

# Time Metrology Projects

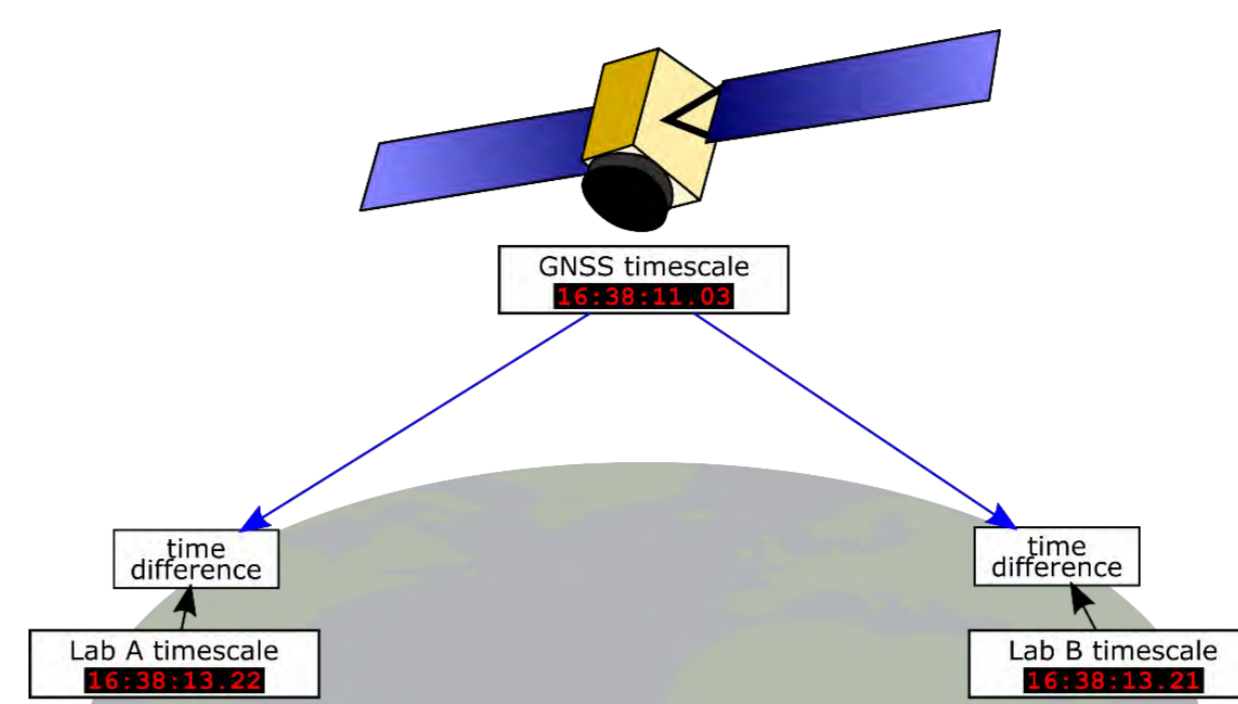
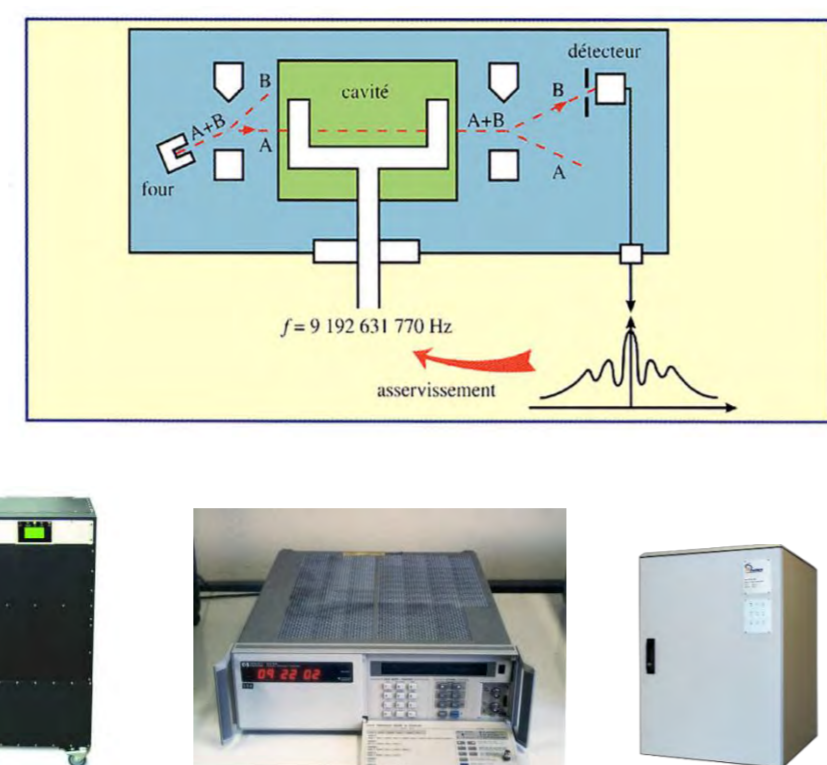
## The reference time scale UTC - Coordinated Universal Time

### Atomic clocks realize the SI second

The second is the duration of 9 192 631 770 periods of the radiation corresponding to the transition between the two hyperfine levels of the ground state of the caesium 133 atom (CGPM 1967).

Any device able to generate the caesium reference signal is a frequency standard.

Devices can fail, the use of an ensemble of clocks and frequency standards helps to ensure reliability, robustness, accuracy, and continuity of a time scale.

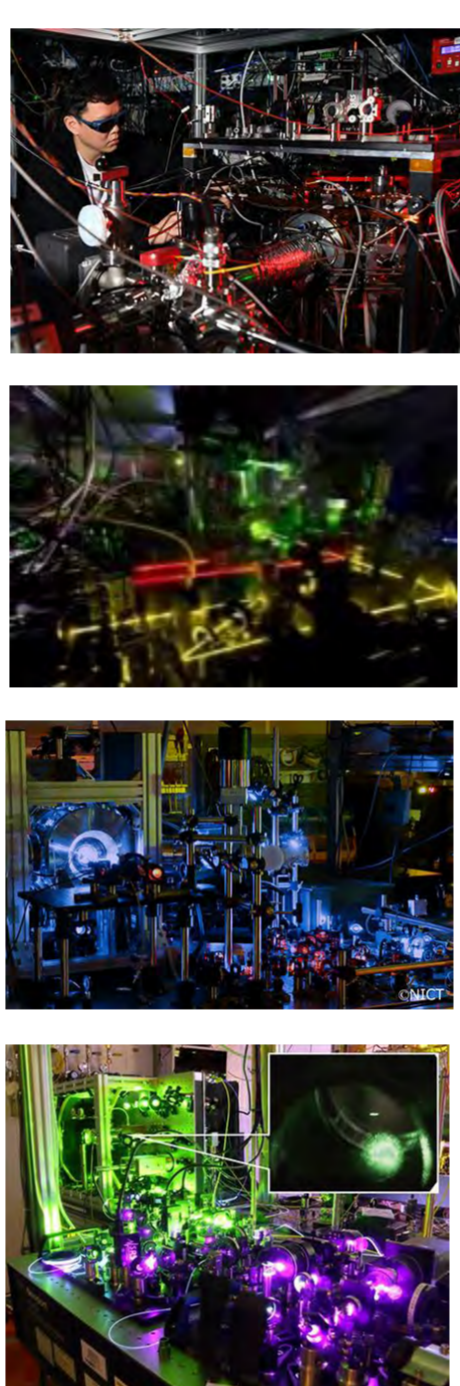
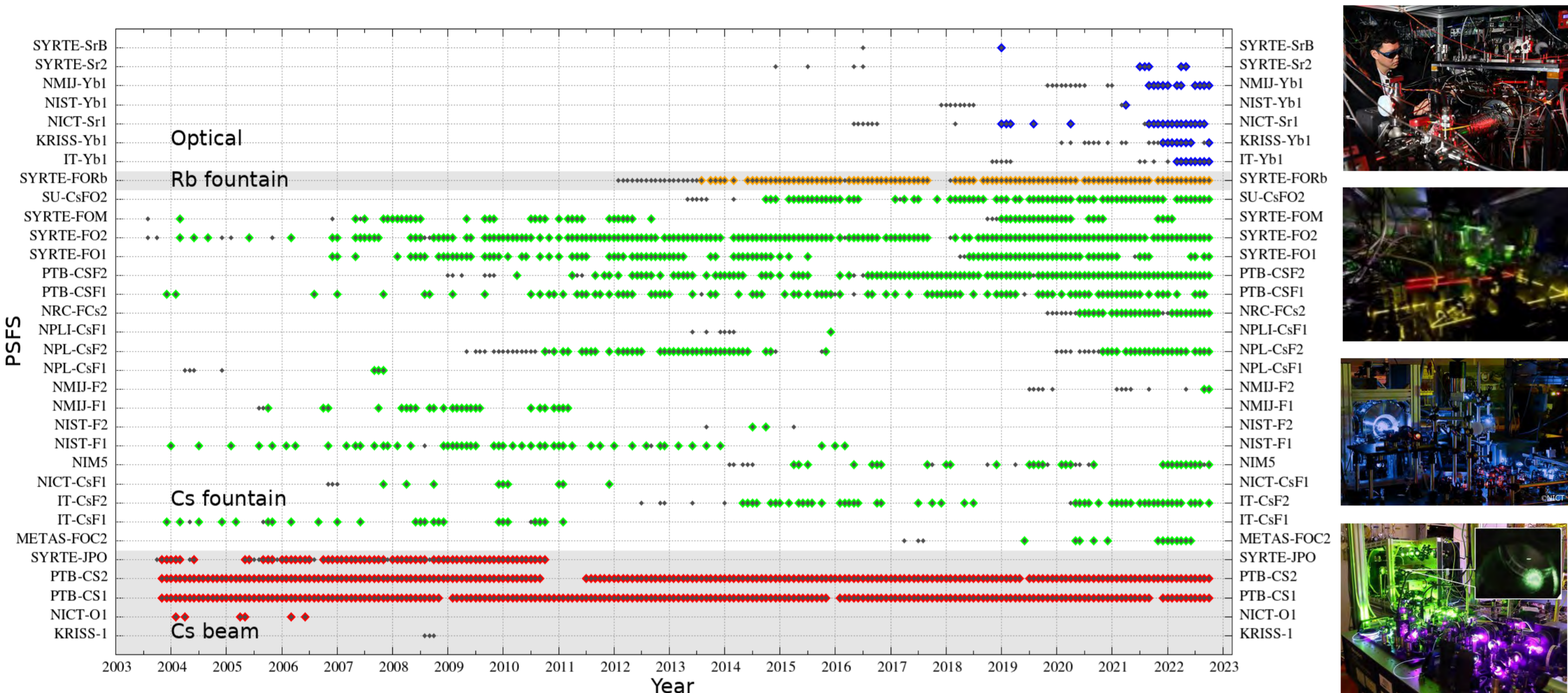


Clocks in different laboratories are compared by suitable time and frequency transfer techniques

The uncertainty of a caesium commercial clock is about  $10^{-14}$

300 nanoseconds accumulated in one year

### Primary and secondary frequency standard

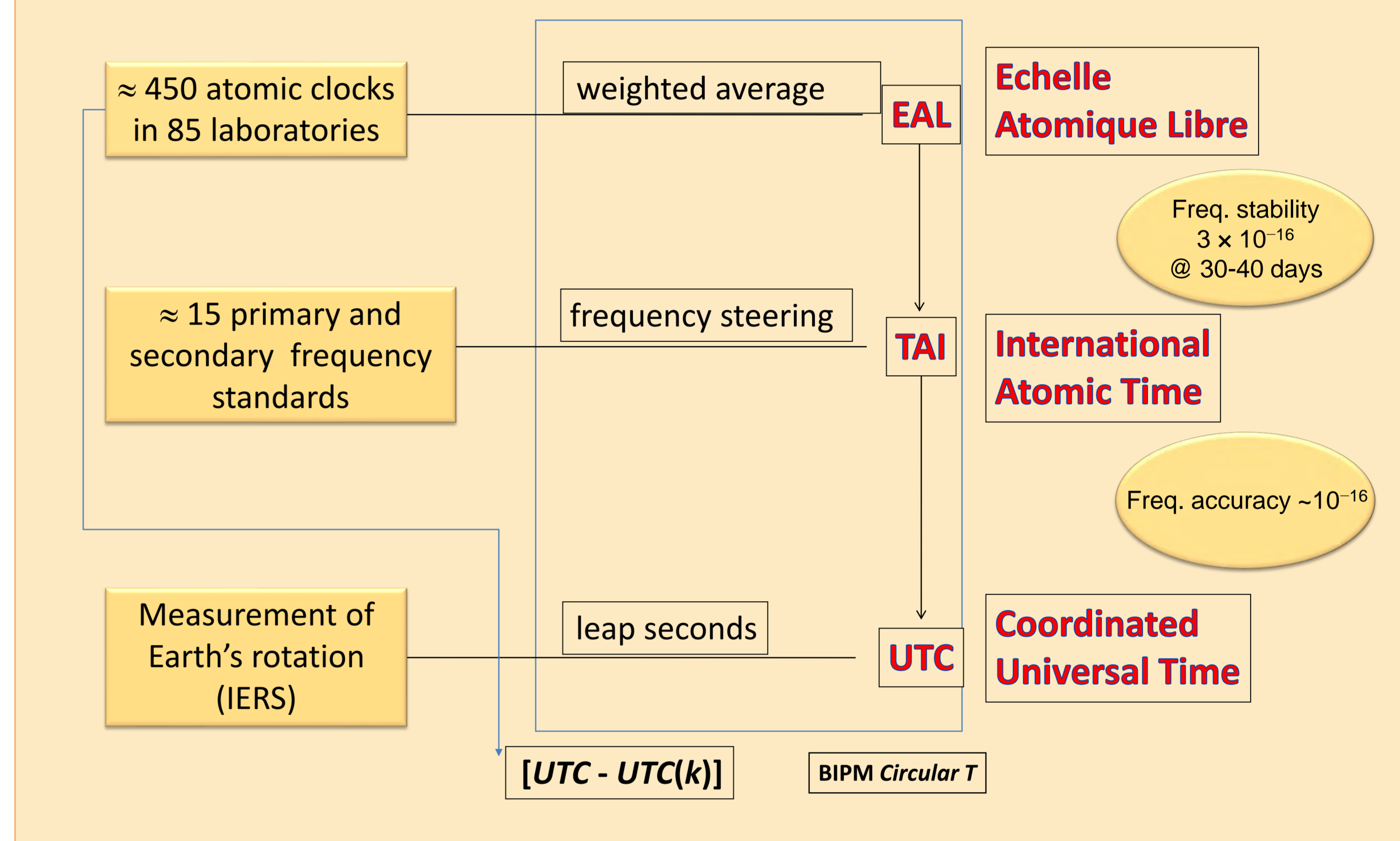


The uncertainty of caesium primary fountains can reach  $10^{-16}$

3 nanoseconds accumulated in one year

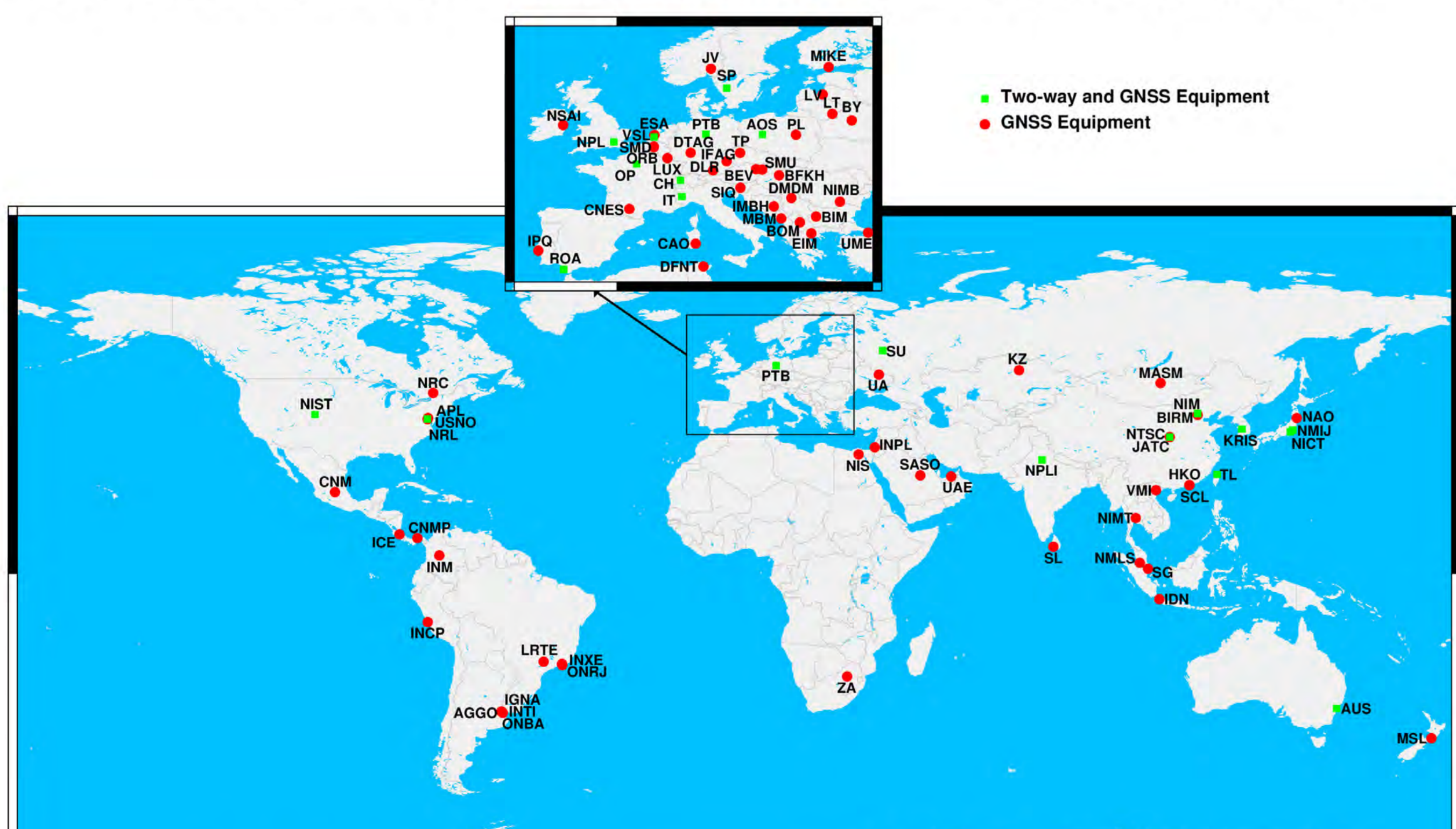
Some laboratories operate primary and secondary frequency standards that calibrate the frequency of the Echelle Atomique Libre (EAL)

### Computation of UTC (monthly) at the BIPM



### Laboratories contributing to UTC

Geographical distribution of the laboratories that contribute to TAI and time transfer equipment (2021)



An approximation called Rapid UTC (UTC<sub>r</sub>) is calculated weekly and published each Wednesday by the BIPM.

All data and products are available on <http://webtai.bipm.org/database/> and <https://www.bipm.org/en/time-ftp>

### UTC - UTC(k) in BIPM Circular T and the CCTF-K001.UTC

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The contents of the sections of BIPM Circular T are fully described in the document "Explanatory supplement to BIPM Circular T" available at [https://webtai.bipm.org/ftp/pub/taf/other-products/notes/explanatory\\_supplement\\_v0.6.pdf](https://webtai.bipm.org/ftp/pub/taf/other-products/notes/explanatory_supplement_v0.6.pdf)

1 - Difference between UTC and its local realizations UTC(k) and corresponding uncertainties. From 2017 January 1, 0h UTC,  $TAI - UTC = 37$  s.

Laboratory k	MJD	[UTC - UTC(k)]ns												
		JUL 29	AUG 3	AUG 8	AUG 13	AUG 18	AUG 23	AUG 28	Uncertainty/ns	u <sub>A</sub>	u <sub>B</sub>	u <sub>C</sub>		
AGGO (La Plata)	123	808.6	811.2	800.8	804.5	805.0	824.4	815.9	1.0	20.0	20.0			
AOS (Borowiec)	123	-3.2	-3.3	-3.4	-3.5	-3.5	-4.4	-5.0	0.3	3.2	3.2			
APL (Laurel)	123	-1.9	-2.6	-3.1	-2.4	-0.6	0.0	-0.6	0.3	20.0	20.0			
AUS (Sydney)	123	-505.9	-517.1	-538.8	-534.7	-543.0	-540.8	-536.9	0.3	11.2	11.2			
BEV (Wien)	123	17.6	26.0	31.4	39.5	44.5	38.7	23.9	0.3	2.7	2.7			
BFKH (Budapest)	123	5375.7	5414.4	5444.4	5480.6	5521.5	5559.4	5601.3	1.5	20.0	20.1			
BIM (Sofiya)	123	16502.8	16550.3	16577.6	16585.7	16603.8	16635.9	16649.5	0.3	7.2	7.2			
BIRM (Beijing)	123	51.1	37.5	23.1	-24.7	-45.8	-66.3	-140.6	0.3	3.1	3.1			(1)
BOM (Skopje)	123	-	-	-	-	-	-	-	-	-	-			
BY (Minsk)	123	0.9	0.5	-0.3	0.0	-0.9	-1.6	-0.7	1.5	2.8	3.2			
CAO (Cagliari)	123	-37636.9	-37760.4	-37881.1	-38001.0	-38124.4	-38236.8	-38351.6	1.5	20.0	20.1			
CH (Bern-Wabern)	123	16534.6	16532.5	16532.5	16483.2	16483.2	16483.0	16483.2	0.5	1.5	1.6			(2)

The difference UTC - UTC(k) is computed by the BIPM and published in the monthly Circular T

Contributing laboratories realize local real-time time scales named UTC(k)

