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 BIPM Time Department issues four periodic publications. These are: UTCr (weekly), *Circular T* (monthly), TT(BIPM) (yearly) and the *BIPM Annual Report on Time Activities*.

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BIPM Time Department

Director: E.F. Arias

(1 January 2016 to 31 December 2016)

1. International Atomic Time (TAI), Coordinated Universal Time (UTC) and Rapid UTC (UTCr)

(E.F. Arias, A. Harmegnies, Z. Jiang, H. Konaté[1], G. Panfilo, G. Petit and L. Tisserand)

The reference time scales, International Atomic Time (TAI) and Coordinated Universal Time (UTC), are computed from data reported regularly to the BIPM by various timing centres that maintain a local UTC; monthly results are published in *Circular T*. The UTC rapid solution (UTCr) is published every Wednesday by 18 h UTC at the latest. All information related to the publication of UTC and UTCr can be accessed at www.bipm.org/en/scientific/tai/ftp_server/introduction.html.

The structure and content of BIPM *Circular T* were updated in 2016 with the introduction of an interactive version, which gives complete access to the information hosted on the BIPM website and ftp server. The dissemination of information has significantly improved following the development and launch of the 'BIPM Time Department Data Base'. Time Department services can be accessed at http://www.bipm.org/en/bipm/tai/.

The *BIPM Annual Report on Time Activities for 2015*, volume 10, provides comprehensive data for 2015 and is available on the BIPM website at http://www.bipm.org/en/bipm-services/timescales/time-ftp/annual-reports.html

2. Algorithms for time scales (G. Panfilo, G. Petit, A. Harmegnies and L. Tisserand)

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

After the implementation of the new algorithms (prediction and weights) for UTC calculation, behaviour is routinely and carefully monitored to trap and fix unexpected anomalies, although none were observed throughout 2016.

The results concerning the uncertainties of [*UTC-UTC(k)*] reported in Section 1 of *Circular T* have been analysed to evaluate the possibility of revising the algorithm. There are two main issues concerning the current algorithm: firstly, the statistical uncertainty, indicated with uStb in *Circular T*, of the pivot laboratory (at present PTB) is underestimated and unrealistic and secondly, the strict correlation of the uncertainty given by calibration (indicated by uCal). In fact the value of the uncertainty for uncalibrated laboratories (now arbitrarily fixed to 20 ns) affects the uncertainties of the ensemble in a significant way, including the calibrated laboratories. The particular case of the United States Naval Observatory (USNO) should be mentioned due to its important weight in the calculation of UTC; a small change in its calibration uncertainty affects, with the current algorithm, the ensemble of uncertainties in a critical way. A different approach to the problem is being studied, taking into account correlations that are not fully considered in the current algorithm.

2.1 EAL stability

Some 89 % of clocks used in the calculation of UTC are either commercial atomic clocks with high performance caesium tubes or active hydrogen masers. The number of hydrogen masers operated by contributing laboratories is increasing and represented 28 % of the participating clocks in 2016. The weighting procedure involved in time

[1] Retired on 31 October 2016

scale computation guarantees the long-term stability of EAL. To prevent domination of the scale by a small number of very stable clocks, a maximum relative weight is used each month, which depends on the number of participating clocks. On average, about 12 % of the participating clocks were at the maximum weight during 2016; almost all of these were hydrogen masers. The weighting algorithm, which has been in use since 2014, is based on the predictability of the clock's frequency. It enhances the influence of hydrogen masers on the resulting time scale; 42 % of the contributing hydrogen masers were, on average, at the maximum weight in 2016, whilst no caesium clocks reached the maximum weight.

UTC implicitly relies on hydrogen masers in the short term and on caesium clocks in the long term, which was an aim of the new weighting procedure. The stability of EAL at the end of 2016, expressed in terms of an Allan deviation, is about three parts in 10^{16} for averaging times of one month.

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 and secondary frequency standards. Since January 2016, individual measurements of the TAI frequency have been provided by nine primary frequency standards, including seven caesium fountains (SYRTE FO2, NIST F1, IT CSF2, SU CSFO2, PTB CSF1, PTB CSF2 and NIM 5), and by a rubidium secondary frequency standard (SYRTE FORb). Reports of the operation of the primary and secondary frequency standards are regularly published on the BIPM website and collated in the *BIPM Annual Report on Time Activities*.

Since January 2016, the global treatment of individual measurements has led to a relative departure of the duration of the TAI scale unit from the SI second on the geoid ranging from -0.30×10^{-15} to -1.45×10^{-15}, with a maximum standard uncertainty of 0.33×10^{-15}. A steering correction $+0.3 \times 10^{-15}$ had been applied in December 2016; this was the first time it had been applied since October 2012, confirming that the new algorithm maintains a positive impact on the accuracy of TAI.

2.3 Independent atomic time scales: TT(BIPM)

TAI is computed in 'real-time' and is subject to operational constraints; as a result it does not provide an optimal realization of TT, the time coordinate of the geocentric reference system. The BIPM therefore computes an additional realization, TT(BIPM), in post-processing, which is based on a weighted average of the evaluation of the TAI frequency by the primary frequency standards. The Time Department provided an updated computation of TT(BIPM) in January 2016, known as TT(BIPM15), valid until December 2015, which had an estimated accuracy of about 2-3 parts in 10^{16} over recent years. Moreover, the Time Department provides a formula to extend TT(BIPM15) based on the most recent TAI computation. Such an extension is useful for pulsar analysis pending the yearly updates of TT(BIPM). Studies to improve the computation of TT(BIPM) are ongoing in order to keep it in line with improvements in primary and secondary frequency standards.

An accurate analysis of a different approach to the calculation of TT that is more adapted to the case of the secondary frequency standards required a more flexible calculation interval and is ongoing.

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

The Time Department continues to calculate and publish the differences between the predictions of UTC(USNO) and UTC(SU) (as broadcast by GPS and GLONASS) and UTC in BIPM *Circular T*. Following the project to correct the large offset between UTC and GLONASS time, the absolute calibration of a BIPM receiver was concluded at the VNIIFTRI. This receiver has been used as the reference for the relative calibration of receivers at the Astrogeodynamical Observatory of the Space Research Centre (AOS, Borowiec, Poland) which provides data for computing this offset.

3. **Primary frequency standards and secondary representations of the second** (E.F. Arias, G. Panfilo, G. Petit and L. Robertsson)

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

Following an invitation by the CCTF to systematically study frequency ratios of ultra-high precision frequency standards, a somewhat different approach is needed to generate the update of the frequency list. Redundant measurements in this scheme allow for consistency studies but also require a non-linear least squares approach for complete evaluation. Such resources have been developed at the BIPM based on graph theory concepts. This method is a simplified approach, which is an alternative but complementary method to that developed at the NPL. Numerical validation of the two approaches is under way in order to be ready for the next recommended frequency list update in 2017.

Secondary representations of the second reported in BIPM Circular T

Since January 2012 the LNE-SYRTE has reported frequency measurements of the Rb microwave transition obtained with a double Cs-Rb fountain (FORb). Twelve measurement reports of FORb were submitted in 2015 and have been officially used for the accuracy of TAI. In addition, measurements of two Sr optical lattice clocks were reported for the first time by the LNE-SYRTE. They will be introduced following the advice of the CCTF Working Group on Primary and Secondary Frequency Standards.

4. **Time links used for UTC** (E.F. Arias, A. Harmegnies, Z. Jiang, H. Konaté, G. Panfilo, G. Petit and L. Tisserand)

At the end of 2016, 77 time laboratories supplied data for the calculation of UTC at the BIPM. The laboratories are equipped with GNSS receivers and some also operate two-way satellite time and frequency transfer (TWSTFT) stations.

Data from three independent techniques are included in the process of comparison of laboratories’ clocks based on the tracking of GPS and GLONASS satellites, and TWSTFT.

The GPS all-in-view method is widely used and takes advantage of the increasing quality of the International GNSS Service (IGS) products (clocks and IGS time). Clock comparisons for UTC are implemented using C/A code measurements from GPS single-frequency receivers, or dual-frequency, multi-channel GPS geodetic-type receivers (P3). The GPS phase and code data provided by time laboratories which operate geodetic-type receivers is processed monthly using the Precise Point Positioning (PPP) technique. The Time Department also regularly computes combined GPS/GLONASS links resulting in improved link uncertainty. About five GPS/GLONASS links are regularly computed for *Circular T*.

Thirteen laboratories operating TWSTFT stations officially submitted data in 2016 for use in the computation of UTC, representing 15 % of the time links. The number of TW links increased during the year with the re-incorporation of laboratories in the Asia Pacific region, which had been absent due to an interruption of the satellite service in the region in 2015. The combination of TWSTFT and PPP (so called TWPPP) has been used whenever possible. This combination takes advantage of the small noise of the GPSPPP and of the accuracy of the TWSTFT links.

GPS PPP alone or in combination with TWSTFT are in use for UTC clock comparisons in almost 60 % of the links, where the statistical uncertainty of time transfer is well below the nanosecond, the best value being 0.3 ns.

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

All GNSS time and frequency transfer data are corrected for satellite positions using IGS and the Information and Analysis Centre of Navigation (IAC) of the Mission Control Centre in Russia. The measurement data obtained by using single-frequency receivers are corrected for ionospheric delays using maps of the total electron content of the ionosphere provided by the Centre for Orbit Determination in Europe (CODE).

Techniques that use dual-frequency, GNSS carrier-phase measurements in addition to the codes, are widely used by the geodetic community and have been adapted to the needs of time and frequency transfer. This topic is studied within the framework of the IGS Working Group on Clock Products, which includes a physicist from the BIPM Time Department as a member.

Data from world-wide geodetic-type receivers are collected for UTC computation, using procedures and software that was developed in collaboration with the Observatoire Royal de Belgique (ORB). These P3 time links are routinely computed and compared to other available techniques, notably two-way time transfer. The software that produces ‘iono-free’ solutions has been implemented in some receivers and these now automatically produce both formatted GPS and GLONASS P3 code results. These newly available data will be used in multi-GNSS system time links, but further studies on GLONASS inter-frequency biases have to be carried out first.

The NRCan’s PPP software is used for the time link calculation. The current version of the software is capable of processing both GPS and GLONASS data but only GPS results are used operationally. Comparisons with other PPP software have been carried out. Studies are ongoing to improve long-term stability, using new processing techniques, in collaboration with software developers at NRCan, the ORB, the *Centre National d’Études Spatiales* (CNES) and also with other institutes. A novel PPP technique using integer phase ambiguities (IPPP) has been successfully developed within the framework of a post-doctoral project. It significantly improves the stability in the medium term (several hours), but mostly in the long term (days). Since 2015 the IPPP technique moved to a pre-operational stage and it is now used regularly to compare IPPP results to the few available optical fibre links.

Comparisons of the different links possible on a baseline between two contributing laboratories, are computed and published monthly on the Time Department’s ftp server.

4.2. Two-way satellite time and frequency transfer

The TWSTFT participating stations held a meeting at the 30th European Frequency and Time Forum (EFTF) in York, UK, on 6 April 2016. The 24th annual meeting of the CCTF WG on TWSTFT was held at the NIST on 7-8 September 2016. Two major issues discussed at the meetings were the realization of a pilot project involving the BIPM and the WG on TWSTFT: one on the impact of the Software-Defined Radio (SDR) receiver on the uncertainty of the TWSTFT time links; and the establishment of a task group to study the long-term comparison of GPS and TWSTFT links. One output of the pilot study could be the integration of data from SDR-equipped TW stations in the computation of UTC. The BIPM is also involved in the calibration of two-way time-transfer links by comparison with the corresponding GPS links. This is necessary to maintain stability of the TWSTFT links, in case of a loss of their direct calibration.

The TWSTFT technique is currently operational in eleven European, two North American and nine Asia-Pacific time laboratories. Ten TWSTFT links had been used in the computation of UTC in 2016 in Europe-USA-Asia;

they are combined with GPS PPP solutions. Some of the TWSTFT links involved in the computation of UTC are used in the experiment 'Time Transfer by Laser Link' (T2L2). The BIPM plans to develop studies on this technique, which could be used to validate less accurate time links and their calibrations.

Campaigns with a TW travelling calibration station were organized and funded by the participating laboratories in 2016. The parameters obtained have been implemented for UTC computation after validation of the results by the Time Department.

Results of the time links and link comparison using GNSS single-frequency, dual-frequency and TW observations are published monthly on the Time Department's ftp server (ftp://ftp2.bipm.org/pub/tai/timelinks/lkc/).

4.3 Calibration of delays of time-transfer equipment and time links

The characterization of the delays (so-called "calibration") of time transfer equipment in the contributing laboratories is necessary to improve the uncertainty of [*UTC-UTC*(*k*)] and for the accuracy of UTC dissemination.

The *BIPM Guidelines for GNSS calibration* are intended for Regional Metrology Organizations (RMOs) and establish a permanent cooperation for sharing the organization of campaigns to determine the relative delays of time transfer equipment and links in UTC contributing laboratories. The '*Guidelines'* are under continuous improvement; the latest revision was issued in March 2016.

The BIPM started the second calibration campaign of the "Group 1" laboratories in APMP, EURAMET, SIM and COOMET in 2016, following the planned periodicity of two years. Several regional calibration trips concerning 27 "Group 2" laboratories have been initiated by the RMOs in accordance with the *BIPM Guidelines* and the first results have been implemented in 2016. By repeatedly applying this new procedure, time transfer accuracy is expected to improve by a factor of at least 2 with respect to the pre-2015 situation.

The BIPM Time Department is not directly involved in specific TWSTFT calibration trips, but is responsible for the validation of the calibration reports and implementation of the results in the calculation of UTC. It also provides support whenever necessary to maintain a TW calibration by alignment with a calibrated GPS link (see section 4.2).

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.

4.4 Advanced time and frequency transfer

Data from two fibre links between UTC contributing laboratories in Europe are regularly submitted to the Time Department and compared with the corresponding links by GNSS time transfer techniques. The Time Department aims to include fibre links in the computation of UTC in the future, and for this purpose the CCTF WG on Coordination of the Development of Advanced Time and Frequency Transfer Techniques (WGATFT) has established a study group to develop the strategy for the use of these very accurate links in UTC. The terms of reference of this study group include the establishment of standards for data transmission and the validation of the compatibility of the different techniques.

5. **Key comparisons** (E.F. Arias, H. Konaté, G. Panfilo, A. Harmegnies and L. Robertsson)

Key comparison in Time CCTF-K001.UTC

Results of the key comparison in time, CCTF-K001.UTC, involving the time laboratories that participate in the CIPM MRA, are published monthly in the BIPM key comparison database (KCDB). The number of participants at the end of 2016 was 59, and they constitute a subset of the participants to BIPM *Circular T*.

Key comparison of stabilized lasers CCL-K11

Following a decision at the 98th meeting of the CIPM (2009) the BIPM continues to support the CCL-K11 key comparison by participating in measurement campaigns and by providing general advice whenever solicited. This comparison is the internationally recognized traceability chain to the SI metre and is supervised by the CCL-CCTF Working Group on Frequency Standards, which submits results to the CCL for formal approval. In 2016, BIPM staff members supported the key comparison on issues relating to the development of the measurement campaigns and reporting. Two final reports of the results of this ongoing key comparison, which involved measurements by nine institutes in 2014 and 2015, have been published in 2016.

6. **Rapid UTC** (A. Harmegnies, G. Panfilo, G. Petit and L. Tisserand)

Since January 2013 the Time Department has published a UTC rapid solution ‘UTCr’, that is, daily values of [*UTCr* – *UTC*(*k*)] evaluated on a weekly solution on one-month batches of data. About 48 laboratories that are traceable to UTC contribute to UTCr, which together represent 60 % to 70 % of the clocks that participate in UTC.

UTCr attained the expected quality, providing a weekly solution which is consistent within 1.1 ns RMS and ±3 ns peak to peak with the values published monthly in BIPM *Circular T*. The results (http://www.bipm.org/en/bipm-services/timescales/time-ftp/Rapid-UTC.html) have been published every Wednesday, without interruption since the end of February 2012.

UTCr does not change the procedures for the monthly calculation of UTC, which remains the only key comparison on time. However, UTCr has a favorable impact on the quality of the local representations UTC(k) in national laboratories, and on the steering of GNSS times to UTC via some UTC(k).

7. **New proposed definition of UTC** (F. Arias)

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

The BIPM contributed to this process at the International Telecommunication Union (ITU), and participated in the meeting of Study Group 7 (Science services) and Working Party 7A (Time signals and frequency standard emissions) in April 2016.

The CCTF established a task group for proposing definitions of TAI and UTC to be submitted to the CGPM in 2018. This was in response to an invitation by the World Radiocommunication Conference 2015 (WRC15) to strengthen the cooperation between the ITU and the BIPM on this matter, and in preparation for the discussions scheduled for the WRC23. This task group, which includes two Time Department staff members, continued to draft the text of the recommendation during 2016 for consideration by the CCTF in June 2017.

8. Space-time references (E.F. Arias and G. Petit)

Activities related to the realization of reference frames for astronomy and geodesy are ongoing, in cooperation with the International Earth Rotation and Reference Systems Service (IERS). In these domains, improvements in accuracy will increase the need for a full relativistic treatment and continued participation in the international working groups in this field is essential.

Cooperation continues on the maintenance of the international celestial reference system within the framework of the activities of a working group created by the International Astronomical Union (IAU) in August 2012. This working group met within the period and submitted a report on the features of the next realization of the International Celestial Reference Frame (ICRF3) to the IAU General Assembly held in Honolulu (USA) in August 2015, with a view to the submission of the catalogue with the set of coordinates in the ICRF3 in 2018.

As part of its participation in the Conventions Centre of the IERS, the BIPM maintains the web and ftp sites for the *IERS Conventions*. The Conventions describe the latest realizations of the celestial and terrestrial reference frames, and the model for the transformation between them. They also describe conventional models for the gravitational field, the displacement of markers on the Earth's crust and for the propagation of electromagnetic signals. In addition, the *Conventions* now provide a complete set of associated conventional software. Since the completion of the latest reference edition, *IERS Conventions* (2010) in December 2010, work is continuing with the help of an editorial board to provide updates to the *Conventions* (2010).

With the development of optical clocks accurate at the 10^{-18} level, "relativistic geodesy" is the subject of numerous developments, which suggest the full potential of these clocks for the measurement of terrestrial gravity potential and the definition of systems of altimetry references. A physicist from the Time Department is co-chairing a new IAG working group on this subject. In 2016, international collaborations led to publications on the implications of such "chronometric geodesy" for geodesy and the definition of time scales and on the calculation of the relativistic frequency shift with the required accuracy for optical clocks.

9. Comb activities (L. Robertsson)

The BIPM comb activities are limited to maintenance of the BIPM frequency comb for internal use related to laser applications only and in other departments when needed.

10. Publications

External publications

1. Denker H., Timmen L., Voigt C., Weyers S., Peik E., Delva P., Wolf P., Petit G., Geodetic methods to determine the relativistic redshift at the level of 10^{-18} in the context of international timescales – A review and practical results; *J. Geodesy*, submitted.

2. Hachisu H., Petit G., Ido T., Absolute frequency measurement with uncertainty below 1×10^{-15} using International Atomic Time, *Appl. Phys. B*, 2017, **123**(1).

3. Jiang Z., (2016) Final report of the BIPM Pilot Study on UTC time link calibration, *PTTI Proc.* 20-26, Monterey, CA, USA, 2016.

4. Jiang Z., Matsakis D., Zhang V., Esteban H., Piester D., Lin S.Y., Dierikx E., A TWSTFT calibration guideline and the use of a GPS calibrator for UTC TWSTFT link calibrations, *PTTI Proc.* 231-242, Monterey, CA, USA, 2016.

5. Jiang Z., Piester D., Schlunegger C., Dierikx E., Zhang V., Galindo J., Matsakis D., The 2015 TWSTFT calibration for UTC and related time links, Proc. 30th EFTF meeting, York, UK, 2016.

6. Matus M., Gavalyugov V., Tamakyarska D., Ranusawud M., Tonmueanwai A., Hong F.-L., Ishikawa J., Moona G., Sharma R., Hapiddin A., Boynawan A.M., Alqahtani N., Alfohaid M., Robertsson L., Report on on-going CCL Key Comparison for the year 2014 Comparison of optical frequency and wavelength standards CCL-K11, *Metrologia*, 2017, **54**, *Tech. Suppl.*, 04001.

7. Matus M., van den Berg S., Czulek D., Seppä J., Robertsson L., The CCL-K11 ongoing key comparison. Final report for the year 2015, *Metrologia*, 2016, **53**, *Tech. Suppl.*, 04007.

8. Panfilo G. The Coordinated Universal Time, *IEEE Instrumentation and Measurement Magazine*, June 2016, **19**(3), 28-33.

9. Parisi F., Panfilo G., A new approach to UTC calculation by means of the Kalman Filter, *Metrologia*, 2016, **53**(5), 1185-1192.

10. Petit G., Defraigne P., The performance of GPS time and frequency transfer: comment on 'A detailed comparison of two continuous GPS carrier-phase time transfer techniques', *Metrologia*, 2016, **53**(3), 1003-1008.

11. Riedel F., *et al*. (G. Petit), Remote optical and fountain clock comparison using broadband TWSTFT and GPS PPP, Proc. 30th EFTF meeting, York, UK, 2016.

12. Robertsson L., On the evaluation of ultra-high-precision frequency ratio measurements: examining closed loops in a graph theory framework, *Metrologia*, 2016, **53**(6), 1272-1280.

13. Visser PNAM., Müller J., Lon G., Panet I., Kopeikin S.M., Petit G., Dirkx D., High performance clocks and gravity field determination, Proc ISSI Workshop HISPAC, Space Science Reviews, to be published.

14. Wielgosz R., Arias F., Stock M., Los Arcos J.-M., Milton M., News from the BIPM laboratories – 2015, *Metrologia*, 2016, **53**, 103-107.

BIPM publications

15. *BIPM Annual Report on Time Activities for 2015*, 10, 137 pp., available only at http://www.bipm.org/en/bipm-services/timescales/time-ftp/annual-reports.html

16. *Circular T* (monthly)

17. *Rapid UTC* (*UTCr*) (weekly)

11. Activities related to the work of Consultative Committees

E.F. Arias is Executive Secretary of the Consultative Committee for Time and Frequency (CCTF). She is the Secretary of the CCTF Working Group on TAI (WGTAI) and the CCTF Working Group on Strategic Planning (WGSP).

Z. Jiang is Secretary of the CCTF Working Group on Two-Way Satellite Time and Frequency Transfer (WGTWSTFT).

G. Panfilo is Secretary of the CCTF Working Group on the CIPM MRA (WGMRA) and the CCTF Working Group on Time Scale Algorithms (WG-ALGO). She is the Executive Secretary of the Consultative Committee for Acoustics, Ultrasound and Vibration (CCAUV). She is Secretary of the CCAUV Working Groups for Key Comparisons (CCAUV-KCWG), for RMO coordination (CCAUV-RMO) and on Strategic Planning (CCAUV-SPWG).

G. Petit is Secretary of the CCTF Working Group on Primary and Secondary Frequency Standards (WGPSFS) and the Working Group on Global Navigation Satellite Systems (WGGNSS).

L. Robertsson is Executive Secretary of the Consultative Committee for Length (CCL), a member of the CCL Working Group on Strategic Planning (WG-S) and of the Discussion Group DG-11 (Lasers). He is the BIPM representative on the CCM Working Group on Gravimetry (WGG). He is also Secretary for the CCTF WG on

Coordination of the Development of Advanced Time and Frequency Transfer Techniques (WGATFT) and shares the secretariat of the CCL-CCTF Frequency Standards WG (WGFS) with E.F. Arias.

12. Activities related to external organizations

E.F. Arias is a member of the IAU and participates in its working group on the International Celestial Reference Frame (ICRF); she is a member of the Steering Committee of IAU Division A on Fundamental Astronomy and a member of the Division A Working Group on the Third Realisation of the International Celestial Reference Frame. She is an associate member of the IERS, a member of its International Celestial Reference System Centre, and until end 2016 of the Conventions Centre. E.F. Arias is a member of the International VLBI[2] Service (IVS). She is the BIPM representative to the Governing Board of the International GNSS Service (IGS). She is the BIPM representative to the UN sponsored International Committee on GNSS (ICG) and the chairperson of its Task Force on Time References. She is a member of the Technical Advisory Committee of International Union of Radio Science (URSI) Commission A. E.F. Arias is a member of the IAG Global Geodetic Observing System (GGOS) Steering Committee representing the BIPM. She is a member of the Argentine Council of Research (CONICET) and an associate astronomer at the LNE-SYRTE, Paris Observatory. She is a corresponding member of the *Bureau des longitudes* and the BIPM representative to the Working Party 7A of Study Group 7 of the International Telecommunication Union – Radiocommunication Sector (ITU-R).

G. Petit is co-director of the Conventions Centre of the IERS and a member of the IERS Directing Board until the end of 2016. He is an associate member of the IGS and member of the IGS Working Groups on Clock Products and on Bias Calibration. In 2016 he represented the BIPM at the United Nations International Committee on Global Navigation Satellite Systems (ICG), and has acted as chairperson of the Task Force on Time References. He is co-chair of the IAG Joint Working Group on Relativistic Geodesy and a member of the IAU Working Groups on Numerical Standards in Fundamental Astronomy and on Pulsar Time Scale.

13. Travel in 2016 (conferences, lectures and presentations, visits)

E.F. Arias to:

- Teddington (UK), 13-14 January, for the meeting of the Quantum, Electromagnetics and Time Programme Expert Group;
- Monterey (USA), 25-29 January, for the PTTI 2016 to chair a session and participate to CCTF Working Group meetings;
- Espoo (Finland); 1-2 March, for the meeting of the Technical Committee on Time and Frequency of EURAMET to give reports on BIPM activities and to coordinate calibrations;
- Geneva (Switzerland), 4-8 April, for the meeting of Study Group 7 and Working Party 7A at the ITU;
- Cambridge (Massachusetts, USA), 6-10 June, for the Symposium on the Science of Time to give an invited talk, and oral contribution;
- Brussels (Belgium), 19-21 September, for the Workshop “Understanding the Earth core and nutation”;
- Teddington (UK), 7 October, for the meeting of the Quantum, Electromagnetics and Time Programme Expert Group;
- Haystack (USA), 17-19 October, for the meeting of the IAU Working Group on the third realisation of the International Celestial Reference Frame.

[2] Very Long Baseline Interferometry (VLBI)

Z. Jiang to:

- Monterey (California, USA) 25-28 January, for the PTTI meeting with one oral presentation and a poster and for the TWSTFT participation station (PS) meeting;
- York, UK, 4-8 April, to attend the EFTF meeting with an oral presentation and a poster, to the TWSTFT participation station (PS) other CCTF WG meetings;
- NIST, Boulder, USA, 7-8 September, to the 24th Annual meeting of the CCTF WG on TWSTFT and to give oral reports on the WG activities;
- Shangsa, China, 17-21 May, for the China Satellite Navigation Conference 2016 to co-chair the Session on time and frequency and one oral presentation;
- Xian, China, 17-18 October, to attend the Ceremony of the 50th anniversary of the NTSC foundation and to give an invited presentation;
- NIM, Beijing China, 20 October – 3 November, to audit the Gravity and Time laboratories and activities.

G. Panfilo to:

- Espoo (Finland); 1-2 March, for the meeting of the Technical Committee on Time and Frequency of EURAMET to give reports on UTC algorithms and existing guidelines of the CCTF WGMRA.

G. Petit to:

- Monterey (California, USA) 25-28 January, to give a tutorial course and attend the PTTI meeting, with one oral presentation;
- Villetaneuse (France), 24 March, to attend the General Assembly of the Labex “FIRST-TF”;
- York (UK) 4-8 April, to attend the EFTF 2016 meeting, to give one oral presentation, to attend four CCTF WG meetings, and to attend the Workshop “Optical clocks: Quantum engineering and international timekeeping”;
- Vienna (Austria), 17 April, to attend the Directing Board of the IERS;
- Besançon (France), 28-29 June, to give two lectures at the European Frequency and Time Seminar;
- Paris (France), 10 October, to attend the *Journée thématique* “Miniature atomic clocks”;
- Sochi (Russian Federation), 7-11 November, for the eleventh meeting the International Committee on GNSS (ICG), with chair of a task force and presentations;
- Paris (France), 30 November, to attend a PhD jury as reviewer.

L. Robertsson to:

- York (UK) 4-8 April, to attend the EFTF 2016 meeting, to attend four CCTF WG meetings, and to attend the Workshop “Optical clocks: Quantum engineering and international timekeeping”.

14. Visitors, secondees in 2016

- V. Lizardi, CENAM (Mexico), for a visit to the Time Department and laboratory, 10 January;
- T. Ido, NICT (Japan), for a discussion on Secondary Frequency Standards, 25 February;
- X. Zhang accompanied with a delegation from ISO for a visit to the Time Department and laboratory, 26 February;
- B. Ouyanj and a delegation from NIM/QTSA (China), for a visit to the Time Department and laboratory, 15 April;
- J.W. Chung, I.T. Lim and K.L. Jeong from KRISS (Republic of Korea), 24 May;

- J. Feng, NIM (China), for training on the implementation of CCM.G-K2, 6 July to 6 August;
- P. Koppang, USNO (USA), for a discussion on algorithms, 27 September;
- A. Bauch, PTB (Germany), L. Erard (CCTF), P. Koppang, USNO (USA) and ITU WP7A, D. Rovera, LNE-SYRTE (France), P. Tavella, INRIM (Italy), P. Whibberley, NPL (UK) for the meeting of the CCTF WGTAI Task Group on Time Scale Definitions, 28 September;
- D. Matsakis, USNO (USA), for a collaboration on the evaluation of uncertainties of *[UTC-UTC(k)]* reported in Section 1 of *Circular T*, 10 October to 8 November.

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

The files related to BIPM Time Activities are available from the website. (http://www.bipm.org/en/bipm-services/timescales/time-ftp.html)

The files can be found in the nine subdirectories: **data**, **Circular T, Rapid-UTC,TT-BIPM, other-products, timelinks, scale and annual-reports.** They are all are available by ftp (62.161.69.5 or ftp2.bipm.org, user anonymous, e-mail address as password, cd pub/tai).

Data – All data used for the computation of TAI, including reports of evaluation of primary and secondary frequency standards and all clock and time transfer data files used for the computation of TAI, arranged in yearly directories. See readme for details.

Circular T – All issues of BIPM *Circular T*.

Rapid UTC **-** From February 2012 until June 2013 results of the Pilot Experiment on Rapid UTC (UTCr). Starting in July 2013 official results of Rapid UTC (UTCr).

TT(BIPM) – The realizations of terrestrial time TT(BIPMXY).

Other products – Other products, including time differences and monthly values of clock weights and frequency drifts, etc.

Timelinks – Results of time links and time link comparisons processed with *Circular T*.

Scale – Annual results of time scales data.

Annual reports – Archive of the BIPM Annual Reports on Time Activities and extracts from the BIH Annual Reports.

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

products	**filename**
Acronyms of laboratories	acronyms.pdf
Leap seconds	leaptab.pdf
UTCr	UTCr_XYWW
Circular T	cirt.XXX
Circular T HTML	cirt.XXX.html (starting 2016)
Fractional frequency of EAL from primary and secondary 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
Frequency drifts of clocks participating in the computation of TAI	dXY.ZT
Daily values of the differences between UTCr and its local representation by the given laboratory	UTCr - lab
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 graphics and relevant notes	UTC - lab
Values of the differences between UTC(k) and UTC(l) obtained from TWSTFT comparisons	lab1 – lab2
Relations of UTC and TAI with predictions of UTC(k) disseminated by GNSS and with the GNSS times	UTC - gnss

time scales data	**filename**
Time Dissemination Services	TIMESERVICES.PDF
Time Signals	TIMESIGNALS.PDF
Rates of clocks contributing to TAI	RTAIXY.ar
Weights of clocks contributing to TAI	WTAIXY.ar
Drifts of clocks contributing to TAI	DTAIXY.ar
TT(BIPMXY) computation ending in 19XY or 20XY	TTBIPM.XY
Difference between the normalized frequencies of EAL and TAI	EALTAIXY.ar (starting 1993)
Measurements of the duration of the TAI scale interval	UTAIXY.ar (starting 1995)
Mean fractional deviation of the TAI scale interval from that of TT duration of TAI scale interval	SITAIXY.ar (starting 2000)
Relations of UTC and TAI with GPS and GLONASS system times, and also with the predictions of UTC(*k*) disseminated by GNSS	UTC-GNSS (starting January 2011)

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

Any comments or queries should be sent 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 Centre
Dr Christian Bizouard
Observatoire de Paris
61, avenue de l'Observatoire
75014 Paris, France

Telephone:	+ 33 1 40 51 23 35
Telefax:	+ 33 1 40 51 22 91
Email:	iers@obspm.fr
Website:	http://hpiers.obspm.fr
Anonymous:	ftp://hpiers.obspm.fr or ftp://145.238.203.2/

Establishment of International Atomic Time
and Coordinated Universal Time

1. Data and computation

International Atomic Time (TAI) and Coordinated Universal Time (UTC) are obtained from a combination of data from about 500 atomic clocks operated by more than 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. The weighting procedure and clock frequency prediction [1, 2] 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 (SI).

2. Accuracy

The duration of the scale interval of EAL is evaluated by comparison with the data of primary frequency caesium standards and secondary frequency standards recommended for secondary representations of the second, 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 including uncertainties of [*UTC* – *UTC*(*k*)] [3].

The computation of TAI/UTC is carried out every month and the results are published monthly in *Circular T*.

The BIPM pilots the key comparison in time CCTF-K001.UTC. Institutes participating in the key comparison are National Metrology Institutes and Designated Institutes; they constitute a sub-set of the participants in *Circular T* listed in table 3.

A rapid solution, *UTCr* has been published without interruption since July 2013. Regular publication of the values [*UTCr - UTC(k)*] allows weekly access to a prediction of UTC [4] for about fifty laboratories which also contribute to the regular monthly publication. However, the final results published in BIPM *Circular T* remain the only official source of traceability to the SI second for participating laboratories.

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 calculation 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 receivers are regularly used in the calculation of time links, in addition to that acquired by a few multi-channel single-frequency GPS time receivers. For those links realized using more than one technique, one of them is considered official for UTC and the others are calculated as back-ups. Single-frequency GPS data are corrected using the ionospheric maps produced by the Centre 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 using the method known as “GPS all in view” [5], with a network of time links that uses the PTB as a unique pivot laboratory for all the GPS links. Links between laboratories equipped with dual-frequency receivers providing Rinex format files are computed with the “Precise Point Positioning” method GPS PPP [6].

Clock comparisons using GLONASS C/A (L1C frequency) satellite observations with multi-channel receivers have been in use since October 2009 [7]. These links are computed using the “common-view” [8] method; data are corrected using the IAC ephemerides SP3 files and the CODE ionospheric maps.

A combination of individual TWSTFT and GPS PPP links and of individual GPS and GLONASS links are currently used in the calculation of TAI [9, 10].

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 BIPM *Circular T* for the techniques and methods of time transfer officially used and for the values of the uncertainty of [$UTC(k_1)$ - $UTC(k_2)$], obtained at the BIPM with these procedures.

The BIPM publishes in *Circular T* daily values of
[*UTC – UTC(USNO)_GPS*] and [*UTC – UTC(SU)_GLONASS*] where *UTC(USNO)_GPS* and *UTC(SU)_GLONASS* are respectively, UTC(USNO) and UTC(SU) as predicted by USNO and SU and broadcast by GPS and GLONASS. Evaluations of [*UTC - GPS time*] and [*UTC - GLONASS time*] are provided only through the ftp server of the Time Department. These tables are based on GPS data provided by the Paris Observatory (LNE-SYRTE), France, and on GLONASS data provided by the Astrogeodynamical Observatory (AOS), Poland.

5. Time scales established in retrospect

For the most demanding applications, such as millisecond pulsar timing, the BIPM retrospectively issues atomic time scales. These are designated TT(BIPMxx) where 19xx or 20xx is the year of computation [11, 12, 13]. The successive versions of TT(BIPMxx) are both updates and revisions; they may differ for common dates.

Starting with TT(BIPM09), until TT(BIPM12) extrapolation for the current year of the latest realization TT(BIPMxx) had been provided in the file TTBIPMxx.ext. It had been updated each month after the TAI computation. Starting with TT(BIPM13), a formula for extrapolation is provided in the file TTBIPM.xx.

Notes

Tables 8, 9 and 10 of this report give the following details for the clocks contributing to TAI in 2016: their rates relative to TAI; their weights; and their drifts relative to a monthly realization of TT(BIPM).

Since January 2016 BIPM *Circular T* has been published in a new format with a different distribution of content in the sections. See
ftp://ftp2.bipm.org/pub/tai/publication/notes/explanatory_supplement_v0.1.pdf.

Since September 2016, a Time Department Database has been made accessible via the website at http://webtai.bipm.org/database/html/. It contains all relevant information relating to contributions to UTC and UTCr.

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 January - December 2016 is at the *Director's Report on the Activity and Management of the BIPM (1 January − 31 December 2016)* supplement. All the publications mentioned in this report are available on request from the BIPM.

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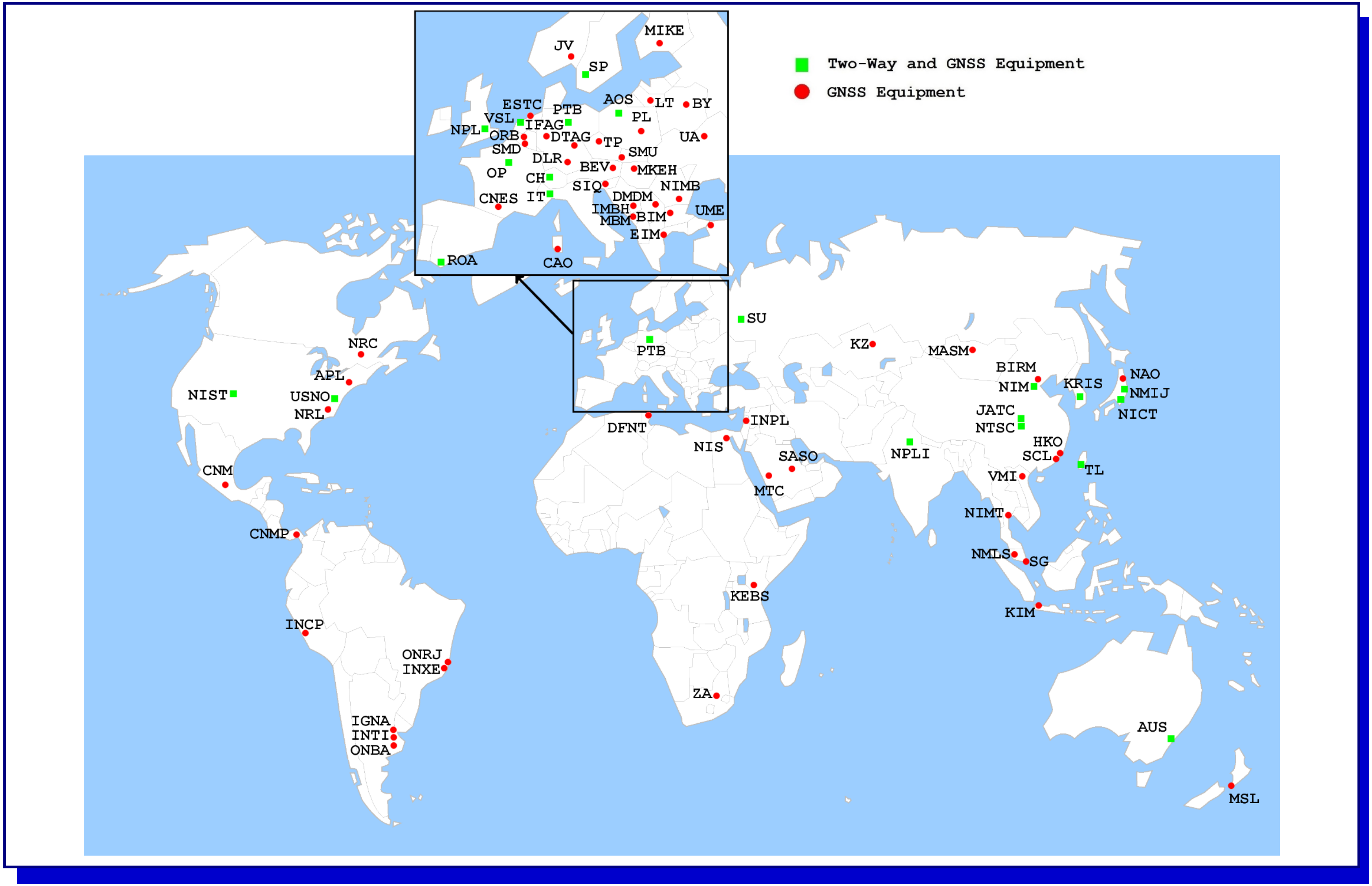

Geographical distribution of the laboratories that contribute to TAI and time transfer equipment (December 2016)

Table 1. Relative frequency offsets and step adjustments of UTC, up to 31 December 2017

Date (at 0 h UTC)	Offsets	Steps/s
1961 Jan. 1	-150×10^{-10}	
1961 Aug. 1	"	+0.050
1962 Jan. 1	-130×10^{-10}	
1963 Nov. 1	"	−0.100
1964 Jan. 1	-150×10^{-10}	
1964 Apr. 1	"	−0.100
1964 Sep. 1	"	−0.100
1965 Jan. 1	"	−0.100
1965 Mar. 1	"	−0.100
1965 Jul. 1	"	−0.100
1965 Sep. 1	"	−0.100
1966 Jan. 1	-300×10^{-10}	
1968 Feb. 1	"	+0.100
1972 Jan. 1	0	−0.107 7580
1972 Jul. 1	"	−1
1973 Jan. 1	"	−1
1974 Jan. 1	"	−1
1975 Jan. 1	"	−1
1976 Jan. 1	"	−1
1977 Jan. 1	"	−1
1978 Jan. 1	"	−1
1979 Jan. 1	"	−1
1980 Jan. 1	"	−1
1981 Jul. 1	"	−1
1982 Jul. 1	"	−1
1983 Jul. 1	"	−1
1985 Jul. 1	"	−1
1988 Jan. 1	"	−1
1990 Jan. 1	"	−1
1991 Jan. 1	"	−1
1992 Jul. 1	"	−1
1993 Jul. 1	"	−1
1994 Jul. 1	"	−1
1996 Jan. 1	"	−1
1997 Jul. 1	"	−1
1999 Jan. 1	"	−1
2006 Jan. 1	"	−1
2009 Jan. 1	"	−1
2012 Jul. 1	"	−1
2015 Jul. 1	"	−1
2017 Jan. 1	"	−1

Table 2. Relationship between TAI and UTC, up to 31 December 2017

Limits of validity (at 0 h UTC)	[*TAI* - *UTC*] / s
1961 Jan. 1 - 1961 Aug. 1	1.422 8180 + (MJD - 37300) × 0.001 296
1961 Aug. 1 - 1962 Jan. 1	1.372 8180 + " "
1962 Jan. 1 - 1963 Nov. 1	1.845 8580 + (MJD - 37665) × 0.001 1232
1963 Nov. 1 - 1964 Jan. 1	1.945 8580 + " "
1964 Jan. 1 - 1964 Apr. 1	3.240 1300 + (MJD - 38761) × 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) × 0.002 592
1968 Feb. 1 - 1972 Jan. 1	4.213 1700 + " "
1972 Jan. 1 - 1972 Jul. 1	10 (integral number of seconds)
1972 Jul. 1 - 1973 Jan. 1	11
1973 Jan. 1 - 1974 Jan. 1	12
1974 Jan. 1 - 1975 Jan. 1	13
1975 Jan. 1 - 1976 Jan. 1	14
1976 Jan. 1 - 1977 Jan. 1	15
1977 Jan. 1 - 1978 Jan. 1	16
1978 Jan. 1 - 1979 Jan. 1	17
1979 Jan. 1 - 1980 Jan. 1	18
1980 Jan. 1 - 1981 Jul. 1	19
1981 Jul. 1 - 1982 Jul. 1	20
1982 Jul. 1 - 1983 Jul. 1	21
1983 Jul. 1 - 1985 Jul. 1	22
1985 Jul. 1 - 1988 Jan. 1	23
1988 Jan. 1 - 1990 Jan. 1	24
1990 Jan. 1 - 1991 Jan. 1	25
1991 Jan. 1 - 1992 Jul. 1	26
1992 Jul. 1 - 1993 Jul. 1	27
1993 Jul. 1 - 1994 Jul. 1	28
1994 Jul. 1 - 1996 Jan. 1	29
1996 Jan. 1 - 1997 Jul. 1	30
1997 Jul. 1 - 1999 Jan. 1	31
1999 Jan. 1 - 2006 Jan. 1	32
2006 Jan. 1 - 2009 Jan. 1	33
2009 Jan. 1 - 2012 Jul. 1	34
2012 Jul. 1 - 2015 Jul. 1	35
2015 Jul. 1 - 2017 Jan. 1	36
2017 Jan. 1 -	37

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

#AOS	Astrogeodynamical Observatory, Space Research Centre P.A.S., Borowiec, Poland
#APL	Applied Physics Laboratory, Laurel, Maryland, USA
AUS	Consortium of laboratories in Australia
BEV	Bundesamt für Eich- und Vermessungswesen, Vienna, Austria
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	Federal Institute of Metrology (METAS), Bern-Wabern, Switzerland
#CNES (1)	Centre National d'Etudes Spatiales, Toulouse, France
CNM	Centro Nacional de Metrología, Querétaro (CENAM), Mexico
CNMP	Centro Nacional de Metrología de Panamá (CENAMEP), Panama
DFNT	Laboratoire de Métrologie de la Direction Générale des Transmissions et de l'Informatique (DEF-NAT), Tunis, Tunisia
DMDM	Directorate of Measures and Precious Metals, Belgrade, Serbia
#DTAG	Deutsche Telekom AG, Frankfurt/Main, Germany
EIM	Hellenic Institute of Metrology, Thessaloniki, Greece
ESTC	European Space Research and Technology Centre (ESA-ESTEC), Noordwijk, the Netherlands
#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
IMBH	Institute of Metrology of Bosnia and Herzegovina, Sarajevo, Bosnia and Herzegovina
INCP (2)	Instituto Nacional de Calidad (INACAL) of Peru, Lima, Peru.
INPL	National Physical Laboratory, Jerusalem, Israel
INTI	Instituto Nacional de Tecnología Industrial, Buenos Aires, Argentina
INXE	National Institute for Metrology and Technology (INMETRO) - Time and Frequency Laboratory, Rio de Janeiro, Brazil
IT	Istituto Nazionale di Ricerca Metrologica (INRIM), Torino, Italy
#JATC	Joint Atomic Time Commission, Lintong, P.R. China
JV	Justervesenet, Norwegian Metrology and Accreditation Service, Kjeller, Norway
KEBS	Kenya Bureau of Standards, Nairobi, Kenya
KIM	Research Centre for Calibration, Instrumentation and Metrology, The Indonesian Institute of Sciences, Serpong-Tangerang, Indonesia
KRIS	Korea Research Institute of Standards and Science (KRISS), Daejeon, Rep. of Korea
KZ	Kazakhstan Institute of Metrology (KazInMetr), Astana, Kazakhstan
LT	Center for Physical Sciences and Technology (VMT/FTMC), Vilnius, Lithuania
MASM	Mongolian Agency for Standardization and Metrology, Bayanzurkh District, Mongolia
MBM	Bureau of Metrology - Laboratory for time and frequency, Podgorica, Montenegro
MIKE	MIKES Metrology, VTT Technical Centre of Finland Ltd, Espoo, Finland
MKEH	Hungarian Trade Licensing Office, Budapest, Hungary
MSL	Measurement Standards Laboratory, Lower Hutt, New Zealand
#MTC	MAKKAH Time Centre - King Abdulah Centre for Crescent Observations and Astronomy, Makkah, Saudi Arabia
#NAO	National Astronomical Observatory, Misuzawa, Japan
NICT	National Institute of Information and Communications Technology, Tokyo, Japan

(1) First participation since May 2016
(2) First participation since April 2016

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.)

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
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	Laboratoire national de métrologie et d'essais – Systèmes de références Temps-Espace, Observatoire de Paris (LNE-SYRTE), Paris, France
#ORB	Observatoire Royal de Belgique, 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
SASO	Saudi Standards, Metrology and Quality Organization, Riyadh, Saudi Arabia
SCL	Standards and Calibration Laboratory, Hong Kong, China
SG	National Metrology Centre - Agency for Science, Technology and Research (A*STAR), Singapore
SIQ	Slovenian Institute of Quality and Metrology, Ljubljana, Slovenia
SMD	Metrology Division of the Quality and Safety Department - Scientific Metrology, Brussels, Belgium
SMU	Slovenský Metrologičký Ústav (Slovak Institute of Metrology), Bratislava, Slovakia
SP	Sveriges Provnings- och Forskningsinstitut (Swedish National Testing and Research Institute), Borås, Sweden
SU	Institute of Metrology for Time and Space (IMVP), NPO "VNIIFTRI" Mendeleevo, Moscow Region, Russian Federation
TL	Telecommunication Laboratories, Chung-Li, Chinese Taipei
TP	Institute of Photonics and Electronics, Czech Academy of Sciences (IPE/ASCR), Prague, Czech Republic
UA	National Science Center "Institute of Metrology" (NSC), Kharkhov, Ukraine
UME	Ulusai Metroloji Enstitüsü, Marmara Research Centre, (National Metrology Institute), Gebze Kocaeli, Turkey
#USNO	U.S. Naval Observatory, Washington D.C., USA
VMI	Vietnam Metrology Institute, Ha Noi, Viet Nam
VSL	VSL, Dutch Metrology Institute, Delft, the Netherlands
ZA	National Metrology Institute of South Africa (NMISA), Pretoria, South Africa

Laboratories not participating in the key comparison CCTF-K001.UTC. See details at "Participants list"

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 2016

Ind. Cs: industrial caesium standard
Ind. Rb: industrial rubidium standard
Lab. Cs: laboratory caesium standard
Lab. Rb: laboratory rubidium 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*)	UTCr	Time Links			
					GPS		GLONASS	Two-Way
					SF	DF		
AOS	3 Ind. Cs 2 H-masers	1 H-maser (2) + microphase-stepper	* (19)	*	*	*	*	*
APL	3 Ind. Cs 3 H-masers	1 H-maser + frequency synthesizer steered to UTC(APL)			*	*		
AUS	5 Ind. Cs 2 H-masers	1 Cs		*	*	*	*	*
BEV	2 Ind. Cs 1 H-maser	1 Cs		*	*	*	*	
BIM	2 Ind. Cs	1 Cs			*	*		
BIRM	2 Ind. Cs 3 H-masers	1 H-maser + microphase-stepper			*			
BY (a)	6 H-masers	3-4 H-masers + microphase-stepper			*		*	
CAO	2 Ind. Cs	1 Cs			*	*	*	
CH	3 Ind. Cs (3) 2 H-maser	1 H-maser (3) + frequency synthesizer steered to UTC(CH.P)	*	*		*		*
CNES	8 Ind. Cs (4) 3 H-maser	1 H-maser (4) + microphase-stepper				*		

Table 4. Equipment and source of UTC(*k*) of the laboratories contributing to TAI in 2016 (Cont.)

Ind. Cs: industrial caesium standard
Ind. Rb: industrial rubidium standard
Lab. Cs: laboratory caesium standard
Lab. Rb: laboratory rubidium 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*)	UTCr	Time Links: GPS SF	Time Links: GPS DF	Time Links: GLONASS	Time Links: Two-Way
CNM (a)	4 Ind. Cs 2 H-maser	1 H-maser + microphase-stepper	*	*		*	*	
CNMP	3 Ind. Cs	1 Cs + frequency offset generator		*	*	*	*	
DFNT	2 Ind. Cs	1 Cs				*	*	
DLR	3 Ind. Cs 3 H-maser	1 Cs		*		*	*	
DMDM	2 Ind. Cs	1 Cs + microphase-stepper		*	*	*		
DTAG	3 Ind. Cs	1 Cs		*		*		
EIM	2 Ind. Cs	1 Cs			*			
ESTC	3 Ind. Cs 3 H-masers	1 H-maser + microphase-stepper		*		*		
HKO	2 Ind. Cs	1 Cs				*	*	
IFAG	5 Ind. Cs 2 H-masers	1 Cs + microphase-stepper		*		*		

Table 4. Equipment and source of UTC(*k*) of the laboratories contributing to TAI in 2016 (Cont.)

Ind. Cs: industrial caesium standard
Ind. Rb: industrial rubidium standard
Lab. Cs: laboratory caesium standard
Lab. Rb: laboratory rubidium 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*)	UTCr	Time Links GPS SF	Time Links GPS DF	Time Links GLONASS	Time Links Two-Way
IGNA	1 Ind. Cs	1 Cs			*			
IMBH	2 Ind. Cs	1 Cs		*		*	*	
INCP	1 Ind. Cs	1 Cs			*			
INPL	2 Ind. Cs	1 Cs				*	*	
INTI	1 Ind. Cs	1 Cs		*	*			
INXE	3 Ind. Cs 1 Ind. Rb 1 Lab. Cs	1 Cs + microphase-stepper		*	*	*		
IT	6 Ind. Cs 4 H-masers 2 Lab. Cs	1 H-maser + microphase-stepper		*		*		*
JATC	(5)	1 Cs + microphase-stepper	*					
JV	3 Ind. Cs 1 H-maser	1 H-maser + microphase-stepper		*		*	*	
KEBS	3 Ind. Cs	1 Cs + reference generator				*	*	

Table 4. Equipment and source of UTC(*k*) of the laboratories contributing to TAI in 2016 (Cont.)

Ind. Cs: industrial caesium standard
Ind. Rb: industrial rubidium standard
Lab. Cs: laboratory caesium standard
Lab. Rb: laboratory rubidium 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*)	UTCr	Time Links			
					GPS		GLONASS	Two-Way
					SF	DF		
KIM (a)	2 Ind. Cs	1 Cs				*	*	
KRIS (a)	5 Ind. Cs 4 H-masers	1 H-maser + microphase-stepper	*	*	*	*	*	*
KZ	5 Ind. Cs (6)	1 Cs + microphase-stepper				*	*	
LT	2 Ind. Cs	1 Cs		*	*			
MASM	1 Ind. Cs	1 Cs + time/frequency steering				*	*	
MBM	1 Ind. Cs	1 Cs			*			
MIKE	1 Ind. Cs 4 H-masers	1 H-maser + microphase-stepper		*	*	*		
MKEH	1 Ind. Cs	1 Cs			*			
MSL	2 Ind. Cs	1 Cs + microphase-stepper		*		*		
MTC	11 Ind. Cs	1 Cs		*	*	*	*	

Table 4. Equipment and source of UTC(*k*) of the laboratories contributing to TAI in 2016 (Cont.)

Ind. Cs: industrial caesium standard
Ind. Rb: industrial rubidium standard
Lab. Cs: laboratory caesium standard
Lab. Rb: laboratory rubidium 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*)	UTCr	Time Links			
					GPS		GLONASS	Two-Way
					SF	DF		
NAO	4 Ind. Cs 1 H-maser	1 Cs + microphase-stepper		*	*			
NICT	33 Ind. Cs 9 H-masers (7) 1 Lab. Cs	1 H-maser (8) + microphase-stepper	* (9)	*	*	*		*
NIM	7 Ind. Cs 6 H-masers 1 Lab. Cs	1 H-maser + microphase-stepper		*	*	*	*	*
NIMB	2 Ind. Cs	1 Cs		*	*	*		
NIMT	2 Ind. Cs	1 Cs + microphase-stepper		*	*	*		
NIS	2 Ind. Cs	1 Cs			*	*	*	
NIST	2 Lab. Cs 15 Ind. Cs 13 H-masers	6 Cs 8 H-masers + microphase-stepper	*	*		*		*
NMIJ	3 Ind. Cs 1 Lab. Cs 4 H-masers	1 H-maser + microphase-stepper		*	*	*		*
NMLS (a)	2 Ind. Cs	1 Cs		*		*		
NPL	2 Ind. Cs 5 H-masers	1 H-maser			*	*		*

Table 4. Equipment and source of UTC(*k*) of the laboratories contributing to TAI in 2016 (Cont.)

Ind. Cs: industrial caesium standard
Ind. Rb: industrial rubidium standard
Lab. Cs: laboratory caesium standard
Lab. Rb: laboratory rubidium 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*)	UTCr	Time Links			
					GPS		GLONASS	Two-Way
					SF	DF		
NPLI	5 Ind. Cs 1 H-maser	1 H-maser + microphase-stepper		*		*		*
NRC	6 Ind. Cs (10) 1 H-masers	1 Cs + microphase-stepper	*	*		*		
NRL	9 Ind. Cs 9 H-masers	1 H-maser + frequency synthesizer steered to UTC(NRL)		*		*		
NTSC	24 Ind. Cs 4 H-masers	1 H-maser + microphase-stepper	*	*	*	*		*
ONBA	2 Ind. Cs	1 Cs			*			
ONRJ	7 Ind. Cs 2 H-masers	7 Cs 2 H-masers + frequency offset generator	* (11)	*		*	*	
OP	5 Ind. Cs 3 Lab. Cs 1 Lab. Rb 4 H-masers	1 H-maser (12) + microphase-stepper	* (13)	*	*	*	*	*
ORB	4 Ind. Cs 1 H-masers	1 H-maser or 1 Cs (14) + femtostepper		*		*	*	
PL	13 Ind. Cs 4 H-masers	1 Cs (15) + femtostepper	* (16)	*	*	*	*	
PTB	3 Ind. Cs 4 Lab. Cs (17) 4 H-masers	1 H-maser (18) + microphase-stepper	* (19)	*	*	*	*	*

Table 4. Equipment and source of UTC(*k*) of the laboratories contributing to TAI in 2016 (Cont.)

Ind. Cs: industrial caesium standard
Ind. Rb: industrial rubidium standard
Lab. Cs: laboratory caesium standard
Lab. Rb: laboratory rubidium 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*)	UTCr	Time Links			
					GPS		GLONASS	Two-Way
					SF	DF		
ROA	6 Ind. Cs (20) 2 H-maser	1 H-maser (21) + frequency synthesizer steered to UTC(ROA)		*		*	*	*
SASO	5 Ind. Cs	1 Cs		*		*	*	
SCL	2 Ind. Cs	1 Cs + microphase-stepper		*	*			
SG	5 Ind. Cs 1 H-maser	1 H-maser + microphase-stepper	*	*		*	*	
SIQ	1 Ind. Cs	1 Cs				*	*	
SMD	3 Ind. Cs 1 H-maser	1 Cs + microphase-stepper		*		*	*	
SMU	1 Ind. Cs	1 Cs + output frequency steering			*	*	*	
SP	19 Ind. Cs (22) 9 H-masers	1 H-maser + microphase-stepper		*		*	*	*
SU	2 Lab. Cs (23) 9-12 H-masers	6-9 H-masers (24)	* (25)	*		*	*	*
TL	10 Ind. Cs 4 H-masers	1 H-maser + microphase-stepper	* (26)	*		*		*

Table 4. Equipment and source of UTC(*k*) of the laboratories contributing to TAI in 2016 (Cont.)

Ind. Cs: industrial caesium standard
Ind. Rb: industrial rubidium standard
Lab. Cs: laboratory caesium standard
Lab. Rb: laboratory rubidium 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*)	UTCr	Time Links			
					GPS		GLONASS	Two-Way
					SF	DF		
TP	5 Ind. Cs	1 Cs + output frequency steering				*	*	
UA (a)	1 Ind. Cs 3 H-masers	3 H-masers + microphase-stepper			*	*	*	
UME	5 Ind. Cs	1 Cs		*		*	*	
USNO (a)	81 Ind. Cs 33 H-masers 6 Lab. Rb	1 H-maser (27) + frequency synthesizer steered to UTC(USNO)	* (27)	*	*	*		*
VMI	3 Ind. Cs	1 Cs + microphase-stepper				*		
VSL	4 Ind. Cs	1 Cs + microphase-stepper		*		*		*
ZA	6 Ind. Cs 1 H-maser	1 H-maser				*	*	

Notes

(a)		Information based on the Annual Report for 2015, not confirmed by the laboratory.
(1)		When several clocks are indicated as a 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. TA(PL) laboratories are linked via MC GPS-CV and/or two-directional optical fibre connections. Optical Fibre Link *UTC*(*AOS*)-*UTC*(*PL*) is 420 km long.
(3)	CH	All the standards are located in Bern at METAS (Swiss Federal Institute 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)	CNES	All the standards are located in Toulouse at CNES (French Space Agency). UTC(CNES) is defined in real time by a H-Maser steered to an ensemble of industrial high-performance Cs clocks. UTC(CNES) is steered monthly on UTC.
(5)	JATC	The standards are located at National Time Service Centre (NTSC). The link between UTC(JATC) and UTC(NTSC) is obtained by internal connection.
(6)	KZ	The standards are located as follows: *Kazakhstan Institute for Metrology (Astana) — 4 Cs *South-Kazakhstan branch of Kazakhstan Institute for Metrology (Almaty) — 1 Cs
(7)	NICT	The standards are located as follows: * Koganei Headquarters — 20 Cs, 7 H-masers * Ohtakadoya-yama LF station — 4 Cs * Hagane-yama LF station — 5 Cs * Advanced ICT Research Institute in Kobe — 5 Cs, 2 H-masers
(8)	NICT	The NICT atomic timescale TA(NICT) is computed from the weighted average of 18 commercial Cs clocks at the Koganei HQ.
(9)	NICT	UTC(NICT) is generated from the output of a hydrogen maser, steered to TA(NICT) regularly, and steered to UTC if necessary.
(10)	NRC	The standards are located as follows: * Measurement Science and Standards (Ottawa) — 4 Cs, 1 H-maser * CHU Time signal radio station (Ottawa) — 2 Cs
(11)	ONRJ	The Brazilian atomic time scale TA(ONRJ) is computed by the National Observatory Time Service Division in Rio de Janeiro with data from 7 industrial caesium clocks and 2 hydrogen masers.
(12)	OP	Since MJD 56218 UTC(OP) is based on the output signal of a H-maser frequency steered towards UTC using the LNE-SYRTE fountains calibrations.

Notes (Cont.)

(13) OP The French atomic time scale TA(F) is computed by the LNE-SYRTE with data from up to 21 industrial caesium clocks in 2016 located as follows :

* Centre Electronique de l'Armement (CELAR, Rennes)	1 Cs
* Centre National d'Etudes Spatiales (CNES, Toulouse)	3 Cs
* France Telecom Recherche et Developpement (Lannion)	2 Cs
* Observatoire de la Côte d'Azur (OCA, Grasse)	2 Cs
* Observatoire de Paris (LNE-SYRTE, Paris)	5 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 is steered using the LNE-SYRTE PFS data. The difference TA(F) – UTC(OP) is published in the OP Time Service Bulletin.

(14) ORB The source of UTC(ORB) is generated by a Cs clock since July 2013.

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

(16) PL The Polish atomic timescale TA(PL) is computed by the AOS and GUM with data from 15 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 (Orange Polska S.A., Warsaw)	3 Cs
* Military Primary Standards Laboratory (CWOM, Warsaw and Poznan)	3 Cs
* Poznan Supercomputing and Networking Center (PSNC, Poznan)	1 H-maser

and additionally

* Time and Frequency Standard Laboratory of the Center for Physical Science and Technology (FTMC), a guest laboratory from Lithuania (LT, Vilnius, Lithuania)	2 Cs

All laboratories are linked via MC GPS-CV and/or two-directional optical fibre connections.

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

(18) PTB UTC(PTB) is based on the output of an active hydrogen maser steered in frequency since MJD 55224 (February 2010).

(19) PTB Since MJD 56079 0:00 UTC TA(PTB) has been generated from an active hydrogen maser, steered in frequency so as to follow PTB caesium fountains as close as possible. The deviation *d* between the fountains and the TAI second is not taken into account.
TAI-TA(PTB) got an initial arbitrary offset from TAI without continuity to the data reported in previous months.

Notes (Cont.)

(20)	ROA	The standards are located as follows:	
		* Real Observatorio de la Armada en San Fernando	5 Cs, 1 H-maser
		* Centro Español de Metrología	1 Cs
		* Added in October 2016, not yet declared to the BIPM	1 H-maser
(21)	ROA	Since March 2009, UTC(ROA) is defined in real time by a hydrogen maser, steered to the paper time scale UTC(ROA), which is defined as a weighted average of all the clocks, steered to UTC.	
(22)	SP	The standards are located as follows (at the end of 2016):	
		* SP Technical Research Institute of Sweden (SP, Borås)	4 Cs, 2 H-masers
		* SP Technical Research Institute of Sweden (SP, Stockholm)	6 Cs, 2 H-masers
		* STUPI AB (Stockholm)	8 Cs, 3 H-masers
		* Onsala Space Observatory (Onsala)	1 Cs, 2 H-masers
(23)	SU	CsFO1 and CsFO2 are fountain frequency standards using laser cooled caesium atoms. CsFO2 operated as frequency standard almost regularly and contributed to TAI.	
(24)	SU	Laboratory computes UTC(SU) as a software clock, steered to UTC.	
(25)	SU	TA(SU) is generated from an ensemble of active hydrogen masers, software steered in frequency so as to follow SU caesium fountains as close as possible. The deviation *d* between the fountains and the TAI second is not taken into account. TAI-TA(SU) has an initial arbitrary offset from TAI.	
(26)	TL	TA(TL) is generated from a 10-caesium-clock ensemble.	
(27)	USNO	The time scales A.1(MEAN) and UTC(USNO) are computed by USNO. They are determined by a weighted average of Cs clocks, hydrogen masers, and rubidium fountains located at the USNO. A.1(MEAN) is a free atomic time scale, while UTC(USNO) is steered to UTC. Included in the total number of USNO atomic standards are the clocks located at the USNO Alternate Master Clock in Colorado Springs, CO.	

Table 5. Differences between the normalized frequencies of EAL and TAI, up to March 2017

(File containing values since the beginning of the steering is available at ftp://62.161.69.5/pub/tai/scale/ealtai16.ar)

Date	MJD	$[f(EAL) - f(TAI)] \times 10^{-13}$
2010 Jan 28 - 2010 Feb 27	55224 - 55254	6.666
2010 Feb 27 - 2010 Mar 29	55254 - 55284	6.661
2010 Mar 29 - 2010 Apr 28	55284 - 55314	6.656
2010 APR 28 - 2010 MAY 28	55314 - 55344	6.651
2010 MAY 28 - 2010 JUN 27	55344 - 55374	6.645
2010 JUN 27 - 2010 JUL 27	55374 - 55404	6.639
2010 JUL 27 - 2010 AUG 26	55404 - 55434	6.633
2010 AUG 26 - 2010 SEP 30	55434 - 55469	6.626
2010 SEP 30 - 2010 OCT 30	55469 - 55499	6.619
2010 OCT 30 - 2010 NOV 29	55499 - 55529	6.612
2010 NOV 29 - 2010 DEC 29	55529 - 55559	6.605
2010 DEC 29 - 2011 JAN 28	55559 - 55589	6.598
2011 JAN 28 - 2011 FEB 27	55589 - 55619	6.591
2011 FEB 27 - 2011 MAR 29	55619 - 55649	6.584
2011 MAR 29 - 2011 APR 28	55649 - 55679	6.577
2011 APR 28 - 2011 MAY 28	55679 - 55709	6.570
2011 MAY 28 - 2011 JUN 27	55709 - 55739	6.563
2011 JUN 27 - 2011 JUL 27	55739 - 55769	6.556
2011 JUL 27 - 2011 AUG 31	55769 - 55804	6.551
2011 AUG 31 - 2011 SEP 30	55804 - 55834	6.546
2011 SEP 30 - 2011 OCT 30	55834 - 55864	6.541
2011 OCT 30 - 2011 NOV 29	55864 - 55894	6.536
2011 NOV 29 - 2011 DEC 29	55894 - 55924	6.531
2011 DEC 29 - 2012 JAN 28	55924 - 55954	6.526
2012 JAN 28 - 2012 FEB 27	55954 - 55984	6.521
2012 FEB 27 - 2012 MAR 28	55984 - 56014	6.516
2012 MAR 28 - 2012 APR 27	56014 - 56044	6.511
2012 APR 27 - 2012 MAY 27	56044 - 56074	6.506
2012 MAY 27 - 2012 JUN 26	56074 - 56104	6.501
2012 JUN 26 - 2012 JUL 31	56104 - 56139	6.496
2012 JUL 31 - 2012 AUG 30	56139 - 56169	6.491
2012 AUG 30 - 2012 SEP 29	56169 - 56199	6.486
2012 SEP 29 - 2016 NOV 27	56199 - 57719	6.483
2016 NOV 27 - 2016 DEC 27	57719 - 57749	6.486
2016 DEC 27 - 2017 JAN 31	57749 - 57784	6.489
2017 JAN 31 - 2017 FEB 25	57784 - 57809	6.492
2017 FEB 25 - 2017 MAR 27	57809 - 57839	6.495

As the time scales UTC and TAI differ by an integral number of seconds(see Tables 1 and 2), UTC is necessarily subjected to the same intentional frequency adjustment as TAI.

Table 6. Measurements of the duration of the TAI scale interval

(File available on ftp://ftp2.bipm.org/pub/tai/scale/UTAI/utai16.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 Table 6A, *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-CsF2, NIM5, NIST-F1, PTB-CS1, PTB-CS2, PTB-CSF1, PTB-CSF2, SU-CsFO2 and SYRTE-FO2 reported on the year 2016.
In Table 6B, *d* is obtained on the given periods of estimation by comparison of the TAI frequency with that of the individual secondary frequency standard (SFS) SYRTE-FORb reported on the year 2016.
Previous calibrations are available in the successive annual reports of the BIPM Time Section volumes 1 to 18 and in the BIPM Annual Report on Time Activities volumes 1 to 10 (web only since volume 4 for 2009).

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 addition, Table 6B includes the following information:
u_{SRep} is the recommended uncertainty of the secondary representation of the second, as specified in the CIPM Recommendation identified under Ref(u_S).

In these tables, 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 and secondary standards reported in 2016 are indicated below. Reports of individual evaluations may be found at ftp://ftp2.bipm.org/pub/tai/data/PFS_reports. Ref(u_B) is a reference giving information on the value of u_B as stated in the 2016 reports, 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/ 10^{-15}	u_B(Ref)/10^{-15}	Ref(u_B)	Comparison with	Number/typical duration of comp.
IT-CsF2	Fountain	(0.17 to 0.48)	0.18	[1]	H maser	7 / 10 d to 35 d
NIM5	Fountain	1.4	1.4	[2]	H maser	4 / 20 d to 20 d
NIST-F1	Fountain	0.31	0.35	[3]	H maser	1 / 20 d
PTB-CS1	Beam /Mag.	8	8.	[4]	TAI	12 / 30 d to 35 d
PTB-CS2	Beam /Mag.	12	12.	[5]	TAI	12 / 30 d to 35 d
PTB-CSF1	Fountain	0.7 then (0.35-0.37)	1.4	[6]	H maser	6 / 15 d to 35 d
PTB-CSF2	Fountain	(0.20 to 0.22)	0.41	[7]	H maser	10 / 10 d to 30 d
SU-CsFO2	Fountain	0.25	0.50	[8]	H maser	4 / 15 d to 30 d
SYRTE-FO2	Fountain	(0.25 to 0.35)	0.23	[9]	H maser	12 / 10 d to 30 d

Secondary Standard	Type	Type B std. uncertainty/ 10^{-15}	u_B(Ref)/10^{-15}	Ref(u_B)	Comparison with	Number/typical duration of comp.
SYRTE-FORb	Fountain	(0.28 to 0.35)	0.32	[10]	H maser	13 / 10 d to 35 d

More detailed information on the characteristics and operation of individual PFS and SFS may be found in the annexes supplied by the individual laboratories.

Table 6A. Measurements of the duration of the TAI scale interval by Primary Frequency Standards

Standard	Period of estimation		$d/10^{-15}$	$u_A/10^{-15}$	$u_B/10^{-15}$	$u_{link/lab}/10^{-15}$	$u_{link/TAI}/10^{-15}$	$u/10^{-15}$	Note
IT-CsF2	57404	57414	-0.23	0.61	0.17	0.10	0.53	0.83	
IT-CsF2	57414	57444	-0.87	0.45	0.17	0.13	0.20	0.54	
IT-CsF2	57444	57474	-0.62	0.34	0.17	0.13	0.20	0.45	
IT-CsF2	57474	57499	-1.13	0.34	0.17	0.14	0.23	0.47	
IT-CsF2	57504	57539	-0.94	0.31	0.48	0.10	0.17	0.60	
IT-CsF2	57639	57659	-0.60	0.34	0.17	0.22	0.28	0.52	
IT-CsF2	57659	57689	-0.80	0.43	0.17	0.22	0.20	0.55	
NIM5	57459	57479	-1.05	0.80	1.40	0.20	0.66	1.75	
NIM5	57604	57629	-0.53	0.50	1.40	0.20	0.23	1.52	
NIM5	57634	57654	0.68	0.50	1.40	0.20	0.28	1.53	
NIM5	57664	57684	-0.94	0.60	1.40	0.20	0.28	1.56	
NIST-F1	57419	57439	0.06	0.23	0.31	0.20	0.28	0.52	
PTB-CS1	57384	57414	-12.55	6.00	8.00	0.00	0.07	10.00	(1)
PTB-CS1	57414	57444	-14.41	6.00	8.00	0.00	0.07	10.00	
PTB-CS1	57444	57474	-2.14	6.00	8.00	0.00	0.07	10.00	
PTB-CS1	57474	57504	-7.35	6.00	8.00	0.00	0.07	10.00	
PTB-CS1	57504	57539	-6.46	6.00	8.00	0.00	0.06	10.00	
PTB-CS1	57539	57569	-8.04	6.00	8.00	0.00	0.07	10.00	
PTB-CS1	57569	57599	-6.61	6.00	8.00	0.00	0.07	10.00	
PTB-CS1	57599	57629	-7.42	6.00	8.00	0.00	0.07	10.00	
PTB-CS1	57629	57659	-14.21	6.00	8.00	0.00	0.10	10.00	
PTB-CS1	57659	57689	-20.97	6.00	8.00	0.00	0.13	10.00	
PTB-CS1	57689	57719	-9.16	6.00	8.00	0.00	0.13	10.00	
PTB-CS1	57719	57749	-21.05	6.00	8.00	0.00	0.13	10.00	
PTB-CS2	57384	57414	0.68	3.00	12.00	0.00	0.07	12.37	(1)
PTB-CS2	57414	57444	-2.22	3.00	12.00	0.00	0.07	12.37	
PTB-CS2	57444	57474	-1.02	3.00	12.00	0.00	0.07	12.37	
PTB-CS2	57474	57504	-8.54	3.00	12.00	0.00	0.07	12.37	
PTB-CS2	57504	57539	-5.37	3.00	12.00	0.00	0.06	12.37	
PTB-CS2	57539	57569	-9.51	3.00	12.00	0.00	0.07	12.37	
PTB-CS2	57569	57599	-6.03	3.00	12.00	0.00	0.07	12.37	
PTB-CS2	57599	57629	-4.95	3.00	12.00	0.00	0.07	12.37	
PTB-CS2	57629	57659	-5.42	3.00	12.00	0.00	0.10	12.37	
PTB-CS2	57659	57689	-8.74	3.00	12.00	0.00	0.13	12.37	
PTB-CS2	57689	57719	-4.22	3.00	12.00	0.00	0.13	12.37	
PTB-CS2	57719	57749	-4.42	3.00	12.00	0.00	0.13	12.37	
PTB-CSF1	57369	57384	-0.25	0.10	0.70	0.01	0.12	0.72	
PTB-CSF1	57384	57404	-0.46	0.09	0.70	0.02	0.09	0.71	
PTB-CSF1	57474	57504	-1.02	0.08	0.37	0.08	0.07	0.39	
PTB-CSF1	57564	57599	-0.40	0.06	0.35	0.05	0.06	0.36	
PTB-CSF1	57599	57629	-0.41	0.08	0.35	0.10	0.07	0.38	
PTB-CSF1	57699	57714	-1.95	0.12	0.35	0.05	0.24	0.45	
PTB-CSF2	57379	57389	-0.52	0.21	0.22	0.07	0.18	0.36	
PTB-CSF2	57459	57474	-1.21	0.15	0.20	0.02	0.12	0.28	
PTB-CSF2	57474	57504	-1.38	0.12	0.20	0.13	0.07	0.27	
PTB-CSF2	57539	57569	-0.58	0.12	0.20	0.04	0.07	0.25	
PTB-CSF2	57579	57599	-0.75	0.12	0.20	0.02	0.09	0.25	
PTB-CSF2	57599	57629	-0.89	0.13	0.20	0.07	0.07	0.26	
PTB-CSF2	57634	57649	-0.88	0.13	0.20	0.03	0.24	0.34	
PTB-CSF2	57659	57689	-1.51	0.13	0.20	0.04	0.13	0.27	
PTB-CSF2	57699	57719	-1.54	0.26	0.20	0.07	0.19	0.38	
PTB-CSF2	57719	57749	-1.40	0.12	0.20	0.04	0.13	0.27	
SU-CsFO2	57384	57414	-0.05	0.27	0.25	0.11	0.59	0.70	
SU-CsFO2	57444	57459	0.22	0.40	0.25	0.11	1.10	1.20	
SU-CsFO2	57474	57504	0.49	0.40	0.25	0.11	0.59	0.76	
SU-CsFO2	57509	57529	-0.75	0.27	0.25	0.11	0.85	0.93	

Table 6A. (Cont.)

Standard	Period of estimation		$d/10^{-15}$	$u_A/10^{-15}$	$u_B/10^{-15}$	$u_{link/lab}/10^{-15}$	$u_{link/TAI}/10^{-15}$	$u/10^{-15}$
SYRTE-FO2	57394	57414	-0.48	0.25	0.35	0.12	0.28	0.53
SYRTE-FO2	57414	57424	-0.23	0.33	0.34	0.10	0.53	0.72
SYRTE-FO2	57459	57474	-1.58	0.30	0.29	0.11	0.37	0.57
SYRTE-FO2	57474	57504	-1.09	0.35	0.26	0.10	0.20	0.49
SYRTE-FO2	57509	57539	-1.21	0.35	0.27	0.10	0.20	0.49
SYRTE-FO2	57539	57569	-0.19	0.20	0.27	0.10	0.20	0.40
SYRTE-FO2	57569	57599	-0.15	0.26	0.26	0.12	0.20	0.43
SYRTE-FO2	57599	57629	-0.86	0.20	0.25	0.10	0.20	0.39
SYRTE-FO2	57629	57659	-0.97	0.27	0.28	0.11	0.20	0.45
SYRTE-FO2	57689	57709	-1.71	0.25	0.29	0.12	0.28	0.49
SYRTE-FO2	57709	57719	-1.18	0.30	0.29	0.14	0.53	0.69
SYRTE-FO2	57719	57749	-1.12	0.30	0.34	0.11	0.20	0.51

Note:
(1) Continuously operating as a clock participating in TAI.

Table 6B. Measurements of the duration of the TAI scale interval by Secondary Frequency Standards

Standard	Period of estimation		$d/10^{-15}$	$u_A/10^{-15}$	$u_B/10^{-15}$	$u_{link/lab}/10^{-15}$	$u_{link/TAI}/10^{-15}$	$u/10^{-15}$	u_{SRep}	Ref(u_s)
SYRTE-FORb	57389	57409	-0.22	0.20	0.35	0.11	0.28	0.50	1.3	[11]
SYRTE-FORb	57414	57444	-0.28	0.25	0.29	0.11	0.20	0.44	1.3	[11]
SYRTE-FORb	57444	57474	-0.16	0.20	0.28	0.13	0.20	0.42	0.7	[12]
SYRTE-FORb	57474	57504	-0.50	0.30	0.28	0.10	0.20	0.47	0.7	[12]
SYRTE-FORb	57504	57539	-0.23	0.20	0.28	0.10	0.17	0.40	0.7	[12]
SYRTE-FORb	57539	57569	0.02	0.20	0.28	0.10	0.20	0.41	0.7	[12]
SYRTE-FORb	57569	57599	-0.36	0.24	0.28	0.11	0.20	0.43	0.7	[12]
SYRTE-FORb	57599	57629	-0.04	0.20	0.30	0.10	0.20	0.42	0.7	[12]
SYRTE-FORb	57629	57659	-0.46	0.20	0.31	0.11	0.20	0.43	0.7	[12]
SYRTE-FORb	57659	57689	-0.80	0.20	0.28	0.10	0.20	0.41	0.7	[12]
SYRTE-FORb	57689	57709	-0.84	0.30	0.29	0.10	0.28	0.51	0.7	[12]
SYRTE-FORb	57709	57719	-1.16	0.30	0.29	0.15	0.53	0.69	0.7	[12]
SYRTE-FORb	57719	57749	-0.48	0.20	0.30	0.11	0.20	0.42	0.7	[12]

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Operation of IT-CsF2 in 2016

F. Levi and G.A. Costanzo

IT-CsF2 is the primary atomic frequency standard operated at INRIM. The frequency standard is based on a laser-cooled Cs fountain apparatus operating at cryogenic temperature (88.5K), in order to reduce the blackbody radiation shift. The formal evaluation of the frequency standard is published in [1], while TAI calibration data has been reported to the BIPM since the end of 2013 and is published in the *Circular T*. The accuracy evaluation of the PFS involves periodic checks and validations of the whole set of parameters affecting the standard frequency: i.e. Zeeman shift, spectral purity of the microwave synthesis chain, interaction region temperature, atomic density shift, gravitational potential, and laser and microwave leakage.

During 2016 we reported to the BIPM seven formal TAI evaluations of the standard hereafter summarized. The seven measurements have a duration ranging from 10 to 35 days with unwanted dead times ranging from 3 % to 20 % over the various evaluation periods. The total operating time of IT-CsF2 as PFS during 2016 was 180 days.

Circ T	Period	days	ITCsF2-d (10^{-15})	uA (10^{-15})	uB (10^{-15})	Ul/Lab (10^{-15})	Ul/Tai (10^{-15})	u (10^{-15})
337	57404 57414	10	-0.23	0.61	0.17	0.10	0.53	0.83
338	57414 57444	30	-0.87	0.23	0.31	0.20	0.28	0.52
339	57444 57474	30	-0.62	0.34	0.17	0.13	0.20	0.45
340	57474 57499	25	-1.13	0.34	0.17	0.14	0.23	0.47
341	57504 57539	35	-0.94	0.31	0.48	0.10	0.17	0.60
345	57639 57659	20	-0.60	0.34	0.17	0.22	0.28	0.52
346	57659 57689	30	-0.80	0.43	0.17	0.22	0.20	0.55

The accuracy of ITCsF2 is nearly the same that was reported in [1] and it is summarized in the following table. It is worth mentioning that the statistical uncertainty associated with the atomic density is obtained with long measurement time and thus varies from case to case according to the available set of data. Typically the low density uncertainty can reach ~2×10^{-16}.

Typical accuracy evaluation

Physical effect	**Bias (10^{-16})**	**Uncert. (10^{-16})**
Zeeman effect	1074.9	0.8
Blackbody radiation	-1.45	0.12
Gravitational redshift	260.4	0.1
Microwave leakage	-1.2	1.4
DCP	-	0.2
2^{nd} order cavity pulling	-	0.3
Background gas	-	0.5
Total Type B**	**1332.6**	**1.7**
Atomic density (typical LD)*	-6.3	1.9
Total	**1326.3**	**2.5**

[1] Accuracy evaluation of ITCsF2: a nitrogen cooled caesium fountain, F. Levi, D. Calonico, C.E. Calosso, A. Godone, S. Micalizio and G.A. Costanzo; *Metrologia*, (2014), **51**, 270–284

Evaluations of NIM5 for BIPM Annual Report 2016

1. Primary clocks

1.1 Fountain clock NIM5

The NIM5 Cs fountain primary frequency standard was reported to the BIPM four times in 2016 during MJD 57459-57479, 57604-57629, 57634-57654 and 57664-57684. There is no big modification of NIM5. A typical fractional frequency instability of 3 × 10^{-13} $(\tau/s)^{-1/2}$ was obtained when running at high atom density. A typical Type B fractional frequency uncertainty is 1.4 × 10^{-15} [1]. The results are summarized in the following table.

Table 1 NIM5 evaluation results in 2016

MJD periods	$d/10^{-15}$	$u_A/10^{-15}$	$u_B/10^{-15}$	$U_{l/lab}/10^{-15}$	$U_{l/TAI}/10^{-15}$	$u/10^{-15}$
57459.0-57479.0	-1.05	0.80	1.40	0.20	0.66	1.75
57604.0-57629.0	-0.53	0.50	1.40	0.20	0.23	1.52
57634.0-57654.0	0.68	0.50	1.40	0.20	0.28	1.53
57664.0-57684.0	-0.94	0.60	1.40	0.20	0.28	1.56

1.2 Research work on the new fountain NIM6

NIM6 fountain clock is under development [2]. The laser system and computer control system are completed, and atoms are collected in a 3D MOT and loaded into optical molasses in another chamber. The time of flight signal from optical molasses is obtained with a launching height of 810 mm. The new fountain is operated in a lab with temperature fluctuations less than 0.3 K, and no active temperature control system will be added outside the flight tube. Instead, an isothermal liner will be surrounded the flight tube. A 4-feeds Ramsey cavity with a loaded Q factor of about 16 000 was made, and a long copper tube is sat on the cavity to reduce the microwave leakage effect. The whole fountain system is under optimization and hopefully will be evaluated in 2017.

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Operation of the PTB primary clocks in 2016

PTB's primary clocks with a thermal beam

During 2016 PTB's primary clocks CS1 and CS2 were operated almost continuously. Time differences UTC(PTB) - clock in the standard ALGOS format were reported to BIPM, so that $u_{l/lab}$ is zero. The mean relative frequency offset y(CS1 – CS2) amounted to -5.41×10^{-15}, which is compliant with the stated u_B values [1,2].

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. Using a high-resolution phase comparator, the 5 MHz output signals of both clocks have been continuously compared to 5 MHz representing the rate of UTC(PTB) or of the back-up time scale. The signal is derived from an active hydrogen maser such that the comparisons reveal the unbiased instability of CS1 and CS2, respectively. Data analysis has been made based on several 15 to 20-day batches distributed during 2016.

CS1

The CS1 relative frequency instability $\sigma_y(\tau = 5000\ \mathrm{s})$ was found to vary between 83×10^{-15} and 98×10^{-15} during 2016, in reasonable agreement with the prediction based on the prevailing parameters beam flux, clock transition signal and line width. With reference to TAI, the standard deviation of *d*(CS1) (*Circular T* Section 3, 12 months) was 5.9×10^{-15}, still not at variance with the value $u_A(\tau = 30\ \mathrm{d}, \mathrm{CS1}) = 6 \times 10^{-15}$ stated in Circular T. The scatter of data is larger than in previous years, but no root cause can be given. During the year, two reversals of the beam direction were performed on CS1. No findings call for a modification of the previously stated relative frequency uncertainty u_B, which is 8×10^{-15} for CS1 [2].

CS2

The relative CS2 frequency instability of $\sigma_y(\tau = 5000\ \mathrm{s})$ was measured between 62×10^{-15} and 78×10^{-15} during 2016. The standard deviation of the 12 *d*-values reported in *Circular T* for 2016 amounted to 3.1×10^{-15}, in reasonable agreement with the uncertainty contribution $u_A(\tau = 30\ \mathrm{d}, \mathrm{CS2}) = 3 \times 10^{-15}$ reported in Circular T. During the year, three reversals of the beam direction were performed on CS2.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}. This value complies well with the mean offset between the CS2 seconds and the scale unit of TAI during 2016 of 5.0×10^{-15}.

PTB's primary caesium fountain clocks

In 2016 both caesium fountain clocks, CSF1 and CSF2, were operated regularly with a high duty cycle. The frequency synthesis for both fountains routinely makes use of an optically stabilized microwave oscillator [3-5] instead of employing quartz based microwave synthesis. For the generation of UTC(PTB) data of both fountains were routinely used for the steering of a hydrogen maser output frequency [6]. The steering data was selected based on the availability of the respective fountain data and the chosen priority.

Within the project "Times scales with optical clocks" (JRP55 ITOC) of the European Metrology Research Program, the gravity potential for CSF1 and CSF2 was newly determined with respect to the conventional zero potential $W_0(\mathrm{IERS2010}) = 62\ 636\ 856.0\ \mathrm{m^2 s^{-2}}$. As a result of these investigations the gravitational redshift corrections of CSF1 and CSF2 have been changed by about $+2 \times 10^{-17}$. While the uncertainties of the new gravitational redshift corrections are at the level of 2×10^{-18} only, an uncertainty of 3×10^{-17} is taken into account in the fountain uncertainty budgets, as at present there is no exact and internationally accepted geoid definition, i.e. agreed zero potential value.

In June 2015, CSF1 and CSF2 participated in a European clock comparison campaign, during which various optical and caesium fountain clocks were running simultaneously for a direct remote comparison over three weeks via Two-Way Satellite Time and Frequency Transfer and Global Positioning System frequency transfer. Additionally a comparison of the two PTB fountain clocks with two fountain clocks at the French LNE-SYRTE (Laboratoire National de métrologie et d'Essais - SYstème de Références Temps-Espace) has been performed via an optical fibre link. While the complex evaluation of the satellite based comparisons is still ongoing, the evaluation of the fibre link based comparison could recently be finalized [7]: As a result, the measured frequency differences for the four individual pairs of distant fountain clocks, were all in the range $\pm 3 \times 10^{-16}$, which is fully compatible with the combined uncertainties. These results support the performance and stated accuracies of the SYRTE's and PTB's fountain clocks.

CSF1

A detailed description of the PTB fountain CSF1 is given in Refs. [8] and [9]. Five measurements of the TAI scale unit of 15 (1×), 20 (1×), 30 (2×) and 35 (1×) days duration were performed in 2016 and reported to the BIPM. Due to the performance and reliability of the laser systems, dead times are normally kept between 3 % to 10 % of the nominal measurement duration. The resulting clock link uncertainty $u_{\mathrm{l/lab}}$ was typically 0.05×10^{-15}. The statistical uncertainty of CSF1 measurements was calculated with the assumption of white frequency noise during the measurement intervals. For the five TAI contributions in 2016 statistical uncertainties $u_{\mathrm{A}} < 0.2 \times 10^{-15}$ were achieved.

Since a new evaluation of the effect of cavity phase gradients was performed, the previous microwave power dependence entry in the uncertainty budget has become obsolete. A publication about the findings together with the results of a new evaluation of other significant physical effects is in preparation.

Below we compile typical frequency biases and type B uncertainties of CSF1, valid for TAI scale unit measurements in 2016.

Physical effect	Bias / 10^{-15}	Type B uncertainty / 10^{-15}
Quadratic Zeeman shift	107.77	0.10
Black body radiation shift	- 16.59	0.10
Cold collisions	0.73	0.17
Gravitational red shift	8.556	0.030
Cavity phase		0.10
Majorana transitions		0.10
Rabi and Ramsey pulling		0.10
Microwave leakage		0.10
Electronics		0.10
Light shift		0.10
Background gas collisions		0.10
Total type B uncertainty		0.35

CSF2

A detailed description of the PTB fountain CSF2 is given in Refs. [10] and [11]. Nine measurements of the TAI scale unit of 15 (2×), 20 (2×) and 30 (5×) days duration were performed and reported to the BIPM. The dead times of these measurements were in most cases below 10 %, so that the resulting clock link uncertainty $u_{l/lab}$ was typically 0.07×10^{-15} or below. The statistical uncertainty of CSF2 measurements was calculated with the assumption of white frequency noise for the total measurement intervals. For the TAI contributions in 2016 we arrived at statistical uncertainties u_A typically below 0.2×10^{-15}.

Since a cold atom beam source is now in routine operation for loading the optical molasses, the number of loaded and detected atoms in a given amount of time is significantly increased, and - benefitting from the low phase noise of the optically stabilized microwave oscillator – the frequency instability is reduced accordingly. The collisional shift is now evaluated online during a fountain measurement making use of a periodic variation of the atom density by the technique of rapid adiabatic passage [12]. In contrast to previous operation [10], the known factor of two between high and low cloud density, and the frequency values for both high and low density modes of operation are used to determine the collisional shift correction. The statistical uncertainty of this collisional shift correction is now part of the statistical uncertainty u_A of the frequency measurement. The systematic uncertainty of the collisional shift correction is calculated as 0.5 % of the collisional shift correction, as described in [12].

The utilization of cold atom beam loading necessitated new evaluations of the effects of cavity phase gradients and microwave lensing. Furthermore, the effects of the electronics and background gas collisions have been again evaluated, leading to reduced systematic uncertainties. Details will be published together with the new CSF1 evaluation results.

Below we compile typical frequency biases and type B uncertainties of CSF2, valid for TAI scale unit measurements in 2016.

Physical effect	Bias / 10^{-15}	Type B uncertainty / 10^{-15}
Quadratic Zeeman shift	100.237	0.010
Black body radiation shift	- 16.537	0.057
Cold collisions	- 8.32	0.04
Gravitational red shift	8.545	0.03
Cavity phase	0.032	0.15
Microwave lensing	0.067	0.034
Majorana transitions		0.0001
Rabi and Ramsey pulling		0.0013
Microwave leakage		0.10
Electronics		0.01
Light shift		0.001
Background gas collisions		0.01
Total type B uncertainty		0.20

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Operation of SU-CsFO2 in 2016

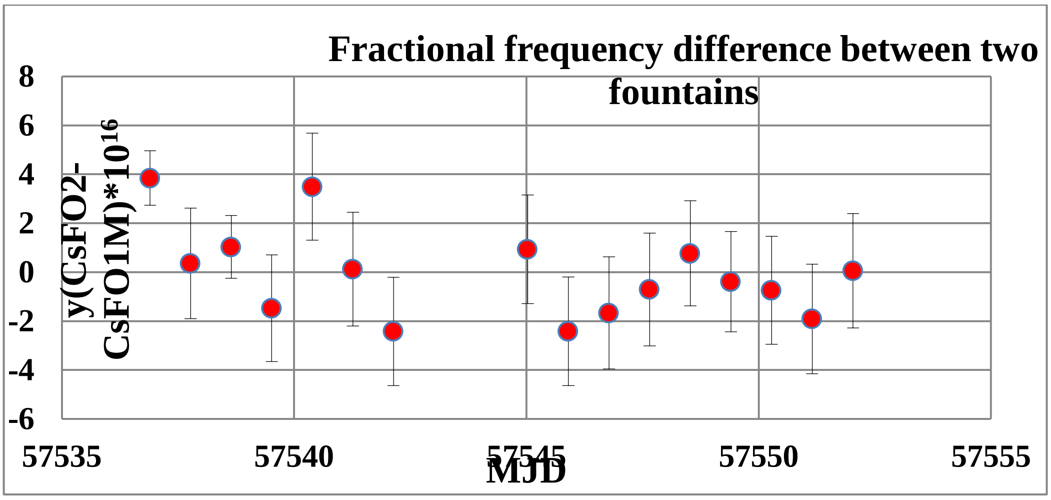
For the year 2016 the SU-CsFO2 results were reported to TAI four times.

To process the measurement data an algorithm was developed. The algorithm is based on the fountain noise model presented in [1]. According to the model every phenomenon produces first of all the noise. The following noises are considered: They are – photodetector noise, quantum projection noise, atomic temperature noise, microwave power (synthesizer) noise and spin-exchange noise.

The further matching of algorithm was performed [2]. For practical realization the measurements were grouped by five parts containing one hundred cycles each. Every part corresponds to its own number of atoms in a cycle. The number of atoms is changed by changing selecting cavity power. When we find the equation solutions we find the dispersions due to different kind of noises. In the solution there are dispersions with positive and negative signs. The negative sign means that dispersion and standard deviation that are used for frequency correction should have the negative sign.

Five equations are compiled for five fluxes of atoms. The solution of the equations enables us to determine the frequency corrections. As a result we have a meaning of fountain frequency, which is referenced to zero number of atoms. All shifts are taken into account via uncertainty u_a **and are not included in** uncertainty u_b.

In the picture below the difference in H-maser frequency evaluation by two fountains in one and the same time is presented.



The mean frequency difference for given interval is **y(CsFO2-CsFO1M)= -6.3E-17± 4.1E-16**

Its worth noting that CsFO1M has completely different design [3].

Reference

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Operation of the SYRTE fountain clocks in 2016

FO1 and FO2-Cs primary frequency standards

During 2016 we have transmitted to the BIPM 12 calibrations of the reference hydrogen maser performed by the SYRTE caesium fountain FO2-Cs, the Cs part of the dual fountain FO2 operating with both Cs and Rb.

The nominal operation of FO2-Cs was the same as in 2015. The microwave synthesizer of the fountain is referenced to the signal provided by a cryogenic sapphire oscillator (CSO) phase locked to a hydrogen maser taking benefit of the CSO ultra-low phase noise. The relative frequency instabilities are typically $\sigma_y(\tau) \sim 8.5 \times 10^{-14}\ \tau^{-1/2}$ for FO2Cs. This instability results from the combination of low and high atomic density operations required for the real time extrapolation of the cold collisions frequency shift and corresponds to the quantum projection noise. It is larger than in the past because of a progressive aging of the caesium cold atom source which is based on a 2DMOT. The linear Zeeman shift and the temperature around the interrogation zone are measured every ~1 hour in order to estimate the corresponding frequency shifts of the clock transition. The distributed cavity phase shift is verified from time to time with differential measurements alternating the cavity feeds.

Table 1 gives the typical uncertainty budget for the SYRTE caesium fountain FO2-Cs operating in 2016. The values and the uncertainties of the frequency shifts, which depend on the operating parameters, are updated for each TAI monthly contribution.

Fountain	FO2-Cs	
Physical origin	Correction	Uncertainty
2^{nd} order Zeeman	-1920.4	0.3
Blackbody Radiation	169.9	0.6
Cold Collisions + cavity pulling	97.4	1.6
Distributed cavity phase shift	-0.9	1.0
Microwave Leaks, spectral purity	0	<0.5
Ramsey & Rabi pulling	0	<0.1
Microwave lensing	-0.7	0.7
Second order Doppler	0	<0.1
Background gas collisions	0	<1
Red shift	-65.4	1
Total (1σ) uncertainty u_B		**2.6**

Table 1: Typical accuracy budgets for the SYRTE caesium fountain FO2-Cs similar to the one given in [1]. (Values given in units of 10^{-16})

The FO1 fountain did not contribute to TAI because of important maintenance operations since the end of 2015. The vacuum chamber was open in order to replace the caesium source and to remove the experimental setup used to evaluate the effect of the DC Stark shift. An important work was also performed on the optical bench and on the electronics in order to improve the long-term reliability of the clock. The accuracy budget of FO1 is under evaluation since several months. The first comparisons between FO1 and FO2 show an agreement at the 10^{-16} level. FO1 will restart to provide frequency calibrations in 2017.

FO2-Rb secondary frequency standard

During 2016, FO2-Rb calibration reports were regularly sent to the BIPM and included in *Circular T* as SYRTE-FORb, providing 13 calibration values of the reference H-maser which participated in the steering of TAI. An update of the recommended value was proposed at the last CCTF meeting (September 2015) and then officially adopted by the CIPM [3]. Accordingly, the reference value for the calibration reports of FO2-Rb was changed in March 2016.

The operation of FO2-Rb, which is the Rb part of the dual fountain FO2, is similar to that of the Cs fountains. FO2-Rb operates simultaneously to FO2-Cs, but with a slightly different launch velocity allowing for separated time of flights and selective detection of both atom clouds. The microwave synthesis of FO2-Rb is also based on the low noise signal provided by the CSO signal phase locked to the reference H-maser. The fountain stability is typically 5 × 10^{-14} $\tau^{-1/2}$ when combining low and high atomic density measurements. For each calibration, in addition to the type A uncertainty (typically 1 – 2 × 10^{-16}), the type B uncertainty (typically 3 × 10^{-16}), and the uncertainty due to the link between the reference maser and the standard (typically 1 – 2 × 10^{-16}), the recommended uncertainty of the secondary representation of the second is included. The latter was reduced from 1.3 × 10^{-15} [4] to 0.7 × 10^{-15} [3] according to the update of the recommended value in March 2016. Table 2 gives the typical type B uncertainty budget of FO2-Rb.

Fountain	FO2-Rb	
Physical origin	Correction	Uncertainty
2^{nd} order Zeeman	-3471.0	0.7
Blackbody Radiation	125.6	1.4
Cold Collisions + cavity pulling	4.0	1.2
First order Doppler	-0.35	1.0
Microwave Leaks, spectral purity	0	<0.5
Ramsey & Rabi pulling	0	<0.1
Microwave lensing	-0.7	0.7
Second order Doppler	0	<0.1
Background gas collisions	0	<1.0
Red shift	-65.4	1
Total (1σ) uncertainty u_B		**2.8**

Table 2: Typical type B uncertainty budget for the SYRTE FO2-Rb fountain similar to the one given in [2]. (Values given in units of 10^{-16})

Throughout 2016, the frequency calibrations of the reference H-maser by the SYRTE fountains were also used to produce a daily steering of the H-maser output signal for the generation of the French timescale UTC(OP) [5].

References

[1] J. Guéna, *et al*, *IEEE Trans. Ultr. Ferr. Freq. Contr.* **59** (3), (2012) 391-410
[2] J. Guéna, *et al*, *Metrologia* (2014) **51**, 108.
[3] CIPM Recommendation 2 (CI-2015) : Updates to the list of standard frequencies in Procès-Verbaux des Séances du Comité International des Poids et Mesures, 104th meeting (2015), 2016, 47 p.
[4] CIPM Recommendation 1 (CI-2013) : Updates to the list of standard frequencies in Procès-Verbaux des Séances du Comité International des Poids et Mesures, 102nd meeting (2013), 2014, 188 p.
[5] G. D. Rovera, *et al*, *Metrologia* (2016) **53,** s81-S88.

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

(File available at ftp://ftp2.bipm.org/pub/tai/scale/sitai16.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, IT-CSF2, NICT-CSF1, NIM5, NIST-F1, NIST-F2, NMIJ-F1, NPL-CSF2, NPLI-CSF1, PTB-CS1, PTB-CS2, PTB-CSF1, PTB-CSF2, SU-CSFO2, SYRTE-FO1, SYRTE-FO2, SYRTE-FOM and secondary frequency standard (SFS) SYRTE-FORb 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 $1.7 \times 10^{-15}/\sqrt{(\tau)}$ in 2013 and 2014 and $1.4 \times 10^{-15}/\sqrt{(\tau)}$ in 2015 and 2016, a flicker frequency noise 0.35×10^{-15} in 2013 and 2014 and 0.3×10^{-15} in 2015 and 2016 and a random walk frequency noise $0.4 \times 10^{-16} \times \sqrt{(\tau)}$ in 2013 and $0.2 \times 10^{-16} \times \sqrt{(\tau)}$ in 2014, 2015 and 2016, with τ in days. The relation between EAL and TAI is given in Table 5.

Month	Interval	$d/10^{-15}$	uncertainty/10^{-15}
Jan. 2014	56654-56684	+0.32	0.25
Feb. 2014	56684-56714	-0.27	0.20
Mar. 2014	56714-56744	-0.64	0.21
Apr. 2014	56744-56774	-0.49	0.19
May 2014	56774-56804	-0.79	0.20
Jun. 2014	56804-56834	-0.81	0.23
Jul. 2014	56834-56869	-0.27	0.22
Aug. 2014	56869-56899	+0.43	0.19
Sep. 2014	56899-56929	+0.21	0.18
Oct. 2014	56929-56959	+0.41	0.19
Nov. 2014	56959-56989	+0.71	0.25
Dec. 2014	56989-57019	+0.51	0.24
Jan. 2015	57019-57049	+0.15	0.26
Feb. 2015	57049-57079	-0.42	0.23
Mar. 2015	57079-57109	-0.13	0.23
Apr. 2015	57109-57139	-0.10	0.23
May 2015	57139-57169	+0.36	0.21
Jun. 2015	57169-57199	+0.84	0.17
Jul. 2015	57199-57234	+0.56	0.24
Aug. 2015	57234-57264	+0.36	0.26
Sep. 2015	57264-57294	+0.09	0.21
Oct. 2015	57294-57324	+0.29	0.24
Nov. 2015	57324-57354	+0.06	0.29
Dec. 2015	57354-57384	-0.11	0.28
Jan. 2016	57384-57414	-0.32	0.25
Feb. 2016	57414-57444	-0.37	0.26
Mar. 2016	57444-57474	-0.75	0.23
Apr. 2016	57474-57504	-1.05	0.17
May 2016	57504-57539	-0.85	0.26
Jun. 2016	57539-57569	-0.49	0.19
Jul. 2016	57569-57599	-0.52	0.20
Aug. 2016	57599-57629	-0.74	0.17
Sep. 2016	57629-57659	-0.84	0.22
Oct. 2016	57659-57689	-1.28	0.21
Nov. 2016	57689-57719	-1.48	0.22
Dec. 2016	57719-57749	-1.23	0.21

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. Starting on 1 January 1998, 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, including the relevant notes. 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.

For dates from January 1982 to December 1992 and from January 1993 to December 1998, the differences between TAI and the atomic scale maintained by each laboratory are available on the Scales page of the Time Department's FTP server including the relevant notes. The values of [*TAI - TA*(*lab*)] are given in yearly files. Note that the formats of the [TAI – TA(lab)] files are different in the two intervals.

Local representations of UTC

The time laboratories which submit data to the BIPM keep local representations of UTC. Starting on 1 January 1998, the computed differences between UTC and each local representation are available on the Publications page of the Time Department's FTP Server including the relevant notes. 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.

For dates from January 1990 to December 1992 and from January 1993 to December 1998, the computed differences between UTC and each local representation maintained by each laboratory are available on the Scales page of the Time Department's FTP server including the relevant notes. The values of [*UTC - UTC*(*lab*)] are given in yearly files. Note that the formats of the files [*UTC – UTC*(*lab*)] are different in the two intervals.

Starting on MJD 56467 daily values of the differences [*UTCr-UTC*(*lab*)] in nanoseconds are given in one file per laboratory. The results during the UTCr Pilot Experiment (February 2012-June 2013) are also available.

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

(File available at ftp://ftp2.bipm.org/pub/tai/other-products/utcgnss/utc-gnss)

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

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

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

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

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

From 1 January 2017, 0 h UTC, until further notice, $[UTC - GPS\ time] = -18\ \text{s} + C_0$,

Here C_0 is given at 0 h UTC every day.

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

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

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

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

From 1 January 2017, 0 h UTC, until further notice, $[TAI – UTC(USNO)\_GPS] = 37\ \text{s} + C_0'$

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

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

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

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

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

(File available at ftp://ftp2.bipm.org/pub/tai/other-products/utcgnss/utc-gnss)

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

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

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

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

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

From 1 January 2017, 0 h UTC, until further notice, [*TAI* - *GLONASS time*] = 37 s + C_1.

Here C_1 is given at 0 h UTC every day.

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

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

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

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

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

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

From 1 January 2017, 0 h UTC, until further notice, [*TAI – UTC(SU)_GLONASS*] = 37 s + C_1'

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

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

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

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

Table 8A. Rates relative to TAI of contributing clocks in 2016

(File available ftp://ftp2.bipm.org/pub/tai/scale/RTAI/rtai16.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 2016. For studies including the clock rates of previous years, corrections must be brought to the data published in the Annual Report for the previous years. These corrections are available from the Time department under request. Unit is ns/day,
"   -" denotes that the clock was not used, "*" denotes that the related rate was influenced by a frequency jump.

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

12	HEWLETT-PACKARD 5061A	25	HEWLETT_PACKARD 5062C
13	EBAUCHES, OSCILLATOM B5000	30	HEWLETT-PACKARD 5061B
14	HEWLETT-PACKARD 5061A OPT. 4	31	HEWLETT-PACKARD 5061B OPT. 4
16	OSCILLOQUARTZ 3200	34	H-P 5061A/B with 5071A tube
17	OSCILLOQUARTZ 3000	35	H-P/AGILENT/SYMMETRICOM/MICROSEMI 5071A High perf.
15	DATUM/SYMMETRICOM Cs III	36	H-P/AGILENT/SYMMETRICOM/MICROSEMI 5071A Low perf.
18	DATUM/SYMMETRICOM/MICROSEMI Cs 4000	4x	HYDROGEN MASERS
19	RHODES AND SCHWARZ XSC	50	FREQ. AND TIME SYSTEMS INC. 4065A
21	OSCILLOQUARTZ 3210	51	DATUM/SYMMETRICOM 4065 B
22	OSCILLOQUARTZ OSA 3230B	52	DATUM/SYMMETRICOM 4065 C
23	OSCILLOQUARTZ EUDICS 3020	53	DATUM/SYMMETRICOM/MICROSEMI 4310 B
24	OSCILLOQUARTZ OSA 3235B	9x	PRIMARY CLOCKS AND PROTOTYPES

Lab.	Clock	57414	57444	57474	57504	57539	57569	57599	57629	57659	57689	57719	57749
APL	35 904	34.51	32.59	31.84	32.58	33.28	32.52	33.33	34.26	34.59	34.78	34.20	34.17
APL	35 1264	19.45	18.96	19.48	19.56	18.97	-	-	-	-	-	-	-
APL	35 1791	0.46	1.31	1.35	1.93	0.52	1.76	1.42	1.55	1.38	2.33	2.06	1.95
APL	40 3107	35.78	35.89	36.12	36.34	36.56	36.85	37.07	37.31	37.61	37.73	38.09	38.28
APL	40 3108	522.15	524.69	527.35	529.98	532.74	535.56	538.19	540.84	543.51	545.90	548.49	551.00
APL	40 3109	26.90	26.58	26.36	26.09	25.78	25.51	25.23	25.00	24.84	24.43	24.24	24.07
AUS	36 299	15.55	14.39	14.56	14.56	14.83	15.15	15.22	13.81	14.00	15.95	16.49	15.66
AUS	36 340	0.38	0.85	1.93	2.53	2.14	3.11	2.85	1.51	2.83	4.28	3.09	2.03
AUS	36 654	4.35	3.65	4.56	3.73	4.57	2.71	3.92	3.31	4.10	-	1.19	1.20
AUS	36 1141	14.38	9.39	15.76	16.29	14.94	13.95	14.22	14.04	12.03	10.58	9.16	16.83

Table 8A. (Cont.)

Lab.	Clock	57414	57444	57474	57504	57539	57569	57599	57629	57659	57689	57719	57749
AUS	36 2269	28.54*	26.61*	28.35*	28.22*	27.80*	28.27*	29.41*	29.06*	28.95*	-	-	-1.74
BEV	35 1793	-1.33*	-0.78*	2.45*	0.43*	-0.26*	-1.26*	-1.63*	-0.89*	-0.81*	-0.62*	-1.01*	0.19
BEV	35 3009	0.15	0.15	0.35	-0.15	0.10	0.66	0.63	1.46	0.74	0.97	1.38	1.22
BEV	40 3452	-70.89*	-66.35*	-61.85*	-57.23*	-52.76*	-48.96*	-45.05*	-41.02*	-36.49*	-31.35*	-26.22	-19.27
BIM	18 8058	6.92	2.94	4.36	6.21	5.83	6.49	5.72	-	-	6.21	3.66	-
BY	40 4227	-5.01*	-5.44*	-7.82*	-5.50*	-2.01	-0.68	0.95	-	2.20	2.18	10.16	1.12
BY	40 4229	19.90*	16.17*	14.76*	15.16*	10.00	10.66	11.95	-	17.94	17.06	19.19	16.78
BY	40 4278	-91.37*	-29.82	-4.78	-6.00	-5.84	-1.57	-3.29	-	0.22	20.24	28.10	26.67
CH	24 105	45.94	49.72	53.01	52.51	54.07	62.51	64.77	68.44	70.12	72.56	73.56	72.36
CH	35 2117	1.67	2.10	2.62	2.27	1.74	2.22	2.77	2.79	1.36	2.67	1.91	2.05
CH	35 2743	-14.76	-13.60	-13.08	-13.38	-13.21	-14.33	-12.40	-12.51	-10.82	-12.01	-10.68	-10.31
CH	40 5701	-2.20	-2.41	-2.61	-3.06	-3.24	-3.42	-3.84	-4.06	-3.93	-3.94	-3.90	-4.06
CH	40 5702	28.61	30.02	31.44	33.23	35.10	36.90	38.93	40.70	41.81	43.09	44.02	45.01
CNM	35 2708	-8.10	-9.50	-8.38	-8.31	-8.92	-8.50	-8.56	-9.16	-9.25	-9.56	-9.20	-9.43
CNM	35 2709	-1.00	-1.08	2.79	2.39	2.66	2.53	5.49	7.63	7.37	7.17	7.52	7.12
CNM	35 2885	-22.56	-22.71	-21.86	-22.09	-22.60	-22.43	-22.40	-22.39	-22.79	-21.57	-22.62	-21.84
CNM	35 3055	5.17	5.01	5.18	5.74	6.09	5.34	5.37	5.94	6.09	5.73	6.01	5.56
CNM	40 7301	-2.78	-2.83	-1.95	-1.99	-1.48	-1.61	-2.41	-3.21	-3.24	-3.08	-3.13	-3.36
CNM	40 7302	28.66	37.38	45.87	54.40	63.44	72.62	81.07	89.01	96.72	17.94	2.27	1.64
CNMP	36 1752	-24.21	-25.20	-23.46	-23.75	-24.40	-24.53	-24.02	-	-	-	-	-
CNMP	36 1806	34.49	36.17	37.03	36.75	34.43	35.96	36.20	-	-	-	-	-
CNMP	36 2873	-4.22	-3.58	-4.03	-4.59	-3.87	-2.34	-3.20	-	-	-	-	-
DFNT	36 1811	56.27	-773.18	-	-	56.02	55.41	54.42	59.23	59.54	56.29	55.44	56.12
DFNT	36 2866	38.74	-583.23	-	-	37.90	38.19	37.63	39.44	39.75	38.29	38.15	37.95
DMDM	35 2191	1.98	2.38	2.38	2.25	2.86	2.30	2.72	2.92	3.06	2.96	3.18	3.41
DMDM	36 2033	10.42	9.04	9.58	9.68	9.28	9.93	9.18	10.19	10.06	9.78	10.75	10.78
DTAG	35 2805	-0.43*	0.20*	1.04*	-0.78*	-0.35	-0.30	-0.59	0.64	0.48	0.38	0.12	-0.21
DTAG	35 2966	-0.81*	-0.13*	-0.97*	-1.11*	-0.95	-0.91	-0.91	-0.52	-0.62	-0.61	-0.44	-0.65
DTAG	35 3053	-1.52*	-1.41*	-1.18*	-0.96	-0.75	-0.56	-0.69	-0.11	-0.22	0.88	1.10	0.30
EIM	35 2060	-	-	-	0.01	-	-	0.00	-0.44	0.42	-0.05	0.12	-0.06

Table 8A. (Cont.)

Lab.	Clock	57414	57444	57474	57504	57539	57569	57599	57629	57659	57689	57719	57749
ESTC	35 1615	9.12	8.80	10.14	9.69	9.79	9.44	9.40	10.17	9.78	10.61	10.32	10.22
ESTC	35 2025	5.03	4.85	5.63	5.52	5.68	4.35	4.96	4.93	4.45	4.54	4.37	3.81
ESTC	35 2353	20.24	20.68	20.95	20.64	21.44	21.56	20.39	19.96	19.25	19.91	20.27	19.34
ESTC	40 2543	0.13	-0.56	-1.87	-2.25	-3.08	-3.83	-4.57	-5.49	-6.17	-6.51	-7.27	-8.00
ESTC	40 2544	-9.62	-10.21	-10.79	-10.44	-12.02	-23.40	-67.43	-70.92	-73.95	-76.28	-76.84	-69.09
F	35 157	12.13	12.68	-	-	19.94	19.65	19.86	-	-	-	11.91	12.06
F	35 355	1.88	1.71	1.76	1.87	2.81	4.06	3.91	0.55	1.38	1.72	1.67	1.42
F	35 396	2.73	2.69	2.96	2.73	2.98	2.06	2.19	2.93	3.02	3.51	3.61	3.94
F	35 469	-4.68	-5.07	-	-	-	-	-	-	-	-	-	-
F	35 489	19.27	20.47	-	-	12.98	13.46	12.95	-	-	-	20.65	19.98
F	35 609	-34.42	-34.91	-34.37	-35.48	-35.68	-35.45	-35.33	-35.56	-35.66	-36.62	-35.90	-36.58
F	35 770	-	-	-	-	-	-	-10.76	-11.47	-12.33	-11.26	-11.29	-11.79
F	35 774	30.02	30.08	30.76	31.85	30.88	32.27	31.49	30.30	29.09	27.34	26.92	27.71
F	35 781	7.85	7.46	7.26	6.98	-	-	-	-	-	-	-	-
F	35 859	5.31	5.48	2.89	3.90	3.44	-	-	-	3.53	3.76	2.96	1.37
F	35 1177	-1.68	-2.49	-3.67	-5.04	-6.70	-	-	-	-6.56	-6.42	-4.20	-3.84
F	35 1222	0.86	1.69	1.45	1.99	1.61	0.85	1.61	1.76	1.21	1.04	1.05	1.48
F	35 1321	0.79	1.86	1.41	1.49	0.39	1.59	1.05	2.15	2.10	2.83	2.29	1.26
F	35 1556	-6.08	-5.30	-5.03	-5.03	-6.47	-4.99	-5.68	-5.12	-5.82	-5.11	-5.47	-6.49
F	35 1644	8.63	8.25	-	-	8.12	7.96	8.36	-	-	-	8.99	8.21
F	35 2027	-	-	-	-	-	-	-	-	7.68	8.57	8.71	9.31
F	35 2388	4.69	4.68	3.74	3.78	5.12	4.16	5.28	5.96	5.20	5.27	4.73	5.13
F	35 2609	3.12	2.52	1.82	0.74	2.18	1.96	1.14	1.11	0.67	1.52	1.17	1.22
F	35 2647	24.04	23.25	24.71	25.41	16.90	15.38	-	-	13.16	15.21	22.46	-
F	35 2804	6.14	5.73	6.33	6.79	6.42	6.27	6.31	6.49	6.84	6.01	6.39	6.71
F	35 2985	-11.80	-11.09	-11.19	-10.92	-11.28	-11.43	-10.79	-10.62	-10.17	-10.52	-9.64	-9.79
F	35 3054	-	-	-	-	25.93	26.25	25.54	-	-	-	27.60	27.71
F	40 809	14.93	15.84	17.66	18.62	19.24	19.84	20.48	21.12	21.72	22.22	22.90	23.38
F	40 810	40.19	40.73	41.11	42.04	42.55	42.95	43.55	44.00	44.50	44.97	45.66	46.16
F	40 889	27.04	27.40	27.72	28.07	28.43	28.86	29.25	29.55	29.84	30.27	30.70	31.01

Table 8A. (Cont.)

Lab.	Clock	57414	57444	57474	57504	57539	57569	57599	57629	57659	57689	57719	57749
F	40 890	18.19	18.24	18.50	18.74	18.69	18.61	18.20	18.32	18.42	18.56	18.59	18.63
HKO	35 2425	-0.97	-1.61	-1.07	-1.80	-1.87	-1.33	-1.91	-1.73	-2.28	-2.69	-2.64	-2.59
HKO	35 2884	1.11	1.60	1.21	1.80	1.21	1.09	2.30	1.86	1.83	1.84	2.21	2.46
IFAG	36 1167	-4.10	-3.64	-0.08	-1.55	0.07	0.72	-0.83	-0.45	-0.58	-1.01	-1.54	-3.34
IFAG	36 1173	-5.31	-4.96	-4.71	-2.90	-2.84	-4.17	-5.01	-5.38	-5.52	-2.75	-3.02	-5.94
IFAG	36 1629	13.72	12.82	13.92	14.67	13.92	14.54	15.26	16.28	15.80	14.99	14.56	14.80
IFAG	36 1732	14.94*	14.03*	14.00*	13.77*	14.00*	13.93*	13.77*	14.43*	13.98*	13.14*	13.04	12.89
IFAG	36 1798	-2.09	-1.57	-1.48	-2.00	-2.36	-0.85	-1.75	-1.79	-1.76	-1.24	-0.79	-1.02
IFAG	40 4418	10.08	10.20	10.45	-	-	-	-1.11	0.27	0.49	0.80	0.64	0.78
IFAG	40 4439	-6.48*	-3.05*	0.33	-	2.67	4.78	7.19	9.73	12.09	14.81	17.19	19.72
IMBH	35 2685	-14.03*	-15.65*	-35.73*	-28.63*	-7.59*	20.03*	-	-	-	-	-	-
IMBH	35 2909	-1.35*	-0.22*	0.47*	-1.70*	-6.40*	-5.25*	-	-	-	-	-	-
INPL	35 2480	0.75	0.82	0.98	0.37	0.25	1.37	1.52	1.46	1.30	0.61	1.91	-
INPL	35 2481	-2.37	-3.65	-3.71	-3.59	-3.14	-2.68	-2.50	-0.27	-0.43	-0.61	-0.31	-
INPL	35 3333	-	-	-	-	-	-	-	-8.24	-7.87	-7.86	-7.63	-
INPL	35 3351	-	-	-	-	-	-	-	-1.28	-1.99	-1.11	-0.92	-
INTI	36 2377	0.53	1.18	-0.33	-0.32	1.08	0.50	-0.19	1.08	1.72	1.76	-0.85	-0.14
INXE	35 2393	-	-	-	-0.17	0.09	-1.06	0.55	0.33	-0.13	-0.46	-0.54	-0.05
IT	35 219	1.70	2.64	1.64	2.38	1.75	-	1.33	1.11	1.13	1.03	1.83	1.10
IT	35 505	-24.70	-23.68	-24.06	-23.44	-24.09	-23.59	-23.26	-23.67	-23.53	-23.09	-22.97	-24.12
IT	35 1115	-2.09	-2.07	-1.10	-1.05	-1.32	-	-1.39	-0.15	-1.32	-2.60	-1.98	-2.08
IT	35 1373	0.84	1.11	0.69	0.68	1.56	-	0.51	0.52	0.90	0.77	1.93	1.41
IT	35 2118	9.72	9.98	9.28	9.23	9.04	9.69	8.98	10.26	9.43	9.92	10.11	10.00
IT	40 1101	108.30	112.61	116.68	120.65	125.19	129.86	133.88	138.03	142.18	146.11	150.24	154.17
IT	40 1102	106.62	110.49	114.13	117.91	122.02	126.50	130.12	134.02	137.65	141.46	145.39	149.16
IT	40 1103	55.33	56.22	57.00	57.87	58.75	59.62	60.19	61.09	61.84	62.73	63.35	64.40
IT	40 1104	-31.28	-28.11	-24.56	-20.74	-16.62	-12.05	-8.20	-3.84	0.63	4.97	9.49	13.92
JV	36 1277	-15.62	-13.38	-14.36	-13.96	-13.45	-14.22	-12.77	-13.54	-13.60	-12.62	-14.48	-
JV	36 2617	12.49	13.21	11.46	12.15	13.63	13.92	14.83	12.85	13.49	12.34	13.47	13.55
JV	36 2629	-4.30	-4.19	-2.40	-3.78	-3.62	-4.32	-2.94	-2.21	-3.67	-3.23	-3.89	-3.76

Table 8A. (Cont.)

Lab.	Clock	57414	57444	57474	57504	57539	57569	57599	57629	57659	57689	57719	57749
JV	40 8713	-5.00	-5.14	-6.74	-7.24	-8.74	-9.08	-10.24	-11.26	-12.15	-13.36	-15.06	-15.56
KRIS	35 321	5.10	5.35	5.70	5.92	5.83	6.06	6.61	7.09	7.53	8.77	8.15	8.64
KRIS	35 739	0.60	0.17	0.11	1.53	0.58	0.83	1.81	1.91	1.42	1.29	1.38	0.52
KRIS	35 1135	26.29	26.53	28.88	29.36	27.13	26.26	24.96	22.28	22.43	17.34	18.25	16.68
KRIS	35 1693	9.09	9.41	9.18	9.12	9.72	10.26	10.17	10.22	10.06	9.97	10.08	8.82
KRIS	35 1783	21.90	22.09	22.58	21.11	22.17	21.84	24.10	23.13	22.71	22.40	22.96	23.47
KRIS	40 5626	5.57	5.69	5.85	6.12	6.36	6.55	6.78	7.00	7.15	7.78	7.83	8.00
KZ	35 2202	0.77	1.81	0.89	2.08	1.89	1.45	1.07	2.10	1.87	2.03	2.27	1.48
KZ	35 2665	5.70	5.32	5.73	5.15	5.02	6.01	6.12	6.58	5.72	5.96	5.59	5.38
KZ	35 2667	2.92	3.36	1.32	1.68	-0.09	-0.09	-1.55	-0.75	-1.29	-1.16	0.96	0.53
LT	35 1362	-0.92	-0.19	1.91	3.11	1.67	0.49	0.89	1.70	1.04	1.08	2.42	0.38
LT	35 1868	2.30	2.10	1.72	0.77	1.56	1.88	1.25	2.31	2.30	2.68	0.97	2.10
MBM	24 125	-	6.87	-	-	55.19	-	-	61.69	-	-	-	-
MIKE	36 986	3.57	4.40	2.89	2.64	3.08	3.32	1.91	4.44	2.57	3.97	2.31	4.18
MIKE	40 4108	0.47	0.36	0.92	1.59	2.55	-	-	-	-0.74	-1.15	-1.16	-0.99
MIKE	40 4113	22.85	22.99	26.65	26.89	31.24	32.47	36.91	38.17	38.80	41.13	41.40	43.06
MIKE	40 4180	6.26	6.86	7.42	7.96	8.73	9.01	9.89	10.41	10.99	11.53	12.08	12.58
MIKE	40 4189	7.47	10.78	13.95	17.24	21.01	24.60	28.47	31.89	35.66	39.52	43.31	47.24
MKEH	36 849	-39.98	-40.32	-40.66	-41.33	-	-	-41.91	-42.33	-42.60	-40.83	-41.42	-41.03
MSL	36 274	-	-	-	-	-	-	-	-	10.11	10.31	-	7.54
MSL	36 2869	-	-	-	-	-	-	-	-	2.83	1.69	-	3.05
MTC	35 3000	1.02	1.11	1.66	1.14	1.29	1.54	1.32	0.98	1.36	1.83	1.57	-
MTC	35 3002	3.13	2.78	3.66	3.93	2.86	3.25	2.37	3.17	4.03	3.83	4.37	3.72
MTC	35 3005	1.76	1.11	1.48	1.92	1.86	2.64	1.86	1.30	2.90	3.30	3.66	2.94
NAO	35 779	0.24	-	-	-0.35	-0.68	-0.93	0.99	0.60	-0.81	-0.48	0.83	0.88
NAO	35 1206	-5.39	-	-	-0.21	-0.62	3.75	4.22	-3.01	-0.40	0.04	0.31	-1.70
NAO	35 1214	2.74	-	-	4.63	4.92	-	-	-	-	-5.19	-5.43	-5.25
NAO	35 1689	2.64	-	-	3.44	3.47	2.42	2.36	3.55	3.06	2.46	2.53	3.14
NAO	40 1301	6.84	-	-	5.63	-4.97	-1.86	-0.60	-2.50	3.33	-1.89	-2.23	-0.69
NICT	35 332	8.90	8.92	8.56	9.03	8.83	8.86	8.38	8.41	8.47	8.72	7.97	8.37

Table 8A. (Cont.)

Lab.	Clock	57414	57444	57474	57504	57539	57569	57599	57629	57659	57689	57719	57749
NICT	35 343	35.97	36.72	35.93	35.75	35.73	36.10	35.69	35.95	35.11	36.09	36.62	36.53
NICT	35 715	8.75	9.59	9.47	9.05	8.78	8.81	9.21	8.85	8.32	9.10	9.06	8.23
NICT	35 732	-7.97	-8.13	-13.41	-11.90	-13.10	-15.22	-14.66	-14.38	-13.44	-16.77	-17.84	-21.96
NICT	35 907	15.74	15.50	14.41	15.85	15.91	14.01	14.73	15.08	15.41	15.90	15.29	14.12
NICT	35 913	-13.24	-13.16	-15.21	-14.78	-12.03	-10.68	-13.18	-12.59	-12.72	-11.56	-12.12	-
NICT	35 916	2.86	2.93	3.72	3.85	4.29	3.81	4.29	4.51	4.59	5.76	5.53	5.05
NICT	35 1225	28.19	28.03	27.66	28.54	27.70	28.33	28.41	28.63	28.93	27.74	28.15	27.89
NICT	35 1226	-	-	-7.74	-8.35	-7.67	-7.66	-7.30	-6.47	-6.78	-5.49	-5.73	-5.03
NICT	35 1611	-	-	-24.46	-	-	-	-	-	-	-	-	3.12
NICT	35 1778	-24.57	-24.48	-23.80	-23.93	-24.40	-24.02	-24.83	-24.78	-24.42	-24.88	-24.65	-
NICT	35 1789	-8.54	-2.54	0.45	1.97	2.22	2.26	1.74	1.32	0.03	0.32	0.20	-0.06
NICT	35 1790	5.89	-	-	-	2.99	3.15	3.65	3.23	3.58	3.31	3.81	3.80
NICT	35 1866	2.37	2.85	3.86	3.31	2.85	2.64	2.40	2.49	2.06	2.54	3.02	2.88
NICT	35 1882	4.86	6.13	4.09	4.97	6.01	6.72	6.37	6.00	5.49	5.89	5.28	4.72
NICT	35 1887	12.77	13.65	13.65	14.72	14.07	14.43	14.52	14.72	14.69	15.34	15.31	16.36
NICT	35 1944	11.23	11.65	11.88	11.81	11.74	11.68	11.52	12.15	11.46	11.29	10.64	11.07
NICT	35 2010	0.83	0.74	1.17	1.15	1.55	2.17	1.85	3.12	2.34	3.00	3.13	2.66
NICT	35 2011	2.22	2.36	2.97	2.41	2.46	1.77	2.44	1.42	1.74	1.46	1.91	1.73
NICT	35 2056	-15.66	-15.75	-15.99	-14.93	-15.66	-13.79	-14.73	-13.60	-13.70	-13.02	-13.45	-13.09
NICT	35 2113	11.71	11.49	12.09	11.32	12.77	11.49	13.59	13.60	13.85	13.41	13.61	14.29
NICT	35 2116	-9.57	-9.12	-8.91	-8.86	-8.50	-8.94	-9.02	-8.86	-8.70	-8.67	-8.42	-9.56
NICT	35 2570	10.12	10.89	9.76	8.18	7.65	7.64	7.90	8.01	8.23	8.15	8.65	7.42
NICT	35 2574	2.36	1.86	0.75	2.72	1.22	2.55	3.08	2.81	4.10	4.92	6.57	6.89
NICT	35 2627	2.30	1.49	1.60	3.05	3.77	2.96	3.81	3.66	2.66	2.21	3.07	2.70
NICT	35 2628	5.26	5.05	4.82	4.61	5.44	5.30	4.68	5.26	4.08	4.49	5.37	4.95
NICT	35 2784	7.98	8.91	8.68	8.68	8.65	9.05	8.98	8.41	9.39	9.75	8.90	9.21
NICT	35 2876	-9.05	-8.66	-8.81	-8.79	-9.40	-9.61	-9.64	-9.42	-9.13	-9.29	-9.34	-8.36
NICT	35 2903	-7.62	-6.48	-7.05	-6.73	-7.72	-8.13	-8.29	-7.64	-8.12	-8.02	-7.67	-8.26
NICT	35 3259	-	-	-	-	-	12.43	12.57	12.18	12.54	13.02	13.06	13.06
NICT	36 1217	3.66	4.89	4.19	4.18	4.96	3.26	5.14	5.41	4.30	5.63	4.42	2.40

Table 8A. (Cont.)

Lab.	Clock	57414	57444	57474	57504	57539	57569	57599	57629	57659	57689	57719	57749
NICT	40 2003	-44.56	-44.71	-45.11	-44.99	-44.92	-44.75	-44.55	-44.61	-44.45	-44.43	-44.40	-44.35
NICT	40 2004	75.97	78.56	81.19	83.87	86.86	89.90	92.79	95.74	98.75	-	-	-
NICT	40 2006	75.58	-	-	1.89	4.43	-	-	-	11.67	12.65	13.15	13.06
NICT	40 2012	-	-	-	-	-	-	-	-	-	5.59	8.29	11.01
NICT	40 2013	-	-	-	-	-	-	-2.56	1.69	5.22	8.63	11.87	15.09
NICT	40 2014	-	-	-	-	-	-0.26	0.94	2.00	2.63	2.98	2.31	2.62
NICT	40 2015	-	-	-	-	-	-	-	-	-	5.09	7.29	9.42
NIM	35 1235	19.68	17.63	19.27	18.74	20.80	20.31	22.03	18.97	20.36	20.85	21.25	20.93
NIM	35 2256	15.05	14.72	13.54	13.85	14.00	14.88	14.06	15.25	14.74	16.03	17.10	16.49
NIM	35 2483	2.25	2.10	2.14	1.52	0.94	1.03	1.02	0.78	-0.87	-0.38	-0.57	-0.02
NIM	35 2643	-5.27	-5.44	-4.36	-3.06	-2.71	-3.01	-2.59	-1.52	-1.81	-1.53	-1.03	-0.77
NIM	35 2744	-1.87	-2.29	-2.85	-1.75	-0.90	-0.30	-1.56	-2.00	-2.22	-2.03	-1.66	-1.77
NIM	35 2767	-26.85	-26.93	-26.32	-27.54	-26.93	-26.80	-27.19	-27.18	-27.39	-26.06	-26.88	-26.08
NIM	35 2769	16.07	16.76	16.38	16.68	17.53	16.99	16.98	16.40	17.15	17.88	16.83	17.46
NIM	40 4832	212.81	215.56	218.51	221.66	225.08	228.58	231.87	235.36	238.77	242.15	245.60	249.05
NIM	40 4835	187.31	199.91	212.72	224.67	237.98	250.58	262.38	273.53	285.56	296.74	308.52	320.18
NIM	40 4871	284.64	288.40	292.27	296.32	300.76	304.34	307.88	311.37	314.95	318.31	321.70	325.04
NIM	40 4878	177.15	181.00	184.62	189.29	194.33	198.34	201.60	205.22	208.75	212.18	215.51	218.87
NIM	40 4879	212.12	220.23	218.14	221.79	230.85	236.70	232.09	234.60	238.72	239.63	245.16	249.15
NIM	40 4880	70.45	74.61	78.85	81.40	84.90	90.44	94.54	97.95	101.44	104.53	108.59	112.47
NIMB	35 600	-0.17	1.32	1.72	2.15	-	-	-	-	-	-	-0.37	3.06
NIMT	35 1511	-	-	-	-	-	-	-	10.12	10.75	11.44	10.23	11.22
NIMT	35 2246	3.83	3.20	3.59	3.76	4.17	-	-	-	-	-	-	-
NIMT	35 2247	3.04	-2.70	-3.28	-0.95	1.38	-	-	4.00	3.84	3.80	4.08	-
NIMT	36 1169	-	-	-	-	-	-	-	10.28	9.96	9.14	10.73	9.75
NIS	35 2140	-	-	-	-	-	-	-	-	-	-	35.34	-
NIS	35 2181	-	-	-	-	-	-	-	-	-	-	10.21	-
NIS	35 2182	-	-	-	-	-	-	-	-	-	-	-4.13	-
NIS	35 2633	-	-	-	-	-	-	-	-	-	-	16.87	-
NIST	35 282	-10.48	-10.99	-10.53	-10.81	-10.28	-10.50	-10.43	-10.46	-9.84	-10.05	-9.95	-9.52

Table 8A. (Cont.)

Lab.	Clock	57414	57444	57474	57504	57539	57569	57599	57629	57659	57689	57719	57749
NIST	35 408	-22.70	-30.59	-37.73	-44.80	-45.94	-45.84	-45.97	-44.34	-44.10	-43.49	-40.08	-35.10
NIST	35 1074	-7.19	-6.90	-7.22	-7.00	-6.43	-6.12	-6.33	-6.14	-5.63	-6.38	-5.45	-6.90
NIST	35 1519	1.63	0.51	0.75	0.67	-0.14	0.94	0.18	-0.41	-	-	-	-
NIST	35 2031	-11.10	-11.87	-10.43	-11.40	-10.66	-11.56	-10.82	-11.88	-10.46	-10.40	-5.83	-5.01
NIST	35 2032	-1.63	-2.18	-1.15	-1.57	-1.51	-1.45	-1.66	-2.23	-1.61	-2.56	-2.70	-2.14
NIST	35 2034	-11.57	-11.69	-10.83	-11.70	-11.58	-11.57	-11.27	-12.31	-11.45	-10.44	-12.19	-11.78
NIST	35 2579	-5.28	-4.15	-4.37	-2.58	-3.92	-4.49	-4.58	-4.86	-4.54	-4.85	-4.86	-4.86
NIST	35 2672	-3.15	-2.98	-4.44	-4.45	-2.63	-3.46	-3.84	-4.38	-2.23	-2.50	-0.83	-1.24
NIST	35 2935	-16.80	-16.79	-16.02	-17.14	-16.62	-16.60	-16.88	-16.85	-17.74	-17.17	-17.67	-17.41
NIST	40 4	-	-	-	-	-	-	-	-	43.66	43.95	44.32	44.71
NIST	40 203	-	-	-	-	-	-	-	-	-	273.40	276.39	279.33
NIST	40 205	-24.15	-24.04	-24.01	-23.89	-23.85	-24.07	-24.05	-24.02	-23.95	-23.85	-23.76	-23.71
NIST	40 206	-21.47	-20.09	-18.68	-17.36	-15.98	-14.39	-12.97	-11.82	-10.95	-9.85	-8.70	-7.61
NIST	40 207	212.52	216.98	221.54	225.86	230.94	235.61	240.05	244.54	249.12	253.78	258.48	263.27
NIST	40 210	109.14	116.42	124.53	131.93	139.73	147.28	154.37	161.53	168.73	175.94	183.11	190.38
NIST	40 212	309.90	317.11	324.52	331.57	339.39	347.04	354.26	361.42	368.61	375.69	382.95	390.02
NIST	40 222	36.54	36.66	36.89	37.07	37.29	37.23	37.44	37.69	37.89	37.99	38.13	38.28
NMIJ	35 224	-15.78	-16.14	-15.77	-15.43	-15.59	-15.31	-15.27	-16.37	-15.35	-14.75	-15.22	-15.54
NMIJ	35 459	-	-	-	-	-	-	-0.32	1.74	-2.09	2.18	2.93	3.61
NMIJ	35 523	21.77	21.75	27.40	22.80	24.91	24.86	26.48	26.32	26.11	26.69	27.65	27.88
NMIJ	40 5002	-10.83	-11.25	-10.86	-10.00	-9.86	-10.43	-9.89	-9.73	-8.22	-6.53	-5.71	-4.87
NMIJ	40 5003	1.38	1.47	1.86	2.41	1.96	2.33	2.58	2.47	2.61	2.75	3.18	3.17
NMIJ	40 5012	-	-	-	-	-	8.23	8.64	9.02	9.42	9.87	10.29	10.70
NMIJ	40 5015	31.22	34.12	37.18	39.81	43.40	46.92	50.04	53.17	56.17	59.31	62.52	65.47
NPL	35 1275	5.22	3.83	4.06	5.32	5.40	7.28	6.33	5.11	4.09	2.92	2.97	2.93
NPL	35 3167	7.65	7.80	7.24	7.72	7.66	8.27	8.96	8.24	8.75	8.26	8.80	8.39
NPL	40 1701	5.82	5.90	6.13	6.36	6.37	6.03	6.75	5.67	6.41	7.13	7.62	7.92
NPL	40 1708	0.25*	-0.58*	-0.58*	-1.13*	-0.84*	-0.56*	0.29*	-0.55*	-0.98*	-0.29*	-0.14*	-0.79
NPLI	35 57	103.37	100.91	101.78	102.87	39.91	-	-	-	-	-	-	-
NPLI	35 140	19.72	17.15	19.21	21.79	20.65	24.01	23.67	22.19	22.41	20.91	-	-

Table 8A. (Cont.)

Lab.	Clock	57414	57444	57474	57504	57539	57569	57599	57629	57659	57689	57719	57749
NPLI	35 1324	-0.73	-2.73	-2.02	-2.96	-0.66	-0.84	1.13	0.31	-1.03	0.81	-1.64	-0.33
NPLI	35 2245	-0.60	0.11	0.36	0.19	-0.05	-0.30	-0.19	-0.51	0.59	0.00	-0.38	1.10
NPLI	35 2796	-22.50	-22.02	-21.91	-22.27	-22.36	-21.95	-21.75	-22.11	-21.59	-21.89	-20.79	-21.04
NPLI	40 5201	14.82	-7.62	-10.96	-7.35	-3.64	0.02	3.52	6.69	10.79	14.37	0.34	-11.57
NRC	35 2115	-0.55	0.43	-1.79	2.45	0.79	1.11	0.32	0.94	1.01	1.48	1.09	3.06
NRC	35 2150	1.40	1.33	-0.71	3.44	1.54	1.80	1.55	0.80	1.84	1.33	1.45	2.53
NRC	35 2152	-4.23	-5.09	-7.56	-2.76	-5.52	-4.98	-4.67	-4.91	-5.13	-4.13	-5.33	-4.75
NRC	36 2219	4.30	3.71	3.15	6.26	3.66	4.31	4.83	5.08	4.70	4.91	4.50	5.62
NRC	40 304	7.19	8.59	-	-	-	-	-	-	-	-	-	-
NRC	40 306	0.77	0.44	-1.80	2.51	0.23	0.17	-0.91	-1.48	-2.07	-2.41	-2.09	-4.22
NRL	35 714	-	-	-5.23	-5.88	-5.80	-5.39	-6.36	-	-	-	-	-
NRL	35 719	-	-	-1.48	1.23	11.19	15.63	17.39	-	-	-	-	-
NRL	35 1245	-	-	8.94	33.31	17.21	0.23	0.86	-	-	-	-	-
NRL	35 2460	29.77	-	-	-	83.40	-	-	-	-	-	-	-
NRL	35 2464	-	-	-	-	-66.02	-	-	-	-	-	-	-
NRL	35 2580	-5.25	-	-	-	-2.12	-	-	-	-	-	-	-
NRL	36 387	-	-	6.07	5.70	4.15	3.54	4.65	-	-	-	-	-
NRL	36 2788	-	-	-4.41	-4.16	-4.30	-5.71	-3.54	-	-	-	-	-
NRL	36 2791	-	-	-0.01	-0.66	-0.69	0.25	0.64	-	-	-	-	-
NRL	36 2799	3.25	-	-	-	-	-	-	-	-	-	-	-
NRL	36 2800	-0.52	-	-	-	-	-	-	-	-	-	-	-
NRL	36 2807	10.88	-	-	-	-	-	-	-	-	-	-	-
NRL	36 2818	23.08	-	-	-	-	-	-	-	-	-	-	-
NRL	36 2820	-	-	8.75	8.90	6.77	-3.91	-6.94	-	-	-	-	-
NRL	36 2829	-	-	4.92	5.60	4.46	5.92	3.97	-	-	-	-	-
NRL	36 2832	-	-	2.78	3.45	2.53	0.59	0.52	-	-	-	-	-
NRL	36 2834	-	-	0.61	2.53	1.94	4.44	-1.31	-	-	-	-	-
NRL	40 1001	-	-	-1.91	-2.01	-2.19	-2.22	-1.56	-	-	-	-	-
NRL	40 1004	-	-	5.30	5.59	5.84	6.08	6.23	-	-	-	-	-
NRL	40 1009	-	-	-8.89	-9.82	-12.45	-14.65	-16.79	-	-	-	-	-

Table 8A. (Cont.)

Lab.	Clock	57414	57444	57474	57504	57539	57569	57599	57629	57659	57689	57719	57749
NRL	40 1010	-	-	-5.07	-5.26	55.68	-	-	-	-	-	-	-
NRL	40 1012	-	-	-19.56	-21.44	-24.10	-26.65	-28.47	-	-	-	-	-
NTSC	35 1016	0.61	0.61	0.24	1.05	2.64	2.19	2.00	3.27	2.38	3.90	3.96	4.47
NTSC	35 1018	-7.00	-6.95	-6.40	-6.77	-5.44	-5.05	-3.54	-2.92	-4.62	-3.82	-3.98	-3.32
NTSC	35 1818	-23.59	-22.78	-22.10	-22.43	-21.33	-21.77	-20.49	-19.77	-20.03	-19.29	-18.33	-18.72
NTSC	35 1823	22.55	23.08	23.02	23.09	-	-	-	-	-	-	-	-
NTSC	35 2098	5.83	5.57	4.80	-0.37	-	-	1.03	1.59	1.45	1.64	1.62	1.95
NTSC	35 2142	-	-	-	-	-	-	6.19	6.27	6.34	6.95	7.29	6.62
NTSC	35 2143	5.64	4.95	4.99	5.23	-	-	-10.98	-11.15	-11.74	-11.20	-10.87	-11.27
NTSC	35 2145	-12.53	-12.03	-12.11	-11.70	-	-	-6.93	-7.48	-6.83	-6.69	-6.11	-6.90
NTSC	35 2573	6.66	6.33	6.16	6.45	6.67	6.43	6.70	6.78	6.50	7.92	7.06	6.59
NTSC	35 2831	17.19	17.30	17.41	18.30	17.96	18.11	18.88	18.53	17.91	18.53	18.31	18.11
NTSC	35 2921	0.64	0.89	0.04	0.53	0.64	0.90	1.19	1.46	1.70	2.08	1.48	1.73
NTSC	35 2922	2.52	1.92	2.07	1.97	2.23	2.70	2.82	2.76	3.44	3.86	3.49	3.87
NTSC	35 2924	31.31	30.80	30.73	30.35	-	-	-	-	-	-	-	-
NTSC	35 2926	2.88	3.56	4.31	4.47	-	-	-	-	-	-	-	-
NTSC	35 2928	4.92	4.98	5.84	5.86	5.05	5.74	5.65	5.91	6.00	6.44	6.57	6.58
NTSC	35 2933	-5.09	-5.41	-5.89	-5.50	-4.72	-4.74	-4.41	-4.14	-4.87	-4.59	-5.09	-5.28
NTSC	35 2959	10.52	9.69	10.53	9.96	10.67	10.70	11.11	11.91	11.48	11.10	11.67	11.27
NTSC	35 2962	-0.59	-1.29	-1.05	-0.53	-0.50	-0.19	-0.94	-0.90	-0.60	-0.75	-1.18	-1.23
NTSC	35 2964	21.35	20.82	20.89	21.58	21.26	21.41	21.67	21.33	21.71	21.78	21.65	21.44
NTSC	35 2965	13.54	13.68	13.76	13.50	13.33	14.21	13.71	14.72	13.86	13.91	14.46	13.71
NTSC	35 2976	30.01	29.85	30.43	30.51	30.30	30.77	30.53	31.37	31.08	30.99	31.08	31.65
NTSC	35 2978	-2.67	-2.13	-2.42	-2.69	-1.34	-2.36	-1.67	-1.30	-0.92	-1.81	-1.54	-0.27
NTSC	35 2980	-6.45	-6.18	-6.54	-5.62	-5.93	-5.43	-5.15	-5.90	-5.34	-6.01	-	-
NTSC	35 2981	1.94	1.60	1.44	2.28	1.96	2.67	3.08	3.77	2.59	2.69	3.16	2.36
NTSC	35 3089	18.23	18.74	18.46	18.36	18.28	18.51	19.00	18.27	18.60	18.78	18.87	19.13
NTSC	35 3090	6.87	7.34	7.29	7.46	7.67	7.48	8.03	8.18	8.58	8.40	8.68	9.26
NTSC	35 3091	-4.47	-4.19	-4.33	-4.24	-4.42	-3.80	-3.46	-3.10	-2.97	-3.04	-3.14	-2.60
NTSC	35 3102	-6.65	-6.47	-6.55	-5.89	-5.60	-5.47	-5.45	-4.30	-4.86	-3.63	-4.21	-3.99

Table 8A. (Cont.)

Lab.	Clock	57414	57444	57474	57504	57539	57569	57599	57629	57659	57689	57719	57749
NTSC	40 296	60.84	63.12	65.57	68.09	70.74	73.44	75.88	78.41	81.56	85.16	87.56	90.29
NTSC	40 297	53.43	57.75	62.21	66.78	72.29	78.48	83.47	88.71	94.06	99.24	104.85	110.87
NTSC	40 326	-	-	-	-	-	-	-	-	33.14	38.96	44.31	50.03
NTSC	40 4903	-	-	-	-	-	-	-	-	-	-	-	100.13
NTSC	40 4926	28.25	27.81	27.17	26.17	25.19	24.16	23.05	22.36	22.10	21.96	21.46	21.19
NTSC	40 4927	-25.99	-24.37	-21.12	-21.98	-16.54	-10.38	-11.80	-10.43	-4.80	-3.34	1.09	3.04
ONRJ	35 102	1.08	1.07	0.66	0.99	0.82	2.09	1.73	1.05	1.55	1.81	2.24	2.62
ONRJ	35 103	1.65	-0.58	0.33	-0.32	0.54	0.96	0.14	0.42	-1.22	-	-	-
ONRJ	35 123	33.45	32.81	33.40	33.02	33.67	33.10	32.40	32.72	33.88	32.71	34.15	35.16
ONRJ	35 129	11.89	11.55	10.49	10.02	10.75	11.23	12.13	11.22	10.77	11.33	11.19	12.15
ONRJ	35 147	9.02	8.43	8.40	9.67	9.46	9.05	7.47	8.03	7.96	8.35	7.56	8.31
ONRJ	35 1153	5.05	5.10	6.96	7.90	6.72	7.85	7.16	7.07	6.91	9.04	8.14	7.89
ONRJ	35 1942	14.99	15.70	16.33	16.65	16.60	17.51	16.82	17.35	18.13	18.14	17.93	18.57
ONRJ	40 1950	35.89	39.87	42.60	43.57	45.54	46.94	46.34	47.54	48.83	49.08	49.24	49.93
ONRJ	40 1958	39.93	38.81	35.54	25.52	509.38	-	-	-	-	-	-	-
ORB	35 2722	2.21	3.13	3.17	2.96	4.37	4.13	-	4.79	4.76	4.97	4.19	3.67
ORB	35 2723	5.02	4.56	4.27	-	-	-	-	-1.25	-1.39	-0.39	-1.39	-0.30
ORB	35 2724	2.70	3.11	2.49	2.20	2.14	2.49	1.43	1.98	1.93	1.32	1.41	1.31
ORB	36 593	75.10	74.77	74.10	75.01	73.14	71.74	73.07	74.58	73.77	74.65	74.27	83.96
ORB	40 2602	-	-	-	-	34.78	35.45	36.08	36.61	37.24	37.70	-	9.59
PL	25 124	-15.83	-18.99	-12.04	-	-	-	-	-	-	-	-	-
PL	25 125	-44.72	-46.63	-49.54	-	-	-	-	-	-	-	-	-
PL	35 441	18.66	19.35	19.52	19.69	20.03	20.12	20.62	20.82	20.38	19.75	20.21	20.99
PL	35 745	-0.17	-0.05	0.59	-0.04	0.09	-0.23	0.16	-0.03	0.61	0.15	1.13	1.40
PL	35 761	1.53	2.32	-1.28	2.83	0.12	0.80	3.84	2.01	-0.01	4.53	3.33	2.81
PL	35 1120	0.68	-0.65	-0.25	-0.48	0.04	-0.24	0.52	0.27	-0.38	0.35	0.84	0.67
PL	35 1660	0.73	0.86	1.60	1.89	1.20	0.33	2.15	0.93	0.88	1.02	0.75	0.03
PL	35 1746	-9.56	11.68	27.98	30.14	30.78	31.50	31.29	31.47	31.56	30.69	30.88	30.82
PL	35 1934	3.74	4.76	4.69	4.13	4.00	4.24	3.62	4.08	4.60	4.58	4.14	4.12
PL	35 2175	-7.22	-7.55	-6.86	-6.79	-7.95	-7.94	-7.88	-7.69	-6.54	-7.09	-7.37	-6.85

Table 8A. (Cont.)

Lab.	Clock	57414	57444	57474	57504	57539	57569	57599	57629	57659	57689	57719	57749
PL	35 2394	0.08	0.89	0.42	-1.65	-1.46	-2.42	-2.06	-2.08	-2.91	-2.71	-2.94	-2.95
PL	35 2891	4.96	5.63	5.37	5.05	5.27	5.54	5.62	5.01	5.05	4.98	5.94	5.07
PL	40 4004	-541.45	-558.90	-576.51	-578.81	-592.04	-595.91	-600.15	-597.04	-606.27	-613.93	-611.17	-607.54
PL	40 4601	34.03	34.79	35.37	35.95	36.58	37.24	37.79	38.29	38.97	39.56	40.23	40.72
PL	40 4602	-61.25*	-54.32*	-48.00*	-34.77*	-23.67*	-19.08*	-15.86*	-8.29*	-2.31*	-4.21*	-	6.92
PTB	35 415	-4.02	-5.35	-3.67	-4.48	-3.28	-4.28	-4.31	-4.58	-4.70	-4.01	-4.23	-3.97
PTB	35 1072	11.99	12.90	12.38	12.56	12.91	12.97	12.25	13.02	12.58	12.37	11.88	12.56
PTB	35 2987	-6.81	-6.53	-6.58	-6.33	-5.45	-5.50	-6.01	-5.12	-5.43	-5.68	-5.04	-5.05
PTB	40 506	9.97	11.60	13.33	15.05	16.90	18.63	20.34	9.20	-8.39	-7.23	-5.95	-4.48
PTB	40 508	27.37	29.22	31.46	-	-	-	-	-	-	0.83	2.22	3.47
PTB	40 509	-9.37*	-9.03*	-8.67*	-8.40*	-8.24*	-8.02*	-7.71*	-7.45*	-7.13	-6.90	-6.61	-6.36
PTB	40 510	-	-	-	-	-	-	-	-	-	3.82	3.04	2.30
PTB	92 1	2.55	2.71	1.66	2.10	2.03	2.16	2.04	2.11	2.69	3.28	2.26	3.29
PTB	92 2	1.41	1.66	1.56	2.20	1.93	2.29	1.99	1.90	1.93	2.23	1.83	1.85
ROA	35 583	6.83	7.52	7.81	6.81	7.38	7.28	7.75	8.50	7.72	7.50	8.40	6.03
ROA	35 718	4.08	5.13	4.45	3.90	4.65	4.11	3.55	3.25	3.93	3.95	3.72	3.29
ROA	35 1699	7.30	5.59	5.59	6.55	4.63	4.10	4.24	4.02	4.54	4.27	4.08	4.87
ROA	35 2270	-8.39	-10.08	-9.28	-9.54	-8.52	-9.37	-6.51	1.61	2.90	3.46	3.60	3.53
ROA	36 1488	10.03	10.11	8.82	9.76	12.00	11.96	10.64	10.40	9.64	10.08	10.24	10.96
ROA	36 1490	11.97	12.35	12.19	12.44	12.48	12.46	12.58	12.65	11.40	14.72	14.32	11.17
ROA	40 1436	274.17	277.12	281.29	284.45	288.08	291.07	293.92	296.90	300.03	303.49	306.64	307.89
SASO	35 221	1.75	-	2.96	3.30	2.92	0.38	-0.09	0.54	0.51	0.64	0.61	0.34
SASO	35 1628	6.44*	-	6.27*	6.47*	12.70*	-1.15*	-0.99*	-0.44*	-0.65*	-0.56*	-1.17*	-0.60
SASO	35 2923	1.46	-	1.28	1.88	1.31	1.64	2.12	0.93	1.09	1.89	1.28	2.17
SASO	35 2931	-0.22	-	-0.78	-0.40	-0.25	-0.25	-0.63	-0.30	-0.84	-0.43	-0.21	-0.44
SASO	35 2932	-0.81	-	-0.69	-1.19	-0.85	-0.92	-1.00	-0.25	-1.04	-0.94	-0.09	-0.34
SCL	35 2178	4.77	0.84	-	-	-	-	-	-	-	-	-	-
SCL	35 2525	-1.99	-3.86	0.01	-	-1.63	-1.97	-2.40	-2.73	-3.09	-3.08	-2.88	-2.60
SG	35 188	14.34	14.89	14.66	14.59	14.22	14.68	15.01	14.62	14.47	14.12	15.01	14.77
SG	35 475	-0.90	-0.40	-1.10	-0.92	-0.68	-1.30	-0.75	-0.78	-0.35	-0.67	-0.64	-0.80

Table 8A. (Cont.)

Lab.	Clock	57414	57444	57474	57504	57539	57569	57599	57629	57659	57689	57719	57749
SG	35 696	-5.57	-5.33	-	-	-	-	-	-	-	-4.11	-4.40	-4.23
SG	35 3135	3.57	5.01	4.62	4.78	4.84	4.24	5.09	-1.70	-14.98	6.12	5.24	6.26
SG	36 522	5.79	8.75	8.14	6.23	6.11	4.52	5.35	5.67	6.48	5.13	6.35	6.37
SG	40 7701	166.82	171.60	175.12	179.54	184.23	188.60	192.84	193.91	201.34	205.54	209.83	214.09
SIQ	36 1268	0.00	2.00	-0.65	-2.08	-0.48	-2.25	-1.34	-2.60	0.07	-1.01	1.53	-2.23
SMD	35 1766	11.42	10.65	-	-	-	-	-	12.03	12.14	11.68	11.96	11.09
SMD	35 2003	10.15	10.05	9.93	10.75	10.26	10.76	10.23	10.10	11.29	10.42	10.49	11.06
SMD	35 2543	17.98	18.74	17.53	16.60	19.02	21.75	22.92	22.53	23.01	22.79	24.02	27.60
SMD	40 7909	5.29*	3.79*	2.33*	-0.23	-6.14	-12.19	-14.44	-16.82	-17.90	-15.15	-16.55	-18.79
SMU	35 1193	-	-0.53	-0.74	-2.19	-1.84	-1.98	-0.99	-1.75	-	-	-0.44	-1.94
SP	35 572	16.74	16.48	17.24	18.08	17.20	17.84	17.30	16.64	16.90	16.68	18.03	17.28
SP	35 641	1.30	0.22	0.66	1.29	0.88	0.19	1.07	0.54	0.33	1.30	-0.07	-0.03
SP	35 767	14.74	13.74	13.69	14.08	13.77	14.22	14.97	15.38	15.65	16.05	15.57	15.93
SP	35 1188	-1.56	-1.49	-1.11	-1.51	-2.03	-1.82	-1.78	-1.93	-2.27	-1.94	-2.39	-2.27
SP	35 1642	1.23	1.59	1.30	0.77	2.01	2.42	1.88	2.77	2.53	2.37	2.94	3.69
SP	35 2166	9.47	8.90	8.72	8.17	8.59	8.65	8.89	9.34	9.52	9.05	8.90	9.02
SP	35 2745	-3.90	-3.13	-2.36	-3.26	-3.40	-3.49	-3.78	-1.52	-2.04	-1.40	-2.38	-1.80
SP	35 2746	22.35	23.23	22.09	23.72	23.18	23.18	22.26	22.01	21.76	20.46	21.82	21.92
SP	35 2749	5.67	4.96	4.76	4.39	4.31	4.48	4.29	3.86	4.56	4.02	5.09	4.89
SP	35 2750	-19.68	-19.82	-19.33	-20.61	-20.98	-20.61	-20.37	-20.58	-20.66	-20.44	-20.39	-21.08
SP	35 2758	18.40	18.44	18.59	19.08	19.17	18.89	19.23	19.35	20.10	19.57	19.74	20.59
SP	36 223	8.74	9.75	7.45	8.32	8.86	-	16.79	16.55	16.96	16.10	16.86	16.72
SP	36 1175	4.60	3.34	4.22	1.73	4.44	2.69	1.97	4.28	4.94	3.66	2.54	4.13
SP	36 1187	-43.64	-42.87	-43.47	-44.97	-44.31	-	-44.24	-44.58	-43.81	-44.58	-45.66	-44.71
SP	36 1531	78.18	79.06	80.67	79.27	80.06	80.00	79.73	81.84	81.00	81.14	81.61	83.47
SP	36 2068	4.39	3.24	4.22	5.92	5.01	3.89	4.31	3.03	5.50	4.81	3.89	2.35
SP	36 2218	23.92	25.63	24.18	24.90	25.62	25.15	25.08	24.95	24.97	24.78	25.12	25.09
SP	36 2295	15.12	16.54	16.49	17.22	17.31	17.41	18.10	17.64	16.82	18.49	17.66	18.64
SP	36 2297	-2.09	-2.24	-3.14	-1.72	-1.77	-2.59	-2.73	-2.15	-0.63	-1.29	-0.65	-1.41
SP	40 7201	-91.39*	-88.05*	-85.43*	-81.68*	-77.80*	-74.45*	-71.69*	-69.05*	-66.33*	-63.23*	-60.40	-57.53

Table 8A. (Cont.)

Lab.	Clock	57414	57444	57474	57504	57539	57569	57599	57629	57659	57689	57719	57749
SP	40 7203	57.72	58.42	59.17	59.88	60.61	61.30	61.99	62.65	63.31	63.98	64.61	65.18
SP	40 7210	-7.86	-7.39	-	2.07	5.89	8.61	-	5.10	7.28	9.08	10.19	12.56
SP	40 7212	0.35	0.49	0.87	1.04	1.32	1.52	1.82	2.01	2.38	2.63	2.79	3.07
SP	40 7221	-33.75	-33.58	-33.35	-33.16	-33.00	-32.82	-32.63	-32.45	-32.27	-32.07	-31.89	-31.79
SP	40 7223	8.89	10.57	13.05	14.13	14.72	15.48	16.21	16.89	17.64	18.36	19.04	19.63
SP	40 7231	158.13	165.62	173.10	180.56	188.47	196.24	203.55	210.77	217.96	225.08	232.12	239.13
SP	40 7232	-13.26	-12.02	-10.42	-8.87	-6.86	-3.61	-1.23	1.04	3.62	6.41	9.47	12.66
SU	40 3809	-0.28	0.00	0.29	0.50	0.80	1.08	1.30	1.55	1.81	2.19	2.58	2.85
SU	40 3810	8.21	8.48	8.75	8.97	9.27	9.53	9.82	10.04	10.23	10.62	10.97	11.17
SU	40 3811	-	-31.61	-30.89	-30.17	-29.34	-28.46	-27.76	-27.00	-26.26	-25.50	-24.85	-24.08
SU	40 3812	13.79	14.03	14.32	14.52	14.80	15.07	15.24	15.47	15.70	15.97	16.22	16.39
SU	40 3814	56.72	57.40	58.18	58.84	59.64	60.40	61.05	61.76	62.40	63.14	63.82	64.46
SU	40 3815	-24.55	-24.07	-23.57	-23.17	-22.60	-21.89	-21.37	-20.87	-20.45	-20.09	-19.71	-19.40
SU	40 3816	-49.71	-49.26	-48.69	-48.13	-47.46	-46.80	-46.23	-45.58	-44.99	-44.32	-43.82	-43.44
SU	40 3817	35.15	35.39	36.04	36.23	36.75	37.24	37.65	38.19	38.55	39.12	39.53	39.89
SU	40 3818	6.12	6.44	6.83	7.16	7.66	8.10	8.48	8.92	9.23	9.62	9.94	10.27
SU	40 3844	-	-	-	-	-	-2.44	-2.55	-2.55	-2.58	-2.50	-2.72	-2.67
TL	35 1012	2.03	1.28	14.52	-	-	-	-	-	-	-	-	-
TL	35 1498	4.71	4.64	4.45	4.51	5.30	4.43	5.92	4.12	3.61	5.06	3.95	4.35
TL	35 1500	13.84	15.28	13.76	13.82	14.34	-	-	-	-	-	-	-
TL	35 1712	-8.36	-7.57	-8.67	-7.97	-8.18	-7.24	-7.53	-8.99	-9.00	-8.46	-7.15	-7.75
TL	35 2365	3.65	4.12	4.14	3.68	4.09	3.98	3.36	3.35	4.74	3.73	4.26	4.69
TL	35 2366	-9.69	-9.86	-8.89	-8.88	-8.13	-8.93	-9.13	-10.57	-9.54	-9.89	-10.48	-10.21
TL	35 2367	11.18	11.73	12.53	10.90	12.02	10.70	10.68	10.81	12.27	11.50	11.40	11.57
TL	35 2368	0.71	1.49	1.16	2.03	2.19	2.45	2.54	2.86	2.27	2.94	2.37	2.60
TL	35 2630	-9.87	-10.38	-9.90	-9.42	-8.59	-9.03	-7.05	-7.45	-7.58	-8.33	-8.44	-8.82
TL	35 2634	12.56	11.65	11.16	12.01	12.18	12.54	13.85	-	-	-	-	-
TL	35 2636	16.41	15.94	15.00	16.47	15.92	16.53	16.70	19.40	20.22	19.30	18.69	17.99
TL	35 2853	-1.64	-0.90	-1.67	-2.17	-3.50	-4.83	-5.75	-7.07	-5.29	-5.26	-4.52	-5.77
TL	35 2910	5.29	5.79	4.87	5.42	5.40	5.45	5.53	6.13	6.18	5.88	5.84	6.67

Table 8A. (Cont.)

Lab.	Clock		57414	57444	57474	57504	57539	57569	57599	57629	57659	57689	57719	57749
TL	40	57	-111.09	-113.92	-115.86	-118.08	-120.40	-122.80	-124.85	-126.40	-128.68	-131.13	-133.71	-137.85
TL	40	3011	23.69	27.84	32.18	36.57	41.63	46.76	51.60	56.54	61.51	66.69	71.83	76.95
TL	40	3052	-32.31	-	-	-	-33.66	-34.39	-33.93	-34.51	-34.07	-33.88	-34.04	-36.45
TL	40	3053	-	-	-	-	-	15.05	24.35	32.72	41.32	49.63	57.61	65.22
TP	35	163	8.20	7.46	8.47	8.44	8.47	8.34	7.55	7.97	7.81	8.32	8.79	8.99
TP	35	1227	4.77	5.23	6.44	6.04	6.44	6.56	6.14	6.29	6.30	6.76	6.36	6.28
TP	35	2179	-	-	11.25	11.79	-	-	11.42	10.96	12.45	11.46	11.15	-
TP	35	2476	-1.31	-2.29	-2.38	-2.79	-2.52	-3.98	-3.01	-2.95	-3.33	-3.48	-4.97	-4.05
TP	35	2970	23.48	24.04	24.38	24.29	24.08	24.79	24.26	24.64	25.54	25.33	25.41	24.93
UA	35	2465	-11.14	-10.84	-9.56	-9.60	-9.67	-10.61	-9.61	-10.22	-10.59	-9.86	-3.10	-1.74
UA	40	7854	0.07	0.24	0.11	-0.29	0.11	0.02	-0.22	0.14	-0.43	0.27	-0.27	-0.02
UA	40	7881	1.42	0.56	-0.43	-0.77	0.63	-0.31	-0.22	0.06	-0.21	-1.24	1.12	0.65
UA	40	7882	0.89	-0.30	-0.07	-0.42	-0.04	-0.42	-2.44	-1.77	0.18	-1.40	1.74	1.67
UME	35	251	-0.10	0.20	-0.08	-0.45	0.32	-0.41	-0.19	0.34	-0.13	0.42	-	1.79
UME	35	252	2.13	2.51	2.39	3.14	1.45	-2.63	0.76	1.67	0.57	-0.03	-	1.38
UME	35	872	1.00	1.36	1.63	1.22	0.35	0.28	-0.71	-0.49	0.01	1.71	-	9.83
UME	35	2703	2.96	2.48	2.87	1.43	1.40	0.47	-0.94	-0.31	-1.25	-1.08	-	12.56
UME	35	2710	1.90	0.69	-0.16	-1.72	-1.26	-1.11	-0.69	-0.74	-0.40	-0.49	-	-6.65
USNO	35	101	16.11	17.62	17.07	17.35	17.21	16.85	18.05	17.43	18.56	17.06	17.29	17.77
USNO	35	104	19.82	19.36	20.62	20.47	20.23	20.80	20.77	21.61	22.15	21.26	21.49	21.06
USNO	35	108	2.63	2.58	3.12	2.28	2.94	2.43	2.26	2.20	2.89	3.43	2.34	2.72
USNO	35	114	-0.23	0.10	-	-	-	-	-	-	-	-	-	-
USNO	35	120	21.11	21.51	21.17	21.45	21.10	21.03	20.42	20.40	20.69	20.35	21.22	21.08
USNO	35	142	-13.58	-12.99	-12.68	-13.50	-13.23	-13.39	-12.91	-13.11	-13.75	-14.34	-14.22	-14.51
USNO	35	150	-5.04	-3.79	-5.01	-4.72	-5.35	-3.70	-5.89	-6.30	-6.40	-6.13	-5.96	-4.75
USNO	35	161	29.42	29.98	29.80	29.92	30.78	32.13	31.78	30.65	30.08	31.00	31.29	32.42
USNO	35	164	1.12	-0.37	0.27	0.13	-0.52	1.15	2.00	1.96	1.63	2.41	2.92	0.96
USNO	35	166	52.07	52.77	51.67	51.64	51.20	50.85	51.27	51.87	51.01	50.98	50.56	49.68
USNO	35	169	-13.44	-11.07	-3.82	-1.35	0.04	-0.13	-3.52	-4.13	-5.92	-7.92	-9.32	-9.89
USNO	35	173	-12.00	-11.75	-12.63	-11.87	-13.44	-12.99	-13.42	-13.94	-14.83	-13.50	-13.81	-13.26

Table 8A. (Cont.)

Lab.	Clock	57414	57444	57474	57504	57539	57569	57599	57629	57659	57689	57719	57749
USNO	35 226	10.03	9.91	10.40	10.00	10.20	10.74	9.72	9.95	10.76	11.33	10.88	10.91
USNO	35 233	13.72	16.43	15.79	15.62	14.95	14.94	14.19	14.01	13.74	13.21	12.82	13.42
USNO	35 244	10.63	9.02	9.32	10.14	9.61	8.99	9.24	9.17	-	-	-	-
USNO	35 254	8.96	8.86	8.89	8.61	8.90	9.43	9.02	8.67	10.05	9.12	9.91	9.44
USNO	35 256	22.02	21.82	21.61	20.64	21.38	20.90	20.92	21.32	20.86	20.58	21.26	20.74
USNO	35 260	34.10	44.28	43.54	41.25	39.23	37.35	37.28	36.65	37.02	39.53	39.34	39.29
USNO	35 268	-20.50	-21.62	-16.29	-15.72	-17.47	-17.19	-17.21	-16.06	-17.71	-18.78	-16.81	-19.84
USNO	35 270	14.19	14.53	14.06	12.69	14.03	13.08	14.21	13.05	13.81	13.38	13.93	12.96
USNO	35 279	30.54	28.11	27.37	27.36	24.46	23.98	24.44	23.77	22.83	27.36	25.47	24.32
USNO	35 389	-14.05	-12.77	-13.97	-13.18	-13.73	-13.59	-13.36	-13.33	-12.08	-13.32	-12.64	-12.21
USNO	35 394	-35.72	-35.51	-35.57	-34.89	-35.43	-35.23	-37.17	-	-	-	-	-
USNO	35 703	-1.23	-1.84	-1.95	-1.73	-1.36	-2.44	-1.75	-2.05	-3.14	-2.75	-5.45	-6.04
USNO	35 717	-14.37	-14.81	-15.53	-15.59	-16.05	-15.75	-17.41	-16.64	-15.90	-15.23	-15.10	-14.65
USNO	35 762	-1.73	-1.83	-0.94	-0.82	-1.79	-1.16	-0.74	-1.02	-0.97	-1.02	-1.73	-0.35
USNO	35 1096	14.59	15.07	14.17	14.81	15.10	13.87	12.00	11.66	11.93	11.51	12.00	12.66
USNO	35 1125	-12.36	-10.81	-10.56	-12.05	-11.81	-12.96	-11.37	-12.35	-12.06	-12.22	-12.28	-12.25
USNO	35 1327	-10.31	-9.68	-9.45	-10.71	-	-	-	-	-	-	-	-
USNO	35 1328	4.18	4.36	-	-	-	-	-	-	-	-	-	-
USNO	35 1331	-	-	-	-	-	-	-0.48	-0.59	-1.13	-	-	-
USNO	35 1459	-8.66	-7.94	-7.75	-7.83	-8.74	-8.30	-8.66	-7.73	-7.23	-7.18	-7.69	-7.63
USNO	35 1462	-0.50	-1.10	-1.03	-1.08	-0.58	-0.81	-0.92	-1.23	-0.06	-0.64	-0.61	0.01
USNO	35 1463	12.40	12.77	12.53	11.33	11.14	12.43	11.93	11.72	12.16	11.23	11.00	12.02
USNO	35 1468	5.79	6.29	6.51	6.53	6.25	6.57	5.71	5.26	5.23	4.63	6.74	7.22
USNO	35 1481	-28.12	-27.98	-28.14	-26.63	-	-	-	-	-	-	-	-
USNO	35 1543	10.24	11.45	11.55	12.57	13.52	13.53	14.20	13.89	12.97	12.75	13.14	12.73
USNO	35 1573	15.18	14.79	13.90	14.55	14.29	14.66	14.77	18.10	18.99	19.28	20.32	19.50
USNO	35 1575	-6.11	-6.39	-5.93	-6.09	-6.99	-5.68	-6.86	-6.50	-7.11	-6.33	-6.86	-6.55
USNO	35 1580	-16.22	-15.95	-16.24	-16.11	-16.53	-15.75	-15.57	-15.76	-14.17	-14.68	-15.25	-14.99
USNO	35 1585	-0.62	-3.42	-5.42	-5.89	-5.69	-5.20	-5.29	-4.67	-4.51	-5.36	-4.53	-5.09
USNO	35 1598	-21.57	-19.02	-18.54	-21.20	-22.91	-21.56	-20.60	-19.18	-20.58	-17.46	-17.04	-16.46

Table 8A. (Cont.)

Lab.	Clock	57414	57444	57474	57504	57539	57569	57599	57629	57659	57689	57719	57749
USNO	35 1655	-5.84	-6.12	-5.97	-6.35	-6.81	-7.86	-7.61	-8.32	-7.86	-8.43	-10.24	-11.05
USNO	35 1658	20.56	20.81	20.27	20.82	20.32	20.31	19.25	18.85	18.61	18.53	18.08	18.67
USNO	35 1692	-7.71	-7.70	-8.98	-7.51	-8.29	-7.12	-7.98	-8.69	-8.34	-7.96	-7.64	-8.69
USNO	35 1694	16.62	17.17	15.56	16.47	15.60	15.47	14.97	15.31	15.65	14.80	16.56	15.31
USNO	35 1696	14.01	13.37	13.32	13.23	13.54	12.27	12.98	12.60	12.37	12.06	11.74	12.09
USNO	35 1697	27.77	27.24	27.73	27.95	28.36	28.57	29.03	32.61	33.56	29.26	26.32	26.32
USNO	40 701	52.43	52.86	52.64	52.88	52.56	52.20	52.27	51.39	50.93	51.26	51.39	51.77
USNO	40 702	-6.71	-6.54	-6.51	-6.45	-6.40	-6.30	-6.09	-6.13	-6.27	-6.13	-6.05	-6.00
USNO	40 705	-70.25	-70.01	-70.08	-69.92	-69.88	-69.91	-69.83	-69.85	-69.68	-69.51	-69.50	-69.41
USNO	40 708	94.55	94.87	95.25	95.48	95.80	96.14	96.45	96.70	96.90	97.11	97.39	97.71
USNO	40 710	-532.81	-532.50	-532.06	-531.76	-531.46	-531.14	-530.81	-530.53	-530.31	-530.42	-530.15	-529.77
USNO	40 711	404.91	406.30	407.71	409.06	410.53	411.83	413.24	414.68	416.07	417.48	418.79	420.17
USNO	40 712	59.66	59.73	59.73	59.67	59.65	59.51	59.52	59.43	59.41	59.42	59.44	59.27
USNO	40 713	53.79	54.45	55.12	55.80	56.45	57.08	57.82	58.47	59.14	59.82	60.50	61.20
USNO	40 714	5.92	6.21	6.55	7.00	7.26	7.37	7.75	8.09	8.40	8.74	9.09	9.36
USNO	40 715	119.20	119.69	120.22	120.69	121.21	121.70	122.26	122.69	123.32	123.71	124.41	125.30
USNO	40 716	220.32	220.44	220.76	220.99	221.13	221.15	221.35	221.53	221.70	221.85	-	-
USNO	40 717	109.97	111.31	112.54	113.84	115.43	116.89	118.20	119.58	120.89	122.30	123.40	124.31
USNO	40 718	253.69	254.92	256.49	257.85	259.58	261.27	262.98	264.76	266.49	268.18	269.86	271.51
USNO	40 720	261.08	263.42	265.73	268.25	270.73	273.36	276.02	278.49	280.70	283.24	285.49	287.36
USNO	40 721	-467.11	-463.35	-459.63	-456.19	-452.36	-448.43	-444.63	-441.46	-438.16	-434.86	-431.37	-427.92
USNO	40 722	564.08	567.16	570.25	573.55	576.80	580.08	583.19	586.29	589.28	592.24	595.25	598.12
USNO	40 723	-63.34	-63.16	-62.92	-62.69	-62.59	-62.27	-61.97	-61.81	-61.62	-61.42	-61.17	-60.85
USNO	40 724	-100.54	-100.65	-100.71	-100.82	-100.99	-101.13	-101.17	-101.35	-101.52	-101.60	-101.81	-102.23
USNO	40 725	-35.06	-35.01	-34.67	-34.58	-34.38	-34.21	-33.90	-33.81	-33.60	-33.55	-33.44	-33.26
USNO	40 726	140.52	143.94	147.37	150.81	154.46	158.08	161.52	164.90	168.22	171.61	174.92	178.24
USNO	40 727	-726.82	-723.46	-719.97	-716.51	-712.80	-708.75	-705.16	-701.55	-698.11	-694.62	-691.06	-687.75
USNO	40 728	415.42	418.18	420.90	423.65	426.58	429.53	432.27	434.84	437.57	440.15	442.74	445.23
USNO	40 729	299.10	303.41	307.67	311.91	316.41	320.90	325.02	329.17	333.22	337.36	341.42	345.49
USNO	40 730	322.29	325.52	328.66	331.93	335.22	338.53	341.67	344.70	347.86	350.80	353.68	356.57

Table 8A. (Cont.)

Lab.	Clock		57414	57444	57474	57504	57539	57569	57599	57629	57659	57689	57719	57749
USNO	40	731	-178.53	-178.50	-178.55	-178.64	-178.80	-178.84	-178.89	-178.88	-178.90	-178.71	-178.77	-178.72
USNO	40	732	42.97	46.04	48.91	51.80	54.82	57.96	60.83	63.65	66.52	69.45	72.34	75.17
USNO	40	734	238.09	234.90	233.69	229.40	-	-	-	-	-	-	-	-
USNO	40	735	252.83	257.63	263.49	267.26	272.46	277.70	282.39	287.30	291.48	296.41	301.13	306.07
USNO	40	736	146.57	151.23	155.88	160.48	165.40	170.24	174.86	179.39	183.85	188.30	192.71	197.08
USNO	40	737	300.60	309.08	317.39	325.74	334.72	343.52	351.75	359.80	367.63	375.38	382.92	390.28
USNO	40	740	-	-	-	-	-	-	-	-	20.32	24.91	29.80	34.55
USNO	40	741	-	-	-	-	-	-	-	-	66.52	80.02	94.78	109.86
USNO	93	2	-5.91	-5.87	-5.86	-5.86	-5.80	-5.91	-5.84	-5.97	-5.92	-5.92	-5.89	-5.89
USNO	93	3	-5.78	-5.75	-5.68	-5.72	-5.73	-5.77	-5.72	-5.77	-5.78	-5.76	-5.75	-5.72
USNO	93	4	-5.78	-5.78	-5.71	-5.74	-5.71	-5.73	-5.75	-5.71	-5.70	-5.70	-5.68	-5.70
USNO	93	5	-5.80	-5.78	-5.74	-5.73	-5.75	-5.75	-5.75	-5.74	-5.75	-5.72	-5.74	-5.73
VMI	35	2230	-	-19.61	-16.85	-17.85	-15.88	-18.17	-15.41	-18.36	-	-15.19	-18.35	-17.79
VMI	36	1233	-	-8.50	-6.87	-7.10	-5.42	-6.05	-4.37	-8.13	-	-4.83	-8.92	-9.09
VMI	36	2314	-	18.16	20.44	19.64	21.94	20.23	21.58	19.02	-	21.38	18.69	19.47
VSL	35	179	27.16	27.53	27.23	28.09	27.21	27.44	27.51	27.19	27.52	27.04	27.36	27.12
VSL	35	456	-1.75	-2.11	-1.66	-3.88	-3.93	-4.01	-4.38	-5.29	-4.21	-5.48	-4.93	-4.43
VSL	35	548	18.30	18.73	18.49	17.33	17.93	17.37	18.21	18.72	18.35	17.87	18.02	16.60
VSL	35	731	-7.20	-7.34	-7.51	-8.10	-7.45	-7.65	-8.21	-7.99	-8.40	-8.66	-8.25	-7.98
ZA	36	1821	-7.64	-7.53	-8.06	-8.04	-8.51	-7.94	-8.35	-6.76	-	-	-	-
ZA	40	2901	-	-	-	-3.93*	1.34*	3.52*	4.73*	3.50*	2.31*	2.18*	1.14*	2.26

Table 9A. Relative weights (in percent) of contributing clocks in 2016

(File available at ftp://ftp2.bipm.org/pub/tai/scale/WTAI/wtai16.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/MICROSEMI Cs 4000
19 RHODES AND SCHWARZ XSC
21 OSCILLOQUARTZ 3210
22 OSCILLOQUARTZ OSA 3230B
23 OSCILLOQUARTZ EUDICS 3020
24 OSCILLOQUARTZ OSA 3235B
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/MICROSEMI 5071A High perf.
36 H-P/AGILENT/SYMMETRICOM/MICROSEMI 5071A Low perf.
4x HYDROGEN MASERS
50 FREQ. AND TIME SYSTEMS INC. 4065A
51 DATUM/SYMMETRICOM 4065 B
52 DATUM/SYMMETRICOM 4065 C
53 DATUM/SYMMETRICOM/MICROSEMI 4310 B
9x PRIMARY CLOCKS AND PROTOTYPES

Lab.	Clock	57414	57444	57474	57504	57539	57569	57599	57629	57659	57689	57719	57749
APL	35 904	0.000	0.000	0.000	0.000	0.000	0.019	0.022	0.025	0.032	0.039	0.038	0.045
APL	35 1264	0.077	0.075	0.089	0.106	0.109	-	-	-	-	-	-	-
APL	35 1791	0.020	0.022	0.025	0.028	0.026	0.024	0.025	0.028	0.034	0.037	0.043	0.061
APL	40 3107	0.978	0.976	0.990	0.995	1.010	1.039	1.036	1.044	1.047	1.039	1.053	1.028
APL	40 3108	0.978	0.976	0.990	0.995	1.010	1.039	1.036	1.044	1.047	1.039	1.053	1.028
APL	40 3109	0.978	0.976	0.990	0.995	1.010	1.039	1.036	1.044	1.047	1.039	1.053	1.028
AUS	36 299	0.000	0.000	0.023	0.033	0.041	0.053	0.060	0.042	0.050	0.030	0.032	0.035
AUS	36 340	0.016	0.022	0.024	0.030	0.035	0.038	0.039	0.030	0.030	0.029	0.026	0.027
AUS	36 654	0.000	0.154	0.111	0.098	0.087	0.043	0.036	0.039	0.039	-	0.000	0.000
AUS	36 1141	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.050	0.033	0.038	0.042	0.000

Table 9A. (Cont.)

Lab.	Clock	57414	57444	57474	57504	57539	57569	57599	57629	57659	57689	57719	57749
AUS	36 2269	0.000	0.000	0.000	0.000	0.033	0.044	0.039	0.043	0.052	-	-	0.000
BEV	35 1793	0.148	0.154	0.023	0.027	0.027	0.024	0.023	0.020	0.023	0.026	0.028	0.030
BEV	35 3009	0.215	0.286	0.376	0.287	0.320	0.289	0.311	0.216	0.142	0.158	0.163	0.184
BEV	40 3452	0.000	0.039	0.043	0.050	0.045	0.039	0.043	0.048	0.054	0.048	0.046	0.025
BIM	18 8058	0.014	0.009	0.010	0.011	0.012	0.014	0.016	-	-	0.000	0.000	-
BY	40 4227	0.022	0.029	0.021	0.019	0.012	0.014	0.014	-	0.000	0.000	0.000	0.000
BY	40 4229	0.000	0.020	0.017	0.008	0.009	0.007	0.006	-	0.000	0.000	0.000	0.000
BY	40 4278	0.024	0.000	0.000	0.000	0.000	0.000	0.000	-	0.000	0.000	0.000	0.000
CH	24 105	0.007	0.008	0.009	0.007	0.007	0.000	0.000	0.000	0.000	0.000	0.014	0.007
CH	35 2117	0.043	0.048	0.053	0.063	0.066	0.076	0.080	0.096	0.063	0.055	0.053	0.058
CH	35 2743	0.041	0.039	0.045	0.059	0.079	0.058	0.036	0.038	0.032	0.027	0.027	0.031
CH	40 5701	0.978	0.976	0.990	0.995	1.010	1.039	1.036	1.044	0.978	0.966	0.896	1.024
CH	40 5702	0.978	0.323	0.253	0.331	0.394	0.479	0.406	0.447	0.289	0.269	0.200	0.205
CNM	35 2708	0.155	0.087	0.072	0.085	0.083	0.090	0.095	0.089	0.105	0.122	0.125	0.159
CNM	35 2709	0.052	0.062	0.018	0.020	0.021	0.021	0.017	0.016	0.017	0.017	0.018	0.019
CNM	35 2885	0.134	0.158	0.116	0.137	0.137	0.159	0.173	0.201	0.238	0.110	0.076	0.072
CNM	35 3055	0.147	0.175	0.215	0.230	0.255	0.154	0.163	0.159	0.188	0.200	0.221	0.203
CNM	40 7301	0.352	0.416	0.205	0.239	0.239	0.244	0.133	0.101	0.113	0.115	0.118	0.136
CNM	40 7302	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.371	0.204	0.000	0.000	0.000
CNMP	36 1752	0.036	0.034	0.030	0.038	0.041	0.050	0.052	-	-	-	-	-
CNMP	36 1806	0.036	0.023	0.026	0.034	0.020	0.021	0.023	-	-	-	-	-
CNMP	36 2873	0.011	0.015	0.019	0.023	0.026	0.023	0.023	-	-	-	-	-
DFNT	36 1811	0.000	0.000	-	-	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
DFNT	36 2866	0.000	0.000	-	-	0.000	0.000	0.000	0.000	0.000	0.021	0.027	0.035
DMDM	35 2191	0.000	0.000	0.000	0.573	0.311	0.215	0.225	0.258	0.316	0.347	0.376	0.449
DMDM	36 2033	0.035	0.032	0.037	0.043	0.045	0.049	0.049	0.048	0.060	0.073	0.073	0.095
DTAG	35 2805	0.000	0.302	0.266	0.219	0.268	0.281	0.210	0.119	0.133	0.145	0.141	0.145
DTAG	35 2966	0.000	0.058	0.053	0.070	0.085	0.106	0.119	0.121	0.140	0.189	0.266	0.367
DTAG	35 3053	0.000	0.000	0.000	0.000	0.402	0.561	0.485	0.379	0.411	0.174	0.197	0.110
EIM	35 2060	-	-	-	0.000	-	-	0.000	0.000	0.000	0.000	0.000	0.116

Table 9A. (Cont.)

Lab.	Clock	57414	57444	57474	57504	57539	57569	57599	57629	57659	57689	57719	57749
ESTC	35 1615	0.000	0.000	0.000	0.000	0.012	0.017	0.020	0.023	0.028	0.031	0.034	0.040
ESTC	35 2025	0.046	0.051	0.061	0.070	0.080	0.059	0.061	0.067	0.078	0.093	0.112	0.133
ESTC	35 2353	0.000	0.000	0.000	0.000	0.009	0.012	0.013	0.015	0.018	0.020	0.021	0.024
ESTC	40 2543	0.054	0.050	0.039	0.044	0.047	0.054	0.059	0.066	0.083	0.103	0.126	0.180
ESTC	40 2544	0.037	0.049	0.066	0.054	0.055	0.000	0.000	0.000	0.000	0.000	0.000	0.000
F	35 157	0.191	0.184	-	-	0.000	0.000	0.000	-	-	-	0.000	0.000
F	35 355	0.049	0.056	0.066	0.077	0.082	0.082	0.082	0.016	0.017	0.018	0.019	0.022
F	35 396	0.138	0.172	0.227	0.258	0.306	0.177	0.184	0.131	0.149	0.150	0.162	0.190
F	35 469	0.085	0.098	-	-	-	-	-	-	-	-	-	-
F	35 489	0.055	0.049	-	-	0.000	0.000	0.000	-	-	-	0.000	0.000
F	35 609	0.000	0.000	0.000	0.000	0.083	0.102	0.116	0.139	0.174	0.113	0.093	0.100
F	35 770	-	-	-	-	-	-	0.000	0.000	0.000	0.000	0.000	0.031
F	35 774	0.050	0.053	0.063	0.069	0.054	0.053	0.046	0.038	0.038	0.033	0.035	0.025
F	35 781	0.153	0.190	0.256	0.372	-	-	-	-	-	-	-	-
F	35 859	0.020	0.024	0.017	0.019	0.020	-	-	-	0.000	0.000	0.000	0.000
F	35 1177	0.032	0.032	0.029	0.026	0.024	-	-	-	0.000	0.000	0.000	0.000
F	35 1222	0.043	0.038	0.045	0.053	0.056	0.055	0.055	0.063	0.074	0.093	0.108	0.123
F	35 1321	0.035	0.036	0.041	0.048	0.044	0.038	0.039	0.035	0.041	0.047	0.047	0.044
F	35 1556	0.000	0.000	0.000	0.000	0.043	0.036	0.039	0.043	0.048	0.052	0.055	0.053
F	35 1644	0.136	0.164	-	-	0.000	0.000	0.000	-	-	-	0.000	0.000
F	35 2027	-	-	-	-	-	-	-	-	0.000	0.000	0.000	0.000
F	35 2388	0.332	0.442	0.199	0.240	0.100	0.084	0.064	0.064	0.053	0.059	0.057	0.064
F	35 2609	0.054	0.067	0.091	0.092	0.052	0.060	0.060	0.066	0.074	0.068	0.074	0.088
F	35 2647	0.041	0.048	0.030	0.031	0.000	0.000	-	-	0.000	0.000	0.000	-
F	35 2804	0.279	0.308	0.262	0.233	0.226	0.251	0.264	0.286	0.293	0.189	0.184	0.197
F	35 2985	0.215	0.184	0.209	0.250	0.203	0.220	0.192	0.214	0.226	0.209	0.169	0.178
F	35 3054	-	-	-	-	0.000	0.000	0.000	-	-	-	0.000	0.000
F	40 809	0.978	0.976	0.288	0.325	0.262	0.229	0.214	0.219	0.251	0.285	0.317	0.387
F	40 810	0.978	0.976	0.990	0.995	1.010	1.039	1.036	1.044	1.047	1.039	1.053	1.028
F	40 889	0.978	0.976	0.990	0.995	1.010	1.039	1.036	1.044	1.047	1.039	1.053	1.028

Table 9A. (Cont.)

Lab.	Clock	57414	57444	57474	57504	57539	57569	57599	57629	57659	57689	57719	57749
F	40 890	0.978	0.976	0.990	0.995	1.010	1.039	0.852	0.843	0.862	0.810	0.845	0.957
HKO	35 2425	0.000	0.070	0.082	0.090	0.110	0.112	0.113	0.124	0.133	0.161	0.183	0.214
HKO	35 2884	0.150	0.174	0.156	0.178	0.142	0.164	0.096	0.095	0.110	0.127	0.135	0.157
IFAG	36 1167	0.023	0.026	0.013	0.014	0.014	0.016	0.013	0.014	0.016	0.018	0.021	0.022
IFAG	36 1173	0.010	0.012	0.016	0.015	0.017	0.018	0.019	0.022	0.031	0.015	0.016	0.011
IFAG	36 1629	0.029	0.028	0.031	0.037	0.036	0.042	0.045	0.049	0.056	0.055	0.063	0.072
IFAG	36 1732	0.064	0.070	0.089	0.090	0.095	0.115	0.129	0.106	0.125	0.104	0.115	0.135
IFAG	36 1798	0.145	0.171	0.227	0.233	0.238	0.085	0.068	0.072	0.082	0.086	0.090	0.104
IFAG	40 4418	0.978	0.976	0.990	-	-	-	0.000	0.000	0.000	0.000	0.000	0.051
IFAG	40 4439	0.169	0.213	0.267	-	0.000	0.000	0.000	0.000	0.000	0.429	0.567	0.729
IMBH	35 2685	0.000	0.000	0.000	0.000	0.000	0.000	-	-	-	-	-	-
IMBH	35 2909	0.000	0.000	0.000	0.006	0.000	0.000	-	-	-	-	-	-
INPL	35 2480	0.101	0.127	0.166	0.185	0.245	0.135	0.155	0.163	0.174	0.123	0.076	-
INPL	35 2481	0.098	0.067	0.083	0.098	0.093	0.099	0.113	0.046	0.048	0.047	0.050	-
INPL	35 3333	-	-	-	-	-	-	-	0.000	0.000	0.000	0.000	-
INPL	35 3351	-	-	-	-	-	-	-	0.000	0.000	0.000	0.000	-
INTI	36 2377	0.020	0.025	0.022	0.027	0.029	0.035	0.041	0.036	0.041	0.048	0.021	0.023
INXE	35 2393	-	-	-	0.000	0.000	0.000	0.000	0.000	0.031	0.040	0.051	0.058
IT	35 219	0.065	0.061	0.061	0.062	0.063	-	0.000	0.000	0.000	0.000	0.000	0.092
IT	35 505	0.069	0.064	0.073	0.085	0.079	0.092	0.102	0.114	0.153	0.185	0.215	0.106
IT	35 1115	0.184	0.232	0.164	0.215	0.219	-	0.000	0.000	0.000	0.000	0.000	0.037
IT	35 1373	0.000	0.000	0.000	0.246	0.142	-	0.000	0.000	0.000	0.000	0.000	0.050
IT	35 2118	0.104	0.117	0.112	0.133	0.149	0.120	0.111	0.069	0.063	0.070	0.077	0.088
IT	40 1101	0.978	0.976	0.990	0.995	1.010	1.039	1.036	1.044	1.047	1.039	1.053	1.028
IT	40 1102	0.816	0.925	0.939	0.995	1.010	0.867	0.822	0.885	0.896	1.039	1.053	1.028
IT	40 1103	0.978	0.976	0.990	0.995	1.010	1.039	1.036	1.044	1.047	1.039	1.053	1.028
IT	40 1104	0.017	0.022	0.027	0.033	0.037	0.042	0.054	0.060	0.071	0.089	0.113	0.181
JV	36 1277	0.019	0.015	0.017	0.020	0.022	0.025	0.024	0.026	0.033	0.039	0.028	-
JV	36 2617	0.030	0.030	0.028	0.032	0.029	0.035	0.038	0.024	0.027	0.027	0.024	0.028
JV	36 2629	0.052	0.067	0.054	0.042	0.046	0.048	0.039	0.040	0.035	0.038	0.038	0.044

Table 9A. (Cont.)

Lab.	Clock	57414	57444	57474	57504	57539	57569	57599	57629	57659	57689	57719	57749
JV	40 8713	0.098	0.109	0.095	0.116	0.119	0.121	0.126	0.138	0.166	0.193	0.159	0.144
KRIS	35 321	0.146	0.171	0.207	0.260	0.246	0.298	0.298	0.328	0.405	0.200	0.105	0.119
KRIS	35 739	0.172	0.173	0.216	0.091	0.077	0.085	0.074	0.078	0.076	0.085	0.095	0.086
KRIS	35 1135	0.023	0.025	0.027	0.030	0.015	0.016	0.016	0.013	0.014	0.009	0.008	0.009
KRIS	35 1693	0.137	0.154	0.184	0.224	0.201	0.200	0.210	0.238	0.265	0.328	0.399	0.138
KRIS	35 1783	0.119	0.150	0.173	0.087	0.067	0.074	0.034	0.030	0.032	0.033	0.035	0.039
KRIS	40 5626	0.978	0.976	0.990	0.995	1.010	1.039	1.036	1.044	1.047	1.039	1.053	1.028
KZ	35 2202	0.112	0.082	0.084	0.063	0.069	0.072	0.071	0.059	0.067	0.078	0.087	0.083
KZ	35 2665	0.022	0.026	0.031	0.037	0.044	0.048	0.060	0.088	0.100	0.120	0.118	0.135
KZ	35 2667	0.056	0.059	0.042	0.045	0.041	0.045	0.045	0.034	0.040	0.043	0.023	0.026
LT	35 1362	0.013	0.015	0.014	0.014	0.014	0.015	0.016	0.017	0.020	0.024	0.024	0.020
LT	35 1868	0.118	0.126	0.125	0.092	0.083	0.090	0.088	0.068	0.078	0.089	0.042	0.038
MBM	24 125	-	0.000	-	-	0.000	-	-	0.000	-	-	-	-
MIKE	36 986	0.037	0.045	0.031	0.037	0.041	0.049	0.044	0.021	0.018	0.018	0.016	0.014
MIKE	40 4108	0.000	0.000	0.000	0.000	0.000	-	-	-	0.000	0.000	0.000	0.000
MIKE	40 4113	0.013	0.016	0.014	0.015	0.012	0.014	0.012	0.012	0.013	0.015	0.014	0.017
MIKE	40 4180	0.978	0.976	0.990	0.995	1.010	1.039	1.036	1.044	1.047	1.039	1.053	1.028
MIKE	40 4189	0.031	0.030	0.035	0.041	0.044	0.053	0.054	0.066	0.088	0.112	0.138	0.179
MKEH	36 849	0.083	0.088	0.099	0.105	-	-	0.000	0.000	0.000	0.000	0.000	0.018
MSL	36 274	-	-	-	-	-	-	-	-	0.000	0.000	-	0.000
MSL	36 2869	-	-	-	-	-	-	-	-	0.000	0.000	-	0.000
MTC	35 3000	0.000	0.000	0.000	0.165	0.217	0.271	0.283	0.274	0.263	0.249	0.251	-
MTC	35 3002	0.000	0.000	0.000	0.197	0.070	0.089	0.075	0.065	0.059	0.069	0.074	0.068
MTC	35 3005	0.000	0.000	0.000	0.151	0.195	0.173	0.104	0.092	0.052	0.060	0.066	0.059
NAO	35 779	0.031	-	-	0.000	0.000	0.000	0.000	0.000	0.015	0.020	0.020	0.026
NAO	35 1206	0.000	-	-	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
NAO	35 1214	0.014	-	-	0.000	0.000	-	-	-	-	0.000	0.000	0.000
NAO	35 1689	0.000	-	-	0.000	0.000	0.000	0.000	0.000	0.046	0.057	0.070	0.075
NAO	40 1301	0.000	-	-	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
NICT	35 332	0.113	0.137	0.136	0.163	0.179	0.220	0.199	0.217	0.255	0.269	0.203	0.199

Table 9A. (Cont.)

Lab.	Clock	57414	57444	57474	57504	57539	57569	57599	57629	57659	57689	57719	57749
NICT	35 343	0.187	0.160	0.132	0.156	0.193	0.187	0.185	0.183	0.142	0.100	0.097	0.111
NICT	35 715	0.173	0.132	0.158	0.165	0.175	0.209	0.203	0.223	0.238	0.161	0.180	0.141
NICT	35 732	0.115	0.149	0.000	0.000	0.000	0.000	0.000	0.021	0.022	0.011	0.013	0.008
NICT	35 907	0.115	0.133	0.114	0.063	0.066	0.044	0.042	0.043	0.048	0.052	0.052	0.042
NICT	35 913	0.069	0.084	0.045	0.050	0.021	0.021	0.013	0.014	0.015	0.016	0.018	-
NICT	35 916	0.109	0.121	0.122	0.143	0.145	0.137	0.143	0.161	0.201	0.133	0.136	0.113
NICT	35 1225	0.148	0.165	0.177	0.159	0.129	0.126	0.134	0.150	0.174	0.090	0.092	0.105
NICT	35 1226	-	-	0.000	0.000	0.000	0.000	0.000	0.115	0.121	0.087	0.085	0.101
NICT	35 1611	-	-	0.000	-	-	-	-	-	-	-	-	0.000
NICT	35 1778	0.072	0.081	0.081	0.094	0.095	0.110	0.094	0.108	0.123	0.155	0.167	-
NICT	35 1789	0.083	0.000	0.000	0.000	0.000	0.000	0.009	0.010	0.012	0.015	0.017	0.021
NICT	35 1790	0.154	-	-	-	0.000	0.000	0.000	0.000	0.000	0.179	0.181	0.240
NICT	35 1866	0.220	0.236	0.168	0.156	0.146	0.161	0.166	0.174	0.200	0.169	0.153	0.180
NICT	35 1882	0.056	0.064	0.022	0.025	0.026	0.030	0.030	0.031	0.034	0.039	0.044	0.057
NICT	35 1887	0.146	0.128	0.157	0.134	0.117	0.132	0.137	0.150	0.175	0.165	0.183	0.137
NICT	35 1944	0.069	0.075	0.085	0.101	0.114	0.141	0.165	0.162	0.176	0.216	0.190	0.164
NICT	35 2010	0.165	0.186	0.214	0.260	0.274	0.286	0.233	0.131	0.093	0.099	0.107	0.107
NICT	35 2011	0.183	0.213	0.188	0.205	0.233	0.206	0.166	0.116	0.116	0.130	0.117	0.136
NICT	35 2056	0.241	0.292	0.302	0.207	0.138	0.066	0.051	0.047	0.050	0.055	0.051	0.058
NICT	35 2113	0.336	0.323	0.352	0.203	0.098	0.065	0.035	0.036	0.040	0.040	0.043	0.048
NICT	35 2116	0.242	0.257	0.309	0.368	0.409	0.308	0.311	0.340	0.401	0.501	0.540	0.148
NICT	35 2570	0.343	0.323	0.105	0.056	0.057	0.061	0.053	0.051	0.056	0.064	0.069	0.054
NICT	35 2574	0.057	0.058	0.051	0.035	0.032	0.029	0.030	0.031	0.033	0.037	0.036	0.042
NICT	35 2627	0.271	0.150	0.179	0.093	0.090	0.074	0.071	0.069	0.054	0.058	0.049	0.057
NICT	35 2628	0.035	0.043	0.056	0.077	0.070	0.082	0.080	0.080	0.062	0.067	0.056	0.064
NICT	35 2784	0.202	0.160	0.183	0.229	0.260	0.287	0.300	0.233	0.147	0.159	0.104	0.116
NICT	35 2876	0.192	0.202	0.232	0.279	0.237	0.277	0.307	0.299	0.313	0.379	0.421	0.194
NICT	35 2903	0.049	0.044	0.050	0.056	0.054	0.063	0.070	0.063	0.075	0.089	0.102	0.115
NICT	35 3259	-	-	-	-	-	0.000	0.000	0.000	0.000	0.000	0.281	0.384
NICT	36 1217	0.033	0.034	0.042	0.052	0.053	0.041	0.029	0.031	0.030	0.029	0.026	0.020

Table 9A. (Cont.)

Lab.	Clock	57414	57444	57474	57504	57539	57569	57599	57629	57659	57689	57719	57749
NICT	40 2003	0.484	0.677	0.551	0.667	0.723	0.717	0.679	0.729	0.886	1.039	1.053	1.028
NICT	40 2004	0.912	0.936	0.990	0.995	1.010	1.039	1.011	0.975	1.037	-	-	-
NICT	40 2006	0.942	-	-	0.000	0.000	-	-	-	0.000	0.000	0.000	0.000
NICT	40 2012	-	-	-	-	-	-	-	-	-	0.000	0.000	0.000
NICT	40 2013	-	-	-	-	-	-	0.000	0.000	0.000	0.000	0.000	0.215
NICT	40 2014	-	-	-	-	-	0.000	0.000	0.000	0.000	0.000	0.041	0.056
NICT	40 2015	-	-	-	-	-	-	-	-	-	0.000	0.000	0.000
NIM	35 1235	0.076	0.037	0.033	0.037	0.028	0.030	0.027	0.012	0.012	0.014	0.015	0.017
NIM	35 2256	0.211	0.216	0.132	0.136	0.134	0.099	0.086	0.065	0.063	0.056	0.054	0.050
NIM	35 2483	0.154	0.180	0.221	0.213	0.222	0.238	0.247	0.285	0.105	0.092	0.098	0.077
NIM	35 2643	0.047	0.053	0.045	0.037	0.038	0.041	0.043	0.045	0.049	0.059	0.069	0.093
NIM	35 2744	0.062	0.072	0.081	0.077	0.075	0.088	0.052	0.051	0.057	0.064	0.063	0.075
NIM	35 2767	0.153	0.176	0.197	0.105	0.100	0.112	0.113	0.126	0.153	0.084	0.072	0.070
NIM	35 2769	0.089	0.091	0.103	0.114	0.100	0.101	0.108	0.102	0.100	0.095	0.075	0.078
NIM	40 4832	0.243	0.296	0.394	0.521	0.629	0.707	0.724	0.673	0.809	1.006	1.047	1.028
NIM	40 4835	0.023	0.025	0.029	0.034	0.041	0.046	0.050	0.049	0.059	0.067	0.081	0.105
NIM	40 4871	0.978	0.976	0.990	0.995	1.010	0.488	0.428	0.398	0.449	0.480	0.521	0.599
NIM	40 4878	0.978	0.976	0.990	0.361	0.214	0.211	0.135	0.127	0.131	0.141	0.149	0.174
NIM	40 4879	0.010	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.006
NIM	40 4880	0.079	0.077	0.081	0.071	0.075	0.052	0.053	0.056	0.064	0.062	0.068	0.077
NIMB	35 600	0.008	0.010	0.013	0.015	-	-	-	-	-	-	0.000	0.000
NIMT	35 1511	-	-	-	-	-	-	-	0.000	0.000	0.000	0.000	0.000
NIMT	35 2246	0.030	0.033	0.037	0.043	0.044	-	-	-	-	-	-	-
NIMT	35 2247	0.014	0.000	0.000	0.000	0.000	-	-	0.000	0.000	0.000	0.000	-
NIMT	36 1169	-	-	-	-	-	-	-	0.000	0.000	0.000	0.000	0.000
NIS	35 2140	-	-	-	-	-	-	-	-	-	-	0.000	-
NIS	35 2181	-	-	-	-	-	-	-	-	-	-	0.000	-
NIS	35 2182	-	-	-	-	-	-	-	-	-	-	0.000	-
NIS	35 2633	-	-	-	-	-	-	-	-	-	-	0.000	-
NIST	35 282	0.363	0.243	0.270	0.292	0.257	0.279	0.298	0.330	0.270	0.293	0.326	0.341

Table 9A. (Cont.)

Lab.	Clock		57414	57444	57474	57504	57539	57569	57599	57629	57659	57689	57719	57749
NIST	35	408	0.028	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.006	0.004
NIST	35	1074	0.170	0.200	0.234	0.304	0.290	0.375	0.349	0.397	0.436	0.198	0.132	0.065
NIST	35	1519	0.232	0.122	0.148	0.172	0.141	0.088	0.081	0.078	-	-	-	-
NIST	35	2031	0.163	0.140	0.082	0.073	0.070	0.067	0.062	0.053	0.039	0.044	0.010	0.011
NIST	35	2032	0.234	0.209	0.140	0.151	0.161	0.184	0.188	0.168	0.139	0.114	0.128	0.109
NIST	35	2034	0.089	0.108	0.106	0.093	0.100	0.115	0.119	0.088	0.075	0.066	0.037	0.042
NIST	35	2579	0.035	0.028	0.031	0.022	0.022	0.023	0.024	0.027	0.031	0.037	0.046	0.065
NIST	35	2672	0.031	0.034	0.041	0.047	0.026	0.030	0.032	0.035	0.025	0.028	0.024	0.025
NIST	35	2935	0.227	0.260	0.189	0.134	0.120	0.136	0.138	0.151	0.131	0.124	0.129	0.134
NIST	40	4	-	-	-	-	-	-	-	-	0.000	0.000	0.000	0.000
NIST	40	203	-	-	-	-	-	-	-	-	-	0.000	0.000	0.000
NIST	40	205	0.978	0.976	0.990	0.995	1.010	1.039	1.036	1.044	1.047	1.039	1.053	1.028
NIST	40	206	0.287	0.270	0.291	0.339	0.365	0.414	0.447	0.470	0.408	0.478	0.574	0.792
NIST	40	207	0.803	0.869	0.895	0.995	0.976	1.039	1.036	1.044	1.047	1.039	1.053	1.028
NIST	40	210	0.000	0.000	0.362	0.452	0.382	0.284	0.284	0.318	0.381	0.435	0.482	0.566
NIST	40	212	0.000	0.000	0.000	0.000	1.010	1.039	1.036	1.044	1.047	1.039	1.053	1.028
NIST	40	222	0.978	0.976	0.990	0.995	1.010	1.039	1.036	1.044	1.047	1.039	1.053	1.028
NMIJ	35	224	0.246	0.315	0.312	0.308	0.344	0.370	0.406	0.133	0.095	0.091	0.087	0.093
NMIJ	35	459	-	-	-	-	-	-	0.000	0.000	0.000	0.000	0.000	0.000
NMIJ	35	523	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.063	0.087	0.087	0.110
NMIJ	40	5002	0.139	0.139	0.171	0.167	0.203	0.181	0.187	0.204	0.095	0.060	0.063	0.070
NMIJ	40	5003	0.978	0.976	0.990	0.961	0.449	0.467	0.474	0.437	0.499	0.565	0.514	0.591
NMIJ	40	5012	-	-	-	-	-	0.000	0.000	0.000	0.000	0.000	1.053	1.028
NMIJ	40	5015	0.978	0.705	0.865	0.603	0.545	0.544	0.564	0.613	0.685	0.802	0.899	1.028
NPL	35	1275	0.068	0.053	0.064	0.050	0.055	0.039	0.033	0.025	0.025	0.025	0.026	0.028
NPL	35	3167	0.000	0.000	0.000	0.000	0.000	0.195	0.160	0.098	0.122	0.110	0.115	0.125
NPL	40	1701	0.054	0.052	0.052	0.053	0.049	0.050	0.049	0.043	0.045	0.048	0.054	0.070
NPL	40	1708	0.978	0.754	0.856	0.661	0.628	0.349	0.227	0.100	0.093	0.099	0.105	0.088
NPLI	35	57	0.019	0.012	0.015	0.017	0.000	-	-	-	-	-	-	-
NPLI	35	140	0.011	0.008	0.010	0.010	0.011	0.010	0.010	0.009	0.010	0.011	-	-

Table 9A. (Cont.)

Lab.	Clock	57414	57444	57474	57504	57539	57569	57599	57629	57659	57689	57719	57749
NPLI	35 1324	0.017	0.014	0.018	0.021	0.016	0.019	0.016	0.016	0.015	0.016	0.012	0.013
NPLI	35 2245	0.100	0.091	0.107	0.129	0.142	0.161	0.179	0.196	0.107	0.108	0.111	0.063
NPLI	35 2796	0.103	0.113	0.140	0.157	0.197	0.260	0.371	0.366	0.328	0.299	0.152	0.155
NPLI	40 5201	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
NRC	35 2115	0.220	0.177	0.044	0.014	0.012	0.014	0.013	0.014	0.016	0.018	0.020	0.018
NRC	35 2150	0.059	0.070	0.040	0.013	0.012	0.014	0.014	0.015	0.016	0.018	0.020	0.022
NRC	35 2152	0.055	0.056	0.031	0.000	0.000	0.000	0.000	0.000	0.069	0.046	0.035	0.041
NRC	36 2219	0.054	0.059	0.065	0.023	0.015	0.017	0.017	0.018	0.020	0.023	0.026	0.028
NRC	40 304	0.000	0.000	-	-	-	-	-	-	-	-	-	-
NRC	40 306	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.126	0.136	0.092	0.043
NRL	35 714	-	-	0.000	0.000	0.000	0.000	0.000	-	-	-	-	-
NRL	35 719	-	-	0.000	0.000	0.000	0.000	0.000	-	-	-	-	-
NRL	35 1245	-	-	0.000	0.000	0.000	0.000	0.000	-	-	-	-	-
NRL	35 2460	0.000	-	-	-	0.000	-	-	-	-	-	-	-
NRL	35 2464	-	-	-	-	0.000	-	-	-	-	-	-	-
NRL	35 2580	0.000	-	-	-	0.000	-	-	-	-	-	-	-
NRL	36 387	-	-	0.000	0.000	0.000	0.000	0.000	-	-	-	-	-
NRL	36 2788	-	-	0.000	0.000	0.000	0.000	0.000	-	-	-	-	-
NRL	36 2791	-	-	0.000	0.000	0.000	0.000	0.000	-	-	-	-	-
NRL	36 2799	0.000	-	-	-	-	-	-	-	-	-	-	-
NRL	36 2800	0.000	-	-	-	-	-	-	-	-	-	-	-
NRL	36 2807	0.000	-	-	-	-	-	-	-	-	-	-	-
NRL	36 2818	0.000	-	-	-	-	-	-	-	-	-	-	-
NRL	36 2820	-	-	0.000	0.000	0.000	0.000	0.000	-	-	-	-	-
NRL	36 2829	-	-	0.000	0.000	0.000	0.000	0.000	-	-	-	-	-
NRL	36 2832	-	-	0.000	0.000	0.000	0.000	0.000	-	-	-	-	-
NRL	36 2834	-	-	0.000	0.000	0.000	0.000	0.000	-	-	-	-	-
NRL	40 1001	-	-	0.000	0.000	0.000	0.000	0.000	-	-	-	-	-
NRL	40 1004	-	-	0.000	0.000	0.000	0.000	0.000	-	-	-	-	-
NRL	40 1009	-	-	0.000	0.000	0.000	0.000	0.000	-	-	-	-	-

Table 9A. (Cont.)

Lab.	Clock	57414	57444	57474	57504	57539	57569	57599	57629	57659	57689	57719	57749
NRL	40 1010	-	-	0.000	0.000	0.000	-	-	-	-	-	-	-
NRL	40 1012	-	-	0.000	0.000	0.000	0.000	0.000	-	-	-	-	-
NTSC	35 1016	0.000	0.000	0.000	0.000	0.032	0.037	0.042	0.042	0.036	0.034	0.038	0.045
NTSC	35 1018	0.066	0.076	0.080	0.096	0.072	0.087	0.068	0.078	0.032	0.036	0.037	0.040
NTSC	35 1818	0.045	0.046	0.053	0.056	0.060	0.056	0.053	0.058	0.062	0.076	0.081	0.076
NTSC	35 1823	0.028	0.030	0.036	0.042	-	-	-	-	-	-	-	-
NTSC	35 2098	0.194	0.201	0.162	0.000	-	-	0.000	0.000	0.000	0.000	0.000	0.271
NTSC	35 2142	-	-	-	-	-	-	0.000	0.000	0.000	0.000	0.000	0.115
NTSC	35 2143	0.044	0.051	0.061	0.074	-	-	0.000	0.000	0.000	0.000	0.000	0.092
NTSC	35 2145	0.045	0.038	0.041	0.043	-	-	0.000	0.000	0.000	0.000	0.000	0.077
NTSC	35 2573	0.159	0.164	0.184	0.216	0.230	0.275	0.303	0.358	0.393	0.113	0.084	0.082
NTSC	35 2831	0.000	0.011	0.015	0.021	0.022	0.027	0.029	0.032	0.034	0.046	0.072	0.125
NTSC	35 2921	0.142	0.159	0.140	0.133	0.139	0.147	0.155	0.168	0.201	0.241	0.158	0.192
NTSC	35 2922	0.096	0.097	0.112	0.133	0.140	0.152	0.168	0.187	0.202	0.247	0.211	0.272
NTSC	35 2924	0.000	0.048	0.070	0.096	-	-	-	-	-	-	-	-
NTSC	35 2926	0.083	0.092	0.099	0.120	-	-	-	-	-	-	-	-
NTSC	35 2928	0.326	0.382	0.315	0.347	0.148	0.147	0.149	0.158	0.181	0.191	0.212	0.253
NTSC	35 2933	0.294	0.340	0.381	0.302	0.155	0.175	0.178	0.194	0.123	0.137	0.131	0.152
NTSC	35 2959	0.000	0.118	0.111	0.115	0.111	0.138	0.145	0.136	0.125	0.114	0.116	0.122
NTSC	35 2962	0.172	0.131	0.155	0.168	0.185	0.215	0.149	0.162	0.181	0.213	0.227	0.289
NTSC	35 2964	0.377	0.295	0.363	0.313	0.284	0.321	0.325	0.281	0.301	0.358	0.378	0.426
NTSC	35 2965	0.283	0.307	0.349	0.418	0.479	0.210	0.181	0.120	0.089	0.097	0.096	0.089
NTSC	35 2976	0.000	0.378	0.431	0.531	0.407	0.417	0.377	0.228	0.233	0.252	0.270	0.239
NTSC	35 2978	0.289	0.326	0.278	0.280	0.137	0.091	0.086	0.090	0.101	0.074	0.079	0.061
NTSC	35 2980	0.283	0.349	0.364	0.259	0.241	0.253	0.264	0.146	0.153	0.128	-	-
NTSC	35 2981	0.215	0.193	0.211	0.194	0.197	0.187	0.205	0.200	0.078	0.086	0.087	0.082
NTSC	35 3089	0.260	0.254	0.298	0.370	0.422	0.448	0.406	0.246	0.266	0.295	0.325	0.344
NTSC	35 3090	0.182	0.207	0.256	0.321	0.364	0.359	0.344	0.403	0.461	0.441	0.516	0.474
NTSC	35 3091	0.434	0.563	0.481	0.588	0.553	0.422	0.406	0.411	0.470	0.438	0.400	0.356
NTSC	35 3102	0.173	0.225	0.275	0.268	0.306	0.354	0.377	0.196	0.141	0.103	0.082	0.091

Table 9A. (Cont.)

Lab.	Clock		57414	57444	57474	57504	57539	57569	57599	57629	57659	57689	57719	57749
NTSC	40	296	0.978	0.976	0.990	0.995	1.010	1.039	1.036	1.044	0.533	0.187	0.177	0.194
NTSC	40	297	0.000	0.000	0.000	0.000	0.238	0.082	0.098	0.115	0.142	0.169	0.175	0.139
NTSC	40	326	-	-	-	-	-	-	-	-	0.000	0.000	0.000	0.000
NTSC	40	4903	-	-	-	-	-	-	-	-	-	-	-	0.000
NTSC	40	4926	0.029	0.033	0.042	0.053	0.066	0.092	0.122	0.163	0.162	0.149	0.166	0.187
NTSC	40	4927	0.000	0.011	0.012	0.011	0.007	0.006	0.004	0.005	0.005	0.005	0.005	0.006
ONRJ	35	102	0.207	0.253	0.252	0.313	0.345	0.144	0.134	0.103	0.113	0.125	0.129	0.140
ONRJ	35	103	0.034	0.027	0.028	0.033	0.031	0.036	0.038	0.046	0.035	-	-	-
ONRJ	35	123	0.062	0.072	0.076	0.098	0.102	0.106	0.099	0.105	0.073	0.060	0.042	0.043
ONRJ	35	129	0.392	0.457	0.236	0.280	0.135	0.113	0.080	0.064	0.063	0.067	0.072	0.061
ONRJ	35	147	0.158	0.143	0.173	0.109	0.113	0.114	0.057	0.056	0.063	0.062	0.063	0.059
ONRJ	35	1153	0.150	0.183	0.072	0.073	0.046	0.049	0.041	0.042	0.048	0.028	0.026	0.030
ONRJ	35	1942	0.000	0.000	0.000	0.000	0.000	0.140	0.077	0.092	0.099	0.117	0.117	0.125
ONRJ	40	1950	0.027	0.029	0.041	0.035	0.033	0.031	0.019	0.020	0.022	0.024	0.026	0.031
ONRJ	40	1958	0.653	0.286	0.038	0.000	0.000	-	-	-	-	-	-	-
ORB	35	2722	0.270	0.215	0.262	0.264	0.146	0.135	-	0.000	0.000	0.000	0.000	0.000
ORB	35	2723	0.020	0.022	0.027	-	-	-	-	0.000	0.000	0.000	0.000	0.000
ORB	35	2724	0.219	0.237	0.271	0.346	0.363	0.292	0.162	0.126	0.142	0.138	0.144	0.168
ORB	36	593	0.023	0.027	0.033	0.035	0.030	0.033	0.027	0.022	0.025	0.026	0.026	0.000
ORB	40	2602	-	-	-	-	0.000	0.000	0.000	0.000	0.000	1.039	-	0.000
PL	25	124	0.007	0.006	0.000	-	-	-	-	-	-	-	-	-
PL	25	125	0.015	0.018	0.020	-	-	-	-	-	-	-	-	-
PL	35	441	0.412	0.325	0.401	0.502	0.586	0.631	0.628	0.720	0.355	0.208	0.185	0.126
PL	35	745	0.088	0.124	0.123	0.126	0.145	0.170	0.168	0.183	0.172	0.172	0.121	0.139
PL	35	761	0.000	0.000	0.000	0.000	0.005	0.006	0.005	0.006	0.006	0.004	0.005	0.005
PL	35	1120	0.000	0.000	0.049	0.066	0.075	0.095	0.083	0.089	0.085	0.086	0.090	0.108
PL	35	1660	0.000	0.000	0.000	0.141	0.082	0.064	0.035	0.031	0.038	0.044	0.049	0.056
PL	35	1746	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.047
PL	35	1934	0.172	0.137	0.178	0.166	0.184	0.213	0.179	0.150	0.141	0.163	0.155	0.184
PL	35	2175	0.052	0.062	0.073	0.090	0.073	0.088	0.100	0.118	0.080	0.085	0.085	0.093

Table 9A. (Cont.)

Lab.	Clock	57414	57444	57474	57504	57539	57569	57599	57629	57659	57689	57719	57749
PL	35 2394	0.039	0.043	0.051	0.036	0.040	0.048	0.047	0.049	0.057	0.065	0.074	0.092
PL	35 2891	0.137	0.136	0.146	0.148	0.166	0.196	0.213	0.180	0.217	0.267	0.139	0.114
PL	40 4004	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
PL	40 4601	0.978	0.976	0.990	0.995	1.010	1.039	1.036	1.044	1.047	1.039	1.053	1.028
PL	40 4602	0.005	0.006	0.009	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-	0.000
PTB	35 415	0.050	0.047	0.031	0.036	0.030	0.031	0.033	0.036	0.043	0.046	0.053	0.067
PTB	35 1072	0.184	0.144	0.153	0.176	0.177	0.207	0.140	0.115	0.118	0.131	0.134	0.113
PTB	35 2987	0.080	0.092	0.110	0.124	0.098	0.112	0.095	0.088	0.094	0.104	0.101	0.126
PTB	40 506	0.059	0.074	0.094	0.116	0.130	0.192	0.320	0.000	0.000	0.000	0.000	0.000
PTB	40 508	0.000	0.976	0.990	-	-	-	-	-	-	0.000	0.000	0.000
PTB	40 509	0.978	0.976	0.990	0.995	1.010	1.039	1.036	1.044	1.047	1.039	1.053	1.028
PTB	40 510	-	-	-	-	-	-	-	-	-	0.000	0.000	0.000
PTB	92 1	0.000	0.000	0.000	0.000	0.000	0.118	0.151	0.186	0.186	0.186	0.086	0.077
PTB	92 2	0.386	0.425	0.504	0.343	0.322	0.339	0.292	0.310	0.371	0.372	0.337	0.399
ROA	35 583	0.045	0.046	0.054	0.052	0.058	0.069	0.074	0.073	0.072	0.085	0.083	0.031
ROA	35 718	0.056	0.052	0.058	0.066	0.061	0.070	0.073	0.085	0.085	0.102	0.117	0.136
ROA	35 1699	0.038	0.029	0.033	0.034	0.028	0.032	0.032	0.036	0.039	0.047	0.059	0.066
ROA	35 2270	0.033	0.028	0.032	0.038	0.039	0.040	0.020	0.000	0.000	0.000	0.000	0.000
ROA	36 1488	0.032	0.041	0.047	0.049	0.027	0.030	0.023	0.024	0.025	0.027	0.030	0.032
ROA	36 1490	0.035	0.042	0.052	0.066	0.082	0.110	0.154	0.276	0.116	0.021	0.021	0.011
ROA	40 1436	0.206	0.238	0.097	0.110	0.117	0.115	0.110	0.116	0.136	0.143	0.167	0.057
SASO	35 221	0.049	-	0.000	0.000	0.000	0.000	0.000	0.023	0.029	0.034	0.041	0.049
SASO	35 1628	0.066	-	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.014	0.018
SASO	35 2923	0.061	-	0.000	0.000	0.000	0.000	0.000	0.050	0.069	0.063	0.066	0.060
SASO	35 2931	0.225	-	0.000	0.000	0.000	0.000	0.000	0.290	0.219	0.204	0.221	0.263
SASO	35 2932	0.194	-	0.000	0.000	0.000	0.000	0.000	0.061	0.060	0.079	0.068	0.082
SCL	35 2178	0.000	0.000	-	-	-	-	-	-	-	-	-	-
SCL	35 2525	0.000	0.000	0.007	-	0.000	0.000	0.000	0.000	0.000	0.051	0.059	0.070
SG	35 188	0.459	0.390	0.425	0.510	0.489	0.379	0.343	0.314	0.345	0.328	0.169	0.188
SG	35 475	0.053	0.062	0.072	0.097	0.124	0.173	0.199	0.215	0.224	0.225	0.248	0.279

Table 9A. (Cont.)

Lab.	Clock	57414	57444	57474	57504	57539	57569	57599	57629	57659	57689	57719	57749
SG	35 696	0.054	0.068	-	-	-	-	-	-	-	0.000	0.000	0.000
SG	35 3135	0.201	0.079	0.092	0.122	0.144	0.128	0.108	0.000	0.000	0.000	0.000	0.000
SG	36 522	0.019	0.016	0.017	0.015	0.017	0.017	0.017	0.018	0.019	0.020	0.020	0.024
SG	40 7701	0.244	0.246	0.206	0.239	0.262	0.307	0.346	0.028	0.013	0.014	0.015	0.016
SIQ	36 1268	0.008	0.009	0.008	0.010	0.009	0.010	0.010	0.010	0.009	0.010	0.009	0.006
SMD	35 1766	0.110	0.105	-	-	-	-	-	0.000	0.000	0.000	0.000	0.000
SMD	35 2003	0.000	0.105	0.123	0.146	0.120	0.141	0.126	0.138	0.090	0.082	0.089	0.090
SMD	35 2543	0.078	0.104	0.055	0.050	0.028	0.019	0.019	0.018	0.019	0.019	0.020	0.012
SMD	40 7909	0.017	0.022	0.026	0.032	0.015	0.012	0.012	0.012	0.010	0.000	0.000	0.000
SMU	35 1193	-	0.000	0.000	0.000	0.000	0.000	0.043	0.049	-	-	0.000	0.000
SP	35 572	0.248	0.333	0.237	0.186	0.121	0.123	0.103	0.088	0.095	0.106	0.058	0.060
SP	35 641	0.163	0.116	0.124	0.116	0.124	0.121	0.093	0.092	0.106	0.080	0.054	0.061
SP	35 767	0.084	0.071	0.083	0.094	0.102	0.112	0.099	0.110	0.138	0.174	0.124	0.150
SP	35 1188	0.078	0.094	0.117	0.137	0.140	0.185	0.210	0.249	0.303	0.320	0.301	0.356
SP	35 1642	0.273	0.346	0.352	0.284	0.134	0.146	0.120	0.104	0.107	0.111	0.108	0.103
SP	35 2166	0.055	0.059	0.069	0.078	0.076	0.090	0.098	0.110	0.144	0.145	0.182	0.227
SP	35 2745	0.064	0.071	0.080	0.083	0.092	0.108	0.116	0.036	0.039	0.043	0.034	0.039
SP	35 2746	0.085	0.073	0.069	0.048	0.049	0.056	0.049	0.052	0.060	0.058	0.036	0.041
SP	35 2749	0.109	0.104	0.120	0.138	0.160	0.182	0.204	0.221	0.177	0.173	0.104	0.116
SP	35 2750	0.138	0.156	0.171	0.091	0.092	0.099	0.098	0.105	0.122	0.141	0.163	0.155
SP	35 2758	0.252	0.293	0.324	0.265	0.286	0.296	0.312	0.351	0.272	0.201	0.219	0.173
SP	36 223	0.024	0.025	0.021	0.024	0.026	-	0.000	0.000	0.000	0.000	0.000	0.047
SP	36 1175	0.046	0.043	0.049	0.027	0.017	0.017	0.017	0.013	0.014	0.014	0.014	0.014
SP	36 1187	0.069	0.094	0.086	0.052	0.054	-	0.000	0.000	0.000	0.000	0.000	0.031
SP	36 1531	0.014	0.016	0.018	0.018	0.021	0.026	0.028	0.022	0.025	0.031	0.037	0.033
SP	36 2068	0.016	0.019	0.022	0.022	0.024	0.026	0.031	0.033	0.019	0.021	0.021	0.019
SP	36 2218	0.028	0.027	0.026	0.029	0.031	0.034	0.037	0.043	0.055	0.076	0.097	0.136
SP	36 2295	0.030	0.030	0.036	0.039	0.044	0.053	0.057	0.058	0.058	0.044	0.042	0.043
SP	36 2297	0.083	0.099	0.081	0.071	0.076	0.071	0.074	0.076	0.054	0.055	0.059	0.051
SP	40 7201	0.978	0.976	0.844	0.437	0.356	0.383	0.284	0.214	0.206	0.225	0.243	0.283

Table 9A. (Cont.)

Lab.	Clock	57414	57444	57474	57504	57539	57569	57599	57629	57659	57689	57719	57749
SP	40 7203	0.978	0.976	0.990	0.995	1.010	1.039	1.036	1.044	1.047	1.039	1.053	1.028
SP	40 7210	0.137	0.061	-	0.000	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000
SP	40 7212	0.978	0.976	0.990	0.995	1.010	1.039	1.036	1.044	1.047	1.039	1.053	1.028
SP	40 7221	0.978	0.976	0.990	0.995	1.010	1.039	1.036	1.044	1.047	1.039	1.053	1.028
SP	40 7223	0.047	0.052	0.059	0.051	0.034	0.034	0.034	0.036	0.043	0.051	0.061	0.083
SP	40 7231	0.864	0.884	0.981	0.995	1.005	0.943	1.036	1.044	1.047	1.039	1.053	1.028
SP	40 7232	0.026	0.025	0.025	0.027	0.029	0.026	0.027	0.031	0.038	0.046	0.053	0.064
SU	40 3809	0.978	0.976	0.990	0.995	1.010	1.039	1.036	1.044	1.047	1.039	1.053	1.028
SU	40 3810	0.978	0.976	0.990	0.995	1.010	1.039	1.036	1.044	1.047	1.039	1.053	1.028
SU	40 3811	-	0.000	0.000	0.000	0.000	0.000	1.036	1.044	1.047	1.039	1.053	1.028
SU	40 3812	0.978	0.976	0.990	0.995	1.010	1.039	1.036	1.044	1.047	1.039	1.053	1.028
SU	40 3814	0.978	0.976	0.990	0.995	1.010	1.039	1.036	1.044	1.047	1.039	1.053	1.028
SU	40 3815	0.978	0.976	0.990	0.995	1.010	1.039	1.036	1.044	1.047	1.039	1.053	1.028
SU	40 3816	0.978	0.976	0.990	0.995	1.010	1.039	1.036	1.044	1.047	1.039	1.053	1.028
SU	40 3817	0.978	0.976	0.990	0.995	1.010	1.039	1.036	1.044	1.047	1.039	1.053	1.028
SU	40 3818	0.978	0.976	0.990	0.995	1.010	1.039	1.036	1.044	1.047	1.039	1.053	1.028
SU	40 3844	-	-	-	-	-	0.000	0.000	0.000	0.000	0.000	1.053	1.028
TL	35 1012	0.084	0.077	0.000	-	-	-	-	-	-	-	-	-
TL	35 1498	0.115	0.142	0.189	0.267	0.227	0.168	0.081	0.039	0.042	0.032	0.030	0.033
TL	35 1500	0.101	0.070	0.045	0.052	0.057	-	-	-	-	-	-	-
TL	35 1712	0.012	0.014	0.013	0.016	0.018	0.021	0.024	0.024	0.030	0.037	0.034	0.040
TL	35 2365	0.437	0.462	0.635	0.377	0.378	0.403	0.265	0.279	0.090	0.071	0.069	0.074
TL	35 2366	0.160	0.185	0.123	0.147	0.134	0.098	0.097	0.057	0.047	0.051	0.055	0.059
TL	35 2367	0.162	0.145	0.118	0.062	0.055	0.044	0.045	0.047	0.035	0.036	0.039	0.046
TL	35 2368	0.144	0.143	0.163	0.138	0.155	0.186	0.206	0.227	0.154	0.150	0.128	0.146
TL	35 2630	0.111	0.127	0.137	0.149	0.136	0.122	0.062	0.054	0.056	0.048	0.051	0.057
TL	35 2634	0.000	0.000	0.000	0.000	0.036	0.050	0.040	-	-	-	-	-
TL	35 2636	0.018	0.021	0.024	0.022	0.023	0.026	0.029	0.019	0.023	0.022	0.021	0.023
TL	35 2853	0.103	0.107	0.095	0.099	0.071	0.068	0.071	0.076	0.026	0.027	0.025	0.024
TL	35 2910	0.115	0.137	0.107	0.125	0.143	0.174	0.199	0.182	0.216	0.213	0.240	0.184

Table 9A. (Cont.)

Lab.	Clock	57414	57444	57474	57504	57539	57569	57599	57629	57659	57689	57719	57749
TL	40 57	0.051	0.059	0.074	0.098	0.121	0.158	0.203	0.235	0.317	0.311	0.266	0.059
TL	40 3011	0.127	0.137	0.152	0.174	0.173	0.186	0.190	0.199	0.230	0.251	0.283	0.354
TL	40 3052	0.458	-	-	-	0.000	0.000	0.000	0.000	0.000	0.088	0.114	0.023
TL	40 3053	-	-	-	-	-	0.000	0.000	0.000	0.000	0.000	0.114	0.087
TP	35 163	0.153	0.166	0.072	0.093	0.109	0.132	0.103	0.107	0.138	0.128	0.125	0.148
TP	35 1227	0.052	0.063	0.049	0.061	0.072	0.087	0.081	0.089	0.114	0.135	0.164	0.205
TP	35 2179	-	-	0.000	0.000	-	-	0.000	0.000	0.000	0.000	0.000	-
TP	35 2476	0.294	0.170	0.219	0.289	0.206	0.125	0.073	0.079	0.088	0.100	0.062	0.052
TP	35 2970	0.040	0.054	0.074	0.096	0.100	0.108	0.098	0.104	0.106	0.136	0.160	0.147
UA	35 2465	0.000	0.009	0.012	0.017	0.021	0.024	0.025	0.026	0.031	0.045	0.000	0.000
UA	40 7854	0.107	0.125	0.148	0.173	0.179	0.229	0.254	0.265	0.259	0.213	0.184	0.197
UA	40 7881	0.000	0.000	0.000	0.031	0.024	0.029	0.034	0.039	0.046	0.044	0.022	0.025
UA	40 7882	0.023	0.025	0.034	0.046	0.054	0.063	0.040	0.038	0.024	0.023	0.012	0.014
UME	35 251	0.249	0.299	0.426	0.479	0.286	0.202	0.197	0.167	0.162	0.156	-	0.000
UME	35 252	0.093	0.109	0.111	0.135	0.046	0.014	0.008	0.008	0.008	0.009	-	0.000
UME	35 872	0.082	0.095	0.114	0.123	0.111	0.130	0.116	0.108	0.093	0.044	-	0.000
UME	35 2703	0.073	0.067	0.082	0.050	0.054	0.058	0.053	0.043	0.051	0.053	-	0.000
UME	35 2710	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.160	-	0.000
USNO	35 101	0.019	0.020	0.023	0.028	0.031	0.036	0.037	0.041	0.048	0.038	0.045	0.050
USNO	35 104	0.132	0.139	0.085	0.099	0.103	0.109	0.115	0.111	0.128	0.083	0.092	0.096
USNO	35 108	0.054	0.062	0.069	0.066	0.067	0.074	0.080	0.091	0.091	0.103	0.078	0.096
USNO	35 114	0.067	0.073	-	-	-	-	-	-	-	-	-	-
USNO	35 120	0.117	0.117	0.133	0.159	0.168	0.201	0.189	0.224	0.251	0.334	0.157	0.175
USNO	35 142	0.041	0.043	0.051	0.055	0.063	0.075	0.078	0.093	0.110	0.131	0.172	0.212
USNO	35 150	0.066	0.055	0.052	0.060	0.063	0.044	0.026	0.027	0.032	0.035	0.038	0.032
USNO	35 161	0.124	0.138	0.147	0.173	0.167	0.121	0.101	0.056	0.054	0.053	0.056	0.044
USNO	35 164	0.041	0.039	0.045	0.056	0.064	0.046	0.044	0.046	0.050	0.056	0.062	0.032
USNO	35 166	0.040	0.042	0.045	0.054	0.058	0.067	0.066	0.062	0.065	0.081	0.096	0.107
USNO	35 169	0.238	0.061	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.031
USNO	35 173	0.031	0.039	0.049	0.053	0.047	0.051	0.056	0.064	0.074	0.047	0.050	0.051

Table 9A. (Cont.)

Lab.	Clock	57414	57444	57474	57504	57539	57569	57599	57629	57659	57689	57719	57749
USNO	35 226	0.203	0.245	0.260	0.284	0.330	0.331	0.153	0.157	0.119	0.116	0.107	0.121
USNO	35 233	0.132	0.033	0.033	0.035	0.030	0.033	0.032	0.035	0.041	0.049	0.059	0.061
USNO	35 244	0.087	0.053	0.061	0.060	0.064	0.070	0.073	0.082	-	-	-	-
USNO	35 254	0.129	0.170	0.251	0.400	0.618	0.485	0.382	0.330	0.114	0.079	0.071	0.073
USNO	35 256	0.121	0.137	0.160	0.148	0.105	0.116	0.120	0.116	0.127	0.144	0.121	0.133
USNO	35 260	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.008	0.010	0.013
USNO	35 268	0.030	0.033	0.000	0.000	0.000	0.000	0.000	0.026	0.022	0.026	0.018	0.012
USNO	35 270	0.060	0.062	0.074	0.060	0.047	0.049	0.041	0.038	0.040	0.045	0.046	0.045
USNO	35 279	0.015	0.015	0.019	0.022	0.021	0.025	0.023	0.025	0.030	0.000	0.000	0.000
USNO	35 389	0.076	0.070	0.057	0.061	0.064	0.075	0.080	0.091	0.073	0.054	0.056	0.064
USNO	35 394	0.110	0.138	0.170	0.185	0.176	0.220	0.059	-	-	-	-	-
USNO	35 703	0.014	0.015	0.017	0.019	0.020	0.023	0.025	0.030	0.034	0.042	0.025	0.031
USNO	35 717	0.082	0.096	0.108	0.127	0.143	0.128	0.076	0.061	0.057	0.057	0.062	0.071
USNO	35 762	0.095	0.128	0.128	0.168	0.119	0.120	0.121	0.126	0.153	0.184	0.143	0.068
USNO	35 1096	0.566	0.453	0.249	0.208	0.206	0.108	0.051	0.053	0.051	0.056	0.045	0.043
USNO	35 1125	0.139	0.061	0.072	0.054	0.057	0.052	0.034	0.034	0.038	0.043	0.048	0.058
USNO	35 1327	0.216	0.154	0.174	0.099	-	-	-	-	-	-	-	-
USNO	35 1328	0.039	0.045	-	-	-	-	-	-	-	-	-	-
USNO	35 1331	-	-	-	-	-	-	0.000	0.000	0.000	-	-	-
USNO	35 1459	0.094	0.093	0.115	0.150	0.125	0.138	0.149	0.096	0.099	0.112	0.094	0.109
USNO	35 1462	0.122	0.119	0.146	0.185	0.193	0.228	0.265	0.286	0.128	0.120	0.131	0.124
USNO	35 1463	0.098	0.108	0.125	0.089	0.097	0.062	0.064	0.069	0.077	0.066	0.073	0.057
USNO	35 1468	0.143	0.142	0.179	0.234	0.228	0.279	0.174	0.176	0.202	0.211	0.037	0.039
USNO	35 1481	0.097	0.110	0.130	0.066	-	-	-	-	-	-	-	-
USNO	35 1543	0.041	0.047	0.056	0.070	0.083	0.081	0.089	0.080	0.060	0.068	0.071	0.087
USNO	35 1573	0.048	0.060	0.062	0.072	0.085	0.097	0.107	0.022	0.025	0.026	0.028	0.022
USNO	35 1575	0.183	0.241	0.212	0.263	0.178	0.092	0.066	0.066	0.071	0.065	0.065	0.070
USNO	35 1580	0.137	0.138	0.168	0.196	0.217	0.152	0.163	0.179	0.084	0.075	0.063	0.072
USNO	35 1585	0.017	0.017	0.022	0.026	0.024	0.022	0.023	0.024	0.028	0.028	0.030	0.035
USNO	35 1598	0.019	0.012	0.015	0.013	0.012	0.013	0.013	0.012	0.014	0.011	0.012	0.014

Table 9A. (Cont.)

Lab.	Clock	57414	57444	57474	57504	57539	57569	57599	57629	57659	57689	57719	57749
USNO	35 1655	0.432	0.533	0.573	0.653	0.674	0.324	0.241	0.237	0.151	0.160	0.068	0.072
USNO	35 1658	0.295	0.318	0.299	0.274	0.245	0.282	0.157	0.167	0.189	0.194	0.215	0.128
USNO	35 1692	0.105	0.111	0.098	0.058	0.058	0.050	0.046	0.044	0.051	0.056	0.060	0.058
USNO	35 1694	0.114	0.110	0.075	0.062	0.063	0.071	0.074	0.071	0.079	0.081	0.042	0.036
USNO	35 1696	0.040	0.044	0.053	0.066	0.076	0.069	0.064	0.073	0.094	0.114	0.135	0.144
USNO	35 1697	0.075	0.079	0.092	0.113	0.128	0.153	0.164	0.024	0.027	0.000	0.000	0.000
USNO	40 701	0.000	0.040	0.058	0.078	0.089	0.103	0.114	0.101	0.117	0.161	0.160	0.151
USNO	40 702	0.978	0.976	0.990	0.995	1.010	1.039	1.036	1.044	1.047	1.039	1.053	1.028
USNO	40 705	0.978	0.976	0.990	0.995	1.010	1.039	1.036	1.044	1.047	1.039	1.053	1.028
USNO	40 708	0.978	0.976	0.990	0.995	1.010	1.039	1.036	1.044	1.047	1.039	1.053	1.028
USNO	40 710	0.978	0.976	0.990	0.995	1.010	1.039	1.036	1.044	1.047	1.039	1.053	1.028
USNO	40 711	0.978	0.976	0.990	0.995	1.010	1.039	1.036	1.044	1.047	1.039	1.053	1.028
USNO	40 712	0.978	0.976	0.990	0.995	1.010	1.039	1.036	1.044	1.047	1.039	1.053	1.028
USNO	40 713	0.000	0.000	0.000	0.000	0.000	0.000	1.036	1.044	1.047	1.039	1.053	1.028
USNO	40 714	0.492	0.541	0.607	0.710	0.671	0.625	0.643	0.694	0.826	0.985	1.053	1.028
USNO	40 715	0.978	0.976	0.990	0.995	1.010	1.039	1.036	1.044	1.047	1.039	1.053	1.028
USNO	40 716	0.978	0.976	0.990	0.995	1.010	1.039	1.036	1.044	1.047	1.039	-	-
USNO	40 717	0.978	0.976	0.990	0.995	1.010	1.039	1.036	1.044	1.047	1.039	1.053	1.028
USNO	40 718	0.048	0.059	0.071	0.087	0.095	0.313	0.457	0.484	0.579	0.738	0.939	1.028
USNO	40 720	0.978	0.976	0.990	0.995	1.010	1.039	1.036	1.044	1.047	1.039	1.053	0.624
USNO	40 721	0.805	0.846	0.966	0.995	1.010	1.039	1.036	0.913	0.855	0.841	0.886	0.961
USNO	40 722	0.733	0.627	0.677	0.842	0.846	0.946	1.036	1.044	1.047	1.039	1.053	1.028
USNO	40 723	0.978	0.976	0.990	0.995	1.010	1.039	1.036	1.044	1.047	1.039	1.053	1.028
USNO	40 724	0.154	0.215	0.309	0.517	1.010	1.039	1.036	1.044	1.047	1.039	1.053	1.028
USNO	40 725	0.978	0.976	0.990	0.995	1.010	1.039	1.036	1.044	1.047	1.039	1.053	1.028
USNO	40 726	0.978	0.976	0.990	0.995	1.010	1.039	1.036	1.044	1.047	1.039	1.053	1.028
USNO	40 727	0.303	0.402	0.545	0.731	1.010	0.906	0.967	1.044	1.047	1.039	1.053	1.028
USNO	40 728	0.024	0.030	0.038	0.047	0.053	0.086	0.167	0.626	1.047	1.039	1.053	1.028
USNO	40 729	0.978	0.976	0.990	0.995	1.010	1.039	1.036	1.044	1.047	1.039	1.053	1.028
USNO	40 730	0.978	0.976	0.990	0.995	1.010	1.039	1.036	1.044	1.047	1.039	1.053	1.028

Table 9A. (Cont.)

Lab.	Clock	57414	57444	57474	57504	57539	57569	57599	57629	57659	57689	57719	57749
USNO	40 731	0.978	0.976	0.990	0.995	1.010	1.039	1.036	1.044	1.047	1.039	1.053	1.028
USNO	40 732	0.044	0.055	0.070	0.086	0.097	0.149	0.270	0.702	1.047	1.039	1.053	1.028
USNO	40 734	0.099	0.088	0.036	0.037	-	-	-	-	-	-	-	-
USNO	40 735	0.150	0.140	0.073	0.074	0.080	0.091	0.098	0.108	0.121	0.143	0.169	0.203
USNO	40 736	0.978	0.976	0.990	0.995	1.010	1.039	1.036	1.044	1.047	1.039	1.053	1.028
USNO	40 737	0.488	0.551	0.601	0.698	0.749	0.791	0.906	0.939	0.770	0.648	0.456	0.357
USNO	40 740	-	-	-	-	-	-	-	-	0.000	0.000	0.000	0.000
USNO	40 741	-	-	-	-	-	-	-	-	0.000	0.000	0.000	0.000
USNO	93 2	0.978	0.976	0.990	0.995	1.010	1.039	1.036	1.044	1.047	1.039	1.053	1.028
USNO	93 3	0.978	0.976	0.990	0.995	1.010	1.039	1.036	1.044	1.047	1.039	1.053	1.028
USNO	93 4	0.978	0.976	0.990	0.995	1.010	1.039	1.036	1.044	1.047	1.039	1.053	1.028
USNO	93 5	0.978	0.976	0.990	0.995	1.010	1.039	1.036	1.044	1.047	1.039	1.053	1.028
VMI	35 2230	-	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-	0.000	0.000	0.000
VMI	36 1233	-	0.000	0.000	0.000	0.000	0.000	0.000	0.005	-	0.000	0.000	0.000
VMI	36 2314	-	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-	0.000	0.000	0.000
VSL	35 179	0.127	0.150	0.166	0.156	0.122	0.141	0.157	0.176	0.187	0.193	0.197	0.235
VSL	35 456	0.123	0.144	0.162	0.049	0.052	0.058	0.061	0.064	0.044	0.041	0.040	0.043
VSL	35 548	0.092	0.124	0.195	0.123	0.112	0.123	0.090	0.086	0.095	0.089	0.096	0.060
VSL	35 731	0.158	0.184	0.201	0.186	0.167	0.193	0.183	0.192	0.220	0.273	0.215	0.221
ZA	36 1821	0.028	0.034	0.042	0.055	0.070	0.084	0.104	0.060	-	-	-	-
ZA	40 2901	-	-	-	0.000	0.000	0.000	0.000	0.000	0.050	0.043	0.038	0.026

Table 9B: Statistical data on the weights attributed to the clocks in 2016

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	
2016 Jan.	120	279	451	7	26	42	10	13	25	53	0	57	0.978
2016 Feb.	118	269	438	5	16	28	9	15	26	51	0	55	0.976
2016 Mar.	121	271	447	8	24	43	9	19	30	50	0	54	0.990
2016 Apr.	122	273	448	12	23	46	10	19	30	50	0	54	0.995
2016 May	124	270	449	13	27	53	10	16	27	51	0	55	1.010
2016 June	124	257	433	15	22	48	9	13	24	49	0	53	1.039
2016 July	125	265	445	15	32	59	8	10	22	51	0	55	1.036
2016 Aug.	119	263	428	12	26	45	7	11	20	51	0	55	1.044
2016 Sep.	128	263	435	19	26	53	7	9	17	51	0	55	1.047
2016 Oct.	132	264	441	21	26	56	9	9	20	54	0	58	1.039
2016 Nov.	129	267	440	17	35	60	8	8	17	55	0	59	1.053
2016 Dec.	132	259	436	18	22	47	7	7	17	57	0	61	1.028

Wmax=A/N, here N is the number of clocks, excluding those with a priori null weight, A=4.00.
* 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.

Table 10. Relative drifts of contributing clocks in 2016

(File available at ftp://ftp2.bipm.org/pub/tai/scale/DTAI/dtai16.ar)

Clock drifts are computed using a monthly realization of TT(BIPM) as reference for 6-months intervals ending at the MJD dates given in the table. "-" denotes that the clock was not used. Unit is ns/day/30days.

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/MICROSEMI Cs 4000
19 RHODES AND SCHWARZ XSC
21 OSCILLOQUARTZ 3210
22 OSCILLOQUARTZ OSA 3230B
23 OSCILLOQUARTZ EUDICS 3020
24 OSCILLOQUARTZ OSA 3235B
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/MICROSEMI 5071A High perf.
36 H-P/AGILENT/SYMMETRICOM/MICROSEMI 5071A Low perf.
4x HYDROGEN MASERS
50 FREQ. AND TIME SYSTEMS INC. 4065A
51 DATUM/SYMMETRICOM 4065 B
52 DATUM/SYMMETRICOM 4065 C
53 DATUM/SYMMETRICOM/MICROSEMI 4310 B
9x PRIMARY CLOCKS AND PROTOTYPES

Lab.	Clock	57414	57444	57474	57504	57539	57569	57599	57629	57659	57689	57719	57749
APL	35 0904	-0.6293	-1.0857	-1.4610	-1.5426	-1.1252	-0.2111	0.1706	0.3527	0.3810	0.3746	0.3198	0.0982
APL	35 1264	0.3407	0.2214	0.1529	-0.0547	-0.1283	-	-	-	-	-	-	-
APL	35 1791	0.1338	-0.0788	-0.1762	-0.1233	-0.3574	0.1076	0.0015	0.0056	-0.0016	0.2056	0.0811	0.1071
APL	40 3107	0.1764	0.1381	0.1552	0.1514	0.1741	0.2052	0.2287	0.2325	0.2438	0.2292	0.2285	0.2289
APL	40 3108	2.6624	2.6119	2.6182	2.6106	2.6033	2.5974	2.6065	2.6062	2.6181	2.5964	2.5693	2.5405
APL	40 3109	-0.3298	-0.3449	-0.3074	-0.3043	-0.2876	-0.2706	-0.2639	-0.2648	-0.2482	-0.2622	-0.2675	-0.2553
AUS	36 0299	0.2366	0.5450	0.2300	0.1572	0.1444	-0.0722	0.1066	-0.0729	-0.1929	-0.0054	0.1772	0.2920
AUS	36 0340	-0.2327	-0.2160	-0.2424	-0.0802	0.0787	0.4496	0.3266	-0.0072	-0.0208	0.1821	0.0437	-0.0290
AUS	36 0654	0.0683	-0.0092	0.0652	-0.0186	0.0365	-0.1889	-0.1099	-0.2368	-0.0504	-	-1.8597	0.2676
AUS	36 1141	0.4647	-0.1500	0.2398	0.1958	0.4246	0.3676	0.4335	-0.4072	-0.6968	-0.8310	-1.1302	-0.1401

Table 10. (Cont.)

Lab.	Clock	57414	57444	57474	57504	57539	57569	57599	57629	57659	57689	57719	57749
AUS	36 2269	0.0203	-0.4346	0.0372	0.1087	0.0346	-0.0017	0.3459	0.1832	0.2256	-	-	-5.5769
BEV	35 1793	0.0023	-0.2626	-0.9171	-1.1384	-1.4826	-1.3043	-0.9639	-0.2574	-0.0205	0.1478	0.1168	0.2540
BEV	35 3009	0.0972	0.1017	0.1276	0.0542	0.0401	0.0364	0.0822	0.2123	0.2246	0.1495	0.0835	0.0552
BEV	40 3452	5.5213	5.4892	5.4281	5.2469	4.7927	4.2954	4.1105	3.9705	3.9577	4.1665	4.5430	5.0743
BIM	18 8058	0.2516	0.0167	0.1396	0.2043	0.0947	0.2378	0.5795	-	-	1.6275	-1.4469	-
BY	40 4227	0.1979	0.2936	0.0199	0.0788	0.5331	1.0451	1.6135	-	1.5965	0.2127	1.7972	-0.2889
BY	40 4229	-4.3102	-3.4885	-3.9355	-3.4394	-2.7540	-1.8327	-1.0864	-	-0.1521	-0.4997	0.5315	-0.1087
BY	40 4278	-1.7538	7.7827	16.6975	20.6511	19.0059	14.2390	4.2342	-	13.6959	19.0968	13.4338	8.6749
CH	24 0105	2.7503	2.9298	3.7898	3.5252	2.5888	2.6233	2.9305	3.3863	3.7004	3.4031	2.3185	1.6273
CH	35 2117	-0.0656	-0.1711	-0.1718	0.0817	-0.0081	0.0210	0.0607	0.1259	0.0222	0.1117	-0.0609	-0.0936
CH	35 2743	-0.1774	-0.0953	0.0686	0.2436	0.3725	0.0369	0.0290	0.1061	0.4498	0.4412	0.5716	0.4093
CH	40 5701	-0.0635	-0.0708	-0.0966	-0.1700	-0.2201	-0.2536	-0.2682	-0.2664	-0.2019	-0.1584	-0.0886	-0.0323
CH	40 5702	2.0921	2.0228	1.8752	1.7295	1.6255	1.6210	1.7232	1.7877	1.7116	1.5889	1.3912	1.1762
CNM	35 2708	0.0298	-0.1444	-0.0577	0.0412	-0.0131	0.0070	0.1105	-0.0989	-0.1162	-0.1494	-0.2015	-0.1454
CNM	35 2709	-0.0338	-0.0742	0.4838	0.9241	0.9691	0.7699	0.9079	0.9342	1.2078	1.1080	0.8516	0.2249
CNM	35 2885	-0.3174	-0.2339	-0.1034	-0.0505	0.0458	0.0252	-0.0090	-0.0686	-0.0597	0.1164	0.0177	0.0762
CNM	35 3055	0.0779	0.0426	0.1253	0.2667	0.2745	0.1452	0.0859	0.0639	0.0405	0.0209	0.1183	0.0162
CNM	40 7301	-0.1426	-0.1272	0.0723	0.1316	0.2672	0.2803	0.1060	-0.1980	-0.3256	-0.3809	-0.2854	-0.1399
CNM	40 7302	-17.4478	-8.0182	8.0275	8.6279	8.5588	8.4990	8.4591	8.3837	8.2286	-3.6161	-14.9307	-20.5971
CNMP	36 1752	0.3429	0.1197	0.2010	0.1234	-0.0508	-0.0087	0.0291	-	-	-	-	-
CNMP	36 1806	-0.4290	-0.2686	-0.0072	0.1986	0.0787	0.0153	-0.1736	-	-	-	-	-
CNMP	36 2873	0.3004	0.4226	0.2818	-0.0256	-0.2488	0.2018	0.2006	-	-	-	-	-
DFNT	36 1811	-3.6257	-314.76	-	-	2.6228	1.2210	-0.2289	0.8223	1.0389	0.5312	0.1536	-0.2295
DFNT	36 2866	0.7129	-104.01	-	-	0.2013	0.7753	0.0622	0.3748	0.4754	0.2334	0.0417	-0.1519
DMDM	35 2191	-0.1433	0.0087	0.0403	0.0219	0.1076	0.0925	0.0761	0.1178	0.1409	0.0883	0.1382	0.1034
DMDM	36 2033	0.0860	0.0082	0.2228	0.2474	-0.0788	-0.0240	0.0354	0.0703	0.1256	0.0944	0.1270	0.2169
DTAG	35 2805	0.2831	0.3233	0.4511	0.4084	0.4011	0.3421	0.1757	0.2014	0.2501	0.1912	0.1212	-0.0225
DTAG	35 2966	0.1751	0.2828	0.2222	0.0589	0.0718	-0.0608	-0.0608	0.1022	0.1119	0.0698	0.0614	-0.0001
DTAG	35 3053	0.1042	0.1640	0.1358	0.1661	0.1601	0.2020	0.1555	0.1646	0.1550	0.2652	0.3588	0.2554
EIM	35 2060	-	-	-	2.5192	-	-	-0.1010	-0.5282	0.1413	0.0312	0.0225	0.0095

Table 10. (Cont.)

Lab.	Clock	57414	57444	57474	57504	57539	57569	57599	57629	57659	57689	57719	57749
ESTC	35 1615	-1.6462	-2.1945	-2.0608	-1.3801	-0.0461	0.1246	0.0386	-0.0241	0.0441	0.1437	0.1915	0.1339
ESTC	35 2025	0.5313	0.5015	0.5164	0.3845	0.1586	-0.0126	-0.0791	-0.1540	-0.1698	-0.1499	-0.0471	-0.2051
ESTC	35 2353	2.4975	3.0617	3.0050	2.2684	0.5445	0.2192	0.0112	-0.1732	-0.3629	-0.4354	-0.2731	-0.1287
ESTC	40 2543	0.4555	0.4674	0.0999	-0.1873	-0.5678	-0.7736	-0.7387	-0.7132	-0.7598	-0.7143	-0.6905	-0.6671
ESTC	40 2544	-1.0252	-0.8994	-0.9704	-0.7033	-0.6941	-2.1884	-8.8625	-13.1394	-14.8376	-13.5291	-8.5195	-0.7874
HKO	35 2425	-0.0872	-0.1140	-0.0350	-0.1111	-0.0883	-0.1068	-0.0636	-0.0846	-0.0541	-0.1787	-0.2924	-0.2147
HKO	35 2884	0.2558	0.3763	0.2290	0.2415	0.1194	-0.0180	0.0719	0.1303	0.1078	0.1431	0.1181	0.0476
IFAG	36 1167	-0.3449	-0.4238	0.0861	0.2771	0.6302	0.9886	0.5738	0.0882	0.0909	-0.2335	-0.3576	-0.4670
IFAG	36 1173	0.6286	-0.0155	-0.3533	0.0038	0.3235	0.3629	0.0328	-0.3121	-0.6046	-0.1637	0.3196	0.1130
IFAG	36 1629	0.5627	0.5600	0.5249	0.2658	0.2392	0.2257	0.3558	0.3776	0.3555	0.2716	-0.0668	-0.2666
IFAG	36 1732	-0.2193	-0.1639	-0.2703	-0.3679	-0.4439	-0.3902	-0.2522	-0.0789	0.0497	-0.1088	-0.1961	-0.2908
IFAG	36 1798	0.1577	0.0954	0.0611	-0.0304	-0.1380	0.0921	0.0295	0.0294	0.0512	0.0825	0.0277	0.1744
IFAG	40 4418	0.2190	0.2364	0.2290	-	-	-	-1.4862	1.0381	0.6878	0.5355	0.3663	0.2857
IFAG	40 4439	3.4859	3.4876	3.4731	-	2.0871	2.0306	2.1631	2.2840	2.3242	2.3820	2.4719	2.4853
IMBH	35 2685	-4.9454	3.8924	6.6107	-9.1807	-2.3238	5.8849	-	-	-	-	-	-
IMBH	35 2909	4.2050	3.2494	1.6217	0.4033	-0.6996	-1.1639	-	-	-	-	-	-
INPL	35 2480	0.0080	0.0349	-0.0026	-0.1134	-0.1272	0.0059	0.1108	0.1764	0.2437	0.0685	-0.0153	-
INPL	35 2481	0.1900	0.0569	-0.1700	-0.3201	-0.1999	-0.0058	0.2535	0.5738	0.6750	0.6041	0.4955	-
INPL	35 3333	-	-	-	-	-	-	-	0.7223	0.2435	0.1679	0.1629	-
INPL	35 3351	-	-	-	-	-	-	-	0.3795	-0.5851	0.0434	0.1593	-
INTI	36 2377	0.3109	0.5355	0.3376	0.0432	0.1519	0.0446	-0.0454	0.2048	0.2293	0.2083	-0.0178	-0.1718
INXE	35 2393	-	-	-	1.5283	0.7725	-0.2122	0.0976	0.1372	0.0642	-0.0154	-0.0830	-0.2007
IT	35 0219	-0.0786	-0.0043	-0.1519	0.0414	-0.0839	-	-0.8073	-0.1409	-0.0497	-0.0968	0.0818	0.0234
IT	35 0505	-0.0100	0.0455	0.2258	0.2173	0.1064	0.1092	0.0637	0.0882	0.0326	0.1234	0.1051	-0.0410
IT	35 1115	-0.0283	-0.0437	0.0340	0.1584	0.1696	-	0.2075	0.6068	-0.2008	-0.5098	-0.3898	-0.3095
IT	35 1373	0.0696	0.1477	0.0650	0.0295	0.1440	-	-1.9182	-0.2542	0.0966	0.0723	0.2606	0.2179
IT	35 2118	0.0413	0.0777	-0.1254	-0.2844	-0.2873	-0.0738	-0.0883	0.1622	0.1429	0.1670	0.1248	0.1443
IT	40 1101	4.3271	4.3086	4.2706	4.1929	4.1456	4.1436	4.1345	4.1547	4.1665	4.1098	4.0633	4.0438
IT	40 1102	3.9672	3.8939	3.8036	3.7601	3.7593	3.8149	3.8285	3.8612	3.8372	3.7963	3.7618	3.7912
IT	40 1103	0.8566	0.8468	0.8286	0.8165	0.8078	0.8287	0.7892	0.7815	0.7641	0.7708	0.7588	0.8047

Table 10. (Cont.)

Lab.	Clock	57414	57444	57474	57504	57539	57569	57599	57629	57659	57689	57719	57749
IT	40 1104	2.7233	2.9704	3.2416	3.5024	3.7592	3.7209	3.8759	4.0048	4.1298	4.2312	4.3173	4.4118
JV	36 1277	-0.4022	-0.1129	0.0701	-0.1151	0.0965	0.1467	0.0499	0.1248	0.0381	0.0829	-0.0824	-
JV	36 2617	-0.4935	-0.0576	-0.0398	-0.0404	0.0343	0.2336	0.4406	0.4073	0.1360	-0.2699	-0.2623	-0.1641
JV	36 2629	-0.0495	0.2092	0.3823	0.3010	0.1579	-0.0226	0.0171	0.0927	0.1873	0.1807	0.0256	-0.2180
JV	40 8713	-0.6575	-0.5565	-0.6726	-0.8173	-0.9516	-0.8827	-0.9353	-0.8764	-0.9169	-0.9426	-1.1613	-1.1340
KRIS	35 0321	0.0763	0.1306	0.2995	0.3647	0.2573	0.1724	0.1977	0.2490	0.3315	0.5227	0.4794	0.4303
KRIS	35 0739	0.1133	-0.0559	-0.1718	0.0387	0.0049	0.1201	0.2581	0.2885	0.1525	0.1676	0.0384	-0.2169
KRIS	35 1135	1.3442	1.3907	1.2999	1.1074	0.3386	0.0242	-0.5074	-1.3079	-1.4311	-1.7938	-1.8128	-1.6896
KRIS	35 1693	0.0219	-0.0292	-0.1241	-0.0281	0.0266	0.1682	0.2038	0.2351	0.1564	0.0126	-0.0593	-0.2087
KRIS	35 1783	0.1097	0.0978	0.0976	-0.1669	-0.0930	-0.0250	0.2381	0.2872	0.3408	0.0558	-0.0534	-0.1695
KRIS	40 5626	0.1760	0.1535	0.1326	0.1436	0.1675	0.1979	0.2151	0.2193	0.2035	0.2461	0.2605	0.2545
KZ	35 2202	-0.1990	-0.1353	-0.2447	0.0092	0.2147	0.1342	-0.0557	0.0737	-0.0197	0.0518	0.1394	0.0272
KZ	35 2665	-0.2339	0.0833	-0.0576	-0.0004	-0.0957	0.0052	0.1367	0.2404	0.2311	0.1337	-0.1038	-0.2086
KZ	35 2667	-0.3471	-0.2057	-0.5288	-0.5674	-0.6786	-0.7177	-0.8569	-0.5686	-0.5503	-0.2832	0.1381	0.4262
LT	35 1362	0.0716	-0.3003	-0.3215	-0.0263	0.2226	0.3638	-0.0300	-0.2568	-0.3007	-0.0670	0.2125	-0.0575
LT	35 1868	0.2279	0.3118	0.2442	-0.0184	-0.0871	-0.1223	-0.0543	0.1352	0.2577	0.2191	-0.0137	0.0159
MBM	24 0125	-	-160.00	-	-	-0.0258	-	-	-2.6102	-	-	-	-
MIKE	36 0986	0.5281	0.5495	0.3542	0.0345	-0.1587	-0.1654	-0.3126	0.1325	0.0505	0.1159	-0.0356	0.1682
MIKE	40 4108	-1.0048	-1.7188	-1.9122	-1.5948	-0.6734	-	-	-	-0.9681	-0.4867	-0.2508	-0.1012
MIKE	40 4113	0.5987	0.9767	1.6334	1.3604	1.8051	2.0463	2.4998	2.4203	2.3326	1.9797	1.6426	1.2136
MIKE	40 4180	0.4906	0.5106	0.5315	0.5474	0.5814	0.5573	0.5727	0.5807	0.5835	0.5688	0.5775	0.5244
MIKE	40 4189	1.9411	2.2206	2.5093	2.8429	3.2217	3.3226	3.4119	3.4900	3.5654	3.6357	3.7097	3.7513
MKEH	36 0849	0.3089	0.2510	0.0649	-0.0933	-	-	-4.4245	-0.8655	-0.4806	0.1887	0.1907	0.2208
MSL	36 0274	-	-	-	-	-	-	-	-	3.7874	0.8518	-	-1.8020
MSL	36 2869	-	-	-	-	-	-	-	-	0.2937	-0.5757	-	-1.2740
MTC	35 3000	-0.0909	-0.0197	0.0647	0.0194	0.0363	0.0740	0.0339	-0.0650	0.0169	0.0605	0.0405	-
MTC	35 3002	0.3679	0.1436	0.2436	0.2800	0.0766	0.0130	-0.1310	-0.1893	0.0026	0.1880	0.2677	0.2320
MTC	35 3005	0.2195	0.0435	0.0450	0.0895	0.1395	0.2139	0.2060	0.0037	0.0622	0.2038	0.3050	0.3346
NAO	35 0779	-0.0040	-	-	-3.8305	-0.6556	-0.2785	0.2918	0.2832	0.0700	0.0214	0.0652	-0.0007
NAO	35 1206	-2.8811	-	-	1.1992	0.0215	2.2396	1.5438	-0.0226	-0.1804	-0.4073	-0.7781	-0.6603

Table 10. (Cont.)

Lab.	Clock	57414	57444	57474	57504	57539	57569	57599	57629	57659	57689	57719	57749
NAO	35 1214	0.6902	-	-	0.5237	0.3380	-	-	-	-	1.1887	0.0410	0.0655
NAO	35 1689	0.0492	-	-	1.1032	-0.0754	-0.3743	-0.3986	-0.0989	-0.0565	-0.0864	-0.0129	-0.0228
NAO	40 1301	0.1359	-	-	15.7260	-5.9356	-2.6600	-1.0521	-1.1380	-0.0990	0.6660	-0.1160	-0.2603
NICT	35 0332	0.2459	0.3283	0.2938	0.2870	0.1434	-0.0039	-0.0534	-0.0667	-0.1184	-0.0546	-0.0989	-0.0375
NICT	35 0343	0.0158	0.1174	0.0662	0.0061	-0.1342	-0.0893	-0.1331	0.0063	-0.0798	-0.0231	0.0876	0.2113
NICT	35 0715	-0.1224	0.0921	0.1349	0.0385	-0.0040	-0.0756	-0.1212	-0.0859	-0.0942	-0.0277	-0.0179	-0.1169
NICT	35 0732	-0.0625	-0.1575	-0.9594	-1.0423	-1.2067	-1.3389	-1.0625	-0.4163	-0.2891	-0.3879	-0.5418	-1.4668
NICT	35 0907	-0.1706	-0.1523	-0.2971	-0.2658	-0.1081	-0.1498	-0.1282	-0.0578	-0.1168	0.1038	0.2749	-0.0570
NICT	35 0913	0.0263	0.0182	-0.2130	-0.4211	0.0824	0.4825	0.4732	0.5565	0.2211	-0.0507	-0.0552	-
NICT	35 0916	0.2717	0.1629	0.0927	0.0254	0.1915	0.2473	0.2091	0.1337	0.1438	0.2834	0.3803	0.2416
NICT	35 1225	0.2273	0.1196	-0.0407	0.0319	-0.0211	0.0149	0.0825	0.1463	0.1416	0.0572	-0.0908	-0.1637
NICT	35 1226	-	-	-0.7628	-0.5840	0.0349	0.1336	0.1712	0.2654	0.3370	0.4064	0.4272	0.4256
NICT	35 1611	-	-	-34.5445	-	-	-	-	-	-	-	-	13.7397
NICT	35 1778	-0.1993	-0.1504	0.1317	0.1111	0.1154	0.0733	-0.0773	-0.1874	-0.1130	-0.1055	-0.0958	-
NICT	35 1789	-0.0029	0.9399	1.9120	2.5950	2.5511	1.8925	0.7444	0.1091	-0.3499	-0.4676	-0.4801	-0.3658
NICT	35 1790	-0.2531	-	-	-	0.7542	0.2920	0.4187	0.1811	0.1595	0.0796	0.0660	0.0506
NICT	35 1866	0.0861	0.0588	0.1404	0.1123	0.0653	0.0227	-0.1632	-0.2632	-0.2153	-0.1120	0.0371	0.1027
NICT	35 1882	1.1185	1.3429	1.0370	0.7235	0.4423	0.2814	0.2768	0.4014	0.0933	-0.1187	-0.2764	-0.3024
NICT	35 1887	0.0862	0.1701	0.1896	0.2559	0.2434	0.2715	0.1567	0.1305	0.0420	0.1973	0.1991	0.3328
NICT	35 1944	-0.0567	-0.2280	-0.0490	0.0109	-0.0140	0.0384	-0.0627	-0.0049	-0.0327	-0.0742	-0.2060	-0.2168
NICT	35 2010	0.1814	0.1194	0.1341	0.1664	0.2513	0.2469	0.2320	0.3129	0.2685	0.2276	0.1681	0.0876
NICT	35 2011	-0.1111	-0.1445	-0.0986	-0.1003	-0.0065	-0.0636	-0.0893	-0.2139	-0.1518	-0.1745	-0.0783	-0.0908
NICT	35 2056	0.1990	0.2105	0.1748	0.2519	0.1272	0.2862	0.2969	0.4067	0.3365	0.4264	0.1780	0.2372
NICT	35 2113	0.3184	0.2345	0.1777	0.0673	0.1716	0.0728	0.2876	0.3659	0.4773	0.2798	0.2864	0.0838
NICT	35 2116	0.1026	0.1137	0.1366	0.2134	0.1779	0.1474	0.0351	-0.0018	-0.0076	-0.0186	0.0812	-0.0526
NICT	35 2570	0.2558	0.4174	0.2490	-0.0804	-0.4764	-0.6567	-0.6007	-0.2820	0.0432	0.1028	0.1493	-0.0340
NICT	35 2574	0.4267	0.2845	-0.0877	-0.1426	-0.2663	0.0225	0.2803	0.3673	0.3693	0.6493	0.7480	0.8567
NICT	35 2627	0.2876	0.1452	-0.0096	0.1282	0.2642	0.3271	0.4437	0.3287	-0.0234	-0.2585	-0.1673	-0.2256
NICT	35 2628	-0.0146	-0.2665	-0.4013	-0.4549	-0.2202	0.0607	0.0396	0.0784	-0.0971	-0.2159	-0.0407	0.0692
NICT	35 2784	0.0691	0.1443	0.0864	0.0503	0.0350	0.1153	0.0464	0.0147	0.0847	0.1671	0.0784	0.0957

Table 10. (Cont.)

Lab.	Clock	57414	57444	57474	57504	57539	57569	57599	57629	57659	57689	57719	57749
NICT	35 2876	0.0074	0.0876	-0.0223	0.0030	-0.0232	-0.1402	-0.2030	-0.1391	-0.0325	0.0674	0.0731	0.1876
NICT	35 2903	-0.1153	-0.2150	-0.2609	-0.1204	-0.2160	-0.1666	-0.3617	-0.2241	-0.1948	-0.0441	0.0369	-0.0232
NICT	35 3259	-	-	-	-	-	0.3646	0.1070	-0.0925	-0.0243	0.1056	0.1169	0.1359
NICT	36 1217	-0.0776	-0.1322	-0.0601	-0.1090	-0.0148	-0.0760	-0.0319	0.1991	0.1209	0.1669	0.1917	-0.3933
NICT	40 2003	-0.0888	-0.0097	-0.0551	-0.0971	-0.0946	-0.0423	0.0520	0.1118	0.1079	0.0857	0.0502	0.0323
NICT	40 2004	2.4050	2.4859	2.5331	2.5747	2.6226	2.6926	2.7548	2.8178	2.8814	-	-	-
NICT	40 2006	1.4295	-	-	2.2894	2.2640	-	-	-	1.0788	0.8408	0.7312	0.4119
NICT	40 2012	-	-	-	-	-	-	-	-	-	2.4298	2.6755	2.6929
NICT	40 2013	-	-	-	-	-	-	3.6944	4.1150	3.8606	3.6851	3.5588	3.4771
NICT	40 2014	-	-	-	-	-	-0.3177	1.0561	1.0883	0.9523	0.7940	0.5323	0.2642
NICT	40 2015	-	-	-	-	-	-	-	-	-	2.2721	2.1557	2.1555
NIM	35 1235	0.3122	0.0698	0.1197	0.0824	0.2339	0.3412	0.7245	0.1991	0.0916	-0.0847	0.0512	0.0470
NIM	35 2256	0.0789	-0.0482	-0.2431	-0.2872	-0.1985	-0.0601	0.0436	0.2980	0.2387	0.3356	0.4828	0.5519
NIM	35 2483	-0.0284	-0.0468	-0.0048	-0.1958	-0.2941	-0.2977	-0.2753	-0.2456	-0.3684	-0.3742	-0.4291	-0.2705
NIM	35 2643	-0.0388	-0.3371	-0.4040	-0.0820	0.2836	0.5707	0.5078	0.4079	0.2776	0.2757	0.3322	0.2717
NIM	35 2744	-0.0532	0.0755	0.0103	0.0505	0.2959	0.3795	0.3394	0.1609	-0.1613	-0.3062	-0.2398	0.0017
NIM	35 2767	0.1404	0.1870	0.1787	-0.0739	-0.0929	-0.0370	-0.0744	-0.0944	-0.0157	0.0479	0.0589	0.2066
NIM	35 2769	0.0620	-0.0353	-0.1135	0.0113	0.1028	0.1803	0.0943	-0.0035	-0.0593	0.0173	0.0585	0.1130
NIM	40 4832	2.8982	2.8887	2.9156	2.9286	2.9784	3.0606	3.1604	3.2490	3.3106	3.3568	3.3939	3.4131
NIM	40 4835	13.6544	13.4788	13.2220	12.9539	12.4684	12.2615	12.0577	11.7979	11.7070	11.5529	11.5373	11.5489
NIM	40 4871	3.8656	3.8213	3.8233	3.8591	3.9198	3.8682	3.7902	3.6723	3.5574	3.4638	3.4599	3.4186
NIM	40 4878	3.8492	3.8260	3.7685	3.8699	4.0858	4.1725	4.0968	3.9504	3.6912	3.5008	3.4441	3.4333
NIM	40 4879	2.1434	3.1496	3.2360	3.3742	3.9411	4.3591	3.4222	3.2270	2.4871	1.4938	1.9304	3.3331
NIM	40 4880	3.2805	3.4835	3.7316	3.7554	3.5545	3.6865	3.7905	3.8599	3.9757	3.8174	3.5434	3.5512
NIMB	35 0600	0.3937	0.1317	-0.3175	-0.2291	-	-	-	-	-	-	0.5095	3.1010
NIMT	35 1511	-	-	-	-	-	-	-	1.6823	0.3866	0.5655	0.0567	0.1826
NIMT	35 2246	0.1734	-0.2678	-0.3931	-0.5146	-0.1700	-	-	-	-	-	-	-
NIMT	35 2247	0.4141	0.0227	-0.5129	-0.6118	-0.1294	-	-	-0.1279	0.0287	-0.0040	0.1160	-
NIMT	36 1169	-	-	-	-	-	-	-	-0.9371	-0.7744	-0.4447	0.0718	-0.0431
NIS	35 2140	-	-	-	-	-	-	-	-	-	-	-3.7900	-

Table 10. (Cont.)

Lab.	Clock	57414	57444	57474	57504	57539	57569	57599	57629	57659	57689	57719	57749
NIS	35 2181	-	-	-	-	-	-	-	-	-	-	1.0683	-
NIS	35 2182	-	-	-	-	-	-	-	-	-	-	2.0832	-
NIS	35 2633	-	-	-	-	-	-	-	-	-	-	-1.9283	-
NIST	35 0282	0.2695	0.1403	0.0432	0.0199	0.0279	0.0531	0.0776	0.0172	0.1070	0.0697	0.1192	0.1503
NIST	35 0408	-0.3896	-1.7017	-3.5253	-5.2759	-5.6691	-4.6159	-2.7631	-0.9963	0.2061	0.4981	1.0427	1.9356
NIST	35 1074	-0.0463	0.0380	0.0807	0.0345	0.1302	0.1976	0.1969	0.2230	0.2154	0.0587	0.0935	-0.0473
NIST	35 1519	0.2102	0.0961	-0.0015	-0.0548	-0.2084	-0.1431	-0.0394	-0.1535	-	-	-	-
NIST	35 2031	0.0102	-0.0127	0.0853	0.0162	0.0011	-0.0193	0.0279	-0.2064	0.0035	0.0482	0.8815	1.3452
NIST	35 2032	0.0740	-0.0161	0.0015	-0.0657	0.0120	0.0405	0.0213	-0.1808	-0.0888	-0.1888	-0.2324	-0.1198
NIST	35 2034	-0.0042	0.0133	0.1131	0.0754	-0.0792	-0.0100	0.0064	-0.1755	-0.0221	0.1294	-0.0002	-0.0443
NIST	35 2579	-0.7577	-0.8367	-0.7125	-0.1338	0.2062	0.1376	-0.1244	-0.2588	-0.3682	-0.1814	-0.0990	-0.0768
NIST	35 2672	-0.7959	-0.7419	-0.8630	-0.7544	-0.3031	-0.0331	-0.0014	0.0269	0.1410	0.0901	0.5397	0.6596
NIST	35 2935	0.0398	-0.0722	-0.0955	-0.1470	-0.0683	0.0029	-0.0421	-0.0903	-0.1140	-0.1683	-0.2053	-0.1257
NIST	40 0004	-	-	-	-	-	-	-	-	0.2251	0.2484	0.3041	0.3344
NIST	40 0203	-	-	-	-	-	-	-	-	-	3.0572	2.9806	2.9198
NIST	40 0205	0.0361	0.0410	0.0445	0.0531	0.0476	0.0248	-0.0074	-0.0221	-0.0261	-0.0044	0.0473	0.0587
NIST	40 0206	0.9143	1.1011	1.2915	1.3756	1.3459	1.3530	1.3648	1.3425	1.2700	1.1830	1.0913	1.0533
NIST	40 0207	4.2873	4.3206	4.3796	4.4254	4.4734	4.4801	4.4695	4.4576	4.4764	4.4822	4.5601	4.6293
NIST	40 0210	7.6885	7.5940	7.6327	7.5929	7.5110	7.4160	7.2933	7.1349	7.1060	7.1189	7.1605	7.1848
NIST	40 0212	7.1536	7.1727	7.2374	7.2116	7.1982	7.1882	7.1692	7.1443	7.1604	7.1425	7.1588	7.1368
NIST	40 0222	0.1307	0.1403	0.1449	0.1519	0.1549	0.1454	0.1368	0.1360	0.1476	0.1479	0.1671	0.1477
NMIJ	35 0224	-0.0614	-0.1865	-0.1244	-0.0533	-0.0005	0.1082	0.1495	-0.0522	-0.0464	0.0729	0.0753	0.0631
NMIJ	35 0459	-	-	-	-	-	-	-2.9639	1.1267	-0.4110	0.4762	0.7229	0.7953
NMIJ	35 0523	2.2313	1.5592	1.1587	0.0533	0.4416	0.5384	0.4869	0.1615	0.6127	0.3521	0.4010	0.3204
NMIJ	40 5002	0.2409	0.1460	0.1242	0.1832	0.2217	0.1902	0.2242	0.1504	0.2701	0.6339	0.9993	1.1039
NMIJ	40 5003	0.0503	0.0427	0.1049	0.1845	0.1602	0.1844	0.1823	0.1164	0.0872	0.1287	0.1256	0.1319
NMIJ	40 5012	-	-	-	-	-	0.3543	0.3878	0.3890	0.3887	0.3916	0.3959	0.4008
NMIJ	40 5015	3.2966	3.1799	3.1064	2.9950	2.9611	3.0213	3.0891	3.1411	3.1700	3.1172	3.0962	3.0831
NPL	35 1275	0.1103	-0.1170	-0.3455	-0.2560	0.0087	0.4162	0.5739	0.2772	-0.2106	-0.6152	-0.9133	-0.6644
NPL	35 3167	0.4646	0.0764	-0.1366	-0.0238	-0.0119	0.0819	0.2363	0.2722	0.2282	0.1223	0.0382	-0.0364

Table 10. (Cont.)

Lab.	Clock	57414	57444	57474	57504	57539	57569	57599	57629	57659	57689	57719	57749
NPL	40 1701	0.9943	1.1458	1.1315	0.9099	0.4338	0.0750	0.0916	-0.0370	-0.0325	0.0928	0.2677	0.3426
NPL	40 1708	0.5494	0.4687	0.4185	0.4102	0.4759	0.6633	0.8746	0.8173	0.8323	0.8736	0.8735	0.7810
NPLI	35 0057	0.9134	0.6715	0.2677	-0.1234	-10.4384	-	-	-	-	-	-	-
NPLI	35 0140	1.2044	0.9164	0.4939	0.4384	0.2042	0.8086	1.0887	0.5499	0.1520	-0.1364	-	-
NPLI	35 1324	0.4592	0.2834	-0.0305	-0.1940	-0.1902	0.1124	0.6800	0.6427	0.4110	0.1667	-0.1922	-0.3310
NPLI	35 2245	-0.2032	-0.1544	-0.0920	0.0736	0.1469	0.0323	-0.0858	-0.1417	0.0203	0.0648	0.0155	0.1619
NPLI	35 2796	-0.0469	0.0232	0.0751	0.1009	0.0316	0.0741	0.0675	0.0555	0.1527	0.1211	0.1748	0.1999
NPLI	40 5201	3.4524	-0.3948	-3.5288	-4.7129	-3.7961	-1.5294	2.4359	3.4285	3.4744	3.5380	0.9133	-2.6751
NRC	35 2115	0.2070	0.2831	-0.0641	0.3426	0.3304	0.2774	0.0949	0.1168	-0.2537	0.0797	0.0613	0.3620
NRC	35 2150	0.0712	0.1167	-0.2853	-0.0459	0.0319	0.1109	0.0893	-0.0351	-0.3463	-0.0764	-0.0825	0.0787
NRC	35 2152	0.0486	0.0193	-0.4702	-0.1235	-0.2384	-0.1024	0.0995	0.1363	-0.3061	0.1646	-0.0067	-0.0068
NRC	36 2219	-0.0670	-0.0379	-0.1338	0.2247	0.1263	-0.0607	0.0559	0.0703	-0.1573	0.1807	-0.0160	0.0259
NRC	40 0304	-8.7884	-3.7281	-	-	-	-	-	-	-	-	-	-
NRC	40 0306	-2.8916	-3.2046	-2.9851	-1.0955	-0.0688	-0.0685	-0.1652	-0.3184	-0.8385	-0.5834	-0.4696	-0.5211
NRL	35 0714	-	-	-1.0610	-0.6407	-0.2154	-0.0118	-0.1487	-	-	-	-	-
NRL	35 0719	-	-	3.7492	2.9702	6.1873	5.7638	4.9573	-	-	-	-	-
NRL	35 1245	-	-	11.0452	22.2084	1.8435	-4.2492	-4.7931	-	-	-	-	-
NRL	35 2460	-0.1358	-	-	-	-2.3829	-	-	-	-	-	-	-
NRL	35 2464	-	-	-	-	0.2099	-	-	-	-	-	-	-
NRL	35 2580	-0.0493	-	-	-	0.3599	-	-	-	-	-	-	-
NRL	36 0387	-	-	1.7915	-0.5714	-0.8864	-0.8360	-0.4539	-	-	-	-	-
NRL	36 2788	-	-	0.8830	0.6340	0.0873	-0.2621	0.0540	-	-	-	-	-
NRL	36 2791	-	-	1.2772	-0.7149	-32.1434	-13.9139	-7.1090	-	-	-	-	-
NRL	36 2799	0.5184	-	-	-	-	-	-	-	-	-	-	-
NRL	36 2800	-0.1593	-	-	-	-	-	-	-	-	-	-	-
NRL	36 2807	0.5892	-	-	-	-	-	-	-	-	-	-	-
NRL	36 2818	-1.1544	-	-	-	-	-	-	-	-	-	-	-
NRL	36 2820	-	-	-4.4519	-0.6205	-1.0329	-3.7237	-4.1565	-	-	-	-	-
NRL	36 2829	-	-	-0.6805	1.0347	0.1814	0.3950	-0.0020	-	-	-	-	-
NRL	36 2832	-	-	2.0213	1.1052	0.0361	-0.5443	-0.6411	-	-	-	-	-

Table 10. (Cont.)

Lab.	Clock	57414	57444	57474	57504	57539	57569	57599	57629	57659	57689	57719	57749
NRL	36 2834	-	-	-1.6062	0.4607	-13.5217	-5.2681	-3.4401	-	-	-	-	-
NRL	40 1001	-	-	0.0053	-0.0990	-0.1403	-0.0939	0.0676	-	-	-	-	-
NRL	40 1004	-	-	0.3755	0.3072	0.2503	0.2513	0.2252	-	-	-	-	-
NRL	40 1009	-	-	-2.0965	-1.3787	-1.8148	-1.9073	-1.9754	-	-	-	-	-
NRL	40 1010	-	-	-3.0325	-0.8505	31.0627	-	-	-	-	-	-	-
NRL	40 1012	-	-	-1.1879	-1.9510	-2.1954	-2.2392	-2.1803	-	-	-	-	-
NTSC	35 1016	-0.8854	0.5804	0.3540	0.3392	0.3772	0.4448	0.4213	0.4931	0.2440	0.2308	0.3984	0.4493
NTSC	35 1018	-0.3219	-0.2000	-0.0546	0.0467	0.3042	0.3599	0.5977	0.7191	0.5422	0.2646	0.0353	-0.0381
NTSC	35 1818	-0.1009	0.1062	0.5038	0.4849	0.6268	0.4053	0.4311	0.5030	0.5263	0.4624	0.5719	0.3749
NTSC	35 1823	-0.2754	-0.3550	-0.3748	-0.2445	-	-	-	-	-	-	-	-
NTSC	35 2098	0.2426	0.1162	-0.0918	-0.9643	-	-	-0.4576	0.4860	0.2116	0.1409	0.1076	0.1340
NTSC	35 2142	-	-	-	-	-	-	0.4921	0.2237	0.1324	0.2597	0.2872	0.1726
NTSC	35 2143	-0.2181	-0.3838	-0.3125	-0.2448	-	-	1.3733	-0.0670	-0.3298	-0.1124	0.0059	-0.0100
NTSC	35 2145	-1.0510	-0.9429	-0.5724	-0.3095	-	-	-0.7456	-0.4816	0.0717	0.1235	0.1995	0.0983
NTSC	35 2573	0.1563	0.1690	0.0607	-0.0873	-0.0320	-0.0087	0.0659	0.0881	0.0181	0.1553	0.1605	0.0248
NTSC	35 2831	0.1296	0.2494	0.4515	0.7684	0.3291	0.2071	0.2624	0.2099	0.0224	0.0572	-0.0356	-0.1316
NTSC	35 2921	0.0259	-0.0489	-0.2295	-0.2183	-0.1848	0.0213	0.1310	0.2629	0.2511	0.2813	0.1559	0.0936
NTSC	35 2922	0.0290	-0.1189	-0.0953	-0.1093	0.0303	0.0459	0.1917	0.1817	0.2616	0.2791	0.2028	0.2016
NTSC	35 2924	-0.0232	-0.1736	-0.3942	-0.5091	-	-	-	-	-	-	-	-
NTSC	35 2926	0.2239	0.1111	0.2634	0.4296	-	-	-	-	-	-	-	-
NTSC	35 2928	0.2363	0.2464	0.3655	0.3478	0.1700	0.1105	0.0641	0.0212	0.0944	0.2203	0.1619	0.1732
NTSC	35 2933	-0.1024	-0.2008	-0.2572	-0.2747	-0.0357	0.1149	0.2570	0.3148	0.1289	0.0016	-0.1088	-0.2125
NTSC	35 2959	0.2118	0.0822	0.1112	0.0415	0.0692	0.0798	0.2250	0.2979	0.3290	0.1563	0.1216	-0.0003
NTSC	35 2962	0.2358	0.1501	0.0961	0.1014	0.1459	0.1212	0.1220	-0.0013	-0.0601	-0.0838	-0.1413	-0.0861
NTSC	35 2964	0.1103	0.0729	0.0859	0.1066	0.0553	0.0403	0.1388	0.0669	0.0241	0.0787	0.0387	-0.0149
NTSC	35 2965	-0.1065	-0.1458	-0.1474	-0.1204	-0.1260	0.0617	0.0562	0.2002	0.1721	0.1061	0.0317	-0.0305
NTSC	35 2976	0.3261	0.2699	0.2882	0.2343	0.1330	0.1215	0.1020	0.1313	0.1741	0.1634	0.0765	0.1313
NTSC	35 2978	0.3001	0.3306	0.2278	0.1422	0.2255	0.1345	0.1387	0.2281	0.2663	0.0723	0.1085	0.1187
NTSC	35 2980	0.0676	0.1314	0.1221	0.1429	0.1528	0.1944	0.2450	0.1735	0.0937	0.0199	-	-
NTSC	35 2981	0.3369	0.2566	0.1527	0.1213	0.0567	0.1529	0.2884	0.3876	0.1929	0.0952	-0.0342	-0.1807

Table 10. (Cont.)

Lab.	Clock	57414	57444	57474	57504	57539	57569	57599	57629	57659	57689	57719	57749
NTSC	35 3089	0.0270	0.0078	0.0073	-0.0440	-0.0292	-0.0058	0.0413	0.0496	0.0593	0.0596	0.0203	0.0561
NTSC	35 3090	0.0952	0.1629	0.1299	0.1183	0.1841	0.1114	0.1175	0.1604	0.2088	0.1788	0.1991	0.1983
NTSC	35 3091	0.3064	0.2994	0.2117	0.1212	0.0788	0.0791	0.1413	0.2542	0.2991	0.2682	0.1235	0.1121
NTSC	35 3102	0.2098	0.1519	0.1644	0.2826	0.2478	0.2476	0.2342	0.3518	0.2473	0.3413	0.3066	0.2366
NTSC	40 0296	2.5421	2.5246	2.5279	2.5178	2.4661	2.4447	2.4726	2.4814	2.5736	2.7751	2.8841	2.9252
NTSC	40 0297	4.2115	4.2704	4.3204	4.3834	4.5199	4.8042	5.0239	5.1850	5.2843	5.2695	5.2560	5.4259
NTSC	40 0326	-	-	-	-	-	-	-	-	5.4399	5.7071	5.5416	5.5810
NTSC	40 4903	-	-	-	-	-	-	-	-	-	-	-	3.9065
NTSC	40 4926	0.1111	-0.0651	-0.2407	-0.4520	-0.6694	-0.8171	-0.9275	-0.9433	-0.8313	-0.6690	-0.5077	-0.3670
NTSC	40 4927	0.9960	1.1115	1.6632	1.5321	1.8052	2.8005	2.7532	2.4888	2.8482	2.4175	2.4971	3.1155
ONRJ	35 0102	0.2290	0.1579	0.0905	0.0397	0.0260	0.1407	0.2173	0.1809	0.1146	0.1097	0.0423	0.2116
ONRJ	35 0103	-0.2089	-0.4242	-0.3817	-0.4734	-0.2639	-0.0604	0.1610	0.0792	-0.1155	-	-	-
ONRJ	35 0123	-0.1947	-0.2826	-0.1297	0.0538	0.0467	-0.0084	-0.0841	-0.1545	0.0058	-0.0664	0.2248	0.4966
ONRJ	35 0129	-0.0055	-0.0828	-0.2417	-0.4239	-0.3570	-0.1873	0.1390	0.2660	0.1559	0.0140	-0.1057	0.0038
ONRJ	35 0147	0.2321	0.0554	0.0047	0.1920	0.1763	0.1072	-0.0969	-0.2513	-0.4038	-0.2559	-0.1751	0.0663
ONRJ	35 1153	0.2028	0.0289	0.1851	0.4996	0.4574	0.5312	0.3293	0.0073	-0.0929	0.2536	0.2014	0.2586
ONRJ	35 1942	2.2474	0.4670	0.5688	0.5342	0.3666	0.4174	0.2437	0.1969	0.2650	0.2839	0.1980	0.3000
ONRJ	40 1950	2.3887	2.8923	3.1615	2.9538	2.5448	2.0178	1.3041	0.9471	0.8825	0.6925	0.5824	0.6569
ONRJ	40 1958	-0.2537	-0.4107	-0.9558	-2.6565	79.6954	-	-	-	-	-	-	-
OP	35 0157	-0.1063	-0.0806	-	-	-0.3429	-0.4360	-0.1666	-	-	-	-1.7397	0.0776
OP	35 0355	0.0410	0.2364	0.4392	0.3851	0.3797	0.4015	0.5189	0.0534	-0.2249	-0.4262	-0.5066	-0.2503
OP	35 0396	0.0676	0.0993	0.2440	0.1990	0.1079	-0.0883	-0.1387	-0.0757	0.0362	0.1557	0.3443	0.3297
OP	35 0469	-0.1579	-0.2968	-	-	-	-	-	-	-	-	-	-
OP	35 0489	-0.0524	0.0584	-	-	1.5856	0.4733	0.0814	-	-	-	-0.8825	-0.6592
OP	35 0609	0.2297	-0.1035	0.0604	-0.1300	-0.2112	-0.2102	-0.1177	-0.0953	0.0254	-0.1226	-0.1516	-0.1965
OP	35 0770	-	-	-	-	-	-	-3.6736	-0.8273	-0.7628	-0.2937	-0.1332	-0.1292
OP	35 0774	0.8001	0.3925	0.3473	0.4204	0.2818	0.4114	0.2878	-0.0319	-0.4342	-0.7560	-1.1516	-0.8956
OP	35 0781	-0.2654	-0.3060	-0.2766	-0.1891	-	-	-	-	-	-	-	-
OP	35 0859	0.0875	0.4244	0.0296	0.0145	-0.1240	-	-	-	-0.2858	0.1620	-0.2666	-0.6904
OP	35 1177	0.5182	0.6332	0.4189	-0.1922	-0.7760	-	-	-	2.1828	0.4628	1.2019	0.9951

Table 10. (Cont.)

Lab.	Clock	57414	57444	57474	57504	57539	57569	57599	57629	57659	57689	57719	57749
OP	35 1222	-0.6655	-0.2369	0.1135	0.2815	0.2824	0.0207	-0.0543	-0.0030	-0.0586	-0.0463	-0.0335	-0.0674
OP	35 1321	-0.0491	0.0074	0.0424	0.0131	-0.2941	-0.0121	-0.0926	0.1307	0.2306	0.4064	0.2435	0.0620
OP	35 1556	0.5657	0.5759	0.4614	0.3681	0.0614	0.0455	-0.0774	-0.0020	0.0238	0.1595	-0.0298	-0.1152
OP	35 1644	0.0089	-0.1064	-	-	-0.6987	-0.1327	0.1439	-	-	-	-1.5511	-0.7222
OP	35 2027	-	-	-	-	-	-	-	-	-0.6801	0.6521	0.4253	0.4338
OP	35 2388	0.1130	0.1564	-0.0204	-0.1075	0.0313	0.0038	0.1877	0.4207	0.3072	0.1190	0.0390	-0.1403
OP	35 2609	-0.0524	-0.1108	-0.1444	-0.3600	-0.2341	-0.2126	-0.1242	-0.0692	-0.1177	-0.1996	-0.0837	0.0466
OP	35 2647	-0.7100	-0.9370	-0.4763	-0.1064	-1.0613	-1.7209	-	-	1.3977	2.8313	4.4756	-
OP	35 2804	0.0354	-0.0996	-0.1272	0.0015	0.0098	0.0593	0.0387	-0.0314	0.0035	-0.0197	-0.0023	0.0316
OP	35 2985	-0.0005	0.2105	0.3043	0.2995	0.2102	0.0389	0.0241	0.0979	0.1870	0.2200	0.2622	0.1887
OP	35 3054	-	-	-	-	0.3171	0.3117	-0.1226	-	-	-	-0.0014	-0.0345
OP	40 0809	0.7127	0.7670	0.9495	1.0760	1.0707	0.9822	0.8336	0.6475	0.6004	0.5879	0.5903	0.5689
OP	40 0810	0.5414	0.5227	0.4917	0.5325	0.5583	0.5544	0.5518	0.5290	0.4759	0.4734	0.5090	0.5161
OP	40 0889	0.3572	0.3763	0.3782	0.3651	0.3359	0.3442	0.3574	0.3610	0.3496	0.3431	0.3437	0.3479
OP	40 0890	0.1216	0.1096	0.1195	0.1374	0.1199	0.0967	0.0045	-0.0677	-0.0859	-0.0442	0.0138	0.0747
ORB	35 2722	0.1436	0.3240	0.3348	0.2954	0.4127	0.3703	-	2.5532	0.2301	0.0699	-0.1514	-0.2752
ORB	35 2723	-0.2498	-0.2294	-0.3117	-	-	-	-	-0.1177	0.0975	0.3890	0.0638	0.1831
ORB	35 2724	-0.0876	-0.1321	-0.2446	-0.2751	-0.2329	-0.1121	-0.2285	-0.1316	-0.0785	-0.1584	-0.1880	-0.1063
ORB	36 0593	0.1864	-0.1579	-0.2718	-0.0428	-0.3319	-0.5694	-0.4750	-0.1069	0.0190	0.4256	0.4806	1.6892
ORB	40 2602	-	-	-	-	0.6213	0.6315	0.6324	0.6007	0.5965	0.5697	-	0.0151
PL	25 0124	0.5801	-0.0495	0.2776	-	-	-	-	-	-	-	-	-
PL	25 0125	-1.2321	-1.3812	-2.0122	-	-	-	-	-	-	-	-	-
PL	35 0441	0.0860	0.2222	0.2886	0.3053	0.3311	0.2765	0.2633	0.2672	0.1832	-0.0167	-0.1065	-0.0407
PL	35 0745	0.0314	-0.0497	0.0389	-0.0853	-0.0656	-0.0298	-0.0444	-0.0794	0.0802	0.0586	0.1911	0.2475
PL	35 0761	0.3429	0.2939	-0.0419	-0.0031	-0.5914	-0.1997	0.2635	0.5275	-0.1232	0.4948	0.3813	0.1343
PL	35 1120	0.6459	0.2731	0.1737	-0.0060	-0.0622	-0.0662	0.1711	0.1417	0.0593	0.0262	0.1110	0.0836
PL	35 1660	0.3272	0.3832	0.4025	0.3984	0.2452	-0.0001	0.0769	-0.0902	-0.1115	-0.0439	-0.0703	-0.3280
PL	35 1746	-0.0525	1.8950	5.2947	7.3669	7.4517	7.2912	3.1406	0.5765	0.2360	-0.0149	-0.1653	-0.1673
PL	35 1934	-0.0001	0.0945	0.1470	0.0407	0.0084	-0.0163	-0.1903	-0.1116	0.0327	0.0846	0.0460	0.0347
PL	35 2175	-0.1015	-0.1322	0.0734	0.0139	-0.1149	-0.1380	-0.1417	-0.1748	0.0614	0.2087	0.1427	0.1317

Table 10. (Cont.)

Lab.	Clock	57414	57444	57474	57504	57539	57569	57599	57629	57659	57689	57719	57749
PL	35 2394	0.0442	-0.0289	0.0155	-0.2478	-0.5010	-0.5809	-0.6091	-0.3877	-0.1883	-0.1995	-0.1311	-0.1964
PL	35 2891	0.0649	0.2247	0.2799	0.1515	0.1268	0.0186	0.0277	0.0181	-0.0058	-0.0945	0.0014	-0.0065
PL	40 4004	-13.3974	-14.2244	-15.4721	-14.2967	-12.4228	-10.3415	-7.6090	-4.6934	-4.3751	-3.9331	-3.6393	-2.5558
PL	40 4601	0.6343	0.6378	0.6204	0.6032	0.6095	0.6085	0.5878	0.5755	0.5787	0.5737	0.5844	0.5872
PL	40 4602	5.7476	6.2184	6.1993	7.0872	8.3545	8.7532	7.9781	7.1580	5.9051	4.4215	-	7.3111
PTB	35 0415	-0.0748	-0.5691	-0.4316	-0.4072	-0.0699	0.0787	0.0842	-0.1720	-0.1630	-0.1572	0.0281	0.0852
PTB	35 1072	0.0064	-0.0106	-0.0416	-0.0452	0.0677	0.1657	0.0031	0.1021	0.0188	-0.0697	-0.1406	-0.0419
PTB	35 2987	0.1560	0.0327	-0.0879	-0.1003	0.0447	0.2897	0.1936	0.2291	0.1441	-0.0022	0.0728	0.1168
PTB	40 0506	1.7060	1.6994	1.6927	1.6875	1.6853	1.6855	1.6869	-0.2090	-3.8075	-5.8292	-6.3889	-4.8661
PTB	40 0508	2.1177	2.0803	2.0844	-	-	-	-	-	-	1.4492	1.3794	1.3184
PTB	40 0509	0.3360	0.3311	0.3270	0.3136	0.2694	0.2570	0.2408	0.2326	0.2488	0.2615	0.2643	0.2572
PTB	40 0510	-	-	-	-	-	-	-	-	-	-0.9028	-0.8036	-0.7669
PTB	92 0001	-0.7595	0.1255	-0.4446	-0.2321	-0.1528	-0.0890	-0.0306	0.0912	0.1212	0.2346	0.1504	0.2149
PTB	92 0002	0.0033	-0.0424	-0.0261	0.0966	0.0694	0.1548	0.0983	0.0455	-0.0319	0.0115	-0.0593	-0.0352
ROA	35 0583	-0.2893	-0.1735	0.1374	0.1995	0.0503	0.0085	-0.0004	0.1555	0.2348	0.0758	0.0848	-0.2831
ROA	35 0718	-0.0589	-0.1528	-0.0893	-0.2462	-0.1271	-0.0557	-0.2283	-0.2220	-0.1320	-0.1272	-0.0032	0.0213
ROA	35 1699	0.2318	0.0627	-0.1437	-0.1922	-0.2242	-0.4747	-0.3388	-0.3906	-0.3062	-0.0075	-0.0092	0.0663
ROA	35 2270	0.1889	0.0897	0.1912	0.0482	0.1903	0.0098	0.5816	1.7452	2.6141	2.8922	2.7264	1.6418
ROA	36 1488	-0.2626	-0.2058	-0.4679	-0.2775	0.3340	0.4867	0.4469	0.3399	-0.0985	-0.3855	-0.2558	0.0853
ROA	36 1490	-0.2545	-0.0315	-0.0134	0.1001	0.1624	0.0873	0.0470	0.0902	-0.0944	0.2461	0.3857	0.0162
ROA	40 1436	2.6498	2.6339	2.8536	3.1553	3.3564	3.3350	3.2141	3.0072	2.9720	3.0068	3.1212	2.9173
SASO	35 0221	0.2132	-	0.3138	0.2253	-0.1034	-0.7234	-0.8365	-0.6704	-0.5998	-0.3291	0.0794	0.0615
SASO	35 1628	0.1688	-	2.3538	0.3244	3.6505	-0.9588	-1.8283	-1.7926	-2.0184	-1.8328	0.0133	-0.0267
SASO	35 2923	0.1503	-	0.1698	0.6705	0.0492	0.0584	0.1427	-0.0163	-0.1083	0.0084	-0.0602	0.0581
SASO	35 2931	0.0564	-	1.3013	0.1674	0.1263	0.0862	0.0170	0.0300	-0.0900	-0.0806	-0.0135	0.0446
SASO	35 2932	-0.0964	-	2.2750	-0.0356	0.1254	0.0376	0.0047	0.0902	0.0661	-0.0231	0.0510	0.0601
SCL	35 2178	-0.3271	-0.9714	-	-	-	-	-	-	-	-	-	-
SCL	35 2525	-0.5925	-0.7383	-0.1455	-	-3.5015	-0.7017	-0.4415	-0.3946	-0.3876	-0.3339	-0.2082	-0.0616
SG	35 0188	0.0455	0.0409	0.0048	-0.0490	-0.0950	-0.0299	-0.0032	0.0425	0.0324	-0.0305	-0.0393	-0.0114
SG	35 0475	-0.0961	0.0170	-0.0562	-0.1330	-0.0589	-0.0635	-0.0302	0.0493	0.0868	0.0876	0.1211	-0.0101

Table 10. (Cont.)

Lab.	Clock	57414	57444	57474	57504	57539	57569	57599	57629	57659	57689	57719	57749
SG	35 0696	0.1783	0.2805	-	-	-	-	-	-	-	0.2630	-0.1067	-0.0984
SG	35 3135	0.1583	0.1952	0.1631	0.1726	0.1598	0.0696	-0.0184	-0.7228	-2.5957	-1.0678	0.4335	1.9014
SG	36 0522	0.3040	0.8298	0.6790	0.3312	-0.0708	-0.4084	-0.7266	-0.4249	0.0341	0.0284	0.2328	0.0953
SG	40 7701	4.2265	4.2469	4.1858	4.1927	4.1772	4.1811	4.1514	3.8448	3.9823	4.1469	4.3656	4.5447
SIQ	36 1268	0.6559	0.6334	-0.0528	-0.8132	-0.7638	-0.5271	-0.5410	-0.2560	0.0765	-0.0170	0.5482	0.1328
SMD	35 1766	-0.0183	-0.0925	-	-	-	-	-	-0.4605	-0.2897	-0.3307	-0.1661	-0.2511
SMD	35 2003	0.4654	0.4290	0.3688	0.2885	0.1830	0.1171	0.0775	-0.0067	0.0338	0.0376	-0.0103	0.1079
SMD	35 2543	0.6206	0.6929	0.3472	-0.0170	0.0662	0.5132	0.9722	1.2500	1.1872	0.6319	0.2895	0.7595
SMD	40 7909	-1.8956	-2.0498	-2.1855	-2.0903	-2.6485	-3.3580	-3.8657	-3.9655	-3.4071	-1.9404	-0.7514	-0.5591
SMU	35 1193	-	-0.0824	-0.3252	-0.7876	-0.5306	-0.3613	-0.1547	-0.0480	-	-	0.7220	-1.3436
SP	35 0572	-0.0881	-0.1286	-0.0286	0.1627	0.1309	0.2133	0.1397	-0.1180	-0.2048	-0.1600	-0.0425	0.0869
SP	35 0641	0.0089	-0.1189	-0.1907	-0.0621	-0.0160	-0.0943	0.0564	-0.0715	-0.1506	0.0186	-0.0542	-0.2025
SP	35 0767	0.1197	0.1016	-0.0674	-0.0179	-0.0656	-0.0761	0.1973	0.3208	0.3764	0.4471	0.2851	0.1577
SP	35 1188	0.1187	0.1410	0.1185	0.1300	0.0204	-0.0930	-0.1170	-0.1208	-0.0824	-0.0094	-0.0818	-0.0860
SP	35 1642	0.2513	0.2352	0.1441	0.0323	0.1273	0.1952	0.1764	0.2993	0.2809	0.0754	0.0937	0.2476
SP	35 2166	-0.0107	0.0152	-0.0407	-0.3165	-0.1668	-0.1358	0.0204	0.1608	0.2537	0.1502	0.0404	-0.0434
SP	35 2745	0.0932	0.0474	0.0075	-0.0492	-0.0177	0.0208	-0.1472	0.1106	0.3670	0.4985	0.3956	0.2795
SP	35 2746	-0.2651	-0.0829	-0.1330	0.1233	0.2449	0.1542	-0.0398	-0.1100	-0.3567	-0.4631	-0.3203	-0.0925
SP	35 2749	0.0784	0.1591	0.0202	-0.1676	-0.2349	-0.2223	-0.1110	-0.1074	-0.0065	-0.0298	0.0766	0.1565
SP	35 2750	0.0305	0.0846	0.1997	0.0925	-0.1022	-0.2606	-0.1967	-0.1383	0.0374	0.0720	0.0114	-0.0854
SP	35 2758	-0.0812	-0.1439	-0.1577	-0.0699	0.0823	0.1668	0.1659	0.1417	0.1814	0.1640	0.1585	0.1898
SP	36 0223	-0.2828	0.0246	-0.1253	-0.0557	0.1186	-	2.2201	0.4873	0.3037	-0.0822	-0.0223	0.0205
SP	36 1175	0.0533	0.1056	0.1808	-0.2758	-0.1481	-0.2436	-0.2765	-0.0546	0.3648	0.0833	0.1345	0.1102
SP	36 1187	0.7102	0.6312	0.4500	0.0725	-0.1343	-	-0.0770	-0.8046	0.1407	-0.0488	-0.2823	-0.1788
SP	36 1531	0.2296	0.1745	0.3250	0.4762	0.2587	0.3200	0.0818	0.1882	0.3427	0.2579	0.2829	0.4653
SP	36 2068	-0.3887	-0.1969	-0.1755	0.1013	0.2445	0.0598	0.0666	-0.3500	-0.2281	0.0350	0.1207	-0.1826
SP	36 2218	0.0773	0.1641	-0.0377	0.1943	0.1680	0.2017	0.0405	0.1114	-0.0426	-0.1257	-0.0210	0.0073
SP	36 2295	0.2076	0.1226	-0.1478	-0.0115	0.2151	0.3895	0.3061	0.2315	0.0364	0.1043	0.0087	0.0935
SP	36 2297	0.2963	0.3660	0.2575	0.1708	0.1190	0.0496	0.0176	0.0539	0.1180	0.2367	0.4091	0.2956
SP	40 7201	3.0496	3.1148	3.0748	3.1430	3.2508	3.3058	3.2614	3.1656	2.9380	2.8186	2.7978	2.8350

Table 10. (Cont.)

Lab.	Clock	57414	57444	57474	57504	57539	57569	57599	57629	57659	57689	57719	57749
SP	40 7203	0.6843	0.6812	0.6843	0.6975	0.6976	0.6947	0.6877	0.6736	0.6656	0.6569	0.6487	0.6303
SP	40 7210	2.3215	2.2495	-	4.3192	3.4363	2.9737	-	1.5795	2.0763	1.9565	1.6960	1.7808
SP	40 7212	0.2440	0.2568	0.2596	0.2578	0.2308	0.2320	0.2446	0.2270	0.2501	0.2537	0.2463	0.2400
SP	40 7221	0.1861	0.1818	0.1804	0.1847	0.1634	0.1767	0.1777	0.1723	0.1740	0.1751	0.1725	0.1612
SP	40 7223	1.8597	2.1775	2.4158	2.2920	1.7267	1.2746	0.9899	0.7264	0.6868	0.7064	0.6994	0.6809
SP	40 7231	7.7015	7.6617	7.6163	7.5533	7.4447	7.3815	7.3286	7.2790	7.2391	7.2048	7.1638	7.1040
SP	40 7232	-0.3431	0.1791	0.6771	1.0846	1.4033	1.8089	2.0986	2.2979	2.4614	2.5518	2.5920	2.7737
SU	40 3809	0.2889	0.2828	0.2737	0.2517	0.2425	0.2579	0.2505	0.2463	0.2481	0.2549	0.2847	0.3082
SU	40 3810	0.2577	0.2530	0.2520	0.2385	0.2337	0.2517	0.2551	0.2546	0.2477	0.2489	0.2674	0.2718
SU	40 3811	-	0.4319	0.6847	0.7054	0.7174	0.7514	0.7501	0.7564	0.7540	0.7418	0.7184	0.7192
SU	40 3812	0.2170	0.2127	0.2271	0.2292	0.2264	0.2447	0.2347	0.2236	0.2226	0.2165	0.2219	0.2270
SU	40 3814	0.7457	0.7385	0.7394	0.7258	0.7090	0.7104	0.7043	0.6943	0.6877	0.6761	0.6745	0.6738
SU	40 3815	0.4521	0.4460	0.4496	0.4432	0.4481	0.4991	0.5236	0.5377	0.5349	0.4862	0.4242	0.3829
SU	40 3816	0.5961	0.5640	0.5454	0.5342	0.5348	0.5651	0.5897	0.6005	0.6070	0.6063	0.5950	0.5590
SU	40 3817	0.4162	0.4310	0.4524	0.3931	0.3801	0.4023	0.4219	0.4256	0.4511	0.4526	0.4514	0.4398
SU	40 3818	0.3501	0.3503	0.3531	0.3432	0.3487	0.3817	0.3969	0.4070	0.4015	0.3768	0.3585	0.3449
SU	40 3844	-	-	-	-	-	-0.1360	-0.0939	-0.0500	-0.0409	-0.0249	-0.0488	-0.0383
TL	35 1012	0.2260	0.0969	1.8211	-	-	-	-	-	-	-	-	-
TL	35 1498	-0.0505	-0.0515	-0.1022	-0.0329	0.0611	0.0167	0.1903	0.0456	-0.1815	-0.1755	-0.1799	-0.2116
TL	35 1500	0.0000	0.3363	0.2729	0.2743	0.1320	-	-	-	-	-	-	-
TL	35 1712	1.2844	1.3773	0.9210	0.3730	0.0774	0.1064	0.0944	0.0080	-0.2215	-0.2208	-0.0701	0.1414
TL	35 2365	0.0492	0.1404	0.2295	0.1802	0.0922	0.0285	-0.1017	-0.1369	0.0479	-0.0182	0.0785	0.1990
TL	35 2366	-0.0036	-0.1545	-0.0223	0.0585	0.3059	0.2408	0.0928	-0.2956	-0.3284	-0.3686	-0.2854	-0.1792
TL	35 2367	-0.1782	-0.1488	0.1548	0.0842	0.1487	-0.0694	-0.2406	-0.2588	0.0866	0.0298	0.1995	0.1471
TL	35 2368	0.1077	0.0671	-0.0091	0.1096	0.2140	0.3458	0.2854	0.3168	0.1174	0.1157	0.0086	-0.0149
TL	35 2630	-0.1392	-0.0917	-0.0254	0.1288	0.3642	0.3318	0.5955	0.5437	0.4098	0.1535	-0.0575	-0.3742
TL	35 2634	-0.3128	0.4620	1.3738	1.0246	0.2107	0.0482	0.3433	-	-	-	-	-
TL	35 2636	-0.7162	-0.5874	-0.4129	-0.1646	0.1331	0.0502	0.2123	0.6333	0.7872	0.8140	0.4883	0.0433
TL	35 2853	0.1945	0.1968	0.1563	-0.0233	-0.4184	-0.6765	-0.9473	-1.0563	-0.7432	-0.3512	0.1261	0.2035
TL	35 2910	0.1279	0.2292	0.0978	0.0317	0.0656	0.0427	0.0635	0.2333	0.2078	0.1736	0.1116	0.1369

Table 10. (Cont.)

Lab.	Clock	57414	57444	57474	57504	57539	57569	57599	57629	57659	57689	57719	57749
TL	40 0057	-2.2500	-2.4588	-2.4151	-2.3686	-2.2731	-2.2217	-2.1339	-2.0784	-2.0392	-2.0648	-2.1841	-2.5693
TL	40 3011	3.6750	3.8899	4.0668	4.2016	4.3332	4.4658	4.6032	4.7228	4.8263	4.9119	5.0018	5.0657
TL	40 3052	-1.0157	-	-	-	-2.0744	-0.6674	-0.1815	-0.2216	-0.1073	-0.0430	0.0493	-0.3252
TL	40 3053	-	-	-	-	-	9.7623	9.3773	8.9321	8.7585	8.6222	8.4905	8.2071
TP	35 0163	-0.2409	-0.4109	-0.2690	-0.1705	-0.0118	0.1012	0.0229	-0.1285	-0.1429	-0.0471	0.1168	0.2645
TP	35 1227	-0.1700	-0.1726	0.0849	0.3298	0.3106	0.3157	0.1400	-0.0131	0.0043	0.0124	0.0129	0.0313
TP	35 2179	-	-	1.9561	0.7528	-	-	0.7732	-0.2361	0.4310	0.1416	-0.0035	-
TP	35 2476	-0.1848	-0.3475	-0.3709	-0.4029	-0.3533	-0.3853	-0.2230	-0.1459	-0.1114	-0.1140	-0.2163	-0.3437
TP	35 2970	0.1675	0.2585	0.1948	0.3080	0.1385	0.1815	0.0571	0.0514	0.2119	0.2419	0.1874	0.1346
UA	35 2465	0.5043	0.7802	0.1662	-0.0501	0.0133	0.1858	0.0770	-0.1421	-0.1574	-0.0411	1.0694	1.7687
UA	40 7854	0.0778	0.1436	-0.0297	-0.1003	-0.0341	-0.0440	-0.0562	0.0157	-0.0062	0.0111	0.0088	0.0321
UA	40 7881	0.3971	0.5216	0.2898	-0.3264	-0.0987	-0.2508	-0.0705	0.0648	0.0424	-0.2110	0.1778	0.2573
UA	40 7882	0.1997	0.0345	-0.1898	-0.2949	-0.0928	-0.1724	-0.3396	-0.4213	-0.1294	-0.1249	0.4625	0.8419
UME	35 0251	-0.1094	-0.0053	-0.0003	-0.0137	0.0502	-0.0506	-0.0572	0.0516	0.0405	0.0313	-	-0.5815
UME	35 0252	0.3915	0.5932	0.5826	0.5383	0.1434	-0.7354	-0.7021	-0.4097	-0.2661	0.0212	-	1.2528
UME	35 0872	0.3053	0.2517	0.1145	-0.0773	-0.2199	-0.2439	-0.4368	-0.4551	-0.2773	0.1511	-	1.5580
UME	35 2703	0.6001	0.4921	0.4819	0.0006	-0.2768	-0.4886	-0.6736	-0.6642	-0.5825	-0.5285	-	-0.8935
UME	35 2710	2.1100	0.0349	-2.1703	-5.1148	-0.6426	-0.6390	-0.2846	-0.0074	0.2370	0.1656	-	-0.3209
USNO	35 0101	0.2636	0.1445	0.1078	0.4594	0.3454	0.0850	0.0592	0.1193	0.2198	0.1138	0.0127	-0.0771
USNO	35 0104	-0.0004	-0.1537	-0.0565	0.1261	0.0717	0.2111	0.2337	0.2166	0.3828	0.3030	0.1663	0.0087
USNO	35 0108	0.0093	0.0421	0.1791	0.0761	-0.0649	-0.0237	-0.0715	-0.1241	0.0248	0.0919	0.0771	0.0795
USNO	35 0114	-0.2317	-0.3612	-	-	-	-	-	-	-	-	-	-
USNO	35 0120	-0.2282	-0.0016	0.1126	0.0398	-0.0112	-0.0524	-0.1675	-0.1883	-0.1780	-0.1425	0.0153	0.1368
USNO	35 0142	-0.2313	-0.0442	0.0520	0.2297	0.0496	-0.0442	-0.0562	-0.0157	-0.0208	-0.2119	-0.2755	-0.3504
USNO	35 0150	-0.1378	-0.0373	-0.0990	-0.1754	-0.0951	0.0528	-0.1862	-0.2142	-0.3587	-0.3382	-0.3537	0.1752
USNO	35 0161	0.3214	0.2826	0.2180	0.3082	0.2857	0.4629	0.4792	0.3333	0.0447	-0.1317	-0.1738	0.1750
USNO	35 0164	-0.1314	-0.1304	-0.1175	-0.1143	-0.1412	0.0045	0.3836	0.4362	0.4438	0.4559	0.2516	-0.0720
USNO	35 0166	-0.1234	-0.1539	-0.3098	-0.1735	-0.0841	-0.3026	-0.2909	-0.0143	-0.0264	-0.0308	-0.1168	-0.3521
USNO	35 0169	0.2896	0.6544	1.8149	2.7140	3.1165	2.8163	1.4066	-0.1888	-1.0483	-1.6037	-1.7639	-1.4017
USNO	35 0173	-0.1723	-0.1168	-0.3731	-0.1615	-0.2515	-0.2395	-0.2758	-0.2509	-0.4287	-0.1752	-0.1832	0.0261

Table 10. (Cont.)

Lab.	Clock	57414	57444	57474	57504	57539	57569	57599	57629	57659	57689	57719	57749
USNO	35 0226	-0.0160	0.0052	0.0613	0.0143	0.0370	0.0808	0.0001	-0.0875	0.0319	0.1322	0.1633	0.2483
USNO	35 0233	-0.1128	0.4656	0.6839	0.7347	0.3557	0.0345	-0.3765	-0.3635	-0.3602	-0.3520	-0.4031	-0.2190
USNO	35 0244	0.1264	-0.1018	-0.2184	-0.0426	-0.0898	-0.1267	0.0078	-0.0851	-	-	-	-
USNO	35 0254	0.0002	-0.0305	-0.0103	-0.0335	0.0194	0.0874	0.0978	0.0498	0.1969	0.0819	0.0877	0.1143
USNO	35 0256	-0.2735	-0.2756	-0.2494	-0.3133	-0.1443	-0.2122	-0.1591	-0.0250	0.0280	-0.1075	-0.0014	-0.0417
USNO	35 0260	-0.5728	0.3752	1.4777	3.6966	2.1095	0.0248	-1.5033	-1.2988	-0.7734	-0.0436	0.4602	0.5623
USNO	35 0268	-0.2500	0.0473	0.6958	1.2318	1.0033	0.8283	0.4989	-0.0409	-0.1408	-0.1728	-0.1354	-0.4793
USNO	35 0270	-0.4019	-0.2102	0.0202	-0.1366	-0.0993	-0.2186	-0.0846	-0.0519	0.0727	-0.1002	0.0095	-0.1617
USNO	35 0279	-0.4956	-0.9511	-1.1423	-1.0858	-1.1796	-1.2130	-0.8706	-0.7436	-0.6536	0.2695	0.4157	0.2447
USNO	35 0389	0.2480	0.1910	-0.0163	-0.0356	-0.0099	-0.0067	-0.0601	0.0719	0.1696	0.1450	0.1406	0.1674
USNO	35 0394	0.0298	0.1389	0.1232	0.1204	0.0932	0.0648	-0.1977	-	-	-	-	-
USNO	35 0703	-0.2602	-0.9570	-0.9438	-0.6679	-0.2380	-0.1385	-0.0028	-0.0320	-0.2181	-0.2796	-0.5555	-0.8923
USNO	35 0717	-0.3361	-0.2677	-0.3982	-0.5472	-0.4917	-0.2743	-0.3474	-0.2641	-0.1301	0.1139	0.2750	0.5145
USNO	35 0762	0.0702	0.0665	0.0555	0.0632	0.0420	0.0907	0.1114	0.0199	0.0521	0.1048	-0.1229	-0.0339
USNO	35 1096	-0.0604	-0.0026	-0.0971	-0.0516	0.0660	-0.0908	-0.4224	-0.6027	-0.7437	-0.7061	-0.3440	0.0962
USNO	35 1125	-0.3440	-0.0649	0.0926	-0.0329	-0.0224	-0.2361	-0.2975	-0.2475	-0.0331	-0.0382	0.0064	-0.1459
USNO	35 1327	-0.3381	-0.1336	0.1188	0.0448	-	-	-	-	-	-	-	-
USNO	35 1328	0.2463	0.1110	-	-	-	-	-	-	-	-	-	-
USNO	35 1331	-	-	-	-	-	-	2.2407	0.2216	-0.2741	-	-	-
USNO	35 1459	-0.0865	-0.0118	-0.0244	0.0150	-0.1071	-0.0515	-0.1774	-0.0511	0.1411	0.3087	0.2054	0.1213
USNO	35 1462	0.1458	0.0094	-0.0524	-0.0009	0.0026	-0.0083	0.0484	-0.0381	0.0641	0.0081	0.0406	0.1313
USNO	35 1463	0.0226	0.0646	0.0878	-0.1797	-0.2339	-0.1766	-0.1379	-0.0233	0.1507	-0.0021	-0.2488	-0.0576
USNO	35 1468	-0.2275	-0.0076	0.1071	0.2104	0.1216	0.0757	-0.0912	-0.2260	-0.2707	-0.3434	-0.0788	0.3017
USNO	35 1481	-0.0448	-0.1105	-0.2363	0.0993	-	-	-	-	-	-	-	-
USNO	35 1543	0.3835	0.7648	0.8592	0.9779	0.8483	0.6472	0.5552	0.4382	0.0977	-0.1576	-0.2064	-0.2668
USNO	35 1573	-0.0391	0.1193	0.0129	-0.0096	-0.0593	-0.0984	0.0571	0.6057	0.9194	1.1346	1.2144	0.8857
USNO	35 1575	-0.4460	-0.2993	-0.1272	-0.0295	-0.0925	0.0182	-0.0479	-0.0802	-0.0949	0.0077	-0.1489	0.0205
USNO	35 1580	-0.3045	-0.2533	-0.1918	-0.1386	-0.1931	0.0091	0.0761	0.1451	0.3418	0.3737	0.1980	0.1282
USNO	35 1585	-0.7134	-1.0715	-1.6016	-1.7112	-1.3007	-0.8244	-0.2359	0.1603	0.2619	0.1057	0.0573	-0.0141
USNO	35 1598	-0.5231	-0.1340	0.1044	0.2338	-0.1792	-0.4268	-0.5306	-0.0151	0.4019	0.8844	0.8652	0.8708

Table 10. (Cont.)

Lab.	Clock	57414	57444	57474	57504	57539	57569	57599	57629	57659	57689	57719	57749
USNO	35 1655	-0.1373	-0.1493	-0.1733	-0.2236	-0.2353	-0.3672	-0.3925	-0.4690	-0.3286	-0.2615	-0.4062	-0.6739
USNO	35 1658	-0.0752	-0.0090	-0.0375	0.0563	-0.0386	-0.0849	-0.2387	-0.3401	-0.4658	-0.4267	-0.4058	-0.1557
USNO	35 1692	-0.5087	-0.3305	-0.2960	-0.1721	-0.0959	0.0763	0.1105	0.0550	-0.1509	-0.0677	-0.0691	-0.0025
USNO	35 1694	-0.1677	-0.2141	-0.3921	-0.2732	-0.3652	-0.2732	-0.3303	-0.1711	-0.1648	-0.1193	0.1173	0.0833
USNO	35 1696	0.3898	-0.0077	-0.0844	-0.1044	-0.0618	-0.2276	-0.1414	-0.1636	-0.1795	-0.2067	-0.1654	-0.2170
USNO	35 1697	0.0934	0.1663	0.1741	0.2147	0.2960	0.2106	0.3402	0.7703	1.1141	0.6140	-0.3085	-1.0621
USNO	40 0701	-0.3632	-0.0668	0.0458	0.1035	0.0577	-0.0514	-0.1270	-0.2330	-0.3630	-0.3229	-0.2290	-0.0754
USNO	40 0702	0.0493	0.0881	0.0917	0.0835	0.0665	0.0722	0.0834	0.0873	0.0555	0.0363	0.0186	0.0123
USNO	40 0705	0.0619	0.0647	0.0415	0.0688	0.0646	0.0579	0.0386	0.0395	0.0390	0.0610	0.0754	0.0794
USNO	40 0708	0.2473	0.2565	0.2780	0.2795	0.2867	0.3013	0.2996	0.2897	0.2807	0.2509	0.2279	0.2323
USNO	40 0710	0.2865	0.2766	0.2955	0.3032	0.3079	0.3220	0.3157	0.2976	0.2870	0.2216	0.1691	0.1675
USNO	40 0711	1.3828	1.3751	1.3770	1.3715	1.3610	1.3451	1.3336	1.3380	1.3535	1.3706	1.3801	1.3683
USNO	40 0712	-0.0240	-0.0261	-0.0193	-0.0236	-0.0317	-0.0334	-0.0474	-0.0565	-0.0538	-0.0517	-0.0344	-0.0475
USNO	40 0713	-5.0487	0.6058	0.5935	0.5954	0.6163	0.6397	0.6434	0.6451	0.6496	0.6593	0.6641	0.6622
USNO	40 0714	0.4364	0.4959	0.5092	0.4924	0.4161	0.2960	0.2852	0.2761	0.2712	0.2938	0.3250	0.3118
USNO	40 0715	0.4832	0.4854	0.4961	0.4905	0.4814	0.4833	0.4892	0.4839	0.5000	0.4908	0.5143	0.5790
USNO	40 0716	0.1616	0.1772	0.1984	0.2165	0.2118	0.1743	0.1600	0.1365	0.1355	0.1429	-	-
USNO	40 0717	1.2836	1.2421	1.2178	1.2321	1.2960	1.3358	1.3470	1.3681	1.3604	1.3417	1.3043	1.2265
USNO	40 0718	0.9814	1.0876	1.2123	1.3052	1.3983	1.4738	1.5498	1.6066	1.6739	1.6959	1.7075	1.6911
USNO	40 0720	2.2985	2.2950	2.2955	2.3254	2.3407	2.3776	2.4283	2.4678	2.4493	2.4536	2.4017	2.2813
USNO	40 0721	3.5570	3.5661	3.5942	3.5711	3.5703	3.5950	3.6009	3.5600	3.5160	3.4322	3.3600	3.3367
USNO	40 0722	3.4358	3.3413	3.2348	3.1950	3.1580	3.1063	3.0977	3.0860	3.0536	3.0386	3.0130	2.9705
USNO	40 0723	0.2158	0.2115	0.2012	0.1943	0.1675	0.1987	0.2207	0.2215	0.2219	0.2164	0.1947	0.2055
USNO	40 0724	-0.0595	-0.0627	-0.0733	-0.0905	-0.1133	-0.1141	-0.1091	-0.1188	-0.1265	-0.1304	-0.1532	-0.2051
USNO	40 0725	0.1053	0.1269	0.1655	0.1732	0.1706	0.1695	0.1955	0.1808	0.1916	0.1640	0.1333	0.1149
USNO	40 0726	3.4026	3.3984	3.3930	3.3963	3.3960	3.4003	3.3960	3.3883	3.3755	3.3669	3.3502	3.3297
USNO	40 0727	3.2055	3.2077	3.2414	3.3030	3.3794	3.4849	3.5409	3.5792	3.5858	3.5642	3.5123	3.4715
USNO	40 0728	2.8023	2.8183	2.7772	2.6848	2.7022	2.7279	2.7263	2.7077	2.6936	2.6631	2.6260	2.5871
USNO	40 0729	4.3079	4.3102	4.2897	4.2724	4.2421	4.2150	4.1786	4.1540	4.1267	4.1112	4.0904	4.0792
USNO	40 0730	3.1811	3.1695	3.1637	3.1721	3.1584	3.1459	3.1235	3.0982	3.0823	3.0658	3.0205	2.9680

Table 10. (Cont.)

Lab.	Clock	57414	57444	57474	57504	57539	57569	57599	57629	57659	57689	57719	57749
USNO	40 0731	-0.0293	-0.0345	-0.0615	-0.0703	-0.0835	-0.0705	-0.0775	-0.0634	-0.0435	-0.0011	0.0110	0.0251
USNO	40 0732	2.9207	2.9304	2.9333	2.9175	2.8864	2.8828	2.8579	2.8534	2.8531	2.8631	2.8610	2.8635
USNO	40 0734	-4.1536	-3.7480	-3.2746	-3.0738	-	-	-	-	-	-	-	-
USNO	40 0735	4.0841	4.2340	4.5662	4.6916	4.7645	4.7691	4.7086	4.6580	4.7186	4.6814	4.6506	4.6944
USNO	40 0736	4.6005	4.5776	4.5766	4.5842	4.5830	4.5821	4.5639	4.5477	4.5294	4.5067	4.4751	4.4303
USNO	40 0737	8.6013	8.5496	8.4931	8.4379	8.3535	8.3074	8.2593	8.2088	8.1179	8.0049	7.8628	7.6936
USNO	40 0740	-	-	-	-	-	-	-	-	4.3325	4.5407	4.7078	4.7372
USNO	40 0741	-	-	-	-	-	-	-	-	11.8137	13.3716	14.0689	14.4478
USNO	93 0002	0.0010	0.0059	0.0055	-0.0009	0.0022	0.0037	0.0030	-0.0136	-0.0195	-0.0279	-0.0176	-0.0142
USNO	93 0003	-0.0027	-0.0034	0.0037	0.0027	-0.0014	-0.0006	-0.0024	-0.0122	-0.0106	-0.0148	-0.0144	-0.0116
USNO	93 0004	0.0025	0.0019	0.0045	-0.0016	-0.0034	0.0083	0.0036	0.0003	0.0044	-0.0029	-0.0020	-0.0037
USNO	93 0005	0.0019	0.0032	0.0042	0.0014	-0.0060	0.0062	0.0019	-0.0014	-0.0016	-0.0031	-0.0092	-0.0085
VMI	35 2230	-	14.8250	5.3970	1.3710	1.1079	0.5043	0.5966	-0.0794	-	-2.9771	-3.8250	-1.3813
VMI	36 1233	-	17.3004	3.9440	1.3678	1.0043	0.6922	0.7431	0.0014	-	-3.5599	-5.3754	-2.2734
VMI	36 2314	-	20.3656	4.8403	1.1487	1.1429	0.6733	0.6030	-0.1021	-	-1.6330	-3.8137	-1.0934
VSL	35 0179	0.1516	0.1590	0.0769	0.0887	0.0409	0.0329	-0.0137	-0.0410	-0.0756	-0.0205	-0.0573	-0.0723
VSL	35 0456	-0.0223	0.0227	0.1116	-0.1535	-0.3804	-0.5070	-0.4990	-0.5354	-0.1719	-0.2646	-0.2044	-0.0335
VSL	35 0548	0.0344	0.1579	0.0833	-0.1466	-0.1645	-0.2058	-0.1187	0.1073	0.2326	0.0870	0.0478	-0.2865
VSL	35 0731	0.1905	0.1971	0.0797	0.0141	-0.0591	-0.0856	-0.1022	-0.0883	-0.1047	-0.2171	-0.1109	0.0225
ZA	36 1821	-0.0903	-0.0736	-0.2843	-0.2399	-0.2584	-0.1197	-0.1291	0.1695	-	-	-	-
ZA	40 2901	-	-	-	-4.4813	-4.2447	-3.9009	-3.7879	-3.7452	-3.5391	-3.1974	-2.8922	-2.4533

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 seconds.

The following tables are based on information received at the BIPM in April 2017.

AUTHORITIES RESPONSIBLE FOR TIME SIGNAL EMISSIONS

Signal	Authority
BPC, BPL, 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 Measurement Science and 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
HLA	Center for Time and Frequency Division of Physical Metrology Korea Research Institute of Standards and Science 267 Gajeong-Ro, Yuseong, Daejeon 34113 Republic of Korea
JJY	Space-Time Standards Laboratory National Institute of Information and Communications Technology 4 -2- 1, Nukui-kitamachi Koganei, Tokyo 184-8795 Japan
LOL	Servicio de Hidrografía Naval Observatorio Naval Buenos Aires Av. España 2099 C1107AMA – Buenos Aires, Argentina
MIKES	VTT Technical Research Centre of Finland Ltd Centre for Metrology MIKES P.O. Box 1000, FI-02044 VTT, Finland

Signal	Authority
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
TDF	CFHM Chambre française de l'horlogerie et des microtechniques 22 avenue Franklin Roosevelt 75008 Paris, France and ANFR Agence nationale des fréquences 78, avenue du général de Gaulle 94704 Maisons-Alfort, 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, 688.00 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
BPC	Shangqiu China 34° 27'N 115° 50'E	68.5	00 h 00 m to 21 h 00 m	UTC second pulse modulation of the phase shift keying of the carrier. The additional pulse width modulation includes calendar and local time information.
BPL	Pucheng China 34° 56'N 109° 32'E	100	continuous	The BPL time signals are generated by NTSC and are in accordance with the legal time of China which is UTC(NTSC)+8 . The BPL system is the same as the Loran-C system, utilizing the multi-pulse phase coding scheme. Carrier Frequency of 100KHz. The information that BPL broadcasts contains minutes, seconds, year, month, day, and other information. Using pulse shift modulation.
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.

Station	Location Latitude Longitude	Frequency (kHz)	Schedule (UTC)	Form of the signal
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.
HLA (1)	Daejeon Rep. of Korea 36° 23'N 127° 22'E	5 000	continuous	Second pulses of 9 cycles of 1 800 Hz tones. 29th and 59th second pulses omitted. Hour identified by 0.8 s long 1 500 Hz tones. Beginning of each minute identified by 0.8 s long 1 800 Hz tones. BCD time code given on 100 Hz subcarrier.
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	11 h to 12 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, but with 1 kHz amplitude modulation added and without pseudo-random phase shift keying of the carrier. Time code in UTC.
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.

(1) Information based on the Annual Report 2015, not confirmed by the Laboratory

Station	Location Latitude Longitude	Frequency (kHz)	Schedule (UTC)	Form of the signal
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.
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	00 h 00 m to 19 h 00 m 20 h 00 m to 24 h 00 m	DXXXW type 0.1 s signals. The numbers of the minute, hour, day of the month, day of the week, month, year of the century, difference between the universal time and the local time, TJD and DUT1+dUT1 are transmitted each minute from the 1st to the 59th second. DUT1+dUT1: by double pulse.

Station	Location Latitude Longitude	Frequency (kHz)	Schedule (UTC)	Form of the signal
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.
TDF	Allouis France 47° 10'N 2° 12'E	162	continuous, except every Tuesday from 1 h to 5 h	Phase modulation of the carrier by +1 and -1 rd in 0.1 s every second except the 59th second of each minute. This modulation is doubled to indicate binary 1. The numbers of the minute, hour, day of the month, day of the week, month and year are transmitted each minute from the 21st to the 58th second, in accordance with the French legal time scale. In addition, a binary 1 at the 17th second indicates that the local time is 2 hours ahead of UTC (summer time); a binary 1 at the 18th second indicates that the local time is 1 hour ahead of UTC (winter time); a binary 1 at the 14th second indicates that the current day is a public holiday (Christmas, 14 July, etc...); a binary 1 at the 13th second indicates that the current day is a day before a public holiday.
WWV	Fort-Collins CO, USA 40° 41'N 105° 3'W	2 500 5 000 10 000 15 000 20 000	continuous	Second pulses are 1 000 Hz tones, 5 ms in duration. 29th and 59th second pulses omitted. Hour is identified by 0.8 second long 1 500 Hz tone. Beginning of each minute identified by 0.8 second long 1 000 Hz tones. DUT1: ITU-R code by double pulse. BCD time code given on 100 Hz subcarrier, includes DUT1 correction.
WWVB	Fort-Collins CO, USA 40° 41'N 105° 3'W	60	continuous	Second pulses given by reduction of the amplitude, reversal of phase, and by binary phase shift keying of the carrier, AM, PM and BPSK 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.

(2) RWM 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.

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
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
TDF	0.02
WWV	0.01
WWVB	0.01
WWVH	0.01

TIME DISSEMINATION SERVICES

The following tables are based on information received at the BIPM between February and April 2017.

AUTHORITIES RESPONSIBLE FOR TIME DISSEMINATION SERVICES

AOS	Astrogeodynamical Observatory Borowiec near Poznan Space Research Centre P.A.S. PL 62-035 Kórnik - Poland
AUS	Electricity Section National Measurement Institute PO Box 264 Lindfield NSW 2070 - Australia
BelGIM	Belarussian State Institute of Metrology National Standard for Time, Frequency and Time-scale of the Republic of Belarus Minsk, Minsk Region – 220053 Belarus
BEV	Bundesamt für Eich- und Vermessungswesen Arltgasse 35 A-1160 Wien, Vienna - Austria
BoM	Ministry of economy - Bureau of metrology Jane Sandanski 109a 1000 Skopje, Macedonia
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. 206 Panama
DMDM	Directorate of Measures and Precious Metals Group for Time, Frequency and Time Dissemination. Mike Alasa 14 11000 Belgrade Serbia
EIM	Hellenic Institute of Metrology Electrical Measurements Department Block 45, Industrial Area of Thessaloniki PO 57022, Sindos Thessaloniki, Greece
GUM	Time and Frequency Laboratory Główny Urząd Miar – Central Office of Measures ul. Elektoralna 2 PL 00 – 950 Warszawa P–10, Poland
HKO	Hong Kong Observatory 134A, Nathan Road Kowloon, Hong Kong, China

IGNA	Instituto Geográfico Nacional Argentino Servicio Internacional de la Hora General Manuel N. Savio 1898 B1650KLP – Villa Maipú, Provincia de Buenos Aires, Argentina
IMBH	Institute of Metrology of Bosnia and Herzegovina (IMBH) Laboratory for time and frequency Augusta Brauna 2 71000 Sarajevo, Bosnia and Herzegovina
INACAL	Instituto Nacional de Calidad Calle De La Prosa 150 San Borja, Lima 41, Peru
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 Turin, Italy
JV	Justervesenet Norwegian Metrology Service PO Box 170 2027 Kjeller, Norway
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 34113 Republic of Korea
KZ	Kazakhstan Institute of Metrology Orynbor str., 11 Astana, Republic of Kazakhstan
LNE-SYRTE	Laboratoire National de Métrologie et d'Essais Systèmes de Référence Temps-Espace Observatoire de Paris 61, avenue de l'Observatoire, 75014 Paris – France
LT	Time and Frequency Standard Laboratory Center for Physical Sciences and Technology Savanoriu av. 231 Vilnius LT-02300, Lithuania
MASM	Time and Frequency Standard Laboratory Mongolian Agency for Standardization and Metrology Peace avenue 46A, Bayanzurkh district, Ulaanbaatar 13343 Mongolia

METAS	Federal Institute of Metrology Sector Length, Optics and Time Lindenweg 50 CH-3003 Bern-Wabern Switzerland
MIKES	VTT Technical Research Centre of Finland Ltd Centre for Metrology MIKES P.O. Box 1000, FI-02044 VTT, Finland
MSL	Measurement Standards Laboratory Callaghan Innovation 69 Gracefield Road PO Box 31-310 Lower Hutt – New Zealand
NAO	Time Keeping Office Mizusawa VLBI Observatory National Astronomical Observatory of Japan 2-12, Hoshigaoka, Mizusawa, Oshu, Iwate 023-0861 Japan
NICT	Space-Time Standards Laboratory National Institute of Information and Communications Technology 4 -2 -1, Nukui-kitamachi Koganei, Tokyo 184-8795 - Japan
NIM	Time & Frequency Laboratory National Institute of Metrology No. 18, Bei San Huan Dong Lu Beijing 100029 - People's Republic of China
NIMB	Time and Frequency Laboratory National Institute of Metrology Sos. Vitan - Barzesti, 11 042122 Bucharest, Romania
NIMT	Time and 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, 688.00 325 Broadway Boulder, Colorado 80305, USA
NMIJ	Time Standards Group 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, Pretoria - South Africa

NMLS	Time and Frequency Laboratory National Metrology Institute of Malaysia 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 CSIR-National Physical Laboratory Dr.K.S.Krishnan Road New Delhi 110012 - India
NRC	National Research Council of Canada Measurement Science and Standards Frequency and Time Standards Bldg M-36, 1200 Montreal Road Ottawa, Ontario, K1A 0R6, Canada
NSC IM	Time and Frequency Section National Scientific Center "Institute of Metrology" Kharkov - Ukraine Region – 61002 Ukraine
NTSC	National Time Service Center Chinese Academy of Sciences 3 East Shuyuan Rd, Lintong District, Xi'an Shaanxi 710600, China
ONBA	Servicio de Hidrografía Naval Observatorio Naval Buenos Aires Servicio de Hora Av. España 2099 C1107AMA – Buenos Aires, Argentina
ONRJ	Observatorio Nacional (MCTI) Divisão Serviço da Hora Rua General José Cristino, 77 São Cristovão 20921-400 Rio de Janeiro, Brazil
ORB	Royal Observatory of Belgium Avenue Circulaire, 3 B-1180 Brussels, Belgium
PTB	Physikalisch-Technische Bundesanstalt Time and Frequency Department, WG 4. 42 Bundesallee 100 D-38116 Braunschweig, Germany

ROA	Real Instituto y Observatorio de la Armada Plaza de las Tres Marinas 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	SIQ Ljubljana 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. 99, Dianyan Road Yang-Mei, Taoyuan, 32661 Taiwan Chinese Taipei
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 Baris Mah. Dr. Zeki Acar Cad. No: 1 41470 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/
AUS	Network Time Service Computers connected to the Internet can be synchronized to UTC(AUS) using the NTP protocol. The NTP servers are referenced to UTC(AUS) either directly or via a GPS common view link. Please see http://www.measurement.gov.au/Services/Pages/TimeandFrequencyDisseminationService.aspx for information on access or contact time@measurement.gov.au Dial-up Computer Time Service Computers can also obtain time via a modem connection to our dial-up timeserver. For further information, please see our web pages as above.
BelGIM (1)	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	Three 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…).
BoM	Internet Time Service BoM operates two Stratum 1 NTP servers referenced to UTC(BoM). BoM also operates one time server Stratum 2 using the "Network Time Protocol" (NTP). Server Host Name: time.bom.gov.mk
CENAM (1)	CENAM operates a voice automatic system that provides the local time for four different time zones for Mexico; Southeast Time, Central Time, Pacific Time and Northwest Time as well the UTC(CNM). The access numbers are: +52 442 211 0505: Southeast Time +52 442 211 0506: Central Time +52 442 211 0507: Pacific Time +52 442 211 0508: Northwest Time +52 442 215 3902: UTC(CNM)

(1) Information based on the Annual Report 2015, not confirmed by the Laboratory.

	Telephone Code CENAM provides a telephone code for setting time in computers. For more information about this service please contact Eduardo De Carlos López at edlopez@cenam.mx
	Network Time Protocol Operates two time server using the "Network Time Protocol", it is located at the Centro Nacional de Metrología, Querétaro, Mexico. Further information at http://www.cenam.mx/hora_oficial/
	Web-based time-of-day clock that displays local time for Mexico's time zones. Referenced to CENAM Internet Time Service. Available at http://www.cenam.mx/hora_oficial/
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 service, call the telephone numbers (507) 5173201, (507) 5173202 and (507) 5173203
DMDM	Internet Time Service (ITS) DMDM operates two Stratum 1 time servers using the "Network Time Protocol" (NTP), synchronized to UTC(DMDM). Access policy: restricted. DMDM also operates two Stratum 2 NTP servers: vreme1.dmdm.rs or vreme1.dmdm.gov.rs vreme2.dmdm.rs or vreme2.dmdm.gov.rs Access policy: free. More information on: http://www.dmdm.rs/en/GrupaZaVremeFrekfencijuIDistribucijuVremena.php#TacnoVreme
	Web-based time-of-day clock that displays local time for Serbia referenced to the DMDM ITS. Available at the web page: http://www.dmdm.rs/en/index.php
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 83.212.233.6. This route is offered under a restricted access policy. The server uses the 10 MHz signal from our primary standard as reference and is synchronized to UTC(EIM).
GUM	Telephone Time Service providing the European time code by telephone modem for setting time in computers. Includes provision for compensation of propagation time delay. Access phone number : +48 22 654 88 72
	Network Time Service Two NTP servers are available: tempus1.gum.gov.pl tempus2.gum.gov.pl with an open access policy. It provides synchronization to UTC(PL). Contact: timegum@gum.gov.pl

HKO	Internet Clock Services HKO operates time-of-day clocks that display Hong Kong Standard Time (=UTC(HKO) + 8 h) Available as: 1. Web Clock (Flash): http://www.hko.gov.hk/gts/time/HKSTime.htm 2. Web Clock (HTML): http://www.hko.gov.hk/gts/time/clock_e.html 3. Palm Clock (Flash): http://pda.weather.gov.hk/clocke.htm 4. Palm Clock (HTML5): http://www.hko.gov.hk/m/clock.htm Speaking Clock Service HKO operates an automatic “Dial-a-weather System” that provides a 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 names of the NTP servers: stdtime.gov.hk; time.hko.hk (for IPv6 users) Further information at http://www.hko.gov.hk/nts/ntime.htm
INACAL	Network Time Server A 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 enter the link http://www.inacal.gob.pe/metrologia/categoria/sincronizacion-de-sistemas-de-computo 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://www.inacal.gob.pe/
IGNA	GPS common-view data GPS common-view data using CGGTTS format referred to UTC(IGNA) is available through our website at http://www.ign.gob.ar/NuestrasActividades/Geodesia/ServicioInternacionalHora/TransferenciaDeTiempo
IMBH	Internet Time Service IMBH operates several Stratum 1 time servers using the NTP protocol. These servers are directly synchronized to UTC(IMBH). The servers are available at IP address: 185.12.78.85 Common-view data GPS and GLONASS common-view data using CGGTTS format referred to UTC(IMBH) are available at request. Further information can be found at: http://met.gov.ba
INPL	Time dissemination service is performed in Israel by telecommunication companies, whose time and frequency standards are traceable to local UTC(INPL) time and are calibrated regularly once a year against the Israeli Time and Frequency National Standard kept by INPL.
INRIM	CTD Telephone Time Code Time signals dissemination, according to the European Time code format, available via modem on regular dial-up connection. Access phone numbers : 0039 011 3919 263 and 0039 011 3919 264. Provides a synchronization to UTC(IT) for computer clocks without compensation for the propagation time. Software for the synchronization of computer clocks is available on the 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: http://rime.inrim.it/labtf/ntp/. SRC (Segnale RAI Codificato) coded time signal broadcast 20 – 30 times per day by “Radio Uno” and “Radio Tre” FM radio stations of the national broadcasting company RAI. The SRC code dissemination to RAI by INRIM, will be definitively interrupted since 2017 January 1st. RAI could decide to continue to disseminate the SRC code to the country via Radio1 and Radio3 channels, but the traceability to UTC will not be guaranteed anymore by INRIM. It is worth highlighting that the SRC code is listed among the ITU Time Dissemination Codes (Rec. ITU-R TF.583-4). Web-based time-of-day clock that displays UTC or local time for Italy (Central Europe Time), referenced to INRIM Internet Time Service. Provides a snapshot of time with any web browser. A continuous time display requires a web browser with Java plug-in installed.
JV	Network Time Protocol JV operates an open access stratum 1 server referenced to UTC(JV) ntp.justervesenet.no Other stratum 1 servers over a separate network are available by special agreement. Contact: hha@justervesenet.no
KIM (1)	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 provides time services using Daytime Protocol, and Time Protocol.
KRISS (1)	Telephone Time Service Provides digital time code to synchronize computer clocks to Korea Standard Time (=UTC(KRIS) + 9 h) via modem. Access phone number: + 82 42 868 5116 Network Time Service KRISS operates three time servers using the NTP to synchronize computer clocks to Korea Standard Time via the Internet. Host name of the server: time.kriss.re.kr (210.98.16.100). Software for the synchronization of computer clocks is available at http://www.kriss.re.kr
KZ	Network Time Service Stratum-1 time server using the "Network Time Protocol" (NTP). Restricted access and free access ip 89.218.41.170 Stratum-2 time server using the "Network Time Protocol" (NTP). Free access. Stratum-2 is available: ip 88.204.171.178 Web-based Time Services: A real-time clock aligned to UTC(KZ) and corrected for internet transmission delay. “Six-pip time signals” are broadcast by FM radio stations hourly every day.

(1) Information based on the Annual Report 2015, not confirmed by the Laboratory.

LNE-SYRTE	LNE-SYRTE operates several time servers using the "Network Time Protocol" (NTP) : Stratum-1 time server: ntp-p1.obspm.fr (restricted access) Stratum-2 time server: ntp.obspm.fr (free access) 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/
MASM	Network Time Service MASM operates public NTP server referenced to UTC(MASM) in free access. Host name: ntp.mn More information at http://www.masm.gov.mn
METAS	Internet Time Service METAS operates stratum-1 public NTP servers in free access. Host names: ntp.metas.ch metasntp11.admin.ch metasntp12.admin.ch metasntp13.admin.ch More information available at http://www.metas.ch/metas/en/home/fabe/zeit-und-frequenz/time-dissemination.html
MIKES	MIKES provides an official stratum-1 level service to paying organizations and institutions. Stratum-2 level service is freely available to everyone and the servers providing the public service are synchronized to the stratum-1 level servers of MIKES. Stratum-1 NTP servers (official service, synchronized to UTC(MIKE)) Ntp1.mikes.fi 194.100.49.131 ntp2.mikes.fi 194.100.49.132 ntp3.mikes.fi 194.100.49.133 ntp4.mikes.fi 194.100.49.134 ntp1.mikes.funet.fi 193.166.4.49 ntp2.mikes.funet.fi 193.166.4.50 ntp3.mikes.funet.fi 193.166.4.51 ntp4.mikes.funet.fi 193.166.4.52 Stratum-2 NTP servers (public service) time.mikes.fi 194.100.49.139 time1.mikes.fi 194.100.49.151 time2.mikes.fi 194.100.49.152 Further information can be found at http://www.mikes.fi/ntp-palvelu/
MSL	Network Time Service Computers connected to the Internet can be synchonized to UTC(MSL) using the NTP protocol. Access is available for users within New Zealand. Two servers are available at msltime1.irl.cri.nz and msltime2.irl.cri.nz Speaking Clock A speaking clock gives New Zealand time. Because it is a pay service, access is restricted to callers within New Zealand. Further information about these services can be found at http://msl.irl.cri.nz/services/time-and-frequency

NAO	Network Time Service Three stratum 2 NTP servers are available. The NTP servers internally refer stratum 1 NTP server that is linked to UTC(NAO). One of the three stratum 2 NTP servers are selected automatically by a round-robin DNS server to reply for an NTP access. The server host name is s2csntp.miz.nao.ac.jp.
NICT	Telephone Time Service (TTS) NICT provides digital time code accessible by computer at 300/1200/2400 bps, 8 bits, no parity. Access number to the lines: + 81 42 327 7592. Network Time Service (NTS) NICT operates four Stratum 1 NTP time servers linked to UTC(NICT) through a leased line. Internet Time Service (ITS) NICT operates four 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. Further information at: http://en.nim.ac.cn/page/976
NIMB	1 NTP server is available: Address: ntp.inm.ro (STRATUM 1) with an open access policy Server is referenced to UTC(NIMB).
NIMT	Internet Time Service NIMT operates 3 NTP servers at: time1.nimt.or.th time2.nimt.or.th time3.nimt.or.th The NTP servers are referenced to UTC(NIMT) Telephone Time Service The time code is generated and disseminated through the telephone lines. Computers and displayed clocks are able to access UTC(NIMT) by dialling +66 (0) 2 551 0332. FM/RDS Radio Transmission The time code is applied to the sub-carrier frequency of 57 kHz using the Radio Data System protocol. The accuracy of time transmission is around 1 s of UTC(NIMT). The time code is broadcast via 40 radio stations across the country.
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 (2 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 multiple time servers at multiple locations within the United States of America. For most current listing of time servers and locations, see: http://tf.nist.gov/tf-cgi/servers.cgi Free software and source code available for download from NIST. Further information at http://www.nist.gov/pml/div688/grp40/its.cfm 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://time.nmisa.org/
NMLS (1)	Web-based time-of-day clock A web clock is used to display the local time for Malaysia. The service is available at http://mst.sirim.my Network Time Service The NTP time information is referenced to UTC(NMLS) and is currently generated by Stratum-1 NTP servers, made available to the 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 020 8943 6333. 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 an NPLI-developed Teleclock Receiver already available in the market. Internet Time Service Two servers referenced to UTC(NPLI) provide Network Time Protocol (NTP) time code across the internet. The server host names are: time1.nplindia.org time2.nplindia.org

(1) Information based on the Annual Report 2015, not confirmed by the Laboratory

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/time/time_date.html Talking Clock Service Voice announcements of Eastern Time are at ten-second intervals 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/time/talking_clock.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://www.nrc-cnrc.gc.ca/eng/services/time/web_clock.html. Short Wave Radio CHU radio station broadcasts the time of day with voice announcements in English and French and time code at three different frequencies: 3.330 MHz, 7.850 MHz and 14.670 MHz. Further information at: http://www.nrc-cnrc.gc.ca/eng/services/time/short_wave.html Network Time Protocol Operates multiple time servers using the " Network Time Protocol " at different locations and on two networks. Host names: time.nrc.ca and time.chu.nrc.ca. Further information at: http://www.nrc-cnrc.gc.ca/eng/services/time/network_time.html The official website for the Frequency and Time group is: http://www.nrc-cnrc.gc.ca/eng/services/time/index.html The contact email is: MSS-SMETime@nrc-cnrc.gc.ca
NSC IM (1)	Network Time Service. National Science Center Institute of Metrology (Kharkiv, Ukraine) operates one time server Stratum 1 using the “Network Time Protocol” (NTP). The server host name is: 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 http://www.hidro.gov.ar/observatorio/lahora.asp

(1) Information based on the Annual Report 2015, not confirmed by the Laboratory

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 voice starting with "Observatório Nacional" followed by the current time (hh:mm:ss) each ten seconds with a beep for each second with a 1KHz modulation during 5ms and a long beep with 1KHz modulation during 200ms at the 58 , 59 and 00 seconds. The signal is transmitted every day of the year by the radio station PPE, whose signal is at 10 MHz with kind of modulation A3H and HF transmission power of 1 kW.

ORB

Network Time Service via NTP protocol
Hostname : ntp1.oma.be and ntp2.oma.be
Access policy : free
Synchronization to UTC(ORB)
Contact : f.roosbeek@oma.be
Information on the web pages
http://www.astro.oma.be/en/scientific-research/reference-systems-and-planetology/time-lab/

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/cms/en/ptb/fachabteilungen/abtq/fb-q4/ag-q42.html 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
More information is available from the ROA web site at www.roa.es
Host names of the servers:
hora.roa.es
minuto.roa.es

SG

Network Time Service (NeTS)
Transmit digital time code via the Internet using three protocols -
Time Protocol, Daytime Protocol and Network Time Protocol.
Operate one time server at domain name: nets.org.sg

Automated Computer Time Service (ACTS)
Transmit digital time code (NIST format) via telephone modem for setting time in computers. The coded time information is referenced to UTC(SG). Include provision for correcting telephone time delay.
Access phone number: +65 67799978.

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 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 several NTP servers using the Network Time Protocol (NTP) for both IPv4 and IPv6.
Access host names: ntp1.sptime.se, ntp2.sptime.se, ntp3.sptime.se and ntp4.sptime.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 on the web site www.sp.se

TL

Speaking Clock Service
Traceable to UTC(TL). Broadcast through PSTN (Public Switching Telephone Network) automatically and provides an accurate voice time signal to public users. Local access phone number: 117.

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

NTP Service
TL operates the network time service using the "Network Time Protocol" (NTP).
Host name of the server: time.stdtime.gov.tw, further information in
http://www.stdtime.gov.tw/english/e-home.aspx

TP

Internet Time Service
UFE operates time servers directly referenced to UTC(TP).
Time information is accessible through Network Time Protocol (NTP).
Server host name: ntp2.ufe.cz
More information at http://www.ufe.cz/

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:ume.zamanfrekans@tubitak.gov.tr.
Access phone number: +90 262 679 50 24

Network Time Service
UME operates an NTP server referenced to UTC(UME).
Server Host Name: time.ume.tubitak.gov.tr

USNO (1)

Telephone Voice Announcer +1 202 762-1401
Backup voice announcer: +1 719 567-6742

Telephone Code +1 202 762-1594
provides digital time code at 1200 baud, 8 bits, no parity

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 to the website, please contact phuongtv@vmi.gov.vn. The server host name is:
http://standardtime.vmi.gov.vn/ or IP: 113.160.59.166 port 123

VNIIFTRI

Internet Time Service
VNIIFTRI operates eight time servers Stratum 1 and 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)
ntp4.vniiftri.ru (Stratum 1)
ntp1. niiftri.irkutsk.ru (Stratum 1)
ntp2. niiftri.irkutsk.ru (Stratum 1)
vniiftri.khv.ru (Stratum 1)
vniiftri2.khv.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

(1) Information based on the Annual Report 2015, not confirmed by the Laboratory