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Contents

Practical information about the BIPM Time Department

The Time Department of the BIPM issues two periodic publications. These are the monthly *Circular T* and the *BIPM Annual Report on Time Activities*.

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Director's Report on the Activity and Management of the BIPM, 2011

(1 July 2010 to 31 December 2011)

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

The reference time scales, International Atomic Time (TAI) and Coordinated Universal Time (UTC), are computed from data reported regularly to the BIPM by the various timing centres that maintain a local UTC; monthly results are published in *Circular T*. The *BIPM Annual Report on Time Activities for 2010, volume 5*, complemented by computer-readable files on the BIPM website (www.bipm.org/en/publications/time_activities.html), provides the definitive results for 2010.

2 Algorithms for time scales

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

A new prediction algorithm for EAL has been studied, validated and implemented for the monthly calculation of UTC. The new prediction model takes into account the frequency drift which affects most of the participating atomic clocks. The frequency drift of each clock is estimated with respect to the Terrestrial Time (TT) computed at the BIPM and representing the best reference for frequency. Several tests on the past data have shown a reduction of the EAL frequency drift of about 1 order of magnitude with the introduction of the new prediction algorithm. As a consequence, an important improvement in the long-term stability of EAL is expected.

The new algorithm for predicting clock frequency has been implemented in the UTC calculation starting in September 2011 with the agreement of the Consultative Committee for Time and Frequency (CCTF). After few months of having incorporated the new algorithm in the calculation, an improvement in the long-term performance of EAL is already clear.

2.1 EAL stability

Some 88 % of the clocks used in the calculation of time scales are either commercial caesium clocks of the Symmetricom/HP/Agilent 5071A type or active, auto-tuned hydrogen masers. To improve the stability of EAL, a weighting procedure is applied to clocks where the maximum relative weight each month depends on the number of participating clocks. On average during 2010 and 2011, about 15 % of the participating clocks were at the maximum weight. This procedure generates a time scale which relies upon the best clocks.

The stability of EAL, expressed in terms of an Allan deviation, is about 4 parts in 10^{16} for averaging times of one month. Long-term drifts limit the stability to around 2 parts in 10^{15} for averaging times of six months.

2.2 TAI accuracy

To characterize the accuracy of TAI, estimates are made of the relative departure, and its uncertainty, of the duration of the TAI scale interval from the SI second, as produced on the rotating geoid, by primary frequency standards. Since July 2010, individual measurements of the TAI frequency have been provided by thirteen primary frequency standards, including ten caesium fountains (IT CSF1, LNE-SYRTE FO1, LNE-SYRTE FO2, LNE-SYRTE FOM, NICT CSF1, NIST F1, NMIJ F1, NPL CSF2, PTB CSF1 and PTB CSF2). Reports on the operation of the primary frequency standards are regularly published on the BIPM website and collated in the *BIPM Annual Report on Time Activities*.

As of July 2004, a monthly steering correction of at most 7 parts in 10^{16} is applied as deemed necessary. Since July 2010, 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 $+4.6 \times 10^{-15}$ to $+6.7 \times 10^{-15}$, with a standard uncertainty of less than 1×10^{-15}. From July 2010 to August 2011, fourteen steering corrections have been applied, giving a total correction to $[f(EAL) - f(TAI)]$ of -9.4×10^{-15}. Since the introduction of the new prediction algorithm in September 2011, monthly steering corrections of -5×10^{-16} have been applied.

2.3 Independent atomic time scales: TT(BIPM)

Because TAI is computed in ‘real-time’ and has operational constraints, it does not provide an optimal realization of TT, the time coordinate of the geocentric reference system. The BIPM therefore computes an additional realization, TT(BIPM), in post-processing, which is based on a weighted average of the evaluation of the TAI frequency by the primary frequency standards. We have provided an updated computation of TT(BIPM), named TT(BIPM10), valid until December 2010, which has an estimated accuracy of about 5 parts in 10^{16}. Moreover we provide each month an extension of TT(BIPM10) based on the most recent TAI computation. Such an extension is useful for pulsar analysis pending the yearly updates of TT(BIPM). Studies aimed at improving the computation of TT(BIPM) are ongoing, in order to keep it in line with improvements in the primary frequency standards.

2.4 Local representations of UTC in national laboratories as broadcast by the GNSS

Following a recommendation by the CCTF (2009), the Time Department has implemented the calculation of the differences between the predictions of UTC(USNO) and UTC(SU) (as broadcast by GPS and GLONASS) and UTC. These differences have been published in BIPM *Circular T* since January 2011.

3 Primary frequency standards and secondary representations of the second

Members of the BIPM Time Department actively participate in the work of the Consultative Committee for Length (CCL)/CCTF Frequency Standards Working Group, and the CCTF Primary Frequency Standards Working Group, seeking to encourage comparisons, knowledge-sharing between laboratories, the creation of better documentation, and the use of high-accuracy primary frequency standards (Cs fountains) for TAI.

The CCL/CCTF Frequency Standards Working Group has proposed various other microwave and optical atomic transitions as secondary representations of the second. The latest changes to the list, containing frequency values and uncertainties for transitions in Rb, Hg^+, Yb^+, Sr^+ and Sr, were recommended by the CCTF in June 2009, and no further updates have been produced during the period covered by this report.

Advanced time and frequency transfer

During the past decade very significant advances have been made in the field of optical frequency metrology, concerning both ultra-stable optical frequency standards as well as the means to compare frequencies locally using the optical comb technique. These developments imply strong requirements on time and frequency transfer techniques, which are not satisfied by the methods currently in common use, and it is urgent to focus attention on this aspect.

A workshop arranged at the BIPM in June 2011, had the objectives to survey the current situation of time and frequency transfer, to project future needs and to study the perspectives for satisfying them.

The workshop was organized by the CCTF Working Group on Coordination of the Development of Advanced Time and Frequency Transfer Techniques (WGATFT) with the support of the BIPM and served as a basis for further work by the WG in support of preparations for future improvements of the SI second and of time scales. Some 50 participants took part in the workshop.

4 Time links

TAI currently relies on data from about 70 participating time laboratories equipped with GNSS receivers and/or operating two-way satellite time and frequency transfer (TWSTFT) stations.

Significant improvements have been made within the Time Department on the time links used for the calculation of TAI; data from three independent techniques are included in the process of comparison of laboratories' clocks based on tracking GPS and GLONASS satellites, and TWSTFT.

The GPS all-in-view method is widely used and takes advantage of the increasing quality of the International GNSS Service (IGS) products (clocks and IGS time). Clock comparisons are possible using C/A code measurements from GPS single-frequency receivers, or dual-frequency, multi-channel GPS geodetic-type receivers (P3). The older GPS single-channel single-frequency receivers have almost disappeared, replaced by either multi-channel single- or dual-frequency receivers. Ten TWSTFT links are officially submitted for use in the computation of TAI, representing 15 % of the time links. Additional TW links exist in the Asia-Pacific region but have not yet been officially introduced into the calculation; various other European laboratories are becoming equipped.

The GPS phase and code data provided by time laboratories is processed each month using the Precise Point Positioning (PPP) technique. Following approval by the CCTF at its meeting in June 2009, such PPP links were introduced in the calculation of TAI from September 2009. Currently, more than 30 laboratories participate regularly, close to 20 of which are used as TAI links. Since 2011, the combination of TWSTFT and PPP (so called TWPPP) is used whenever possible, and generally concerns some ten links for which the two techniques are available. Comparisons of the TAIPPP links with others obtained by TWSTFT and P3 are published monthly on the Time Department's ftp server.

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

After the introduction of the first GLONASS common-view civil-code link between PTB and VNIIFTRI into UTC in November 2009, studies proved that time link uncertainty could be improved by a combination with the corresponding GPS link. As a result, two time links have been regularly computed since January 2011 by a combination of GLONASS and GPS.

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

All GNSS links are corrected for satellite positions using IGS and ESA post-processed, precise satellite ephemerides, and those links using single-frequency receivers are corrected for ionospheric delays using IGS maps of the total electron content of the ionosphere.

4.2 Phase and code measurements from geodetic-type receivers

In addition to GPS and GLONASS code measurements, time and frequency transfer may also be carried out using dual-frequency, carrier-phase measurements. This technique, already widely used by the geodetic community, can be adapted to the needs of time and frequency transfer. A study is being conducted under the framework of the IGS Working Group on Clock Products, of which a physicist from the Time Department is a member.

The method developed to perform the absolute calibration of the Ashtech Z12-T hardware delays allows the BIPM to use this receiver for differential calibrations of similar receivers world-wide, and calibration campaigns began in January 2001. Calibration results have also been issued for other receivers: the Septentrio PolaRx2 since 2006 and the Dicom GTR50 and Javad JPS E-GGD since 2009. Other types of receivers are being investigated in collaboration with laboratories equipped with them. Since 2009, the BIPM travelling receiver for differential calibrations is a GTR50. In all cases, at least two receivers remain at the BIPM to serve as a local reference with which the travelling receiver is compared between calibration trips. Results of the differential calibration exercises are made available on a dedicated web page (www.bipm.org/jsp/en/TimeCalibrations.jsp), where past calibration results are also provided.

Data from geodetic-type receivers world-wide are collected for TAI computation, using procedures and software developed in collaboration with the Observatoire Royal de Belgique (ORB). These P3 time links are now routinely computed and compared to other available techniques, notably two-way time transfer. After one year of work, the software producing GPS P3 (iono-free) data has been upgraded and is now able to produce GLONASS P3. It will be implemented in some receivers to automatically produce both formatted GPS and GLONASS P3 code results. In the future, these new available data are likely to be used in the frame of multi-GNSS system time links, but further studies on inter-frequency biases have to be carried out.

Geodetic-type receivers also provide raw phase measurements which may be used, along with the code measurements, to compute time links. The BIPM has computed its own solutions for such time links since October 2007, using the GPSPPP software from Natural Resources Canada (NRCan), and these links have been introduced into the TAI regular computation since September 2009. In 2011 a new version of the NRCan PPP software was installed. It is capable of processing both GPS and GLONASS data. Comparisons with other PPP software have been carried out and studies are continuing to improve long-term stability brought about by new processing techniques. Cooperation has started with the Space Research Centre in Poland (SRC) to improve GLONASS time transfer.

4.3. Two-way time transfer

Three meetings of the TWSTFT participating stations have been held since July 2010, and the CCTF WG on TWSTFT met at the NIM (Beijing, China) in October 2010 and at NMIJ (Tsukuba, Japan) in September 2011. The TWSTFT technique is currently operational in twelve European, two North American and seven Asia-Pacific time laboratories. Ten TWSTFT links are routinely used in the computation of TAI; four others are in preparation for their introduction or re-introduction into TAI, or for particular studies such as the T2L2 experiment. The TWSTFT technique applied to clock comparisons in TAI is at present reaching its maximum potential with sessions scheduled every two hours.

The BIPM is also involved in the calibration of two-way time-transfer links by comparison with GPS.

Results of time links and link comparison using GNSS single-frequency, dual-frequency and TW observations are published monthly on the Time Department's ftp server (ftp://tai.bipm.org/TimeLink/LkC).

4.4 Uncertainties of TAI time links

The values of the Type A and Type B uncertainties of TAI time links are published in *Circular T*, together with information on the time links used in each monthly calculation. The values of u_A have been individually updated when deemed necessary, depending on the noise level present in the links. Due to upgrading of time transfer equipment at participating laboratories, the Time Department has refined the methods for clock comparison, a re-computation of u_A values, using latest evaluation tools, and has presented the results at a meeting.

4.5 Calibration of delays of time-transfer equipment

The BIPM continues to organize and run campaigns for measuring the relative delays of GPS time equipment in time laboratories that contribute to TAI. From July 2010 to December 2011, GPS and GLONASS time equipment for single- and dual-frequency reception was calibrated. The BIPM also supports TWSTFT calibration trips, using a GPS receiver from our time laboratory.

Work on the absolute calibration of GNSS receivers has been carried out by a Ph.D. student through a collaboration co-financed with the CNES, and involving the LNE-SYRTE. The doctoral thesis "Contribution to the absolute calibration of a GNSS reception chain" was defended in November 2011, completing the planned programme of work. It focused on the development and optimization of a method of absolute calibration to independently determine the electrical delay of each element in a GNSS reception chain (time receiver, antenna and antenna cable) with an overall uncertainty of less than one nanosecond. The absolute calibration method can be used to characterize performance and environmental sensitivity of each component of the acquisition system.

Cooperation continued with EURAMET in obtaining regional support for GNSS equipment calibration in contributing laboratories. This action follows the recommendation CCTF (2009) and opens up the possibility of future interaction with other RMOs.

5 Key comparisons

Key comparison in Time CCTF-K001.UTC

Results of the key comparison in time, CCTF-K001.UTC, involving the time laboratories participating in the CIPM MRA, are published regularly in the form of the monthly BIPM *Circular T*. Guidelines for the characterization of the frequency traceability of local realizations UTC(*k*) to the SI second have been prepared by staff of the Time Department, as requested by the CCTF WG on the CIPM MRA.

Key comparison of stabilized lasers CCL-K11.UTC

As decided at the 98th meeting of the CIPM in 2009, the BIPM continues to support the CCL-K11 key comparison in terms of participation in measurement campaigns as well as in giving general advice. During the period of this report, staff from the Time Department have been involved only in the reporting of the measurement results and no BIPM presence for measurement campaigns took place.

Key comparison of absolute gravimeters CCM.G-K1

The Gravimetry activity at the BIPM has been closed and the absolute gravimeter has been prepared for transfer to a Member State. The Draft A report of the key comparison CCM.G-K1 that was part of the International Comparison of Absolute Gravimeters ICAG-2009 was prepared by the staff of the Time Department and has been endorsed by the CCL-WG. The Draft B report has been submitted to the Consultative Committee for Mass and Related Quantities (CCM) for approval. A scientific article is being written, which covers the full ICAG-2009 comparison, including the Pilot Study results, for submission to a scientific journal.

6 Rapid UTC

The publication of the five-day values of [UTC-UTC(*k*)] in BIPM *Circular T* gives traceability of the SI second to local realizations of UTC. The participating laboratories make predictions of UTC, which are validated after publication of [UTC-UTC(*k*)] with a delay that ranges to 10 days after the last day of data. Clearly, a better prediction could be possible with more frequent publication of [UTC-UTC(*k*)]. Improvement in the prediction of the local time scales will impact on the steering of the various GNSS times, that use values of some UTC(*k*) as references.

With the aim of providing support to National Metrology Institutes (NMIs) and other participants in this direction, and to improve access to UTC, the Time Department has called for expressions of interest for laboratories to participate in a pilot experiment for producing daily values of the differences on a weekly solution. Laboratories are requested to provide daily time transfer files and clocks. The call has been a success, 74 % of the laboratories have responded positively, representing about 86 % of the total clock weight. The pilot experiment will start at the beginning of 2012, and after some studies a report will be submitted to the CCTF in September 2012.

This new study will be published only on the Time Department's ftp server. Nothing in the procedure applied will change for the monthly calculation of UTC, which remains the only key comparison on time.

7 New proposed definition of UTC

The BIPM has actively participated, since 2000, in discussions about a possible redefinition of UTC without leap seconds. This proposal is in favour of systems that need precise time synchronization and does not allow a discontinuity in the time scale that they use as a reference.

The actions of BIPM delegates during this process have been critical at the International Telecommunication Union (ITU), and also in disseminating information and promoting decision making at the level of national representatives. Some of these actions were promoted through the publication of a *Metrologia* Special Issue on Modern Applications of Time Scale in August 2011 (Guest editors: F. Arias and W. Lewandowski), and via the organization of a discussion meeting at the Royal Society on "UTC for the 21st Century" (Organizers: T. Quinn and F. Arias, 3-4 November 2011). The process will conclude with the vote on the recommendation that will take place in January 2012 at the ITU.

8 Pulsars

Some collaboration continues with radioastronomy groups observing pulsars and analyzing pulsar data to study the potential capability of using millisecond pulsars as a means of sensing the very long-term stability of atomic time. The Time Department provides these groups with its post-processed realization of Terrestrial Time, TT(BIPM).

9 Space-time references

The BIPM maintains the web and ftp sites for the *IERS Conventions* (tai.bipm.org/iers/). Updates to the *Conventions* (2003) were posted on the website (tai.bipm.org/iers/convupdt) until the completion of the new reference edition, the *IERS Conventions* (2010) in December 2010. The new edition implements the latest recommendations of scientific unions and the conclusions of the unions' working groups and commissions and describes the latest realizations of the celestial and terrestrial reference frames, and an updated model for the transformation between them. It also describes updated conventional models for the gravitational field and for the effect of ocean tides and complements the models for the displacement of reference points with new models for atmospheric tidal loading and for the oceanic pole tide loading, along with updated or new conventional models for signal propagation in the troposphere and ionosphere. In addition, the *Conventions* now provide a complete set of associated conventional software. These tasks have been carried out with the help of the Advisory Board for the *IERS Conventions* updates, including representatives from all groups involved in the International Earth Rotation and Reference Systems Service (IERS).

Activities related to the realization of reference frames for astronomy and geodesy are being developed in cooperation with the IERS. In these domains, improvements in accuracy will increase the need for a full relativistic treatment and it is essential to continue to participate in international working groups on these matters. Cooperation continues for the maintenance of the international celestial reference system.

Some of the activities on international coordination on space-time references that has been the work of staff of the Time Department converged on the approval by the 24th CGPM of Resolution 9 on the adoption of the International Terrestrial Reference System (ITRS), as defined by the International Union of Geodesy and Geophysics (IUGG) and realized by the IERS. This will now be adopted as the unique international reference system for terrestrial reference frames for all metrological applications.

10 Comb activities

As a result of the reorganization of activities in the Time Department, BIPM comb activities are limited to the maintenance of the BIPM frequency comb for internal use related to laser applications only and in other sections when needed.

11 Publications

11.1 External publications

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11.2 BIPM publications

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Access to electronic files on the FTP server of the BIPM Time Department.

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

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

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

Publications **-** the latest issues on time activities

In the following directories XY represents the last two digits of the year number (19XY or 20XY); ZT equals 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.pdf
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*(*lab*1) - *UTC*(*lab*2)] obtained by the TWSTFT link	lab1 - lab2.tw
BIPM Two-Way Satellite Time and Frequency Transfer Reports (until February 2003)	twstftXX.pdf
Most recent schedules for common-view observations of GPS and	schgps.XX
GLONASS satellites (until April 2008)	schglo.XX

Older files can be accessed directly from the ftp site (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) computation ending in 19XY or 20XY	TTBIPM.XY
Starting 1993:	
Difference between the normalized frequencies of EAL and TAI	EALTAIXY.ar
TAI frequency	FTAIXY.ar (for 1993,1994)
Measurements of the duration of the TAI scale interval	UTAIXY.ar (starting 1995)
Mean duration of TAI scale interval	SITAIXY.ar (1993-1999)
Mean fractional deviation of the TAI scale interval from that of TT duration of TAI scale interval	SITAIXY.ar (starting 2000)
[*TAI* - *GPS time*] and [*UTC* - *GPS time*] (until March 2003)	UTCGPSXY.ar
[*TAI* - *GLONASS time*] and [*UTC* - *GLONASS time*] (until March 2003)	UTCGLOXY.ar
[*TAI* - *GPS time*] and [*UTC* - *GPS time*], [*TAI* - *GLONASS time*] and [*UTC* - *GLONASS time*] (starting April 2003)	UTCGPSGLOXY.ar
Local representations of UTC: Values of [*UTC* - *UTC*(*lab*)]	UTCXY.ar (1993-1998)
Independent local atomic time scales: values of [*TAI* - *TA*(*lab*)]	TAIXY.ar (1993-1998)
Until 1992:	
Local representations of UTC: Values of [*UTC* - *UTC*(*lab*)]	UTC.XY
Local values of [*TAI* - *TA*(*lab*)]	TA.XY

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

Starting with the BIPM Time Section Annual Report for 1999, some tables traditionally included in the printed version are only available in electronic form. From the BIPM Annual Report on Time Activities for 2009, only electronic files are available.

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

Leap seconds

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.

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

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

Telephone: + 33 1 40 51 22 26
Telefax: + 33 1 40 51 22 91
iers@obspm.fr
http://hpiers.obspm.fr
Anonymous ftp://hpiers.obspm.fr or ftp://145.238.203.2

Establishment of International Atomic Time
and of Coordinated Universal Time

1. Data and computation

International Atomic Time (TAI) and Coordinated Universal Time (UTC) are obtained from a combination of data from some 400 atomic clocks kept by almost 70 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 for Modified Julian Dates (MJD) ending in 4 and 9, at 0 h UTC; these dates are referred to here as "standard dates". The equipment maintained by the timing centres is detailed in Table 4.

An iterative algorithm produces a free atomic time scale, EAL (Échelle Atomique Libre), defined as a weighted average of clock readings. The processing is carried out and, subsequently, treats one month batches of data [1] and [2]. The weighting procedure and clock frequency prediction [3] are chosen such 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 frequency 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 an appropriate 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 Table 6 and Table 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.

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

4. Time links

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

Most time links are based on GPS satellite observations. Data from multi-channel dual-frequency GPS geodetic-type receivers are regularly used in the calculation of time links, in addition to that acquired by a few single-frequency (single- or multi-channel) GPS time receivers. For those links realized using more than one technique, one of them is considered official for TAI and the others are calculated as back-ups.

Single-frequency GPS data are corrected using the ionospheric maps produced by the Center for Orbit Determination in Europe (CODE); all GPS data are corrected using precise satellite ephemerides and clocks produced by the International GNSS Service (IGS).

GPS links are computed with the method called "GPS all in view" [4], with a network of time links that uses the PTB as a unique pivot laboratory for all the GPS links. Since September 2009, links equipped with geodetic-type receivers are computed with the "Precise Point Positioning" method [5].

Clock comparisons using GLONASS C/A (L1C frequency) satellite observations with multi-channel receivers have been introduced since October 2009 [6]. These links are computed using the "common-view" [7] method; data are corrected using the ESA ephemerides SP3 files and the IGS ionospheric maps.

Combination of individual TWSTFT and GPS PPP links and of individual GPS and GLONASS links were introduced in January 2011 and are currently used in the calculation of TAI [8, 9]

A figure showing the time link techniques in the contributing laboratories can be downloaded from the BIPM website. For more detailed information on the equipment refer to [Table 4] and to Section 6 of BIPM *Circular T* for the techniques and methods of time transfer officially used.

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

The BIPM regularly publishes an evaluation of [*UTC - GLONASS time*] based on ongoing observations of the GLONASS system at the Astrogeodynamical Observatory (AOS), Poland.

Since 1 January 2011 the BIPM also publishes in *Circular T* daily values of [*UTC – UTC(USNO)_GPS*] and [*UTC – UTC(SU)_GLONASS*] where *UTC(USNO)_GPS* and *UTC(SU)_GLONASS* are respectively, UTC(USNO) and UTC(SU) as predicted by USNO and SU broadcast by GPS and GLONASS.

International GPS tracking schedules are published by the BIPM about every six months.

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 [10, 11]. The successive versions of TT(BIPMxx) are both updates and revisions; they may differ for common dates.

Starting with TT(BIPM09), an extrapolation for the current year of the latest realization TT(BIPMxx) is provided in the file TTBIPMxx.ext. It is updated each month after the TAI computation.

Notes

Tables 8 and 9 of this report give the rates relative to TAI and the weights of the clocks contributing to TAI in 2011.

A full list of time signals and time dissemination services is compiled by the BIPM from the information provided by the time laboratories. The report on the scientific work of the BIPM on time activities for the period July 2010-December 2011 is extracted from the *Director's Report on the Activity and Management* *of the BIPM (1 July 2010 − 31 December 2011).* All the publications mentioned in this report are available on request from the BIPM.

References

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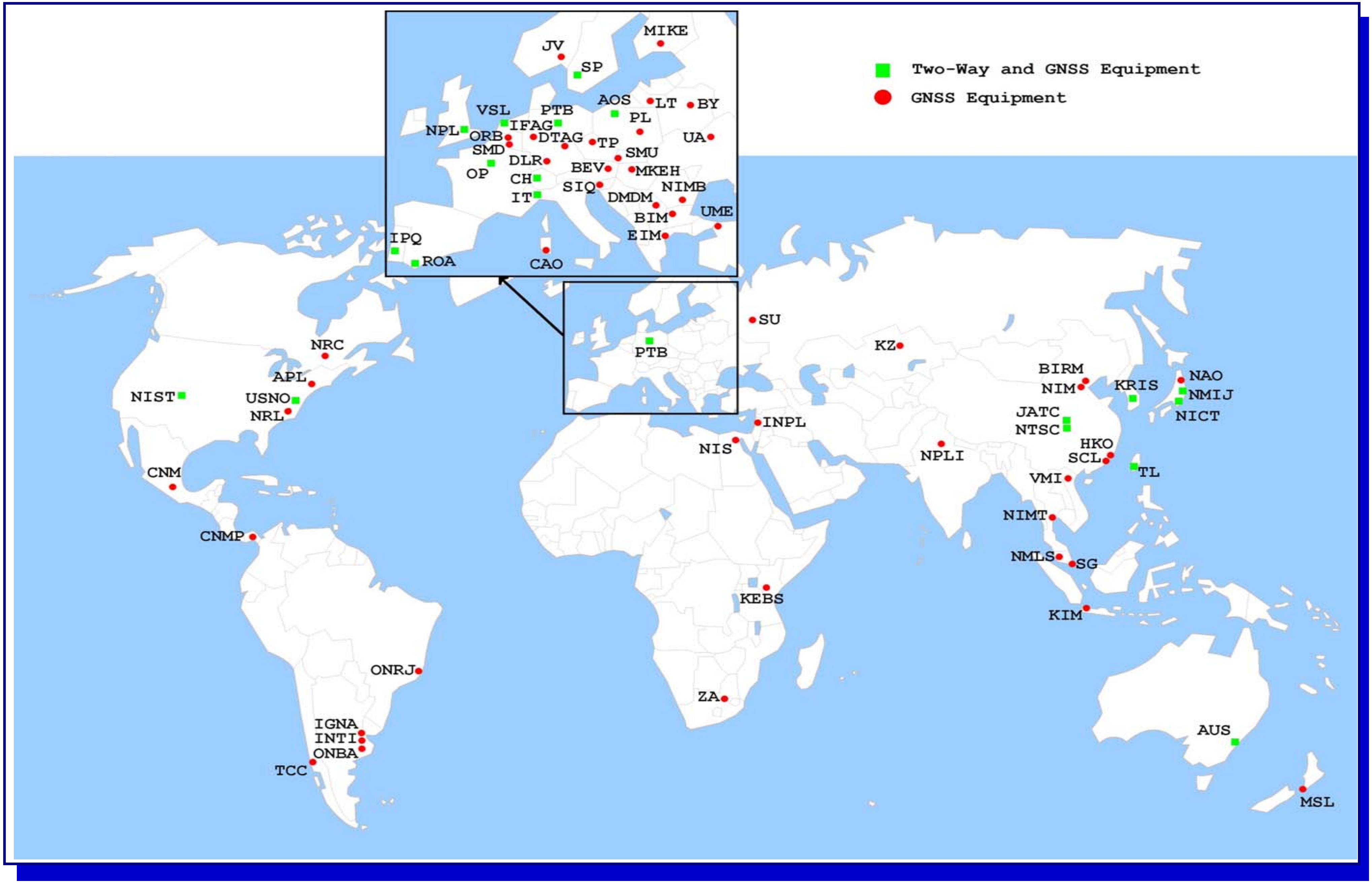
The report on the scientific work of the BIPM on time activities for the period July 2010-December 2011 is extracted from the *Director's Report on the Activity and Management of the BIPM (1 July 2010 − 31 December 2011).* All the publications mentioned in this report are available on request from the BIPM.



Geographical distribution of the laboratories that contribute to TAI and time transfer equipment (April 2012)

Table 1. Relative frequency offsets and step adjustments of UTC, up to 31 December 2012

Date (at 0 h UTC)	Offsets	Steps/s
1961 Jan. 1	-150×10^{-10}	
1961 Aug. 1	"	+0.050
1962 Jan. 1	-130×10^{-10}	
1963 Nov. 1	"	-0.100
1964 Jan. 1	-150×10^{-10}	
1964 Apr. 1	"	-0.100
1964 Sep. 1	"	-0.100
1965 Jan. 1	"	-0.100
1965 Mar. 1	"	-0.100
1965 Jul. 1	"	-0.100
1965 Sep. 1	"	-0.100
1966 Jan. 1	-300×10^{-10}	
1968 Feb. 1	"	+0.100
1972 Jan. 1	0	-0.107 7580
1972 Jul. 1	"	-1
1973 Jan. 1	"	-1
1974 Jan. 1	"	-1
1975 Jan. 1	"	-1
1976 Jan. 1	"	-1
1977 Jan. 1	"	-1
1978 Jan. 1	"	-1
1979 Jan. 1	"	-1
1980 Jan. 1	"	-1
1981 Jul. 1	"	-1
1982 Jul. 1	"	-1
1983 Jul. 1	"	-1
1985 Jul. 1	"	-1
1988 Jan. 1	"	-1
1990 Jan. 1	"	-1
1991 Jan. 1	"	-1
1992 Jul. 1	"	-1
1993 Jul. 1	"	-1
1994 Jul. 1	"	-1
1996 Jan. 1	"	-1
1997 Jul. 1	"	-1
1999 Jan. 1	"	-1
2006 Jan. 1	"	-1
2009 Jan. 1	"	-1
2012 Jul. 1	"	-1

Table 2. Relationship between TAI and UTC, up to 31 December 2012

Limits of validity (at 0 h UTC)	[*TAI* - *UTC*] / s
1961 Jan. 1 - 1961 Aug. 1	1.422 8180 + (MJD - 37300) x 0.001 296
1961 Aug. 1 - 1962 Jan. 1	1.372 8180 + " "
1962 Jan. 1 - 1963 Nov. 1	1.845 8580 + (MJD - 37665) x 0.001 1232
1963 Nov. 1 - 1964 Jan. 1	1.945 8580 + " "
1964 Jan. 1 - 1964 Apr. 1	3.240 1300 + (MJD - 38761) x 0.001 296
1964 Apr. 1 - 1964 Sep. 1	3.340 1300 + " "
1964 Sep. 1 - 1965 Jan. 1	3.440 1300 + " "
1965 Jan. 1 - 1965 Mar. 1	3.540 1300 + " "
1965 Mar. 1 - 1965 Jul. 1	3.640 1300 + " "
1965 Jul. 1 - 1965 Sep. 1	3.740 1300 + " "
1965 Sep. 1 - 1966 Jan. 1	3.840 1300 + " "
1966 Jan. 1 - 1968 Feb. 1	4.313 1700 + (MJD - 39126) x 0.002 592
1968 Feb. 1 - 1972 Jan. 1	4.213 1700 + " "
1972 Jan. 1 - 1972 Jul. 1	10 (integral number of seconds)
1972 Jul. 1 - 1973 Jan. 1	11
1973 Jan. 1 - 1974 Jan. 1	12
1974 Jan. 1 - 1975 Jan. 1	13
1975 Jan. 1 - 1976 Jan. 1	14
1976 Jan. 1 - 1977 Jan. 1	15
1977 Jan. 1 - 1978 Jan. 1	16
1978 Jan. 1 - 1979 Jan. 1	17
1979 Jan. 1 - 1980 Jan. 1	18
1980 Jan. 1 - 1981 Jul. 1	19
1981 Jul. 1 - 1982 Jul. 1	20
1982 Jul. 1 - 1983 Jul. 1	21
1983 Jul. 1 - 1985 Jul. 1	22
1985 Jul. 1 - 1988 Jan. 1	23
1988 Jan. 1 - 1990 Jan. 1	24
1990 Jan. 1 - 1991 Jan. 1	25
1991 Jan. 1 - 1992 Jul. 1	26
1992 Jul. 1 - 1993 Jul. 1	27
1993 Jul. 1 - 1994 Jul. 1	28
1994 Jul. 1 - 1996 Jan. 1	29
1996 Jan. 1 - 1997 Jul. 1	30
1997 Jul. 1 - 1999 Jan. 1	31
1999 Jan. 1 - 2006 Jan. 1	32
2006 Jan. 1 - 2009 Jan. 1	33
2009 Jan. 1 - 2012 Jul. 1	34
2012 Jul. 1 -	35

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*)

AMC	Alternate Master Clock station, Colorado Springs, Colo., USA
AOS	Astrogeodynamical Observatory, Space Research Centre P.A.S., Borowiec, Poland
APL	Applied Physics Laboratory, Laurel, Maryland, USA
AUS	Consortium of laboratories in Australia
BEV	Bundesamt für Eich- und Vermessungswesen, Vienna, Austria
BIM	Bulgarian Institute of Metrology, Sofiya, Bulgaria, formerly NMC
BIRM	Beijing Institute of Radio Metrology and Measurement, Beijing, P. R. China
BY	Belarussian State Institute of Metrology, Minsk, Belarus
CAO	Stazione Astronomica di Cagliari (Cagliari Astronomical Observatory), Cagliari, Italy
CH	METAS Swiss Federal Office of Metrology, Bern-Wabern, Switzerland
CNM	Centro Nacional de Metrología, Querétaro, Mexico (CENAM)
CNMP	Centro Nacional de Metrología de Panamá, Panama
DLR	Deutsche Zentrum für Luft- und Raumfahrt (German Aerospace Centre) Oberpfaffenhofen, Germany
DMDM	Directorate of Measures and Precious Metals, Belgrade, Serbia (formerly ZMDM)
DTAG	Deutsche Telekom AG, Frankfurt/Main, Germany
EIM	Hellenic Institute of Metrology, Thessaloniki, Greece
F	Commission Nationale de l'Heure, Paris, France
GUM	Glówny Urząd Miar (Central Office of Measures), Warsaw, Poland
HKO	Hong Kong Observatory, Hong Kong, China
IFAG	Bundesamt für Kartographie und Geodäsie (Federal Agency for Cartography and Geodesy), Fundamental station, Wettzell, Kötzting, Germany
IGNA	Instituto Geográfico Nacional, Buenos Aires, Argentina (formerly IGMA)
INPL	National Physical Laboratory, Jerusalem, Israel
INTI	Instituto Nacional de Tecnologia Industrial, Buenos Aires, Argentina
IPQ	Instituto Português da Qualidade, Monte de Caparica, Portugal
IT	Istituto Nazionale di Ricerca Metrologica (INRIM), Torino, Italy
JATC	Joint Atomic Time Commission, Lintong, P.R. China
JV	Justervesenet, Norwegian Metrology and Accreditation Service, Kjeller, Norway
KEBS(1)	Kenya Bureau of Standards, Nairobi, Kenya
KIM	Research Centre for Calibration, Instrumentation and Metrology The Indonesian Institute of Sciences, Serpong-Tangerang, Indonesia
KRIS	Korea Research Institute of Standards and Science, Daejeon, Rep. of Korea
KZ	Kazakhstan Institute of Metrology, Astana, Rep. of Kazakhstan
MIKE	Center for Metrology and Accreditation, Espoo, Finland
MKEH	Hungarian Trade Licensing Office, Budapest, Hungary
LT	Center for Physical Sciences and Technology, Vilnius, Lithuania
LV(2)	SA Latvian National Metrology Centre, Riga, Latvia
MSL	Measurement Standards Laboratory, Lower Hutt, New Zealand
NAO	National Astronomical Observatory, Misuzawa, Japan
NICT	National Institute of Information and Communications Technology, Tokyo, Japan
NIM	National Institute of Metrology, Beijing, P.R. China
NIMB	National Institute of Metrology, Bucharest, Romania

(1) KEBS Participates since January 2012.

(2) LV Time activities are suspended since February 2011 for an undetermined period.

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.)

NIMT	National Institute of Metrology, Pathumthani, Thailand
NIS	National Institute for Standards, Cairo, Egypt
NIST	National Institute of Standards and Technology, Boulder, Colo., USA
NMIA	National Measurement Institute, Australia, Sydney, Australia
NMIJ	National Metrology Institute of Japan, Tsukuba, Japan
NMLS	National Metrology Laboratory of SIRIM Berhad, Shah Alam, Malaysia
NPL	National Physical Laboratory, Teddington, United Kingdom
NPLI	National Physical Laboratory, New Delhi, India
NRC	National Research Council of Canada, Ottawa, Canada
NRL	U.S. Naval Research Laboratory, Washington D.C., USA
NTSC	National Time Service Center of China, Lintong, P.R. China
ONBA	Observatorio Naval, Buenos Aires, Argentina
ONRJ	Observatório Nacional, Rio de Janeiro, Brazil
OP	Observatoire de Paris (Paris Observatory), Paris, France
ORB	Observatoire Royal de Belgique (Royal Observatory of Belgium), Brussels, Belgium
PL	Consortium of laboratories in Poland
PTB	Physikalisch-Technische Bundesanstalt, Braunschweig, Germany
ROA	Real Instituto y Observatorio de la Armada, San Fernando, Spain
SCL	Standards and Calibration Laboratory, Hong Kong (China)
SG	National Metrology Centre - Agency for Science, Technology and Research (A*STAR), Singapore
SIQ	Slovenian Institute of Quality and Metrology, Ljubljana, Slovenia
SMD	Metrology Division of the Quality and Safety Department - Scientific Metrology Brussels, Belgium
SMU	Slovenský Metrologičký 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, Russian Federation
TCC	TIGO Concepción Chile, Chile
TL	Telecommunication Laboratories, Chung-Li, Taiwan
TP	Institute of Photonics and Electronics, Czech Academy of Sciences, Praha, Czech Republic
UA	National Science Center "Institute of Metrology", Kharkhov, Ukraine
UME	Ulusai Metroloji Enstitüsü, Marmara Research Centre, (National Metrology Institute), Gebze Kocaeli, Turkey
USNO	U.S. Naval Observatory, Washington D.C., USA
VMI	Vietnam Metrology Institute, Ha Noi, Viet Nam
VSL	VSL Dutch Metrology Institute, Delft, Netherlands
ZA	National Metrology Institute of South Africa, Pretoria, South Africa

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 2011

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	GPS DF	GLONASS	Two-Way
AOS	3 Ind. Cs 2 H-masers	1 H-maser (2) + microphase-stepper	* (9)	*	*	*	*
APL	3 Ind. Cs 3 H-masers	1 H-maser + frequency synthesizer steered to UTC(APL)		*			
AUS	5 Ind. Cs 2 H-masers	1 Cs		*	*		*
BEV	3 Ind. Cs 1 H-maser	1 Cs		*	*	*	
BIM	3 Ind. Cs	1 Cs		*	*		
BIRM	2 Ind. Cs 3 H-masers	1 Cs		*	*		
BY (a)	6 H-masers	3-4 H-masers		*		*	
CAO (a)	2 Ind. Cs	1 Cs		*	*	*	
CH	4 Ind. Cs (3) 1 H-maser	all the Cs 1 H-maser	*		*		*
CNM	3 Ind. Cs 1 H-maser	3 Ind. Cs 1 H-maser + microphase-stepper			*		
CNMP	2 Ind. Cs	1 Cs + frequency offset generator		*			
DLR (a)	3 Ind. Cs 5 H-masers	1 Cs			*		
DMDM	2 Ind. Cs	1 Cs + microphase-stepper		*			
DTAG	3 Ind. Cs	1 Cs		*	*		
EIM	4 Ind. Cs	1 Cs		*			
HKO	2 Ind. Cs	1 Cs		*			
IFAG	5 Ind. Cs 2 H-masers	1 Cs + microphase-stepper		*	*		
IGNA	3 Ind. Cs	1 Cs + microphase-stepper		*			

Table 4. Equipment and source of UTC(*k*) of the laboratories contributing to TAI in 2011 (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		
INPL	2 Ind. Cs	1 Cs			*	*	
INTI (a)	1 Ind. Cs	1 Cs		*			
IPQ	3 Ind. Cs	1 Cs + microphase-stepper			*	*	*
IT	6 Ind. Cs 3 H-masers 2 Lab. Cs	1 H-maser + microphase-stepper	*	*	*	*	*
JATC	(4)	1 Cs + microphase-stepper	*				
JV	4 Ind. Cs	1 Cs + microphase-stepper (5)		*			
KIM	1 Ind. Cs	1 Cs		*	*	*	
KRIS	5 Ind. Cs 3 H-masers	1 H-maser + microphase-stepper	*	*	*	*	*
KZ	4 Ind. Cs	1 Cs + microphase-stepper			*	*	
LT (a)	2 Ind. Cs	1 Cs		*			
LV (b)	2 Ind. Cs	1 Cs		*			
MIKE	2 Ind. Cs 3 H-masers	1 H-maser + microphase-stepper		*	*		
MKEH	1 Ind. Cs	1 Cs		*			
MSL	3 Ind. Cs	1 Cs + microphase-stepper		*	*		
NAO	4 Ind. Cs 1 H-maser	1 Cs + microphase-stepper		*			
NICT	29 Ind. Cs 7 H-masers (6) 1 Lab. Cs	18 Cs	*	*	*		*
NIM	2 Ind. Cs 1 H-masers	1 H-maser + microphase-stepper		*	*		
NIMB	2 Ind. Cs	1 Cs		*	*		

Table 4. Equipment and source of UTC(*k*) of the laboratories contributing to TAI in 2011 (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		
NIMT	2 Ind. Cs	1 Cs + microphase-stepper		*	*		
NIS	3 Ind. Cs	1 Cs		*	*	*	
NIST	10 Ind. Cs 2 Lab. Cs 6 H-masers	5 Cs 6 H-masers + microphase-stepper	*	*	*	*	*
NMIJ	4 Ind. Cs 1 Lab. Cs 4 H-masers	1 H-maser + microphase-stepper		*	*		*
NMLS	2 Ind. Cs	1 Cs			*		
NPL	3 Ind. Cs 4 H-masers	1 H-maser		*	*		*
NPLI	5 Ind. Cs	1 Cs		*			
NRC	6 Ind. Cs 2 Lab. Cs 3 H-masers	1 Ind. Cs + microphase-stepper	*		*		
NRL (a)	4 Ind. Cs 3 H-masers	1 H-maser + microphase-stepper			*		
NTSC	18 Ind. Cs 3 H-masers	1 Cs + microphase-stepper	*	*	*		*
ONBA	2 Ind. Cs	1 Cs		*			
ONRJ	8 Ind. Cs 1 H-maser	8 Cs 1 H-maser + microphase-stepper	* (7)	*			
OP	7 Ind. Cs 3 Lab. Cs 4 H-masers	1 Cs + microphase-stepper	* (8)	*	*	*	*
ORB (a)	3 Ind. Cs 2 H-masers	1 H-maser			*		
PL	11 Ind. Cs 4 H-masers	1 Cs (9) + microphase-stepper	* (10)	*			
PTB	3 Ind. Cs 4 Lab. Cs (11) 3 H-masers	1 H-maser (12) + microphase-stepper	* (12)	*	*	*	*
ROA	6 Ind. Cs (13) 1 H-maser	1 H-maser + frequency synthesizer steered to UTC(ROA) (14)		*	*	*	*

Table 4. Equipment and source of UTC(*k*) of the laboratories contributing to TAI in 2011 (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		
SCL	2 Ind. Cs	1 Cs + microphase-stepper		*			
SG	4 Ind. Cs 1 H-maser	1 H-maser + microphase-stepper	*	*	*	*	
SIQ	1 Ind. Cs	1 Cs		*			
SMD	4 Ind. Cs 1 H-maser	1 Cs + microphase-stepper		*			
SMU	1 Ind. Cs	1 Cs + output frequency steering		*	*	*	
SP	13 Ind. Cs (15) 7 H-masers	1 H-maser + microphase-stepper			*		*
SU	1 Lab. Cs 8 H-masers	4-8 H-masers	*		*	*	
TCC	3 Ind. Cs 3 H-masers	1 Cs		*	*		
TL	13 Ind. Cs 2 H-masers	1 H-maser + microphase-stepper	* (16)		*		*
TP	4 Ind. Cs	1 Cs + output frequency steering			*		
UA (a)	1 Ind. Cs 3 H-masers	3 H-masers + microphase-stepper		*			
UME	5 Ind. Cs	1 Cs		*	*	*	
USNO	70 Ind. Cs 29 H-masers	1 H-maser + frequency synthesizer steered to UTC(USNO) (17)	* (17)	*	*		*
VMI (a)	3 Ind. Cs	1 Cs + microphase-stepper			*		
VSL	4 Ind. Cs	1 Cs + microphase-stepper			*		*
ZA	4 Ind. Cs	1 Cs			*		

Notes

(a)		Information based on the Annual Report for 2010, not confirmed by the laboratory.
(b)		Time activities are suspended since february 2011 for an undetermined period.
(1)		When several clocks are indicated as source of UTC(*k*), laboratory k computes a software clock, steered to UTC. Often a physical realization of UTC(*k*) is obtained using a Cs clock and a micro-phase-stepper.
(2)	AOS	The UTC(AOS) is formed technically using 1 hydrogen maser and microstepper, it is steered using TA(PL) data as a reference.
(3)	CH	All the standards are located in Bern at METAS (Federal Office of Metrology). Since November 2007, UTC(CH) is defined in real time by a hydrogen maser steered to the paper time scale UTC(CH.P) which is defined as a weighted average of all the clocks, steered to UTC. TA(CH) is also a weighted average of all the clocks, but free running.
(4)	JATC	The standards are located at National Time Service Centre (NTSC). The link between UTC(JATC) and UTC(NTSC) is obtained by internal connection.
(5)	JV	Until 31 July 2011 source of UTC(JV) was 1 Cs. From 1 August 2011 source of UTC(JV) is 1 Cs + micro phase-stepper.
(6)	NICT	The standards are located as follows (at the end of 2011):

* Koganei Headquarters	20 Cs, 7 H-masers
* Ohtakadoya-yama LF station	3 Cs
* Hagane-yama LF station	5 Cs
* Kobe Advanced ICT Research Center	2 Cs

(7)	ONRJ	The Brazilian atomic time scale TA(ONRJ) is computed by the National Observatory Time Service Division in Rio de Janeiro with data from 8 industrial caesium clocks and 1 hydrogen maser.
(8)	OP	The French atomic time scale TA(F) is computed by the LNE-SYRTE with data from 26 industrial caesium clocks located as follows (at the end of 2011) :

* Centre Electronique de l'Armement (CELAR, Rennes)	2 Cs
* Centre National d'Etudes Spatiales (CNES, Toulouse)	4 Cs
* France Telecom Recherche et Developpement (Lannion)	2 Cs
* Agilent Technologies France (Massy)	1 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)	4 Cs
* Spectracom, Orolia (Les Ulis)	1 Cs

All laboratories are linked via GPS receivers.

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

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

Notes (Cont.)

(10) PL The Polish atomic timescale TA(PL) is computed by the AOS and GUM with data from 13 cesium clocks and 4 hydrogen masers located as follows:

* Central Office of Measures (GUM, Warsaw)	3 Cs, 1 H-maser
* Astrogeodynamical Observatory, Space Research Center P.A.S. (AOS, Borowiec)	2 Cs, 2 H-masers
* National Institute of Telecommunications (IŁ, Warsaw)	2 Cs
* Polish Telecom (TPSA, Warsaw)	3 Cs
* Military Primary Standards Laboratory (CWOM, Warsaw)	1 Cs, 1 H-maser

and additionally

* Time and Frequency Standard Laboratory of the Semiconductor Physics Institute, a guest laboratory from Lithuania (LT, Vilnius, Lithuania)	2 Cs

All laboratories are linked via MC GPS-CV, except for two clocks of TPSA linked via two-directional optical fiber connection.

(11) PTB The laboratory Cs, PTB CS1 and PTB CS2 are operated continuously as clocks. PTB CSF1 and CSF2 are fountain frequency standards using laser cooled caesium atoms. Both are intermittently operated as frequency standards. Contributions to TAI are made through comparisons with one of PTB's hydrogen masers.

(12) PTB UTC(PTB) is based on the output of an active hydrogen maser steered in frequency since MJD 55224 (February 2010). *TA*(*PTB*)-*UTC*(*PTB*) is published in PTB Time Service Bulletin.

(13) ROA The standards are located as follows (during the whole year 2011):

* Real Observatorio de la Armada en San Fernando	5 Cs, 1 H-maser
* Centro Español de Metrología	1 Cs

(14) ROA Since March 2009, UTC(ROA) is defined in real time by an hydrogen maser, steered to the paper time scale UTC(ROA) which is defined as a weighted average of all the clocks, steered to UTC.

(15) SP The standards are located as follows (at the end of 2011):

* SP Technical Research Institute of Sweden (SP, Borås)	4 Cs, 2 H-masers
* STUPI AB (Stockholm)	7 Cs, 3 H-masers
* Pendulum Instruments AB (Stockholm)	1 Cs
* Onsala Space Observatory (Onsala)	1 CS, 2 H-masers

(16) TL TA(TL) is generated from a 13-caesium-clock ensemble.

(17) 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 hydrogen 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.

Table 5. Differences between the normalized frequencies of EAL and TAI, up to March 2012

(File containing values since the beginning of the steering is available at ftp://62.161.69.5/pub/tai/scale/ealtai11.ar)

Date	MJD	[f(EAL) - f(TAI)] x 10^{-13}
2008 Jan 29 - 2008 Feb 28	54494 - 54524	6.772
2008 Feb 28 - 2008 Mar 29	54524 - 54554	6.769
2008 Mar 29 - 2008 Apr 28	54554 - 54584	6.766
2008 Apr 28 - 2008 May 28	54584 - 54614	6.763
2008 May 28 - 2008 Jun 27	54614 - 54644	6.758
2008 Jun 27 - 2008 Jul 27	54644 - 54674	6.753
2008 Jul 27 - 2008 Aug 31	54674 - 54709	6.750
2008 Aug 31 - 2008 Sep 30	54709 - 54739	6.747
2008 Sep 30 - 2008 Oct 30	54739 - 54769	6.742
2008 Oct 30 - 2008 Nov 29	54769 - 54799	6.739
2008 Nov 29 - 2008 Dec 29	54799 - 54829	6.736
2008 Dec 29 - 2009 Jan 28	54829 - 54859	6.731
2009 Jan 28 - 2009 Feb 27	54859 - 54889	6.726
2009 Feb 27 - 2009 Mar 29	54889 - 54919	6.721
2009 Mar 29 - 2009 Apr 28	54919 - 54949	6.716
2009 Apr 28 - 2009 May 28	54949 - 54979	6.711
2009 May 28 - 2009 Jun 27	54979 - 55009	6.706
2009 Jun 27 - 2009 Jul 27	55009 - 55039	6.701
2009 Jul 27 - 2009 Aug 31	55039 - 55074	6.696
2009 Aug 31 - 2009 Sep 30	55074 - 55104	6.691
2009 Sep 30 - 2009 Oct 30	55104 - 55134	6.686
2009 Oct 30 - 2009 Nov 29	55134 - 55164	6.681
2009 Nov 29 - 2009 Dec 29	55164 - 55194	6.676
2009 Dec 29 - 2010 Jan 28	55194 - 55224	6.671
2010 Jan 28 - 2010 Feb 27	55224 - 55254	6.666
2010 Feb 27 - 2010 Mar 29	55254 - 55284	6.661
2010 Mar 29 - 2010 Apr 28	55284 - 55314	6.656
2010 APR 28 - 2010 MAY 28	55314 - 55344	6.651
2010 MAY 28 - 2010 JUN 27	55344 - 55374	6.645
2010 JUN 27 - 2010 JUL 27	55374 - 55404	6.639
2010 JUL 27 - 2010 AUG 26	55404 - 55434	6.633
2010 AUG 26 - 2010 SEP 30	55434 - 55469	6.626
2010 SEP 30 - 2010 OCT 30	55469 - 55499	6.619
2010 OCT 30 - 2010 NOV 29	55499 - 55529	6.612
2010 NOV 29 - 2010 DEC 29	55529 - 55559	6.605
2010 DEC 29 - 2011 JAN 28	55559 - 55589	6.598
2011 JAN 28 - 2011 FEB 27	55589 - 55619	6.591
2011 FEB 27 - 2011 MAR 29	55619 - 55649	6.584
2011 MAR 29 - 2011 APR 28	55649 - 55679	6.577
2011 APR 28 - 2011 MAY 28	55679 - 55709	6.570
2011 MAY 28 - 2011 JUN 27	55709 - 55739	6.563
2011 JUN 27 - 2011 JUL 27	55739 - 55769	6.556
2011 JUL 27 - 2011 AUG 31	55769 - 55804	6.551
2011 AUG 31 - 2011 SEP 30	55804 - 55834	6.546
2011 SEP 30 - 2011 OCT 30	55834 - 55864	6.541
2011 OCT 30 - 2011 NOV 29	55864 - 55894	6.536
2011 NOV 29 - 2011 DEC 29	55894 - 55924	6.531
2011 DEC 29 - 2012 JAN 28	55924 - 55954	6.526
2012 JAN 28 - 2012 FEB 27	55954 - 55984	6.521
2012 FEB 27 - 2012 MAR 28	55984 - 56014	6.516

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 at ftp://62.161.69.5/pub/tai/scale/utai11.ar)

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

In this table, *d* is obtained on the given periods of estimation by comparison of the TAI frequency with that of the individual primary frequency standards (PFS) IT-CSF1, NICT-CSF1, NIST-F1, NMIJ-F1, NPL-CSF2, PTB-CS1, PTB-CS2, PTB-CSF1, PTB-CSF2, SYRTE-FO1, SYRTE-FO2, SYRTE-FOM and SYRTE-JPO for the year 2011. Previous calibrations are available in the successive annual reports of the BIPM Time Section volumes 1 to 18 and in the BIPM annual report on time activities volumes 1 to 5.

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,
$u_{link/lab}$ is the uncertainty in the link between the PFS and the clock participating to TAI, including the uncertainty due to dead-time,
$u_{link/TAI}$ is the uncertainty in the link to TAI, computed using the standard uncertainty of [UTC-UTC(k)],
u is the quadratic sum of all four uncertainty values.

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

The typical characteristics of the calibrations of the TAI frequency provided by the different primary standards over 2011 are indicated below. Reports of individual PFS evaluations may be found at ftp://62.161.69.5/pub/tai/data/PFS_reports. Subdirectory named 'data'. Ref(u_B) is a reference giving information on the stated value of u_B, u_B(Ref) is the u_B value stated in this reference. Note that the current u_B values are generally not the same as the peer reviewed values given in Ref(u_B).

Primary Standard	Type /selection	Type B std. uncertainty	u_B(Ref)/10^{-15}	Ref(u_B)	Comparison with	Number/typical duration of comp.
IT-CSF1	Fountain	0.7×10^{-15}	0.5	[1]	H maser	1 / 25 d
NICT-CSF1	Fountain	$(1.0\text{ to }1.2)\times10^{-15}$	1.9	[2]	UTC(NICT)	2 / 10 d to 20 d
NIST-F1	Fountain	0.31×10^{-15}	0.35	[3]	H maser	5 / 15 d to 30 d
NMIJ-F1	Fountain	3.9×10^{-15}	3.9	[4]	H maser	2 / 30 d
NPL-CSF2	Fountain	$(0.40\text{ or }0.41)\times10^{-15}$	0.41	[5]	H maser	5 / 15 d to 25 d
NPL-CSF2	Fountain	0.23×10^{-15}	0.23	[6]	H maser	2 / 15 d to 25 d
PTB-CS1	Beam /Mag.	8×10^{-15}	8.	[7]	TAI	12 / 30 d to 35 d
PTB-CS2	Beam /Mag.	12×10^{-15}	12.	[8]	TAI	7 / 30 d to 35 d
PTB-CSF1	Fountain	$(0.74\text{ to }0.79)\times10^{-15}$	1.4	[9]	H maser	10 / 15 d to 25 d
PTB-CSF2	Fountain	$(0.36\text{ to }0.54)\times10^{-15}$	0.8	[10]	H maser	5 / 15 d to 25 d
PTB-CSF2	Fountain	0.56×10^{-15}	0.41	[11]	H maser	1 / 20 d
SYRTE-FO1	Fountain	$(0.42\text{ to }0.49)\times10^{-15}$	0.72	[12]	H maser	6 / 10 d to 25 d
SYRTE-FO2	Fountain	$(0.26\text{ to }0.39)\times10^{-15}$	0.65	[12]	H maser	12 / 15 d to 35 d
SYRTE-FOM	Fountain	$(0.82\text{ to }0.92)\times10^{-15}$	0.80	[13]	H maser	6 / 20 d 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		$d/10^{-15}$	$u_A/10^{-15}$	$u_B/10^{-15}$	$u_{link/lab}$ $/10^{-15}$	$u_{link/TAI}$ $/10^{-15}$	$u/10^{-15}$	Notes
IT-CsF1	55564	55589	9.91	0.30	0.70	0.30	0.54	0.98	
NICT-CsF1	55554	55574	3.79	1.00	1.00	0.30	0.28	1.47	
NICT-CsF1	55864	55874	4.15	1.00	1.20	0.30	0.53	1.68	
NIST-F1	55574	55589	5.20	0.46	0.31	0.25	0.37	0.71	
NIST-F1	55634	55649	5.71	0.50	0.31	0.18	0.37	0.72	
NIST-F1	55744	55759	7.25	0.60	0.31	0.29	0.37	0.82	
NIST-F1	55794	55814	6.89	0.44	0.31	0.19	0.28	0.64	
NIST-F1	55894	55924	2.38	0.31	0.31	0.20	0.20	0.52	
NMIJ-F1	55559	55589	6.34	0.70	3.90	0.30	0.20	3.98	
NMIJ-F1	55589	55619	5.92	0.70	3.90	0.30	0.20	3.98	
NPL-CsF2	55554	55569	8.10	0.29	0.40	0.10	0.97	1.10	
NPL-CsF2	55579	55599	5.13	0.23	0.40	0.01	0.75	0.88	
NPL-CsF2	55669	55684	4.89	0.32	0.41	0.07	0.97	1.11	
NPL-CsF2	55709	55734	3.78	0.21	0.41	0.03	0.46	0.65	
NPL-CsF2	55744	55759	4.52	0.27	0.40	0.03	0.49	0.69	
NPL-CsF2	55789	55804	4.47	0.28	0.23	0.01	0.49	0.61	
NPL-CsF2	55864	55889	3.88	0.22	0.23	0.02	0.23	0.39	
PTB-CS1	55559	55589	-2.21	6.00	8.00	0.00	0.13	10.00	(1)
PTB-CS1	55589	55619	4.11	6.00	8.00	0.00	0.13	10.00	
PTB-CS1	55619	55649	-6.78	6.00	8.00	0.00	0.13	10.00	
PTB-CS1	55649	55679	-11.60	6.00	8.00	0.00	0.13	10.00	
PTB-CS1	55679	55709	-3.20	6.00	8.00	0.00	0.13	10.00	
PTB-CS1	55709	55739	-9.15	6.00	8.00	0.00	0.13	10.00	
PTB-CS1	55739	55769	-8.61	6.00	8.00	0.00	0.13	10.00	
PTB-CS1	55769	55804	-2.04	6.00	8.00	0.00	0.11	10.00	
PTB-CS1	55804	55834	-5.33	6.00	8.00	0.00	0.13	10.00	
PTB-CS1	55834	55864	-8.65	6.00	8.00	0.00	0.13	10.00	
PTB-CS1	55864	55894	-6.68	6.00	8.00	0.00	0.13	10.00	
PTB-CS1	55894	55924	-12.00	6.00	8.00	0.00	0.13	10.00	
PTB-CS2	55709	55739	1.31	3.00	12.00	0.00	0.13	12.37	(1)
PTB-CS2	55739	55769	9.06	3.00	12.00	0.00	0.13	12.37	
PTB-CS2	55769	55804	1.47	3.00	12.00	0.00	0.11	12.37	
PTB-CS2	55804	55834	1.31	3.00	12.00	0.00	0.13	12.37	
PTB-CS2	55834	55864	-0.97	3.00	12.00	0.00	0.13	12.37	
PTB-CS2	55864	55894	5.36	3.00	12.00	0.00	0.13	12.37	
PTB-CS2	55894	55924	5.90	3.00	12.00	0.00	0.13	12.37	
PTB-CSF1	55539	55564	7.03	0.23	0.76	0.02	0.15	0.81	
PTB-CSF1	55569	55589	6.48	0.32	0.76	0.03	0.19	0.85	
PTB-CSF1	55634	55654	5.68	0.11	0.76	0.02	0.19	0.79	
PTB-CSF1	55659	55674	7.04	0.14	0.76	0.02	0.24	0.81	
PTB-CSF1	55694	55709	6.92	0.24	0.76	0.02	0.24	0.83	
PTB-CSF1	55714	55729	6.64	0.17	0.79	0.02	0.24	0.84	
PTB-CSF1	55774	55794	5.79	0.12	0.77	0.01	0.19	0.80	
PTB-CSF1	55804	55824	4.67	0.12	0.74	0.01	0.19	0.77	
PTB-CSF1	55854	55869	4.75	0.15	0.74	0.01	0.24	0.79	
PTB-CSF1	55874	55894	4.49	0.15	0.74	0.01	0.19	0.78	

Table 6. (Cont.)

Standard	Period of estimation		$d/10^{-15}$	$u_A/10^{-15}$	$u_B/10^{-15}$	$u_{link/lab}/10^{-15}$	$u_{link/TAI}/10^{-15}$	$u/10^{-15}$	Notes
PTB-CSF2	55629	55644	6.81	0.21	0.54	0.02	0.24	0.63	
PTB-CSF2	55659	55679	7.31	0.16	0.46	0.02	0.19	0.52	
PTB-CSF2	55694	55709	6.83	0.20	0.42	0.03	0.24	0.53	
PTB-CSF2	55774	55799	5.69	0.20	0.43	0.04	0.15	0.50	
PTB-CSF2	55824	55839	4.33	0.28	0.36	0.04	0.24	0.52	
PTB-CSF2	55859	55879	4.24	0.17	0.56	0.06	0.19	0.62	
SYRTE-FO1	55639	55649	4.17	0.30	0.45	0.10	0.53	0.76	
SYRTE-FO1	55664	55679	5.17	0.20	0.49	0.14	0.37	0.66	
SYRTE-FO1	55684	55709	5.05	0.40	0.42	0.14	0.23	0.64	
SYRTE-FO1	55709	55729	6.36	0.30	0.43	0.13	0.28	0.61	
SYRTE-FO1	55869	55889	2.96	0.25	0.43	0.11	0.28	0.58	
SYRTE-FO1	55914	55924	1.98	0.20	0.46	0.18	0.53	0.75	
SYRTE-FO2	55619	55639	6.10	0.20	0.39	0.11	0.51	0.68	
SYRTE-FO2	55594	55619	6.66	0.25	0.39	0.11	0.54	0.72	
SYRTE-FO2	55654	55679	5.83	0.20	0.39	0.11	0.23	0.51	
SYRTE-FO2	55684	55709	5.68	0.30	0.26	0.13	0.23	0.48	
SYRTE-FO2	55709	55734	7.23	0.30	0.26	0.12	0.23	0.47	
SYRTE-FO2	55739	55769	6.25	0.40	0.26	0.11	0.20	0.53	
SYRTE-FO2	55769	55804	5.08	0.30	0.28	0.13	0.17	0.46	
SYRTE-FO2	55804	55819	6.18	0.20	0.27	0.17	0.37	0.52	
SYRTE-FO2	55819	55834	3.88	0.30	0.27	0.10	0.37	0.55	
SYRTE-FO2	55834	55864	4.79	0.30	0.28	0.14	0.20	0.48	
SYRTE-FO2	55864	55894	4.34	0.40	0.28	0.11	0.20	0.54	
SYRTE-FO2	55894	55924	3.22	0.20	0.26	0.11	0.20	0.40	
SYRTE-FOM	55594	55614	6.52	0.30	0.82	0.22	0.66	1.12	
SYRTE-FOM	55629	55649	4.66	0.20	0.92	0.22	0.28	1.01	
SYRTE-FOM	55649	55679	5.77	0.30	0.82	0.37	0.20	0.97	
SYRTE-FOM	55684	55709	5.79	0.20	0.82	0.12	0.23	0.88	
SYRTE-FOM	55869	55894	3.86	0.25	0.82	0.11	0.23	0.89	
SYRTE-FOM	55894	55924	2.94	0.20	0.82	0.12	0.20	0.87	

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

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Report on the activity of IT-CsF1 Primary Frequency Standard during 2011

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During 2011, IT-CsF1 reported one frequency evaluation to the BIPM. In the tables below, a summary of the report and its accuracy budget is shown.

CircT	Period (MJD)	Dur.	Local Osc.	yITCsF1-yTAI	uA	uB	ulab	uTAI	u
277	55564-55589	25	1401101	9.91	0.3	0.70	0.3	0.54	0.98

Effect	Bias ($x10^{-15}$)	Uncertainty ($x10^{-15}$)
Quadratic Zeeman (field map)	46.3	0.2
Blackbody Radiation	-28.50	0.30
Collisional (average shift $1.1x10^{-15}$) (*)	-2	0.4
Gravitational Potential	26.10	0.01
Microwave related	-	0.40
Total	41.9	0.70

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

The reference papers for IT-CsF1 evaluations procedure are [1,2]. Some details are reported here. The local oscillator during this evaluation was a H-maser, exhibiting a drift of $-1.97(0.05)x10^{-15}$ /day.

Quadratic Zeeman shift: the magnetic field is mapped along the atom flight path before each fountain evaluation, with low frequency transition spectroscopy ($\Delta F=0$, $\Delta m=\pm1$); the field map is then used to calculate the DC Zeeman shift experienced by the atoms .The AC quadratic Zeeman shift due to the RF cavity heater was measured to be lower than $4x10^{-17}$. The C-field map showed a long term stability for the Zeeman shift of few parts in 10^{16} .
Blackbody radiation shift (BBRS): the BBRS is corrected using the value $\beta=-1.711(.003)x10^{-14}$; IT-CsF1 is operated around 343 K and the uncertainty on this correction is typically 3×10^{-16}.
Atomic density shift: IT-CsF1 is operated alternating a low-density state (~20000 s) and a high-density state (~5000 s), then the measured frequency is extrapolated to the zero density condition. The collisional shift uncertainty, mainly of type A, is included in the uncertainty of the final linear fit of the measured frequencies and then accounts for the type A uncertainty part; uncertainty accounted as the type B is due to the signal stability and to the linearity assumption between density and signal is <10% of the weighted averaged density shift [1]. The analysis of the collisional shift correction uses both classical and bayesian statistical approaches [3,4].
Gravitational shift: At the end of 2007, IT-CsF1 orthometric height was evaluated to be (239.43±0.03) m over the Geoid [5]. The frequency shift for IT-CsF1 is $(26.10\pm0.01)\times10^{-15}$.
Microwave related shifts: the presence of unwanted microwave related shifts (such as microwave leakages, spurious spectrum components, distributed phase shifts) is tested as described in [6] before and after each TAI evaluation. The measured shift is compatible with zero at 4×10^{-16} level.

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Operation of Cs atomic fountain NICT-CsF1 in 2011

The cesium atomic fountain NICT-CsF1 at the National Institute of Information and Communications Technology (Japan) has been making contributions to the determination of TAI since 2006. In 2011 accuracy evaluations using CsF1 were carried out twice; 20 days over the period MJD 55554-55574 and 10-days over the period of MJD 55864-55874 [2, 3].

The optical system has undergone changes in early 2011; firstly optics were realigned due to a vacuum system overhaul in early 2011, and then the Tohoku earthquake of March 2011 damaged parts of the optical setup. Repairs are complete and the vacuum is significantly improved and it is now possible to capture more atoms than before, resulting in a short term stability of $6 \times 10^{-14}/\tau^{1/2}$. However, this high atomic density is associated with a large collisional shift. To reduce the collisional shift, CsF1 is operated with reduced atomic density in normal operation, and has a short term stability of $2 \times 10^{-13}/\tau^{1/2}$. Evaluation of systematic shifts has been carried out following the same procedure described in the first evaluation report circulated to the working group on the primary frequency standard in 2007 and also in [1]. Additionally, following the new approach proposed in [4], we are currently re-evaluating the distributed cavity phase shift.

We summarize the correction biases and their uncertainties for 2011 measurements below.

Table 1. Frequency shifts and their uncertainties in the campaign of MJD 55554-55574

Physical Effect	Bias (10^{-15})	Uncertainty (10^{-15})
2nd Zeeman	71.9	<0.1
Collision (averaged)	-3.3	0.7
Blackbody Radiation	-16.9	0.4
Gravity Potential	8.4	0.1
MW-PW Dependence □	-2.0	0.3
Cavity Pulling	0.0	<0.1
Rabi Pulling	0.0	<0.1
Ramsey Pulling	0.0	<0.1
Spectral Impurities	0.0	<0.1
Light Shift	0.0	<0.1
Distributed Cavity Phase □	0.0	0.3
Majorana	0.0	<0.1
Background Gas	0.0	0.3
Total (Type B)		1.0

□ Improved evaluation is underway.

The total uncertainty including both Type A and B is 1.4×10^{-15}.
For the contribution to the TAI, a frequency difference between CsF1 and UTC(NICT) is reported with a 0.3×10^{-15} uncertainty of the internal link.

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Operation of NIST-F1 in 2011

NIST-F1, the Cs fountain primary frequency standard at the National Institute of Standards and Technology (NIST), has been in operation since November 1998, and the first formal report to the BIPM was made in November 1999 [1]. Two papers updating the operation of NIST-F1 were later published in 2005 [2, 3]. During a formal evaluation the average frequency of one of the hydrogen masers at NIST is measured by NIST-F1 and the results, along with all relevant biases and uncertainties, are reported to the BIPM for publication in Circular T. NIST-F1 is not operated as a clock and is run only intermittently. The standard is constantly evolving, and both hardware and software improvements are continually being made. These improvements now tend to be aimed more at increasing the fountain run time and reliability, rather than decreasing the uncertainty. In addition there is always an improved understanding of how the standard operates [4]. In all formal evaluations a range of atom densities were used along with a weighted linear least squares fit to determine the frequency at zero density. The typical frequency shift from the lowest measured density to zero density in 2011 was on the order of $6x10^{-16}$. Each formal evaluation also includes mapping the magnetic field, and measurements of possible biases due to such things as microwave amplitude and light leaks.

Five formal NIST-F1 evaluations were carried out in 2011. All were made with a range of atom densities to determine the spin exchange shift. NIST-F1 has also been used in comparisons to NIST-F2, a new cryogenic cesium fountain frequency standard. This cryogenic operation will ultimately lead to an improved measurement of the blackbody shift. Four comparisons of NIST-F2 with NIST-F1 have been made with agreement between the two standards falling within the comparison uncertainty of $1x10^{-15}$. At this time NIST-F2 is not quite ready for formal reports to the BIPM.

The Type B uncertainties in NIST-F1 for the five runs in 2011 are substantially the same as those given in Table 1 of [2], and are dominated by the blackbody and microwave amplitude shifts. Reference 2 is the source for u_B(Ref) given in Circular T. The density shift uncertainty is included in the Type A uncertainty. The total Type B uncertainty for all of the runs in 2011 was $3.1x10^{-16}$, dominated by the blackbody shift with an uncertainty of $2.8x10^{-16}$. The Type A uncertainties ranged from $3.1x10^{-16}$ to $6.0x10^{-16}$ for the five runs. The uncertainties due to the spin exchange shift ranged from $1.6x10^{-16}$ to $2.7x10^{-16}$. Total uncertainties, including frequency transfer and dead time uncertainties, ranged from $5.2x10^{-16}$ to $8.2x10^{-16}$.

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Operation of NMIJ-F1 Primary Frequency Standard in 2011

In 2011, we have operated NMIJ-F1 officially twice for 30 days in each campaign to calibrate TAI. The operation time during a year was 60 days in total. The uncertainty budget was the same as the previous one [1,2], which is shown in Table 1.

Source of uncertainty	Bias ($x10^{-15}$)	Uncertainty ($x10^{-15}$)
2^{nd} order Zeeman	185.0	0.5
Blackbody radiation	-18.0	1.4
Gravitation	1.6	0.1
Cold collisions	0.0	3.3
Distributed cavity phase	0.0	1.2
Microwave power dependence	0.0	0.7
Total	168.6	3.9

Table 1: Typical uncertainty budget used in 2011

After the earthquake on March 11, it turned out that the resonant frequency of selection cavity shifted. It was not certain whether it is influence of the earthquake. Moreover, the source of Cs atoms was exhausted. Therefore, operation was stopped, a vacuum chamber was opened, and some maintenances are performed in order to resume calibration of TAI.

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Operation of the NPL-CsF2 primary frequency standard in 2011

The caesium fountain standard NPL-CsF2 was made operational and characterised in 2009, and started to contribute to the evaluations of the TAI step interval in 2010. In 2011 a major reassessment of the uncertainty budget was performed [1]. In particular, the uncertainties of two systematic effects with largest uncertainties in the 2010 uncertainty budget [2] were reduced. The new assessment was based on the theoretical models by K. Gibble *et al*. for the distributed cavity phase effect [3] and for the microwave lensing [4]. The model of ref. [3], applied to the NPL-CsF2 parameters, was verified experimentally. The table below summarises the new accuracy evaluation.

Type B uncertainty evaluation	Uncertainty / 10^{-16}
Second order Zeeman	0.8
Blackbody radiation	1.1
AC Stark (lasers)	0.1
Microwave spectrum	0.1
Gravity	0.5
Cold collisions (typically)	0.4[a]
Collisions with background gas	1.0
Rabi, Ramsey pulling	0.1
Cavity phase (distributed)	1.1
Cavity phase (dynamic)	0.1
Cavity pulling	0.2
Microwave leakage	0.6
Microwave lensing	0.3
Second-order Doppler	0.1
Total u_B (1σ)	2.3
Type A uncertainty evaluation	
u_A (1σ for 15-day averaging)	2.4[b]
Total uncertainty	3.3

[a] An exemplary value of the type B contribution to the uncertainty.
[b] A 15 day period of operation is required for the type A uncertainty to be reduced to the level of the type B uncertainty.

During the calendar year 2011, the NPL-CsF2 standard was used 7 times to evaluate the TAI step interval. The measurement procedure was the same as in the previous year, with the fountain operating in the vicinity of the zero-collisional frequency shift point. The residual collisional shift was continuously evaluated and the standard frequency extrapolated to the zero-density value.

In addition to the TAI evaluations, the NPL-CsF2 standard was used as a reference and provided a realisation of the SI second definition for an accurate optical frequency measurement of the octupole transition in a single ion $^{171}Yb^{+}$ [5].

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Operation of the SYRTE primary clocks in 2011

SYRTE Fountain clocks

In 2011 we have sent to BIPM 6, 12 and 6 calibrations performed by the 3 SYRTE fountains FO1, FO2 and FOM.

The nominal operation of the FO1, FO2 and FOM fountains is the same as in 2010. The microwave synthesizers are referenced to the signal provided by a cryogenic sapphire oscillator (CSO) phase locked to a hydrogen Maser, to take the benefit of the ultra-low phase noise of the CSO. The relative frequency instabilities are routinely $\sigma_y(\tau) = 5 \times 10^{-14}\ \tau^{-1/2}$ for the FO1 and FO2 fountains and $\sigma_y(\tau) = 8 \times 10^{-14}\ \tau^{-1/2}$ for FOM. This levels correspond to the quantum projection noise of the clocks.
FO2 is located close to the CSO, whereas FO1 and FOM are in different buildings, distant from ~100 m. The signal from the CSO is distributed to FOM through a compensated optical fiber link to avoid long term drifts in the reference transfer or to avoid electrical ground problems. A similar link will be implemented for FO1 in the near future.

Table 1 gives the typical uncertainty budgets for the three SYRTE fountain clocks in 2011. The value and the uncertainty of the frequency shifts, which depend on the operating parameters, are updated for each TAI contribution.

Fountain	FO1		FO2-Cs		FOM	
Physical origin	Correction	Uncertainty	Correction	Uncertainty	Correction	Uncertainty
2nd order Zeeman	-1274.5	0.4	-1916.4	0.3	-305.6	1.2
Blackbody Radiation	172.6	0.6	168.3	0.6	+165.6	0.6
Cold Collisions + cavity pulling	70.5	1.4	60.8	1.1	+28.6	5.0
First Doppler + Synchronous phase fluctuations	0	<3.2	-0.75	0.93	0	6
Microwave Leaks, spectral purity	0	<1	0	0.5		
Ramsey & Rabi pulling	0	<1	0	<0.1	0	<0.1
Microwave lensing	0	<1.4	0	<1.4	0	<1.4
Second order Doppler	0	<0.1	0	<0.1	0	<0.1
Background gas collisions	0	<0.3	0	<1	0	<1
Red shift	-69.3	1	-65.4	1	-68.7	1
Total (1σ) uncertainty u_B		**4.2**		**2.6**		**8.2**

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

The accuracy budgets of FO1, FO2 and FOM have been modified as follows:

The systematic shift so far denoted as “Microwave Recoil” [1] is now denoted by “Microwave Lensing” following reference [2] and its physical interpretation for this effect in the case of atomic fountain clocks.

The accuracy budget of FO2 has been modified to take into account the new evaluation of the residual first order Doppler effects:

The systematic correction and the related uncertainty corresponding to the residual first order Doppler frequency shift have been modified, starting May 2011, on the basis of our recent experimental investigation of this effect, as reported in [3]. The theory used to model this effect, to analyze the measurements and to determine the uncertainty of this effect is described in [4, 5]. The model relies on an azimuthal decomposition of the distributed cavity phase variations in the Ramsey cavity. Consequently, the corresponding uncertainty is the quadratic sum of several contributions of the lowest relevant terms in the azimuthal decomposition, namely m=0 (which turns out to have a negligible contribution for FO2 for nominal operation), m=1 (2 contributions for 2 possible components of the tilt of the launch direction), m=2. The m=1 term contributions to the uncertainty depend on the uncertainty on the tilt, which itself depends on several factors (such as the interval between checks of the launch direction, stability of the fountain environment, etc). The m=1 is therefore subject to changes from one TAI report period to the other. Correspondingly, the overall residual first

order Doppler uncertainty is subject to small changes from one TAI report period to the other. The nominal overall uncertainty as established in [3] is 8.4x10^{-17}.
Based on [3], measurements are underway in FO1 and FOM to reduce the residual first order Doppler uncertainty. Until these studies are completed, the existing less sophisticated and less stringent estimation of the uncertainty due to the residual first order Doppler is kept for FO1 and FOM.

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Operation of the PTB primary clocks in 2011

PTB's primary clocks with a thermal beam

During 2011 PTB's primary clocks CS1 and CS2 [1] were operated continuously. Time differences UTC(PTB) - clock in the standard ALGOS format were reported to BIPM, so that $u_{l/lab}$ is zero. The mean relative frequency offset between the two clocks amounted to about 9.2×10^{-15}, which is compliant with the stated u_B. The standard deviation of the 12 d - values are compliant with the stated u_A values for both clocks.

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.

CS1

Based on continuous comparison with an active hydrogen maser, the CS1 relative frequency instability was found to vary between 77×10^{-15} and 84×10^{-15} for an averaging time of 1 hour, in agreement with the prediction based on the beam flux, clock transition signal and line width. With reference to TAI, the standard deviation of d(CS1) (Circular T Section 4) was well within the value $u_A(\tau = 30\text{ d, CS1}) = 6\times10^{-15}$ stated in Circular T. During 2011, only three reversals of the beam direction were performed on CS1. No findings call for a modification of the previously stated relative frequency uncertainty u_B, which is 8×10^{-15} for CS1 [2].

CS2

PTB's primary clock CS2 was out of operation between 1st September and early November 2010. Both caesium ovens had become empty, one already in summer 2008. It was decided to re-start CS2 operations with a minimum of intervention to the vacuum and atomic beam forming system. The two caesium ovens were refilled and part of the (outdated) vacuum measurement equipment was replaced. Aside of this, we took the chance to replace the signal cabling and connected the clock electronics with the signal distribution and measurement system of PTB using state-of-the-art rf-cables.

The CS2 oven temperature was adjusted so that a relative frequency instability of $\sigma_y(\tau = 1\text{ hour})$ between 65×10^{-15} and 75×10^{-15} has been obtained. This value justifies the estimate of the uncertainty contributions u_A as $u_A(\tau = 30\text{ d, CS2}) = 3\times10^{-15}$.

Five reversals of the beam direction were performed during 2011, and the beam reversal frequency shift (due to end-to-end cavity phase difference) was found unchanged from the values obtained before summer 2008 with a statistical uncertainty of 5×10^{-15}. The uncertainty estimate as detailed in [1, 2] is considered as still valid, and the CS2 u_B is thus estimated as 12×10^{-15}.

PTB's caesium fountain clock CSF1

A detailed description of the PTB fountain CSF1 is given in Refs. [3] and [4]. In 2011 CSF1 provided a primary clock signal during 362 days of the year. The high degree of availability supported the steering of a hydrogen maser output frequency by CSF1 to realize UTC(PTB). CSF1 was also used as frequency reference for the second PTB fountain clock CSF2 to perform a new evaluation of the frequency shifting effects due to distributed cavity phase (see below).

Nine measurements of the TAI scale unit of 15 (4×) and 20 (5×) days duration, respectively, were performed in 2011 and reported to the BIPM. Due to the performance and reliability of the laser systems, dead times are routinely kept below 1% of the nominal measurement duration.

The resulting clock link uncertainty $u_{l/lab}$ was thus far below 0.1×10^{-15}. The statistical uncertainty of CSF1 measurements was calculated with the assumption of white frequency noise during the measurement intervals. Including a small statistical uncertainty contribution due to the measurement instrumentation, we arrived at statistical uncertainties $u_A \leq 0.3\times10^{-15}$ for the nine TAI contributions in 2011.

Below we compile typical frequency biases and type B uncertainties of CSF1.

Physical effect	Bias / 10^{-15}	Type B uncertainty / 10^{-15}
Quadratic Zeeman shift	46.22	0.10
Black body radiation shift	- 16.54	0.10
Cold collisions	- 1.09	0.23
Gravitational red shift	8.58	0.10
Cavity phase		0.10
Majorana transitions		0.10
Rabi and Ramsey pulling		0.10
Microwave leakage		0.10
Electronics		0.20
Light shift		0.10
Background gas collisions		0.10
Microwave power dependence		0.60
Total type B uncertainty		0.74

Table 1: Typical frequency biases and type B uncertainties of PTB-CSF1 in 2011

PTB's caesium fountain clock CSF2

A detailed description of the PTB fountain CSF2 is given in Ref. [5]. In 2010 and 2011 the frequency shift due to the distributed cavity phase in CSF2 was reevaluated by extensive theoretical and experimental investigations [6]. Due to this improved evaluation and since the collisional frequency shift is now evaluated with a lower statistical uncertainty, the systematic uncertainty of CSF2 is significantly reduced (see table below). Additionally, the frequency shifting effect of microwave lensing was calculated for CSF2 [6]. A proper correction is applied and the related uncertainty is included in the uncertainty budget.

The systematic uncertainty of CSF2 is currently limited by the statistical uncertainty of the collisional frequency shift evaluation. To prepare CSF2 for future operation with increased atom numbers (loading from a cold beam) recently the method of "rapid adiabatic passage" (RAP) [7] was introduced to modify homogeneously the atom cloud density for the collisional shift evaluation. It is expected that operating CSF2 at increased atom numbers will reduce the statistical uncertainty of the collisional frequency shift evaluation and at the same time keep the systematic uncertainty contribution small.

In 2011 six measurements of the TAI scale unit of 15 (3×), 20 (2×) and 25(1×) days duration, respectively, were performed and reported to the BIPM. The dead times of these measurements were below 1.5%, so that the resulting clock link uncertainty $u_{l/lab}$ was clearly below 0.1×10^{-15}. For all these TAI scale unit measurements the atoms were loaded from the background gas into the molasses. For the last of these measurements the method of RAP was utilized for the first time for controlling the collisional shift during the measurement period. The statistical uncertainty of CSF2 measurements was calculated with the assumption of white frequency noise for the total measurement intervals. Including a small statistical uncertainty contribution due to the measurement instrumentation, we arrived at statistical uncertainties $u_A < 0.3\times10^{-15}$ for the six TAI contributions in 2011.

Below we compile typical frequency biases and type B uncertainties of CSF2.

Physical effect	Bias / 10^{-15}	Type B uncertainty / 10^{-15}
Quadratic Zeeman shift	100.596	0.059
Black body radiation shift	- 16.457	0.076
Cold collisions	- 0.947	0.296
Gravitational red shift	8.567	0.006
Cavity phase	0.044	0.134
Microwave lensing	0.083	0.042
Majorana transitions		0.0001
Rabi pulling		0.0002
Ramsey pulling		0.001
Microwave leakage		0.10
Electronics		0.20
Light shift		0.001
Background gas collisions		0.05
Total type B uncertainty		0.41

Table 2: Typical frequency biases and type B uncertainties of PTB-CSF2 in 2011.

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

(File available at ftp://62.161.69.5/pub/tai/scale/sitai11.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**, 87-93', using all available measurements from the most accurate primary frequency standards (PFS) IT-CSF1, KRISS-1, NICT-CSF1, NIST-F1, NMIJ-F1, NPL-CSF1, NPL-CSF2, PTB-CS1, PTB-CS2, PTB-CSF1, PTB-CSF2, SYRTE-FO1, SYRTE-FO2, SYRTE-FOM and SYRTE-JPO, consistently corrected for the black-body radiation shift.
In this computation, the uncertainty of the link to TAI has been computed using the standard uncertainty of [UTC-UTC(k)], following the recommendation of the CCTF working group on PFS.
The model for the instability of EAL has been expressed as the quadratic sum of three components: a white frequency noise $1.7\times10^{-15}/\sqrt{(\tau)}$, a flicker frequency noise 0.35×10^{-15} and a random walk frequency noise $1.0\times10^{-16}\times\sqrt{(\tau)}$, with τ in days. The relation between EAL and TAI is given in Table 5.

Month	Interval	$d/10^{-15}$	uncertainty/10^{-15}
Jan. 2009	54829-54859	+5.5	0.3
Feb. 2009	54859-54889	+5.2	0.4
Mar. 2009	54889-54919	+4.7	0.4
Apr. 2009	54919-54949	+5.2	0.4
May 2009	54949-54979	+4.9	0.4
Jun. 2009	54979-55009	+5.3	0.6
Jul. 2009	55009-55039	+6.1	0.6
Aug. 2009	55039-55074	+5.2	0.4
Sep. 2009	55074-55104	+5.0	0.3
Oct. 2009	55104-55134	+3.8	0.3
Nov. 2009	55134-55164	+3.6	0.3
Dec. 2009	55164-55194	+4.3	0.4
Jan. 2010	55194-55224	+4.7	0.3
Feb. 2010	55224-55254	+4.5	0.4
Mar. 2010	55254-55284	+4.8	0.4
Apr. 2010	55284-55314	+5.3	0.4
May 2010	55314-55344	+5.6	0.4
Jun. 2010	55344-55374	+6.6	0.4
Jul. 2010	55374-55404	+5.7	0.4
Aug. 2010	55404-55439	+5.6	0.3
Sep. 2010	55439-55469	+6.7	0.4
Oct. 2010	55469-55499	+6.5	0.4
Nov. 2010	55499-55529	+6.7	0.5
Dec. 2010	55529-55559	+6.0	0.4
Jan. 2011	55559-55589	+6.5	0.4
Feb. 2011	55589-55619	+6.2	0.5
Mar. 2011	55619-55649	+5.8	0.3
Apr. 2011	55649-55679	+6.0	0.3
May 2011	55679-55709	+5.7	0.3
Jun. 2011	55709-55739	+6.2	0.3
Jul. 2011	55739-55769	+5.9	0.4
Aug. 2011	55769-55804	+5.4	0.3
Sep. 2011	55804-55834	+5.0	0.3
Oct. 2011	55834-55864	+4.6	0.4
Nov. 2011	55864-55894	+3.9	0.2
Dec. 2011	55894-55924	+2.9	0.3

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 the Publications page of the Time Department's FTP Server. 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 also gives 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 the Publications page of the Time Department's FTP Server. 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 also gives values of [*TAI - TA(lab)*].

International GPS Tracking Schedules

(Files available at ftp://62.161.69.5/pub/tai/publication/schgps/)

GPS Schedule no 56 File SCHGPS.56	implemented on MJD = 55680 (2011 April 29) at 0 h UTC	Reference date MJD = 50722 (1997 October 1)
GPS Schedule no 57 File SCHGPS.57	implemented on MJD = 55868 (2011 November 3) at 0 h UTC	Reference date MJD = 50722 (1997 October 1)

Relations of UTC and TAI with GPS time, GLONASS time, UTC(USNO)_GPS and UTC(SU)_GLONASS

(File available at ftp://62.161.69.5/pub/tai/scale/UTCGPSGLO/utcgpsglo11.ar)

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

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

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

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

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

From 1 January 2009, 0 h UTC, until 1 July 2012, 0 h UTC:

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

from 1 July 2012, 0 h UTC, until further notice, $[UTC - GPS\ time] = -16\ \text{s} + C_0$,

Here C_0 is given at 0 h UTC every day.

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

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

[*TAI – UTC(USNO)_GPS*] and [*UTC – UTC(USNO)_GPS*]

The GPS satellites broadcast a prediction of UTC(USNO) calculated at the USNO, indicated by UTC(USNO)_GPS. The relation between UTC(USNO)_GPS and TAI involves a variable number of seconds as a consequence of the leap seconds of the UTC system, and is as follows:

From 1 January 2009, 0 h UTC, until 1 July 2012, 0 h UTC: $[TAI – UTC(USNO)\_GPS] = 34\ \text{s} + C_0'$

From 1 July 2012, 0 h UTC, until further notice, $[TAI – UTC(USNO)\_GPS] = 35\ \text{s} + C_0'$

Here C_0' is given at 0 h UTC every day.

C_0' is computed using the values of [*UTC* - *UTC*(*OP*)] similarly than the computation of C_0.

The relation between UTC(USNO)_GPS and UTC is $[UTC– UTC(USNO)\_GPS] = 0\ \text{s} + C_0'$

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

Relations of UTC and TAI with GPS time, GLONASS time, UTC(USNO)_GPS and UTC(SU)_GLONASS (Cont.)

(File available at ftp://62.161.69.5/pub/tai/scale/UTCGPSGLO/utcgpsglo11.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

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

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

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

From 1 January 2009, 0 h UTC, until 1 July 2012, 0 h UTC, [*TAI - GLONASS time*] = 34 s + C_1,

from 1 July 2012, 0 h UTC, until further notice, [*TAI - GLONASS time*] = 35 s + C_1.

Here C_1 is given at 0 h UTC every day.

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

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

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

[*TAI – UTC(SU)_GLONASS*] and [*UTC – UTC(SU)_GLONASS*]

The satellites broadcast a prediction of UTC(SU) calculated at the SU, indicated by UTC(SU)_GLONASS. The relation between UTC(SU)_GLONASS and TAI involves a variable number of seconds as a consequence of the leap seconds of the UTC system, and is as follows:

From 1 January 2009, 0 h UTC, until 1 July 2012, 0 h UTC: [*TAI – UTC(SU)_GLONASS*] = 34 s + C_1'

From 1 July 2012, 0 h UTC, until further notice, [*TAI – UTC(SU)_GLONASS*] = 35 s + C_1'

Here C_1' is given at 0 h UTC every day.

C_1' is computed using the values of [*UTC - UTC*(*AOS*)] similarly than the computation of C_1.

The relation between UTC(SU)_GLONASS and UTC is [*UTC– UTC(SU)_GLONASS*] = 0 s + C_1'

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

Table 8. Rates relative to TAI of contributing clocks in 2011

(File is available at ftp://62.161.69.5/pub/tai/scale/RTAI/rtai11.ar)

Mean clock rates relative to TAI are computed for one-month intervals ending at the MJD dates given in the table. When an intentional frequency adjustment has been applied to a clock, the data prior to this adjustment are corrected, so that Table 8 gives homogeneous rates for the whole year 2011. For studies including the clock rates of previous years, corrections must be brought to the data published in the Annual Report for the previous years. These corrections are available from the Time Department under request.

Unit is ns/day, "   -" denotes that the clock was not used, "*" denotes that the related rate was influenced by a frequency jump.

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

12 HEWLETT-PACKARD 5061A
13 EBAUCHES, OSCILLATOM B5000
14 HEWLETT-PACKARD 5061A OPT. 4
16 OSCILLOQUARTZ 3200
17 OSCILLOQUARTZ 3000
15 DATUM/SYMMETRICOM Cs III
18 DATUM/SYMMETRICOM Cs 4000
19 RHODES AND SCHWARZ XSC
4x HYDROGEN MASERS
9x PRIMARY CLOCKS AND PROTOTYPES
21 OSCILLOQUARTZ 3210
23 OSCILLOQUARTZ EUDICS 3020
25 HEWLETT_PACKARD 5062C
30 HEWLETT-PACKARD 5061B
31 HEWLETT-PACKARD 5061B OPT. 4
34 H-P 5061A/B with 5071A tube
35 H-P/AGILENT/SYMMETRICOM 5071A High perf.
36 H-P/AGILENT/SYMMETRICOM 5071A Low perf.
50 FREQ. AND TIME SYSTEMS INC. 4065A
51 DATUM/SYMMETRICOM 4065 B
52 DATUM/SYMMETRICOM 4065 C
53 DATUM/SYMMETRICOM 4310 B

Lab.	Clock	55589	55619	55649	55679	55709	55739	55769	55804	55834	55864	55894	55924
APL	35 1264	20.77	21.43	20.80	21.02	19.18	19.41	22.09	21.77	19.88	19.11	-	-
APL	35 1791	-1.26	-0.60	-1.30	0.08	-1.85	-	-	-	-	-	-	-
APL	40 3107	24.49	24.59	24.75	24.76	24.88	24.97	25.20	25.19	25.06	25.02	-	-
APL	40 3108	327.25	330.95	334.61	338.34	342.20	346.12	350.10	354.24	-	-	-	-
APL	40 3109	40.48	40.47	40.43	40.60	40.72	40.51	40.61	40.75	40.75	40.58	-	-
AUS	35 2269	-3.12*	-2.03*	-2.42*	-3.03*	-2.51*	-3.53*	-2.87*	-1.62	-1.84	-1.58	-1.66	-0.53
AUS	36 299	12.83	11.63	10.19	9.78	12.59	12.43	12.57	11.95	12.39	12.02	11.57	10.91
AUS	36 340	0.30	0.02	1.18	1.72	-0.33	0.35	1.35	1.41	-0.14	0.32	1.17	1.97
AUS	36 654	-11.95	-11.11	-12.06	-12.67	-12.36	-12.02	-13.31	-13.02	-12.54	-14.08	-12.96	-13.46
AUS	36 1141	9.93	11.26	11.06	11.00	8.24	7.68	8.71	7.55	9.26	8.09	7.74	9.34

Table 8. (Cont.)

Lab.	Clock	55589	55619	55649	55679	55709	55739	55769	55804	55834	55864	55894	55924
AUS	40 5401	-0.26	-4.51	6.94	-0.10	-0.97	0.85	1.36	1.38	2.79	-0.38	-4.89	-
AUS	40 5402	-	-	-	-	4.80	10.48	14.19	15.61	14.99	18.39	22.07	-
BEV	35 1065	0.20*	-0.86*	-1.98*	3.20*	0.47*	-1.53*	0.93*	0.39*	1.31*	0.91*	0.74*	2.48
BEV	35 1793	-1.53	-0.89	-0.87	-0.30	-0.25	0.21	0.66	0.62	0.55	1.01	1.54	0.95
BEV	40 3452	-52.39*	-43.56*	-34.06*	-77.12*	-68.20*	-59.32*	-50.53*	-40.71*	-26.75	-27.29	-14.08	-6.31
BIM	18 8058	2.14	1.75	0.75	1.34	2.43	3.23	2.04	2.07	1.33	-	0.29	0.82
BY	40 4222	-	-	-	5.65*	-4.60*	-2.37*	-1.58*	0.59*	-	-	4.80	0.75
BY	40 4227	-1.63*	1.47*	-5.77*	-2.27*	-1.70*	-1.07*	-0.88*	-0.78*	-	-	-	-
BY	40 4260	21.57*	12.96*	-	-	-	-	-	-	-	-	-	-
BY	40 4278	12.25*	17.98*	10.37*	15.84*	19.11*	18.06*	19.00*	-4.88*	-	-	0.52	1.37
CAO	35 939	-3.67	-1.16	-2.69	-4.28	-2.38	-4.32	-3.70	-3.85	-3.31	-2.60	-3.51	-4.10
CAO	35 1270	4.89	5.52	5.59	7.05	6.86	5.88	6.04	6.22	6.69	6.92	6.59	6.83
CH	35 771	4.92	4.37	3.75	5.21	5.06	5.13	5.75	5.80	5.90	5.82	6.39	6.11
CH	35 2117	1.64	1.21	2.17	1.45	0.82	1.63	1.65	1.58	1.83	1.74	1.88	1.88
CH	35 2743	-	-	-	-	-	-	-	-	-	-4.76	-4.58	-4.22
CH	36 354	42.22	43.99	42.13	42.54	43.00	42.09	43.10	45.16	41.13	42.19	42.87	43.41
CH	36 413	2.33	3.39	2.44	1.20	2.12	1.66	-	-	-	-	-	-
CH	40 5701	-13.66	-14.13	-14.54	-15.18	-15.54	-16.09	-16.43	-16.84	-17.14	-17.41	-17.69	-18.03
CNM	35 1815	-0.95	2.21	-0.94	-1.06	-0.14	0.08	1.17	-0.42	-0.43	0.69	0.56	0.08
CNM	35 2708	-	-	-	-	-	-	-	-	-	-	-3.21	-4.09
CNM	35 2709	-	-	-	-	-	-	-	-	-	-	-0.66	-0.96
CNM	36 1537	-1.70	0.19	0.09	-1.99	-2.90	-0.37	1.64	0.03	-	-	-	-
CNM	40 7301	-2.40	-0.43	-4.58	-6.30	-4.66	-4.61	-3.23	-4.49	-6.97	-6.43	-5.99	-7.52
CNMP	36 1752	5.80	6.20	6.49	6.76	6.52	6.70	6.50	7.17	8.19	6.44	6.68	7.86
CNMP	36 1806	0.44	0.03	-0.53	-0.08	0.41	-1.04	0.34	-0.76	0.16	0.77	0.11	0.29
DLR	35 1714	-0.56	-0.03	0.31	0.67	1.90	-3.14	-	-	-1.11	-0.25	-0.39	1.88
DMDM	35 2191	16.27	16.84	17.60	17.23	17.03	17.60	18.01	18.26	18.68	18.89	18.24	19.85
DMDM	36 2033	6.12	6.65	6.68	6.62	6.84	6.73	5.64	6.03	5.99	5.90	7.32	6.01
DTAG	35 2635	-	-	1.53	0.85	1.16	0.89	1.00	0.30	0.43	0.64	0.30	0.72
DTAG	36 345	-	-	-3.03	-2.57	-2.97	-3.55	2.31	1.57	2.67	4.77	1.35	-
DTAG	36 2370	-	-	-0.06	1.33	-0.26	0.74	-0.74	0.21	0.88	2.52	2.87	-0.29
EIM	35 716	-	12.92	13.27	-	12.50	13.20	13.07	14.59	-	-	13.98	-
EIM	35 1431	-	-8.67	-8.85	-	-8.91	-8.93	-9.07	-8.10	-	-	-7.60	-
EIM	35 2060	-	-0.08	0.16	0.10	-0.01	-0.05	-0.10	0.07	-	-	0.08	-
F	35 124	11.13	11.13	10.75	11.16	10.84	10.58	10.87	11.12	10.05	10.29	10.66	9.98

Table 8. (Cont.)

Lab.	Clock		55589	55619	55649	55679	55709	55739	55769	55804	55834	55864	55894	55924
F	35	158	13.78	12.56	13.56	13.89	13.95	13.87	13.75	13.69	13.32	12.17	13.14	11.36
F	35	355	3.57	3.07	3.28	3.50	4.05	3.90	3.87	4.31	6.87	6.72	7.02	4.78
F	35	385	18.38	19.99	20.05	20.40	20.34	20.79	19.97	20.11	20.06	20.55	20.60	20.82
F	35	396	-0.45	-0.46	0.24	-0.47	0.06	-0.82	-1.91	-1.02	-0.39	-0.34	-0.07	-1.41
F	35	469	-1.60	-1.45	-	-	-1.19	-1.77	-0.78	-0.21	-1.46	-1.32	0.04	0.10
F	35	489	13.64	13.73	-	-	13.43	13.81	13.62	13.49	13.20	13.40	13.55	13.14
F	35	520	18.79	18.72	-	-	19.49	19.17	19.03	18.35	18.55	20.28	18.85	18.35
F	35	536	6.40	6.37	5.12	-	-	4.36	3.36	2.56	2.54	2.00	2.19	1.72
F	35	609	-	-23.00	-22.70	-23.60	-24.21	-23.59	-23.15	-22.86	-22.87	-22.59	-23.07	-23.05
F	35	700	-	-17.14	-15.35	-16.02	-15.08	-13.85	-11.47	-11.71	-14.59	-13.15	-12.33	-11.53
F	35	770	-7.28	-7.57	-6.96	-7.28	-6.80	-6.67	-6.72	-6.24	-7.10	-7.28	-6.38	-6.37
F	35	774	27.45	28.20	27.59	27.27	27.02	27.21	27.86	28.34	27.76	27.32	28.58	28.33
F	35	781	6.65	6.99	7.07	6.21	5.94	6.87	6.33	6.98	6.37	6.76	6.71	-
F	35	819	14.09	7.84	9.51	10.25	10.38	10.49	10.74	10.24	10.51	11.36	10.84	9.34
F	35	859	2.36	5.10	4.51	5.61	-	-	4.25	4.71	3.80	3.18	4.63	5.66
F	35	909	-14.63	-13.59	-12.60	-12.04	-10.98	-11.57	-12.04	-11.65	-11.71	-11.34	-11.95	-
F	35	1068	-16.84	-15.84	-	-	-	-	-	-	-	-	-	-
F	35	1177	-3.59	-4.55	-3.83	-3.90	-	-	-2.58	-3.02	-1.98	-1.81	-2.25	-2.11
F	35	1222	-	-	-	-	-	1.04	1.79	1.13	1.45	1.71	1.96	-
F	35	1321	3.91	3.30	4.25	-	-	2.96	4.39	3.92	4.25	3.38	5.24	4.92
F	35	1556	-	-6.29	-6.97	-7.05	-6.91	-6.38	-5.72	-5.88	-6.39	-6.11	-7.22	-5.66
F	35	1644	11.64	11.15	-	-	11.47	11.45	11.45	10.92	11.02	11.59	10.79	11.30
F	35	2027	0.85	1.76	0.71	1.62	1.65	1.09	1.99	1.17	1.49	1.86	2.13	3.09
F	35	2388	6.24	6.15	6.24	-	-	6.77	5.58	4.53	3.96	4.02	2.56	1.59
F	35	2609	-	4.12	4.57	3.96	4.36	4.54	4.92	4.17	4.37	4.88	5.18	5.28
F	35	2647	-	6.46	6.06	-	-	-	5.15	5.32	6.25	6.52	6.73	6.72
F	40	805	63.70	68.74	71.39	72.28	70.30	67.68	61.53	56.27	53.65	51.75	56.05	61.69
F	40	816	-0.58	-0.83	-0.64	-1.81	-2.11	-2.89	-3.36	-4.01	-4.21	-3.77	-3.20	-2.32
F	40	889	-	0.74	2.67	-	-	-	-	-	-	-	-	-
F	40	890	-	1.44	1.93	2.30	3.50	3.87	4.26	4.73	5.45	5.71	6.06	6.58
HKO	35	1893	0.27	-0.27	-0.71	-0.32	0.08	0.60	0.42	0.58	0.28	0.95	1.34	-
HKO	35	2425	1.80	1.16	2.07	-	-	2.60	3.41	2.67	3.05	3.29	3.88	-
IFAG	36	1167	-3.06	-3.18	-3.91	0.44	1.04	-1.12	0.53	-0.49	0.61	0.47	-2.54	-0.96
IFAG	36	1173	7.29	7.56	9.07	11.68	11.84	11.45	12.25	13.26	13.71	13.65	12.99	11.50
IFAG	36	1629	14.84	14.42	14.83	13.65	16.05	16.92	16.27	16.52	15.32	13.75	14.13	13.49

Table 8. (Cont.)

Lab.	Clock	55589	55619	55649	55679	55709	55739	55769	55804	55834	55864	55894	55924
IFAG	36 1732	13.76	13.99	14.24	14.00	14.22	13.78	13.83	14.47	14.20	13.85	14.52	14.70
IFAG	36 1798	-1.97	-1.56	-1.30	-1.09	-1.46	-1.50	-1.51	-2.07	-1.74	-2.31	-2.71	-2.08
IFAG	40 4418	6.10	6.69	7.09	7.42	7.67	7.72	7.79	8.07	8.54	8.86	9.41	10.30
IFAG	40 4439	0.95	0.19	-1.03	-2.09	-3.15	-4.31	-5.92	-7.30	-8.26	-9.05	-9.97	-10.70
IGNA	35 1196	-	-	-	-	12.68	13.47	14.33	13.75	13.65	14.04	14.64	13.21
INPL	35 1653	-0.75	-0.77	-0.53	-1.24	-0.95	-0.09	1.24	-1.60	-1.20	-1.18	-1.31	-1.42
INTI	35 2377	5.13	0.00	-1.65	-0.96	0.57	0.41	-1.99	-	-1.19	-0.13	-1.46	3.60
IPQ	35 1797	-2.36	-3.62	-7.80	-2.84	-2.22	-2.88	-1.75	-2.21	-2.42	-2.33	-2.88	-3.82
IPQ	35 2012	7.27	6.44	2.84	7.12	7.27	7.26	7.34	7.47	8.25	9.01	7.91	8.60
IPQ	35 2169	1.05	-0.98	-4.38	0.23	-0.24	-0.64	-1.14	-1.19	-0.16	-1.91	-1.76	-1.03
IT	35 219	7.40	5.77	6.63	6.28	5.57	5.09	5.22	4.81	4.64	3.31	0.86	1.46
IT	35 505	-29.96	-28.46	-28.82	-28.85	-28.99	-28.13	-27.64	-28.09	-27.56	-27.06	-26.37	-25.97
IT	35 1115	15.86	15.19	16.69	17.96	18.52	18.36	18.18	17.65	18.88	18.63	17.23	17.71
IT	35 1373	-3.69	-3.87	-3.58	-3.24	-3.47	-3.15	-3.33	-4.22	-3.86	-3.78	-3.44	-2.86
IT	35 2118	8.98	8.92	-	-	9.20	9.02	9.96	-	-	-	-	-
IT	35 2487	-9.38	-9.11	-9.38	-8.86	-9.63	-8.80	-9.29	-9.49	-8.83	-8.85	-9.48	-9.37
IT	40 1101	-31.15*	-25.25*	-19.21*	-13.16*	-7.08	-1.09	5.00	11.76	18.45	24.75	31.01	37.21
IT	40 1102	38.65	44.69	51.69	58.02	65.38	73.37	82.40	92.64	102.74	110.46	118.06	125.14
IT	40 1103	-	-	-	-	-	-	-	-	-	-17.38	-16.19	-14.78
JV	21 216	58.44	61.77	59.24	58.23	61.82	62.51	58.04	61.35	59.56	61.88	-	59.84
JV	36 1277	-17.81	-13.82	-16.49	-16.63	-17.98	-17.20	-17.78	-15.11	-17.25	-16.77	-	-18.09
JV	36 2617	-	-	-	-	-	-	-	-	12.19	-	-	-
JV	36 2629	-	-	-	-	-	-	-	-	-4.86	-6.16	-	-6.13
KIM	36 618	2.30	-1.18	-1.25	-0.86	0.71	-0.02	0.76	1.61	-1.58	-0.18	0.11	-0.80
KRIS	35 321	3.54	6.38	6.22	6.35	6.39	5.74	6.01	5.84	5.96	6.41	5.91	6.69
KRIS	35 739	-3.58	-3.14	-3.32	-2.89	-3.16	-3.11	-2.34	-2.45	-2.83	-2.61	-2.83	-2.31
KRIS	35 1135	-	-	-	-	15.29	15.56	16.08	17.03	16.26	16.90	17.18	18.02
KRIS	35 1693	6.46	6.99	7.04	6.78	6.64	6.96	7.07	6.40	7.51	8.00	7.01	8.06
KRIS	35 1783	22.63	22.93	21.45	21.79	20.33	22.02	21.71	20.59	21.92	21.77	21.85	21.06
KRIS	36 1135	17.76	17.29	17.18	-	-	-	-	-	-	-	-	-
KRIS	40 5624	-46.30	-46.70	-47.04	-47.43	-47.69	-47.96	-48.17	-48.25	-48.27	-48.42	-48.53	-48.52
KRIS	40 5625	9.21	7.46	6.13	5.01	4.09	3.23	2.63	2.06	1.76	1.38	1.13	1.00
KRIS	40 5626	-18.06	-18.05	-17.68	-17.46	-17.08	-16.79	-16.51	-16.27	-16.03	-15.89	-15.54	-15.12
KZ	35 2202	-	-0.48	0.08	0.52	-0.18	0.96	-0.16	-0.01	0.87	-0.78	-1.01	-5.04
KZ	35 2665	-	-	-	-	-	-	-	-	-	5.04	7.21	3.14

Table 8. (Cont.)

Lab.	Clock	55589	55619	55649	55679	55709	55739	55769	55804	55834	55864	55894	55924
KZ	35 2667	-	-	-	-	-	-	-	-	-	1.59	3.62	0.59
KZ	40 2707	-	-	-133.68	-	4.64	-	-	-	-	-	-	-
LT	35 1362	0.27	-2.62	-1.66	-1.62	1.63	-1.04	-0.07	-1.41	0.00	-3.10	-0.31	0.18
LT	35 1868	-	-	-0.10	-1.00	0.13	-0.33	-1.03	-0.86	0.02	-0.55	-0.72	-0.38
LV	35 2335	-1.99	-	-	-	-	-	-	-	-	-	-	-
MIKE	35 1171	-0.01	0.28	-2.00	-1.11	-0.55	-1.46	-0.61	-0.15	-1.35	-0.54	-0.05	0.06
MIKE	36 986	1.18	1.39	0.18	0.15	1.49	0.32	1.25	1.23	1.58	1.44	0.96	-0.57
MIKE	40 4108	4.04*	4.33*	4.73*	5.05*	5.42*	4.65	-2.45	-1.99	-1.43	-1.03	-0.57	-0.02
MIKE	40 4113	0.38	1.98	3.94	5.77	7.75	9.48	11.54	13.70	-	-	-	-
MIKE	40 4180	-	-	-	-	-	-	-	-0.04	-	-	-	-
MKEH	36 849	-41.43	-43.07	-40.79	-40.86	-40.30	-42.63	-44.09	-41.25	-42.00	-40.35	-41.99	-39.62
MSL	12 933	-	-43.47	-34.37	-26.49	-22.56	-20.48	-	-	-33.39	-37.62	-	-
MSL	36 274	-	-27.07	-20.64	-12.17	-10.47	-10.98	-10.40	-11.64	-11.26	-8.51	-	-
MSL	36 1025	-	-27.03	-13.27	0.72	1.88	2.09	2.12	-2.17	-9.10	1.52	-	-
NAO	35 779	0.47	0.71	-	-	-	-	-	-1.79	-	-	-	-
NAO	35 1206	13.02	11.75	-	-	-	-	-	10.61	-	-	0.85	1.11
NAO	35 1214	-1.09	-0.12	-	-	-	-	-	-	-	-	0.73	1.44
NAO	35 1689	-31.78	-32.14	-	-	-	-	-	0.22	-	-	1.16	0.98
NICT	35 112	-4.98	-5.06	-4.26	-4.91	-7.03	-7.68	-8.10	-9.19	-8.77	-8.57	-8.27	-6.73
NICT	35 332	7.87	8.16	7.91	7.53	6.85	6.94	7.82	7.44	6.17	7.35	7.26	7.51
NICT	35 342	48.12	48.68	48.44	49.79	48.52	49.35	49.06	49.20	50.72	49.82	50.18	49.77
NICT	35 343	9.40	8.09	9.58	9.12	8.50	7.88	7.80	8.11	7.18	7.43	8.06	7.96
NICT	35 715	10.69	10.42	10.54	10.20	10.33	10.14	10.25	10.75	10.53	11.06	10.84	10.45
NICT	35 732	-2.51	-2.32	-2.97	-3.20	-3.03	-2.43	-2.81	-4.33	-3.92	-4.01	-4.45	-4.29
NICT	35 907	-10.21	-	-	19.17	19.52	19.57	19.55	19.84	19.78	19.74	19.67	19.77
NICT	35 908	-5.22	-	-	-	-	-	-	-	-	-	-	-
NICT	35 913	-17.41	-17.37	-17.51	-18.32	-20.19	-20.39	-19.81	-19.74	-19.16	-19.52	-15.57	-16.99
NICT	35 916	0.53	1.45	1.17	0.81	0.91	1.48	0.56	0.74	0.40	0.45	0.51	0.22
NICT	35 1225	-9.75	-9.54	-9.06	-	4.68	3.83	4.60	4.12	4.25	3.72	4.56	4.96
NICT	35 1226	8.24	7.19	7.64	8.07	8.22	9.10	8.69	9.04	8.70	9.44	9.13	9.42
NICT	35 1611	29.33	29.68	30.89	28.95	28.02	28.05	28.49	27.72	26.92	15.43	23.74	-4.37
NICT	35 1778	-30.57	-30.42	-29.58	-29.48	-28.88	-29.18	-28.85	-28.46	-27.92	-26.50	-26.55	-26.40
NICT	35 1789	-7.83	-7.70	-7.28	-8.11	-7.53	-7.19	-7.15	-7.26	-7.60	-7.41	-6.85	-6.96
NICT	35 1790	2.23	3.19	3.14	3.82	4.37	4.98	5.70	5.75	6.77	7.01	7.68	8.34
NICT	35 1866	1.31	1.68	1.72	2.08	2.68	2.37	2.79	2.79	3.10	2.96	2.39	2.54

Table 8. (Cont.)

Lab.	Clock	55589	55619	55649	55679	55709	55739	55769	55804	55834	55864	55894	55924
NICT	35 1882	-2.25	-1.79	-1.60	-1.48	-1.17	-1.28	-0.72	-0.27	-0.21	-0.45	-0.42	0.41
NICT	35 1887	1.25	1.35	1.06	1.32	1.44	0.82	1.34	1.45	1.25	1.66	1.56	2.35
NICT	35 1944	3.03	3.62	3.62	3.00	3.47	3.89	2.28	3.57	3.02	2.75	3.33	3.26
NICT	35 2010	5.58	5.65	5.91	6.12	6.25	5.74	5.65	5.96	6.03	4.99	5.29	6.15
NICT	35 2011	-43.37	-42.65	-39.40	-35.85	-33.58	-33.37	-33.70	-29.77	-29.71	-28.14	-27.39	-25.58
NICT	35 2056	12.53	10.45	9.89	9.60	8.83	8.09	8.33	8.74	9.93	9.62	9.62	9.19
NICT	35 2113	-27.36	-26.90	-27.75	-27.52	-29.34	-29.12	-28.90	-29.21	-28.40	-28.12	-30.08	-30.99
NICT	35 2116	14.02	13.90	13.69	15.09	14.07	15.26	14.08	14.40	12.56	14.16	13.40	13.54
NICT	35 2570	-1.31	-0.88	-0.34	-	-	-	-	-	-	6.95	6.98	6.95
NICT	35 2574	-4.04	-4.00	-3.24	-3.36	-3.96	-3.18	-3.39	-3.04	-2.51	-2.71	-2.40	-2.78
NICT	35 2620	9.80	9.55	9.13	-	-	-	-	-	-	-	-	-
NICT	35 2627	-0.39	-0.96	-0.10	-0.28	-0.19	-0.14	0.79	0.21	0.78	-0.19	1.23	0.93
NICT	35 2628	3.45	3.61	3.63	4.30	4.15	4.92	4.29	5.08	4.87	5.04	5.15	4.79
NICT	36 1217	3.75	4.14	4.33	1.75	6.88	6.98	9.15	7.86	7.53	8.10	6.87	3.86
NICT	40 2002	21.34	21.88	22.40	23.03	23.65	24.11	24.71	25.52	26.44	27.17	27.75	28.50
NICT	40 2003	24.05	24.21	24.60	24.88	25.10	24.89	24.18	23.95	24.60	24.44	23.68	-
NICT	40 2004	17.67	18.36	19.11	19.73	-	-	-	-	-	-	-	-
NICT	40 2005	-	34.81	36.27	36.17	37.58	39.17	41.04	42.84	44.74	47.94	50.20	51.83
NIM	35 1235	4.77	7.53	8.06	10.14	9.04	7.81	8.62	10.03	8.88	8.34	9.00	8.96
NIM	35 2239	2.93	2.26	2.22	2.52	1.39	3.05	2.10	2.35	2.77	2.62	2.77	2.69
NIM	40 4835	130.65	133.70	136.75	140.03	143.14	146.15	149.60	152.88	156.66	159.68	162.41	164.97
NIMB	35 600	0.03	-1.69	-2.03	0.19	2.01	-2.06	-3.04	-1.80	-0.32	-0.49	-1.92	-3.61
NIMT	35 2246	-	-	4.30	3.19	3.82	3.51	-	4.33	4.20	-	-	-
NIMT	35 2247	-	-	7.99	-8.07	-14.08	-0.63	-0.71	-0.69	-2.02	-	-	-
NIS	35 1126	-	-	-0.47	-	-	-	-1.22	-0.80	-1.05	-0.47	-	-0.91
NIST	35 182	2.81	3.53	3.10	2.62	2.93	3.14	2.76	1.91	1.58	1.15	1.22	1.65
NIST	35 282	-3.28	-2.50	-0.92	-0.77	-0.03	0.43	0.78	2.01	2.44	3.08	4.67	3.70
NIST	35 408	-22.35	-22.56	-22.28	-22.24	-20.92	-20.67	-20.68	-20.90	-21.06	-21.06	-19.94	-20.40
NIST	35 1074	-18.62	-18.50	-18.25	-18.28	-18.72	-19.72	-18.67	-19.48	-18.94	-19.66	-20.04	-19.35
NIST	35 2031	-9.47	-8.31	-7.40	-8.96	-8.21	-8.30	-7.95	-7.65	-8.03	-7.68	-8.34	-8.87
NIST	35 2032	-3.78	-4.07	-2.44	-3.89	-3.31	-3.20	-3.23	-3.48	-4.50	-4.48	-4.00	-4.93
NIST	35 2034	-7.56	-7.75	-7.98	-7.42	-8.25	-7.33	-8.44	-7.83	-9.26	-8.78	-8.01	-8.88
NIST	35 2579	-	-	-4.48	-3.29	-3.57	-2.88	-2.57	-2.43	-2.07	-2.15	-1.78	-1.49
NIST	35 2672	-	-	-4.04	-4.52	-4.98	-5.17	-5.01	-5.32	-5.13	-5.16	-4.70	-4.50
NIST	36 1661	-	-	-18.26	-18.44	-17.75	-18.15	-19.75	-18.19	-16.73	-16.02	-15.67	-19.20

Table 8. (Cont.)

Lab.	Clock		55589	55619	55649	55679	55709	55739	55769	55804	55834	55864	55894	55924
NIST	40	203	150.80	151.96	153.21	154.30	155.35	156.47	157.86	159.12	160.44	161.48	162.76	164.05
NIST	40	204	-	30.77	31.01	31.21	31.52	31.63	31.99	32.25	32.54	32.74	33.05	33.28
NIST	40	205	-26.34	-26.34	-26.28	-26.23	-26.05	-26.03	-26.02	-25.94	-25.86	-25.84	-25.83	-25.72
NIST	40	206	-61.58	-61.17	-60.81	-60.64	-60.25	-59.83	-59.45	-58.81	-57.92	-57.02	-56.06	-55.19
NIST	40	222	28.95	29.05	29.28	29.47	29.68	29.72	29.88	30.02	30.24	30.35	30.49	30.63
NMIJ	35	224	-27.31	-27.02	-	-	-	-	-	-	-	-	-	-8.81
NMIJ	35	523	9.18	8.33	-	9.49	9.74	9.87	9.08	9.74	9.93	10.39	10.48	10.87
NMIJ	35	1273	21.08	21.60	-	18.14	17.87	18.37	18.99	18.43	18.59	18.83	18.95	18.40
NMIJ	35	2057	-5.98	-6.43	-	-6.82	-6.20	-6.27	-7.04	-6.63	-5.82	-6.34	-7.58	-9.04
NMIJ	40	5002	-15.55	-15.46	-	-	-	-	-	0.00	-	-	-	-0.22
NMIJ	40	5003	-1.45	-1.39	-	6.35	5.36	5.10	5.04	4.99	4.98	5.45	5.42	5.37
NMIJ	40	5014	-	1.47	-	-	-	-	-	-	-	-	-	-
NMIJ	40	5015	63.41	65.49	-	-	-	-	-	-	-	-	4.65	7.28
NMLS	35	328	-2.11	13.02	12.66	12.47	11.37	6.95	-1.40	-2.45	-3.02	-3.01	-2.64	-3.23
NPL	35	1275	3.70	3.75	4.09	4.15	4.04	4.22	4.93	5.67	4.90	5.93	7.03	5.90
NPL	36	784	4.22	5.80	9.31	9.33	8.41	8.56	8.69	8.41	8.80	8.74	9.07	8.09
NPL	40	1701	11.48	11.88	12.24	12.47	12.62	12.88	12.70	12.83	13.09	13.37	13.85	14.03
NPL	40	1708	-0.76*	-0.47*	-1.24*	-1.04*	-1.40*	-1.24*	-1.05*	-0.89*	-0.56*	-0.34*	-0.17	0.16
NPLI	35	2257	0.93	-0.01	0.22	-0.01	1.92	-1.33	-1.95	1.75	-	-2.27	-2.40	-3.63
NRC	35	2148	7.45	8.36	7.74	7.32	8.88	10.87	11.06	10.06	11.19	10.93	10.80	10.39
NRC	35	2150	-1.25	-1.98	-1.97	-0.82	-1.26	-2.01	-0.95	-0.59	-0.97	-3.02	-4.02	-3.50
NRC	35	2151	0.92	1.24	1.77	-	-	-	-	-	-	-	-	-
NRC	35	2152	-5.19*	-5.75	-4.88	-4.98	-5.13	-5.43	-5.64	-5.30	-5.17	-5.45	-4.88	-5.23
NRL	35	714	0.35	0.26	-0.26	-0.18	-0.41	-	-	0.63	-0.08	-0.06	-0.61	-
NRL	35	719	-10.24	-8.00	-5.82	-11.49	-6.60	-	-	2.45	3.06	2.65	3.42	-
NRL	35	1245	-10.27	-8.04	-5.85	-11.52	-6.64	-	-	-3.83	-4.72	-5.17	-3.38	-
NRL	36	387	-2.23	-3.68	-3.73	-3.12	-2.96	-	-	-2.88	-2.53	-0.29	-2.54	-
NRL	40	1001	113.90	114.21	113.36	112.68	99.72	-	-	105.63	108.28	111.84	114.11	-
NRL	40	1003	13.02	13.42	13.73	13.99	14.34	-	-	15.34	15.75	15.42	15.76	-
NTSC	35	1007	16.70	17.67	17.36	12.97	10.50	10.17	10.09	11.49	8.35	6.66	6.38	6.53
NTSC	35	1008	3.33	4.17	3.72	5.13	4.03	4.30	3.79	3.87	4.33	5.31	4.85	4.30
NTSC	35	1011	-	-	-	-	-	-	-	-	-	-3.33	-3.74	-3.04
NTSC	35	1016	14.50	14.62	14.75	14.95	14.95	15.33	14.87	13.14	13.26	13.17	13.11	13.13
NTSC	35	1017	4.08	5.40	5.52	7.21	8.08	6.13	5.98	6.17	6.32	6.41	5.49	4.75
NTSC	35	1018	-13.38	-13.05	-12.85	-12.49	-13.03	-11.73	-12.34	-12.14	-12.41	-12.35	-12.41	-11.43

Table 8. (Cont.)

Lab.	Clock	55589	55619	55649	55679	55709	55739	55769	55804	55834	55864	55894	55924
NTSC	35 1818	-23.82	-23.60	-23.16	-23.58	-23.86	-22.94	-22.46	-22.61	-22.64	-22.99	-23.84	-22.84
NTSC	35 1820	11.26	11.33	11.42	11.60	11.28	11.71	10.77	10.66	10.63	11.20	12.12	10.10
NTSC	35 1823	8.91	9.27	9.84	10.44	10.24	11.11	11.35	11.12	11.56	11.70	12.52	12.77
NTSC	35 2096	-4.56	-5.18	-5.11	-5.52	-5.29	-4.78	-4.65	-5.35	-4.87	-4.84	-4.93	-4.92
NTSC	35 2098	7.43	8.02	7.45	7.99	8.57	7.99	7.50	7.76	7.72	6.97	7.01	7.39
NTSC	35 2131	-11.94	-11.33	-12.20	-12.56	-11.92	-12.51	-11.44	-10.87	-13.70	-13.36	-12.12	-12.82
NTSC	35 2141	34.89	34.19	34.40	28.25	28.06	33.73	32.76	34.87	37.52	38.37	39.30	35.20
NTSC	35 2142	-11.44	-11.49	-11.90	-11.88	-12.42	-11.74	-11.78	-12.09	-11.67	-11.27	-11.60	-11.57
NTSC	35 2143	7.98	7.36	7.21	7.15	7.47	7.79	8.56	6.78	7.99	7.48	8.66	7.88
NTSC	35 2144	-3.94	-4.17	-5.58	-4.04	-3.39	-4.00	-4.21	-4.20	-2.42	-3.66	-3.53	-3.35
NTSC	35 2145	-5.07	-4.38	-3.76	-3.80	-3.28	-3.74	-3.08	-3.42	-2.64	-2.88	-2.96	-2.25
NTSC	35 2146	2.77	2.81	2.34	2.60	3.66	3.66	3.73	3.13	-	-	-	-
NTSC	35 2147	10.40	9.77	9.71	9.74	9.03	9.74	9.90	9.16	9.78	9.99	10.17	9.25
NTSC	35 2573	1.94	1.80	2.01	2.25	2.61	2.53	1.91	2.20	2.65	2.08	2.57	2.68
NTSC	35 2576	-1.79	-1.77	-1.62	-0.96	-1.37	-1.49	-0.24	-0.29	-0.57	-0.07	-0.18	0.35
NTSC	40 4926	406.18	411.92	418.51	424.89	432.08	439.79	445.47	451.97	456.18	461.71	466.37	472.17
NTSC	40 4927	421.41	427.08	432.38	437.44	442.59	449.81	454.71	461.69	466.19	469.55	473.88	478.49
NTSC	40 4946	-	-	-	-	-	-	-	-	-	183.23	-	-
ONBA	36 2228	-4.02	-4.61	-	-4.56	-2.28	-4.42	-	-	-	-3.23	-3.95	-
ONRJ	35 102	-2.33	-2.17	-2.09	-1.73	-1.40	-1.79	-1.82	-1.87	-2.39	-4.20	-3.06	-3.56
ONRJ	35 103	1.93	1.59	2.14	1.54	1.49	2.84	1.28	1.40	0.75	0.61	0.74	-0.15
ONRJ	35 111	-3.16	-3.60	-3.36	-2.62	-2.86	-2.23	-2.98	-3.33	-3.70	-4.30	-5.71	-5.98
ONRJ	35 123	31.42	30.59	31.00	31.11	31.00	31.90	31.07	30.86	30.96	31.43	30.45	31.85
ONRJ	35 129	2.81	3.27	3.77	4.37	3.99	4.61	4.81	4.61	4.09	4.53	4.72	4.09
ONRJ	35 147	3.28	2.78	3.21	3.06	2.65	2.49	3.59	3.11	3.44	2.73	3.93	2.61
ONRJ	35 1153	273.29	348.52	430.49	-	-2.00	-1.32	-1.44	-1.19	-0.79	0.03	0.09	-0.39
ONRJ	35 1942	6.24	6.95	7.08	8.23	8.75	8.42	9.55	9.62	10.55	10.73	9.79	9.16
ONRJ	40 1950	135.48	173.36	214.36	258.11	111.44	50.20	101.06	163.17	227.21	288.60	271.96	-6.38
ORB	35 2722	-	-	-	-	-	-	-	-	-	-0.60	0.13	0.47
ORB	35 2723	-	-	-	-	-	-	-	-	-	3.51	4.38	4.14
ORB	35 2724	-	-	-	-	-	-	-	-	-	-0.67	-0.80	-0.76
ORB	36 201	-0.84	0.91	-	-	-	-	-	-	-	-	-	-
ORB	36 202	7.51	9.98	11.63	6.39	7.64	9.53	7.51	6.50	4.26	6.48	7.47	-
ORB	36 593	87.43	85.58	85.55	87.09	86.33	86.82	85.56	87.21	86.14	86.94	85.46	85.13
ORB	40 2602	-0.84	0.91	-	-	-	-	-	-	-	0.88	-	-

Table 8. (Cont.)

Lab.	Clock	55589	55619	55649	55679	55709	55739	55769	55804	55834	55864	55894	55924
PL	25 124	1.98	5.03	3.79	0.32	-8.19	-5.60	-12.04	-8.63	-8.34	-4.23	3.50	3.87
PL	25 125	-	-	8.25	6.43	3.12	4.89	1.72	3.35	2.98	4.57	8.74	8.75
PL	35 441	11.55	11.78	11.39	10.74	11.49	10.90	11.50	11.11	11.87	11.57	12.26	11.16
PL	35 502	7.05	9.18	9.20	9.00	7.82	7.69	6.48	5.87	5.40	4.84	5.10	5.43
PL	35 745	-0.29	0.24	1.81	1.35	0.83	0.08	0.59	0.97	0.48	1.16	0.45	0.69
PL	35 761	-3.10	-0.46	-1.64	-1.38	0.43	-1.63	-1.78	-0.56	-0.92	-1.81	-1.18	-1.96
PL	35 1120	-2.85	-2.28	-2.33	-3.26	-2.86	-3.58	-3.13	-2.79	-3.24	-3.64	-2.91	-3.33
PL	35 1660	-	-	-	-0.64	0.89	0.17	-0.42	-	-	-	-	-
PL	35 1746	1.48	1.44	1.71	2.46	2.56	2.36	2.39	3.17	3.06	3.61	3.82	-
PL	35 1934	2.12	2.92	1.11	0.97	0.15	0.17	-0.33	-0.29	0.49	1.44	1.64	1.77
PL	35 2394	4.09	3.93	4.63	4.49	4.76	4.15	4.05	3.23	3.86	3.11	3.80	3.67
PL	40 4002	-43.69	-45.21	-47.17	-49.71	-51.56	-53.14	-54.93	-55.98	-57.45	-59.34	-60.18	-61.84
PL	40 4601	19.42	20.40	21.28	21.93	22.87	23.56	24.49	25.37	26.33	27.09	28.32	28.92
PL	40 4602	238.73	249.65	260.35	270.47	281.90	294.38	309.27	326.32	322.18	331.84	341.26	360.42
PTB	35 128	0.99	0.50	1.10	0.20	1.95	2.18	2.83	2.03	1.79	1.71	3.18	3.04
PTB	35 415	0.70	1.03	1.48	1.09	1.52	1.72	1.82	2.02	2.07	1.95	1.97	1.43
PTB	35 1072	10.70	11.56	11.41	10.76	11.39	10.90	11.02	11.02	11.40	11.65	11.17	11.49
PTB	40 506	-21.29*	-20.58*	-17.69*	-14.93*	-14.20*	-12.62*	-10.05*	-7.59*	-6.88*	-6.81	-8.15	-9.70
PTB	40 508	-40.44*	-35.69*	-30.78*	-25.61*	-20.93*	-16.18*	-24.74*	-19.04*	-13.82*	-8.95	-4.24	0.24
PTB	40 590	-7.34	-6.50	-5.62	-5.21	-4.46	-3.75	-2.94	-1.96	-1.32	-0.84	-0.31	0.50
PTB	92 1	1.80	1.19	2.04	2.45	1.77	2.19	2.23	1.65	1.93	2.22	2.04	2.51
PTB	92 2	0.84	1.43	1.57	0.99	1.42	1.40	0.70	1.34	1.36	1.55	1.00	0.96
ROA	35 583	5.69	5.55	5.27	4.90	4.23	5.00	5.52	5.51	6.61	6.46	6.57	6.33
ROA	35 718	3.04	3.71	3.10	3.93	4.49	6.50	6.02	5.51	6.22	6.78	6.52	6.73
ROA	35 1699	8.52	7.96	8.60	7.67	8.55	9.03	8.49	8.39	8.58	9.26	10.14	8.24
ROA	35 2270	-4.22	-3.83	-4.42	-4.65	-4.75	-4.34	-5.78	-5.13	-4.45	-4.41	-5.31	-5.56
ROA	36 1488	8.69	10.75	9.30	8.87	8.74	8.60	7.98	9.88	9.21	8.64	10.62	11.55
ROA	36 1490	9.05	9.59	8.89	10.37	7.85	9.92	8.72	9.65	9.13	9.63	9.78	10.69
ROA	40 1436	97.20	99.97	103.19	105.82	108.77	112.06	114.44	117.67	120.95	123.81	127.22	129.87
SCL	35 2178	2.39	2.99	2.43	3.22	2.98	3.08	2.72	4.17	3.12	3.91	3.46	3.59
SCL	35 2525	1.41	2.27	2.01	1.90	1.64	2.25	2.32	2.34	2.83	2.62	2.43	2.71
SG	35 475	-3.28	-3.49	-4.00	-3.36	-4.09	-3.69	-3.53	-3.85	-3.07	-3.23	-2.93	-3.33
SG	35 476	8.05	8.02	8.36	8.12	8.62	8.01	8.26	8.80	8.43	9.06	9.09	8.77
SG	35 1889	16.66	17.12	17.05	16.74	18.11	17.04	16.49	16.85	16.91	16.98	16.60	17.94
SG	36 522	2.18	2.01	3.98	0.53	1.42	2.29	1.09	2.11	1.85	2.11	3.69	3.24

Table 8. (Cont.)

Lab.	Clock	55589	55619	55649	55679	55709	55739	55769	55804	55834	55864	55894	55924
SG	40 7701	90.21	98.49	107.13	116.18	126.11	136.31	147.43	157.06	171.16	183.35	196.16	209.34
SIQ	36 1268	1.56	0.15	1.24	0.06	-3.89	-1.05	0.21	1.05	-0.84	-2.97	-0.96	-1.51
SMD	35 810	-6.21	-6.73	-5.77	-5.47	-4.33	-3.60	-5.25	-5.51	-2.44	-4.47	-4.10	-5.96
SMD	35 1766	13.50	13.56	13.47	13.12	-	-	0.19	0.21	0.10	-	-	-
SMD	35 2003	11.97	11.69	11.38	11.12	11.32	10.73	10.04	11.45	9.45	10.33	10.06	10.24
SMD	35 2543	7.70	7.24	7.63	7.75	7.83	7.62	7.67	7.86	8.06	8.50	8.10	8.79
SMU	36 1193	0.50	-0.86	-1.68	-	-1.39	-5.19	1.20	2.64	2.52	1.91	0.18	0.30
SP	19 197	-26.95	-27.02	-	-	-30.80	-29.11	-	-	-	-	-	-
SP	35 572	19.17	18.88	19.13	18.92	19.81	18.59	19.19	18.86	18.39	19.21	19.48	18.85
SP	35 641	2.66	3.13	3.49	3.62	4.30	4.88	4.72	4.64	5.80	5.47	6.24	5.73
SP	35 1188	21.54	21.06	21.19	21.11	20.83	20.29	20.76	20.53	20.00	20.23	20.06	20.74
SP	35 1642	-1.20	-0.43	0.35	-0.30	0.21	0.64	0.47	0.16	0.24	0.23	-0.38	0.00
SP	35 2166	4.50	3.99	4.26	4.81	4.49	3.96	4.87	4.28	4.59	3.94	4.39	4.57
SP	36 223	8.47	7.45	9.27	7.42	8.03	8.21	8.62	9.13	7.81	9.44	9.42	8.55
SP	36 1175	0.44	2.55	0.42	1.85	1.28	2.86	2.43	1.88	3.66	2.10	1.51	2.34
SP	36 2068	3.21	2.50	4.32	0.78	2.89	3.00	2.42	2.59	3.43	3.36	2.33	4.90
SP	36 2218	23.56	22.41	23.24	22.50	23.95	23.66	23.45	23.89	22.85	22.96	23.78	23.33
SP	36 2295	7.69	8.34	7.44	7.14	7.58	8.16	8.15	8.80	6.59	8.44	8.37	8.15
SP	36 2297	-6.94	-8.08	-6.35	-6.52	-6.83	-6.90	-6.88	-7.54	-8.15	-7.32	-6.55	-7.39
SP	40 7201	115.28	117.72	120.10	122.76	125.36	127.81	130.47	133.16	135.94	138.61	141.23	143.75
SP	40 7203	7.93	9.02	10.12	11.11	12.15	13.09	14.13	15.23	16.36	17.33	18.34	19.36
SP	40 7210	111.42	115.33	118.37	121.85	124.97	128.17	131.85	134.84	138.30	140.98	144.43	147.51
SP	40 7211	21.13	22.91	24.73	26.12	27.38	28.93	30.68	32.14	33.59	35.01	36.45	37.87
SP	40 7212	10.03	10.61	11.21	11.76	12.37	12.76	13.16	13.79	14.41	15.03	15.61	16.22
SP	40 7218	-30.99	-32.57	-33.86	-35.64	-36.92	-38.46	-39.34	-41.01	-42.80	-44.12	-45.17	-46.56
SP	40 7221	-44.40	-44.30	-44.19	-44.12	-44.01	-43.97	-43.80	-43.61	-43.42	-43.32	-43.16	-42.95
SU	40 3809	9.16*	9.38*	9.58*	8.29*	8.70*	9.08*	9.33*	9.63*	10.07*	10.29*	10.72	11.04
SU	40 3810	-	-	-	-	-	-	-	-	-	-	10.07	-5.18
SU	40 3811	36.11	37.31	38.50	39.89	41.06	42.28	43.49	44.75	46.16	47.12	48.31	49.57
SU	40 3812	2.08	2.33	2.54	2.71	2.90	3.14	3.34	3.61	4.01	4.01	-	-
SU	40 3814	8.54*	9.18*	9.92*	-	-	-	-	-	-	-	15.88	16.38
SU	40 3815	-11.93*	-11.44*	-10.75*	-14.36*	-13.55*	-12.83*	-11.98*	-11.19*	-10.28*	-9.86*	-9.07*	-8.39
SU	40 3816	27.67*	27.72	27.98	28.38	28.91	29.85	30.55	31.43	32.34	32.37	33.54	33.76
SU	40 3817	9.11	9.91	10.72	12.17	13.57	14.89	17.25	-	-	-	-	-
SU	40 3822	-20.46*	-20.88*	-21.05*	-22.45*	-22.99*	-23.26	-22.85	-21.64	-19.17	-15.12	-	-

Table 8. (Cont.)

Lab.	Clock	55589	55619	55649	55679	55709	55739	55769	55804	55834	55864	55894	55924
SU	40 3831	51.58*	51.03*	50.94*	51.95*	52.97*	52.68*	53.19*	52.67	-	-	-	-
TCC	35 768	2.97	2.04	3.51	4.79	2.63	5.58	3.47	5.66	5.53	7.31	3.95	5.16
TCC	35 1881	2.24	-0.82	1.57	2.87	2.89	2.92	2.28	2.89	2.46	3.04	3.13	3.29
TCC	40 8620	-3.22*	-3.95*	-1.35*	-0.43*	0.32*	1.21	1.92	4.59	4.67	3.91	4.33	4.96
TCC	40 8624	-2.88*	-4.14*	-0.95*	-1.07*	-0.90*	-0.45	-	-	-	-	-	-
TCC	40 8650	4.50*	1.93*	2.37*	0.89*	-0.12*	-1.44	-2.97	-4.20	-5.33	-6.65	-7.89	-8.78
TL	35 300	12.32	13.21	13.49	15.66	15.74	15.35	-	-	-	-	-	-
TL	35 1012	3.60	3.95	3.03	2.17	2.62	3.52	3.08	3.16	3.72	4.32	3.86	4.73
TL	35 1104	18.22	19.47	18.88	19.59	19.28	18.72	19.61	18.51	18.93	17.77	17.58	18.51
TL	35 1132	-4.78	-3.10	-4.60	-4.25	-5.09	-4.70	-5.59	-3.40	-3.45	-3.32	-4.86	-2.83
TL	35 1498	-0.96	-0.93	-0.74	-0.40	0.36	0.43	0.90	1.29	0.96	0.88	1.10	1.40
TL	35 1500	16.53	16.02	16.93	17.19	16.77	16.86	16.50	16.51	16.06	16.97	15.96	15.81
TL	35 1712	-	-	-	-	-	-13.56	-13.19	-12.87	-13.09	-12.15	-12.32	-11.35
TL	35 2365	5.06	5.35	5.28	6.01	5.32	5.36	5.37	5.25	5.15	5.13	4.76	5.71
TL	35 2366	-8.91	-8.45	-8.53	-8.33	-7.96	-8.13	-7.50	-7.80	-6.89	-7.03	-7.36	-7.20
TL	35 2367	8.99	9.82	9.20	9.44	8.96	9.23	9.05	8.23	9.36	8.67	9.07	8.76
TL	35 2368	-1.53	-1.59	-1.18	-1.49	-0.94	-1.19	-1.24	-1.16	-0.89	-0.06	0.81	0.38
TL	35 2630	-16.88	-16.29	-16.17	-16.90	-16.72	-16.53	-16.15	-16.07	-15.93	-15.90	-15.90	-14.95
TL	35 2634	1.51	1.99	1.98	2.98	2.60	2.36	4.10	3.41	4.70	3.56	6.81	5.20
TL	35 2636	12.50	12.44	12.69	12.96	13.01	13.46	13.34	13.42	12.78	13.44	13.65	13.82
TL	40 57	14.00	21.61	-4.37	-	-	-	-	-	-	-	-	-2.74
TL	40 3052	63.98	63.95	63.17	63.69	64.01	63.97	64.33	65.74	65.39	65.34	65.60	65.94
TL	40 3053	6.40	6.76	6.07	6.59	7.15	6.60	6.52	6.61	6.31	5.80	5.68	5.53
TP	35 163	17.03	17.24	17.53	18.13	18.23	19.62	19.88	20.38	21.03	21.72	-	-
TP	35 1227	14.19	13.76	13.50	14.06	14.15	14.63	14.23	14.15	14.41	14.06	14.11	13.80
TP	35 2476	6.20	6.47	6.24	6.10	5.40	6.58	6.07	5.93	6.67	5.88	6.85	7.17
TP	36 154	8.90	8.57	8.54	10.89	11.73	9.66	9.80	9.17	8.94	11.28	10.43	10.46
UA	35 2465	-	-4.16	-4.11	-3.51	-3.49	-2.28	-3.50	-2.13	-1.31	-3.76	-4.21	-4.43
UA	40 7854	-	11.29*	10.72*	7.62*	3.63*	0.27	-0.39	2.64	-0.08	0.10	0.87	1.98
UA	40 7881	-	-1.81	1.55	-0.86	2.53	1.09	3.16	3.90	6.39	6.53	3.81	2.73
UA	40 7882	-	-0.27	-0.37	-0.19	-0.09	0.77	0.73	0.01	0.53	0.71	1.03	2.30
UME	35 251	0.65	1.29	0.34	0.95	-0.16	0.24	0.50	0.80	0.98	1.27	1.27	1.20
UME	35 252	-	-	-	-	-	-1.30	-1.51	-1.81	-2.35	-2.04	-2.14	-1.71
UME	35 710	-	-	-	-	-	0.28	0.78	0.84	0.49	1.38	1.61	1.56
UME	35 2703	-	-	-	-	-	0.01	-0.52	-0.60	-0.49	-0.28	0.43	0.62

Table 8. (Cont.)

Lab.	Clock		55589	55619	55649	55679	55709	55739	55769	55804	55834	55864	55894	55924
USNO	35	101	9.15	8.24	9.03	8.55	8.99	9.80	8.10	8.55	8.83	8.32	8.02	7.70
USNO	35	104	22.78	23.24	22.61	23.83	22.67	23.14	23.23	22.57	22.91	22.58	22.07	22.58
USNO	35	106	18.26	17.69	17.53	17.91	17.93	17.84	19.07	-	-	17.88	17.57	17.47
USNO	35	108	3.86	3.33	3.30	3.04	3.97	2.91	3.11	2.14	2.66	1.60	1.82	1.92
USNO	35	114	-0.94	-0.96	-0.53	-	-	0.65	0.25	0.01	0.52	1.21	1.68	1.43
USNO	35	120	26.11	25.37	25.20	25.96	25.27	24.96	25.18	24.93	25.01	24.90	24.52	24.99
USNO	35	142	-8.45	-8.18	-8.98	-9.10	-7.42	-7.73	-9.78	-8.64	-8.71	-8.03	-8.45	-8.46
USNO	35	145	19.09	19.53	18.90	17.89	18.89	19.40	19.69	17.85	19.35	18.90	18.34	17.95
USNO	35	146	-0.80	-1.07	-0.36	-0.52	-1.25	-1.34	-0.04	-0.20	-1.61	-0.54	-0.44	-0.91
USNO	35	148	9.05	8.81	9.10	9.79	8.94	9.19	11.32	9.52	9.53	9.65	9.16	9.63
USNO	35	150	-2.01	-1.83	-2.22	-1.57	-1.26	-2.21	-2.00	-1.51	-2.06	-1.33	-1.50	-2.22
USNO	35	152	2.92	3.10	3.15	4.92	3.55	4.02	3.68	2.61	3.51	2.92	1.86	3.01
USNO	35	153	15.70	16.01	-	-	-	-	-	-	-	-	-	-
USNO	35	156	10.43	9.71	11.14	10.05	8.96	9.72	9.68	-	-	11.78	10.54	10.51
USNO	35	161	7.08	7.98	6.90	7.00	7.35	7.09	7.02	7.01	7.17	6.12	5.75	5.73
USNO	35	165	12.41	-	-	5.67	7.00	6.25	6.22	7.37	-	-	9.14	9.26
USNO	35	166	-0.84	0.04	-0.50	-0.06	-0.28	-	-	-	52.01	51.26	52.01	51.74
USNO	35	167	-2.44	-2.56	-1.55	-2.99	-1.82	-3.02	-2.03	-	-	-	-	-
USNO	35	169	-	-	-	-19.13	-17.94	-18.22	-18.43	-18.13	-	-	-19.17	-18.48
USNO	35	173	-5.78	-5.69	-5.11	-5.84	-5.76	-5.98	-5.76	-6.08	-5.83	-5.74	-5.74	-5.46
USNO	35	213	11.82	11.87	11.23	11.18	11.48	10.93	11.13	11.70	10.31	10.39	10.40	10.69
USNO	35	217	-	-	-	-	-	-1.39	-1.52	-1.98	-1.90	-2.06	-1.73	-1.03
USNO	35	226	9.95	9.71	9.63	-	-	9.50	10.32	10.76	10.46	11.16	11.23	11.56
USNO	35	227	23.49	23.60	24.80	25.49	25.06	25.79	26.37	26.49	26.62	27.39	26.87	26.22
USNO	35	231	-11.93	-12.91	-	-	-	-	-	-	-	-	-	-2.69
USNO	35	233	17.69	18.32	18.88	-	-	17.61	18.07	17.71	16.31	16.37	16.99	16.01
USNO	35	242	13.70	13.62	13.51	14.00	14.15	13.92	12.46	13.49	13.17	12.96	13.42	13.17
USNO	35	244	9.58	6.35	5.57	-	-	7.14	7.09	7.37	8.26	8.27	8.83	8.28
USNO	35	253	-20.00	-18.57	-19.42	-19.95	-23.08	-23.69	-21.57	-22.38	-22.50	-22.53	-23.12	-22.16
USNO	35	254	5.07	5.42	5.31	4.87	7.86	6.86	7.92	8.77	9.06	9.46	8.88	8.51
USNO	35	255	-	-	-	-	-	24.62	24.75	24.70	25.02	25.13	24.94	25.02
USNO	35	256	-	-	-	-	-	17.59	18.55	18.81	19.04	19.11	18.69	19.99
USNO	35	260	1.70	2.76	2.72	2.30	1.02	2.02	0.96	2.87	3.24	4.55	-	-
USNO	35	266	-	-	-	-	-	20.84	20.30	21.49	21.66	21.61	22.27	22.47
USNO	35	268	-2.05	-1.59	-1.69	-1.71	-1.42	-1.72	-1.96	-1.88	-1.79	-0.92	-1.59	-1.00

Table 8. (Cont.)

Lab.	Clock	55589	55619	55649	55679	55709	55739	55769	55804	55834	55864	55894	55924
USNO	35 270	13.71	13.38	13.90	13.22	14.91	12.23	12.90	15.81	16.34	15.16	15.60	15.36
USNO	35 279	-	-	-	-	-	23.80	24.65	25.01	24.57	24.60	24.74	24.54
USNO	35 389	-	-	-	-30.51	-29.50	-28.96	-27.84	-27.41	-26.20	-26.51	-25.72	-25.36
USNO	35 392	-	-	-	-	12.88	12.28	10.18	11.31	10.77	10.83	11.01	10.45
USNO	35 416	-9.34	-9.73	-10.03	-	-	-	-	-	-	-6.42	-4.83	-5.63
USNO	35 417	-9.41	-9.68	-9.28	-8.30	-8.10	-8.58	-8.57	-8.11	-7.83	-8.77	-7.37	-8.23
USNO	35 703	-	-	-	-6.91	-7.47	-6.03	-6.19	-5.80	-5.39	-5.63	-4.40	-5.38
USNO	35 717	-10.29	-11.42	-11.77	-11.50	-11.41	-11.40	-11.29	-9.77	-9.72	-10.96	-10.93	-11.19
USNO	35 762	-2.60	-0.36	-0.45	-0.46	-0.27	0.23	0.14	0.03	0.80	0.52	0.22	0.23
USNO	35 763	-15.21	-14.63	-14.72	-14.03	-14.43	-14.32	-14.85	-13.85	-14.38	-14.32	-14.53	-13.73
USNO	35 765	-46.27	-41.59	-43.00	-48.24	-48.39	-47.74	-45.49	-45.19	-43.81	-42.95	-42.47	-42.20
USNO	35 1096	13.40	14.06	14.42	13.98	14.33	14.58	15.43	14.52	14.98	14.62	14.41	15.65
USNO	35 1097	8.65	9.72	8.98	9.13	8.16	7.70	8.37	7.31	8.80	8.61	8.43	9.29
USNO	35 1125	-13.23	-13.11	-13.17	-13.10	-12.80	-14.94	-15.60	-15.28	-14.31	-13.31	-13.55	-15.22
USNO	35 1327	-3.56	-4.23	-4.13	-4.54	-5.33	-5.69	-5.29	-5.24	-4.93	-5.53	-5.35	-5.13
USNO	35 1328	1.16	1.09	1.87	2.46	0.67	-0.11	0.34	1.06	0.66	0.78	1.34	1.48
USNO	35 1331	-39.23	-41.78	-42.42	-42.31	-42.16	-42.53	-40.47	-40.37	-40.79	-41.22	-41.67	-40.36
USNO	35 1438	-5.05	-5.09	-4.52	-2.42	-2.05	-2.16	-1.93	-2.59	-1.42	-2.07	-1.68	-1.82
USNO	35 1459	-3.20	-4.20	-2.42	-1.64	-1.57	-2.09	-1.93	-1.87	-1.51	-2.28	-1.73	-2.05
USNO	35 1462	-4.01	-3.52	-3.21	-3.60	-3.27	-4.10	-4.02	-3.47	-3.38	-4.20	-4.01	-2.69
USNO	35 1463	14.68	13.57	13.65	14.50	13.91	14.83	14.35	14.78	13.76	13.50	14.09	14.96
USNO	35 1468	-	-	-	-	-	9.32	10.14	9.93	10.11	10.54	11.04	10.85
USNO	35 1481	-	-	-	-	-	-20.14	-20.93	-21.34	-21.47	-20.96	-21.95	-20.90
USNO	35 1543	5.35	5.55	5.59	4.39	3.44	3.51	3.78	3.41	3.76	3.57	3.36	4.30
USNO	35 1573	-	-	-	-	-	15.17	15.51	15.30	14.77	15.85	15.61	15.40
USNO	35 1575	-5.75	-5.56	-5.84	-5.79	-4.95	-5.50	-4.87	-5.89	-5.50	-5.38	-6.15	-5.25
USNO	35 1580	-	-	-	-	-	-	-	-	-	-	-20.11	-19.70
USNO	35 1585	-	-	-	-	-	19.44	19.62	19.49	19.69	20.17	20.65	21.59
USNO	35 1598	0.91	0.77	1.69	0.55	0.13	-1.43	-0.88	-0.28	1.13	1.06	0.94	-0.09
USNO	35 1655	-10.69	-9.46	-9.28	-9.48	-10.06	-9.67	-10.25	-	-	-	-	-
USNO	35 1658	17.76	17.32	17.32	18.17	18.12	18.89	20.07	19.65	19.97	19.54	19.99	20.80
USNO	35 1692	-2.22	-2.29	-2.01	-1.63	-2.49	-2.12	-2.50	-2.83	-2.03	-2.20	-2.10	-2.25
USNO	35 1694	-	-	-	-	-	19.97	19.97	20.51	20.84	20.45	20.79	20.26
USNO	35 1696	11.21	11.71	11.52	12.13	12.63	12.51	12.30	12.89	12.26	12.25	11.21	11.81
USNO	35 1697	20.30	19.93	19.53	19.55	21.53	21.86	21.86	21.60	22.34	22.17	22.68	22.25

Table 8. (Cont.)

Lab.	Clock	55589	55619	55649	55679	55709	55739	55769	55804	55834	55864	55894	55924
USNO	40 702	-9.67	-9.54	-9.55	-9.70	-9.77	-10.86	-11.15	-11.21	-10.99	-10.96	-10.89	-10.73
USNO	40 704	19.33	19.32	19.28	19.29	31.35	31.29	31.35	31.79	32.64	32.60	32.60	32.89
USNO	40 705	-77.07	-76.33	-77.14	-77.02	-78.38	-77.52	-76.79	-76.05	-74.23	-73.75	-74.17	-74.89
USNO	40 708	77.22	77.37	77.57	77.88	78.78	79.09	79.93	-	-	-	-	-
USNO	40 710	-568.21	-567.40	-566.45	-565.75	-564.89	-	-	-548.38	-546.11	-544.42	-542.70	-540.74
USNO	40 711	311.24	312.94	314.73	316.39	318.14	319.86	321.74	323.62	325.55	327.16	329.09	332.09
USNO	40 712	49.44	49.49	49.70	49.77	49.79	49.79	49.85	49.85	49.93	49.96	49.96	50.02
USNO	40 713	20.87	21.28	21.80	22.20	22.65	23.03	23.37	23.85	24.41	24.89	25.46	25.91
USNO	40 714	-11.76	-11.57	-11.26	-11.07	-10.79	-10.57	-9.92	-9.77	-9.44	-9.85	-9.18	-8.88
USNO	40 715	93.01	93.49	94.00	94.44	94.92	95.36	95.83	96.54	96.95	97.42	98.02	98.68
USNO	40 716	212.14	212.25	212.46	212.51	212.68	212.63	212.72	212.93	213.16	213.08	213.33	213.54
USNO	40 718	161.74	162.85	163.96	164.91	166.03	167.12	168.35	169.70	171.27	172.59	173.97	175.41
USNO	40 719	60.49	61.58	62.79	63.97	65.14	66.23	67.37	68.61	69.92	70.93	72.01	73.09
USNO	40 720	118.76	121.19	123.57	125.98	128.54	130.96	133.53	136.12	-	-	144.09	146.50
USNO	40 721	-	-	-	-	-	80.30	88.04	94.00	102.54	107.58	114.76	120.67
USNO	40 722	389.99	393.33	396.51	399.74	403.00	406.31	409.71	413.27	416.84	420.11	423.37	426.47
USNO	40 723	-73.46	-73.51	-73.44	-73.44	-73.41	-73.41	-73.18	-73.08	-72.94	-72.91	-72.84	-72.65
USNO	40 724	-104.84	-105.16	-105.45	-105.82	-106.01	-106.36	-106.88	-107.02	-106.48	-106.44	-106.39	-106.58
USNO	40 725	-27.50	-27.22	-26.89	-26.88	-43.59	-43.37	-43.11	-42.97	-43.00	-42.90	-42.28	-42.44
USNO	40 728	234.52	238.30	241.90	244.69	247.85	250.96	254.26	257.78	262.62	266.63	269.49	272.41
USNO	40 730	-	-	-	-	-	134.53	138.02	141.83	145.70	149.16	152.60	156.08
USNO	40 731	-157.26	-158.00	-158.68	-159.60	-160.49	-161.02	-161.35	-162.10	-162.84	-163.37	-164.00	-164.49
USNO	40 732	-	-	-	-	-	-97.29	-95.43	-93.25	-91.04	-89.21	-87.20	-84.92
USNO	40 734	-	-	-	-	-	119.58	141.42	165.31	189.55	211.78	234.56	236.26
USNO	40 735	-	-	-	-	-	64.17	62.70	61.61	61.43	61.69	62.78	63.30
VMI	35 2230	-24.47	-	-	-26.70	-27.32	-24.31	-23.93	-24.32	-25.11	-24.81	-25.36	-27.75
VMI	36 1233	-0.89	-	-	-1.59	-8.22	-2.36	-4.89	-4.98	-2.56	-3.92	-4.31	-6.64
VMI	36 2314	23.37	-	-	22.32	19.45	23.91	23.45	22.66	21.55	22.10	22.88	19.47
VSL	35 179	-27.10	-27.09	-26.53	-26.86	-27.16	-27.49	-27.87	-27.29	-27.43	-27.12	-26.72	-26.93
VSL	35 456	-	-	-	-	-	-4.35	-3.99	-4.61	-5.24	-5.24	-5.37	-5.47
VSL	35 548	22.97	23.51	23.49	23.31	23.51	23.27	22.48	23.29	22.44	22.98	22.95	23.01
VSL	35 731	19.35	18.55	19.72	19.56	18.24	-	-	-	-	-	-	-
ZA	35 2232	-5.20	-4.46	-5.10	-5.04	-5.18	-5.23	-5.54	-5.57	-5.74	-5.65	-5.66	-5.88
ZA	35 2233	-16.59	-15.85	-16.43	-16.00	-15.72	-15.65	-15.74	-15.96	-14.92	-15.66	-14.84	-15.85
ZA	36 1034	-14.65	-16.50	-13.90	-	-13.14	-12.84	-18.72	-	-	-	-	-
ZA	36 1821	-9.83	-9.00	-8.58	-10.10	-8.81	-8.83	-8.58	-9.50	-8.33	-8.52	-9.02	-8.53

Table 9A. Relative weights (in percent) of contributing clocks in 2011

(File is available at ftp://62.161.69.5/pub/tai/scale/WTAI/wtai11.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
- 18 DATUM/SYMMETRICOM Cs 4000
- 19 RHODES AND SCHWARZ XSC
- 4x HYDROGEN MASERS
- 9x PRIMARY CLOCKS AND PROTOTYPES
- 21 OSCILLOQUARTZ 3210
- 23 OSCILLOQUARTZ EUDICS 3020
- 25 HEWLETT_PACKARD 5062C
- 30 HEWLETT-PACKARD 5061B
- 31 HEWLETT-PACKARD 5061B OPT. 4
- 34 H-P 5061A/B with 5071A tube
- 35 H-P/AGILENT/SYMMETRICOM 5071A High perf.
- 36 H-P/AGILENT/SYMMETRICOM 5071A Low perf.
- 50 FREQ. AND TIME SYSTEMS INC. 4065A
- 51 DATUM/SYMMETRICOM 4065 B
- 52 DATUM/SYMMETRICOM 4065 C
- 53 DATUM/SYMMETRICOM 4310 B

Lab.	Clock	55589	55619	55649	55679	55709	55739	55769	55804	55834	55864	55894	55924
APL	35 1264	0.000	0.100	0.154	0.220	0.136	0.128	0.136	0.149	0.151	0.114	-	-
APL	35 1791	0.000	0.069	0.104	0.093	0.122	-	-	-	-	-	-	-
APL	40 3107	0.000	0.729	0.744	0.755	0.751	0.737	0.729	0.716	0.720	0.668	-	-
APL	40 3108	0.000	0.002	0.001	0.001	0.001	0.001	0.001	0.001	-	-	-	-
APL	40 3109	0.000	0.729	0.744	0.755	0.751	0.737	0.729	0.716	0.720	0.668	-	-
AUS	35 2269	0.011	0.013	0.016	0.028	0.097	0.295	0.476	0.416	0.354	0.319	0.317	0.255
AUS	36 299	0.000	0.000	0.000	0.037	0.047	0.060	0.079	0.098	0.114	0.128	0.152	0.140
AUS	36 340	0.208	0.391	0.391	0.360	0.281	0.269	0.293	0.305	0.238	0.241	0.256	0.250
AUS	36 654	0.273	0.248	0.351	0.300	0.312	0.314	0.216	0.172	0.225	0.138	0.165	0.148
AUS	36 1141	0.058	0.048	0.045	0.043	0.053	0.050	0.059	0.060	0.068	0.059	0.054	0.060

Table 9A. (Cont.)

Lab.	Clock	55589	55619	55649	55679	55709	55739	55769	55804	55834	55864	55894	55924
AUS	40 5401	0.012	0.016	0.000	0.006	0.008	0.010	0.012	0.014	0.013	0.013	0.014	-
AUS	40 5402	-	-	-	-	0.000	0.000	0.000	0.000	0.003	0.003	0.003	-
BEV	35 1065	0.195	0.230	0.442	0.439	0.274	0.274	0.372	0.360	0.347	0.335	0.434	0.451
BEV	35 1793	0.000	0.000	0.000	0.000	0.336	0.292	0.247	0.251	0.275	0.251	0.219	0.254
BEV	40 3452	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
BIM	18 8058	0.400	0.440	0.330	0.311	0.368	0.300	0.315	0.330	0.258	-	0.000	0.000
BY	40 4222	-	-	-	0.000	0.000	0.000	0.000	0.004	-	-	0.000	0.000
BY	40 4227	0.003	0.002	0.002	0.002	0.002	0.002	0.002	0.002	-	-	-	-
BY	40 4260	0.000	0.001	-	-	-	-	-	-	-	-	-	-
BY	40 4278	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	-	-	0.000	0.000
CAO	35 939	0.311	0.233	0.298	0.205	0.214	0.155	0.150	0.134	0.144	0.139	0.135	0.133
CAO	35 1270	0.445	0.417	0.409	0.230	0.192	0.191	0.220	0.229	0.444	0.401	0.419	0.428
CH	35 771	0.325	0.543	0.499	0.569	0.603	0.723	0.644	0.570	0.551	0.477	0.374	0.373
CH	35 2117	0.559	0.421	0.513	0.643	0.471	0.455	0.560	0.521	0.720	0.668	0.683	0.702
CH	35 2743	-	-	-	-	-	-	-	-	-	0.000	0.000	0.000
CH	36 354	0.087	0.090	0.080	0.080	0.090	0.119	0.125	0.105	0.075	0.072	0.119	0.123
CH	36 413	0.019	0.017	0.016	0.021	0.022	0.023	-	-	-	-	-	-
CH	40 5701	0.017	0.015	0.014	0.013	0.014	0.014	0.017	0.019	0.022	0.026	0.035	0.051
CNM	35 1815	0.194	0.132	0.120	0.130	0.140	0.139	0.142	0.147	0.152	0.138	0.140	0.149
CNM	35 2708	-	-	-	-	-	-	-	-	-	-	0.000	0.000
CNM	35 2709	-	-	-	-	-	-	-	-	-	-	0.000	0.000
CNM	36 1537	0.109	0.088	0.087	0.101	0.097	0.113	0.083	0.083	-	-	-	-
CNM	40 7301	0.044	0.044	0.038	0.031	0.030	0.028	0.033	0.037	0.034	0.030	0.034	0.029
CNMP	36 1752	0.000	0.000	0.033	0.048	0.070	0.091	0.123	0.141	0.128	0.140	0.160	0.434
CNMP	36 1806	0.000	0.000	0.085	0.131	0.185	0.169	0.226	0.232	0.269	0.277	0.359	0.467
DLR	35 1714	0.166	0.181	0.189	0.238	0.224	0.000	-	-	0.000	0.000	0.000	0.000
DMDM	35 2191	0.253	0.215	0.148	0.133	0.152	0.180	0.194	0.226	0.240	0.200	0.237	0.203
DMDM	36 2033	0.182	0.194	0.211	0.225	0.243	0.243	0.262	0.268	0.266	0.370	0.468	0.427
DTAG	35 2635	-	-	0.000	0.000	0.000	0.000	0.564	0.311	0.306	0.340	0.343	0.425
DTAG	36 345	-	-	0.000	0.000	0.000	0.000	0.000	0.012	0.011	0.009	0.011	-
DTAG	36 2370	-	-	0.000	0.000	0.000	0.000	0.088	0.126	0.157	0.091	0.076	0.084
EIM	35 716	-	0.000	0.000	-	0.000	0.000	0.000	0.000	-	-	0.000	-
EIM	35 1431	-	0.000	0.000	-	0.000	0.000	0.000	0.000	-	-	0.000	-
EIM	35 2060	-	0.000	0.000	0.000	0.000	0.737	0.729	0.716	-	-	0.000	-
F	35 124	0.527	0.695	0.634	0.755	0.741	0.543	0.591	0.716	0.585	0.457	0.460	0.417

Table 9A. (Cont.)

Lab.	Clock	55589	55619	55649	55679	55709	55739	55769	55804	55834	55864	55894	55924
F	35 158	0.744	0.000	0.477	0.482	0.511	0.511	0.592	0.645	0.612	0.000	0.316	0.000
F	35 355	0.198	0.143	0.123	0.109	0.110	0.106	0.119	0.130	0.100	0.088	0.078	0.079
F	35 385	0.201	0.203	0.212	0.229	0.302	0.277	0.384	0.379	0.511	0.480	0.481	0.477
F	35 396	0.744	0.729	0.744	0.755	0.751	0.566	0.000	0.310	0.295	0.305	0.314	0.275
F	35 469	0.106	0.205	-	-	0.000	0.000	0.000	0.000	0.174	0.220	0.197	0.210
F	35 489	0.744	0.729	-	-	0.000	0.000	0.000	0.000	0.720	0.668	0.683	0.702
F	35 520	0.116	0.155	-	-	0.000	0.000	0.000	0.000	0.202	0.137	0.180	0.190
F	35 536	0.744	0.729	0.703	-	-	0.000	0.000	0.000	0.000	0.056	0.072	0.080
F	35 609	-	0.000	0.000	0.000	0.000	0.144	0.227	0.291	0.361	0.392	0.490	0.607
F	35 700	-	0.000	0.000	0.000	0.000	0.049	0.023	0.021	0.027	0.031	0.035	0.038
F	35 770	0.744	0.684	0.699	0.755	0.751	0.737	0.729	0.716	0.720	0.668	0.683	0.702
F	35 774	0.744	0.729	0.744	0.755	0.751	0.737	0.729	0.716	0.720	0.668	0.606	0.614
F	35 781	0.000	0.000	0.029	0.034	0.040	0.051	0.064	0.076	0.083	0.090	0.322	-
F	35 819	0.013	0.013	0.013	0.015	0.016	0.017	0.020	0.024	0.027	0.026	0.047	0.062
F	35 859	0.126	0.123	0.126	0.120	-	-	0.000	0.000	0.000	0.000	0.131	0.101
F	35 909	0.000	0.000	0.095	0.100	0.076	0.088	0.118	0.135	0.152	0.158	0.160	-
F	35 1068	0.000	0.000	-	-	-	-	-	-	-	-	-	-
F	35 1177	0.088	0.102	0.111	0.308	-	-	0.000	0.000	0.000	0.000	0.280	0.428
F	35 1222	-	-	-	-	-	0.000	0.000	0.000	0.000	0.587	0.652	-
F	35 1321	0.744	0.697	0.671	-	-	0.000	0.000	0.000	0.000	0.160	0.117	0.144
F	35 1556	-	0.000	0.000	0.000	0.000	0.443	0.351	0.403	0.505	0.592	0.429	0.477
F	35 1644	0.529	0.729	-	-	0.000	0.000	0.000	0.000	0.513	0.665	0.521	0.701
F	35 2027	0.288	0.000	0.214	0.175	0.176	0.199	0.184	0.243	0.321	0.336	0.681	0.000
F	35 2388	0.253	0.449	0.506	-	-	0.000	0.000	0.000	0.000	0.034	0.028	0.024
F	35 2609	-	0.000	0.000	0.000	0.000	0.737	0.729	0.716	0.720	0.668	0.683	0.702
F	35 2647	-	0.000	0.000	-	-	-	0.000	0.000	0.000	0.000	0.132	0.173
F	40 805	0.001	0.001	0.001	0.001	0.001	0.000	0.001	0.001	0.001	0.001	0.002	0.003
F	40 816	0.058	0.071	0.086	0.109	0.134	0.133	0.111	0.081	0.061	0.049	0.047	0.063
F	40 889	-	0.000	0.000	-	-	-	-	-	-	-	-	-
F	40 890	-	0.000	0.000	0.000	0.000	0.070	0.073	0.069	0.058	0.052	0.052	0.051
HKO	35 1893	0.074	0.076	0.078	0.664	0.751	0.690	0.729	0.716	0.720	0.668	0.620	-
HKO	35 2425	0.067	0.068	0.069	-	-	0.000	0.000	0.000	0.000	0.499	0.368	-
IFAG	36 1167	0.071	0.073	0.053	0.051	0.049	0.048	0.050	0.059	0.054	0.051	0.048	0.049
IFAG	36 1173	0.015	0.023	0.039	0.044	0.044	0.048	0.049	0.043	0.035	0.028	0.027	0.032
IFAG	36 1629	0.050	0.055	0.060	0.055	0.062	0.065	0.094	0.128	0.186	0.128	0.112	0.091

Table 9A. (Cont.)

Lab.	Clock	55589	55619	55649	55679	55709	55739	55769	55804	55834	55864	55894	55924
IFAG	36 1732	0.744	0.729	0.744	0.755	0.751	0.737	0.729	0.716	0.720	0.668	0.683	0.702
IFAG	36 1798	0.276	0.249	0.243	0.244	0.239	0.336	0.457	0.514	0.484	0.528	0.391	0.381
IFAG	40 4418	0.129	0.110	0.096	0.087	0.093	0.107	0.128	0.149	0.181	0.189	0.184	0.140
IFAG	40 4439	0.008	0.008	0.008	0.008	0.009	0.009	0.009	0.009	0.008	0.007	0.007	0.008
IGNA	35 1196	-	-	-	-	0.000	0.000	0.000	0.000	0.201	0.259	0.251	0.269
INPL	35 1653	0.000	0.000	0.000	0.000	0.588	0.526	0.000	0.141	0.153	0.160	0.178	0.195
INTI	35 2377	0.012	0.015	0.017	0.018	0.019	0.019	0.021	-	0.000	0.000	0.000	0.000
IPQ	35 1797	0.000	0.000	0.000	0.021	0.027	0.027	0.031	0.034	0.035	0.037	0.048	0.057
IPQ	35 2012	0.494	0.622	0.000	0.088	0.107	0.103	0.107	0.101	0.087	0.067	0.068	0.066
IPQ	35 2169	0.189	0.206	0.000	0.065	0.082	0.080	0.083	0.088	0.083	0.070	0.068	0.071
IT	35 219	0.017	0.014	0.014	0.014	0.015	0.017	0.023	0.037	0.085	0.075	0.000	0.030
IT	35 505	0.690	0.404	0.453	0.531	0.661	0.496	0.445	0.445	0.407	0.276	0.198	0.144
IT	35 1115	0.095	0.083	0.098	0.117	0.121	0.119	0.121	0.114	0.092	0.079	0.084	0.129
IT	35 1373	0.744	0.729	0.744	0.755	0.751	0.737	0.729	0.716	0.720	0.668	0.683	0.702
IT	35 2118	0.491	0.418	-	-	0.000	0.000	0.000	-	-	-	-	-
IT	35 2487	0.729	0.729	0.744	0.755	0.751	0.737	0.729	0.716	0.720	0.668	0.683	0.702
IT	40 1101	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
IT	40 1102	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
IT	40 1103	-	-	-	-	-	-	-	-	-	0.000	0.000	0.000
JV	21 216	0.000	0.000	0.011	0.017	0.018	0.017	0.022	0.025	0.029	0.029	-	0.000
JV	36 1277	0.000	0.000	0.021	0.032	0.040	0.052	0.064	0.067	0.076	0.083	-	0.000
JV	36 2617	-	-	-	-	-	-	-	-	0.000	-	-	-
JV	36 2629	-	-	-	-	-	-	-	-	0.000	0.000	-	0.000
KIM	36 618	0.049	0.054	0.056	0.062	0.064	0.086	0.092	0.089	0.075	0.070	0.071	0.089
KRIS	35 321	0.000	0.000	0.000	0.000	0.045	0.066	0.097	0.124	0.151	0.171	0.209	0.247
KRIS	35 739	0.744	0.693	0.643	0.667	0.751	0.737	0.729	0.716	0.720	0.668	0.683	0.702
KRIS	35 1135	-	-	-	-	0.000	0.000	0.000	0.000	0.160	0.172	0.185	0.141
KRIS	35 1693	0.414	0.325	0.280	0.383	0.473	0.486	0.542	0.572	0.720	0.668	0.683	0.700
KRIS	35 1783	0.329	0.238	0.264	0.311	0.243	0.236	0.286	0.222	0.213	0.206	0.207	0.192
KRIS	36 1135	0.000	0.000	0.000	-	-	-	-	-	-	-	-	-
KRIS	40 5624	0.003	0.004	0.005	0.007	0.011	0.016	0.024	0.036	0.052	0.072	0.109	0.156
KRIS	40 5625	0.004	0.005	0.006	0.007	0.008	0.008	0.008	0.008	0.008	0.008	0.011	0.017
KRIS	40 5626	0.066	0.051	0.046	0.043	0.044	0.044	0.050	0.054	0.063	0.087	0.236	0.220
KZ	35 2202	-	0.000	0.000	0.000	0.000	0.246	0.319	0.400	0.421	0.276	0.222	0.000
KZ	35 2665	-	-	-	-	-	-	-	-	-	0.000	0.000	0.000

Table 9A. (Cont.)

Lab.	Clock		55589	55619	55649	55679	55709	55739	55769	55804	55834	55864	55894	55924
KZ	35	2667	-	-	-	-	-	-	-	-	-	0.000	0.000	0.000
KZ	40	2707	-	-	0.000	-	0.000	-	-	-	-	-	-	-
LT	35	1362	0.000	0.000	0.039	0.056	0.044	0.056	0.075	0.085	0.097	0.072	0.072	0.076
LT	35	1868	-	-	0.000	0.000	0.000	0.000	0.203	0.244	0.303	0.355	0.414	0.526
LV	35	2335	0.063	-	-	-	-	-	-	-	-	-	-	-
MIKE	35	1171	0.333	0.482	0.294	0.290	0.325	0.275	0.308	0.296	0.250	0.230	0.249	0.267
MIKE	36	986	0.144	0.146	0.138	0.128	0.149	0.142	0.170	0.171	0.163	0.205	0.484	0.000
MIKE	40	4108	0.028	0.030	0.034	0.040	0.054	0.084	0.000	0.021	0.016	0.013	0.012	0.012
MIKE	40	4113	0.000	0.010	0.008	0.007	0.006	0.005	0.005	0.004	-	-	-	-
MIKE	40	4180	-	-	-	-	-	-	-	0.000	-	-	-	-
MKEH	36	849	0.084	0.085	0.101	0.130	0.126	0.121	0.095	0.102	0.098	0.087	0.099	0.086
MSL	12	933	-	0.000	0.000	0.000	0.000	0.001	-	-	0.000	0.000	-	-
MSL	36	274	-	0.000	0.000	0.000	0.000	0.001	0.002	0.002	0.003	0.003	-	-
MSL	36	1025	-	0.000	0.000	0.000	0.000	0.000	0.001	0.001	0.001	0.001	-	-
NAO	35	779	0.387	0.337	-	-	-	-	-	0.000	-	-	-	-
NAO	35	1206	0.486	0.000	-	-	-	-	-	0.000	-	-	0.000	0.000
NAO	35	1214	0.002	0.002	-	-	-	-	-	-	-	-	0.000	0.000
NAO	35	1689	0.408	0.299	-	-	-	-	-	0.000	-	-	0.000	0.000
NICT	35	112	0.521	0.729	0.744	0.755	0.000	0.000	0.085	0.050	0.038	0.031	0.032	0.038
NICT	35	332	0.274	0.257	0.318	0.374	0.245	0.243	0.388	0.388	0.214	0.202	0.243	0.311
NICT	35	342	0.416	0.488	0.499	0.496	0.638	0.617	0.672	0.691	0.000	0.355	0.323	0.328
NICT	35	343	0.699	0.589	0.507	0.541	0.551	0.391	0.328	0.282	0.179	0.141	0.139	0.168
NICT	35	715	0.744	0.729	0.744	0.755	0.751	0.737	0.729	0.716	0.720	0.668	0.683	0.702
NICT	35	732	0.548	0.645	0.599	0.602	0.601	0.737	0.729	0.000	0.231	0.176	0.156	0.148
NICT	35	907	0.293	-	-	0.000	0.000	0.000	0.000	0.716	0.720	0.668	0.683	0.702
NICT	35	908	0.099	-	-	-	-	-	-	-	-	-	-	-
NICT	35	913	0.063	0.063	0.062	0.066	0.065	0.064	0.077	0.071	0.073	0.069	0.057	0.058
NICT	35	916	0.374	0.478	0.480	0.459	0.488	0.489	0.516	0.446	0.633	0.483	0.565	0.452
NICT	35	1225	0.000	0.000	0.000	-	0.000	0.000	0.000	0.000	0.419	0.331	0.452	0.497
NICT	35	1226	0.050	0.088	0.185	0.255	0.556	0.508	0.588	0.609	0.568	0.484	0.466	0.445
NICT	35	1611	0.006	0.006	0.005	0.014	0.022	0.026	0.031	0.032	0.036	0.000	0.008	0.000
NICT	35	1778	0.163	0.136	0.111	0.108	0.117	0.132	0.155	0.179	0.168	0.000	0.091	0.084
NICT	35	1789	0.744	0.729	0.744	0.755	0.751	0.737	0.729	0.716	0.720	0.668	0.683	0.702
NICT	35	1790	0.116	0.090	0.100	0.094	0.089	0.075	0.068	0.062	0.054	0.047	0.048	0.044
NICT	35	1866	0.385	0.300	0.287	0.235	0.200	0.221	0.239	0.254	0.248	0.316	0.521	0.702

Table 9A. (Cont.)

Lab.	Clock	55589	55619	55649	55679	55709	55739	55769	55804	55834	55864	55894	55924
NICT	35 1882	0.744	0.729	0.744	0.755	0.751	0.737	0.729	0.634	0.445	0.404	0.382	0.383
NICT	35 1887	0.744	0.729	0.744	0.755	0.751	0.737	0.729	0.716	0.720	0.668	0.683	0.702
NICT	35 1944	0.458	0.416	0.400	0.353	0.607	0.673	0.000	0.417	0.367	0.307	0.335	0.497
NICT	35 2010	0.744	0.729	0.744	0.755	0.751	0.737	0.729	0.716	0.720	0.668	0.675	0.696
NICT	35 2011	0.000	0.000	0.000	0.000	0.000	0.001	0.001	0.003	0.005	0.004	0.004	0.004
NICT	35 2056	0.366	0.000	0.000	0.061	0.049	0.036	0.034	0.033	0.039	0.044	0.062	0.084
NICT	35 2113	0.267	0.315	0.318	0.339	0.000	0.143	0.130	0.105	0.098	0.119	0.101	0.075
NICT	35 2116	0.159	0.158	0.195	0.331	0.514	0.435	0.471	0.465	0.000	0.250	0.225	0.213
NICT	35 2570	0.744	0.729	0.744	-	-	-	-	-	-	0.000	0.000	0.000
NICT	35 2574	0.148	0.185	0.209	0.245	0.649	0.737	0.729	0.716	0.720	0.668	0.683	0.702
NICT	35 2620	0.000	0.000	0.000	-	-	-	-	-	-	-	-	-
NICT	35 2627	0.000	0.000	0.000	0.543	0.751	0.737	0.566	0.677	0.597	0.630	0.499	0.518
NICT	35 2628	0.000	0.000	0.000	0.000	0.735	0.359	0.529	0.440	0.484	0.488	0.531	0.650
NICT	36 1217	0.163	0.158	0.172	0.195	0.000	0.056	0.033	0.029	0.026	0.025	0.025	0.029
NICT	40 2002	0.000	0.000	0.000	0.000	0.000	0.038	0.047	0.046	0.040	0.033	0.030	0.028
NICT	40 2003	0.105	0.091	0.082	0.077	0.115	0.188	0.358	0.470	0.613	0.668	0.548	-
NICT	40 2004	0.000	0.060	0.051	0.046	-	-	-	-	-	-	-	-
NICT	40 2005	-	0.000	0.000	0.000	0.000	0.026	0.017	0.011	0.008	0.005	0.004	0.004
NIM	35 1235	0.132	0.130	0.150	0.091	0.088	0.089	0.098	0.079	0.078	0.078	0.078	0.081
NIM	35 2239	0.283	0.362	0.361	0.481	0.347	0.335	0.349	0.391	0.543	0.571	0.631	0.671
NIM	40 4835	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
NIMB	35 600	0.000	0.041	0.037	0.053	0.053	0.049	0.044	0.048	0.055	0.061	0.064	0.051
NIMT	35 2246	-	-	0.000	0.000	0.000	0.000	-	0.000	0.000	-	-	-
NIMT	35 2247	-	-	0.000	0.000	0.000	0.000	0.001	0.001	0.002	-	-	-
NIS	35 1126	-	-	0.000	-	-	-	0.000	0.000	0.000	0.000	-	0.000
NIST	35 182	0.744	0.729	0.744	0.650	0.659	0.627	0.551	0.000	0.270	0.170	0.135	0.141
NIST	35 282	0.143	0.145	0.000	0.059	0.045	0.037	0.037	0.033	0.030	0.027	0.024	0.027
NIST	35 408	0.404	0.500	0.744	0.755	0.751	0.522	0.424	0.378	0.369	0.358	0.264	0.271
NIST	35 1074	0.145	0.528	0.713	0.628	0.678	0.496	0.530	0.525	0.488	0.347	0.245	0.236
NIST	35 2031	0.291	0.285	0.317	0.279	0.293	0.283	0.299	0.361	0.382	0.371	0.463	0.413
NIST	35 2032	0.020	0.016	0.017	0.018	0.022	0.023	0.029	0.036	0.067	0.140	0.303	0.213
NIST	35 2034	0.332	0.269	0.272	0.384	0.352	0.500	0.378	0.361	0.193	0.175	0.189	0.243
NIST	35 2579	-	-	0.000	0.000	0.000	0.000	0.154	0.173	0.171	0.183	0.193	0.197
NIST	35 2672	-	-	0.000	0.000	0.000	0.000	0.218	0.228	0.272	0.301	0.390	0.494
NIST	36 1661	-	-	0.000	0.000	0.000	0.000	0.000	0.142	0.109	0.077	0.069	0.071

Table 9A. (Cont.)

Lab.		Clock	55589	55619	55649	55679	55709	55739	55769	55804	55834	55864	55894	55924
NIST	40	203	0.008	0.008	0.009	0.009	0.009	0.009	0.010	0.009	0.009	0.008	0.008	0.008
NIST	40	204	-	0.000	0.000	0.000	0.000	0.737	0.715	0.547	0.423	0.345	0.301	0.277
NIST	40	205	0.744	0.729	0.744	0.755	0.751	0.737	0.729	0.716	0.720	0.668	0.683	0.702
NIST	40	206	0.258	0.269	0.272	0.273	0.283	0.252	0.235	0.177	0.126	0.077	0.051	0.038
NIST	40	222	0.744	0.729	0.744	0.755	0.751	0.737	0.729	0.716	0.720	0.668	0.683	0.702
NMIJ	35	224	0.177	0.187	-	-	-	-	-	-	-	-	-	0.000
NMIJ	35	523	0.000	0.000	-	0.000	0.000	0.000	0.000	0.558	0.720	0.599	0.603	0.501
NMIJ	35	1273	0.296	0.312	-	0.000	0.000	0.000	0.000	0.487	0.689	0.668	0.683	0.702
NMIJ	35	2057	0.065	0.063	-	0.000	0.000	0.000	0.000	0.423	0.393	0.506	0.254	0.000
NMIJ	40	5002	0.000	0.000	-	-	-	-	-	0.000	-	-	-	0.000
NMIJ	40	5003	0.744	0.729	-	0.000	0.000	0.000	0.000	0.152	0.189	0.243	0.325	0.422
NMIJ	40	5014	-	0.000	-	-	-	-	-	-	-	-	-	-
NMIJ	40	5015	0.002	0.002	-	-	-	-	-	-	-	-	0.000	0.000
NMLS	35	328	0.037	0.000	0.003	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002
NPL	35	1275	0.000	0.000	0.000	0.755	0.751	0.737	0.729	0.433	0.489	0.323	0.000	0.171
NPL	36	784	0.000	0.000	0.000	0.010	0.014	0.019	0.025	0.030	0.035	0.038	0.045	0.066
NPL	40	1701	0.000	0.000	0.000	0.331	0.374	0.369	0.483	0.550	0.559	0.500	0.412	0.433
NPL	40	1708	0.000	0.000	0.000	0.717	0.677	0.652	0.668	0.627	0.515	0.420	0.389	0.381
NPLI	35	2257	0.093	0.093	0.097	0.100	0.093	0.078	0.076	0.067	-	0.000	0.000	0.000
NRC	35	2148	0.744	0.729	0.744	0.755	0.644	0.000	0.101	0.092	0.075	0.063	0.066	0.073
NRC	35	2150	0.744	0.729	0.744	0.755	0.751	0.737	0.729	0.716	0.720	0.000	0.000	0.091
NRC	35	2151	0.000	0.000	0.091	-	-	-	-	-	-	-	-	-
NRC	35	2152	0.744	0.663	0.705	0.755	0.751	0.737	0.672	0.691	0.720	0.668	0.683	0.702
NRL	35	714	0.744	0.729	0.480	0.428	0.376	-	-	0.000	0.000	0.000	0.000	-
NRL	35	719	0.024	0.035	0.039	0.024	0.031	-	-	0.000	0.000	0.000	0.000	-
NRL	35	1245	0.004	0.006	0.007	0.009	0.011	-	-	0.000	0.000	0.000	0.000	-
NRL	36	387	0.075	0.075	0.083	0.109	0.145	-	-	0.000	0.000	0.000	0.000	-
NRL	40	1001	0.000	0.001	0.001	0.001	0.001	-	-	0.000	0.000	0.000	0.000	-
NRL	40	1003	0.307	0.257	0.234	0.224	0.214	-	-	0.000	0.000	0.000	0.000	-
NTSC	35	1007	0.008	0.006	0.005	0.005	0.006	0.007	0.010	0.013	0.013	0.010	0.008	0.007
NTSC	35	1008	0.287	0.330	0.387	0.387	0.425	0.510	0.633	0.573	0.546	0.492	0.493	0.503
NTSC	35	1011	-	-	-	-	-	-	-	-	-	0.000	0.000	0.000
NTSC	35	1016	0.218	0.249	0.247	0.242	0.256	0.313	0.530	0.000	0.199	0.136	0.139	0.126
NTSC	35	1017	0.000	0.045	0.045	0.052	0.054	0.053	0.054	0.051	0.055	0.074	0.104	0.124
NTSC	35	1018	0.104	0.091	0.091	0.090	0.109	0.098	0.123	0.133	0.189	0.261	0.650	0.702

Table 9A. (Cont.)

Lab.	Clock	55589	55619	55649	55679	55709	55739	55769	55804	55834	55864	55894	55924
NTSC	35 1818	0.339	0.642	0.686	0.704	0.751	0.663	0.625	0.716	0.720	0.668	0.566	0.656
NTSC	35 1820	0.076	0.078	0.089	0.104	0.117	0.132	0.153	0.155	0.210	0.373	0.478	0.332
NTSC	35 1823	0.744	0.729	0.744	0.623	0.653	0.417	0.292	0.276	0.233	0.198	0.157	0.133
NTSC	35 2096	0.627	0.553	0.650	0.501	0.595	0.688	0.729	0.716	0.720	0.668	0.683	0.702
NTSC	35 2098	0.360	0.421	0.465	0.491	0.604	0.737	0.729	0.716	0.720	0.532	0.431	0.426
NTSC	35 2131	0.065	0.078	0.099	0.156	0.213	0.395	0.729	0.644	0.000	0.164	0.169	0.164
NTSC	35 2141	0.016	0.018	0.018	0.010	0.008	0.008	0.008	0.009	0.010	0.010	0.010	0.012
NTSC	35 2142	0.520	0.552	0.408	0.415	0.319	0.304	0.434	0.387	0.387	0.653	0.683	0.702
NTSC	35 2143	0.281	0.270	0.308	0.342	0.394	0.408	0.357	0.316	0.315	0.291	0.362	0.489
NTSC	35 2144	0.242	0.251	0.178	0.204	0.295	0.292	0.305	0.298	0.275	0.255	0.271	0.314
NTSC	35 2145	0.739	0.654	0.412	0.394	0.334	0.366	0.302	0.286	0.251	0.298	0.358	0.374
NTSC	35 2146	0.392	0.349	0.336	0.387	0.412	0.459	0.474	0.525	-	-	-	-
NTSC	35 2147	0.583	0.639	0.612	0.550	0.360	0.331	0.415	0.319	0.535	0.560	0.578	0.587
NTSC	35 2573	0.744	0.729	0.744	0.755	0.751	0.737	0.729	0.716	0.720	0.668	0.683	0.702
NTSC	35 2576	0.744	0.729	0.744	0.755	0.751	0.737	0.716	0.501	0.511	0.420	0.446	0.401
NTSC	40 4926	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
NTSC	40 4927	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
NTSC	40 4946	-	-	-	-	-	-	-	-	-	0.000	-	-
ONBA	36 2228	0.414	0.337	-	0.000	0.000	0.000	-	-	-	0.000	0.000	-
ONRJ	35 102	0.288	0.236	0.240	0.206	0.222	0.251	0.359	0.472	0.720	0.000	0.191	0.150
ONRJ	35 103	0.301	0.313	0.324	0.356	0.345	0.321	0.351	0.300	0.264	0.191	0.233	0.156
ONRJ	35 111	0.019	0.021	0.025	0.030	0.113	0.254	0.311	0.550	0.432	0.265	0.000	0.083
ONRJ	35 123	0.441	0.412	0.420	0.445	0.578	0.614	0.729	0.670	0.612	0.668	0.674	0.643
ONRJ	35 129	0.528	0.512	0.433	0.556	0.514	0.401	0.326	0.312	0.297	0.296	0.348	0.566
ONRJ	35 147	0.317	0.729	0.744	0.755	0.751	0.737	0.729	0.716	0.720	0.668	0.683	0.647
ONRJ	35 1153	0.000	0.000	0.000	-	0.000	0.000	0.000	0.000	0.451	0.184	0.170	0.222
ONRJ	35 1942	0.024	0.023	0.025	0.025	0.025	0.031	0.040	0.041	0.039	0.044	0.053	0.086
ONRJ	40 1950	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 2722	-	-	-	-	-	-	-	-	-	0.000	0.000	0.000
ORB	35 2723	-	-	-	-	-	-	-	-	-	0.000	0.000	0.000
ORB	35 2724	-	-	-	-	-	-	-	-	-	0.000	0.000	0.000
ORB	36 201	0.000	0.000	-	-	-	-	-	-	-	-	-	-
ORB	36 202	0.000	0.000	0.000	0.008	0.012	0.016	0.022	0.025	0.022	0.024	0.028	-
ORB	36 593	0.000	0.000	0.000	0.072	0.113	0.151	0.168	0.189	0.216	0.238	0.226	0.177
ORB	40 2602	0.000	0.000	-	-	-	-	-	-	-	0.000	-	-

Table 9A. (Cont.)

Lab.	Clock		55589	55619	55649	55679	55709	55739	55769	55804	55834	55864	55894	55924
PL	25	124	0.007	0.006	0.005	0.006	0.005	0.005	0.004	0.004	0.004	0.003	0.004	0.004
PL	25	125	-	-	0.000	0.000	0.000	0.000	0.009	0.012	0.015	0.018	0.016	0.017
PL	35	441	0.000	0.000	0.578	0.236	0.333	0.307	0.409	0.425	0.491	0.534	0.638	0.702
PL	35	502	0.010	0.039	0.029	0.031	0.035	0.038	0.043	0.063	0.059	0.045	0.043	0.042
PL	35	745	0.344	0.335	0.285	0.328	0.345	0.329	0.355	0.341	0.380	0.360	0.334	0.399
PL	35	761	0.000	0.000	0.000	0.000	0.040	0.056	0.078	0.097	0.118	0.125	0.153	0.170
PL	35	1120	0.254	0.393	0.444	0.338	0.323	0.287	0.281	0.331	0.273	0.236	0.361	0.428
PL	35	1660	-	-	-	0.000	0.000	0.000	0.000	-	-	-	-	-
PL	35	1746	0.210	0.231	0.262	0.266	0.317	0.331	0.420	0.326	0.399	0.382	0.302	-
PL	35	1934	0.326	0.293	0.270	0.215	0.147	0.108	0.084	0.066	0.062	0.062	0.080	0.117
PL	35	2394	0.032	0.030	0.029	0.028	0.027	0.027	0.029	0.041	0.072	0.203	0.287	0.336
PL	40	4002	0.017	0.027	0.029	0.016	0.010	0.007	0.006	0.005	0.004	0.003	0.003	0.004
PL	40	4601	0.021	0.020	0.020	0.020	0.020	0.020	0.021	0.020	0.018	0.017	0.016	0.016
PL	40	4602	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
PTB	35	128	0.604	0.625	0.641	0.755	0.552	0.402	0.271	0.246	0.254	0.291	0.233	0.206
PTB	35	415	0.266	0.279	0.242	0.296	0.305	0.339	0.541	0.710	0.720	0.668	0.683	0.702
PTB	35	1072	0.525	0.652	0.735	0.613	0.751	0.737	0.729	0.661	0.720	0.668	0.683	0.702
PTB	40	506	0.004	0.003	0.003	0.002	0.002	0.002	0.002	0.002	0.002	0.003	0.004	0.005
PTB	40	508	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
PTB	40	590	0.021	0.022	0.023	0.025	0.028	0.029	0.030	0.027	0.025	0.023	0.024	0.024
PTB	92	1	0.698	0.665	0.744	0.755	0.751	0.737	0.729	0.716	0.720	0.668	0.683	0.702
PTB	92	2	0.000	0.000	0.000	0.000	0.725	0.737	0.626	0.716	0.720	0.668	0.683	0.702
ROA	35	583	0.458	0.536	0.552	0.536	0.417	0.490	0.556	0.547	0.415	0.341	0.322	0.327
ROA	35	718	0.008	0.008	0.008	0.010	0.014	0.022	0.114	0.114	0.094	0.076	0.079	0.083
ROA	35	1699	0.386	0.662	0.664	0.647	0.657	0.581	0.671	0.666	0.637	0.569	0.000	0.420
ROA	35	2270	0.078	0.097	0.121	0.143	0.197	0.476	0.369	0.391	0.374	0.344	0.296	0.259
ROA	36	1488	0.303	0.197	0.206	0.208	0.211	0.302	0.266	0.273	0.262	0.224	0.184	0.129
ROA	36	1490	0.141	0.147	0.162	0.146	0.138	0.134	0.144	0.153	0.173	0.302	0.310	0.260
ROA	40	1436	0.002	0.002	0.002	0.002	0.002	0.001	0.002	0.001	0.001	0.001	0.001	0.001
SCL	35	2178	0.017	0.020	0.024	0.028	0.036	0.056	0.128	0.685	0.707	0.638	0.658	0.702
SCL	35	2525	0.416	0.385	0.451	0.543	0.751	0.720	0.729	0.716	0.720	0.668	0.683	0.702
SG	35	475	0.744	0.729	0.744	0.755	0.751	0.737	0.729	0.716	0.720	0.668	0.683	0.702
SG	35	476	0.744	0.729	0.744	0.755	0.751	0.737	0.729	0.716	0.720	0.668	0.683	0.702
SG	35	1889	0.228	0.263	0.337	0.443	0.330	0.398	0.460	0.455	0.465	0.464	0.464	0.516
SG	36	522	0.099	0.138	0.107	0.089	0.109	0.131	0.144	0.149	0.143	0.133	0.136	0.140

Table 9A. (Cont.)

Lab.	Clock	55589	55619	55649	55679	55709	55739	55769	55804	55834	55864	55894	55924
SG	40 7701	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
SIQ	36 1268	0.024	0.029	0.029	0.032	0.026	0.032	0.055	0.058	0.055	0.044	0.044	0.044
SMD	35 810	0.016	0.013	0.012	0.013	0.014	0.017	0.024	0.062	0.077	0.106	0.115	0.104
SMD	35 1766	0.666	0.729	0.744	0.755	-	-	0.000	0.000	0.000	-	-	-
SMD	35 2003	0.744	0.725	0.640	0.715	0.751	0.509	0.000	0.300	0.159	0.151	0.147	0.153
SMD	35 2543	0.413	0.612	0.744	0.755	0.751	0.737	0.729	0.716	0.720	0.668	0.683	0.702
SMU	36 1193	0.115	0.102	0.083	-	0.000	0.000	0.000	0.000	0.006	0.007	0.010	0.014
SP	19 197	0.023	0.023	-	-	0.000	0.000	-	-	-	-	-	-
SP	35 572	0.643	0.729	0.744	0.755	0.751	0.737	0.729	0.716	0.699	0.640	0.683	0.701
SP	35 641	0.666	0.729	0.744	0.755	0.530	0.313	0.312	0.316	0.186	0.155	0.127	0.148
SP	35 1188	0.102	0.105	0.159	0.219	0.190	0.143	0.162	0.172	0.151	0.142	0.185	0.325
SP	35 1642	0.240	0.211	0.138	0.137	0.147	0.152	0.176	0.176	0.261	0.426	0.445	0.661
SP	35 2166	0.744	0.729	0.744	0.755	0.751	0.737	0.729	0.716	0.720	0.668	0.683	0.702
SP	36 223	0.168	0.117	0.121	0.097	0.093	0.115	0.156	0.177	0.233	0.209	0.210	0.310
SP	36 1175	0.123	0.161	0.126	0.131	0.128	0.123	0.145	0.172	0.137	0.126	0.121	0.181
SP	36 2068	0.117	0.125	0.106	0.086	0.091	0.105	0.138	0.153	0.147	0.172	0.170	0.134
SP	36 2218	0.264	0.194	0.193	0.172	0.252	0.440	0.466	0.716	0.572	0.465	0.508	0.528
SP	36 2295	0.319	0.321	0.493	0.426	0.429	0.495	0.523	0.602	0.000	0.292	0.359	0.371
SP	36 2297	0.181	0.161	0.192	0.213	0.225	0.263	0.297	0.302	0.289	0.281	0.331	0.328
SP	40 7201	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002
SP	40 7203	0.010	0.010	0.010	0.010	0.011	0.011	0.012	0.012	0.011	0.011	0.011	0.011
SP	40 7210	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 7211	0.004	0.004	0.004	0.004	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005
SP	40 7212	0.054	0.052	0.051	0.051	0.052	0.051	0.055	0.053	0.049	0.043	0.043	0.042
SP	40 7218	0.002	0.002	0.003	0.003	0.003	0.003	0.004	0.004	0.004	0.004	0.005	0.005
SP	40 7221	0.744	0.729	0.744	0.755	0.751	0.737	0.729	0.716	0.720	0.668	0.683	0.702
SU	40 3809	0.744	0.729	0.735	0.514	0.389	0.282	0.236	0.190	0.161	0.137	0.131	0.125
SU	40 3810	-	-	-	-	-	-	-	-	-	-	0.000	0.000
SU	40 3811	0.009	0.008	0.009	0.009	0.009	0.009	0.009	0.009	0.008	0.007	0.007	0.008
SU	40 3812	0.744	0.729	0.744	0.618	0.568	0.509	0.506	0.439	0.358	0.311	-	-
SU	40 3814	0.028	0.025	0.024	-	-	-	-	-	-	-	0.000	0.000
SU	40 3815	0.033	0.033	0.034	0.035	0.035	0.033	0.033	0.029	0.026	0.023	0.022	0.022
SU	40 3816	0.000	0.000	0.000	0.290	0.321	0.180	0.124	0.080	0.055	0.046	0.038	0.031
SU	40 3817	0.090	0.056	0.040	0.028	0.022	0.017	0.013	-	-	-	-	-
SU	40 3822	0.006	0.008	0.013	0.016	0.018	0.023	0.032	0.045	0.062	0.000	-	-

Table 9A. (Cont.)

Lab.	Clock	55589	55619	55649	55679	55709	55739	55769	55804	55834	55864	55894	55924
SU	40 3831	0.018	0.014	0.012	0.013	0.017	0.023	0.032	0.039	-	-	-	-
TCC	35 768	0.044	0.039	0.046	0.086	0.093	0.085	0.088	0.094	0.085	0.060	0.067	0.068
TCC	35 1881	0.608	0.000	0.147	0.143	0.147	0.143	0.151	0.153	0.145	0.133	0.133	0.134
TCC	40 8620	0.020	0.022	0.020	0.020	0.023	0.022	0.022	0.016	0.014	0.014	0.014	0.015
TCC	40 8624	0.095	0.068	0.083	0.085	0.112	0.129	-	-	-	-	-	-
TCC	40 8650	0.004	0.004	0.004	0.004	0.005	0.005	0.006	0.006	0.006	0.006	0.006	0.007
TL	35 300	0.485	0.231	0.184	0.000	0.055	0.055	-	-	-	-	-	-
TL	35 1012	0.369	0.315	0.353	0.427	0.453	0.469	0.483	0.566	0.533	0.409	0.407	0.327
TL	35 1104	0.646	0.418	0.426	0.446	0.451	0.477	0.462	0.428	0.442	0.335	0.225	0.224
TL	35 1132	0.097	0.156	0.352	0.428	0.385	0.373	0.274	0.255	0.234	0.207	0.201	0.181
TL	35 1498	0.619	0.621	0.674	0.604	0.448	0.443	0.366	0.256	0.306	0.282	0.262	0.275
TL	35 1500	0.253	0.204	0.224	0.306	0.386	0.550	0.597	0.602	0.720	0.668	0.508	0.441
TL	35 1712	-	-	-	-	-	0.000	0.000	0.000	0.000	0.262	0.314	0.180
TL	35 2365	0.461	0.448	0.436	0.464	0.461	0.429	0.455	0.406	0.356	0.319	0.500	0.702
TL	35 2366	0.360	0.409	0.495	0.674	0.751	0.737	0.729	0.716	0.469	0.364	0.374	0.603
TL	35 2367	0.301	0.638	0.545	0.661	0.517	0.673	0.671	0.000	0.463	0.356	0.446	0.493
TL	35 2368	0.235	0.268	0.337	0.584	0.751	0.737	0.729	0.716	0.720	0.668	0.000	0.334
TL	35 2630	0.000	0.194	0.202	0.287	0.403	0.504	0.601	0.646	0.666	0.668	0.683	0.702
TL	35 2634	0.000	0.072	0.109	0.112	0.147	0.185	0.147	0.157	0.123	0.175	0.000	0.071
TL	35 2636	0.000	0.343	0.528	0.734	0.751	0.737	0.729	0.716	0.720	0.668	0.683	0.702
TL	40 57	0.006	0.004	0.000	-	-	-	-	-	-	-	-	0.000
TL	40 3052	0.543	0.530	0.517	0.591	0.751	0.737	0.729	0.000	0.329	0.259	0.233	0.224
TL	40 3053	0.162	0.176	0.205	0.260	0.507	0.737	0.729	0.716	0.720	0.668	0.510	0.363
TP	35 163	0.010	0.012	0.014	0.018	0.022	0.023	0.027	0.029	0.033	0.032	-	-
TP	35 1227	0.744	0.729	0.744	0.755	0.751	0.737	0.729	0.716	0.720	0.668	0.683	0.702
TP	35 2476	0.536	0.571	0.744	0.755	0.751	0.737	0.729	0.716	0.720	0.657	0.639	0.684
TP	36 154	0.081	0.067	0.074	0.077	0.075	0.079	0.085	0.089	0.077	0.070	0.101	0.131
UA	35 2465	-	0.000	0.000	0.000	0.000	0.138	0.215	0.175	0.115	0.121	0.123	0.125
UA	40 7854	-	0.000	0.000	0.000	0.000	0.003	0.003	0.004	0.004	0.004	0.005	0.006
UA	40 7881	-	0.000	0.000	0.000	0.000	0.021	0.023	0.022	0.015	0.013	0.016	0.020
UA	40 7882	-	0.000	0.000	0.000	0.000	0.417	0.447	0.561	0.677	0.668	0.683	0.000
UME	35 251	0.304	0.283	0.205	0.237	0.204	0.202	0.228	0.310	0.394	0.517	0.670	0.702
UME	35 252	-	-	-	-	-	0.000	0.000	0.000	0.000	0.236	0.298	0.427
UME	35 710	-	-	-	-	-	0.000	0.000	0.000	0.000	0.411	0.341	0.397
UME	35 2703	-	-	-	-	-	0.000	0.000	0.000	0.000	0.668	0.474	0.421

Table 9A. (Cont.)

Lab.		Clock	55589	55619	55649	55679	55709	55739	55769	55804	55834	55864	55894	55924
USNO	35	101	0.733	0.697	0.733	0.755	0.751	0.737	0.698	0.605	0.566	0.429	0.376	0.280
USNO	35	104	0.093	0.084	0.089	0.089	0.108	0.145	0.292	0.560	0.582	0.547	0.452	0.424
USNO	35	106	0.681	0.729	0.701	0.690	0.689	0.737	0.729	-	-	0.000	0.000	0.000
USNO	35	108	0.744	0.729	0.744	0.606	0.640	0.430	0.424	0.264	0.248	0.154	0.135	0.150
USNO	35	114	0.336	0.563	0.571	-	-	0.000	0.000	0.000	0.000	0.305	0.210	0.258
USNO	35	120	0.300	0.714	0.729	0.755	0.751	0.737	0.729	0.716	0.598	0.493	0.367	0.369
USNO	35	142	0.270	0.309	0.274	0.248	0.252	0.280	0.225	0.280	0.288	0.280	0.309	0.314
USNO	35	145	0.022	0.030	0.028	0.028	0.030	0.030	0.034	0.037	0.047	0.066	0.202	0.247
USNO	35	146	0.692	0.544	0.572	0.613	0.482	0.387	0.729	0.716	0.491	0.454	0.472	0.520
USNO	35	148	0.607	0.634	0.591	0.604	0.751	0.737	0.000	0.410	0.392	0.361	0.341	0.355
USNO	35	150	0.476	0.485	0.639	0.649	0.751	0.737	0.729	0.716	0.720	0.668	0.683	0.702
USNO	35	152	0.229	0.246	0.277	0.211	0.345	0.331	0.356	0.281	0.267	0.249	0.188	0.193
USNO	35	153	0.744	0.729	-	-	-	-	-	-	-	-	-	-
USNO	35	156	0.345	0.253	0.310	0.304	0.214	0.208	0.277	-	-	0.000	0.000	0.000
USNO	35	161	0.236	0.440	0.585	0.533	0.751	0.737	0.729	0.716	0.720	0.000	0.254	0.206
USNO	35	165	0.320	-	-	0.000	0.000	0.000	0.000	0.158	-	-	0.000	0.000
USNO	35	166	0.355	0.692	0.717	0.755	0.751	-	-	-	0.000	0.000	0.000	0.000
USNO	35	167	0.235	0.246	0.315	0.313	0.517	0.495	0.613	-	-	-	-	-
USNO	35	169	-	-	-	0.000	0.000	0.000	0.000	0.360	-	-	0.000	0.000
USNO	35	173	0.744	0.729	0.744	0.755	0.751	0.737	0.729	0.716	0.720	0.668	0.683	0.702
USNO	35	213	0.380	0.297	0.355	0.370	0.414	0.404	0.677	0.716	0.481	0.329	0.275	0.263
USNO	35	217	-	-	-	-	-	0.000	0.000	0.000	0.000	0.413	0.616	0.576
USNO	35	226	0.730	0.726	0.744	-	-	0.000	0.000	0.000	0.000	0.182	0.213	0.221
USNO	35	227	0.054	0.066	0.062	0.057	0.060	0.051	0.057	0.073	0.085	0.076	0.097	0.120
USNO	35	231	0.461	0.291	-	-	-	-	-	-	-	-	-	0.000
USNO	35	233	0.713	0.729	0.744	-	-	0.000	0.000	0.000	0.000	0.071	0.105	0.102
USNO	35	242	0.487	0.580	0.600	0.685	0.734	0.737	0.000	0.352	0.300	0.416	0.408	0.383
USNO	35	244	0.480	0.000	0.000	-	-	0.000	0.000	0.000	0.000	0.200	0.162	0.224
USNO	35	253	0.744	0.000	0.312	0.327	0.000	0.065	0.065	0.056	0.048	0.043	0.040	0.041
USNO	35	254	0.288	0.374	0.344	0.255	0.190	0.185	0.167	0.117	0.081	0.059	0.056	0.056
USNO	35	255	-	-	-	-	-	0.000	0.000	0.000	0.000	0.668	0.683	0.702
USNO	35	256	-	-	-	-	-	0.000	0.000	0.000	0.000	0.184	0.278	0.196
USNO	35	260	0.263	0.333	0.343	0.527	0.341	0.344	0.259	0.252	0.245	0.144	-	-
USNO	35	266	-	-	-	-	-	0.000	0.000	0.000	0.000	0.190	0.174	0.177
USNO	35	268	0.650	0.729	0.744	0.755	0.751	0.737	0.729	0.716	0.720	0.668	0.683	0.702

Table 9A. (Cont.)

Lab.	Clock		55589	55619	55649	55679	55709	55739	55769	55804	55834	55864	55894	55924
USNO	35	270	0.494	0.458	0.477	0.403	0.390	0.224	0.206	0.157	0.104	0.091	0.094	0.094
USNO	35	279	-	-	-	-	-	0.000	0.000	0.000	0.000	0.340	0.510	0.701
USNO	35	389	-	-	-	0.000	0.000	0.000	0.000	0.047	0.034	0.035	0.036	0.037
USNO	35	392	-	-	-	-	0.000	0.000	0.000	0.000	0.044	0.056	0.076	0.089
USNO	35	416	0.294	0.296	0.303	-	-	-	-	-	-	0.000	0.000	0.000
USNO	35	417	0.000	0.000	0.744	0.349	0.273	0.342	0.452	0.464	0.434	0.471	0.373	0.454
USNO	35	703	-	-	-	0.000	0.000	0.000	0.000	0.164	0.158	0.187	0.131	0.167
USNO	35	717	0.671	0.672	0.524	0.498	0.498	0.460	0.465	0.345	0.320	0.294	0.298	0.317
USNO	35	762	0.704	0.000	0.103	0.087	0.077	0.075	0.077	0.083	0.083	0.100	0.138	0.260
USNO	35	763	0.744	0.729	0.744	0.755	0.751	0.737	0.729	0.716	0.720	0.668	0.683	0.702
USNO	35	765	0.077	0.000	0.034	0.031	0.030	0.031	0.034	0.033	0.032	0.027	0.025	0.024
USNO	35	1096	0.000	0.000	0.000	0.472	0.664	0.721	0.391	0.484	0.522	0.587	0.683	0.576
USNO	35	1097	0.024	0.023	0.022	0.023	0.023	0.022	0.029	0.034	0.057	0.245	0.250	0.248
USNO	35	1125	0.087	0.104	0.134	0.129	0.120	0.113	0.118	0.111	0.118	0.123	0.124	0.105
USNO	35	1327	0.353	0.383	0.472	0.408	0.354	0.273	0.257	0.214	0.193	0.163	0.171	0.207
USNO	35	1328	0.359	0.704	0.564	0.347	0.345	0.299	0.298	0.287	0.265	0.238	0.240	0.245
USNO	35	1331	0.067	0.047	0.034	0.029	0.027	0.023	0.035	0.042	0.046	0.051	0.057	0.128
USNO	35	1438	0.111	0.107	0.110	0.113	0.125	0.116	0.101	0.093	0.077	0.068	0.079	0.098
USNO	35	1459	0.374	0.559	0.406	0.226	0.170	0.152	0.147	0.142	0.165	0.189	0.220	0.296
USNO	35	1462	0.744	0.729	0.744	0.755	0.751	0.737	0.729	0.716	0.720	0.668	0.653	0.598
USNO	35	1463	0.744	0.729	0.660	0.674	0.662	0.657	0.698	0.680	0.657	0.436	0.491	0.466
USNO	35	1468	-	-	-	-	-	0.000	0.000	0.000	0.000	0.379	0.266	0.322
USNO	35	1481	-	-	-	-	-	0.000	0.000	0.000	0.000	0.168	0.143	0.204
USNO	35	1543	0.744	0.729	0.744	0.755	0.000	0.224	0.194	0.152	0.135	0.113	0.107	0.132
USNO	35	1573	-	-	-	-	-	0.000	0.000	0.000	0.000	0.365	0.534	0.702
USNO	35	1575	0.604	0.562	0.459	0.395	0.418	0.431	0.472	0.393	0.613	0.657	0.683	0.702
USNO	35	1580	-	-	-	-	-	-	-	-	-	-	0.000	0.000
USNO	35	1585	-	-	-	-	-	0.000	0.000	0.000	0.000	0.668	0.418	0.162
USNO	35	1598	0.000	0.000	0.253	0.241	0.199	0.000	0.081	0.090	0.104	0.114	0.142	0.146
USNO	35	1655	0.527	0.000	0.204	0.211	0.243	0.252	0.300	-	-	-	-	-
USNO	35	1658	0.000	0.000	0.673	0.696	0.751	0.523	0.000	0.186	0.167	0.172	0.157	0.132
USNO	35	1692	0.162	0.172	0.205	0.237	0.297	0.611	0.729	0.716	0.720	0.668	0.683	0.702
USNO	35	1694	-	-	-	-	-	0.000	0.000	0.000	0.000	0.533	0.678	0.702
USNO	35	1696	0.744	0.729	0.744	0.755	0.751	0.737	0.729	0.716	0.720	0.668	0.478	0.487
USNO	35	1697	0.744	0.729	0.744	0.755	0.000	0.249	0.203	0.185	0.157	0.130	0.121	0.141

Table 9A. (Cont.)

Lab.		Clock	55589	55619	55649	55679	55709	55739	55769	55804	55834	55864	55894	55924
USNO	40	702	0.744	0.729	0.744	0.755	0.751	0.000	0.000	0.274	0.226	0.186	0.178	0.184
USNO	40	704	0.585	0.596	0.744	0.755	0.000	0.007	0.006	0.005	0.004	0.003	0.003	0.004
USNO	40	705	0.019	0.015	0.014	0.014	0.018	0.020	0.027	0.034	0.039	0.048	0.067	0.073
USNO	40	708	0.223	0.223	0.225	0.231	0.190	0.156	0.124	-	-	-	-	-
USNO	40	710	0.015	0.016	0.017	0.018	0.020	-	-	0.000	0.000	0.000	0.000	0.007
USNO	40	711	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.003	0.003	0.003
USNO	40	712	0.744	0.729	0.744	0.755	0.751	0.737	0.729	0.716	0.720	0.668	0.683	0.702
USNO	40	713	0.086	0.085	0.084	0.084	0.087	0.086	0.092	0.090	0.081	0.071	0.068	0.065
USNO	40	714	0.304	0.364	0.405	0.431	0.469	0.474	0.317	0.270	0.224	0.234	0.233	0.229
USNO	40	715	0.048	0.047	0.047	0.048	0.053	0.055	0.062	0.059	0.056	0.053	0.053	0.051
USNO	40	716	0.744	0.729	0.744	0.755	0.751	0.737	0.729	0.716	0.720	0.668	0.683	0.702
USNO	40	718	0.012	0.011	0.010	0.010	0.010	0.010	0.011	0.010	0.009	0.008	0.008	0.007
USNO	40	719	0.008	0.008	0.009	0.009	0.010	0.010	0.010	0.010	0.009	0.008	0.008	0.009
USNO	40	720	0.001	0.001	0.002	0.002	0.002	0.002	0.002	0.002	-	-	0.000	0.000
USNO	40	721	-	-	-	-	-	0.000	0.000	0.000	0.000	0.000	0.000	0.000
USNO	40	722	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
USNO	40	723	0.522	0.456	0.454	0.478	0.583	0.737	0.729	0.716	0.720	0.668	0.683	0.702
USNO	40	724	0.077	0.082	0.089	0.094	0.101	0.102	0.098	0.088	0.098	0.110	0.142	0.189
USNO	40	725	0.744	0.568	0.460	0.436	0.000	0.004	0.003	0.002	0.002	0.002	0.002	0.002
USNO	40	728	0.003	0.002	0.002	0.002	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
USNO	40	730	-	-	-	-	-	0.000	0.000	0.000	0.000	0.002	0.001	0.001
USNO	40	731	0.010	0.011	0.012	0.013	0.014	0.014	0.017	0.018	0.018	0.018	0.019	0.021
USNO	40	732	-	-	-	-	-	0.000	0.000	0.000	0.000	0.005	0.005	0.004
USNO	40	734	-	-	-	-	-	0.000	0.000	0.000	0.000	0.000	0.000	0.000
USNO	40	735	-	-	-	-	-	0.000	0.000	0.000	0.000	0.037	0.056	0.074
VMI	35	2230	0.000	-	-	0.000	0.000	0.000	0.000	0.028	0.040	0.051	0.068	0.052
VMI	36	1233	0.000	-	-	0.000	0.000	0.000	0.000	0.009	0.012	0.015	0.021	0.022
VMI	36	2314	0.000	-	-	0.000	0.000	0.000	0.000	0.022	0.029	0.037	0.049	0.039
VSL	35	179	0.298	0.729	0.744	0.755	0.751	0.737	0.551	0.485	0.581	0.572	0.675	0.702
VSL	35	456	-	-	-	-	-	0.000	0.000	0.000	0.000	0.147	0.162	0.181
VSL	35	548	0.216	0.253	0.294	0.421	0.474	0.499	0.413	0.408	0.360	0.347	0.335	0.574
VSL	35	731	0.151	0.161	0.239	0.243	0.191	-	-	-	-	-	-	-
ZA	35	2232	0.085	0.103	0.116	0.130	0.202	0.305	0.476	0.415	0.399	0.502	0.490	0.422
ZA	35	2233	0.744	0.729	0.744	0.755	0.751	0.737	0.729	0.716	0.720	0.668	0.683	0.702
ZA	36	1034	0.105	0.102	0.112	-	0.000	0.000	0.000	-	-	-	-	-
ZA	36	1821	0.085	0.106	0.133	0.140	0.160	0.209	0.226	0.195	0.286	0.283	0.537	0.558

Table 9B. Statistical data on the weights attributed to the clocks in 2011

Interval	Number of Clocks			Number of clocks with a given weight: Weight = 0*			Weight = 0**			Max weight			Max relative weight
	HM	5071A	Total	HM	5071A	Total	HM	5071A	Total	HM	5071A	Total	
2011 Jan.	90	248	387	10	28	51	12	3	15	10	39	50	0.744
2011 Feb.	98	253	401	13	31	58	10	13	23	11	43	55	0.729
2011 Mar.	93	244	388	11	28	52	12	7	19	10	41	53	0.744
2011 Apr.	91	236	378	8	28	47	10	2	12	9	42	53	0.755
2011 May	92	245	391	10	35	58	12	6	19	9	48	59	0.751
2011 June	93	263	409	8	52	70	11	4	16	11	47	61	0.737
2011 July	92	265	406	8	51	63	11	7	20	10	47	59	0.729
2011 Aug.	95	266	410	11	48	61	10	4	14	9	44	57	0.716
2011 Sep.	86	258	395	8	36	48	9	3	13	9	46	58	0.720
2011 Oct.	89	267	406	6	22	32	12	6	18	11	46	60	0.668
2011 Nov.	89	274	408	10	29	42	11	7	18	7	39	49	0.683
2011 Dec.	86	265	395	9	26	39	12	5	18	6	44	53	0.702

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

TIME SIGNALS

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

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

The following tables are based on information received at the BIPM in February and March 2012.

AUTHORITIES RESPONSIBLE FOR THE TIME SIGNAL EMISSIONS

Signal	Authority
BPM	National Time Service Center, NTSC Chinese Academy of Sciences 3 East Shuyuan Rd, Lintong District, Xi'an Shaanxi 710600, China
CHU	National Research Council of Canada Institute for National Measurement Standards Frequency and Time Standards Bldg M-36, 1200 Montreal Road Ottawa, Ontario, K1A 0R6, Canada
DCF77	Physikalisch-Technische Bundesanstalt Time and Frequency Department, WG 4.42 Bundesallee 100 D-38116 Braunschweig Germany
EBC	Real Instituto y Observatorio de la Armada Cecilio Pujazón s/n 11.110 San Fernando Cádiz, Spain
HBG	METAS Federal Office of Metrology Time and Frequency Laboratory Length, Optics and Time Section Lindenweg 50 CH-3003 Bern-Wabern Switzerland
HLA	Center for Time and Frequency Division of Physical Metrology Korea Research Institute of Standards and Science 267 Gajeong-Ro, Yuseong, Daejeon 305-340 Republic of Korea
JJY	Space-Time Standards Laboratory National Institute of Information and Communications Technology 4 -2- 1, Nukui-kitamachi Koganei, Tokyo 184-8795 Japan

Signal	Authority
LOL	Servicio de Hidrografía Naval Observatorio Naval Buenos Aires Av. España 2099 C1107AMA – Buenos Aires, Argentina
MIKES	Centre for Metrology and Accreditation Tekniikantie 1 FI-02150 Espoo Finland
MSF	National Physical Laboratory Time Quantum and Electromagnetics Division Hampton Road Teddington, Middlesex TW11 0LW United Kingdom
RAB-99, RBU, RJH-63, RJH-69, RJH-77, RJH-86, RJH-90,RTZ,RWM	All-Russian Scientific Research Institute for Physical Technical and Radiotechnical Measurements FGUP “VNIIFTRI” Meendeleevo, Moscow Region 141570 Russia
STFS	National Physical Laboratory Dr. K.S. Krishnan Road New Delhi - 110012, India
TDF	CFHM Chambre française de l’horlogerie et des microtechniques 22 avenue Franklin Roosevelt 75008 Paris, France and LNE Laboratoire national de métrologie et d'essais 1 rue Gaston Boissier 75724 Paris Cedex 15, France
WWV, WWVB, WWVH	Time and Frequency Division, 847.00 National Institute of Standards and Technology - 325 Broadway Boulder, Colorado 80305, U.S.A.

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	The BPM time signals are generated by NTSC and are in accordance with the legal time of China which is UTC(NTSC)+8 h. Signals emitted in advance on UTC by 20 ms. Second pulses of 10 ms duration with 1 kHz modulation. Minute pulses of 300 ms duration with 1 kHz modulation. UTC time signals are emitted from minute 0 to 10, 15 to 25, 30 to 40, 45 to 55. UT1 time signals are emitted from minute 25 to 29, 55 to 59.
CHU	Ottawa Canada 45° 18'N 75° 45'W	3 330 7 850 14 670	continuous	Second pulses of 300 cycles of a 1 kHz modulation, with 29th and 51st to 59th pulses of each minute omitted. Minute pulses are 0.5 s long. Hour pulses are 1.0 s long, with the following 1st to 9th pulses omitted. A bilingual (Fr. Eng.) announcement of time (UTC) is made each minute following the 50th second pulse. FSK code (300 bps, Bell 103) after 10 cycles of 1 kHz on seconds 31 to 39. Year, DUT1, leap second information, TAI-UTC and Canadian daylight saving time format on 31, and time code on 32-39. Broadcast is single sideband; upper sideband with carrier reinsert. DUT1 : ITU-R code by double pulse.
DCF77	Mainflingen Germany 50° 1'N 9° 0'E	77.5	continuous	The DCF77 time signals are generated by PTB and are in accordance with the legal time of Germany which is UTC(PTB)+1 h or UTC(PTB)+2 h. At the beginning of each second (except in the last second of each minute) the carrier amplitude is reduced to about 15% for a duration of 0.1 or 0.2 s corresponding to “binary 0” or “binary 1”, respectively, referred to as second marks 0 to 59 in the following. The number of the minute, hour, day of the month, day of the week, month and year are transmitted in BCD code using second marks 20 to the 58, including overhead. Information emitted during minute n is valid for minute n+1. The information transmitted during the second marks 1 to the 14 is provided by third parties. Information on that additional service can be obtained from PTB. To achieve a more accurate time transfer and a better use of the frequency spectrum available an additional pseudo-random phase shift keying of the carrier is superimposed on the AM second markers. No transmission of DUT1.
EBC	San Fernando Spain 36° 28'N 6° 12'W	15006 4998	10 h 00 m to 10 h 25 m 10 h 30 m to 10 h 55 m except Saturday, Sunday and national holidays.	Second pulses of 0.1 s duration of a 1 kHz modulation. Minute pulses of 0.5 s duration of 1 250 Hz modulation. DUT1: ITU-R code by double pulse.

Station	Location Latitude Longitude	Frequency (kHz)	Schedule (UTC)	Form of the signal
HBG(1)	Prangins Switzerland 46° 24'N 6° 15'E	75	continuous	At the beginning of each second (except the 59th second), the carrier is interrupted for a duration of 0.1 s or 0.2 s corresponding to "binary 0" or "binary 1", respectively, double pulse each minute. The number of the minute, hour, day of the month, day of the week, month and year are transmitted in BCD code from the 21st to the 58th second. The HBG time signal is generated in accordance with the legal time of Switzerland which is UTC + 1 h (Central European Time CET) or UTC + 2 h (Central European Summer Time CEST). In addition, CET and CEST are indicated by a binary 1 at the 18th or 17th second, respectively.
HLA	Daejeon Rep. of Korea 36° 23'N 127° 22'E	5 000	continuous	Pulses of 9 cycles of 1 800 Hz modulation. 29th and 59th second pulses omitted. Hour identified by 0.8 s long 1 500 Hz tone. Beginning of each minute identified by a 0.8 s long 1 800 Hz tone. Voice announcement of hours and minutes each minute following the 52nd second pulse. BCD time code given on 100 Hz subcarrier. DUT1: ITU-R code by double pulse.
JJY	Tamura-shi Fukushima Japan 37° 22'N 140° 51'E	40	Continuous	A1B type 0.2 s, 0.5 s and 0.8 s second pulses, spacings are given by the reduction of the amplitude of the carrier. Coded announcement of hour, minute, day of the year, year, day of the week and leap second. Transmitted time refers to UTC(NICT) + 9 h.
JJY	Saga-shi Saga Japan 33° 28'N 130° 11'E	60	Continuous	A1B type 0.2 s, 0.5 s and 0.8 s second pulses, spacings are given by the reduction of the amplitude of the carrier. Coded announcement of hour, minute, day of the year, year, day of the week and leap second same as JJY(40). Transmitted time refers to UTC(NICT) + 9 h.
LOL	Buenos Aires Argentina 34° 37'S 58° 21'W	10 000	14 h to 15 h except Saturday, Sunday and national holidays.	Second pulses of 5 cycles of 1000 Hz modulation. Second 59 is omitted. Announcement of hours and minutes every 5 minutes, followed by 3 minutes of 1000 Hz or 440 Hz modulation. DUT1: ITU-R code by lengthening.
MIKES	Espoo Finland 60° 11'N 24° 50'E	25 000	Continuous	Modulation as in DCF77, time code in UTC.

(1)The HBG service was discontinued at the end of 2011

Station	Location Latitude Longitude	Frequency (kHz)	Schedule (UTC)	Form of the signal
MSF	Anthorn United Kingdom 54° 54'N 3° 16'W	60	Continuous, except for interruptions for maintenance from 10 h 0 m to 14 h 0 m on the second Thursday of December and March, and from 09 h 0 m to 13 h 0 m on the second Thursday of June and September. A longer period of maintenance during the summer is announced annually.	The carrier is interrupted for 0.1 s at the start of each second, except during the first second of each minute (second 0) when the interruption is 0.5 s. Two data bits are transmitted each second (except second 0): data bit “A” between 0.1 and 0.2 s after the start of the second and data bit “B” between 0.2 and 0.3 s after the start of the second. Presence of the carrier represents “binary 0” and an interruption represents “binary 1”. The values of data bit “A” provide year, month, day of the month, day of the week, hour and minute in BCD code. The time represented is UTC(NPL) in winter and UTC(NPL)+1h when DST is in effect. The values of data bit “B” provide DUT1 and an indication whether DST is in effect. The information transmitted applies to the following minute. DUT1: ITU-R code by double pulse.
RAB-99	Khabarovsk Russia 48° 30'N 134° 50'E	25.0 25.1 25.5 23.0 20.5	From 01.01.2011 to 27.03.2011: 02 h 06 m to 02 h 36 m 06 h 06 m to 06 h 36 m Since 28.03.2011: 01 h 06 m to 01 h 36 m 05 h 06 m to 05 h 36 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; 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 11 and 20.
RBU	Moscow Russia 56° 44'N 37° 40'E	200/3	Continuous	DXXXW type 0.1 s signals. The numbers of the minute, hour, day of the month, day of the week, month, year of the century, difference between the universal time and the local time, TJD and DUT1+dUT1 are transmitted each minute from the 1st to the 59th second. DUT1+dUT1 : by double pulse.
RJH-63	Krasnodar Russia 44° 46'N 39° 34'E	25.0 25.1 25.5 23.0 20.5	From 01.01.2011 to 27.03.2011: 11 h 06 m to 11 h 40 m Since 28.03.2011: 10 h 06 m to 10 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	From 01.01.2011 to 27.03.2011: 07 h 06 m to 07 h 47 m Since 28.03.2011: 06 h 06 m to 06 h 47 m	A1N type signals are transmitted between minutes 10 and 22 : 0.025 second pulses of 12.5 ms duration are transmitted between minutes 10 and 13; second pulses of 0.1 s duration, 10 second pulses of 1 s duration, 0.1 second pulses of 25 ms and minute pulses of 10 s duration are transmitted between minutes 13 and 22.

Station	Location Latitude Longitude	Frequency (KHz)	Schedule (UTC)	Form of the signal
RJH-77	Arkhangelsk Russia 64° 22'N 41° 35'E	25.0 25.1 25.5 23.0 20.5	From 01.01.2011 to 27.03.2011: 09 h 06 m to 09 h 47 m Since 28.03.2011: 08 h 06 m to 08 h 47 m	A1N type signals are transmitted between minutes 10 and 22 : 0.025 second pulses of 12.5 ms duration are transmitted between minutes 10 and 13; second pulses of 0.1 s duration, 10 second pulses of 1 s duration, 0.1 second pulses of 25 ms and minute pulses of 10 s duration are transmitted between minutes 13 and 22.
RJH-86	Bishkek Kirgizstan 43° 03'N 73° 37'E	25.0 25.1 25.5 23.0 20.5	From 01.01.2011 to 27.03.2011: 04 h 06 m to 04 h 47 m 10 h 06 m to 10 h 47 m Since 28.03.2011: 03 h 06 m to 03 h 47 m 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-90	Nizhni Novgorod Russia 56° 11'N 43° 57'E	25.0 25.1 25.5 23.0 20.5	From 01.01.2011 to 27.03.2011: 08 h 06 m to 08 h 47 m Since 28.03.2011: 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.
RTZ	Irkutsk Russia 52° 26'N 103° 41'E	50	From 01.01.2011 to 27.03.2011: 00 h 00 m to 19 h 00 m 20 h 00 m to 24 h 00 m Since 28.03.2011: 00 h 00 m to 18 h 00 m 19 h 00 m to 24 h 00 m	DXXXW type 0.1 s signals. The numbers of the minute, hour, day of the month, day of the week, month, year of the century, difference between the universal time and the local time, TJD and DUT1+dUT1 are transmitted each minute from the 1st to the 59th second. DUT1+dUT1: by double pulse.
RWM (2)	Moscow Russia 56° 44'N 37° 38'E	4 996 9 996 14 996	The station operates simultaneously on the three frequencies.	A1X type second pulses of 0.1 s duration are transmitted between minutes 10 and 20, 40 and 50. The pulses at the beginning of the minute are prolonged to 0.5 s. A1N type 0.1 s second pulses of 0.02 s duration are transmitted between minutes 20 and 30. The pulses at the beginning of the second are prolonged to 40 ms and of the minute to 0.5 ms. DUT1+dUT1: by double pulse.

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

Station	Location Latitude Longitude	Frequency (kHz)	Schedule (UTC)	Form of the signal
STFS	Sikandrabad India 28° 28'N 77° 13'E	2 599 675	continuous	Pulse width modulated binary coded 5 kHz pulses carrying information on Indian Standard Time – IST (UTC + 5 h 30 m), Time of Day and current position coordinates of the satellite. Pulse repetition rate is 100 pps. The above format is frequency modulated on the carrier.
TDF	Allouis France 47° 10'N 2° 12'E	162	continuous, except every Tuesday from 1 h to 5 h	Phase modulation of the carrier by +1 and -1 rd in 0.1 s every second except the 59th second of each minute. This modulation is doubled to indicate binary 1. The numbers of the minute, hour, day of the month, day of the week, month and year are transmitted each minute from the 21st to the 58th second, in accordance with the French legal time scale. In addition, a binary 1 at the 17th second indicates that the local time is 2 hours ahead of UTC (summer time); a binary 1 at the 18th second indicates that the local time is 1 hour ahead of UTC (winter time); a binary 1 at the 14th second indicates that the current day is a public holiday (Christmas, 14 July, etc...); a binary 1 at the 13th second indicates that the current day is a day before a public holiday.
WWV	Fort-Collins CO, USA 40° 41'N 105° 3'W	2 500 5 000 10 000 15 000 20 000	continuous	Second pulses are 1 000 Hz tones, 5 ms in duration. 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 tones. DUT1: ITU-R code by double pulse. BCD time code given on 100 Hz subcarrier, includes DUT1 correction.
WWVB	Fort-Collins CO, USA 40° 41'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	Second pulses are 1 200 Hz tones, 5 ms in duration. 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 tones. DUT1: ITU-R code by double pulse. BCD time code given on 100 Hz subcarrier, includes DUT1 correction.

ACCURACY OF THE CARRIER FREQUENCY

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

TIME DISSEMINATION SERVICES

The following tables are based on information received at the BIPM between February and April 2012.

AUTHORITIES RESPONSIBLE FOR THE TIME DISSEMINATION SERVICES

AOS	Astrogeodynamical Observatory Borowiec near Poznan Space Research Centre P.A.S. PL 62-035 Kórnik - Poland
AUS	Electricity Section National Measurement Institute PO Box 264 Lindfield NSW 2070 - Australia
BelGIM	Belarussian State Institute of Metrology National Standard for Time, Frequency and Time-scale of the Republic of Belarus Minsk, Minsk Region – 220053 Belarus
BEV	Bundesamt für Eich- und Vermessungswesen Arltgasse 35 A-1160 Wien , Vienna - Austria
CENAM	Centro Nacional de Metrología km. 4.5 Carretera a Los Cués El Marqués, Querétaro, C.P. 76246 - Mexico
CENAMEP	Centro Nacional de Metrología de Panamá AIP CENAMEP AIP Ciudad del Saber Edif. 215 Panama
DMDM	Directorate of Measures and Precious Metals Group for Time, Frequency and Time Dissemination. Mike Alasa 14 11000 Belgrade Serbia
EIM	Hellenic Institute of Metrology Electrical Measurements Department Block 45, Industrial Area of Thessaloniki PO 57022, Sindos Thessaloniki, Greece
GUM	Time and Frequency Laboratory Electricity Department 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 (China)
IGNA	Instituto Geográfico Nacional Argentino Servicio Internacional de la Hora General Manual N. Savio 1898 B1650KLP – Villa Maipú, Provincia de Buenos Aires, Argentina

INPL	National Physical Laboratory Danciger A bldg Givat - Ram, The Hebrew university 91904 Jerusalem, Israel
INRIM	Istituto Nazionale di Ricerca Metrologica Strada delle Cacce, 91 I – 10135 Torino, Italy
KIM	Puslit Kalibrasi, Instrumentasi dan Metrologi -- Lembaga Ilmu Pengetahuan Indonesia Research Centre for Calibration, Instrumentation and Metrology -- Indonesian Institute of Sciences (Puslit KIM – LIPI) Kawasan PUSPIPTEK Serpong Tangerang 15314 Banten - Indonesia
KRISS	Center for Time and Frequency Division of Physical Metrology Korea Research Institute of Standards and Science 267 Gajeong-Ro, Yuseong Daejeon 305-340 Republic of Korea
KZ	Kazakhstan Institute of Metrology Orynbor str., 11 Astana, Republic of Kazakhstan
LNE-SYRTE	Laboratoire National de Métrologie et d'Essais Systèmes de Référence Temps-Espace Observatoire de Paris 61, avenue de l'Observatoire, 75014 Paris – France
LT	Time and Frequency Standard Laboratory Center for Physical Sciences and Technology – State Metrology Service A. Goštauto 11 Vilnius LT01108, Lithuania
METAS	Federal Office of Metrology Length, Optics and Time Section Lindenweg 50 CH-3003 Bern-Wabern Switzerland
MIKES	Centre for Metrology and Accreditation Tekniikantie 1 FI-02150 Espoo - Finland
MSL	Measurement Standards Laboratory Industrial Research Gracefield Road PO Box 31-310 Lower Hutt – New Zealand
NAO	Time Keeping Office Mizusawa VLBI Observatory National Astronomical Observatory of Japan 2-12, Hoshigaoka, Mizusawa, Oshu, Iwate 023-0861 Japan

NICT	Space-Time Standards Laboratory National Institute of Information and Communications Technology 4 -2 -1, Nukui-kitamachi Koganei, Tokyo 184-8795 - Japan
NIM	Time & Frequency Laboratory National Institute of Metrology No. 18, Bei San Huan Dong Lu Beijing 100013 - People's Republic of China
NIMB	Time and Frequency Laboratory National Institute of Metrology Sos. Vitan - Barzesti, 11 042122 Bucharest, Romania
NIMT	Time & Frequency Laboratory National Institute of Metrology (Thailand) 3/5 Moo 3, Klong 5, Klong Luang, Pathumthani 12120, Thailand
NIST	National Institute of Standards and Technology Time and Frequency Division, 847.00 325 Broadway Boulder, Colorado 80305, USA
NMIJ	Time and Frequency Division National Metrology Institute of Japan (NMIJ), AIST Umezono 1-1-1, Tsukuba, Ibaraki 305-8563, Japan
NMISA	Time and Frequency Laboratory National Metrology Institute of South Africa Private Bag X34 Lynnwood Ridge 0040 - South Africa
NMLS	Time and Frequency Laboratory National Metrology Laboratory SIRIM Berhad, Lot PT 4803, Bandar Baru Salak Tinggi, 43900 Sepang - Malaysia
NPL	National Physical Laboratory Time Quantum and Electromagnetics Division Hampton Road Teddington, Middlesex TW11 0LW United Kingdom
NPLI	Time and Frequency Section National Physical Laboratory Dr.K.S.Krishnan Road New Delhi 110012 - India
NRC	National Research Council of Canada Institute for National Measurement Standards Frequency and Time Standards Bldg M-36, 1200 Montreal Rd. Ottawa, Ontario, K1A OR6, Canada

NSC IM	Time and Frequency Section National Scientific Center "Institute of Metrology" Kharkov - Ukraine Region – 61002, Ukraine
NTSC	National Time Service Center Chinese Academy of Sciences 3 East Shuyuan Rd, Lintong District, Xi’an 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 (MCTI) Divisão Serviço da Hora Rua General José Cristino, 77 São Cristovão 20921-400 Rio de Janeiro, Brazil
ORB	Royal Observatory of Belgium Avenue Circulaire, 3 B-1180 Brussels, Belgium
PTB	Physikalisch-Technische Bundesanstalt Time and Frequency Department, WG 4. 42 Bundesallee 100 D-38116 Braunschweig, Germany
ROA	Real Instituto y Observatorio de la Armada Cecilio Pujazón s/n 11.100 San Fernando Cádiz, Spain
SG	National Metrology Centre Agency for Science, Technology and Research (A*STAR) 1 Science Park Drive 118221 Singapore
SIQ	Slovenian Institute of Quality and Metrology Metrology department Trzaska ul. 2 1000 Ljubljana Slovenia
SP	SP Technical Research Institute of Sweden Box 857 S-501 15 Borås Sweden
TL	National Standard Time and Frequency Laboratory Telecommunication Laboratories Chunghwa Telecom. Co., Ltd. No. 12, Ln.551, Ming-Tsu Road Sec. 5 Yang-Mei, Taoyuan, 326 Taiwan

TP	Institute of Photonics and Electronics Academy of Sciences of the Czech Republic Chaberská 57, 182 51 Praha 8 Czech Republic
UME	Ulusal Metroloji Enstitüsü TUBITAK Gebze Yerleskesi, National Metrology Institute Gebze Kocaeli Turkey
USNO	U.S. Naval Observatory 3450 Massachusetts Ave., N.W. Washington, D.C. 20392-5420 USA
VMI	Laboratory of Time and Frequency (TFL) Vietnam Metrology Institute (VMI) No 8, Hoang Quoc Viet Rd, Cau Giay Dist., Hanoi Viet Nam
VNIIFTRI	All-Russian Scientific Research Institute for Physical Technical and Radiotechnical Measurements, Moscow Region 141570 Russian Federation
VSL	VSL Dutch Metrology Institute 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/

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 http://www.measurement.gov.au/Services/Pages/TimeandFrequencyDisseminationService.aspx for information on access or contact time@measurement.gov.au

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

BelGIM

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

BEV

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

Provides a time dissemination service via phone and modem to synchronize PC clocks.
Uses the Time Distribution System from TUG. It has a baud rate of 1200 and everyone can use it with no cost.
Access phone number is +43 (0) 1 211106381
The system will be updated periodically (DUT1, Leap Second…).

CENAM

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

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

Telephone Code
CENAM provides a telephone code for setting time in computers. More information about this service please contact J. Mauricio López at jlopez@cenam.mx

	Network Time Protocol Operates one time server using the "Network Time Protocol", it is located at the Centro Nacional de Metrología, Querétaro, México. Further information at http://www.cenam.mx/hora_oficial/ Web-based time-of-day clock that displays local time for México time zones. Referenced to CENAM Internet Time Service. Available at http://www.cenam.mx/hora_oficial/ Transmission of voice by radio in Mexico City to more than 20 million inhabitants. The voice messages are transmitted every minute, 24 hours a day, every day of the year, by the radio station XEQK, whose signal is at 1350 kHz amplitude modulated (AM).
CENAMEP	Network Time Server A Stratum 1 time server is used to synchronize computer networks of the government institutions and companies in the private sector using the NTP protocol. To access the Network time service, send an email to servicios@cenamep.org.pa Web Clock A web clock is used to display the time of day in real time. To access the Web Clock, enter the link http://horaexacta.cenamep.org.pa/ Voice Time Server An assembly of computers provides the local time. To access the voice time service, call to the telephone numbers (507) 5173201 (507) 5173202 and (507) 5173203
DMDM	Internet Time Service (ITS) DMDM operates two Stratum 1 time servers using the "Network Time Protocol" (NTP v.4.), synchronized to UTC(DMDM). Access for paying organizations and institutions. DMDM also operates two Stratum 2 NTP servers: vreme1.dmdm.rs or vreme1.dmdm.gov.rs vreme2.dmdm.rs or vreme2.dmdm.gov.rs Access is free. More information on: http://www.dmdm.rs/en/GrupaZaVremeFrekfencijuIDistribucijuVremena.php Web-based time-of-day clock that displays local time for Serbia referenced to the DMDM ITS. Available at the web page as above.
EIM	Internet Time Service EIM operates a time server using the "Network Time Protocol" (NTP). The address hercules.eim.gr is also accessible through IP address 79.129.72.250. This route is offered under an open policy. The server uses the 10 MHz signal from our primary standard as reference and is synchronized with UTC(EIM). The same server is accessible under restrictions through a different IP address by using a dedicated internet connection, for specific organizations.
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

Internet Clock Services
HKO operates time-of-day clocks that display Hong Kong Standard Time (=UTC(HKO) + 8 h)
Available as:

1. Web Clock (Flash): http://www.hko.gov.hk/gts/time/HKSTime.htm
2. Web Clock (HTML): http://www.hko.gov.hk/gts/time/clock_e.html
3. Palm Clock: http://pda.weather.gov.hk/clocke.htm

Speaking Clock Service
HKO operates an automatic “Dial-a-weather System” that provides voice announcement of Hong Kong Standard Time.
Access phone number: +852 1878200
(when connected, press “3”, “6”, “1” in sequence)

Network Time Service
HKO operates network time service using Network Time Protocol (NTP).
Host name of the NTP servers: stdtime.gov.hk
Further information at http://www.hko.gov.hk/nts/ntime.htm

IGNA

GPS common-view data
GPS common-view data using CGGTTS format referred to UTC(IGNA) is available as requested by users.

INPL

Time dissemination service is performed in Israel by telecommunication companies, whose time and frequency standards are traceable to local UTC(INPL) time and are calibrated regularly once a year against the Israeli Time and Frequency National Standard kept by INPL .

INRIM

CTD Telephone Time Code
Time signals dissemination, according to the European Time code format, available via modem on regular dial-up connection.
Access phone numbers : 0039 011 3919 263 and 0039 011 3919 264.
Provides a synchronization to UTC(IT) for computer clocks without compensation for the propagation time.
Software for the synchronization of computer clocks is available on INRIM home page (www.inrim.it).

Internet Time Service
INRIM operates two time servers using the "Network Time Protocol" (NTP); host names of the servers are ntp1.inrim.it and ntp2.inrim.it.
More information on this service can be found on the web pages: www.inrim.it/ntp/index_i.shtml.

SRC (Segnale RAI Codificato) coded time signal broadcasted 20 – 30 times per day by “Radio Uno” and “Radio Tre” FM radio stations of the national broadcasting company RAI.

Web-based time-of-day clock that displays UTC or local time for Italy (Central Europe Time), referenced to INRIM Internet Time Service. Provides snapshot of time with any web browser. A continuous time display requires a web browser with Java plug-in installed. Service available at www.inrim.it/ntp/webclock_i.shtml.

KIM	Network Time Protocol (NTP) Service The NTP time information referenced to UTC(KIM) is generated by Stratum-1 NTP server at URL: ntp.kim.lipi.go.id or IP: 203.160.128.178 The server also provide time service using Daytime Protocol, and Time Protocol.
KRISS	Telephone Time Service Provides digital time code to synchronize computer clocks to Korea Standard Time (=UTC(KRIS) + 9 h) via modem. Access phone number: + 82 42 868 5116 Network Time Service KRISS operates three time servers using the NTP to synchronize computer clocks to Korea Standard Time via the Internet. Host name of the server : time.kriss.re.kr (210.98.16.100) Software for the synchronization of computer clocks is available at http://www.kriss.re.kr
KZ	Network Time Service Stratum-1 time server using the "Network Time Protocol" (NTP). Restricted access. Startum-2 time server using the "Network Time Protocol" (NTP). Free access. Stratum-2 is available: uakyt.kz Web-based Time Services: A real-time clock aligned to UTC(KZ) and corrected for internet transmission delay. Web-page uakyt.kz “Six-pip time signals” are broadcast by FM radio stations hourly every day.
LNE-SYRTE	LNE-SYRTE operates one primary time server using the “Network Time Protocol” (NTP) : Hostname: ntp-p1.obspm.fr Futher information at: http://syrte.obspm.fr/informatique/ntp_infos.php
LT	Network Time Service via NTP protocol NTP v3 DNS: laikas.pfi.lt Port 123 Synchronization from caesium clock (1 pps) System: Datum TymeServe 2100 NTP server Access policy: free Contact: Rimantas Miškinis Mail: Laikas@pfi.lt http://www.pfi.lt/index_e.html
METAS	Telephone Time Service The coded time string (compliant to the European Time Code format) is referenced to UTC(CH) and generated by a TUG type time code generator. Access phone numbers: +41 31 323 32 25, +41 31 323 47 00.

	Network Time Protocol METAS operates public NTP servers in free access. Host names: ntp.metas.ch ntp11.metas.ch ntp12.metas.ch More information at http://www.metas.ch and http://www.ntp.org
MIKES	MIKES provides an official stratum-1 level service to paying organizations and institutions. Stratum-2 level service, which MIKES acquires from a commercial service provider, is freely available for everyone. MIKES does not take responsibility for the public service, but servers providing the public service are syncronized to the stratum-1 level servers of MIKES.

Stratum-1 NTP servers (official service)

ntp2.mikes.fi	194.100.49.132	Synchronized to UTC(MIKE)
ntp4.mikes.fi	194.100.49.134	Synchronized to UTC(GPS)
ntp1.mikes.funet.fi	193.166.4.49	Synchronized to UTC(MIKE)
ntp2.mikes.funet.fi	193.166.4.50	Synchronized to UTC(GPS)

Stratum-2 NTP servers (public service)
time1.mikes.fi
time2.mikes.fi
Further information can be found from www.mikes.fi.

MSL	Network Time Service Computers connected to the Internet can be synchonized to UTC(MSL) using the NTP protocol. Access is available for users within New Zealand. Two servers are available at msltime1.irl.cri.nz and msltime2.irl.cri.nz Speaking Clock A speaking clock gives New Zealand time. Because it is a pay service, access is restricted to callers within New Zealand. Further information about these services can be found at http://msl.irl.cri.nz/services/time-and-frequency
NAO	Network Time Service Three stratum 2 NTP servers are available. The NTP servers internally refer stratum 1 NTP server that is linked to UTC(NAO). One of the three stratum 2 NTP servers are selected automatically by a round-robin DNS server to reply for an NTP access. The server host name is s2csntp.miz.nao.ac.jp.
NICT	Telephone Time Service (TTS) NICT provides digital time code accessible by computer at 300/1200/2400 bps, 8 bits, no parity. Access number to the lines: + 81 42 327 7592. Network Time Service (NTS) NICT operates a Stratum 1 NTP time server linked to UTC(NICT) through a leased line. Internet Time Service (ITS) NICT operates five Stratum 1 NTP time servers linked to UTC(NICT) through the Internet. Host name of the servers: ntp.nict.jp (Round robin).

GPS common view data
NICT provides the GPS common view data based on UTC(NICT) to the time business service in Japan.

NIM

Telephone Time Service
The coded time information generated by NIM time code generator, referenced to UTC(NIM). Telephone Code provides digital time code at 1200 to 9600 bauds, 8 bits, no parity, 1 stop bit.
Access phone number: 8610 6422 9086.

Network Time Service
Provides digital time code across the Internet using NTP.

NIMB

1 NTP server is available:
Address: ntp.inm.ro (STRATUM 1) with an open access policy
Server is referenced to UTC(NIMB).

NIMT

Internet Time service
NIMT operates 3 NTP servers at:
time1.nimt.or.th
time2.nimt.or.th
time3.nimt.or.th
The NTP servers are referenced to UTC(NIMT)

Telephone Time Service
The time code is generated and disseminated through the telephone lines. Computers and displayed clocks are able to access to UTC(NIMT) by dialling to +66 (0) 2 551 0332.

FM/RDS Radio Transmission
The time code is applied to the sub-carrier frequency of 57 kHz using the Radio Data System protocol. The accuracy of time transmission is around 1 s of UTC(NIMT).

NIST

Automated Computer Time Service (ACTS)
Provides digital time code by telephone modem for setting time in computers. Free software and source code available for download from NIST.
Includes provision for calibration of telephone time delay.
Access phone numbers : +1 303 494 4774 (12 phone lines) and +1 808 335 4721 (4 phone lines).
Further information at http://www.nist.gov/pml/div688/grp40/acts.cfm

Internet Time Service (ITS)
Provides digital time code across the Internet using three different protocols: Network Time Protocol (NTP), Daytime Protocol, and Time Protocol. (Time Protocol is not supported by all servers)

Geographically distributed set of 38 time servers at 26 locations within the United States of America. Free software and source code available for download from NIST.Further information at http://www.nist.gov/pml/div688/grp40/its.cfm

Web-based time-of-day clock that displays UTC or local time for United States time zones. Referenced to NIST Internet Time Service. Provides snapshot of time with any web browser, but continuously running time display requires web browser with Java plug-in installed. Available at http://www.time.gov (in cooperation with the United States Naval Observatory), and at http://nist.time.gov

Telephone voice announcement: Audio portions of radio broadcasts from time and frequency stations WWV and WWVH can be heard by telephone: +1 303 499 7111 for WWV and +1 808 335 4363 for WWVH

NMIJ	GPS common-view data GPS common-view data using CGGTTS format referred to UTC(NMIJ) are available through the NMIJ's web site for the remote frequency calibration service.
NMISA	Network Time Service One open access NTP server is available at address http://www.time.org.za/. More information is available at http://www.nmisa.org
NMLS	Web-based time-of-day clock A web clock is used to display the local time for Malaysia. The service is available at http://mst.sirim.my and http://time.sirim.my Network Time Service The NTP time information is referenced to UTC(NMLS) and is currently generated by Stratum-1 NTP servers, made available for public freely. The NTP server host names are ntp1.sirim.my and/or ntp2.sirim.my.
NPL	Telephone Time Service A TUG time code generator provides the European Telephone Time Code, referenced to UTC(NPL), by telephone modem. Software for synchronising computers is available from the NPL web site at www.npl.co.uk/time. The service telephone number is 0906 851 6333. Note: this is a premium rate number and can only be accessed from within the UK. Internet Time Service Two servers referenced to UTC(NPL) provide Network Time Protocol (NTP) time code across the internet. More information is available from the NPL web site at www.npl.co.uk/time. The server host names are: ntp1.npl.co.uk ntp2.npl.co.uk
NPLI	Telephone Time Service The coded time information generated by time code generator of NPLI, referenced to UTC(NPLI). Telephone Code provides digital time code (for the current time of Indian standard Time) at 1200 bauds, 8 bits, no parity, 1 stop bit. This service is known as TELECLOCK Service. Accessible by : a. an NPLI-developed Teleclock Receiver already available in the market. b. a Computer through Telephone Modem and NPLI-developed software. One-way Geostationary Satellite Time Service.
NRC	Telephone Code Provides digital time code by telephone modem for setting time in computers. Access phone number : +1 613 745 3900. http://www.nrc-cnrc.gc.ca/eng/services/inms/time-services/time-date.html Talking Clock Service Voice announcements of Eastern Time are at ten-second interval followed by a tone to indicate the exact time. The service is available to the public in English at +1 613 745 1576 and in French at +1 613 745 9426. For more information see: http://www.nrc-cnrc.gc.ca/eng/services/inms/time-services/time-broadcast.html

	Web Clock Service The Web Clock shows dynamic clocks in each Canadian Time zone, for both Standard time and daylight saving time. The web page is at: http://time5.nrc.ca/webclock_e.shtml.
	Network Time Protocol Operates two time servers using the " Network Time Protocol ", each one being on different location and network. Host names : time.nrc.ca and time.chu.nrc.ca. Further information at: http://www.nrc-cnrc.gc.ca/eng/services/inms/time-services/network-time.html
NSC IM	Network Time Service. Computers connected to the Internet can be synchronized to UTC(UA) using NTP protocol. NTP servers are referenced to UTC(UA) directly. Link to Time server: ntpd.metrology.kharkov.ua or IP address: 81.17.128.133. More information on http://www.metrology.kharkov.ua.
NTSC	Network Time Service (NTS) NTSC operates a time server directly referenced to China Standard Time (=UTC(NTSC) + 8 h). Software for the synchronization of computer clocks is available on the NTSC Time and Frequency web page : http://english.ntsc.cas.cn/rs/fs/200909/t20090917_39104.html Access Policy: free Contact: Shaowu DONG (sdong@ntsc.ac.cn).
ONBA	Speaking clock access phone number 113 (only accessible in Argentina). Hourly and half hourly radio-broadcast time signal. Internet time service at web site www.hidro.gov.ar/hora/hora.asp
ONRJ	Telephone Voice Announcer (55) 21 25806037. Telephone Code (55) 21 25800677 provides digital time code at 300 bauds, 8 bits, no parity, 1 stop bit (Leitch CSD5300) Internet Time Service at the address : 200.20.186.75 and 200.20.186.94 SNTP at port 123 Time/UDP at port 37 Time/TCP at port 37 Daytime/TCP at port 13 WEB-based Time Services: 1) A real-time clock aligned to UTC(ONRJ) and corrected for internet transmission delay. Further information at: http://200.20.186.71/asp/relogio/horainicial.asp 2) Voice Announcer, in Portuguese, each ten seconds, after download of the Web page at: http://200.20.186.71. Broadcast brazilian legal time (UTC – 3 hours) announced by a lady voice starting with “Observatório Nacional” followed by the current time (hh:mm:ss) each ten seconds with a beep for each second with a 1KHz modulation during 5ms and a long beep with 1KHz modulation during 200ms at the 58 , 59 and 00 seconds. The signal is transmitted every day of the year by the radio station PPE, whose signal is at 10 MHz with kind of modulation A3H and HF transmission power of 1 kW.

ORB

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

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 three time servers using the “ Network Time Protocol “ (NTP), see http://www.ptb.de/en/org/q/q4/q42/_index.htm for details and explanations.

Host names of the servers:
ptbtime1.ptb.de
ptbtime2.ptb.de
ptbtime3.ptb.de

ROA

Telephone Code
The coded time information is referenced to UTC(ROA) and generated by a TUG type time code generator using an ASCII-character code. The time protocols are sent in a common format, the "European Telephone Time Code". Access phone number : +34 956 599 429
Network Time Protocol
Server : hora.roa.es
Synchonized to UTC(ROA) better than 10 microseconds
Service policy : free

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

SG

Website: http://www.SingaporeStandardTime.org.sg.

Automated Computer Time Service (ACTS)
Transmits digital time code (NIST format) via telephone modem for setting time in computers. The coded time information is referenced to UTC(SG). Includes provision for correcting telephone time delay.
Free software available for downloading from the website.
Access phone number : +65 67799978.
Network Time Service (NeTS)
Transmits digital time code via the Internet using three protocols - Time Protocol, Daytime Protocol and Network Time Protocol.
Free software available for downloading from the website. Operates two time servers at addresses nets.org.sg and 203.117.180.35.

Web-based time service:
Displays a real time clock referenced to NeTS. User-selectable display of local time (adjusted for daylight saving) of any major city worldwide

and time difference information between any two cities.
Further information is available at the website.

SIQ	Internet Time Service (Network Time Protocol) One server referenced to UTC(SIQ) provides Network Time Protocol (NTP) time code across the internet. There is a free access to the server for all users. The server host names are:ntp.siq.si or time.siq.si (two URL's for the same server; IP: 194.249.234.70)
SP	Telephone Time Service The coded time information is referenced to UTC(SP) and generated by two TUG type time code generators using an ASCII-character code. The time protocols are sent in a common format, the "European Telephone Time Code". Access phone number: +46 33 41 57 83 Internet Time Service The coded time information is referenced to UTC(SP) and generated by two NTP servers using the Network Time Protocol (NTP). Access host names : ntp1.sp.se and ntp2.sp.se Speaking Clock The speaking clock service is operated by Telia AB in Sweden. The time announcement is referenced to UTC(SP) and disseminated from a computer based system operated and maintained at SP. Access phone number : 90510 (only accessible in Sweden). Access phone number : +4633 90510 (from outside Sweden). More information about these services are found at the web site www.sp.se
TL	Speaking Clock Service: Traceable to UTC(TL). Broadcast through PSTN (Public Switching Telephone Network) automatically and provides accurate voice time signal to public users. The Computer Time Service: Provides digital time code by telephone modem for setting time in computers. Access phone number : +886 3 4245117. 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.aspx
TP	Internet Time Service IPE operates time servers directly referenced to UTC(TP). Time information is accessible through Network Time Protocol (NTP). Server host name: time.ufe.cz, ntp1.ufe.cz, ntp2.ufe.cz More information at http://www.ufe.cz/time
UME	Telephone Time Service Providing the European time code that is referenced to UTC(UME) by telephone modem for setting computer time. Includes compensation of propagation time delay. More information for this service please contact to eml@ume.tubitak.gov.tr . Access phone number : +90 262 679 50 24 Network Time Service UME operates an NTP server referenced to UTC(UME). Host server name : time.ume.tubitak.gov.tr

USNO	Telephone Voice Announcer +1 202 762-1401 Backup voice announcer: +1 719 567-6742 Telephone Code +1 202 762-1594 provides digital time code at 1200 baud, 8 bits, no parity GPS via subframe 4 page 18 of the GPS broadcast navigation message Web site for time and for data files: http://tycho.usno.navy.mil/ Network Time Protocol (NTP) see http://www.usno.navy.mil/USNO/time/ntp for software and site closest to you.
VMI	Network Time Service VMI operates one time server Stratum 1 using the Network Time Protocol (NTP). For information on accessing the website, please contact bangn@vmi.gov.vn. The server host name is: http://www.vmi.gov.vn/
VNIIFTRI	Internet Time Service VNIIFTRI operates three time servers Stratum 1and one time server Stratum 2 using the “Network Time Protocol” (NTP). The server host names are: ntp1.vniiftri.ru (Stratum 1) ntp2.vniiftri.ru (Stratum 1) ntp3.vniiftri.ru (Stratum 1) ntp21.vniiftri.ru (Stratum 2).
VSL	Internet Time Service VSL operates a time server directly referenced to UTC(VSL). Time information is accessible through Network Time Protocol (NTP). The URL for the NTP server is: ntp.vsl.nl