REFIMEVE frequency and time network and applications

E. Cantin[1], O. Lopez[1], N. Cahuzac[1], Y. Liu[1], M. Manceau[1], B. Darquié[1], C. Chardonnet[1], A. Amy-Klein[1], M. Rabault[2], G. Coget[2], P. Rosenbusch[2], V. Ménoret[2], N. Quintin[3], M. Tønnes[4], B. Pointard[4], M. Mazouth[4], H. Alvarez-Martinez[4], C. B. Lim[4], P. Tuckey[4], M. Abgrall[4], R. Le Targat[4], P.-E. Pottie[4]

1. Laboratoire de Physique des Lasers, Université Sorbonne Paris Nord, CNRS, Villetaneuse, France
2. Exail Quantum Sensors (formerly MuQuans), Talence, France
3. RENATER, Paris, France
4. LNE-SYRTE, Observatoire de Paris, Université PSL, CNRS, Sorbonne Université, Paris, France

email: amy@univ-paris13.fr

REFIMEVE is a national research infrastructure of optical fiber links which disseminates time and frequency reference signals generated at LNE-SYRTE to more than 30 research labs all over France. It uses mainly the optical fiber backbone of RENATER, the French National Research and Education Network. It is currently providing an optical frequency reference to around 15 labs and to connection points to Germany, UK, Italy and Switzerland, as depicted on Fig. 1. For that purpose, the network is equipped with industrial-grade Repeater Laser Stations (RLS) [1] and with Multibranch Laser Stations [2] allowing multiple coherent outputs for the dissemination to several links and the simultaneous real-time supervision of all the links. In Paris suburban, the frequency signal is dropped using Extraction Stations along a main link using a ring topology [3]. An embedded supervision system enables us to control and assess the network operation and performances [4] and enables to characterize the signal received by each user labs.

We have recently developed a new link to CERN in Switzerland and we have also extended the network in Paris region for both frequency and time reference signals. The residual frequency fluctuations of the optical links for 1-s measurement time range from a few 10^{-17} to a few 10^{-15} depending on the length and noise of each links, and the uptime of the links is between 70% and 90%. We checked that there is no bias of the frequency transfer with an uncertainty typically below 10^{-19}. Thanks to these performances, the REFIMEVE network has been used for the precise comparison of primary and optical clocks in Europe, especially for the ROCIT project [5]. In France, the REFIMEVE signals are currently exploited by user labs for photonics, laser stabilisation or control, atomic and molecular spectroscopy [6-7]. At LPL for instance a Quantum Cascade Laser is stabilized to the optical reference enabling high precision spectroscopy of methanol and other molecules of interest for atmospheric and astrophysics studies [7].

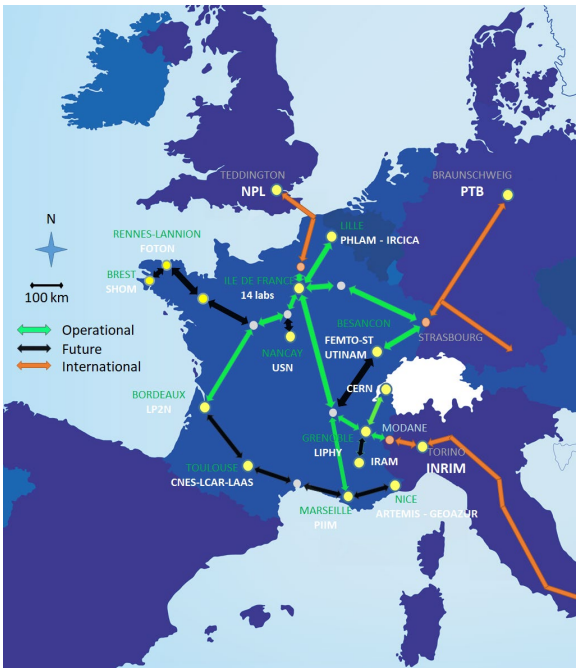

Fig.1. schematic of the REFIMEVE network, with its European Connections.

References

[1] F. Guillou-Camargo et al, Applied optics 57, 7203-7210, 2018
[2] E. Cantin et al, New Journal of Physics 23, p. 053027, 2021
[3] A. Bercy et al, JOSA B 31, p. 678-685, 2014
[4] M. Tønnes et al, Metrologia 59, p. 065004, 2022,
[5] C. Clivati et al , Physical Review Applied 18, p. 054009, 2022.
[6] O. Votava, S. Kassi, A. Campargue and D. Romanini, Phys. Chem. Chem. Phys 24, p. 4157-4173, 2022
[7] R. Santagata et al, Optica 6, p 411, 2019