FREQUENCY COMPARISON (H_MASER 140 0816) - (LNE-SYRTE-FOM)
For the period MJD 54554 to MJD 54584

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 54554 and 54584 (29th March 2008 - 28th April 2008).

The mean frequency difference at the middle date of the period is given in the following table:

Period (MJD)	Date of the estimation	y(HMaser$_{140\ 0816}$ – FOM)	u_B	u_A	$u_{link\ /\ maser}$
54554 – 54584	**54569**	**5187.4**	**7.1**	**3**	**1**

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

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 to the maser 140 0816. 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.

Average value and statistical uncertainty

The data points of the frequency comparison between Maser 140 0816 and FOM Fountain are plotted in Figure 1. Each point has been obtained by averaging the data over 0.2 day. The error bars are the corresponding statistical uncertainties. The maser presented peak to peak frequency fluctuations at about 1.6 10^{-14}. A linear frequency fit is not appropriate to determine the average frequency over the calibration period.
To overcome this problem, we calculated the accumulated phase by integrating the data points, assuming a linear frequency drift during each segment, and during the dead times of the fountain operation. The average frequency is then obtained by dividing the total accumulated phase by the calibration period duration. The value given in Table 1 has been obtained with segments of 0.2 day duration. To estimate the uncertainty of the processing method, we performed calculations with segments of 0.01, 0.1 and 1 day durations. The differences between the results are within 3 10^{-16}. This value reflects the statistical uncertainty u_A. It also includes the effect of the dead times of the fountain operation, which represent ~15 % of the total measurement duration.

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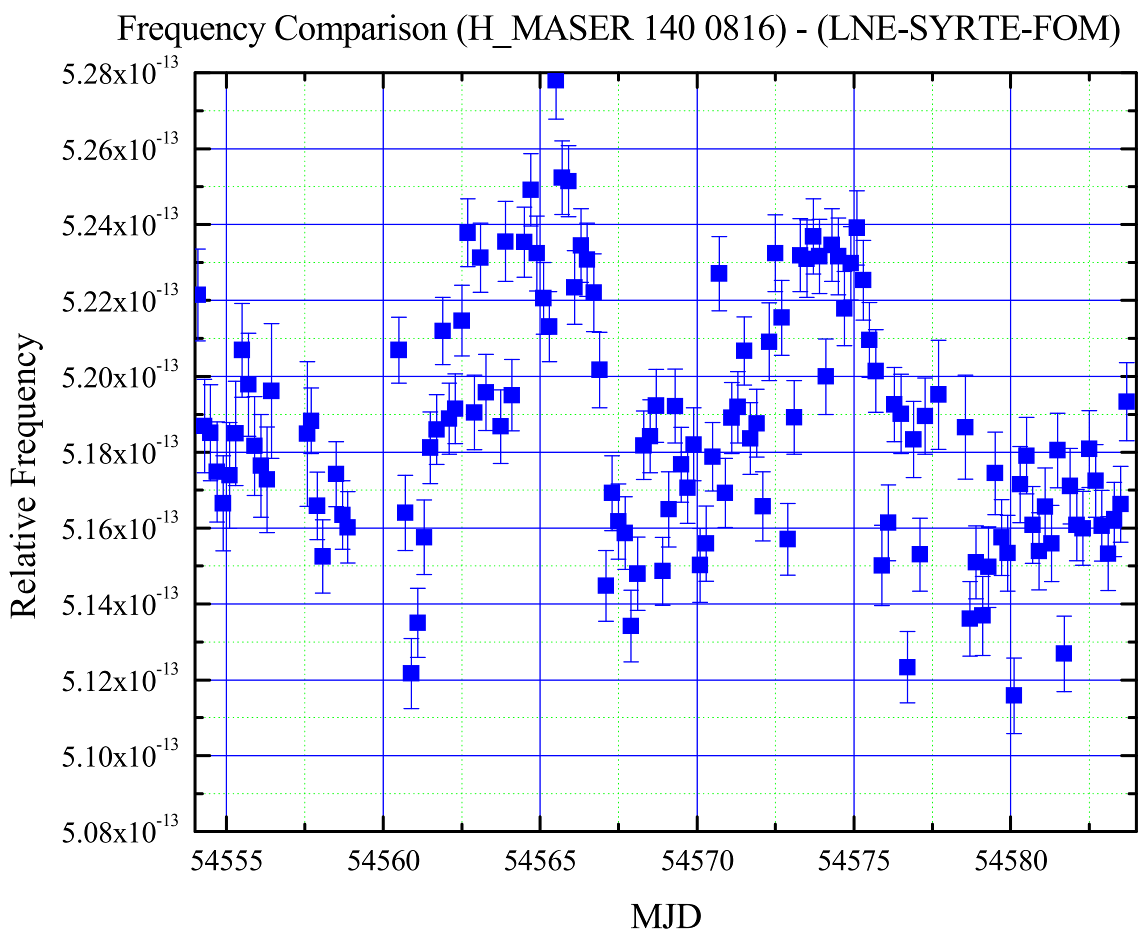

Figure 1: Frequency calibration of Maser 140 0816 by FOM Fountain between MJD 54554-54584

Accuracy

The frequency is corrected from 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 systematic uncertainties.

	Correction (10^{-16})	**Uncertainty (10^{-16})**
Quadratic Zeeman effect	-305.4	1.1
Black body radiation	162.6	0.6
Cold collisions and cavity pulling	27.9	2.8
Microwave power dependence : First order Doppler & Microwave spectral purity & leakage	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		**7.0**
Red shift	- 68.7	1.0
Total with red shift	**-183.6**	**7.1**

Table 2: budget of systematic effects and uncertainties for SYRTE-FOM fountain

$$u_B = 7.1 \times 10^{-16}$$

Uncertainty of the link

The uncertainty of the link stems from 2 contributions:
-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.
This contribution is already included in the value of u_A given in Table 1.