Progress of Ultra-stable Frequency Dissemination and Synchronization in Free Space

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During past years, disseminating and synchronizing frequency in free space has been actively studied[1-3].We demonstrate a new ultra-stable frequency dissemination scheme. By compensating phase noise actively and a series of frequency conversions, the phase fluctuation is well compensated. Two links disseminate different frequency signals phase locked to a common reference simultaneously, and recover the disseminated frequency respectively at remote site. The relative stability between the recovered frequencies, i.e., the stability of dissemination link with phase compensation in free space is better than 3×10^{-13}/s and 4×10^{-17}/day (Fig. 1). The FWHM of the links' relative time jitter is about 6.5 ps over several days. In contrast, when the frequency signal is disseminated freely, the relative stability is 4×10^{-13}/s and 4.0×10^{-15}/day and the FWHM of time jitter is about 230 ps. The result is better than that of conventional frequency dissemination methods in free space. The relationship between the frequency stability and the distance of free space will be discussed during the conference.

Together with fiber-based time and frequency dissemination, this scheme may be used to set up a three-dimensional regional time and frequency network. It also can be applied to long distance frequency dissemination and synchronization, global navigation satellite systems (especially COMPASS) and radio astronomy (such as VLBI and SKA).

This work was supported by the National Key Scientific Instrument and Equipment Development Project (No.2013YQ09094303) and the Beijing Higher Education Young Elite Teacher Project (No. YETP0088).

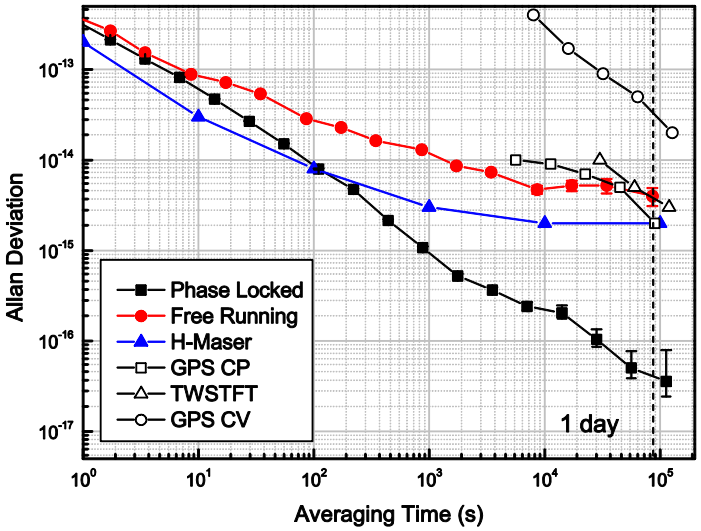

Fig. 1: Measured frequency stability of the dissemination system with PLLs closed (solid squares) and running freely (red curve); stability of GPS CP (hollow squares), TWSTFT (hollow triangles) GPS CV (hollow circles) and typical commercial active hydrogen maser (H-maser, blue curve).

[1] B. Sprenger, J. Zhang, Z. H. Lu, and L. J. Wang, Opt. Lett. **34**, 965 (2009).

[2] K. Djerroud, O. Acef, A. Clairon, P. Lemonde, C. N. Man, E. Samain, and P. Wolf, Opt. Lett. **35**, 1479 (2010).

[3] J. Nie, L. Yang, and L. Duan, Appl. Opt. **51**, 8190 (2012).