

**FREQUENCY COMPARISON (H\_MASER 40 0889) - (LNE-SYRTE-FO2)  
From MJD 54249 to MJD 54279**

The primary frequency standard LNE-SYRTE-FO2 was compared to the hydrogen Maser (40 0889) of the laboratory during the 29<sup>th</sup> of May to 28<sup>th</sup> of June 2007 period corresponding to MJD 54249 and MJD 54279.

Period (MJD)	y(HMaser <sub>40 0889</sub> - FO2)	$u_B$	$u_A$	$u_{link} / maser$
54249 – 54279	-12371.9	4.6	2.6	1.2

Table 1: Results of the comparison in  $1 \times 10^{-16}$ .

Figure 1 collects the measurements of fractional frequency differences during the 28<sup>th</sup> of May to 28<sup>th</sup> of June 2007 period. Error bars represent the statistical uncertainties. The measurements are corrected for the systematic frequency shifts listed below.

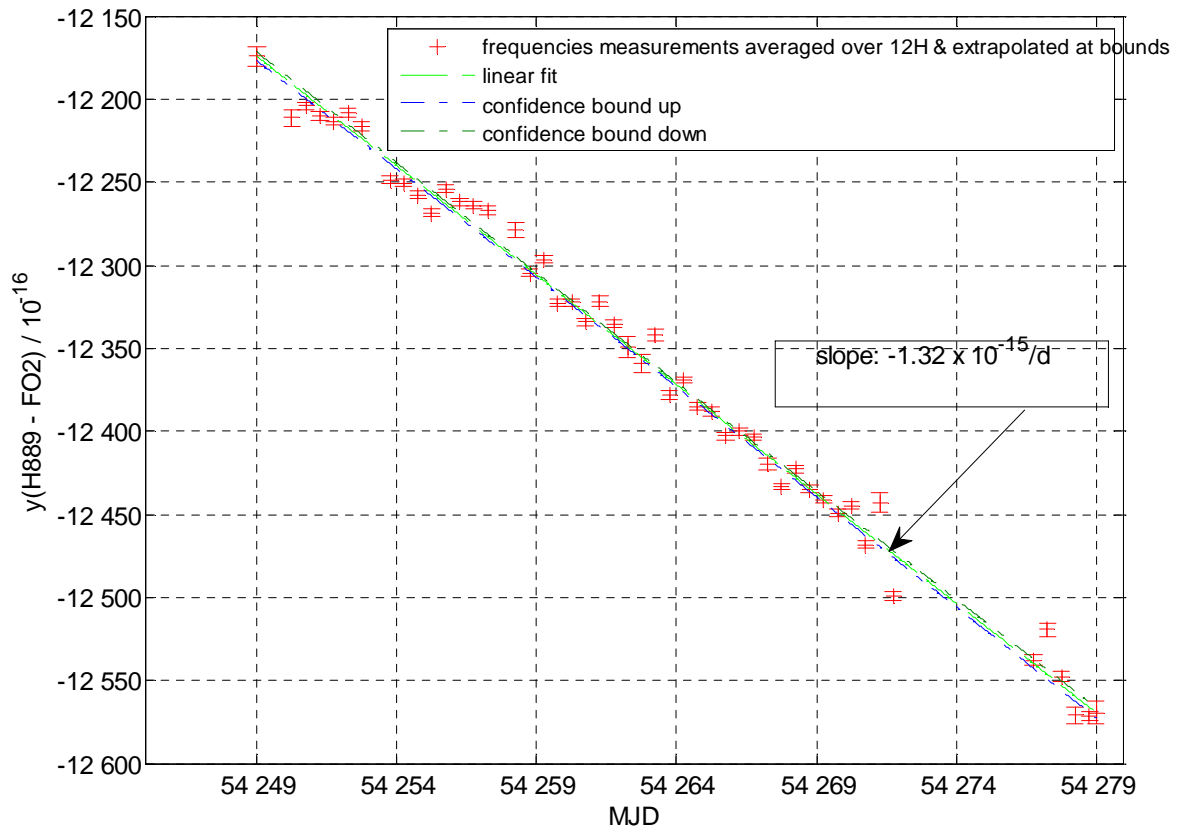


Figure 1: fractional frequency differences between H\_Maser40 0889 & FO2 from MJD 54249 to MJD 54279

Table 2 gives the results of the frequency estimate for the middle date of the period, and the associated statistical uncertainty, using either a linear or a polynomial fit to the data.

.Dates of measurements .Duration & .Measurement Rate	Mean normalized frequency difference $y_{Maser} - y_{FO2}$	type A uncertainty $\sigma_{Stat}$	Uncertainty due to the dead times $\sigma_{deadTime}$
Start date MJD UTC <b>54250.529</b> End date MJD UTC <b>54278.97</b> Length of interval 28.447 d Measurement Rate: 67.05%	Mean by linear fit at middle date 54264 $\bar{y} = -12371.86 \times 10^{-16}$ Mean by polynomial fit order 9: $\bar{y} = -12370.78 \times 10^{-16}$	Uncertainty of linear fit <b><math>2.6 \times 10^{-16}</math></b> Allan Deviation at T with assumption of White Frequency Noise $\sigma_y = 1.8 \times 10^{-16}$	$\sigma_{deadTime} =$ <b><math>0.7 \times 10^{-16}</math></b>

Table 2: Statistics of measurements

Summary of the systematic corrections and uncertainties:

	Correction ( $10^{-16}$ )	Uncertainty ( $10^{-16}$ )
Cold collisions and cavity pulling	<b>201</b>	2.6
Quadratic Zeeman effect	<b>-1919.5</b>	0.2
Black body radiation	<b>167.2</b>	0.6
Microwave spectral purity & leakage		0.5
First order Doppler effect		3.0
Ramsey & Rabi pulling		< 1.0
Microwave recoil		< 1.4
Second order Doppler effect		< 0.1
Background gas collisions		<1.0
<b>Total</b>		<b>4.5</b>
Red shift	- 65.4	1.0
<b>Total with red shift</b>		<b>4.6</b>

Table 3: Budget of systematic effects and associated uncertainties in the FO2 fountain.

Systematic effects taken into account are listed in Table 3. The correction and estimated uncertainty for each of them is given. Here the collisional shift correction is the average correction over all measurements, which are taken alternatively at high and low densities. The uncertainty on this correction is taken as 1% of the collisional shift correction at high density to account for 1% spurious population in non-zero  $m_F$  states which affect the measurements equally at both densities. Finally, including also an uncertainty for the red shift effect, this gives the type B total uncertainty:

$$\sigma_B = \left( \sigma_{Zeeman}^2 + \sigma_{BlackBody}^2 + \sigma_{Collision_{Syst}}^2 + \sigma_{Microwave\_Spectrum\_Leakage}^2 + \sigma_{first\_Doppler}^2 + \sigma_{Ramsey\_Rabi}^2 + \sigma_{Recoil}^2 + \sigma_{second\_Doppler}^2 + \sigma_{Background\_collisions}^2 + \sigma_{Redshift}^2 \right)^{(1/2)}$$

For the whole June 2007 period it gives

$$\sigma_B = 4.6 \times 10^{-16}$$