	0.057	0.051	0.000	0.013	0.011	0.010
DLR	35 1714	0.305	0.240	0.275	0.329	0.320	0.333	0.341	-	-	0.000	0.000	0.000
DTAG	36 136	0.000	0.001	0.001	0.001	0.001	0.001	0.002	0.003	0.002	0.002	-	-
DTAG	36 345	0.293	0.297	0.350	0.354	0.290	0.257	0.265	0.289	0.289	0.284	0.337	0.338
DTAG	36 465	0.071	0.079	0.099	0.116	0.127	0.127	0.116	0.131	0.127	0.116	0.113	0.237
DTAG	36 2370	-	-	-	-	-	-	-	-	-	-	0.000	0.000
EIM	35 716	-	0.000	0.000	0.000	-	-	-	-	-	0.000	0.000	0.000
EIM	35 1431	-	0.000	0.000	0.000	-	-	-	-	-	0.000	-	0.000
EIM	35 2060	-	-	0.000	0.000	-	-	-	-	-	-	0.000	0.000
F	35 122	0.842	0.836	0.842	-	-	0.000	0.000	0.000	0.000	0.286	0.410	0.370
F	35 124	0.699	0.836	0.842	0.831	0.847	0.833	0.836	0.859	0.831	0.833	0.839	0.853
F	35 131	0.553	0.562	0.842	0.831	0.847	0.833	0.836	0.859	0.831	0.833	0.726	0.821
F	35 157	-	-	0.000	0.000	0.000	0.000	0.836	0.859	0.831	0.833	0.839	-
F	35 158	0.342	0.356	0.443	0.426	0.488	0.352	0.403	0.369	0.619	0.519	0.347	0.387

Table 9A. (Cont.)

Lab.	Clock		54494	54524	54554	54584	54614	54644	54674	54709	54739	54769	54799	54829
F	35	198	-	-	0.000	0.000	0.000	0.000	-	-	-	-	-	-
F	35	385	0.473	0.000	0.000	0.298	0.292	0.275	0.229	0.240	0.230	0.148	0.158	0.135
F	35	396	-	-	-	-	-	0.000	0.000	0.000	0.000	0.108	0.084	0.077
F	35	469	-	-	0.000	0.000	0.000	0.000	0.017	0.019	0.021	0.025	0.027	-
F	35	520	-	-	-	-	0.000	0.000	0.000	0.000	0.213	0.071	0.079	-
F	35	536	-	-	-	-	0.000	0.000	0.000	-	-	-	-	-
F	35	609	0.000	0.000	0.652	0.625	0.847	0.833	0.836	0.859	0.831	0.833	0.799	-
F	35	770	0.482	0.634	0.745	0.822	0.847	0.833	0.836	0.859	0.666	0.676	0.721	0.733
F	35	774	-	-	-	-	-	-	-	-	-	0.000	0.000	0.000
F	35	781	-	-	0.000	0.000	0.000	0.000	0.063	0.064	0.073	0.066	0.078	0.098
F	35	819	-	-	0.000	0.000	0.000	0.000	0.150	0.110	0.098	0.128	0.154	0.191
F	35	859	-	-	-	-	0.000	0.000	0.000	0.000	0.168	0.096	0.107	0.115
F	35	1029	0.842	-	-	-	-	-	-	-	-	-	-	-
F	35	1068	-	-	-	-	-	-	-	-	-	0.000	0.000	0.000
F	35	1178	0.000	0.000	0.000	0.115	0.107	0.074	0.072	0.087	0.106	0.129	0.151	0.151
F	35	1222	-	-	0.000	0.000	0.000	0.000	0.836	0.610	0.468	0.515	0.461	0.575
F	35	1258	0.119	0.144	0.133	0.159	0.164	0.231	0.358	0.472	0.831	0.833	0.839	0.853
F	35	1321	0.842	0.836	0.842	0.831	0.847	0.833	0.836	0.859	0.831	0.833	0.839	0.853
F	35	1556	0.173	0.089	-	-	0.000	0.000	0.000	0.000	-	-	0.000	0.000
F	35	1644	-	-	-	0.000	0.000	0.000	0.000	0.185	0.262	0.303	0.330	-
F	35	2027	0.329	0.313	0.300	0.278	0.250	0.209	0.279	0.376	0.359	0.290	0.263	0.190
F	35	2388	-	-	-	0.000	0.000	0.000	0.000	0.444	0.618	0.833	0.839	0.853
F	40	805	0.021	0.014	0.011	0.008	0.006	0.005	0.004	0.005	0.005	0.006	0.006	0.006
F	40	816	0.046	0.046	0.058	0.095	0.120	0.000	0.058	0.046	0.042	0.044	0.046	0.052
F	40	889	0.001	0.001	-	-	0.000	0.000	0.000	-	-	0.000	0.000	0.000
F	40	890	0.014	0.012	-	-	0.000	0.000	0.000	-	-	0.000	0.000	0.000
F	53	6385	0.000	0.000	0.010	0.005	0.004	0.003	0.003	0.003	0.003	0.003	0.004	0.005
HKO	35	358	-	-	-	-	-	-	-	-	0.000	0.000	0.000	0.000
HKO	35	1893	0.049	0.048	0.051	0.054	0.064	0.058	0.091	0.170	0.694	0.833	0.839	0.853
IFAG	36	1167	0.044	0.033	0.030	0.028	0.028	0.026	0.025	0.026	0.024	0.026	0.025	0.027
IFAG	36	1173	0.027	0.026	0.029	0.031	0.025	0.019	0.015	0.010	0.007	0.006	0.006	0.007
IFAG	36	1629	0.247	0.216	0.232	0.253	-	-	-	-	-	0.000	0.000	0.000
IFAG	36	1732	0.378	0.276	0.222	0.205	0.247	0.288	0.406	0.517	0.595	0.611	0.592	0.575
IFAG	36	1798	0.036	0.045	0.058	0.076	0.100	0.113	0.139	0.165	0.322	0.405	0.307	0.287
IFAG	40	4418	0.026	0.019	0.018	0.017	0.015	0.014	0.013	0.014	0.015	0.021	0.057	0.070

Table 9A. (Cont.)

Lab.	Clock	54494	54524	54554	54584	54614	54644	54674	54709	54739	54769	54799	54829
IFAG	40 4439	0.002	0.003	0.005	0.006	0.007	0.008	0.008	0.008	0.006	0.005	0.004	0.004
INTI	35 2377	-	-	-	-	-	-	-	-	-	-	0.000	0.000
IT	35 219	0.330	0.315	0.470	0.554	0.693	0.593	-	-	-	-	-	-
IT	35 505	0.480	0.662	0.705	0.790	0.744	0.690	0.681	0.590	0.795	0.821	0.661	0.629
IT	35 1115	0.071	0.088	0.099	0.189	0.470	0.440	0.681	0.508	0.452	0.373	0.399	0.408
IT	35 1373	0.516	0.492	0.375	0.299	0.251	0.317	0.358	0.343	0.321	0.254	0.308	0.276
IT	35 2118	0.719	0.808	0.842	0.831	0.847	0.833	0.836	0.859	0.831	0.833	0.833	0.853
IT	40 1102	0.006	0.006	0.007	0.007	0.007	0.007	0.008	0.007	0.006	0.005	0.004	0.003
JV	21 216	0.011	0.009	-	-	0.000	0.000	0.000	0.000	0.005	0.004	0.005	0.006
JV	21 387	0.000	0.000	-	-	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
JV	36 1277	0.178	0.187	-	-	0.000	0.000	0.000	0.000	0.059	0.088	0.040	0.047
KIM	36 618	-	-	0.000	0.000	0.000	0.000	0.050	0.053	0.073	0.094	0.079	-
KRIS	35 321	0.070	0.000	0.031	0.024	0.019	0.017	0.019	0.020	0.022	0.028	0.044	0.114
KRIS	35 739	-	-	-	-	-	0.000	0.000	0.000	0.000	0.833	0.839	0.853
KRIS	35 1693	0.842	0.836	0.842	0.831	0.847	0.833	0.836	0.859	0.742	0.807	0.600	0.620
KRIS	35 1783	0.242	0.286	0.325	0.391	0.293	0.279	0.282	0.296	0.297	0.292	0.297	0.277
KRIS	36 739	-	-	0.000	0.000	-	-	-	-	-	-	-	-
KRIS	36 1135	0.048	0.000	0.019	0.021	0.030	0.022	0.024	0.024	0.025	0.028	0.029	0.048
KRIS	40 5623	0.080	0.104	0.132	0.158	0.135	0.101	0.087	0.081	0.080	0.084	0.090	0.091
LT	35 1362	0.294	0.305	0.320	0.328	0.000	0.100	0.104	-	-	-	-	-
LT	35 1868	0.169	0.151	0.135	0.118	0.134	0.150	0.177	-	-	-	-	-
LV	35 2335	0.000	0.000	0.000	0.005	0.005	0.006	0.007	0.009	0.010	0.013	0.014	0.018
MIKE	35 1171	0.149	0.174	0.183	0.243	0.267	0.251	0.312	0.436	0.369	0.320	0.000	0.183
MIKE	36 986	0.164	0.165	0.210	0.215	0.196	0.162	0.170	0.249	0.234	0.141	0.129	0.154
MIKE	40 4108	-	-	-	-	0.000	0.000	0.000	0.000	0.789	0.833	0.491	0.401
MIKE	40 4113	0.005	0.004	0.004	0.004	0.005	0.004	0.005	0.005	0.004	0.004	0.004	0.004
MIKE	40 4180	0.842	0.836	0.842	-	-	-	-	-	-	-	-	-
MKEH	36 849	-	0.000	0.000	0.000	0.000	0.110	0.139	0.051	0.058	0.075	0.090	0.109
MSL	12 933	0.002	0.002	0.002	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
MSL	36 274	0.060	0.069	0.069	0.072	0.083	0.071	0.083	0.082	0.079	0.080	0.083	0.063
MSL	36 1025	0.001	0.001	0.001	0.001	0.002	0.002	0.002	0.002	0.002	0.002	0.003	0.004
NAO	35 779	0.000	0.000	0.000	0.132	0.201	0.206	-	-	-	-	-	0.000
NAO	35 1206	0.431	0.481	0.638	0.624	0.637	0.593	-	-	-	-	-	0.000
NAO	35 1214	0.154	0.149	0.143	0.140	0.140	0.134	-	-	-	-	-	0.000
NAO	35 1689	0.014	0.015	0.019	0.021	0.022	0.020	-	-	-	-	-	0.000

Table 9A. (Cont.)

Lab.		Clock	54494	54524	54554	54584	54614	54644	54674	54709	54739	54769	54799	54829
NICT	35	112	-	-	-	-	-	-	-	0.000	0.000	0.000	0.000	0.311
NICT	35	144	0.619	0.767	0.842	0.831	0.847	0.833	0.000	0.330	0.320	0.357	0.284	0.161
NICT	35	332	0.032	0.036	0.042	0.071	0.127	0.246	0.401	0.635	0.731	0.833	0.839	0.853
NICT	35	342	0.102	0.103	0.123	0.343	0.363	0.454	0.471	0.498	0.481	0.529	0.000	0.473
NICT	35	343	0.611	0.703	0.697	0.519	0.500	0.419	0.326	0.290	0.388	0.000	0.361	0.405
NICT	35	715	0.537	0.500	0.558	0.403	0.428	0.425	0.496	0.505	0.482	0.419	0.423	0.563
NICT	35	732	0.371	0.325	0.342	0.369	0.376	0.364	0.485	0.631	0.712	-	-	-
NICT	35	907	0.138	0.423	0.567	0.559	0.555	0.716	0.636	0.546	0.541	0.461	0.552	0.455
NICT	35	908	0.608	0.680	0.811	0.792	0.635	0.685	0.737	0.495	0.371	0.394	0.385	0.277
NICT	35	913	-	-	-	0.000	0.000	0.000	0.000	0.113	0.161	0.118	0.126	0.145
NICT	35	916	0.000	-	-	-	-	-	-	-	-	-	-	-
NICT	35	1225	0.842	0.836	0.842	0.831	0.847	0.639	0.589	0.616	0.669	0.711	0.664	0.682
NICT	35	1778	0.842	0.836	0.842	0.831	0.847	0.833	0.836	0.744	0.720	0.420	0.539	0.524
NICT	35	1789	0.362	0.340	0.374	0.377	0.293	0.283	0.256	0.368	0.477	0.725	0.839	0.853
NICT	35	1790	0.842	0.836	0.842	0.831	0.847	0.833	0.836	0.859	0.807	0.818	0.814	0.648
NICT	35	1866	0.646	0.320	0.372	0.363	0.443	0.315	0.388	0.384	0.501	0.550	0.536	0.467
NICT	35	1882	0.842	0.836	0.842	0.831	0.847	0.833	0.836	0.000	0.000	0.215	0.166	0.000
NICT	35	1887	0.041	0.044	0.047	0.050	0.049	0.045	0.050	0.096	0.104	0.000	0.046	-
NICT	35	1944	0.842	0.579	0.573	0.570	0.486	0.547	0.747	0.841	0.831	0.833	0.839	0.853
NICT	35	2010	0.743	0.836	0.842	0.796	0.587	0.429	0.406	0.321	0.328	0.293	0.265	0.366
NICT	35	2011	0.773	0.736	0.842	0.831	0.847	0.833	0.836	0.744	0.551	0.465	0.388	0.394
NICT	35	2056	0.831	0.836	0.842	0.831	0.847	0.833	0.836	0.859	0.831	0.833	0.839	0.853
NICT	35	2113	0.033	0.034	0.038	0.039	0.042	0.046	0.058	0.107	0.163	0.346	0.343	0.425
NICT	35	2116	0.190	0.190	0.216	0.229	0.211	0.242	0.278	0.417	0.494	0.492	0.697	0.702
NICT	36	1217	0.124	0.128	0.167	0.189	0.230	0.258	0.198	0.199	0.186	0.190	0.221	0.205
NICT	36	1226	0.265	0.302	0.224	0.274	0.335	0.353	-	-	-	-	-	-
NICT	36	1611	0.047	0.058	0.076	0.077	0.094	0.095	0.101	0.108	0.147	-	-	-
NICT	40	2002	0.042	0.042	0.044	0.040	0.037	-	-	-	-	-	-	-
NICT	40	2003	0.035	0.032	0.032	0.034	0.042	0.053	0.077	0.121	0.226	0.248	0.225	0.209
NICT	40	2004	0.000	0.000	0.000	-	-	-	-	-	-	-	-	-
NICT	40	2005	-	-	-	-	-	0.000	0.000	0.000	0.000	0.016	0.013	0.011
NIM	35	479	0.186	0.244	0.000	0.238	0.213	0.000	-	-	-	-	-	-
NIM	35	1235	0.581	0.676	0.000	0.137	0.000	0.000	0.016	0.015	0.013	0.013	0.013	0.016
NIM	35	1239	0.224	0.265	0.000	0.132	0.133	0.122	0.104	0.056	0.055	0.050	0.000	0.000
NIM	35	2239	-	-	-	-	-	-	-	0.000	0.000	0.000	0.000	0.032

Table 9A. (Cont.)

Lab.	Clock		54494	54524	54554	54584	54614	54644	54674	54709	54739	54769	54799	54829
NIM	40	4832	0.527	0.489	0.000	0.178	0.176	0.000	0.000	0.000	0.000	0.000	0.000	0.000
NIM	40	4835	0.146	0.239	0.323	0.320	0.000	-	-	-	-	-	0.000	0.000
NIMB	35	600	0.074	0.076	-	-	0.000	0.000	0.000	0.000	0.831	0.618	0.729	0.000
NIS	35	1126	0.095	0.083	0.087	0.088	-	-	0.000	-	-	0.000	-	-
NIST	35	132	0.756	0.740	0.842	0.789	0.783	0.453	0.526	-	-	-	-	-
NIST	35	282	0.015	0.018	0.023	0.028	0.034	0.602	0.569	0.449	-	-	-	0.000
NIST	35	408	0.804	0.706	0.745	0.732	0.687	0.742	0.531	0.692	0.670	-	-	-
NIST	35	1074	0.842	0.836	0.842	0.831	0.847	0.833	0.836	0.859	0.831	0.833	0.839	0.853
NIST	35	2031	0.004	0.004	0.005	0.006	0.008	0.068	0.107	0.312	0.386	0.536	0.828	0.853
NIST	35	2032	0.023	0.027	0.036	0.045	0.054	0.664	0.807	0.859	0.825	0.750	0.725	0.723
NIST	35	2034	0.000	0.000	0.000	0.336	0.376	0.295	0.234	0.253	0.251	0.269	0.000	0.121
NIST	40	203	0.008	0.008	0.008	0.008	0.008	0.007	0.008	0.008	0.008	0.008	0.008	0.008
NIST	40	204	0.408	0.367	0.377	0.342	0.355	0.322	0.313	0.330	0.305	0.314	0.314	0.379
NIST	40	205	0.842	0.836	0.842	0.831	0.847	0.833	0.836	0.859	0.831	0.833	0.839	0.853
NIST	40	206	0.566	0.836	0.842	0.831	0.847	0.833	0.836	0.859	0.831	0.789	0.627	0.555
NIST	40	222	0.034	0.035	0.042	0.048	0.056	0.055	0.060	0.064	0.064	0.070	0.074	0.081
NMIJ	35	224	0.491	0.488	0.772	0.831	0.731	0.716	0.736	0.700	0.671	-	-	-
NMIJ	35	523	0.526	0.499	0.620	0.522	0.371	0.284	0.453	0.492	0.432	0.436	0.383	0.431
NMIJ	35	1273	-	-	-	-	-	-	-	-	-	-	0.000	0.000
NMIJ	40	5002	0.051	0.044	-	-	-	-	-	-	0.000	0.000	0.000	0.000
NMIJ	40	5014	0.500	0.836	0.842	0.000	0.250	0.228	0.248	0.241	0.168	-	-	-
NMIJ	40	5015	-	-	-	-	-	-	-	-	-	0.000	0.000	0.000
NMLS	35	1659	0.141	0.170	0.298	0.402	0.234	0.143	0.122	-	0.000	0.000	-	-
NPL	35	1275	-	0.000	0.000	0.000	0.000	0.221	0.229	0.310	0.305	0.390	0.446	0.329
NPL	36	784	-	0.000	0.000	0.000	0.000	0.226	0.344	0.141	0.069	0.090	0.106	0.130
NPL	40	1701	-	0.000	0.000	0.000	0.000	0.205	0.284	0.354	0.396	0.285	0.317	0.342
NPL	40	1708	-	0.000	0.000	0.000	0.000	0.775	0.836	0.859	0.831	0.833	0.839	0.853
NPLI	35	2257	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.191	0.173
NRC	35	234	0.357	0.653	0.842	0.831	0.847	0.830	0.784	-	-	-	-	-
NRC	35	372	0.842	0.836	0.842	0.828	0.667	0.681	0.425	0.308	0.288	0.293	0.269	0.307
NRC	35	2148	-	-	-	-	0.000	0.000	0.000	0.000	0.831	0.833	0.000	0.167
NRC	35	2150	-	-	-	-	0.000	0.000	0.000	0.000	0.071	0.099	0.100	0.135
NRC	35	2151	-	-	-	-	0.000	0.000	0.000	0.000	0.040	0.055	0.040	0.053
NRC	35	2152	-	-	-	-	0.000	0.000	0.000	0.000	0.296	0.366	0.339	0.425
NRL	35	714	-	0.000	0.000	0.000	0.000	0.230	0.321	-	0.000	0.000	0.000	0.000

Table 9A. (Cont.)

Lab.	Clock		54494	54524	54554	54584	54614	54644	54674	54709	54739	54769	54799	54829
NRL	35	719	-	0.000	0.000	0.000	0.000	0.188	0.286	-	0.000	0.000	0.000	0.000
NRL	40	1001	-	0.000	0.000	0.000	0.000	0.004	0.003	-	0.000	0.000	0.000	0.000
NRL	40	1003	-	0.000	0.000	0.000	0.000	0.293	0.235	-	0.000	0.000	0.000	0.000
NRL	40	1004	-	0.000	0.000	-	-	-	-	-	-	-	-	-
NRL	40	1009	-	0.000	0.000	-	0.000	0.000	0.000	-	0.000	0.000	0.000	0.000
NRL	40	1010	-	-	-	-	-	-	-	-	-	-	0.000	0.000
NTSC	35	1007	0.010	0.009	0.010	0.010	0.009	0.008	0.009	0.008	0.010	0.016	0.084	0.063
NTSC	35	1008	0.557	0.537	0.756	0.791	0.767	0.772	0.836	0.859	0.831	0.833	0.839	0.853
NTSC	35	1011	0.405	0.517	0.796	0.831	0.847	0.833	0.836	0.859	0.831	0.833	0.839	0.853
NTSC	35	1016	0.400	0.380	0.335	0.419	0.488	0.496	0.816	0.844	0.794	0.000	0.484	0.392
NTSC	35	1017	0.162	0.164	0.166	0.170	0.195	0.170	0.198	0.171	0.235	0.285	0.549	0.327
NTSC	35	1818	0.040	0.038	0.047	0.066	0.087	0.125	0.144	0.170	0.143	0.141	0.145	0.139
NTSC	35	1820	0.637	0.836	0.000	0.327	0.272	0.232	0.210	0.163	0.127	0.135	0.136	0.139
NTSC	35	1823	0.001	0.001	0.001	0.001	0.002	0.003	0.008	0.013	0.025	0.079	0.247	0.269
NTSC	35	2096	0.842	0.836	0.842	0.831	0.847	0.787	0.779	0.779	0.831	0.833	0.839	0.853
NTSC	35	2098	0.261	0.210	0.193	0.220	0.230	0.227	0.329	0.481	0.580	0.627	0.757	0.733
NTSC	35	2131	0.090	0.080	0.074	0.074	0.069	0.066	0.062	0.072	0.066	0.062	0.059	0.057
NTSC	35	2141	0.010	0.007	0.009	0.014	0.015	0.012	0.014	0.021	0.017	0.014	0.013	0.013
NTSC	35	2142	0.842	0.836	0.842	0.831	0.847	0.833	0.836	0.859	0.000	0.000	0.175	0.167
NTSC	35	2143	0.842	0.836	0.842	0.831	0.816	0.775	0.802	0.859	0.831	0.833	0.839	0.853
NTSC	35	2144	0.842	0.836	0.842	0.831	0.530	0.327	0.322	0.318	0.256	0.260	0.252	0.205
NTSC	35	2145	0.842	0.836	0.842	0.831	0.847	0.833	0.836	0.859	0.831	0.833	0.839	0.853
NTSC	35	2146	0.204	0.204	0.285	0.284	0.400	0.614	0.836	0.859	0.831	0.833	0.839	0.853
NTSC	35	2147	0.085	0.079	0.097	0.090	0.105	0.134	0.144	0.137	0.142	0.162	0.213	0.000
NTSC	40	4926	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
NTSC	40	4927	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-	-	-
NTSC	40	4933	0.000	0.000	0.000	0.000	0.001	0.001	0.001	0.001	0.001	0.002	0.002	0.002
NTSC	40	4945	0.000	0.000	0.000	0.000	-	-	0.000	-	-	-	-	-
NTSC	40	4946	0.000	-	-	-	-	-	-	-	-	-	-	-
ONBA	36	2228	-	0.000	0.000	-	-	0.000	0.000	-	0.000	0.000	0.000	0.000
ONRJ	35	102	-	-	-	-	-	-	-	-	0.000	0.000	0.000	0.000
ONRJ	35	103	0.842	0.836	0.000	0.378	0.382	0.359	0.359	0.516	0.479	0.706	0.503	0.584
ONRJ	35	123	0.321	0.273	0.285	0.279	0.292	0.361	0.335	0.330	0.338	0.345	0.211	0.189
ONRJ	35	129	0.842	0.836	0.842	0.831	0.847	0.833	0.836	0.859	0.831	0.833	0.839	0.853
ONRJ	35	1942	0.395	0.624	0.842	0.831	0.847	0.833	0.836	0.859	0.831	0.833	0.839	0.853

Table 9A. (Cont.)

Lab.	Clock		54494	54524	54554	54584	54614	54644	54674	54709	54739	54769	54799	54829
ONRJ	52	125	0.000	0.005	0.003	0.002	0.002	0.002	0.002	0.001	0.001	0.001	0.001	0.001
ORB	35	201	0.171	0.160	0.138	0.159	-	0.000	0.000	0.000	0.000	0.112	0.165	0.205
ORB	35	202	0.073	0.070	0.079	0.080	-	0.000	0.000	0.000	0.000	0.036	0.018	0.022
ORB	35	593	0.200	0.178	0.203	0.278	-	0.000	0.000	0.000	0.000	0.042	0.055	0.078
ORB	40	2601	0.117	0.112	0.124	0.195	-	0.000	0.000	0.000	0.000	0.643	0.322	0.289
PL	25	124	0.002	0.002	0.003	0.003	0.004	0.005	0.005	0.006	0.005	0.005	0.005	0.006
PL	35	441	0.367	0.452	0.475	0.811	0.847	0.833	0.836	0.735	0.775	0.833	0.839	0.853
PL	35	502	0.194	0.201	0.196	0.131	0.098	0.085	-	-	-	-	-	-
PL	35	745	0.842	0.836	0.842	0.831	0.847	0.790	0.596	0.593	0.584	0.605	0.839	0.764
PL	35	1120	0.776	0.703	0.784	0.705	0.630	0.610	0.608	0.537	0.408	0.426	0.343	0.353
PL	35	1660	0.004	0.006	0.008	0.014	0.058	0.114	0.572	0.575	0.831	0.764	0.839	0.853
PL	35	1709	0.286	0.268	0.299	0.283	0.392	0.374	0.407	0.479	0.524	0.508	0.338	0.283
PL	35	1746	0.842	0.836	0.842	0.831	0.847	0.833	0.000	0.740	0.752	0.750	0.765	0.680
PL	35	1934	0.707	0.684	0.767	0.746	0.847	0.833	0.836	0.582	0.636	0.793	0.507	0.509
PL	35	2394	-	-	-	-	0.000	0.000	0.000	0.000	0.003	0.004	0.005	0.007
PL	36	1395	0.121	0.114	0.121	0.116	-	-	-	-	-	-	-	-
PL	40	4002	0.000	0.000	-	-	0.000	0.000	0.000	0.000	0.007	0.010	0.013	0.017
PL	40	4004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.003	0.004	0.005	0.004
PL	40	4601	-	0.000	0.000	0.000	0.000	0.155	0.136	0.133	0.113	0.104	0.093	0.073
PL	40	4602	-	-	-	-	-	-	-	-	-	-	0.000	0.000
PTB	35	128	0.647	0.787	0.803	0.831	0.847	0.833	0.833	0.859	0.831	0.833	0.839	0.853
PTB	35	415	0.842	0.836	0.842	0.831	0.847	-	-	-	-	-	-	-
PTB	35	1072	0.432	0.348	0.382	0.361	0.388	0.513	0.525	0.519	0.565	0.833	0.839	0.853
PTB	40	506	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
PTB	40	510	0.000	0.000	-	-	-	-	-	-	-	-	-	-
PTB	40	590	0.013	0.013	0.014	0.016	0.016	0.014	0.014	0.014	0.013	0.013	0.013	0.015
PTB	92	1	0.440	0.419	0.365	0.347	0.310	0.323	0.342	0.343	0.347	0.472	-	-
PTB	92	2	0.842	0.836	0.842	0.831	0.847	0.833	0.836	0.859	0.831	0.833	0.839	0.853
ROA	35	583	0.842	0.802	0.842	0.831	0.775	0.539	0.494	0.477	0.433	0.458	0.385	0.528
ROA	35	718	0.842	0.836	0.842	0.831	0.847	0.833	0.836	0.859	0.831	0.833	0.731	0.783
ROA	35	1699	0.762	0.681	0.000	0.322	0.315	0.307	0.315	0.508	0.584	0.744	0.735	0.853
ROA	36	1488	0.428	0.775	0.826	0.679	0.546	0.465	0.000	0.251	0.249	0.256	0.239	0.262
ROA	36	1490	0.000	0.212	0.208	0.220	0.126	0.135	0.138	0.127	0.120	0.117	0.113	0.096
ROA	40	1436	0.006	0.005	0.004	0.004	0.004	0.003	0.003	0.003	0.002	0.002	0.002	0.002
SCL	35	1745	0.326	0.353	0.441	0.574	0.700	0.698	0.750	0.735	0.541	0.367	0.347	0.333

Table 9A. (Cont.)

Lab.	Clock	54494	54524	54554	54584	54614	54644	54674	54709	54739	54769	54799	54829
SCL	35 2178	0.000	0.000	0.104	0.142	0.191	0.237	0.309	0.388	0.461	0.517	0.513	0.789
SG	35 1127	0.000	0.000	-	-	-	-	-	-	-	-	-	-
SG	35 1889	0.000	0.000	0.108	0.161	0.202	0.212	0.222	0.183	0.147	0.135	0.132	0.165
SG	36 522	0.000	0.000	0.518	0.000	0.141	0.108	0.140	0.126	0.150	0.181	0.177	0.178
SG	40 7701	-	-	-	0.000	0.000	0.000	-	-	-	-	-	-
SIQ	36 1268	0.000	0.000	0.000	0.000	0.001	0.001	0.001	0.001	0.001	0.014	0.012	0.010
SMU	36 1193	0.429	0.420	0.000	0.105	0.073	0.060	0.059	0.058	0.055	0.057	0.059	0.063
SP	19 197	0.017	0.019	-	-	0.000	0.000	0.000	0.000	0.005	0.005	-	0.000
SP	35 572	0.228	0.200	0.167	0.139	0.116	0.087	0.083	0.074	0.066	0.068	0.066	0.066
SP	35 641	0.520	0.836	0.842	0.000	0.313	0.239	0.215	0.161	0.145	0.140	0.130	0.152
SP	35 1188	0.842	0.836	0.842	0.831	0.847	0.833	0.540	0.427	0.268	0.172	0.152	0.164
SP	35 1531	0.302	0.262	0.287	0.351	0.000	0.136	0.128	0.120	0.112	0.115	0.116	0.151
SP	35 1642	0.491	0.381	-	-	-	-	-	-	-	-	-	-
SP	35 2166	0.842	0.836	0.842	0.831	0.847	0.833	0.836	0.859	0.765	0.557	0.678	0.853
SP	36 1175	0.407	0.302	0.259	0.299	0.309	0.308	0.296	0.295	0.366	0.366	0.599	0.577
SP	36 2068	0.091	0.087	0.092	0.098	0.100	0.094	0.138	0.136	0.101	0.111	0.166	0.202
SP	36 2218	0.687	0.645	0.412	0.495	0.502	0.501	0.458	0.561	0.536	0.833	0.000	0.445
SP	36 2297	0.604	0.671	0.591	0.717	0.541	0.396	0.421	0.466	0.459	0.563	0.613	0.612
SP	40 7201	0.003	0.002	0.002	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003
SP	40 7203	0.026	0.022	0.020	0.018	0.016	0.014	0.012	0.011	0.010	0.009	0.008	0.008
SP	40 7210	0.001	-	-	0.000	0.000	0.000	0.000	0.008	0.004	0.003	0.002	0.002
SP	40 7211	-	-	-	-	-	-	-	-	-	-	-	0.000
SP	40 7212	0.000	0.000	0.000	0.000	0.105	0.090	0.090	0.088	0.078	0.080	0.080	0.082
SU	40 3802	0.076	0.073	0.081	0.079	0.075	0.072	0.076	0.085	0.086	0.096	0.088	0.086
SU	40 3804	-	0.000	0.000	0.000	0.000	0.007	0.006	0.006	0.007	0.007	0.006	-
SU	40 3805	0.028	0.027	0.029	0.029	0.031	0.036	0.057	0.068	0.084	0.113	0.168	0.161
SU	40 3810	0.061	0.050	0.046	0.052	0.064	0.072	0.071	0.050	0.032	0.022	0.016	0.013
SU	40 3811	-	-	-	-	-	-	-	-	-	-	-	0.000
SU	40 3812	-	-	-	-	-	-	-	-	-	-	-	0.000
SU	40 3822	0.005	0.005	0.005	0.006	0.006	0.005	0.006	0.006	0.006	0.006	0.006	0.006
SU	40 3831	0.062	0.070	0.080	0.080	0.077	0.083	0.105	0.116	0.131	0.138	0.130	0.112
SU	40 3837	0.842	0.836	0.842	0.831	0.833	0.000	0.000	0.271	0.209	0.158	0.162	0.185
TCC	35 768	0.000	0.000	0.041	0.023	0.029	0.035	-	-	-	0.000	0.000	0.000
TCC	35 1881	0.000	0.000	0.001	0.002	0.002	0.003	-	-	-	0.000	0.000	0.000
TCC	40 8620	-	-	0.000	0.000	0.000	0.000	-	-	-	0.000	0.000	0.000

Table 9A. (Cont.)

Lab.	Clock	54494	54524	54554	54584	54614	54644	54674	54709	54739	54769	54799	54829
TCC	40 8624	0.000	0.000	0.021	0.029	0.039	0.042	-	-	-	0.000	0.000	0.000
TCC	40 8650	-	-	-	-	-	-	-	-	-	0.000	0.000	0.000
TL	35 160	0.659	0.533	0.719	0.737	0.847	0.833	0.836	0.000	0.000	0.042	0.031	0.026
TL	35 300	0.037	0.037	0.044	0.049	0.061	0.063	0.064	0.056	0.000	0.026	0.021	0.021
TL	35 474	0.057	0.078	0.076	0.111	0.112	0.204	0.204	0.164	0.136	0.130	0.122	0.126
TL	35 809	0.055	0.075	0.094	0.124	0.131	0.124	0.000	0.036	0.028	0.023	0.023	0.024
TL	35 1012	0.014	0.010	0.009	0.008	0.009	0.008	0.010	0.011	0.014	0.019	0.081	0.071
TL	35 1104	0.149	0.144	0.158	0.214	0.210	0.188	0.162	0.145	0.112	0.085	0.069	0.050
TL	35 1132	0.191	0.179	0.118	0.116	0.130	0.116	0.123	0.109	0.083	0.073	0.127	0.132
TL	35 1498	0.483	0.556	0.528	0.533	0.405	-	-	-	-	-	-	-
TL	35 1500	0.110	0.103	0.115	0.162	0.200	0.212	0.300	0.246	0.203	0.184	0.242	0.212
TL	35 1712	0.842	0.836	0.842	0.831	0.847	0.833	0.836	0.859	0.831	0.833	0.793	0.779
TL	35 2365	-	0.000	0.000	0.000	0.000	0.338	0.503	0.513	0.667	0.705	0.729	0.697
TL	35 2366	-	0.000	0.000	0.000	0.000	0.833	0.836	0.859	0.831	0.833	0.839	0.853
TL	35 2367	-	0.000	0.000	0.000	0.000	0.833	0.836	0.859	0.831	0.833	0.839	0.853
TL	35 2368	-	0.000	0.000	0.000	0.000	0.508	0.000	0.098	0.105	0.122	0.132	0.154
TL	40 3052	0.018	0.022	0.029	0.042	0.067	0.116	0.226	0.560	0.831	0.833	0.839	0.853
TL	40 3053	0.180	0.208	0.304	0.399	0.531	0.757	0.836	0.859	0.831	0.833	0.839	0.853
TP	35 163	0.439	0.442	0.367	0.403	0.561	0.405	0.344	0.309	0.266	0.257	0.245	0.256
TP	35 326	0.000	0.000	0.001	0.001	0.003	0.008	0.012	0.012	0.011	0.011	0.010	0.011
TP	35 1227	0.459	0.444	0.000	0.000	0.079	0.058	0.044	0.042	0.052	-	-	-
TP	36 154	0.129	0.119	0.116	0.118	0.104	0.110	0.135	0.211	0.206	0.211	0.278	0.252
UA	40 7871	-	-	-	-	-	-	0.000	0.000	0.000	0.000	0.007	0.007
UA	40 7881	-	-	-	-	-	-	0.000	0.000	0.000	0.000	0.017	0.009
UA	40 7882	-	-	-	-	-	-	0.000	0.000	0.000	0.000	0.001	0.001
UME	35 872	0.193	0.167	0.221	0.213	0.288	0.278	0.496	0.799	0.000	0.001	0.001	0.001
USNO	35 101	0.110	0.113	0.142	0.161	0.193	0.346	0.307	0.311	0.324	0.339	0.504	0.553
USNO	35 104	0.053	0.048	0.051	0.048	0.071	0.125	0.107	0.102	0.117	0.185	0.256	0.451
USNO	35 106	0.842	0.836	0.842	0.831	0.847	0.833	0.836	0.859	0.831	0.833	0.839	0.853
USNO	35 108	0.000	0.043	0.036	-	-	-	-	-	-	-	-	-
USNO	35 114	0.842	0.836	0.842	0.831	0.847	0.658	0.757	0.725	0.809	0.701	0.674	0.691
USNO	35 120	0.803	0.633	0.632	-	-	-	-	-	-	-	-	-
USNO	35 142	0.000	0.000	0.000	0.578	0.558	0.732	0.803	0.568	0.609	0.650	0.539	0.439
USNO	35 145	0.016	0.014	0.017	0.021	0.026	-	-	-	-	0.000	0.000	0.000
USNO	35 146	0.842	0.447	0.630	0.577	0.506	0.447	0.552	0.643	0.484	0.554	0.566	0.652

Table 9A. (Cont.)

Lab.		Clock	54494	54524	54554	54584	54614	54644	54674	54709	54739	54769	54799	54829
USNO	35	148	0.239	0.245	0.252	0.298	0.361	0.294	0.332	-	-	-	-	-
USNO	35	150	0.754	0.836	0.842	0.831	0.847	0.833	0.836	0.859	0.831	0.833	0.839	0.853
USNO	35	152	-	0.000	0.000	0.000	0.000	0.306	0.441	0.622	0.473	0.473	0.573	0.670
USNO	35	153	0.062	0.058	0.054	0.052	0.056	0.054	0.063	0.099	0.144	0.229	0.727	0.816
USNO	35	156	0.313	0.316	0.390	0.461	0.490	0.499	0.480	0.474	0.583	0.625	0.629	0.663
USNO	35	161	0.098	0.116	0.138	0.131	0.136	0.144	0.345	0.386	0.507	0.491	0.450	0.449
USNO	35	164	0.010	0.009	0.010	0.010	0.012	0.020	0.062	0.080	0.115	0.116	0.112	0.193
USNO	35	165	0.842	0.735	0.842	0.831	0.847	0.833	-	-	0.000	0.000	0.000	0.000
USNO	35	166	0.103	0.108	0.147	0.184	0.279	0.538	0.836	0.859	0.831	0.833	0.839	0.581
USNO	35	167	0.135	0.116	0.121	0.121	0.124	0.163	0.283	0.443	0.612	0.542	0.487	0.335
USNO	35	173	0.000	0.000	0.000	0.073	0.090	0.108	0.110	0.127	0.144	0.145	0.147	0.259
USNO	35	213	0.842	0.836	0.842	0.831	0.847	0.833	0.717	0.482	0.372	0.359	0.251	0.233
USNO	35	217	-	-	-	-	-	-	-	-	-	0.000	0.000	0.000
USNO	35	226	-	-	-	-	-	-	-	-	-	0.000	0.000	0.000
USNO	35	227	0.000	0.000	0.000	0.018	0.019	0.020	0.023	0.027	0.030	0.033	0.037	0.069
USNO	35	231	0.000	0.133	0.119	0.148	0.197	0.236	0.298	0.349	0.400	0.753	0.839	0.853
USNO	35	233	0.000	0.836	0.842	0.831	0.847	0.833	0.836	0.859	0.831	0.833	0.839	0.853
USNO	35	242	0.842	0.836	0.842	0.810	0.799	0.661	0.703	0.768	0.768	0.816	0.775	0.734
USNO	35	244	0.721	0.689	0.539	0.388	0.407	0.338	0.349	0.346	0.505	0.574	0.707	0.853
USNO	35	249	0.122	0.105	0.112	0.074	0.057	-	-	-	-	-	-	-
USNO	35	253	0.000	0.000	0.009	0.010	0.011	0.012	0.014	0.016	0.014	0.014	0.021	0.030
USNO	35	254	-	-	-	-	-	-	-	-	-	0.000	0.000	0.000
USNO	35	255	0.842	0.836	0.842	0.831	0.650	0.604	0.575	-	-	-	-	-
USNO	35	256	0.000	0.000	0.000	0.115	0.168	0.191	0.247	0.308	0.359	0.407	0.467	-
USNO	35	260	0.044	0.043	0.042	0.044	0.042	-	-	-	-	0.000	0.000	0.000
USNO	35	279	0.842	0.836	0.842	-	-	-	-	-	-	-	-	-
USNO	35	389	0.842	0.836	0.842	0.831	0.847	0.833	0.836	0.809	0.818	0.000	0.271	0.278
USNO	35	392	0.106	0.057	0.072	0.063	0.067	0.071	0.078	0.080	0.094	0.126	0.202	0.306
USNO	35	394	-	-	0.000	0.000	0.000	0.000	0.004	0.006	0.008	0.007	-	-
USNO	35	416	0.000	0.170	0.149	0.172	0.226	0.266	0.337	0.406	0.465	0.689	0.645	0.642
USNO	35	417	0.000	0.000	0.000	0.000	0.109	0.155	0.214	0.285	0.357	0.438	0.497	0.584
USNO	35	703	0.359	0.310	0.229	0.221	0.226	0.231	0.239	0.253	0.250	0.255	0.207	0.202
USNO	35	717	0.542	0.489	0.540	0.583	0.810	0.816	0.825	0.859	0.831	0.833	0.839	0.853
USNO	35	762	0.000	0.000	0.000	0.281	0.381	0.479	0.472	0.600	0.653	0.769	0.773	0.621
USNO	35	763	0.842	0.836	0.842	0.831	0.847	0.833	0.836	0.859	0.831	0.833	0.839	0.853

Table 9A. (Cont.)

Lab.	Clock		54494	54524	54554	54584	54614	54644	54674	54709	54739	54769	54799	54829
USNO	35	765	0.591	0.833	0.650	0.764	0.847	0.724	0.586	0.393	0.375	0.299	0.302	0.299
USNO	35	1096	0.454	0.488	0.526	0.687	0.811	0.772	0.836	0.845	0.621	-	-	-
USNO	35	1097	0.174	0.316	0.531	0.450	0.568	0.452	0.000	0.203	0.184	0.232	0.252	0.297
USNO	35	1125	-	-	-	-	-	-	-	-	0.000	0.000	0.000	0.000
USNO	35	1327	0.690	0.628	0.665	0.553	0.322	0.239	0.239	0.259	0.303	0.328	0.366	0.516
USNO	35	1328	0.054	0.058	0.073	0.093	0.117	0.144	0.251	0.859	0.831	0.833	0.839	0.853
USNO	35	1331	0.380	0.416	0.552	0.584	0.670	0.637	0.604	0.587	0.580	0.000	0.802	0.824
USNO	35	1438	0.267	0.253	0.231	0.295	0.370	0.348	0.215	0.233	0.286	0.356	0.378	0.465
USNO	35	1459	-	-	-	-	-	-	-	-	-	0.000	0.000	0.000
USNO	35	1462	0.000	0.000	0.000	0.831	0.846	0.833	0.836	0.859	0.831	0.833	0.839	0.817
USNO	35	1463	0.842	0.836	0.842	0.831	0.847	0.833	0.836	0.859	0.831	0.833	0.839	0.853
USNO	35	1468	0.842	0.817	0.755	-	-	-	-	-	-	-	-	-
USNO	35	1543	-	-	-	-	-	-	-	-	0.000	0.000	0.000	0.000
USNO	35	1575	0.532	0.601	0.572	0.576	0.632	-	-	-	-	-	-	-
USNO	35	1655	0.683	0.598	0.656	0.681	0.652	0.537	0.579	0.616	0.591	0.508	0.504	0.548
USNO	35	1692	0.664	0.411	0.540	0.351	0.320	0.275	0.351	0.359	0.371	0.477	0.479	0.788
USNO	35	1694	0.842	0.000	0.535	0.524	0.509	0.485	0.442	0.552	0.545	0.702	0.656	0.806
USNO	35	1696	0.503	0.558	0.842	0.831	0.847	0.819	0.000	0.341	0.316	0.394	0.391	0.414
USNO	35	1697	0.842	0.836	0.842	0.831	0.847	0.833	0.836	0.859	0.831	0.833	0.701	0.487
USNO	40	701	0.006	0.006	0.007	0.007	0.009	0.014	0.037	0.110	0.189	0.203	-	-
USNO	40	702	0.842	0.836	0.842	0.831	0.847	0.833	0.836	0.859	0.831	0.833	0.839	0.853
USNO	40	704	0.407	0.423	0.493	0.531	0.617	0.602	0.613	0.545	0.451	0.396	0.352	0.331
USNO	40	705	0.133	0.123	0.134	0.141	0.138	0.122	0.113	0.109	0.132	0.196	0.614	0.000
USNO	40	708	0.842	0.836	0.842	0.831	0.847	0.691	0.504	0.369	0.251	0.189	0.138	0.105
USNO	40	710	0.104	0.089	0.078	0.068	0.064	0.053	0.049	0.047	0.045	0.045	0.044	0.046
USNO	40	711	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004
USNO	40	712	0.842	0.836	0.842	0.831	0.847	0.833	0.836	0.859	0.831	0.833	0.839	0.853
USNO	40	713	0.126	0.121	0.131	0.127	0.129	0.118	0.119	0.120	0.118	0.118	0.115	0.112
USNO	40	714	0.384	0.453	0.520	0.624	0.690	0.000	0.271	0.239	0.218	0.219	0.241	0.253
USNO	40	715	0.070	0.066	0.070	0.066	0.066	0.061	0.063	0.063	0.063	0.064	0.062	0.062
USNO	40	716	0.842	0.836	0.842	0.831	0.847	0.833	0.836	0.859	0.831	0.833	0.839	0.853
USNO	40	718	0.039	0.033	0.032	0.031	0.033	0.031	0.032	0.033	0.032	0.031	0.026	0.023
USNO	40	719	0.005	0.005	0.005	0.005	0.005	-	-	0.000	0.000	0.000	0.000	0.012
USNO	40	720	0.000	0.000	0.007	0.006	0.005	0.004	0.004	0.003	0.003	0.003	0.003	0.003
USNO	40	722	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001

Table 9A. (Cont.)

Lab.		Clock	54494	54524	54554	54584	54614	54644	54674	54709	54739	54769	54799	54829
USNO	40	723	0.842	0.836	0.842	0.831	0.847	0.833	0.836	0.859	0.831	0.833	0.839	0.853
USNO	40	724	0.842	0.836	0.842	0.831	0.762	0.652	0.449	0.499	0.000	0.000	0.068	0.047
USNO	40	725	0.198	0.168	0.173	0.178	0.204	0.264	0.611	0.859	0.000	0.369	0.287	0.226
USNO	40	726	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	728	-	-	0.000	0.000	0.000	0.000	0.001	0.001	0.001	0.001	0.001	0.001
USNO	40	729	0.000	0.000	0.000	0.000	0.000	-	-	-	-	-	-	-
USNO	40	730	0.001	0.001	0.001	0.001	0.001	-	-	-	-	-	-	-
USNO	40	731	0.013	0.012	0.012	0.013	0.014	0.014	0.016	0.018	0.021	0.024	0.029	0.037
VMI	35	2230	-	-	0.000	0.000	0.000	0.000	0.021	0.020	-	0.000	0.000	0.000
VMI	36	1233	-	-	0.000	0.000	0.000	0.000	0.014	0.015	-	0.000	0.000	0.000
VMI	36	2314	-	-	0.000	0.000	0.000	0.000	0.032	0.020	-	0.000	0.000	0.000
VSL	35	179	0.286	0.199	0.224	0.225	0.275	0.248	0.325	0.284	0.252	0.260	-	-
VSL	35	456	0.188	0.285	0.184	0.154	0.134	0.116	0.101	0.095	0.099	0.151	0.299	0.471
VSL	35	548	0.824	0.836	0.842	0.831	0.847	0.692	0.836	0.859	0.000	-	-	-
VSL	35	731	0.761	0.724	0.000	0.231	0.146	0.137	0.118	0.103	0.109	0.116	0.129	0.141
ZMDM	36	2033	0.585	0.483	-	0.000	0.000	0.000	0.000	0.197	0.268	0.310	0.347	0.446

Table 9B: Statistical data on the weights attributed to the clocks in 2008

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	
2008	Jan.	79	208	330	7	24	35	7	1	12	9	41	51	0.842
2008	Feb.	85	216	347	15	29	50	6	5	14	11	42	54	0.836
2008	Mar.	82	220	347	13	30	50	9	10	21	11	50	62	0.842
2008	Apr.	81	218	344	13	23	43	9	3	14	9	47	57	0.831
2008	May	83	221	351	16	29	56	7	5	13	7	47	55	0.847
2008	June	81	221	350	14	27	51	9	3	12	6	41	48	0.833
2008	July	81	211	340	14	20	42	7	7	15	8	42	51	0.836
2008	Aug.	77	199	323	9	17	32	8	5	13	9	38	48	0.859
2008	Sep.	82	205	333	14	18	34	8	8	18	9	37	47	0.831
2008	Oct.	86	215	349	16	28	49	8	6	15	9	41	52	0.833
2008	Nov.	88	214	348	16	29	50	7	5	14	8	38	47	0.839
2008	Dec.	89	214	349	16	34	56	8	4	13	8	39	48	0.853

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 Hewlett-Packard 5071A units with high performance tube.
Clocks with missing data during an 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 April 2009.

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 Federal Office of Metrology Time and Frequency Laboratory Length, Optics and Time Section Lindenweg 50 CH-3003 Bern-Wabern Switzerland
HLA	Center for Length & Time 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
MIKES	Centre for Metrology and Accreditation Tekniikantie 1 FI-02150 Espoo Finland
MSF	National Physical Laboratory Industry and Innovation Division 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 FGUP "VNIIFTRI" Meendeleevo, Moscow Region 141570 Russia
STFS	National Physical Laboratory Dr. K.S. Krishnan Road New Delhi - 110012, India
TDF	CFHM Chambre française de l'horlogerie et des microtechniques 22 avenue Franklin Roosevelt 75008 Paris, France and LNE Laboratoire national de métrologie et d'essais 1 rue Gaston Boissier 75724 Paris Cedex 15, 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 7 850 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 daylight saving 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.
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.

Station	Location Latitude Longitude	Frequency (kHz)	Schedule (UTC)	Form of the signal
HBG	Prangins Switzerland 46° 24'N 6° 15'E	75	continuous	At the beginning of each second (except the 59th second), the carrier is interrupted for a duration of 0.1 s or 0.2 s corresponding to "binary 0" or "binary 1", respectively, double pulse each minute. The number of the minute, hour, day of the month, day of the week, month and year are transmitted in BCD code from the 21st to the 58th second. The HBG time signal is generated in accordance with the legal time of Switzerland which is UTC + 1 h (Central European Time CET) or UTC + 2 h (Central European Summer Time CEST). In addition, CET and CEST are indicated by a binary 1 at the 18th or 17th second, respectively.
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(1)	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	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.
MIKES	Espoo Finland 60° 11'N 24° 50'E	25 000	Continuous	Modulation as in DCF77, time code in UTC.

(1)Transmission has been discontinued permanently during the year 2008

Station	Location Latitude Longitude	Frequency (kHz)	Schedule (UTC)	Form of the signal
MSF	Anthorn United Kingdom 54° 54'N 3° 16'W	60	Continuous, except for interruptions for maintenance from 10 h 0 m to 14 h 0 m on the second Thursday of December and March, and from 09 h 0 m to 13 h 0 m on the second Thursday of June and September. A longer period of maintenance during the summer is announced annually.	The carrier is interrupted for 0.1 s at the start of each second, except during the first second of each minute (second 0) when the interruption is 0.5 s. Two data bits are transmitted each second (except second 0): data bit "A" between 0.1 and 0.2 s after the start of the second and data bit "B" between 0.2 and 0.3 s after the start of the second. Presence of the carrier represents "binary 0" and an interruption represents "binary 1". The values of data bit "A" provide year, month, day of the month, day of the week, hour and minute in BCD code. The time represented is UTC(NPL) in winter and UTC(NPL)+1h when DST is in effect. The values of data bit "B" provide DUT1 and an indication whether DST is in effect. The information transmitted applies to the following minute. 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 56° 44'N 37° 40'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 1st to the 59th 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.

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	08 h 06 m to 08 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 56° 44'N 37° 38'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* x 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* x 0.02 s.

Station	Location Latitude Longitude	Frequency (kHz)	Schedule (UTC)	Form of the signal
STFS	Sikandrabad India 28° 28'N 77° 13'E	2 599 675	continuous	Pulse width modulated binary coded 5 kHz pulses carrying information on Indian Standard Time – IST (UTC + 5 h 30 m), Time of Day and current position coordinates of the satellite. Pulse repetition rate is 100 pps. The above format is frequency modulated on the carrier.
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(3)	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.

(3) Information based on the Annual Report 2007, not confirmed by the Laboratory

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
MIKES	0.01
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	0.05
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 April 2009.

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 Optical Standards 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. 76246 - México
EIM	Hellenic Institute of Metrology Electrical Measurements Department Block 45, Industrial Area of Thessaloniki PO 57022, Sindos Thessaloniki, Greece
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	Center for Length & Time 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	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
NAO	Time Keeping Office Mizusawa VERA Observatory National Astronomical Observatory of Japan 2-12, Hoshigaoka, Mizusawa, Oshu, Iwate 023-0861 Japan
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
NMIJ	Time and Frequency Division National Metrology Institute of Japan (NMIJ), AIST Umezono 1-1-1, Tsukuba, Ibaraki 305-8563, Japan

NMISA	Time and Frequency Laboratory National Metrology Institute of South Africa Private Bag X34 Lynnwood Ridge 0040 - 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 Industry and Innovation Division 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
NSC IM	Time and Frequency Section National Scientific Center "Institute of Metrology" Kharkov - Ukraine Region – 61002 Ukraine
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

ROA	Real Instituto y Observatorio de la Armada Cecilio Pujazón s/n 11.100 San Fernando Cádiz, Spain
SG	National Metrology Centre Agency for Science, Technology and Research (A*STAR) 1 Science Park Drive 118221 Singapore
SIQ	Slovenian Institute of Quality and Metrology Metrology department Trzaska ul. 2 1000 Ljubljana Slovenia
SP	SP Technical Research Institute of Sweden Box 857 S-501 15 Borås 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 Academie of Sciences of the Czech Republic Chaberská 57 182 51 Praha 8 Czech Republic
UME	Ulusal Metroloji Enstitüsü TUBITAK Gebze Yerleskesi, 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, Moscow Region 141570 Russia
VSL	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 211106381
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 México; Central Time, Pacific Time and Northwest Time as well the UTC(CNM). The access numbers are:

+52 442 211 0506: Central Time
+52 442 211 0507: Pacific Time
+52 442 211 0508: Northwest 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/hora_oficial/

Web-based time-of-day clock that displays local time for México time zones. Referenced to CENAM Internet Time Service. Available at http://www.cenam.mx/hora_oficial/

Transmission of voice by radio in Mexico City to more than 20 million inhabitants. The voice messages are transmitted every minute, 24 hours a day, every day of the year, by the radio station XEQK, whose signal is at 1350 kHz amplitude modulated (AM).

EIM

Internet Time Service
EIM operates a stratum-1 time server using the "Network Time Protocol" (NTP). The DNS electronic address is ntp.eim.gr (IP: 194.30.249.20). A second, newer time server is now operational under the address hercules.eim.gr (IP: 194.30.249.26). It is directly connected to our standard which uses as a reference, however, it is classified as stratum 2 for the moment. During this year it will be upgraded to stratum 1 level (GPS enabled) and possibly the IP will be changed (not the domain name).

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 “Dial-a-weather 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 (210.98.16.100)
Software for the synchronization of computer clocks is available at http://www.kriss.re.kr

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
NTP v3
DNS: laikas.pfi.lt
Port 123
Synchronization from caesium clock (1 pps)
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 string (compliant to the European Time Code format) is referenced to UTC(CH) and generated by a TUG type time code generator.
Access phone numbers: +41 31 323 32 25, +41 31 323 47 00.

Network Time Protocol
METAS operates public NTP servers in free access.
Host names:
ntp.metas.ch
ntp11.metas.ch
ntp12.metas.ch
More information at http://www.metas.ch and http://www.ntp.org

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://msl.irl.cri.nz/services/time/index.html

NAO

Network Time Service
Three stratum 2 NTP servers are available. The NTP servers internally refer stratum 1 NTP server that is linked to UTC(NAO).
One of the three stratum 2 NTP servers are selected automatically by a round-robin DNS server to reply for an NTP access.
The server host name is s2csntp.miz.nao.ac.jp.

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

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

3 NTP servers are available:
Addresses: time1.nimt.or.th
time2.nimt.or.th
time3.nimt.or.th
The 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 27 time servers at 16 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

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

NMIJ

GPS common-view data
GPS common-view data using CGGTTS format referred to UTC(NMIJ) are available through the NMIJ's web site for the remote frequency calibration service.

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.

Network Time Service
One open access NTP server is available at address time.nmisa.org. More information is available at http://www.nmisa.org/time.html

NMLS

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 (NTP) Service
The NTP time information is referenced to UTC(NMLS) and is currently generated by two Stratum-1 NTP servers, made available for public freely. The NTP server host names are ntp1.sirim.my and ntp2.sirim.my.

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

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
NSC IM	Network Time Service. Computers connected to the Internet can be synchronized to UTC(UA) using NTP protocol. NTP servers are referenced to UTC(UA) directly. Link to Time server: ntpd.metrology.kharkov.ua or IP address: 81.17.128.133. More information on http://www.metrology.kharkov.ua.
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 (sdong@ntsc.ac.cn).
ONBA	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 25806037.
Telephone Code (55) 21 25800677 provides digital time code at 300 bauds, 8 bits, no parity, 1 stop bit (Leitch CSD5300)

Internet Time Service at the address : 200.20.186.75 and 200.20.186.94
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), see http://www.ptb.de/en/org/q/q4/q42/_index.htm for details and explanations.
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
Synchronized to UTC(ROA) better than 10 microseconds
Service policy : free

Server : ntp0.roa.es
Synchronized 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.

SIQ

Internet Time Service (Network Time Protocol)
One server referenced to UTC(SIQ) provides Network Time Protocol (NTP) time code across the internet.
There is a free access to the server for all users.
The server host names are:ntp.siq.si or time.siq.si
(two URL's for the same server; IP: 194.249.234.70)

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.

IRIG-B time code service
Provides IRIG-B Modulated time code via a dial-up phone connection. No need of any kind of modem.
Access phone number: +886 3 4203090

	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 (1)	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://www.usno.navy.mil/USNO/time/ntp 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. VSL operates a time server directly referenced to UTC(VSL). Time information is accessible through Network Time Protocol (NTP). Server host name: ntp.nmi.nl (Stratum 1) From March 2009, the server host name will be ntp.vsl.nl (Stratum 1).

(1) Automated data service (7621503) is now discontinued.

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(July 2007 – June 2008)

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 *BIPM Annual Report on Time Activities for 2007*, volume **2**, complemented by computer-readable files on the BIPM website (http://www.bipm.org), provides the definitive results for 2007.

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. A new physicist was recruited in August 2007 to cover activities on time scale algorithms, which had been delayed in the last few years.

The Vth International Symposium on Time Scale Algorithms was organized jointly by the BIPM, the ROA, the INRiM and the USNO, and took place in San Fernando (Spain) on 28-30 April 2007, with the participation of about 70 metrologists.

2.1 EAL stability

Some 86 % of the clocks used in the calculation of time scales are either commercial cæsium clocks of the Symmetricom/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 16 % of the participating clocks have, on average, been at the maximum weight, during 2007. 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 at or below 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 2007, individual measurements of the TAI frequency have been provided by twelve primary frequency standards, including eight cæsium fountains (IT CSF1, LNE-SYRTE FO1, LNE-SYRTE FO2, LNE-SYRTE FOM, NICT CSF1, NIST F1, NMIJ F1 and NPL CSF1). Reports on the operation of the primary frequency standards are regularly published in the *BIPM Annual Report on Time Activities* and on the BIPM website.

Starting in July 2004, a monthly steering correction of a maximum of 0.7×10^{-15} is applied as deemed necessary. Since July 2007, 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

$+2.3 \times 10^{-15}$ to $+4.9 \times 10^{-15}$, with a standard uncertainty of less than 1×10^{-15}. Over the year, twelve steering corrections have been applied for a total correction of $[f(EAL) - f(TAI)]$ of -3.6×10^{-15}.

To improve the performances of TAI, in term of accuracy, a study of the influence of different atomic clocks (caesium clocks, hydrogen masers, etc.) on the time scale algorithm has been initiated.

2.3 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(BIPM07), valid until December 2007, which has an estimated accuracy of order 0.5×10^{-15}. Studies aiming at improving the computation of TT(BIPM) have been undertaken, in order to keep it in line with improvements in primary frequency standards.

3 Primary frequency standards and secondary representations of the second

Members of the BIPM Time, Frequency and Gravimetry section are actively participating in the work of the CCL/CCTF Frequency Standards Working Group, seeking to encourage knowledge sharing between laboratories, the creation of better documentation, comparisons, and the use of high accuracy PFS (Cs fountains) for TAI.

Other microwave and optical atomic transitions are being proposed as secondary representations of the second by the CCL/CCTF Frequency Standards Working Group. The list containing frequency values and uncertainties for transitions in Rb, Hg^{+}, Yb^{+}, Sr^{+} and Sr, recommended by the Consultative Committee for Time and Frequency (CCTF): Recommendation CCTF 2 (2006) and by the CIPM: Recommendation 1 (CI-2006), remains valid as there was no meeting of the CCTF in 2007. 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

As recommended by the CCTF at its meeting in October 2006, GPS time links used for clock comparison in TAI are calculated with the so-called method "GPS all in view". The introduction of this method decreased particularly the link noise for long distance links, and avoided the use of intermediate links for comparing clocks at very distant laboratories. Clock comparisons can presently be made by three independent techniques: GPS all in view based on C/A code measurements from GPS single frequency receivers; GPS all in 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 (thirteen official links in May 2007, and several more computed as additional links), and with a regular schedule of twelve daily TWSTFT observations. The classical GPS single-channel, single-frequency receivers today represent only 14 % of the time transfer equipment and are in the process of being replaced by multi-channel, single or dual frequency receivers. As a result, there has been an improvement in the accuracy of time transfer, and the whole system of time links has become more reliable.

Testing continues on other time and frequency comparison methods and techniques.

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 links made 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. Since 2006, calibration results have also been 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. A new receiver recently developed and commercialized (GTR50) has been purchased and is included in the calibration procedures since 2008. In all cases, at least two receivers remain at the BIPM to serve as a local reference with which the travelling receiver 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). Such P3 time links are now routinely computed and compared to 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. The BIPM has computed its own solutions for such time links since October 2007, using Precise Point Positioning (PPP) software, developed in collaboration with geodetic institutes. Comparisons between PPP, IGS, P3 and two-way links have led to insightful results on the stability of each technique. Since April 2008, a pilot experiment (TAIPPP) has been started with the participation of some 25 TAI laboratories, to study the introduction of such PPP time links for TAI computation.

4.3 Two-way time transfer

Two meetings of the TWSTFT participating stations have been held since July 2007; the CCTF WG on TWSTFT met in METAS in September 2007. The BIPM collects two-way data from 17 operational stations and undertakes treatment of some two-way links. About ten TWSTFT links are routinely used in the computation of TAI; some other links are in preparation for their introduction into the computation of TAI. The BIPM is also involved in the calibration of two-way time-transfer links by comparison with GPS. A major event occurred in February 2008 with a satellite change that required hardware modification in the Earth TW stations, which provoked a loose of the equipment's calibration. The BIPM played a key role in maintaining the continuity of the links by keeping the calibrations through the GPS PPP links that are calculated in the scope of the pilot project.

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. The values of u_A are updated when deemed necessary, depending on the noise level present in the links.

4.5 Calibration of TAI time links

The BIPM continues to organize and run calibration campaigns of GPS time equipment in time laboratories which contribute to TAI. From July 2007 to June 2008, GPS time equipment for single and dual frequency reception have been calibrated. The BIPM is also taking part in the organization of TWSTFT calibration trips; these trips are supported with a GPS receiver from our time laboratory.

Progress has been possible on the calibration of GLONASS equipment thanks to the cooperation with the Space Research Centre in Warsaw (Poland). As a result of this cooperation, we plan to initiate in the last semester of 2008 the calibration of GLONASS frequencies on GPS/GLONASS receivers operated in TAI participating laboratories.

5 Key comparisons

Monthly updates of key comparison in time CCTF-K001.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, take part in this key comparison.

As recommended by the CCTF at its meeting in October 2006, a study on the frequency uncertainty for the key comparison in frequency CCTF-K002.FREQ has been started in the Section. The first results have been obtained and further studies are in progress.

6 Pulsars

Collaboration continues with the Observatoire Midi-Pyrénées (OMP), Toulouse (France), and other radio-astronomy groups observing pulsars and analyzing pulsar data to study the potential capability of using millisecond pulsars as a means of sensing the very long-term stability of atomic time. The Time, Frequency and Gravimetry 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 are 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. A Workshop on the IERS Conventions was organized at the BIPM on 20-21 September 2007 for a discussion of the improvement of already published models and on the implementation of new ones. About 65 scientists from 15 countries attended the workshop. The presentations are available on the BIPM website (http://www.bipm.org/en/events/iers/iers_documents.html).

Activities related to the realization of reference frames for astronomy and geodesy are developing in cooperation with the IERS. In these domains, improvements in accuracy will enhance the need for a full relativistic treatment and it is essential to continue participating in international working groups on these matters; e.g. through the new IAU Commission "Relativity in Fundamental Astronomy". Cooperation continues for the maintenance of the international celestial reference system, and work has progressed in the framework of the IAU, IVS and IERS for the construction of a new conventional reference frame to be submitted to the IAU in August 2009.

8 Publications, lecture, travel: Time, Frequency and Gravimetry section

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