

## I. SUMMARY

The primary frequency standard NIM5 was used to measure the average fractional frequency difference of the H-maser 50, identified by the clock code 1404850, during an evaluation campaign over 20 days in Feb. 2020. The results are given in table 1, together with the total uncertainties in relating NIM5 to maser 50.

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

Period	MJD 58879.0 to 58899.0
$y_{(\text{NIM5-H50})} [\times 10^{-15}]$	26.5
Duty cycle [%]	93.4%
$u_A [\times 10^{-15}]$	0.2
$u_B [\times 10^{-15}]$	0.9
$u_{\text{link/lab}} [\times 10^{-15}]$	0.2
$u_{\text{total}} [\times 10^{-15}]$	1.0

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

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

Type A uncertainty  $u_A$  is the statistical uncertainty on the frequency measurement,  $u_B$  is the Type B uncertainty from bias evaluations, and  $u_{\text{link/lab}}$  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-50. All the above uncertainties are calculated at  $1\sigma$ .

## II. Measurement methods

There is no change has been introduced since the previously reported evaluation, although the H-maser signal was disturbed in two days and the number of valid data were low, and causing a low operation rate. A summary of the systematic frequency shift evaluations for NIM5 is listed in Table 2. The combined relative Type B uncertainty is approximately  $0.9 \times 10^{-15}$ .

**Table 2** Uncertainty budget of NIM5 in these evaluations.

Physical Effect	Bias [ $\times 10^{-15}$ ]	Uncertainty [ $\times 10^{-15}$ ]
2nd order Zeeman	73.3	0.2
Collisional shift	-1.1*	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	-16.3	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	67.7*	0.9*

\* The collision shift is calculated at low density.

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

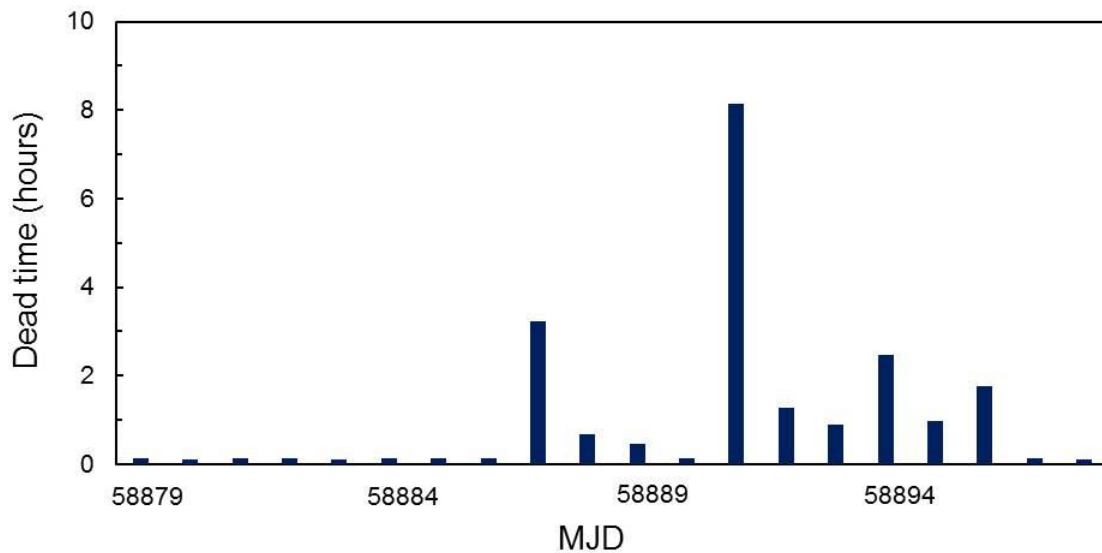


Figure 1 Dead time distributions in Feb., 2020 report period.