



Quantum Dots for Quantum Communication

Towards the ideal entangled photon source for
Quantum Cryptography and Quantum Networking



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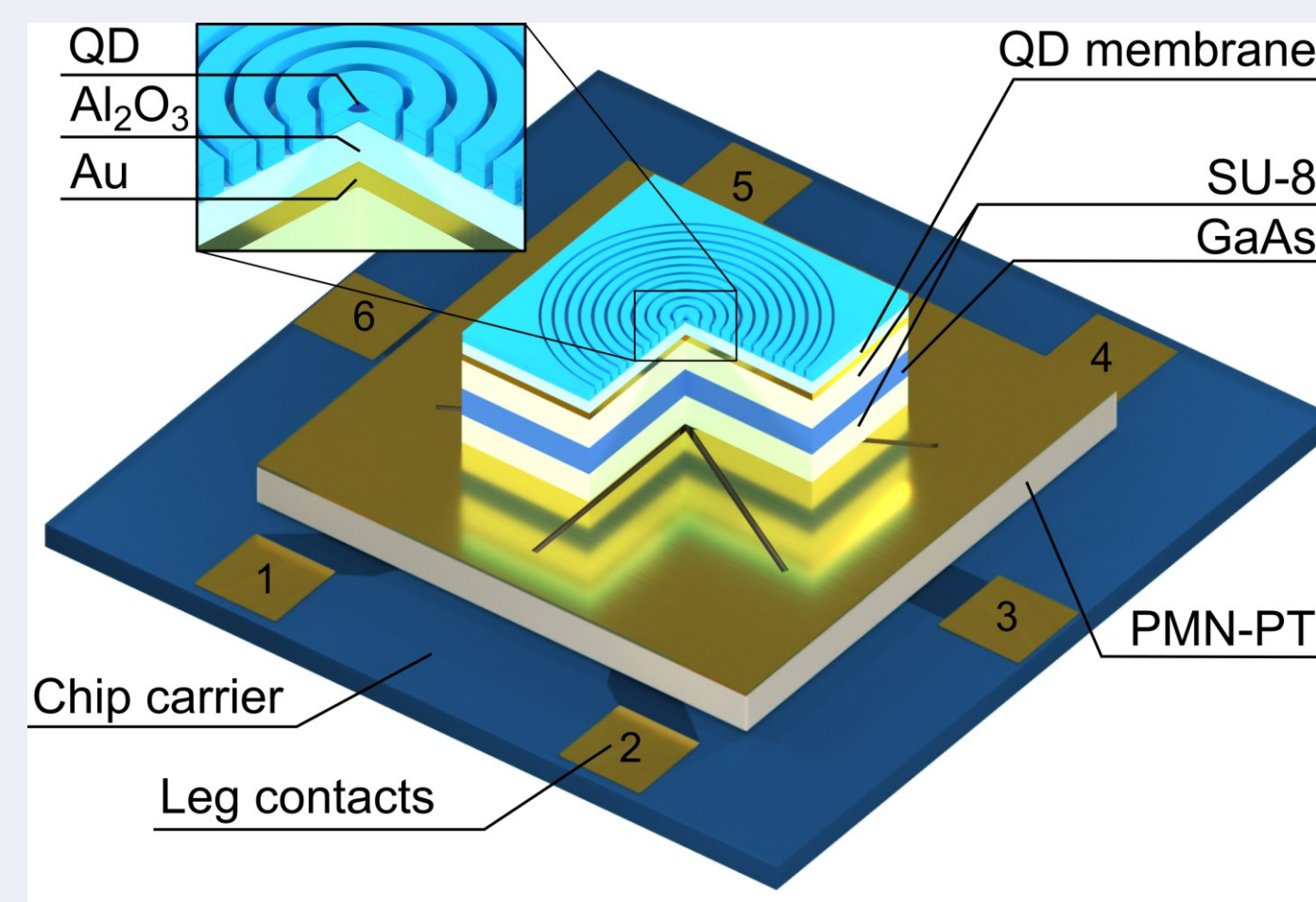
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We aimed at realizing the ultimate entangled photons source for efficient Quantum Key Distribution in practical scenarios. Our research activities delivered much more: from fundamental physical insights on entangled photon emitters to seminal demonstration of quantum networking primitives, our results went way beyond the state-of-the-art for Quantum Communication with QDs.

Entangled photon source device

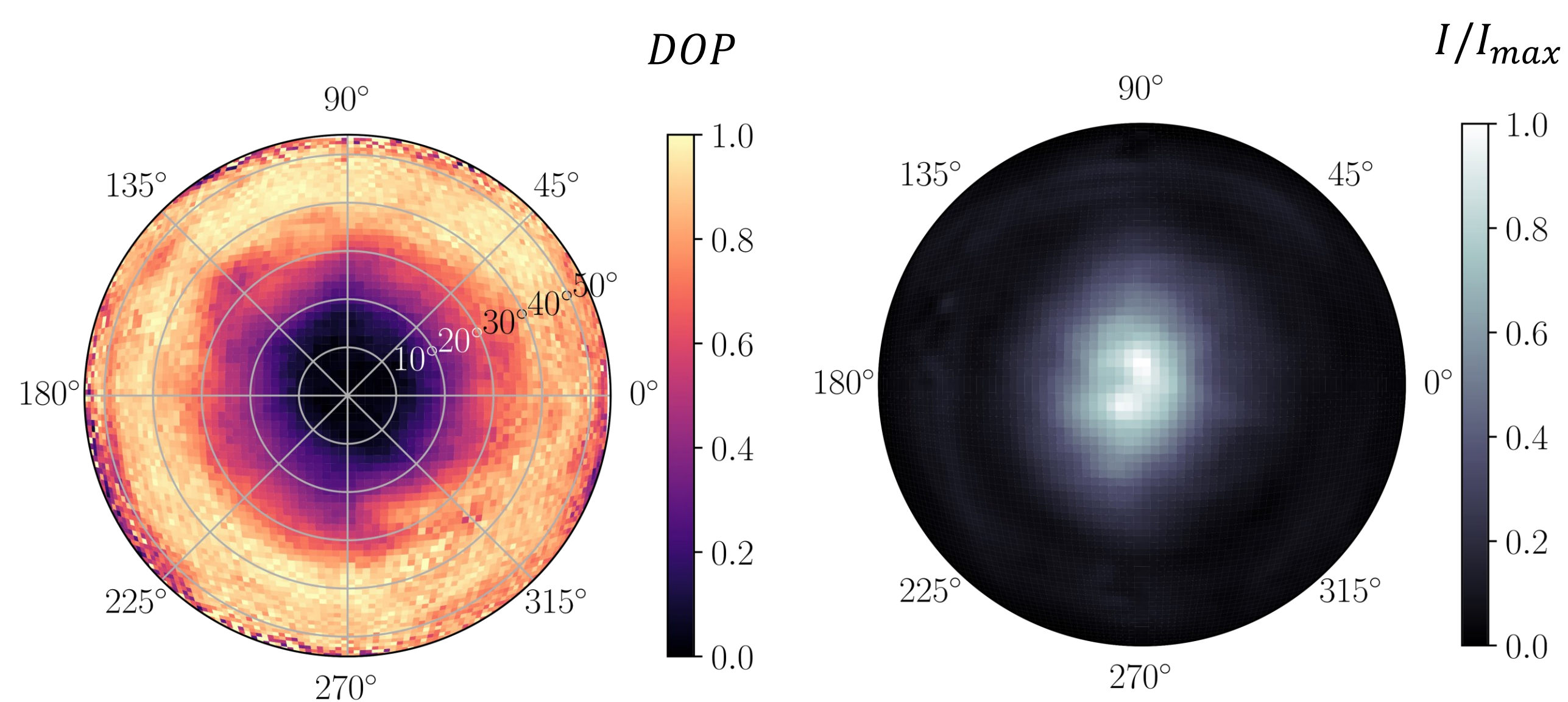
- Circular Bragg Resonators (CBR) cavities to boost the flux of photon pairs
- Piezo actuator to increase degree of entanglement

Entanglement fidelity up to 96%
Photon-pair extraction up to 65%
Purcell Factor up to 10



M. B. Rota, .. and R. Trotta, *Elight* 4, 13 (2024)

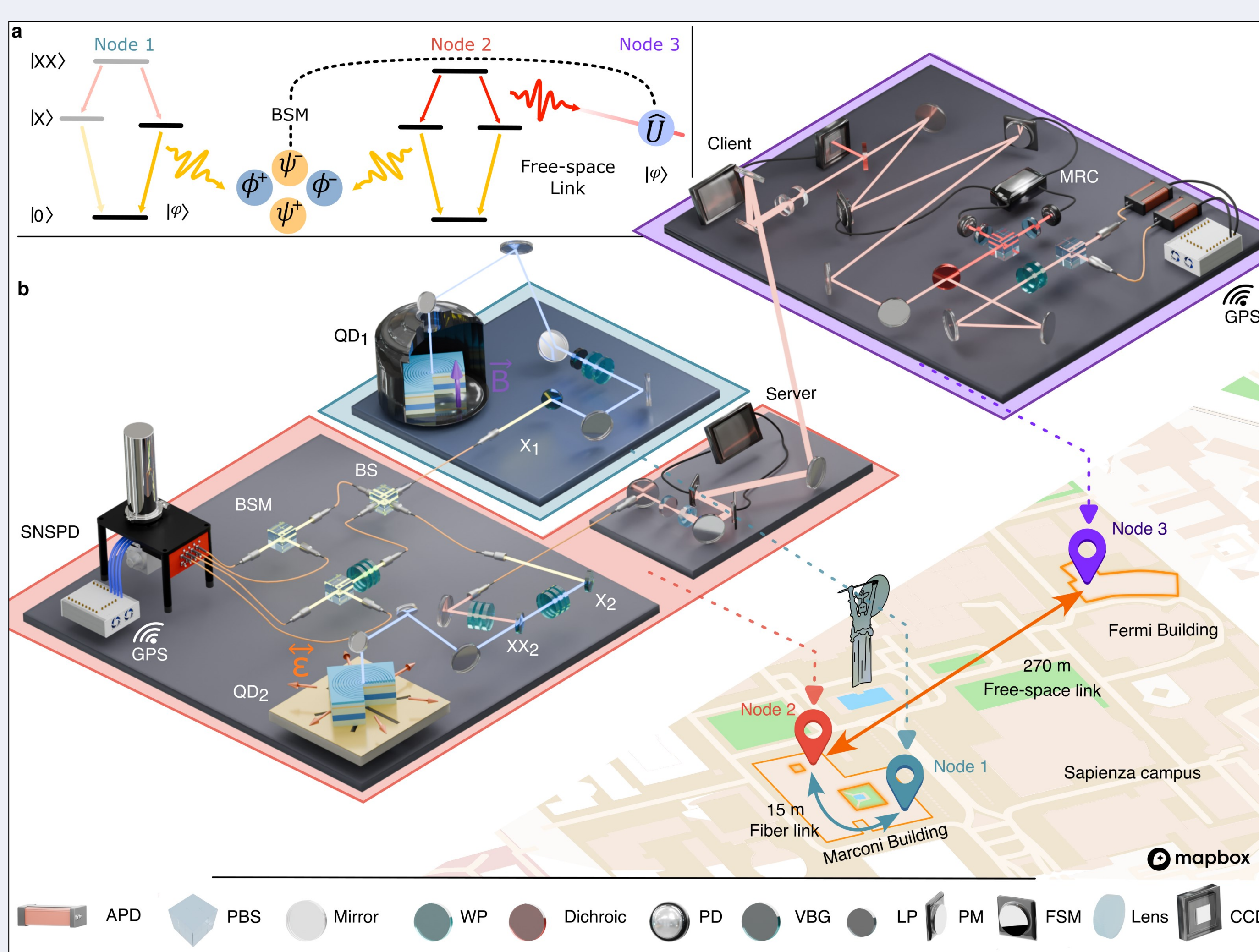
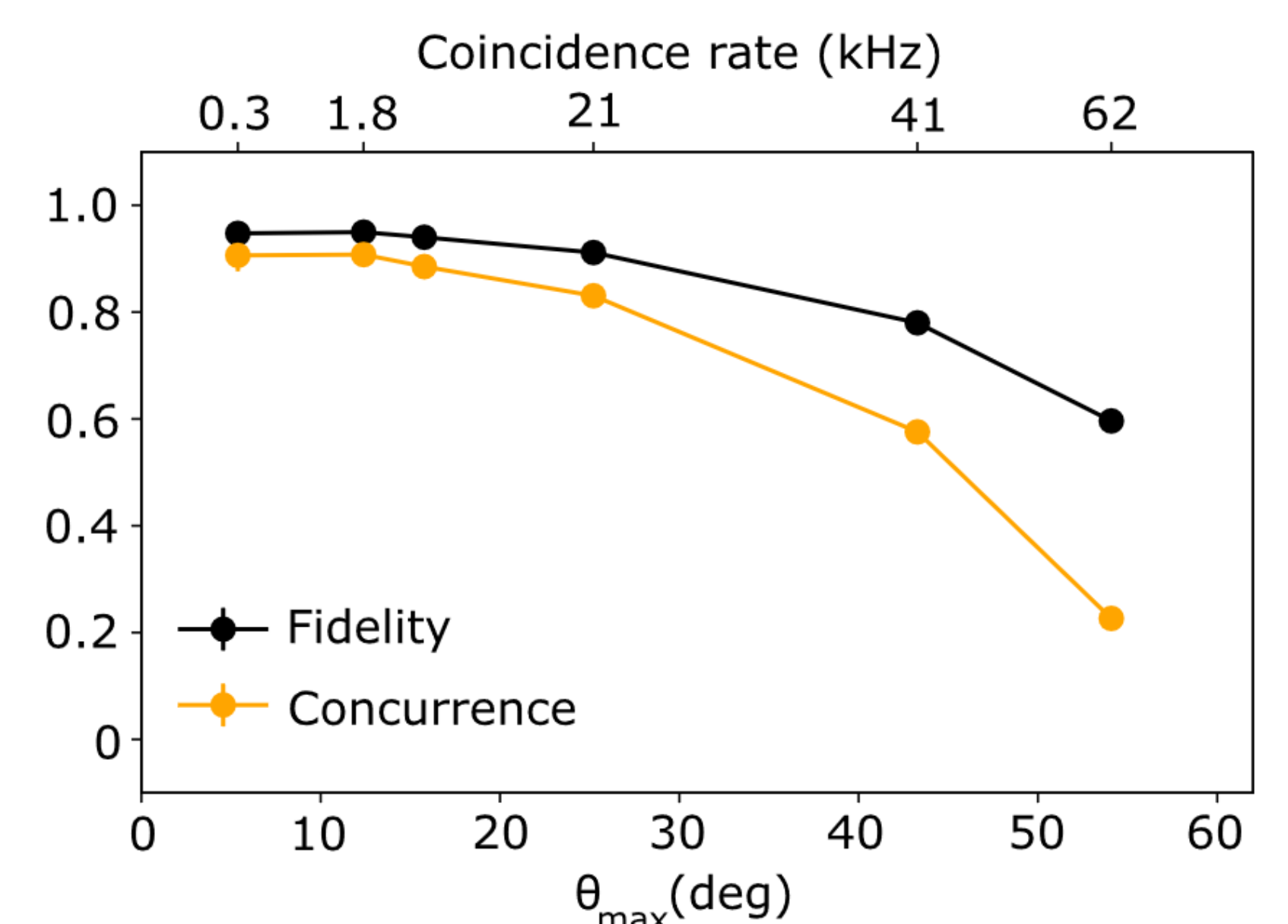
Wavevector-resolved polarization entanglement



- Back focal plane polarimetric investigation of CBR QD
- Emergence of an unbalanced mixing of different radiative transitions
- Heavy effect on entanglement in presence of CBR

cavity design must be optimized

A. Laneve, .. and R. Trotta, *Nature Communications* 16.1 (2025): 6209.

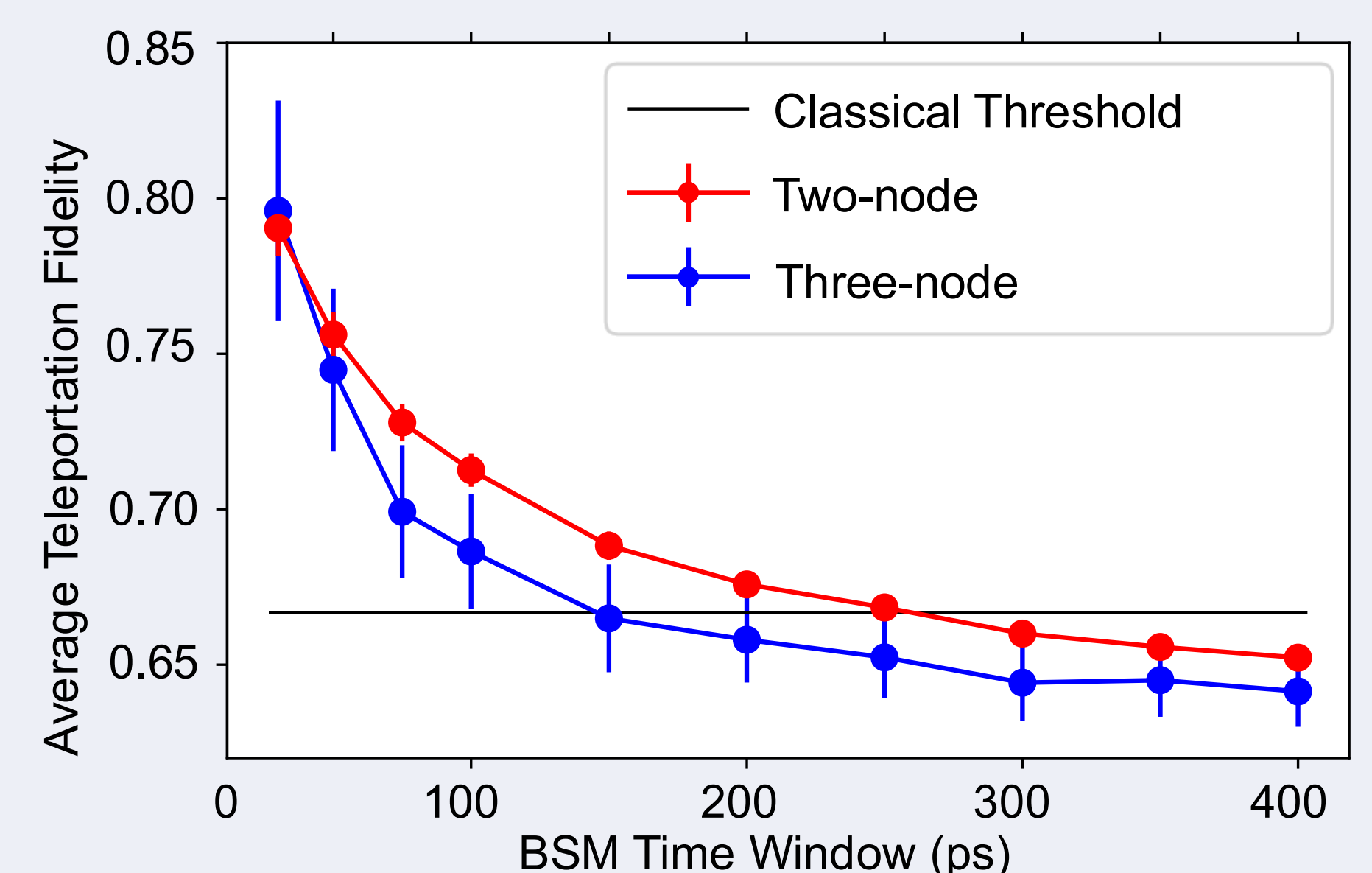


All-photonic quantum teleportation over free-space urban channel

- CBR-QD integrated on piezoelectric actuators grant high brightness and high entanglement
- Indistinguishability improved by energy tuning and time-resolved post-selection on Bell State Measurement
- High degree of entanglement allows relaxation of requirements on indistinguishability
- Successful teleportation with fidelity above the classical limit by 10σ (laboratory) and 2σ (out-of-lab)

first all-photonic quantum state teleportation with distinct QDs

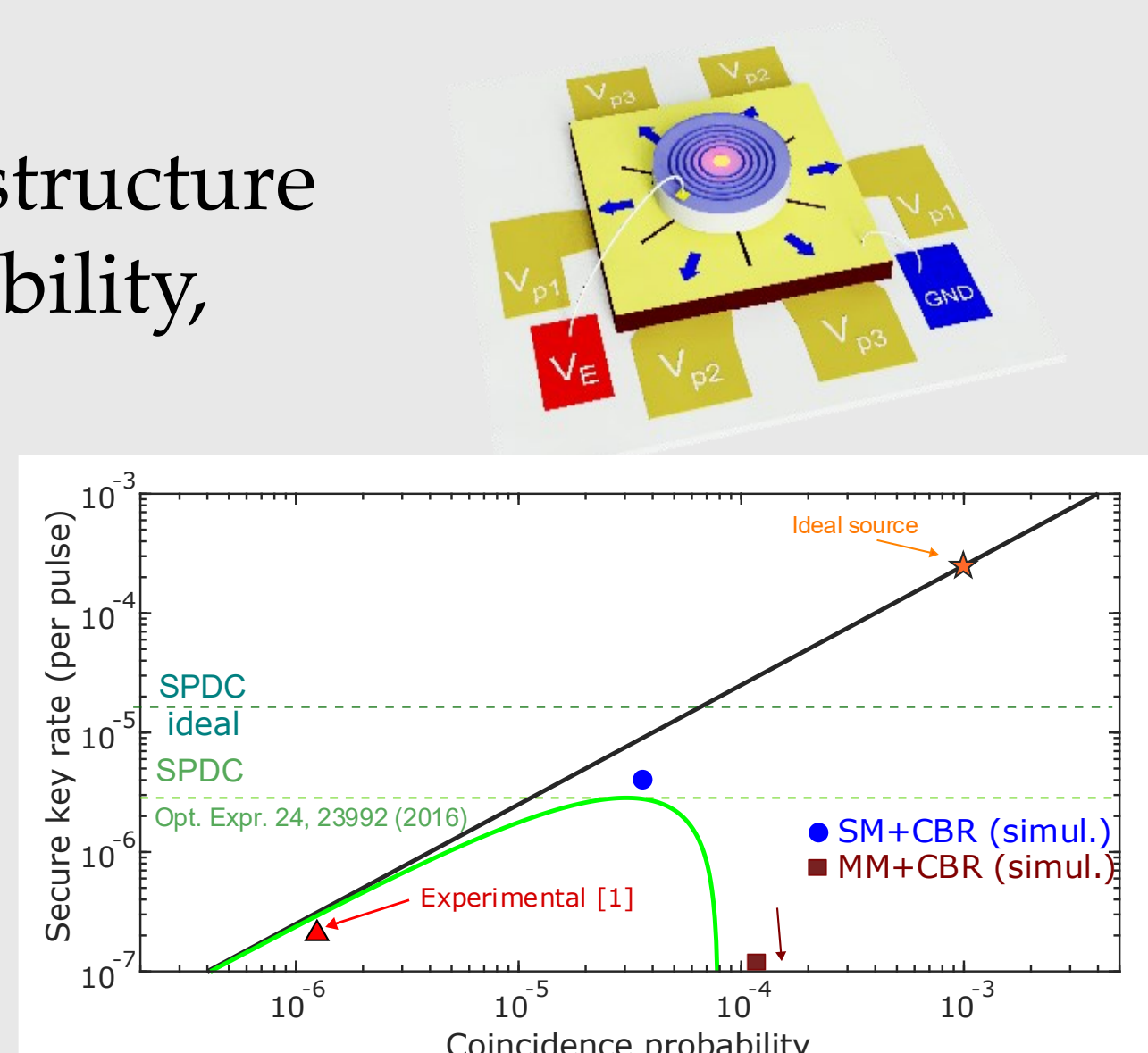
A. Laneve, .. and R. Trotta, arXiv:2411.12387 (2024), to appear in Nat. Comm.



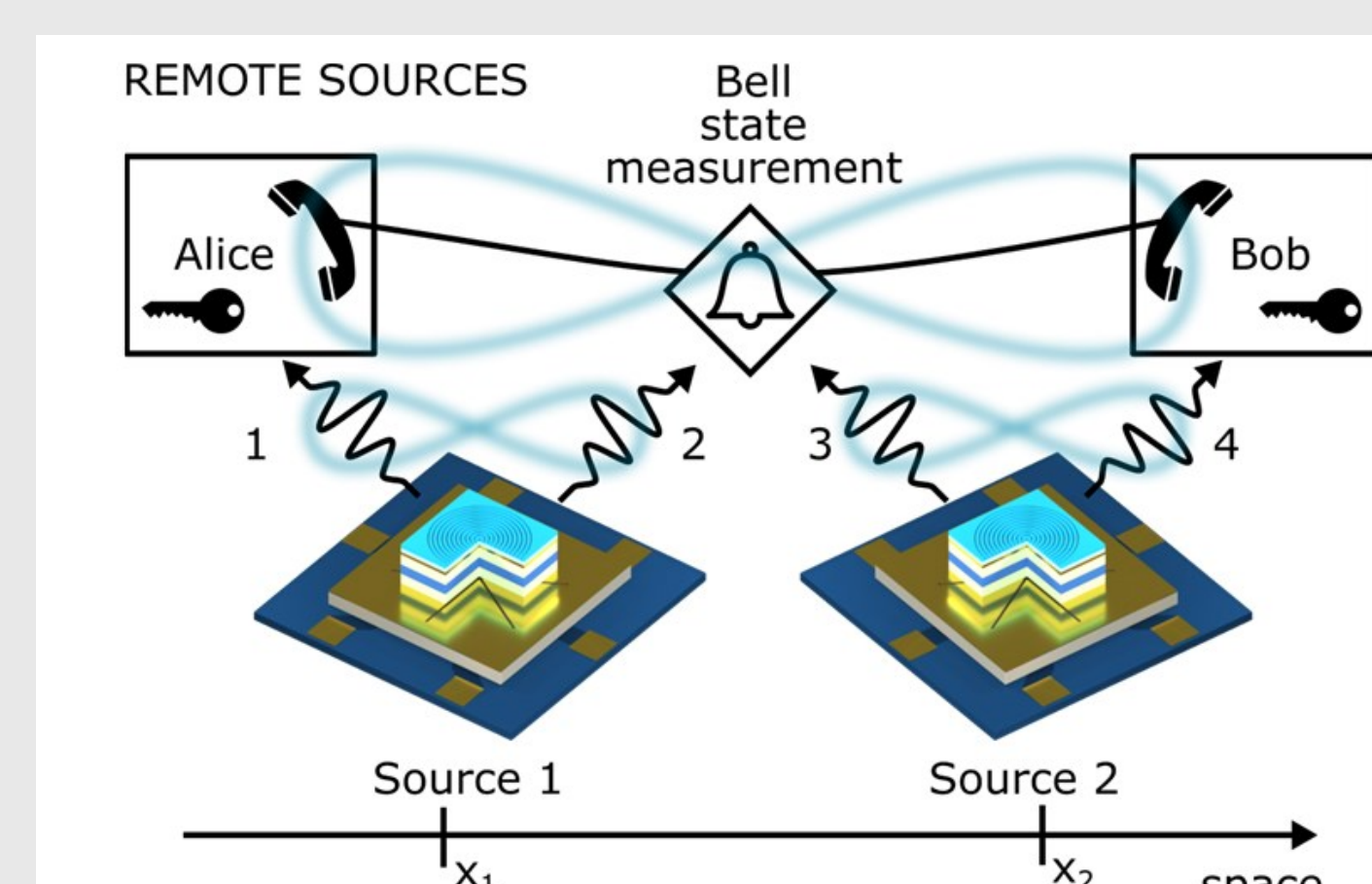
Future perspectives:

CBR-QD in p-i-n diode structure
→ Higher indistinguishability,
higher brightness

Demonstration of
QKD performances
beyond SPDC
capabilities



Entanglement swapping between photons from remote QDs



Other publications:

Qu. Sci. and Tech. 8 (2), 025002 (2023)
Physical Review B 108 (8), L081405 (2023)
ACS photonics 11, 596 (2024)
Laser & Photonics Rev. 18, 2300835 (2024)

Further support

