LNE-SYRTE REPORT

by

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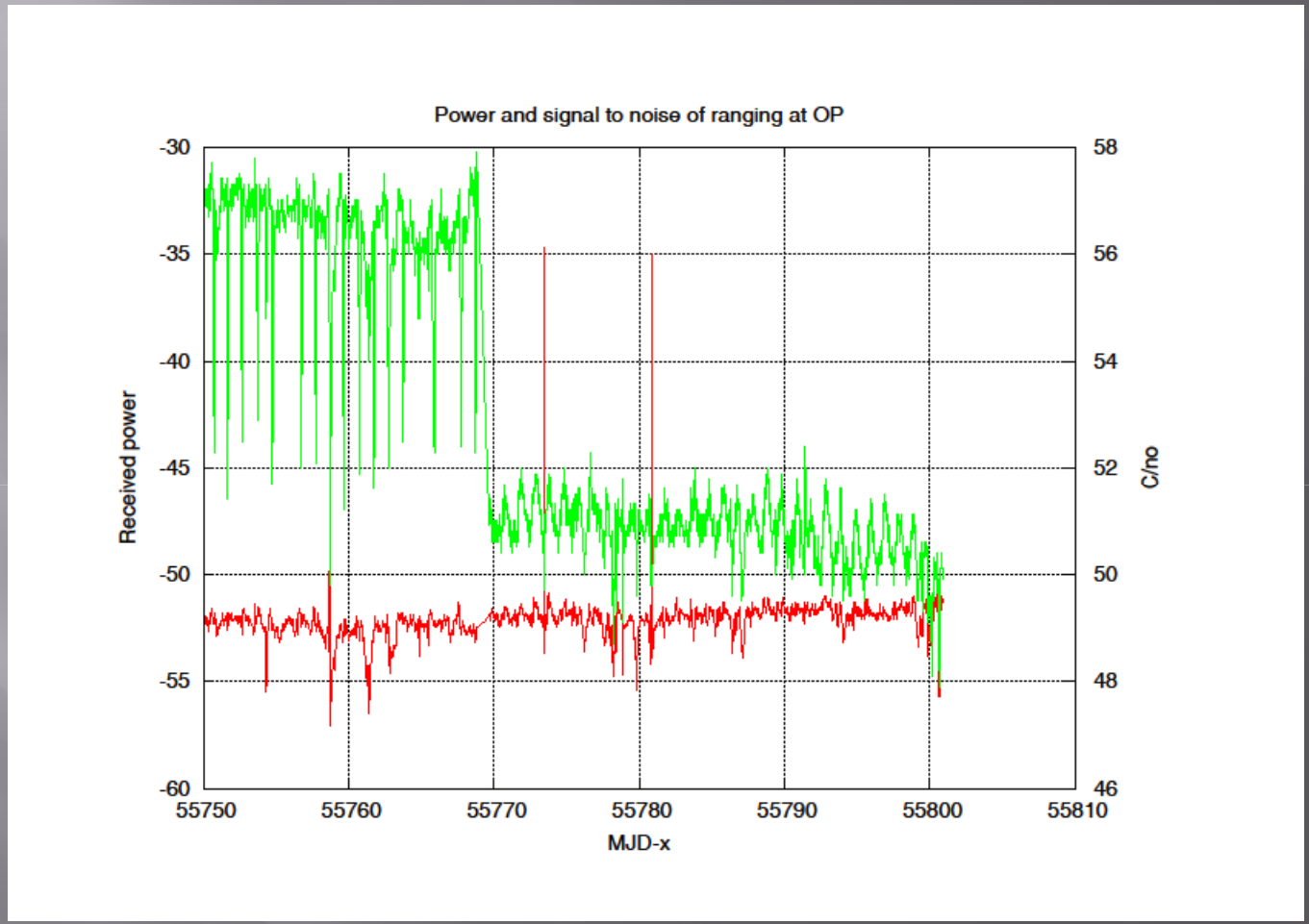
Progress work at OP since the last meeting:

1. OP01 used continuously to linking UTC(OP) to UTC through PTB, and UTC(OP) to all available UTC(k) in Europe and the US;
2. OP02 used on request for specific applications and tests (with OP01 for CP experiment; also with NIST, USNO and PTB);
3. OP01 is operated now with a new software under Linux system;
4. Two additional modems have been ordered from TimeTech;
5. OP01 satellite simulator re-switched ON recently (internal differential delay is known at ± 400 ps, measurements on going)
6. The development of the TWSTFT carrier phase is in progress (frequency stability of $1{,}13 \times 10^{-12}$ @ 1 s is achieved)
7. A link with TT station for CP applications will be established soon (to coordinate with PTB).


Power and signal to noise of ranging at OP
Received power
C/no
MJD-x
-30
-35
-40
-45
-50
-55
-60
58
56
54
52
50
48
46
55750
55760
55770
55780
55790
55800
55810

Comments from OP following the change of transponders happened in July 2011:

1. OP is very happy with the two Transatlantic transponders provided by T-11N;

2. OP is not happy with the European transponder provided by T-11N for the following reason: the carrier to noise ratio becomes more and more bad (even if the received power remains unchanged) implying more noisy the European links in comparison with the past.

3. To reduce the noise on the European links, at three solutions (to be considered as « potential » or not) can be noted here:

   - to increase the transmission power of all the stations (seems to be impossible);

   - to split the number of stations per hour (half of the total stations will be operated in the even hours, the remaining half operated in the odd hours). This solution allows all the stations to increase their Tx power;

   - to find another transponder « more clean and quiet ». This solution is the most expensive.

N.B. Increasing the power is unavoidable since the origin of the additional noise is not caused by the stations but is external to the network !

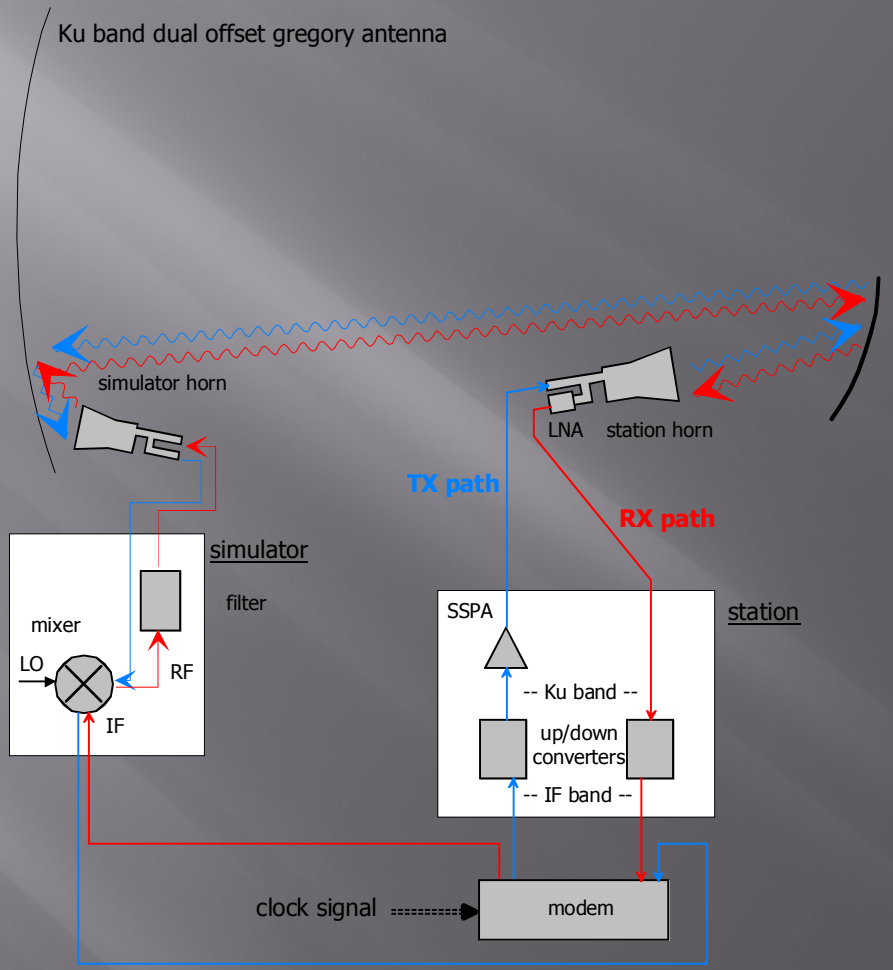
Comments (con't):

In addition:

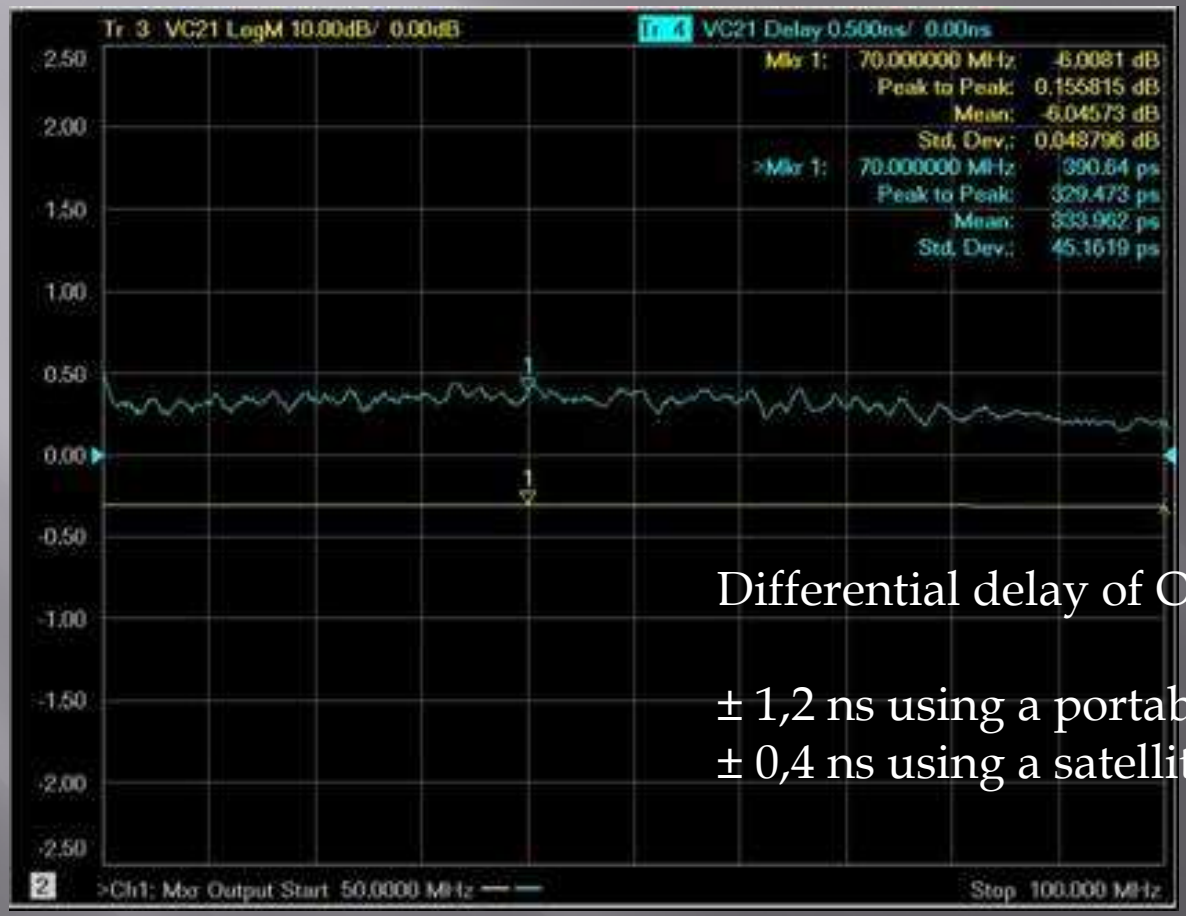
To apply frequency offsets could also improve the links and can be used as a first step (to be confirmed when a « noisy » transponder is used while it's already confirmed with a « better » transponder i.e. transtalantic ones).

Satellite simulator developments

Design of The Satellite Simulator



Satellite simulator: improvement of absolute delay measurement using a MVNA



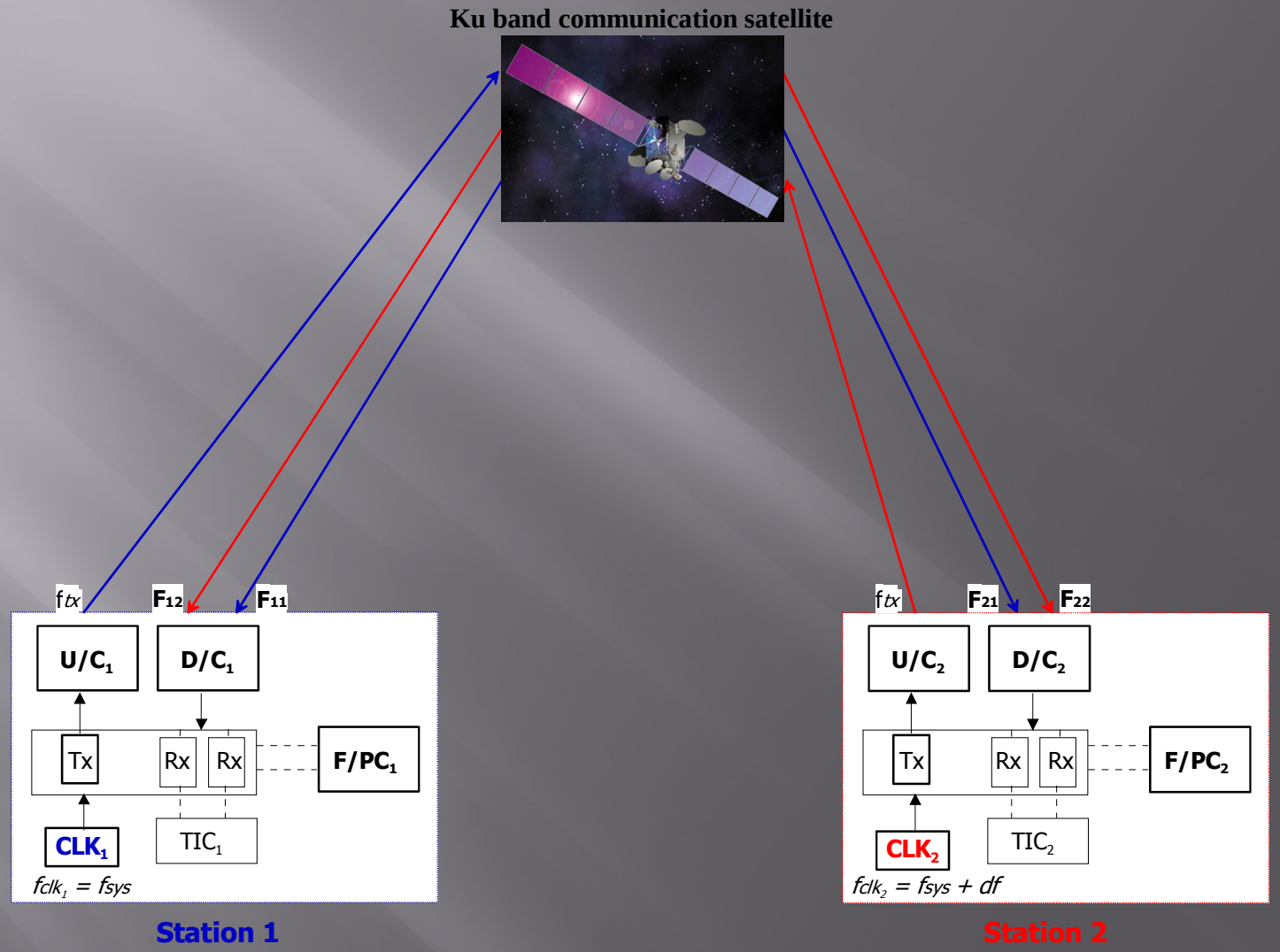
Differential delay of OP01 station known at:

± 1,2 ns using a portable station (relative value)
± 0,4 ns using a satellite simulator (absolute value)

TWSTFT carrier phase developments

in collaboration with TimeTech

TWSTFT Carrier Phase Technique



Parameters of the system

TWCP works were initiated by USNO and TimeTech; an important work were done but still to be improved and achieved; LNE-SYRTE decided recently to contribute on this way.

From the previous diagram

- F_{11}, F_{22} : ranging signal frequencies
- F_{12} : signal frequency received by station 1, *transmitted by station 2.*
- F_{21} : signal frequency received by station 2, *transmitted by station 1.*

These 4 frequencies receive a shift due to the Doppler effect.

TWSTFT carrier phase system equations

$$
\begin{cases}
F_{11} = f_{tx}(1+k_1)^2 - f_{slo}(1+k_1) \\
F_{12} = f_{tx}\left(\dfrac{f_{sys}+df}{f_{sys}}\right)(1+k_1)(1+k_2) - f_{slo}(1+k_1) \\
F_{21} = f_{tx}\left(\dfrac{f_{sys}}{f_{sys}+df}\right)(1+k_1)(1+k_2) - f_{slo}\left(\dfrac{f_{sys}}{f_{sys}+df}\right)(1+k_2) \\
F_{22} = f_{tx}(1+k_2)^2 - f_{slo}\left(\dfrac{f_{sys}}{f_{sys}+df}\right)(1+k_2)
\end{cases}
$$

Example of 1s data format for the TWSTFT carrier phase experiment

For the ranging signal

* A5566607.01A					
* MJD	HHMMSS	s	dBm	dBHz	Hz
55666	070354	0.262365232980	-53.8	56.2	69971248.038
55666	070355	0.262365222380	-53.8	56.2	69971248.053
55666	070356	0.262365221210	-53.8	56.2	69971248.111
55666	070357	0.262365217040	-53.8	56.2	69971248.124
55666	070358	0.262365207060	-53.8	56.2	69971248.027
55666	070359	0.262365197190	-53.8	56.2	69971248.043
55666	070400	0.262365191710	-54.0	55.9	69971248.008
55666	070401	0.262365188730	-54.0	55.9	69971248.012

For the two-way signal

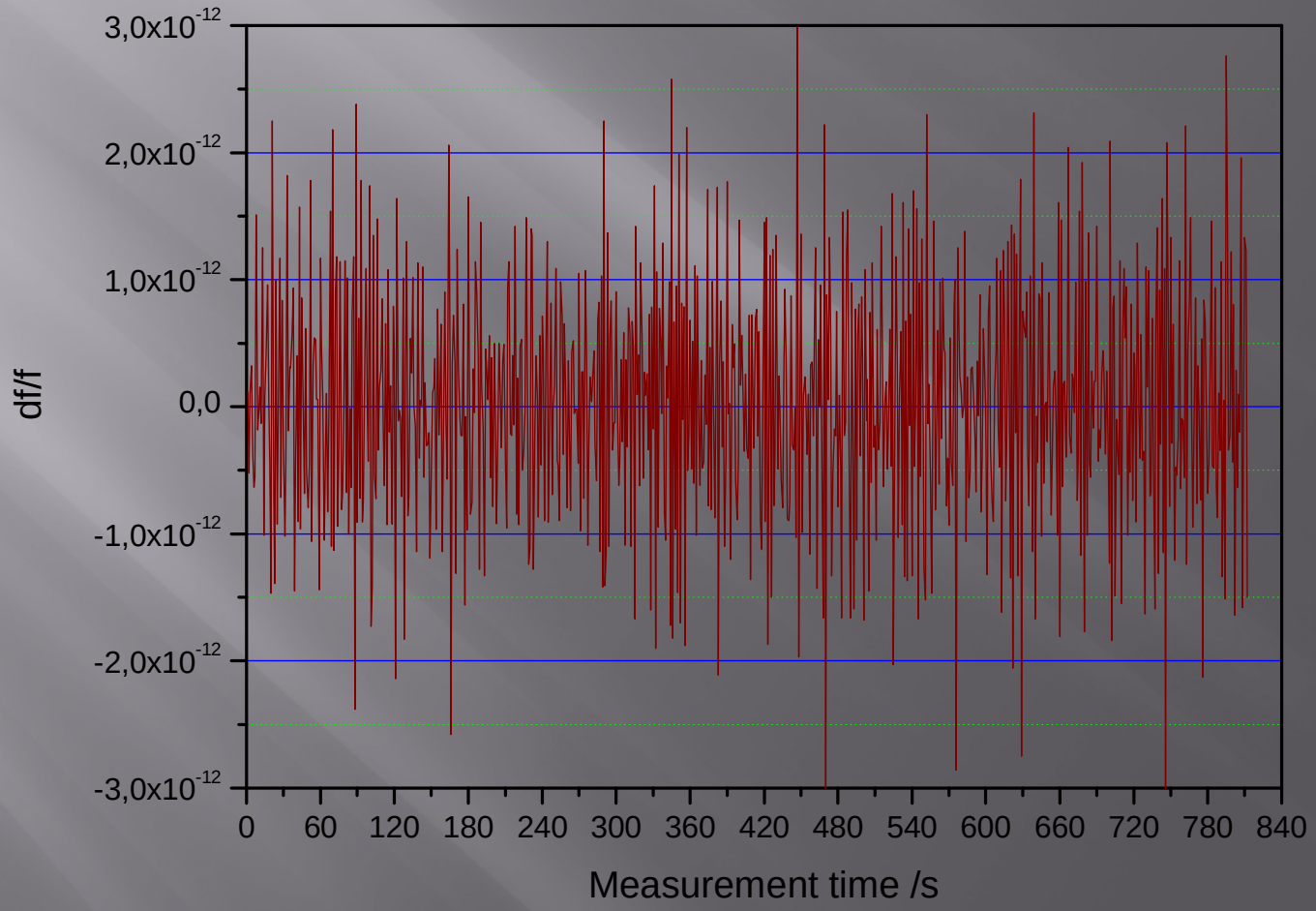
* A5566607.01B					
* MJD	HHMMSS	s	dBm	dBHz	Hz
55666	070355	0.262365095950	-53.7	56.5	69971248.040
55666	070356	0.262365087320	-53.7	56.5	69971248.102
55666	070357	0.262365083320	-53.7	56.5	69971248.134
55666	070358	0.262365077300	-53.7	56.5	69971248.029
55666	070359	0.262365070460	-53.7	56.5	69971248.028
55666	070400	0.262365062380	-53.7	56.5	69971248.014
55666	070401	0.262365057520	-53.7	56.5	69971248.049
55666	070402	0.262365050840	-53.7	56.5	69971248.052

N.B. This format could also be adopted for the TWSTFT code phase experiment

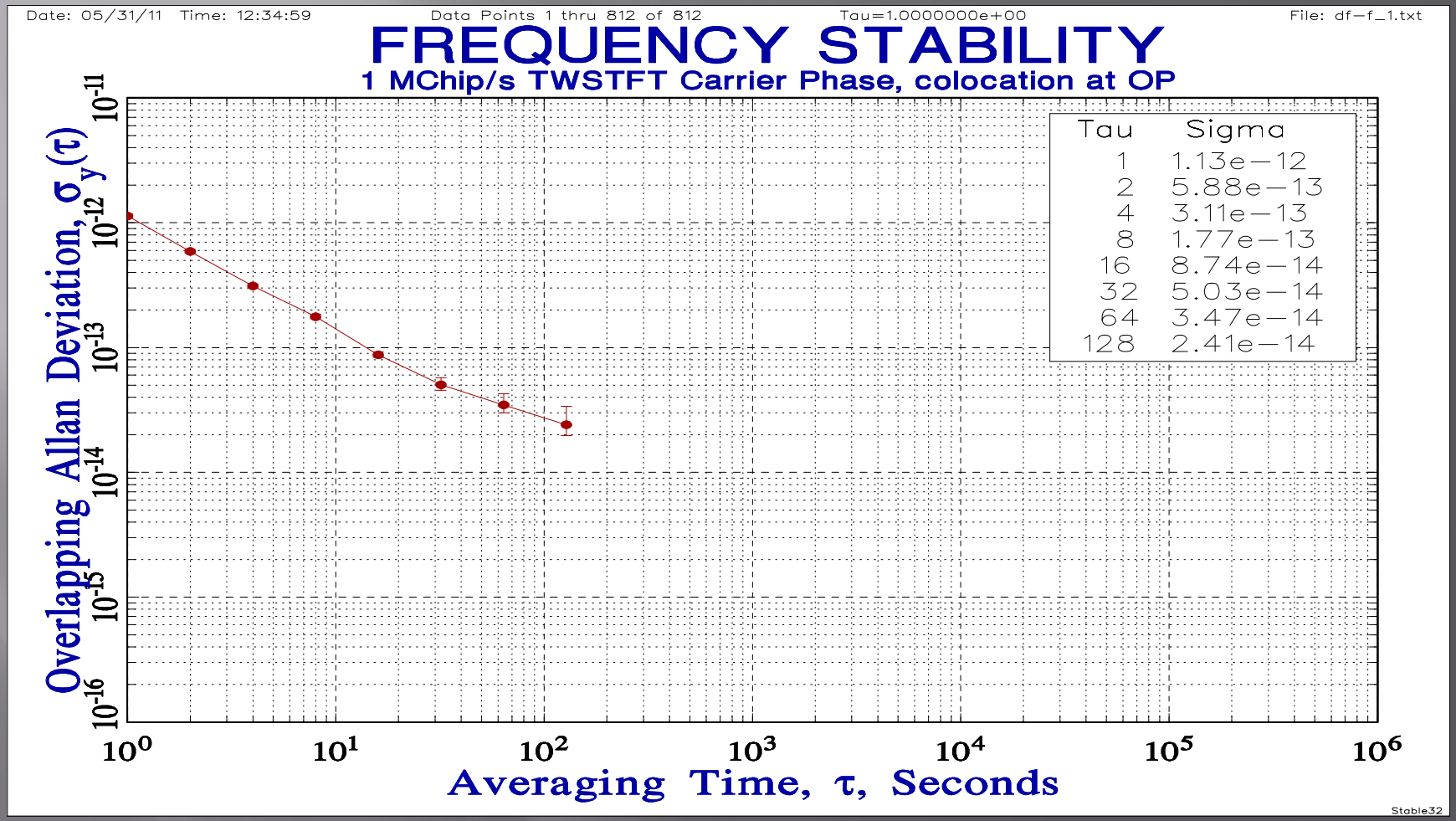
First TWCP results obtained at LNE-SYRTE (2011)

OP01 and OP02 participated in common clock (HM890)

Clock frequency shift not considered here, on-board LO frequency translation included



First TWCP results obtained at LNE-SYRTE (2011)



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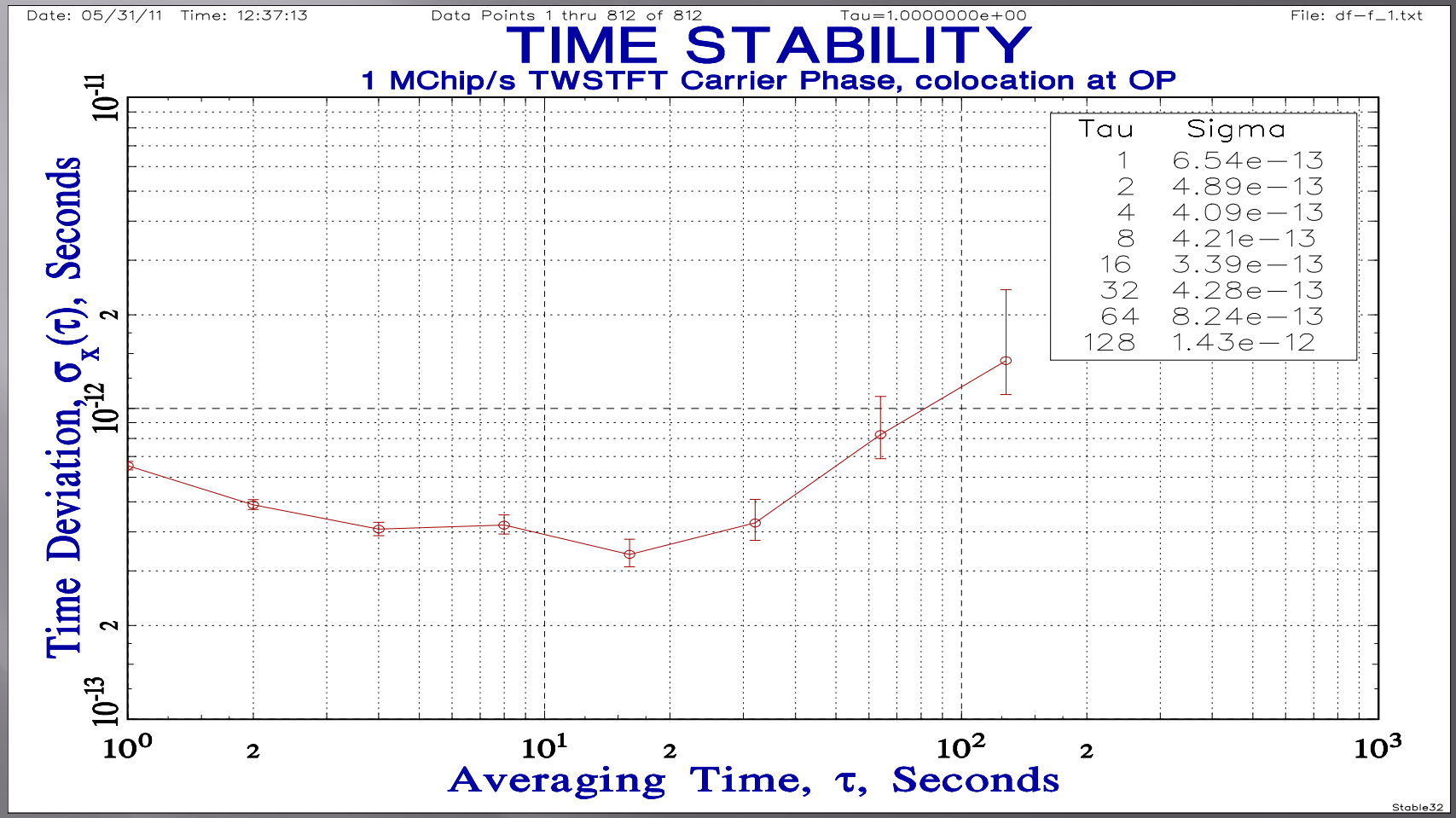

THANK YOU !