FREQUENCY COMPARISON (H_MASER 140 0889) - (LNE-SYRTE-FOM)
For the period MJD 54374 to MJD 54404

The primary frequency standard LNE-SYRTE-FOM has been compared to the hydrogen Maser (140 0889) of the laboratory, during 2 measurement sessions between MJD 54374 and 54404

The mean frequency differences are given in the following table :

Period (MJD)	Date of the estimation	y(HMaser$_{140\ 0889}$ - FOM)	u_B	u_A	$u_{link\ /\ maser}$
54374 – 54384	**54379**	**-13936.5**	**9.3**	**2.4**	**1.2**
54389 – 54404	**54396.5**	**-14174.9**	**9.3**	**2.2**	**1.2**

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

Average Value and statistical uncertainty

The details of the 2 calculations are given in figures 1 and 2 :

The frequency data averaged over 0.2 day are plotted on the upper graphs (blue points) together with a linear weighted fit (red lines).
The parameter of the fit y=a + bx are respectively :

Period (MJD)	a	b
54374 – 54384	**(72.3 +/-8.3) 10^{-12}**	**(-13.5 +/-1.5) 10^{-16}/day**
54389 – 54404	**(71.0 +/-3.0) 10^{-12}**	**(-13.3 +/-0.6) 10^{-16}/day**

Table 1: coefficients of the linear fits in 1 x 10^{-16}.

These coefficients are used to remove the drift (data plotted in the graphs in the middle, red points) and to calculate the average values given in table 1. The lower graphs give the variance of the residual frequencies. We determine the statistical uncertainties u_B on the average frequencies given in table 1 by extrapolating of the variances at the total measurement durations.

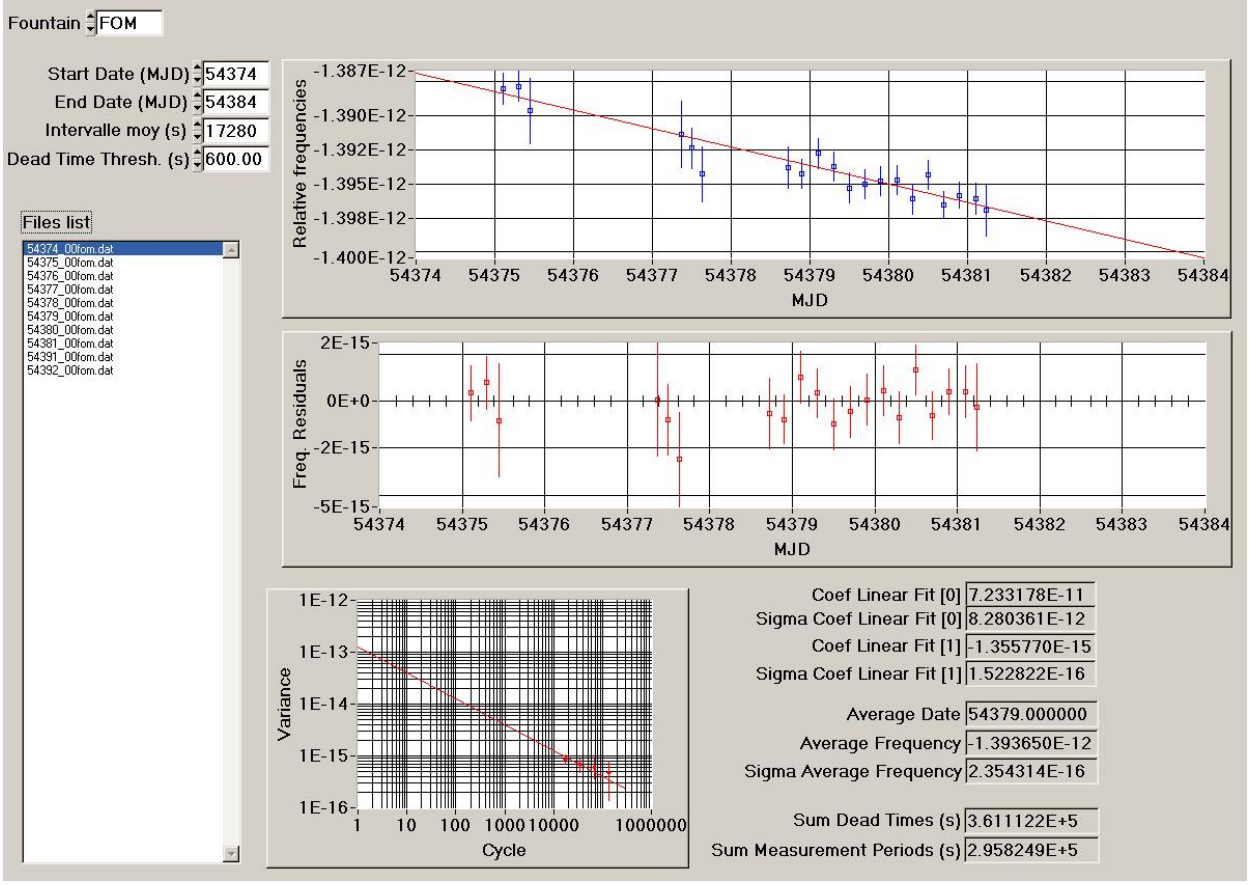

Figure 1: Data processing for the period MJD 54374-54384

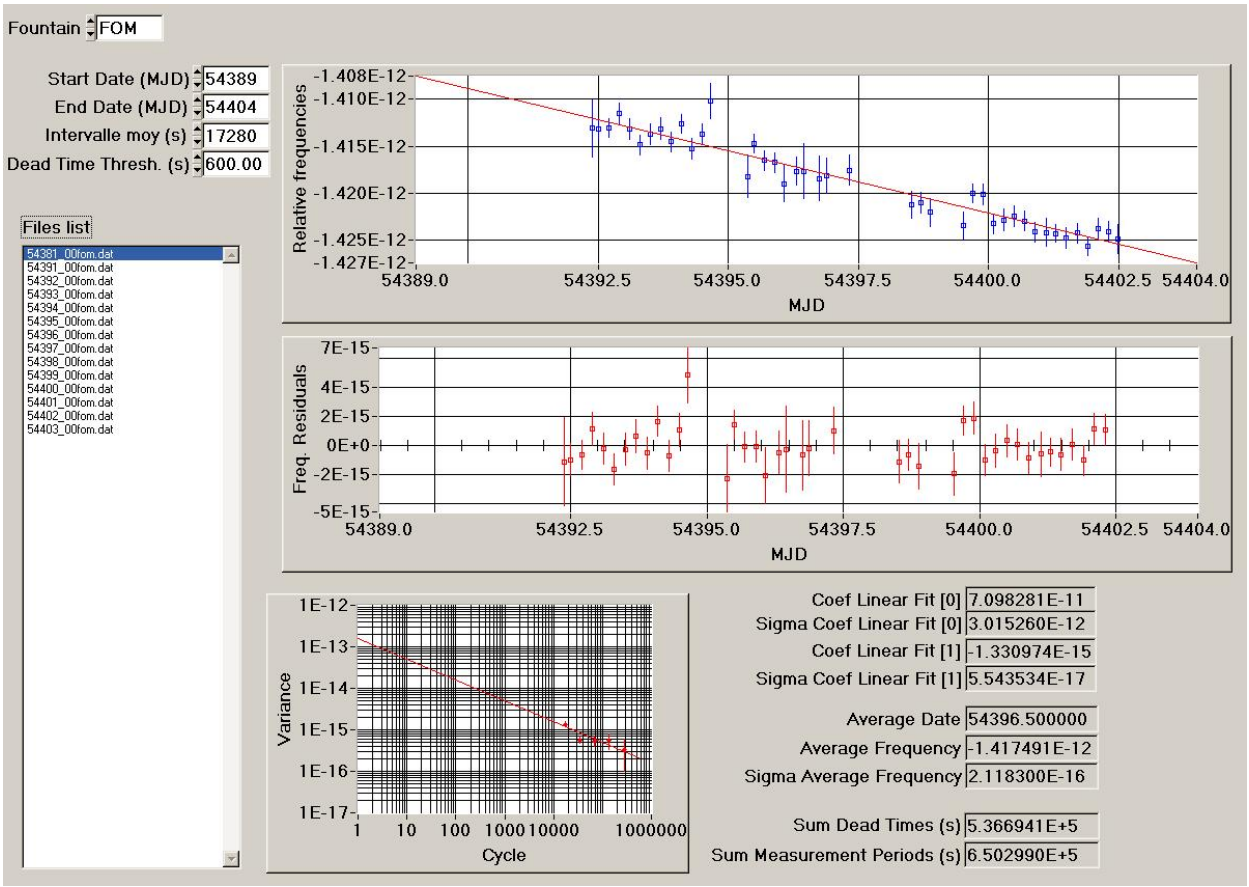

Figure 2: Data processing for the period MJD 54389-54404

Accuracy

During this period FOM has been operated in an autonomous mode : the clock signal is delivered by a quartz oscillator frequency locked on the hyperfine resonance. The results presented here correspond to the phase comparison between the quartz oscillator and the H-maser.
The delivered frequency is corrected form the quadratic Zeeman, the Black Body, 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	-305.7	1.1
Black body radiation	165.35	0.6
Cold collisions and cavity pulling	37.9	6.7
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		**9.25**
Red shift	- 68.7	1.0
Total with red shift	**-171.15**	**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 :
-The 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 the reference Maser and Maser 140 0890 and calculate the time deviation of the normalized phase differences with the linear drift removed (Figure 4). The uncertainty is given by :

$$\sigma_{\text{Dead Time}} = \sigma_x(\text{Total Dead Time})/\ T$$

where T is the total duration of the comparison between the primary standard and the reference Maser. The total dead time is the sum of the differences between 2 clock cycle dates, that are larger than a threshold of 600s. The estimations for the 2 measurement sessions of october are given in Table 4.

Period (MJD)	**Total Dead Time (s)**	**T (days)**	**σ_x**	**$\sigma_{\text{Dead\_Time}}$**
54374 – 54384	**$3.6\ 10^5$**	**10**	**$5\ 10^{-11}$**	**$0.6\ 10^{-16}$**
54389 – 54404	**$5.4\ 10^5$**	**15**	**$7\ 10^{-11}$**	**$0.6\ 10^{-16}$**

Table 4: Uncertainty due to the dead times.

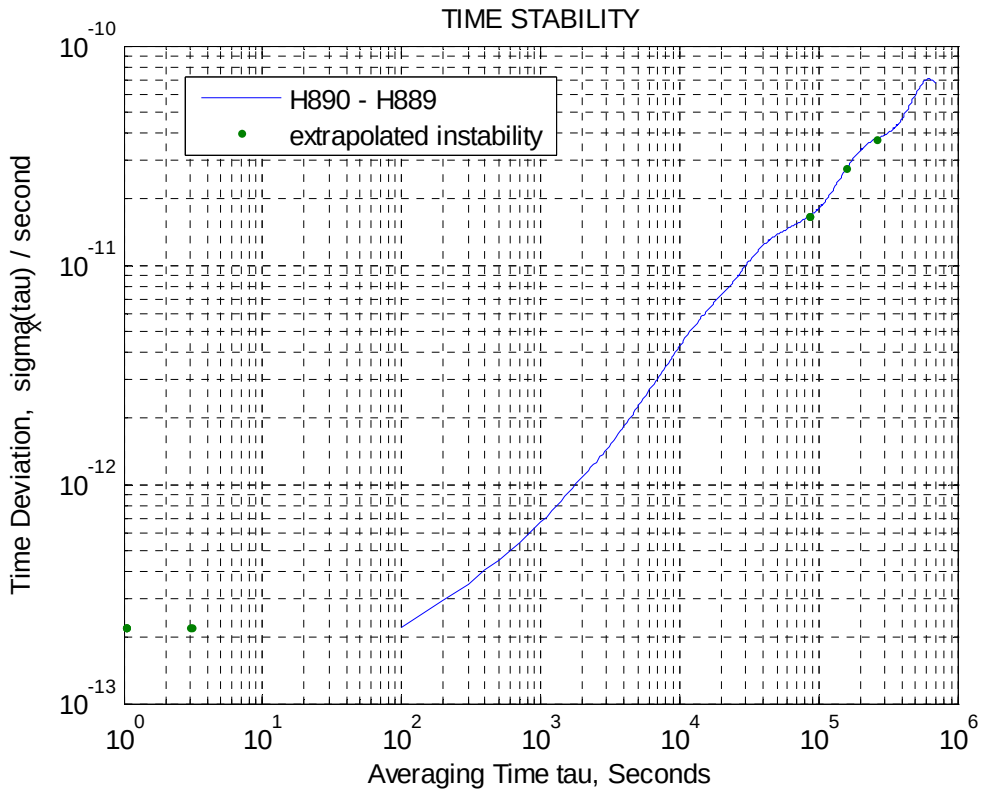

Figure 4: Time stability on normalized phase differences between Masers 140 0889 and 140 0890 linear drift removed, from MJD 54374 to MJD 54404