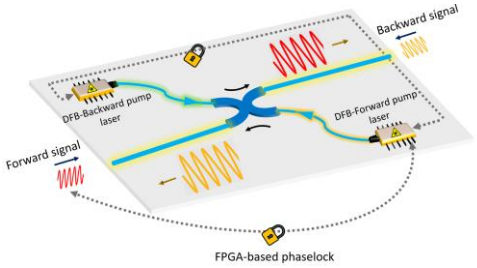

Fig. Schematic representation of the optical amplifier

Advantages

- **cost-effective design based on DFB diode lasers**
- **continuous tracking of the Brillouin frequency shift**
- **can be used flexibly for different fibre links and frequency layouts without hardware modification**
- **demonstrated frequency transfer uncertainties of less than 10^{-20}**

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4.34 Frequency Dissemination with Fibres

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Flexible optical amplifier for optical frequency transmission

Optical loss compensation is a major challenge for long-distance optical frequency transmission via fibre links. Conventional optical amplifiers based on erbium-doped fibres offer a limited gain of < 20dB and are susceptible to backscatter and reflection which lead to unavoidable phase jumps in the transmitted signal. PTB's new concept is based on a Brillouin amplifier, which has a particularly high optical gain and narrow bandwidth. The core of the new development is a low-cost and flexibly applicable structure that allows frequency transfer uncertainties of less than 10^{-20}. The new Brillouin amplifier is suitable for various frequency bands and can amplify optical signals outside the ITU C-band.

The Brillouin amplifier uses the phenomenon of stimulated Brillouin scattering in the optical fibre. Brillouin scattering is based on the non-linear interaction between the signal light and a counter-propagating stronger pump wave. By means of an optoacoustic process, the amplification of the signal light can be achieved if the frequency difference of the pump wave and the signal wave corresponds to the Brillouin frequency shift of ≈11 GHz. The configuration of the innovative optical set-up, including phase stabilisation, is designed to be used for commercial application as a bidirectional adjustable Brillouin amplifier, allowing continuous tracking of the time-varying Brillouin frequency shift. There is no need for adapting the hardware to be able to use the amplifier on different fibre-optic links. Moreover, the optical set-up can optionally be designed in such a way that both pump and signal wave have the same direction of polarisation in order to minimise the recently experimentally observed uncertainty contribution resulting from polarisation non-reciprocity.

Economic impact

The technique is highly relevant in the fields of optical frequency transmission using optical fibres and enables a wide range of applications. The Brillouin amplifier scheme proposed in this invention is suitable for manufacturers of ultra-stable optical laser sources. The approach is equally conceivable in the field of optical sensor technology, as well as for other National Metrology Institutes.

Development status

A German patent application has been filed for the invention. Licences for use are available.