Stable optical frequency dissemination with remote passive phase noise cancellation over a 102 km urban fiber link

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Over the last few decades, Ultra-precision clock network will play an indispensable role in testing of fundamental physics, relativistic geodesy, and searching for dark matter. Among existing frequency transfer schemes, fiber-based dissemination technique has been recognized as an ideal solution for coherent optical frequency transmission over thousands of kilometers

In order to meet the increasing requirements for optical frequency reference, optical frequency transfer via topological fiber networks have attracted widespread research attention. In addition to the traditional point-to-point distribution scheme, a series of effective optical frequency distribution schemes such as in-line extraction[1], cascade station and point to multi-nodes dissemination have been proposed and demonstrated. Among these blue prints, the branching fiber based multi-nodes dissemination scheme has been highlighted[2], because which can effectively distribute optical frequency reference among multi users and simultaneously ensures the independence of each remote users. Nevertheless, A clear disadvantage of this scheme is that the frequency of retrieved optical signal is associated with the remote time base. To overcome the above existing drawback, an AOM working at a special frequency is cascaded after the phase compensated system to eliminate the relatedness of remote time base. The unwanted phase noise of this active device caused by the thermal fluctuation will not be efficaciously compensated and ulteriorly deteriorate the long-term fractional frequency instability of the retrieved optical frequency signal.

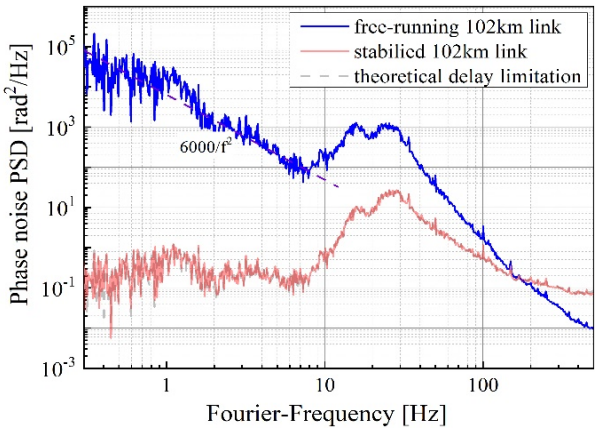

Fig. 1: Measured phase noise power spectra density (PSDs) in the free-running case (blue curve) and stabilized case (red curve). The gray dotted curve stands for the theoretical compensation limitation.

In this article, we propose an enhanced multi-users optical frequency dissemination scheme. By adopting a new configuration of the AOM, the outside phase noise could be significantly cancelled by inserting the AOM inside the loop. Additionally, the stabilized light at the remote site is also independent of the remote base, enabling that the better short and long-term frequency transfer instability.

[1] Anthony Bercy *et al.,* "In-line extraction of an ultrastable frequency signal over an optical fiber link", J. Opt. Soc. Am. B., vol.31, p.678-685, 2014.

[2] Sascha W.Schediwy *et al.,* "High-precision optical-frequency dissemination on branching optical-fiber networks", Opt.Lett., vol.38, p.2893-2896, 2013.