

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

(File available on <ftp://ftp2.bipm.org/pub/tai/scale/UTAI/utai2018.pdf>)

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:  $d = -y_{\text{TAI}}$ .

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, METAS-FOC2, NIM5, PTB-CS1, PTB-CS2, PTB-CSF1, PTB-CSF2, SU-CsFO2, SYRTE-FO1, SYRTE-FO2 and SYRTE-FOM reported on the year 2018.

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 standards (SFS) NICT-Sr1, SYRTE-SrB and SYRTE-FORb reported on the year 2018.

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 12 (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,

$u_{\text{link/lab}}$  is the uncertainty in the link between the PFS and the clock participating to TAI, including the uncertainty due to dead-time,

$u_{\text{link/TAI}}$  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:

$u_{\text{SRep}}$  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 2018 are indicated below. Reports of individual evaluations may be found at [ftp://ftp2.bipm.org/pub/tai/data/PFS\\_reports](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 2018 reports,  $u_B(\text{Ref})$  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/ $10^{-15}$	$u_B(\text{Ref})/10^{-15}$	Ref( $u_B$ )	Comparison with	Number/typical duration of comp.
IT-CsF2	Fountain	0.17	0.18	[1]	H maser	2 / 10 d to 15 d
METAS-FOC2	Fountain	2.01	1.99	[2]	H maser	3 / 15 d to 25 d
NIM5	Fountain	0.9	1.4	[3]	H maser	3 / 15 d to 25 d
PTB-CS1	Beam /Mag.	8	8.	[4]	TAI	12 / 25 d to 35 d
PTB-CS2	Beam /Mag.	12	12.	[5]	TAI	12 / 25 d to 35 d
PTB-CSF1	Fountain	0.28 to 0.40	0.28	[6]	H maser	8 / 10 d to 30 d
PTB-CSF2	Fountain	0.18 to 0.21	0.17	[6]	H maser	11 / 10 d to 30 d
SU-CsFO2	Fountain	0.24	0.50	[7]	H maser	10 / 10 d to 30 d
SYRTE-FO1	Fountain	0.32 to 0.43	0.37	[8]	H maser	11 / 15 d to 35 d
SYRTE-FO2	Fountain	0.20 to 0.31	0.23	[8]	H maser	11 / 15 d to 35 d
SYRTE-FOM	Fountain	0.63 to 1.13	0.7	[8]	H maser	4 / 30 d

Secondary Standard	Type	Type B std. uncertainty/ $10^{-15}$	$u_B(\text{Ref})/10^{-15}$	Ref( $u_B$ )	Comparison with	Number/typical duration of comp.
NICT-Sr1	Lattice	0.06 to 0.08	0.06	[9]	H maser	8 / 10 d to 35 d
SYRTE-SrB	Lattice	0.10	0.05	[10]	H maser	1 / 10d
SYRTE-FORb	Fountain	0.24 to 0.30	0.34	[11]	H maser	12 / 15 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		$d/10^{-15}$	$u_A/10^{-15}$	$u_B/10^{-15}$	$u_{\text{link/lab}}/10^{-15}$	$u_{\text{link/TAI}}/10^{-15}$	$u/10^{-15}$	Note
IT-CsF2	58219	58229	1.09	0.83	0.17	0.14	0.88	1.23	
IT-CsF2	58284	58299	0.43	0.69	0.17	0.22	0.49	0.89	
METAS-FOC2	57809	57839	-0.74	0.11	2.01	0.07	0.23	2.03	
METAS-FOC2	57919	57934	-0.02	0.20	2.01	0.13	0.49	2.08	
METAS-FOC2	57944	57964	-0.03	0.17	2.01	0.10	0.38	2.05	
NIM5	58124	58144	-0.59	0.30	0.90	0.20	0.38	1.04	
NIM5	58369	58384	1.01	0.30	0.90	0.30	0.49	1.11	
NIM5	58424	58449	0.62	0.20	0.90	0.20	0.31	0.99	
PTB-CS1	58114	58149	-16.86	8.00	8.00	0.00	0.11	11.31	(1)
PTB-CS1	58149	58174	-14.98	8.00	8.00	0.00	0.15	11.31	
PTB-CS1	58174	58204	-20.98	8.00	8.00	0.00	0.13	11.31	
PTB-CS1	58204	58234	-17.93	8.00	8.00	0.00	0.13	11.31	
PTB-CS1	58234	58269	-14.45	8.00	8.00	0.00	0.11	11.31	
PTB-CS1	58269	58299	-4.08	8.00	8.00	0.00	0.13	11.31	
PTB-CS1	58299	58329	-1.03	8.00	8.00	0.00	0.13	11.31	
PTB-CS1	58329	58359	3.98	8.00	8.00	0.00	0.13	11.31	
PTB-CS1	58359	58389	-2.34	8.00	8.00	0.00	0.13	11.31	
PTB-CS1	58389	58419	5.06	8.00	8.00	0.00	0.13	11.31	
PTB-CS1	58419	58449	1.98	8.00	8.00	0.00	0.13	11.31	
PTB-CS1	58449	58479	-0.72	8.00	8.00	0.00	0.13	11.31	
PTB-CS2	58114	58149	-0.86	5.00	12.00	0.00	0.11	13.00	(1)
PTB-CS2	58149	58174	-6.51	5.00	12.00	0.00	0.15	13.00	
PTB-CS2	58174	58204	-3.54	5.00	12.00	0.00	0.13	13.00	
PTB-CS2	58204	58234	3.64	5.00	12.00	0.00	0.13	13.00	
PTB-CS2	58234	58269	-3.44	5.00	12.00	0.00	0.11	13.00	
PTB-CS2	58269	58299	-3.46	5.00	12.00	0.00	0.13	13.00	
PTB-CS2	58299	58329	-5.28	5.00	12.00	0.00	0.13	13.00	
PTB-CS2	58329	58359	-6.55	5.00	12.00	0.00	0.13	13.00	
PTB-CS2	58359	58389	-1.57	5.00	12.00	0.00	0.13	13.00	
PTB-CS2	58389	58419	-6.59	5.00	12.00	0.00	0.13	13.00	
PTB-CS2	58419	58449	0.51	5.00	12.00	0.00	0.13	13.00	
PTB-CS2	58449	58479	-1.77	5.00	12.00	0.00	0.13	13.00	
PTB-CSF1	58114	58134	0.08	0.07	0.39	0.07	0.19	0.44	
PTB-CSF1	58139	58149	0.22	0.11	0.40	0.03	0.35	0.54	
PTB-CSF1	58149	58174	0.12	0.07	0.39	0.10	0.15	0.44	
PTB-CSF1	58174	58204	0.02	0.07	0.37	0.10	0.13	0.41	
PTB-CSF1	58284	58294	0.60	0.11	0.39	0.03	0.35	0.54	
PTB-CSF1	58359	58389	0.84	0.06	0.31	0.02	0.13	0.34	
PTB-CSF1	58424	58449	0.44	0.07	0.29	0.03	0.15	0.34	
PTB-CSF1	58449	58469	0.76	0.08	0.28	0.04	0.19	0.35	
PTB-CSF2	58139	58149	0.20	0.18	0.20	0.02	0.35	0.44	
PTB-CSF2	58149	58174	-0.07	0.09	0.20	0.04	0.15	0.27	
PTB-CSF2	58174	58204	-0.27	0.10	0.20	0.06	0.13	0.27	
PTB-CSF2	58204	58234	0.02	0.08	0.20	0.02	0.13	0.25	
PTB-CSF2	58234	58264	0.48	0.08	0.20	0.03	0.13	0.25	
PTB-CSF2	58274	58294	0.41	0.10	0.20	0.03	0.19	0.29	
PTB-CSF2	58294	58314	1.15	0.10	0.21	0.09	0.19	0.31	
PTB-CSF2	58359	58379	0.73	0.11	0.20	0.04	0.19	0.30	
PTB-CSF2	58389	58419	0.26	0.20	0.20	0.07	0.13	0.32	
PTB-CSF2	58424	58449	0.59	0.11	0.20	0.05	0.15	0.28	
PTB-CSF2	58449	58469	0.60	0.12	0.18	0.05	0.19	0.29	
SU-CsFO2	58139	58149	-0.65	0.37	0.24	0.13	2.28	2.33	
SU-CsFO2	58149	58174	-0.23	0.30	0.24	0.14	1.00	1.08	
SU-CsFO2	58174	58204	-1.09	0.29	0.24	0.13	0.85	0.94	
SU-CsFO2	58204	58234	-0.84	0.27	0.24	0.14	0.85	0.93	
SU-CsFO2	58234	58269	-0.98	0.31	0.24	0.14	0.74	0.85	

SU-CsFO2	58269	58299	-0.22	0.30	0.24	0.13	0.85	0.94
SU-CsFO2	58299	58329	0.24	0.28	0.24	0.13	0.85	0.93
SU-CsFO2	58329	58359	0.54	0.52	0.24	0.13	0.85	1.03
SU-CsFO2	58419	58449	1.59	0.33	0.24	0.16	0.85	0.95
SU-CsFO2	58449	58479	1.38	0.34	0.24	0.13	0.85	0.95
SYRTE-FO1	58184	58199	-0.41	0.50	0.42	0.09	0.49	0.82
SYRTE-FO1	58199	58214	-0.30	0.25	0.43	0.05	0.49	0.70
SYRTE-FO1	58219	58234	-0.05	0.20	0.43	0.05	0.49	0.68
SYRTE-FO1	58234	58269	0.44	0.25	0.41	0.06	0.23	0.53
SYRTE-FO1	58269	58299	0.33	0.20	0.35	0.07	0.26	0.49
SYRTE-FO1	58299	58329	0.56	0.25	0.34	0.06	0.26	0.50
SYRTE-FO1	58329	58359	0.48	0.20	0.34	0.05	0.26	0.48
SYRTE-FO1	58359	58389	0.34	0.20	0.33	0.05	0.26	0.47
SYRTE-FO1	58389	58419	0.32	0.20	0.32	0.06	0.26	0.46
SYRTE-FO1	58419	58449	0.37	0.25	0.32	0.05	0.26	0.49
SYRTE-FO1	58449	58479	0.51	0.25	0.32	0.05	0.26	0.49
SYRTE-FO2	58114	58149	-0.27	0.40	0.23	0.11	0.23	0.53
SYRTE-FO2	58149	58164	-0.17	0.50	0.31	0.11	0.49	0.77
SYRTE-FO2	58199	58214	-0.21	0.20	0.20	0.05	0.49	0.57
SYRTE-FO2	58219	58234	-0.05	0.20	0.20	0.05	0.49	0.57
SYRTE-FO2	58234	58269	0.42	0.40	0.20	0.06	0.23	0.51
SYRTE-FO2	58314	58329	0.30	0.30	0.23	0.07	0.49	0.62
SYRTE-FO2	58329	58359	0.49	0.20	0.21	0.05	0.26	0.39
SYRTE-FO2	58359	58389	0.74	0.20	0.20	0.06	0.26	0.39
SYRTE-FO2	58389	58419	0.40	0.20	0.20	0.05	0.26	0.39
SYRTE-FO2	58419	58449	0.90	0.30	0.21	0.06	0.26	0.45
SYRTE-FO2	58449	58479	0.59	0.20	0.20	0.05	0.26	0.39
SYRTE-FOM	58359	58389	0.13	0.25	0.85	0.05	0.26	0.93
SYRTE-FOM	58389	58419	0.73	0.20	1.13	0.05	0.26	1.18
SYRTE-FOM	58419	58449	0.73	0.50	0.81	0.07	0.26	0.99
SYRTE-FOM	58449	58479	0.79	0.25	0.63	0.09	0.26	0.73

**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	$d/10^{-15}$	$u_A/10^{-15}$	$u_B/10^{-15}$	$u_{\text{link/lab}}/10^{-15}$	$u_{\text{link/TAI}}/10^{-15}$	$u/10^{-15}$	$u_{\text{SRep}}$	Ref ( $u_s$ )
NICT-Sr1	57474 57504	-0.34	0.03	0.08	0.36	0.20	0.42	0.4	[12]
NICT-Sr1	57504 57539	-0.37	0.03	0.07	0.31	0.17	0.37	0.4	
NICT-Sr1	57539 57569	-0.13	0.03	0.08	0.31	0.20	0.38	0.4	
NICT-Sr1	57569 57599	-0.57	0.03	0.06	0.30	0.20	0.37	0.4	
NICT-Sr1	57599 57629	-0.67	0.03	0.06	0.33	0.20	0.39	0.4	
NICT-Sr1	57629 57659	-0.92	0.03	0.06	0.35	0.20	0.40	0.4	
NICT-Sr1	58149 58174	-0.05	0.03	0.07	0.29	0.31	0.43	0.4	
NICT-Sr1	58454 58464	0.84	0.01	0.08	0.05	0.70	0.71	0.4	
SYRTE-FORb	58114 58149	0.14	0.30	0.28	0.11	0.23	0.48	0.7	[13]
SYRTE-FORb	58149 58174	0.57	0.20	0.28	0.11	0.31	0.47	0.7	
SYRTE-FORb	58174 58189	0.03	0.50	0.30	0.12	0.49	0.77	0.7	
SYRTE-FORb	58199 58214	-0.19	0.25	0.24	0.05	0.49	0.60	0.6	[12]
SYRTE-FORb	58219 58234	0.24	0.20	0.24	0.06	0.49	0.58	0.6	
SYRTE-FORb	58234 58269	0.50	0.25	0.24	0.06	0.23	0.42	0.6	
SYRTE-FORb	58269 58289	0.14	0.20	0.24	0.09	0.38	0.50	0.6	
SYRTE-FORb	58334 58359	0.44	0.20	0.25	0.08	0.31	0.45	0.6	
SYRTE-FORb	58374 58389	0.98	0.20	0.26	0.07	0.49	0.59	0.6	
SYRTE-FORb	58389 58419	0.57	0.20	0.25	0.06	0.26	0.42	0.6	
SYRTE-FORb	58419 58449	0.94	0.32	0.24	0.07	0.26	0.48	0.6	
SYRTE-FORb	58449 58479	0.74	0.30	0.24	0.05	0.26	0.47	0.6	
SYRTE-SrB	58454 58464	0.74	0.20	0.10	0.09	0.70	0.74	0.4	[12]

**References:**

- [1] Levi F. *et al.*, *Metrologia* **51**, 270, 2014.
- [2] Jallageas A. *et al.*, [Metrologia 55, 366, 2018.](#)
- [3] Fang F. *et al.*, *Metrologia* **52**, 454, 2015.
- [4] Bauch A. *et al.*, [Metrologia 35, 829, 1998](#); Bauch A., [Metrologia 42, S43, 2005.](#)
- [5] Bauch A. *et al.*, *IEEE Trans. IM* **36**, 613, 1987; Bauch A., [Metrologia 42, S43, 2005.](#)
- [6] Weyers S. *et al.*, [Metrologia 55, 789, 2018.](#)
- [7] Domnin Y.S. *et al.*, *Measurement Techniques*, Vol. 55, No. 10, January, 2013.
- [8] Guéna J. *et al.*, *IEEE Trans. Ultr. Ferr. Freq. Contr.* **59** (3), 391-410, 2012.
- [9] Hachisu H. *et al.*, *Opt. Express* **25**, 8511, 2017.
- [10] Lodewyck J. *et al.*, [Metrologia 53, 1123, 2016.](#)
- [11] Guéna J. *et al.*, *Metrologia*. **51**, 108, 2014.
- [12] CCTF Recommendation 2 (2017) : Updates to the CIPM list of standard frequencies in Consultative Committee for Time and Frequency Report of the 21st meeting (2017), 2017, 56 p.
- [13] CIPM Recommendation 2 (CI-2015) "Updates to the list of standard frequencies" in Procès-Verbaux des Seances du Comité International des Poids et Mesures, 104th meeting (2015), 2016, 47 p.