

## EUROMET PROJECT FINAL REPORT

1.	Ref. No.: 651	2. Subject Field: Time and Frequency
3	Type of collaboration: Cooperation	
4A.	Partners: (institutions) CMI (IREE), IEN, NPL, PTB, ROA, SIQ, SYRTE* * Joined in 2003	4B. CEC funded? No
5.	Participating countries: CZ, DE, GB, IT, ES, SI, F	
6.	Title: Ultra-sensitive short-term frequency and phase stability measurement	
7.	<p>Survey of activities:</p> <p>2002</p> <ul style="list-style-type: none"> <li>• Inventory of calibration/measurement capability in frequency/phase stability measurement [1] (participating IEN, PTB, ROA, SIQ, IREE)</li> <li>• Working visit to IREE from IEN (one week)</li> <li>• Comparison of dual-mixer time-difference multipliers (DMTDM): TSC5110A, IEN laboratory design, IREE laboratory design – version 1 (participating IEN, ROA, IREE) [2]</li> </ul> <p>2003</p> <ul style="list-style-type: none"> <li>• Working visit to IREE from SYRTE (one week)</li> <li>• Optimization of the IREE DMTDM frequency-stability measurement system [3] (participating SYRTE and IREE)</li> <li>• Comparison of ultra-stable 5 MHz BVA oscillators, one of SYRTE, two of IREE (participating SYRTE and IREE)</li> </ul> <p>2004</p> <ul style="list-style-type: none"> <li>• Working visits to IREE from SYRTE (one week) and ROA (one week)</li> <li>• Comparison of ultra-stable 5 MHz BVA oscillators, one of ROA, two of IREE (participating ROA and IREE)</li> <li>• Application of DMTDM in time delay measurement [4], [5] (participating SYRTE and IREE)</li> </ul> <p>Conclusions</p> <p>The most valuable result obtained within the project is the successful optimization of the IREE DMTDM system which at 5 MHz (15 Hz cutoff) provides the background time stability of 3.5 fs, at the basic sampling interval <math>\tau_0 = 0.2</math> s, with the flicker PM floor <math>\approx 2</math> fs (in terms of time deviation TDEV). The corresponding background frequency stability is <math>7 \times 10^{-15}</math> at 1 s and <math>8 \times 10^{-16}</math> at 10 s in terms of Allan deviation [3]. This noise performance, which to our knowledge is the best reported so far, has been achieved thanks to collaboration between IREE and SYRTE.</p> <p>Perhaps it should be noted that the above result may also be the answer to a question that may arise about whether a project of this kind with no funds has any sense. In other words, one might think that the same result could well have been obtained without the project. Hardly so. At least in this specific case. The merit of the project is that it makes the collaboration easier. Particularly in the initial stage before our common work took a more concrete form, we had a need for a framework of some kind to start the collaboration and that is exactly what the project provided for us.</p>	

## References

- [1] J. Čermák: Status Report on the EUROMET Project No. 651 "Ultra-sensitive short-term frequency and phase stability measurement", *EUROMET Time and Frequency Technical Committee Meeting, 4 and 5 April, 2002, Delft, The Netherlands*
- [2] L. Šojdr, J. Čermák, G. Brida. "Comparison of high-precision frequency-stability measurement systems. *Proc. IEEE International Frequency Control Symposium and 17th European Frequency and Time Forum*, Tampa, USA, (2003), pp. 317-325
- [3] L. Šojdr, J. Čermák and R. Barillet: "Optimization of Dual-Mixer Time-Difference Multiplier", *Proc. 18th European Time and Frequency Forum*, Guildford, UK, (2004), CD-Session 6B/130.pdf
- [4] R. Barillet, J. Čermák, J.Y. Richard, L. Šojdr: "Application of dual-mixer time-difference multiplication in accurate time-delay measurement", *Proc. IEEE International Ultrasonics, Ferroelectrics, and Frequency Control 50th Anniversary Joint Conference*, Montreal, Canada, (2004), in press
- [5] R. Barillet, J. Čermák, L. Šojdr: "On twofold use of dual-mixer time-difference multiplication", *Proc. 19th European Time and Frequency Forum*, Besançon, France, (2005), in press

8. Coordinator's name: Jan Čermák

Address: Institute of Radio Engineering and Electronics, Academy of Sciences of the Czech Republic  
Chaberska 57  
182 51 Praha 8, Czech Republic

Telephone: 420 284680144

Telefax: 420 284680222

E-mail: cermak@ure.cas.cz

9. Completion date:  
December 31, 2004

10. Coordinator's signature:

11. Date:  
April 5, 2005