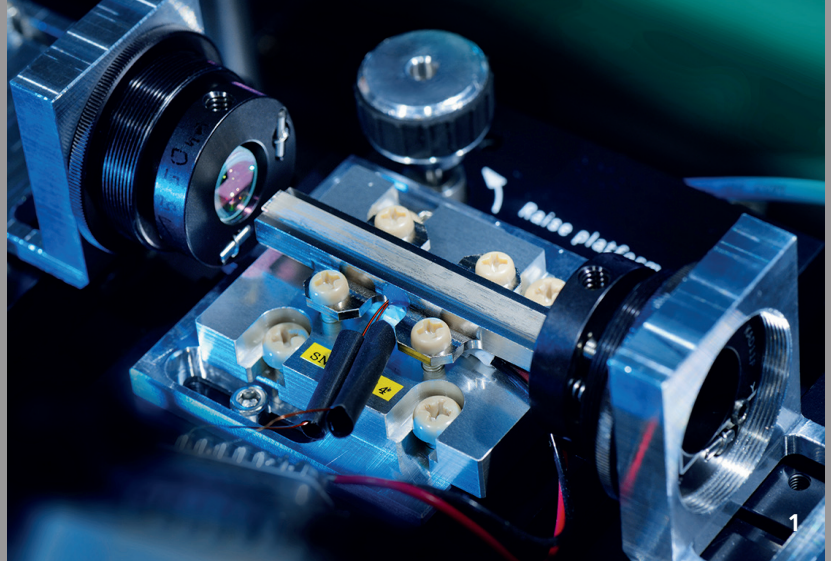

EFFICIENT FREQUENCY CONVERSION FOR QUANTUM COMMUNICATION IN FIBER OPTIC NETWORKS

Task

Powerful quantum computers and quantum networks will enable completely new types of applications that cannot be accomplished with classical computers. For fiber-optic quantum networks, photonic quantum bits (qubits) in the low-loss telecomunication C band around 1.55 µm have to be used to cover long operating distances. Solid-state based spin qubits are a promising platform to develop scalable quantum computers. These can emit photons in the wavelength range of 800 to 900 nm for the optical coupling of several qubits (so-called »flying qubits«). Optical interfaces in the form of quantum frequency converters (QFC) are required to convert the wavelengths into the telecommunication bands.

Method

In quantum frequency conversion (QFC), the wavelength of single photons, which serve as »flying« qubits, is specifically changed without changing other properties of the photons. A first step toward developing efficient quantum frequency converters is, thus, demonstrating a highly efficient frequency conversion of single photons or classical input fields with sufficiently low power. For conversion – analogous to classical parametric frequency conversion – a powerful laser is used in addition to the input and output fields to drive the conversion process in nonlinear crystals.

1 Setup for frequency conversion of single photons in waveguides.

Results

Based on a periodically poled lithium niobate (PPLN) waveguide pumped by a commercial fiber laser at 1950 nm, the frequency conversion from 856 nm to 1526 nm was demonstrated to be 87 percent efficient. The input power at 856 nm was 1.8 mW. In a next step, Fraunhofer ILT is investigating the conversion of single photons at 856 nm, whereby they expect to reach a similar efficiency.

Applications

The conversion demonstrated here is a first step towards implementing efficient quantum frequency converters, a key component for future quantum networks. Quantum frequency converters are still a crucial component for accomplishing quantum repeaters.

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