BUREAU INTERNATIONAL DES POIDS ET MESURES

BIPM Annual Report on Time Activities

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Contents

Practical information about the BIPM Time Department

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

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Director's Report on the Activity and Management of the BIPM, 2010

(July 2009- June 2010)

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 2009*, volume 4, complemented by computer-readable files on the BIPM website, provides the definitive results for 2009. Starting with this volume the Annual Report is available only in electronic form; it is published on the BIPM website at http://www.bipm.org/en/publications/time_activities.html.

2 Algorithms for time scales

The algorithm ALGOS used for the calculation of the time scales is an iterative process that starts by producing a free atomic scale (*Échelle atomique libre,* EAL) from which TAI and UTC are derived. Research into time-scale algorithms continues in the Department with the aim of improving the long-term stability of EAL and the accuracy of TAI. After having studied the clock frequency prediction, and concluded that the H-masers could be responsible only for about 20 % of the drift of EAL, a comparative analysis of algorithms in different time scales has started and is ongoing.

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. On average during 2009, about 15 % of the participating clocks were at the maximum weight. This procedure generates a time scale which relies upon the best clocks.

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

2.2 TAI accuracy

To characterize the accuracy of TAI, estimates are made of the relative departure, and its uncertainty, of the duration of the TAI scale interval from the SI second, as produced on the rotating geoid, by primary frequency standards. Since July 2009, individual measurements of the TAI frequency have been provided by thirteen primary frequency standards, including nine caesium fountains (IT CSF1, LNE-SYRTE FO1, LNE-SYRTE FO2, LNE-SYRTE FOM, NICT CSF1, NIST F1, NMIJ F1, PTB CSF1 and PTB CSF2). Reports on the operation of the primary frequency standards are regularly published on the BIPM website and collated in the *BIPM Annual Report on Time Activities*.

As of July 2004, a monthly steering correction of at most 7 parts in 10^{16} is applied as deemed necessary. Since July 2009, 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 $+2.6 \times 10^{-15}$ to $+5.7 \times 10^{-15}$, with a standard uncertainty of less than 1×10^{-15}. Over the year, twelve steering corrections have been applied, giving a total correction to $[f(EAL) - f(TAI)]$ of -6.1×10^{-15}.

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(BIPM09), valid until December 2009, which has an estimated accuracy of about 5 parts in 10^{16}. Moreover, since January 2010, we provide each month an extension of TT(BIPM09) based on the most recent TAI computation. Such an extension is useful for pulsar analysis pending the yearly updates of TT(BIPM). Studies aimed at improving the computation of TT(BIPM) are ongoing, in order to keep it in line with improvements in the primary frequency standards.

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

Following a recommendation by the CCTF (2009), preparatory work has started in the Department with a view to publishing the relationship between UTC(USNO) and UTC(SU) (as broadcast by GPS and GLONASS) and UTC as disseminated in the BIPM's *Circular T*.

3 Primary frequency standards and secondary representations of the second

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

The CCL/CCTF Frequency Standards Working Group proposes various other microwave and optical atomic transitions as secondary representations of the second. The latest changes to the list, containing frequency values and uncertainties for transitions in Rb, Hg^{+}, Yb^{+}, Sr^{+} and Sr, were recommended by the CCTF in June 2009, and no further updates have been produced during the period covered by this report. Staff from the BIPM Time, Frequency and Gravimetry Department continue to participate in the rapidly evolving field of optical frequency standards, addressing the issue of their comparison at the level of parts in 10^{17}.

4 Time links

TAI currently relies on data from 69 participating time laboratories equipped with GNSS receivers and/or operating TWSTFT stations. Significant improvements have been made within the Department on the time links used for the calculation of TAI; data from three independent techniques are included in the process of comparison of laboratories' clocks based on tracking GPS and GLONASS satellites, and on two-way satellite time and frequency transfer through geostationary telecommunications satellites (TWSTFT).

The GPS all-in-view method is widely used and takes advantage of the increasing quality of the International GNSS Service (IGS) products. Clock comparisons are possible using C/A code measurements from GPS single frequency receivers, or dual-frequency, multi-channel GPS geodetic-type receivers (P3). The older GPS single-channel single-frequency receivers currently represent only 3 % of the total number and have mostly been replaced by either multi-channel 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 becoming equipped. The GPS phase and code data provided by time laboratories is processed each month using the Precise Point Positioning (PPP) technique. Following approval by the CCTF at its meeting in June 2009, such PPP links have been introduced in the calculation of TAI since September 2009. Currently, 30 laboratories participate regularly, about 15 of which are used as TAI links. Comparisons of the PPP links with others obtained by TWSTFT and P3 are published monthly on the Time, Frequency and Gravimetry Department's ftp server. Testing continues on other time and frequency comparison methods and techniques. The first GLONASS common-view civil-code link between PTB and VNIIFTRI was introduced into TAI computation in November 2009, providing results consistent with the GPS multi-channel single-frequency links.

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

All GNSS links are corrected for satellite positions using IGS and ESA postprocessed, precise satellite ephemerides, and those links using singlefrequency receivers are corrected for ionospheric delays using IGS maps of the total electron content of the ionosphere.

4.2 Phase and code measurements from geodetic-type receivers

In addition to GPS and GLONASS code measurements, time and frequency transfer may also be carried out using dual-frequency, carrier-phase measurements. This technique, already widely used by the geodetic community, can be adapted to the needs of time and frequency transfer. A study is being conducted in the framework of the IGS Working Group on Clock Products, of which a physicist of the Time, Frequency and Gravimetry Department is a member. The method developed to perform the absolute calibration of the Ashtech Z12-T hardware delays allows the BIPM to use this receiver for differential calibrations of similar receivers world-wide, and calibration campaigns began in January 2001. Calibration results have also been issued for other receivers: the Septentrio PolaRx2 since 2006 and the Dicom GTR50 and Javad JPS E-GGD since 2009. Other types of receivers are being investigated in collaboration with laboratories equipped with them. Since 2009, the BIPM travelling receiver for differential calibrations is a GTR50. In all cases, at least two receivers remain at the BIPM to serve as a local reference with which the travelling receiver is compared between calibration trips. Results of the differential calibration exercises are made available on a dedicated web page (www.bipm.org/jsp/en/TimeCalibrations.jsp), where past calibration results are also provided. Data from geodetic-type receivers world-wide are collected for TAI computation, using procedures and software developed in collaboration with the Observatoire Royal de Belgique (ORB). These P3 time links are now routinely computed and compared to other available techniques, notably two-way time transfer. Geodetic-type receivers also provide raw phase measurements which may be used, along with the code measurements, to compute time links. The BIPM has computed its own solutions for such time links since October 2007, using the GPSPPP software from Natural Resources Canada, and these links have been introduced into the TAI regular computation since September 2009. Work on GLONASS P3 and GLONASS PPP time links started in June 2010.

4.3 Two-way time transfer

Two meetings of the TWSTFT participating stations have been held since July 2009, and the CCTF WG on TWSTFT met at the AOS (Poznań, Poland) in October 2009. 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 GNSS single-frequency, dual-frequency and TW observations are published monthly on the Time, Frequency and Gravimetry Department's ftp server (ftp://tai.bipm.org/TimeLink/LkC).

4.4 Uncertainties of TAI time links

The values of the Type A and Type B uncertainties of TAI time links are published in *Circular T*, together with information on the time links used in each monthly calculation. The values of u_A 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 2009 to June 2010, GPS and GLONASS time equipment for single- and dual-frequency reception has been calibrated. The BIPM is also supporting TWSTFT calibration trips, supported by a GPS receiver from our time laboratory.

Work on the absolute calibration of GNSS receivers was started by a Ph.D. student through a collaboration co-financed with the CNES and also involving the LNE-SYRTE. In 2009 work started at the CNES to carry out absolute calibration of GNSS antennas. In addition, the PhD 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. Cooperation started with EURAMET for having regional support to the GNSS equipment calibration in contributing laboratories. This action follows Recommendation CCTF 2 (2009) and opens the possibilities of further interaction with other RMOs.

5 Key comparisons

Results of the key comparison in time, CCTF-K001.UTC, involving the time laboratories participating in the CIPM MRA, were regularly published in the KCDB after publication of the monthly *Circular T* until June 2009. Since then, a link to the most recent issue of *Circular T* has been proposed from the KCDB.

Guidelines for the characterization of the frequency traceability of local realizations UTC(*k*) to the SI second are under preparation in the Time, Frequency and Gravimetry Department, as requested by the CCTF in June 2009.

As decided by the 98th CIPM meeting in 2009, the BIPM continues to support the CCL-K11 key comparison in terms of participation in measurement campaigns as well as in giving general advice. In particular, the BIPM took part in the campaign held at the NMIJ/AIST in April 2010 in which 8 participants successfully participated. Together with a similar campaign at the NRC in September 2009 and measurements in BEV and MIKES, the total number of participating NMIs is now 17. This demonstrates that after the initial start-up period the CCL-K11 is running effectively and produces valuable data to support CMC claims.

6 Pulsars

The work with the Observatoire Midi-Pyrénées (OMP, Toulouse, France) on a pulsar survey has stopped. Collaboration continues with 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 Time, Frequency and Gravimetry Department 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* (tai.bipm.org/iers/). Updates to the *Conventions* (2003) have been posted on the website (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* is expected to be available before end-2010.

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 Time, Frequency and Gravimetry Department, BIPM comb activities are limited to the maintenance of the BIPM frequency combs for internal applications.

9 Calibration and measurement service

The Time, Frequency and Gravimetry Department 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.

Twenty lasers were measured for ICAG-2009. As planned, for the first time in this international comparison, studies of the beam characteristics in the interferometers of the participating gravimeters were made, in order to account for small corrections related to diffraction effects.

Checks of the frequency of the rubidium clocks in the gravimeters were made during the measurement campaign.

10 Iodine cells

As decided by the CIPM, the service of filling and testing iodine cells was stopped on 31 July 2009, after having delivered all the cells to national laboratories and various institutes.

11 Gravimeter FG5-108

After having modified the laser head of the compact Nd:YVO_4/KTP/I_2 laser at 532 nm and the optical fibre system for light delivery to the interferometer of the FG5-108, the gravimeter has been tested with good results. However, after having replaced the motor of the dropping chamber and the dropping controller, tests after re-adjustments showed that the gravimeter was still malfunctioning. After many trials and discussions with the developers of the instrument it has been decided to stop the measurements.

12 8th International Comparison of Absolute Gravimeters, ICAG-2009

In contrast to earlier comparisons of absolute gravimeters, the ICAG-2009 was split into two parts which ran consecutively, one as a key comparison, CCM.G-K1, and a second as a pilot study, with 12 and 10 participants respectively. This was the first time a key comparison for absolute gravimetry was arranged. Both comparisons were running under essentially the same protocol even though some relaxed conditions were accepted for the pilot study. A 5 station scheme with 3 measurements for each instrument was used. A preliminary evaluation of all the results has now been made and a Draft A report has been edited.

In connection with the ICAG-2009, measurements of both the laser frequency and the frequency of the Rubidium frequency standards of the gravimeters were carried out. A BIPM reference laser, calibrated with an optical frequency comb system prior to the ICAG-2009, were used as a reference in the beat frequency measurements. In the case of the Rubidium standards, a reference signal, calibrated relative to UTC, was used and a phase meter giving frequency as well as stability measurements was carried out.

In addition, measurement of the beam parameters for the laser beams used for the interferometric determination of the position of the free falling test mass was made. This is important for making a good estimate of the error due to the Gouy phase shift.

Measurements at two sites in the room that will house the watt balance have been made with some participating gravimeters. These measurements are not included in the official report, but will serve to monitor the stability of the gravity field in the room.

13 Publications, lecture, travel: Time, Frequency and Gravimetry Department

13.1 External publications

1. Arias E.F., Current and future realizations of coordinate time scales, *Proc. IAU Symp.* **261**, Cambridge University Press, 2010, 16-21.

2. Arias E.F., Panfilo G., Impact of new frequency standards on the international timescales, *Proc. IAU*, Vol **5**, 2010, 223-224.

3. Harmegnies A., Panfilo G., Arias E.F., Detection of outliers in TWSTFT data used in TAI, *Proc. 41st PTTI Systems and Applications Meeting*, 2010, 421-432.

4. Harmegnies A., Panfilo G., Arias E.F., BIPM time activities update, *Proc. 41st PTTI Systems and Applications Meeting*, 2010, 183-188.

5. Jiang Z., Arias E.F., Lewandowski W., Petit G., Toward unified TWSTFT and GNSS delay characterization for UTC time transfer?, *Proc. EFTF 2010*, 2010, CD-ROM.

6. Jiang Z., Lewandowski W., Konaté H., TWSTFT Data Treatment for UTC time transfer, *Proc. 41st PTTI Systems and Applications Meeting*, 2010, 409-420.

7. Jiang Z., Petit G., Combination of TWSTFT and GNSS for accurate UTC time transfer, *Metrologia*, 2009, **46**, 305-314.

8. Jiang Z., Becker M., Francis O., *et al*, Relative Gravity Measurement Campaign during the 7th International Comparison of Absolute Gravimeters, *Metrologia*, 2009, **46**, 214-226.

9. Jiang Z., Fully use of the redundancy in TWSTFT and GNSS time and frequency transfer, *Proc. EFTF2009*, 1194-1197.

10. Jiang Z., Lewandowski W., Konaté H., TWSTFT data treatment for UTC time transfer, *Proc. 41st PTTI Systems and Applications Meeting, 2010*, 409-420.

11. Jiang Z., Piester D., Liang K., Restoring a TWSTFT Calibration with a GPS Bridge - a standard procedure for UTC time transfer, *Proc. EFTF 2010*, 2010, CD-ROM.

12. Jiang Z., Interpolation of TW time transfer from measured points onto standard MJD for UTC generation, *Proc. EFTF 2010,* 2010, CD-ROM.

13. Lewandowski W., Jiang, Z., Use of GLONASS at the BIPM, *Proc. 41st PTTI Systems and Applications Meeting*, 2010, 5-14.

14. Lewandowski W., Jiang Z., Use of GLONASS at the BIPM, *Proc. PTTI2009*, 2010, 5-13.

15. Liu Y., Jiang Z., Precise time transfer activities in Singapore, *Proc. EFTF-IFCS 2009*, 2010, 634-638.

16. Ma C., Arias E.F., Bianco G., Boboltz D., Bolotin S., Charlot P., Engelhardt G., Fey A., Gaume R., Gontier A.-M., Heinkelmann R., Jacobs C., Kurdubov S., Lembert S., Malkin Z., Nothnagel A., Petrov L., Skurikhina E., Sokolova J., Souchay J., Sovers O., Tesmer V., Titov O., Wang G., Zharov V., The Second Realization of the International Celestial Reference Frame by Very Long Baseline Interferometry, *IERS Technical Note N°35*, 2009.

17. Panfilo G., Arias E.F., Algorithms for International Atomic Time, *UFFC special issue on the 2009 Joint Meeting of the EFTF and IEEE FCS*, 2010, 140-150.

18. Panfilo G., Arias E.F., Studies and possible improvements on EAL algorithm, *Proc. EFTF-IFCS 2009*, 2010, 110-115.

19. Petit G., Relativity in the IERS Conventions, *Proc IAU Symposium 261*, Cambridge University Press, 2010, 16-21.

20. Petit G., Current use of GNSS time transfer in TAI and future strategies, Proc. 2nd Int. Colloq. on scientific and fundamental aspects of Galileo, 2009, CD-Rom.

21. Petit G., Luzum B., Report of the IERS Conventions Center, *IAU Transactions XXIIB*, 2010.

22. Petit G., Atomic time scales TAI and TT(BIPM): present performances and prospects, *Proc. IAU*, Vol **5**, 2010, 220-221.

23. Souchay J., Andrei A., Barache C., Bouquillon S., Suchet D., Baudin M., Gontier A.-M, Lambert S., Le Poncin Lafitte C., Taris F., Arias E.F., The construction of the Large Quasar Astrometric Catalogue, *A&A* 494, 2, 2009, 799-815.

24. Zhang H., Li H., Lewandowski W., Jiang Z., TWSTFT activities at NTSC*, Proc. EFTF-IFCS 2009*, 2010, 1206-1208.

13.2 BIPM publications

25. *BIPM Annual Report on Time Activities for 2009*, 2010, 4, 104 pp., available only at www.bipm.org/en/publications/time_activities.html

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

27. Lewandowski W., Tisserand L., Relative characterization of GPS time equipment delays at the OP, AOS, GUM, LT, TP, BEV, OMH, NIMB, NMC, and ZMDM, *Rapport BIPM*-2010/02, 27 pp.

28. Lewandowski W., Tisserand L., Relative characterizaton of GPS time equipment delays at the OP, PTB, AOS, USNO and IT, *Rapport BIPM*-2010/03, 16 pp.

29. Lewandowski W., Tisserand L., Relative characterization of GNSS receiver delays for GPS and GLONASS C/A codes in the L1 frequency band at the OP, SU, PTB and AOS, *Rapport BIPM*-2010/04, 40 pp.

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

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

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

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

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

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

publications	**filename**
Acronyms of laboratories	acronyms.pdf
Leap seconds	leaptab.pdf
Circular T	cirt.XXX
Fractional frequency of EAL from primary frequency standards	etXY.ZT
Weights of clocks participating in the computation of TAI	wXY.ZT
Rates relative to TAI of clocks participating in the computation of TAI	rXY.ZT
Values of the differences between TAI and the local atomic scale of the given laboratory, including relevant notes	TAI - lab
Values of the differences between UTC and its local representation by the given laboratory, including relevant notes	UTC - lab
Values of the differences between TAI and UTC and the respective local scales, evaluated for two-month periods until the end of 1997	TAIXYZ
[*UTC*(*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. From the BIPM Annual Report on Time Activities for 2009, only electronic files are available.

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

Leap seconds

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

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

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

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

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

3. Availability

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

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

4. Time links

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

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

GPS links are computed with the method called "GPS all in view" [3], with a network of time links that uses the PTB as a unique pivot laboratory for all the GPS links. Since September 2009, links equipped with geodetic-type receivers are computed with the "Precise Point Positioning" method [4].

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 [5]. This link is computed using the "common-view" [6] method; data are corrected using the ESA ephemerides SP3 files and the IGS ionospheric maps.

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

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

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

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 [7, 8]. 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 2010.

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 2009-June 2010 is extracted from the *Director's Report on the Activity and Management of the BIPM (1 July 2009 – 30 June 2010)*. All the publications mentioned in this report are available on request from the BIPM.

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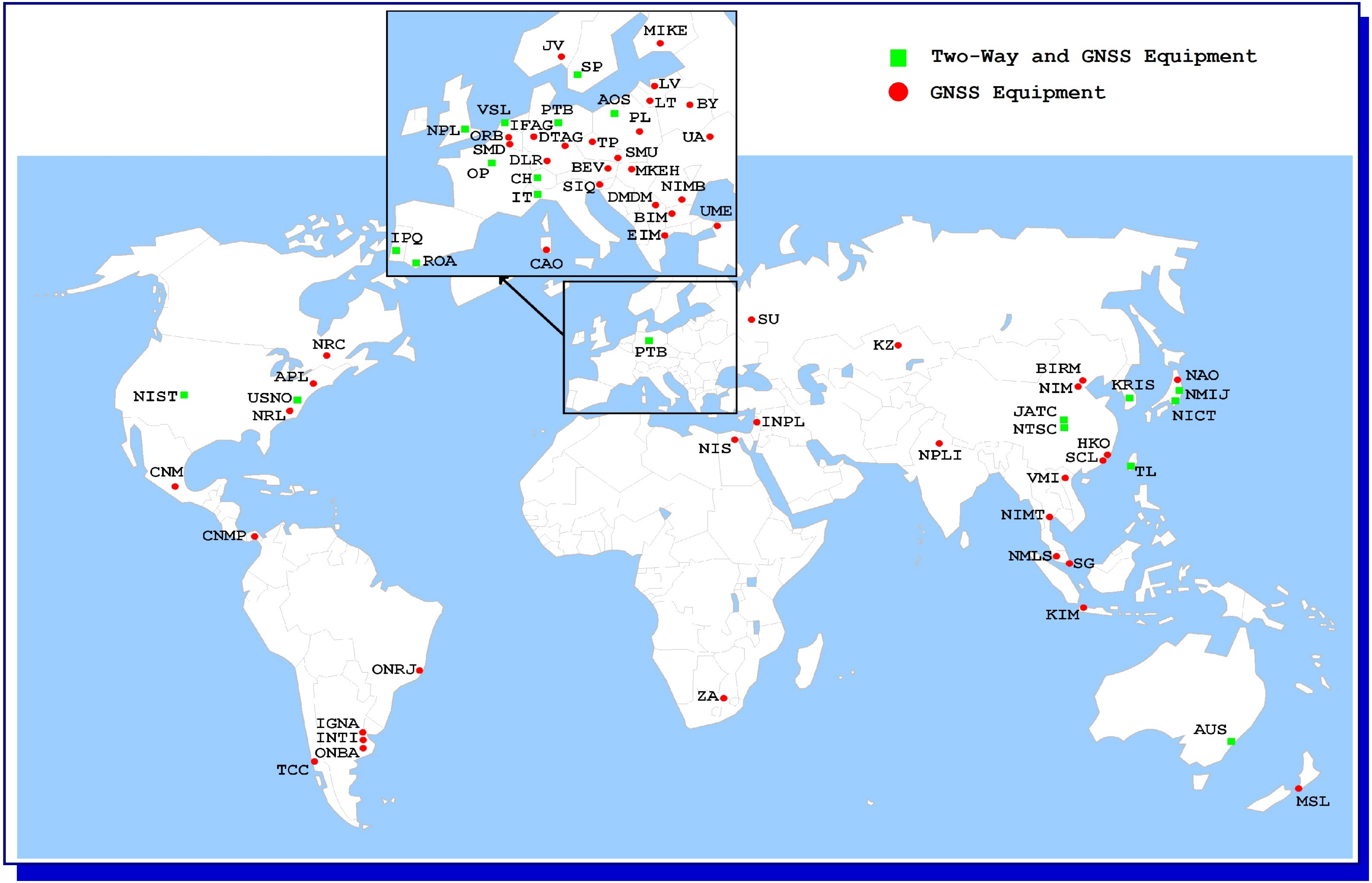

Geographical distribution of the laboratories that contribute to TAI and time transfer equipment operated in 2010

Table 1. Relative frequency offsets and step adjustments of UTC, up to 31 December 2011

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

Table 2. Relationship between TAI and UTC, up to 31 December 2011

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 March 2011)

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, Sofia, Bulgaria
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
DTAG	Deutsche Telekom AG, Frankfurt/Main, Germany
EIM	Hellenic Institute of Metrology, Thessaloniki, Greece
F	Commission Nationale de l'Heure, Paris, France
GUM	Glówny Urząd Miar (Central Office of Measures), Warsaw, Poland
HKO	Hong Kong Observatory, Hong Kong, China
IFAG	Bundesamt für Kartographie und Geodäsie (Federal Agency for Cartography and Geodesy), Fundamental station, Wettzell, Kötzting, Germany
IGNA	Instituto Geográfico Nacional, Buenos Aires, Argentina (formerly IGMA)
INPL	National Physical Laboratory, Jerusalem, Israel
INTI	Instituto Nacional de Tecnologia Industrial, Buenos Aires, Argentina
IPQ	Instituto Português da Qualidade, Monte de Caparica, Portugal
IT	Istituto Nazionale di Ricerca Metrologica (INRIM), Italy
JATC	Joint Atomic Time Commission, Lintong, P.R. China
JV	Justervesenet, Norwegian Metrology and Accreditation Service, Kjeller, Norway
KEBS	Kenya Bureau of Standards, Nairobi, Kenya
KIM	Research Centre for Calibration, Instrumentation and Metrology The Indonesian Institute of Sciences, Serpong-Tangerang, Indonesia
KRISS	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	Center for Physical Sciences and Technology, 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 March 2011)

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 Metrologičký Ústav (Slovak Institute of Metrology), Bratislava, Slovakia
SP	Sveriges Provnings- och Forskningsinstitut (Swedish National Testing and Research Institute), Borås, Sweden
SU	Institute of Metrology for Time and Space (IMVP), NPO "VNIIFTRI" Mendeleevo, Moscow Region, 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 Netherlands
ZA	National metrology Institute of South Africa, Pretoria, South Africa

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

Table 4. Equipment and source of UTC(*k*) of the laboratories contributing to TAI in 2010

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	* (9)	*	*	*	*
APL	3 Ind. Cs 3 H-masers	1 H-maser + frequency synthesizer steered to UTC(APL)		*			
AUS (a)	5 Ind. Cs 2 H-masers	1 Cs		*	*		*
BEV	3 Ind. Cs 1 H-maser	1 Cs		*			
BIM	3 Ind. Cs	1 Cs		*	*		
BIRM	2 Ind. Cs 6 H-masers	1 Cs		*	*		
BY (a)	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	2 Ind. Cs	1 Cs		*			
DLR	3 Ind. Cs 5 H-masers	1 Cs			*		
DMDM	2 Ind. Cs	1 Cs + microphase-stepper		*			
DTAG	3 Ind. Cs	1 Cs		*	*		
EIM	4 Ind. Cs	1 Cs		*			
HKO	2 Ind. Cs	1 Cs		*			
IFAG	5 Ind. Cs 2 H-masers	1 Cs + microphase-stepper		*	*		
IGNA	3 Ind. Cs	1 Cs + microphase-stepper		*			

Table 4. Equipment and source of UTC(*k*) of the laboratories contributing to TAI in 2010 (Cont.)

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

Lab k	Equipment	Source of UTC(*k*) (1)	TA(*k*)	Time Links			
				GPS		GLONASS	Two-Way
				SF	DF		
INPL	2 Ind. Cs	1 Cs		*	*		
INTI (a)	1 Ind. Cs	1 Cs		*			
IPQ	3 Ind. Cs	1 Cs + microphase-stepper			*	*	*
IT	6 Ind. Cs 3 H-masers 2 Lab. Cs	1 H-maser + microphase-stepper	*	*	*	*	*
JATC	18 Ind. Cs (4) 3 H-masers	1 Cs + microphase-stepper	*	*	*		*
JV (a)	4 Ind. Cs	1 Cs		*			
KIM (a)	1 Ind. Cs	1 Cs		*	*	*	
KRIS	5 Ind. Cs 4 H-masers	1 H-maser + microphase-stepper	*	*	*	*	*
KZ	4 Ind. Cs	1 Cs + microphase-stepper			*	*	
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		*	*		

Table 4. Equipment and source of UTC(*k*) of the laboratories contributing to TAI in 2010 (Cont.)

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

Lab k	Equipment	Source of UTC(*k*) (1)	TA(*k*)	Time Links			
				GPS		GLONASS	Two-Way
				SF	DF		
NIMT	2 Ind. Cs	1 Cs + microphase-stepper		*	*		
NIS (a)	3 Ind. Cs	1 Cs		*	*	*	
NIST	8 Ind. Cs 2 Lab. Cs 6 H-masers	4 Cs 6 H-masers + microphase-stepper	*	*	*	*	*
NMIJ	4 Ind. Cs 1 Lab. Cs 4 H-masers	1 H-maser + microphase-stepper		*	*		*
NMLS	3 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	4 Ind. Cs 3 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	8 Ind. Cs 1 H-maser	8 Cs 1 H-maser + microphase-stepper	* (6)	*			
OP	8 Ind. Cs 4 Lab. Cs 4 H-masers	1 Cs + microphase-stepper	* (7)	*	*	*	*
ORB	3 Ind. Cs 2 H-masers	1 H-maser			*		
PL	10 Ind. Cs 4 H-masers	1 Cs (8) + microphase-stepper	* (9)	*			
PTB	3 Ind. Cs 4 Lab. Cs (10) 3 H-masers	1 H-maser (11) + microphase-stepper	* (11)	*	*	*	*
ROA	6 Ind. Cs (12) 1 H-maser	1 H-maser + frequency synthesizer steered to UTC(ROA) (13)		*	*	*	*

Table 4. Equipment and source of UTC(*k*) of the laboratories contributing to TAI in 2010 (Cont.)

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

Lab k	Equipment	Source of UTC(*k*) (1)	TA(*k*)	Time Links			
				GPS		GLONASS	Two-Way
				SF	DF		
SCL	2 Ind. Cs	1 Cs + microphase-stepper		*			
SG	4 Ind. Cs 1 H-maser	1 H-maser + microphase-stepper	*	*	*	*	
SIQ	1 Ind. Cs	1 Cs		*			
SMD	4 Ind. Cs 1 H-maser	1 Cs + microphase-stepper		*			
SMU	1 Ind. Cs	1 Cs + output frequency steering		*	*	*	
SP	13 Ind. Cs (14) 7 H-masers	1 H-maser + microphase-stepper			*		*
SU	1 Lab. Cs 8-12 H-masers	4-8 H-masers	*		*	*	
TCC	3 Ind. Cs 3 H-masers	1 Cs		*	*		
TL	13 Ind. Cs 3 H-masers	1 H-maser + microphase-stepper	* (15)		*		*
TP	5 Ind. Cs	1 Cs + output frequency steering			*		
UA	1 Ind. Cs 3 H-masers	3 H-masers + microphase-stepper		*			
UME	3 Ind. Cs	1 Cs		*	*	*	
USNO	70 Ind. Cs 29 H-masers	1 H-maser + frequency synthesizer steered to UTC(USNO) (16)	* (16)	*	*		*
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 2009, 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 1 hydrogen maser and microstepper, it is steered using TA(PL) data as a reference.

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

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

(5) NICT The standards are located as follows (at the end of 2010):

* 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 Time Service Division in Rio de Janeiro with data from 8 industrial caesium clocks and 1 hydrogen maser.

(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 2010) :

* 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)	1 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
* Spectracom, Orolia (Les Ulis)	1 Cs

All laboratories are linked via GPS receivers.

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

(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 12 caesium clocks and 4 hydrogen masers located as follows:

* Central Office of Measures (GUM, Warsaw)	3 Cs, 1 H-maser
* Astrogeodynamical Observatory, Space Research Center P.A.S. (AOS, Borowiec)	2 Cs, 2 H-masers
* 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)	1 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, except for one clock of TPSA linked via two-directional optical fibre connection.

(10) PTB The laboratory Cs, PTB CS1 and PTB CS2 are operated continuously as clocks. PTB CS2 was out of operation for the three months, September to November 2010. 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.

(11) PTB Until September 2010, TA(PTB) has been derived from PTB CS2, later from PTB CS1, without frequency steering. UTC(PTB) is based on the output of an active hydrogen maser steered in frequency since MJD 55224 (February 2010). *TA*(*PTB*)-*UTC*(*PTB*) is published in PTB Time Service Bulletin.

(12) ROA The standards are located as follows (at the end of 2010):

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

(13) 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.

(14) SP The standards are located as follows (at the end of 2010):

* 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 13-caesium-clock ensemble.

(16) USNO The time scales A.1(MEAN) and UTC(USNO) are computed by USNO. They are determined by a weighted average of Cs clocks and hydrogen masers located at the USNO.
A.1(MEAN) is a free atomic time scale, while UTC(USNO) is steered to UTC. Included in the total number of USNO atomic standards are the clocks located at the USNO Alternate Master Clock in Colorado Springs, CO.

Table 5. Differences between the normalized frequencies of EAL and TAI, up to April 2011

(File containing values since the beginning of the steering is available at ftp://62.161.69.5/pub/tai/scale/ealtai10.ar)

Date	MJD	[f(EAL) - f(TAI)] x 10^{-13}
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
2010 APR 28 - 2010 MAY 28	55314 - 55344	6.651
2010 MAY 28 - 2010 JUN 27	55344 - 55374	6.645
2010 JUN 27 - 2010 JUL 27	55374 - 55404	6.639
2010 JUL 27 - 2010 AUG 26	55404 - 55434	6.633
2010 AUG 26 - 2010 SEP 30	55434 - 55469	6.626
2010 SEP 30 - 2010 OCT 30	55469 - 55499	6.619
2010 OCT 30 - 2010 NOV 29	55499 - 55529	6.612
2010 NOV 29 - 2010 DEC 29	55529 - 55559	6.605
2010 DEC 29 - 2011 JAN 28	55559 - 55589	6.598
2011 JAN 28 - 2011 FEB 27	55589 - 55619	6.591
2011 FEB 27 - 2011 MAR 29	55619 - 55649	6.584
2011 MAR 29 - 2011 APR 28	55649 - 55679	6.577

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/utai10.ar)

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

In this table, *d* is obtained on the given periods of estimation by comparison of the TAI frequency with that of the individual primary frequency standards (PFS) IT-CSF1, NICT-CSF1, NIST-F1, NMIJ-F1, NPL-CSF2, PTB-CS1, PTB-CS2, PTB-CSF1, PTB-CSF2, SYRTE-FO1, SYRTE-FO2, SYRTE-FOM and SYRTE-JPO for the year 2010. 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 4.

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 2010 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	$(0.5$ to $0.9)\times10^{-15}$	0.5	[1]	H maser	6 / 15 d to 35 d
NICT-CSF1	Fountain	$(0.9$ to $1.0)\times10^{-15}$	1.9	[2]	UTC(NICT)	2 / 15 d to 25 d
NIST-F1	Fountain	0.31×10^{-15}	0.35	[3]	H maser	7 / 15 d to 25 d
NMIJ-F1	Fountain	3.9×10^{-15}	3.9	[4]	H maser	5 / 15 d to 35 d
NPL-CSF2	Fountain	$(0.40$ to $0.59)\times10^{-15}$	0.41	[5]	H maser	18 (8 in 2009)/10 d to 40 d
PTB-CS1	Beam /Mag.	8×10^{-15}	8.	[6]	TAI	12 / 30 d
PTB-CS2	Beam /Mag.	12×10^{-15}	12.	[7]	TAI	8 / 30 d
PTB-CSF1	Fountain	$(0.76$ to $0.81)\times10^{-15}$	1.4	[8]	H maser	4 / 15 d to 30 d
PTB-CSF2	Fountain	0.60×10^{-15}	0.8	[9]	H maser	1 / 15 d
SYRTE-FO1	Fountain	$(0.40$ to $0.48)\times10^{-15}$	0.72	[10]	H maser	6 / 15 d to 30 d
SYRTE-FO2	Fountain	$(0.38$ to $0.41)\times10^{-15}$	0.65	[10]	H maser	9 / 15 d to 30 d
SYRTE-FOM	Fountain	$(0.82$ to $0.86)\times10^{-15}$	0.80	[11]	H maser	5 / 15 d to 35 d
SYRTE-JPO	Beam /Opt.	6.3×10^{-15}	6.3	[12]	H maser	9 / 5 d to 35 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	55194	55214	2.71	0.60	0.60	0.50	0.52	1.11	
IT-CsF1	55334	55349	4.66	0.40	0.50	0.40	0.73	1.05	
IT-CsF1	55349	55374	7.29	0.60	0.50	0.20	0.46	0.93	
IT-CsF1	55379	55399	4.40	0.40	0.50	0.20	0.56	0.88	
IT-CsF1	55399	55434	4.95	0.30	0.60	0.10	0.34	0.76	
IT-CsF1	55449	55464	8.34	0.40	0.90	0.20	0.73	1.24	
NICT-CsF1	55189	55214	4.09	1.00	0.90	0.30	0.23	1.40	
NICT-CsF1	55534	55549	6.44	1.00	1.10	0.30	0.37	1.56	
NIST-F1	55219	55244	5.20	0.31	0.31	0.21	0.46	0.67	
NIST-F1	55274	55299	6.38	0.37	0.31	0.19	0.46	0.69	
NIST-F1	55354	55374	8.04	0.30	0.31	0.16	0.56	0.73	
NIST-F1	55404	55419	5.62	0.47	0.31	0.21	0.73	0.95	
NIST-F1	55444	55469	7.10	0.35	0.31	0.19	0.38	0.63	
NIST-F1	55494	55509	6.37	0.46	0.31	0.31	0.43	0.77	
NIST-F1	55529	55549	4.55	0.43	0.31	0.21	0.28	0.64	
NMIJ-F1	55349	55364	3.54	0.90	3.90	0.40	0.49	4.05	
NMIJ-F1	55404	55439	4.14	0.60	3.90	0.10	0.20	3.95	
NMIJ-F1	55439	55469	6.73	0.60	3.90	0.10	0.26	3.96	
NMIJ-F1	55504	55529	5.30	0.70	3.90	0.30	0.23	3.98	
NMIJ-F1	55529	55559	4.99	0.70	3.90	0.30	0.20	3.98	
NPL-CsF2	54904	54934	5.36	0.41	0.41	0.07	0.33	0.67	
NPL-CsF2	54974	54984	3.22	0.66	0.45	0.05	0.88	1.19	
NPL-CsF2	55004	55014	4.84	1.08	0.59	0.43	0.88	1.57	
NPL-CsF2	55039	55049	3.11	0.74	0.43	0.28	1.39	1.65	
NPL-CsF2	55064	55074	5.38	0.76	0.51	0.15	1.75	1.98	
NPL-CsF2	55084	55114	3.30	0.38	0.41	0.07	0.65	0.86	
NPL-CsF2	55119	55144	3.51	0.42	0.41	0.08	0.77	0.97	
NPL-CsF2	55169	55194	4.70	0.19	0.40	0.01	0.46	0.64	
NPL-CsF2	55194	55224	4.86	0.18	0.40	0.10	0.39	0.60	
NPL-CsF2	55224	55254	2.79	0.35	0.43	0.19	0.39	0.70	
NPL-CsF2	55254	55284	3.91	0.37	0.41	0.06	0.39	0.68	
NPL-CsF2	55284	55294	3.10	0.69	0.40	0.11	1.05	1.33	
NPL-CsF2	55314	55329	6.08	0.45	0.40	0.23	0.73	0.97	
NPL-CsF2	55334	55349	3.94	0.32	0.41	0.35	0.73	0.96	
NPL-CsF2	55394	55404	6.43	0.31	0.42	0.09	1.05	1.18	
NPL-CsF2	55404	55444	5.32	0.17	0.40	0.20	0.26	0.54	
NPL-CsF2	55459	55479	7.21	0.20	0.40	0.03	2.67	2.71	
NPL-CsF2	55484	55509	5.01	0.41	0.49	0.05	2.18	2.27	
PTB-CS1	55194	55224	-2.86	5.00	8.00	0.00	0.13	9.43	(1)
PTB-CS1	55224	55254	-6.48	6.00	8.00	0.00	0.13	10.00	
PTB-CS1	55254	55284	-4.25	6.00	8.00	0.00	0.13	10.00	
PTB-CS1	55284	55314	-5.21	6.00	8.00	0.00	0.13	10.00	
PTB-CS1	55314	55344	-1.81	6.00	8.00	0.00	0.13	10.00	
PTB-CS1	55344	55374	5.69	6.00	8.00	0.00	0.13	10.00	
PTB-CS1	55374	55404	-3.55	6.00	8.00	0.00	0.13	10.00	
PTB-CS1	55404	55439	0.14	6.00	8.00	0.00	0.11	10.00	
PTB-CS1	55439	55469	-0.84	6.00	8.00	0.00	0.13	10.00	
PTB-CS1	55469	55499	-1.93	6.00	8.00	0.00	0.13	10.00	
PTB-CS1	55499	55529	3.05	6.00	8.00	0.00	0.13	10.00	
PTB-CS1	55529	55559	-4.41	6.00	8.00	0.00	0.13	10.00	

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-CS2	55194	55224	7.63	3.00	12.00	0.00	0.13	12.37	(1)
PTB-CS2	55224	55254	6.29	3.00	12.00	0.00	0.13	12.37	
PTB-CS2	55254	55284	1.89	3.00	12.00	0.00	0.13	12.37	
PTB-CS2	55284	55314	0.23	3.00	12.00	0.00	0.13	12.37	
PTB-CS2	55314	55344	5.09	3.00	12.00	0.00	0.13	12.37	
PTB-CS2	55344	55374	1.45	3.00	12.00	0.00	0.13	12.37	
PTB-CS2	55374	55404	-1.04	3.00	12.00	0.00	0.13	12.37	
PTB-CS2	55404	55439	5.37	3.00	12.00	0.00	0.11	12.37	
PTB-CSF1	55349	55364	7.23	0.24	0.81	0.05	0.24	0.88	
PTB-CSF1	55379	55409	6.34	0.22	0.76	0.02	0.13	0.80	
PTB-CSF1	55484	55499	7.36	0.24	0.76	0.02	0.24	0.83	
PTB-CSF1	55514	55529	8.20	0.24	0.76	0.03	0.24	0.83	
PTB-CSF2	55244	55259	7.39	0.70	0.60	0.02	0.24	0.95	
SYRTE-FO1	55199	55224	4.90	0.20	0.41	0.11	0.54	0.71	
SYRTE-FO1	55284	55314	4.84	0.30	0.40	0.11	0.46	0.69	
SYRTE-FO1	55329	55344	5.09	0.20	0.41	0.10	0.85	0.97	
SYRTE-FO1	55409	55434	5.59	0.20	0.44	0.14	0.54	0.74	
SYRTE-FO1	55469	55494	5.79	0.30	0.48	0.14	0.54	0.79	
SYRTE-FO1	55539	55559	5.77	0.70	0.42	0.12	0.66	1.06	
SYRTE-FO2	55194	55224	5.50	0.35	0.38	0.10	0.43	0.68	
SYRTE-FO2	55224	55254	4.56	0.30	0.39	0.10	0.46	0.68	
SYRTE-FO2	55254	55284	4.79	0.30	0.39	0.10	0.46	0.68	
SYRTE-FO2	55284	55309	5.58	0.30	0.39	0.11	0.54	0.74	
SYRTE-FO2	55329	55344	6.30	0.30	0.38	0.10	0.85	0.99	
SYRTE-FO2	55344	55364	6.41	0.30	0.40	0.14	0.66	0.84	
SYRTE-FO2	55409	55429	5.09	0.20	0.40	0.11	0.66	0.80	
SYRTE-FO2	55479	55494	6.88	0.30	0.41	0.12	0.85	1.00	
SYRTE-FO2	55539	55559	6.58	0.70	0.39	0.12	0.66	1.04	
SYRTE-FOM	55344	55359	5.96	0.20	0.86	2.00	0.85	2.35	(2)
SYRTE-FOM	55364	55399	4.52	0.20	0.86	1.00	0.40	1.39	(3)
SYRTE-FOM	55404	55434	4.76	0.20	0.86	2.00	0.46	2.23	(3)
SYRTE-FOM	55439	55469	5.82	0.20	0.86	1.00	0.46	1.41	(3)
SYRTE-FOM	55529	55544	6.53	1.00	0.82	0.12	0.85	1.55	
SYRTE-JPO	55194	55224	3.89	0.61	6.30	0.30	0.43	6.35	
SYRTE-JPO	55224	55254	3.37	0.68	6.30	0.30	0.46	6.36	
SYRTE-JPO	55254	55284	5.33	0.65	6.30	0.30	0.46	6.36	
SYRTE-JPO	55284	55314	7.38	0.61	6.30	0.30	0.46	6.35	
SYRTE-JPO	55324	55344	7.76	0.71	6.30	0.30	0.66	6.38	
SYRTE-JPO	55344	55374	4.04	0.94	6.30	0.30	0.46	6.39	
SYRTE-JPO	55374	55404	2.77	0.90	6.30	0.30	0.46	6.39	
SYRTE-JPO	55404	55439	-0.12	0.85	6.30	0.30	0.40	6.38	
SYRTE-JPO	55439	55444	7.91	2.83	6.30	0.30	2.29	7.28	

Notes:
(1) Continuously operating as a clock participating to TAI.
(2) Operated in MPQ, Garching (Germany)
(3) Operated in OCA (France)

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Report on the activity of IT-CsF1 Primary Frequency Standard during 2010

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During 2010, IT-CsF1 reported six frequency evaluation to the BIPM. In the tables below, a summary of the report and a typical accuracy budget is shown.

CircT	Period (MJD)	Dur.	Local Osc.	yITCsF1-yTAI	uA	uB	ulab	uTAI	u
265	55194 55214	20	1401103	2.71	0.60	0.60	0.50	0.52	1.11
271	55334 55349	15	1401103	4.66	0.40	0.50	0.40	0.73	1.05
271	55349 55374	25	1401103	7.29	0.60	0.50	0.20	0.46	0.93
271	55379 55399	20	1401103	4.40	0.40	0.50	0.20	0.56	0.88
272	55399 55434	35	1401103	4.95	0.30	0.60	0.10	0.34	0.76
274	55449 55464	15	1401103	8.34	0.40	0.90	0.20	0.73	1.24

Effect	Bias ($x10^{-15}$)	Uncertainty ($x10^{-15}$)
Quadratic Zeeman (field map)	45.75	0.06
Blackbody Radiation	-28.50	0.30
Collisional (average)(*)	-1.0	0.10
Gravitational Potential	26.10	0.01
Microwave related	-	0.50
Total	42.35	0.70

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

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

<u>Atomic density shift</u>: 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 uncertainty, is composed of a type A part, taken into account by the linear fit of the data, and of a type B component, ≤10% of the weighted averaged density shift [1].
<u>Statistical analysis:</u> both orthodox and Bayesian techniques has been applied to the analysis of the collisional shift correction [3]. This leads to the rigorous embedding of the theoretical information concerning the sign of the collisional shift in the analysis, reducing up to 30% the type A uncertainty.
<u>Quadratic Zeeman shift</u>: the magnetic field is mapped along the atom flight path before each fountain evaluation, with low frequency transition spectroscopy ($\Delta F=0$, $\Delta m=\pm1$); Long term stability of the Zeeman shift is of few parts in 10^{16} .
<u>Blackbody radiation shift:</u> the blackbody radiation shift is corrected using the value β=-1.711(3)$x10^{-14}$; IT-CsF1 is operated around 343 K and the uncertainty on this correction is typically 2-3$\times10^{-16}$.
<u>Microwave related shifts</u>: the presence of unwanted microwave related shifts (such as microwave leakages, spurious spectrum components, distributed phase shifts) is tested as described in [4] before and after each TAI evaluation. The measured shift is compatible with zero at 3-5$\times10^{-16}$ level.

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Operation of Cs atomic fountain NICT-CsF1 in 2010

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. In 2010, we performed accuracy evaluations with the NICT-CsF1 twice, i.e. 25-days over the period of MJD 55189-55214 and 15-days over the period of MJD 55534-55549[2, 3]. Among 2010, we had many troubles on the NICT-CsF1 and its operation was interrupted many times. Despite of the accidental troubles the NICT-CsF1 still made valuable contribution to the TAI.

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]. The lower atomic number density operation resulted in smaller collisional shift and associated uncertainty (20% of the frequency bias) than those stated in the first report, and the variation of the collisional shift measurement became a little larger. However, we have confirmed that it was consistent with stated Type A uncertainty of 1.0 × 10^{-15}.

We summarize the corrected biases and their uncertainties in 2010 measurements as below.

Physical Effect	Bias (10^{-15})	Uncertainty (10^{-15})
2nd Zeeman	74.8	<0.1
Collision (averaged)	-2.5	0.5
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 55189-55214

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 2010

NIST-F1, the Cs fountain primary frequency standard at the National Institute of Standards and Technology (NIST), has been in operation since November 1998, and the first formal report to the BIPM was made in November 1999 [1]. Two papers updating the operation of NIST-F1 were later published in 2005 [2, 3]. During a formal evaluation the average frequency of one of the hydrogen masers at NIST is measured by NIST-F1 and the results, along with all relevant biases and uncertainties, are reported to the BIPM for publication in Circular T. NIST-F1 is not operated as a clock and is run only intermittently. The standard is constantly evolving, and both hardware and software improvements are continually being made. These improvements now tend to be aimed more at increasing the fountain run time and reliability, rather than decreasing the uncertainty. In addition there is always an improved understanding of how the standard operates [4]. In all formal evaluations a range of atom densities was used along with a weighted linear least squares fit to determine the frequency at zero density. The typical frequency shift from the lowest measured density to zero density in 2010 was on the order of $6x10^{-16}$. Each formal evaluation also includes mapping the magnetic field, and measurements of possible biases due to such things as microwave amplitude and light leaks.

Seven formal evaluations were carried out in 2010. All were made with a range of atom densities to determine the spin exchange shift. We stopped using historical atom density slopes in 2010 after it was observed that, after years of stability, the slope of the spin exchange slope began changing. The cause was traced to increasing noise levels in the master laser due to pump laser degradation. This increased the slope due to changes in atom detection efficiency. For the foreseeable future all evaluations of NIST-F1 will be made with a range of atom densities. NIST-F1 has also been used in comparisons to NIST-F2, a cryogenic cesium fountain frequency standard. This will ultimately lead to an improved measurement of the blackbody shift. Hopefully, NIST-F2 will be in operation as a primary frequency standard in 2011.

The Type B uncertainties in NIST-F1 for the seven runs in 2010 are substantially the same as those given in Table 1 of [2], and are dominated by the blackbody and microwave amplitude shifts. Reference 2 is the source for u_B(Ref) given in Circular T. The density shift uncertainty is included in the Type A uncertainty. The total Type B uncertainty for all of the runs in 2010 was $3.1x10^{-16}$, dominated by the blackbody shift with an uncertainty of $2.8x10^{-16}$. The Type A uncertainties ranged from $3.0x10^{-16}$ to $4.7x10^{-16}$ for the seven runs. The uncertainties due to the spin exchange shift ranged from $1.4x10^{-16}$ to $3.3x10^{-16}$. Total uncertainties, including frequency transfer and dead time uncertainties, ranged from $6.3x10^{-16}$ to $9.5x10^{-16}$.

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Operation of NMIJ-F1 Primary Frequency Standard in 2010

In 2010, we have operated NMIJ-F1 officially six times for 15 to 35 days in each one campaign to calibrate TAI. The operation time during a year was 165 days in total. 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 ($x10^{-15}$)
2^{nd} order Zeeman	185.0	0.5
Blackbody radiation	-18.0	1.4
Gravitation	1.6	0.1
Cold collisions	0.0	3.3
Distributed cavity phase	0.0	1.2
Microwave power dependence	0.0	0.7
Total	168.6	3.9

Table 1: Typical uncertainty budget used in 2010

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Operation of the NPL-CsF2 primary frequency standard in 2010

The caesium fountain standard NPL-CsF2 was made fully operational and characterised in 2009, but it was in 2010 when the first official report of the TAI step interval evaluation was submitted to the BIPM Time section. This was following the publication of the details of the standard [1] and its acceptance by the CCTF Working Group on Primary Frequency Standards. The first report covered eight operation periods in 2009 to demonstrate a consistent long-term behaviour of the new standard. Subsequent reports covered ten periods of operation in 2010.

After the initial evaluation of the NPL-CsF2 fountain standard in 2009, its operation procedure was later optimized following an implementation of an optical pumping stage after the launch of cold atoms [2]. A short pulse of linearly polarised light (π-polarisation), resonant with the $F = 4 \rightarrow F' = 4$ transition and accompanied by a repumper pulse ($F = 3 \rightarrow F' = 4$) resulted in an accumulation of the atomic populations in one of the clock states, $F = 4$, $m_F = 0$, which is a “dark state” for this light configuration.

The improved and optimized standard, operating in an alternating mode (between high and low density/atom number), demonstrated the effective short-term stability of the frequency extrapolated to zero density at the level of less than 1×10^{-15} in one day of averaging. The type A uncertainty for NPL-CsF2 was calculated assuming white frequency noise and a reduction of statistical noise as $1/\tau^{1/2}$.

An uncertainty due to dead time is calculated as a quadratic sum of uncertainties due to individual gaps in the measurement. Assuming the instability of the reference hydrogen maser to be dominated by a flicker frequency modulation, we get: $u_{dt}^{\,2} = \sum_i \left(\tau_i \sigma_y / T\right)^2$; where τ_i is a duration of a gap, T is a duration of the entire campaign, and the maser instability is $\sigma_y(\tau) \cong 1.2 \times 10^{-15}$ (for $500 < \tau[\mathrm{s}] < 6 \times 10^5$).

The type B uncertainties are summarized in the table below [1]. The low type B uncertainty of the frequency shift due to collisions between cold atoms is achieved by operating the fountain near the shift cancellation point [3].

Type B evaluation	Uncertainty / 10^{-16}
Second order Zeeman	0.8
Blackbody radiation	1.1
AC Stark (lasers)	0.1
Microwave spectrum	0.1
Gravity	0.5
Cold collisions (typically)	<1.0
Collisions with background gas	1.0
Rabi, Ramsey pulling	0.1
Cavity phase (distributed)	3.0
Cavity phase (dynamic)	0.1
Cavity pulling	0.2
Microwave leakage	1.0
Microwave recoil	1.5
Second-order Doppler	0.1
Total u_B	**4.0**

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Operation of the PTB primary clocks in 2010

PTB's primary clocks with a thermal beam

During 2010 PTB's primary clocks CS1 and CS2 [1] have been operated continuously during 12 months and 8 months, respectively. 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 (for 9 months) between the two clocks amounted to about 6×10^{-15}.

The clocks' operational parameters were checked periodically and validated to estimate the clock uncertainty. These parameters are the Zeeman frequency, the temperature of the beam tube (vacuum enclosure), the line width of the clock transition as a measure of the mean atomic velocity, the microwave power level, the spectral purity of the microwave excitation signal, and some characteristic signals of the electronics.

CS1

Based on continuous comparison with an active hydrogen maser, the CS1 relative frequency instability was found to vary between 68×10^{-15} and 80×10^{-15} for an averaging time of 1 hour, in good agreement with the prediction based on the beam flux, clock transition signal and line width. With reference to TAI, the standard deviation of *d*(CS1) (Circular T Section 4) was well within the value $u_A(\tau = 30\text{ d, CS1}) = 6\times10^{-15}$ stated in Circular T. During 2009, only one reversal of the beam direction was performed on CS1. No findings call for a modification of the previously stated relative frequency uncertainty u_B, which is 8×10^{-15} for CS1 [2].

CS2

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

The work performed was thoroughly described in a report to the CCTF Working Group on Primary Frequency Standards (WGPFS). As a result of all measures taken we reported that the CS2 frequency shifting effects have not been affected by the repair measures. The uncertainty estimate as detailed in [1, 2] is considered as still valid, and the CS2 u_B is thus estimated as 12×10^{-15}. No beam reversal and thus no determination of the beam-reversal frequency shift have been made for 2.5 years. Until mid 2011 we plan to perform a beam reversal every 2 to 3 weeks so that we get confidence in the frequency correction to be applied.

The CS2 oven temperature was finally adjusted so that we can expect a relative frequency instability of $\sigma_y(\tau = 1\text{ hour}) = 65\times10^{-15}$. This value corresponds to the findings of previous years and justifies the estimate of the uncertainty contributions u_A as $u_A(\tau = 30\text{ d, CS2}) = 3\times10^{-15}$. The standard deviation of the 9 monthly values *d*(CS2) from 2010 also supports this estimate.

The WGPFS recommended monitoring the stability of CS2 with respect to TAI during a few months before making use of it as a primary frequency standard.

PTB's caesium fountain clock CSF1

A detailed description of the PTB fountain CSF1 is given in Refs. [3] and [4]. In 2010 CSF1 provided a primary clock signal during 94.5% of the year. The high degree of availability enabled us to successfully introduce a new realization method for UTC(PTB) by steering the PTB hydrogen maser H5 output frequency by CSF1. Five measurements of the TAI scale unit of 15 (3x), 25 and 30 days duration, respectively, were performed in 2010 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. Including a small statistical uncertainty contribution due to the measurement instrumentation, we arrived at statistical uncertainties $u_A < 0.3\times10^{-15}$ for the five TAI contributions in 2010.

Moreover, in 2010 CSF1 was used for optical frequency measurements of the 467 nm octupole transition in a single $^{171}Yb^{+}$-ion, of the 698 nm optical clock transition in a ^{87}Sr lattice clock, and of the 2-photon 1S-2S atomic hydrogen transition at the Max-Planck-Institut für Quantenoptik (Munich) – via a 900 km optical fibre link.

Below we compile corrected biases and the uncertainty budget of CSF1, valid for the most recent TAI scale unit measurements.

Physical effect	Bias / 10^{-15}	Type B uncertainty / 10^{-15}
Second order Zeeman shift	46.28	0.10
Black body radiation shift	- 16.59	0.10
Cold collisions	- 1.15	0.30
Gravitational red shift	8.58	0.10
Cavity phase		0.10
Majorana transitions		0.10
Rabi and Ramsey pulling		0.10
Microwave leakage		0.10
Electronics		0.20
Light shift		0.10
Background gas collisions		0.10
Microwave power dependence		0.60
Total type B uncertainty		0.76

Table 1: Typical frequency biases and type B uncertainties of PTB-CSF1 in 2010

PTB's caesium fountain clock CSF2

PTB's new caesium fountain clock CSF2 has been fully evaluated in 2008/2009. A detailed description of the fountain and its uncertainty evaluation has been published in Metrologia [5]. In 2010 one measurement of the TAI scale unit of 15 days duration was performed and reported to the BIPM. The dead time of this measurement was below 0.3%, so that the resulting clock link uncertainty $u_{l/lab}$ was far below 0.1×10^{-15}. For this measurement for the first time the atoms were loaded into the molasses from a cold atom beam, which increased the number of loaded atoms, so that a relative frequency instability of 1.6×10^{-13} $(\tau/\mathrm{s})^{-1/2}$ was obtained. At that time a 9.2 GHz microwave synthesis was still employed in CSF2, which was not specified at instability levels below 10^{-15}. However, an internal frequency comparison between CSF1 and CSF2, for which the Allan standard deviation was dominated by 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 an upper limit for the statistical uncertainty of CSF2. The cold beam utilization also enabled a more efficient determination of the collisional shift at lower statistical uncertainty levels than before.

Later in 2010 the same new microwave frequency synthesis setup [6] as utilized in CSF1 has been introduced in the CSF2 electronics setup. Therefore the statistical uncertainty of CSF2 frequency measurements is no more limited at the 7×10^{-16}-level. The replacement of the master laser diode and a better profile adjustment and intensity balancing of the cooling laser beams resulted in an improved performance with respect to the loaded atom number and the achievable signal-to-noise ratio. Currently the systematic uncertainty contribution due to the distributed cavity phase is re-evaluated based on the findings in Ref. [7]. After this CSF2 will be used again for TAI scale unit measurements.

Below we compile corrected biases and the uncertainty budget of CSF2, valid for the February/March 2010 TAI scale unit measurement.

Physical effect	Bias / 10^{-15}	Type B uncertainty / 10^{-15}
Second order Zeeman shift	99.58	0.06
Black body radiation shift	- 16.57	0.06
Cold collisions	- 1.04	0.34
Gravitational red shift	8.567	0.006
Cavity phase		0.15
Majorana transitions		0.0001
Rabi pulling		0.0002
Ramsey pulling		0.001
Microwave leakage		0.10
Electronics		0.20
Light shift		0.001
Background gas collisions		0.05
Microwave power dependence		0.40
Total type B uncertainty		0.60

Table 2: Frequency biases and type B uncertainties of PTB-CSF2 in February/March 2010.

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Operation of the SYRTE primary clocks in 2010

SYRTE-JPO Thermal Beam

SYRTE-JPO is a primary frequency standard operating with a thermal beam of cesium atoms optically pumped and detected. Its last complete accuracy evaluation was performed in 2005 and gave the same value as in [1]: u_B = 6.3x10^{-15}. The parameters of the clock (Zeeman frequency, microwave power, cavity detuning, optical power, …) are periodically measured to assess this accuracy. The mean stability is $\sigma_y(\tau)$=8 x 10^{-13} $\tau^{-1/2}$. The stability deterioration compared to [1] is due to a lower oven temperature in order to increase the lifetime of the cesium loads.
The operation of JPO remained nearly continuous until September 7, when the cesium ovens get empty. Because of the performances and the reliability of the fountain clocks it has been decided not to restart JPO.
In 2010, 9 calibrations were transmitted to BIPM. During this period, the average difference between the relative frequency of JPO and the SI second calculated by the BIPM was -0.5 x 10^{-15}, with a standard deviation of 2.7 x 10^{-15}. Over the past 6 years, this average difference is 2.0 x 10^{-15}, with a standard deviation of 4.5 x 10^{-15} (66 calibrations).

SYRTE Fountain clocks

In 2010 the 3 SYRTE fountains FO1, FO2 and FOM have transmitted respectively 6, 9 and 5 calibrations to BIPM.

The nominal operation of the FO1 and FO2 fountains was similar as in 2009. The microwave synthesizers are referenced to the signal provided by a cryogenic sapphire oscillator (CSO) phase locked to a hydrogen Maser, to take the benefit of the ultra-low phase noise of the CSO. The relative frequency instabilities are routinely $\sigma_y(\tau)$ = 5 x 10^{-14} $\tau^{-1/2}$ for the 2 fountains, at the quantum projection noise limit. FOM is also at this theoretical limit when it uses a CSO as a reference. Its short term stability is then $\sigma_y(\tau)$ = 8 x 10^{-14} $\tau^{-1/2}$.
FO2 is located close to the CSO, whereas FO1 and FOM are in different buildings, distant from ~100 m. The reference signal from the CSO was distributed by one way RF cables, which could induce long term drifts in the reference transfer or electrical ground problems. To improve this, we have set-up a compensated optical fiber link for FOM since it came at SYRTE in November 2010. A similar link will be installed for FO1.
A repairing had to be performed on our usual reference maser. Therefore the fountains were connected to another maser between November 2010 and January 2011. This backup maser presented frequency jumps at the level of 10^{-14}. This is the reason why we decided not to transmit to BIPM the fountains data of November 2010, and we increased the statistical uncertainty on the maser calibration for December 2010.

Table 1 gives the typical uncertainty budgets for the three SYRTE fountain clocks in 2010. 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	-1273.4	0.4	-1916.6	0.3	-305.4	1.2
Blackbody Radiation	+167.6	0.6	+167.6	0.6	+165.6	0.6
Cold Collisions + cavity pulling	+131.2	1.2	+152.0	1.4	+28.6	5.0
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		**4.2**		**4.0**		**8.2**

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

FOM was operated at CNES, the French space agency, in Toulouse, until the end of May 2010. The transportable fountain was serving as a frequency reference for the ground tests of the PHARAO/ACES space clocks. It was connected to the CNES time and frequency facilities that include a cryogenic sapphire oscillator, a hydrogen maser, and a GPS phase transfer link. The clock was then moved for 2-3 weeks to the Max Planck Institut für Quantenoptik (MPQ), near Munich, to serve as frequency reference in a new absolute measurement of the 1S-2S transition of hydrogen, in the 10^{-15} range. FOM also participated to the characterisation of the time transfer by laser link T2L2. For that purpose, it was installed for 3-4 months in Observatoire de la Cote d'Azur (OCA), near Grasse, and compared to the FO1 and FO2 fountains in Observatoire de Paris via T2L2, TWSTFT and GPS phase time transfer links. During its journey, FOM continued to provide calibrations to the BIPM, using GPS links (1 when it was at MPQ and 3 at OCA). The main uncertainty stemmed from the stability of the time transfer link, limited to 1-2 x 10^{-15} for averaging periods of 1 month. FOM is back in Observatoire de Paris since November 2010. The first comparisons to FO2 show a difference of 1.8 x 10^{-16}.

In 2010 FO2 was operated continuously and reliably as a double Rb/Cs clock [2], providing 308 days of direct Rb-Cs comparison. The FO2-Rb/Cs frequency difference is reproducible within +/- 2.8 10^{-16}, which is much better than the 6 x 10^{-16} combined uncertainty of the comparison. The effect of Rb atom number dependent shift is extrapolated in real time while alternating measurements at low and high atom density.

In 2010, we pursued with FO2Cs our thorough investigation of the first Doppler effect associated with the phase distribution inside the interrogation cavity, which is currently the main limitation to fountain PFS accuracy (see table 1 for SYRTE PFS). In the interpretation by the theoretical model of K. Gibble [3] of the measurements performed in 2009 there remained a slight disagreement. We have elucidated the origin of this disagreement and solved it by implementing a new method to balance the microwave cavity feeds. The validation of the model by our further measurements allows the first Doppler uncertainty to be reduced to $\pm 8.4\times 10^{-17}$. This work is accepted for publication in Phys. Rev. Lett.

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

(File available at ftp://62.161.69.5/pub/tai/scale/sitai10.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, KRISS-1, NICT-CSF1, NIST-F1, NMIJ-F1, NPL-CSF1, NPL-CSF2, PTB-CS1, PTB-CS2, PTB-CSF1, PTB-CSF2, SYRTE-FO1, SYRTE-FO2, SYRTE-FOM and SYRTE-JPO, consistently corrected for the black-body radiation shift.
In this computation, the uncertainty of the link to TAI has been computed using the standard uncertainty of [UTC-UTC(k)], following the recommendation of the CCTF working group on PFS.
The model for the instability of EAL has been expressed as the quadratic sum of three components: a white frequency noise $1.7\times10^{-15}/\sqrt{(\tau)}$, a flicker frequency noise 0.35×10^{-15} and a random walk frequency noise $1.0\times10^{-16}\times\sqrt{(\tau)}$, with τ in days. The relation between EAL and TAI is given in Table 5.

Month	Interval	$d/10^{-15}$	uncertainty/10^{-15}
Jan. 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	+4.9	0.4
Jan. 2009	54829-54859	+5.5	0.3
Feb. 2009	54859-54889	+5.2	0.4
Mar. 2009	54889-54919	+4.7	0.4
Apr. 2009	54919-54949	+5.2	0.4
May 2009	54949-54979	+4.9	0.4
Jun. 2009	54979-55009	+5.3	0.6
Jul. 2009	55009-55039	+6.1	0.6
Aug. 2009	55039-55074	+5.2	0.4
Sep. 2009	55074-55104	+5.0	0.3
Oct. 2009	55104-55134	+3.8	0.3
Nov. 2009	55134-55164	+3.6	0.3
Dec. 2009	55164-55194	+4.3	0.4
Jan. 2010	55194-55224	+4.7	0.3
Feb. 2010	55224-55254	+4.5	0.4
Mar. 2010	55254-55284	+4.8	0.4
Apr. 2010	55284-55314	+5.3	0.4
May 2010	55314-55344	+5.6	0.4
Jun. 2010	55344-55374	+6.6	0.4
Jul. 2010	55374-55404	+5.7	0.4
Aug. 2010	55404-55439	+5.6	0.3
Sep. 2010	55439-55469	+6.7	0.4
Oct. 2010	55469-55499	+6.5	0.4
Nov. 2010	55499-55529	+6.7	0.5
Dec. 2010	55529-55559	+5.6	0.4

Independent local atomic time scales

Local atomic time scales are established by the time laboratories which contribute with the appropriate clock data to the BIPM. The differences between TAI and the atomic scale maintained by each laboratory are available on the Publications page of the Time Department's FTP Server. For each time laboratory 'lab' a separate file TAI-lab is provided; it contains the respective values of the differences [*TAI - TA(lab)*] in nanoseconds, for the standard dates, starting on 1 January 1998.

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

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

Local representations of UTC

The time laboratories which submit data to the BIPM keep local representations of UTC. The computed differences between UTC and each local representation are available on the Publications page of the Time Department's FTP Server. For each time laboratory 'lab' a separate file UTC-lab is provided; it contains the values of the differences [*UTC - UTC(lab)*] in nanoseconds, for the standard dates, starting on 1 January 1998.

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

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

International GPS Tracking Schedules

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

GPS Schedule no 54 File SCHGPS.54	implemented on MJD = 55316 (2010 April 30) at 0 h UTC	Reference date MJD = 50722 (1997 October 1)
GPS Schedule no 55 File SCHGPS.55	implemented on MJD = 55503 (2010 November 3) 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/utcgpsglo10.ar)

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

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

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

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

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

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

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

Here C_0 is given at 0 h UTC every day.

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

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

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

(File available at ftp://62.161.69.5/pub/tai/scale/UTCGPSGLO/utcgpsglo10.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 2010

(File is available at ftp://62.161.69.5/pub/tai/scale/RTAI/rtai10.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 2010. For studies including the clock rates of previous years, corrections must be brought to the data published in the Annual Report for the previous years. These corrections are available from the Time Department on 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	55224	55254	55284	55314	55344	55374	55404	55439	55469	55499	55529	55559
APL	35 904	10.47*	11.31*	10.56*	10.38*	10.94*	8.14	-	-	-	-	-	-
APL	35 1264	21.74	21.57	21.41	21.84	21.75	20.52	21.67	21.09	-	21.11	20.71	19.43
APL	35 1791	-2.51	-3.04	-3.04	-2.64	-2.35	-2.76	-2.63	-2.51	-	-3.27	-2.04	-1.53
APL	40 3107	23.08	23.49	21.44	23.30	23.25	23.37	23.56	23.75	-	24.01	24.13	24.33
APL	40 3108	277.54	281.78	286.31	290.14	294.22	298.32	302.59	306.94	-	315.59	319.49	323.41
APL	40 3109	30.17	31.95	34.15	34.83	35.76	36.73	37.66	38.49	-	39.78	39.86	40.33
AUS	35 2269	-7.45*	-7.15*	-5.60*	-5.95*	-5.31*	-1.84	0.42	1.05	1.95	1.58	1.99	1.71
AUS	36 299	12.52	14.35	14.23	13.89	14.09	15.07	10.47	-	11.15	10.66	-	10.94
AUS	36 340	1.17	2.25	0.06	0.68	-0.12	0.65	0.83	1.06	0.19	1.19	0.85	-0.53
AUS	36 654	-10.83	-12.84	-13.73	-12.13	-13.02	-12.85	-12.26	-12.49	-10.75	-11.84	-11.33	-12.63

Table 8. (Cont.)

Lab.	Clock	55224	55254	55284	55314	55344	55374	55404	55439	55469	55499	55529	55559
AUS	36 1141	6.04	7.11	9.38	7.64	6.16	10.00	6.76	6.43	10.95	8.29	9.17	7.35
AUS	40 5401	77.85	-	-	-	-	-	-	-	-4.08	-4.01	-5.62	-1.01
AUS	40 5402	15.67	-	-	-	-	-	-	-	-	-5.04	-10.64	-16.65
BEV	35 1065	2.93*	2.62*	3.17*	1.01*	1.53*	2.06*	2.38*	1.59*	1.80*	1.73*	0.34	1.65
BEV	35 1793	20.06*	20.58*	20.33*	19.26*	19.96*	28.32*	-	-	-	-	-	-
BEV	40 3452	-68.64*	-57.98*	-47.49*	-37.27*	-79.15*	-69.30*	-59.50*	-48.96*	-38.11*	-28.14	-18.60	-9.21
BIM	18 8058	-0.04	2.13	1.99	1.16	0.56	1.73	1.36	0.94	1.86	2.69	2.54	2.14
BY	40 4209	-21.29*	-17.26*	-15.33*	-16.97*	-6.16*	-3.30*	-3.37*	-2.57*	-3.29*	0.19	-	-
BY	40 4222	-	-26.97*	-24.74*	-26.95*	-19.11*	-	-	-43.20*	-53.33*	-3.69*	4.55*	4.73
BY	40 4227	-	-7.41*	-7.03*	-10.51*	-2.51*	-6.55*	-7.63*	1.50*	-4.54*	2.12*	5.28*	-4.98
BY	40 4260	-7.11*	-1.38*	-0.02*	-2.43*	3.21*	1.88*	8.13*	9.87*	11.79*	11.31*	17.02*	13.33
BY	40 4278	-2.17*	0.71*	2.32*	0.06*	4.95*	2.37*	7.83*	8.07*	7.88*	11.77*	12.51*	10.84
CAO	35 939	-3.12	-2.44	-4.39	-2.73	-3.15	-3.61	-3.73	-2.82	-2.19	-2.79	-3.51	-2.63
CAO	35 1270	4.59	4.41	4.63	4.52	5.15	4.50	4.11	4.34	3.37	5.03	5.35	5.54
CH	35 771	2.59	2.36	3.36	3.06	3.68	3.41	4.68	3.87	3.86	4.85	4.70	4.52
CH	35 2117	1.29	1.59	2.22	2.41	1.94	1.49	2.04	1.39	2.36	1.99	1.36	1.44
CH	36 354	42.84	43.99	42.91	43.92	44.20	45.24	42.67	41.75	42.12	44.19	45.37	42.96
CH	36 413	-3.10	-1.94	-0.72	-4.88	1.04	2.42	3.01	-4.10	-3.84	-1.76	-2.07	-0.33
CH	40 5701	-4.16	-5.07	-5.75	-6.08	-6.68	-7.14	-7.62	-8.29	-9.14	-9.93	-10.98	-11.76
CNM	35 1815	-0.08	0.02	-0.04	1.06	-1.13	-0.74	0.20	0.74	0.64	-0.78	-0.02	-1.02
CNM	36 1537	3.85	-1.80	-3.35	-0.45	-2.96	-3.82	-2.32	-0.25	-2.76	-2.71	-0.81	-2.28
CNM	40 7301	-8.08	-1.04	1.29	1.81	-0.65	-1.46	-0.32	-0.21	-0.37	-1.94	-1.66	-4.20
CNM	53 6038	7.24	30.64	-	-	-	-	-	-	-	-	-	-
CNMP	36 1752	-	-	2.61	5.12	7.91	4.36	7.09	3.06	6.68	-	7.23	3.68
CNMP	36 1806	4.00*	-2.28*	-4.21*	-3.69*	-4.29*	-2.48	1.49	0.56	0.02	-	-1.47	0.61
DLR	35 1714	0.24	-1.20	-0.48	1.12	0.86	-1.15	1.32	0.75	0.53	-0.79	0.29	-0.01
DMDM	35 2191	-	15.76	14.20	14.55	14.06	13.86	14.58	14.48	14.92	15.80	15.94	15.87
DMDM	36 2033	4.92	6.36	6.32	6.19	6.28	6.11	6.29	4.89	5.05	4.25	4.80	6.31
DTAG	36 345	-2.72	-1.60	-2.08	-2.06	-3.72	-4.86	-2.98	-4.61	-3.56	-4.18	-2.23	-1.51
DTAG	36 465	0.63*	1.73*	-0.40*	0.27*	-1.13*	0.18*	0.29*	1.40*	-0.86*	0.78*	1.60	1.78

Table 8. (Cont.)

Lab.	Clock	55224	55254	55284	55314	55344	55374	55404	55439	55469	55499	55529	55559
DTAG	36 2370	0.10	-0.70	-0.10	0.45	0.98	0.16	1.93	1.07	0.93	1.08	0.95	-0.31
EIM	35 716	14.48	-	-	-	14.39	13.81	-	-	12.75	12.94	12.77	13.17
EIM	35 1431	-8.66	-	-	-	-10.59	-10.46	-	-	-6.58	-8.17	-8.70	-8.39
EIM	35 2060	-0.33	-	-	-	-	0.09	-	-	-	0.01	-0.37	0.06
F	35 122	25.29	22.74	25.42	23.44	23.79	24.76	24.61	23.99	23.82	24.19	23.59	-
F	35 124	12.12	12.03	11.63	11.67	11.25	11.00	11.39	11.94	11.04	11.11	10.97	11.29
F	35 131	-5.84	-	-	-	-	-	-	-	-	-	-	-
F	35 158	13.56	13.75	13.61	13.46	13.66	13.78	14.08	14.08	14.03	14.21	13.70	13.70
F	35 355	2.85	3.48	3.38	4.63	4.22	4.88	5.31	5.25	5.35	5.84	5.75	4.31
F	35 385	19.86	18.94	19.62	20.06	20.54	19.73	18.25	19.87	20.66	19.14	19.41	19.52
F	35 396	-0.84	-0.45	-0.78	-0.65	-0.72	-0.39	0.12	0.29	-1.03	-0.07	-0.51	-0.12
F	35 469	-5.65	-6.01	-4.67	-2.41	-2.88	-3.54	-2.71	-3.98	-2.27	-2.50	-1.99	-2.23
F	35 489	12.07	12.45	13.37	13.28	12.90	13.02	13.15	13.06	13.29	13.35	13.11	13.57
F	35 520	15.20	16.64	18.95	17.11	17.61	20.66	18.33	20.10	18.82	18.91	19.47	19.00
F	35 536	3.93	4.50	5.07	5.07	4.93	5.39	5.48	4.78	5.52	5.83	5.76	6.15
F	35 609	-	-	-25.11	-24.47	-24.50	-24.40	-24.09	-23.86	-24.04	-23.82	-	-
F	35 770	-7.12	-7.71	-7.25	-6.75	-7.24	-7.44	-6.85	-7.24	-7.65	-6.30	-6.97	-6.85
F	35 774	25.61	26.81	26.54	26.55	26.71	27.36	27.44	27.32	27.20	27.13	27.36	27.65
F	35 781	10.78	10.28	11.20	10.86	10.41	9.83	10.03	9.59	-	-	9.98	8.02
F	35 819	11.18	7.57	7.59	6.81	7.15	7.10	7.72	6.19	7.10	12.32	15.59	13.41
F	35 859	2.14	2.50	3.60	2.91	4.79	4.97	4.36	2.49	4.29	4.87	3.03	3.18
F	35 909	-17.93	-18.26	-17.28	-15.51	-15.00	-14.81	-14.30	-13.53	-	-	-12.95	-13.18
F	35 1068	-16.50	-16.36	-16.39	-16.18	-16.04	-16.44	-16.02	-15.86	-	-	-16.58	-16.40
F	35 1177	-7.79	-6.94	-6.36	-7.93	-6.40	-4.99	-5.47	-4.70	-4.11	-4.38	-3.66	-3.96
F	35 1258	4.81	4.26	5.53	4.46	4.17	4.97	4.04	4.27	-	-	3.65	-
F	35 1321	3.75	3.01	2.89	2.92	2.29	3.15	3.46	3.60	3.81	4.05	4.04	3.20
F	35 1556	-5.18	-5.00	-4.59	-4.22	-3.50	-3.29	-4.34	-4.26	-3.87	-5.07	-	-
F	35 1644	9.27	9.43	10.66	10.66	11.30	11.22	11.50	11.18	11.01	11.54	11.23	11.84
F	35 2027	-1.84	-2.16	-1.62	-0.86	-1.26	-1.22	-0.23	-1.27	-0.88	-0.19	-0.65	0.35
F	35 2388	4.33	4.08	5.23	5.05	5.97	6.43	6.22	7.01	5.71	7.05	5.97	6.06

Table 8. (Cont.)

Lab.	Clock		55224	55254	55284	55314	55344	55374	55404	55439	55469	55499	55529	55559
F	40	805	32.68	43.87	50.27	53.85	54.60	49.64	38.75	32.25	30.25	32.51	39.38	49.69
F	40	816	0.23	0.67	1.61	-	-	-	-2.29	-3.13	-3.33	-2.58	-2.20	0.01
F	40	889	65.50	68.14	70.52	73.15	75.65	78.05	80.21	82.75	85.09	87.36	-	-
F	40	890	14.46	14.96	15.31	15.77	16.15	16.60	17.10	17.65	18.07	18.56	-	-
F	53	6385	1.85	0.52	0.78	-0.04	-0.33	-0.99	-0.37	-	-	-	-	-
HKO	35	1893	0.32*	0.65*	0.06*	-4.08*	-0.14*	0.60*	-0.13*	0.29	0.60	1.54	1.05	0.51
HKO	35	2425	-0.61*	0.21*	0.24*	-3.63*	0.51*	1.07	1.60	1.47	1.83	1.38	1.50	2.02
IFAG	36	1167	-3.96	-3.97	-1.22	-1.34	-1.84	-0.89	-0.50	1.18	-0.68	0.12	-0.21	-2.07
IFAG	36	1173	3.73	2.54	3.89	6.99	9.13	11.88	11.03	11.89	11.29	10.05	10.77	8.00
IFAG	36	1629	12.91	12.97	13.51	13.80	13.87	16.90	17.88	17.58	17.18	15.52	14.92	14.53
IFAG	36	1732	13.25	13.11	13.76	13.79	13.73	13.83	13.70	13.98	13.55	14.70	13.74	13.99
IFAG	36	1798	-0.72	-0.85	-1.58	-1.12	-0.98	0.15	-0.37	-0.43	-1.21	-0.59	-1.14	-1.68
IFAG	40	4418	1.70	2.65	3.05	3.27	3.02	3.20	3.89	4.12	4.33	5.03	5.52	5.99
IFAG	40	4439	-11.30	-1.48	-2.21	-3.30	-4.64	-5.46	-6.21	-7.63	-8.48	3.98	2.92	1.96
INTI	35	2377	-2.58	-	-	-2.43	-0.03	1.02	2.35	-1.87	3.79	-4.18	-3.56	0.34
IPQ	35	1797	0.80	1.54	1.86	-	-	-0.63	0.10	-0.29	-0.75	-0.37	-0.10	-1.04
IPQ	35	2012	3.68	4.76	4.89	-	-	5.70	6.43	6.22	6.63	5.93	5.95	6.56
IPQ	35	2169	-0.83	0.18	-0.16	-	-	-1.03	-0.64	0.34	-0.94	-1.01	-0.48	-0.76
IT	35	219	12.10	12.04	12.82	12.31	12.94	13.09	12.59	12.63	11.59	8.28	6.75	6.61
IT	35	505	-6.28	-	-	-	-	-29.98	-30.51	-30.07	-30.04	-29.38	-29.65	-29.15
IT	35	1115	17.06	17.41	17.74	18.03	17.76	17.64	17.19	16.36	16.45	16.19	15.85	14.71
IT	35	1373	-4.94	-4.53	-4.88	-4.33	-4.03	-4.03	-4.15	-4.15	-4.18	-4.34	-3.77	-3.76
IT	35	2118	9.55	9.54	9.41	9.92	9.75	10.01	9.42	9.49	9.67	9.13	9.16	8.84
IT	35	2487	-10.05	-	-	-10.54	-9.53	-9.59	-10.08	-9.87	-9.64	-10.09	-8.92	-9.86
IT	40	1101	32.16	37.07	41.99	47.10	52.23	57.68	63.11	69.16	75.13	80.98	86.75	92.57
IT	40	1102	283.43*	290.02*	296.45*	302.88*	-5.70	-2.39	1.71	7.56	13.76	20.04	26.27	32.44
IT	40	1103	-36.49	-	-	-	-	-31.37	-30.06	-28.40	-26.62	-24.39	-	-
JV	21	216	50.84	50.10	55.04	56.78	54.57	52.54	55.71	55.65	57.91	-	55.41	57.22
JV	21	387	-307.25	-623.46	-645.57	-618.32	-615.28	-614.02	-632.90	-643.03	-468.94	-	-591.70	-
JV	36	1277	-17.22	-18.47	-17.06	-18.27	-16.09	-16.69	-16.75	-16.24	-16.57	-	-18.19	-17.10

Table 8. (Cont.)

Lab.	Clock		55224	55254	55284	55314	55344	55374	55404	55439	55469	55499	55529	55559
KIM	36	618	-1.27	1.78	0.63	0.92	-1.11	-3.21	0.26	0.97	0.35	0.05	-0.22	-2.65
KRIS	35	321	16.18	17.33	-	-	-	-	-	-	-	-	-	-
KRIS	35	739	-3.20	-3.00	-2.75	-2.98	-2.61	-3.04	-3.35	-2.96	-2.34	-2.73	-2.68	-3.03
KRIS	35	1693	-	4.23	4.64	4.11	4.78	5.16	5.30	5.40	5.02	5.38	6.20	6.15
KRIS	35	1783	19.84	21.36	21.61	20.10	21.32	20.94	20.14	20.82	20.91	20.64	21.30	21.68
KRIS	36	1135	34.48	35.14	36.47	37.53	-	-	-	-	-	-	-	-
KRIS	40	5623	115.94	115.22	114.12	112.38	109.58	105.02	98.03	81.19	-	-	-	-
KRIS	40	5624	-21.26	-25.60	-29.18	-32.36	-34.88	-37.01	-39.07	-40.81	-42.48	-43.74	-44.78	-45.73
KRIS	40	5625	-	24.90	24.41	22.52	19.94	17.36	14.49	12.79	13.16	13.34	12.51	11.15
KRIS	40	5626	-16.71	-16.38	-16.11	-15.95	-15.71	-15.50	-15.18	-14.85	-14.61	-14.17	-13.83	-18.38
KZ	35	2202	-8.36	-6.64	-7.07	-5.41	-2.26	-2.79	-2.92	-2.60	-0.32	0.00	0.00	-
KZ	40	2707	-	-	-	-	4.63	-2.92	-0.86	-2.18	20.70	0.19	3.37	-
LT	35	1362	-18.66*	-16.78*	-16.52*	-16.98*	-17.43*	-16.51*	-18.97*	-15.76*	-16.84*	-	-1.22	-0.10
LV	35	2335	3.31	3.13	-0.94	-1.02	-0.57	-1.24	-1.58	-1.35	-0.95	-1.76	-1.38	-1.69
MIKE	35	1171	-0.38	0.26	-1.18	-1.58	-0.65	-1.14	-0.66	-0.90	-1.21	-1.11	-1.83	-0.33
MIKE	36	986	0.50	0.10	0.13	0.68	-0.54	1.41	1.72	1.17	0.26	-0.88	2.83	1.28
MIKE	40	4108	2.79*	2.88*	2.95*	3.03*	3.10*	3.32*	3.50*	0.63	-1.43	-1.13	-0.90	-0.59
MIKE	40	4113	-3.27	-1.48	0.37	2.26	4.21	6.43	8.39	-	-	-4.18	-3.08	-1.43
MIKE	40	4180	-31.44	-27.87	-24.10	-20.56	-16.83	-12.97	-9.37	-5.39	-1.61	1.75	4.42	8.20
MKEH	36	849	-41.50	-40.44	-40.55	-40.35	-41.56	-41.36	-41.48	-43.88	-42.89	-41.32	-43.58	-41.51
MSL	12	933	13.77	19.05	-	5.73	3.37	7.15	1.97	2.31	3.16	5.26	23.35	-
MSL	36	274	7.69	10.16	-	10.08	11.37	8.97	8.68	9.01	8.72	10.66	10.13	-
MSL	36	1025	-0.06	0.96	-	-1.42	0.12	-0.34	-0.18	1.63	7.02	15.52	9.90	-
NAO	35	779	0.58	0.87	1.07	0.66	1.73	1.33	1.79	0.72	1.80	0.96	0.35	1.73
NAO	35	1206	13.37	14.16	13.32	12.54	13.34	12.80	13.00	12.60	12.86	13.75	13.13	13.48
NAO	35	1214	-0.50	-0.25	-1.57	-1.97	-23.66	20.98	-1.24	-1.99	-1.59	-0.74	-1.37	-1.05
NAO	35	1689	-	-	-	-	-	-	-	-	-31.02	-31.49	-31.52	-31.61
NICT	35	112	-7.04	-6.90	-6.46	-6.00	-6.40	-5.37	-5.25	-5.61	-5.73	-5.61	-4.92	-4.75
NICT	35	332	8.98	8.31	9.35	9.25	8.11	9.04	9.05	8.17	7.73	7.91	8.37	8.21
NICT	35	342	47.13	47.19	47.83	47.20	47.39	48.18	48.14	48.89	49.31	48.34	48.57	48.93

Table 8. (Cont.)

Lab.	Clock	55224	55254	55284	55314	55344	55374	55404	55439	55469	55499	55529	55559
NICT	35 343	8.03	8.22	8.50	7.79	7.91	8.46	7.74	7.98	8.21	8.69	8.48	9.40
NICT	35 715	9.85	10.01	9.63	9.93	9.95	9.64	10.24	9.87	10.06	9.98	10.80	10.51
NICT	35 732	-3.04	-2.28	-2.49	-2.20	-2.60	-3.98	-2.69	-2.58	-2.43	-2.72	-2.27	-2.67
NICT	35 907	-10.61	-10.46	-10.51	-10.60	-10.81	-10.09	-10.03	-9.03	-9.31	-9.45	-8.47	-8.59
NICT	35 908	0.54	-4.61	-6.29	-6.32	-3.45	-3.86	-4.61	-4.58	-4.98	-7.21	-6.03	-5.72
NICT	35 913	-18.62	-18.04	-18.80	-18.29	-20.06	-21.09	-21.48	-19.97	-20.66	-20.42	-17.34	-17.70
NICT	35 916	0.58	1.74	0.87	1.21	1.29	0.96	1.56	0.59	2.02	0.74	1.38	0.51
NICT	35 1225	-2.10	-1.66	-2.24	-2.41	-	-	-	-	-	-	-	-9.54
NICT	35 1226	2.19	2.53	3.57	5.24	5.20	6.28	6.75	6.82	7.74	7.20	8.24	7.76
NICT	35 1611	15.48	16.35	19.11	11.17	20.04	22.71	23.89	25.23	24.15	24.07	23.96	27.79
NICT	35 1778	-32.66	-32.88	-33.32	-33.45	-33.69	-33.11	-32.65	-32.55	-31.85	-31.35	-31.36	-30.65
NICT	35 1789	-	-	-8.34	-8.39	-8.10	-8.14	-8.20	-8.37	-7.94	-8.07	-8.03	-7.64
NICT	35 1790	-1.83	-1.20	-1.66	-0.94	-0.61	-0.08	0.16	0.50	0.57	1.14	1.12	2.31
NICT	35 1866	-	-	-	-0.39	-0.68	-0.80	-0.40	-0.15	0.25	0.11	0.47	1.02
NICT	35 1882	-3.63	-3.65	-3.42	-2.75	-3.03	-2.49	-2.48	-2.39	-2.03	-2.28	-1.71	-2.54
NICT	35 1887	0.66	0.51	-0.15	0.32	0.22	0.81	0.72	1.02	0.95	0.77	1.86	1.23
NICT	35 1944	2.61	3.46	3.82	4.29	4.78	3.84	3.87	4.01	3.57	3.70	3.64	4.13
NICT	35 2010	4.59	5.13	5.51	5.92	5.73	5.18	5.17	5.44	5.27	5.11	5.01	5.22
NICT	35 2011	3.17	3.10	2.63	2.84	1.92	3.08	2.08	2.79	-19.25	-34.43	-43.16	-44.33
NICT	35 2056	13.06	12.55	13.71	12.81	13.47	12.87	12.81	12.94	13.25	12.59	12.76	11.86
NICT	35 2113	-25.34	-26.65	-26.91	-27.03	-27.29	-26.91	-27.62	-27.89	-28.82	-26.32	-27.00	-27.35
NICT	35 2116	15.70	15.03	15.61	15.75	15.13	13.90	14.43	14.18	13.43	14.96	14.14	13.48
NICT	35 2570	-	-	-	-	-1.81	-2.21	-2.18	-1.42	-1.43	-1.48	-1.46	-0.96
NICT	35 2574	-	-	-	-	-6.43	-5.15	-4.80	-4.66	-4.20	-3.42	-3.79	-3.42
NICT	35 2620	-	-	-	-	-	-	-	-	-	-	-	10.19
NICT	35 2627	-	-	-	-	-	-	-	-	-	-	-	-0.89
NICT	36 1217	3.31	3.28	3.89	4.41	2.21	1.99	2.43	2.12	2.92	2.21	3.87	2.15
NICT	40 2001	-	-	-	-	-	-	31.14	66.97	99.76	-	-	-
NICT	40 2002	12.92	13.72	14.38	15.02	15.57	110.36	17.06	18.30	19.01	19.79	20.38	20.89
NICT	40 2003	21.54	21.53	21.48	21.38	19.93	20.63	21.54	22.46	22.82	23.16	23.47	23.82

Table 8. (Cont.)

Lab.	Clock	55224	55254	55284	55314	55344	55374	55404	55439	55469	55499	55529	55559
NICT	40 2004	10.63	11.17	11.65	12.07	12.43	13.01	-	-	-	15.66	16.29	17.01
NICT	40 2005	33.20	35.19	36.84	-	-	-	-	-	-	-	-	-
NIM	35 1235	7.85	6.16	5.18	6.76	7.54	6.43	6.23	7.62	6.63	6.56	8.38	7.43
NIM	35 2239	-	3.39	2.51	3.07	2.36	2.17	2.51	2.82	0.84	2.69	2.56	2.42
NIM	40 4832	46.37	52.47	57.80	63.27	-	-	-	-	-	-	-	-
NIM	40 4835	89.63	94.00	97.21	101.57	104.67	108.10	111.50	114.27	116.18	120.87	124.42	127.54
NIMB	35 600	-0.71	-3.06	-2.42	-0.72	-	-	-4.04	-2.34	-	1.27	0.41	-0.24
NIMT	35 2246	1.15	0.85	1.51	1.23	-	1.69	2.28	2.32	1.55	1.67	-	-
NIMT	35 2247	-2.98	-3.93	-3.31	-4.30	-0.47	2.78	7.18	7.32	6.64	6.41	-	-
NIS	35 1126	0.74	0.24	0.14	-0.14	-0.39	0.13	-0.31	-	-	-0.26	-0.27	-0.17
NIST	35 132	-17.80	-17.53	-16.31	-16.34	-15.46	-15.10	-14.92	-14.60	-14.05	-13.73	-	-
NIST	35 182	3.61	3.07	2.90	2.76	3.36	3.04	3.01	3.72	3.67	3.32	2.85	3.27
NIST	35 282	-	-3.10	-3.75	-3.84	-4.92	-5.25	-5.85	-5.83	-5.11	-4.60	-4.05	-3.45
NIST	35 408	-22.66	-22.22	-24.53	-23.41	-22.96	-22.33	-22.90	-22.68	-22.67	-22.58	-22.20	-22.33
NIST	35 1074	-16.18	-16.79	-18.54	-19.71	-19.23	-19.65	-19.68	-20.24	-19.39	-19.59	-19.54	-19.25
NIST	35 2031	-8.11	-8.69	-7.79	-8.20	-8.47	-8.72	-8.53	-7.51	-7.94	-8.08	-7.67	-9.19
NIST	35 2032	2.99	2.06	2.88	2.86	2.47	1.40	1.32	1.19	1.92	0.29	-1.49	-4.01
NIST	35 2034	-6.41	-7.61	-6.26	-6.21	-6.70	-6.57	-7.30	-7.41	-7.75	-6.94	-7.40	-6.68
NIST	40 203	136.63	137.93	139.08	140.21	141.34	142.52	143.73	145.00	146.17	147.35	148.40	149.64
NIST	40 204	27.42	27.79	27.95	28.18	28.38	28.62	28.79	29.14	29.34	29.57	29.66	30.01
NIST	40 205	-26.48	-26.34	-26.42	-26.41	-26.49	-26.54	-26.48	-26.46	-26.46	-26.41	-26.49	-26.39
NIST	40 206	-64.65	-64.19	-63.90	-63.57	-63.46	-63.16	-62.90	-62.59	-62.68	-62.07	-61.57	-61.63
NIST	40 222	27.23	27.50	27.63	27.77	27.92	27.98	28.20	28.34	28.45	28.55	28.57	28.83
NMIJ	35 224	-28.63	-28.25	-28.14	-28.51	-28.19	-28.05	-27.64	-26.65	-26.41	-25.80	-25.58	-27.43
NMIJ	35 1273	21.36	21.33	21.85	21.55	21.35	21.21	20.55	21.34	21.45	20.63	20.50	20.02
NMIJ	35 2057	-4.37	-4.33	-4.28	-3.51	-3.32	-3.56	-5.39	-6.56	-6.57	-6.51	-6.25	-5.89
NMIJ	40 5002	-17.34	-17.31	-17.03	-16.90	-16.81	-16.74	-16.60	-16.51	-16.51	-16.21	-16.00	-
NMIJ	40 5003	-0.64	-0.91	-1.16	-1.22	-1.50	-1.55	-1.59	-1.53	-1.78	-1.69	-1.44	-1.39
NMIJ	40 5014	8.22	12.29	6.76	6.87	7.34	7.90	8.19	8.29	8.48	-	-	-
NMIJ	40 5015	36.71	39.20	41.41	43.58	46.08	48.27	50.43	52.69	54.85	57.11	59.15	61.27

Table 8. (Cont.)

Lab.	Clock	55224	55254	55284	55314	55344	55374	55404	55439	55469	55499	55529	55559
NMLS	35 328	-	-1.89	-4.00	-5.77	-5.99	-6.69	-6.73	-6.10	-5.67	-6.33	-7.02	-7.59
NPL	35 1275	4.38	4.99	4.35	5.41	4.80	5.82	4.99	5.05	4.93	-	-	3.86
NPL	36 784	6.89	5.17	4.19	4.83	4.53	-	2.10	2.08	0.92	-	-	4.46
NPL	40 1701	8.86	9.26	9.49	9.64	9.82	10.15	10.66	10.78	10.92	-	-	11.21
NPL	40 1708	-0.16*	0.10*	-1.17*	-0.94*	-0.82*	-0.40*	-0.91*	-0.73*	-0.11*	-	-	0.21
NPLI	35 2257	0.76	-0.60	-0.73	0.23	-0.56	0.14	1.43	-0.79	-0.33	0.13	1.72	-2.87
NRC	35 2148	5.95	6.33	6.78	6.64	6.67	6.78	6.91	6.92	6.90	7.68	7.26	7.71
NRC	35 2150	-3.11	-2.17	-1.45	-2.28	-2.10	-1.31	-1.98	-2.28	-1.23	-1.42	-1.64	-1.59
NRC	35 2151	0.27	1.53	1.26	0.65	1.67	2.00	1.78	2.33	2.53	-	2.78	1.05
NRC	35 2152	-6.94	-6.88	-7.01	-7.83	-7.64	-6.71	-7.29	-6.60	-6.31	-7.01	-7.09	-6.37
NRL	35 714	0.70	0.28	1.18	1.94	0.91	1.56	0.97	-	0.54	0.58	0.53	0.54
NRL	35 719	-	-	-1.13	-1.29	-0.82	-0.60	-2.39	-	-7.45	-7.72	-6.13	-7.56
NRL	35 1245	-	-	-1.19	-1.32	-0.85	-0.63	-2.42	-	-16.05	-7.76	-6.16	-7.59
NRL	36 387	-	-	-1.42	-1.67	-1.87	-2.77	-2.32	-	-3.10	-3.54	-2.51	-1.10
NRL	40 1001	71.41	73.99	76.33	78.62	80.68	82.91	85.14	-	89.68	92.11	95.22	111.09
NRL	40 1003	9.29	9.64	10.01	9.99	10.43	10.81	11.09	-	11.68	12.13	12.42	12.76
NRL	40 1009	-46.06	-47.21	-47.55	-49.67	-51.99	-54.50	-56.57	-	-60.49	-62.21	-63.15	-
NTSC	35 1007	8.97	11.22	9.74	10.01	5.94	3.50	3.86	5.05	7.56	8.97	11.57	14.68
NTSC	35 1008	4.77	4.48	4.51	2.88	4.26	4.52	4.52	3.72	3.59	4.60	3.42	3.69
NTSC	35 1011	-1.59	-1.83	-2.04	-2.46	-2.73	-2.26	-2.81	-3.22	-3.32	-4.17	-	-
NTSC	35 1016	15.26	14.58	13.58	13.56	13.34	12.70	12.78	13.36	13.47	14.40	15.64	14.62
NTSC	35 1017	7.82	8.78	9.12	8.77	7.03	7.88	5.77	7.47	8.59	9.34	8.62	7.89
NTSC	35 1018	-	-	-	-	-	-	-16.18	-15.47	-15.71	-15.05	-14.96	-13.90
NTSC	35 1818	-22.97	-23.08	-23.77	-24.77	-23.95	-24.67	-25.12	-24.99	-24.52	-24.04	-24.00	-24.15
NTSC	35 1820	-	-	-	-	-	-	13.53	13.05	13.38	12.98	12.00	11.67
NTSC	35 1823	10.66	10.44	10.09	10.48	-	-	9.23	8.49	8.77	9.01	9.13	9.45
NTSC	35 2096	-5.52	-5.04	-4.51	-5.38	-4.51	-4.77	-4.33	-5.58	-5.26	-5.44	-4.99	-4.75
NTSC	35 2098	7.91	8.36	8.37	7.80	8.26	8.74	7.76	7.50	7.33	7.22	7.97	7.78
NTSC	35 2131	-8.13	-9.17	-9.12	-9.03	-10.36	-10.01	-10.87	-12.25	-11.71	-12.04	-12.00	-11.93
NTSC	35 2141	40.01	31.61	36.25	35.56	36.00	30.48	35.08	38.58	39.91	39.96	38.29	38.83

Table 8. (Cont.)

Lab.	Clock	55224	55254	55284	55314	55344	55374	55404	55439	55469	55499	55529	55559
NTSC	35 2142	-10.79	-10.58	-11.22	-10.62	-10.95	-11.32	-10.53	-11.35	-11.43	-10.67	-11.58	-11.20
NTSC	35 2143	5.45	6.38	5.55	5.81	7.19	5.89	7.40	6.66	6.12	6.74	5.75	6.29
NTSC	35 2144	-3.88	-3.97	-4.88	-3.68	-3.10	-4.80	-4.83	-4.18	-5.73	-4.46	-3.69	-3.40
NTSC	35 2145	-	-	-	-	-	-	-4.87	-5.32	-5.57	-5.73	-5.12	-4.94
NTSC	35 2146	4.09	3.07	3.78	3.73	3.03	3.41	2.84	3.48	3.58	3.58	2.63	2.41
NTSC	35 2147	10.61	10.78	10.44	10.08	9.97	9.80	10.56	9.81	11.00	10.01	9.69	10.21
NTSC	35 2573	-	-	-	-	-	-	-	1.61	1.83	2.40	1.86	1.88
NTSC	35 2576	-	-	-	-	-	-	-	-2.31	-2.56	-2.31	-2.23	-2.00
NTSC	40 4926	334.30	340.10	346.64	352.90	359.04	366.12	372.23	377.57	383.53	389.38	394.76	399.89
NTSC	40 4927	345.38	350.35	356.51	363.15	369.82	377.29	384.38	391.20	398.18	404.61	410.75	416.24
ONBA	36 2228	-3.97	-3.55	-4.19	-	-	-4.55	-3.84	-3.37	-3.46	-4.51	-3.42	-3.85
ONRJ	35 102	-4.64	-4.42	-4.76	-3.95	-4.71	-4.29	-4.30	-3.90	-4.06	-3.21	-2.46	-2.76
ONRJ	35 103	3.61	0.82	1.93	2.59	2.00	1.75	2.63	1.49	2.57	1.73	2.74	0.85
ONRJ	35 111	-	-	-	-	3.65	-0.08	-1.99	-1.44	-2.66	-2.74	-3.54	-2.21
ONRJ	35 123	28.95	31.01	30.44	30.21	29.79	31.39	29.93	31.15	31.28	31.63	31.57	30.98
ONRJ	35 129	2.08	1.88	2.38	1.01	2.62	2.25	3.17	2.39	3.16	2.59	2.59	2.44
ONRJ	35 147	-	4.40	2.86	3.28	2.79	2.84	2.76	2.94	2.33	2.99	2.20	2.94
ONRJ	35 1153	-	-	-	-	-	-	-	-	-	-	-	210.30
ONRJ	35 1942	-1.73	-1.47	-0.71	-0.31	0.99	0.34	1.19	3.11	3.75	3.58	5.18	5.02
ONRJ	40 1950	-	-	-	-	-	-	-	12.50	29.09	50.99	76.21	104.04
ORB	36 201	0.31	1.21	0.86	-0.11	1.80	2.20	1.92	0.11	-0.79	-	-	-0.36
ORB	36 202	6.82	7.56	9.83	9.55	6.27	5.09	10.53	7.59	7.52	-	-	4.66
ORB	36 593	83.73	82.37	83.15	83.57	85.14	84.01	83.13	84.87	84.27	-	-	85.62
ORB	40 2601	-0.43	0.62	1.16	-	-	-	-	-	-	-	-	-
ORB	40 2602	8.20	9.16	10.18	0.17	-0.59	-0.68	0.00	0.24	-0.44	-	-	-0.36
PL	25 124	3.89	-0.37	-2.37	-0.86	-3.54	-6.08	-4.08	-11.43	-6.71	-1.23	4.52	2.96
PL	25 125	-	9.05	5.18	-0.07	-3.70	-7.50	-10.35	-20.87	-11.44	-	-	-
PL	35 441	2.31	3.32	3.14	2.25	-	-	-	-	-	-	11.94	11.90
PL	35 502	13.09	16.22	4.59	1.50	3.54	3.58	4.36	2.54	4.87	6.14	4.84	5.34
PL	35 745	0.81	0.56	0.25	1.12	0.39	-0.53	-0.23	0.32	1.41	0.74	0.41	1.23

Table 8. (Cont.)

Lab.	Clock	55224	55254	55284	55314	55344	55374	55404	55439	55469	55499	55529	55559
PL	35 1120	-0.99	-0.84	-1.70	-1.78	-2.14	-1.53	-2.31	-1.86	-3.03	-2.12	-1.75	-2.34
PL	35 1660	12.09	12.89	12.00	12.02	37.55	-	-	-	-	-	-	-
PL	35 1709	-1.82	-2.71	-2.53	-3.25	-2.71	-3.10	-2.66	-	-	-	-	-
PL	35 1746	-1.75	-1.27	-1.06	-1.00	-0.81	-0.04	-0.01	0.63	0.14	0.52	1.42	1.29
PL	35 1934	1.01	1.35	0.75	1.31	0.92	1.55	1.52	1.06	2.13	2.32	3.13	3.12
PL	35 2394	2.39	1.96	3.28	3.25	1.16	0.85	0.40	-1.69	-1.26	-0.54	2.13	4.70
PL	40 4002	-34.95	-35.39	-38.00	-44.08	-45.19	-42.79	-39.34	-41.14	-42.42	-42.01	-41.95	-41.97
PL	40 4004	-32.23	-27.26	-31.96	-31.26	-30.90	-31.88	-37.06	-6.66	11.72	-	-	-
PL	40 4601	10.32	11.16	11.80	12.55	13.15	13.78	14.71	15.48	16.20	17.10	17.90	18.66
PL	40 4602	119.08	134.40	146.94	156.93	164.78	171.13	180.14	188.31	198.30	209.25	216.69	227.38
PTB	35 128	-1.22	-0.54	-0.68	-0.77	-0.51	-0.25	0.01	0.66	0.02	-0.13	0.42	1.10
PTB	35 415	-2.09	-1.42	-0.67	-1.24	-0.59	-0.82	-0.95	-0.43	-0.30	1.17	0.58	0.96
PTB	35 1072	12.01	11.62	10.43	10.41	11.78	11.54	10.80	11.06	11.61	11.43	11.19	11.61
PTB	40 506	0.88	3.32	5.71	8.54	11.14	13.49	-5.65	-4.19	-1.79	0.56	2.66	6.67
PTB	40 508	-42.66*	-34.97*	-28.19*	-21.28*	-15.31*	-9.25*	-3.23	3.14	9.61	16.98	20.76	27.78
PTB	40 510	-45.57	-46.54	-49.96	-50.09	-55.26	-56.58	-20.60	-	-	-	-	-
PTB	40 590	-16.50*	-15.55*	-14.72*	-14.10*	-13.29*	-12.26*	-11.37*	-10.52*	-9.86*	-9.37	-8.73	-7.81
PTB	92 1	1.77	1.99	1.89	1.96	1.69	0.74	1.84	1.40	1.48	1.67	1.23	1.97
PTB	92 2	0.84	0.89	1.37	1.44	1.02	1.25	1.59	1.02	-	-	-	-
ROA	35 583	3.71	3.67	4.53	4.56	4.24	3.78	4.26	4.58	4.59	5.24	5.67	5.64
ROA	35 718	-5.37	-5.42	-5.63	-5.69	-5.92	-5.70	-5.27	1.94	2.87	2.71	2.83	3.17
ROA	35 1699	6.29	5.98	6.91	7.13	7.41	7.24	7.27	8.12	7.97	7.40	7.12	8.58
ROA	35 2270	-	-	-	-	-3.03	-2.70	-4.20	-4.27	-5.04	-5.18	-5.25	-5.72
ROA	36 1488	9.31	8.80	8.21	8.80	8.47	10.21	7.88	7.64	8.89	8.81	8.95	8.47
ROA	36 1490	9.58	9.26	9.30	8.15	9.37	9.02	9.19	7.45	9.97	6.63	8.52	9.11
ROA	40 1436	67.33	68.97	71.46	73.63	76.14	78.15	80.43	83.21	85.98	88.97	91.71	94.90
SCL	35 1745	-0.69	-1.21	-	-	-1.74	0.41	-2.00	-	-	-	-	-
SCL	35 2178	6.47	6.62	-	-	6.82	7.23	6.76	5.96	2.87	1.86	2.40	2.30
SCL	35 2525	-0.17	-0.11	-	-	0.17	1.26	0.17	1.24	0.98	1.14	1.48	2.03
SG	35 475	-4.75	-4.47	-5.26	-4.73	-4.71	-	-	-4.03	-3.85	-3.82	-3.73	-3.63

Table 8. (Cont.)

Lab.	Clock	55224	55254	55284	55314	55344	55374	55404	55439	55469	55499	55529	55559
SG	35 476	-	-	7.68	7.66	8.19	-	-	-	7.82	8.13	7.57	8.06
SG	35 1889	15.13	16.41	15.52	15.53	16.19	-	-	16.70	16.87	15.87	15.96	15.74
SG	36 522	1.60	0.56	1.40	1.01	0.54	-	-	0.70	1.12	2.20	3.10	2.65
SG	40 7701	19.67	23.65	27.73	31.57	35.89	-	-	52.52	59.59	66.69	74.23	82.16
SIQ	36 1268	0.12	3.17	-0.57	1.27	0.99	2.67	3.22	-3.46	-1.16	-2.62	-1.41	-1.94
SMD	35 810	1.40	0.96	0.09	-0.21	-0.77	1.34	0.98	2.04	-1.89	-2.64	-4.18	-5.57
SMD	35 1766	12.01	13.12	12.17	12.54	12.52	12.37	11.85	12.19	12.86	13.06	13.36	13.40
SMD	35 1896	18.07	18.37	-	-	-	-	-	-	-	-	-	-
SMD	35 2003	11.89	11.30	11.30	12.17	11.73	11.52	11.64	10.57	11.43	12.02	11.75	11.51
SMD	35 2543	-	-	-	-	-	-	-	-	6.53	7.32	6.90	7.27
SMU	36 1193	-	0.06	-0.50	-1.07	-0.87	-1.19	-1.73	0.55	1.63	2.12	0.67	1.10
SP	19 197	-	-26.65	-25.19	-21.80	-28.21	-26.72	-29.67	-29.58	-26.85	-24.10	-28.26	-29.25
SP	35 572	19.41	19.59	19.22	19.24	19.61	18.71	19.22	19.36	18.66	18.69	19.29	18.79
SP	35 641	3.07	3.58	-	-	-	-	-	-	3.10	2.69	2.74	2.54
SP	35 1188	24.15	24.43	24.70	23.89	22.38	22.31	22.78	22.70	22.21	22.03	22.49	22.26
SP	35 1531	21.46	20.43	20.27	20.28	-	-	-	-	-	-	-	-
SP	35 1642	-3.92	-3.98	-2.95	-3.13	-3.40	-3.29	-2.75	-1.89	-2.77	-2.29	-1.14	-1.44
SP	35 2166	4.17	4.18	4.69	3.77	4.25	3.63	4.76	4.23	4.39	4.24	4.58	4.61
SP	36 223	9.55	8.48	8.96	9.10	8.65	10.54	10.10	9.50	9.96	8.62	7.53	9.67
SP	36 1175	2.66	-0.01	2.63	2.18	1.54	1.51	2.79	3.08	1.49	1.33	2.05	3.62
SP	36 2068	2.52	1.04	2.12	2.36	2.37	0.49	4.00	3.37	1.45	0.75	1.76	3.10
SP	36 2218	24.53	23.50	23.41	23.76	24.62	24.61	22.69	24.15	23.03	22.76	23.46	23.28
SP	36 2295	9.10	7.30	8.94	7.95	7.09	8.14	7.49	8.42	7.02	7.72	8.46	7.32
SP	36 2297	-7.11	-6.78	-6.30	-6.69	-7.69	-6.44	-8.13	-6.55	-8.85	-6.75	-6.60	-7.86
SP	40 7201	85.79	88.57	90.90	93.15	95.42	97.58	100.16	102.78	105.45	107.61	110.21	112.88
SP	40 7203	-5.25	-4.04	-2.92	-1.83	-0.80	0.22	1.28	2.55	3.76	4.77	5.83	6.95
SP	40 7210	69.86	73.04	76.71	80.28	83.76	87.66	91.38	94.99	98.74	102.06	105.04	108.04
SP	40 7211	1.93	3.60	5.14	6.64	8.19	9.83	11.36	12.93	14.62	16.22	17.82	19.62
SP	40 7212	4.31	4.71	5.09	5.51	5.95	6.45	6.98	7.53	8.05	8.52	8.96	9.56
SP	40 7218	-7.24	-7.88	-10.09	-12.02	-14.95	-17.19	-19.14	-21.19	-23.31	-24.96	-27.23	-29.14

Table 8. (Cont.)

Lab.	Clock	55224	55254	55284	55314	55344	55374	55404	55439	55469	55499	55529	55559
SP	40 7221	-44.44	-44.44	-44.50	-44.58	-44.64	-44.59	-44.56	-44.46	-44.43	-44.41	-44.45	-44.40
SU	40 3802	10.64*	9.70*	6.42*	2.51*	0.04*	-2.84*	-2.45*	-3.11*	-2.69	-1.04	-0.67	-
SU	40 3809	8.38*	8.40*	8.33*	8.32*	8.33*	8.53*	8.76*	8.86*	8.75	9.04	9.17	9.56
SU	40 3810	7.72*	7.54*	7.34*	7.18*	6.98*	6.90*	6.90*	7.08*	6.80	6.84	-	-
SU	40 3811	22.84*	23.57*	24.51*	25.60*	26.65*	27.83*	29.01*	30.34*	31.33*	32.76	33.89	35.00
SU	40 3812	0.61	0.68	0.67	0.69	0.70	0.77	0.91	1.12	1.24	1.50	1.45	1.60
SU	40 3814	-9.71*	-9.45*	-9.17*	-8.76*	-8.30*	-7.74*	-7.08	-6.26	-5.64	-4.76	-4.05	-3.18
SU	40 3815	-5.93	-5.35	-4.84	-4.30	-3.72	-3.11	-2.48	-1.69	-1.22	-0.52	0.04	0.71
SU	40 3816	2.29*	3.07	4.09	5.59	7.97	11.57	17.26	26.77	32.40	26.67	-	11.40
SU	40 3817	5.73	5.42	5.18	4.98	4.84	4.94	5.19	5.64	6.01	6.69	7.30	8.16
SU	40 3822	-6.24*	-9.33*	-11.19*	-14.51*	-17.23*	-16.46*	-18.05*	-19.41*	-20.11*	-21.50*	-21.88*	-22.75
SU	40 3831	57.09*	57.58*	57.79*	58.26*	58.67*	52.60*	51.03*	55.20*	55.35*	53.75*	51.90*	50.21
SU	40 3837	51.70	51.34	51.32	51.20	-	-	-	-	-	-	-	-
TCC	35 768	3.42	-	-	7.91	5.63	4.03	3.01	5.58	4.29	5.13	5.67	3.69
TCC	35 1028	-1.24	-	-	-1.64	-1.75	-3.02	-2.77	-1.31	-2.79	-	-	-
TCC	35 1881	1.50	-	-	1.63	1.02	1.27	1.57	2.61	1.92	2.31	2.32	2.54
TCC	40 8620	11.50	-	-	3.12	3.45	4.88	5.90	6.92	7.39	8.21	9.23	10.01
TCC	40 8624	-4.84	-	-	-28.69	-26.61	-26.98	-27.17	-27.99	-28.42	-28.59	-28.74	-29.13
TCC	40 8650	-18.14	-	-	-174.92	-177.39	-177.69	-179.30	-181.15	-183.12	-184.63	-186.43	-187.80
TL	35 300	-	-	-	-	-	-	-	10.94	11.87	11.81	11.85	11.63
TL	35 474	0.41	-	-	-	-	-	-	-	-	-	-	-
TL	35 809	-0.56	-	-	-	-	-	-	-	-	-	-	-
TL	35 1012	1.09	1.74	1.80	1.20	1.90	2.19	2.53	3.56	2.97	3.13	2.73	2.77
TL	35 1104	16.40	17.21	17.37	16.91	18.42	17.63	17.91	18.63	17.79	17.43	18.37	18.08
TL	35 1132	-7.84	-7.37	-6.91	-3.48	-3.61	-3.96	-4.05	-4.31	-4.96	-4.32	-3.80	-4.10
TL	35 1498	-2.42	-2.20	-2.30	-1.81	-2.08	-2.35	-1.86	-1.45	-2.08	-1.04	-0.52	-1.01
TL	35 1500	17.65	17.82	17.62	18.02	17.68	17.74	17.19	17.08	17.55	16.67	16.29	16.97
TL	35 2365	5.50	5.37	5.28	5.53	4.89	5.30	4.64	5.50	4.75	5.81	6.68	6.11
TL	35 2366	-9.01	-8.33	-8.32	-8.21	-8.49	-8.44	-8.25	-9.17	-9.11	-9.05	-8.97	-9.56
TL	35 2367	9.80	10.92	9.10	10.01	9.14	10.17	9.64	9.90	9.39	9.12	9.79	9.55

Table 8. (Cont.)

Lab.	Clock	55224	55254	55284	55314	55344	55374	55404	55439	55469	55499	55529	55559
TL	35 2368	-0.19	0.10	-0.25	0.06	-0.81	-1.14	-1.07	-1.33	-0.76	-1.35	-0.64	-1.73
TL	35 2630	-	-	-	-	-	-	-	-	-	-17.77	-17.79	-17.16
TL	35 2634	-	-	-	-	-	-	-	-	-	0.02	2.50	1.37
TL	35 2636	-	-	-	-	-	-	-	-	-	13.16	12.48	12.31
TL	40 57	-	-	-	-	-	-	-	-	19.01	10.34	14.11	15.57
TL	40 3052	63.34	63.20	62.70	63.56	63.87	62.74	62.32	62.63	63.62	63.55	63.29	63.15
TL	40 3053	7.91	7.44	7.79	7.52	7.88	7.68	6.31	6.09	6.41	6.05	6.27	6.07
TP	35 163	3.94	4.09	5.97	7.18	9.34	10.29	11.44	11.88	12.56	14.00	14.47	15.32
TP	35 326	-71.02	-71.70	-71.41	-71.44	-71.83	-72.54	-72.10	-72.58	-73.64	-73.59	-	-
TP	35 1227	13.10	13.44	13.07	13.30	12.99	13.20	13.28	13.50	13.55	13.77	14.11	13.75
TP	35 2476	4.13	4.48	4.41	5.22	5.06	4.94	5.42	5.35	5.70	6.19	5.65	6.61
TP	36 154	10.35	9.89	11.96	8.87	10.02	11.21	10.55	7.91	10.00	10.52	12.16	11.34
UA	35 2465	-	-	-9.80	-8.69	-7.13	-6.45	-	-	-	-	-5.26	-
UA	40 7854	-	-	0.70	-2.32	1.58	2.46	-	-	-	-	-6.09	-
UA	40 7881	-	-10.84	-6.58	-2.61	-0.70	-0.53	-	-	-	-	9.72	-
UA	40 7882	-	4.02	3.59	4.36	5.21	5.87	-	-	-	-	8.17	-
UME	35 251	0.18	1.30	1.37	2.31	2.20	1.93	1.71	2.02	1.59	1.50	1.21	0.74
USNO	35 101	-	8.15	7.61	7.56	7.32	8.24	7.94	8.56	8.53	8.43	9.08	8.56
USNO	35 104	20.76	20.11	20.27	19.97	20.16	19.89	19.89	20.63	23.10	23.13	21.73	22.64
USNO	35 106	17.53	16.66	17.90	17.96	17.41	18.38	18.30	18.01	17.93	18.50	17.56	18.29
USNO	35 108	3.51	4.25	3.93	3.92	3.52	3.69	3.99	4.01	4.02	3.74	3.69	4.13
USNO	35 114	-2.61	-2.96	-1.73	-1.57	-1.93	-1.95	-1.42	-1.01	-1.04	-0.38	-0.17	-1.72
USNO	35 120	22.48	22.84	24.63	23.90	24.35	24.44	24.79	25.30	25.06	25.33	24.88	25.31
USNO	35 142	-8.27	-7.73	-8.23	-8.17	-8.31	-7.82	-7.81	-7.57	-8.23	-8.40	-9.64	-8.99
USNO	35 145	20.22	20.98	15.43	15.84	14.20	14.68	14.35	14.93	14.30	14.76	14.56	20.22
USNO	35 146	0.56	-0.38	-0.56	-0.39	-0.49	-0.43	0.35	-0.41	-0.73	-0.95	-0.76	-0.42
USNO	35 148	8.37	8.10	9.16	8.90	10.27	9.20	9.30	9.24	9.36	9.26	9.45	9.41
USNO	35 150	-1.50	-1.14	-0.68	-1.80	-1.39	-1.06	-1.63	-1.44	-1.72	-1.81	-1.66	-1.69
USNO	35 152	3.34	3.59	3.56	3.15	4.47	3.15	2.61	2.84	2.88	2.21	4.01	2.38
USNO	35 153	16.57	15.45	15.93	15.47	15.30	15.88	15.54	15.31	16.08	15.63	15.52	15.33

Table 8. (Cont.)

Lab.	Clock		55224	55254	55284	55314	55344	55374	55404	55439	55469	55499	55529	55559
USNO	35	156	11.52	11.07	11.36	11.15	11.19	10.96	11.46	10.67	10.74	10.46	10.42	9.94
USNO	35	161	8.93	8.81	8.12	7.03	8.00	6.63	6.77	7.58	7.41	6.72	7.30	7.39
USNO	35	164	7.54	7.88	6.85	6.87	6.12	6.70	7.74	8.27	7.92	7.67	7.71	-
USNO	35	165	12.88	12.73	13.27	12.93	13.06	12.43	12.70	12.28	12.11	11.45	11.97	12.36
USNO	35	166	-1.29	-2.56	-1.19	-0.58	-0.04	-1.25	-0.73	-0.62	-0.15	-0.56	-1.25	-0.58
USNO	35	167	-0.66	-1.25	-1.27	-1.33	-1.22	-1.65	-2.03	-2.65	-2.87	-2.32	-1.78	-2.49
USNO	35	173	-6.86	-7.17	-6.49	-7.17	-6.49	-6.06	-6.62	-6.33	-6.47	-6.17	-6.56	-6.05
USNO	35	213	10.79	9.84	9.41	10.09	9.91	10.82	9.38	9.92	10.55	10.99	10.38	11.15
USNO	35	217	-14.96	-16.07	-13.48	-	-	-	-	-	-	-	-	-
USNO	35	226	8.96	9.14	8.27	9.29	8.93	8.94	9.82	9.52	9.38	10.21	10.11	9.64
USNO	35	227	17.19	17.96	19.24	19.53	20.30	21.79	20.20	20.17	21.38	22.49	22.57	23.57
USNO	35	231	-11.51	-11.39	-11.61	-11.71	-11.91	-11.70	-11.32	-11.41	-11.48	-12.78	-10.82	-11.97
USNO	35	233	17.98	18.38	18.15	18.25	18.09	18.11	18.39	17.81	18.37	17.79	17.77	17.74
USNO	35	242	13.50	13.83	12.83	12.66	13.02	13.67	13.34	13.55	13.42	14.75	13.00	13.31
USNO	35	244	8.72	9.04	8.44	8.79	8.77	9.31	9.65	9.17	10.15	10.06	9.05	8.45
USNO	35	253	-20.42	-20.47	-20.86	-21.05	-20.75	-20.64	-21.19	-20.85	-21.41	-20.01	-20.77	-20.53
USNO	35	254	4.35	4.18	4.97	5.71	5.79	6.03	6.52	6.80	6.22	5.60	5.78	6.21
USNO	35	260	0.80	0.51	2.04	3.02	1.38	1.20	2.21	1.21	2.64	1.90	2.95	2.00
USNO	35	268	-2.15	-1.84	-2.64	-2.50	-2.69	-2.65	-2.70	-2.38	-1.56	-2.97	-2.56	-2.70
USNO	35	270	-	13.86	13.61	13.28	13.96	13.94	13.48	14.33	13.93	13.68	12.53	14.28
USNO	35	392	33.23	33.34	34.19	33.69	32.92	33.54	33.86	33.80	33.30	33.62	33.75	-
USNO	35	394	71.15	71.62	68.59	64.82	69.72	76.31	73.76	64.87	-	-	-	-
USNO	35	416	-11.01	-10.58	-10.64	-10.52	-10.40	-10.37	-8.42	-9.45	-10.08	-10.28	-10.91	-10.26
USNO	35	417	11.15	11.35	9.95	10.83	11.49	10.03	-	-	-	-	-9.63	-9.72
USNO	35	703	-1.71	-1.61	-1.82	-1.59	-	-	-	-	-	-	-	-
USNO	35	717	-10.85	-11.00	-11.76	-11.24	-11.34	-11.51	-11.66	-11.51	-10.48	-11.61	-11.63	-10.60
USNO	35	762	-1.34	-3.53	-3.73	-4.20	-3.55	-4.60	-3.75	-3.83	-3.50	-3.60	-2.96	-2.86
USNO	35	763	-16.02	-16.33	-15.86	-15.77	-15.48	-16.01	-15.85	-15.69	-15.48	-14.82	-15.28	-15.49
USNO	35	765	-47.28	-46.20	-45.51	-47.37	-48.39	-48.77	-47.83	-45.35	-44.35	-45.16	-46.89	-46.87
USNO	35	1096	-	-	-	-	-	-	-	-	-	-	-	13.50

Table 8. (Cont.)

Lab.	Clock	55224	55254	55284	55314	55344	55374	55404	55439	55469	55499	55529	55559
USNO	35 1097	13.20	12.36	13.06	13.00	12.81	12.83	13.77	13.14	13.23	12.97	7.68	8.24
USNO	35 1125	-12.77	-12.89	-12.90	-14.18	-14.46	-15.22	-16.27	-15.81	-15.90	-15.73	-14.18	-14.34
USNO	35 1327	-3.44	-3.35	-3.36	-4.02	-3.26	-3.40	-4.03	-4.84	-4.69	-4.18	-4.02	-3.91
USNO	35 1328	1.58	1.74	0.74	0.37	0.61	-0.54	-0.19	0.38	1.07	0.86	0.74	0.55
USNO	35 1331	-39.33	-38.20	-39.15	-38.96	-41.01	-40.59	-35.54	-37.48	-38.70	-38.51	-39.38	-37.71
USNO	35 1438	-2.70	-3.63	-4.07	-3.09	-2.57	-3.12	-3.97	-4.44	-5.07	-4.50	-5.53	-5.20
USNO	35 1459	-	-2.95	-3.74	-3.94	-3.79	-3.87	-3.69	-4.40	-4.98	-4.36	-3.91	-3.89
USNO	35 1462	-3.71	-3.15	-3.53	-3.85	-3.54	-3.59	-3.55	-3.88	-3.65	-3.90	-4.01	-3.56
USNO	35 1463	13.53	13.31	14.20	13.68	13.39	14.15	14.08	14.13	14.67	13.97	14.46	13.72
USNO	35 1543	3.84	4.25	3.63	3.82	4.45	4.46	4.37	4.87	4.76	4.53	4.81	5.41
USNO	35 1575	-6.30	-5.08	-5.31	-5.56	-5.51	-4.98	-5.30	-5.21	-4.42	-5.17	-4.77	-5.87
USNO	35 1598	-	-	-	-	-	-	-	-	-	-	1.71	0.89
USNO	35 1655	-	-13.01	-12.09	-12.70	-12.14	-11.92	-11.75	-11.67	-11.48	-11.08	-11.59	-10.94
USNO	35 1658	-	-	-	-	-	-	-	-	-	-	17.73	17.58
USNO	35 1692	-	-	-5.26	-4.97	-4.31	-4.82	-3.72	-3.80	-3.21	-2.66	-2.65	-2.81
USNO	35 1696	-	-	11.99	10.92	11.02	11.08	11.12	11.15	11.54	11.25	11.60	11.19
USNO	35 1697	-	19.53	19.11	19.30	18.89	18.97	19.13	19.09	18.97	19.88	19.49	19.39
USNO	40 702	-9.90	-9.97	-9.76	-9.61	-9.64	-9.83	-9.94	-10.09	-9.93	-10.18	-10.10	-10.03
USNO	40 704	-	-	20.34	20.02	19.63	19.55	19.46	19.51	19.49	19.53	19.51	19.31
USNO	40 705	-	-	-83.82	-85.09	-85.25	-84.31	-84.12	-83.49	-82.85	-82.11	-80.65	-78.12
USNO	40 708	73.83	74.09	74.46	74.61	74.90	75.20	75.38	75.69	75.95	76.07	76.33	76.91
USNO	40 710	-	-577.91	-576.98	-576.07	-575.08	-574.01	-573.15	-572.15	-571.34	-570.52	-569.64	-568.82
USNO	40 711	290.67	292.40	294.15	295.92	297.37	299.01	300.68	302.51	304.39	306.01	307.79	309.53
USNO	40 712	49.45	49.50	49.58	49.70	49.39	49.39	49.46	49.45	49.50	49.44	49.49	49.51
USNO	40 713	16.09	16.45	16.87	17.23	17.57	18.00	18.36	18.74	19.30	19.64	20.01	20.49
USNO	40 714	-14.59	-14.42	-14.04	-13.72	-13.54	-13.29	-12.25	-12.91	-12.66	-12.55	-12.28	-11.99
USNO	40 715	86.84	87.34	87.87	88.26	88.63	89.09	89.70	90.33	90.92	91.32	91.89	92.49
USNO	40 716	210.93	211.02	211.16	211.31	211.34	211.50	211.49	211.63	211.77	211.80	211.87	212.04
USNO	40 718	149.50	150.69	151.47	152.36	153.05	154.03	154.93	156.02	157.18	158.14	159.25	160.47
USNO	40 719	45.95	47.26	48.62	49.90	51.12	52.41	53.58	54.83	56.00	57.00	58.22	59.45

Table 8. (Cont.)

Lab.	Clock	55224	55254	55284	55314	55344	55374	55404	55439	55469	55499	55529	55559
USNO	40 720	85.43	88.28	91.16	94.15	96.77	99.67	102.43	105.46	108.38	110.90	113.49	116.09
USNO	40 722	347.23	350.74	354.53	358.45	361.88	365.37	368.85	372.56	376.29	379.68	383.07	386.45
USNO	40 723	-74.45	-74.82	-75.16	-75.09	-75.18	-75.18	-75.14	-74.98	-74.18	-73.95	-73.82	-73.69
USNO	40 724	-100.97	-101.37	-101.75	-102.13	-102.55	-102.82	-103.34	-103.71	-103.73	-104.03	-104.30	-104.63
USNO	40 725	-29.38	-29.14	-29.27	-29.16	-28.84	-28.60	-28.74	-28.71	-28.60	-28.44	-28.42	-27.43
USNO	40 728	-	-	-	-	218.90	218.65	217.88	217.65	221.59	225.81	228.24	231.34
USNO	40 731	-146.01	-147.01	-147.96	-148.85	-149.94	-150.90	-151.80	-152.86	-153.81	-154.82	-155.72	-156.60
VMI	35 2230	-23.43	-25.74	-24.91	-25.50	-	-	-	-	-	-27.81	-26.92	-23.93
VMI	36 1233	-2.17	-5.08	-2.68	-2.61	-	-	-	-	-	-6.53	-5.81	-4.58
VMI	36 2314	24.67	22.65	21.85	22.92	-	-	-	-	-	20.05	21.13	23.62
VSL	35 179	-29.89	-29.46	-27.91	-28.44	-27.66	-27.16	-27.47	-27.24	-26.41	-27.01	-26.88	-27.16
VSL	35 456	17.65	18.16	17.50	17.45	18.20	19.80	-	-	-	-	-	-
VSL	35 548	20.97	22.08	22.31	21.91	24.06	24.13	24.18	23.64	24.08	23.62	23.23	24.20
VSL	35 731	17.65	17.65	17.45	18.92	19.91	20.08	20.16	20.78	19.87	18.96	18.76	19.48
ZA	35 2232	-	-	-	-	-2.62	-3.13	-3.54	-4.66	-4.43	-4.26	-5.02	-5.30
ZA	35 2233	-	-	-	-	-17.46	-16.19	-16.98	-16.31	-16.68	-16.56	-16.35	-16.62
ZA	36 1034	-	-	-	-	-	-17.24	-15.89	-16.04	-15.36	-14.28	-14.25	-14.61
ZA	36 1821	-	-	-	-	-10.46	-10.94	-8.81	-9.20	-7.55	-8.69	-7.78	-9.64

Table 9A. Relative weights (in percent) of contributing clocks in 2010

(File is available at ftp://62.161.69.5/pub/tai/scale/WTAI/wtai10.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	55224	55254	55284	55314	55344	55374	55404	55439	55469	55499	55529	55559
APL	35 904	0.000	0.000	0.273	0.386	0.534	0.000	-	-	-	-	-	-
APL	35 1264	0.000	0.000	0.064	0.081	0.116	0.136	0.168	0.215	-	0.000	0.000	0.000
APL	35 1791	0.000	0.000	0.758	0.742	0.746	0.718	0.712	0.714	-	0.000	0.000	0.000
APL	40 3107	0.000	0.000	0.000	0.117	0.176	0.228	0.283	0.350	-	0.000	0.000	0.000
APL	40 3108	0.000	0.000	0.002	0.001	0.001	0.001	0.001	0.001	-	0.000	0.000	0.000
APL	40 3109	0.000	0.000	0.007	0.007	0.008	0.008	0.008	0.008	-	0.000	0.000	0.000
AUS	35 2269	0.077	0.104	0.107	0.116	0.120	0.000	0.000	0.018	0.014	0.012	0.011	0.011
AUS	36 299	0.000	0.061	0.089	0.120	0.173	0.191	0.000	-	0.000	0.000	-	0.000
AUS	36 340	0.454	0.366	0.371	0.347	0.279	0.265	0.360	0.411	0.353	0.342	0.347	0.224
AUS	36 654	0.190	0.171	0.132	0.142	0.141	0.127	0.140	0.147	0.151	0.198	0.198	0.195

Table 9A. (Cont.)

Lab.	Clock	55224	55254	55284	55314	55344	55374	55404	55439	55469	55499	55529	55559
AUS	36 1141	0.067	0.074	0.063	0.071	0.072	0.059	0.060	0.060	0.054	0.062	0.065	0.061
AUS	40 5401	0.000	-	-	-	-	-	-	-	0.000	0.000	0.000	0.000
AUS	40 5402	0.000	-	-	-	-	-	-	-	-	0.000	0.000	0.000
BEV	35 1065	0.081	0.070	0.063	0.068	0.095	0.119	0.140	0.195	0.262	0.232	0.166	0.176
BEV	35 1793	0.779	0.767	0.758	0.634	0.656	0.000	-	-	-	-	-	-
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	0.114	0.121	0.138	0.169	0.206	0.237	0.303	0.302	0.315	0.274	0.253	0.287
BY	40 4209	0.002	0.002	0.003	0.004	0.004	0.002	0.003	0.002	0.002	0.002	-	-
BY	40 4222	-	0.000	0.000	0.000	0.000	-	-	0.000	0.000	0.000	0.000	0.000
BY	40 4227	-	0.000	0.000	0.000	0.000	0.007	0.010	0.004	0.005	0.004	0.004	0.004
BY	40 4260	0.003	0.002	0.004	0.004	0.003	0.003	0.005	0.004	0.003	0.002	0.002	0.002
BY	40 4278	0.002	0.002	0.003	0.003	0.003	0.004	0.011	0.010	0.008	0.005	0.004	0.003
CAO	35 939	0.206	0.215	0.168	0.166	0.183	0.195	0.243	0.334	0.304	0.398	0.355	0.405
CAO	35 1270	0.646	0.612	0.758	0.742	0.746	0.718	0.712	0.714	0.000	0.599	0.554	0.485
CH	35 771	0.335	0.394	0.417	0.534	0.746	0.718	0.000	0.412	0.461	0.319	0.314	0.331
CH	35 2117	0.187	0.203	0.241	0.246	0.306	0.285	0.338	0.531	0.533	0.737	0.755	0.669
CH	36 354	0.407	0.361	0.394	0.393	0.345	0.204	0.187	0.151	0.149	0.141	0.122	0.112
CH	36 413	0.026	0.037	0.045	0.042	0.041	0.033	0.026	0.024	0.022	0.022	0.024	0.023
CH	40 5701	0.000	0.016	0.015	0.016	0.018	0.018	0.018	0.019	0.019	0.020	0.022	0.023
CNM	35 1815	0.191	0.189	0.199	0.247	0.292	0.282	0.286	0.324	0.329	0.336	0.326	0.255
CNM	36 1537	0.011	0.010	0.009	0.008	0.009	0.008	0.010	0.018	0.017	0.022	0.030	0.033
CNM	40 7301	0.111	0.000	0.000	0.012	0.012	0.011	0.011	0.012	0.013	0.013	0.017	0.022
CNM	53 6038	0.000	0.000	-	-	-	-	-	-	-	-	-	-
CNMP	36 1752	-	-	0.000	0.000	0.000	0.000	0.015	0.018	0.023	-	0.000	0.000
CNMP	36 1806	0.147	0.000	0.000	0.029	0.026	0.024	0.024	0.028	0.029	-	0.000	0.000
DLR	35 1714	0.162	0.127	0.119	0.116	0.125	0.145	0.138	0.145	0.166	0.185	0.192	0.201
DMDM	35 2191	-	0.000	0.000	0.000	0.000	0.099	0.147	0.209	0.280	0.261	0.261	0.277
DMDM	36 2033	0.000	0.000	0.025	0.021	0.021	0.019	0.018	0.023	0.031	0.036	0.058	0.196
DTAG	36 345	0.091	0.098	0.115	0.127	0.141	0.111	0.122	0.109	0.118	0.108	0.108	0.105
DTAG	36 465	0.076	0.076	0.063	0.068	0.071	0.057	0.133	0.129	0.127	0.121	0.114	0.101

Table 9A. (Cont.)

Lab.	Clock	55224	55254	55284	55314	55344	55374	55404	55439	55469	55499	55529	55559
DTAG	36 2370	0.459	0.325	0.318	0.315	0.328	0.363	0.299	0.307	0.363	0.349	0.437	0.308
EIM	35 716	0.000	-	-	-	0.000	0.000	-	-	0.000	0.000	0.000	0.000
EIM	35 1431	0.000	-	-	-	0.000	0.000	-	-	0.000	0.000	0.000	0.000
EIM	35 2060	0.000	-	-	-	-	0.000	-	-	-	0.000	0.000	0.000
F	35 122	0.468	0.000	0.148	0.107	0.121	0.128	0.144	0.138	0.136	0.135	0.132	-
F	35 124	0.779	0.767	0.758	0.742	0.746	0.718	0.712	0.714	0.674	0.540	0.531	0.479
F	35 131	0.000	-	-	-	-	-	-	-	-	-	-	-
F	35 158	0.779	0.767	0.758	0.742	0.746	0.718	0.712	0.714	0.716	0.737	0.755	0.758
F	35 355	0.000	0.000	0.000	0.000	0.158	0.152	0.140	0.160	0.183	0.177	0.191	0.211
F	35 385	0.779	0.700	0.677	0.629	0.561	0.625	0.333	0.402	0.380	0.314	0.295	0.303
F	35 396	0.371	0.390	0.662	0.669	0.712	0.718	0.656	0.514	0.620	0.707	0.739	0.758
F	35 469	0.096	0.087	0.084	0.093	0.124	0.111	0.102	0.114	0.106	0.097	0.098	0.097
F	35 489	0.232	0.267	0.292	0.435	0.630	0.718	0.712	0.714	0.716	0.737	0.755	0.758
F	35 520	0.028	0.027	0.019	0.020	0.024	0.019	0.022	0.024	0.033	0.040	0.056	0.074
F	35 536	0.342	0.347	0.255	0.208	0.258	0.269	0.297	0.451	0.662	0.737	0.755	0.698
F	35 609	-	-	0.000	0.000	0.000	0.000	0.688	0.689	0.716	0.737	-	-
F	35 770	0.779	0.767	0.758	0.742	0.746	0.718	0.712	0.714	0.716	0.737	0.755	0.758
F	35 774	0.000	0.000	0.197	0.262	0.352	0.297	0.292	0.339	0.406	0.464	0.599	0.758
F	35 781	0.018	0.018	0.018	0.017	0.020	0.024	0.035	0.058	-	-	0.000	0.000
F	35 819	0.029	0.015	0.013	0.012	0.013	0.013	0.013	0.013	0.016	0.020	0.000	0.016
F	35 859	0.125	0.136	0.191	0.190	0.180	0.167	0.187	0.165	0.184	0.161	0.150	0.153
F	35 909	0.000	0.000	0.000	0.024	0.025	0.026	0.027	0.028	-	-	0.000	0.000
F	35 1068	0.779	0.767	0.758	0.742	0.746	0.718	0.712	0.714	-	-	0.000	0.000
F	35 1177	0.000	0.167	0.114	0.151	0.164	0.099	0.099	0.093	0.084	0.086	0.080	0.086
F	35 1258	0.204	0.187	0.217	0.210	0.193	0.255	0.336	0.370	-	-	0.000	-
F	35 1321	0.711	0.588	0.470	0.501	0.444	0.597	0.596	0.613	0.614	0.620	0.733	0.690
F	35 1556	0.000	0.000	0.758	0.742	0.387	0.293	0.369	0.473	0.577	0.483	-	-
F	35 1644	0.648	0.679	0.564	0.506	0.350	0.274	0.220	0.250	0.328	0.289	0.314	0.344
F	35 2027	0.352	0.320	0.356	0.347	0.385	0.405	0.355	0.480	0.488	0.477	0.586	0.445
F	35 2388	0.000	0.569	0.000	0.218	0.152	0.106	0.091	0.077	0.095	0.094	0.135	0.223

Table 9A. (Cont.)

Lab.	Clock	55224	55254	55284	55314	55344	55374	55404	55439	55469	55499	55529	55559
F	40 805	0.001	0.001	0.000	0.000	0.000	0.000	0.001	0.001	0.001	0.001	0.001	0.002
F	40 816	0.000	0.000	0.015	-	-	-	0.000	0.000	0.000	0.000	0.272	0.000
F	40 889	0.001	0.001	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	-	-
F	40 890	0.082	0.114	0.138	0.152	0.198	0.170	0.125	0.103	0.094	0.082	-	-
F	53 6385	0.137	0.113	0.118	0.085	0.068	0.052	0.048	-	-	-	-	-
HKO	35 1893	0.000	0.000	0.000	0.000	0.026	0.033	0.043	0.057	0.071	0.075	0.086	0.083
HKO	35 2425	0.000	0.000	0.000	0.023	0.033	0.037	0.040	0.047	0.054	0.061	0.070	0.072
IFAG	36 1167	0.044	0.039	0.039	0.042	0.046	0.053	0.056	0.051	0.068	0.083	0.080	0.074
IFAG	36 1173	0.014	0.017	0.025	0.028	0.028	0.021	0.018	0.016	0.015	0.015	0.014	0.014
IFAG	36 1629	0.093	0.099	0.131	0.142	0.155	0.099	0.059	0.051	0.045	0.044	0.047	0.049
IFAG	36 1732	0.567	0.527	0.451	0.434	0.444	0.531	0.712	0.714	0.716	0.737	0.755	0.758
IFAG	36 1798	0.300	0.347	0.376	0.422	0.460	0.448	0.447	0.468	0.716	0.737	0.691	0.441
IFAG	40 4418	0.027	0.077	0.052	0.043	0.045	0.046	0.050	0.062	0.076	0.095	0.109	0.132
IFAG	40 4439	0.005	0.010	0.008	0.009	0.010	0.009	0.009	0.010	0.010	0.006	0.006	0.007
INTI	35 2377	0.013	-	-	0.000	0.000	0.000	0.000	0.017	0.015	0.012	0.012	0.015
IPQ	35 1797	0.000	0.000	0.000	-	-	0.000	0.000	0.000	0.000	0.515	0.747	0.431
IPQ	35 2012	0.000	0.000	0.000	-	-	0.000	0.000	0.000	0.000	0.509	0.594	0.758
IPQ	35 2169	0.000	0.000	0.000	-	-	0.000	0.000	0.000	0.000	0.185	0.273	0.346
IT	35 219	0.027	0.028	0.029	0.038	0.066	0.251	0.712	0.714	0.716	0.000	0.000	0.022
IT	35 505	0.779	-	-	-	-	0.000	0.000	0.000	0.000	0.538	0.755	0.659
IT	35 1115	0.332	0.298	0.284	0.287	0.424	0.441	0.430	0.350	0.399	0.319	0.220	0.115
IT	35 1373	0.694	0.766	0.758	0.742	0.746	0.718	0.712	0.714	0.716	0.737	0.755	0.758
IT	35 2118	0.779	0.767	0.758	0.742	0.746	0.718	0.712	0.714	0.716	0.737	0.755	0.660
IT	35 2487	0.000	-	-	0.000	0.000	0.000	0.000	0.427	0.640	0.707	0.565	0.650
IT	40 1101	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.000	0.000	0.000	0.000
IT	40 1102	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
IT	40 1103	0.040	-	-	-	-	0.000	0.000	0.000	0.000	0.009	-	-
JV	21 216	0.013	0.014	0.016	0.015	0.021	0.024	0.027	0.030	0.031	-	0.000	0.000
JV	21 387	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-	0.000	-
JV	36 1277	0.001	0.001	0.001	0.002	0.002	0.003	0.003	0.004	0.227	-	0.000	0.000

Table 9A. (Cont.)

Lab.	Clock	55224	55254	55284	55314	55344	55374	55404	55439	55469	55499	55529	55559
KIM	36 618	0.060	0.065	0.076	0.080	0.074	0.000	0.057	0.066	0.080	0.088	0.086	0.062
KRIS	35 321	0.022	0.019	-	-	-	-	-	-	-	-	-	-
KRIS	35 739	0.779	0.767	0.758	0.742	0.746	0.718	0.712	0.714	0.716	0.737	0.755	0.758
KRIS	35 1693	-	0.000	0.000	0.000	0.000	0.467	0.465	0.528	0.713	0.737	0.554	0.507
KRIS	35 1783	0.379	0.337	0.503	0.468	0.530	0.527	0.472	0.503	0.519	0.477	0.469	0.452
KRIS	36 1135	0.113	0.119	0.117	0.083	-	-	-	-	-	-	-	-
KRIS	40 5623	0.623	0.321	0.000	0.000	0.000	0.000	0.000	0.000	-	-	-	-
KRIS	40 5624	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.002	0.002
KRIS	40 5625	-	0.000	0.000	0.000	0.000	0.006	0.004	0.004	0.004	0.005	0.005	0.005
KRIS	40 5626	0.000	0.000	0.000	0.000	0.672	0.618	0.507	0.426	0.380	0.300	0.251	0.000
KZ	35 2202	0.001	0.001	0.001	0.001	0.000	0.035	0.032	0.029	0.022	0.019	0.019	-
KZ	40 2707	-	-	-	-	0.000	0.000	0.000	0.000	0.000	0.001	0.001	-
LT	35 1362	0.187	0.184	0.180	0.220	0.297	0.314	0.224	0.184	0.187	-	0.000	0.000
LV	35 2335	0.000	0.000	0.000	0.012	0.017	0.019	0.021	0.025	0.031	0.033	0.036	0.041
MIKE	35 1171	0.012	0.012	0.011	0.011	0.012	0.012	0.012	0.180	0.182	0.352	0.342	0.342
MIKE	36 986	0.014	0.013	0.013	0.013	0.014	0.014	0.014	0.107	0.107	0.143	0.138	0.159
MIKE	40 4108	0.010	0.010	0.010	0.009	0.010	0.010	0.010	0.104	0.000	0.045	0.037	0.032
MIKE	40 4113	0.002	0.002	0.002	0.003	0.003	0.003	0.004	-	-	0.000	0.000	0.000
MIKE	40 4180	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
MKEH	36 849	0.157	0.207	0.194	0.195	0.208	0.200	0.201	0.000	0.104	0.100	0.090	0.092
MSL	12 933	0.000	0.000	-	0.000	0.000	0.000	0.000	0.013	0.018	0.024	0.000	-
MSL	36 274	0.055	0.045	-	0.000	0.000	0.000	0.000	0.049	0.064	0.076	0.099	-
MSL	36 1025	0.014	0.017	-	0.000	0.000	0.000	0.000	0.063	0.000	0.000	0.003	-
NAO	35 779	0.000	0.000	0.000	0.000	0.398	0.553	0.543	0.556	0.633	0.673	0.499	0.561
NAO	35 1206	0.000	0.000	0.000	0.000	0.182	0.210	0.270	0.288	0.347	0.400	0.466	0.540
NAO	35 1214	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.001	0.001	0.001	0.001	0.002
NAO	35 1689	-	-	-	-	-	-	-	-	0.000	0.000	0.000	0.000
NICT	35 112	0.779	0.767	0.758	0.742	0.746	0.626	0.465	0.454	0.457	0.532	0.468	0.451
NICT	35 332	0.576	0.429	0.443	0.437	0.379	0.458	0.451	0.364	0.274	0.237	0.222	0.322
NICT	35 342	0.302	0.258	0.208	0.207	0.242	0.206	0.223	0.184	0.179	0.310	0.374	0.416

Table 9A. (Cont.)

Lab.	Clock	55224	55254	55284	55314	55344	55374	55404	55439	55469	55499	55529	55559
NICT	35 343	0.455	0.566	0.632	0.740	0.746	0.718	0.668	0.616	0.716	0.737	0.755	0.758
NICT	35 715	0.000	0.000	0.758	0.742	0.746	0.718	0.712	0.714	0.716	0.737	0.755	0.758
NICT	35 732	0.136	0.190	0.235	0.305	0.375	0.196	0.228	0.275	0.377	0.371	0.588	0.613
NICT	35 907	0.603	0.486	0.408	0.339	0.299	0.340	0.336	0.407	0.603	0.621	0.441	0.343
NICT	35 908	0.032	0.000	0.007	0.005	0.005	0.005	0.005	0.005	0.007	0.010	0.017	0.034
NICT	35 913	0.133	0.106	0.105	0.093	0.100	0.088	0.085	0.106	0.105	0.101	0.084	0.075
NICT	35 916	0.779	0.767	0.758	0.742	0.746	0.718	0.712	0.714	0.716	0.614	0.742	0.515
NICT	35 1225	0.779	0.738	0.713	0.689	-	-	-	-	-	-	-	0.000
NICT	35 1226	0.068	0.067	0.056	0.038	0.038	0.032	0.031	0.034	0.032	0.034	0.036	0.042
NICT	35 1611	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.008	0.007
NICT	35 1778	0.000	0.000	0.204	0.190	0.194	0.242	0.308	0.395	0.422	0.369	0.352	0.235
NICT	35 1789	-	-	0.000	0.000	0.000	0.000	0.712	0.714	0.716	0.737	0.755	0.758
NICT	35 1790	0.000	0.000	0.000	0.344	0.318	0.229	0.200	0.186	0.190	0.166	0.165	0.131
NICT	35 1866	-	-	-	0.000	0.000	0.000	0.000	0.714	0.716	0.737	0.755	0.562
NICT	35 1882	0.000	0.000	0.000	0.000	0.578	0.472	0.512	0.594	0.569	0.649	0.591	0.680
NICT	35 1887	0.470	0.423	0.501	0.742	0.746	0.718	0.712	0.714	0.716	0.737	0.755	0.758
NICT	35 1944	0.646	0.610	0.710	0.645	0.544	0.531	0.600	0.626	0.687	0.634	0.581	0.581
NICT	35 2010	0.745	0.767	0.758	0.688	0.746	0.718	0.712	0.714	0.716	0.737	0.755	0.758
NICT	35 2011	0.779	0.767	0.758	0.742	0.000	0.639	0.437	0.451	0.000	0.000	0.000	0.000
NICT	35 2056	0.771	0.444	0.514	0.461	0.635	0.511	0.509	0.524	0.656	0.644	0.752	0.000
NICT	35 2113	0.206	0.208	0.204	0.206	0.274	0.297	0.286	0.236	0.153	0.147	0.144	0.168
NICT	35 2116	0.779	0.767	0.758	0.742	0.746	0.000	0.410	0.327	0.210	0.216	0.204	0.156
NICT	35 2570	-	-	-	-	0.000	0.000	0.000	0.000	0.594	0.737	0.755	0.758
NICT	35 2574	-	-	-	-	0.000	0.000	0.000	0.000	0.116	0.096	0.117	0.128
NICT	35 2620	-	-	-	-	-	-	-	-	-	-	-	0.000
NICT	35 2627	-	-	-	-	-	-	-	-	-	-	-	0.000
NICT	36 1217	0.197	0.288	0.250	0.206	0.227	0.210	0.196	0.194	0.202	0.175	0.202	0.176
NICT	40 2001	-	-	-	-	-	-	0.000	0.000	0.000	-	-	-
NICT	40 2002	0.029	0.026	0.024	0.023	0.024	0.000	0.000	0.000	0.000	0.000	0.000	0.000
NICT	40 2003	0.779	0.767	0.758	0.742	0.000	0.496	0.494	0.415	0.327	0.243	0.187	0.141

Table 9A. (Cont.)

Lab.	Clock		55224	55254	55284	55314	55344	55374	55404	55439	55469	55499	55529	55559
NICT	40	2004	0.057	0.054	0.051	0.052	0.059	0.060	-	-	-	0.000	0.000	0.000
NICT	40	2005	0.003	0.003	0.003	-	-	-	-	-	-	-	-	-
NIM	35	1235	0.034	0.057	0.088	0.089	0.084	0.105	0.239	0.215	0.247	0.255	0.215	0.214
NIM	35	2239	-	0.000	0.000	0.000	0.000	0.202	0.281	0.405	0.000	0.185	0.227	0.261
NIM	40	4832	0.000	0.000	0.000	0.000	-	-	-	-	-	-	-	-
NIM	40	4835	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
NIMB	35	600	0.140	0.087	0.071	0.070	-	-	0.000	0.000	-	0.000	0.000	0.000
NIMT	35	2246	0.000	0.681	0.758	0.742	-	0.000	0.000	0.000	0.000	0.390	-	-
NIMT	35	2247	0.779	0.328	0.411	0.248	0.000	0.000	0.000	0.010	0.008	0.007	-	-
NIS	35	1126	0.493	0.522	0.502	0.463	0.463	0.718	0.712	-	-	0.000	0.000	0.000
NIST	35	132	0.000	0.618	0.271	0.263	0.186	0.146	0.133	0.129	0.118	0.095	-	-
NIST	35	182	0.556	0.745	0.753	0.742	0.746	0.718	0.712	0.714	0.716	0.737	0.755	0.758
NIST	35	282	-	0.000	0.000	0.000	0.000	0.071	0.061	0.066	0.086	0.106	0.129	0.142
NIST	35	408	0.779	0.767	0.000	0.159	0.210	0.249	0.286	0.297	0.332	0.356	0.390	0.428
NIST	35	1074	0.174	0.144	0.079	0.000	0.057	0.046	0.043	0.039	0.045	0.047	0.060	0.081
NIST	35	2031	0.779	0.767	0.758	0.742	0.746	0.588	0.671	0.714	0.716	0.737	0.755	0.000
NIST	35	2032	0.055	0.057	0.053	0.052	0.067	0.086	0.108	0.183	0.296	0.171	0.000	0.000
NIST	35	2034	0.268	0.200	0.249	0.247	0.416	0.554	0.557	0.449	0.338	0.322	0.279	0.373
NIST	40	203	0.009	0.008	0.008	0.008	0.009	0.009	0.009	0.009	0.009	0.009	0.009	0.009
NIST	40	204	0.456	0.444	0.435	0.465	0.523	0.480	0.498	0.511	0.484	0.419	0.394	0.373
NIST	40	205	0.779	0.767	0.758	0.742	0.746	0.718	0.712	0.714	0.716	0.737	0.755	0.758
NIST	40	206	0.779	0.767	0.758	0.742	0.687	0.496	0.367	0.290	0.258	0.249	0.221	0.237
NIST	40	222	0.537	0.447	0.427	0.445	0.503	0.564	0.626	0.714	0.716	0.737	0.755	0.758
NMIJ	35	224	0.000	0.000	0.000	0.742	0.746	0.718	0.712	0.000	0.309	0.207	0.171	0.178
NMIJ	35	1273	0.000	0.000	0.000	0.742	0.746	0.718	0.559	0.714	0.716	0.666	0.532	0.314
NMIJ	35	2057	0.000	0.000	0.000	0.557	0.504	0.645	0.000	0.000	0.081	0.074	0.076	0.073
NMIJ	40	5002	0.000	0.000	0.000	0.742	0.746	0.718	0.712	0.714	0.716	0.737	0.755	-
NMIJ	40	5003	0.000	0.000	0.000	0.000	0.432	0.424	0.443	0.515	0.504	0.512	0.583	0.645
NMIJ	40	5014	0.000	0.000	0.000	0.012	0.018	0.025	0.033	0.043	0.055	-	-	-
NMIJ	40	5015	0.000	0.000	0.000	0.005	0.005	0.004	0.004	0.003	0.003	0.003	0.002	0.002

Table 9A. (Cont.)

Lab.	Clock		55224	55254	55284	55314	55344	55374	55404	55439	55469	55499	55529	55559
NMLS	35	328	-	0.000	0.000	0.000	0.000	0.016	0.020	0.028	0.037	0.043	0.047	0.046
NPL	35	1275	0.083	0.078	0.079	0.090	0.140	0.196	0.222	0.588	0.669	-	-	0.000
NPL	36	784	0.303	0.204	0.122	0.140	0.166	-	0.000	0.000	0.000	-	-	0.000
NPL	40	1701	0.368	0.367	0.342	0.347	0.368	0.334	0.278	0.289	0.283	-	-	0.000
NPL	40	1708	0.350	0.328	0.313	0.314	0.354	0.338	0.307	0.299	0.287	-	-	0.000
NPLI	35	2257	0.296	0.259	0.225	0.249	0.250	0.243	0.215	0.218	0.216	0.239	0.197	0.000
NRC	35	2148	0.311	0.248	0.205	0.244	0.252	0.265	0.274	0.290	0.387	0.457	0.746	0.758
NRC	35	2150	0.003	0.004	0.004	0.004	0.130	0.140	0.132	0.173	0.190	0.241	0.331	0.710
NRC	35	2151	0.000	0.000	0.000	0.000	0.527	0.431	0.421	0.412	0.445	-	0.000	0.000
NRC	35	2152	0.334	0.317	0.360	0.345	0.709	0.654	0.693	0.714	0.716	0.737	0.755	0.758
NRL	35	714	0.154	0.139	0.145	0.171	0.351	0.372	0.456	-	0.000	0.000	0.000	0.000
NRL	35	719	-	-	0.000	0.000	0.000	0.000	0.000	-	0.000	0.000	0.000	0.000
NRL	35	1245	-	-	0.000	0.000	0.000	0.000	0.000	-	0.000	0.000	0.000	0.000
NRL	36	387	-	-	0.000	0.000	0.000	0.000	0.179	-	0.000	0.000	0.000	0.000
NRL	40	1001	0.002	0.002	0.002	0.002	0.002	0.002	0.002	-	0.000	0.000	0.000	0.000
NRL	40	1003	0.165	0.163	0.158	0.174	0.199	0.201	0.205	-	0.000	0.000	0.000	0.000
NRL	40	1009	0.003	0.004	0.005	0.006	0.007	0.007	0.006	-	0.000	0.000	0.000	-
NTSC	35	1007	0.052	0.058	0.060	0.064	0.000	0.000	0.019	0.018	0.020	0.020	0.019	0.014
NTSC	35	1008	0.779	0.767	0.758	0.000	0.478	0.486	0.503	0.422	0.356	0.355	0.281	0.315
NTSC	35	1011	0.268	0.468	0.758	0.742	0.746	0.718	0.712	0.501	0.384	0.206	-	-
NTSC	35	1016	0.200	0.188	0.174	0.171	0.191	0.210	0.182	0.187	0.192	0.195	0.156	0.174
NTSC	35	1017	0.011	0.010	0.011	0.014	0.021	0.051	0.082	0.138	0.152	0.143	0.144	0.145
NTSC	35	1018	-	-	-	-	-	-	0.000	0.000	0.000	0.000	0.368	0.161
NTSC	35	1818	0.266	0.201	0.141	0.103	0.105	0.093	0.080	0.076	0.087	0.115	0.191	0.245
NTSC	35	1820	-	-	-	-	-	-	0.000	0.000	0.000	0.000	0.142	0.102
NTSC	35	1823	0.779	0.767	0.758	0.742	-	-	0.000	0.000	0.000	0.000	0.742	0.758
NTSC	35	2096	0.236	0.227	0.216	0.297	0.348	0.365	0.356	0.377	0.358	0.321	0.696	0.675
NTSC	35	2098	0.779	0.767	0.758	0.742	0.746	0.718	0.712	0.714	0.644	0.437	0.452	0.459
NTSC	35	2131	0.046	0.040	0.039	0.043	0.049	0.051	0.060	0.046	0.053	0.052	0.055	0.057
NTSC	35	2141	0.021	0.017	0.017	0.019	0.021	0.017	0.021	0.018	0.015	0.013	0.014	0.016

Table 9A. (Cont.)

Lab.	Clock	55224	55254	55284	55314	55344	55374	55404	55439	55469	55499	55529	55559
NTSC	35 2142	0.697	0.649	0.511	0.638	0.574	0.436	0.570	0.449	0.424	0.483	0.466	0.626
NTSC	35 2143	0.779	0.579	0.584	0.584	0.000	0.380	0.263	0.289	0.372	0.458	0.400	0.401
NTSC	35 2144	0.279	0.269	0.214	0.219	0.228	0.330	0.282	0.338	0.241	0.237	0.267	0.251
NTSC	35 2145	-	-	-	-	-	-	0.000	0.000	0.000	0.000	0.424	0.583
NTSC	35 2146	0.779	0.767	0.758	0.742	0.746	0.718	0.655	0.714	0.716	0.737	0.498	0.372
NTSC	35 2147	0.400	0.472	0.758	0.742	0.746	0.718	0.712	0.660	0.716	0.737	0.547	0.557
NTSC	35 2573	-	-	-	-	-	-	-	0.000	0.000	0.000	0.000	0.758
NTSC	35 2576	-	-	-	-	-	-	-	0.000	0.000	0.000	0.000	0.758
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	0.001	0.001	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
ONBA	36 2228	0.381	0.440	0.325	-	-	0.000	0.000	0.000	0.000	0.209	0.286	0.378
ONRJ	35 102	0.129	0.106	0.102	0.111	0.139	0.160	0.259	0.370	0.481	0.530	0.000	0.410
ONRJ	35 103	0.000	0.000	0.055	0.048	0.046	0.043	0.048	0.051	0.057	0.061	0.080	0.195
ONRJ	35 111	-	-	-	-	0.000	0.000	0.000	0.000	0.010	0.013	0.014	0.018
ONRJ	35 123	0.257	0.269	0.264	0.264	0.263	0.235	0.218	0.220	0.251	0.304	0.291	0.289
ONRJ	35 129	0.779	0.767	0.758	0.709	0.658	0.718	0.637	0.678	0.575	0.556	0.608	0.583
ONRJ	35 147	-	0.000	0.000	0.000	0.000	0.121	0.157	0.215	0.219	0.266	0.251	0.292
ONRJ	35 1153	-	-	-	-	-	-	-	-	-	-	-	0.000
ONRJ	35 1942	0.008	0.010	0.016	0.066	0.102	0.150	0.162	0.000	0.052	0.041	0.032	0.029
ONRJ	40 1950	-	-	-	-	-	-	-	0.000	0.000	0.000	0.000	0.000
ORB	36 201	0.135	0.158	0.188	0.196	0.200	0.178	0.170	0.164	0.184	-	-	0.000
ORB	36 202	0.110	0.130	0.095	0.091	0.088	0.067	0.050	0.053	0.054	-	-	0.000
ORB	36 593	0.153	0.178	0.208	0.230	0.169	0.158	0.155	0.136	0.243	-	-	0.000
ORB	40 2601	0.407	0.463	0.655	-	-	-	-	-	-	-	-	-
ORB	40 2602	0.026	0.022	0.019	0.016	0.014	0.011	0.009	0.009	0.008	-	-	0.000
PL	25 124	0.018	0.023	0.019	0.018	0.017	0.013	0.012	0.007	0.006	0.008	0.007	0.007
PL	25 125	-	0.000	0.000	0.000	0.000	0.001	0.001	0.001	0.001	-	-	-
PL	35 441	0.523	0.559	0.602	0.455	-	-	-	-	-	-	0.000	0.000
PL	35 502	0.032	0.031	0.000	0.000	0.006	0.005	0.004	0.004	0.004	0.005	0.006	0.008
PL	35 745	0.621	0.591	0.654	0.611	0.746	0.525	0.510	0.523	0.473	0.481	0.464	0.477

Table 9A. (Cont.)

Lab.	Clock	55224	55254	55284	55314	55344	55374	55404	55439	55469	55499	55529	55559
PL	35 1120	0.618	0.597	0.575	0.465	0.391	0.361	0.302	0.356	0.227	0.303	0.315	0.281
PL	35 1660	0.331	0.431	0.524	0.457	0.000	-	-	-	-	-	-	-
PL	35 1709	0.779	0.767	0.758	0.434	0.476	0.404	0.469	-	-	-	-	-
PL	35 1746	0.303	0.383	0.456	0.541	0.668	0.527	0.520	0.321	0.301	0.287	0.211	0.211
PL	35 1934	0.262	0.208	0.203	0.194	0.213	0.200	0.294	0.531	0.697	0.737	0.000	0.347
PL	35 2394	0.486	0.767	0.729	0.571	0.379	0.240	0.162	0.000	0.051	0.045	0.046	0.038
PL	40 4002	0.049	0.051	0.037	0.000	0.009	0.007	0.007	0.007	0.007	0.007	0.009	0.014
PL	40 4004	0.006	0.009	0.012	0.014	0.018	0.024	0.000	0.000	0.000	-	-	-
PL	40 4601	0.053	0.042	0.037	0.034	0.034	0.032	0.030	0.030	0.029	0.027	0.025	0.023
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	0.779	0.767	0.758	0.742	0.746	0.718	0.712	0.714	0.716	0.737	0.755	0.610
PTB	35 415	0.311	0.374	0.420	0.500	0.614	0.718	0.712	0.714	0.716	0.000	0.294	0.232
PTB	35 1072	0.553	0.464	0.423	0.435	0.420	0.404	0.389	0.398	0.404	0.509	0.509	0.514
PTB	40 506	0.003	0.003	0.002	0.002	0.003	0.002	0.003	0.004	0.004	0.004	0.004	0.004
PTB	40 508	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
PTB	40 510	0.000	0.000	0.000	0.000	0.000	0.001	0.001	-	-	-	-	-
PTB	40 590	0.021	0.019	0.019	0.019	0.021	0.021	0.019	0.020	0.020	0.021	0.021	0.021
PTB	92 1	0.493	0.636	0.758	0.742	0.746	0.000	0.550	0.497	0.481	0.595	0.743	0.719
PTB	92 2	0.779	0.767	0.758	0.742	0.746	0.718	0.712	0.714	-	-	-	-
ROA	35 583	0.044	0.033	0.024	0.020	0.020	0.019	0.019	0.019	0.022	0.065	0.231	0.529
ROA	35 718	0.779	0.767	0.758	0.742	0.746	0.718	0.712	0.000	0.000	0.012	0.010	0.009
ROA	35 1699	0.221	0.268	0.267	0.244	0.261	0.504	0.459	0.443	0.488	0.572	0.611	0.428
ROA	35 2270	-	-	-	-	0.000	0.000	0.000	0.000	0.063	0.063	0.069	0.067
ROA	36 1488	0.433	0.415	0.307	0.288	0.325	0.284	0.206	0.166	0.213	0.207	0.318	0.291
ROA	36 1490	0.120	0.117	0.117	0.108	0.206	0.245	0.241	0.162	0.165	0.000	0.140	0.140
ROA	40 1436	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002
SCL	35 1745	0.779	0.767	-	-	0.000	0.000	0.000	-	-	-	-	-
SCL	35 2178	0.148	0.150	-	-	0.000	0.000	0.000	0.000	0.000	0.014	0.015	0.016
SCL	35 2525	0.000	0.000	-	-	0.000	0.000	0.000	0.000	0.254	0.356	0.424	0.359
SG	35 475	0.000	0.767	0.641	0.742	0.746	-	-	0.000	0.000	0.000	0.000	0.758

Table 9A. (Cont.)

Lab.	Clock	55224	55254	55284	55314	55344	55374	55404	55439	55469	55499	55529	55559
SG	35 476	-	-	0.000	0.000	0.000	-	-	-	0.000	0.000	0.000	0.000
SG	35 1889	0.164	0.135	0.165	0.200	0.236	-	-	0.000	0.000	0.000	0.000	0.174
SG	36 522	0.149	0.187	0.191	0.228	0.301	-	-	0.000	0.000	0.000	0.000	0.073
SG	40 7701	0.000	0.000	0.000	0.000	0.000	-	-	0.000	0.000	0.000	0.000	0.000
SIQ	36 1268	0.156	0.126	0.105	0.102	0.107	0.103	0.094	0.000	0.041	0.030	0.028	0.027
SMD	35 810	0.340	0.287	0.189	0.123	0.091	0.088	0.100	0.113	0.087	0.055	0.034	0.023
SMD	35 1766	0.779	0.000	0.597	0.680	0.720	0.718	0.712	0.714	0.716	0.737	0.744	0.758
SMD	35 1896	0.483	0.408	-	-	-	-	-	-	-	-	-	-
SMD	35 2003	0.496	0.571	0.652	0.565	0.612	0.651	0.712	0.624	0.614	0.737	0.755	0.699
SMD	35 2543	-	-	-	-	-	-	-	-	0.000	0.000	0.000	0.000
SMU	36 1193	-	0.000	0.000	0.000	0.000	0.201	0.161	0.149	0.100	0.077	0.094	0.106
SP	19 197	-	0.000	0.000	0.000	0.000	0.011	0.010	0.012	0.016	0.018	0.020	0.021
SP	35 572	0.779	0.767	0.758	0.742	0.746	0.718	0.712	0.714	0.596	0.498	0.626	0.649
SP	35 641	0.365	0.389	-	-	-	-	-	-	0.000	0.000	0.000	0.000
SP	35 1188	0.000	0.258	0.279	0.196	0.000	0.081	0.076	0.079	0.088	0.080	0.099	0.118
SP	35 1531	0.101	0.083	0.075	0.093	-	-	-	-	-	-	-	-
SP	35 1642	0.302	0.353	0.345	0.329	0.455	0.546	0.433	0.316	0.379	0.340	0.250	0.273
SP	35 2166	0.779	0.767	0.758	0.742	0.746	0.718	0.712	0.714	0.716	0.737	0.755	0.758
SP	36 223	0.077	0.130	0.110	0.107	0.102	0.169	0.210	0.273	0.278	0.215	0.172	0.200
SP	36 1175	0.426	0.000	0.159	0.155	0.153	0.155	0.166	0.185	0.174	0.163	0.168	0.173
SP	36 2068	0.215	0.205	0.206	0.410	0.435	0.276	0.179	0.170	0.163	0.125	0.138	0.130
SP	36 2218	0.315	0.280	0.264	0.241	0.435	0.424	0.261	0.379	0.308	0.254	0.238	0.237
SP	36 2295	0.779	0.000	0.452	0.394	0.290	0.313	0.300	0.313	0.259	0.274	0.270	0.244
SP	36 2297	0.326	0.766	0.758	0.742	0.585	0.565	0.341	0.358	0.000	0.241	0.236	0.198
SP	40 7201	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002
SP	40 7203	0.000	0.038	0.028	0.022	0.020	0.017	0.015	0.014	0.013	0.011	0.011	0.010
SP	40 7210	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
SP	40 7211	0.000	0.011	0.009	0.008	0.008	0.007	0.006	0.006	0.005	0.005	0.005	0.005
SP	40 7212	0.000	0.264	0.203	0.165	0.151	0.124	0.104	0.092	0.082	0.071	0.067	0.062
SP	40 7218	0.003	0.003	0.002	0.002	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003

Table 9A. (Cont.)

Lab.	Clock	55224	55254	55284	55314	55344	55374	55404	55439	55469	55499	55529	55559
SP	40 7221	0.312	0.303	0.298	0.389	0.532	0.619	0.712	0.714	0.716	0.737	0.755	0.758
SU	40 3802	0.018	0.019	0.022	0.025	0.018	0.010	0.008	0.006	0.005	0.005	0.005	-
SU	40 3809	0.096	0.121	0.166	0.234	0.390	0.687	0.712	0.714	0.716	0.737	0.755	0.758
SU	40 3810	0.036	0.035	0.044	0.056	0.080	0.105	0.138	0.199	0.268	0.359	-	-
SU	40 3811	0.064	0.041	0.027	0.021	0.019	0.016	0.014	0.013	0.013	0.011	0.010	0.010
SU	40 3812	0.104	0.182	0.338	0.631	0.746	0.718	0.712	0.714	0.716	0.737	0.755	0.758
SU	40 3814	0.000	0.767	0.758	0.742	0.565	0.319	0.198	0.132	0.100	0.065	0.048	0.037
SU	40 3815	0.211	0.150	0.116	0.095	0.086	0.071	0.061	0.053	0.050	0.044	0.040	0.037
SU	40 3816	0.217	0.122	0.071	0.040	0.023	0.000	0.000	0.000	0.002	0.001	-	0.000
SU	40 3817	0.000	0.077	0.080	0.084	0.097	0.107	0.125	0.155	0.190	0.318	0.333	0.000
SU	40 3822	0.018	0.020	0.022	0.021	0.017	0.014	0.010	0.008	0.007	0.005	0.005	0.005
SU	40 3831	0.115	0.101	0.090	0.084	0.085	0.091	0.119	0.138	0.139	0.116	0.063	0.032
SU	40 3837	0.719	0.593	0.504	0.429	-	-	-	-	-	-	-	-
TCC	35 768	0.074	-	-	0.000	0.000	0.000	0.000	0.018	0.026	0.035	0.046	0.049
TCC	35 1028	0.733	-	-	0.000	0.000	0.000	0.000	0.116	0.140	-	-	-
TCC	35 1881	0.341	-	-	0.000	0.000	0.000	0.000	0.220	0.330	0.392	0.483	0.538
TCC	40 8620	0.003	-	-	0.000	0.000	0.000	0.000	0.029	0.029	0.027	0.024	0.022
TCC	40 8624	0.070	-	-	0.000	0.000	0.000	0.000	0.096	0.109	0.113	0.118	0.112
TCC	40 8650	0.000	-	-	0.000	0.000	0.000	0.000	0.012	0.009	0.007	0.006	0.005
TL	35 300	-	-	-	-	-	-	-	0.000	0.000	0.000	0.000	0.526
TL	35 474	0.008	-	-	-	-	-	-	-	-	-	-	-
TL	35 809	0.169	-	-	-	-	-	-	-	-	-	-	-
TL	35 1012	0.020	0.020	0.023	0.029	0.054	0.074	0.122	0.000	0.381	0.395	0.391	0.379
TL	35 1104	0.107	0.167	0.207	0.274	0.299	0.353	0.369	0.392	0.400	0.395	0.482	0.481
TL	35 1132	0.352	0.338	0.302	0.000	0.051	0.042	0.047	0.047	0.053	0.058	0.061	0.072
TL	35 1498	0.779	0.767	0.758	0.742	0.746	0.718	0.712	0.714	0.716	0.737	0.661	0.678
TL	35 1500	0.371	0.383	0.317	0.325	0.362	0.528	0.375	0.356	0.459	0.381	0.289	0.325
TL	35 2365	0.779	0.767	0.758	0.742	0.746	0.718	0.712	0.714	0.716	0.737	0.611	0.576
TL	35 2366	0.000	0.579	0.564	0.641	0.647	0.671	0.712	0.559	0.435	0.547	0.530	0.423
TL	35 2367	0.779	0.767	0.479	0.635	0.491	0.482	0.449	0.462	0.463	0.408	0.441	0.404

Table 9A. (Cont.)

Lab.	Clock	55224	55254	55284	55314	55344	55374	55404	55439	55469	55499	55529	55559
TL	35 2368	0.433	0.450	0.571	0.558	0.408	0.295	0.261	0.285	0.320	0.301	0.304	0.271
TL	35 2630	-	-	-	-	-	-	-	-	-	0.000	0.000	0.000
TL	35 2634	-	-	-	-	-	-	-	-	-	0.000	0.000	0.000
TL	35 2636	-	-	-	-	-	-	-	-	-	0.000	0.000	0.000
TL	40 57	-	-	-	-	-	-	-	-	0.000	0.000	0.000	0.000
TL	40 3052	0.779	0.767	0.758	0.742	0.746	0.718	0.624	0.583	0.591	0.576	0.623	0.601
TL	40 3053	0.329	0.473	0.485	0.516	0.605	0.563	0.000	0.198	0.202	0.181	0.179	0.160
TP	35 163	0.000	0.000	0.047	0.028	0.018	0.014	0.012	0.012	0.012	0.011	0.010	0.011
TP	35 326	0.000	0.049	0.063	0.079	0.098	0.091	0.100	0.106	0.090	0.108	-	-
TP	35 1227	0.391	0.739	0.758	0.742	0.746	0.718	0.712	0.714	0.716	0.737	0.755	0.758
TP	35 2476	0.000	0.428	0.496	0.284	0.322	0.369	0.362	0.407	0.414	0.376	0.524	0.487
TP	36 154	0.000	0.124	0.122	0.071	0.096	0.118	0.144	0.091	0.108	0.115	0.112	0.108
UA	35 2465	-	-	0.000	0.000	0.000	0.000	-	-	-	-	0.000	-
UA	40 7854	-	-	0.000	0.000	0.000	0.000	-	-	-	-	0.000	-
UA	40 7881	-	0.000	0.000	0.000	0.000	0.003	-	-	-	-	0.000	-
UA	40 7882	-	0.000	0.000	0.000	0.000	0.090	-	-	-	-	0.000	-
UME	35 251	0.000	0.397	0.403	0.202	0.214	0.247	0.301	0.359	0.438	0.490	0.487	0.363
USNO	35 101	-	0.000	0.000	0.000	0.000	0.399	0.589	0.594	0.693	0.737	0.699	0.758
USNO	35 104	0.734	0.700	0.756	0.742	0.746	0.718	0.712	0.714	0.000	0.130	0.129	0.115
USNO	35 106	0.779	0.767	0.745	0.715	0.746	0.718	0.682	0.707	0.716	0.737	0.755	0.751
USNO	35 108	0.779	0.767	0.758	0.742	0.746	0.718	0.712	0.714	0.716	0.737	0.755	0.758
USNO	35 114	0.419	0.407	0.321	0.285	0.404	0.491	0.420	0.399	0.383	0.327	0.277	0.322
USNO	35 120	0.779	0.767	0.000	0.278	0.241	0.196	0.160	0.151	0.147	0.150	0.176	0.239
USNO	35 142	0.183	0.212	0.232	0.232	0.307	0.450	0.712	0.714	0.716	0.737	0.000	0.309
USNO	35 145	0.057	0.072	0.056	0.047	0.036	0.030	0.025	0.024	0.022	0.021	0.021	0.021
USNO	35 146	0.779	0.767	0.758	0.733	0.708	0.639	0.626	0.578	0.477	0.353	0.466	0.494
USNO	35 148	0.779	0.767	0.758	0.742	0.000	0.501	0.486	0.500	0.569	0.604	0.670	0.656
USNO	35 150	0.686	0.627	0.616	0.392	0.382	0.378	0.354	0.369	0.320	0.412	0.468	0.670
USNO	35 152	0.575	0.519	0.542	0.552	0.576	0.463	0.433	0.384	0.339	0.323	0.318	0.258
USNO	35 153	0.779	0.767	0.758	0.742	0.746	0.718	0.712	0.693	0.716	0.737	0.755	0.639

Table 9A. (Cont.)

Lab.		Clock	55224	55254	55284	55314	55344	55374	55404	55439	55469	55499	55529	55559
USNO	35	156	0.373	0.304	0.291	0.361	0.431	0.448	0.712	0.714	0.716	0.617	0.475	0.357
USNO	35	161	0.328	0.757	0.758	0.000	0.386	0.207	0.154	0.162	0.174	0.154	0.153	0.188
USNO	35	164	0.000	0.328	0.311	0.330	0.390	0.384	0.329	0.352	0.377	0.369	0.394	-
USNO	35	165	0.419	0.418	0.458	0.659	0.746	0.718	0.712	0.636	0.508	0.288	0.358	0.334
USNO	35	166	0.728	0.000	0.378	0.371	0.426	0.417	0.413	0.437	0.475	0.459	0.411	0.400
USNO	35	167	0.555	0.462	0.421	0.434	0.485	0.514	0.476	0.000	0.259	0.228	0.239	0.213
USNO	35	173	0.779	0.767	0.758	0.742	0.746	0.685	0.712	0.714	0.716	0.737	0.755	0.758
USNO	35	213	0.000	0.212	0.229	0.199	0.204	0.165	0.177	0.253	0.292	0.288	0.536	0.520
USNO	35	217	0.077	0.000	0.068	-	-	-	-	-	-	-	-	-
USNO	35	226	0.779	0.767	0.758	0.742	0.746	0.718	0.712	0.714	0.716	0.737	0.755	0.758
USNO	35	227	0.011	0.009	0.009	0.009	0.011	0.012	0.015	0.022	0.030	0.034	0.044	0.050
USNO	35	231	0.779	0.767	0.758	0.742	0.746	0.718	0.712	0.714	0.716	0.000	0.575	0.540
USNO	35	233	0.779	0.767	0.758	0.742	0.746	0.718	0.712	0.714	0.716	0.737	0.755	0.758
USNO	35	242	0.779	0.767	0.758	0.676	0.716	0.718	0.712	0.714	0.716	0.525	0.490	0.516
USNO	35	244	0.779	0.767	0.758	0.742	0.746	0.718	0.712	0.714	0.680	0.737	0.755	0.527
USNO	35	253	0.135	0.096	0.086	0.082	0.116	0.131	0.165	0.253	0.302	0.501	0.755	0.758
USNO	35	254	0.192	0.402	0.399	0.402	0.410	0.420	0.377	0.276	0.287	0.291	0.307	0.308
USNO	35	260	0.093	0.089	0.088	0.134	0.165	0.159	0.188	0.212	0.222	0.228	0.270	0.274
USNO	35	268	0.779	0.767	0.758	0.742	0.746	0.718	0.712	0.714	0.716	0.737	0.742	0.626
USNO	35	270	-	0.000	0.000	0.000	0.000	0.718	0.712	0.714	0.716	0.737	0.000	0.472
USNO	35	392	0.357	0.340	0.245	0.296	0.325	0.357	0.468	0.603	0.702	0.737	0.755	-
USNO	35	394	0.000	0.039	0.000	0.000	0.012	0.011	0.012	0.009	-	-	-	-
USNO	35	416	0.779	0.767	0.758	0.742	0.746	0.718	0.000	0.393	0.404	0.397	0.322	0.321
USNO	35	417	0.579	0.479	0.404	0.521	0.523	0.425	-	-	-	-	0.000	0.000
USNO	35	703	0.779	0.767	0.758	0.742	-	-	-	-	-	-	-	-
USNO	35	717	0.779	0.767	0.758	0.742	0.746	0.718	0.712	0.714	0.716	0.737	0.755	0.712
USNO	35	762	0.000	0.000	0.000	0.000	0.050	0.055	0.074	0.099	0.130	0.154	0.184	0.211
USNO	35	763	0.779	0.767	0.758	0.742	0.746	0.718	0.712	0.714	0.716	0.737	0.755	0.758
USNO	35	765	0.000	0.000	0.000	0.000	0.051	0.046	0.061	0.064	0.056	0.062	0.074	0.084
USNO	35	1096	-	-	-	-	-	-	-	-	-	-	-	0.000

Table 9A. (Cont.)

Lab.	Clock	55224	55254	55284	55314	55344	55374	55404	55439	55469	55499	55529	55559
USNO	35 1097	0.678	0.645	0.654	0.702	0.746	0.718	0.712	0.714	0.716	0.737	0.000	0.033
USNO	35 1125	0.487	0.737	0.758	0.000	0.000	0.143	0.077	0.065	0.062	0.062	0.069	0.080
USNO	35 1327	0.779	0.767	0.758	0.742	0.746	0.718	0.712	0.000	0.347	0.334	0.354	0.347
USNO	35 1328	0.125	0.399	0.000	0.195	0.167	0.104	0.084	0.088	0.102	0.133	0.184	0.292
USNO	35 1331	0.196	0.226	0.217	0.221	0.000	0.143	0.000	0.079	0.080	0.077	0.081	0.076
USNO	35 1438	0.779	0.767	0.758	0.742	0.703	0.717	0.590	0.425	0.249	0.213	0.139	0.113
USNO	35 1459	-	0.000	0.000	0.000	0.000	0.312	0.449	0.355	0.228	0.252	0.307	0.358
USNO	35 1462	0.779	0.767	0.758	0.742	0.746	0.718	0.712	0.714	0.716	0.737	0.755	0.758
USNO	35 1463	0.528	0.667	0.647	0.742	0.746	0.718	0.712	0.714	0.716	0.737	0.755	0.758
USNO	35 1543	0.000	0.000	0.000	0.000	0.666	0.718	0.712	0.714	0.716	0.737	0.755	0.758
USNO	35 1575	0.285	0.000	0.103	0.107	0.125	0.126	0.139	0.169	0.184	0.244	0.318	0.707
USNO	35 1598	-	-	-	-	-	-	-	-	-	-	0.000	0.000
USNO	35 1655	-	0.000	0.000	0.000	0.000	0.388	0.447	0.548	0.614	0.532	0.652	0.618
USNO	35 1658	-	-	-	-	-	-	-	-	-	-	0.000	0.000
USNO	35 1692	-	-	0.000	0.000	0.000	0.000	0.219	0.260	0.223	0.171	0.168	0.182
USNO	35 1696	-	-	0.000	0.000	0.000	0.000	0.284	0.418	0.586	0.720	0.755	0.758
USNO	35 1697	-	0.000	0.000	0.000	0.000	0.640	0.712	0.714	0.716	0.737	0.755	0.758
USNO	40 702	0.779	0.767	0.758	0.742	0.746	0.718	0.712	0.714	0.716	0.737	0.755	0.758
USNO	40 704	-	-	0.000	0.000	0.000	0.000	0.336	0.429	0.520	0.593	0.661	0.633
USNO	40 705	-	-	0.000	0.000	0.000	0.000	0.169	0.185	0.157	0.113	0.065	0.000
USNO	40 708	0.059	0.056	0.060	0.073	0.092	0.109	0.136	0.163	0.190	0.217	0.262	0.262
USNO	40 710	-	0.000	0.000	0.000	0.000	0.031	0.026	0.024	0.022	0.020	0.018	0.017
USNO	40 711	0.000	0.000	0.000	0.000	0.010	0.009	0.007	0.007	0.006	0.005	0.005	0.004
USNO	40 712	0.663	0.554	0.489	0.571	0.746	0.718	0.712	0.714	0.716	0.737	0.755	0.758
USNO	40 713	0.116	0.108	0.102	0.097	0.106	0.101	0.099	0.107	0.107	0.102	0.100	0.096
USNO	40 714	0.255	0.267	0.245	0.222	0.236	0.225	0.160	0.175	0.220	0.251	0.280	0.301
USNO	40 715	0.111	0.097	0.084	0.077	0.080	0.073	0.066	0.069	0.068	0.063	0.059	0.055
USNO	40 716	0.779	0.767	0.758	0.742	0.746	0.718	0.712	0.714	0.716	0.737	0.755	0.758
USNO	40 718	0.017	0.014	0.013	0.012	0.013	0.013	0.013	0.014	0.015	0.015	0.014	0.014
USNO	40 719	0.011	0.010	0.010	0.010	0.010	0.009	0.009	0.009	0.009	0.008	0.009	0.008

Table 9A. (Cont.)

Lab.	Clock		55224	55254	55284	55314	55344	55374	55404	55439	55469	55499	55529	55559
USNO	40	720	0.002	0.002	0.001	0.001	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	0.000	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.003	0.004	0.009	0.683
USNO	40	724	0.024	0.020	0.018	0.019	0.024	0.034	0.044	0.052	0.060	0.067	0.074	0.078
USNO	40	725	0.192	0.168	0.144	0.154	0.187	0.228	0.386	0.601	0.716	0.737	0.755	0.758
USNO	40	728	-	-	-	-	0.000	0.000	0.000	0.000	0.029	0.008	0.005	0.004
USNO	40	731	0.022	0.019	0.017	0.016	0.016	0.014	0.013	0.013	0.012	0.012	0.012	0.011
VMI	35	2230	0.042	0.054	0.080	0.078	-	-	-	-	-	0.000	0.000	0.000
VMI	36	1233	0.027	0.036	0.066	0.063	-	-	-	-	-	0.000	0.000	0.000
VMI	36	2314	0.028	0.029	0.069	0.067	-	-	-	-	-	0.000	0.000	0.000
VSL	35	179	0.000	0.146	0.070	0.066	0.064	0.057	0.052	0.055	0.055	0.066	0.099	0.185
VSL	35	456	0.494	0.336	0.377	0.435	0.392	0.000	-	-	-	-	-	-
VSL	35	548	0.407	0.386	0.416	0.412	0.000	0.129	0.111	0.114	0.120	0.139	0.159	0.156
VSL	35	731	0.018	0.019	0.020	0.021	0.051	0.227	0.176	0.134	0.147	0.145	0.140	0.144
ZA	35	2232	-	-	-	-	0.000	0.000	0.000	0.000	0.077	0.098	0.094	0.088
ZA	35	2233	-	-	-	-	0.000	0.000	0.000	0.000	0.290	0.420	0.569	0.706
ZA	36	1034	-	-	-	-	-	0.000	0.000	0.000	0.000	0.067	0.072	0.090
ZA	36	1821	-	-	-	-	0.000	0.000	0.000	0.000	0.042	0.058	0.066	0.080

Table 9B. Statistical data on the weights attributed to the clocks in 2010

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	
2010	Jan.	100	232	384	20	40	63	8	10	21	6	53	61	0.779
2010	Feb.	100	231	386	17	40	60	8	8	23	7	50	58	0.767
2010	Mar.	103	233	389	16	38	59	11	8	21	7	54	64	0.758
2010	Apr.	103	235	393	15	33	56	12	10	23	8	52	63	0.742
2010	May	103	238	394	14	36	59	11	13	25	7	52	61	0.746
2010	June	102	240	395	11	30	47	8	9	22	7	55	63	0.718
2010	July	100	237	391	9	25	40	10	9	22	8	55	65	0.712
2010	Aug.	98	236	386	8	23	36	10	9	22	9	50	61	0.714
2010	Sep.	99	237	389	12	23	40	10	7	21	10	47	59	0.716
2010	Oct.	99	242	386	15	27	47	8	5	15	10	49	61	0.737
2010	Nov.	96	246	391	17	34	60	8	9	18	10	39	50	0.755
2010	Dec.	93	246	389	15	34	59	14	4	20	9	36	46	0.758

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 2011.

AUTHORITIES RESPONSIBLE FOR THE TIME SIGNAL EMISSIONS

Signal	Authority
BPM	National Time Service Center, NTSC Chinese Academy of Sciences 3 East Shuyuan Rd, Lintong District, Xi'an Shaanxi 710600, China
CHU	National Research Council of Canada Institute for National Measurement Standards Frequency and Time Standards Bldg M-36, 1200 Montreal Road Ottawa, Ontario, K1A 0R6, Canada
DCF77	Physikalisch-Technische Bundesanstalt Time and Frequency Department, WG 4.42 Bundesallee 100 D-38116 Braunschweig Germany
EBC	Real Instituto y Observatorio de la Armada Cecilio Pujazón s/n 11.110 San Fernando Cádiz, Spain
HBG	METAS Federal Office of Metrology Time and Frequency Laboratory Length, Optics and Time Section Lindenweg 50 CH-3003 Bern-Wabern Switzerland
HLA	Center for Time and Frequency Division of Physical Metrology Korea Research Institute of Standards and Science 267 Gajeong-Ro, Yuseong, Daejeon 305-340 Republic of Korea
JJY	Space-Time Standards 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 and Electromagnetics Division Hampton Road Teddington, Middlesex TW11 0LW United Kingdom
RAB-99, RBU, RJH-63, RJH-69, RJH-77, RJH-86, RJH-90,RTZ,RWM	All-Russian Scientific Research Institute for Physical Technical and Radiotechnical Measurements FGUP "VNIIFTRI" Meendeleevo, Moscow Region 141570 Russia
STFS	National Physical Laboratory Dr. K.S. Krishnan Road New Delhi - 110012, India
TDF	CFHM Chambre française de l'horlogerie et des microtechniques 22 avenue Franklin Roosevelt 75008 Paris, France and LNE Laboratoire national de métrologie et d'essais 1 rue Gaston Boissier 75724 Paris Cedex 15, France
WWV, WWVB, WWVH	Time and Frequency Division, 847.00 National Institute of Standards and Technology - 325 Broadway Boulder, Colorado 80305, U.S.A.

TIME SIGNALS EMITTED IN THE UTC SYSTEM

Station	Location Latitude Longitude	Frequency (kHz)	Schedule (UTC)	Form of the signal
BPM	Pucheng China 35° 0'N 109° 31'E	2 500 5 000 10 000 15 000	7 h 30 m to 1 h continuous continuous 1 h to 9 h	The BPM time Signals are generated by NTSC and are in accordance with UTC(NTSC)+8 h. Signals emitted in advance on UTC by 20 ms. Second pulses of 10 ms duration with 1 kHz modulation. Minute pulses of 300 ms duration with 1 kHz modulation. UTC time signals are emitted from minute 0 to 10, 15 to 25, 30 to 40, 45 to 55. UT1 time signals are emitted from minute 25 to 29, 55 to 59.
CHU	Ottawa Canada 45° 18'N 75° 45'W	3 330 7 850 14 670	continuous	Second pulses of 300 cycles of a 1 kHz modulation, with 29th and 51st to 59th pulses of each minute omitted. Minute pulses are 0.5 s long. Hour pulses are 1.0 s long, with the following 1st to 9th pulses omitted. A bilingual (Fr. Eng.) announcement of time (UTC) is made each minute following the 50th second pulse. FSK code (300 bps, Bell 103) after 10 cycles of 1 kHz on seconds 31 to 39. Year, DUT1, leap second information, TAI-UTC and Canadian daylight saving time format on 31, and time code on 32-39. Broadcast is single sideband; upper sideband with carrier reinsert. DUT1 : ITU-R code by double pulse.
DCF77	Mainflingen Germany 50° 1'N 9° 0'E	77.5	continuous	The DCF77 time signals are generated by PTB and are in accordance with the legal time of Germany which is UTC(PTB)+1 h or UTC(PTB)+2 h. At the beginning of each second (except in the last second of each minute) the carrier amplitude is reduced to about 15% for a duration of 0.1 or 0.2 s corresponding to “binary 0” or “binary 1”, respectively, referred to as second marks 0 to 59 in the following. The number of the minute, hour, day of the month, day of the week, month and year are transmitted in BCD code using second marks 20 to the 58, including overhead. Information emitted during minute n is valid for minute n+1. The information transmitted during the second marks 1 to the 14 is provided by third parties. Information on that additional service can be obtained from PTB. To achieve a more accurate time transfer and a better use of the frequency spectrum available an additional pseudo-random phase shift keying of the carrier is superimposed on the AM second markers. No transmission of DUT1.
EBC	San Fernando Spain 36° 28'N 6° 12'W	15006 4998	10 h 00 m to 10 h 25 m 10 h 30 m to 10 h 55 m except Saturday, Sunday and national holidays.	Second pulses of 0.1 s duration of a 1 kHz modulation. Minute pulses of 0.5 s duration of 1 250 Hz modulation. DUT1: ITU-R code by double pulse.

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

(1)The HBG service 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 36 m 06 h 06 m to 06 h 36 m	A1N type signals are transmitted between minutes 9 and 20 : 0.025 second pulses of 12.5 ms duration are transmitted between minutes 9 and 11; second pulses of 0.1 s duration, 10 second pulses of 1 s duration, 0.1 second pulses of 25 ms and minute pulses of 10 s duration are transmitted between minutes 11 and 20.
RBU	Moscow Russia 56° 44'N 37° 40'E	200/3	Continuous	DXXXW type 0.1 s signals. The numbers of the minute, hour, day of the month, day of the week, month, year of the century, difference between the universal time and the local time, TJD and DUT1+dUT1 are transmitted each minute from the 1st to the 59th second. DUT1+dUT1 : by double pulse.
RJH-63	Krasnodar Russia 44° 46'N 39° 34'E	25.0 25.1 25.5 23.0 20.5	11 h 06 m to 11 h 40 m	A1N type signals are transmitted between minutes 9 and 20 : 0.025 second pulses of 12.5 ms duration are transmitted between minutes 9 and 11 ; 0.1 second pulses of 25 ms duration, 10 second pulses of 1 s duration and minute pulses of 10 s duration are transmitted between minutes 11 and 20.
RJH-69	Molodechno Belarus 54° 28'N 26° 47'E	25.0 25.1 25.5 23.0 20.5	07 h 06 m to 07 h 47 m	A1N type signals are transmitted between minutes 10 and 22 : 0.025 second pulses of 12.5 ms duration are transmitted between minutes 10 and 13; second pulses of 0.1 s duration, 10 second pulses of 1 s duration, 0.1 second pulses of 25 ms and minute pulses of 10 s duration are transmitted between minutes 13 and 22.

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

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

Station	Location Latitude Longitude	Frequency (kHz)	Schedule (UTC)	Form of the signal
STFS	Sikandrabad India 28° 28'N 77° 13'E	2 599 675	continuous	Pulse width modulated binary coded 5 kHz pulses carrying information on Indian Standard Time – IST (UTC + 5 h 30 m), Time of Day and current position coordinates of the satellite. Pulse repetition rate is 100 pps. The above format is frequency modulated on the carrier.
TDF	Allouis France 47° 10'N 2° 12'E	162	continuous, except every Tuesday from 1 h to 5 h	Phase modulation of the carrier by +1 and -1 rd in 0.1 s every second except the 59th second of each minute. This modulation is doubled to indicate binary 1. The numbers of the minute, hour, day of the month, day of the week, month and year are transmitted each minute from the 21st to the 58th second, in accordance with the French legal time scale. In addition, a binary 1 at the 17th second indicates that the local time is 2 hours ahead of UTC (summer time); a binary 1 at the 18th second indicates that the local time is 1 hour ahead of UTC (winter time); a binary 1 at the 14th second indicates that the current day is a public holiday (Christmas, 14 July, etc...); a binary 1 at the 13th second indicates that the current day is a day before a public holiday.
WWV	Fort-Collins CO, USA 40° 41'N 105° 2'W	2 500 5 000 10 000 15 000 20 000	continuous	Second pulses are 1 000 Hz tones, 5 ms in duration. 29th and 59th second pulses omitted. Hour is identified by 0.8 second long 1 500 Hz tone. Beginning of each minute identified by 0.8 second long 1 000 Hz tones. DUT1: ITU-R code by double pulse. BCD time code given on 100 Hz subcarrier, includes DUT1 correction.
WWVB	Fort-Collins CO, USA 40° 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	Second pulses are 1 200 Hz tones, 5 ms in duration. 29th and 59th second pulses omitted. Hour is identified by 0.8 second long 1 500 Hz tone. Beginning of each minute identified by 0.8 second long 1 200 Hz tones. DUT1: ITU-R code by double pulse. BCD time code given on 100 Hz subcarrier, includes DUT1 correction.

ACCURACY OF THE CARRIER FREQUENCY

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

TIME DISSEMINATION SERVICES

The following tables are based on information received at the BIPM in February and March 2011.

AUTHORITIES RESPONSIBLE FOR THE TIME DISSEMINATION SERVICES

AOS	Astrogeodynamical Observatory Borowiec near Poznan Space Research Centre P.A.S. PL 62-035 Kórnik - Poland
AUS	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 - Mexico
CENAMEP	Centro Nacional de Metrología de Panamá AIP CENAMEP AIP Ciudad del Saber Edif. 215 Panama
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 Time and Frequency Division of Physical Metrology Korea Research Institute of Standards and Science 267 Gajeong-Ro, Yuseong Daejeon 305-340 Republic of Korea
KZ	Kazakhstan Institute 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 Center for Physical Sciences and Technology – State Metrology Service A. Goštauto 11 Vilnius LT01108, Lithuania
METAS	Federal Office of Metrology Length, Optics and Time Section Lindenweg 50 CH-3003 Bern-Wabern Switzerland
MIKES	Centre for Metrology and Accreditation Tekniikantie 1 FI-02150 Espoo - Finland
MSL	Measurement Standards Laboratory Industrial Research Gracefield Road PO Box 31-310 Lower Hutt – New Zealand
NAO	Time Keeping Office Mizusawa VLBI Observatory National Astronomical Observatory of Japan 2-12, Hoshigaoka, Mizusawa, Oshu, Iwate 023-0861 Japan

NICT	Space-Time Standards 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, Brazil
ORB	Royal Observatory of Belgium Avenue Circulaire, 3 B-1180 Brussels, Belgium
PTB	Physikalisch-Technische Bundesanstalt Time and Frequency Department, WG 4. 42 Bundesallee 100 D-38116 Braunschweig, Germany
ROA	Real Instituto y Observatorio de la Armada Cecilio Pujazón s/n 11.100 San Fernando Cádiz, Spain
SG	National Metrology Centre Agency for Science, Technology and Research (A*STAR) 1 Science Park Drive 118221 Singapore
SIQ	Slovenian Institute of Quality and Metrology Metrology department Trzaska ul. 2 1000 Ljubljana Slovenia

SP	SP Technical Research Institute of Sweden Box 857 S-501 15 Borås Sweden
TL	National Standard Time and Frequency Laboratory Telecommunication Laboratories Chunghwa Telecom. Co., Ltd. No. 12, Ln.551, Ming-Tsu Road Sec. 5 Yang-Mei, Taoyuan, 326 Taiwan 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
VMI	Laboratory of Time and Frequency (TFL) Vietnam Metrology Institute (VMI) No 8, Hoang Quoc Viet Rd, Cau Giay Dist., Hanoi Vietnam
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 A Stratum 1 time server is used to synchronize computer networks of the government institutions and companies in the private sector using the NTP protocol. To access the Network time service send an email to servicios@cenamep.org.pa Web Clock A web clock is used to display the time of day in real time. To access the Web Clock, enter the link http://horaexacta.cenamep.org.pa/ Voice Time Server An assembly of computers provides the local time. To access the voice time service, call to the telephone numbers (507) 5173201 (507) 5173202 and (507) 5173203
EIM	Internet Time Service EIM operates a time server using the "Network Time Protocol" (NTP). The address hercules.eim.gr is also accessible through IP address 79.129.72.250. This route is offered under an open policy. The server uses the 10 MHz signal from our primary standard as reference and is synchronized with UTC(EIM). The same server is accessible under restrictions through a different IP address by using a dedicated internet connection, for specific organizations.
GUM	Telephone Time Service providing the European time code by telephone modem for setting time in computers. Includes provision for compensation of propagation time delay. Access phone number : +48 22 654 88 72 Network Time Service Two NTP servers are available: tempus1.gum.gov.pl tempus2.gum.gov.pl with an open access policy. It provides synchronization to UTC(PL). Contact: timegum@gum.gov.pl
HKO	Web Clock Service HKO operates web-based time-of-day clocks that display Hong Kong Standard Time (=UTC(HKO) + 8 h) Available at: 1. for PCs: http://www.hko.gov.hk/gts/time/HKSTime.htm 2. for mobile devices: http://pda.hko.gov.hk/clocke.htm 3. as Google gadget: http://www.hko.gov.hk/gts/time/HKOclock_e.htm

	Speaking Clock Service HKO operates an automatic “Dial-a-weather System” that provides voice announcement of Hong Kong Standard Time. Access phone number: +852 1878200 (when connected, press “3”, “6”, “1” in sequence)
	Network Time Service HKO operates network time service using Network Time Protocol (NTP). Host name of the NTP servers: stdtime.gov.hk Further information at http://www.hko.gov.hk/nts/ntime.htm
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. SRC (Segnale RAI Codificato) coded time signal broadcasted 20 – 30 times per day by “Radio Uno” and “Radio Tre” FM radio stations of the national broadcasting company RAI. Web-based time-of-day clock that displays UTC or local time for Italy (Central Europe Time), referenced to INRIM Internet Time Service. Provides snapshot of time with any web browser. A continuous time display requires a web browser with Java plug-in installed. Service available at www.inrim.it/ntp/webclock_i.shtml.
KIM	Network Time Protocol (NTP) Service The NTP time information referenced to UTC(KIM) is generated by Stratum-1 NTP server at URL: ntp.kim.lipi.go.id or IP: 203.160.128.178 The server also provide time service using Daytime Protocol, and Time Protocol.
KRISS	Telephone Time Service Provides digital time code to synchronize computer clocks to Korea Standard Time (=UTC(KRIS) + 9 h) via modem. Access phone 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://syrte.obspm.fr/informatique/ntp_infos.php
LT	Network Time Service via NTP protocol NTP v3 DNS: laikas.pfi.lt Port 123 Synchronization from caesium clock (1 pps) System: Datum TymeServe 2100 NTP server Access policy: free Contact: Rimantas Miškinis Mail: Laikas@pfi.lt http://www.pfi.lt/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).

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

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://www.nist.gov/pml/div688/grp40/acts.cfm Internet Time Service (ITS) Provides digital time code across the Internet using three different protocols: Network Time Protocol (NTP), Daytime Protocol, and Time Protocol. (Time Protocol is not supported by all servers) Geographically distributed set of 24 time servers at 19 locations within the United States of America. Free software and source code available for download from NIST.Further information at http://www.nist.gov/pml/div688/grp40/its.cfm Web-based time-of-day clock that displays UTC or local time for United States time zones. Referenced to NIST Internet Time Service. Provides snapshot of time with any web browser, but continuously running time display requires web browser with Java plug-in installed. Available at http://www.time.gov (in cooperation with the United States Naval Observatory), and at http://nist.time.gov Telephone voice announcement: Audio portions of radio broadcasts from time and frequency stations WWV and WWVH can be heard by telephone: +1 303 499 7111 for WWV and +1 808 335 4363 for WWVH
NMIJ	GPS common-view data GPS common-view data using CGGTTS format referred to UTC(NMIJ) are available through the NMIJ's web site for the remote frequency calibration service.
NMISA	Network Time Service One open access NTP server is available at address time.nmisa.org. More information is available at http://www.nmisa.org/time.html
NMLS	Telephone Time Service The coded time information is referenced to UTC(NMLS) and generated by a TUG type telephone time code generator using an ASCII-character code. The time protocols are sent in the "European Telephone Time Code" format. The service phone number is +60 3 8778 1674. Current service status is free of charge. Fees are made only on the provision of the software for accessing the service via modem dial-up. Network Time Protocol (NTP) Service The NTP time information is referenced to UTC(NMLS) and is currently generated by two Stratum-1 NTP servers, made available for public freely. The NTP server host names are ntp1.sirim.my and ntp2.sirim.my.

NPL	Telephone Time Service A TUG time code generator provides the European Telephone Time Code, referenced to UTC(NPL), by telephone modem. Software for synchronising computers is available from the NPL web site at www.npl.co.uk/time. The service telephone number is 0906 851 6333. Note: this is a premium rate number and can only be accessed from within the UK. Internet Time Service Two servers referenced to UTC(NPL) provide Network Time Protocol (NTP) time code across the internet. More information is available from the NPL web site at www.npl.co.uk/time. The server host names are: ntp1.npl.co.uk ntp2.npl.co.uk
NPLI	Telephone Time Service The coded time information generated by time code generator of NPLI, referenced to UTC(NPLI). Telephone Code provides digital time code (for the current time of Indian standard Time) at 1200 bauds, 8 bits, no parity, 1 stop bit. This service is known as TELECLOCK Service. Accessible by : a. an NPLI-developed Teleclock Receiver already available in the market. b. a Computer through Telephone Modem and NPLI-developed software. One-way Geostationary Satellite Time Service.
NRC	Telephone Code Provides digital time code by telephone modem for setting time in computers. Access phone number : +1 613 745 3900. http://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 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.

VMI	Network Time Service VMI operates one time server Stratum 1 using the Network Time Protocol (NTP). For information on access the website, please contact to email bangn@vmi.gov.vn. The server host name is: http://standardtime.vmi.gov.vn/
VNIIFTRI	Internet Time Service VNIIFTRI operates three time servers Stratum 1and one time server Stratum 2 using the “Network Time Protocol” (NTP). The server host names are: ntp1.vniiftri.ru (Stratum 1) ntp2.vniiftri.ru (Stratum 1) ntp3.vniiftri.ru (Stratum 1) ntp21.vniiftri.ru (Stratum 2).
VSL	Internet Time Service VSL operates a time server directly referenced to UTC(VSL). Time information is accessible through Network Time Protocol (NTP). The URL for the NTP server is: ntp.vsl.nl