On-demand storage of single quantum-dot photons in a warm-vapour quantum memory

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On-demand storage and retrieval of quantum information in coherent light-matter interfaces is a key requirement for future optical quantum communication applications. Warm-alkali-vapour memories offer scalable and robust high-bandwidth storage at high repetition rates which makes them a natural fit for interfaces with solid-state single-photon sources. Recently, we deterministically stored and retrieved single photons from an InGaAs quantum dot after a storage time of 17(2) ns [1], which is an order of magnitude longer than in previous experiments [2]. Electro-optical laser pulse control allows for variable retrieval times from our ladder-type quantum memory that operates on the Cs D1 line at 895 nm [3]. Employing weak coherent laser pulses on the level of 0.06(2) photons per pulse, we achieve an internal memory efficiency of $\eta_{\text{int}} = 15(1)\%$, a $1/e$-storage time of $\tau_{\text{s}} = 32\,\text{ns}$, and a high signal-to-noise ratio of SNR = 830(80). The memory's wide spectral acceptance window of 560(60) MHz allows for storage of broadband photons from sources prone to spectral diffusion and frequency drifts. Benchmark properties for the storage of single photons from inhomogeneously broadened state-of-the-art solid-state emitters are estimated from the memory performance.

[1] Manuscript in preparation.
[2] S.E. Thomas et al., "Deterministic storage and retrieval of telecom light from a quantum dot single-photon source interfaced with an atomic quantum memory", *Sci. Adv.* **10**, eadi7346 (2024).
[3] B. Maaß, N.V. Ewald, A. Barua, S. Reitzenstein, and J. Wolters, "Room-temperature ladder-type optical memory compatible with single photons from InGaAs quantum dots", arXiv:2402.14686 (2024).