# Infrared-to-Telecom Frequency Conversion in an Atom-Filled Hollow-Core Fibre

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The creation of a fibre-based optical quantum information network will enable long-distance quantum-secure communications, as well as distributed quantum computing and quantum sensing and timing networks. Such a network, however, is currently limited by loss of the single-photon-level signals through optical fibres. Quantum repeaters provide an option to reduce these losses and therefore extend the maximum point-to-point link distance for the quantum information network. These repeaters typically rely on a quantum memory for photon storage and synchronisation between the network nodes. Rubidium-based memories, in particular have achieved efficiencies over 90%, unconditional fidelities of 98%, and storage times of hundreds of milliseconds. However, they have operating wavelengths in the near-infrared (NIR) regime, from 780-795 nm, and therefore will not be suitable for long-range low-loss data transmission via optical fibres.

One solution to this problem is to transfer the optical information from a frequency suitable for alkali matter-light interactions to one that can readily be transmitted over optical fibre. Four-wave mixing (FWM) has been used to generate entangled photons and to convert single photon frequencies. While conversion between NIR and telecom regimes has been demonstrated, these were either to the more lossy O-band or under 1% efficient. Here we will present our results characterising a diamond-type FWM scheme (Fig. 1a) inside a warm rubidium-filled hollow-core fibre (HCF) system [1] (Fig. 1b). The tight transverse confinement within the HCF (tens of microns) and extended length (up to ten centimetres) provide extreme atom-light interaction strengths which should allow for significant increases in FWM efficiencies. With this system we have achieved preliminary performance at the 1% level, comparable with the best past warm-atoms experiments.

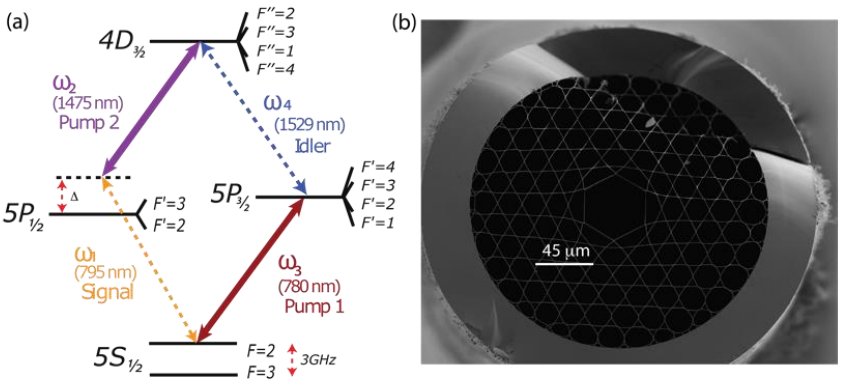


Figure 1 - (a) Four-wave mixing diamond scheme. (b) Scanning electron microscope image of the rubidium-filled hollow-core fibre.

[1] C. Perrella *et al.*, *Phys. Rev. Appl.* **9**, 044001 (2018).