

# Latest improvements in the performances of a Cryogenic Sapphire Oscillator

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The preliminary measurement of two identical Cryogenic Sapphire Oscillators (CSO) was realized in the frame of the ULISS project and presented during the last EFTF in Prague [1]. Since, the two instruments have been improved leading today to an unprecedented frequency stability better than  $1 \times 10^{-15}$  between 1 s and 10,000 s integration times (one unit flicker floor:  $3 \times 10^{-16}$ ) with a measured frequency drift of  $1.7 \times 10^{-15}$  /day. The frequency synthesis providing from the CSO signal the useful frequencies (10 GHz, 1 GHz, 100 MHz) has been also improved and completely characterised.

The returns from the ULISS Odyssey experience, where the transportable ULISS CSO was successively tested in few laboratories around Europe, permitted to us to better understand the main limitations in the CSO performances. Thus, the thermal configuration of the cryogenic resonator was modified to increase the rejection of the temperature modulation arising from the Pulse-Tube Cryocooler. EMC was also greatly improved leading to make the CSO less sensitive to its environment. We conducted careful measurements to better understand power sensibility of the cryogenic resonator.

The measurement campaign of these ultra-stable oscillators permitted also to compare the resolution different of commercial instruments (frequency counters and Signal Source Analysers).

[1] *ULISS project : 2013 progress report*. V. Giordano, S. Grop, B. Dubois, J.L. Masson, G. Cabodevilla, E. Rubiola, Y. Kersalé, P.Y. Bourgeois and G. Haye.  
Proceedings of the joint UFFC/EFTF Symposium 2013, 21-25 July 2013, Prague (CZ).

## *Acknowledgements:*

*This work is a part of the Oscillator IMP project and of the First TF network.  
We thank ANR, CNES and Région Franche-Comté for funding*

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