

Latest news from NEAT-FT, a joint research project of the EMRP

Background

The aim of the project NEAT-FT is to investigate new techniques for time transfer and phase-coherent comparison of remotely located optical clocks using optical fibres. Furthermore, the feasibility of a European fibre network connecting optical clocks in Europe will be studied in close collaborations with potential fibre providers.

Scientific and technical objectives

NEAT-FT comprises 4 technical workpackages dedicated to frequency (WP 1 & 2) and time transmission (WP 3 & 4) between remote clocks. About 80% of the JRP's total person month and of the total cost are allotted to these 4 workpackages. WP 5 is dedicated to generate impact by establishing close collaboration with the stakeholders with the aim to foster the decision of funding a future European fibre network or of bi-directional connections of selected points of presence.

Expected results and potential impact

The JRP brings together the long standing expertise of nine leading European National Metrology Institutes (NMI) and CESNET as a representative of National Research and Educational Networks (NREN) to meet the scientific and technical needs for highly stable and accurate reference signals in fundamental physics, GNSS, geodesy, astronomy, and (space-) industry. With the joint activities of the JRP-Partners will provide an alternative to established satellite based T&F methods that allow improvement of clock comparisons at least by one order of magnitude.

Activities and highlights (June 2012 - May 2013)

- The start date of the JRP was on June 1st 2012 with the kick-off meeting held at PTB/ Berlin on July 18th to 19th 2012.
- Since July 2012 the homepage of NEAT-FT http://www.ptb.de/emrp/neatft_home.html is updated regularly and informs about recent achievements and upcoming events.
- G. Santarelli, former member of LNE-SYRTE, one of Europe's leading scientists on time and frequency transfer over fibres, Prof. Dr. C. Salomon from École Normale Supérieure, Paris, one of the principal investigators of the ACES project, F. L. Hong from the National Metrology Institute of Japan, chairman of the CCTF Working Group on Coordination of the Development of Advanced Time and Frequency Transfer Techniques (WGATFT), and Prof. H. Schuh, a world-wide renowned scientist on Very Long Baseline Interferometry and geodesy have agreed to act as members of the NEAT-FT advisory board.
- As of November 2012 two organisational research excellence grants (REG)s have been selected and 42 person months have been allocated to different tasks.
 - With the REG from Akademia Gorniczo-Hutnicza im. Stanislaw Staszica w Krakowie (AGH), Poland, one of the leading institutes in time and frequency in Europe outside the NMI community supports NEAT-FT since November 2012. First joint measurements have been performed using the existing fibre link between PTB in Braunschweig and Leibniz University (LUH) in Hanover. AGH's novel technique for delay stabilization could be tested and evaluated. Short term measurement capability could be improved using harmonic tracking of 10 MHz timing signals and novel time interval counters. Stable operation of the full system over weeks has been achieved.
 - In May 2013 a new REG joined the consortium. With the University of Southampton (UoS) experts in the field of nonlinear optics support our activities.
- Meetings with the advisory board members in line with JRP meetings resulted in vivid discussions on progress report and future applications:
 - The need for timing signals and the performance required for specific end users have been discussed.
 - Establishing fibre links between remote VLBI stations such as ONSALA (Sweden) and Metsähovi (Finland) VLBI stations (and at some later stage to Wettzell in Germany) was recommended by the advisory board member Prof. Schuh from the German Research Centre for Geosciences (GFZ).

- As part of the workpackage IMPACT (WP5) NEAT-FT has organized a workshop for stakeholders interested in advanced Time & Frequency transfer. This workshop was mainly organized by VSL and was held in Hoofddorp, The Netherlands, on November, 20. -21. 2012. The aim of the workshop was to create impact for the European time and frequency metrology, to analyse present needs, to identify potential future applications and to draw up the required performance of remote fibre links. We have invited about 200 individuals from industry, science and network services from all over the world. For the workshop 85 participants signed up. Participants started early on discussing their needs and the unique possibilities of optical fibre links in two poster sessions, during lunch and dinner time. Thus a direct contact between

the JRP-Consortium and the main stakeholders is now established. The distribution of participants is shown in figure 1.

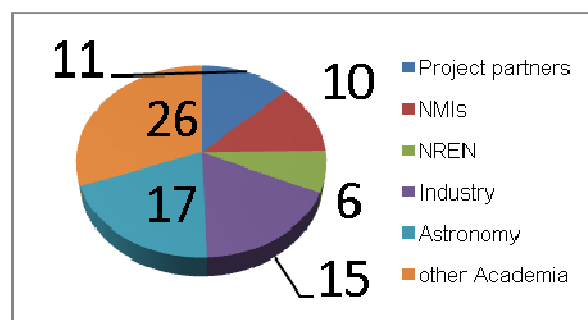


Figure 1: Workshop participants, demonstrating the interest and need for accurate time and frequency distribution.

- The Italian project LIFT for establishing an optical network for time and frequency has started in November 2012. LIFT will connect INRIM in Torino with LENS in Firenze via Milano and the Radio-astronomical Center in Bologna and has as a guaranteed lifetime of 3 years. First light was launched from Torino to Firenze and received in Torino by May 2013. Lighting of the second fibre is expected by the end of 2013. This link now connects a Sr lattice clock in Firenze with clocks at INRIM. An extension from Torino towards the French border is in preparation.



Figure 2: Topology of LIFT, the Italian fibre link project.

- In May 2013 PTB has signed a contract with the fibre provider GasLine that allows establishing a direct fibre link (yellow route) between Braunschweig and Paris via a cross border link of RENATER and DFN in Kehl, and to extend this link towards the Max Planck Institute of Quantum Optics (MPQ) in Garching via Stuttgart (blue line). This will allow for future clock comparisons at the highest level of accuracy. Together with the activities and links mentioned above this is another breakthrough towards a European scientific network.



Figure 3: Novel fibre link between OBS-PARIS and PTB. This link (yellow) will allow clock comparisons at the highest level.

- Support of NEAT-FT was confirmed from GÉANT and DANTE representatives at the workshop. DANTE initiated an open call for applications requiring a fibre testbed. Five fibre routes between major GÉANT PoPs, including Paris – London and Vienna- Milano will be made available for scientific use by October 2013. Members of NEAT-FT have submitted two proposals in order to get access to the fibre route London-Paris and Vienna-Milano. A decision on funding of individual proposals has been made in July. A consortium of OBSPARIS, NPL and PTB has been invited to negotiate the co-funding of the *International Clock Comparisons via Optical Fibre* (ICOF) project with GÉANT. ICOF is dedicated to establish a connection between Paris and London. Thus, the vision of a European network for optical clocks becomes even more realistic.



Figure 4: Envisaged fibre route from Paris to London (ICOF) via GÉANT (yellow line).

- Overall, the project advances quite rapidly. The results of the JRP will enable NMIs to perform better clock comparisons within Europe, and to disseminate highly accurate and stable frequency and timing signals to the user community for groundbreaking science and innovation. Some members of the potential user community are already included in the list of collaborating institutes.

Project Details

• Participants:

For contact with members of the consortium see:

http://www.ptb.de/emrp/neatft_contact.html

• Advisory board:

For contact with the advisory board see:

<http://projects.ptb.de/emrp/1263.html>

• Information about technical work packages:

http://projects.ptb.de/emrp/neatft_work.html



Figure 5: Existing NEAT-FT fibre links.

Recent technical achievements:

WP1 & 2:

- We developed and tested a Fibre Brillouin Amplifier (FBA) at a distance of 160 km (installed fibre). We observed up to 40 dB gain and achieved automated locking,
- developed and tested a remote regeneration station,
- tested and characterized commercially available bi- directional EDFA,
- and measured the phase noise of the Italian link between Torino and Firenze (LIFT).

WP 3:

- For the distribution of timing signals derived from a fs-comb we developed and tested a simple event marker and event extractor.

WP 4:

- We investigated the expected performance and practicability of a one-way transfer technique on existing telecom optic fibre networks.

The EMRP is jointly funded by the EMRP participating countries within EURAMET and the European Union