BUREAU INTERNATIONAL DES POIDS ET MESURES

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Rapport annuel de la Section du temps du BIPM

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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 Section

The Time Section of the BIPM issues two periodic publications. These are the monthly *Circular T* and the *Annual Report of the BIPM Time Section*. 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 du temps du BIPM produit deux publications périodiques : la Circulaire T, *mensuelle, et le* Rapport annuel de la Section du temps du BIPM. *Les circulaires et la plupart des tableaux de ce rapport annuel sont disponibles par utilisation du site internet du BIPM, http://www.bipm.org.*

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Electronic access to the BIPM Time Section files

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

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

Data- all data used for the computation of TAI, arranged in yearly directories, starting May 1999. See readme.txt for details.

Publication- the latest issues of the Time Section

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

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

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

Scale- time scales data

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

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

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

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

Leap seconds

Secondes intercalaires

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

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

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

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

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

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

Establishment of International Atomic Time and of Coordinated Universal Time

1. Data and computation

International Atomic Time (TAI) and Coordinated Universal Time (UTC) are obtained from a combination of data from some 300 atomic clocks kept by about 65 laboratories spread worldwide. The data are regularly reported to the BIPM by about 55 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 0h UTC for Modified Julian Dates (MJD) ending in 4 and 9, at 0h UTC ; these dates are referred here as 'standard dates'. The equipment maintained by the timing centres is detailed in Table 4.

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

2. Accuracy

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

3. Availability

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

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

4. Time links

The BIPM organizes the international network of time links, which takes the form of local stars within a continent, joined by long-distance links (see Figure).
In 2004, the network of time links used by the BIPM was non-redundant and relied on observation of GPS satellites in common views and on two way satellite time and frequency transfer (TWSTFT). Most time links are based on GPS satellite common views. Data from multi-channel dual-frequency GPS

geodetic type receivers is regularly used in the calculation of time links, in addition to that acquired by the traditional single-frequency (single or multi-channel) GPS time receivers. For those links performed with more than one technique, one of them is considered as official for TAI and the others are calculated as a back-up. GPS links in TAI with single-frequency receivers are corrected using the ionospheric maps produced by the International GNSS Service (IGS); all GPS links are corrected using the IGS precise operational satellite ephemerides. The ultimate precision of one single measurement of [$UTC(k_1)$ - $UTC(k_2)$], obtained at the BIPM with these procedures, is about 2 ns for short distances and 4 ns for long distances. 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 NMi Van Swinden Laboratorium, the Netherlands.

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

5. Time scales established in retrospect

For the most demanding applications, such as millisecond pulsar timing, the BIPM issues atomic time scales in retrospect. These are designated TT(BIPMxx) where 19xx or 20xx is the year of computation [3]. 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

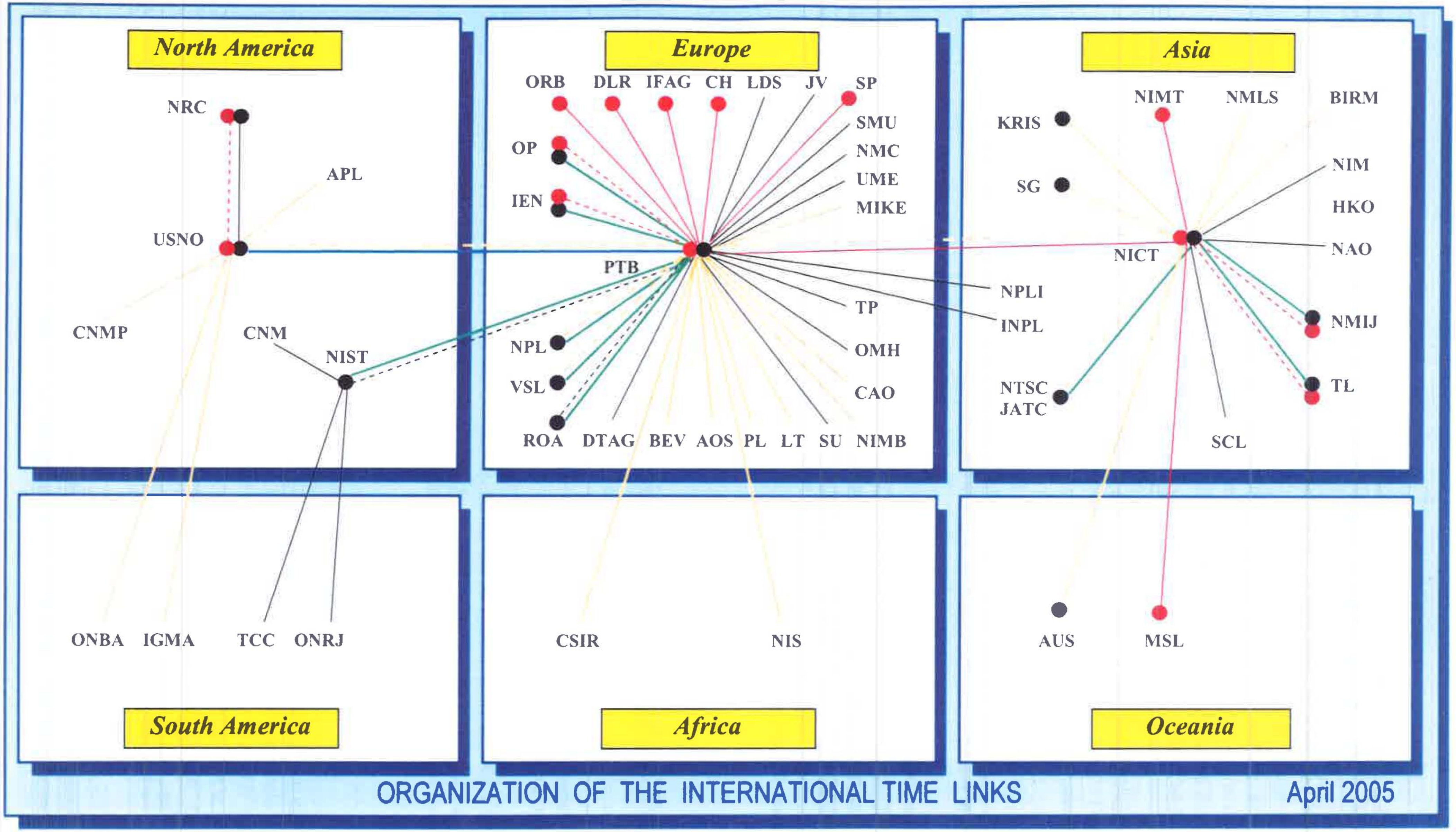
Tables 8 and 9 of this report give the rates relative to TAI and the weights of the clocks contributing to TAI in 2004.

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

The report of the BIPM Time Section for the period July 2003-June 2004, published in the *Director's Report on the Activity and Management of the BIPM*, 2004, **5** is reproduced after the yellow pages. All the publications mentioned in this report are available on request from the BIPM.

References

[1] C. Thomas and J. Azoubib, TAI computation: study of an alternative choice for implementing an upper limit of clock weights, *Metrologia*, 1996, **33**, 227-240.
[2] J. Azoubib, 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] B. Guinot, Atomic time scales for pulsar studies and other demanding applications, *Astron. Astrophys.*, 1988, **192**, 370-373.



- ● Laboratory equipped with TWSTFT
- TWSTFT
- TWSTFT by Ku band with X band back-up
- GPS CV single-channel link
- GPS CV single-channel back-up link
- ● Laboratory equipped with dual frequency GPS reception
- GPS CV dual frequency link
- GPS CV dual frequency back-up link
- GPS CV multi-channel link
- GPS CV multi-channel 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 300 horloges atomiques conservées par environ 65 laboratoires répartis dans le monde entier, et fournies régulièrement au BIPM par environ 55 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 0hUTC, '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 1 mois de données [1], [2] produit une échelle atomique libre, EAL, définie comme étant une moyenne pondérée de lectures d'horloges (jusqu'en 1997 des blocs de deux mois étaient utilisés). Le choix de la pondération et du mode de prédiction de fréquence optimise la stabilité de l'EAL à long terme. Il n'est pas tenté d'assurer la conformité de l'intervalle unitaire de l'EAL avec la seconde du Système international d'unités.

2. Exactitude

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

3. Disponibilité

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

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 comparaisons horaires selon un schéma en étoile au niveau des continents, et en liaisons à longue distance. En 2004, le système des liaisons horaires utilisé par le BIPM était non-redondant et reposait sur l'observation des satellites du GPS en vues simultanées et sur la technique d'aller et retour sur satellite de télécommunications (TWSTFT).

La plupart des liaisons se fait par vues simultanées 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 addition à celles avec des récepteurs monofréquence traditionnels (mono et multi-canaux). Dans les cas où plusieurs techniques participent à une liaison horaire, une d'entre elles est considérée comme étant officielle, et les autres sont calculées pour sauvegarde. Les liaisons par GPS mono-fréquence sont corrigées à l'aide des cartes ionosphériques produites par l'IGS ; toutes les liaisons par GPS sont corrigées en utilisant des éphémerides précises et opérationnelles des satellites produites par l'IGS . La précision ultime d'une mesure unique [UTC(k_1) - UTC(k_2)] *est alors d'environ 2 ns pour les liaisons à courte distance et d'environ 4 ns pour les liaisons à longue distance. Le BIPM publie aussi une évaluation de* [UTC - temps du GPS] *dont les valeurs sont disponibles sur le réseau internet.*

Le BIPM publie régulièrement une évaluation de [UTC - temps du GLONASS], *accessible par anonymous ftp and sur le site web du BIPM et déduite des observations habituelles du système GLONASS, réalisées au NMi Van Swinden Laboratorium, Pays-Bas.*

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

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 [3]. Les versions successives de TT(BIPMxx) ne sont pas seulement des mises à jour, mais aussi des révisions, de sorte qu'elles peuvent différer pour les dates communes. Ces échelles de temps sont disponibles sur demande faite au BIPM ou par utilisation du réseau internet.

Notes

Les tableaux 8 et 9 de ce rapport donnent les fréquences relatives au TAI et les poids des horloges qui ont contribué au calcul en 2004.
Les pages jaunes, à la fin de ce volume, concernent les émissions de signaux horaires.

Le rapport (juillet 2003 - juin 2004) de la section du temps du BIPM publié dans le Rapport du directeur sur l'activité et la gestion du Bureau international des poids et mesures (BIPM), 2004, **5**, *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 9.

Table 1. Relative frequency offsets and step adjustments of UTC, up to 31 December 2005

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

Table 2. Relationship between TAI and UTC, up to 31 December 2005

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

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)

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
BIRM	Beijing Institute of Radio Metrology and Measurement, Beijing, P. R. China
CAO	Stazione Astronomica di Cagliari (Cagliari Astronomical Observatory) Cagliari, Italy
CH	METrology and Accreditation Switzerland (METAS)
CNM	Centro Nacional de Metrología, Querétaro, Mexico (CENAM)
CNMP	Centro Nacional de Metrología, de Panamá, Panamá
CSIR	Council for Scientific and Industrial Research, Pretoria, South Africa
DLR	Deutsche Zentrum für Luft- und Raumfahrt (German Aerospace Centre) Oberpfaffenhofen, Germany
DTAG	Deutsche Telekom AG, Darmstadt, Germany
F	Commission Nationale de l'Heure, Paris, France
GUM	Główny Urząd Miar (Central Office of Measures), Warsaw, Poland
HKO	Hong Kong Observatory, Hong Kong, China
IEN	Istituto Elettrotecnico Nazionale Galileo Ferraris, Turin, Italy
IFAG	Bundesamt für Kartographie und Geodäsie (Federal Agency for Cartography and Geodesy), Fundamental station, Wettzell, Kötzting, Germany
IGMA	Instituto Geográfico Militar, Buenos Aires, Argentina
INPL	National Physical Laboratory, Jerusalem, Israel
JATC	Joint Atomic Time Commission, Lintong, P.R. China
JV	Justervesenet, Norwegian Metrology and Accreditation Service, Kjeller, Norway
KRIS	Korea Research Institute of Standards and Science, Daejeon, Rep. of Korea
LDS	University of Leeds, Leeds, United Kingdom
LT	Lithuanian National Metrology Institute, Vilnius, Lithuania
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
NMC	National Centre of Metrology, Sofiya, Bulgary
NMIJ	National Metrology Institute of Japan, Tsukuba, Japan
NML	National Measurement Laboratory, Sydney, Australia
NMLS	National Metrology Laboratory of SIRIM Berhad, Shah Alam, Malaysia

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

NPL	National Physical Laboratory, Teddington, United Kingdom
NPLI	National Physical Laboratory, New Delhi, India
NRC	National Research Council of Canada, Ottawa, Canada
NTSC	National Time Service Center of China, Lintong, P.R. China
OMH	Országos Mérésügyi Hivatal (National Office of Measures) Budapest, Hungary
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)
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 Radio Engineering and Electronics, Academy of Sciences of the Czech Republic, Prague, Czech Republic
UME	Ulusai Metroloji Enstitüsü, Marmara Research Center, (National Metrology Institute), Gebze Kocaeli, Turkey
USNO	U.S. Naval Observatory, Washington D.C., USA
VSL	NMi Van Swinden Laboratorium, Delft, the Nederlands

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 2004

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	Time Links: GLONASS	Time Links: Two-Way
AOS	1 Ind. Cs	1 Cs + microphase-stepper		*		*	
APL	3 Ind. Cs 2 H-masers	1 Cs + microphase-stepper		*			
AUS (b)	11 Ind. Cs 4 H-masers 1 Linear Ion Trap Standard (2)	1 Cs		*	*		*
BEV	3 Ind. Cs 2 Ind. Rb	1 Cs		*			
BIRM	2 Ind. Cs 3 H-masers	1 Cs (3)		*		*	
CAO	2 Ind. Cs	1 Cs		* (4)			
CH	3 Ind. Cs (5) 1 H-maser	all the Cs 1 H-maser	*	*	*		*
CNM (b)	3 Ind. Cs 1 H-maser	1 Cs		*			
CNMP	2 Ind. Cs	1 Cs		*			
CSIR	2 Ind. Cs	1 Cs		*		*	
DLR	1 Ind. Cs 5 H-masers	1 Cs			*		
DTAG	3 Ind. Cs	1 Cs		*			
HKO	2 Ind. Cs	1 Cs		*			
IEN	4 Ind. Cs 2 H-masers 1 Lab.Cs	1 Cs + microphase-stepper	*	*	*	*	*
IFAG	5 Ind. Cs 3 H-masers	1 Cs + microphase-stepper		*	*		
IGMA	3 Ind. Cs	1 Cs + microphase-stepper		*			
INPL (b)	3 Ind. Cs	1 Cs		*			
JATC	9 Ind. Cs (6)	1 Cs + microphase-stepper	*	*	*	*	*
JV	4 Ind. Cs	1 Cs		* (a)			

Table 4. Equipment and source of UTC(k) of the laboratories contributing to TAI in 2004. (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
KRIS	4 Ind. Cs 2 H-masers	1 H-maser + microphase-stepper	*	*	*	*	*
LDS	1 Ind. Cs	1 Cs		*		*	
LT	1 Ind. Cs	1 Cs		*			
MSL	3 Ind. Cs	1 Cs		*	*	*	
NAO	4 Ind. Cs 1 H-maser	1 Cs + microphase-stepper		*			
NICT (7)	21 Ind. Cs 3 H-masers 1 Lab. Cs	15 Cs	*	*	*	*	*
NIM (b)	3 Ind. Cs	1 Cs + microphase-stepper		*			
NIMB	1 Ind. Cs	1 Cs		*			
NIMT	1 Ind. Cs	1 Cs		*	*		
NIS	1 Ind. Cs	1 Cs		*			
NIST	5 Ind. Cs 1 Lab. Cs 5 H-masers	4 Cs 5 H-masers	*	*	*	*	*
NMC	1 Ind. Cs	1 Cs		* (a)			
NMIJ	4 Ind. Cs 1 Lab. Cs 2 H-masers	1 Cs + microphase-stepper		*	*		*
NMLS	5 Ind. Cs	1 Cs + microphase-stepper			*	*	
NPL	2 Ind. Cs 3 H-masers	1 H-maser		*	*		*
NPLI	3 Ind. Cs	1 Cs		*		*	
NRC (b)	2 Ind. Cs 3 Lab. Cs 3 H-masers	1 Lab. Cs + microphase-stepper (8)	*	*	*		*
NTSC	9 Ind. Cs	all the Cs	*	*	*	*	*

Table 4. Equipment and source of UTC(k) of the laboratories contributing to TAI in 2004 (Cont.)

Ind. Cs : Industrial caesium standard
Ind. Rb : Industrial rubidium standard
Lab. Cs : Laboratory caesium standard
H-maser : Hydrogen maser
SF : single frequency receiver
DF : dual frequency receiver
* means 'yes'

Lab k	Equipment	Source of UTC(k) (1)	TA(k)	Time Links			
				GPS		GLONASS	Two-Way
				SF	DF		
OMH	1 Ind. Cs	1 Cs		*			
ONBA	1 Ind. Cs	1 Cs		*	*		
ONRJ	3 Ind. Cs	1 Cs		*			
OP	7 Ind. Cs 3 Lab. Cs 2 H-masers	1 Cs + microphase-stepper	* (9)	*	*		*
ORB	3 Ind. Cs 2 H-masers	1 H-maser			*		
PL	8 Ind. Cs 2 H-masers	1 Cs + microphase-stepper (10)	* (11)	*			
PTB	3 Ind. Cs 2 Lab. Cs (12) 3 H-masers	1 Lab. Cs	* (13)	*	*		*
ROA	5 Ind. Cs	all the Cs		*	*		*
SCL	2 Ind. Cs	1 Cs + microphase-stepper		*			
SG	3 Ind. Cs	1 Cs + microphase-stepper		*			
SMU	1 Ind. Cs	1 Cs		*			
SP	6 Ind. Cs (14) 3 H-masers	1 Cs + microphase-stepper		*	*		*
SU	1 Lab. Cs 10 H-masers	4-6 H-masers	* (15)	*	*	*	
TCC	3 Ind. Cs	1 Cs + microphase-stepper		*			
TL	9 Ind. Cs 2 H-masers	1 H-maser + microphase-stepper	*	*	*		*
TP	4 Ind. Cs	1 Cs + output frequency steering		*			
UME	3 Ind. Cs	1 Cs		*			
USNO	72 Ind. Cs 20 H-masers	1 H-maser + frequency synthesizer steered to UTC(USNO) (16)	* (16)	*	*	*	*
VSL	4 Ind. Cs	1 Cs + microphase-stepper		*	* (17)	*	*

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 microphase-stepper.	
(2)	AUS	Some of the standards are located as follows (at the end of 2003):	
		* National Measurement Laboratory (NML, Sydney)	4 Cs, 2 H-maser,
		Australian laboratories intercompared by GPS are:	
		* National Measurement Laboratory Melbourne branch (NMLMEL, Melbourne)	1 Cs,
		* Telstra Corporation Ltd (TELSTRA, Melbourne)	3 Cs,
		* Australian Land Information Group, Yarragadee Observatory (Yarragadee, Western Australia)	1 Cs,
		* Canberra Deep Space Communication Complex (CDSCC, Canberra)	1 Cs, 2 H-maser, 1 Linear Ion Trap Standard (LITS),
		Australian laboratories intercompared by TV are:	
		* VMS International (Sydney)	1 Cs.
(3)	BIRM	The Source of UTC(BIRM) have been changed to 1 Ind. Cs during 2004.	
(4)	CAO	From February 2005 the gps receiver used is a multichannel TTS-2.	
(5)	CH	All the standards are located in Bern at METAS (METrology and Accreditation Switzerland, situation at the end of 2004).	
(6)	JATC	The standards are located at National Time Service Center, (NTSC). The link between UTC(JATC) and UTC(NTSC) is obtained by internal connection.	
(7)	NICT	In April 1, 2004, the Communications Research Laboratory (CRL), an independent administrative institution, and the Telecommunications Advancement Organization (TAO), an authorized corporation, were to be integrated with the National Institute of Information and Communications Technology (NICT), an incorporated administrative agency. The detail information is referred to the URL: http://www.nict.go.jp/overview/index.html http://jjy.nict.go.jp/index_e.html New address NICT, Independent Administrative Institution Technology Koganei Headquaters Applied Research and Standards Dept. Japan Standard Time Group Address: 4-2-1 Nukui-Kitamachi, Koganei, Tokyo 184-8795 Japan	
(8)	NRC	In 2003, UTC(NRC) was derived from NRC CsVIA.	
(9)	OP	The French atomic time scale TA(F) is computed by the BNM-SYRTE with data from 24 industrial caesium clocks located as follows (at the end of 2004) :	
		* Centre Electronique de l'Armement (CELAR, Rennes)	1 Cs,
		* Centre National d'Etudes Spatiales (CNES, Toulouse)	3 Cs,
		* France Telecom Recherche et Developpement (Lannion)	3 Cs,
		* Agilent Technologies France (Massy)	2 Cs,
		* Observatoire de la Côte d'Azur (OCA, Grasse)	2 Cs,
		* Observatoire de Paris (LNE-SYRTE, Paris)	7 Cs,
		* Observatoire de Besançon (OB, Besançon)	3 Cs,
		* Direction des Constructions Navales (DCN, Brest)	3 Cs.
		All laboratories are linked via GPS receivers.	

Notes (Cont.)

(10) PL Microphase-stepper added since 1st November 2004.

(11) PL The Polish atomic time scale TA(PL) is computed by the AOS and GUM with data from 11 caesium clocks and hydrogen masers located as follows:

* Central Office of Measures (GUM, Warsaw)	3 Cs, 1 H-maser,
* Astrogeodynamical Observatory, Space Research Center P.A.S. (AOS, Borowiec)	1 Cs,
* Institute of Telecommunications) (IŁ, Warsaw)	1 Cs,
* Research & Development Centre of the Polish Telecom (CBR, Warsaw)	2 Cs,
* 1st Specialized Metrology Center of Polish Air Forces (1SOM, Warsaw)	1 H-maser,
* Military Primary Standards Laboratory (COMW, Zielonka)	1 Cs,
* Time and Frequency Standard Laboratory of the Semiconductor Physics Institute, a guest laboratory from Lithuania (LT, Vilnius, Lithuania)	1 Cs.

All laboratories are linked via MC GPS-CV receivers.
The Polish official time scale UTC(PL) is maintained by the GUM.

(12) PTB The laboratory Cs, PTB CS1, PTB CS2 and PTB CS3, are operated continuously as clocks. PTB CS3 was essentially out of service during 2004. 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 steering.

(13) PTB *TA(PTB)-UTC(PTB)* is published in PTB Time Service Bulletin.

(14) SP SP The standards are located as follows (at the end of 2004):

* Swedish National Testing and Research Institute (SP, Borås)	3 Cs, 1 H-maser,
* STUPI AB (Stockholm)	2 Cs, 1 H-maser,
* Pendulum Instruments AB (Stockholm)	1 Cs,
* Onsala Space Observatory (Onsala)	1 H-maser.

(15) SU *TA(SU)-UTC(SU)* = 29.172 759 000 s from MJD 53004 to 53368,
TA(SU)-UTC(SU) = 29.172 758 840 s from MJD 53369.

(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.

(17) VSL GPS dual frequency results from geodetic Topcon 40 channel receiver, but not in CGGTTS format.

(a) GPS link via local restitution of GPS time.

(b) Information based on the Annual Report for 2003, not confirmed by the laboratory.

Table 5. Differences between the normalized frequencies of EAL and TAI, up to May 2005

(File available on http://www.bipm.org under the name EALTAI04.AR, which contains values since the beginning of the steering)

Date	MJD	[f(EAL) - f(TAI)] x 10^{-13}
1992 Apr 27 - 1992 Jun 26	48739 - 48799	7.40
1992 Jun 26 - 1993 Apr 22	48799 - 49099	7.35
1993 Apr 22 - 1995 Feb 21	49099 - 49769	7.40
1995 Feb 21 - 1995 Apr 22	49769 - 49829	7.39
1995 Apr 22 - 1995 Jun 21	49829 - 49889	7.38
1995 Jun 21 - 1995 Aug 30	49889 - 49959	7.37
1995 Aug 30 - 1995 Oct 29	49959 - 50019	7.36
1995 Oct 29 - 1995 Dec 28	50019 - 50079	7.35
1995 Dec 28 - 1996 Feb 26	50079 - 50139	7.34
1996 Feb 26 - 1996 Apr 26	50139 - 50199	7.33
1996 Apr 26 - 1996 Jun 30	50199 - 50264	7.32
1996 Jun 30 - 1996 Aug 29	50264 - 50324	7.31
1996 Aug 29 - 1996 Oct 28	50324 - 50384	7.295
1996 Oct 28 - 1996 Dec 27	50384 - 50444	7.280
1996 Dec 27 - 1997 Feb 25	50444 - 50504	7.265
1997 Feb 25 - 1997 Apr 26	50504 - 50564	7.250
1997 Apr 26 - 1997 Jun 30	50564 - 50629	7.230
1997 Jun 30 - 1997 Aug 29	50629 - 50689	7.210
1997 Aug 29 - 1997 Oct 28	50689 - 50749	7.190
1997 Oct 28 - 1997 Dec 27	50749 - 50809	7.170
1997 Dec 27 - 1998 Jan 31	50809 - 50844	7.160
1998 Jan 31 - 1998 Feb 25	50844 - 50869	7.150
1998 Feb 25 - 1998 Mar 27	50869 - 50899	7.140
1998 Mar 27 - 1999 Feb 25	50899 - 51234	7.130
1999 Feb 25 - 1999 Dec 27	51234 - 51539	7.140
1999 Dec 27 - 2000 May 30	51539 - 51694	7.130
2000 May 30 - 2000 Sep 27	51694 - 51814	7.120
2000 Sep 27 - 2000 Nov 26	51814 - 51874	7.110
2000 Nov 26 - 2001 Jan 30	51874 - 51939	7.100
2001 Jan 30 - 2001 Apr 30	51939 - 52029	7.090
2001 Apr 30 - 2001 Jul 29	52029 - 52119	7.080
2001 jul 29 - 2001 Sep 27	52119 - 52179	7.070
2001 Sep 27 - 2001 Nov 26	52179 - 52239	7.060
2001 Nov 26 - 2002 Jan 30	52239 - 52304	7.050
2002 Jan 30 - 2002 Mar 31	52304 - 52364	7.040
2002 Mar 31 - 2002 Jun 30	52364 - 52424	7.030
2002 Jun 30 - 2002 Jul 29	52424 - 52484	7.020
2002 Jul 29 - 2002 Sep 27	52484 - 52544	7.010
2002 Sep 27 - 2002 Nov 26	52544 - 52604	7.000
2002 Nov 26 - 2003 Jan 30	52604 - 52669	6.990
2003 Jan 30 - 2003 Mar 31	52669 - 52729	6.980
2003 Mar 31 - 2003 May 30	52729 - 52789	6.970
2003 May 30 - 2003 Aug 28	52789 - 52909	6.960
2003 Sep 27 - 2003 Nov 26	52909 - 52969	6.950
2003 Nov 26 - 2004 Jan 30	52969 - 53034	6.940
2004 Jan 30 - 2004 Mar 30	53034 - 53094	6.930
2004 Mar 30 - 2004 May 29	53094 - 53154	6.920
2004 May 29 - 2004 Jun 28	53154 - 53184	6.910
2004 Jun 28 - 2004 Jul 28	53184 - 53214	6.904
2004 Jul 28 - 2004 Dec 30	53214 - 53369	6.899
2004 Dec 30 - 2005 Feb 28	53369 - 53429	6.895
2005 Feb 28 - 2005 Mar 30	53429 - 53459	6.891
2005 Mar 30 - 2005 Apr 29	53459 - 53489	6.888
2005 Apr 29 - 2005 May 29	53489 - 53519	6.886

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 UTAI04.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) IEN-CSF1, NICT-O1, NIST-F1, NPL-CSF1, PTB-CS1, PTB-CS2, PTB-CSF1, SYRTE-FO2, SYRTE-FOM, and SYRTE-JPO for the year 2004.
Previous calibrations are available in the successive annual reports of the BIPM Time Section volumes 1 to 16.

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,
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 2004 are indicated below.

Primary Standard	Type /selection	Typical type B std. Uncertainty	Operation	Comparison with	Number/typical duration of comp.
IEN-CSF1	Fountain	1.1×10^{-15}	Discontinuous	H maser	4 /10 to 20 d
NICT-01	Beam /Opt.	5×10^{-15}	Discontinuous	UTC(NICT)	2 / 15-20 d
NIST-F1	Fountain	0.3×10^{-15}	Discontinuous	H maser	1 / 60 d
NPL-CSF1	Fountain	1×10^{-15}	Discontinuous	H maser	4 / 30 d
PTB-CS1	Beam /Mag.	8×10^{-15}	Continuous	TAI	12 / 30 d
PTB-CS2	Beam /Mag.	12×10^{-15}	Continuous	TAI	12 / 30 d
PTB-CSF1	Fountain	1×10^{-15}	Discontinuous	H maser	1 / 15 d
SYRTE-F02	Fountain	0.7×10^{-15}	Discontinuous	H maser	5 / 20 to 30 d
SYRTE-FOM	Fountain	1.1×10^{-15}	Discontinuous	H maser	1 / 30 d
SYRTE-JPO	Beam /Opt.	6×10^{-15}	Discontinuous	H maser	4 / 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
IEN-CSF1	53034 53044	7.8	0.4	1.2	[1]	0.4	3.0	3.3	
IEN-CSF1	53089 53099	9.4	0.6	1.2		0.4	3.0	3.3	
IEN-CSF1	53154 53174	9.8	0.3	1.2		0.3	1.5	2.0	
IEN-CSF1	53304 53324	5.9	0.3	1.0		0.4	1.5	1.9	
NICT-01	53019 53034	-2.5	11.0	5.5	[2]	0.8	2.0	12.5	(1)
NICT-01	53064 53084	4.1	7.7	5.5		0.8	1.5	9.6	
NIST-F1	53109-53169	6.5	0.5	0.3	[3]	0.4	0.5	0.9	
NPL-CSF1	53049 53084	4.1	0.6	1.0	[4]	0.4	0.9	1.5	(2)
NPL-CSF1	53089 53119	2.1	0.6	1.0		0.4	1.0	1.6	
NPL-CSF1	53119 53149	1.7	0.5	1.0		0.5	1.0	1.6	
NPL-CSF1	53299 53329	1.6	0.5	1.0		0.4	1.0	1.5	
PTB-CS1	53004 53034	0.4	5.0	8.0	[5]	0.0	1.0	9.5	(3)
PTB-CS1	53034 53064	4.3	5.0	8.0		0.0	1.0	9.5	
PTB-CS1	53064 53094	-5.9	5.0	8.0		0.0	1.0	9.5	
PTB-CS1	53094 53124	6.4	5.0	8.0		0.0	1.0	9.5	
PTB-CS1	53124 53154	3.5	5.0	8.0		0.0	1.0	9.5	
PTB-CS1	53154 53184	1.8	5.0	8.0		0.0	1.0	9.5	
PTB-CS1	53184 53214	-1.3	5.0	8.0		0.0	1.0	9.5	
PTB-CS1	53214 53244	5.9	5.0	8.0		0.0	1.0	9.5	
PTB-CS1	53244 53274	-4.0	5.0	8.0		0.0	1.0	9.5	
PTB-CS1	53274 53309	-5.3	5.0	8.0		0.0	0.9	9.5	
PTB-CS1	53309 53339	-3.9	5.0	8.0		0.0	1.0	9.5	
PTB-CS1	53339 53369	-7.3	5.0	8.0		0.0	1.0	9.5	
PTB-CS2	53004 53034	4.6	3.0	12.0	[6]	0.0	1.0	12.4	(3)
PTB-CS2	53034 53064	8.8	3.0	12.0		0.0	1.0	12.4	
PTB-CS2	53064 53094	9.1	3.0	12.0		0.0	1.0	12.4	
PTB-CS2	53094 53124	11.6	3.0	12.0		0.0	1.0	12.4	
PTB-CS2	53124 53154	1.5	3.0	12.0		0.0	1.0	12.4	
PTB-CS2	53154 53184	1.4	3.0	12.0		0.0	1.0	12.4	
PTB-CS2	53184 53214	8.2	3.0	12.0		0.0	1.0	12.4	
PTB-CS2	53214 53244	1.0	3.0	12.0		0.0	1.0	12.4	
PTB-CS2	53244 53274	-2.4	3.0	12.0		0.0	1.0	12.4	
PTB-CS2	53274 53309	6.5	3.0	12.0		0.0	0.9	12.4	
PTB-CS2	53309 53339	4.5	3.0	12.0		0.0	1.0	12.4	
PTB-CS2	53339 53369	9.2	3.0	12.0		0.0	1.0	12.4	
PTB-CSF1	52999 53014	13.2	1.0	0.9	[7]	0.1	2.0	2.4	
SYRTE-FO2	53014-53044	7.5	0.2	0.8	[8,9]	0.5	1.0	1.4	
SYRTE-FO2	53109-53129	4.1	0.04	0.6		0.2	1.5	1.6	
SYRTE-FO2	53129-53149	4.9	0.04	0.6		0.2	1.5	1.6	
SYRTE-FO2	53199-53224	2.6	0.1	0.7		0.2	1.2	1.4	
SYRTE-FO2	53304-53329	3.9	0.2	0.7		0.1	1.2	1.4	
SYRTE-FOM	53019-53049	6.6	0.3	1.1	[8]	0.7	1.0	1.7	

Table 6. (Cont.)

Standard	Period of estimation	d (10^{-15})	u_A (10^{-15})	u_B (10^{-15})	Ref(u_B)	$u_{link/lab}$ (10^{-15})	$u_{link/TAI}$ (10^{-15})	u (10^{-15})	Notes
SYRTE-JPO	53004-53034	18.2	0.6	6.5	[10]	0.3	1.0	6.6	
SYRTE-JPO	53034-53059	17.7	0.5	6.5		0.3	1.2	6.6	
SYRTE-JPO	53114-53124	4.9	0.7	6.5		0.3	3.0	7.2	
SYRTE-JPO	53124-53144	8.0	0.5	6.5		0.3	1.5	6.7	

Notes:

(1) Formerly CRL-O1.
(2) NPL atomic caesium fountain.
(3) Continuously operating as a clock participating to TAI.

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Operation of the BNM-SYRTE primary clocks in 2004

Uncertainty budget for uB

In 2004 the fountain clocks FO2 and FOM have transmitted calibrations to TAI (four and one respectively) and caesium beam clock JPO was operational in an almost continuous way until May and have transmitted four calibrations to TAI. Evaluations of relative frequency uncertainties u_B were measured. Particularly the evaluation of the uncertainty of the quadratic Zeeman and the cold collisions effects in FO2 clock was appreciably improved. A comparison between FO2 and FO1 fountains have shown a very good consistency and a combined stability reaches 2,2 x 10^{-16} .That results have well consolidated the accuracy budget of FO2 see ref [1]. Systematic effects shifting the frequency of the primary clocks are listed in Table I (FO2) and Table II (FOM) and see ref [4] for JPO.

Physical origin	Correction $[10^{-16}]$	Uncertainty $[10^{-16}]$
2^{nd} order Zeeman	-1927,3	+/- 0,3
Blackbody Radiation	168,2	+/- 2,5
Cold Collisions + cavity pulling	357,5	+/- 2,0
others	0,0	+/- 3,6
Total (1σ) uncertainty u_B		6,5

Table I: Accuracy budget of the FO2-CS fountain involved in the 2004 measurements.

Physical origin	Correction $[10^{-16}]$	Uncertainty $[10^{-16}]$
2^{nd} order Zeeman	-351,9	+/- 2,4
Blackbody Radiation	191,0	+/- 2,5
Cold Collisions + cavity pulling	34,0	+/- 5,8
others	0,0	+/- 3,6
Total (1σ) uncertainty u_B		7,7

Table II: Accuracy budget of the FOM fountain involved in the 2004 measurements.

Evaluation of uA

The short-term frequency instability of the fountain clocks were evaluated throughout 2004 by comparison with an active H maser locked by a BVA quartz oscillator and also by a cryogenic oscillator. Experimentally the relative frequency stability for FO2 was measured to $\sigma_y(\tau) = 1{,}1\ \ 10^{-13}\tau^{-1/2}$ with BVA quartz oscillator and $\sigma_y(\tau) = 1{,}6\ \ 10^{-14}\tau^{-1/2}$ with cryogenic oscillator and for FOM $\sigma_y(\tau) = 1{,}7\ \ 10^{-13}\tau^{-1/2}$ with BVA quartz oscillator.

Evaluation of ul/lab

The uncertainty due to the H maser link lab for FO2 or FOM was evaluated to $0{,}1\ \ 10^{-15}$ and for JPO was evaluated to $0{,}3\ \ 10^{-15}$. The dead times uncertainties were included in ul/lab for each fountain clocks measurements.

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5. M. Abgrall, Evaluation des performances de la fontaine atomique PHARAO, Participation à l'horloge spatiale PHARAO, thèse de doctorat de l'université de PARIS VI, 2003.

Report on the activity of IEN-CsF1 Primary Frequency Standard during 2004

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During 2004, four IEN-CsF1 frequency evaluations were reported to the BIPM. In the table below, a summary of those reports are shown. The fourth evaluation (period MJD 53304-53324) was done in the framework of a remote comparison experiment involving other Cesium Fountain Primary Frequency Standards.

CircT	Period (MJD)	Dur.	Local Osc.	yIENCsF1-yTAI	uA	uB	ulab	uTAI	Dead Time
195	53034-53044	10dd	1401102	+7.8	0.4	1.2	0.4	3.0	<10%
198	53089-53099	10dd	1401102	+9.4	0.6	1.2	0.3	3.0	<2%
198	53154-53174	20dd	1401102	+9.8	0.3	1.2	0.3	1.5	<10%
203	53304-53324	20dd	1401102	+5.9	0.3	1.0	0.4	1.5	<15%

The reference paper for IEN-CsF1 accuracy evaluation procedure is [1]. Further details are reported here.

Quadratic Zeeman shift: before each fountain evaluation run the magnetic field is mapped along the atom flight path, with low frequency ($\Delta F=0$, $\Delta m=\pm1$) spectroscopy; the mapped field is then used to estimate the DC quadratic Zeeman shift experienced by the atoms.

The AC quadratic Zeeman shift generated by the cavity heater (operated in AC to shield the spurious magnetic field with the aid of the skin effect) was measured to be lower than 4×10^{-16}.

Atomic density shift: a calibration of the atomic density shift with respect to the detected signal is performed with a differential measurement before and after each frequency evaluation run. The fountain is operated alternatively (every 2500 s) at high density and at low density for 2-4 days; the resulting calibration accuracy is approximately 20%. As the detection efficiency can change during the measurement run, a second calibration is usually performed at the end of the run and, if the case is given, the density shift bias is averaged and the uncertainty is enlarged. During the evaluation runs, the fountain is usually operated at low atomic density and the density shift correction (typical value $1\text{-}2\times10^{-15}$) is applied according to the detected signal.

Blackbody radiation shift: during 2003, we have recalculated the BBR shift [2] and measured it on the IEN-CsF1 fountain [3]; our results are in agreement among them, but they do not agree with previously used values. In fact our theoretical and experimental values for β are:

$\beta_{theo} = (-1.49 \pm 0.07)\times10^{14}$ [2], $\beta_{exp} = (-1.43 \pm 0.09)\times10^{14}$ [3]

Waiting for a general discussion on these results, and to allow comparison with other frequency standards, the value used during the 2004 evaluation runs is $\beta = -1.711 \pm 0.003 \times10^{-14}$, as deduced by the results reported in [4].

Gravitational shift: the elevation of IEN-CsF1 on the geoid is measured to be 242.5(0.5) m, with the IEN geodetic GPS receiver (which is part of the IGS station network) and with the local geoid height tabulated by NIMA (EGM96) [5].

Type A uncertainty IEN-CSF1 is generally operated by comparing its frequency with a BVA quartz oscillator phase locked to an H-maser (BIPM code 1401102). The short term stability is limited by the quartz noise at $3\times10^{-13}\tau^{-1/2}$. During frequency evaluation runs, the atomic density is set to a level which do not allow a significant degradation of the stability value.

Laboratory link uncertainty: long term stability measurements show that the H Maser (code 1401102) stability is better than fountain stability up to 10^5 seconds. During the evaluations performed in 2004, IEN-CSF1 operated with dead time intervals shorter than 10^5 seconds and then with negligible added uncertainty. The local link uncertainty is then limited by the H maser to UTC(IEN) transfer measurements in the IEN laboratory.

A typical accuracy budget (evaluation period MJD 53154-53174) is reported in the table below:

Effect	Correction ($\times10^{-15}$)	Uncertainty ($\times10^{-15}$)
Quadratic Zeeman (field map)	-46.1	0.04
Blackbody Radiation	29.8	0.07
Atomic Density (*)	2.4	0.7
Gravitational Potential	-26.4	0.1
Others Effects (**)	-	1
Total	-40.3	1.2

(*) Average value during the whole experiment

(**) Including quadratic Zeeman shift from the heater, leakage and other effects as reported in [1]

[1] F. Levi, L. Lorini, D. Calonico, A. Godone, "IEN-CsF1 Accuracy Evaluation and Two-Way Frequency Comparison", IEEE Trans. On UFFC, Vol. 51, No. 10, October 2004
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Operation of the NICT primary clocks in 2004

On April 1st 2004, with the change of the name of the organization, CRL-O1, an optically pumped primary frequency standard, has changed its name to NICT-O1. Its Type B uncertainty has been fully rechecked and a paper on its accuracy evaluation has published [1]. Due to the baking of the vacuum chamber, its operation had stopped for a few months in the latter half of 2004. The operation has restarted since the end of 2004.

Physical Effect	Bias (10^{-15})	Uncertainty (10^{-15})
Second-order Doppler	$\delta\nu_D \sim -260$	2
Second-order Zeeman	$\delta\nu_{QZ} \sim 1.5\times10^5$	0.2
Cavity pulling	$\delta\nu_C \sim 0$	0.6
Cavity phase	$\delta\nu_E \sim \pm160$	3.6
Blackbody	$\delta\nu_B \sim -20$	0.5
Gravitation	$\delta\nu_G \sim 8.2$	0.1
Uncorrected biases	0	3.6
Combined Type B Uncertainty		5.5

Table 1: Uncertainty budget for uB

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

Table 2: Details on the uncertainty of uncorrected biases

Reference

[1] Hasegawa A., Fukuda K., Kajita M., Ito H., Kumagai M., Hosokawa M., Kotake N., Morikawa T., *Metrologia,* 2004, 41-4, 257.

Operation of NIST-F1 in 2004

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]. During a formal evaluation the average frequency of one of the hydrogen masers at NIST is measured by NIST-F1 and the results, along with all relevant biases and uncertainties, are reported to the BIPM. NIST-F1 is not operated as a clock and is run only intermittently. The standard is constantly evolving, and both hardware and software improvements are continually being made. In most formal evaluations we have used a range of atom densities along with a weighted linear least squares fit to determine the frequency at zero density. If no major changes have been made to the fountain since the previous evaluation, we may at times make mainly low density measurements and use the previous slope, along with any new high density data, to perform an extrapolation to zero density. The typical frequency shift from the lowest measured density to zero density is on the order of $5x10^{-16}$. Each formal evaluation also includes mapping the magnetic field, and measuring possible biases due to such things as microwave leakage and light leaks.

NIST operates a clock ensemble comprised of five active, cavity tuned hydrogen masers, and four commercial caesium standards. This provides a very stable frequency reference, which allows us to accurately characterize the performance of the reference maser. Since the masers are quite stable, we can tolerate a relatively large amount of fountain dead time [2, 3]. This allows us to use a significantly longer report interval for a given fountain run time in order to reduce the frequency uncertainty introduced by the noise in transferring the result to TAI. Frequency noise in the NIST internal measurement system has an uncertainty well under $1x10^{-16}$, and therefore the uncertainty introduced by the dead time dominates the value of $u_{link/lab}$, which ranged from $3x10^{-16}$ to $4x10^{-16}$ in 2004.

Two formal evaluations were carried out in 2004, one 60 day report interval in April/June 2004 and a 40 day interval starting in December 2004. In between these evaluations a number of improvements to NIST-F1 were made. A very important improvement was the introduction and verification of new software to operate the fountain. This new software provides increased flexibility, better monitoring of system operation, and greater reliability. Also, new optical shutters and a shutter monitoring system were introduced. In the fall of 2004 a new microwave synthesizer was installed and tested. This synthesizer has a lower noise level and is more user friendly. There has also been considerable theoretical work on distributed cavity phase induced frequency biases, and a paper has been accepted for publication [4]. Reports on recent improvements to, and operational aspects of, NIST-F1 were presented at the 2004 Conference on Precision Electromagnetic Measurements (CPEM), the IEEE International Frequency Control Symposium (IFCS), and the Asia Pacific Workshop on Time and Frequency (ATF2004). A journal paper on recent improvements to NIST-F1 will be submitted in early 2005 and this will contain a new table of uncertainties.

The 60 day run in April/June 2004 had the lowest total uncertainty ever reported to TAI. The combined fountain uncertainty was $6.1x10^{-16}$ for this run, with the statistical uncertainty, u_A, being equal to $5.1x10^{-16}$ (including a spin exchange uncertainty of $4.3x10^{-16}$) and the systematic uncertainty, u_B, equal to $3.3x10^{-16}$. Significant contributors to the systematic uncertainty in this evaluation were; blackbody shift at $2.6x10^{-16}$, microwave leakage at $1.4x10^{-16}$, and Zeeman and gravitational shift at $1x10^{-16}$ each. Combined with a dead time uncertainty of $4x10^{-16}$ and a link to TAI uncertainty of $5x10^{-16}$, the overall reported uncertainty was $8.8x10^{-16}$. This is the first total uncertainty less than $1x10^{-15}$ for a primary frequency standard reported in Circular T.

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Contributions to evaluations of the frequency of TAI by the primary frequency standard NPL-CsF1

National Physical Laboratory

The primary frequency standard NPL-CsF1 was used to measure the frequency of the H-maser HM1 (BIPM clock code: 1401701) during four campaigns of 30-40 days in 2004. A detailed description of the standard as well as the evaluation procedures of the systematic frequency biases can be found in ref. [1].

Uncertainties of systematic frequency biases, u_B

Those biases and uncertainties used to calculate the total contribution to the frequency of NPL-CsF1 are as follows:

Effect	Bias ($\times 10^{-15}$)	Uncertainty ($\times 10^{-15}$)
2nd ord. Zeeman	142.7	0.1
black-body rad.	-16.9	0.4
collisions	(-7.7)	0.8
μ-w leakage	0.8	0.3
cavity pulling	0.0	0.1
μ-w spectrum	0.0	<0.1
cavity phase	0.0	0.3
Rabi pulling	0.0	0.1
AC Stark	0.0	0.1
gravity	1.3	0.1
total (1σ), u_B		1.0

The value of frequency bias due to cold collisions is given for example only. The actual value was computed continuously and standard's frequency was extrapolated to zero atomic density. To extrapolate the fountain frequency to the zero-density value, it was operated in an alternating mode, where every two cycles the density of the cold atomic sample was toggled between a high and low value. The ratio between the low and high density was approximately ½ and was calculated from the amplitude of the detection signal measured and recorded every cycle.

Corrections due to effects other than collisions were sufficiently stable over a campaign period, so that a single correction value could be applied. Nevertheless, the validity of that value, where possible, was checked during a campaign. The temperature of the vacuum vessel was recorded at one-minute intervals. The microwave leakage level and the C-field value for the operating launch height were checked every two or three days.

Uncertainties of the frequency measurement

Stability, u_A

The short-term stability of the measurement of the frequency extrapolated to zero atomic density was typically 7×10^{-13} in 1s. The type A uncertainty of the complete measurement u_A was obtained by assuming white FM noise over the effective period of integration.

Link with the local time scale, $u_{l/lab}$

The frequency of NPL-CsF1 was related to a hydrogen maser HM3 (not reported to BIPM), which in turn was linked to the maser HM1. The two masers maintained a 10 MHz link between them.

The uncertainty of the link with the local time scale $u_{l/lab}$ is a quadratic sum of two contributions:

$$(u_{l/lab})^2 = (u_{link})^2 + (u_{dt})^2$$

where u_{link} is the uncertainty associated with the frequency transfer between CsF1 and HM1, and u_{dt} is an additional uncertainty of the measured maser frequency due to gaps (dead time) in the operation of the fountain standard.

In order to estimate the u_{link}, which arose predominantly from instabilities of the temperature of the linking cable, the round-trip phase-delay in the cable was monitored.

The fractional frequency uncertainty, u_{dt}, arising from the dead time was approximated by the square root of the sum of the time variances, normalised by the length of the measurement campaign, thus:

$$u_{dt} = \frac{1}{T}\sqrt{\sum_{i=1}^{N}[\sigma_x(\tau_i)]^2}$$

where $\sigma_x(\tau_i)$ is the time deviation (TDEV) of the maser over a duration τ_i; and T is the duration of the campaign.

Reference:

[1] K. Szymaniec, W. Chalupczak, P.B. Whibberley, S.N. Lea, D. Henderson, *Metrologia*, **42** (2005) 49-57

Operation of the PTB primary clocks in 2004

PTB's primary clocks with a thermal beam

During 2004, PTB CS1 and CS2 were in continuous clock operation without any modification or (major) disturbance. The frequency instability of the clock signals was checked repeatedly with an active hydrogen maser as the reference, and the expected values were found, $\sigma_y(\tau= 1\text{h, CS1}) = 80\times10^{-15}$, and $\sigma_y(\tau= 1\text{h, CS2}) = 65\times10^{-15}$. From this, the uncertainty contributions u_A were estimated as $u_A(\tau=30\text{d, CS1}) = 5\times10^{-15}$, and $u_A(\tau=30\text{d, CS2}) = 3\times10^{-15}$.

The clocks' operational parameters were checked periodically and validated to estimate the clock uncertainty. These parameters are the Zeeman frequency, the temperature of the beam tube (vacuum enclosure), the line width of the clock transition as a measure of the mean atomic velocity, the microwave power level, the spectral purity of the microwave excitation signal, and some characteristic signals of the electronics. Reversals of the beam direction were performed on each clock three times, and the end-to end phase difference values were found unchanged. No indications were found calling for a modification of the previously stated relative frequency uncertainties, u_B, which are 8×10^{-15} and 12×10^{-15} for CS1 and CS2, respectively [1]. The clocks are operated continuously, and time differences UTC(PTB) – clock in the standard ALGOS format are reported so that $u_{l/lab}$ is zero.

Following non perfect service work on 2004-11-16, the control signal of the CS2 quartz oscillator was disturbed, and phase excursions happened in UTC(PTB) which is derived form the CS2 quartz output. This disturbance became visible in PTB's GPS and TWSTFT data. We cured the defect on the following day and reported on the event via e-mails to users of our signals.

PTB's caesium fountain clock CSF1

Routine operation of CSF1 has continued throughout the year 2004, with typically one or two frequency data points with respect to PTB's hydrogen masers H4 and H5 evaluated per day. These masers in turn are compared to all relevant time scales at PTB. Most of our work has been concentrated on further steps of modernizing CSF1's electronics and control systems and on a more thorough characterization of potential systematic frequency shifts. This is why only one measurement of the TAI scale unit was performed during a 15-day interval in December 2003/January 2004. For this interval we followed our standard practise of previous years. The CSF1 frequency instability was $\sigma_y(\tau=1\text{h}) = 3.5\times10^{-15}$. The frequency difference y(CSF1 – HM) for averaging times of 15 days in between standard dates was reported, in parallel with time differences UTC(PTB) – H4 in ALGOS format. $u_A(\tau=15\text{d, CSF1})$ was conservatively estimated as 1×10^{-15}, $u_{l/lab}$ was negligible.

During a joint measurement campaign in October/November 2004 a sudden relative frequency excursion of PTB's CSF1 with respect to FO2 (BNM-SYRTE), CSF1 (IEN), and CsF1 (NPL) of several parts in 10^{14} occurred. This could be traced back to a faulty cable in the 5-MHz circuitry. We have checked that this effect was a really new problem, so that none of the measurements reported for CSF1 in the past had been affected. As the outcome of such studies we estimate that u_B(CSF1) = 0.9×10^{-15} was correctly stated - following the practise described in [2] - at the time of reporting CSF1 data in January 2004.

For 2005, more work is planned to investigate the existence of small systematic frequency shifts. Having completed this procedures we will provide a more up to date uncertainty estimate.

References
1. Heindorff T., Bauch A., Hetzel P., Petit G., Weyers S., Metrologia, 2001, 38, 497-502.
2. Weyers S., Bauch A., Schröder R., Tamm Chr., Proc. of Symp. Frequ. Stand. and Metrol., St. Andrews, Sept. 2001, World Scientific (2002), 64-71.

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

(File available on http://www.bipm.org under the name SITAI04.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 IEN-CSF1, NICT-O1, NIST-F1, NPL-CSF1, PTB-CS1, PTB-CS2, PTB-CSF1, SYRTE-FO2, SYRTE-FOM and SYRTE-JPO consistently corrected for the black-body radiation shift.
In this computation, a model for the instability of EAL is needed. Starting in 1998, it has been expressed as the quadratic sum of three components: a white frequency noise $6.0\times10^{-15}/\sqrt{(\tau)}$, a flicker frequency noise 0.6×10^{-15} and a random walk frequency noise $1.6\times10^{-16}\times\sqrt{(\tau)}$, with τ in days. The relation between EAL and TAI is given in Table 5.

Month	Interval	$d/10^{-15}$	uncertainty/10^{-15}
Jan. 2002	52274-52304	+9.7	1.9
Feb. 2002	52304-52329	+10.2	1.5
Mar. 2002	52329-52364	+10.6	1.4
Apr. 2002	52364-52394	+9.7	1.7
May 2002	52394-52424	+10.2	1.7
Jun. 2002	52424-52454	+9.5	1.9
Jul. 2002	52454-52484	+10.8	1.5
Aug. 2002	52484-52514	+8.9	1.9
Sep. 2002	52514-52544	+8.9	1.4
Oct. 2002	52544-52574	+8.7	1.7
Nov. 2002	52574-52604	+9.8	1.5
Dec. 2002	52604-52639	+10.7	1.5
Jan. 2003	52639-52669	+9.5	1.9
Feb. 2003	52669-52694	+9.0	1.6
Mar. 2003	52694-52729	+8.9	1.0
Apr. 2003	52729-52759	+10.0	1.5
May 2003	52759-52789	+6.8	1.4
Jun. 2003	52789-52819	+6.2	1.5
Jul. 2003	52819-52849	+8.2	1.7
Aug. 2003	52849-52879	+10.2	1.7
Sep. 2003	52879-52909	+10.3	0.9
Oct. 2003	52909-52939	+9.7	1.5
Nov. 2003	52939-52969	+10.5	1.6
Dec. 2003	52969-53004	+9.8	1.0
Jan. 2004	53004-53034	+8.9	1.1
Feb. 2004	53034-53064	+6.3	1.2
Mar. 2004	53064-53094	+5.0	1.3
Apr. 2004	53094-53124	+4.0	1.0
May 2004	53124-53154	+5.1	0.9
Jun. 2004	53154-53184	+6.6	1.3
Jul. 2004	53184-53214	+3.8	1.5
Aug. 2004	53214-53244	+3.0	1.7
Sep. 2004	53244-53274	+2.9	2.0
Oct. 2004	53274-53309	+3.0	1.7
Nov. 2004	53309-53339	+3.6	1.2
Dec. 2004	53339-53369	+4.2	1.6

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 42 File SCHGPS.42	implemented on MJD = 53097 (2004 April 2) at 0h UTC	Reference date MJD = 50722 (1997 October 1)
GPS Schedule no 43 File SCHGPS.43	implemented on MJD = 53276 (2004 September 28) at 0h UTC	Reference date MJD = 50722 (1997 October 1)
GLONASS Schedule no 17 File SCHGLO.17	implemented on MJD = 53097 (2004 April 2) at 0h UTC	Reference date MJD = 50722 (1997 October 1)
GLONASS Schedule no 18 File SCHGLO.18	implemented on MJD = 53276 (2004 September 28) at 0h UTC	Reference date MJD = 50722 (1997 October 1)

Relations of UTC and TAI with GPS time and GLONASS time

(File available on http://www.bipm.org under the name UTCGPSGLO04.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

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

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 1999 January 1, 0h UTC until further notice:

$$[UTC - GPS\ time] = -13\ \mathrm{s} + C_0.$$

Here C_0 is given at 0h UTC every day.

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

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

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

(File available on http://www.bipm.org under the name UTCGPSGLO04.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 1999 January 1, 0h UTC, until further notice:

$$[TAI - GLONASS\ time] = 32\ \mathrm{s} + C_1.$$

Here C_1 is given at 0h UTC every day.

C_1 is computed as follows. The GLONASS data recorded at the NMi Van Swinden Laboratorium, Delft, The Netherlands for the highest-elevation satellites are smoothed to obtain daily values of [*UTC*(*VSL*) - *GLONASS time*] at 0h UTC. Daily values of C_1 are then derived by linear interpolation of [*UTC* - *UTC*(*VSL*)].

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

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

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

Table 8A. Rates relative to TAI of contributing clocks in 2004

(File available on http://www.bipm.org under the name RTAI04.AR)

Mean clock rates relative to TAI are computed for one-month intervals ending at the MJD dates given in the table. When an intentional frequency adjustment has been applied to a clock, the data prior to this adjustment are corrected, so that Table 8A gives homogeneous rates for the whole year 2004. For studies including the clock rates of previous years, corrections must be brought to the data published in the Annual Report for the previous years. These corrections are given in Table 8B. Unit is ns/day,
"-" denotes that the clock was not used,
"*" denotes that the related rate was influenced by a frequency jump.

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

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

Lab.	Clock	53034	53064	53094	53124	53154	53184	53214	53244	53274	53309	53339	53369
APL	35 904	3.43	-	8.53*	6.83*	6.04*	6.17*	6.71	7.01	5.53	-	-	4.21
APL	35 1264	10.03	11.04	12.69	10.86	11.32	10.49	11.59	11.66	10.37	-	-	10.34
APL	35 1791	12.44	12.80	15.13	14.22	14.10	-	-	-	-	-	-	-5.09
APL	40 3107	-1.65	-3.46	-2.43	-5.04	-6.40	-7.14	-7.73	-8.40	-8.84	-	-	-7.25
APL	40 3108	-	-	-	-	-	-	-	-	-58.29	-	-	-53.04
AUS	36 249	-	-9.54	-8.10	-3.32	-3.89	-7.29	-9.19	-7.24	-4.61	-4.96	-4.18	-5.47
AUS	36 299	18.79	19.47	18.28	17.57	17.40	18.26	19.56	18.47	18.53	18.96	18.45	17.99
AUS	36 340	-0.91	0.25	0.82	-0.96	-0.06	-1.94	-0.37	-0.75	1.67	1.05	0.85	0.42
AUS	36 654	-22.28	-22.78	-21.93	-22.35	-21.48	-21.22	-20.60	-21.39	-21.33	-20.35	-20.88	-20.70
AUS	36 1035	-	8.69	3.45	3.91	4.51	3.39	4.87	7.04	1.79	3.72	2.81	2.46

Table 8A. (Cont.)

Lab.	Clock	53034	53064	53094	53124	53154	53184	53214	53244	53274	53309	53339	53369
AUS	40 5401	24.20	-	25.72	23.46	-	-	-	30.50	-	-	33.58	32.22
AUS	40 5402	12.72	-	-	9.88	11.22	12.38	13.69	11.96	-	-	9.08	7.77
AUS	40 5403	-	7.09	9.83	8.73	4.34	2.61	2.91	0.91	-3.53	-10.96	-15.20	-3.22
AUS	99 1	-	50.51	60.54	70.68	18.68	15.99	-	-	-	7.75	9.94	14.46
BEV	16 71	65.34	101.61	-	-	10.29	-6.09	-13.29	87.14	-4.11	36.04	38.11	101.16
BEV	35 1065	-5.56	-4.52	-4.64	-4.73	-4.64	-3.74	-3.78	-4.75	-2.92	-2.75	-5.18	-5.45
BEV	35 1793	-0.96*	-0.27*	-0.08	-0.06	-0.12	0.57	0.11	0.27	0.12	0.96	0.32	1.13
CAO	35 939	3.90	1.86	3.04	2.60	3.01	2.10	1.89	2.94	1.85	-0.32	3.66	3.32
CAO	35 1270	-7.70	-8.18	-7.70	-8.47	-8.15	-7.55	-7.03	-7.95	-7.33	-7.74	-7.71	-7.08
CH	21 194	-16.21	-13.95	-11.56	-15.36	-	-	-	-	-	-	-	-
CH	35 771	7.83	8.45	8.50	9.81	8.28	8.82	9.32	9.12	9.04	9.12	8.81	8.52
CH	36 354	45.32	44.80	45.93	44.61	46.54	45.32	46.21	46.34	45.19	46.48	45.92	46.36
CH	36 413	-	3.48	2.43	3.43	2.40	2.27	5.24	1.88	2.10	1.83	2.88	-
CH	40 5701	-62.00	-63.38	-64.77	-66.76	-69.56	-71.42	-72.84	-74.61	-76.35	-78.41	-80.51	-82.38
CNM	35 1705	-0.70	-0.27	-1.08	-0.80	-0.89	-0.64	-0.08	-0.46	-0.70	-0.71	-0.86	-0.60
CNM	35 1815	0.05*	-0.36*	-1.75*	-2.08*	-1.07*	-1.45*	-1.08*	0.22*	0.40*	1.15*	0.66*	0.90
CNM	36 1537	-18.98	-19.66	-18.71	-20.65	-19.59	-18.49	-17.49	-18.51	-19.03	-17.73	-19.94	-20.14
CNM	40 7301	-19.14	-19.66	-27.43	-23.81	-23.74	-25.42	-26.57	-28.02	-31.70	-39.51	-43.40	-32.78
CNMP	36 1752	-10.12	-12.72	-9.96	-11.24	132.34	-11.94	-10.97	-10.20	-5.34	-6.74	-6.20	-5.17
DLR	35 1714	0.08	0.64	-0.08	0.56	0.63	-2.35	-	-	-	-	0.99	-0.88
DTAG	36 136	12.97	-0.60	-6.89	-7.59	-5.78	-7.85	-6.61	-7.98	-3.63	-3.36	-4.41	-3.19
DTAG	36 345	-2.81	-1.75	-1.19	-2.01	-1.54	-1.48	-0.09	-0.07	-0.79	-2.05	-2.30	-0.16
DTAG	36 465	-0.28	-0.14	-0.57	0.75	0.47	-0.26	1.08	-0.12	-1.47	-1.55	-1.31	-0.48
F	35 122	13.58	14.26	13.61	14.07	13.62	13.89	15.19	15.21	14.43	13.62	14.48	15.72
F	35 124	4.97	5.41	4.82	5.25	5.40	5.23	5.87	5.75	5.55	6.29	6.62	6.49
F	35 131	15.10	15.01	15.13	15.08	14.75	15.76	16.20	15.20	15.46	15.29	15.52	15.18
F	35 158	13.99	14.40	14.20	14.14	14.59	15.07	15.18	14.50	14.21	15.23	14.48	17.06
F	35 172	9.59	9.60	9.39	9.67	8.40	8.81	8.95	8.90	9.24	7.93	7.95	8.70
F	35 198	9.63	8.90	8.97	8.28	8.44	7.46	7.52	7.13	6.19	6.75	5.99	5.58
F	35 385	-	-	-	-	-	-	20.82	19.91	19.27	20.45	22.60	22.21

Table 8A. (Cont.)

Lab.	Clock	53034	53064	53094	53124	53154	53184	53214	53244	53274	53309	53339	53369
F	35 396	6.12	5.60	6.46	7.09	6.40	6.28	6.83	5.94	5.52	6.36	-	-
F	35 489	-	-	20.53	21.22	-	-	-	-	-	-	-	-
F	35 520	-	-	16.58	16.57	14.68	14.94	16.27	16.39	15.28	15.64	14.13	13.63
F	35 536	5.60	6.39	6.18	6.32	6.58	6.79	7.02	7.44	7.43	7.81	7.22	7.34
F	35 609	-8.52	-7.49	-7.60	-7.50	-8.31	-5.95	-7.44	-9.03	-8.49	-5.30	-5.42	-6.01
F	35 770	15.43	15.12	14.72	14.47	15.13	15.03	14.78	15.59	14.83	15.19	15.33	18.82
F	35 774	-	-	-19.12	-19.53	-19.69	-20.00	-19.79	-18.99	-19.38	-19.17	-18.27	-16.21
F	35 781	20.70	20.55	20.70	20.89	20.59	21.07	21.49	20.84	-	-	-	-
F	35 819	5.18	-	-	5.39	6.73	-	-	6.08	6.44	8.31	7.04	6.61
F	35 1029	-	-	17.42	17.94	16.91	17.11	-	-	16.16	16.07	15.75	14.09
F	35 1177	-15.31	-14.76	-14.73	-15.16	-13.86	-14.06	-14.34	-14.48	-	-	-	-13.74
F	35 1178	5.25	6.46	5.91	5.12	5.61	5.78	5.48	5.26	-	-	-	4.29
F	35 1222	4.71	4.50	5.27	5.65	5.33	5.44	5.04	6.28	6.99	6.50	6.45	5.71
F	35 1321	7.75	8.59	10.20	10.12	10.10	9.38	9.62	10.74	10.89	10.69	10.93	11.53
F	35 1556	-16.75	-15.72	-16.94	-17.66	-18.52	-16.44	-19.05	-19.52	-18.94	-16.03	-14.97	-16.90
F	35 2027	-	-	-	-	-	5.08	5.07	5.43	5.68	5.55	5.86	6.06
F	40 805	-59.96	-59.09	-58.20	-57.79	-57.80	-58.86	-61.09	-65.25	-67.60	-66.97	-63.47	-59.03
F	40 816	-	-	-26.31	-28.24	-29.68	-29.75	-29.42	-29.72	-29.85	-29.62	-	-
HKO	35 1893	-	-	-	-	-45.26	14.10	-21.10	1.65	1.12	-4.43	-8.59	-1.82
IEN	35 219	15.58	15.80	15.24	14.31	14.27	14.42	14.18	13.74	13.70	14.67	15.37	14.47
IEN	35 505	-7.86	-7.11	-7.48	-9.09	-9.47	-9.68	-8.87	-9.54	-10.10	-10.06	-9.52	-8.39
IEN	35 1115	-	1.10	1.60	2.55	2.67	4.66	4.79	3.17	2.82	2.58	4.34	4.36
IEN	35 1373	0.59	0.16	0.52	0.94	0.30	1.25	-0.08	-1.13	-0.87	-1.28	-1.26	-0.08
IEN	40 1101	65.78	75.19	85.76	94.39	98.01	111.12	118.68	127.29	135.60	145.38	-	-
IEN	40 1102	4.11	4.08	4.72	5.05	5.44	6.02	6.64	7.07	7.52	7.85	8.67	9.00
IFAG	36 1167	-8.83	-8.67	-6.23	-5.89	-5.22	-1.77	-2.78	-1.41	-0.84	-2.47	-2.55	-4.52
IFAG	36 1173	-	-	-	-	-	-3.63	-2.82	-0.42	-0.95	-4.24	-6.20	-6.83
IFAG	36 1629	4.06	4.24	4.94	5.65	6.53	7.79	6.74	7.50	7.87	7.51	6.37	5.78
IFAG	36 1732	-2.21	-2.37	-2.19	-1.95	-0.68	-0.53	-0.48	-0.48	-0.17	-0.66	0.40	-0.32
IFAG	36 1798	-2.49	-3.02	-2.85	-2.52	-1.63	-0.75	-1.67	-0.59	-1.33	-1.19	-1.22	-1.67

Table 8A. (Cont.)

Lab.	Clock	53034	53064	53094	53124	53154	53184	53214	53244	53274	53309	53339	53369
IFAG	40 4401	34.43	26.61	48.59	73.51	37.51	13.62	27.15	-	-	-	-	-
IFAG	40 4403	15.95	23.65	75.93	201.72	-	-	-	-	-	-	-	-
IFAG	40 4418	26.24	27.56	29.65	30.99	32.39	32.75	29.97	30.94	31.16	35.95	30.24	0.67
IGMA	16 112	41.95	43.14	50.86	49.74	42.26	41.87	45.97	47.92	49.67	54.73	47.08	42.49
IGMA	35 674	-0.05	-0.10	-0.09	-0.35	-0.05	0.37	-0.10	0.76	1.26	0.77	1.60	0.71
IGMA	35 676	-4.85	-5.12	-4.85	-6.09	-5.43	-5.38	-5.03	-4.87	-4.68	-4.69	-5.02	-4.82
INPL	35 1652	-5.42	-6.02	-4.45	-4.19	-7.58	-7.25	-7.65	-9.16	-11.73	-11.77	-9.00	-6.89
JV	21 216	-	-	6.92	8.23	6.63	7.86	-	-	8.95	10.07	6.78	9.60
JV	21 387	-	16.68	-66.36	-34.49	-58.85	142.46	-	-	28.56	103.09	84.99	-20.34
JV	36 1277	-	-20.55	-19.57	-17.04	-19.60	-18.81	-	-	-18.80	-18.03	-	-18.48
JV	51 2040	-	49.53	48.17	41.27	45.64	34.74	-	-	40.47	-	-	-
KRIS	35 1693	-	-	-	-	-	-	-	-	-	9.37	10.43	10.13
KRIS	35 1783	-	-	-	-	-	-	-4.40	-6.17	-5.25	-5.70	-6.01	-5.71
KRIS	36 321	5.82	4.28	4.31	3.42	1.63	1.94	3.22	3.72	2.87	3.99	4.33	4.27
KRIS	36 739	-13.25	-15.51	-12.60	-11.45	-12.13	-13.69	-13.33	-13.97	-13.26	-10.70	-12.22	-11.96
KRIS	36 1135	35.08	36.00	32.00	30.21	30.53	29.87	33.24	33.89	32.26	32.56	32.78	30.64
KRIS	36 1783	-	-	-	-	-4.90	-3.60	-	-	-	-	-	-
KRIS	40 5623	37.79	38.17	38.58	38.99	38.80	39.51	39.88	40.62	41.27	40.59	39.86	40.11
KRIS	40 5624	-	-	-	-	-	-	79.11	82.66	86.78	97.52	91.04	100.94
LDS	35 289	7.36	5.33	6.20	-	4.34	5.77	6.21	5.47	5.32	7.67	6.10	6.19
LT	35 1362	-0.35	0.50	1.12	0.45	0.15	2.10	-0.60	1.26	2.56	1.12	2.79	2.17
MSL	12 933	9.36	14.73	5.46	6.32	9.70	16.34	10.77	4.04	-1.15	4.64	6.61	5.91
MSL	36 274	7.13	8.29	12.56	10.05	12.08	10.40	11.02	9.98	13.84	9.62	8.02	8.55
MSL	36 1025	-	-	-	-	-	-	-	-	-	111.01*	31.53	4.71
NAO	35 779	0.22	0.70	0.88	1.15	1.83	2.27	2.09	2.45	2.11	2.39	3.31	3.16
NAO	35 1206	11.38	12.00	13.18	12.87	13.26	13.84	13.33	13.39	-	-	20.77	18.19
NAO	35 1214	-7.11	-4.21	-1.10	0.26	0.78	1.71	0.91	1.93	1.30	1.42	1.60	1.71
NAO	35 1689	-1.63	-1.42	-0.30	-0.22	0.31	0.15	-0.20	0.00	0.12	0.15	-0.43	-0.22
NICT	35 112	0.03	0.76	1.14	1.49	0.30	1.11	0.27	0.44	1.42	1.23	1.01	0.69
NICT	35 144	-24.09	-24.32	-	-	-	-23.18	-23.95	-23.84	-23.98	-24.02	-19.85	-19.27

Table 8A. (Cont.)

Lab.	Clock	53034	53064	53094	53124	53154	53184	53214	53244	53274	53309	53339	53369
NICT	35 332	15.25	15.33	15.39	16.00	16.59	16.32	16.17	16.05	15.91	15.06	14.80	14.92
NICT	35 342	8.15	7.59	8.18	8.40	8.53	8.61	8.92	9.41	9.37	9.22	9.75	9.02
NICT	35 343	12.99	12.25	12.97	12.96	12.34	11.81	11.79	12.61	13.33	12.95	15.29	14.64
NICT	35 715	5.90	6.78	7.39	7.17	7.32	7.68	7.48	7.38	8.26	8.53	8.50	8.91
NICT	35 732	4.40	4.71	5.48	4.38	5.72	5.00	6.04	5.59	6.57	5.33	3.66	3.46
NICT	35 907	-10.69	-12.06	-12.57	-12.47	-13.59	-12.95	-12.16	-11.01	-11.28	-11.66	-10.52	-11.08
NICT	35 908	8.88	10.65	10.39	11.57	11.07	11.58	11.10	11.40	10.99	10.56	12.93	13.07
NICT	35 1778	9.67	10.53	9.98	10.73	10.92	11.38	11.28	11.17	11.69	11.33	11.86	11.82
NICT	35 1789	7.01	7.91	7.70	7.47	8.04	8.28	8.13	8.48	8.19	8.79	8.89	8.55
NICT	35 1790	-8.06	-8.03	-7.51	-7.03	-6.01	-5.87	-5.74	-5.42	-4.51	-4.95	-4.81	-4.64
NICT	35 1882	-	-	51.96	52.21	52.37	52.54	51.90	51.78	54.03	54.08	54.51	54.68
NICT	35 1887	-	-	23.96	24.47	24.02	24.02	24.07	23.74	23.93	23.25	25.25	24.93
NICT	35 1944	-	-	-	-	-	-	-	7.00	6.88	6.69	6.81	-
NIM	35 479	3.44	3.83	3.84	3.78	3.89	4.40	3.56	3.71	3.75	4.04	4.44	4.71
NIM	35 1238	2.89	3.00	3.42	3.39	3.84	3.93	2.49	3.15	3.43	3.38	4.63	3.63
NIM	35 1239	3.41	3.93	3.73	3.59	3.67	3.87	3.51	3.60	3.86	3.87	4.76	4.33
NIMB	35 600	0.69	1.16	-1.12	-0.44	-1.38	-	-	-	-	-	-	-
NIS	35 1126	-	-	-	-	-	4.91	5.31	5.64	0.88	29.24	-	-
NIST	15 9866	-44.39	-	-48.71	-49.53	-50.51	-50.53	-52.48	-51.92	-52.35	-53.83	-54.33	-54.11
NIST	35 132	-0.56	-0.52	-0.56	-0.75	-0.62	-0.74	-0.85	-1.06	-0.98	-1.46	-2.33	-1.65
NIST	35 182	-10.59	-10.25	-10.05	-10.60	-10.67	-10.42	-10.91	-10.49	-10.04	-10.61	-9.72	-9.61
NIST	35 408	-1.53	-1.64	-1.55	-1.63	-0.96	-0.96	-1.30	-1.51	-1.21	-2.12	-1.11	-1.91
NIST	35 1074	-18.95	-18.10	-17.80	-17.69	-17.26	-16.78	-16.45	-17.09	-15.79	-16.32	-16.19	-15.45
NIST	40 201	12.65	14.07	13.80	14.43	15.10	15.84	16.67	17.35	18.19	19.15	20.21	20.95
NIST	40 203	47.90	49.11	50.22	51.37	52.42	53.50	54.68	55.77	56.86	58.06	59.37	60.32
NIST	40 204	11.70	12.06	12.31	12.63	12.89	13.17	13.32	13.71	14.06	14.37	14.67	14.70
NIST	40 205	-25.01	-24.92	-24.97	-25.02	-25.12	-25.10	-25.14	-25.23	-25.37	-25.41	-25.40	-25.56
NIST	40 222	-9.11	-8.70	-8.33	-7.91	-7.57	-7.25	-6.84	-6.48	-6.11	-5.65	-5.07	-4.78
NMC	35 1501	-4.98	-2.95	-3.44	-2.84	-5.33	-5.53	-1.89	-3.65	-3.06	-3.17	-4.51	-2.91
NMIJ	35 224	0.34	0.76	0.42	0.43	0.52	-0.88	-4.49	-5.01	-2.02	-0.53	2.33	1.35

Table 8A. (Cont.)

Lab.	Clock	53034	53064	53094	53124	53154	53184	53214	53244	53274	53309	53339	53369
NMIJ	35 459	-0.64	-0.10	0.03	0.27	-0.54	0.12	-0.42	-0.28	-0.06	0.16	0.22	-0.40
NMIJ	35 1273	-9.63	-9.82	-9.78	-8.95	-9.16	-9.58	-9.37	-9.60	-9.37	-9.43	-9.61	-10.51
NMIJ	35 1466	9.93	10.05	8.89	9.04	9.07	9.18	7.68	8.56	7.61	7.87	7.71	9.34
NMIJ	40 5014	-1.17	-0.34	0.07	-0.11	-1.31	-0.20	0.03	0.31	0.63	0.61	1.13	1.42
NMLS	35 1659	0.83	0.10	1.85	-	-	-	-	-	-	-	-	-
NPL	35 784	3.74	4.62	4.79	4.62	-	-	-	-	-	-	-	-
NPL	35 1275	-0.71	-0.83	-0.73	-0.94	-0.94	-1.74	-1.07	-1.98	-1.77	-1.66	-2.38	-1.74
NPL	36 404	12.09	11.62	11.50	10.35	9.58	13.39	12.05	11.48	11.53	10.82	-	-
NPL	40 1701	-1.62*	-2.37*	-2.14*	-1.80*	-0.51*	-0.67*	-0.26	-0.26	-0.15	0.11	0.51	0.88
NPL	40 1708	4.63	4.81	4.90	5.13	5.02	5.49	5.49	5.70	5.84	5.69	5.78	6.20
NPLI	35 725	6.14	8.10	7.60	10.42	9.01	8.89	10.59	8.22	7.30	6.48	7.75	7.94
NRC	35 234	16.69	16.50	16.16	16.71	17.03	16.56	16.43	16.03	16.00	16.28	16.32	16.82
NRC	35 372	24.46	24.12	22.59	23.29	23.25	20.97	20.62	20.61	22.20	22.78	22.56	21.48
NRC	90 61	0.39	-0.85	-0.56	0.21	-0.53	-0.53	-0.38	-0.43	-0.13	0.05	-0.44	-0.38
NTSC	16 7408	-	-	-	-	-	-	-	-	-	-	159.90	-
NTSC	35 1007	12.78	11.86	12.78	16.44	16.69	16.94	17.17	16.45	16.66	18.01	17.57	18.35
NTSC	35 1011	-	-	-	-	1.36	1.95	3.92	3.16	3.97	3.96	4.58	2.93
NTSC	35 1016	-	-	-	-	14.67	14.53	14.49	14.10	14.19	13.99	13.76	14.07
NTSC	35 1017	-	-	-	-	-1.90	-1.46	-1.09	-1.36	0.70	-1.11	0.36	2.02
NTSC	35 1018	12.69	12.15	12.76	12.18	12.58	12.12	11.89	11.98	11.32	11.21	11.11	11.85
NTSC	35 1808	-	-	-	-	11.11	11.16	7.32	7.71	8.26	7.84	7.21	7.84
NTSC	35 1818	-23.92	-23.73	-25.35	-25.46	-26.00	-25.30	-26.14	-26.61	-	-	-	-
NTSC	35 1820	-	-8.25	-8.67	-9.29	-	-	-	-	-	-	-6.59	-6.70
NTSC	35 1823	1.24	1.15	0.80	1.60	1.80	1.76	2.61	2.39	1.71	2.20	2.54	2.34
NTSC	40 226	-	-	-	-	-	-	-	-	-	-	-75.41	-75.74
NTSC	40 227	-	-	-	-	-	-	-	-	-	-	-6.76	-1.20
OMH	36 849	-0.03	3.00	2.69	2.90	1.83	1.76	1.26	3.92	3.80	3.28	1.71	3.59
ONBA	12 1091	-	-	-	-	-	-	-	-	-	3.83	-1.92	-18.50
ONRJ	52 6184	-17.76	-18.99	-23.41	-32.39	-48.23	-53.76	42.22	34.78	46.83	41.73	24.57	-127.11
ORB	35 201	2.37	3.08	2.79	2.62	2.04	2.97	4.76	5.11	3.04	4.21	4.05	3.78

Table 8A. (Cont.)

Lab.	Clock	53034	53064	53094	53124	53154	53184	53214	53244	53274	53309	53339	53369
ORB	35 202	7.97	5.80	10.91	7.70	8.84	7.34	9.34	9.37	7.77	6.10	6.35	9.05
ORB	35 593	69.96	70.52	70.72	69.43	71.61	71.76	71.99	69.49	73.48	72.10	70.27	71.41
ORB	40 2601	-0.09	-0.16	-0.11	0.51	0.12	-0.41	-0.42	-0.32	-0.12	0.13	-0.10	0.53
PL	35 441	0.37	0.74	0.15	1.04	0.54	0.83	0.46	1.31	0.13	0.06	0.91	1.28
PL	35 502	0.49*	0.29*	0.21	0.55	0.79	0.63	0.30	0.63	0.23	-	-	-
PL	35 761	-0.87	-2.72	-2.53	-1.31	-1.30	-3.16	-2.44	-4.43	-5.50	-2.66	-2.98	-1.22
PL	35 1120	-1.66	-1.60	-1.40	-1.04	-0.66	-1.75	-0.83	-5.97	-	-	-	-
PL	35 1660	-0.23*	0.89*	-1.36	-0.18	-0.34	0.01	1.47	2.65	1.05	1.14	1.82	1.07
PL	35 1709	0.07	0.40	0.61	0.07	-0.26	0.32	-	-	-	-	-	-
PL	35 1746	-0.12	-0.10	0.45	-0.09	-0.40	-0.39	0.10	-0.06	-0.51	0.30	0.44	0.46
PL	35 1934	-	-	-	-	-	-1.76	-1.61	-1.38	-3.00	-1.70	-2.15	-1.18
PL	40 4002	8.67	6.60	8.39	10.57	8.37	7.57	9.51	11.17	14.66	16.58	20.01	24.21
PTB	35 128	-2.65	-3.11	-2.54	-2.71	-2.70	-3.00	-2.66	-3.38	-2.52	-3.27	-1.81	-2.83
PTB	35 415	2.82	3.89	4.66	4.49	3.26	3.64	2.51	2.89	2.55	3.10	2.08	2.24
PTB	35 1072	-	-	-	-	-	-	-	13.72	12.13	13.37	13.77	14.16
PTB	40 505	-4.46	-4.41	-4.19	-5.55	-2.32	-1.54	0.03	-0.06	1.33	0.63	1.06	-1.83
PTB	40 510	1.32*	1.85*	2.14*	3.42*	3.25*	3.12*	3.53*	3.19*	4.14*	5.44*	6.08*	0.39
PTB	40 590	-12.96*	-7.71*	-3.33	0.38	4.17	7.32	10.31	12.93	15.69	18.22	20.63	22.50
PTB	92 1	1.35	1.11	2.05	0.85	1.10	1.26	1.52	0.94	1.86	1.95	1.84	2.12
PTB	92 2	1.04	0.80	0.70	0.45	1.45	1.32	0.77	1.35	1.58	0.83	1.06	0.69
ROA	14 1569	35.81	34.71	34.82	28.34	34.19	48.49	56.17	54.10	51.30	45.24	37.69	36.13
ROA	35 583	-1.81*	-1.99*	-2.11*	-1.64*	-2.41*	-1.54*	-1.27*	-0.96*	-1.70*	-2.25*	-2.22	0.04
ROA	35 718	-12.19	-12.89	-11.81	-11.35	-11.61	-13.32	-12.80	-13.97	-12.93	-13.67	-12.88	-12.45
ROA	36 1488	6.02	8.55	7.52	8.23	7.64	7.23	8.49	6.21	6.05	7.72	10.48	9.59
ROA	36 1490	7.68	7.06	8.01	8.33	5.20	7.40	8.31	7.14	9.41	8.59	8.11	7.03
SCL	35 621	-1.28	-0.73	-0.78	-0.40	-0.55	-0.13	-0.85	-0.24	-0.68	-0.97	-1.54	-2.17
SCL	35 745	-3.98	-4.43	-4.01	-3.70	-3.25	-2.95	-2.65	-2.78	-2.43	-1.66	-1.93	-2.14
SG	35 1035	5.47	5.19	6.31	5.31	5.12	5.25	4.42	5.54	5.37	5.50	5.93	5.24
SG	35 1127	-0.07	-0.43	0.80	-0.05	0.56	1.39	0.33	1.36	0.37	0.86	1.00	0.85
SG	36 522	-6.89	-6.58	-7.99	-5.58	-5.88	-4.79	-4.57	-5.40	-6.87	-4.32	-6.06	-5.48

Table 8A. (Cont.)

Lab.	Clock	53034	53064	53094	53124	53154	53184	53214	53244	53274	53309	53339	53369
SMU	36 1063	-4.26	-4.54	-5.33	-5.43	-6.46	-5.95	-	-	-	-	-	-
SMU	36 1193	-	-	-	-	-	-	-	-2.51	-2.79	-1.72	1.39	1.55
SP	19 197	65.35	55.69	37.32	21.72	23.99	4.75	6.10	-36.14	-	-	-	-
SP	35 572	-	-	-	-	-	-	-	-	-	22.33	23.00	24.80
SP	35 641	7.99	7.45	7.80	7.93	8.57	7.92	7.87	8.02	7.52	7.46	7.76	8.00
SP	35 1188	-	-	-	-	-	24.58	25.92	26.93	27.62	27.66	27.80	28.31
SP	35 1642	15.09	15.32	14.58	14.75	15.21	15.19	15.72	15.22	14.25	15.57	14.47	15.32
SP	36 1175	-0.32	-0.36	-1.08	-2.35	-0.04	1.48	1.07	1.61	2.31	2.48	1.84	2.04
SP	40 7201	56.03	59.67	62.86	65.98	68.83	71.57	75.21	78.82	81.74	84.94	88.37	91.45
SP	40 7218	-37.78	-41.02	-43.64	-45.77	-48.02	-51.52	-52.30	-54.77	-57.97	-62.40	-66.12	-69.18
SU	40 3802	-3.16*	-2.64*	-2.22	-1.82	-1.39	-0.73	-0.40	-0.12	0.10	0.90	1.09	1.14
SU	40 3803	-32.16*	-32.01*	-32.94*	-33.14*	-33.56*	-33.50*	-34.18*	-34.24*	-37.00*	-36.81*	-37.05	-34.15
SU	40 3805	64.87	66.96	68.00	69.13	70.06	70.44	70.72	71.26	71.71	72.68	73.67	76.14
SU	40 3807	-5.71*	-5.40*	-5.29*	-5.01*	-4.95*	-4.38*	-2.77*	-2.34*	-1.62*	-1.57	-1.64	-0.38
SU	40 3810	57.25	57.33	57.56	57.88	57.85	58.22	58.10	58.22	58.02	58.47	58.51	59.30
SU	40 3822	-	-	-2.71*	-0.58*	1.24*	3.64*	5.68*	7.67*	9.34*	11.81	13.71	15.59
SU	40 3825	12.41*	13.65*	13.58*	13.38*	16.89*	16.59*	17.09*	16.47*	22.75*	24.77*	23.42	23.80
SU	40 3827	67.51	-	-	-	-	70.29*	70.60*	71.06*	71.55*	71.25	69.28	69.35
SU	40 3831	21.39*	22.10*	23.33*	24.69*	25.57*	27.23*	27.77*	28.39*	27.61	27.94	28.26	29.77
SU	40 3837	41.70	42.21	42.50	42.96	43.26	43.98	44.30	44.45	44.84	45.38	45.30	45.52
TCC	35 768	-12.82	-12.28	-9.68	-12.24	-9.56	-12.89	-12.85	-15.28	-13.45	-11.03	-10.91	-10.04
TCC	35 1028	-	-	-	-	-6.21	-5.79	-5.35	-5.55	-6.14	-7.58	-8.19	-4.97
TCC	35 1881	-6.81	-6.67	-6.38	-5.32	-3.71	-4.35	-4.23	-3.62	-2.21	-4.15	-3.75	-2.34
TCC	40 8620	21.59	21.72	22.46	22.27	23.57	23.45	24.06	23.58	23.97	22.22	22.66	24.06
TCC	40 8624	-	-	-18.38	-19.82	-20.79	-21.35	-21.58	-22.49	-22.36	-24.31	-23.79	-23.38
TL	35 160	-7.38	-7.94	-7.60	-6.18	-7.10	-6.32	-6.55	-7.03	-6.57	-7.59	-7.38	-8.41
TL	35 300	7.46	6.76	6.74	6.47	4.92	4.97	5.05	5.55	8.33	7.31	5.96	7.08
TL	35 474	22.26	22.64	22.16	22.64	22.01	22.35	22.14	22.47	22.09	22.26	21.54	20.07
TL	35 809	2.12	2.36	2.17	2.55	1.93	2.28	2.33	2.09	2.34	1.83	0.95	2.87
TL	35 1012	-	-	-	-	-	-	-	-	-	6.80	6.24	7.73

Table 8A. (Cont.)

Lab.	Clock	53034	53064	53094	53124	53154	53184	53214	53244	53274	53309	53339	53369
TL	35 1132	-3.57	-2.01	-4.17	-3.29	-4.43	-2.88	-3.01	-3.50	-3.00	-3.88	-2.13	1.73
TL	35 1498	13.64	14.49	14.30	13.71	14.52	14.69	14.27	13.76	15.18	14.53	14.08	14.13
TL	35 1712	0.47	0.36	1.03	1.19	0.38	1.05	0.53	1.47	0.31	0.85	1.19	1.15
TL	40 3052	-	-	-	-	13.03	14.95	16.35	17.93	19.66	21.27	22.84	23.90
TL	40 3053	-2.33	-2.40	-2.29	-2.22	-2.32	-1.74	-1.65	-1.65	-1.17	-0.95	-0.81	-0.68
TP	35 163	20.55	19.78	20.49	20.85	19.78	21.06	20.09	20.50	20.47	20.82	20.21	19.79
TP	35 326	-20.20	-20.17	-20.04	-19.92	-20.49	-20.31	-20.41	-20.36	-20.16	-20.22	-19.71	-20.57
TP	35 1227	4.06	4.47	3.40	4.16	3.50	3.07	4.39	4.60	3.28	4.05	4.61	3.97
TP	36 154	13.07	11.79	12.17	14.74	12.68	13.05	13.94	11.38	13.45	13.39	11.48	15.49
USNO	15 5561	-	-	-	-	-	-	35.31	34.14	34.81	33.90	32.61	32.81
USNO	15 5563	-	-	-	-	-	-	-0.75	-	-	-	-	-
USNO	15 5564	-	-	-	-	-	-	-13.24	-15.70	-15.86	-16.44	-17.61	-16.81
USNO	35 101	-2.80	-2.46	-4.47	-4.80	-4.31	-4.59	-4.59	-4.36	-4.59	-3.40	-3.75	-5.80
USNO	35 104	17.63	18.74	18.55	18.32	18.68	18.19	19.05	18.89	18.79	19.01	18.25	19.01
USNO	35 108	10.68	10.71	9.71	9.73	9.27	9.17	9.34	9.29	9.75	9.72	9.78	9.40
USNO	35 114	-	-	-	-	-	-	-	-	-125.56	-122.32	-118.52	-117.67
USNO	35 120	-0.57	-0.45	-	-	0.75	0.52	1.73	1.35	1.81	1.32	0.80	0.47
USNO	35 142	4.74	4.75	4.90	3.92	5.80	5.48	4.77	4.85	4.12	5.21	5.31	5.57
USNO	35 146	-2.42	-3.03	-1.17	-0.50	-0.89	-0.57	-0.64	-0.49	-0.41	-1.65	-0.31	0.78
USNO	35 148	11.88	13.02	12.31	12.66	12.42	11.60	-	-	16.74	16.78	16.63	16.78
USNO	35 150	6.73	8.19	7.90	9.00	8.45	7.81	8.91	8.00	7.88	7.85	7.16	9.18
USNO	35 152	11.49	-	-	-	8.86	4.75	2.92	2.65	1.28	1.55	1.12	1.25
USNO	35 153	13.11	12.17	11.31	11.81	12.93	12.16	12.07	11.91	11.73	-	-	-
USNO	35 156	18.17	17.18	17.04	17.55	-	-	-	-	14.50	13.73	13.75	12.49
USNO	35 161	-17.43	-17.78	-17.54	-18.89	-19.22	-19.18	-18.21	-19.52	-18.65	-	-	-
USNO	35 164	5.62	5.33	4.92	4.16	4.07	4.01	3.74	4.10	4.30	4.62	4.46	3.95
USNO	35 165	-0.24	-0.12	-0.41	0.51	-0.05	3.50	-	-	-	-	-	-
USNO	35 166	-2.43	-3.00	-1.74	-2.18	-1.74	-2.70	-2.38	-2.15	-1.32	-1.10	-2.42	-
USNO	35 167	4.53	4.62	4.98	4.87	4.89	5.39	4.81	5.26	5.17	5.19	5.22	5.01
USNO	35 169	-8.22	-8.21	-7.98	-8.31	-8.25	-9.48	-9.76	-9.42	-8.13	-8.00	-7.83	-8.22
USNO	35 173	-12.43	-12.11	-12.63	-12.23	-12.36	-12.12	-12.33	-12.22	-12.13	-11.07	-11.83	-11.82
USNO	35 213	6.09	7.05	7.75	7.91	7.59	8.13	7.54	-	-	-	-	-
USNO	35 217	-0.85	-0.35	-0.52	-1.11	-1.84	-0.26	-1.51	-0.27	-0.50	-1.11	-0.51	0.19
USNO	35 225	-1.55	-1.38	-1.18	-1.13	-1.52	-1.22	-1.04	-0.88	-0.63	-0.98	-1.43	-1.13
USNO	35 226	20.71	21.65	21.08	20.94	22.12	22.00	21.37	21.22	21.41	21.62	21.17	21.64

Table 8A. (Cont.)

Lab.	Clock		53034	53064	53094	53124	53154	53184	53214	53244	53274	53309	53339	53369
USNO	35	227	5.47	6.33	6.08	6.75	6.64	7.19	6.66	6.67	6.66	7.23	7.54	7.31
USNO	35	229	10.14	10.97	10.31	11.50	10.56	11.20	12.37	11.81	11.24	11.58	12.16	12.93
USNO	35	231	-8.54	-8.15	-8.46	-8.03	-9.36	-9.06	-7.21	-6.84	-5.78	-5.17	-6.24	-6.25
USNO	35	233	0.09	1.32	0.38	1.14	1.25	1.65	1.54	1.46	1.52	1.83	2.29	2.15
USNO	35	242	20.69	20.57	19.70	21.26	21.30	20.40	21.12	21.75	21.30	23.85	21.81	21.71
USNO	35	244	18.28	19.04	18.54	18.67	20.44	18.94	19.50	19.62	19.47	19.00	19.33	19.52
USNO	35	249	4.73	5.40	5.16	5.16	5.22	4.87	5.11	5.43	5.31	5.12	4.64	4.25
USNO	35	253	11.19	11.25	11.47	11.13	11.51	12.08	11.64	-	-	-	-	-
USNO	35	254	9.17	8.75	9.18	9.17	8.46	9.67	9.73	9.40	9.44	7.69	-	-
USNO	35	255	6.36	6.59	6.08	6.30	6.07	5.88	5.94	6.54	6.39	6.07	6.13	6.20
USNO	35	256	12.42	12.51	13.96	13.57	12.82	12.51	13.02	12.95	13.05	12.85	13.09	13.35
USNO	35	260	1.19	1.77	1.57	1.54	1.17	1.45	1.66	1.60	1.47	0.82	1.60	1.15
USNO	35	268	2.22	2.90	2.24	3.32	3.17	3.41	2.79	2.43	3.16	2.66	2.56	2.17
USNO	35	270	-10.94	-10.72	-11.18	-10.81	-11.54	-11.38	-10.64	-10.95	-10.81	-11.01	-10.84	-11.13
USNO	35	279	2.77	2.10	3.08	2.59	3.13	3.65	3.23	2.93	2.47	2.40	2.82	2.48
USNO	35	389	-24.31	-22.67	-23.67	-23.32	-22.39	-21.87	-22.07	-22.17	-21.69	-21.63	-21.31	-21.82
USNO	35	392	8.56	8.20	7.98	8.04	8.74	8.43	9.02	9.38	8.82	8.92	9.07	9.34
USNO	35	394	-	-	-	31.98	30.78	29.28	28.45	27.51	26.69	26.38	25.91	25.99
USNO	35	416	-24.34	-24.48	-24.32	-23.87	-24.38	-24.49	-24.18	-23.83	-24.36	-24.44	-25.08	-24.47
USNO	35	417	8.23	8.06	8.88	8.33	8.92	9.17	8.64	8.73	9.50	8.56	8.95	8.15
USNO	35	703	-6.80	-7.12	-6.31	-	-	-	-	-	-	-	-	-
USNO	35	717	-14.60	-13.48	-14.50	-14.20	-14.12	-14.26	-14.46	-14.88	-15.04	-14.48	-15.02	-14.86
USNO	35	762	-4.93	-4.48	-5.19	-4.15	-4.16	-4.40	-4.54	-3.53	-4.31	-4.18	-4.46	-4.04
USNO	35	763	-14.59	-14.66	-15.41	-14.94	-14.73	-15.40	-15.45	-15.44	-15.02	-14.74	-14.18	-15.50
USNO	35	765	-6.29	-5.98	-6.62	-5.91	-6.33	-5.22	-5.89	-5.37	-5.06	-5.72	-5.92	-5.77
USNO	35	1096	25.79	26.65	25.47	25.74	25.46	24.96	25.76	25.66	25.24	25.52	26.30	26.64
USNO	35	1097	8.45	10.79	9.68	9.90	9.21	9.91	9.94	10.44	8.75	8.60	8.96	-
USNO	35	1125	20.47	19.73	20.06	20.39	19.90	19.43	19.55	19.75	20.16	19.43	19.49	19.61
USNO	35	1327	9.01	8.60	8.17	7.98	8.04	8.42	8.34	8.86	7.47	8.68	8.95	6.97
USNO	35	1328	6.22	6.00	5.97	5.13	4.00	5.27	4.79	5.88	4.98	5.59	5.82	5.60
USNO	35	1331	-4.20	-3.29	-3.60	-3.81	-3.72	-3.89	-4.15	-3.05	-3.90	-3.28	-3.97	-3.97
USNO	35	1438	2.33	2.51	1.89	2.69	2.14	2.38	2.34	2.63	1.67	1.63	1.19	1.78
USNO	35	1459	-4.32	-4.14	-3.35	-3.72	-4.10	-3.93	-4.76	-4.04	-3.77	-3.82	-3.45	-4.25
USNO	35	1462	10.36	9.26	10.09	10.09	9.38	9.64	10.44	10.44	10.16	10.13	10.20	10.03
USNO	35	1463	10.46	10.52	10.16	9.98	10.58	10.47	11.14	10.81	10.71	10.28	8.98	9.79

Table 8A. (Cont.)

Lab.	Clock	53034	53064	53094	53124	53154	53184	53214	53244	53274	53309	53339	53369
USNO	35 1468	-0.63	-0.40	-0.06	-0.03	0.75	0.41	1.09	1.33	1.13	1.07	0.72	1.23
USNO	35 1481	6.66	6.95	6.34	6.57	6.69	5.85	6.31	6.37	5.70	5.73	5.51	6.21
USNO	35 1543	10.84	10.25	10.10	12.03	11.88	11.84	12.53	11.26	12.09	11.45	11.48	11.74
USNO	35 1573	3.62	3.99	4.25	3.10	3.87	3.85	3.46	3.05	3.07	3.16	3.26	1.93
USNO	35 1575	-2.46	-1.31	-0.44	-1.52	-0.97	-1.56	-1.64	-1.38	-1.81	-1.34	-1.77	-1.88
USNO	35 1655	-13.37	-13.63	-12.80	-12.47	-12.96	-12.19	-13.12	-12.63	-12.41	-12.54	-12.34	-12.53
USNO	35 1692	4.50	3.86	3.84	4.40	4.37	3.48	-	-	-	-	3.48	2.91
USNO	35 1694	-0.05	-0.69	-0.52	-0.89	-0.26	-0.22	-0.83	-0.56	-0.48	-0.71	-0.60	-0.95
USNO	35 1696	5.03	4.62	4.25	4.02	5.59	3.95	4.86	4.47	4.37	5.34	4.61	5.18
USNO	35 1697	0.53	1.24	0.73	1.09	1.10	0.91	1.74	0.86	1.57	1.98	1.73	1.00
USNO	35 1698	12.39	13.12	12.94	13.41	12.60	12.83	13.39	12.11	13.14	12.42	12.75	12.21
USNO	40 701	-22.93	-26.15	-26.49	-26.48	-25.83	-26.23	-26.33	-26.35	-26.28	-24.96	-24.93	-26.01
USNO	40 702	-9.43	-9.93	-9.86	-9.98	-10.49	-10.63	-10.43	-9.50	-8.91	-10.13	-10.01	-10.50
USNO	40 703	-107.87	-105.96	-	-	-	-	-	-	-	-	-	-
USNO	40 704	8.13	8.57	8.67	9.12	9.25	9.43	9.77	9.76	9.91	10.14	10.35	10.47
USNO	40 705	-44.19	-45.19	-45.12	-45.06	-45.16	-45.41	-45.42	-45.64	-46.05	-45.68	-45.87	-46.20
USNO	40 708	21.01	21.42	21.75	22.02	22.32	22.37	23.11	23.38	23.73	24.38	24.44	25.17
USNO	40 709	-16.62	-16.35	-16.50	-15.49	-13.08	-	-	-	-	-	-	-
USNO	40 710	44.35	45.06	45.44	46.28	46.85	47.50	48.29	48.77	49.11	49.67	50.10	50.67
USNO	40 711	156.55	158.43	160.19	162.05	163.84	165.60	167.50	169.26	171.01	173.02	175.08	176.84
USNO	40 712	-4.13	-	-	-	-	-	-	-	-	-	-131.74	-132.37
USNO	40 713	-2.35	-1.97	-1.78	-1.63	-1.29	-1.08	-0.94	-0.54	-	-	-2.97	-2.80
USNO	40 714	-38.56	-38.00	-37.73	-37.55	-37.09	-36.77	-36.48	-36.12	-	-	-34.89	-33.61
USNO	40 715	-12.14	-11.73	-14.28	-15.59	-16.31	-16.68	-16.23	-15.68	-15.07	-	-	-
USNO	40 716	205.32	205.61	205.61	205.64	205.70	205.75	205.75	205.90	206.09	207.46	205.98	206.00
USNO	40 718	119.64	118.64	117.57	117.57	117.62	117.58	117.77	117.85	117.93	118.12	118.30	118.39
USNO	40 719	-45.51	-44.36	-42.06	-40.44	-39.23	-38.23	-37.22	-36.42	-35.85	-35.13	-34.39	-33.78
USNO	40 720	-	-	-49.26	-48.79	-48.17	-47.48	-46.37	-45.42	-44.35	-43.09	-41.73	-40.57
VSL	35 179	8.21	8.37	7.57	7.62	7.48	8.28	8.27	8.64	9.27	10.50	8.95	8.21
VSL	35 456	17.57	17.51	16.99	16.63	16.59	17.18	17.82	17.43	17.56	16.36	17.01	15.88
VSL	35 548	11.41	11.48	12.51	13.00	13.36	12.45	12.40	12.37	12.05	12.95	12.44	12.52
VSL	35 731	17.64	17.99	19.01	18.94	18.67	18.80	18.97	19.28	19.68	19.66	20.25	19.05

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

Each line refers to the same clock working without interruption.

	clock nø	2003 corr. (ns/d)	2002 corr. (ns/d)	2001 corr. (ns/d)	2000 corr. (ns/d)
AUS	36 340				(1)
BEV	35 1793	-1.64 (2)			
CNM	35 1815	-2.16			
IGMA	16 112			-0.50	-0.50 (3)
LT	35 1362			+3.28 (4)	
NPL	40 1701	-1.00	-4.00	-5.00	-5.80 (5)
ORB	40 2601		-1.73	-6.03 (6)	
PL	35 441		+2.16		
PL	35 0502	+2.76			
PL	35 761				-4.32 (7)
PL	35 1120		+1.64	+1.64	+9.25 (8)
PL	35 1660	+0.52	+1.10	+0.08 (9)	
PL	35 1746		+4.40		
PTB	40 510	-0.61	-3.11		
ROA	35 583		-1.64		
SU	40 3802	-17.30	-17.30	-43.30 (10)	
SU	40 3803	-0.80	-7.30 (11)		
SU	40 3807	-89.00			
SU	40 3810		-3.00	-1.00 (12)	
SU	40 3825	-66.30	-66.30 (13)		
SU	40 3831	-0.60	-0.60		

(1) A correction of +3.28 ns/d has to be applied in 1999.
(2) A correction of -1.64 ns/d has to be applied for the last 7 months of 2003.
(3) A correction of -0.50 ns/d has to be applied for the last 5 two-month intervals of 1996, in 1997, 1998 and 1999.
(4) A correction of +3.28 ns/d has to be applied for the last 5 months of 2001.
(5) A correction of -7.60 ns/d has to be applied in 1999, a correction of -9.20 ns/d has to be applied in 1998, a correction of -12.00 ns/d has to be applied in 1997, a correction of -13.2 ns/d has to be applied in 1996, a correction of -9.55 ns/d has to be applied in 1995, 1994, 1993 and 1992, and a correction of +17.45 ns/d has to be applied in 1991.
(6) A correction of -6.03 ns/d has to be applied for the last four months of 2001.
(7) A correction of -4.32 ns/d has to be applied for the last two months of 2000.
(8) A correction of +9.25 ns/d has to be applied in 1999.
(9) A correction of +0.08 ns/d has to be applied for the last four months of 2001.
(10) A correction of -43.30 ns/d has to be applied for the last four months of 2001.
(11) A correction of -7.30 ns/d has to be applied for the last month of 2002.
(12) A correction of -1.00 ns/d has to be applied for the last four months of 2001.
(13) A correction of -66.30 ns/d has to be applied for the last six months of 2002.

Table 9A. Relative weights (in percent) of contributing clocks in 2004

(File available on http://www.bipm.org under the name WTAI04.AR)

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

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

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

Lab.	Clock		53034	53064	53094	53124	53154	53184	53214	53244	53274	53309	53339	53369
APL	35	904	0.000	-	0.000	0.000	0.000	0.000	0.064	0.094	0.095	-	-	0.000
APL	35	1264	0.000	0.000	0.000	0.000	0.084	0.108	0.139	0.179	0.196	-	-	0.000
APL	35	1791	0.000	0.000	0.000	0.000	0.066	-	-	-	-	-	-	0.000
APL	40	3107	0.000	0.000	0.000	0.000	0.019	0.017	0.016	0.016	0.017	-	-	0.000
APL	40	3108	-	-	-	-	-	-	-	-	0.000	-	-	0.000
AUS	36	249	-	0.000	0.000	0.000	0.000	0.011	0.012	0.016	0.020	0.024	0.028	0.035
AUS	36	299	0.331	0.328	0.352	0.229	0.201	0.234	0.213	0.240	0.282	0.344	0.348	0.399
AUS	36	340	0.266	0.238	0.192	0.188	0.289	0.288	0.329	0.314	0.203	0.175	0.171	0.179
AUS	36	654	0.292	0.367	0.300	0.382	0.315	0.316	0.235	0.221	0.241	0.196	0.353	0.417
AUS	36	1035	-	0.000	0.000	0.000	0.000	0.015	0.021	0.024	0.023	0.028	0.033	0.038

Table 9A. (Cont.)

Lab.	Clock	53034	53064	53094	53124	53154	53184	53214	53244	53274	53309	53339	53369
AUS	40 5401	0.000	-	0.000	0.000	-	-	-	0.000	-	-	0.000	0.000
AUS	40 5402	0.002	-	-	0.000	0.000	0.000	0.000	0.038	-	-	0.000	0.000
AUS	40 5403	-	0.000	0.000	0.000	0.000	0.008	0.009	0.008	0.006	0.003	0.002	0.003
AUS	99 1	-	0.000	0.000	0.000	0.000	0.000	-	-	-	0.000	0.000	0.000
BEV	16 71	0.000	0.000	-	-	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
BEV	35 1065	0.023	0.032	0.041	0.051	0.068	0.085	0.098	0.108	0.193	0.193	0.276	0.241
BEV	35 1793	0.388	0.340	0.307	0.318	0.367	0.298	0.281	0.486	0.489	0.417	0.538	0.854
CAO	35 939	0.024	0.028	0.029	0.033	0.038	0.040	0.038	0.040	0.045	0.064	0.129	0.130
CAO	35 1270	0.046	0.053	0.064	0.071	0.088	0.119	0.139	0.264	0.355	0.539	0.646	0.984
CH	21 194	0.004	0.005	0.005	0.006	-	-	-	-	-	-	-	-
CH	35 771	1.064	0.973	0.821	0.000	0.365	0.424	0.404	0.426	0.434	0.508	0.653	0.820
CH	36 354	0.095	0.108	0.167	0.187	0.171	0.174	0.178	0.172	0.236	0.209	0.399	0.461
CH	36 413	-	0.000	0.000	0.000	0.000	0.188	0.072	0.075	0.091	0.100	0.128	-
CH	40 5701	0.007	0.006	0.006	0.005	0.005	0.004	0.004	0.004	0.004	0.004	0.004	0.004
CNM	35 1705	0.356	0.357	0.336	0.331	0.346	0.415	0.455	0.450	0.594	0.896	0.984	0.984
CNM	35 1815	0.361	0.442	0.386	0.387	0.323	0.319	0.279	0.245	0.225	0.319	0.502	0.446
CNM	36 1537	0.127	0.128	0.131	0.120	0.129	0.132	0.114	0.108	0.111	0.127	0.125	0.204
CNM	40 7301	0.001	0.002	0.001	0.002	0.002	0.002	0.003	0.005	0.009	0.000	0.003	0.003
CNMP	36 1752	0.000	0.000	0.054	0.081	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
DLR	35 1714	1.064	1.087	1.059	1.025	1.004	0.000	-	-	-	-	0.000	0.000
DTAG	36 136	0.007	0.004	0.003	0.002	0.002	0.002	0.002	0.002	0.003	0.003	0.003	0.005
DTAG	36 345	0.007	0.006	0.006	0.006	0.007	0.008	0.010	0.016	0.168	0.169	0.283	0.249
DTAG	36 465	0.156	0.159	0.498	0.546	0.597	0.560	0.505	0.668	0.000	0.241	0.206	0.228
F	35 122	0.695	0.696	0.783	0.861	0.814	0.980	0.828	0.605	0.696	0.610	0.643	0.417
F	35 124	0.351	0.368	0.378	0.366	0.407	0.493	0.509	0.581	0.977	0.977	0.711	0.764
F	35 131	1.064	1.087	1.059	1.025	1.004	0.980	0.943	0.984	0.977	0.977	0.984	0.984
F	35 158	1.064	0.944	0.889	0.992	0.851	0.716	0.532	0.632	0.768	0.624	0.947	0.000
F	35 172	1.064	1.087	1.059	1.025	0.000	0.437	0.386	0.394	0.553	0.340	0.286	0.370
F	35 198	1.064	0.898	0.708	0.390	0.323	0.191	0.140	0.114	0.089	0.097	0.092	0.090
F	35 385	-	-	-	-	-	-	0.000	0.000	0.000	0.000	0.045	0.054

Table 9A. (Cont.)

Lab.	Clock		53034	53064	53094	53124	53154	53184	53214	53244	53274	53309	53339	53369
F	35	396	0.266	0.221	0.244	0.364	0.368	0.384	0.412	0.395	0.488	0.618	-	-
F	35	489	-	-	0.000	0.000	-	-	-	-	-	-	-	-
F	35	520	-	-	0.000	0.000	0.000	0.000	0.079	0.111	0.143	0.183	0.147	0.124
F	35	536	1.064	0.881	0.809	0.690	0.663	0.870	0.648	0.529	0.498	0.415	0.488	0.660
F	35	609	0.000	0.000	0.000	0.165	0.248	0.124	0.156	0.141	0.167	0.117	0.109	0.118
F	35	770	0.623	1.087	1.059	1.025	1.004	0.980	0.979	0.976	0.977	0.977	0.984	0.000
F	35	774	-	-	0.000	0.000	0.000	0.000	0.432	0.492	0.710	0.883	0.531	0.000
F	35	781	1.064	1.087	1.059	1.025	1.004	0.980	0.980	0.984	-	-	-	-
F	35	819	0.251	-	-	0.000	0.000	-	-	0.000	0.000	0.000	0.000	0.101
F	35	1029	-	-	0.000	0.000	0.000	0.000	-	-	0.000	0.000	0.000	0.000
F	35	1177	0.298	0.347	0.403	0.399	0.488	0.492	0.555	0.810	-	-	-	0.000
F	35	1178	1.064	0.000	0.578	0.681	0.865	0.924	0.909	0.859	-	-	-	0.000
F	35	1222	0.349	0.332	0.389	0.391	0.431	0.604	0.577	0.605	0.000	0.407	0.373	0.406
F	35	1321	0.227	0.302	0.123	0.116	0.131	0.162	0.181	0.171	0.146	0.136	0.156	0.191
F	35	1556	0.059	0.064	0.069	0.076	0.081	0.082	0.078	0.095	0.095	0.094	0.077	0.082
F	35	2027	-	-	-	-	-	0.000	0.000	0.000	0.000	0.977	0.984	0.879
F	40	805	0.008	0.010	0.012	0.015	0.022	0.027	0.025	0.022	0.017	0.013	0.013	0.013
F	40	816	-	-	0.000	0.000	0.000	0.000	0.030	0.040	0.052	0.065	-	-
HKO	35	1893	-	-	-	-	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
IEN	35	219	0.892	0.851	0.831	0.513	0.409	0.350	0.268	0.208	0.176	0.171	0.241	0.294
IEN	35	505	0.254	0.239	0.261	0.250	0.218	0.178	0.164	0.147	0.123	0.106	0.123	0.148
IEN	35	1115	-	0.000	0.000	0.000	0.000	0.045	0.041	0.056	0.077	0.095	0.105	0.121
IEN	35	1373	0.026	0.026	0.025	0.027	0.028	0.028	0.253	0.201	0.202	0.184	0.165	0.193
IEN	40	1101	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-	-
IEN	40	1102	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.021	0.024	0.022	0.020	0.072
IFAG	36	1167	0.060	0.052	0.051	0.052	0.055	0.038	0.035	0.026	0.022	0.021	0.023	0.026
IFAG	36	1173	-	-	-	-	-	0.000	0.000	0.000	0.000	0.026	0.019	0.018
IFAG	36	1629	0.172	0.158	0.167	0.168	0.179	0.150	0.146	0.127	0.113	0.110	0.113	0.119
IFAG	36	1732	1.064	1.087	1.059	1.025	0.918	0.603	0.459	0.415	0.345	0.327	0.252	0.265
IFAG	36	1798	0.597	0.515	0.500	0.544	0.541	0.386	0.471	0.308	0.305	0.285	0.280	0.364

Table 9A. (Cont.)

Lab.		Clock	53034	53064	53094	53124	53154	53184	53214	53244	53274	53309	53339	53369
IFAG	40	4401	0.000	0.001	0.001	0.000	0.000	0.000	0.001	-	-	-	-	-
IFAG	40	4403	0.000	0.000	0.000	0.000	-	-	-	-	-	-	-	-
IFAG	40	4418	0.001	0.002	0.002	0.002	0.002	0.003	0.003	0.005	0.008	0.010	0.018	0.000
IGMA	16	112	0.007	0.007	0.006	0.005	0.006	0.006	0.006	0.010	0.010	0.007	0.008	0.010
IGMA	35	674	1.064	1.087	1.059	1.025	1.004	0.980	0.980	0.984	0.977	0.977	0.613	0.636
IGMA	35	676	0.769	0.746	0.809	0.773	0.853	0.834	0.852	0.907	0.937	0.902	0.984	0.984
INPL	35	1652	0.045	0.061	0.069	0.078	0.078	0.083	0.079	0.054	0.031	0.022	0.023	0.027
JV	21	216	-	-	0.000	0.000	0.000	0.000	-	-	0.000	0.000	0.000	0.000
JV	21	387	-	0.000	0.000	0.000	0.000	0.000	-	-	0.000	0.000	0.000	0.000
JV	36	1277	-	0.000	0.000	0.000	0.000	0.046	-	-	0.000	0.000	-	0.000
JV	51	2040	-	0.000	0.000	0.000	0.000	0.002	-	-	0.000	-	-	-
KRIS	35	1693	-	-	-	-	-	-	-	-	-	0.000	0.000	0.000
KRIS	35	1783	-	-	-	-	-	-	0.000	0.000	0.073	0.092	0.108	0.142
KRIS	36	321	0.257	0.286	0.270	0.210	0.000	0.088	0.084	0.091	0.090	0.094	0.123	0.128
KRIS	36	739	0.243	0.164	0.171	0.137	0.136	0.140	0.143	0.131	0.153	0.110	0.110	0.116
KRIS	36	1135	0.051	0.051	0.057	0.043	0.038	0.032	0.031	0.033	0.033	0.037	0.047	0.046
KRIS	36	1783	-	-	-	-	0.000	0.000	-	-	-	-	-	-
KRIS	40	5623	0.116	0.109	0.108	0.119	0.143	0.143	0.141	0.128	0.109	0.125	0.153	0.202
KRIS	40	5624	-	-	-	-	-	-	0.000	0.000	0.000	0.000	0.001	0.001
LDS	35	289	0.152	0.158	0.152	-	0.000	0.000	0.000	0.000	0.170	0.075	0.105	0.145
LT	35	1362	0.124	0.142	0.151	0.153	0.175	0.170	0.119	0.125	0.134	0.195	0.156	0.164
MSL	12	933	0.001	0.003	0.009	0.009	0.011	0.008	0.008	0.008	0.006	0.006	0.006	0.008
MSL	36	274	0.177	0.134	0.000	0.036	0.030	0.029	0.025	0.026	0.022	0.028	0.032	0.046
MSL	36	1025	-	-	-	-	-	-	-	-	-	0.000	0.000	0.000
NAO	35	779	0.000	0.000	0.090	0.135	0.186	0.210	0.242	0.264	0.325	0.358	0.298	0.253
NAO	35	1206	0.000	0.000	0.014	0.020	0.030	0.040	0.048	0.058	-	-	0.000	0.000
NAO	35	1214	0.000	0.000	0.011	0.009	0.009	0.009	0.010	0.011	0.013	0.014	0.016	0.025
NAO	35	1689	0.000	0.000	0.091	0.131	0.163	0.206	0.249	0.303	0.374	0.431	0.469	0.639
NICT	35	112	0.489	0.491	0.429	0.383	0.525	0.623	0.572	0.538	0.518	0.702	0.717	0.842
NICT	35	144	0.000	0.000	-	-	-	0.000	0.000	0.000	0.000	0.476	0.000	0.024

Table 9A. (Cont.)

Lab.	Clock		53034	53064	53094	53124	53154	53184	53214	53244	53274	53309	53339	53369
NICT	35	332	0.477	0.490	0.573	0.656	0.525	0.710	0.766	0.847	0.977	0.805	0.536	0.482
NICT	35	342	1.064	0.997	1.059	1.025	1.004	0.980	0.980	0.965	0.915	0.894	0.647	0.677
NICT	35	343	0.315	0.249	0.265	0.326	0.309	0.242	0.191	0.387	0.396	0.531	0.000	0.176
NICT	35	715	0.450	0.391	0.249	0.214	0.192	0.199	0.191	0.249	0.228	0.228	0.331	0.336
NICT	35	732	0.168	0.187	0.170	0.213	0.231	0.250	0.485	0.447	0.376	0.472	0.289	0.206
NICT	35	907	0.000	0.000	0.000	0.017	0.021	0.026	0.033	0.041	0.053	0.063	0.074	0.210
NICT	35	908	0.000	0.028	0.025	0.022	0.024	0.025	0.023	0.024	0.030	0.045	0.065	0.170
NICT	35	1778	1.064	1.067	1.059	0.959	0.921	0.584	0.514	0.541	0.532	0.582	0.509	0.541
NICT	35	1789	0.000	0.557	0.523	0.529	0.701	0.793	0.748	0.820	0.977	0.977	0.942	0.947
NICT	35	1790	0.588	0.776	1.059	1.025	0.000	0.319	0.222	0.177	0.130	0.118	0.111	0.130
NICT	35	1882	-	-	0.000	0.000	0.000	0.000	0.923	0.732	0.000	0.145	0.124	0.121
NICT	35	1887	-	-	0.000	0.000	0.000	0.000	0.980	0.967	0.977	0.677	0.415	0.449
NICT	35	1944	-	-	-	-	-	-	-	0.000	0.000	0.000	0.000	-
NIM	35	479	0.113	0.115	0.118	0.123	0.137	0.140	0.137	0.139	0.152	0.148	0.984	0.984
NIM	35	1238	1.064	0.940	0.887	0.860	0.948	0.980	0.533	0.491	0.557	0.538	0.542	0.652
NIM	35	1239	0.627	0.642	0.731	0.676	0.716	0.702	0.643	0.608	0.672	0.736	0.812	0.984
NIMB	35	600	0.002	0.002	0.003	0.004	0.005	-	-	-	-	-	-	-
NIS	35	1126	-	-	-	-	-	0.000	0.000	0.000	0.000	0.000	-	-
NIST	15	9866	0.001	-	0.000	0.000	0.000	0.000	0.032	0.037	0.042	0.035	0.033	0.036
NIST	35	132	1.004	0.989	1.006	1.025	1.004	0.980	0.980	0.984	0.977	0.977	0.000	0.430
NIST	35	182	0.967	0.846	0.693	0.749	1.004	0.980	0.980	0.984	0.977	0.977	0.984	0.984
NIST	35	408	1.064	1.087	1.059	1.025	1.004	0.980	0.980	0.984	0.977	0.977	0.984	0.984
NIST	35	1074	0.015	0.018	0.022	0.026	0.032	0.036	0.037	0.041	0.107	0.167	0.221	0.221
NIST	40	201	0.106	0.166	0.228	0.216	0.160	0.105	0.067	0.050	0.042	0.035	0.030	0.028
NIST	40	203	0.012	0.012	0.012	0.012	0.012	0.012	0.011	0.011	0.011	0.011	0.011	0.012
NIST	40	204	0.269	0.265	0.247	0.233	0.237	0.226	0.214	0.214	0.210	0.208	0.200	0.223
NIST	40	205	0.696	0.739	0.795	0.849	1.004	0.980	0.980	0.984	0.977	0.977	0.984	0.984
NIST	40	222	0.370	0.334	0.287	0.247	0.222	0.194	0.162	0.142	0.132	0.122	0.109	0.108
NMC	35	1501	0.095	0.104	0.124	0.126	0.101	0.080	0.073	0.073	0.090	0.144	0.141	0.146
NMIJ	35	224	0.131	0.135	0.136	0.203	0.370	0.000	0.000	0.000	0.037	0.037	0.034	0.034

Table 9A. (Cont.)

Lab.	Clock		53034	53064	53094	53124	53154	53184	53214	53244	53274	53309	53339	53369
NMIJ	35	459	1.064	1.087	1.059	1.025	1.004	0.980	0.980	0.984	0.977	0.977	0.984	0.984
NMIJ	35	1273	1.064	1.087	1.059	1.025	1.004	0.980	0.980	0.984	0.977	0.977	0.984	0.984
NMIJ	35	1466	0.656	0.801	0.000	0.310	0.328	0.342	0.000	0.204	0.165	0.159	0.159	0.195
NMIJ	40	5014	0.204	0.269	0.322	0.405	0.392	0.473	0.474	0.521	0.504	0.431	0.331	0.347
NMLS	35	1659	0.015	0.016	0.019	-	-	-	-	-	-	-	-	-
NPL	35	784	0.489	0.480	0.560	0.691	-	-	-	-	-	-	-	-
NPL	35	1275	0.246	0.223	0.238	0.212	0.257	0.244	0.414	0.304	0.305	0.432	0.375	0.394
NPL	36	404	0.113	0.123	0.140	0.125	0.111	0.099	0.098	0.106	0.110	0.109	-	-
NPL	40	1701	0.646	0.769	0.901	0.996	1.002	0.980	0.980	0.984	0.977	0.977	0.865	0.590
NPL	40	1708	0.250	0.254	0.465	0.803	0.810	0.632	0.547	0.488	0.458	0.480	0.548	0.984
NPLI	35	725	0.000	0.000	0.000	0.000	0.032	0.048	0.045	0.058	0.067	0.065	0.079	0.098
NRC	35	234	0.716	0.714	0.665	0.711	1.004	0.980	0.980	0.984	0.977	0.977	0.984	0.984
NRC	35	372	0.122	0.115	0.115	0.116	0.139	0.109	0.094	0.076	0.077	0.076	0.088	0.094
NRC	90	61	1.064	1.087	0.871	0.947	0.822	0.703	0.672	0.600	0.702	0.716	0.826	0.984
NTSC	16	7408	-	-	-	-	-	-	-	-	-	-	0.000	-
NTSC	35	1007	0.000	0.000	0.000	0.000	0.015	0.018	0.020	0.024	0.031	0.032	0.037	0.041
NTSC	35	1011	-	-	-	-	0.000	0.000	0.000	0.000	0.059	0.073	0.079	0.108
NTSC	35	1016	-	-	-	-	0.000	0.000	0.000	0.000	0.747	0.743	0.666	0.888
NTSC	35	1017	-	-	-	-	0.000	0.000	0.000	0.000	0.000	0.115	0.115	0.069
NTSC	35	1018	0.765	0.613	0.598	0.582	0.685	0.980	0.873	0.884	0.530	0.411	0.328	0.410
NTSC	35	1808	-	-	-	-	0.000	0.000	0.000	0.000	0.019	0.026	0.032	0.043
NTSC	35	1818	0.282	0.413	0.162	0.130	0.112	0.125	0.110	0.097	-	-	-	-
NTSC	35	1820	-	0.000	0.000	0.000	-	-	-	-	-	-	0.000	0.000
NTSC	35	1823	0.128	0.151	0.156	0.208	0.286	0.359	0.368	0.420	0.661	0.808	0.733	0.780
NTSC	40	226	-	-	-	-	-	-	-	-	-	-	0.000	0.000
NTSC	40	227	-	-	-	-	-	-	-	-	-	-	0.000	0.000
OMH	36	849	0.014	0.019	0.025	0.032	0.041	0.048	0.050	0.128	0.145	0.138	0.134	0.142
ONBA	12	1091	-	-	-	-	-	-	-	-	-	0.000	0.000	0.000
ONRJ	52	6184	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
ORB	35	201	0.134	0.147	0.144	0.149	0.201	0.204	0.160	0.137	0.141	0.162	0.213	0.233

Table 9A. (Cont.)

Lab.	Clock	53034	53064	53094	53124	53154	53184	53214	53244	53274	53309	53339	53369
ORB	35 202	0.059	0.053	0.044	0.054	0.057	0.058	0.054	0.053	0.054	0.064	0.063	0.076
ORB	35 593	0.052	0.045	0.065	0.097	0.080	0.069	0.067	0.104	0.089	0.084	0.096	0.134
ORB	40 2601	0.223	0.216	0.228	0.312	0.926	0.847	0.848	0.790	0.977	0.977	0.984	0.984
PL	35 441	0.018	0.018	0.017	0.018	0.019	0.019	0.017	0.018	0.018	0.017	0.018	0.984
PL	35 502	1.064	1.087	1.059	1.025	1.004	0.980	0.980	0.984	0.977	-	-	-
PL	35 761	0.133	0.133	0.127	0.131	0.194	0.160	0.184	0.113	0.078	0.089	0.090	0.088
PL	35 1120	0.141	0.156	0.250	0.516	0.853	0.760	0.779	0.000	-	-	-	-
PL	35 1660	0.182	0.186	0.158	0.169	0.212	0.211	0.184	0.145	0.179	0.180	0.164	0.174
PL	35 1709	0.688	0.715	0.679	0.821	0.917	0.980	-	-	-	-	-	-
PL	35 1746	0.914	1.087	0.936	1.025	1.004	0.980	0.980	0.984	0.977	0.977	0.984	0.984
PL	35 1934	-	-	-	-	-	0.000	0.000	0.000	0.000	0.169	0.248	0.287
PL	40 4002	0.000	0.000	0.000	0.021	0.034	0.047	0.053	0.046	0.000	0.015	0.000	0.000
PTB	35 128	1.064	1.040	0.993	0.904	0.897	0.775	0.692	0.471	0.657	0.627	0.732	0.958
PTB	35 415	0.533	0.564	0.397	0.344	0.361	0.371	0.405	0.362	0.309	0.294	0.230	0.211
PTB	35 1072	-	-	-	-	-	-	-	0.000	0.000	0.000	0.000	0.124
PTB	40 505	0.007	0.006	0.006	0.005	0.006	0.006	0.006	0.006	0.007	0.008	0.011	0.034
PTB	40 510	0.006	0.005	0.004	0.004	0.004	0.004	0.004	0.004	0.005	0.008	0.108	0.075
PTB	40 590	0.000	0.000	0.000	0.000	0.002	0.002	0.001	0.001	0.001	0.001	0.001	0.001
PTB	92 1	0.725	0.808	0.929	0.809	0.910	0.892	0.873	0.766	0.843	0.977	0.984	0.984
PTB	92 2	1.064	1.087	1.059	1.025	1.004	0.980	0.980	0.984	0.977	0.977	0.984	0.984
ROA	14 1569	0.002	0.002	0.002	0.001	0.001	0.001	0.001	0.002	0.002	0.002	0.002	0.002
ROA	35 583	1.064	1.087	1.059	1.025	1.004	0.980	0.980	0.984	0.977	0.977	0.967	0.000
ROA	35 718	0.380	0.343	0.465	0.425	0.532	0.424	0.436	0.251	0.246	0.211	0.216	0.227
ROA	36 1488	0.183	0.155	0.155	0.145	0.152	0.172	0.150	0.213	0.208	0.207	0.000	0.099
ROA	36 1490	0.338	0.409	0.533	0.576	0.000	0.248	0.224	0.223	0.166	0.154	0.173	0.171
SCL	35 621	0.441	0.394	0.348	0.341	0.360	0.468	0.511	0.984	0.977	0.977	0.953	0.000
SCL	35 745	0.136	0.121	0.115	0.143	0.142	0.134	0.140	0.162	0.208	0.177	0.225	0.301
SG	35 1035	0.283	0.406	0.320	0.415	0.528	0.633	0.460	0.542	0.558	0.586	0.725	0.747
SG	35 1127	0.322	0.333	0.354	0.443	0.588	0.497	0.564	0.551	0.627	0.704	0.692	0.717
SG	36 522	0.000	0.000	0.000	0.056	0.074	0.068	0.065	0.079	0.097	0.095	0.116	0.178

Table 9A. (Cont.)

Lab.	Clock	53034	53064	53094	53124	53154	53184	53214	53244	53274	53309	53339	53369
SMU	36 1063	0.307	0.349	0.538	0.721	0.431	0.366	-	-	-	-	-	-
SMU	36 1193	-	-	-	-	-	-	-	0.000	0.000	0.000	0.000	0.017
SP	19 197	0.004	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-	-	-	-
SP	35 572	-	-	-	-	-	-	-	-	-	0.000	0.000	0.000
SP	35 641	0.266	0.386	0.513	0.664	0.602	0.756	0.867	0.984	0.977	0.977	0.984	0.984
SP	35 1188	-	-	-	-	-	0.000	0.000	0.000	0.000	0.044	0.057	0.066
SP	35 1642	0.318	0.449	0.484	0.586	0.801	0.980	0.980	0.984	0.977	0.977	0.811	0.844
SP	36 1175	0.032	0.032	0.030	0.028	0.051	0.166	0.166	0.127	0.095	0.076	0.078	0.089
SP	40 7201	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
SP	40 7218	0.002	0.001	0.001	0.001	0.001	0.001	0.002	0.002	0.002	0.002	0.002	0.002
SU	40 3802	0.075	0.073	0.072	0.068	0.074	0.072	0.068	0.069	0.076	0.076	0.081	0.098
SU	40 3803	0.068	0.085	0.094	0.107	0.128	0.152	0.149	0.151	0.111	0.085	0.076	0.095
SU	40 3805	0.071	0.000	0.033	0.024	0.019	0.017	0.015	0.015	0.017	0.019	0.021	0.021
SU	40 3807	0.209	0.340	0.473	0.363	0.350	0.307	0.235	0.174	0.139	0.125	0.127	0.109
SU	40 3810	0.040	0.076	0.166	0.279	0.325	0.360	0.857	0.984	0.977	0.977	0.984	0.000
SU	40 3822	-	-	0.000	0.000	0.000	0.000	0.007	0.006	0.005	0.005	0.004	0.004
SU	40 3825	0.010	0.009	0.011	0.012	0.015	0.018	0.021	0.024	0.020	0.015	0.015	0.016
SU	40 3827	0.344	-	-	-	-	0.000	0.000	0.000	0.000	0.322	0.132	0.131
SU	40 3831	0.029	0.029	0.026	0.023	0.023	0.021	0.019	0.017	0.019	0.021	0.027	0.032
SU	40 3837	0.088	0.086	0.087	0.084	0.089	0.089	0.082	0.098	0.103	0.100	0.108	0.127
TCC	35 768	0.000	0.000	0.000	0.030	0.038	0.041	0.044	0.031	0.037	0.044	0.052	0.059
TCC	35 1028	-	-	-	-	0.000	0.000	0.000	0.000	0.603	0.000	0.084	0.095
TCC	35 1881	0.000	0.000	0.000	0.163	0.072	0.085	0.093	0.094	0.074	0.087	0.102	0.088
TCC	40 8620	0.012	0.015	0.018	0.022	0.028	0.034	0.040	0.050	0.111	0.144	0.246	0.260
TCC	40 8624	-	-	0.000	0.000	0.000	0.000	0.037	0.035	0.041	0.032	0.034	0.040
TL	35 160	0.215	0.380	0.350	0.248	0.253	0.224	0.368	0.400	0.530	0.482	0.551	0.394
TL	35 300	0.111	0.096	0.103	0.107	0.090	0.087	0.082	0.085	0.090	0.122	0.133	0.144
TL	35 474	0.961	0.939	1.059	1.025	1.004	0.980	0.980	0.984	0.977	0.977	0.984	0.000
TL	35 809	0.000	0.000	0.263	0.319	0.471	0.625	0.751	0.902	0.977	0.977	0.000	0.713
TL	35 1012	-	-	-	-	-	-	-	-	-	0.000	0.000	0.000

Table 9A. (Cont.)

Lab.	Clock	53034	53064	53094	53124	53154	53184	53214	53244	53274	53309	53339	53369
TL	35 1132	0.000	0.000	0.102	0.149	0.139	0.184	0.223	0.261	0.329	0.342	0.309	0.000
TL	35 1498	1.019	1.029	1.009	0.802	0.932	0.980	0.980	0.874	0.737	0.750	0.944	0.973
TL	35 1712	1.064	1.087	1.059	1.025	1.004	0.980	0.980	0.984	0.901	0.927	0.984	0.984
TL	40 3052	-	-	-	-	0.000	0.000	0.000	0.000	0.012	0.010	0.008	0.008
TL	40 3053	0.000	0.000	0.225	0.315	0.430	0.569	0.676	0.823	0.863	0.790	0.822	0.628
TP	35 163	0.000	0.000	0.000	0.479	0.428	0.477	0.506	0.636	0.813	0.943	0.984	0.881
TP	35 326	0.244	0.260	0.526	0.463	0.846	0.879	0.980	0.984	0.977	0.977	0.984	0.984
TP	35 1227	0.770	0.618	0.666	0.801	0.897	0.694	0.641	0.608	0.573	0.561	0.579	0.638
TP	36 154	0.516	0.401	0.402	0.230	0.259	0.265	0.225	0.167	0.170	0.167	0.152	0.116
USNO	15 5561	-	-	-	-	-	-	0.000	0.000	0.000	0.000	0.067	0.077
USNO	15 5563	-	-	-	-	-	-	0.000	-	-	-	-	-
USNO	15 5564	-	-	-	-	-	-	0.000	0.000	0.000	0.000	0.027	0.040
USNO	35 101	0.196	0.161	0.153	0.148	0.164	0.176	0.167	0.173	0.163	0.160	0.176	0.184
USNO	35 104	0.462	0.565	0.531	0.546	0.848	0.847	0.796	0.819	0.875	0.790	0.961	0.984
USNO	35 108	0.246	0.259	0.261	0.268	0.284	0.264	0.241	0.259	0.269	0.329	0.504	0.502
USNO	35 114	-	-	-	-	-	-	-	-	0.000	0.000	0.000	0.000
USNO	35 120	0.667	0.773	-	-	0.000	0.000	0.000	0.000	0.261	0.384	0.458	0.463
USNO	35 142	0.788	1.011	1.059	0.000	0.578	0.633	0.625	0.597	0.464	0.457	0.537	0.590
USNO	35 146	0.261	0.297	0.233	0.168	0.166	0.151	0.129	0.122	0.116	0.115	0.150	0.208
USNO	35 148	0.254	0.424	0.616	0.716	0.770	0.637	-	-	0.000	0.000	0.000	0.000
USNO	35 150	0.194	0.255	0.219	0.186	0.196	0.255	0.313	0.374	0.390	0.454	0.430	0.367
USNO	35 152	0.900	-	-	-	0.000	0.000	0.000	0.000	0.008	0.010	0.013	0.016
USNO	35 153	0.583	0.348	0.193	0.194	0.233	0.223	0.263	0.280	0.295	-	-	-
USNO	35 156	0.352	0.343	0.336	0.497	-	-	-	-	0.000	0.000	0.000	0.000
USNO	35 161	1.064	1.087	1.059	0.906	0.543	0.389	0.381	0.259	0.268	-	-	-
USNO	35 164	0.000	0.000	0.000	0.098	0.106	0.115	0.111	0.129	0.159	0.190	0.230	0.390
USNO	35 165	0.183	0.172	0.183	0.248	0.329	0.000	-	-	-	-	-	-
USNO	35 166	0.570	0.623	0.559	0.610	0.671	0.584	0.529	0.525	0.608	0.628	0.621	-
USNO	35 167	0.293	0.419	0.464	0.596	0.790	0.783	0.901	0.984	0.977	0.977	0.984	0.984
USNO	35 169	0.103	0.118	0.128	0.165	0.219	0.240	0.230	0.252	0.358	0.352	0.345	0.363
USNO	35 173	1.064	1.087	1.059	1.025	1.004	0.980	0.980	0.984	0.977	0.977	0.984	0.984
USNO	35 213	0.208	0.205	0.198	0.194	0.225	0.221	0.208	-	-	-	-	-
USNO	35 217	0.000	0.000	1.059	0.701	0.303	0.384	0.336	0.400	0.503	0.543	0.634	0.555
USNO	35 225	0.101	0.099	1.059	1.025	1.004	0.980	0.980	0.984	0.977	0.977	0.984	0.984
USNO	35 226	0.068	0.071	1.045	1.025	1.004	0.957	0.900	0.931	0.977	0.977	0.984	0.984

Table 9A. (Cont.)

Lab.	Clock		53034	53064	53094	53124	53154	53184	53214	53244	53274	53309	53339	53369
USNO	35	227	1.064	1.087	1.059	1.025	0.872	0.587	0.591	0.572	0.633	0.568	0.598	0.803
USNO	35	229	0.264	0.249	0.276	0.257	0.304	0.460	0.389	0.413	0.464	0.566	0.476	0.327
USNO	35	231	0.159	0.120	0.120	0.114	0.163	0.290	0.224	0.169	0.113	0.095	0.090	0.112
USNO	35	233	0.856	0.540	0.537	0.473	0.438	0.418	0.405	0.649	0.764	0.948	0.707	0.643
USNO	35	242	0.583	0.575	0.465	0.493	0.495	0.473	0.451	0.416	0.455	0.000	0.195	0.204
USNO	35	244	1.064	1.087	1.059	1.025	0.000	0.639	0.576	0.540	0.557	0.541	0.564	0.653
USNO	35	249	0.780	0.703	0.610	0.689	0.687	0.693	0.836	0.772	0.790	0.877	0.866	0.984
USNO	35	253	0.119	0.160	0.144	0.167	0.210	0.232	0.240	-	-	-	-	-
USNO	35	254	1.064	1.087	1.059	1.025	1.004	0.980	0.980	0.984	0.977	0.000	-	-
USNO	35	255	0.000	0.695	0.915	1.025	1.004	0.980	0.980	0.984	0.977	0.977	0.984	0.984
USNO	35	256	0.387	0.429	0.461	0.550	0.675	0.551	0.638	0.606	0.612	0.606	0.736	0.854
USNO	35	260	0.000	0.000	0.000	0.072	0.116	0.162	0.198	0.249	0.320	0.354	0.428	0.984
USNO	35	268	0.418	0.540	0.528	0.537	0.588	0.662	0.906	0.747	0.772	0.977	0.984	0.882
USNO	35	270	1.064	1.087	1.059	1.025	1.004	0.980	0.980	0.984	0.977	0.977	0.984	0.984
USNO	35	279	0.963	0.941	0.618	0.715	0.605	0.461	0.459	0.615	0.641	0.808	0.937	0.912
USNO	35	389	0.272	0.234	0.234	0.221	0.183	0.134	0.112	0.114	0.131	0.176	0.178	0.280
USNO	35	392	1.064	1.087	1.059	1.025	1.004	0.980	0.980	0.984	0.977	0.977	0.984	0.984
USNO	35	394	-	-	-	0.000	0.000	0.000	0.000	0.020	0.020	0.021	0.023	0.026
USNO	35	416	0.647	0.545	0.498	0.541	0.606	0.675	0.975	0.984	0.977	0.977	0.984	0.984
USNO	35	417	0.305	0.329	0.327	0.370	0.420	0.547	0.829	0.984	0.914	0.977	0.984	0.984
USNO	35	703	1.064	1.004	0.602	-	-	-	-	-	-	-	-	-
USNO	35	717	1.064	1.087	1.059	1.025	1.004	0.980	0.980	0.874	0.700	0.665	0.595	0.643
USNO	35	762	1.064	1.087	0.998	0.984	1.004	0.980	0.980	0.984	0.977	0.977	0.984	0.984
USNO	35	763	1.064	1.087	0.946	1.025	1.004	0.980	0.804	0.642	0.657	0.781	0.892	0.785
USNO	35	765	0.415	0.406	0.650	0.591	0.694	0.591	0.968	0.875	0.725	0.751	0.789	0.984
USNO	35	1096	0.122	0.137	0.117	0.108	0.105	0.091	0.083	0.086	0.084	0.312	0.600	0.609
USNO	35	1097	0.205	0.196	0.229	0.306	0.513	0.518	0.516	0.517	0.391	0.299	0.297	-
USNO	35	1125	0.270	0.229	0.237	0.284	0.347	0.322	0.264	0.269	0.434	0.822	0.779	0.866
USNO	35	1327	0.763	0.638	0.452	0.338	0.299	0.301	0.268	0.263	0.210	0.246	0.473	0.000
USNO	35	1328	0.533	0.983	1.059	0.673	0.000	0.307	0.241	0.237	0.230	0.233	0.261	0.396
USNO	35	1331	0.305	0.296	0.333	0.356	0.512	0.980	0.812	0.736	0.879	0.879	0.984	0.984
USNO	35	1438	0.832	1.087	1.059	1.025	1.004	0.980	0.980	0.984	0.977	0.717	0.535	0.636
USNO	35	1459	0.347	0.312	0.311	0.317	0.374	0.416	0.348	0.548	0.678	0.806	0.984	0.984
USNO	35	1462	1.064	0.924	0.953	0.958	0.910	0.836	0.980	0.984	0.977	0.977	0.984	0.984
USNO	35	1463	1.064	1.087	1.059	0.943	1.004	0.980	0.980	0.984	0.977	0.977	0.000	0.523

Table 9A. (Cont.)

Lab.	Clock	53034	53064	53094	53124	53154	53184	53214	53244	53274	53309	53339	53369
USNO	35 1468	1.033	1.070	1.026	1.011	0.771	0.732	0.523	0.390	0.403	0.457	0.560	0.575
USNO	35 1481	0.094	0.075	0.073	0.073	0.080	0.108	0.122	0.128	0.196	0.632	0.565	0.587
USNO	35 1543	0.000	0.385	0.379	0.000	0.175	0.169	0.129	0.130	0.152	0.197	0.288	0.405
USNO	35 1573	0.000	0.088	0.074	0.058	0.061	0.061	0.053	0.053	0.066	0.103	0.338	0.000
USNO	35 1575	0.492	0.572	0.375	0.384	0.422	0.511	0.625	0.694	0.661	0.648	0.612	0.645
USNO	35 1655	1.064	1.087	1.059	1.025	1.004	0.980	0.980	0.984	0.977	0.977	0.984	0.984
USNO	35 1692	0.000	0.000	0.000	0.556	0.891	0.514	-	-	-	-	0.000	0.000
USNO	35 1694	1.064	0.623	0.590	0.476	0.590	0.671	0.624	0.639	0.808	0.977	0.984	0.984
USNO	35 1696	0.000	0.659	0.637	0.642	0.406	0.418	0.378	0.380	0.406	0.381	0.574	0.647
USNO	35 1697	0.651	0.510	0.511	0.578	0.576	0.615	0.980	0.984	0.977	0.977	0.984	0.984
USNO	35 1698	0.728	0.729	0.704	0.714	0.716	0.694	0.688	0.538	0.558	0.549	0.740	0.785
USNO	40 701	0.000	0.104	0.103	0.105	0.113	0.117	0.115	0.118	0.128	0.125	0.136	0.154
USNO	40 702	0.984	0.985	1.014	1.025	0.832	0.609	0.808	0.778	0.632	0.585	0.582	0.620
USNO	40 703	0.003	0.003	-	-	-	-	-	-	-	-	-	-
USNO	40 704	0.869	0.798	0.756	0.638	0.612	0.561	0.470	0.476	0.488	0.463	0.451	0.477
USNO	40 705	0.504	0.464	0.500	0.572	0.681	0.653	0.603	0.513	0.429	0.431	0.439	0.419
USNO	40 708	0.119	0.105	0.094	0.091	0.097	0.105	0.099	0.102	0.110	0.106	0.118	0.125
USNO	40 709	0.000	0.000	0.000	0.000	0.000	-	-	-	-	-	-	-
USNO	40 710	0.087	0.073	0.067	0.059	0.058	0.055	0.047	0.043	0.044	0.042	0.044	0.047
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	1.064	-	-	-	-	-	-	-	-	-	0.000	0.000
USNO	40 713	0.191	0.145	0.128	0.121	0.123	0.125	0.128	0.136	-	-	0.000	0.000
USNO	40 714	0.249	0.203	0.185	0.175	0.169	0.163	0.149	0.145	-	-	0.000	0.000
USNO	40 715	0.551	0.519	0.000	0.000	0.080	0.054	0.042	0.039	0.042	-	-	-
USNO	40 716	1.064	1.087	1.059	1.025	1.004	0.980	0.980	0.984	0.977	0.000	0.726	0.825
USNO	40 718	0.000	0.000	0.000	0.074	0.108	0.139	0.168	0.207	0.264	0.316	0.385	0.407
USNO	40 719	0.010	0.010	0.009	0.009	0.009	0.008	0.008	0.008	0.008	0.009	0.010	0.013
USNO	40 720	-	-	0.000	0.000	0.000	0.000	0.064	0.045	0.034	0.025	0.020	0.017
VSL	35 179	0.311	0.327	0.290	0.353	0.509	0.711	0.781	0.818	0.705	0.000	0.281	0.304
VSL	35 456	0.133	0.160	0.183	0.664	0.837	0.853	0.743	0.735	0.977	0.757	0.746	0.462
VSL	35 548	0.677	0.697	0.454	0.353	0.374	0.363	0.348	0.344	0.389	0.377	0.485	0.630
VSL	35 731	1.064	0.996	0.000	0.384	0.379	0.395	0.411	0.486	0.483	0.398	0.376	0.485

Table 9B: Statistical data on the weights attributed to the clocks in 2004

Interval		Number of Clocks			Number of clocks with a given weight									
					Weight = 0*			Weight = 0**			Max weight			Max relative
		HM	5071A	Total	HM	5071A	Total	HM	5071A	Total	HM	5071A	Total	weight %
2004	Jan.	54	178	268	8	22	33	4	5	10	2	36	41	1.064
2004	Feb.	51	177	270	8	22	40	3	1	6	1	26	30	1.087
2004	Mar.	55	182	280	12	21	44	3	2	7	1	31	34	1.059
2004	Apr.	56	181	280	11	15	36	4	3	8	2	30	34	1.025
2004	May	55	186	285	7	18	37	4	4	12	2	30	33	1.004
2004	June	55	188	288	7	21	33	3	3	11	3	35	39	0.980
2004	July	56	184	281	4	17	26	2	2	7	3	31	35	0.980
2004	Aug.	56	185	282	4	19	29	1	2	5	4	33	38	0.984
2004	Sep.	53	183	280	3	13	24	2	4	10	5	38	44	0.977
2004	Oct.	50	181	277	1	11	21	3	6	12	4	36	42	0.977
2004	Nov.	55	182	282	7	14	28	1	6	11	3	34	39	0.984
2004	Dec.	57	184	285	9	16	31	3	10	16	3	36	42	0.984

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

TIME SIGNALS

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

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

The following tables are based on information received at the BIPM in February and June 2005.

AUTHORITIES RESPONSIBLE FOR THE TIME SIGNAL EMISSIONS

Signal	Authority
BPM	Time and Frequency Division National Time Service Center, NTSC (Formely Shaanxi Astronomical Observatory, CSAO) 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 METrology and Accreditation Switzerland Electricity, Acoustic and Time Section Lindenweg 50 CH-3003 Bern-Wabern Switzerland
HLA	Time and Frequency Laboratory Korea Research Institute of Standards and Science Yusong P.O. Box 102, Taejon 305-600 Republic of Korea

Signal	Authority
IAM	Istituto Superiore delle Comunicazioni e delle Tecnologie dell'Informazione Viale America, 201 00144 - Roma, Italia
JJY	Japan Standard Time Group National Institute of Information and Communications Technology 4 -2- 1, Nukui-kitamachi Koganei, Tokyo 184-8795 Japan
LDS	School of Electronic and Electrical Engineering Leeds University Leeds LS2 9JT United Kingdom
LOL	Servicio de Hidrografía Naval Observatorio Naval Buenos Aires Av. España 2099 C1107AMA – Buenos Aires, Argentina
MSF	National Physical Laboratory Division for Enabling Metrology Teddington, Middlesex TW11 0LW United Kingdom
RAB-99, RBU, RJH-63, RJH-69, RJH-77, RJH-86, RJH-90,RTZ,RWM	Institute of Metrology for Time and Space (IMVP), FGUP "VNIIFTRI" Mendeleevo, Moscow Region 141570 Russia
STFS	National Physical Laboratory Dr. K.S. Krishnan Road New Delhi - 110012, India
TDF	FT R et D France Telecom Recherche et Développement Laboratoire RTA/D2M Technopole ANTICIPA 2, avenue Pierre Marzin 22307 - Lannion Cedex, France

Signal	Authority
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 Cagigal Apartado Postal No 6745 Caracas, Venezuela

TIME SIGNALS EMITTED IN THE UTC SYSTEM

Station	Location Latitude Longitude	Frequency (kHz)	Schedule (UTC)	Form of the signal
BPM	Pucheng China 35° 0'N 109° 31'E	2 500 5 000 10 000 15 000	7 h 30 m to 1 h continuous continuous 1 h to 9 h	Signals emitted in advance on UTC by 20 ms. Second pulses of 10 ms duration with 1 kHz modulation. Minute pulses of 300 ms duration with 1 kHz modulation. UTC time signals are emitted from minute 0 to 10, 15 to 25, 30 to 40, 45 to 55. UT1 time signals are emitted from minute 25 to 29, 55 to 59.
CHU	Ottawa Canada 45° 18'N 75° 45'W	3 330 7 335 14 670	continuous	Second pulses of 300 cycles of a 1 kHz modulation, with 29th and 51st to 59th pulses of each minute omitted. Minute pulses are 0.5 s long. Hour pulses are 1.0 s long, with the following 1st to 9th pulses omitted. A bilingual (Fr. Eng.) announcement of time (UTC) is made each minute following the 50th second pulse. FSK code (300 bps, Bell 103) after 10 cycles of 1 kHz on seconds 31 to 39. Year, DUT1, leap second information, TAI-UTC and Canadian summer time format on 31, and time code on 32-39. Broadcast is single sideband; upper sideband with carrier reinsert. DUT1 : ITU-R code by double pulse.
DCF77	Mainflingen Germany 50° 1'N 9° 0'E	77.5	continuous	At the beginning of each second (except the 59th second) the carrier amplitude is reduced to about 25 % for a duration of 0.1 s or 0.2 s. Coded transmission of year, month, day, hour, minute and day of the week in a BCD code from second marker No 21 to No 58 (The second marker durations of 0.1 s or 0.2 s correspond to a binary 0 or a binary 1 respectively). The coded time information is related to legal time of Germany and second markers 17 and 18 indicate if the transmitted time refers to UTC(PTB) + 2 h (summer time) or UTC(PTB) + 1 h (winter time). To achieve a more accurate time transfer and better use of the frequency spectrum available, an additional pseudo-random phase-shift keying of the carrier is superimposed to 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 time signals are generated by the Swiss Federal Office of Metrology and Accreditation and in accordance with the legal time of Switzerland which is UTC(CH) + 1 h (Central European Time CET) or UTC(CH) + 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	Taedok Science Town 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.
IAM (1)	Roma Italy 41° 47'N 12° 27'E	5 000	7 h 30 m to 8 h 30 m 10h 30 m to 11 h 30 m except Sunday and national holidays. Advanced by 1 hour in summer.	Second pulses of 5 cycles of 1 kHz modulation. Minute pulses of 20 cycles. Voice announcements every 15 minutes beginning at 0 h 0 m. DUT1: ITU-R code by double pulse.
JJY	Miyakoji 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	Fuji 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.

(1) Information based on the Annual Report for 2003 not confirmed by the laboratory.

Station	Location Latitude Longitude	Frequency (kHz)	Schedule (UTC)	Form of the signal
LDS	Leeds United Kingdom 53 ° 48'N 1° 33'W	5 000	Continuous	Second pulse amplitude = 2.4 V (50 ohm), 5 ns rise time and 20 μs width. Initial clock synchronization: 50 ns of UTC.
LOL (2)	Buenos Aires Argentina 34° 37'S 58° 21'W	5 000 10 000 *15 000	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.
MSF	Rugby United Kingdom 52° 22'N 1° 11'W	60	Continuous, except for interruptions for maintenance from 10 h 0 m to 14 h 0 m on the first Tuesday of January, May and September. A longer period of maintenance during the summer is announced annually.	Interruptions of the carrier of 100 ms for the second pulses and of 500 ms for the minute pulses. The signal is given by the beginning of the interruption. BCD NRZ code, 1 bit/s (year, month, day of the month, day of the week, hour, minute) from second 17 to 59 in each minute, following the seconds interruption. DUT1: ITU-R code by double pulse.
RAB-99	Khabarovsk Russia 48° 30'N 134° 50'E	25.0 25.1 25.5 23.0 20.5	02 h 06 m to 02 h 40 m 06 h 06 m to 06 h 40 m	A1N type signals are transmitted between minutes 10 and 22 : 0.025 second pulses of 12.5 ms duration are transmitted between minutes 10 and 13; second pulses of 0.1 s duration, 10 second pulses of 1 s duration, 0.1 second pulses of 25 ms and minute pulses of 10 s duration are transmitted between minutes 13 and 22.
RBU	Moscow 55° 44'N 38° 12'E	200/3	Continuous	DXXXW type 0.1 s signals. The numbers of the minute, hour, day of the month, day of the week, month, year of the century, difference between the universal time and the local time, TJD and DUT1+dUT1 are transmitted each minute from the 1st to the 59th second. DUT1+dUT1 : by double pulse.

(2) LOL. * discontinued for maintenance

Station	Location Latitude Longitude	Frequency (KHz)	Schedule (UTC)	Form of the signal
RJH-63	Krasnodar Russia 44° 46'N 39° 34'E	25.0 25.1 25.5 23.0 20.5	11 h 06 m to 11 h 40 m	A1N type signals are transmitted between minutes 9 and 20 : 0.025 second pulses of 12.5 ms duration are transmitted between minutes 9 and 11 ; 0.1 second pulses of 25 ms duration, 10 second pulses of 1 s duration and minute pulses of 10 s duration are transmitted between minutes 11 and 20.
RJH-69	Molodechno Belarus 54° 28'N 26° 47'E	25.0 25.1 25.5 23.0 20.5	07 h 06 m to 07 h 47 m	A1N type signals are transmitted between minutes 10 and 22 : 0.025 second pulses of 12.5 ms duration are transmitted between minutes 10 and 13; second pulses of 0.1 s duration, 10 second pulses of 1 s duration, 0.1 second pulses of 25 ms and minute pulses of 10 s duration are transmitted between minutes 13 and 22.
RJH-77	Arkhangelsk Russia 64° 22'N 41° 35'E	25.0 25.1 25.5 23.0 20.5	09 h 06 m to 09 h 47 m	A1N type signals are transmitted between minutes 10 and 22 : 0.025 second pulses of 12.5 ms duration are transmitted between minutes 10 and 13; second pulses of 0.1 s duration, 10 second pulses of 1 s duration, 0.1 second pulses of 25 ms and minute pulses of 10 s duration are transmitted between minutes 13 and 22.
RJH-86	Bishkek Kirgizstan 43° 03'N 73° 37'E	25.0 25.1 25.5 23.0 20.5	04 h 06 m to 04 h 47 m 10 h 06 m to 10 h 47 m	A1N type signals are transmitted between minutes 10 and 22 : 0.025 second pulses of 12.5 ms duration are transmitted between minutes 10 and 13; second pulses of 0.1 s duration, 10 second pulses of 1 s duration, 0.1 second pulses of 25 ms and minute pulses of 10 s duration are transmitted between minutes 13 and 22.
RJH-90	Nizhni Novgorod Russia 56° 11'N 43° 57'E	25.0 25.1 25.5 23.0 20.5	05 h 06 m to 05 h 47 m	A1N type signals are transmitted between minutes 10 and 22 : 0.025 second pulses of 12.5 ms duration are transmitted between minutes 10 and 13; second pulses of 0.1 s duration, 10 second pulses of 1 s duration, 0.1 second pulses of 25 ms and minute pulses of 10 s duration are transmitted between minutes 13 and 22.
RTZ	Irkutsk Russia 52° 26'N 103° 41'E	50	Winter schedule 22 h 00 m to 24 h 00 m 00 h 00 m to 21 h 00 m Summer schedule 21 h 00 m to 24 h 00 m 00 h 00 m to 20 h 00 m	DXXXW type 0.1 s signals. The numbers of the minute, hour, day of the month, day of the week, month, year of the century, difference between the universal time and the local time, TJD and DUT1+dUT1 are transmitted each minute from the 1st to the 59th second. DUT1+dUT1: by double pulse.

Station	Location Latitude Longitude	Frequency (kHz)	Schedule (UTC)	Form of the signal
RWM (3)	Moscow Russia 55° 44'N 38° 12'E	4 996 9 996 14 996	The station operates simultaneously on the three frequencies.	A1X type second pulses of 0.1 s duration are transmitted between minutes 10 and 20, 40 and 50. The pulses at the beginning of the minute are prolonged to 0.5 s. A1N type 0.1 s second pulses of 0.02 s duration are transmitted between minutes 20 and 30. The pulses at the beginning of the second are prolonged to 40 ms and of the minute to 0.5 ms. DUT1+dUT1: by double pulse.
STFS (1)	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.

(1) Information based on the Annual Report for 2003 not confirmed by the laboratory.

(3) RMW is the radiostation emitting DUT1 information in accordance with the ITU-R code and also giving an additional information, dUT1, which specifies more precisely the difference UT1-UTC down to multiples of 0.02 s, the total value of the correction being DUT1+dUT1.

Positive values of dUT1 are transmitted by the marking of p second markers within the range between the 21st and 24th second so that dUT1 = $+p \times 0.02$ s.

Negative values of dUT1 are transmitted by the marking of q second markers within the range between the 31st and 34th second, so that dUT1 = $-q \times 0.02$ s.

Station	Location Latitude Longitude	Frequency (kHz)	Schedule (UTC)	Form of the signal
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 (1)	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.

(1) Information based on the Annual Report for 2003 not confirmed by the laboratory.

ACCURACY OF THE CARRIER FREQUENCY

Station	Relative uncertainty of the carrier frequency in 10^{-10}
BPM	0.01
BSF	0.1
CHU	0.05
DCF77	0.02
EBC	0.1
HBG	0.02
HLA	0.02
IAM	0.5
JJY	0.01
LDS	0.01
LOL	0.1
MSF	0.02
RAB-99, RJH-63	0.05
RBU, RTZ	0.02
RJH-69, RJH-77	0.05
RJH-86, RJH-90	0.05
RWM	0.1
STFS	0.1
TDF	0.02
WWV	0.01
WWVB	0.01
WWVH	0.01

TIME DISSEMINATION SERVICES

The following tables are based on information received at the BIPM in February and June 2005.

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	Standards for Time and Frequency Project National Measurement Institute PO Box 264 Lindfield NSW 2070 - AUSTRALIA
BEV	Bundesamt für Eich- und Vermessungswesen Arltgasse 35 A-1160 Wien , Vienna - Austria
BNM-SYRTE	Bureau National de Métrologie – Systèmes de Référence Temps-Espace Observatoire de Paris 61, avenue de l'Observatoire, 75014 Paris – France
CENAM	Centro Nacional de Metrología km. 4.5 Carretera a Los Cués El Marqués, Querétaro, C.P. 76241 - México
CSIR	Time and Frequency Laboratory CSIR – National Metrology Laboratory P.O. Box 395 Pretoria 0001 - South Africa
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
IEN	Istituto Elettrotecnico Nazionale Galileo Ferraris Strada delle Cacce, 91 I – 10135 Torino Italie
INPL	National Physical Laboratory Danciger A bldg Givat - Ram, The Hebrew university 91904 Jerusalem ISRAEL
KRISS	Time and Frequency Group Division of Optical Metrology Korea Research Institute of Standards and Science P.O. Box 102, Yuseon Daejon 305-600. Republic of Korea

LT	Time and Frequency Standard Laboratory Semiconductor Physics Institute – State Metrology Service A. Goštauto 11 Vilnius LT01108, Lithuania
METAS	METrology and Accreditation Switzerland Electricity, Acoustic and Time Section Lindenweg 50 CH-3003 Bern-Wabern Switzerland
MSL	Measurement Standards Laboratory Industrial Research Gracefield Road PO Box 31-310 Lower Hutt – New Zealand
NICT	Japan Standard Time Group National Institute of Information and Communications Technology 4 -2 -1, Nukui-kitamachi Koganei, Tokyo 184-8795 Japan
NIM	Time & Frequency Laboratories National Institute of Metrology 7, District 11 Heping street Beijing - Popular Republic of China
NIST	National Institute of Standards and Technology Time and Frequency Division, 847.00 325 Broadway Boulder, Colorado 80305, USA
NMLS	Time and Frequency Laboratory National Metrology Laboratory SIRIM Berhad, Lot PT 4803, Bandar Baru Salak Tinggi, 43900 Sepang - Malaysia
NPL	National Physical Laboratory Division for Enabling Metrology Teddington, Middlesex TW11 0LW United Kingdom
NPLI	Time and Frequency Section National Physical Laboratory Dr.K.S.Krishnan Road New Delhi 110012 - India
NRC	National Research Council of Canada Institute for National Measurement Standards Frequency and Time Standards Bldg M-36, 1200 Montreal Rd. Ottawa, Ontario, K1A OR6, Canada
NTSC	National Time Service Center Chinese Academy of Sciences P.O. Box 18, Lintong Shaanxi 710600, China

ONBA	Servicio de Hidrografía Naval Observatorio Naval Buenos Aires Servicio de Hora Av. España 2099 C1107AMA – Buenos Aires, Argentina
ONRJ	Observatorio Nacional (MCT) Divisão Serviço da Hora Rua General José Cristino, 77 São Cristovão 20291- 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 Standards, Productivity and Innovation Board (SPRING Singapore) 1 Science Park Drive, Singapore 118221 Singapore
SP	SP Swedish National Testing and Research Institute Box 857 S-501 15 BORAS Sweden
TL	National Standard Time and Frequency Laboratory Telecommunication Laboratories Chunghwa Telecom. Co., Ltd. No. 12, Ln.551, Ming-Tsu Road Sec. 5 Yang-Mei, Taoyuan, 326 Taiwan, Rep. of China
TP	Institute of Radio Engineering and Electronics Czech Academy of Sciences Chaberská 57 182 51 Praha 8 Czech Republic
USNO	U.S. Naval Observatory 3450 Massachusetts Ave., N.W. Washington, D.C. 20392-5420 USA
VSL	NMi Van Swinden Laboratorium Postbus 654 2600 AR Delft Netherlands

TIME DISSEMINATION SERVICES

AOS

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

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

AUS

Network Time Service
Computers connected to the Internet can be synchronized to UTC(AUS) using the NTP protocol. The NTP servers are referenced to UTC(AUS) either directly or via a GPS common view link.
Please see our web pages for information on access (www.measurement.gov.au – follow the links "Capabilities" —> "Physical measurement capabilities" —> "Time and frequency:capabilities") 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.

BEV

3 NTP servers are available; addresses:
time.metrology.at
217.19.37.26
217.19.37.27
more information on http://www.metrology.at

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

BNM-SYRTE

BNM-SYRTE operates one primary time server using the "Network Time Protocol" (NTP) :
Hostname: ntp-p1.obspm.fr

Futher information at: http://opdaf1.obspm.fr/www/ntp_infos.html

CENAM

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

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

	Telephone Code CENAM provides a telephone code for setting time in computers. More information about this service please contact J. Mauricio López at jlopez@cenam.mx
	Network Time Protocol Operates one time server using the "Network Time Protocol", it is located at the Centro Nacional de Metrología, Querétaro, México. Further information at http://www.cenam.mx/HoraExacta.asp
CSIR	Telephone Time Service (TTS) Provides digital time code accessible by computer for setting time in computers. Measurement of telephone transmission delay is included. Access phone numbers: + 27 12 349 1576, + 27 12 349 1577. More information and software for accessing the service is available at http://www.nml.csir.co.za/
	Network Time Service Two NTP servers are available, tick.nml.csir.co.za with restricted access policy and tock.nml.csir.co.za with an open access policy. More information is available at http://www.nml.csir.co.za/time.htm
GUM	Telephone Time Service providing the European time code by telephone modem for setting time in computers. Includes provision for compensation of propagation time delay. Access phone number : +48 22 654 88 72
	Network Time Service Two NTP servers are available: tempus1.gum.gov.pl tempus2.gum.gov.pl with an open access policy. It provides synchronization to UTC(PL). Contact: timegum@gum.gov.pl
HKO	Speaking Clock Service HKO operates an automatic Telephone Information Enquiry System that provides voice announcement of the Hong Kong Standard Time. Access phone number: + 852 1878200
	Network Time Service HKO operates two network time servers to synchronize computer clocks to the Hong Kong Standard Time via the Internet. The servers support Network Time Protocol, Time Protocol and Daytime Protocol. Host name of the server: stdtime.gov.hk Further information at http://www.hko.gov.hk/nts/ntime.htm
IEN (1)	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(IEN) for computer clocks without compensation for the propagation time. Software for the synchronization of computer clocks is available on IEN home page (www.ien.it).
	Internet Time Service The IEN operates two time servers using the "Network Time Protocol" (NTP); host names of the servers are npt1.ien.it and ntp2.it. More information on this service can be found on the web pages: www.ien.it/ntp/index_i.shtml.

(1) Information based on the Annual Report for 2003, not confirmed by the laboratory.

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

NICT (c)	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 time server of UTC(NICT) using the "Network Time Protocol" to NTP service companies in Japan as Stratum 1 server. GPS common view data NICT provides the GPS common view data based on UTC(NICT) to the time business service in Japan
NIM (1)	Television Time Service The coded time information generated by one time code generator is inserted into the TV signal. It can be obtained by using a decode TV receiver. The time reference is UTC(NIM). Access TV channel: 1,2,8 of CCTV. Telephone Time Service The coded time information generated by NIM time code generator, referenced to UTC(NIM). Telephone Code provides digital time code at 1200 to 9600 bauds, 8 bits, no parity, 1 stop bit. Access phone number: 8610 6422 9086. Network Time Service Provides digital time code across the Internet using NTP.
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 14 time servers at 11 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

(1) Information based on the Annual Report for 2003, not confirmed by the laboratory.

(c) In April 1, 2004, the Communications Research Laboratory (CRL), an independent administrative institution, and the Telecommunications Advancement Organization (TAO), an authorized corporation, were to be integrated with the National Institute of Information and Communications Technology (NICT), an incorporated administrative agency. The detail information is referred to the URL;
http://www.nict.go.jp/overview/index.html http://jjy.nict.go.jp/index_e.html
New address NICT, Independent Administrative Institution Technology
Koganei Headquaters
Applied Research and Standards Dept.
Japan Standard Time Group
Address: 4-2-1 Nukui-Kitamachi, Koganei, Tokyo 184-8795 Japan

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 Version 3 The NTP time information is referenced to UTC(NMLS) and is currently generated by two Stratum-1 and Stratum-2 NTP servers, made available for public freely. The addresses for the servers are mst.sirim.my, 202.190.27.9 and 202.190.27.10.
NPL	Telephone Time Service A TUG time code generator provides the European Telephone Time Code, referenced to UTC(NPL), by telephone modem. Software for synchronising computers is available from the NPL web site at www.npl.co.uk/time. The service telephone number is 0906 851 6333. Note: this is a premium rate number and can only be accessed from within the UK. Internet Time Service Two servers referenced to UTC(NPL) provide Network Time Protocol (NTP) time code across the internet. More information is available from the NPL web site at www.npl.co.uk/time. The server host names are: ntp1.npl.co.uk ntp2.npl.co.uk
NPLI (1)	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. 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 time.chu.nrc.ca Further information at http://inms-ienm.nrc-cnrc.gc.ca/time_services.html
NTSC	Network Time Service (NTS) Provides a synchronization to UTC(NTSC) computer clocks within China. Software for the synchronization of computer clocks is available on the NTSC Time and Frequency home page : http://time.ntsc.ac.cn Access Policy: free Contact: Shaowu DONG (dongsw@ntsc.ac.cn).

(1) Information based on the Annual Report for 2003, not confirmed by the laboratory.

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 5806037. Telephone Code (55) 21 5800677 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 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 : ntp.oma.be Access policy : free Synchronization to UTC(ORB) from H-Maser clock Contact : f.roosbeek@oma.be ORB provides a time dissemination via phone and modem to synchronize PC clocks on UTC(ORB). The system used is the Time Distribution System from TUG, which produces the telephone time code mostly used in Europe. The baud rate used is 1200. The access phone number is 32 (0) 2 373 03 20. The system is updated periodically with DUT1 and leap seconds
PTB	Telephone Time Service The coded time information is referenced to UTC(PTB) and generated by a TUG type time code generator using an ASCII-character code. The time protocols are sent in a common format, the " European Telephone Time Code ". Access phone number : +49 531 51 20 38 . Internet Time Service The PTB operates two time servers using the " Network Time Protocol " (NTP). Software for the synchronization of computer clocks is available on the web pages of the PTB (www.ptb.de). Host names of the servers: ptbtime1.ptb.de ptbtime2.ptb.de
ROA	Telephone Code The coded time information is referenced to UTC(ROA) and generated by a TUG type time code generator using an ASCII-character code. The time protocols are sent in a common format, the "European Telephone Time Code". Access phone number : +34 956 599 429 Network Time Protocol Server : hora.roa.es Synchonized to UTC(ROA) better than 10 microseconds Service policy : free Server : ntp0.roa.es Synchonized to UTC(ROA) better than 10 microseconds Service policy : free Note : server used as prototype to check new software, hardware, etc.

SG

Web-based time service:
Displays a real-time clock referenced to UTC(SG) at web-site http://www.SingaporeStandardTime.org.sg. User-selectable displays of local time (adjusted for daylight savings) of major cities worldwide and time differences between any two cities are also available at the web-site.

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 delays.
Access phone number : +65 67799978.
Information is available at http://www.SingaporeStandardTime.org.sg.

Network Time Service (NeTS)
Transmits digital time code via the Internet using three different protocols – Time, Daytime and NTP. Operates two time servers.
Host names : NeTS.org.sg
203.117.180.35
Information available at http://www.SingaporeStandardTime.org.sg.

SP

Telephone Time Service
The coded time information is referenced to UTC(SP) and generated by two TUG type time code generators using an ASCII-character code. The time protocols are sent in a common format, the "European Telephone Time Code".
Access phone number: +46 33 41 57 83

Internet Time Service
The coded time information is referenced to UTC(SP) and generated by two NTP servers using the Network Time Protocol (NTP).
Access host names : ntp1.sp.se and ntp2.sp.se

Speaking Clock
The speaking clock service is operated by Telia AB in Sweden. The time announcement is referenced to UTC(SP) and disseminated from a computer based system operated and maintained at SP.
Access phone number : 90510 (only accessible in Sweden).
Access phone number : +4633 90510 (from outside Sweden).

More information about these services are found at the web site www.sp.se

TL

Speaking Clock Service
Traceable to UTC(TL). Broadcast through PSTN (Public Switching Telephone Network) automatically and provides accurate voice time signal to public users.

The Computer Time Service
Provides digital time code by telephone modem for setting time in computers.
Access phone number : +886 3 4245117.

NTP Service
TL operates a time server using the "Network Time Protocol (NTP)".
Host name of the server : time.stdtime.gov.tw
Further information at http://www.stdtime.gov.tw/english/e-home.htm

TP	Internet Time Service IREE operates a time server directly referenced to UTC(TP). Time information is accessible through Network Time Protocol (NTP). Server host name: time.ure.cas.cz More information at http:// www.ure.cas.cz/time
USNO	Telephone Voice Announcer +1 202 762-1401 Telephone Code +1 202 762-1594 provides digital time code at 1200 baud, 8 bits, no parity Automated data service for downloading files +1 202 762-1503 Web site for time and for data files: http://tycho.usno.navy.mil Network Time Protocol (NTP) see http://tycho.usno.navy.mil/ntp.html for software and site closest to you.
VSL	Telephone Time Service The coded time information is referenced to UTC(VSL) and generated by a TUG type time code generator using an ASCII-character code. The time protocols are sent in a common format, the "European Telephone Time Code". The access phone number is 0900 6171819. This is a toll number and therefore can only be accessed in the Netherlands.

Director's Report on the Activity and Management of the BIPM, 2004, **5**

(July 2003 – June 2004)
BIPM Publication

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

The reference time scales TAI and UTC are computed from data reported regularly to the BIPM by the timing centers that maintain a local UTC; monthly results are published in *Circular T*. The *Annual Report of the BIPM Time Section (2003),* Volume **16**, complemented by computer-readable files on the BIPM home page (www.bipm.org), provides the definitive results for 2003.

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 (EAL) from which TAI is derived. Research concerning time scale algorithms is conducted at the Time section with the aim of improving the long-term stability of EAL and the accuracy of TAI.

2.1 EAL stability

Some 85 % of clocks are now either commercial caesium clocks of the HP/Agilent 5071A type or active auto-tuned hydrogen masers. To improve the stability of the free atomic scale (EAL), the weighting procedure applied to clocks sets the maximum relative weight each month to 2.5/N, where N is the total number of participating clocks. In this way, we have substantially reduced the number of the clocks at the maximum weight (13 % in average over year 2003, against 54 % in year 2000). We allow a clock to reach the maximum weight when its variance computed from 12 consecutive 30 day samples is, at most, 5.8×10^{-15} (15.9×10^{-15} in the previous weighting procedure). This procedure generates a time scale which relies upon the very best clocks.

The medium-term stability of EAL, expressed in terms of an Allan deviation, is estimated to be 0.6×10^{-15} for averaging times of 20 to 40 days over the period January 1999 to June 2004.

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 2003, individual measurements of the TAI frequency have been provided by nine primary frequency standards including five caesium fountains (IEN-CSF1, NIST-F1, PTB CSF1, SYRTE-FOM and SYRTE-FO2). Reports on the operation of the primary frequency standards are regularly published in the *Annual Report of the BIPM Time section.*

A steering of the frequency of TAI of 1.0×10^{-15} has been applied every two months to put the TAI scale unit in conformity to the SI second. Since July 2003, 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 $+0.5 \times 10^{-14}$ to $+1.19 \times 10^{-14}$, with a standard uncertainty of 0.2×10^{-14}. These values indicate that the scale unit of TAI has significantly deviated from its definition, and that the steering procedure is in need of revision. This has been recognized by the CCTF in its Recommendation CCTF 3 (2004). Consequently, starting in July 2004, a monthly steering correction of magnitude up to 0.7×10^{-15} will be applied.

2.3 Independent atomic time scales

The BIPM staff have been involved in the organization and elaboration of the Polish independent atomic time scale TA(PL). Specially devised software for a limited number of clocks has been developed, and is being improved. For an averaging time of about one month the stability of TA(PL) is approximately 2.5×10^{-15}.

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 another realization TT(BIPM) in post-processing, which is based on a weighted average of the evaluations of TAI frequency by the primary frequency standard (PFS). The procedures to process PFS data have been recently updated and we have, consequently, provided an updated computation of TT(BIPM), named TT(BIPM2003). In this, we use all recently available data from new caesium fountains and a revised estimation of the stability of the free atomic time scale EAL on which TAI is based. The performance of TT(BIPM2003) is used to assess the accuracy of TAI and to compare recent PFS measurements.

3 Time links

The BIPM Time section organizes the international network of time links. In 2003, significant improvement was made on time transfer for TAI. The pilot experiment TAIP3, which began in summer 2002 to test the use of dual-frequency GPS P-code measurements for TAI links, continues. Several such time links have been introduced into TAI in 2003 and this process continues. This allows the use of four techniques for clock comparison in TAI. At present, 36 % of the links are performed with the classical GPS common-view technique based on C/A-code measurements obtained from single-channel single-frequency receivers; about 33 % of the links are obtained from observations with multichannel receivers, some of them being GPS and GLONASS dual-code dual-system ones; 9 % are calculated from observations of dual frequency GPS receivers; and 15 % are links performed with the TWSTFT technique. As a result, there is an improvement in the accuracy for time transfer, and the whole system of time links becomes more reliable. In addition, the BIPM Time section continues to test other time and frequency comparison methods, such as those using phase measurements.

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

i) Current work

The BIPM publishes an evaluation of the daily time differences [*UTC – GPS time*] and [*UTC – GLONASS time*] in its monthly *Circular T,* and routinely issues GPS and GLONASS international common-view schedules. The international network of GPS common-view links used by the BIPM follows a pattern of local stars within a continent. All GPS links are corrected for satellite positions using IGS post-processed precise satellite ephemerides and those performed with single-frequency receivers are corrected for ionospheric delays using IGS maps.

ii) Standards for GPS and GLONASS receivers

The Time section continues its active involvement in the work of the CCTF Working Group on Global navigation satellite systems Time Transfer Standards (CGGTTS). This has involved the ongoing development of technical guidelines for manufacturers of receivers used for timing in Global navigation satellite systems. A staff member of the BIPM provides the secretariat of the CGGTTS.

iii) Multichannel GPS time links

Eighteen multichannel GPS links are used in the computation of TAI.

iv) IGS estimated ionospheric corrections

Ionospheric parameters estimated by the IGS are routinely used to correct all GPS links performed with single channel receivers for ionospheric delays in regular TAI calculations. A study of the possible correlation between ionospheric parameters and apparent variations in the hardware delays of dual-frequency receivers is under way.

3.2 Phase and code measurements from geodetic-type receivers

It will be recalled that 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 newly created IGS working group on clock products, which replaces the IGS/BIPM Pilot Project for accurate time and frequency comparisons using GPS phase and code measurements.

Studies continue at the BIPM using two Ashtech Z12-T GPS receivers (one acquired in December 2003), one Javad Legacy GPS/GLONASS receiver and one Septentrio PolarX receiver acquired in May 2004.

The method developed to perform the absolute calibration of the Z12-T hardware delays allows us to use this receiver for differential calibrations of similar receivers world-wide. Calibration trips started in January 2001 and have continued ever since. As of June 2004, 26 such calibrations have taken place concerning 21 receivers. The new Z12-T serves as a local reference with which the traveling Z12-T is compared while at the BIPM.

Code P data from these receivers world-wide are collected for the pilot experiment TAIP3, using procedures and software developed in collaboration with the ORB. As of June 2004, 13 laboratories regularly provide such P3 data. Time links computed using these data are systematically compared to other available techniques, notably to two-way time transfer. We have shown that the long-term stability of these links is typically below 1 ns. We started using data from such receivers for the time links of TAI in July 2003.

The IGS now routinely publishes its clock products. Because several time laboratories participate both to TAI with P3 data and to the IGS network, it is possible to compare results obtained through the IGS products and through TAIP3. Several multi-technique time link comparisons are under way.

One of the 3S Navigation receivers in operation at the BIPM is used to collect data for the International GLONASS Service Pilot Project (IGLOS-PP) sponsored by the IGS, in which the BIPM participates. The objective of this project is, among others, to produce post-processed precise GLONASS satellite ephemerides.

3.3 Two-way time transfer

Two meetings related to TWSTFT activities have been held since October 2003. The BIPM collects two-way data from 12 operational stations and undertakes treatment of some two-way links. Nine TWSTFT links have been introduced into the computation of TAI; some others are in preparation for their introduction into TAI. The BIPM is also involved in the calibration of two-way time-transfer links by comparison with GPS. The Time section continues to elaborate BIPM TWSTFT reports, and a staff member of the BIPM provides the secretariat for the CCTF Working Group on TWSTFT.

3.4 Uncertainties of TAI time links

The evaluation of the Type A and Type B uncertainties of TAI time links has been concluded. Their values are published in *Circular T* since March 2004, together with the information on the time links used in each monthly calculation. Mainly because of lack of calibration, the Type B uncertainties of GPS links can reach 20 ns. This underlines the need to complete the calibration of all TAI time links.

3.5 Calibration of TAI time links

The BIPM is conducting a series of calibrations of GPS time equipment located in the time laboratories contributing to TAI. In 2003/2004, a total of 17 laboratories out of a possible 50 have been calibrated (AOS, APL, CH, CRL, IEN, KRISS, OCA, OP, NIST, NMIJ/AIST, NML, NPL, NTSC, PTB, TL, USNO and VSL). In addition, the Time section staff is developing methods for GPS/GLONASS time receiver calibrations. The BIPM is also taking part in the organization of TWSTFT calibration trips.

4 Pulsars

Collaboration is maintained with radio-astronomy groups observing pulsars and analyzing pulsar data provided that it is of interest for us to study the potential capability of millisecond pulsars as a means of sensing the very long-term stability of atomic time. The Time section provides these groups with its post-processed realization of Terrestrial Time. The collaboration continues with the Observatoire Midi-Pyrénées (OMP), Toulouse, on a programme of survey observations.

5 Space-time references

Uniformity in the definition of space reference systems plays an increasingly important role in basic metrology, particularly for astro-geodetic techniques that contribute to the International Earth Rotation Service (IERS). Since 1 January 2001, a collaborative effort between the BIPM and the U.S. Naval Observatory (USNO) provides the Conventions Centre of the IERS. The new edition of the *IERS Conventions (2003)* has been finalized and published after receiving approval by the IERS Directing Board. This is a 127 page document summarizing the models, constants and procedures used for data analysis in the IERS, and for the astrometry-geodesy community at large.

A new 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 set-up (http://tai.bipm.org/iers/forum/) for users to offer comments related to the future updates of the *IERS Conventions*.

Studies on improving the consistency of the *IERS Conventions* and on understanding the influence of inconsistencies on the IERS products started, in collaboration with other IERS analysis centers (IGN, OP).

Activities related to the realization of reference frames for astronomy and geodesy are being developed by E.F. Arias in co-operation with the IERS and with Argentine laboratories.

6 Other studies

The test of Lorentz invariance by comparing the frequencies of a hydrogen maser and a cryogenic sapphire microwave oscillator was continued throughout last year, in collaboration with the BNM-SYRTE (Paris Observatory) and the University of Western Australia (UWA). The measurements now cover a period of over 500 days and the most recent results show an improvement by over a factor 2 with respect to the previously published results. A new theoretical analysis in the framework of the Standard Model Extension (SME) of particle physics has been carried out. In that framework, the experiment improves present limits by about one order of magnitude as shown in the most recent results. For further improvement, the experiments will have to be mounted on a rotating platform in the laboratory, which is expected to lead to improvements by another order of magnitude or more. Such an experiment is under way at UWA with the participation of P. Wolf during a two month stay at UWA. Other work in this field concerns the analysis of Doppler and clock-comparison experiments in the SME, like those planned for the ACES (Atomic Clock Ensemble in Space) experiment on board the international space station in 2008.

The ACES experiment includes a microwave link (MWL) for clock comparisons, which is expected to perform at least an order of magnitude better than present systems (GPS, TWSTFT) for frequency comparisons. Such a technique is essential for the comparison of present and future primary frequency standards. P. Wolf is involved in the modeling and data analysis of the MWL, and is co-supervising a Ph.D. student and a "DEA training" on that subject.

7 Publications, lectures, travel: Time section

7.1 External publications

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4. De Biasi M.S., Osorio J., Amenna J., Esperón C., Arias E.F., The Observatorio Naval Buenos Aires time service, *Astrometry in Latin America*, AdeLA Publications Series N°1, 2004, 25-28.
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9. Soffel M., Klioner S., Petit G., Wolf P. *et al.*, The IAU 2000 Resolutions for Astrometry, Celestial Mechanics, and Metrology in the Relativistic Framework: Explanatory Supplement, *Astron. J.*, 2003, **126**, 2687–2706, arXiv:astro-ph/0303376.
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11. Wolf P., Bize S., Clairon A., Luiten A.N., Santarelli G., Tobar M.E., Tests of Lorentz Invariance using a Microwave Resonator: an update, *Proc. 2003 IEEE FCS and 17th EFTF* (Tampa, United States), 2003, 205-210.
12. Wolf P., Tobar M.E., Bize S., Clairon A., Luiten A.N., Santarelli G., Whispering Gallery Resonators and Tests of Lorentz Invariance, *Gen. Rel. Grav.*, 2004, **36**, 2351-2372.

7.2 BIPM publications

13. *Annual Report of the BIPM Time Section (2003)*, 2004, **16**, 89 pp.

14. *Circular T* (monthly), 7 pp.

15. Lewandowski W., Tisserand L., Determination of the differential time corrections for GPS time equipment located at the OP, NPL, IEN, PTB, and VSL, *Rapport BIPM*-2004/05, 2004, 17 pp.

16. Lewandowski W., Tisserand L., Determination of the differential time corrections for GPS time equipment located at the OP, PTB, AOS, KRISS, CRL, NIST, USNO and APL, *Rapport BIPM*-2004/06, 2004, 29 pp.

17. Lewandowski W., Tisserand L., Determination of the differential time corrections for GPS time equipment located at the OP and CH, *Rapport BIPM*-2004/08, 2004, 15 pp.

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