Light storage in Cesium-filled hollow-core fibres

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Established for quantum metrology and quantum communication applications, photonics has also recently become a very promising platform for quantum computing. A crucial component of optical quantum computing schemes are quantum memories. For "practical" quantum memory applications, e.g. temporal multiplexing of non-deterministic single-photon sources [1], we require on-demand read-in and read-out of ultrashort light pulses at room temperature.

Indeed, our group was able to demonstrate a broadband quantum memory based on stimulated Raman scattering in warm Cesium vapours in a bulk cell [2]. Recently, we have been able to interface the memory with heralded single photons generated via spontaneous parametric down-conversion [3].

For scalability, however, we would require the memory to be power-efficient and integratable with other photonic architectures. To this end, we have successfully implemented the Raman memory scheme for weak coherent states in warm Cs vapours confined to a 26 μm kagome-type hollow-core photonic crystal fibre, as shown in Fig. 1 [4].

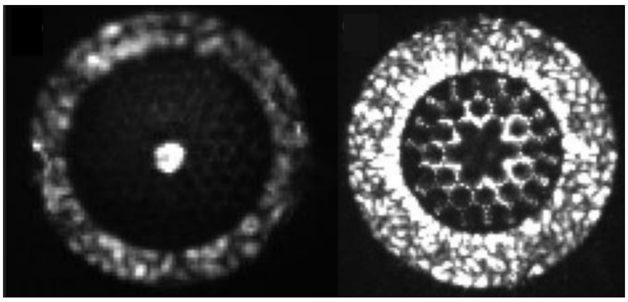

FIG. 1. Left (right) - end face of a 26 μm (46 μm) kagome hollow-core fibre with light coupled to the core (cladding).

The Raman memory efficiency strongly depends on the optical depth (OD) of the storage medium. Unfortunately, alkali-filled hollow-core fibres provide low ambient optical depths due to the reactive metal's absorbance to the fibre walls. However, it has been shown to be possible to increase the OD by several orders of magnitude through Light-Induced Atomic Desorption [5]. We have thus investigated this phenomenon in two Cs-filled fibres of 26 and 46 μm cores and are currently able to maintain quasi-continuously high ODs at room temperature, as shown in Fig. 2.

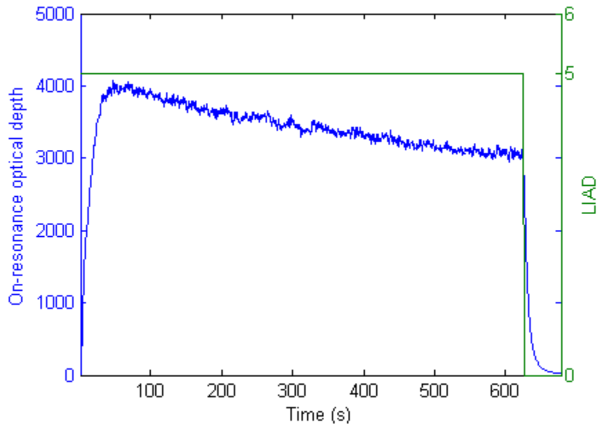

FIG. 2. Change in optical depth over time due to application of LIAD in a 46 μm-core fibre.

We have furthermore observed storage and retrieval of 300 ps long classical light pulses in this new continuously high OD fibre system, as shown in Fig. 3, and are currently investigating whether a larger core size leads to a higher memory efficiency and improves the memory lifetime.

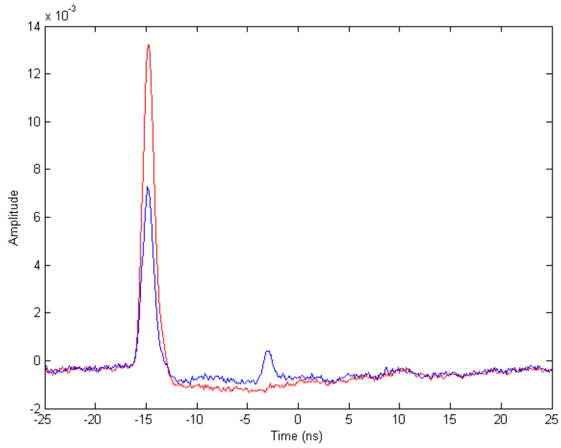

FIG. 3. Storage and retrieval of a classical light pulse in a 26 μm core fibre: red - memory OFF; blue - memory ON.

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