Towards Brillouin-amplified fibre links for long-distance optical frequency transfer

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In long-distance fiber links, losses of around 0.23 dB/km have to be compensated by optical amplification. For fibre frequency transfer, to our knowledge all long-distance links to date rely on broad-band Erbium doped amplifiers (EDFA)[1,2,3,4,5]. In bi-directional operation, the gain of these amplifiers has to be reduced to around 17 dB to avoid spontaneous lasing[2]. This implies a maximum distance between the amplifiers of around 70 km to avoid excess losses, which is not always possible. Signal regenerators can be employed instead, such as a remote laser station[2].

Fiber Brillouin amplification combines high gain in excess of 40 dB with narrow-band amplification, with a gain bandwidth of order 10 MHz. This allows to selectively amplify the frequency-shifted return signal, without amplifying back reflections. At PTB, lab-based fibre Brillouin amplification has been demonstrated for optical frequency transfer already[3,6].

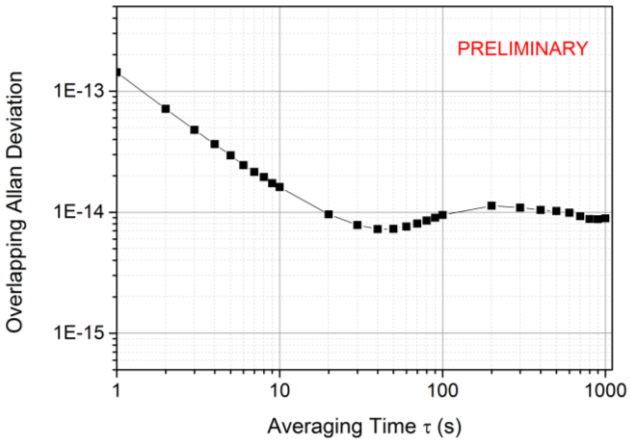

Figure 1 Allan Deviation of the unstabilized remote beat in a loop configuration. The light travelled through around 660 km of installed underground fiber, being amplified by a FBA field-module. The fibers are part of the Link SYRTE-PTB.

Within a European project we are developing field-able fibre Brillouin amplifiers (FBA) at PTB. We have now installed a first prototype in the German part of the PTB-SYRTE-Link, which is currently being set up. The FBA is located at a distance of more than 200 km from PTB. The Brillouin pump laser locks itself to the incoming signal at 11 GHz offset. Remote control allows us to remotely control the polarization. We will describe the field-able Brillouin-amplifier and present first results from a 660 km fiber loop setup based on Brillouin amplification, including phase noise and instability.

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