BUREAU INTERNATIONAL DES POIDS ET MESURES

BIPM Annual Report on Time Activities

Volume 4

2009

Pavillon de Breteuil
F-92312 SÈVRES Cedex, France

ISBN 978-92-822-2237-9
ISSN 1994-9405

Contents

Practical information about the BIPM Time, Frequency and Gravimetry Department

The Time, Frequency and Gravimetry Department of the BIPM issues two periodic publications. These are the monthly *Circular T* and the *BIPM Annual Report on Time Activities*. The complete texts of *Circular T* and most tables of the present Annual Report are available from the BIPM website, BIPM - time, frequency and gravimetry.

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Director's Report on the Activity and Management of the BIPM, 2009, T. 10

(July 2008- June 2009)

BIPM Publication

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

The reference time scales, International Atomic Time (TAI) and Coordinated Universal Time (UTC), are computed from data reported regularly to the BIPM by the various timing centres that maintain a local UTC; monthly results are published in *Circular T*. The *BIPM Annual Report on Time Activities for 2008*, volume **3**, complemented by files on the BIPM website, provides the definitive results for 2008.

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 is conducted in the Section with the aim of improving the long-term stability of EAL and the accuracy of TAI. The effects of the linear prediction algorithm have been studied for the different types of clocks in TAI. ALGOS predicts the clock frequency with a linear model that is well adapted to the caesium clock, but not to the hydrogen maser clock. A test version of EAL without H-masers has been calculated to evaluate the effects of this equal modelling of the clock frequencies. A new mathematical expression for the prediction of the Hmaser frequencies is proposed, taking into account the drift. Tests over a 3-year period have been performed, applying a linear prediction to the caesium clocks and a quadratic prediction to the H-masers. A version of EAL on the basis of the proposed frequency prediction for H-masers, but with the classical clock weighting, has been evaluated. The results seem to indicate that non-modelling of the frequency drift of H-masers could be responsible for 20 % of the drift of EAL. In this test one month of past data were used to evaluate the frequency drift; longer periods still need to be tested. EAL still shows a significant drift; and further work is required on the EAL weighting algorithm.

2.1 EAL stability

Some 87 % 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. During 2008, on average, about 15 % of the participating clocks have been 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, has been about 4 parts in 10^{16} for averaging times of one month. Slowly varying, longterm 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 2008, individual measurements of the TAI frequency have been provided by twelve primary frequency standards, including eight caesium fountains (IT CSF1, LNE-SYRTE FO1, LNE-SYRTE FO2, LNESYRTE FOM, NICT CSF1, NIST F1, NMIJ F1 and PTB CSF1). Reports on the operation of the primary frequency standards are regularly published in the *BIPM Annual Report on Time Activities* and on the BIPM website.

Starting in July 2004, a monthly steering correction of at most 7 parts in 10^{16} is applied as deemed necessary. Since July 2008, the global treatment of individual measurements has led to a relative departure of the duration of the TAI scale unit from the SI second on the geoid ranging from +2.6 x 10^{-15} to +5.7 x 10^{-15}, with a standard uncertainty of less than 1 x 10^{-15}. Over the year, twelve steering corrections have been applied, giving a total correction to [f (EAL) – f (TAI)] of −5.2 x 10^{-15}.

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

2.3 Independent atomic time scales

TT(BIPM)

Because TAI is computed in 'real-time' and has operational constraints, it does not provide an optimal realization of Terrestrial Time (TT), the time coordinate of the geocentric reference system. The BIPM therefore computes an additional realization, TT(BIPM), in post-processing, which is based on a weighted average of the evaluation of the TAI frequency by the primary frequency standards. We have provided an updated computation of TT(BIPM), named TT(BIPM08), valid until December 2008, which has an estimated accuracy of about 5 parts in 10^{16}. Studies aiming at improving the computation of TT(BIPM) have been undertaken, in order to keep it in line with improvements in the primary frequency standards.

3 Primary frequency standards and secondary representations of the second

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

The CCL/CCTF Frequency Standards Working Group proposes various other microwave and optical atomic transitions as secondary representations of the second. Changes to the list, containing frequency values and uncertainties for transitions in Rb, Hg^+, Yb^+, Sr^+ and Sr, have been recommended by the Consultative Committee for Time and Frequency (CCTF) in 2009. BIPM staff continue to participate in the rapidly evolving field of optical frequency standards, addressing, for example, the issue of their comparison at the level of parts in 10^{17}.

4 Time links

TAI currently relies on data from 68 participating time laboratories equipped with GNSS receivers and/or operating TWSTFT stations.

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 with C/A code measurements from GPS single-frequency receivers; dual-frequency, multi-channel GPS geodetic-type receivers (P3); and two-way satellite time and frequency transfer through geostationary telecommunications satellites (TWSTFT). The older GPS single-channel single-frequency receivers represent today only 6 % of the total number and have mostly been replaced by either multichannel single- or dual-frequency receivers. Ten TWSTFT links are officially used for 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 also close to contributing.

Following Recommendation CCTF 4 (2006), in April 2008 the Section started a pilot experiment 'TAIPPP', where time laboratories contribute GPS phase and code data and the BIPM uses the Precise Point Positioning (PPP) technique to generate monthly solutions, in slightly deferred time after the regular TAI computation. At its meeting in June 2009, the CCTF approved the report on the pilot experiment and agreed on the inclusion of TAIPPP links in the calculation of TAI. The number of laboratories regularly participating today is 25; the links will be introduced into TAI before the end of 2009. Comparisons of the TAIPPP links with others obtained by TWSTFT and P3 are published monthly on the Section's ftp server.

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

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

All GPS links are corrected for satellite positions using IGS post-processed, precise satellite ephemerides, and those links using single-frequency receivers are corrected for ionospheric delays using IGS maps.

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 in the framework of the IGS Working Group on Clock Products, of which a physicist of the Section is a member.

The method developed to perform the absolute calibration of the Ashtech Z12-T hardware delays allows us to use this receiver for differential calibrations of similar receivers world-wide, and calibration campaigns began in January 2001. Since 2006, calibration results have also been issued for the Septentrio PolaRx2 receiver, and other types of receivers are being investigated in collaboration with laboratories equipped with them. A new receiver recently developed and commercialized (GTR50) has been purchased by the BIPM and is included in our calibration procedures since 2008. In all cases, at least two receivers remain at the BIPM to serve as a local reference with which the travelling receiver is compared between calibration trips.

Data from geodetic-type receivers 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 twoway time transfer.

Geodetic-type receivers also provide raw phase measurements which may be used, along with the code measurements, to compute time links. This is routinely done by the IGS for time laboratories which are also part of the IGS network. A comparative study of geodetic-type receivers and processing techniques for time links was carried out during a 6-week secondment at the AIUB (Bern) and METAS (Wabern) in mid-2008. The BIPM has computed its own solutions for such time links since October 2007, using PPP software.

As reported above, it is planned to introduce such PPP time links into the TAI computation before the end of 2009.

4.3 Two-way time transfer

Two meetings of the TWSTFT participating stations have been held since July 2008, and the CCTF WG on TWSTFT met at the SP (Borås, Sweden) in October 2008. 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 are used for particular studies such as the T2L2 experiment. The TWSTFT technique applied to clock comparisons in TAI is 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 GPS single-frequency, dualfrequency and TW observations are published monthly on the Section's ftp server (http://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 are updated as necessary, depending on the noise level present in the links.

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 2008 to June 2009, GPS time equipment for single- and dual-frequency reception has been calibrated. The BIPM is also organizing TWSTFT calibration trips, supported by a GPS receiver from our time laboratory.

Progress has also been made on the measurement of relative delays of GLONASS equipment thanks to cooperation with the Space Research Centre (SRC) in Warsaw (Poland). The measurements have already started, with a TTS-3 receiver having visited VNIIFTRI in the third trimester of 2008.

Work on the absolute calibration of GNSS receivers has been started by a Ph.D. student through a collaboration co-financed with the CNES and also involving the LNE-SYRTE. In addition to hardware developments carried out at the CNES, this work includes a comprehensive study of all calibration results available, including past and new absolute calibrations, the series of differential calibrations carried out by the BIPM and other information available from the IGS.

5 Key comparisons

Results of the key comparison in time, CCTF-K001.UTC, involving the time laboratories participating in the CIPM MRA, have been regularly published in the KCDB after publication of the monthly *Circular T*.

Following a decision of the CCTF at its 17th meeting (2006), the BIPM has cooperated with the CCTF WG on the CIPM MRA, and implemented the calculation of the frequency offsets and their uncertainties for a new key comparison in frequency, CCTF-K002.FREQ. In June 2009 the 18th meeting of the CCTF decided that CCTF-K001.UTC will remain the unique key comparison in the field of time and frequency, that it will be directly represented by the results in *Circular T*, and that the participating laboratories should derive the necessary results and uncertainties to support their CMCs in frequency following the guidelines provided by the BIPM TFG Section to the CCTF WG on the CIPM MRA.

6 Pulsars

Collaboration continues with the Observatoire Midi-Pyrénées (OMP, Toulouse, France), and other radioastronomy groups observing pulsars and analysing 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 TFG Section provides these groups with its post-processed realization of Terrestrial Time, TT(BIPM).

7 Space-time references

The BIPM maintains the web and ftp sites for the *IERS Conventions* (http://tai.bipm.org/iers/). Updates to the *Conventions* (2003) have been posted on the website (http://tai.bipm.org/iers/convupdt). These updates consider several new models for effects that affect the positions of Earth points at the millimetre level, which are now significant. These modifications are studied with the help of the Advisory Board for the *IERS Conventions* updates, including representatives of all groups involved in the IERS. Following the conclusions of the Workshop on the IERS Conventions, held at the BIPM on 20-21 September 2007, a new registered edition of the IERS Conventions will be compiled within the next year.

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

8 Comb activities

As a result of the reorganization of activities in the Section, BIPM comb activities are limited to the maintenance of the BIPM frequency comb for internal applications.

9 BIPM key comparison BIPM.L-K11 and CCL-K11

Following the termination of BIPM.L-K11 and a period of preparation of the ensuing key comparison CCL-K11, the latter is now under way.

Measurements have already taken place at MIKES (Finland) and the BEV (Austria), and two larger campaigns at the NMIJ AIST (Japan) and NRC (Canada) are being planned. The BIPM continues to provide technical advice and also assures a BIPM presence during the measurements whenever it is possible and requested. Related to this activity is the question of how best to validate the optical frequency combs themselves. The BIPM continues to take part in this discussion and to examine possible ways to provide support for this process on an international basis.

10 Calibration and measurement service

The Section has provided a comb and laser calibration and measurement service to meet the internal needs of the BIPM. These include the periodic absolute frequency determination of our reference lasers at 633 nm and 532 nm, which are used for testing the quality of iodine cells, for the calculable capacitor project, and for the gravimeter instrumentation at the BIPM. The combs are passively kept in running condition and are used as necessary.

Preparations are well under way for ICAG-2009, during which some 20 lasers will be measured. Furthermore, a study of the beam characteristics in the interferometers of the participating gravimeters is planned, in order to account for small corrections related to diffraction effects.

11 Iodine cells

In 2008 the CIPM took the decision to stop the provision of iodine cells by the BIPM. The activity of the BIPM iodine cell service will cease definitively by the end of July 2009.

A letter was sent to our customers in order to explain the situation, to ask which laboratories would be interested in continuing the service (which is essential for many activities in science), and to propose the transfer of technology from the BIPM. Four NMIs, one institute and one private company expressed interested in taking up this activity from the BIPM.

About twenty iodine cells have been sold during the period of this report.

12 Gravimeter FG5-108

The laser head of the compact Nd:YVO_4/KTP/I_2 laser at 532 nm has been modified and the optical fibre system for light delivery to the interferometer of the FG5-108 gravimeter has been tested. The broken motor of the dropping chamber has been replaced and the dropping controller is being readjusted.

13 8th International Comparison of Absolute Gravimeters, ICAG-2009

The evaluation of the results of ICAG-2005 has been completed and provides valuable input to the design and preparation of ICAG-2009, which will be held at the BIPM in the third quarter of 2009.

Two meetings of the ICAG-2009 Steering Committee were organized: in November 2008 at the BIPM and on 11-12 May 2009 at the Research Institute of Geodesy, Topography and Cartography in Prague (Czech Rep.).

Twenty-seven absolute gravimeters are expected to participate in the comparison. Of these, seventeen gravimeters will take part in the new key comparison CCM.G-K1, which forms part of ICAG-2009. The measurements of the remaining subset of gravimeters will be organized as a Pilot Study, again within ICAG-2009.

The technical protocols have been drawn up and define the strategy of the absolute and relative measurements, the data processing and the evaluation of the comparison reference values with their uncertainties. Separate protocols have been developed for the CCM.G-K1 part and for the ICAG-2009 overall.

The results of all of the participating gravimeters will be included in the evaluation of ICAG-2009 as a whole, while only the results of the gravimeters from the KC subset will be used to calculate the KCRV for CCM.G-KI, published in the KCDB.

Preliminary schedules for the absolute and relative measurements have been prepared and distributed to the participants. Five gravity stations of the microgravity network will be used; this is considered a suitable number in terms of their homogeneous measurement and optimal adjustment.

The BIPM will verify the frequencies of the lasers used for the interferometric measurement of the displacement of the falling test body, as well as the frequencies of the rubidium reference clocks of the absolute gravimeters. The stability of the gravity field at the BIPM will be monitored using the BIPM’s gravimeter FG5-108.

14 Preliminary gravimetry study for the watt balance project

The watt balance requires an uncertainty of 1 part in 10^8 in the absolute gravity value. Preliminary studies have been carried out on the equipment and the influence of the local and global environment for accurate gravity measurements.

15 Publications, lecture, travel: Time, Frequency and Gravimetry Section

15.1 External publications

1. Petit G., Arias F., Use of IGS products in TAI applications, *J. Geodesy*, 2009, **83**, 327-334.

2. Petit G., Klioner S., Does relativistic time dilation contribute to the divergence of Universal Time and Ephemeris Time?, *Astron. J.*, 2008, **136**, 1909-1912.

3. Petit G., Relativistic aspects in astronomical standards and the IERS Conventions, *Proc. Journées Systèmes de reference spatio-temporels*, in press.

4. Petit G., Atomic time scales TAI and TT(BIPM): present status and prospects, *Proc. 7th Symp. Frequency Standards and Metrology*, in press.

5. Petit G., The TAIPPP pilot experiment, *Proc. 23rd EFTF*, in press.

6. Petit G., Bernier L.-G., Uhrich P., Time and frequency transfer by geodetic GPS: comparison of receivers and computation techniques, *Proc. 23rd EFTF*, in press.

7. Panfilo G., Tavella P., Algorithms for the atomic clock prediction within the GALILEO system, *Proc. 1st Colloquium Scientific and Fundamental Aspects of the Galileo Programme* (1-4 October 2007, Toulouse, France).

8. Lewandowski W., Matsakis D., Panfilo G., Tavella P., Analysis of correlations, and link and equipment noise in the uncertainties of [UTC − UTC(*k*)], *UFFC*, 2008, **55**(4), 750-760.

9. Panfilo G., Tavella P., Atomic clock prediction based on stochastic differential equations', *Metrologia*, 2008, **45**(6), S108-S116.

10. Bibbona E., Panfilo G., Tavella P., The Ornstein-Uhlenbeck process as a model of a low-pass filtered white noise, *Metrologia*, 2008, **45**(6), S117-S126.

11. Panfilo G., Arias E.F., Studies and possible improvements on EAL algorithm, *Proc. 23rd EFTF*, in press.

12. Arias E.F., Panfilo G., International time scales at the BIPM: impact and applications, *Proc. Int. Congress of Metrology*, Paris, June 2009 (CDRom).

13. Jiang Z., Lewandowski W., Piester D., Calibration of TWSTFT links through the triangle closure condition, *Proc. 40th PTTI*, 2008, 467-483.

14. Niessner A., Mache W., Blanzano B., Koudelka O., Becker J., Piester D., Jiang Z., Arias F., Calibration of the BEV GPS receiver by using TWSTFT, *Proc. 40th PTTI*, 2008, 543-548.

15. Defraigne P., Carmen Martínez M., Jiang Z., Time transfer from combined analysis of GPS and TWSTFT data, *Proc. 40th PTTI*, 2008, 565-576.

16. Jiang Z., Niessner A., Calibrating GPS with TWSTFT for accurate time transfer, *Proc. 40th PTTI*, 2008, 577-586.

17. Matsakis D., Breakiron L. Bauch A., Piester D., Jiang Z., Two-way satellite time and frequency transfer (TWSTFT) calibration constancy from closure sums, *Proc. 40th PTTI*, 2008, 587-604.

18. Arias E.F., Panfilo G., Time activities at the BIPM, *Proc. 40th PTTI*, 2008, 657-662.

19. Lewandowski W., Arias F., Nawrocki J., Nogaś P., Use of GLONASS for International Time Keeping, *Proc. Conf. GLONASS*, 2009, St Petersburg, Russian Federation.

20. H. Li, Zhang H., Lewandowski W., Jiang Z, TWSTFT Activities at Chinese National Time Service Center, 2009, *Proc. 23rd EFTF* (in press).

15.2 BIPM publications

21. *BIPM Annual Report on Time Activities for 2008*, 2009, **3,** 102 pp.

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

23. Lewandowski W., Tisserand L., Determination of the differential time corrections for GPS time equipment located at the OP, PTB, NPL and VSL, 2008, *Rapport BIPM*-2008/01, 19 pp.

24. Lewandowski W., Tisserand L., Determination of the differential time corrections for GPS time equipment located at the OP, NTSC, HKO, TL, SG, AUS, KRIS, NMIJ, and NICT, 2008, *Rapport BIPM*-2008/02, 27 pp.

25. Lewandowski W, Tisserand L, Determination of the differential time corrections for GPS time equipment located at the OP, TCC, ONBA, IGMA and CNMP, 2008, *Rapport BIPM*-2008/03.

26. Lewandowski W., Tisserand L., Determination of the differential time corrections for GPS time equipment located at the OP, PTB, NPL and VSL, 2008, *Rapport BIPM*-2008/04.

Access to electronic files on the FTP server of the BIPM Time, Frequency and Gravimetry 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.

Publication- the latest issues on time activities

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

Older files can be accessed directly from the ftp site (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.

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://145.238.100.28

Establishment of International Atomic Time and of Coordinated Universal Time

1. Data and computation

International Atomic Time (TAI) and Coordinated Universal Time (UTC) are obtained from a combination of data from some 400 atomic clocks kept by almost 70 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 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 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 the traditional 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 a back-up. Single-frequency GPS data are corrected using the ionospheric maps produced by the Center for Orbit Determination in Europe (CODE); all GPS data are corrected using precise satellite ephemerides and clocks produced by the International GNSS Service (IGS).

GPS links are computed with the method called “GPS all in view” [3], with a network of time links that uses the PTB as a unique pivot laboratory for all the GPS links.

Clock comparisons using GLONASS C/A (L1C frequency) satellite observations with multi-channel receivers have been introduced for the link between SU and PTB since October 2009 [4]. This link is computed using the “common-view” [5] method; data are corrected using the ESA ephemerides SP3 files and the IGS ionospheric maps.

A figure showing the network of time links can be downloaded from the BIPM website.

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.

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 [6, 7]. The successive versions of TT(BIPMxx) are both updates and revisions; they may differ for common dates.

Notes

Tables 8 and 9 of this report give the rates relative to TAI and the weights of the clocks contributing to TAI in 2009.

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 2008-June 2009 is extracted from the *Director’s Report on the Activity and Management of the BIPM (1 July 2008 − 30 June 2009)*. All the publications mentioned in this report are available on request from the BIPM.

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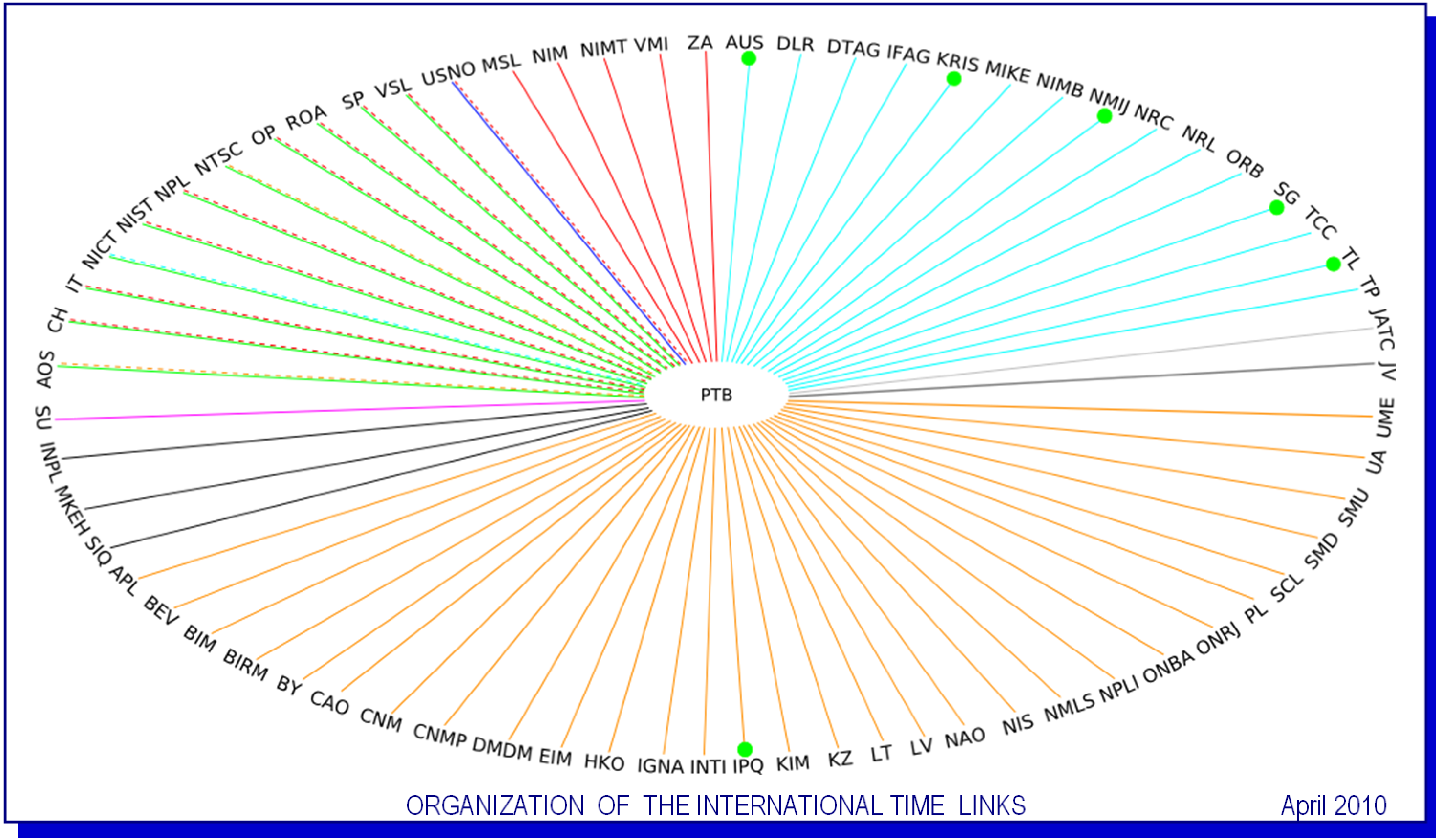

Dotted lines stand for back-up link	Internal cable link between JATC and NTSC
Laboratory equipped with TWSTFT (not yet used)	GPS AV multi-channel link
TWSTFT by Ku band with X band back-up	GPS AV dual frequency link (P3)
TWSTFT link	GPS AV dual frequency link (PPP)
GPS AV single-channel link	GLONASS CV multi-channel link
'GPS time' observations	

Table 1. Relative frequency offsets and step adjustments of UTC, up to 31 December 2010

Date (at 0 h UTC)		Offsets	Steps/s
1961 Jan. 1		–150x10^{-10}	
1961 Aug. 1	"	+0.050	
1962 Jan. 1		–130x10^{-10}	
1963 Nov. 1	"		−0.100
1964 Jan. 1		–150x10^{-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		–300x10^{-10}	
1968 Feb. 1	"	+0.100	
1972 Jan. 1	0	−0.107 7580	
1972 Jul. 1	"	−1	
1973 Jan. 1	"	−1	
1974 Jan. 1	"	−1	
1975 Jan. 1	"	−1	
1976 Jan. 1	"	−1	
1977 Jan. 1	"	−1	
1978 Jan. 1	"	−1	
1979 Jan. 1	"	−1	
1980 Jan. 1	"	−1	
1981 Jul. 1	"	−1	
1982 Jul. 1	"	−1	
1983 Jul. 1	"	−1	
1985 Jul. 1	"	−1	
1988 Jan. 1	"	−1	
1990 Jan. 1	"	−1	
1991 Jan. 1	"	−1	
1992 Jul. 1	"	−1	
1993 Jul. 1	"	−1	
1994 Jul. 1	"	−1	
1996 Jan. 1	"	−1	
1997 Jul. 1	"	−1	
1999 Jan. 1	"	−1	
2006 Jan. 1	"	−1	
2009 Jan. 1	"	−1	

Table 2. Relationship between TAI and UTC, up to 31 December 2010

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

Table 3. Acronyms and locations of the timing centres which maintain a local approximation of UTC, UTC(*k*), and/or an independent local time scale, TA(*k*) (updated to April 2010)

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	Swiss Federal Office of Metrology, Switzerland (METAS)
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	Główny Urząd Miar (Central Office of Measures), Warsaw, Poland
HKO	Hong Kong Observatory, Hong Kong, China
IFAG	Bundesamt für Kartographie und Geodäsie (Federal Agency for Cartography and Geodesy), Fundamental station, Wettzell, Kötzting, Germany
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 (I.N.R.I.M.), Italy
JATC	Joint Atomic Time Commission, Lintong, P.R. China
JV	Justervesenet, Norwegian Metrology and Accreditation Service, Kjeller, Norway
KIM	Research Centre for Calibration, Instrumentation and Metrology The Indonesian Institute of Sciences, Serpong-Tangerang, Indonesia
KRIS	Korea Research Institute of Standards and Science, Daejeon, Rep. of Korea
KZ	Kazakhstan Institute of Metrology, Astana, Kazakhstan
MIKE	Center for Metrology and Accreditation, Finland
MKEH	Hungarian Trade Licensing Office, Hungary
LT	Lithuanian National Metrology Institute, Vilnius, Lithuania
LV	SA Latvian National Metrology Centre, Riga, Latvia
MSL	Measurement Standards Laboratory, Lower Hutt, New Zealand
NAO	National Astronomical Observatory, Misuzawa, Japan
NICT	National Institute of Information and Communications Technology, Tokyo, Japan
NIM	National Institute of Metrology, Beijing, P.R. China
NIMB	National Institute of Metrology, Bucharest, Romania
NIMT	National Institute of Metrology, Bangkok, Thailand
NIS	National Institute for Standards, Cairo, Egypt
NIST	National Institute of Standards and Technology, Boulder, Colo., USA

Table 3. Acronyms and locations of the timing centres which maintain a local approximation of UTC, UTC(*k*), and/or an independent local time scale, TA(*k*) (Cont.) (updated to April 2010)

NMIA	National Measurement Institute, Australia, Sydney, Australia
NMIJ	National Metrology Institute of Japan, Tsukuba, Japan
NMLS	National Metrology Laboratory of SIRIM Berhad, Shah Alam, Malaysia
NPL	National Physical Laboratory, Teddington, United Kingdom
NPLI	National Physical Laboratory, New Delhi, India
NRC	National Research Council of Canada, Ottawa, Canada
NRL	U.S. Naval Research Laboratory, Washington D.C., USA
NTSC	National Time Service Center of China, Lintong, P.R. China
ONBA	Observatorio Naval, Buenos Aires, Argentina
ONRJ	Observatório Nacional, Rio de Janeiro, Brazil
OP	Observatoire de Paris (Paris Observatory), Paris, France
ORB	Observatoire Royal de Belgique (Royal Observatory of Belgium), Brussels, Belgium
PL	Consortium of laboratories in Poland
PTB	Physikalisch-Technische Bundesanstalt, Braunschweig, Germany
ROA	Real Instituto y Observatorio de la Armada, San Fernando, Spain
SCL	Standards and Calibration Laboratory, Hong Kong
SG	National Metrology Centre - Agency for Science, Technology and Research (A*STAR)
SIQ	Slovenian Institute of Quality and Metrology, Ljubljana, Slovenia
SMD	Metrology Division of the Quality and Safety Department - Scientific Metrology Brussels, Belgium
SMU	Slovenský Metrologićký Ústav (Slovak Institute of Metrology), Bratislava, Slovakia
SP	Sveriges Provnings- och Forskningsinstitut (Swedish National Testing and Research Institute), Borås, Sweden
SU	Institute of Metrology for Time and Space (IMVP), NPO "VNIIFTRI" Mendeleevo, Moscow Region, Russia
TCC	TIGO Concepción Chile, Chile
TL	Telecommunication Laboratories, Chung-Li, Taiwan
TP	Institute of Photonics and Electronics, Czech Academy of Sciences, Praha, Czech Republic
UA	National Science Center "Institute of Metrology", Kharkhov, Ukraine
UME	Ulusai Metroloji Enstitüsü, Marmara Research Centre, (National Metrology Institute), Gebze Kocaeli, Turkey
USNO	U.S. Naval Observatory, Washington D.C., USA
VMI	Vietnam Metrology Institute, Ha Noi, Vietnam
VSL	VSL, Dutch Metrology Institute, Delft, the Nederlands
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 2009

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

Lab k	Equipment	Source of UTC(*k*) (1)	TA(*k*)	Time Links			
				GPS		GLONASS	Two-Way
				SF	DF		
AOS	3 Ind. Cs 2 H-masers	1 H-maser (2) + microphase-stepper		*	*	*	*
APL (a)	3 Ind. Cs 3 H-masers	1 Cs + microphase-stepper		*			
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 (a)	2 Ind. Cs 6 H-masers	1 Cs		*	*		
BY	6 H-masers	3-4 H-masers		*		*	
CAO	2 Ind. Cs	1 Cs		*	*	*	
CH	4 Ind. Cs (3) 1 H-maser	all the Cs 1 H-maser	*		*		*
CNM	3 Ind. Cs 1 H-maser	3 Ind. Cs 1 H-maser + microphase-stepper		*			
CNMP (a)	2 Ind. Cs	1 Cs		*			
DLR	3 Ind. Cs 5 H-masers	1 Cs			*		
DMDM	1 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 (a)	3 Ind. Cs	1 Cs + microphase-stepper		*			
INPL	2 Ind. Cs	1 Cs		*			

Table 4. Equipment and source of UTC(*k*) of the laboratories contributing to TAI in 2009 (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		
INTI (a)	1 Ind. Cs	1 Cs		*			
IPQ	3 Ind. Cs	1 Cs + microphase-stepper			*	*	*
IT	6 Ind. Cs 3 H-masers 1 Lab. Cs	1 H-maser + microphase-stepper	*	*	*	*	*
JATC	18 Ind. Cs (4) 3 H-masers	1 Cs + microphase-stepper	*	*	*		*
JV (a)	4 Ind. Cs	1 Cs		*			
KIM	1 Ind. Cs	1 Cs		*	*	*	
KRIS	5 Ind. Cs 4 H-masers	1 H-maser + microphase-stepper	*	*	*	*	*
KZ	2 Ind. Cs	1 Cs			*	*	
LT	2 Ind. Cs	1 Cs		*			
LV	2 Ind. Cs	1 Cs		*			
MIKE	2 Ind. Cs 3 H-masers	1 H-maser + microphase-stepper		*	*	*	
MKEH	1 Ind. Cs	1 Cs		*			
MSL	3 Ind. Cs	1 Cs		*	*		
NAO (a)	4 Ind. Cs 1 H-maser	1 Cs + microphase-stepper		*			
NICT	27 Ind. Cs 7 H-masers (5) 1 Lab. Cs	18 Cs	*	*	*		*
NIM	2 Ind. Cs 2 H-masers	1 H-maser + microphase-stepper		*	*		
NIMB	2 Ind. Cs	1 Cs		*	*		
NIMT	2 Ind. Cs	1 Cs		*	*		

Table 4. Equipment and source of UTC(*k*) of the laboratories contributing to TAI in 2009 (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		
NIS (a)	3 Ind. Cs	1 Cs		*	*	*	
NIST	8 Ind. Cs 2 Lab. Cs 6 H-masers	4 Cs 6 H-masers + microphase-stepper	*	*	*	*	*
NMIJ	3 Ind. Cs 1 Lab. Cs 4 H-masers	1 H-maser + microphase-stepper		*	*		*
NMLS	5 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	2 Ind. Cs 4 H-masers	1 H-maser + microphase-stepper			*	*	
NTSC	18 Ind. Cs 3 H-masers	1 Cs + microphase-stepper	*	*	*		*
ONBA	1 Ind. Cs	1 Cs		*			
ONRJ	6 Ind. Cs	1 Cs + microphase-stepper	* (6)	*			
OP	8 Ind. Cs 3 Lab. Cs 4 H-masers	1 Cs + microphase-stepper	* (7)	*	*	*	*
ORB	3 Ind. Cs 3 H-masers	1 H-maser			*		
PL	11 Ind. Cs 4 H-masers	1 Cs (8) + microphase-stepper	* (9)	*			
PTB	3 Ind. Cs 4 Lab. Cs (10) 3 H-masers	1 Lab. Cs (11)	* (11)	*	*	*	*
ROA	5 Ind. Cs 1 H-maser	1 H-maser + frequency synthesizer steered to UTC(ROA) (12)		*	*	*	*
SCL	2 Ind. Cs	1 Cs + microphase-stepper		*			

Table 4. Equipment and source of UTC(*k*) of the laboratories contributing to TAI in 2009 (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		
SG	4 Ind. Cs (13) 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 (14) 7 H-masers	1 H-maser + microphase-stepper			*		*
SU	1 Lab. Cs 8-12 H-masers	3-10 H-masers	*		*	*	
TCC	3 Ind. Cs 3 H-masers	1 Cs		*	*		
TL	14 Ind. Cs 2 H-masers	1 H-maser + microphase-stepper	* (15)		*		*
TP	5 Ind. Cs	1 Cs + output frequency steering		* (16)	*		
UA	5 H-masers	3 H-masers + microphase-stepper		*			
UME	3 Ind. Cs	1 Cs		*	*	*	
USNO	72 Ind. Cs 24 H-masers	1 H-maser + frequency synthesizer steered to UTC(USNO) (17)	* (17)	*	*		*
VMI	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 2008, not confirmed by the laboratory.

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

(2) AOS The UTC(AOS) is formed technically using 1H-maser and microstepper, it is steered using TA(PL) data as a reference.

(3) CH All the standards are located in Bern at METAS (Federal Office of Metrology). Since November 2007, UTC(CH) is defined in real time by a hydrogen maser steered to the paper time scale UTC(CH.P) which is defined as a weighted average of all the clocks, steered to UTC.
TA(CH) is also a weighted average of all the clocks, but free running.

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

(5) NICT The standards are located as follows (at the end of 2009):

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

(6) ONRJ The Brazilian atomic time scale TA(ONRJ) is computed by the National Observatory in Rio de Janeiro with data from 6 industrial caesium clocks.

(7) OP The French atomic time scale TA(F) is computed by the LNE-SYRTE with data from 26 industrial caesium clocks located as follows (at the end of 2009) :

* Centre Electronique de l'Armement (CELAR, Rennes)	1 Cs
* Centre National d'Etudes Spatiales (CNES, Toulouse)	4 Cs
* France Telecom Recherche et Developpement (Lannion)	2 Cs
* Agilent Technologies France (Massy)	2 Cs
* Observatoire de la Côte d'Azur (OCA, Grasse)	2 Cs
* Observatoire de Paris (LNE-SYRTE, Paris)	8 Cs
* Observatoire de Besançon (OB, Besançon)	3 Cs
* Direction des Constructions Navales (DCN, Brest)	4 Cs

All laboratories are linked via GPS receivers.

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

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

Notes (Cont.)

(9)	PL	The Polish atomic timescale TA(PL) is computed by the AOS and GUM with data from 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-maser
		* National Institute of Telecommunications (IŁ, Warsaw)	2 Cs
		* Polish Telecom (TPSA, Warsaw)	2 Cs
		* Military Primary Standards Laboratory (CWOM, Warsaw)	1 Cs, 1 H-maser
		and additionally	
		* Time and Frequency Standard Laboratory of the Semiconductor Physics Institute, a guest laboratory from Lithuania (LT, Vilnius, Lithuania)	2 Cs
		* Time and Frequency Laboratory of Latvian National Metrology Centre, a guest laboratory from Latvia (LV, Riga, Latvia)	1 Cs
		All laboratories are linked via MC GPS-CV receivers, except for one clock of TPSA linked via two-directional optical fiber connection.	
(10)	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. During 2009, TA(PTB) and UTC(PTB) have been derived, as during the years before, from PTB CS2, TA(PTB) directly, UTC(PTB) including frequency steering. UTC(PTB) is based on the output of an active hydrogen maser steered in frequency since MJD 55224.	
(11)	PTB	*TA*(*PTB*)-*UTC*(*PTB*) is published in PTB Time Service Bulletin, together with the frequency steering applied to UTC(PTB). The latter information is no longer made available since February 2010.	
(12)	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.	
(13)	SG	Before MJD=55088, the UTC(SG) was generated from a Cs. Starting from MJD=55088, the UTC(SG) is from an H-maser. The TA(SG) is a weighted average of 4 Cs and 1 H-maser.	
(14)	SP	The standards are located as follows (at the end of 2009):	
		* 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
(15)	TL	TA(TL) is generated from a 14-caesium-clock ensemble.	
(16)	TP	Since April 2009 no data from SF GPS receiver available.	
(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 H-masers located at the USNO. A.1(MEAN) is a free atomic time scale, while UTC(USNO) is steered to UTC. Included in the total number of USNO atomic standards are the clocks located at the USNO Alternate Master Clock in Colorado Springs, CO.	

Table 5. Differences between the normalized frequencies of EAL and TAI, up to April 2010

(File containing values since the beginning of the steering is available at ftp://62.161.69.5/pub/tai/scale/ealtai09.ar)

Date	MJD	[f(EAL) - f(TAI)] x 10^{-13}
2005 Aug 27 - 2005 Sep 26	53609 - 53639	6.870
2005 Sep 26 - 2005 Oct 31	53639 - 53674	6.868
2005 Oct 31 - 2005 Nov 30	53674 - 53704	6.862
2005 Nov 30 - 2005 Dec 30	53704 - 53734	6.856
2005 Dec 30 - 2006 Jan 29	53734 - 53764	6.850
2006 Jan 29 - 2006 Feb 28	53764 - 53794	6.844
2006 Feb 28 - 2006 Mar 30	53794 - 53824	6.838
2006 Mar 30 - 2006 Apr 29	53824 - 53854	6.832
2006 Apr 29 - 2006 May 29	53854 - 53884	6.826
2006 May 29 - 2006 Jun 28	53884 - 53914	6.823
2006 Jun 28 - 2006 Jul 28	53914 - 53944	6.823
2006 Jul 28 - 2006 Aug 27	53944 - 53974	6.820
2006 Aug 27 - 2006 Sep 26	53974 – 54004	6.820
2006 Sep 26 - 2006 Oct 31	54004 - 54039	6.817
2006 Oct 31 - 2006 Nov 30	54039 - 54069	6.817
2006 Nov 30 - 2006 Dec 30	54069 - 54099	6.812
2006 Dec 30 - 2007 Jan 29	54099 - 54129	6.806
2007 Jan 29 - 2007 Feb 28	54129 - 54159	6.802
2007 Feb 28 – 2007 Mar 30	54159 - 54189	6.802
2007 Mar 30 – 2007 Apr 29	54189 - 54219	6.802
2007 Apr 29 – 2007 May 29	54219 - 54249	6.802
2007 May 29 – 2007 Jun 28	54249 – 54279	6.799
2007 Jun 28 – 2007 Jul 28	54279 – 54309	6.796
2007 Jul 28 – 2007 Aug 27	54309 – 54339	6.793
2007 Aug 27 – 2007 Sep 26	54339 – 54369	6.790
2007 Sep 26 – 2007 Oct 31	54369 – 54404	6.787
2007 Oct 31 – 2007 Nov 30	54404 – 54434	6.784
2007 Nov 30 – 2007 Dec 30	54434 – 54464	6.779
2007 Dec 30 – 2008 Jan 29	54464 – 54494	6.776
2008 Jan 29 – 2008 Feb 28	54494 – 54524	6.772
2008 Feb 28 – 2008 Mar 29	54524 – 54554	6.769
2008 Mar 29 – 2008 Apr 28	54554 – 54584	6.766
2008 Apr 28 – 2008 May 28	54584 – 54614	6.763
2008 May 28 – 2008 Jun 27	54614 – 54644	6.758
2008 Jun 27 – 2008 Jul 27	54644 – 54674	6.753
2008 Jul 27 – 2008 Aug 31	54674 – 54709	6.750
2008 Aug 31 – 2008 Sep 30	54709 – 54739	6.747
2008 Sep 30 – 2008 Oct 30	54739 – 54769	6.742
2008 Oct 30 – 2008 Nov 29	54769 – 54799	6.739
2008 Nov 29 – 2008 Dec 29	54799 – 54829	6.736
2008 Dec 29 – 2009 Jan 28	54829 – 54859	6.731
2009 Jan 28 – 2009 Feb 27	54859 – 54889	6.726
2009 Feb 27 – 2009 Mar 29	54889 – 54919	6.721
2009 Mar 29 – 2009 Apr 28	54919 – 54949	6.716
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

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/UTAI/utai09.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, KRISS-1 NICT-CSF1, NIST-F1, NMIJ-F1, PTB-CS1, PTB-CS2, PTB-CSF1, PTB-CSF2, SYRTE-FO1, SYRTE-FO2, SYRTE-FOM and SYRTE-JPO for the year 2009. Previous calibrations are available in the successive annual reports of the BIPM Time Section volumes 1 to 18 and in the BIPM annual report on time activities volume 1 to 3.

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 2009 are indicated below. Reports of individual PFS evaluations may be found at ftp://62.161.69.5/pub/tai/data/PFS_reports). 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	0.7x10^{-15}	0.5	[1]	H maser	2 / 20 d to 25 d
KRISS-1	Beam /Opt.	9.5x10^{-15}	9.5	[2]	H maser	3 / 10 d to 20 d
NICT-CSF1	Fountain	(0.9 to 1.3)x10^{-15}	1.9	[3]	UTC(NICT)	2 / 10 d to 25 d
NIST-F1	Fountain	(0.3 to 0.6)x10^{-15}	0.35	[4]	H maser	9 / 10 d to 20 d
NMIJ-F1	Fountain	3.9x10^{-15}	3.9	[5]	H maser	7 / 20 d to 30 d
PTB-CS1	Beam /Mag.	8x10^{-15}	8.	[6]	TAI	12 / 30 d
PTB-CS2	Beam /Mag.	12x10^{-15}	12.	[7]	TAI	12 / 30 d
PTB-CSF1	Fountain	(0.8 to 0.9)x10^{-15}	1.4	[8]	H maser	2 / 20 d to 30 d
PTB-CSF2	Fountain	(0.7 to 1.4)x10^{-15}	0.8	[9]	H maser	6 / 10 d to 20 d
SYRTE-FO1	Fountain	(0.4 to 0.5)x10^{-15}	0.72	[10]	H maser	10 / 10 d to 30 d
SYRTE-FO2	Fountain	(0.4 to 0.5)x10^{-15}	0.65	[10]	H maser	8 / 10 d to 30 d
SYRTE-FOM	Fountain	0.7x10^{-15}	0.80	[11]	H maser	4 / 15 d to 30 d
SYRTE-JPO	Beam /Opt.	6.3x10^{-15}	6.3	[12]	H maser	13 / 5 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	55139	55159	3.99	0.40	0.70	0.22	0.47	0.96	
IT-CsF1	55164	55189	3.57	0.70	0.70	0.40	0.38	1.13	
KRISS-1	54654	54669	-4.8	3.0	9.5	1.0	0.9	10.0	
KRISS-1	54699	54709	-6.9	4.0	9.5	1.0	2.6	10.7	
KRISS-1	54719	54739	2.3	2.0	9.5	1.0	1.4	9.9	
NICT-CsF1	55134	55144	1.73	1.00	1.30	0.30	0.53	1.75	
NICT-CsF1	55159	55184	3.83	1.00	0.90	0.30	0.23	1.40	
NIST-F1	54844	54859	5.3	0.3	0.3	0.6	0.6	0.9	
NIST-F1	54864	54879	5.8	0.3	0.3	0.5	0.6	0.9	
NIST-F1	54904	54919	4.1	0.3	0.3	0.6	0.6	1.0	
NIST-F1	54924	54939	6.8	0.3	0.3	0.4	0.6	0.9	
NIST-F1	54969	54979	6.9	0.3	0.3	0.3	0.9	1.0	
NIST-F1	54994	55009	5.93	0.30	0.32	0.53	0.61	0.92	
NIST-F1	55114	55134	6.35	0.43	0.31	0.24	0.47	0.75	
NIST-F1	55134	55149	4.20	0.33	0.37	0.28	0.61	0.83	
NIST-F1	55184	55194	4.06	0.56	0.31	0.32	1.05	1.27	
NMIJ-F1	54839	54859	2.6	0.8	3.9	0.3	0.7	4.0	
NMIJ-F1	54859	54889	5.8	0.7	3.9	0.3	0.5	4.0	
NMIJ-F1	54889	54919	6.2	0.7	3.9	0.3	0.5	4.0	
NMIJ-F1	54919	54949	6.2	0.7	3.9	0.3	0.5	4.0	
NMIJ-F1	54949	54979	5.6	0.7	3.9	0.3	0.5	4.0	
NMIJ-F1	54979	55009	5.69	0.70	3.90	0.30	0.46	4.00	
NMIJ-F1	55009	55039	4.82	0.70	3.90	0.30	0.46	4.00	
PTB-CS1	54829	54859	-9.8	5.0	8.0	0.0	0.2	9.4	(1)
PTB-CS1	54859	54889	-13.0	5.0	8.0	0.0	0.2	9.4	
PTB-CS1	54889	54919	-9.6	5.0	8.0	0.0	0.1	9.4	
PTB-CS1	54919	54949	6.9	5.0	8.0	0.0	0.1	9.4	
PTB-CS1	54949	54979	-6.4	5.0	8.0	0.0	0.1	9.4	
PTB-CS1	54979	55009	2.61	5.00	8.00	0.00	0.13	9.43	
PTB-CS1	55009	55039	-8.31	5.00	8.00	0.00	0.13	9.43	
PTB-CS1	55039	55074	-0.80	5.00	8.00	0.00	0.11	9.43	
PTB-CS1	55074	55104	-5.26	5.00	8.00	0.00	0.13	9.43	
PTB-CS1	55104	55134	-11.55	5.00	8.00	0.00	0.13	9.43	
PTB-CS1	55134	55164	-12.08	5.00	8.00	0.00	0.13	9.43	
PTB-CS1	55164	55194	2.04	5.00	8.00	0.00	0.13	9.43	
PTB-CS2	54829	54859	3.7	3.0	12.0	0.0	0.2	12.4	(1)
PTB-CS2	54859	54889	3.6	3.0	12.0	0.0	0.2	12.4	
PTB-CS2	54889	54919	1.4	3.0	12.0	0.0	0.1	12.4	
PTB-CS2	54919	54949	5.5	3.0	12.0	0.0	0.1	12.4	
PTB-CS2	54949	54979	4.3	3.0	12.0	0.0	0.1	12.4	
PTB-CS2	54979	55009	9.28	3.00	12.00	0.00	0.13	12.37	
PTB-CS2	55009	55039	3.03	3.00	12.00	0.00	0.13	12.37	
PTB-CS2	55039	55074	7.17	3.00	12.00	0.00	0.11	12.37	
PTB-CS2	55074	55104	-1.40	3.00	12.00	0.00	0.13	12.37	
PTB-CS2	55104	55134	0.80	3.00	12.00	0.00	0.13	12.37	
PTB-CS2	55134	55164	5.74	3.00	12.00	0.00	0.13	12.37	
PTB-CS2	55164	55194	1.58	3.00	12.00	0.00	0.13	12.37	
PTB-CSF1	54839	54859	5.9	0.1	0.9	0.0	0.3	1.0	
PTB-CSF1	55019	55049	7.64	0.13	0.76	0.01	0.13	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	54819	54829	4.21	0.70	1.06	0.11	0.53	1.38	
PTB-CSF2	54839	54854	4.29	0.70	0.67	0.06	0.37	1.04	
PTB-CSF2	54884	54899	5.35	0.70	0.82	0.30	0.24	1.15	
PTB-CSF2	55029	55049	5.83	0.70	1.07	0.03	0.19	1.29	
PTB-CSF2	55064	55084	6.03	0.70	1.02	0.03	0.19	1.25	
PTB-CSF2	55099	55109	4.24	0.70	1.35	0.03	0.35	1.56	
SYRTE-FO1	54829	54839	5.7	0.3	0.4	0.1	0.9	1.0	
SYRTE-FO1	54849	54859	5.2	0.2	0.4	0.1	0.9	1.0	
SYRTE-FO1	54859	54884	5.1	0.3	0.4	0.1	0.4	0.6	
SYRTE-FO1	54894	54919	4.3	0.3	0.4	0.1	0.4	0.6	
SYRTE-FO1	54919	54949	4.7	0.3	0.4	0.1	0.3	0.6	
SYRTE-FO1	54949	54979	4.6	0.3	0.5	0.1	0.3	0.6	
SYRTE-FO1	55054	55074	4.20	0.20	0.43	0.11	0.66	0.82	
SYRTE-FO1	55074	55104	4.88	0.20	0.47	0.11	0.40	0.66	
SYRTE-FO1	55104	55134	2.63	0.20	0.42	0.11	0.33	0.58	
SYRTE-FO1	55134	55164	2.79	0.20	0.41	0.11	0.33	0.57	
SYRTE-FO2	54829	54859	6.5	0.3	0.5	0.1	0.3	0.7	
SYRTE-FO2	54934	54949	5.1	0.5	0.5	0.1	0.6	0.9	
SYRTE-FO2	54969	54979	4.4	0.6	0.5	0.1	0.9	1.2	
SYRTE-FO2	55044	55074	5.31	0.50	0.45	0.11	0.46	0.82	
SYRTE-FO2	55074	55104	6.05	0.20	0.45	0.11	0.40	0.64	
SYRTE-FO2	55104	55134	3.90	0.20	0.45	0.10	0.33	0.60	
SYRTE-FO2	55139	55164	3.97	0.20	0.48	0.11	0.38	0.66	
SYRTE-FO2	55164	55194	4.54	0.40	0.39	0.11	0.36	0.67	
SYRTE-FOM	54919	54944	6.1	0.2	0.7	2.0	0.4	2.2	(2)
SYRTE-FOM	55044	55074	5.70	0.20	0.71	2.00	0.46	2.18	(2)
SYRTE-FOM	55074	55104	5.07	0.20	0.71	0.35	0.40	0.91	(2)
SYRTE-FOM	55104	55119	2.38	0.20	0.71	0.56	0.61	1.11	(2)
SYRTE-JPO	54839	54859	13.6	0.9	6.3	0.3	0.5	6.4	
SYRTE-JPO	54869	54889	8.1	0.8	6.3	0.3	0.5	6.4	
SYRTE-JPO	54889	54919	5.7	0.8	6.3	0.3	0.3	6.4	
SYRTE-JPO	54919	54949	4.3	0.7	6.3	0.3	0.3	6.4	
SYRTE-JPO	54949	54979	5.2	0.6	6.3	0.3	0.3	6.3	
SYRTE-JPO	54979	55009	5.63	0.65	6.30	0.30	0.33	6.35	
SYRTE-JPO	55009	55039	3.90	0.61	6.30	0.30	0.33	6.34	
SYRTE-JPO	55039	55044	4.59	1.39	6.30	0.30	1.99	6.76	
SYRTE-JPO	55069	55074	1.78	1.44	6.30	0.30	2.29	6.86	
SYRTE-JPO	55074	55104	3.54	0.56	6.30	0.30	0.40	6.34	
SYRTE-JPO	55104	55134	1.31	0.54	6.30	0.30	0.33	6.34	
SYRTE-JPO	55134	55164	1.57	0.53	6.30	0.30	0.33	6.34	
SYRTE-JPO	55164	55194	2.49	0.53	6.30	0.30	0.36	6.34	

Notes:
(1) Continuously operating as a clock participating to TAI.
(2) Operated in Toulouse (France)

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Report on the activity of IT-CsF1 Primary Frequency Standard during 2009

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During 2009, IT-CsF1 reported two frequency evaluation to the BIPM. In the tables below, a summary of the report and a typical accuracy budget is shown.

CircT	Period (MJD)	Dur.	Local Osc.	yITCsF1-yTAI	uA	uB	ulab	uTAI	u
263	55139-55159	20	1401103	3.99	0.40	0.70	0.22	0.47	0.96
264	55164-55189	25	1401103	3.57	0.70	0.70	0.40	0.38	1.13

Effect	Bias ($x10^{-15}$)	Uncertainty ($x10^{-15}$)
Quadratic Zeeman (field map)	45.75	0.06
Blackbody Radiation	-28.50	0.30
Collisional (average shift $1.1x10^{-15}$) (*)	-0.50	0.10
Gravitational Potential	26.10	0.01
Microwave related	-	0.50
Total	43.40	0.6

(*) 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.
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].
Statistical analysis: Bayesian techniques has been studied for the analysis of the collisional shift correction [3,4]. This leads to the rigorous embedding of the theoretical information concerning the sign of the collisional shift in the analysis of the differential measurement used in our fountain, reducing thus by more than 30% the type A uncertainty. Both evaluations reported in 2009 have been analized with a Bayesian fit as described in [4]. The shift evaluated with Orthodox and Bayesian statistics agree within uncertainty.
Quadratic Zeeman shift: the magnetic field is mapped along the atom flight path before each fountain evaluation, with low frequency transition spectroscopy (ΔF=0, Δm=±1); 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: the blackbody radiation shift is corrected using the value β=-1.711(.003)$x10^{-14}$; IT-CsF1 is operated around 343 K and the uncertainty on this correction is typically $2\text{-}3\times10^{-16}$.
Gravitational shift: At the end of 2007, IT-CsF1 orthometric height 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 $4\text{-}5\times10^{-16}$ level.
Other tests: Some null-shift tests are performed before each evaluation. Typically, they include a light shift test, e.g. a check of the mechanical shutters, and tests on synchronous effects.
Type A uncertainty: IT-CsF1 is generally operated by comparing its frequency to an H-maser (BIPM code 1401102). The short term stability is limited at $3x10^{-13}\tau^{-1/2}$ by the BVA filter noise.
Laboratory link uncertainty: long term stability measurements show that the H Maser stability (drift removed) is better than the fountain one up to 10^6 seconds. During the evaluation in 2009, IT-CsF1 was operated with a dead time uncertainty lower than $3x10^{-16}$; a detailed description of its evaluation procedure is reported in [1].

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Operation of Cs atomic fountain NICT-CsF1 in 2009

NICT-CsF1, the cesium atomic fountain primary frequency standard at the National Institute of Information and Communications Technology has been in operation to contribute to the determination of TAI since 2006 [1]. In 2009, we performed accuracy evaluations with NICT-CsF1 twice, i.e. 10-days over the period of MJD 55134-55144, 25-days over the period of MJD 55159-55184 [2, 3].

The evaluation method of systematic shifts and their uncertainties was essentially the same as described in the first evaluation report circulated to the working group on the primary frequency standard (CCTF-WGPFS) in 2007 and also in the published paper [1]. In the evaluation campaigns of 2008, we purposely decreased the number of the launched atom. This lower atomic number density resulted in smaller collisional shift and associated uncertainty (20% of the frequency bias) than those stated in the first report. The similar accuracy evaluation with the lower atomic density was continued in 2009. Also, we have confirmed that the variation of the collisional shift measurement was consistent with stated Type A uncertainty of 1.0×10^{-15}.

We summarize the corrected biases and their uncertainties in 2009 measurements as below.

Physical Effect	Bias (10^{-15})	Uncertainty (10^{-15})
2nd Zeeman	74.8	<0.1
Collision (averaged)	-3.1	0.6
Blackbody Radiation	-16.9	0.4
Gravity Potential	8.4	0.1
MW-PW Dependence	-2.0	0.3
Cavity Pulling	0.0	<0.1
Rabi Pulling	0.0	<0.1
Ramsey Pulling	0.0	<0.1
Spectral Impurities	0.0	<0.1
Light Shift	0.0	<0.1
Distributed Cavity Phase	0.0	0.3
Majorana	0.0	<0.1
Background Gas	0.0	0.3
Total (Type B)		0.9

Table 1. Frequency shifts and their uncertainties in the campaign of MJD 55159-55184

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

For the operation of NICT-CsF1, a hydrogen maser is used as a local oscillator. At present, instead of sending data of the maser to BIPM, we are reporting a frequency difference between CsF1 and UTC(NICT) with a 0.3×10^{-15} uncertainty of the internal link.

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Operation of NIST-F1 in 2009

NIST-F1, the Cs fountain primary frequency standard at the National Institute of Standards and Technology (NIST), has been in operation since November 1998, and the first formal report to the BIPM was made in November 1999 [1]. Two more recent papers updating the operation of NIST-F1 were published in 2005 [2, 3]. During a formal evaluation the average frequency of one of the hydrogen masers at NIST is measured by NIST-F1 and the results, along with all relevant biases and uncertainties, are reported to the BIPM 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 some formal evaluations a range of atom densities are used along with a weighted linear least squares fit to determine the frequency at zero density. The typical frequency shift from the lowest measured density to zero density is on the order of 4×10^{-16}. Each formal evaluation also includes mapping the magnetic field, and measuring possible biases due to such things as microwave amplitude and light leaks. Some evaluations are also performed at one atom density using historical density shift data if there have been no significant changes to the fountain hardware.

Nine formal evaluations were carried out in 2009, of which two (in October and December) involved measurements at a range of atom densities. The other seven evaluations were made at one density and used historical density shift data. Changes made to the laser and optics in August precluded the use of previous historical data after that date. Work is also in progress at NIST calibrating various optical frequency standards against the SI second [5, 6].

The Type B uncertainties for the nine runs in 2009 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. Note that the uncertainty for the density shift is included in the Type B uncertainty for evaluations which use historical data for the density shift. Otherwise, the density shift uncertainty is included in the Type A uncertainty. The total Type B uncertainty for the October run was 3.1×10^{-16}, dominated by the Blackbody shift with an uncertainty of 2.8×10^{-16}. The Type A uncertainties ranged from 2.7×10^{-16} to 5.6×10^{-16} for the nine runs. The uncertainty due to the spin exchange shift ranged from 0.7×10^{-16} (when historical data were used) to 3.2×10^{-16} (when current data were used). Total uncertainties, including frequency transfer and dead time uncertainties, ranged from 0.75×10^{-15} to 1.27×10^{-15}.

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Operation of NMIJ-F1 Primary Frequency Standard in 2009

In 2009, we have operated NMIJ-F1 officially seven times for 20 to 30 days in each one campaign to calibrate TAI. The operation time during a year was 200 days in total, which is over half a year. Some optics and electronics were replaced to new ones, the uncertainty evaluation was the same as the one we have ever used [1,2], which is shown in Table 1.

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

Table 1: Typical uncertainty budget used in 2009

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Operation of the PTB primary clocks in 2009

PTB's primary clocks with a thermal beam

During 2009 PTB CS1 and CS2 [1] have been operated continuously. For both clocks time differences UTC(PTB) - clock in the standard ALGOS format have been reported to BIPM, so that $u_{l/lab}$ is zero. The mean relative frequency offset between the two clocks amounted to about 1.3×10^{-14}.

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 75×10^{-15} and 85×10^{-15} for an averaging time of 1 hour. The lower value is in perfect agreement with the prediction based on the beam flux, clock transition signal and line width. With reference to TAI, however, the standard deviation of d(CS1) (Circular T Section 4) is larger by almost a factor of two compared to the predicted value. The value $u_A(\tau = 30\ \text{d}, \text{CS1}) = 5 \times 10^{-15}$ stated in Circular T is thus slightly too low and should be increased to 6×10^{-15} in the future.

During 2009, reversals of the beam direction were performed on CS1 three times, and the beam reversal frequency shift determined thereafter exhibited the normal scatter around the long term mean value. No findings call for a modification of the previously stated relative frequency uncertainty u_B, which is 8×10^{-15} for CS1 [2].

CS2

Since summer 2008, only one atomic beam is available in CS2. We will continue operating CS2 until the second oven has run out of caesium before we undertake major refurbishment. The relative frequency instability $\sigma_y(\tau = 1\text{h}, \text{CS2})$ was determined as about 60×10^{-15} throughout the year 2009. This data confirms the findings of previous years and justifies the estimate of the uncertainty contributions u_A as $u_A(\tau = 30\ \text{d}, \text{CS2}) = 3 \times 10^{-15}$. The standard deviation of the 12 monthly values d(CS2) also supports this estimate.

Obviously, no beam reversal can be performed any more. This has an impact on the statement of u_B related to the contribution of the end-to-end cavity phase difference. The respective u_B uncertainty contribution amounts to 10×10^{-15} and dominates the CS2 total uncertainty budget [2]. In Figure 1, the results of all determinations of the beam-reversal frequency F_{BR} shift since May 1997 are shown. Day zero represents the date of the last successful beam reversal, MJD 54628 = 2008-06-11. The standard deviation of the individual values around the regression is explained by the CS2 frequency instability. To the right we predict the variation of F_{BR}. The various solid lines indicate the statistical uncertainty of this prediction based on the fit on the past data. The dashed lines indicate the currently applied correction ± the respective estimated u_B uncertainty contribution which covers any predictable change of F_{BR}. Thus, for 2009 no change in the stated uncertainty u_B (CS2) = 12×10^{-15} is necessary.

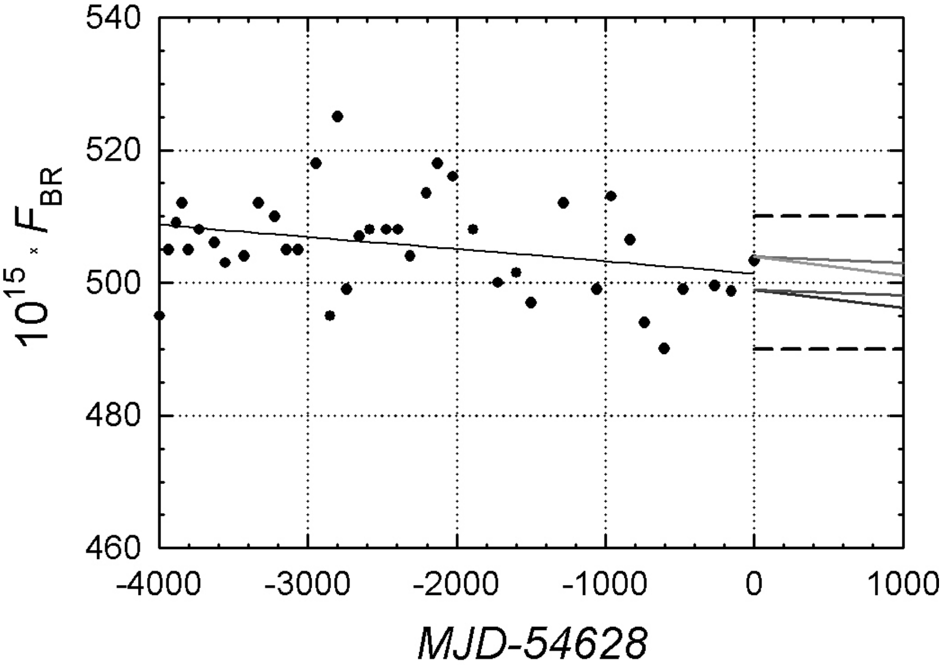

Figure 1: CS2 frequency difference F_{BR} recorded after beam reversal at the indicated dates. Each point is based on 10-day averages of the CS2 frequency with respect to the available frequency standards in PTB. Prediction of F_{BR} and the associated uncertainties are explained in the text.

PTB's caesium fountain clock CSF1

A detailed description of the PTB fountain CSF1 is given in Refs. [3] and [4]. Two measurements of the TAI scale unit of 20 and 30 days duration, respectively, were performed in 2009 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 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 for the total measurement intervals and including a small statistical uncertainty contribution due to the measurement instrumentation, arriving at statistical uncertainties $u_A < 0.2\times10^{-15}$ for the two TAI contributions in 2009.

Initiated by the uncertainty evaluation of the second PTB fountain CSF2 [5] (see also below) the evaluation of the uncertainty contribution due to the effect of distributed cavity phase in CSF1 has been recapitulated. Following the former treatment but implementing more realistic scenarios by using Monte-Carlo simulations for the atomic trajectories instead of considering worst case scenarios, we arrive at an uncertainty contribution due to the effect of distributed cavity phase of less than 0.1×10^{-15} in CSF1. For the first time this lower uncertainty contribution has been attributed to CSF1 for the second TAI scale unit measurement in 2009. Below we compile corrected biases and the uncertainty budget of CSF1, valid for this most recent TAI scale unit measurement.

Physical effect	Bias / 10^{-15}	Type B uncertainty / 10^{-15}
Second order Zeeman shift	46.2	0.1
Black body radiation shift	- 16.6	0.1
Cold collisions	- 2.2	0.3
Gravitational red shift	8.6	0.1
Cavity phase		0.1
Majorana transitions		0.1
Rabi and Ramsey pulling		0.1
Microwave leakage		0.1
Electronics		0.2
Light shift		0.1
Background gas collisions		0.1
Microwave power dependence		0.6
Total type B uncertainty		0.76

Table 1: Typical frequency biases and type B uncertainties of PTB-CSF1 in 2009

PTB's caesium fountain clock CSF2

PTB's new caesium fountain clock CSF2 has been fully evaluated in 2008/2009. As a result, in the course of the year 2009 six TAI scale unit measurements were performed starting in December 2008. A detailed description of the fountain and its uncertainty evaluation has been published in Metrologia [5]. After the Working Group on Primary Frequency Standards had approved the use of CSF2 for TAI calibrations, the results of the first six CSF2 TAI scale unit measurements have been published in the Circular T and taken into account in the calculation of TAI.

The fountain CSF2 uses optical molasses to cool atoms down to 0.6 µK. The atoms are launched vertically in a moving optical molasses, and state-selected in the ($F = 3$, $m_F = 0$) hyperfine ground state. During their ballistic flight, the atoms interact twice with a microwave field, thus completing the Ramsey interaction. With a launch height of 36.5 cm above the cavity center, the central Ramsey fringe has a width of 0.9 Hz. About 3×10^4 atoms, 30% of the initial number in the ($F = 3$, $m_F = 0$) state, are detected after their second interaction with the microwave field. Stabilizing the microwave frequency to the center of the central Ramsey fringe, a typical relative frequency instability of 2.5×10^{-13} $(\tau/\mathrm{s})^{-1/2}$ is obtained. An internal frequency comparison between CSF1 and CSF2, for which the Allan standard deviation was dominated by the white frequency noise of CSF2, showed a $\tau^{-1/2}$-dependence down to 7×10^{-16} at 130000 s averaging time. Therefore $u_A = 0.70\times10^{-15}$ was used as a lower limit for the statistical uncertainty of CSF2.

The six CSF2 2009 measurements had the following durations: 10 days (twice), 15 days (twice) and 20 days (also twice), with operation typically over more than 99 % of the nominal duration. The resulting clock link uncertainty $u_{l/lab}$ was thus at or below 0.1×10^{-15}. Below we compile corrected biases and the uncertainty budget of CSF2, valid for the January 2009 TAI scale unit measurement.

Physical effect	Bias / 10^{-15}	Type B uncertainty / 10^{-15}
Second order Zeeman shift	100.14	0.06
Black body radiation shift	- 16.56	0.06
Cold collisions	0.16	0.45
Gravitational red shift	8.57	0.01
Frequency measurement instrum.	- 0.30	0.10
Cavity phase		0.15
Majorana transitions		0.001
Rabi and Ramsey pulling		0.001
Microwave leakage		0.10
Electronics		0.20
Light shift		0.001
Background gas collisions		0.05
Microwave power dependence		0.40
Total type B uncertainty		0.67

Table 1: Frequency biases and type B uncertainties of PTB-CSF2 in January 2009.

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Operation of the SYRTE primary clocks in 2009

SYRTE-JPO Thermal Beam

During 2009 SYRTE-JPO was in nearly continuous operation. 13 calibrations were transmitted to BIPM. The operational parameters are measured periodically and taken into account for each calibration. They are the Zeeman frequency, the microwave power, the amplitude and the symmetry of the neighbouring lines, the cavity detuning, and the optical power. The last complete accuracy evaluation was performed in 2005 and gave the same value as in [1]: u_B = 6.3x10^{-15}. The mean stability is $\sigma_y(\tau)$=8x10^{-13} $\tau^{-1/2}$. Its deterioration compared to [1] is due to a lower oven temperature in order to increase the lifetime of the cesium loads. The u_A uncertainty is computed for each calibration from the dispersion of the frequency measurements compared to the reference maser.

SYRTE Fountain clocks

In 2009 the 3 SYRTE fountains FO1, FO2 and FOM have transmitted respectively 10, 8 and 4 calibrations to BIPM.

FOM was operated at CNES, the French space agency, in Toulouse. The transportable fountain currently serves as a frequency reference for the ground tests of the PHARAO/ACES space clocks. It is connected to the CNES time and frequency facilities that include a cryogenic sapphire oscillator, a hydrogen maser, and a GPS phase transfer link. This link is used to connect FOM in Toulouse to the reference maser in Paris Observatory [2]. Two GPS receivers were tested. With the first model (Ashtech Z12), the stability was limited to 2 10^{-15} for averaging periods of 1 month. With an Ashtech Z12T, the instability of the link decreased in the mid-10^{-16} range. This allowed the contribution of FOM to TAI, and also distant frequency comparisons with FO1 and FO2 with a combined uncertainty of ~10^{-15}.

No major modifications have been performed on the FO1 and FO2 fountains operation in Paris Observatory. 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 $\sigma_y(\tau)$=5x10^{-14} $\tau^{-1/2}$ for the 2 fountains, at the quantum projection noise limit. Table 1 gives the typical uncertainty budgets for the three SYRTE fountain clocks in 2009. The value and the uncertainty of the frequency shifts, which depend on the operation parameters, are updated for each TAI contribution. The accuracies estimated for the 3 fountains are almost the same as last year.

Fountain	FO1		FO2-Cs		FOM	
Physical origin	Correction	Uncertainty	Correction	Uncertainty	Correction	Uncertainty
2nd order Zeeman	-1275.5	0.2	-1916.1	0.3	-308.3	1.1
Blackbody Radiation	+172.2	0.6	+168.1	0.6	+164.0	0.6
Cold Collisions + cavity pulling	+122.3	1.0	+133	1.4	+27.9	2.8
First Doppler + Synchronous phase fluctuations	0	<3.2	0	<3	0	6
Microwave Leaks, spectral purity	0	<1	0	0.5		
Ramsey & Rabi pulling	0	<1	0	<0.1	0	<0.1
Microwave recoil	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	-116.4	1
Total (1σ) uncertainty u_B		**4.1**		**4.0**		**7.1**

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

In fountain uncertainty budget, the largest uncertainty comes from the first Doppler effect associated with the phase distribution inside the interrogation cavity. In Table 1 the assigned value of 3 x 10^{-16} is an overestimate based on oversimplified models. With the aim to reduce this uncertainty a new deep investigation of these effects has been carried out with FO2Cs. The clock frequency shift has been measured for a wide range of parameters: microwave power, tilt of the fountain with respect to verticality, cavity feeding configuration (either symmetric or asymmetric). Sensitivity to atom cloud spatial distribution before launch and to detection saturation has also been tested. Some of these measurements were performed simultaneously with FO2Rb. In parallel, a full theoretical calculation of the cavity phase distribution, based on the model developed by K. Gibble and R. Li [3], and its effect on the fountain has been developed. The initial software has been thoroughly revisited to allow easy extension of the model to the FO2Rb, FO1 and FOM cavities. In a second step, the cavity phase distribution provided by the model has then been used as starting point into a Monte Carlo simulation of the fountain frequency shift. The simulation has been developed for any experimental configuration. The very reproducible measurements performed with FO2Cs between March and July 2009 have been quantitatively interpreted by the model. This validation of the model would lead to an uncertainty of the first Doppler effect of about 10^{-16}.

FO2 has operated all the year round as a double Rb/Cs clock. Thanks to an increase of the detected Rb atoms number, a stability ~ $4.2 \times 10^{-14}\ \tau^{-1/2}$ is now regularly obtained with FO2 Rb. Operation of FO2Rb in differential configuration alternating between two loading time has been implemented to allow real time evaluation of the atoms number dependent effects. With the current cavity detuning, the cavity pulling effect is of opposite sign of the Rb cold collisions effect. This leads to a combined frequency shift of $1\text{-}2 \times 10^{-16}$. In 2009, 2 new measurements of the Rb hyperfine splitting have been obtained in dual operation of FO2, in agreement within the error bars with the values obtained in 2007 and 2008 [4].

Comparisons between FO1 and FO2 indicated a frequency difference of ~10^{-15} in 2009, incompatible with the combined uncertainties. The regular check of the main frequency shifts seems to exclude an underestimation of the quadratic Zeeman and blackbody radiation effects. The evaluation method of the cold collisions, using the adiabatic passage, has been verified on both fountains, by varying the atomic density. The microwave synthesis has also been tested again, concerning sidebands in the spectrum. A direct comparison of the 2 microwave chains operated in a static mode, both referenced on the CSO, showed an agreement to better than 10^{-16} and a stability in the 10^{-17} range for averaging periods longer than 1000 s. This measurement was performed using a compensated optical link between FO2 and FO1. We made as well new tests on phase transients synchronous with the fountain cycle time. For that purpose, the synthesis were operated as close as possible to the usual fountain operation (microwave level close to nominal, pulsed operation, modulated frequency, ground connexions to the fountain, …). No phase transient was observed in FO2 microwave chain. On the synthesis of FO1, a phase jump of ~10 µrad between the 2 Ramsey pulses was measured. The phase jump was induced by a TTL pulse used for the synchronization of the telemetries acquisition. This defect could produce a frequency shift of ~4×10^{-16}. This has to be confirmed by further direct comparisons between the 2 fountains.

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Operation of KRISS-1 caesium beam frequency standard in 2009

Frequency measurement and accuracy evaluation of KRISS-1 was performed three times over the 15 day period of MJD 54654 to 54669, the 10 day period of MJD 54699 to 54709, and the 20 day period of MJD 54719 to 54739. The results were published in Circular T 253 in 2009 [1].

The frequency biases and relevant type-B uncertainties of KRISS-1 [2] are shown in Table 1.

Physical Effect	Bias ($\times 10^{-14}$)	Uncertainty ($\times 10^{-14}$)
Quadratic Zeeman	48581.5	0.1
Quadratic Doppler	-38.02	0.1
Cavity Pulling	-0.46	0.07
Bloch-Siegert	0.37	0.002
Rabi Pulling	-0.35	0.1
Gravitation	0.9	0.1
Blackbody Radiation	-1.66	0.02
End to end Cavity Phase	117.1 (east to west) 113.0 (west to east)	(Type-A) 0.41
Light Shift	0	0.9
Majorana	0	0.2
C-field Inhomogeneity	0	0.05
Ramsey Pulling	0	0.01
Distributed Cavity Phase	0	0.1
Combined		1.0

Table 1: Uncertainty budget.

[1] Circular T 253

[2] S.-H. Lee, Y.H. Park, S.E. Park, H.S. Lee, S.H. Yang, D.H. Yu, and T.Y. Kwon, " Accuracy evaluation of an optically pumped caesium beam frequency standard KRISS-1", *Metrologia*, 2009, **46**, 227-236.

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/sitai09.ar)

The fractional deviation *d* of the scale interval of TAI from that of TT (in practice the SI second on the geoid), and its relative uncertainty, are computed by the BIPM for all the intervals of computation of TAI, according to the method described in 'Azoubib J., Granveaud M., Guinot B., *Metrologia* 1977, **13**, pp. 87-93', using all available measurements from the most accurate primary frequency standards (PFS) IT-CSF1, NICT-CSF1, NICT-O1, NIST-F1, NMIJ-F1, NPL-CSF1, PTB-CS1, PTB-CS2, PTB-CSF1, SYRTE-FO1, SYRTE-FO2, SYRTE-FOM and SYRTE-JPO consistently corrected for the black-body radiation shift.
In this computation, the uncertainty of the link to TAI has been computed using the standard uncertainty of [UTC-UTC(k)], following the recommendation of the CCTF working group on PFS.
The model for the instability of EAL has been expressed as the quadratic sum of three components: a white frequency noise $1.7\times10^{-15}/\sqrt{(\tau)}$, 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. 2007	54099-54129	+1.3	0.8
Feb. 2007	54129-54159	+1.0	0.6
Mar. 2007	54159-54189	+1.9	0.8
Apr. 2007	54189-54219	+2.7	0.3
May 2007	54219-54249	+3.4	0.5
Jun. 2007	54249-54279	+2.5	0.5
Jul. 2007	54279-54309	+2.7	0.5
Aug. 2007	54309-54339	+3.7	0.4
Sep. 2007	54339-54369	+4.0	0.5
Oct. 2007	54369-54404	+3.3	0.4
Nov. 2007	54404-54434	+3.3	0.6
Dec. 2007	54434-54464	+3.9	0.6
Jan. 2008	54464-54494	+3.1	0.4
Feb. 2008	54494-54524	+3.2	0.6
Mar. 2008	54524-54554	+3.6	0.6
Apr. 2008	54554-54584	+4.0	0.4
May 2008	54584-54614	+4.3	0.4
Jun. 2008	54614-54644	+3.4	0.4
Jul. 2008	54644-54674	+3.7	0.3
Aug. 2008	54674-54709	+4.1	0.5
Sep. 2008	54709-54739	+3.3	0.5
Oct. 2008	54739-54769	+3.7	0.5
Nov. 2008	54769-54799	+4.9	0.4
Dec. 2008	54799-54829	+4.8	0.4
Jan. 2009	54829-54859	+4.8	0.3
Feb. 2009	54859-54889	+5.2	0.4
Mar. 2009	54889-54919	+4.6	0.4
Apr. 2009	54919-54949	+5.2	0.4
May 2009	54949-54979	+5.0	0.4
Jun. 2009	54979-55009	+5.6	0.6
Jul. 2009	55009-55039	+6.3	0.6
Aug. 2009	55039-55074	+5.4	0.4
Sep. 2009	55074-55104	+5.1	0.4
Oct. 2009	55104-55134	+3.9	0.3
Nov. 2009	55134-55164	+3.6	0.3
Dec. 2009	55164-55194	+3.9	0.5

Independent local atomic time scales

Local atomic time scales are established by the time laboratories which contribute with the appropriate clock data to the BIPM. The differences between TAI and the atomic scale maintained by each laboratory are available on the Publications page of the Time, Frequency and Gravimetry 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 giving also values of [*UTC - UTC(lab)*].

Local representations of UTC

The time laboratories which submit data to the BIPM keep local representations of UTC. The computed differences between UTC and each local representation are available on the Publications page of the Time, Frequency and Gravimetry 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 giving also values of [*TAI - TA(lab)*].

International GPS Tracking Schedules

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

GPS Schedule no 52 File SCHGPS.52	implemented on MJD = 54951 (2009 April 30) at 0 h UTC	Reference date MJD = 50722 (1997 October 1)
GPS Schedule no 53 File SCHGPS.53	implemented on MJD = 55137 (2009 November 2) at 0 h UTC	Reference date MJD = 50722 (1997 October 1)

Relations of UTC and TAI with GPS time and GLONASS time

(File available at ftp://62.161.69.5/pub/tai/scale/UTCGPSGLO/utcgpsglo09.ar)

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

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

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

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

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

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

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

Here C_0 is given at 0 h UTC every day.

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

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

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

(File available at ftp://62.161.69.5/pub/tai/scale/UTCGPSGLO/utcgpsglo09.ar

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

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

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

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

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

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

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

Here C_1 is given at 0 h UTC every day.

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

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

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

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

Table 8. Rates relative to TAI of contributing clocks in 2009

(File is available at ftp://62.161.69.5/pub/tai/scale/RTAI/rtai09.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 2009. For studies including the clock rates of previous years, corrections must be brought to the data published in the Annual Report for the previous years. These corrections are available from the TFG section under request. Unit is ns/day, "   -" denotes that the clock was not used, "*" denotes that the related rate was influenced by a frequency jump.

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

12 HEWLETT-PACKARD 5061A
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	54859	54889	54919	54949	54979	55009	55039	55074	55104	55134	55164	55194
APL	35 904	3.18	3.53	4.03	3.64	3.77	3.63	3.38	3.10	3.59	-	2.95	3.10
APL	35 1264	17.18	18.19	19.50	20.08	20.73	20.20	20.41	20.71	21.33	-	20.01	19.43
APL	35 1791	-3.82	-3.97	-3.56	-4.02	-4.60	-3.56	-3.58	-2.74	-3.74	-	-2.84	-3.04
APL	40 3107	17.85	20.49	21.93	22.83	22.47	22.44	22.54	22.63	22.77	-	23.29	23.30
APL	40 3108	223.29	227.83	232.50	237.39	241.62	246.29	250.95	255.96	260.90	-	271.33	273.65
APL	40 3109	-4.30	-1.85	0.91	4.13	6.68	9.88	13.16	16.67	20.14	-	26.21	28.34
AUS	35 2269	-2.76*	-8.80*	-8.05*	-7.13*	-6.47*	-7.09*	-6.01*	-5.15*	-5.18	-4.35	-4.04	-4.00
AUS	36 299	-	-	-	-	-	-	-	-	-	15.26	14.16	13.94
AUS	36 340	1.25	-0.17	-0.55	1.00	0.92	0.34	1.97	1.24	0.57	0.67	1.01	0.81
AUS	36 654	-13.17	-12.97	-13.37	-13.41	-12.98	-12.52	-11.13	-11.71	-11.24	-10.74	-13.12	-11.57

Table 8. (Cont.)

Lab.	Clock	54859	54889	54919	54949	54979	55009	55039	55074	55104	55134	55164	55194
AUS	36 1141	6.14	4.90	6.86	8.91	7.44	8.27	8.22	7.08	4.60	5.24	9.28	7.53
AUS	40 5401	-	49.67	-	-	-	-	-	-	-	-	67.16	71.68
AUS	40 5402	-	-	-	-	-0.36	-1.36	-	-3.88	14.80	-	13.19	14.88
BEV	35 1065	0.18	-2.25	-2.77	-2.91	-3.39	-2.91	-2.18	-2.42	-1.98	-0.51	0.79	0.57
BEV	35 1793	2.54*	1.35*	-0.54*	-0.54*	-0.42	-0.98	-0.32	-0.46	0.33	0.57	-0.19	0.09
BEV	40 3452	-50.86*	-43.17*	-30.20*	-20.42*	-45.99*	-45.82*	-35.33*	-23.88*	-59.29*	-48.42*	-37.50*	-27.00
BIM	18 8058	-	-	-	-	-	-	-0.35	0.56	0.66	1.67	1.22	2.34
BIM	35 1501	-3.99	-2.82	-1.77	-1.13	4.05	-	-	-	-	-	-	-
BY	40 4209	5.80	10.14	-0.27	15.20	18.14	22.75	14.86	28.79	31.59	31.06	28.46	32.79
BY	40 4227	-8.83	0.82	-9.84	2.58	2.25	-	-	-	-	-	-	-
BY	40 4260	-4.29*	-4.18*	-13.33*	-4.21*	-4.15*	-3.66*	-11.42*	0.32	3.21	3.96	2.32	7.74
BY	40 4278	-8.26*	-8.80*	-18.05*	-3.12*	-2.78*	-0.99*	-18.43*	-3.63*	-0.33*	0.55	-1.24	3.25
CAO	35 939	-5.68	-4.25	-2.55	-3.33	-3.89	-2.15	-1.94	-2.25	-3.38	-4.70	-3.67	-2.51
CAO	35 1270	2.15	3.36	2.60	3.97	3.74	3.29	3.35	3.69	3.79	4.48	4.51	4.54
CH	35 771	0.79	0.62	0.66	0.95	0.94	2.13	2.41	1.77	2.14	3.01	2.31	2.53
CH	35 2117	2.13	2.37	0.05	0.86	2.47	1.31	2.52	2.87	1.11	0.21	2.03	1.85
CH	36 354	43.82	43.25	43.36	43.43	42.84	42.49	42.89	42.30	41.70	43.38	42.10	43.19
CH	36 413	-5.71	-9.39	-7.65	-4.52	-6.17	-5.58	-3.94	-0.99	-1.94	-3.01	-4.91	-0.59
CH	40 5701	-143.08	-143.55	-144.11	-144.98	-145.88	-	-	-	-	-0.62	-1.02	-2.36
CNM	35 1705	-3.69	-4.31	-4.05	-4.43	-4.11	-3.74	-3.82	-3.69	-1.03	3.09	-2.88	-
CNM	35 1815	-1.98*	-1.34*	-1.34*	-1.97*	-1.35*	-0.71*	-0.26*	-1.17	-0.38	1.07	-0.43	0.38
CNM	36 1537	0.32	-1.13	-0.25	0.36	-2.97	2.47	-7.48	8.05	0.56	4.59	3.27	1.15
CNM	40 7301	-6.72	-4.97	-5.46	-5.67	-6.31	-6.46	-6.74	-7.20	-7.35	-5.06	-7.59	-7.88
CNM	53 6038	2.79	1.64	3.84	5.35	5.62	6.73	5.09	-	-	-	-	-
CNMP	36 1806	0.64	-1.84	-1.62	-1.07	1.45	0.21	0.02	1.62	-0.56	1.16	0.39	0.30
DLR	35 1714	-0.34	-0.38	-0.66	-0.67	0.13	2.13	0.46	0.47	1.01	1.40	-0.98	-1.12
DMDM	36 2033	6.71	5.57	5.06	5.70	6.50	6.67	6.93	5.57	5.50	7.10	6.19	6.37
DTAG	36 345	-1.93	-1.36	-1.36	-1.83	-2.29	-2.68	-4.72	-2.81	-4.70	-4.35	-4.17	-2.08
DTAG	36 465	-0.42	-0.61	-2.17	-0.04	-1.15	-0.24	1.55	-1.87	-3.52	-3.01	-1.64	-1.90
DTAG	36 2370	0.78	0.26	0.51	-0.23	0.09	-0.85	-0.45	0.45	1.24	0.40	1.39	0.52
EIM	35 716	13.69	13.63	14.71	14.41	13.86	14.34	-	-	14.70	-	-	-
EIM	35 1431	-9.11	-9.79	-9.94	-9.30	-9.31	-9.62	-	-	-9.00	-	-	-
EIM	35 2060	0.02	0.17	-0.02	0.25	-0.05	-0.15	-	-	-	-	-	0.65
F	35 122	25.46	24.46	25.49	24.83	26.41	25.71	25.86	24.75	25.19	25.09	25.20	26.32
F	35 124	11.16	11.32	11.38	11.42	11.44	11.23	10.84	11.55	11.06	11.44	12.06	11.23

Table 8. (Cont.)

Lab.	Clock	54859	54889	54919	54949	54979	55009	55039	55074	55104	55134	55164	55194
F	35 131	10.15	11.09	9.93	10.35	11.39	11.09	9.66	-	-	-	-	-5.84
F	35 157	-	13.20	-	-	-	-	-	-	-	-	-	-
F	35 158	13.79	14.04	13.76	13.58	13.86	13.94	13.69	14.35	13.37	13.67	13.81	14.44
F	35 385	19.58	19.60	19.10	19.18	19.08	19.94	19.25	18.41	19.00	19.40	19.74	20.11
F	35 396	-0.61	-0.64	-0.11	-1.09	-1.48	-0.72	-1.99	-1.26	-1.97	-1.70	-1.31	-1.67
F	35 469	-	-5.93	-5.09	-2.51	-2.68	-5.00	-6.48	-5.97	-5.80	-5.05	-5.68	-4.99
F	35 489	-	-	-	13.76	13.25	13.06	12.33	11.72	12.21	12.76	11.98	12.01
F	35 520	-	6.85	9.20	8.97	9.75	10.62	10.85	11.95	11.92	13.66	13.73	15.00
F	35 536	2.05	1.65	2.41	2.87	2.19	2.47	2.73	2.82	3.12	3.57	4.16	4.35
F	35 609	-	-	-	-	-27.65	-27.20	-	-	-	-	-	-
F	35 770	-7.73	-7.36	-7.53	-7.40	-7.99	-6.91	-7.45	-7.16	-7.39	-7.14	-6.92	-7.16
F	35 774	-12.88	-12.49	-12.23	-	-	-	-	-	-	-	25.46	25.59
F	35 781	7.63	-	-	4.96	4.80	4.34	3.87	5.08	4.51	10.11	9.24	10.05
F	35 819	11.20	10.95	10.63	10.71	-	-	13.13	12.91	14.31	14.87	14.90	10.38
F	35 859	-	-	0.89	2.30	2.88	4.20	4.49	3.50	4.28	3.66	3.30	2.22
F	35 909	-	-	-	-	-	-	-	-	-	-	-	-20.10
F	35 1068	-17.41	-	-	-	-	-16.92	-16.44	-15.95	-16.29	-15.91	-16.11	-16.67
F	35 1177	-	-	-	-	-	-	-	-	-	-8.85	-8.12	-8.04
F	35 1178	-	-	-9.68	-9.50	-9.71	-10.33	-10.08	-10.20	-	-	-	-
F	35 1222	10.82	-	-	11.15	10.18	10.40	10.01	10.10	10.41	-	-	-
F	35 1258	6.33	-	-	5.95	5.19	6.36	6.33	5.42	5.77	5.11	4.60	4.30
F	35 1321	3.40	3.59	2.93	4.05	3.95	4.02	2.75	2.98	3.09	3.61	3.86	3.49
F	35 1556	-5.49	-4.90	-4.74	-4.43	-4.41	-4.81	-4.52	-3.73	-	-	-4.71	-4.74
F	35 1644	-	8.54	8.46	9.94	9.22	9.68	9.40	8.78	8.78	10.13	9.57	9.46
F	35 2027	-2.85	-2.51	-2.65	-1.76	-1.94	-0.93	-1.37	-0.40	-1.58	-0.74	-0.58	-2.01
F	35 2388	1.55	1.91	2.13	2.90	2.89	2.91	3.12	3.11	2.40	2.98	2.67	3.06
F	40 805	1.50	3.89	3.53	5.87	5.74	4.67	-	-	12.21	14.42	17.94	20.89
F	40 816	-33.87	-24.70	-	-	-	-1.68	-	-	-	-	-3.72	-1.33
F	40 889	30.40	33.60	36.66	39.77	42.80	45.63	48.66	51.89	54.90	57.81	60.65	63.03
F	40 890	8.15	9.56	10.67	11.38	11.62	12.69	13.70	13.46	13.36	13.63	13.95	14.16
F	53 6385	-1.63	0.65	-0.03	0.87	2.13	2.99	2.92	3.55	3.40	3.11	1.98	2.99
HKO	35 358	-4.73	-	-	-	-	-	-	-	-	-	-	-
HKO	35 1893	-0.68	-0.02	-0.33	0.51	0.33	0.44	0.40	0.76	0.45	-	-	0.23
HKO	35 2425	-	-	-0.87	-0.77	-0.29	-0.18	-0.66	0.74	0.98	-	-	1.17
IFAG	36 1167	-2.76	-3.94	-2.48	0.88	0.02	0.88	-0.08	-0.55	1.34	0.98	-1.92	-2.18

Table 8. (Cont.)

Lab.	Clock	54859	54889	54919	54949	54979	55009	55039	55074	55104	55134	55164	55194
IFAG	36 1173	-2.38	-1.54	-0.66	2.71	4.97	4.32	8.41	8.74	8.85	8.46	7.33	5.40
IFAG	36 1629	12.33	11.47	10.88	12.17	12.98	12.24	14.17	15.82	14.78	13.80	12.74	12.99
IFAG	36 1732	12.29	12.35	11.90	11.94	12.93	11.80	11.70	12.60	13.21	12.47	13.56	12.67
IFAG	36 1798	-2.45	-2.81	-2.49	-2.26	-1.58	-2.26	-0.84	-1.44	0.13	-1.77	-1.21	-1.34
IFAG	40 4418	5.86	6.49	-1.36	-2.04	-1.80	-1.85	-1.97	-1.64	-0.84	-0.69	0.26	0.58
IFAG	40 4439	-22.68	-23.67	-7.98	-2.79	-4.23	-5.85	-6.79	-9.10	-9.91	-10.90	-11.67	-14.23
INTI	35 2377	-2.31	-1.91	-1.91	3.90	9.36	5.18	-2.11	-0.21	0.39	0.13	1.04	-0.50
IPQ	35 1797	-	-	-	-	-	-	-	-	-	-	-	0.81
IPQ	35 2012	-	-	-	-	-	-	-	-	-	-	-	4.04
IPQ	35 2169	-	-	-	-	-	-	-	-	-	-	-	-0.08
IT	35 219	-	6.78	7.11	6.73	6.82	7.04	9.59	11.56	12.01	12.30	12.38	12.32
IT	35 505	-6.36	-7.95	-7.86	-7.52	-7.13	-7.43	-7.19	-7.31	-7.87	-6.63	-7.78	-7.59
IT	35 1115	17.94	17.25	17.75	17.22	18.88	18.19	18.24	18.45	18.61	17.95	17.28	17.05
IT	35 1373	-6.42	-6.28	-6.34	-5.96	-5.45	-5.50	-5.45	-4.46	-4.82	-4.92	-4.80	-5.08
IT	35 2118	8.71	8.65	8.74	9.01	9.51	8.54	9.08	9.40	9.58	9.72	9.55	9.59
IT	35 2487	-	-	-	-	-	-	-	-	-	-	-10.20	-9.86
IT	40 1101	-	-	-	-	-	-	5.05	9.36	13.85	18.39	22.81	27.32
IT	40 1102	48.92	55.46	62.05	68.47	74.98	81.52	88.24	95.17	102.14	108.61	114.85	120.99
IT	40 1103	-42.60*	-42.76*	-42.66*	-42.44*	-41.99	-41.69	-41.14	-40.41	-39.69	-38.73	-38.05	-37.44
JV	21 216	24.01	24.59	26.20	23.36	20.83	-	-	50.52	57.53	52.33	52.73	52.72
JV	21 387	-479.85	-485.50	-413.58	-719.66	-607.12	-	-	-171.22	-202.16	-279.32	-92.97	-83.33
JV	36 1277	-20.36	-19.81	-17.49	-16.38	-17.47	-	-	-19.72	5.30	-18.12	-17.83	-15.69
KIM	36 618	-	-	-	-1.00	0.35	-2.83	0.41	1.90	2.03	1.50	0.27	0.58
KRIS	35 321	10.13	10.02	9.88	10.44	9.32	10.25	10.91	11.91	13.58	15.30	16.02	16.84
KRIS	35 739	-4.25	-4.27	-4.50	-3.93	-4.48	-4.29	-3.48	-3.68	-4.11	-3.65	-3.56	-3.16
KRIS	35 1693	-0.20	-	-	-	-	-	-	-	-	-	-	-
KRIS	35 1783	19.67	19.22	18.49	19.74	19.78	20.70	20.96	20.04	20.21	20.35	20.66	21.06
KRIS	36 1135	38.58	32.83	32.71	34.40	34.09	34.45	33.94	35.25	33.67	32.84	37.17	35.47
KRIS	40 5623	116.28	116.56	116.74	116.91	117.11	117.25	116.99	116.41	116.53	116.27	116.27	116.40
KRIS	40 5624	-	-	-	-	-	-	-	-	4.38	-3.15	-10.49	-16.13
KRIS	40 5626	-	-	-	-	-19.35	-19.19	-18.99	-18.68	-15.92	-17.93	-17.46	-
KZ	35 2202	1.85	-0.60	-	-10.41	32.03	-10.09	-9.43	-7.47	-8.02	-8.20	-8.67	-7.11
LT	35 1362	-	-	-	-	-	-	-	1.19	1.14	0.39	0.12	1.33
LV	35 2335	4.24	4.54	4.54	4.36	4.33	4.08	3.49	2.44	2.97	-	-	2.50
MIKE	35 1171	1.67	-3.11	-1.69	-1.12	-2.44	-2.00	-2.02	10.86	-1.70	-3.42	0.16	-0.73

Table 8. (Cont.)

Lab.	Clock	54859	54889	54919	54949	54979	55009	55039	55074	55104	55134	55164	55194
MIKE	36 986	0.86	-0.13	-0.19	-0.51	-1.21	-0.04	-0.42	11.13	0.10	-2.46	2.18	1.87
MIKE	40 4108	-1.22*	-0.15	0.03	0.45	-0.54	-0.03	0.11	12.80	-0.62	-3.63	0.19	-0.16
MIKE	40 4113	-23.70	-26.53	-23.85	-21.41	-20.52	-17.87	-15.58	0.27	-12.57	-12.27	-6.55	-5.19
MIKE	40 4180	-	-78.08*	-73.44*	-68.60*	-64.93*	-60.14*	-55.57*	-41.79*	-43.38*	-46.48*	-38.69*	-35.46
MKEH	36 849	-40.87	-39.77	-41.89	-40.77	-41.22	-41.50	-42.15	-42.80	-42.76	-41.60	-39.75	-40.89
MSL	12 933	11.31	12.79	21.58	10.36	9.80	9.25	-338.45	4.10	-2.17	7.00	6.74	2.64
MSL	36 274	4.17	7.23	5.70	5.87	5.82	4.19	10.43	7.59	9.11	9.18	8.61	8.17
MSL	36 1025	4.17	5.25	3.32	6.29	0.61	-2.80	-3.31	-3.39	-2.70	-2.32	-0.77	1.72
NAO	35 779	-4.29	-3.32	-3.31	-4.71	-3.98	-4.17	-4.06	-4.27	-3.22	-2.68	-4.27	-
NAO	35 1206	13.73	13.80	14.15	13.74	13.95	14.39	14.04	13.49	13.67	13.27	13.89	-
NAO	35 1214	4.64	4.90	4.55	4.45	3.61	3.76	4.06	3.84	3.62	3.29	2.95	-
NAO	35 1689	0.31	-0.21	2.21	-1.11	40.24	-1.19	-0.99	-0.65	-0.97	-1.33	-1.19	-
NICT	35 112	-7.72	-7.63	-7.33	-7.23	-6.71	-6.57	-6.40	-6.36	-7.00	-7.45	-7.00	-7.05
NICT	35 144	-15.93	-	-	2.39	1.39	-	-	-	-	-	-	-
NICT	35 332	9.18	8.66	9.24	8.80	8.10	9.72	8.87	8.99	9.17	9.21	8.29	10.10
NICT	35 342	43.31	44.41	44.45	45.03	44.97	45.40	45.15	46.04	45.48	45.17	46.45	46.74
NICT	35 343	6.39	6.64	7.04	6.97	7.55	7.44	7.62	7.97	8.89	8.47	8.83	8.05
NICT	35 715	-11.57	-11.71	-11.56	-11.37	-11.27	-11.32	-	-	-	-	9.50	9.88
NICT	35 732	-	-	-	-	-	-	-	-	-1.45	-2.26	-1.55	-2.36
NICT	35 907	-9.35	-9.75	-9.79	-10.43	-10.18	-9.35	-10.15	-9.18	-9.08	-9.81	-9.65	-10.15
NICT	35 908	3.96	5.35	4.13	3.83	3.93	2.89	5.62	8.11	7.80	6.94	5.65	2.62
NICT	35 913	-19.52	-19.52	-19.18	-19.74	-20.22	-20.69	-21.87	-21.99	-21.05	-20.92	-19.10	-19.34
NICT	35 916	0.76	0.84	0.82	1.03	0.66	1.13	1.18	1.75	1.38	1.09	1.63	1.03
NICT	35 1225	-2.22	-2.86	-2.75	-2.88	-2.19	-2.61	-2.23	-2.35	-2.15	-3.01	-1.09	-1.93
NICT	35 1226	-	-	-	-	-	-	-1.37	-0.54	0.56	0.90	1.42	1.78
NICT	35 1611	-	-	-	-1.21	-0.59	0.74	0.87	1.95	17.87	20.91	284.30	15.05
NICT	35 1778	13.69	13.82	13.18	12.83	12.65	-	-	-	-	-	-32.04	-32.36
NICT	35 1789	7.26	6.63	7.14	7.08	7.52	7.77	7.60	7.63	6.37	5.45	4.87	-
NICT	35 1790	-1.67	-2.47	-2.36	-2.57	-1.04	-1.79	-1.22	-1.90	-	-	-	-2.13
NICT	35 1866	12.96	12.41	14.00	13.11	12.28	13.03	12.06	12.30	12.61	11.83	12.84	-
NICT	35 1882	3.49	-1.11	-1.41	-4.58	-6.43	-9.82	-12.45	-13.17	-14.00	-	-	-
NICT	35 1887	-	-0.25	-1.39	-1.79	-0.47	-0.80	-0.58	-0.31	-0.08	0.37	0.10	0.07
NICT	35 1944	3.64	3.12	3.88	3.56	2.92	3.52	2.81	3.33	4.22	3.66	3.50	3.82
NICT	35 2010	4.25	4.21	4.45	4.60	4.29	4.33	4.94	5.21	5.37	5.24	5.92	5.58
NICT	35 2011	3.84	3.68	3.45	2.74	3.32	3.00	2.85	3.02	2.91	3.26	3.67	3.05

Table 8. (Cont.)

Lab.	Clock	54859	54889	54919	54949	54979	55009	55039	55074	55104	55134	55164	55194
NICT	35 2056	13.71	13.01	14.07	13.94	14.03	13.00	13.86	13.59	13.77	13.75	13.66	13.31
NICT	35 2113	-26.11	-25.72	-25.88	-25.87	-25.39	-26.10	-26.14	-27.44	-26.99	-27.60	-27.43	-25.73
NICT	35 2116	14.70	14.25	14.12	15.36	15.02	15.16	14.57	14.70	14.45	15.36	15.31	14.80
NICT	36 1217	3.96	4.32	2.62	3.14	3.65	1.67	2.42	1.76	2.14	2.86	4.00	2.11
NICT	40 2002	-	-	-	-	-	-	7.70	8.69	9.66	10.58	11.51	12.21
NICT	40 2003	20.77	20.84	20.78	20.74	20.74	20.75	20.75	20.83	21.05	21.31	21.63	21.59
NICT	40 2004	-	5.12	5.64	6.01	6.50	6.99	7.52	8.10	8.58	9.13	9.76	10.17
NICT	40 2005	10.27	11.68	13.81	15.44	17.12	18.97	20.69	22.83	25.12	27.56	29.43	31.42
NIM	35 1235	1.81*	2.20*	3.35*	5.71*	6.60*	3.33*	2.76	6.30	5.15	5.49	5.50	6.02
NIM	35 1239	12.23*	14.39*	9.06*	15.41*	11.98*	12.12*	13.04	11.52	13.97	13.93	15.87	11.69
NIM	35 2239	0.20*	-0.56*	-1.66	1.17	-	-	-	-	-	-	-	-
NIM	40 4832	-14.76*	-8.15*	-3.54*	3.65*	8.84*	12.42*	18.30	24.65	28.09	32.15	36.38	40.55
NIM	40 4835	41.54*	45.02*	48.99*	53.12*	57.14*	59.26*	65.23	71.27	74.59	78.10	81.55	85.51
NIMB	35 600	-1.31	-1.56	-1.32	-0.59	-1.61	-0.64	1.29	1.47	0.17	0.19	-1.67	-1.30
NIMT	35 2246	-	-	-	-	-	-	-	-	-	1.49	1.11	0.90
NIMT	35 2247	-	-	-	-	-	-	-	-	-3.08	-3.29	-2.92	-2.59
NIS	35 1126	0.36	0.40	-0.30	-0.06	0.24	1.13	0.06	-0.84	-0.56	-0.16	0.39	-0.25
NIST	35 132	-	-	-	-	-	-	-	-	-	-17.33	-17.82	-17.11
NIST	35 182	0.63	1.61	2.25	2.06	2.77	2.41	2.63	2.54	2.75	3.80	3.64	3.19
NIST	35 282	6.11	6.23	6.01	5.90	6.84	6.25	6.46	-	-	-	-	-
NIST	35 408	-	-	-	-	-	-	-	-22.71	-22.28	-22.31	-22.33	-22.34
NIST	35 1074	-14.93	-15.00	-15.49	-13.04	-15.47	-15.58	-15.21	-16.15	-15.42	-16.16	-15.64	-16.23
NIST	35 2031	-8.40	-8.18	-7.94	-8.30	-7.96	-7.92	-7.46	-7.80	-7.94	-8.07	-8.04	-7.67
NIST	35 2032	-1.72	-2.15	-1.17	-0.92	-1.37	-1.28	-0.67	-1.03	-0.11	2.49	2.53	2.16
NIST	35 2034	-6.57	-6.72	-5.45	-7.05	-5.27	-7.95	-5.85	-6.56	-6.57	-6.79	-7.03	-5.88
NIST	40 203	121.74	122.88	124.18	125.29	126.53	127.73	128.93	130.27	131.60	132.87	134.17	135.17
NIST	40 204	25.11	25.30	25.56	25.62	25.92	26.27	26.30	26.49	26.84	27.14	27.33	27.33
NIST	40 205	-26.47	-26.41	-26.38	-26.46	-26.43	-26.41	-26.39	-26.48	-26.43	-26.26	-26.28	-26.42
NIST	40 206	-65.97	-65.74	-65.46	-65.28	-65.02	-64.85	-64.61	-64.59	-64.46	-65.36	-65.02	-64.95
NIST	40 222	24.76	25.26	25.26	25.37	25.65	25.77	26.00	26.16	26.37	26.72	26.98	26.97
NMIJ	35 224	-	-	-	-	-	-29.78	-30.50	-30.72	-30.26	-	-	-28.65
NMIJ	35 523	9.92	9.00	9.22	8.63	8.92	8.94	9.43	8.34	9.15	-	-	-
NMIJ	35 1273	22.66	22.89	22.70	23.24	23.03	23.32	23.04	22.24	23.19	-	-	21.03
NMIJ	35 2057	-	-	-7.88	-5.57	-5.25	-5.56	-5.84	-5.83	-4.65	-	-	-4.00
NMIJ	40 5002	-17.39	-17.99	-18.11	-17.94	-17.39	-17.35	-17.64	-17.80	-17.95	-	-	-17.42

Table 8. (Cont.)

Lab.	Clock	54859	54889	54919	54949	54979	55009	55039	55074	55104	55134	55164	55194
NMIJ	40 5014	-	-	-	-	-	-	-	-	-	-	-	8.35
NMIJ	40 5015	17.52	19.59	21.64	23.69	26.13	28.42	30.83	29.86	29.55	-	-	34.80
NMLS	35 328	-	-	-	-1.21	0.78	0.89	-4.85	-3.81	-3.97	-5.61	-6.48	-
NMLS	35 1659	-0.95	-0.87	-9.54	-	-	-	-	-	-	-	-	-
NPL	35 1275	8.27	7.68	8.10	7.47	8.00	7.18	6.32	7.17	5.56	5.57	5.03	5.54
NPL	36 784	6.07	6.17	6.84	7.91	7.45	6.18	6.15	6.48	5.53	5.89	6.10	6.80
NPL	40 1701	6.27	6.45	6.85	6.99	7.37	7.58	7.77	7.72	8.19	8.50	7.98	9.18
NPL	40 1708	-0.69*	-0.44*	-1.24*	-1.15*	-0.89*	-2.72*	-2.49*	-2.24*	-1.87*	-1.59*	-2.38	-0.94
NPLI	35 2257	0.87	0.47	0.29	0.61	-0.58	-0.26	-0.73	0.95	0.15	-1.28	0.21	1.30
NRC	35 2148	3.47	3.81	3.71	3.41	5.96	4.15	4.53	4.94	4.60	4.74	5.04	5.32
NRC	35 2150	-2.26	-	-	-4.80	16.55	-5.57	-3.46	-4.83	-4.30	-4.30	-3.89	-3.95
NRC	35 2151	26.23*	26.78*	26.99*	27.18*	-64.85*	26.98*	-0.09	-0.18	-0.17	0.54	0.78	0.70
NRC	35 2152	-9.46	-8.99	-9.06	-8.12	-9.38	-8.02	-8.10	-8.38	-7.74	-7.45	-7.55	-6.66
NRL	35 714	1.12	0.96	1.55	2.17	2.62	1.31	1.37	-0.67	0.35	0.14	0.13	0.51
NRL	35 719	3.93	2.26	3.48	4.10	4.65	4.23	4.62	-6.16	-5.09	-6.94	-	-
NRL	40 1001	34.88	40.62	43.99	46.86	50.41	53.86	56.38	59.25	61.62	64.08	66.76	69.08
NRL	40 1003	5.43	5.86	6.21	6.50	6.85	7.15	7.48	7.87	8.18	8.54	8.82	9.02
NRL	40 1009	-22.49	-24.96	-27.71	-30.50	-33.38	-36.11	-38.12	-40.02	-41.89	-43.37	-45.02	-45.22
NRL	40 1010	1.74	1.29	1.52	0.18	-0.40	-4.17	-17.73	-3.47	-0.40	-5.84	-	-
NTSC	35 1007	15.10	11.90	10.43	7.64	6.13	6.46	10.29	10.70	10.22	10.07	10.62	9.78
NTSC	35 1008	4.08	3.86	4.69	3.94	4.08	4.46	4.47	4.07	4.29	4.39	4.18	5.05
NTSC	35 1011	-1.01	-0.65	-0.96	-2.07	-2.24	-2.64	-2.55	-2.52	-2.23	-2.68	-2.86	-2.01
NTSC	35 1016	13.52	13.60	13.62	14.28	14.51	15.06	13.33	12.89	12.81	12.66	13.55	14.92
NTSC	35 1017	-1.25	-0.03	-1.12	-0.14	0.24	-0.15	3.16	4.62	6.74	8.61	8.37	8.73
NTSC	35 1818	-21.75	-21.39	-21.30	-20.67	-21.49	-21.37	-21.67	-22.17	-21.80	-21.61	-21.74	-22.88
NTSC	35 1820	-1.32	-0.97	-0.12	0.69	0.18	-	-	-	-	-	-	-
NTSC	35 1823	10.88	10.88	11.33	10.56	10.23	10.78	11.04	10.01	10.09	10.63	10.91	10.55
NTSC	35 2096	-5.09	-5.68	-5.33	-6.91	-4.58	-5.81	-5.06	-4.14	-5.32	-5.71	-3.53	-5.39
NTSC	35 2098	7.63	7.64	7.71	6.97	8.19	8.74	8.22	8.40	8.05	7.88	8.24	8.30
NTSC	35 2131	-3.75	-3.63	-3.98	-4.12	-4.24	-5.20	-4.95	-6.98	-6.07	-7.16	-7.70	-8.27
NTSC	35 2141	37.91	36.58	37.48	37.74	36.89	36.13	38.60	35.46	34.76	32.08	32.13	31.45
NTSC	35 2142	-9.89	-9.82	-9.59	-9.66	-10.42	-10.20	-9.83	-10.64	-10.14	-10.23	-10.15	-10.10
NTSC	35 2143	3.93	4.47	4.27	4.35	4.26	4.59	4.81	4.70	4.55	4.76	5.62	5.48
NTSC	35 2144	-4.49	-3.80	-4.22	-3.71	-4.06	-2.35	-4.77	-5.33	-3.21	-3.90	-3.56	-4.23
NTSC	35 2145	3.02	2.59	2.06	2.02	2.08	2.26	1.90	2.65	2.90	1.95	2.74	-

Table 8. (Cont.)

Lab.	Clock	54859	54889	54919	54949	54979	55009	55039	55074	55104	55134	55164	55194
NTSC	35 2146	3.59	3.42	3.83	3.57	3.38	3.82	4.09	3.87	3.56	3.41	3.21	3.88
NTSC	35 2147	9.55	8.95	8.79	10.98	9.96	10.54	10.02	10.44	10.91	9.85	9.81	10.53
NTSC	40 4926	253.03	260.55	269.57	277.43	285.32	292.77	299.28	305.82	312.30	318.39	323.87	329.06
NTSC	40 4927	274.21	281.42	291.90	-	-	-	312.19	318.67	323.92	329.84	336.99	342.69
NTSC	40 4933	-36.31	-33.36	-	-	-	-	-	-	-	-	-	-
ONBA	36 2228	-2.12	-2.50	-3.73	-2.82	-3.33	-3.31	-2.77	-2.90	-3.08	-4.55	-2.91	-2.97
ONRJ	35 102	-6.39	-7.47	-7.47	-8.18	-7.37	-7.21	-7.47	-6.62	-5.98	-5.88	-5.90	-4.00
ONRJ	35 103	6.85	5.87	5.23	4.61	4.91	5.48	5.67	5.32	4.67	4.81	4.97	6.00
ONRJ	35 123	30.45	30.94	30.42	30.53	30.21	29.96	29.93	30.37	31.26	31.68	29.68	29.99
ONRJ	35 129	1.12	1.92	1.42	0.71	1.26	0.61	1.77	1.49	1.88	2.05	1.46	1.88
ONRJ	35 1942	8.99	9.07	8.04	8.54	2.17	1.55	0.91	-0.77	-1.64	-1.47	-2.00	-1.68
ONRJ	52 125	-39.62	-42.70	-49.31	-50.69	-56.93	-57.51	-54.73	-45.35	-35.50	-52.69	560.20	-
ORB	35 201	-0.52	-0.07	0.36	-0.30	-	-	-	-	-	-	-	-
ORB	35 202	6.02	8.26	6.34	8.70	-	-	-	-	-	-	-	-
ORB	35 593	79.50	78.95	79.66	81.95	-	-	-	-	-	-	-	-
ORB	36 201	-	-	-	-	-0.07	0.01	0.45	1.54	2.64	-0.42	0.23	0.42
ORB	36 202	-	-	-	-	7.12	8.00	7.10	8.19	7.34	6.99	4.68	7.33
ORB	36 593	-	-	-	-	81.69	82.87	82.96	83.11	80.68	82.50	82.31	83.38
ORB	40 2601	-0.60	0.77	1.22	0.55	0.40	-0.19	0.04	-0.36	0.47	0.09	-0.22	-0.17
ORB	40 2602	-	-	-	1.20	1.90	2.52	3.24	3.96	5.12	5.90	6.77	7.40
PL	25 124	11.41	8.95	5.81	3.08	4.60	4.83	-0.51	1.03	-1.73	5.97	2.64	2.40
PL	35 441	3.21	3.48	3.48	3.36	2.69	3.32	2.87	3.28	3.97	3.52	2.57	3.02
PL	35 502	-	-	-	10.82	8.89	10.59	13.54	13.47	13.60	14.69	15.42	15.26
PL	35 745	0.53	-0.01	0.61	0.48	-0.58	0.52	0.63	-0.16	0.54	-0.37	0.23	-0.45
PL	35 1120	-0.71	-1.72	-2.21	-1.81	-0.83	-1.34	-0.78	-0.63	-1.50	-0.32	-1.48	-1.62
PL	35 1660	13.79	13.56	13.48	12.45	13.05	12.69	11.83	13.04	12.76	11.63	12.51	12.73
PL	35 1709	-1.74	-1.51	-2.08	-2.47	-1.84	-1.97	-1.79	-2.30	-2.74	-1.71	-2.13	-2.24
PL	35 1746	1.98	0.62	-	-	-	-	-0.55	-1.59	-1.71	-2.04	-1.66	-1.94
PL	35 1934	0.03	-0.10	-0.81	0.63	-0.65	-0.65	-1.51	-1.06	-0.50	-0.15	0.32	1.30
PL	35 2394	0.21	0.30	1.10	1.89	1.91	2.01	1.12	2.20	1.83	2.32	2.22	2.87
PL	40 4002	-28.29	-30.95	-31.27	-32.41	-31.79	-34.34	-34.85	-36.20	-34.99	-33.20	-31.55	-32.58
PL	40 4004	-16.69	-15.96	-17.27	-21.60	-23.71	-23.02	-24.20	-27.95	-29.88	-27.67	-28.25	-28.99
PL	40 4601	4.60	4.91	4.91	5.21	5.70	6.24	6.65	7.11	7.80	8.57	9.21	9.64
PL	40 4602	13.66	22.52	30.72	39.55	50.86	59.07	69.57	78.82	88.74	94.31	105.87	110.44
PTB	35 128	-1.70	-1.13	-0.72	-0.76	-0.77	-0.89	-0.70	-0.25	-1.37	-0.46	-0.71	-0.26

Table 8. (Cont.)

Lab.	Clock		54859	54889	54919	54949	54979	55009	55039	55074	55104	55134	55164	55194
PTB	35	415	-	-	-	-	-	-0.48	-1.16	-1.04	-1.33	-1.53	-1.85	-1.21
PTB	35	1072	10.09	10.54	10.74	9.77	10.75	10.36	10.93	10.77	11.01	9.79	10.52	10.59
PTB	40	506	-24.44*	-21.59*	-19.93*	-18.45*	-16.63*	-14.21*	-13.59*	-8.64*	-5.74*	-5.06*	-1.78	-1.42
PTB	40	508	-	-	-	-	-	-	-	-	-	-	-	8.99
PTB	40	510	5.22	6.33	7.32	8.18	8.28	8.27	-12.78	-28.64	-37.27	-38.98	-42.41	-44.22
PTB	40	590	-8.85*	-7.95*	-7.36*	-6.71*	-5.79*	-5.13*	-3.79	-3.29	-2.45	-1.75	-0.77	0.02
PTB	92	1	2.45	2.56	2.33	0.87	1.97	1.28	2.15	1.51	1.85	2.41	2.42	1.28
PTB	92	2	1.12	1.10	1.28	0.99	1.12	0.76	1.23	0.88	1.67	1.33	1.08	1.36
ROA	35	583	-1.45*	-2.15	-0.81	-0.54	-0.38	-0.40	-0.81	-0.49	-1.32	-4.54	-0.94	1.83
ROA	35	718	-6.86	-6.62	-6.32	-5.32	-6.27	-6.00	-5.78	-5.93	-5.97	-6.71	-6.22	-5.99
ROA	35	1699	4.38	3.79	4.22	4.78	4.70	4.05	6.12	5.26	5.57	5.92	6.26	6.81
ROA	36	1488	8.56	9.68	8.41	8.54	9.94	9.01	9.20	9.36	10.13	8.98	10.22	8.55
ROA	36	1490	6.65	9.14	8.02	8.22	6.30	10.26	8.75	8.69	9.42	10.79	9.62	7.79
ROA	40	1436	32.55	35.65	38.41	41.42	43.99	46.84	49.62	52.78	56.05	59.03	61.62	64.68
SCL	35	1745	-0.90	-2.17	-1.82	-1.56	-1.00	-1.06	-1.16	-1.36	-0.74	-1.43	-1.72	-1.29
SCL	35	2178	2.94	2.70	3.46	3.12	4.32	4.45	4.24	4.61	4.47	5.35	6.50	5.41
SG	35	475	-	-	-	-	-	-	-	-	-	-4.75	-4.51	-5.04
SG	35	476	-	-	-	-	-	-	-	-	-	7.46	-	-
SG	35	1889	13.36	12.83	13.26	12.85	12.73	-	13.81	13.79	15.42	14.31	14.93	15.97
SG	36	522	2.26	2.79	2.19	3.85	1.42	-	0.72	0.54	-0.59	-0.49	0.00	-0.46
SG	40	7701	-	-	-	0.01	1.03	137.53	3.63	5.65	7.84	10.51	13.34	16.11
SIQ	36	1268	-0.41	0.97	-0.55	0.93	1.03	1.98	1.98	3.42	2.02	0.86	1.26	2.17
SMD	35	810	-	-	-	1.34	1.56	1.15	2.80	2.29	3.05	1.76	1.85	2.38
SMD	35	1766	-	-	-	10.69	11.33	11.14	11.05	11.60	11.76	11.60	12.03	11.63
SMD	35	1896	-	-	-	16.71	16.69	16.84	16.63	16.74	16.66	16.77	17.99	18.00
SMD	35	2003	-	-	-	10.97	11.13	11.67	10.05	11.22	11.07	12.09	11.11	11.37
SMU	36	1193	-0.19	-0.38	-0.46	-0.79	0.89	0.52	-	-	-	-0.41	-0.37	-
SP	19	197	-60.05	-61.62	-57.93	-63.50	-	-	-	-47.30	-47.11	-39.24	-37.25	-
SP	35	572	19.37	19.55	19.61	19.26	19.40	19.09	19.50	19.24	19.67	19.69	19.89	19.75
SP	35	641	2.63	3.34	-	4.63	4.38	4.16	4.06	4.30	3.65	3.74	4.27	3.32
SP	35	1188	26.02	26.11	26.27	25.16	25.68	25.75	25.78	25.80	26.11	24.85	25.57	25.02
SP	35	1531	22.96	21.30	22.83	23.84	23.99	22.95	21.45	21.36	20.11	21.72	21.32	21.14
SP	35	1642	-	-	-	-3.80	-3.16	-3.29	-4.36	-4.87	-4.82	-4.11	-4.47	-4.57
SP	35	2166	2.66	2.28	3.04	3.04	2.95	3.62	3.64	3.56	3.76	4.18	3.43	4.16
SP	36	223	9.17	6.14	10.24	10.80	9.40	12.26	10.87	10.70	9.40	9.26	10.85	10.26

Table 8. (Cont.)

Lab.	Clock	54859	54889	54919	54949	54979	55009	55039	55074	55104	55134	55164	55194
SP	36 1175	2.24	2.59	3.06	2.17	1.89	3.12	1.01	3.05	2.55	2.87	2.53	3.23
SP	36 2068	2.15	1.68	0.42	-0.72	1.37	0.98	1.40	1.41	1.29	2.04	3.06	1.27
SP	36 2218	24.30	25.41	25.29	24.35	25.61	24.09	24.59	25.14	24.15	24.47	23.56	24.27
SP	36 2295	-	-	-	8.59	8.79	8.89	8.82	8.17	8.57	8.70	7.84	8.37
SP	36 2297	-6.29	-5.40	-6.70	-7.06	-7.43	-7.04	-7.64	-6.90	-7.00	-5.90	-7.35	-7.23
SP	40 7201	57.68	59.70	61.77	64.21	66.82	69.27	71.72	74.24	76.60	79.06	81.95	83.60
SP	40 7203	24.96	26.23	27.56	-	-	-	-	-	-	-6.08	-7.63	-6.55
SP	40 7210	25.72	29.57	33.29	36.94	40.58	43.89	47.46	51.65	55.64	59.16	62.64	66.27
SP	40 7211	1.62	3.37	4.98	6.62	8.36	9.97	11.37	-	-	-2.65	-1.21	0.27
SP	40 7212	1.90	2.27	2.59	2.81	3.20	3.53	3.62	-	-	3.35	3.53	3.79
SP	40 7218	-	-	-	13.66	11.18	8.51	6.46	4.32	2.10	0.05	-2.03	-4.11
SP	40 7221	-	-	-	-42.71	-43.08	-43.44	-43.63	-43.78	-43.95	-43.89	-44.06	-44.28
SU	40 3802	10.12*	8.99*	9.08*	9.88	6.67	3.84	1.99	1.96	1.95	3.64	4.23	5.76
SU	40 3805	98.76	99.52	99.97	99.88	-	-	-	-	-	-	-	-
SU	40 3809	-	11.90	11.49	10.88	10.46	10.08	9.55	9.31	9.07	8.83	8.75	8.66
SU	40 3810	57.50	-	10.06	9.09	8.33	7.61	6.80	6.25	5.74	5.36	5.01	4.63
SU	40 3811	21.37	19.82	18.50	17.74	17.26	17.41	17.56	18.20	19.04	19.84	20.66	21.48
SU	40 3812	3.90*	2.96*	2.03*	1.23*	0.69*	0.38*	-0.07*	-0.19*	0.73*	0.71	0.68	0.59
SU	40 3814	-	-	-	-	-	-	-	-	-	-8.94*	-9.07	-9.19
SU	40 3815	-	-	-	-	-	-	-	-	-7.55	-7.15	-6.66	-6.36
SU	40 3816	-	-	-	-	-	-	-	-	0.66	0.97	1.27	1.75
SU	40 3817	-	-	-	-	-	-	-	-	-	7.53	6.82	6.22
SU	40 3822	-19.34*	-18.13*	-16.89*	-15.86*	-16.20*	-16.12*	-15.47*	-14.29*	-13.19*	-10.29*	-8.51*	-7.75
SU	40 3831	51.85*	51.94*	52.56*	52.69*	53.14*	53.45*	53.47*	53.78*	53.12*	53.58*	54.03*	54.38
SU	40 3837	50.83*	51.22*	51.17*	51.06*	51.42*	52.08*	52.40*	52.49*	52.53*	52.09*	51.63*	51.63
SU	40 3855	-	-	55.99	55.21	54.40	-	-	-	-	-	-	-
TCC	35 768	7.28	3.28	4.18	5.27	5.61	3.11	6.51	6.42	5.15	7.38	5.48	3.02
TCC	35 1028	-	-	-2.08	-2.44	-2.27	-1.36	-1.80	-1.43	-2.46	-0.94	-1.48	-1.23
TCC	35 1881	0.50	0.02	1.61	0.64	0.78	0.03	2.02	1.65	1.50	1.90	1.31	2.56
TCC	40 8620	-7.87*	-5.78*	-3.72*	-2.02*	-0.47*	1.08	2.56	3.91	5.38	6.62	7.55	19.94
TCC	40 8624	-3.51	-3.82	-4.18	-4.84	-5.05	-5.49	-5.77	-6.48	-6.89	-7.17	-7.52	-8.31
TCC	40 8650	11.17*	8.48*	5.82*	2.85*	0.38*	-	-	-	-	-	-	-
TL	35 160	-9.41	-9.57	-9.42	-10.82	-10.80	-11.09	-11.20	-11.55	-12.28	-	-	-
TL	35 300	15.88	15.09	-	-	-	-	-	-	-	-	-	-
TL	35 474	12.48	10.58	9.82	9.74	10.50	8.61	7.39	8.51	5.70	3.87	-0.92	-1.31

Table 8. (Cont.)

Lab.	Clock		54859	54889	54919	54949	54979	55009	55039	55074	55104	55134	55164	55194
TL	35	809	-0.16	1.57	-0.86	-1.16	0.12	-0.36	1.09	1.20	-0.94	-0.39	-0.15	-0.96
TL	35	1012	-5.41	-5.68	-5.72	-4.90	-5.27	-3.04	-2.52	-2.28	0.63	0.78	1.64	1.77
TL	35	1104	13.07	12.75	14.09	14.64	14.79	15.45	15.96	15.77	16.95	16.71	16.25	17.72
TL	35	1132	-8.48	-7.86	-7.68	-8.11	-8.57	-8.66	-10.05	-7.92	-8.25	-8.14	-7.38	-7.68
TL	35	1498	-	-	-	-3.30	-2.71	-2.80	-3.45	-3.13	-2.25	-3.02	-2.54	-2.74
TL	35	1500	19.44	19.53	18.90	18.89	18.98	19.37	18.00	18.70	18.76	18.56	18.35	18.33
TL	35	1712	0.60	0.61	0.17	0.80	0.71	0.38	0.35	-0.02	0.72	0.66	-0.02	-0.29
TL	35	2365	4.08	4.79	4.47	4.45	4.47	4.73	5.09	4.93	5.88	4.69	5.09	5.38
TL	35	2366	-7.77	-7.64	-7.88	-7.70	-8.09	-7.85	-7.70	-8.34	-8.45	-7.44	-8.19	-8.08
TL	35	2367	10.30	9.79	9.95	10.66	9.71	9.81	9.88	9.90	10.30	10.23	10.09	9.35
TL	35	2368	1.35	1.02	1.36	0.44	0.35	0.63	0.64	1.00	0.36	0.32	-0.33	0.24
TL	40	3052	63.71	63.93	63.61	63.42	63.24	63.19	63.17	63.43	63.00	63.09	63.46	63.21
TL	40	3053	8.91	9.91	8.80	8.88	8.44	8.20	8.45	8.23	8.68	8.42	8.12	7.65
TP	35	163	18.56	17.96	18.05	-	-	-	-	-	-	-	2.94	3.02
TP	35	326	-62.69	-63.09	-64.01	-65.30	-65.63	-65.68	-65.42	-65.30	-	-69.12	-69.93	-71.48
TP	35	1227	-	11.04	12.18	12.10	12.52	12.33	12.69	13.33	13.31	13.66	13.72	12.92
TP	35	2476	-	-	-	-	-	-	2.66	2.73	-	3.43	3.44	3.79
TP	36	154	10.52	10.67	11.87	11.24	10.82	11.02	10.79	9.89	-	11.29	11.48	10.66
UA	40	7871	4.50	6.04	7.82	10.83	10.12	13.84	16.66	22.34	19.51	19.18	21.57	28.28
UA	40	7881	-5.23	-6.41	-10.11	-7.46	-8.00	-4.81	-5.93	-5.31	-8.74	-4.91	-7.76	-11.05
UA	40	7882	-0.20	-0.71	0.20	0.82	0.60	-0.75	4.33	8.00	3.55	7.98	4.29	3.30
UME	35	251	-	-	-	-	-	-	-	-	-	0.36	0.59	0.83
UME	35	872	-0.48	-1.02	-	-	-	-	-	-	-	-	-	-
USNO	35	101	-4.99	-4.34	-6.83	-7.72	-	-	-	-	-	-	-	-
USNO	35	104	20.27	19.78	19.24	20.17	19.71	19.36	19.64	19.85	20.41	20.93	19.63	19.71
USNO	35	106	16.08	16.12	17.34	17.31	17.67	17.69	17.49	17.14	16.64	17.30	17.93	17.41
USNO	35	108	-	-	3.74	3.88	3.13	3.67	3.47	3.85	3.43	3.89	3.58	4.06
USNO	35	114	-4.71	-4.43	-4.81	-4.62	-4.63	-4.11	-3.37	-3.61	-3.18	-3.31	-2.91	-2.99
USNO	35	120	-	-	-	22.35	22.02	22.90	22.52	21.73	22.43	22.12	22.37	22.24
USNO	35	142	-9.50	-9.81	-9.38	-7.82	-7.14	-7.05	-6.97	-8.37	-8.19	-9.11	-8.41	-9.06
USNO	35	145	20.70	21.73	19.77	17.91	16.61	16.61	16.28	17.89	17.80	18.18	18.22	20.14
USNO	35	146	-1.23	-0.13	-0.40	-0.85	-0.61	-0.70	-0.26	-0.44	-0.20	-0.42	0.81	0.04
USNO	35	148	-	-	-	-	8.45	8.63	8.57	8.66	7.99	8.19	8.25	9.06
USNO	35	150	-0.43	-0.24	-0.61	-0.49	-0.63	-0.60	-0.40	-0.57	-1.22	0.05	-0.59	-0.44
USNO	35	152	4.57	3.77	4.21	4.32	3.83	3.53	4.52	3.71	3.25	4.46	3.41	3.56

Table 8. (Cont.)

Lab.	Clock		54859	54889	54919	54949	54979	55009	55039	55074	55104	55134	55164	55194
USNO	35	153	15.94	16.24	16.49	16.20	16.15	15.65	15.64	15.61	16.16	15.77	15.84	15.77
USNO	35	156	11.73	12.36	12.32	12.87	12.32	12.24	12.61	12.05	11.39	11.52	11.24	11.62
USNO	35	161	9.86	10.29	9.48	8.78	7.71	8.64	8.37	8.78	8.87	8.66	8.27	8.97
USNO	35	164	5.05	5.15	6.02	5.43	5.32	6.01	6.13	5.27	5.94	6.52	6.34	6.28
USNO	35	165	13.01	13.44	13.41	13.78	13.33	13.02	12.96	12.90	12.16	12.38	13.79	12.47
USNO	35	166	-0.70	-0.93	-0.42	-1.13	-0.43	-1.80	-1.26	-0.94	-0.51	-1.29	-1.02	-1.06
USNO	35	167	-1.08	-0.63	-0.49	-0.29	-0.55	-0.23	-0.36	-0.20	-1.37	-1.23	-1.15	-1.29
USNO	35	173	-8.58	-7.96	-7.38	-7.90	-7.74	-8.04	-8.10	-7.62	-7.97	-6.90	-7.41	-7.18
USNO	35	213	6.05	6.32	7.40	8.51	8.57	8.37	8.07	7.52	8.25	8.62	8.06	9.27
USNO	35	217	-16.96	-16.48	-12.58	-11.43	-11.56	-12.13	-12.38	-12.51	-12.09	-12.95	-12.86	-12.68
USNO	35	226	8.13	8.39	8.32	8.73	8.00	7.89	8.53	8.55	8.56	8.89	9.05	9.23
USNO	35	227	5.77	5.65	5.96	6.61	7.88	8.24	9.86	10.65	12.57	14.20	14.91	16.16
USNO	35	231	-12.57	-12.87	-12.70	-12.99	-12.85	-12.34	-12.16	-12.31	-12.04	-12.20	-12.51	-11.26
USNO	35	233	17.92	18.10	17.46	17.70	18.16	18.48	17.96	17.88	18.68	18.73	18.64	18.27
USNO	35	242	12.34	12.72	13.72	13.26	13.25	13.30	13.27	13.37	12.79	13.03	12.55	13.85
USNO	35	244	7.14	7.82	7.55	7.58	7.38	7.73	7.79	7.98	7.88	7.76	8.32	8.62
USNO	35	249	-	-	-	-8.21	-7.34	-7.62	-6.62	-7.94	-8.75	-8.07	-	-
USNO	35	253	-23.51	-23.26	-23.83	-23.46	-24.82	-23.81	-23.57	-23.51	-22.63	-23.07	-22.41	-21.07
USNO	35	254	2.43	2.11	4.97	5.27	4.98	5.63	5.80	4.89	4.31	4.60	4.61	4.84
USNO	35	260	-0.66	0.00	3.41	4.81	3.73	3.01	3.11	2.96	2.26	2.34	2.93	2.11
USNO	35	268	-	-	-	-3.02	-3.21	-2.49	-3.50	-2.97	-3.28	-2.86	-3.03	-2.70
USNO	35	389	-18.40	-18.08	-18.68	-18.39	-18.77	-18.98	-19.21	-	-	-	-	-
USNO	35	392	30.24	30.69	30.97	30.81	32.13	31.60	31.44	31.94	32.33	32.19	32.85	32.64
USNO	35	394	-	-	-	-	75.62	74.94	75.58	75.78	75.57	75.36	75.59	74.08
USNO	35	416	-11.65	-10.76	-11.05	-10.66	-10.91	-11.32	-11.63	-10.90	-10.28	-10.96	-10.81	-9.98
USNO	35	417	10.68	10.30	10.13	9.23	10.73	10.47	9.78	10.84	10.98	10.42	10.34	9.73
USNO	35	703	-1.25	-1.00	-1.23	-1.68	-1.09	-1.09	-1.08	-1.13	-1.40	-1.59	-1.50	-1.52
USNO	35	717	-12.34	-12.01	-12.13	-11.64	-11.76	-11.74	-11.64	-12.27	-11.52	-11.46	-11.52	-11.57
USNO	35	762	-2.93	-1.78	-3.19	-2.37	-3.37	-2.56	-2.98	-1.85	-	-	-	-
USNO	35	763	-17.17	-17.00	-16.67	-16.50	-16.64	-16.20	-16.63	-16.19	-16.16	-16.40	-16.29	-16.58
USNO	35	765	-10.39	-9.71	-9.61	-	-	-	-	-	-	-	-	-
USNO	35	1097	11.86	11.79	11.19	11.43	11.55	11.78	11.99	12.27	13.07	12.08	12.09	12.14
USNO	35	1125	-10.74	-11.70	-12.43	-12.20	-13.80	-12.98	-13.13	-12.56	-12.35	-12.30	-12.76	-12.74
USNO	35	1327	-3.78	-3.90	-3.46	-3.35	-4.11	-4.00	-3.71	-2.88	-3.38	-3.32	-3.31	-3.70
USNO	35	1328	5.90	5.56	3.40	2.48	1.96	2.08	1.69	2.46	2.58	3.02	2.60	2.43

Table 8. (Cont.)

Lab.	Clock	54859	54889	54919	54949	54979	55009	55039	55074	55104	55134	55164	55194
USNO	35 1331	-38.81	-37.34	-37.73	-37.95	-37.71	-37.29	-38.50	-39.57	-38.86	-38.61	-37.55	-39.11
USNO	35 1438	-4.09	-3.98	-3.49	-3.35	-3.67	-4.22	-3.92	-4.19	-4.11	-3.35	-3.89	-3.72
USNO	35 1459	-6.70	-6.45	-5.97	-6.20	-6.62	-5.75	-	-	-	-	-	-
USNO	35 1462	-4.44	-3.55	-4.24	-3.98	-3.98	-4.00	-3.05	-3.76	-2.80	-3.28	-3.02	-3.50
USNO	35 1463	11.92	11.75	11.97	12.05	12.54	12.86	12.93	12.67	13.25	13.83	13.76	13.22
USNO	35 1543	2.95	3.59	1.78	1.73	1.79	-	-	-	-	-	-	-
USNO	35 1575	-	-	-	-	-	-8.66	-8.23	-8.08	-7.75	-7.67	-7.20	-7.58
USNO	35 1655	-8.99	-10.69	-10.66	-9.44	-10.62	-10.17	-10.77	-10.16	-9.29	-	-	-
USNO	35 1692	5.97	5.17	-	-	-	-	-	-	-	-	-	-
USNO	35 1696	4.81	-	-	-	-	-	-	-	-	-	-	-
USNO	35 1697	1.90	1.83	1.39	1.17	-	-	-	-	-	-	-	-
USNO	40 702	-11.16	-10.99	-10.98	-10.96	-10.66	-10.91	-10.90	-10.56	-10.50	-10.61	-10.36	-10.60
USNO	40 704	19.26	19.65	18.95	18.98	20.01	-	-	-	-	-	-	-
USNO	40 705	-45.57	-45.25	-48.71	-49.70	-51.24	-51.01	-50.69	-49.48	-49.17	-48.71	-48.84	-
USNO	40 708	68.28	68.83	68.69	69.03	69.96	70.40	70.92	71.67	72.15	72.59	72.89	73.34
USNO	40 710	-552.06	-551.48	-551.03	-550.68	-550.53	-549.95	-	-	-	-	-	-
USNO	40 711	267.66	269.74	271.70	273.61	275.62	277.49	279.35	281.86	283.95	285.59	-	-
USNO	40 712	47.61	47.96	48.06	47.60	47.88	48.17	47.92	48.37	48.99	49.04	48.99	49.30
USNO	40 713	11.34	11.96	12.32	12.73	13.00	13.42	13.79	14.00	14.46	14.93	15.32	15.63
USNO	40 714	-21.03	-20.77	-20.77	-20.62	-	-	-	-	-16.08	-15.50	-15.11	-14.84
USNO	40 715	79.89	80.49	81.03	81.57	82.23	-	-	84.31	84.95	85.60	86.01	86.42
USNO	40 716	209.23	209.55	209.65	209.74	209.74	209.88	209.99	210.27	210.44	210.63	210.76	210.76
USNO	40 718	138.37	139.57	140.42	141.01	141.69	142.25	142.99	143.98	145.12	146.34	147.34	148.39
USNO	40 719	31.64	33.25	34.66	35.73	37.09	38.42	39.47	40.73	41.68	42.61	43.58	44.68
USNO	40 720	52.96	55.51	58.01	60.15	62.61	65.16	67.52	70.66	74.51	77.55	80.46	83.10
USNO	40 722	297.29	301.61	305.78	309.77	313.91	318.01	322.07	327.21	332.45	336.41	340.19	343.89
USNO	40 723	-70.37	-	-	-	-56.74	-56.58	-56.34	-56.25	-56.18	-56.22	-56.33	-60.88
USNO	40 724	-95.91	-95.51	-95.36	-94.50	-94.54	-94.58	-96.36	-97.80	-98.77	-99.28	-99.88	-100.44
USNO	40 725	-30.28	-29.97	-31.19	-32.25	-32.07	-32.01	-31.88	-31.06	-30.57	-30.34	-30.17	-29.62
USNO	40 726	262.03	267.88	270.96	273.98	265.34	257.93	-	-	-	-	-	-
USNO	40 728	161.88	166.52	-	-	-	-	-	-	-	-	-	-
USNO	40 731	-138.15	-138.34	-138.70	-139.24	-139.77	-140.64	-141.41	-142.21	-142.62	-143.32	-144.06	-145.30
VMI	35 2230	-19.47	-21.02	-28.18	-23.61	-25.01	-23.80	-22.75	-23.02	-23.35	-26.91	-25.94	-24.43
VMI	36 1233	2.93	-0.41	-9.71	-4.81	-6.96	-4.10	-2.21	-3.14	-4.10	-5.30	-6.10	-2.99
VMI	36 2314	25.43	23.64	15.48	22.07	19.46	22.41	23.68	22.27	22.56	19.60	20.70	21.66

Table 8. (Cont.)

Lab.	Clock		54859	54889	54919	54949	54979	55009	55039	55074	55104	55134	55164	55194
VSL	35	179	-	-	-	-	-	-	-31.54	-31.91	-31.54	-31.79	-31.70	-31.09
VSL	35	456	18.08	18.35	-	-	16.37	16.74	16.74	17.06	16.53	15.82	16.68	16.30
VSL	35	548	-	-	21.99	20.27	20.57	20.12	20.35	20.88	20.71	20.80	21.34	21.96
VSL	35	731	18.23	19.02	18.73	13.10	9.73	12.11	17.59	17.86	17.30	18.13	18.50	17.93

Table 9A. Relative weights (in percent) of contributing clocks in 2009

(File is available at ftp://62.161.69.5/pub/tai/scale/WTAI/wtai09.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	54859	54889	54919	54949	54979	55009	55039	55074	55104	55134	55164	55194
APL	35 904	0.256	0.479	0.519	0.779	0.784	0.796	0.799	0.753	0.749	-	0.000	0.000
APL	35 1264	0.000	0.052	0.051	0.055	0.059	0.069	0.082	0.102	0.107	-	0.000	0.000
APL	35 1791	0.817	0.794	0.796	0.779	0.784	0.796	0.799	0.744	0.749	-	0.000	0.000
APL	40 3107	0.146	0.103	0.000	0.052	0.040	0.034	0.033	0.031	0.030	-	0.000	0.000
APL	40 3108	0.000	0.000	0.000	0.001	0.001	0.001	0.001	0.001	0.001	-	0.000	0.000
APL	40 3109	0.006	0.005	0.004	0.003	0.003	0.002	0.002	0.002	0.002	-	0.000	0.000
AUS	35 2269	0.042	0.036	0.033	0.031	0.032	0.034	0.047	0.046	0.047	0.049	0.049	0.056
AUS	36 299	-	-	-	-	-	-	-	-	-	0.000	0.000	0.000
AUS	36 340	0.437	0.334	0.241	0.250	0.256	0.252	0.235	0.390	0.371	0.388	0.373	0.380
AUS	36 654	0.810	0.794	0.796	0.779	0.784	0.796	0.000	0.295	0.218	0.200	0.184	0.199

Table 9A. (Cont.)

Lab.	Clock	54859	54889	54919	54949	54979	55009	55039	55074	55104	55134	55164	55194
AUS	36 1141	0.181	0.171	0.146	0.000	0.080	0.071	0.067	0.066	0.063	0.070	0.065	0.067
AUS	40 5401	-	0.000	-	-	-	-	-	-	-	-	0.000	0.000
AUS	40 5402	-	-	-	-	0.000	0.000	-	0.000	0.000	-	0.000	0.000
BEV	35 1065	0.097	0.109	0.105	0.109	0.108	0.129	0.177	0.178	0.174	0.151	0.093	0.077
BEV	35 1793	0.266	0.160	0.139	0.138	0.144	0.129	0.179	0.300	0.350	0.676	0.746	0.754
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	-	-	-	-	-	-	0.000	0.000	0.000	0.000	0.129	0.104
BIM	35 1501	0.000	0.043	0.052	0.057	0.000	-	-	-	-	-	-	-
BY	40 4209	0.013	0.012	0.011	0.007	0.004	0.003	0.003	0.002	0.002	0.001	0.001	0.001
BY	40 4227	0.002	0.003	0.003	0.003	0.004	-	-	-	-	-	-	-
BY	40 4260	0.002	0.001	0.002	0.002	0.002	0.002	0.003	0.003	0.004	0.004	0.003	0.003
BY	40 4278	0.000	0.000	0.000	0.000	0.000	0.002	0.002	0.002	0.001	0.001	0.001	0.002
CAO	35 939	0.034	0.045	0.057	0.078	0.096	0.107	0.125	0.141	0.136	0.121	0.129	0.128
CAO	35 1270	0.340	0.278	0.381	0.265	0.280	0.344	0.442	0.487	0.543	0.426	0.414	0.413
CH	35 771	0.000	0.000	0.000	0.666	0.784	0.000	0.215	0.254	0.270	0.228	0.245	0.308
CH	35 2117	0.452	0.449	0.000	0.159	0.209	0.194	0.210	0.196	0.207	0.155	0.150	0.174
CH	36 354	0.358	0.319	0.294	0.408	0.327	0.239	0.334	0.330	0.270	0.283	0.233	0.294
CH	36 413	0.029	0.025	0.023	0.023	0.027	0.028	0.050	0.030	0.024	0.024	0.031	0.025
CH	40 5701	0.012	0.014	0.016	0.020	0.024	-	-	-	-	0.000	0.000	0.000
CNM	35 1705	0.083	0.171	0.170	0.312	0.496	0.496	0.540	0.704	0.000	0.000	0.037	-
CNM	35 1815	0.825	0.794	0.796	0.779	0.784	0.685	0.586	0.515	0.362	0.000	0.154	0.163
CNM	36 1537	0.164	0.117	0.111	0.152	0.000	0.064	0.000	0.012	0.012	0.011	0.010	0.011
CNM	40 7301	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.120	0.115	0.134
CNM	53 6038	0.117	0.145	0.113	0.070	0.057	0.044	0.045	-	-	-	-	-
CNMP	36 1806	0.009	0.008	0.008	0.009	0.011	0.017	0.041	0.106	0.100	0.102	0.113	0.134
DLR	35 1714	0.000	0.505	0.671	0.779	0.784	0.000	0.194	0.228	0.243	0.218	0.169	0.155
DMDM	36 2033	0.493	0.492	0.403	0.536	0.567	0.644	0.566	0.493	0.420	0.378	0.365	0.383
DTAG	36 345	0.328	0.328	0.376	0.369	0.645	0.437	0.000	0.119	0.085	0.073	0.072	0.081
DTAG	36 465	0.270	0.277	0.190	0.199	0.185	0.188	0.180	0.142	0.079	0.074	0.072	0.072
DTAG	36 2370	0.000	0.000	0.441	0.382	0.489	0.285	0.325	0.393	0.374	0.465	0.390	0.407
EIM	35 716	0.000	0.018	0.027	0.038	0.048	0.061	-	-	0.000	-	-	-
EIM	35 1431	0.000	0.000	0.000	0.032	0.047	0.062	-	-	0.000	-	-	-
EIM	35 2060	0.000	0.000	0.796	0.779	0.784	0.796	-	-	-	-	-	0.000
F	35 122	0.494	0.334	0.407	0.432	0.428	0.428	0.558	0.513	0.527	0.515	0.502	0.450
F	35 124	0.825	0.794	0.796	0.779	0.784	0.796	0.799	0.753	0.749	0.784	0.769	0.784

Table 9A. (Cont.)

Lab.	Clock		54859	54889	54919	54949	54979	55009	55039	55074	55104	55134	55164	55194
F	35	131	0.459	0.431	0.300	0.289	0.357	0.387	0.314	-	-	-	-	0.000
F	35	157	-	0.000	-	-	-	-	-	-	-	-	-	-
F	35	158	0.435	0.449	0.448	0.462	0.769	0.765	0.799	0.753	0.749	0.784	0.769	0.784
F	35	385	0.140	0.128	0.114	0.125	0.189	0.384	0.454	0.399	0.598	0.671	0.769	0.712
F	35	396	0.073	0.071	0.081	0.082	0.078	0.102	0.113	0.153	0.171	0.223	0.264	0.307
F	35	469	-	0.000	0.000	0.000	0.000	0.027	0.029	0.035	0.042	0.056	0.064	0.079
F	35	489	-	-	-	0.000	0.000	0.000	0.000	0.088	0.111	0.161	0.168	0.194
F	35	520	-	0.000	0.000	0.000	0.000	0.036	0.043	0.038	0.040	0.034	0.031	0.028
F	35	536	0.000	0.000	0.000	0.000	0.361	0.531	0.712	0.753	0.749	0.663	0.405	0.334
F	35	609	-	-	-	-	0.000	0.000	-	-	-	-	-	-
F	35	770	0.804	0.687	0.688	0.724	0.784	0.796	0.799	0.753	0.749	0.784	0.769	0.784
F	35	774	0.000	0.223	0.219	-	-	-	-	-	-	-	0.000	0.000
F	35	781	0.122	-	-	0.000	0.000	0.000	0.000	0.245	0.345	0.000	0.019	0.018
F	35	819	0.216	0.216	0.176	0.162	-	-	0.000	0.000	0.000	0.000	0.080	0.026
F	35	859	-	-	0.000	0.000	0.000	0.000	0.034	0.050	0.060	0.083	0.101	0.111
F	35	909	-	-	-	-	-	-	-	-	-	-	-	0.000
F	35	1068	0.000	-	-	-	-	0.000	0.000	0.000	0.000	0.528	0.746	0.707
F	35	1177	-	-	-	-	-	-	-	-	-	0.000	0.000	0.000
F	35	1178	-	-	0.000	0.000	0.000	0.000	0.439	0.493	-	-	-	-
F	35	1222	0.617	-	-	0.000	0.000	0.000	0.000	0.248	0.360	-	-	-
F	35	1258	0.597	-	-	0.000	0.000	0.000	0.000	0.232	0.328	0.304	0.212	0.176
F	35	1321	0.825	0.719	0.700	0.554	0.487	0.438	0.424	0.421	0.566	0.666	0.646	0.671
F	35	1556	0.000	0.000	0.796	0.624	0.657	0.796	0.799	0.716	-	-	0.000	0.000
F	35	1644	-	0.000	0.000	0.000	0.000	0.167	0.265	0.305	0.348	0.358	0.421	0.527
F	35	2027	0.133	0.117	0.113	0.129	0.144	0.167	0.220	0.251	0.310	0.313	0.310	0.293
F	35	2388	0.825	0.794	0.796	0.779	0.680	0.660	0.565	0.521	0.527	0.578	0.663	0.784
F	40	805	0.005	0.004	0.004	0.004	0.004	0.004	-	-	0.000	0.000	0.000	0.000
F	40	816	0.000	0.000	-	-	-	0.000	-	-	-	-	0.000	0.000
F	40	889	0.000	0.003	0.002	0.002	0.002	0.002	0.002	0.001	0.001	0.001	0.001	0.001
F	40	890	0.000	0.023	0.018	0.017	0.018	0.017	0.018	0.018	0.019	0.025	0.032	0.049
F	53	6385	0.006	0.008	0.013	0.017	0.021	0.020	0.022	0.024	0.025	0.032	0.052	0.070
HKO	35	358	0.298	-	-	-	-	-	-	-	-	-	-	-
HKO	35	1893	0.825	0.794	0.796	0.779	0.762	0.796	0.799	0.753	0.749	-	-	0.000
HKO	35	2425	-	-	0.000	0.000	0.000	0.000	0.799	0.279	0.209	-	-	0.000
IFAG	36	1167	0.029	0.030	0.033	0.040	0.040	0.047	0.058	0.058	0.061	0.060	0.054	0.053

Table 9A. (Cont.)

Lab.	Clock	54859	54889	54919	54949	54979	55009	55039	55074	55104	55134	55164	55194
IFAG	36 1173	0.008	0.011	0.016	0.024	0.022	0.022	0.016	0.012	0.010	0.009	0.009	0.010
IFAG	36 1629	0.000	0.243	0.254	0.294	0.213	0.263	0.154	0.000	0.071	0.079	0.080	0.089
IFAG	36 1732	0.502	0.437	0.400	0.479	0.566	0.447	0.436	0.543	0.626	0.644	0.496	0.586
IFAG	36 1798	0.276	0.335	0.583	0.779	0.784	0.796	0.000	0.472	0.000	0.284	0.273	0.290
IFAG	40 4418	0.052	0.039	0.028	0.021	0.017	0.014	0.013	0.012	0.011	0.012	0.013	0.017
IFAG	40 4439	0.004	0.004	0.004	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.004
INTI	35 2377	0.000	0.000	0.523	0.000	0.000	0.005	0.007	0.008	0.010	0.012	0.012	0.012
IPQ	35 1797	-	-	-	-	-	-	-	-	-	-	-	0.000
IPQ	35 2012	-	-	-	-	-	-	-	-	-	-	-	0.000
IPQ	35 2169	-	-	-	-	-	-	-	-	-	-	-	0.000
IT	35 219	-	0.000	0.000	0.000	0.000	0.796	0.000	0.028	0.022	0.021	0.021	0.023
IT	35 505	0.455	0.414	0.392	0.403	0.406	0.404	0.466	0.637	0.561	0.537	0.514	0.530
IT	35 1115	0.400	0.392	0.384	0.379	0.320	0.356	0.378	0.411	0.408	0.575	0.533	0.392
IT	35 1373	0.304	0.357	0.366	0.370	0.303	0.552	0.799	0.000	0.448	0.448	0.475	0.546
IT	35 2118	0.825	0.794	0.796	0.779	0.784	0.796	0.799	0.753	0.749	0.784	0.769	0.784
IT	35 2487	-	-	-	-	-	-	-	-	-	-	0.000	0.000
IT	40 1101	-	-	-	-	-	-	0.000	0.000	0.000	0.000	0.001	0.001
IT	40 1102	0.002	0.001	0.001	0.001	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000
IT	40 1103	0.000	0.000	0.000	0.000	0.784	0.604	0.352	0.191	0.120	0.082	0.059	0.050
JV	21 216	0.008	0.009	0.011	0.013	0.012	-	-	0.000	0.000	0.000	0.000	0.010
JV	21 387	0.000	0.000	0.000	0.000	0.000	-	-	0.000	0.000	0.000	0.000	0.000
JV	36 1277	0.042	0.043	0.051	0.059	0.059	-	-	0.000	0.000	0.000	0.000	0.001
KIM	36 618	-	-	-	0.000	0.000	0.000	0.000	0.022	0.024	0.033	0.041	0.054
KRIS	35 321	0.466	0.415	0.370	0.382	0.301	0.376	0.799	0.000	0.000	0.000	0.033	0.024
KRIS	35 739	0.825	0.794	0.796	0.779	0.784	0.796	0.799	0.753	0.749	0.784	0.769	0.784
KRIS	35 1693	0.000	-	-	-	-	-	-	-	-	-	-	-
KRIS	35 1783	0.263	0.233	0.262	0.246	0.427	0.289	0.230	0.238	0.264	0.286	0.428	0.380
KRIS	36 1135	0.056	0.000	0.019	0.017	0.015	0.019	0.021	0.021	0.025	0.027	0.033	0.049
KRIS	40 5623	0.087	0.082	0.082	0.092	0.170	0.229	0.413	0.753	0.749	0.784	0.769	0.784
KRIS	40 5624	-	-	-	-	-	-	-	-	0.000	0.000	0.000	0.000
KRIS	40 5626	-	-	-	-	0.000	0.000	0.000	0.000	0.000	0.053	0.066	-
KZ	35 2202	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001
LT	35 1362	-	-	-	-	-	-	-	0.000	0.000	0.000	0.000	0.206
LV	35 2335	0.033	0.794	0.796	0.779	0.784	0.796	0.799	0.000	0.220	-	-	0.000
MIKE	35 1171	0.160	0.000	0.067	0.066	0.059	0.054	0.056	0.000	0.011	0.011	0.010	0.011

Table 9A. (Cont.)

Lab.	Clock		54859	54889	54919	54949	54979	55009	55039	55074	55104	55134	55164	55194
MIKE	36	986	0.151	0.120	0.102	0.086	0.076	0.073	0.071	0.000	0.014	0.014	0.013	0.013
MIKE	40	4108	0.250	0.232	0.245	0.295	0.227	0.209	0.214	0.000	0.012	0.010	0.010	0.010
MIKE	40	4113	0.004	0.004	0.004	0.004	0.004	0.004	0.005	0.000	0.002	0.002	0.002	0.002
MIKE	40	4180	-	0.000	0.000	0.000	0.000	0.001	0.001	0.001	0.001	0.001	0.001	0.001
MKEH	36	849	0.132	0.151	0.164	0.181	0.186	0.181	0.172	0.166	0.127	0.148	0.140	0.145
MSL	12	933	0.002	0.002	0.001	0.002	0.003	0.006	0.000	0.000	0.000	0.000	0.000	0.000
MSL	36	274	0.065	0.061	0.067	0.070	0.070	0.068	0.000	0.042	0.034	0.033	0.029	0.042
MSL	36	1025	0.008	0.011	0.011	0.023	0.021	0.000	0.013	0.010	0.008	0.009	0.010	0.012
NAO	35	779	0.000	0.000	0.000	0.138	0.198	0.249	0.337	0.378	0.423	0.412	0.408	-
NAO	35	1206	0.000	0.000	0.000	0.779	0.784	0.796	0.799	0.753	0.749	0.784	0.769	-
NAO	35	1214	0.000	0.000	0.000	0.779	0.322	0.302	0.392	0.415	0.397	0.360	0.284	-
NAO	35	1689	0.000	0.000	0.000	0.040	0.000	0.000	0.001	0.001	0.001	0.001	0.001	-
NICT	35	112	0.223	0.222	0.269	0.343	0.423	0.505	0.620	0.753	0.749	0.784	0.769	0.784
NICT	35	144	0.093	-	-	0.000	0.000	-	-	-	-	-	-	-
NICT	35	332	0.825	0.794	0.796	0.779	0.000	0.544	0.542	0.512	0.525	0.596	0.437	0.535
NICT	35	342	0.480	0.252	0.191	0.145	0.119	0.121	0.141	0.138	0.171	0.262	0.229	0.245
NICT	35	343	0.484	0.661	0.661	0.686	0.669	0.752	0.713	0.558	0.000	0.326	0.286	0.336
NICT	35	715	0.565	0.546	0.614	0.585	0.555	0.520	-	-	-	-	0.000	0.000
NICT	35	732	-	-	-	-	-	-	-	-	0.000	0.000	0.000	0.000
NICT	35	907	0.432	0.306	0.309	0.241	0.201	0.226	0.238	0.249	0.433	0.515	0.666	0.751
NICT	35	908	0.270	0.156	0.150	0.156	0.159	0.151	0.129	0.000	0.056	0.057	0.060	0.049
NICT	35	913	0.145	0.142	0.156	0.202	0.218	0.180	0.000	0.093	0.107	0.111	0.114	0.135
NICT	35	916	0.000	0.000	0.000	0.000	0.784	0.796	0.799	0.753	0.749	0.784	0.769	0.784
NICT	35	1225	0.671	0.794	0.796	0.779	0.784	0.796	0.799	0.753	0.749	0.784	0.669	0.703
NICT	35	1226	-	-	-	-	-	-	0.000	0.000	0.000	0.000	0.056	0.062
NICT	35	1611	-	-	-	0.000	0.000	0.000	0.000	0.047	0.000	0.001	0.000	0.000
NICT	35	1778	0.530	0.573	0.669	0.540	0.593	-	-	-	-	-	0.000	0.000
NICT	35	1789	0.825	0.794	0.796	0.779	0.784	0.796	0.799	0.753	0.749	0.000	0.000	-
NICT	35	1790	0.558	0.620	0.608	0.619	0.448	0.425	0.378	0.369	-	-	-	0.000
NICT	35	1866	0.627	0.635	0.460	0.528	0.427	0.530	0.410	0.347	0.345	0.274	0.265	-
NICT	35	1882	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-	-	-
NICT	35	1887	-	0.000	0.000	0.000	0.000	0.151	0.235	0.297	0.338	0.340	0.376	0.455
NICT	35	1944	0.825	0.794	0.796	0.779	0.784	0.796	0.799	0.753	0.749	0.784	0.769	0.784
NICT	35	2010	0.475	0.699	0.796	0.779	0.784	0.796	0.799	0.753	0.749	0.784	0.632	0.768
NICT	35	2011	0.455	0.422	0.427	0.314	0.341	0.477	0.480	0.522	0.485	0.519	0.563	0.784

Table 9A. (Cont.)

Lab.	Clock	54859	54889	54919	54949	54979	55009	55039	55074	55104	55134	55164	55194
NICT	35 2056	0.825	0.794	0.796	0.779	0.784	0.796	0.799	0.753	0.749	0.784	0.769	0.784
NICT	35 2113	0.634	0.542	0.535	0.742	0.784	0.796	0.799	0.000	0.319	0.261	0.197	0.204
NICT	35 2116	0.661	0.794	0.796	0.699	0.654	0.676	0.720	0.705	0.686	0.709	0.737	0.784
NICT	36 1217	0.346	0.317	0.250	0.244	0.260	0.159	0.152	0.125	0.111	0.116	0.171	0.157
NICT	40 2002	-	-	-	-	-	-	0.000	0.000	0.000	0.000	0.031	0.029
NICT	40 2003	0.200	0.180	0.174	0.195	0.313	0.796	0.799	0.753	0.749	0.784	0.769	0.784
NICT	40 2004	-	0.000	0.000	0.000	0.000	0.145	0.125	0.099	0.084	0.076	0.063	0.059
NICT	40 2005	0.009	0.008	0.007	0.006	0.005	0.005	0.005	0.005	0.004	0.004	0.003	0.003
NIM	35 1235	0.019	0.026	0.024	0.024	0.018	0.017	0.017	0.015	0.015	0.016	0.019	0.027
NIM	35 1239	0.006	0.004	0.004	0.003	0.003	0.003	0.003	0.005	0.006	0.018	0.029	0.033
NIM	35 2239	0.024	0.028	0.030	0.022	-	-	-	-	-	-	-	-
NIM	40 4832	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
NIM	40 4835	0.000	0.000	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
NIMB	35 600	0.117	0.092	0.090	0.106	0.094	0.100	0.117	0.112	0.121	0.132	0.141	0.133
NIMT	35 2246	-	-	-	-	-	-	-	-	-	0.000	0.000	0.000
NIMT	35 2247	-	-	-	-	-	-	-	-	0.000	0.000	0.000	0.000
NIS	35 1126	0.000	0.000	0.000	0.000	0.579	0.355	0.472	0.281	0.280	0.346	0.399	0.452
NIST	35 132	-	-	-	-	-	-	-	-	-	0.000	0.000	0.000
NIST	35 182	0.000	0.000	0.000	0.000	0.115	0.162	0.219	0.276	0.325	0.260	0.247	0.294
NIST	35 282	0.000	0.000	0.000	0.779	0.780	0.796	0.799	-	-	-	-	-
NIST	35 408	-	-	-	-	-	-	-	0.000	0.000	0.000	0.000	0.784
NIST	35 1074	0.825	0.794	0.796	0.000	0.370	0.297	0.298	0.220	0.202	0.177	0.176	0.175
NIST	35 2031	0.661	0.726	0.697	0.631	0.613	0.796	0.799	0.753	0.749	0.784	0.769	0.784
NIST	35 2032	0.540	0.607	0.389	0.292	0.317	0.395	0.370	0.558	0.378	0.000	0.070	0.065
NIST	35 2034	0.113	0.138	0.121	0.167	0.160	0.160	0.172	0.197	0.217	0.254	0.254	0.257
NIST	40 203	0.008	0.008	0.008	0.008	0.008	0.009	0.009	0.009	0.009	0.009	0.008	0.008
NIST	40 204	0.411	0.399	0.406	0.436	0.431	0.413	0.454	0.465	0.420	0.402	0.371	0.397
NIST	40 205	0.825	0.794	0.796	0.779	0.784	0.796	0.799	0.753	0.749	0.784	0.769	0.784
NIST	40 206	0.481	0.423	0.382	0.377	0.334	0.306	0.298	0.310	0.388	0.548	0.724	0.784
NIST	40 222	0.092	0.096	0.113	0.142	0.192	0.234	0.314	0.380	0.412	0.445	0.434	0.483
NMIJ	35 224	-	-	-	-	-	0.000	0.000	0.000	0.000	-	-	0.000
NMIJ	35 523	0.334	0.000	0.203	0.163	0.140	0.126	0.163	0.165	0.176	-	-	-
NMIJ	35 1273	0.000	0.000	0.796	0.779	0.784	0.796	0.799	0.753	0.749	-	-	0.000
NMIJ	35 2057	-	-	0.000	0.000	0.000	0.000	0.065	0.095	0.101	-	-	0.000
NMIJ	40 5002	0.001	0.001	0.001	0.002	0.002	0.003	0.004	0.004	0.008	-	-	0.000

Table 9A. (Cont.)

Lab.	Clock		54859	54889	54919	54949	54979	55009	55039	55074	55104	55134	55164	55194
NMIJ	40	5014	-	-	-	-	-	-	-	-	-	-	-	0.000
NMIJ	40	5015	0.000	0.004	0.004	0.004	0.003	0.003	0.003	0.003	0.003	-	-	0.000
NMLS	35	328	-	-	-	0.000	0.000	0.000	0.000	0.009	0.012	0.012	0.012	-
NMLS	35	1659	0.000	0.000	0.000	-	-	-	-	-	-	-	-	-
NPL	35	1275	0.378	0.290	0.298	0.316	0.611	0.438	0.000	0.263	0.148	0.128	0.100	0.092
NPL	36	784	0.152	0.141	0.155	0.148	0.170	0.181	0.212	0.220	0.309	0.288	0.258	0.288
NPL	40	1701	0.365	0.481	0.514	0.570	0.447	0.374	0.390	0.427	0.416	0.331	0.386	0.319
NPL	40	1708	0.825	0.794	0.796	0.779	0.784	0.725	0.600	0.517	0.422	0.332	0.428	0.330
NPLI	35	2257	0.176	0.168	0.165	0.172	0.249	0.253	0.268	0.249	0.382	0.264	0.252	0.249
NRC	35	2148	0.215	0.240	0.282	0.350	0.000	0.162	0.165	0.149	0.143	0.145	0.313	0.326
NRC	35	2150	0.167	-	-	0.000	0.000	0.000	0.000	0.001	0.001	0.001	0.002	0.002
NRC	35	2151	0.063	0.074	0.088	0.109	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
NRC	35	2152	0.478	0.410	0.423	0.312	0.339	0.310	0.305	0.304	0.253	0.227	0.351	0.304
NRL	35	714	0.469	0.496	0.662	0.592	0.428	0.491	0.604	0.000	0.189	0.173	0.151	0.148
NRL	35	719	0.261	0.159	0.217	0.256	0.238	0.280	0.319	0.000	0.011	0.007	-	-
NRL	40	1001	0.006	0.003	0.002	0.002	0.002	0.001	0.001	0.001	0.001	0.001	0.001	0.001
NRL	40	1003	0.671	0.437	0.323	0.280	0.236	0.207	0.197	0.171	0.157	0.154	0.138	0.146
NRL	40	1009	0.004	0.003	0.003	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002
NRL	40	1010	0.000	0.000	0.304	0.167	0.109	0.000	0.000	0.004	0.004	0.005	-	-
NTSC	35	1007	0.000	0.026	0.025	0.025	0.023	0.022	0.024	0.024	0.024	0.025	0.024	0.026
NTSC	35	1008	0.825	0.794	0.796	0.779	0.784	0.796	0.799	0.753	0.749	0.784	0.769	0.784
NTSC	35	1011	0.825	0.794	0.796	0.000	0.355	0.235	0.221	0.182	0.180	0.170	0.165	0.204
NTSC	35	1016	0.343	0.280	0.242	0.256	0.331	0.339	0.304	0.264	0.263	0.214	0.249	0.227
NTSC	35	1017	0.218	0.198	0.154	0.156	0.165	0.195	0.000	0.000	0.000	0.016	0.011	0.010
NTSC	35	1818	0.163	0.208	0.170	0.133	0.128	0.130	0.156	0.185	0.248	0.306	0.323	0.000
NTSC	35	1820	0.184	0.277	0.275	0.303	0.298	-	-	-	-	-	-	-
NTSC	35	1823	0.398	0.406	0.498	0.421	0.437	0.470	0.494	0.358	0.297	0.444	0.708	0.691
NTSC	35	2096	0.825	0.794	0.796	0.000	0.424	0.454	0.476	0.354	0.349	0.354	0.227	0.230
NTSC	35	2098	0.825	0.794	0.796	0.779	0.784	0.796	0.799	0.753	0.749	0.784	0.769	0.784
NTSC	35	2131	0.055	0.056	0.054	0.059	0.066	0.064	0.077	0.060	0.064	0.061	0.052	0.047
NTSC	35	2141	0.015	0.019	0.020	0.023	0.024	0.048	0.065	0.079	0.069	0.000	0.031	0.023
NTSC	35	2142	0.184	0.185	0.206	0.230	0.309	0.401	0.557	0.512	0.492	0.661	0.769	0.784
NTSC	35	2143	0.825	0.599	0.504	0.476	0.462	0.670	0.769	0.753	0.749	0.784	0.769	0.784
NTSC	35	2144	0.218	0.220	0.215	0.249	0.540	0.000	0.292	0.218	0.211	0.244	0.230	0.265
NTSC	35	2145	0.825	0.777	0.796	0.779	0.784	0.796	0.799	0.753	0.749	0.784	0.750	-

Table 9A. (Cont.)

Lab.	Clock	54859	54889	54919	54949	54979	55009	55039	55074	55104	55134	55164	55194
NTSC	35 2146	0.825	0.794	0.796	0.779	0.784	0.796	0.799	0.753	0.749	0.784	0.769	0.784
NTSC	35 2147	0.136	0.142	0.227	0.145	0.153	0.157	0.179	0.191	0.195	0.301	0.373	0.382
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	0.001	0.001
NTSC	40 4933	0.002	0.005	-	-	-	-	-	-	-	-	-	-
ONBA	36 2228	0.102	0.145	0.127	0.172	0.195	0.221	0.287	0.332	0.484	0.000	0.320	0.327
ONRJ	35 102	0.062	0.065	0.074	0.074	0.090	0.109	0.134	0.157	0.386	0.354	0.302	0.000
ONRJ	35 103	0.556	0.000	0.000	0.104	0.088	0.091	0.109	0.116	0.115	0.145	0.163	0.297
ONRJ	35 123	0.197	0.246	0.302	0.507	0.568	0.486	0.468	0.453	0.499	0.544	0.453	0.408
ONRJ	35 129	0.825	0.794	0.796	0.779	0.784	0.745	0.761	0.751	0.704	0.784	0.769	0.784
ONRJ	35 1942	0.825	0.794	0.796	0.779	0.000	0.000	0.016	0.011	0.008	0.008	0.007	0.007
ONRJ	52 125	0.002	0.002	0.003	0.003	0.003	0.002	0.003	0.004	0.003	0.003	0.000	-
ORB	35 201	0.138	0.139	0.162	0.169	-	-	-	-	-	-	-	-
ORB	35 202	0.027	0.032	0.037	0.045	-	-	-	-	-	-	-	-
ORB	35 593	0.105	0.124	0.151	0.108	-	-	-	-	-	-	-	-
ORB	36 201	-	-	-	-	0.000	0.000	0.000	0.000	0.054	0.061	0.077	0.104
ORB	36 202	-	-	-	-	0.000	0.000	0.000	0.000	0.253	0.285	0.000	0.083
ORB	36 593	-	-	-	-	0.000	0.000	0.000	0.000	0.056	0.087	0.115	0.137
ORB	40 2601	0.311	0.324	0.301	0.376	0.450	0.405	0.436	0.415	0.455	0.465	0.428	0.436
ORB	40 2602	-	-	-	0.000	0.000	0.000	0.000	0.064	0.043	0.036	0.029	0.027
PL	25 124	0.007	0.009	0.011	0.011	0.013	0.013	0.009	0.007	0.006	0.006	0.007	0.010
PL	35 441	0.825	0.794	0.796	0.779	0.699	0.792	0.771	0.753	0.749	0.784	0.550	0.781
PL	35 502	-	-	-	0.000	0.000	0.000	0.000	0.017	0.021	0.022	0.022	0.024
PL	35 745	0.693	0.794	0.762	0.774	0.636	0.629	0.709	0.624	0.606	0.662	0.620	0.548
PL	35 1120	0.338	0.230	0.171	0.158	0.163	0.201	0.361	0.436	0.435	0.606	0.526	0.482
PL	35 1660	0.825	0.794	0.796	0.779	0.784	0.756	0.427	0.415	0.422	0.281	0.256	0.269
PL	35 1709	0.292	0.347	0.404	0.339	0.557	0.656	0.799	0.753	0.686	0.784	0.769	0.784
PL	35 1746	0.666	0.491	-	-	-	-	0.000	0.000	0.000	0.000	0.166	0.218
PL	35 1934	0.545	0.516	0.449	0.462	0.414	0.395	0.312	0.299	0.286	0.297	0.367	0.277
PL	35 2394	0.009	0.011	0.013	0.016	0.034	0.137	0.153	0.152	0.156	0.171	0.239	0.329
PL	40 4002	0.023	0.025	0.027	0.028	0.027	0.023	0.023	0.018	0.015	0.019	0.022	0.031
PL	40 4004	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.004	0.003	0.004	0.005	0.006
PL	40 4601	0.063	0.056	0.059	0.065	0.068	0.069	0.076	0.081	0.079	0.078	0.069	0.060
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	0.825	0.794	0.796	0.779	0.784	0.796	0.799	0.753	0.749	0.784	0.769	0.784

Table 9A. (Cont.)

Lab.	Clock		54859	54889	54919	54949	54979	55009	55039	55074	55104	55134	55164	55194
PTB	35	415	-	-	-	-	-	0.000	0.000	0.000	0.000	0.317	0.257	0.365
PTB	35	1072	0.825	0.794	0.796	0.779	0.784	0.796	0.799	0.753	0.749	0.784	0.769	0.784
PTB	40	506	0.001	0.001	0.001	0.001	0.001	0.001	0.002	0.002	0.002	0.002	0.002	0.003
PTB	40	508	-	-	-	-	-	-	-	-	-	-	-	0.000
PTB	40	510	0.000	0.000	0.000	0.000	0.042	0.054	0.000	0.000	0.000	0.000	0.000	0.000
PTB	40	590	0.015	0.015	0.016	0.019	0.021	0.021	0.022	0.020	0.019	0.019	0.018	0.020
PTB	92	1	0.000	0.000	0.000	0.000	0.118	0.135	0.201	0.236	0.292	0.368	0.420	0.412
PTB	92	2	0.825	0.794	0.796	0.779	0.784	0.796	0.799	0.753	0.749	0.784	0.769	0.784
ROA	35	583	0.536	0.794	0.796	0.685	0.512	0.417	0.459	0.459	0.469	0.000	0.105	0.075
ROA	35	718	0.631	0.542	0.522	0.475	0.462	0.495	0.633	0.619	0.600	0.486	0.636	0.784
ROA	35	1699	0.825	0.794	0.796	0.664	0.545	0.571	0.000	0.261	0.287	0.275	0.245	0.218
ROA	36	1488	0.260	0.247	0.228	0.252	0.295	0.288	0.698	0.684	0.561	0.539	0.487	0.399
ROA	36	1490	0.117	0.101	0.101	0.105	0.154	0.106	0.114	0.113	0.104	0.093	0.098	0.095
ROA	40	1436	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.001	0.001
SCL	35	1745	0.521	0.309	0.262	0.299	0.453	0.515	0.638	0.753	0.749	0.784	0.769	0.784
SCL	35	2178	0.000	0.277	0.216	0.217	0.159	0.125	0.133	0.133	0.163	0.162	0.119	0.162
SG	35	475	-	-	-	-	-	-	-	-	-	0.000	0.000	0.000
SG	35	476	-	-	-	-	-	-	-	-	-	0.000	-	-
SG	35	1889	0.177	0.275	0.278	0.432	0.598	-	0.000	0.000	0.000	0.000	0.139	0.114
SG	36	522	0.173	0.162	0.145	0.214	0.160	-	0.000	0.000	0.000	0.000	0.156	0.201
SG	40	7701	-	-	-	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
SIQ	36	1268	0.011	0.010	0.012	0.013	0.016	0.017	0.019	0.016	0.017	0.023	0.030	0.149
SMD	35	810	-	-	-	0.000	0.000	0.000	0.000	0.157	0.145	0.198	0.243	0.317
SMD	35	1766	-	-	-	0.000	0.000	0.000	0.000	0.753	0.738	0.784	0.769	0.784
SMD	35	1896	-	-	-	0.000	0.000	0.000	0.000	0.753	0.749	0.784	0.626	0.491
SMD	35	2003	-	-	-	0.000	0.000	0.000	0.000	0.179	0.261	0.254	0.314	0.413
SMU	36	1193	0.066	0.066	0.070	0.077	0.133	0.259	-	-	-	0.000	0.000	-
SP	19	197	0.000	0.000	0.000	0.012	-	-	-	0.000	0.000	0.000	0.000	-
SP	35	572	0.067	0.061	0.065	0.081	0.075	0.081	0.086	0.103	0.135	0.215	0.415	0.784
SP	35	641	0.128	0.179	-	0.000	0.000	0.000	0.000	0.753	0.476	0.500	0.631	0.457
SP	35	1188	0.133	0.113	0.132	0.118	0.121	0.141	0.174	0.227	0.285	0.238	0.283	0.501
SP	35	1531	0.237	0.198	0.215	0.334	0.304	0.307	0.226	0.168	0.097	0.098	0.085	0.093
SP	35	1642	-	-	-	0.000	0.000	0.000	0.000	0.110	0.116	0.167	0.194	0.231
SP	35	2166	0.825	0.794	0.796	0.779	0.784	0.796	0.799	0.753	0.749	0.772	0.769	0.775
SP	36	223	0.000	0.000	0.000	0.000	0.020	0.019	0.027	0.035	0.042	0.054	0.061	0.074

Table 9A. (Cont.)

Lab.	Clock	54859	54889	54919	54949	54979	55009	55039	55074	55104	55134	55164	55194
SP	36 1175	0.825	0.794	0.796	0.779	0.784	0.796	0.000	0.437	0.426	0.435	0.412	0.408
SP	36 2068	0.184	0.177	0.174	0.159	0.160	0.168	0.178	0.174	0.250	0.254	0.185	0.198
SP	36 2218	0.000	0.229	0.204	0.168	0.191	0.174	0.195	0.238	0.265	0.376	0.270	0.307
SP	36 2295	-	-	-	0.000	0.000	0.000	0.000	0.618	0.749	0.784	0.541	0.652
SP	36 2297	0.584	0.349	0.366	0.370	0.349	0.374	0.335	0.323	0.306	0.309	0.258	0.289
SP	40 7201	0.003	0.002	0.002	0.002	0.002	0.002	0.003	0.002	0.002	0.002	0.002	0.002
SP	40 7203	0.008	0.007	0.007	-	-	-	-	-	-	0.000	0.000	0.000
SP	40 7210	0.002	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	0.000	0.000	0.000	0.002	0.002	0.003	0.004	-	-	0.000	0.000	0.000
SP	40 7212	0.102	0.117	0.133	0.157	0.174	0.179	0.213	-	-	0.000	0.000	0.000
SP	40 7218	-	-	-	0.000	0.000	0.000	0.000	0.005	0.004	0.004	0.003	0.003
SP	40 7221	-	-	-	0.000	0.000	0.000	0.000	0.261	0.261	0.312	0.312	0.312
SU	40 3802	0.103	0.143	0.195	0.252	0.000	0.000	0.000	0.013	0.011	0.011	0.011	0.014
SU	40 3805	0.193	0.177	0.149	0.141	-	-	-	-	-	-	-	-
SU	40 3809	-	0.000	0.000	0.000	0.000	0.097	0.089	0.083	0.080	0.083	0.082	0.087
SU	40 3810	0.012	-	0.000	0.000	0.000	0.000	0.038	0.035	0.033	0.034	0.033	0.034
SU	40 3811	0.000	0.000	0.000	0.010	0.011	0.013	0.017	0.021	0.025	0.032	0.035	0.068
SU	40 3812	0.000	0.000	0.000	0.021	0.028	0.034	0.041	0.046	0.050	0.058	0.061	0.061
SU	40 3814	-	-	-	-	-	-	-	-	-	0.000	0.000	0.000
SU	40 3815	-	-	-	-	-	-	-	-	0.000	0.000	0.000	0.000
SU	40 3816	-	-	-	-	-	-	-	-	0.000	0.000	0.000	0.000
SU	40 3817	-	-	-	-	-	-	-	-	-	0.000	0.000	0.000
SU	40 3822	0.005	0.005	0.005	0.006	0.006	0.007	0.009	0.011	0.014	0.020	0.020	0.019
SU	40 3831	0.130	0.161	0.200	0.221	0.224	0.241	0.269	0.260	0.222	0.190	0.143	0.126
SU	40 3837	0.236	0.289	0.352	0.390	0.442	0.435	0.458	0.426	0.423	0.616	0.575	0.603
SU	40 3855	-	-	0.000	0.000	0.000	-	-	-	-	-	-	-
TCC	35 768	0.000	0.020	0.030	0.041	0.050	0.056	0.061	0.065	0.076	0.074	0.078	0.064
TCC	35 1028	-	-	0.000	0.000	0.000	0.000	0.454	0.527	0.457	0.408	0.491	0.591
TCC	35 1881	0.000	0.308	0.246	0.343	0.453	0.397	0.350	0.381	0.432	0.417	0.401	0.312
TCC	40 8620	0.000	0.004	0.004	0.004	0.003	0.003	0.004	0.004	0.003	0.004	0.005	0.000
TCC	40 8624	0.000	0.069	0.067	0.062	0.060	0.057	0.059	0.053	0.048	0.054	0.055	0.054
TCC	40 8650	0.000	0.004	0.003	0.003	0.002	-	-	-	-	-	-	-
TL	35 160	0.026	0.027	0.030	0.032	0.037	0.056	0.132	0.203	0.135	-	-	-
TL	35 300	0.019	0.017	-	-	-	-	-	-	-	-	-	-
TL	35 474	0.112	0.076	0.051	0.045	0.042	0.042	0.035	0.032	0.023	0.017	0.000	0.007

Table 9A. (Cont.)

Lab.	Clock	54859	54889	54919	54949	54979	55009	55039	55074	55104	55134	55164	55194
TL	35 809	0.027	0.027	0.029	0.034	0.039	0.049	0.049	0.049	0.055	0.100	0.179	0.168
TL	35 1012	0.054	0.041	0.036	0.036	0.039	0.047	0.136	0.120	0.000	0.034	0.023	0.019
TL	35 1104	0.055	0.059	0.063	0.085	0.122	0.123	0.120	0.131	0.104	0.097	0.102	0.082
TL	35 1132	0.156	0.180	0.169	0.178	0.196	0.226	0.000	0.227	0.232	0.259	0.288	0.336
TL	35 1498	-	-	-	0.000	0.000	0.000	0.000	0.587	0.454	0.625	0.746	0.784
TL	35 1500	0.179	0.163	0.185	0.365	0.595	0.796	0.773	0.686	0.624	0.563	0.446	0.438
TL	35 1712	0.825	0.794	0.749	0.765	0.784	0.796	0.799	0.753	0.749	0.784	0.685	0.749
TL	35 2365	0.728	0.794	0.796	0.779	0.784	0.796	0.799	0.753	0.749	0.784	0.769	0.784
TL	35 2366	0.825	0.794	0.796	0.779	0.784	0.796	0.799	0.753	0.749	0.784	0.769	0.784
TL	35 2367	0.825	0.794	0.796	0.779	0.784	0.796	0.799	0.753	0.749	0.784	0.769	0.784
TL	35 2368	0.177	0.194	0.251	0.271	0.442	0.643	0.606	0.702	0.576	0.532	0.382	0.404
TL	40 3052	0.825	0.794	0.796	0.779	0.784	0.796	0.799	0.753	0.738	0.687	0.769	0.784
TL	40 3053	0.825	0.794	0.796	0.779	0.549	0.397	0.400	0.324	0.355	0.367	0.329	0.334
TP	35 163	0.231	0.160	0.148	-	-	-	-	-	-	-	0.000	0.000
TP	35 326	0.011	0.012	0.017	0.018	0.017	0.019	0.021	0.026	-	0.000	0.000	0.000
TP	35 1227	-	0.000	0.000	0.000	0.000	0.229	0.302	0.246	0.253	0.254	0.249	0.312
TP	35 2476	-	-	-	-	-	-	0.000	0.000	-	0.000	0.000	0.000
TP	36 154	0.284	0.251	0.250	0.268	0.312	0.368	0.418	0.282	-	0.000	0.000	0.000
UA	40 7871	0.008	0.009	0.008	0.007	0.007	0.006	0.006	0.004	0.004	0.004	0.004	0.003
UA	40 7881	0.005	0.004	0.003	0.004	0.004	0.005	0.005	0.006	0.008	0.015	0.032	0.035
UA	40 7882	0.002	0.002	0.002	0.003	0.004	0.004	0.009	0.000	0.019	0.015	0.014	0.017
UME	35 251	-	-	-	-	-	-	-	-	-	0.000	0.000	0.000
UME	35 872	0.001	0.001	-	-	-	-	-	-	-	-	-	-
USNO	35 101	0.716	0.724	0.000	0.000	-	-	-	-	-	-	-	-
USNO	35 104	0.462	0.579	0.796	0.779	0.784	0.796	0.799	0.753	0.749	0.784	0.717	0.691
USNO	35 106	0.825	0.794	0.796	0.777	0.587	0.495	0.582	0.572	0.528	0.621	0.520	0.561
USNO	35 108	-	-	0.000	0.000	0.000	0.000	0.637	0.753	0.749	0.784	0.769	0.784
USNO	35 114	0.825	0.794	0.796	0.779	0.784	0.796	0.799	0.753	0.710	0.627	0.463	0.445
USNO	35 120	-	-	-	0.000	0.000	0.000	0.000	0.297	0.434	0.560	0.702	0.784
USNO	35 142	0.483	0.442	0.411	0.000	0.122	0.097	0.107	0.111	0.125	0.147	0.154	0.162
USNO	35 145	0.000	0.094	0.090	0.045	0.028	0.025	0.026	0.030	0.033	0.041	0.047	0.049
USNO	35 146	0.000	0.428	0.428	0.358	0.324	0.289	0.339	0.492	0.478	0.585	0.616	0.784
USNO	35 148	-	-	-	-	0.000	0.000	0.000	0.000	0.649	0.753	0.769	0.784
USNO	35 150	0.825	0.794	0.785	0.779	0.784	0.796	0.799	0.753	0.749	0.784	0.769	0.784
USNO	35 152	0.815	0.647	0.619	0.624	0.659	0.490	0.567	0.495	0.620	0.637	0.525	0.506

Table 9A. (Cont.)

Lab.	Clock	54859	54889	54919	54949	54979	55009	55039	55074	55104	55134	55164	55194
USNO	35 153	0.819	0.794	0.796	0.779	0.784	0.796	0.799	0.753	0.749	0.784	0.769	0.784
USNO	35 156	0.698	0.687	0.733	0.775	0.784	0.796	0.799	0.753	0.749	0.658	0.430	0.404
USNO	35 161	0.453	0.556	0.652	0.513	0.000	0.213	0.196	0.183	0.172	0.183	0.196	0.243
USNO	35 164	0.428	0.620	0.734	0.779	0.784	0.796	0.799	0.753	0.749	0.784	0.769	0.784
USNO	35 165	0.270	0.332	0.399	0.549	0.590	0.527	0.528	0.497	0.307	0.292	0.317	0.414
USNO	35 166	0.620	0.561	0.669	0.652	0.672	0.485	0.462	0.440	0.538	0.744	0.714	0.703
USNO	35 167	0.316	0.287	0.303	0.329	0.339	0.356	0.799	0.753	0.749	0.764	0.659	0.534
USNO	35 173	0.245	0.289	0.298	0.418	0.497	0.684	0.705	0.753	0.749	0.784	0.769	0.784
USNO	35 213	0.302	0.319	0.211	0.000	0.109	0.104	0.119	0.131	0.145	0.188	0.207	0.220
USNO	35 217	0.000	0.794	0.000	0.018	0.017	0.019	0.024	0.027	0.030	0.035	0.041	0.054
USNO	35 226	0.000	0.660	0.796	0.779	0.784	0.796	0.799	0.753	0.749	0.784	0.769	0.784
USNO	35 227	0.126	0.402	0.796	0.779	0.000	0.157	0.000	0.047	0.028	0.019	0.014	0.012
USNO	35 231	0.000	0.308	0.308	0.351	0.325	0.295	0.298	0.365	0.481	0.702	0.769	0.784
USNO	35 233	0.825	0.794	0.796	0.779	0.784	0.796	0.799	0.753	0.749	0.784	0.769	0.784
USNO	35 242	0.746	0.794	0.796	0.779	0.784	0.796	0.799	0.753	0.749	0.784	0.686	0.784
USNO	35 244	0.825	0.794	0.796	0.779	0.784	0.796	0.799	0.753	0.749	0.784	0.769	0.784
USNO	35 249	-	-	-	0.000	0.000	0.000	0.000	0.188	0.134	0.183	-	-
USNO	35 253	0.034	0.035	0.039	0.046	0.058	0.082	0.151	0.425	0.364	0.371	0.402	0.000
USNO	35 254	0.000	0.272	0.077	0.064	0.070	0.069	0.075	0.088	0.103	0.113	0.121	0.134
USNO	35 260	0.000	0.035	0.027	0.021	0.025	0.031	0.040	0.047	0.056	0.058	0.055	0.072
USNO	35 268	-	-	-	0.000	0.000	0.000	0.000	0.451	0.550	0.784	0.769	0.784
USNO	35 389	0.281	0.280	0.332	0.364	0.321	0.291	0.290	-	-	-	-	-
USNO	35 392	0.629	0.593	0.796	0.779	0.000	0.491	0.532	0.436	0.329	0.307	0.272	0.327
USNO	35 394	-	-	-	-	0.000	0.000	0.000	0.000	0.689	0.784	0.769	0.000
USNO	35 416	0.617	0.625	0.736	0.779	0.784	0.796	0.799	0.753	0.724	0.784	0.769	0.784
USNO	35 417	0.825	0.794	0.796	0.779	0.784	0.796	0.704	0.666	0.617	0.739	0.684	0.541
USNO	35 703	0.200	0.187	0.216	0.240	0.234	0.271	0.315	0.443	0.444	0.784	0.769	0.784
USNO	35 717	0.825	0.794	0.796	0.779	0.784	0.796	0.799	0.753	0.749	0.784	0.769	0.784
USNO	35 762	0.644	0.398	0.401	0.482	0.479	0.475	0.672	0.658	-	-	-	-
USNO	35 763	0.825	0.794	0.796	0.779	0.784	0.796	0.799	0.753	0.749	0.784	0.769	0.784
USNO	35 765	0.361	0.459	0.451	-	-	-	-	-	-	-	-	-
USNO	35 1097	0.316	0.495	0.510	0.551	0.784	0.796	0.799	0.753	0.651	0.784	0.769	0.784
USNO	35 1125	0.051	0.069	0.094	0.129	0.113	0.132	0.159	0.186	0.210	0.219	0.198	0.220
USNO	35 1327	0.677	0.794	0.796	0.779	0.784	0.796	0.799	0.753	0.749	0.784	0.769	0.784
USNO	35 1328	0.825	0.794	0.000	0.000	0.055	0.045	0.039	0.037	0.037	0.045	0.052	0.074

Table 9A. (Cont.)

Lab.	Clock	54859	54889	54919	54949	54979	55009	55039	55074	55104	55134	55164	55194
USNO	35 1331	0.825	0.514	0.437	0.461	0.419	0.346	0.365	0.251	0.230	0.279	0.261	0.228
USNO	35 1438	0.404	0.315	0.298	0.303	0.287	0.275	0.618	0.612	0.605	0.772	0.769	0.784
USNO	35 1459	0.000	0.630	0.571	0.779	0.784	0.796	-	-	-	-	-	-
USNO	35 1462	0.825	0.632	0.659	0.761	0.784	0.796	0.799	0.753	0.749	0.784	0.769	0.784
USNO	35 1463	0.825	0.794	0.796	0.779	0.784	0.796	0.799	0.753	0.749	0.614	0.463	0.483
USNO	35 1543	0.175	0.248	0.120	0.108	0.109	-	-	-	-	-	-	-
USNO	35 1575	-	-	-	-	-	0.000	0.000	0.000	0.000	0.594	0.413	0.572
USNO	35 1655	0.558	0.526	0.439	0.431	0.459	0.460	0.402	0.391	0.368	-	-	-
USNO	35 1692	0.808	0.769	-	-	-	-	-	-	-	-	-	-
USNO	35 1696	0.435	-	-	-	-	-	-	-	-	-	-	-
USNO	35 1697	0.493	0.472	0.398	0.374	-	-	-	-	-	-	-	-
USNO	40 702	0.825	0.794	0.796	0.779	0.784	0.796	0.799	0.753	0.749	0.784	0.769	0.784
USNO	40 704	0.341	0.331	0.449	0.707	0.702	-	-	-	-	-	-	-
USNO	40 705	0.137	0.091	0.083	0.071	0.048	0.038	0.035	0.034	0.032	0.034	0.033	-
USNO	40 708	0.085	0.068	0.066	0.072	0.068	0.066	0.069	0.064	0.061	0.062	0.058	0.058
USNO	40 710	0.052	0.055	0.058	0.065	0.073	0.079	-	-	-	-	-	-
USNO	40 711	0.004	0.003	0.003	0.003	0.003	0.003	0.004	0.003	0.003	0.003	-	-
USNO	40 712	0.825	0.794	0.796	0.779	0.784	0.796	0.799	0.753	0.749	0.784	0.769	0.717
USNO	40 713	0.118	0.112	0.109	0.110	0.111	0.109	0.116	0.118	0.115	0.117	0.108	0.107
USNO	40 714	0.339	0.413	0.462	0.779	-	-	-	-	0.000	0.000	0.000	0.000
USNO	40 715	0.064	0.061	0.062	0.063	0.060	-	-	0.000	0.000	0.000	0.000	0.109
USNO	40 716	0.825	0.794	0.796	0.779	0.784	0.796	0.799	0.753	0.749	0.784	0.769	0.784
USNO	40 718	0.020	0.016	0.014	0.014	0.014	0.014	0.016	0.017	0.018	0.019	0.018	0.017
USNO	40 719	0.011	0.009	0.008	0.008	0.007	0.007	0.007	0.007	0.007	0.008	0.009	0.009
USNO	40 720	0.003	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002
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	0.825	-	-	-	0.000	0.000	0.000	0.000	0.749	0.784	0.769	0.000
USNO	40 724	0.038	0.031	0.028	0.027	0.029	0.034	0.071	0.109	0.080	0.056	0.037	0.028
USNO	40 725	0.205	0.180	0.209	0.221	0.224	0.209	0.214	0.209	0.203	0.212	0.203	0.200
USNO	40 726	0.000	0.000	0.000	0.000	0.001	0.001	-	-	-	-	-	-
USNO	40 728	0.001	0.001	-	-	-	-	-	-	-	-	-	-
USNO	40 731	0.052	0.075	0.120	0.214	0.274	0.000	0.108	0.063	0.045	0.036	0.028	0.024
VMI	35 2230	0.000	0.106	0.000	0.009	0.010	0.013	0.017	0.020	0.023	0.020	0.020	0.026
VMI	36 1233	0.000	0.016	0.000	0.004	0.005	0.006	0.008	0.009	0.011	0.011	0.012	0.015
VMI	36 2314	0.000	0.033	0.000	0.007	0.009	0.011	0.014	0.017	0.020	0.019	0.020	0.023

Table 9A. (Cont.)

Lab.	Clock		54859	54889	54919	54949	54979	55009	55039	55074	55104	55134	55164	55194
VSL	35	179	-	-	-	-	-	-	0.000	0.000	0.000	0.000	0.769	0.784
VSL	35	456	0.486	0.794	-	-	0.000	0.000	0.000	0.000	0.749	0.376	0.499	0.588
VSL	35	548	-	-	0.000	0.000	0.000	0.000	0.102	0.150	0.204	0.282	0.323	0.320
VSL	35	731	0.200	0.606	0.770	0.000	0.000	0.013	0.015	0.014	0.015	0.016	0.016	0.017

Table 9B: Statistical data on the weights attributed to the clocks in 2009

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	
2009 Jan.	92	216	356	15	31	53	8	7	17	8	42	52	0.825
2009 Feb.	94	214	356	13	24	41	8	4	14	7	49	59	0.794
2009 Mar.	92	213	353	11	26	40	9	6	18	7	52	62	0.796
2009 Apr.	94	229	373	11	37	52	7	10	19	8	53	65	0.779
2009 May	95	226	373	12	37	54	7	12	21	7	52	63	0.784
2009 June	90	224	362	9	34	48	9	7	17	6	53	63	0.796
2009 July	88	224	361	9	32	48	9	9	25	6	54	61	0.799
2009 Aug.	88	223	363	7	16	32	11	11	25	7	56	64	0.753
2009 Sep.	93	221	365	11	15	32	8	9	19	7	52	61	0.749
2009 Oct.	93	213	360	16	17	43	6	10	17	7	49	58	0.784
2009 Nov.	97	219	370	18	20	45	7	5	15	8	48	57	0.769
2009 Dec.	99	223	373	21	31	54	9	6	17	7	54	62	0.784

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 2010.

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 Length & Time Division of Physical Metrology Korea Research Institute of Standards and Science P.O. Box 102, Yuseong Daejeon 305-340 Republic of Korea
JJY	Space-Time Standards Group National Institute of Information and Communications Technology 4 -2- 1, Nukui-kitamachi Koganei, Tokyo 184-8795 Japan

Signal	Authority
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 an 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.
YVTO	Dirección de Hidrografía y Navegación Observatorio Naval Cagigal Apartado Postal No 6745 Caracas, Venezuela

TIME SIGNALS EMITTED IN THE UTC SYSTEM

Station	Location Latitude Longitude	Frequency (kHz)	Schedule (UTC)	Form of the signal
BPM	Pucheng China 35° 0'N 109° 31'E	2 500 5 000 10 000 15 000	7 h 30 m to 1 h continuous continuous 1 h to 9 h	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 25% for a duration of 0.1 or 0.2 s corresponding to “binary 0” or “binary 1”, respectively, referred to as second marks 0 to 59 in the following. The number of the minute, hour, day of the month, day of the week, month and year are transmitted in BCD code using second marks 20 to the 58, including overhead. Information emitted during minute n is valid for minute n+1. The information transmitted during the second marks 1 to the 14 is provided by third parties. Information on that additional service can be obtained from PTB. To achieve a more accurate time transfer and a better use of the frequency spectrum available an additional pseudo-random phase shift keying of the carrier is superimposed on the AM second markers. No transmission of DUT1.
EBC	San Fernando Spain 36° 28'N 6° 12'W	15006 4998	10 h 00 m to 10 h 25 m 10 h 30 m to 10 h 55 m except Saturday, Sunday and national holidays.	Second pulses of 0.1 s duration of a 1 kHz modulation. Minute pulses of 0.5 s duration of 1 250 Hz modulation. DUT1: ITU-R code by double pulse.

Station	Location Latitude Longitude	Frequency (kHz)	Schedule (UTC)	Form of the signal
HBG(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 will be 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	02 h 06 m to 02 h 40 m 06 h 06 m to 06 h 40 m	A1N type signals are transmitted between minutes 10 and 22 : 0.025 second pulses of 12.5 ms duration are transmitted between minutes 10 and 13; second pulses of 0.1 s duration, 10 second pulses of 1 s duration, 0.1 second pulses of 25 ms and minute pulses of 10 s duration are transmitted between minutes 13 and 22.
RBU	Moscow Russia 56° 44'N 37° 40'E	200/3	Continuous	DXXXW type 0.1 s signals. The numbers of the minute, hour, day of the month, day of the week, month, year of the century, difference between the universal time and the local time, TJD and DUT1+dUT1 are transmitted each minute from the 1st to the 59th second. DUT1+dUT1 : by double pulse.
RJH-63	Krasnodar Russia 44° 46'N 39° 34'E	25.0 25.1 25.5 23.0 20.5	11 h 06 m to 11 h 40 m	A1N type signals are transmitted between minutes 9 and 20 : 0.025 second pulses of 12.5 ms duration are transmitted between minutes 9 and 11 ; 0.1 second pulses of 25 ms duration, 10 second pulses of 1 s duration and minute pulses of 10 s duration are transmitted between minutes 11 and 20.
RJH-69	Molodechno Belarus 54° 28'N 26° 47'E	25.0 25.1 25.5 23.0 20.5	07 h 06 m to 07 h 47 m	A1N type signals are transmitted between minutes 10 and 22 : 0.025 second pulses of 12.5 ms duration are transmitted between minutes 10 and 13; second pulses of 0.1 s duration, 10 second pulses of 1 s duration, 0.1 second pulses of 25 ms and minute pulses of 10 s duration are transmitted between minutes 13 and 22.

Station	Location Latitude Longitude	Frequency (KHz)	Schedule (UTC)	Form of the signal
RJH-77	Arkhangelsk Russia 64° 22'N 41° 35'E	25.0 25.1 25.5 23.0 20.5	09 h 06 m to 09 h 47 m	A1N type signals are transmitted between minutes 10 and 22 : 0.025 second pulses of 12.5 ms duration are transmitted between minutes 10 and 13; second pulses of 0.1 s duration, 10 second pulses of 1 s duration, 0.1 second pulses of 25 ms and minute pulses of 10 s duration are transmitted between minutes 13 and 22.
RJH-86	Bishkek Kirgizstan 43° 03'N 73° 37'E	25.0 25.1 25.5 23.0 20.5	04 h 06 m to 04 h 47 m 10 h 06 m to 10 h 47 m	A1N type signals are transmitted between minutes 10 and 22 : 0.025 second pulses of 12.5 ms duration are transmitted between minutes 10 and 13; second pulses of 0.1 s duration, 10 second pulses of 1 s duration, 0.1 second pulses of 25 ms and minute pulses of 10 s duration are transmitted between minutes 13 and 22.
RJH-90	Nizhni Novgorod Russia 56° 11'N 43° 57'E	25.0 25.1 25.5 23.0 20.5	08 h 06 m to 08 h 47 m	A1N type signals are transmitted between minutes 10 and 22 : 0.025 second pulses of 12.5 ms duration are transmitted between minutes 10 and 13; second pulses of 0.1 s duration, 10 second pulses of 1 s duration, 0.1 second pulses of 25 ms and minute pulses of 10 s duration are transmitted between minutes 13 and 22.
RTZ	Irkutsk Russia 52° 26'N 103° 41'E	50	Winter schedule 22 h 00 m to 24 h 00 m 00 h 00 m to 21 h 00 m Summer schedule 21 h 00 m to 24 h 00 m 00 h 00 m to 20 h 00 m	DXXXW type 0.1 s signals. The numbers of the minute, hour, day of the month, day of the week, month, year of the century, difference between the universal time and the local time, TJD and DUT1+dUT1 are transmitted each minute from the 1st to the 59th second. DUT1+dUT1: by double pulse.
RWM (2)	Moscow Russia 56° 44'N 37° 38'E	4 996 9 996 14 996	The station operates simultaneously on the three frequencies.	A1X type second pulses of 0.1 s duration are transmitted between minutes 10 and 20, 40 and 50. The pulses at the beginning of the minute are prolonged to 0.5 s. A1N type 0.1 s second pulses of 0.02 s duration are transmitted between minutes 20 and 30. The pulses at the beginning of the second are prolonged to 40 ms and of the minute to 0.5 ms. DUT1+dUT1: by double pulse.

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

Station	Location Latitude Longitude	Frequency (kHz)	Schedule (UTC)	Form of the signal
STFS	Sikandrabad India 28° 28'N 77° 13'E	2 599 675	continuous	Pulse width modulated binary coded 5 kHz pulses carrying information on Indian Standard Time – IST (UTC + 5 h 30 m), Time of Day and current position coordinates of the satellite. Pulse repetition rate is 100 pps. The above format is frequency modulated on the carrier.
TDF	Allouis France 47° 10'N 2° 12'E	162	continuous, except every Tuesday from 1 h to 5 h	Phase modulation of the carrier by +1 and -1 rd in 0.1 s every second except the 59^{th} 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 21^{st} to the 58^{th} 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 18^{th} second indicates that the local time is 1 hour ahead of UTC (winter time); a binary 1 at the 14^{th} second indicates that the current day is a public holiday (Christmas, 14 July, etc...); a binary 1 at the 13^{th} second indicates that the current day is a day before a public holiday.
WWV	Fort-Collins CO, USA 40° 41'N 105° 2'W	2 500 5 000 10 000 15 000 20 000	continuous	Pulses of 5 cycles of 1 kHz modulation. 29^{th} and 59^{th} second pulses omitted. Hour is identified by 0.8 second long 1 500 Hz tone. Beginning of each minute identified by 0.8 second long 1 000 Hz tone. DUT1: ITU-R code by double pulse. BCD time code given on 100 Hz subcarrier, includes DUT1 correction.
WWVB	Fort-Collins CO, USA 40° 40'N 105° 3'W	60	continuous	Second pulses given by reduction of the amplitude of the carrier, coded announcement of the date, time, DUT1 correction, daylight saving time in effect, leap year and leap second.
WWVH	Kauai HI, USA 21° 59'N 159° 46'W	2 500 5 000 10 000 15 000	continuous	Pulses of 6 cycles of 1 200 Hz modulation. 29^{th} and 59^{th} second pulses omitted. Hour is identified by 0.8 second long 1 500 Hz tone. Beginning of each minute identified by 0.8 second long 1 200 Hz tone. DUT1: ITU-R code by double pulse. BCD time code given on 100 Hz subcarrier, includes DUT1 correction.
YVTO(3)	Caracas Venezuela 10° 30'N 66° 55'W	5 000	continuous	Second pulses of 1 kHz modulation with 0.1 s duration. The minute is identified by a 800 Hz tone and a 0.5 s duration. Second 30 is omitted. Between seconds 40 and 50 of each minute, voice announcement of the identification of the station. Between seconds 52 and 57 of each minute, voice announcement of hour, minute and second.

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

ACCURACY OF THE CARRIER FREQUENCY

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

TIME DISSEMINATION SERVICES

The following tables are based on information received at the BIPM in February and March 2010.

AUTHORITIES RESPONSIBLE FOR THE TIME DISSEMINATION SERVICES

AOS	Astrogeodynamical Observatory Borowiec near Poznań Space Research Centre P.A.S. PL 62-035 Kórnik - Poland
AUS	Length, Time and Optical Standards Section National Measurement Institute PO Box 264 Lindfield NSW 2070 - Australia
BelGIM	Belarusian State Institute of Metrology National Standard for Time, Frequency and Time-scale of the Republic of Belarus Minsk, Minsk Region – 220053 Belarus
BEV	Bundesamt für Eich- und Vermessungswesen Arltgasse 35 A-1160 Wien , Vienna - Austria
CENAM	Centro Nacional de Metrología km. 4.5 Carretera a Los Cués El Marqués, Querétaro, C.P. 76246 - México
CENAMEP	Centro Nacional de Metrología de Panamá AIP CENAMEP AIP Ciudad del Saber Edif. 215 Panamá
EIM	Hellenic Institute of Metrology Electrical Measurements Department Block 45, Industrial Area of Thessaloniki PO 57022, Sindos Thessaloniki, Greece
GUM	Time and Frequency Laboratory Electrical Metrology Division Główny Urząd Miar – Central Office of Measures ul. Elektoralna 2 PL 00 – 950 Warszawa P–10, Poland
HKO	Hong Kong Observatory 134A, Nathan Road Kowloon, Hong Kong
INPL	National Physical Laboratory Danciger A bldg Givat - Ram, The Hebrew university 91904 Jerusalem, Israel

INRIM	Istituto Nazionale di Ricerca Metrologica Strada delle Cacce, 91 I – 10135 Torino, Italy
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 Length & Time Division of Physical Metrology Korea Research Institute of Standards and Science P.O. Box 102, Yuseong Daejeon 305-340 Republic of Korea
KZ	Kazakhstan Institute for 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 Semiconductor Physics Institute – State Metrology Service A. Goštauto 11 Vilnius LT01108, Lithuania
METAS	Federal Office of Metrology Length, Optics and Time Section Lindenweg 50 CH-3003 Bern-Wabern Switzerland
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 Group National Institute of Information and Communications Technology 4 -2 -1, Nukui-kitamachi Koganei, Tokyo 184-8795 - Japan
NIM	Time & Frequency Laboratory National Institute of Metrology No. 18, Bei San Huan Dong Lu Beijing 100013 - People's Republic of China
NIMB	Time and Frequency Laboratory National Institute of Metrology Sos. Vitan - Barzesti, 11 042122 Bucharest Romania
NIMT	Time & Frequency Laboratory National Institute of Metrology (Thailand) 3/5 Moo 3, Klong 5, Klong Luang, Pathumthani 12120, Thailand
NIST	National Institute of Standards and Technology Time and Frequency Division, 847.00 325 Broadway Boulder, Colorado 80305, USA
NMIJ	Time and Frequency Division National Metrology Institute of Japan (NMIJ), AIST Umezono 1-1-1, Tsukuba, Ibaraki 305-8563, Japan
NMISA	Time and Frequency Laboratory National Metrology Institute of South Africa Private Bag X34 Lynnwood Ridge 0040 - South Africa
NMLS	Time and Frequency Laboratory National Metrology Laboratory SIRIM Berhad, Lot PT 4803, Bandar Baru Salak Tinggi, 43900 Sepang - Malaysia
NPL	National Physical Laboratory 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 (MCT) Divisão Serviço da Hora Rua General José Cristino, 77 São Cristovão 20921-400 Rio de Janeiro, Brasil
ORB	Royal Observatory of Belgium Avenue Circulaire, 3 B-1180 Brussels, Belgium
PTB	Physikalisch-Technische Bundesanstalt Time and Frequency Department, WG 4. 42 Bundesallee 100 D-38116 Braunschweig, Germany
ROA	Real Instituto y Observatorio de la Armada Cecilio Pujazón s/n 11.100 San Fernando Cádiz, Spain
SG	National Metrology Centre Agency for Science, Technology and Research (A*STAR) 1 Science Park Drive 118221 Singapore
SIQ	Slovenian Institute of Quality and Metrology Metrology department Trzaska ul. 2 1000 Ljubljana Slovenia

SP	SP Technical Research Institute of Sweden Box 857 S-501 15 Borås Sweden
TL	National Standard Time and Frequency Laboratory Telecommunication Laboratories Chunghwa Telecom. Co., Ltd. No. 12, Ln.551, Ming-Tsu Road Sec. 5 Yang-Mei, Taoyuan, 326 Taiwan, Rep. of China
TP	Institute of Photonics and Electronics 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
VNIIFTRI	All-Russian Scientific Research Institute for Physical Technical and Radiotechnical Measurements, Moscow Region 141570 Russia
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/clock1.htm
AUS	Network Time Service Computers connected to the Internet can be synchronized to UTC(AUS) using the NTP protocol. The NTP servers are referenced to UTC(AUS) either directly or via a GPS common view link. Please see www.measurement.gov.au/time for information on access or contact time@measurement.gov.au Dial-up Computer Time Service Computers can also obtain time via a modem connection to our dialup timeserver. For further information, please see our web pages as above.
BelGIM	Internet Time Service: BelGIM operates one time server Stratum 1 using the "Network Time Protocol" (NTP). The server host name is: http://www.belgim.by (Stratum 1)
BEV	3 NTP servers are available; addresses: bevtime1.metrologie.at bevtime2.metrologie.at time.metrologie.at more information on http://www.metrologie.at Provides a time dissemination service via phone and modem to synchronize PC clocks. Uses the Time Distribution System from TUG. It has a baud rate of 1200 and everyone can use it with no cost. Access phone number is +43 (0) 1 211106381 The system will be updated periodically (DUT1, Leap Second…).
CENAM	CENAM operates a voice automatic system that provides the local time for three different time zones for México; Central Time, Pacific Time and Northwest Time as well the UTC(CNM). The access numbers are: +52 442 211 0506: Central Time +52 442 211 0507: Pacific Time +52 442 211 0508: Northwest Time +52 442 215 3902: UTC(CNM) Telephone Code CENAM provides a telephone code for setting time in computers. More information about this service please contact J. Mauricio López at jlopez@cenam.mx

	Network Time Protocol Operates one time server using the "Network Time Protocol", it is located at the Centro Nacional de Metrología, Querétaro, México. Further information at http://www.cenam.mx/hora_oficial/ Web-based time-of-day clock that displays local time for México time zones. Referenced to CENAM Internet Time Service. Available at http://www.cenam.mx/hora_oficial/ Transmission of voice by radio in Mexico City to more than 20 million inhabitants. The voice messages are transmitted every minute, 24 hours a day, every day of the year, by the radio station XEQK, whose signal is at 1350 kHz amplitude modulated (AM).
CENAMEP	Network Time Server The NTP is used to synchronize computer networks of the government institutions and enterprises in the private sector. For further information send an email to servicios@cenamep.org.pa Web Clock A web clock displayed the time of day in real time. To access the Web Clock, enter the link http://horaexacta.cenamep.org.pa/ Voice Time Server It is a assembly of computers that provides the local time acceding the telephone numbers (507) 5173202 and (507) 5173203
EIM	Internet Time Service EIM operates a stratum-1 time server using the "Network Time Protocol" (NTP). The DNS electronic address ntp.eim.gr (IP: 194.30.249.20) is not operating due to a serious malfunction. At this time our network time server has the host name hercules.eim.gr and is also accessible through IP address 194.30.249.26. 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	Speaking Clock Service HKO operates an automatic “Dial-a-weather System” that provides voice announcement of Hong Kong Standard Time. (=UTC(HKO) + 8 h). Access phone number: + 852 1878200 Network Time Service HKO operates two Internet time servers using Network Time Protocol. Host name of the server: stdtime.gov.hk Further information at http://www.hko.gov.hk/nts/ntime.htm Web-based time-of-day clock that displays Hong Kong Standard Time. Requires web browser with Adobe Flash Player 6.0 or above installed. Available at http://www.hko.gov.hk/gts/time/HKSTime.htm

INPL	INPL is providing two electronic time dissemination services: 1. via telephone. The user must download a program from INPL ftp site (vms.huji.ac.il) 2. NTS via optic fiber to the Hebrew University which provides time on the internet. For details email clock@vms.huji.ac.il
INRIM	CTD Telephone Time Code Time signals dissemination, according to the European Time code format, available via modem on regular dial-up connection. Access phone numbers : 0039 011 3919 263 and 0039 011 3919 264. Provides a synchronization to UTC(IT) for computer clocks without compensation for the propagation time. Software for the synchronization of computer clocks is available on INRIM home page (www.inrim.it). Internet Time Service INRIM operates two time servers using the "Network Time Protocol" (NTP); host names of the servers are ntp1.inrim.it and ntp2.inrim.it. More information on this service can be found on the web pages: www.inrim.it/ntp/index_i.shtml
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 numbers: + 82 42 863 7117, + 82 42 868 5116 Network Time Service KRISS operates three time servers using the NTP to synchronize computer clocks to Korea Standard Time via the Internet. Host name of the server : time.kriss.re.kr (210.98.16.100) Software for the synchronization of computer clocks is available at http://www.kriss.re.kr
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 http://uakyt.kz “Six-pip time signals” are broadcasted 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://lne-syrte.obspm.fr/gen/ntp_infos.html

LT

Network Time Service via NTP protocol
NTP v3
DNS: laikas.pfi.lt
Port 123
Synchronization from caesium clock (1 pps)
System: Datum TymeServe 2100 NTP server
Access policy: free
Contact: Rimantas Miškinis
Mail: Laikas@pfi.lt
http://www.pfi.lt/metrology/

METAS

Telephone Time Service
The coded time string (compliant to the European Time Code format) is referenced to UTC(CH) and generated by a TUG type time code generator.
Access phone numbers: +41 31 323 32 25, +41 31 323 47 00.

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

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	195.255.132.229	Synchronized to UTC(MIKE)
ntp4.mikes.fi	195.255.132.231	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

Telephone Time Service
A dial up computer time setting service for linking computers to UTC(MSL). The service uses a time code specific to New Zealand. Because it is a pay service, access is restricted to callers within New Zealand.

Speaking Clock
A speaking clock gives New Zealand time. Because it is a pay service, access is restricted to callers within New Zealand.
Further information about these services can be found at
http://msl.irl.cri.nz/services/time/index.html

NAO	Network Time Service Three stratum 2 NTP servers are available. The NTP servers internally refer stratum 1 NTP server that is linked to UTC(NAO). One of the three stratum 2 NTP servers are selected automatically by a round-robin DNS server to reply for an NTP access. The server host name is s2csntp.miz.nao.ac.jp.
NICT	Telephone Time Service (TTS) 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)	2 NTP servers are available: Addresses: ntp.oraoficiala.ro (STRATUM 2) with an open access policy ntp.inm.ro (STRATUM 1) with restricted access policy. Both NTP servers are referenced to UTC (NIMB).
NIMT	3 NTP servers are available: Addresses: time1.nimt.or.th time2.nimt.or.th time3.nimt.or.th The NTP servers are referenced to UTC(NIMT)
NIST	Automated Computer Time Service (ACTS) Provides digital time code by telephone modem for setting time in computers. Free software and source code available for download from NIST. Includes provision for calibration of telephone time delay. Access phone numbers : +1 303 494 4774 (12 phone lines) and +1 808 335 4721 (4 phone lines). Further information at http://tf.nist.gov/service/acts.htm Internet Time Service (ITS) Provides digital time code across the Internet using three different protocols: Network Time Protocol, Daytime Protocol, and Time Protocol. (Time Protocol supported by 20 of 22 servers) Geographically distributed set of 22 time servers at 16 locations within the United States of America. Free software and source code available for download from NIST.Further information at http://tf.nist.gov/service/its.htm

(1) NIMB no longer offers time disssemination services for the moment, due to time servers problems,

	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(2)	Network Time Service One open access NTP server is available at address time.nmisa.org. More information is available at http://www.nmisa.org/time.html
NMLS	Telephone Time Service The coded time information is referenced to UTC(NMLS) and generated by a TUG type telephone time code generator using an ASCII-character code. The time protocols are sent in the "European Telephone Time Code" format. The service phone number is +60 3 8778 1674. Current service status is free of charge. Fees are made only on the provision of the software for accessing the service via modem dial-up. Network Time Protocol (NTP) Service The NTP time information is referenced to UTC(NMLS) and is currently generated by two Stratum-1 NTP servers, made available for public freely. The NTP server host names are ntp1.sirim.my and ntp2.sirim.my.
NPL	Telephone Time Service A TUG time code generator provides the European Telephone Time Code, referenced to UTC(NPL), by telephone modem. Software for synchronising computers is available from the NPL web site at www.npl.co.uk/time. The service telephone number is 0906 851 6333. Note: this is a premium rate number and can only be accessed from within the UK. Internet Time Service Two servers referenced to UTC(NPL) provide Network Time Protocol (NTP) time code across the internet. More information is available from the NPL web site at www.npl.co.uk/time. The server host names are: ntp1.npl.co.uk ntp2.npl.co.uk
NPLI	Telephone Time Service The coded time information generated by time code generator of NPLI, referenced to UTC(NPLI). Telephone Code provides digital time code (for the current time of Indian standard Time) at 1200 bauds, 8 bits, no parity, 1 stop bit. This service is known as TELECLOCK Service. Accessible by : a. an NPLI-developed Teleclock Receiver already available in the market. b. a Computer through Telephone Modem and NPLI-developed software. One-way Geostationary Satellite Time Service.

(2) NMISA no longer provides the telephone Time Service for time distribution. Only the Internet Network Time Protocol must remain.

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://time.ntsc.ac.cn
Access Policy: free
Contact: Shaowu DONG (sdong@ntsc.ac.cn).

ONBA

Speaking clock access phone number 113 (only accessible in Argentina).
Hourly and half hourly radio-broadcast time signal.
Internet time service at web site www.hidro.gov.ar/hora/hora.asp

ONRJ

Telephone Voice Announcer (55) 21 25806037.
Telephone Code (55) 21 25800677 provides digital time code at 300 bauds, 8 bits, no parity, 1 stop bit (Leitch CSD5300)

Internet Time Service at the address : 200.20.186.75 and 200.20.186.94
SNTP at port 123
Time/UDP at port 37
Time/TCP at port 37
Daytime/TCP at port 13

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

	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.observatoire.be/D1/TIME/ntp_en.htm ORB provides a time dissemination via phone and modem to synchronize PC clocks on UTC(ORB). The system used is the Time Distribution System from TUG, which produces the telephone time code mostly used in Europe. The baud rate used is 1200. The access phone number is 32 (0) 2 373 03 20. The system is updated periodically with DUT1 and leap seconds
PTB	Telephone Time Service The coded time information is referenced to UTC(PTB) and generated by a TUG type time code generator using an ASCII-character code. The time protocols are sent in a common format, the “ European Telephone Time Code “. Access phone number : +49 531 51 20 38 . Internet Time Service The PTB operates 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. IRIG-B time code service Provides IRIG-B Modulated time code via a dial-up phone connection. No need of any kind of modem. Access phone number: +886 3 4203090 NTP Service TL operates a time server using the "Network Time Protocol" (NTP). Host name of the server : time.stdtime.gov.tw Further information at http://www.stdtime.gov.tw/english/e-home.htm
TP	Internet Time Service IPE operates a time server directly referenced to UTC(TP). Time information is accessible through Network Time Protocol (NTP). Server host name: time.ufe.cz More information at http://www.ufe.cz/time

UME	Telephone Time Service Providing the European time code that is referenced to UTC(UME) by telephone modem for setting computer time. Includes compensation of propagation time delay. More information for this service please contact to eml@ume.tubitak.gov.tr. Access phone number : +90 262 679 50 24 Network Time Service UME operates an NTP server referenced to UTC(UME). Host server name : time.ume.tubitak.gov.tr
USNO	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.
VNIIFTRI	Internet Time Service VNIIFTRI operates three time servers Stratum 1and one time server Stratum 2 using the “Network Time Protocol” (NTP). The server host names are: ntp1.imvp.ru (Stratum 1) ntp2.imvp.ru (Stratum 1) ntp3.imvp.ru (Stratum 1) ntp21.imvp.ru (Stratum 2).
VSL(3)	Telephone Time Service The coded time information is referenced to UTC(VSL) and generated by a TUG type time code generator using an ASCII-character code. The time protocols are sent in a common format, the "European Telephone Time Code". The access phone number is 0900 6171819. This is a toll number and therefore can only be accessed in the Netherlands. VSL operates a time server directly referenced to UTC(VSL). Time information is accessible through Network Time Protocol (NTP). The URL for the NTP server is: ntp.vsl.nl

(3) The telephone time service has been discontinued from December 31 st, 2009.