REPUBLIC OF SLOVENIA
MINISTRY OF ECONOMIC DEVELOPEMENT AND TECHNOLOGY
METROLOGY INSTITUTE OF THE REPUBLIC OF SLOVENIA

Tkalska ulica 15, 3000 Celje

T: +386 3 428 07 50
F: +386 3 428 07 60
E: gp.mirs@gov.si
www.mirs.gov.si

Report on relevant MIRS/SIQ time and frequency activities and dr. Rado Lapuh work

MIRS/SIQ is maintaining a modern time & frequency laboratory, based on Agilent 5071A Primary Frequency Standard, Common View GNSS receiver, Distribution amplifier, phase measurement system with auxiliary equipment, and NTP Server for national-wide time scale distribution. We are participating regularly in CCTF-K001.UTC since 2006. Our claimed CMC for frequency is 2×10^{-13}.

Current research and development activities in the time & frequency field are primarily directed toward implementing EURAMET Time interval comparison Pilot Study, coordinated by dr. Rado Lapuh. Target is to prepare comparison of time interval measurements with TIC using stable travelling time interval active sources. MIRS/SIQ is developing travelling time interval standard source (generating nominal 20 ns, 50 ns, and 200 ns independent fixed time interval values) together with Slovenian company InLambda d.o.o., which is based on temperature compensated optical fibres of different lengths and associated electronics. Latest results has shown long term ps stability, which should be adequate for the comparison purpose. Concurently, the GUM standard was already built, providing a programmable time interval value between 20 ns and 12 µs, which is already running the comparison study in involved laboratories (GUM, MIRS/SIQ, UME, SASO (Saudi Arabia)). We expect that the Pilot Study will be finished early next year, when the EURAMET TC TF will discuss possibility to organise regional time interval comparison, which could serve as a direct support for time interval CMCs.

This Pilot Study was initiated after the completion of EUROMET supplementary comparison TF.TI-K1 Comparison of time interval (cable delay) measurement, which clearly shown in its report that othervise specially prepared cables (provided by BEV) can not serve as a traveling standards for time interval comparison. This comparison was also prepared and coordinated by Rado Lapuh, with a substantial support of BEV.

During this time, the MIRS/SIQ laboratory has upgraded its equipment and capabilities with new state-of-the-art GNSS receiver system and FTP server for dissemination of UTC(SI).

During 2010 and 2011, R. Lapuh was collecting information on legal time regulations, which resulted in his published booklet »EURAMET countries' legal time regulations and practices«.

R. Lapuh was also responsible to establish an optical fibre connection between MIRS/SIQ laboratory and ELES, Ljubljana, which also acquire Caesium clock. The project provided bidirectional frequency transfer between institutions on the 26 km long route, which is successfully operating since then, providing MIRS/SIQ another reference caesium based frequency reference and ELES a technical synchronisation backup for their telecommunication system.

R. Lapuh served as the EUROMET Technical Committee for Time and Frequency chairperson from 2001 till 2005. During his chairmanship, EUROMET members prepared, reviewed and after inter-regional review successfully published first time and frequency CMCs in the KCDB. Since than, he has been coordinating numerous EURAMET time and frequency projects.

Dr. Rado Lapuh is currently also an EMPIR committee deputy chair.

List of projects, coordinated by dr. R. Lapuh

1. EURAMET Project nr. 1288, Time interval comparison Pilot Study, started in 2013, running
2. EURAMET Project nr. 1118, Cooperation of European NMIs t&f laboratories in EMRP/A169 project calls, started in 2010, finished
3. EURAMET Project nr. 1117, Survey of European countries' legal time regulations and practices, started in 2009, finished
4. EURAMET Project nr. 828, EUROMET supplementary comparison TF.TI-K1 Comparison of time interval (cable delay) measurement, started in 2004, finished
5. EURAMET Project nr. 731, Analysis and review of CMCs in 2003 for Time and Frequency field, started in 2003, finished

List of dr. R. Lapuh publications, related specifically to time and frequency

1. R. Lapuh, “EURAMET countries' legal time regulations and practices,” EURAMET, 2011, ISBN 978-3-942992-18-3, available online: http://www.euramet.org/publications-media-centre/documents-and-publications/
2. B. Pinter, M. Lindič, B. Voljč, Z. Svetik, and R. Lapuh, Razvoj meroslovnega sistema za čas in frekvenco na SIQ (Development of time and frequency metrology system at MIRS/SIQ). ERK 2011, Portorož, Slovenia, IEEE Region 8, pp. 466-469
3. B. Pinter, R. Lapuh. Meroslovje na področju časa in frekvence v Sloveniji (Time and frequency metrology in Slovenia. ERK 2008, Portorož, Slovenia, IEEE Region 8, pp. 405-407
4. R. Lapuh. Publishing EUROMET time and frequency CMC files in KCDB Appendix C. ERK 2005, Portorož, Slovenia, IEEE Region 8, pp. 451-454
5. R. Lapuh, Z. Svetik, Traceability of national standard of frequency and its distribution in Slovenia. Conference on precision electromagnetic measurements digest, CPEM, 14-19 May 2000, IEEE, pp. 84-85
6. R. Lapuh, Distribution of time and frequency in Slovenia. ERK '99, Portorož, Slovenia, IEEE Region 8, pp. 565-568
7. Z. Svetik, R. Lapuh, I. Visočnik, Nacionalni etalon frekvence in časa (National standard of time and frequency). ERK '98, Portorož, Slovenia. IEEE Region 8, pp. 603-606
8. R. Lapuh, F. Cordara, G. de Jong, Preparation and review of EUROMET CMC files for time and frequency. 18th European Frequency and Time Forum, 5-7 April 2004, University of Surrey, Guilford, UK. EFTF 2004
9. R. Pajntar, R. Lapuh, A cost-effective subcarrier multiplexed bidirectional fibre-optic transfer of caesium-beam atomic clocks signals. Proceedings of the 19th IEEE Instrumentation and Measurement Technology Conference (IMTC/2002), Anchorage, USA, pp. 443-446
10. R. Lapuh, Z. Svetik, Traceability of national standard of frequency and its distribution in Slovenia. Conference on Precision Electromagnetic Measurements Digest (CPEM 2000), Sydney Australia, pp. 84-85
11. R. Lapuh, Distribucija frekvence in časa po optičnih vlaknih (Distribution of time and frequency over optical fibres). Optične komunikacije : zbornik. 1, Ljubljana: Fakulteta za elektrotehniko, 2000, pp. 1-10

dr. Rado Lapuh
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