Interfacing a rack-mounted narrow-band photon pair-source with a quantum memory

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We are investigating the optical interfacing of heterogeneous quantum systems that show strong potential for applications in quantum computing and networking.
As sources of quantum light are an important research tool for these applications, we have developed a compact and passively stable photon-pair source that can easily match the spectral properties of systems used for research on quantum repeaters or matter qubits.
Using a memory unit that is able to store emitted photons from spontaneous parametric down-conversion (SPDC) into a warm vapor quantum memory [2], we are researching applications in synchronizing single-photons from quantum dots with those from SPDC.
Keeping future applications of the technology in mind, the memory and SPDC source are designed for mobile operation under room-temperature conditions. This has already allowed deployments into remote locations [3] and will aid in future industrial applications.

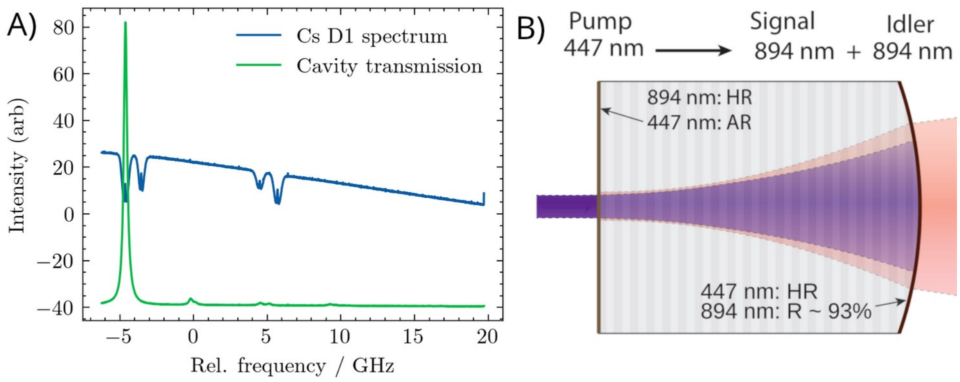

Fig. 1: A) ***Spectra of the Cesium D1 lines and the transmission through the monolithic crystal cavity indicating a good overlap between atomic resonance and SPDC emission. B) Sketch of the design for the monolithic crystal cavity in ppKTP including wavelengths for the relevant optical fields.***

First results show a very good matching of the spectral properties between the SPDC source and the quantum memory. The emitted photon linewidth is well within the memory bandwitdth [1] of 560 MHz. By varying the crystal temperature and pump frequency we are able to fine tune the emission center. Single-photon emission measurements yield a $g^{(2)}(0) = 0.007$ at 1mW of pump while having signal and idler count rates on the order of 120 kcts/s.
This system allows research into how spectrally and temporally dissimilar systems can be interfaced, which will be a central challenge in future quantum networks.

References

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[2] G. Buser et al., PRX Quantum **3**, 020349 (2022)

[3] M. Jutisz et al., Phys. Rev. Applied **23**, 024045 (2025)