Operation of the NIM5 primary frequency standard in 2020

The NIM5 Cs fountain primary frequency standard at NIM was operated for 7 months and the average frequencies of the hydrogen maser H50 (1404850) against NIM5 were measured and the results, including all relevant biases and uncertainties, were reported to the BIPM and published in Circular T as shown in the following table.

MJD periods	$d/10^{-15}$	$u_A/10^{-15}$	$u_B/10^{-15}$	$U_{A/lab}/10^{-15}$	$U_{B/lab}/10^{-15}$	$U_{l/TAI}/10^{-15}$	$u/10^{-15}$
58849.0-58879.0	-0.65	0.20	0.90	0.20		0.20	0.96
58879.0-58899.0	-1.46	0.20	0.90	0.20		0.28	0.98
58909.0-58939.0	-0.97	0.46	0.90	0.10	0.00	0.20	1.03
58839.0-58969.0	-0.76	0.41	0.90	0.10	0.00	0.20	1.01
58969.0-58999.0	-0.35	0.48	0.90	0.10	0.00	0.20	1.04
59029.0-59059.0	0.06	0.46	0.90	0.10	0.00	0.20	1.03
59064.0-59089.0	-0.80	0.47	0.90	0.10	0.00	0.23	1.05

During a formal evaluation, NIM5 operated alternatively in the high and low densities with a ratio about 2 to determine frequencies at zero density. The C-field has been checked once each month without a significant variation. The microwave-related frequency shifts have been checked by comparison between the frequency difference between a π/2 Ramsey pulse and 3π/2, the relative frequency difference is always less than 1×10^{-15}. The microwave leakage due to the RF interferometric switch has been checked each month to check its attenuation. The temperate of the flight tube was monitored and recorded automatically.

The H-maser H50 instability and phase noise has been evaluated and the dead time uncertainty due to the operation ratio has been evaluated. This work is done mainly for the frequency measurement of the Sr optical clock. The paper is published as shown in reference [1].

Meanwhile, a new Rb fountain clock RbF1 has been built with an instability of 1.5×10^{-13} at 1 s and 5×10^{-16} at 1 d has been achieved. The fountain operates semi-continuous and aims to steer an H-maser directly.

[1] Yige Lin, et al, "A ^{87}Sr optical lattice clock with 2.9×10^{-17} uncertainty and its absolute frequency measurement, Metrologia, **58**, 035010 (2021)