FREQUENCY COMPARISON (H_MASER 140 0816) - (LNE-SYRTE-FOM)
For the period MJD 54434 to MJD 54464

The primary frequency standard LNE-SYRTE-FOM has been compared to the hydrogen Maser (140 0816) of the laboratory, during 1 measurement session between MJD 54434 and 54464.

The mean frequency difference is given in the following table:

Period (MJD)	Date of the estimation	y(HMaser$_{140\,0816}$ - FOM)	u_B	u_A	$u_{link\ /\ maser}$
54434 – 54464	54449	5124.9	9.3	2.0	1.8

Table 1: Results of the comparison in 1 x 10^{-16}.

The FOM contribution is given through the measurement of Maser 140 0816, because Maser 140 0889 presented phase jumps during November (tuning of its quartz phase lock loop).

The FOM fountain was operated in the same mode during all the period: the interrogating signal synthesis is based on the multiplication of a 1 GHz signal provided by a cryogenic oscillator phase locked on Maser 140 0889. It uses a synthesizer to lock the microwave signal on the atomic resonance. The frequency difference between the maser and the fountain is deduced from the average correction applied to the synthesizer.
In addition, the phase difference between Maser 140 0889 and Maser 140 0816 is measured by a phase comparator.
FOM was not operating during the disturbed period of Maser 140 0889.

Average Value and statistical uncertainty

We calculate a linear unweighted fit of the frequency data averaged over 0.2 day. The parameters of the fit y=a + bx are respectively:

Period (MJD)	a	b
54434 – 54464	(-14.9 +/- 0.8) 10^{-12}	(+2.8 +/- 0.2) 10^{-16}/day

Table 2: coefficients of the linear fit

These coefficients are used to calculate the average value at middle date, given in table 1. The Figure 1 graph gives the variance of the frequency residuals. The standard deviation is 10^{-13} at 1s but doesn't decrease as white frequency noise during the total measurement duration. This is attributed to the non linearity of the Maser's drift. Even though the measurement duration is 1.9 10^6 s (72% of the time), we estimate a conservative value of 2 10^{-16} for the statistical uncertainty u_A.

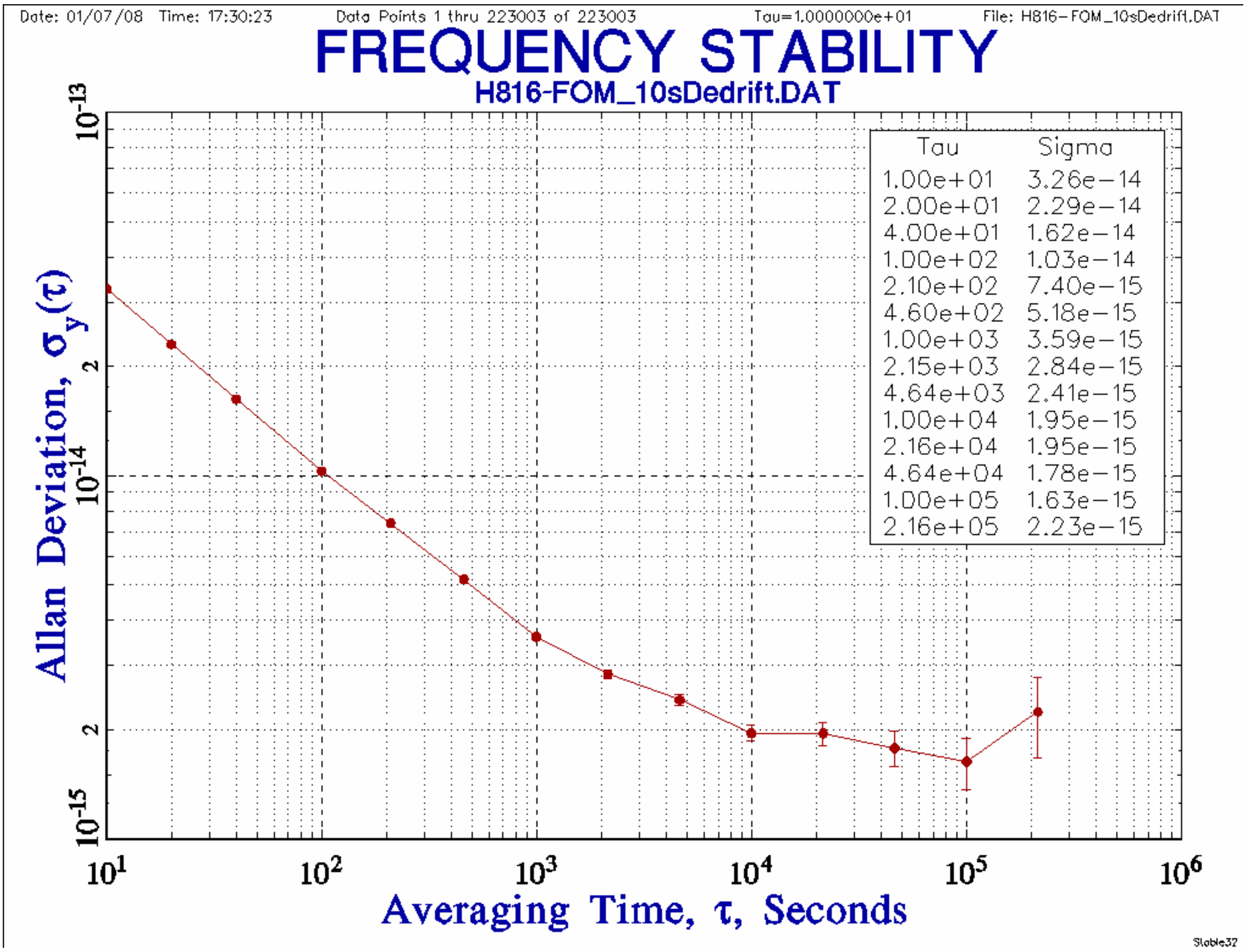

Figure 1: Standard Deviation of the comparison Maser140 0816- FOM

Accuracy

The frequency is corrected form the quadratic Zeeman, the Black Body radiation, the cold collisions and cavity pulling, and the red shift effects. The following table summarizes the budget of systematic effects and their associated uncertainties. The accuracy is the quadratic sum of all the systematics uncertainty.

	Correction (10^{-16})	**Uncertainty (10^{-16})**
Quadratic Zeeman effect	-304.6	1.1
Black body radiation	161.8	0.6
Cold collisions and cavity pulling	33.0	6.6
Microwave power dependence	0	6
Ramsey & Rabi pulling	0	< 0.1
Microwave recoil	0	< 1.4
Second order Doppler effect	0	< 0.1
Background gas collisions	0	<1.0
Total		**9.2**
Red shift	- 68.7	1.0
Total with red shift	**-178.5**	**9.3**

Table 3: budget of systematic effects and uncertainties for SYRTE-FOM fountain

$$u_B = 9.3 \times 10^{-16}$$

Uncertainty of the link

The uncertainty of the link is the quadratic sum of 2 terms:

-A possible effect of phase fluctuations introduced by the cables that connect the primary standard to the Maser. It is estimated to be 10^{-16}.

-The uncertainty due to the dead times of the frequency comparison.

To estimate this contribution, we use the comparison between Maser 140 0889 and Maser 140 0816. The data are corrected from the phase jumps of Maser 140 0889. We then calculate the time deviation of the normalized phase differences with the linear frequency drift removed. The uncertainty is given by:

$$\sigma_{y_{Dead\ Time}} = \frac{\sqrt{\sum_i \sigma_{x_i}^2}}{T}$$

where σ_{xi} are the extrapolated TVar for each dead times. We applied the method to the dead times longer than 600 s and obtained a stability degradation of 1.4 10^{-16}.