

Experimental investigation of interoperability in optical frequency transfer

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Frequency transfer using optical fibers has become the standard for optical clock comparison and optical frequency dissemination. Typical long-distance optical frequency transfer links use some number of repeater laser stations (RLS) terminating the link segments, connected with a few optical bi-directional amplifiers (OBA). In the context of the envisaged pan-European network, the problem of connecting sub-networks using equipment developed in various countries and/or from different commercial vendors turns out to be important.

In this paper we investigate the interoperability of two RLS designs – one available commercially from Exail, based on a design originally developed at Laboratoire de Physique des Lasers (LPL) and LNE-SYRTE [RLS(FR)] and used mostly in the French REFIMEVE+ infrastructure¹, and the second one developed recently by the AGH/PSNC group and used in the Polish NLPQT

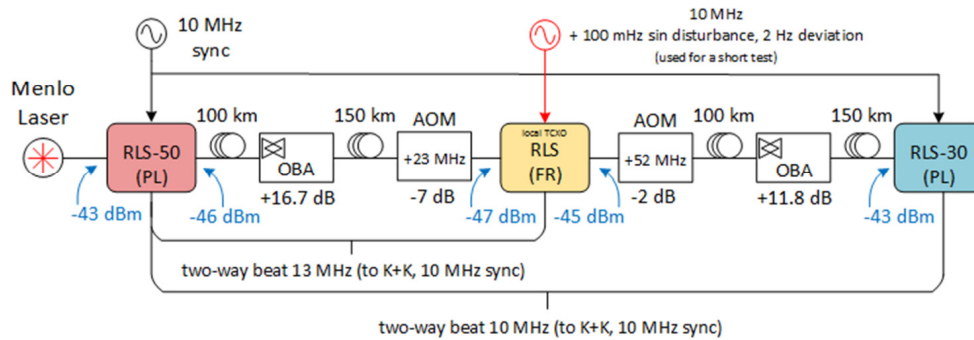


Fig. 1: Generic optical frequency setup used in our experiments.

network [RLS(PL)]. A test setup we used (see Fig. 1) comprises two 250 km long fiber segments, two OBA and three RLS placed in various order. In all cases we demonstrated proper operation of this heterogeneous system and obtained the expected frequency transfer stability below about $2 \cdot 10^{-20}$ for observation times longer than about 10^4 s. We also demonstrated that instability of the local quartz oscillator used internally in the intermediate RLS does not affect the optical transfer stability in any of the tested configurations. In addition, we performed stress tests by deactivating parts of the chain and checking whether, after reactivating, the system returns to a state of proper operation without further intervention.

¹F. Guillou-Camargo *et al*, “First industrial-grade coherent fiber link for optical frequency standard dissemination”, Appl. Opt. 57 7203–10, 2018, <https://doi.org/10.1364/AO.57.007203>.