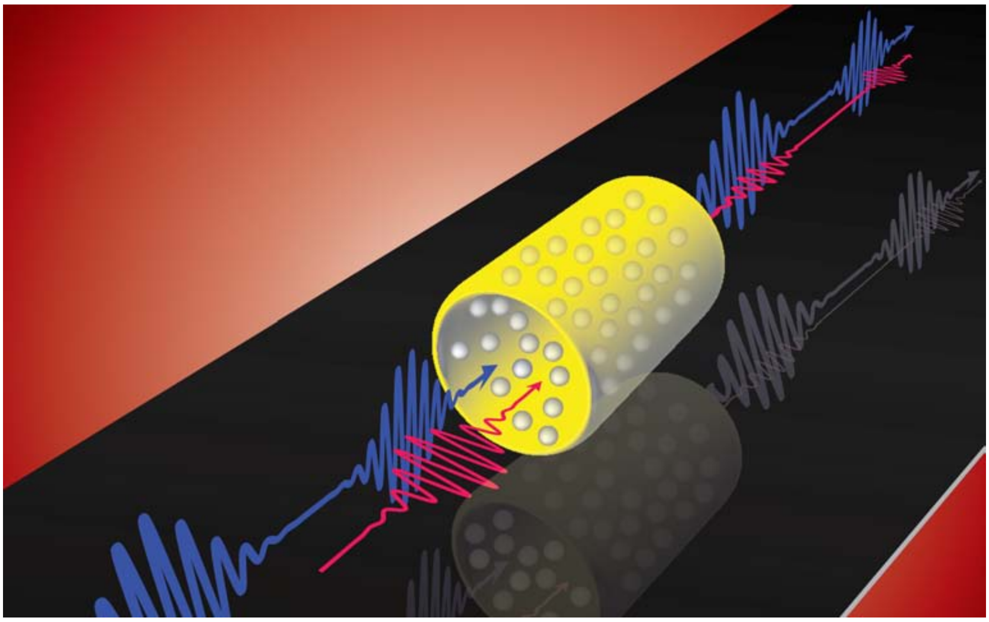
High-speed optical quantum memories

In a globalised world with ever-increasing, intercontinental information exchange, there is growing demand for secure communication technology, such as could be provided by photonic quantum communications networks. Currently, the biggest challenge for such networks is distance. Over short distances, photons, interacting only weakly with their environment, easily and reliably carry quantum information without much decoherence, but intercontinental quantum communication will require quantum repeaters embedded in potentially isolated locations, because photon loss rises otherwise exponentially with distance. In general, these repeaters will require some sort of quantum memory, a coherent device where single photons are reversibly coupled into and out of an atomic system, to be stored, possibly processed and then redistributed. In order to be practically useful, this will need to have sufficiently large bandwidth, high efficiency and long storage time, with multimode capacity, and a low-enough noise level to enable operation at the quantum level.

I am going to talk about our ensemble-based, far off-resonant Raman approach to quantum memories, describe how the interaction mechanism works and show how we store a single photon level signal in the quantum memory and retrieve it at a controlled later point in time. Furthermore, I am going to address de-phasing mechanisms for the stored spin-wave excitation that limit storage times and discuss storage and retrieval of polarization-encoded qubits.



Publications:

- Reim, K. F. *et* al. Nature Photon. **4**, 218-221 (2010)
- Reim, K. F. *et* al. arXiv:1010.3975v1