Short-term light storage with hot atoms: progress so far, and a proposal

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The excitation of collective spin coherence in hot alkali vapours is widely pursued as a route toward quantum memories capable of storing light on ms timescales [1], limited by spin-changing collisions between alkali atoms. However experiments have shown that the storage interaction can be noisy, being contaminated by fluorescence, leakage of the strong driving fields, and/or unwanted four-wave mixing.

In fact, long coherence times are not needed if the desired application is the synchronisation of quantum photonic logic operations, as these can be run at a high clock rate (electronics would permit $\sim$ 10 GHz). Thus storage times on the order of 100 ns would be sufficient to enable a step-change in the scalability of photonic quantum information processing.

Recently we showed that GHz-bandwidth single photons can be stored in an orbital coherence in warm vapour without noise [2], and Firstenberg's group [3] demonstrated coherence times close to 100 ns. In this talk I will present our most recent work, and some proposals for future directions.

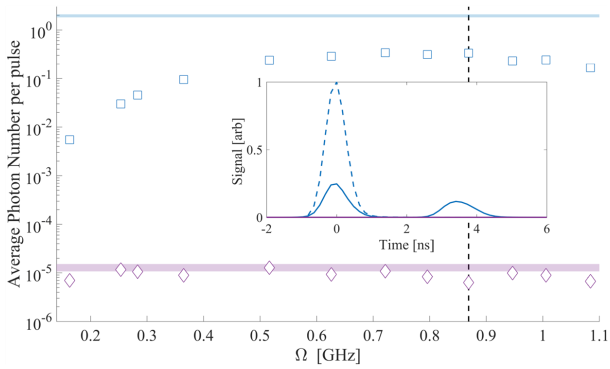

Figure 1. Light storage via off-resonant cascaded absorption. The inset shows intensity time-traces detected with the memory blocked (dotted line) and operational (solid line). The main plot shows the average number of photons retrieved from the memory as a function of the peak Rabi frequency of the applied control pulses (blue squares). The purple diamonds indicate the signals detected with the input pulses blocked, showing that the noise floor of the memory is set by dark counts on our detectors.

[1] Zugenmaier *et al.* "Long-lived non-classical correlations for scalable quantum repeaters at room temperature." arXiv:1801.03286 (2018)

[2] Kaczmarek *et al.* "High-speed noise-free optical quantum memory." PRA **97**4 042316 (2018)

[3] Finkelstein *et al.* "Fast, noise-free memory for photon synchronization at room temperature." Science advances **4**1 eaap8598 (2018)