Towards fibre-integrated optical switching

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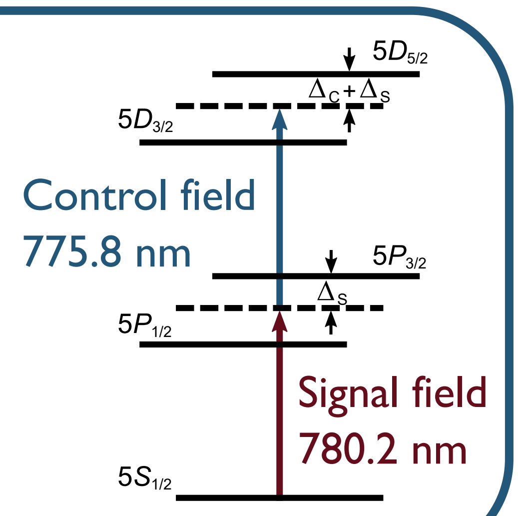
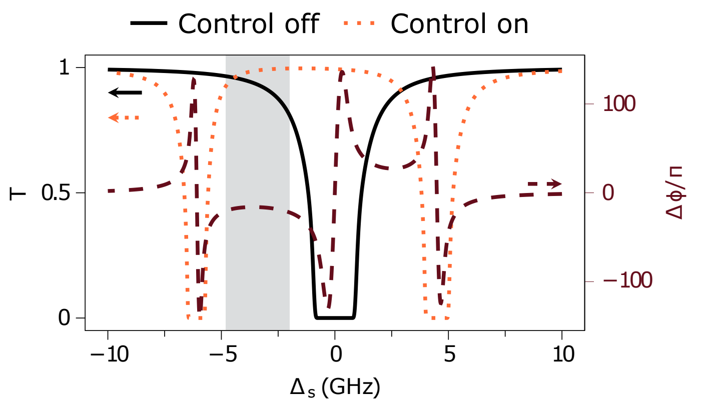
We demonstrate fast, low-loss and all optical phase shifting mediated by a two-photon transition in warm atomic vapour. We present a route towards integration with optical fibre systems.

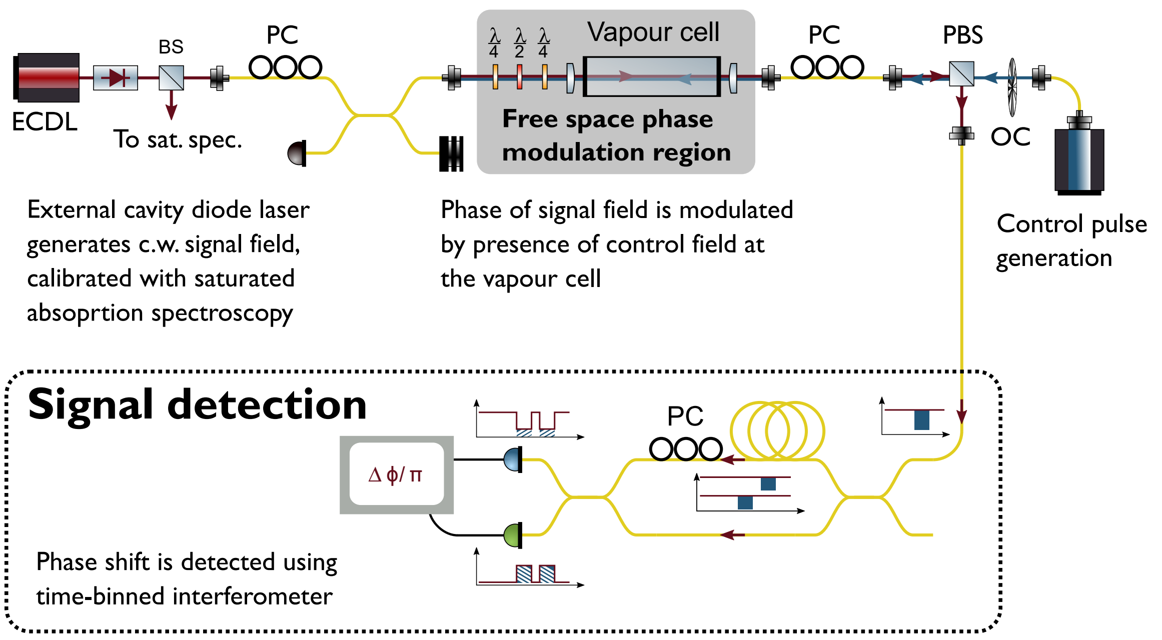
1. Phase modulation

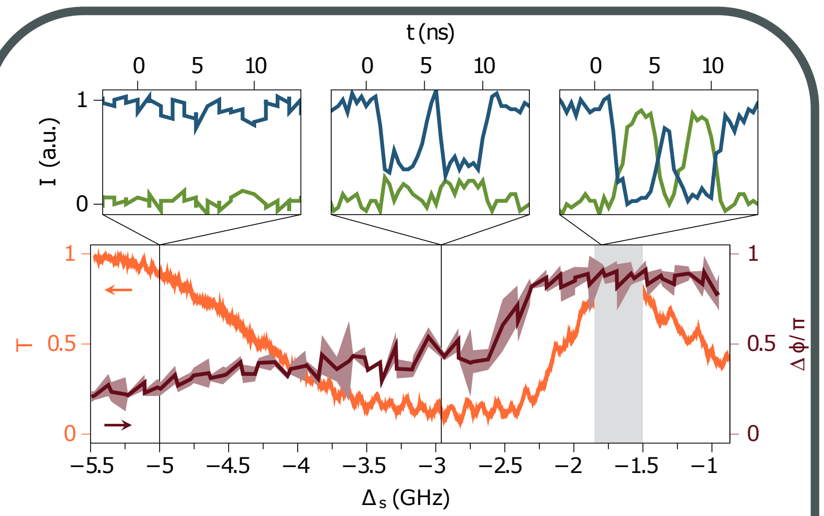
- A weak signal field counter-propagates with a strong control pulse through a rubidium vapour cell.
- The presence of the control pulse induces a change in susceptibility, resulting in a change to the phase of the signal [1].





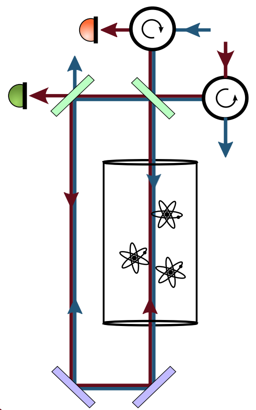
We model phase shift by solving the Maxwell-Bloch equations of motion [2].



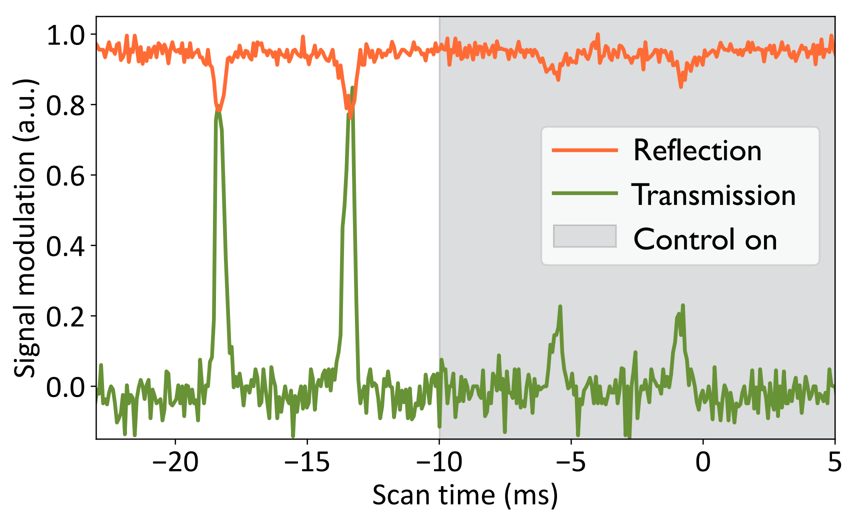


High phase shift with low loss:
$\Delta\phi/\pi = 0.90\pm0.05$; T = 74±2 %

2. Cavity enhancement

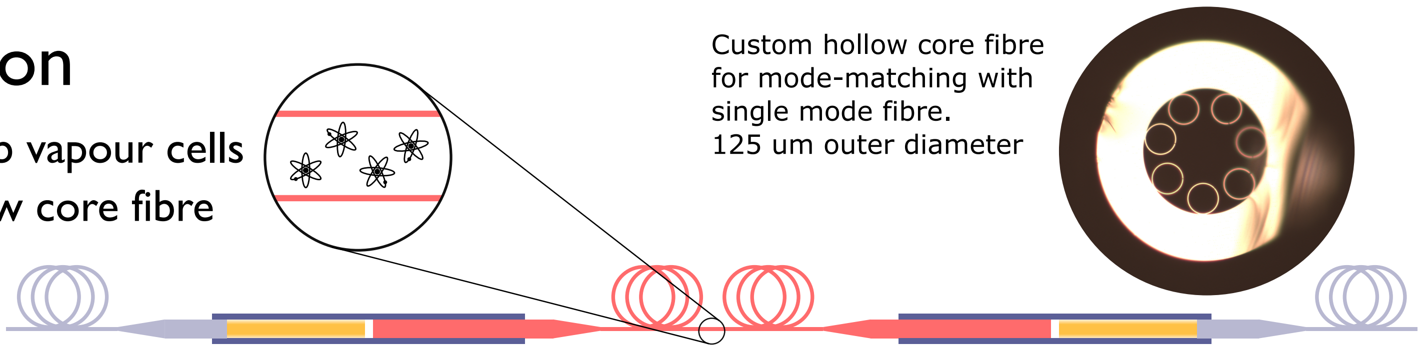


- Enhancement is product of signal and control field finesses.
- A bulk cavity is used currently but a microcavity is desirable for high finesse and scalability.
- Towards phton-photon interaction and implenting gates.



3. Fibre integration

To realise fibre-integrated Rb vapour cells we are connectorising hollow core fibre to single mode fibre and filling the core.



Custom hollow core fibre for mode-matching with single mode fibre.
125 um outer diameter

[1] O. Lahad and O. Firstenberg, "Induced Cavities for Photonic Quantum Gates," Phys. Rev. Lett., vol. 119, p. 113601, Sep. 2017.
[2] H. Metcalf and P. van der Straten, Laser cooling and trapping, Springer 1999
[3] D. Suslov et al., "Low loss and high performance interconnection between standard single-mode fiber and antiresonant hollow-core fiber," Scientific Reports, vol. 11, Art. no. 1, Apr. 2021.