

# Measurement of acoustic noise in field-deployed fiber optic cables

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The stability of a time/frequency transfer through an optical fiber is affected by the phase noise originating in the fiber. Generally, the phase of the signal traveling along the fiber undergoes slow, diurnal and seasonal variations caused by varying temperature of the fiber, and some much faster perturbations, resulting from vibrations and mechanical stresses. Performing the open-loop measurements of the phase noise one may usually identify this acoustic noise as a bump visible around some tens of Hz<sup>1</sup>. It is obvious however, that the environment in which the fiber runs and the nature of the process responsible for the noise, will determine its time and frequency characteristics. Knowing them may allow efficient shaping of the frequency characteristics of the actively-stabilized fiber optic links used for the time/frequency transfer. For such purposes we developed a measurement setup, consisting of a semiconductor laser with electroabsorptive modulator that drives the fiber under test, a fiber-optic receiver, a dual mixer time difference (DM-TD) multiplier with a gain of 100, and A7-MX phase comparator with external time interval counter (TIC) allowing storing the data on the computer for further processing and visualization. Using this setup we are able to characterize the acoustic fiber noise up to 50 Hz (limited by the TIC).

We run two measurement sessions, each lasting for a few days, during which we registered the noise in two different field-deployed fibers: one running along the motorway near Krakow (distance ~120 km) and the second one running along the railroad tracks on the Krakow-Wadowice route (distance ~100 km). Example spectrograms are presented in Fig. 1, showing substantial differences in both spectral and temporal characteristics of observed noise.

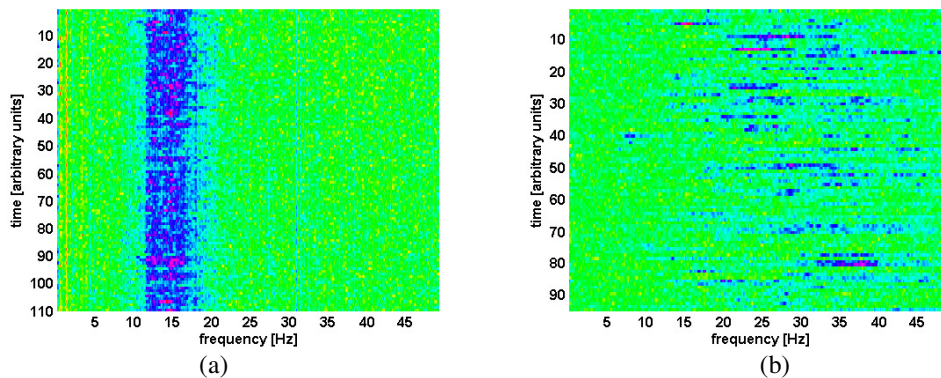


Fig. 1: Spectrograms of the acoustic noise induced in the field deployed fiber cables: running along the motorway (a) and along the railroad tracks (b).

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<sup>1</sup> O. Terra, G. Grosche, K. Predehl, R. Holzwarth, T. Legero, U. Sterr, B. Lipphardt, H. Schnatz, "Phase-coherent comparison of two optical frequency standards over 146 km using a telecommunication fiber link", Appl. Phys. B, vol. 97, pp. 541-551, 2009