I. SUMMARY

The H-maser which frequency was measured by the primary frequency standard NIM5 was switched from H-maser 271 (identified by the clock code 1404871) to H-maser 50 (identified by the clock code 1404850), during an evaluation campaign over 15 days in Sep. 2018. The results are given in table 1, together with the total uncertainties in relating NIM5 to H-maser 50.

Table 1 Summary of the frequency measurements of H-maser 50 (1404850)

Period	MJD 58369.0 to 58384.0
$y_{(NIM5-H271)}$ [$\times 10^{-15}$]	8.7
Duty cycle [%]	90.5%
u_A [$\times 10^{-15}$]	0.3
u_B [$\times 10^{-15}$]	0.9
$u_{link/lab}$ [$\times 10^{-15}$]	0.3
u_{total} [$\times 10^{-15}$]	1.0

The combined total uncertainty u_{total} is the square sum of the three uncertainties as following:

$$u_{total} = \sqrt{(u_A)^2 + (u_B)^2 + (u_{link/lab})^2} \tag{1}$$

Type A uncertainty u_A is the statistical uncertainty on the frequency measurement, u_B is the Type B uncertainty from bias evaluations, and $u_{link/lab}$ is the uncertainty induced by the link between NIM5 fountain clock and the H-maser 50, which includes the dead time and the phase noise of the link between NIM5 and H-maser 50. All the above uncertainties are calculated at 1σ.

II. Measurement methods

Besides switching H-maser from H271 to H50, the computer control system has also been updated from a Labwindow version to a Labview version. Some drivers have also been changed. A summary of the systematic frequency shift evaluations for NIM5 is listed in Table 2. The combined relative Type B uncertainty is approximately 0.9×10⁻¹⁵.

Table 2 Uncertainty budget of NIM5 in these evaluations.

Physical Effect	Bias [$\times 10^{-15}$]	Uncertainty [$\times 10^{-15}$]
2nd order Zeeman	73.2	0.2
Collisional shift	-2.1*	0.1
Microwave interferometric Switch	0.0	0.6
Microwave leakage	0	<0.1
DCP	0.0	0.6
Microwave spectral impurities	0.0	0.1
Blackbody radiation	-16.5	0.1
Gravitational red shift	11.8	0.1
Majorana transition	0. 0	0.1
Light shift	0.0	<0.1
Rabi and Ramsey pulling	0.0	<0.1
Cavity pulling	0.0	<0.1
Collision with background gases	0.0	<0.1
Total	66.4*	0.9*

* The collision shift is calculated at low density.

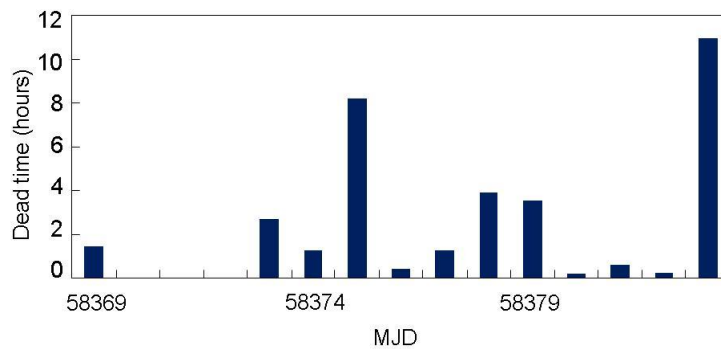The dead time distribution during the report period is shown in the figure 1:

Figure 1 Dead time distributions in Sep., 2018 report period.