

In-line extraction of an ultra-stable frequency signal over an optical fiber link

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Optical frequency links have been demonstrated on distances up to 2000 km and give the possibility to compare future optical clock in Europe with sensitivity far beyond what doable with GPS. A key issue consists now in deploying optical links to a number of research laboratories for high sensitivity frequency measurement or remote laser stabilization for instance. In this context, a point-to-point transfer scheme is not efficient, especially in a metropolitan area network. G. Grosche proposed¹ in 2010 to extract the ultrastable signal at different points along the main link, in order to distribute the optical reference to many users simultaneously.

This work presents the last results we obtained with this technique². The main optical link is composed of two pairs of telecommunication fibers of 6 and 86 km respectively, as displayed on Fig.1. The 92-km link noise is actively compensated, resulting in an End-to-End fractional frequency stability of $1.3 \cdot 10^{-15}$ at 1s with a τ^{-1} slope. The In-line Extraction has been first tested after 86 km, and we observed a fractional frequency stability at the extraction end equal to the End-to-End stability at 1s. Then it has been tested after 6 km and the stability was sensibly better, reaching $8 \cdot 10^{-15}$ at 1s, in agreement with a simple model of the noise compensation. This technique of multiple users dissemination is compatible with fiber links with data traffic.

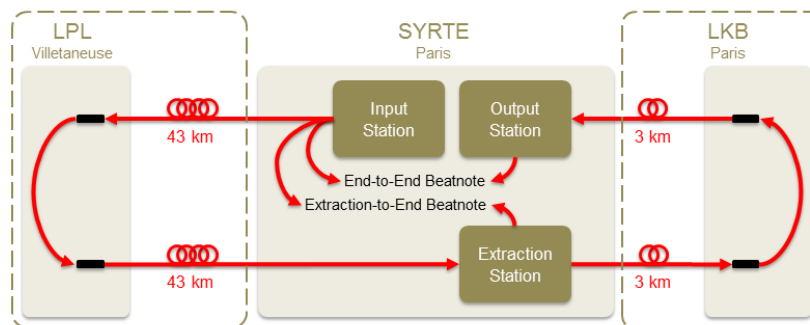


Fig. 1: Scheme of the urban fiber link composed of two sections of 6 km and 86 km (which can be exchanged)

¹ G. Grosche, patent application DE 10.2008.062.139 (2010) and “Eavesdropping time and frequency: phase noise cancellation along a time-varying path, such as an optical fiber”, arXiv:1309.0728, 2013.

² A. Bercy et al, “In-line extraction of an ultra-stable frequency signal over an optical fiber link”, accepted for publication in J. Opt. Soc. Am. B, 2014.