Stable Radio Frequency Transmission Across a Free-Space of 100m in Hostile Environments

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High-precision frequency transmission in free space is affected by factors such as temperature drift, atmospheric turbulence, and platform vibration, resulting in a decrease in system accuracy[1,2]. In order to achieve stable transmission of frequency signals in the air, it is necessary to compensate for the phase jitter of the signal. The current technological roadmap can be divided into two categories, including passive compensation and active compensation. In this article, we experimentally proposed an active compensation scheme based on phase-locked loops.The stability of the stable RF signal through a 100m outdoor free space link is 2.39×10^{-14} @1s and 6.64×10^{-16}@1000s.Experiments have shown that active compensation can effectively eliminate noise generated by factors such as vibration and atmospheric turbulence.

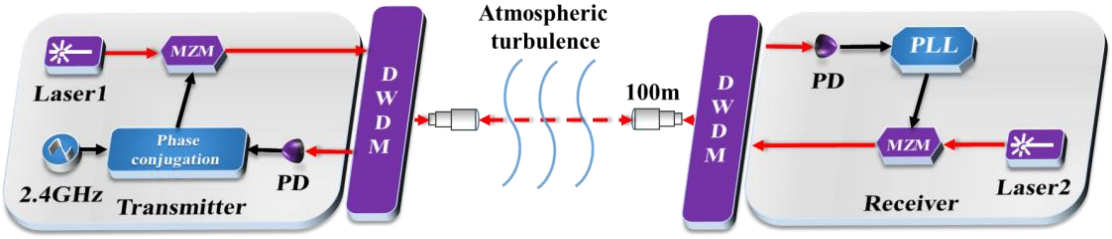
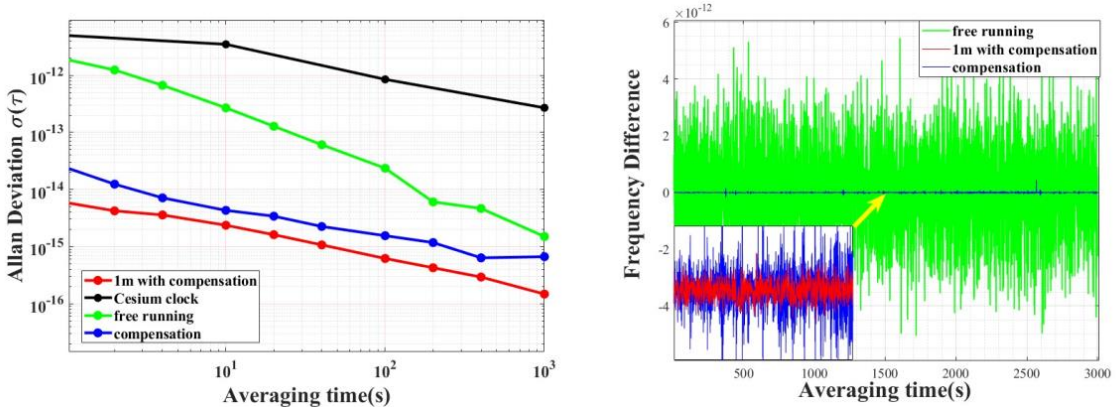


Fig. 1. Experimental Block Diagram of Active Compensation System.MZM:Mach-Zehnder modulator;DWDM:Dense wavelength division multiplexer ;PD:Photodetector.PLL:Phase-locked loop.



(a)Frequency stability curve. (b)Fractional frequency deviation

Fig. 2. System transmission performance test results.

[1] Ayshah Alatawi, Ravi P. Gollapalli, and Lingze Duan, "Radio-frequency clock delivery via free-space frequency-comb transmission," Opt. Lett. 34, 3346-3348,2009.

[2] Shen, Q., Guan, JY., Ren, JG. et al. Free-space dissemination of time and frequency with 10−19 instability over 113 km. Nature 610, 661–666,2022.