

### Operation of the METAS-FOC2 primary frequency standard in 2020

The Swiss continuous Cs fountain clock METAS-FOC2 [1] delivered four contributions to the calibration of TAI, which were published in Circular T 388, 389, 392 and 395.

During these observation periods, the standard was operated with an uptime of, respectively, 98.4%, 99.3%, 98.2% and 65.3%.

The local oscillator was the METAS hydrogen maser (HM, BIPM clock code 1405701). The typical short-term frequency instability of METAS-FOC2 was around  $1.0 \times 10^{-13} (\tau/s)^{-1/2}$  for these four contributions.

The following table summarizes the published values:

#	Evaluation period	$d / 10^{-15}$	$u_A / 10^{-15}$	$u_B / 10^{-15}$	$u_{lab} / 10^{-15}$	$u_{TAI} / 10^{-15}$	$u_{total} / 10^{-15}$
1	58939-58969	-1.61	0.06	1.42	0.04	0.20	1.44

#	Evaluation period	$d / 10^{-15}$	$u_A / 10^{-15}$	$u_B / 10^{-15}$	$u_{A_{lab}} / 10^{-15}$	$u_{B_{lab}} / 10^{-15}$	$u_{TAI} / 10^{-15}$	$u_{total} / 10^{-15}$
2	58969-58999	-1.85	0.06	1.40	0.01	0.04	0.20	1.42
3	59064-59089	-2.37	0.08	1.38	0.02	0.04	0.23	1.40
4	59149-59179	-1.71	0.09	1.36	0.26	0.04	0.20	1.40

One last 30-days long measurement series was realized in December 2021 for control purposes.

The following table shows the uncertainty budget (k=1) used for the calibration in November 2020:

Physical effect	Frequency shift / $10^{-15}$	Uncertainty / $10^{-15}$
Second-order Zeeman	24.02	0.20
Gravitational	59.72	0.02
Second-order Doppler	-0.01	<0.01
Blackbody radiation	-16.67	0.04
Microwave spectrum purity	0.00	0.05
Light shift from source	-0.16	0.04
Cavity pulling	0.00	<0.01
Rabi pulling	0.00	0.02
Ramsey pulling	0.05	0.10
End-to-end	2.17	0.27
Collisional Cs-Cs	-0.29	0.16
Light shift from detection	-0.10	0.41
RF leakage	0.00	0.47
Majorana transitions	0.00	0.50
DCPS	—	1.03
Total	68.72	1.36

#### Reference:

[1] A. Jallageas et al., Metrologia **55** 366, (2018).