Quantum Interference Between Two Remote Cavity-based Emitters

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Semiconductor quantum dots (QDs) embedded in micropillar are bright and deterministic emitters of indistinguishable single photons [1, 2]. Scaling up quantum photonic technologies requires interfering photons emitted from independent sources, which in turn demands perfectly identical emitters. Achieving such reproducibility relies on precise cavity fabrication, robust tuning mechanisms, and environmental noise mitigation.

In this work, we address all three of these challenges. We first adjust the micropillar cavity diameters individually and narrow the acceptable spectral range of the QD transitions to fabricate sources with nearly identical optical properties. Secondly, we lower the QD density across the grown wafers to reduce the charge noise. Finally, making use of our PIN diode structure and a fiber on top of the source we implement both electrical and strain tuning on the emitters. We demonstrate state-of-the-art two-photon interference of (88 ± 1) % between remote cavity-embedded QDs. This value is in close agreement with the estimated upper bound of (88.3 ± 0.5) %, calculated by considering only the individual source Hong–Ou–Mandel interference visibilities and the difference in decay rates between the QDs, demonstrating the near-perfect stability of our emitters. These results marks a critical milestone for the industrialization of multi-source quantum devices and paves the way toward scalable quantum networks and photonic quantum computers.

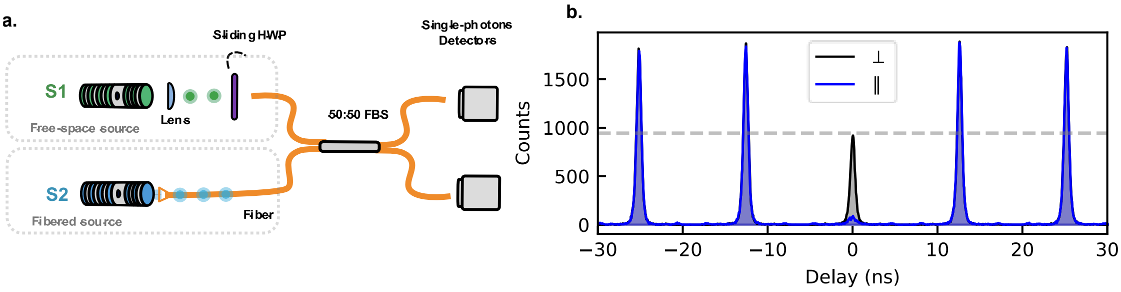

Fig. 1: *a. Illustration of the Hong–Ou–Mandel interference setup with two remote micropillars single-photon sources. b. Intensity correlation histogram of photons emitted from two remote sources. Our results shows a corrected mutual indistinguishability of (88 ± 1)%.*

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References

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