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A 1550 nm telemeter for outdoor application based on off-the-shelf components

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Abstract

We will present at the workshop the development of a telemeter based on an intensity-modulated laser diode. It has the advantage to be more robust than classical fringe counting interferometers, especially for long-distance outdoor propagation, and less expensive than superheterodyne synthetic-wavelength interferometers [1]. For such a system, we aim a relative resolution of 10^{-7}, *i.e.* some micrometers at short range or 100 µm over 1 km.

In this telemeter, depicted in Figure 1, the distance D is determined by measuring the phase shift Φ accumulated by a Radio Frequency (RF) carrier that has been transposed in the optical domain and propagated in free space until a reflective target. The calculation of this distance is detailed in Figure 1.

In practice, we use affordable optoelectronic components coming from the telecommunication world. Thus, an optical beam at 1550 nm is emitted by a Distributed FeedBack laser diode (DFB), RF modulated by an Electro-Absorption Modulator (EAM) and boosted by an Erbium-Doped Fiber Amplifier (EDFA). The signal is then propagated in free space: an off-axis parabolic mirror collimates the beam at the fiber output, and after reflection on a corner cube, reinjects it in the same fiber. Lastly, the optical signal is converted by a free-space photodiode into an electrical one and down-converted at 10 MHz since our phasemeter cannot directly measure high frequencies. An optical switch has also been implemented in the setup to compare successively the measured distance to a reference distance that does not vary during the measurement process. Thus, every variation observed on the reference path is interpreted as a drift from the system (temperature evolution) and is removed.

Tests have been performed outdoor, during a sunny day with temperatures ranging from 32 to 34 °C over a 100 m length asphalt road. In these harsh conditions that induce strong air turbulences, the optical beam was affected by a large intensity noise. The latter was converted by the reception chain in phase noise, but by selecting the phase values of same amplitudes, a standard deviation less than 25 µm has been reached for a 1310 MHz modulation frequency.

The next step will consist in determining the temperature along the optical path with a precision of ± 0.1 °C, which is the required accuracy for the air index calculation. To this end, a second wavelength at 780 nm will be added to the system. Thus, the measured distance will be corrected taking advantage of the dependence of the chromatic dispersion of the refractive index with air temperature [2] [3].

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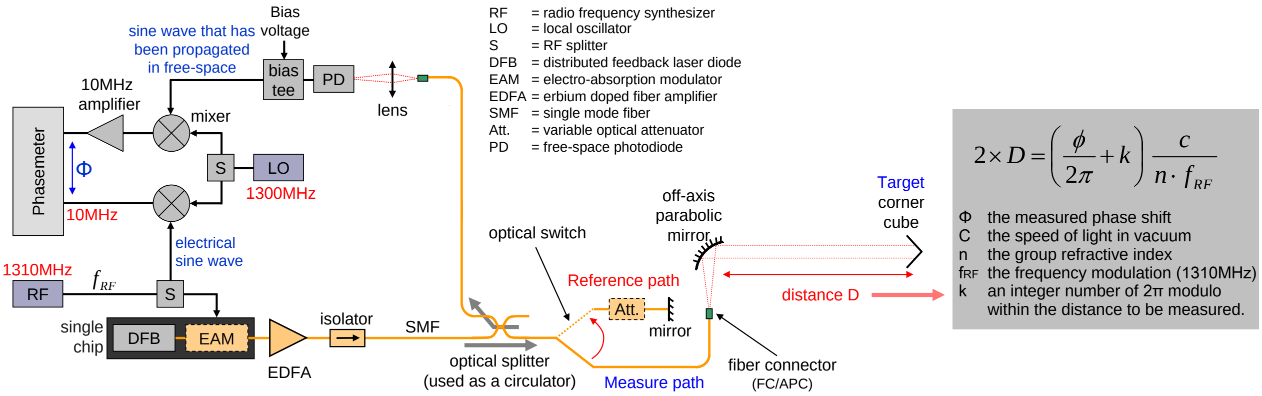

Figure 1: Experimental setup.

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