

## Motivation: quantum networks

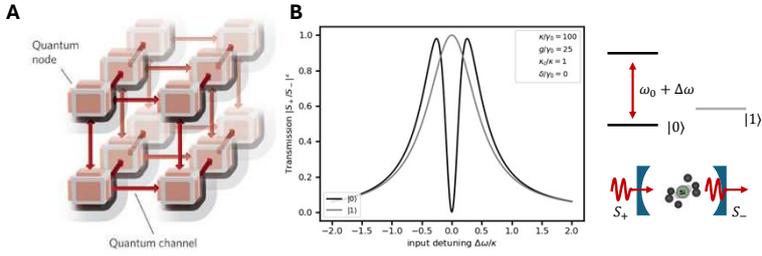


Fig. 1. (A) Quantum nodes and quantum channels to connect nodes<sup>[1]</sup>. (B) The transmission is dependent on the qubit state while qubit is coupling to the cavity. The system can be utilized a quantum node and build up quantum networks.

## Large-scale integration

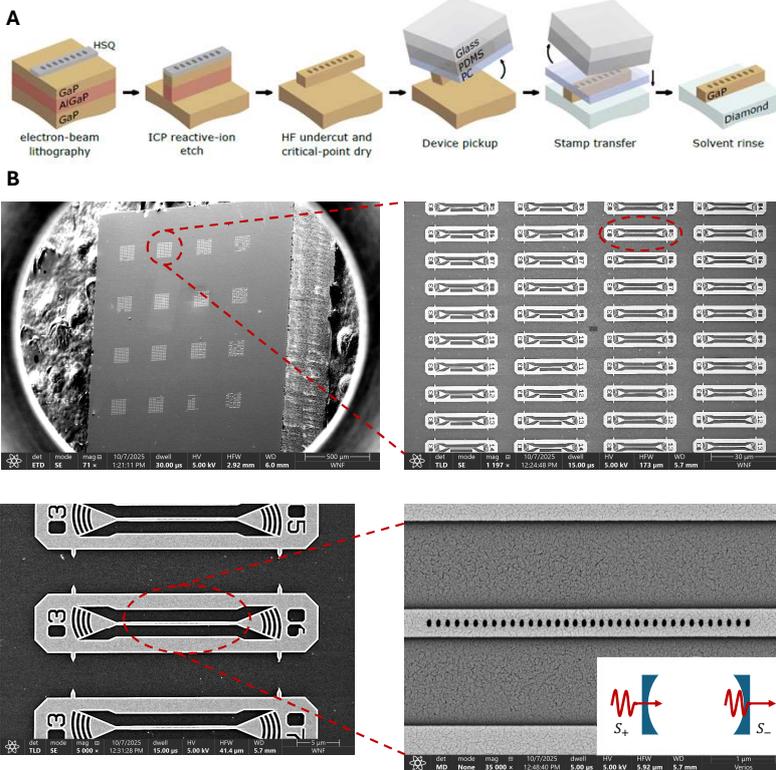


Fig. 2. (A) An illustration of the fabrication progress steps. (B) The SEM images of GaP nanophotonic cavities on the diamond substrates. Hundreds of photonic cavities are stamped on the diamond surface via the process in (A). The surface texture is due to the gold/palladium coating for SEM imaging. The bottom right figure is zoom-in on a single photonic cavity.

## Silicon vacancy center in diamond

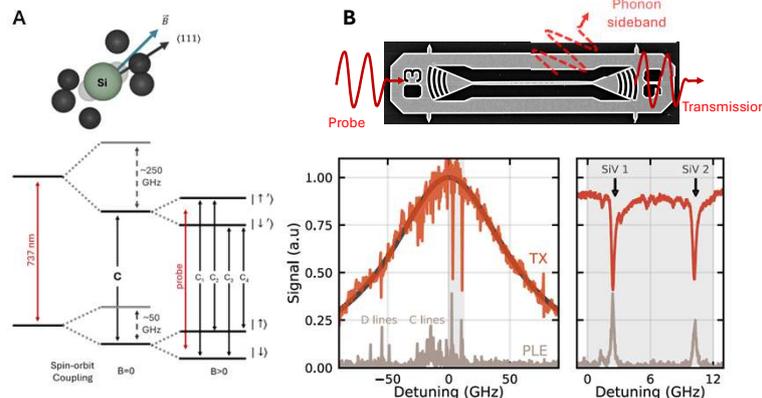


Fig. 2. (A) Left: an illustration of SiV- and its energy level. (B) Transmission and PLE spectra when in near resonance with the C lines. A strong modulation of the transmission is observed for two blueshifted SiV centers (right: expanded view).

## Deterministic absorption and spin state readout

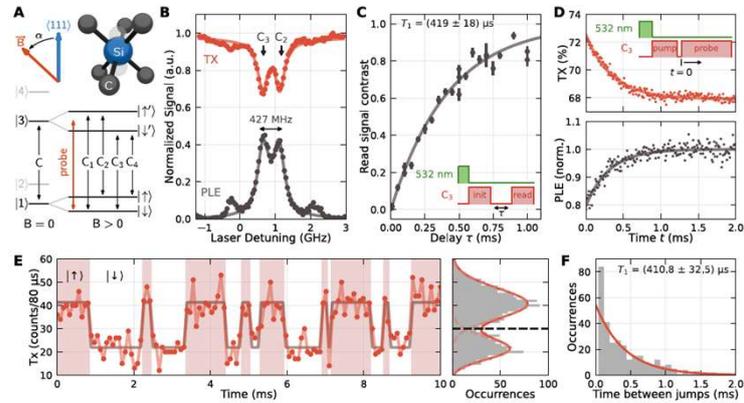


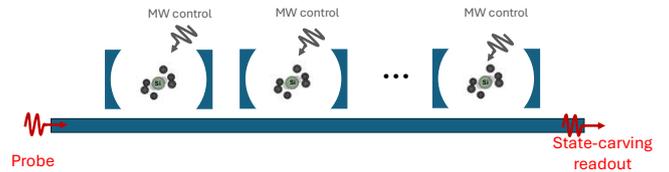
Fig. 3. An efficient spin-photon interface. (A) States and optical transitions of an SiV center in an applied magnetic field at angle  $\alpha$  from the symmetry axis. (B) Transmission and PLE spectra on SiV 1 with clear resolution of the spin conserving transitions  $C_2$  and  $C_3$ . The two weak peaks on either end are attributed to additional SiV centers. (C) Spin-relaxation curve obtained via PLE measurements on SiV, pulse sequence shown in the inset. (D) Spin-dependent switching of the cavity transmission and PLE signal. (E) A typical time trace of the cavity transmission demonstrating single shot readout of the quantum jumps of the SiV spin state (left). The intensity distribution of 15 time traces with a bimodal Poisson fit (right). The dashed line at 30 cts/bin corresponds to the optimal discrimination threshold with fidelity  $F = 96\%$ . (F) Distribution of the time between quantum jumps fit to an exponential distribution.

## Conclusion

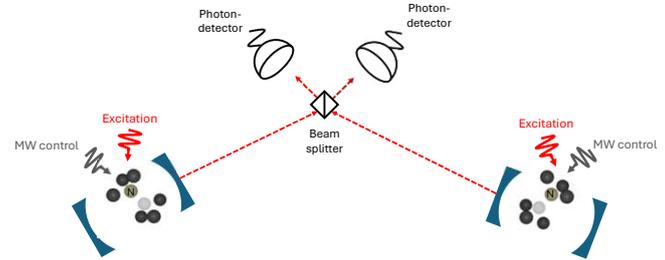
- We demonstrate the first and scalable hybrid nanophotonic platform with deterministic spin-photon interaction.
- We are able to read out the spin states of SiV- (qubit states).

## Outlook

- Scale up and connect each spin-photon interface for SiV-SiV entanglements.



- Combine the long coherence time of nitrogen vacancy (NV) center in diamond<sup>[2]</sup> and deterministic spin-photon interaction for building up a long-lived and efficient quantum networking platform.



## Acknowledgements

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## References

- [1] H. J. Kimble, "The quantum internet", *Nature* **453**, 1023-1030 (2008)
- [2] Childress et al., "Diamond NV centers for quantum computing and quantum networks." *MRS Bulletin* **38**, 134-138 (2013)