

Center for Quantum Networks

NSF Engineering Research Center



CQN Testbed - Boston

Chao Li

Boston Testbed Lead

Massachusetts Institute of Technology

Funded by National Science Foundation Award #1941583



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University of
Massachusetts
Amherst RE REVOLUTIONARY

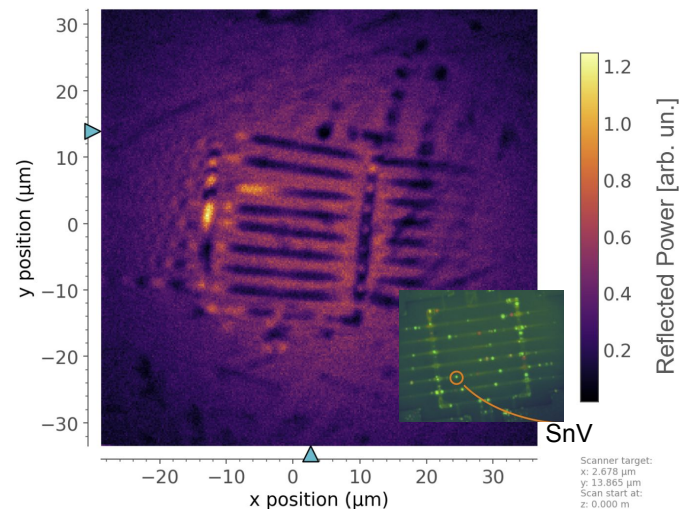
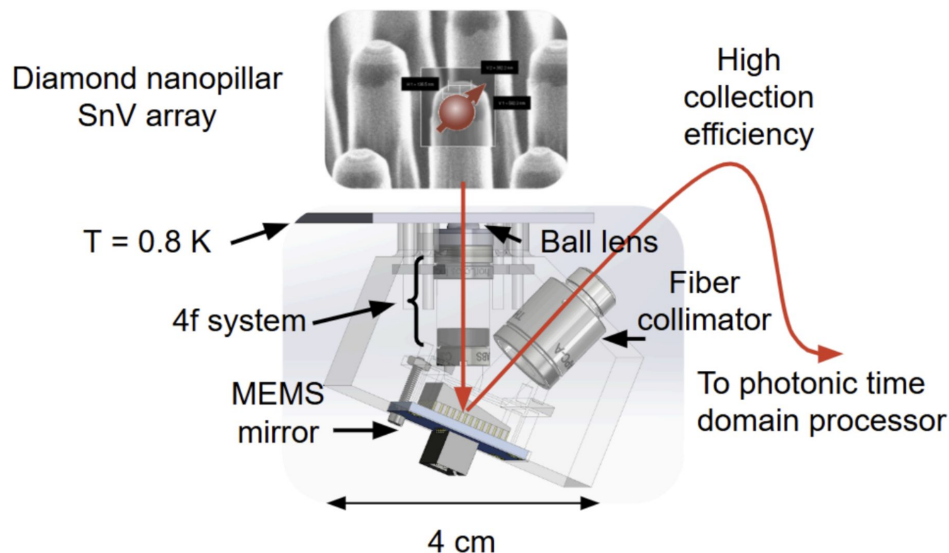


NAU
NORTHERN
ARIZONA
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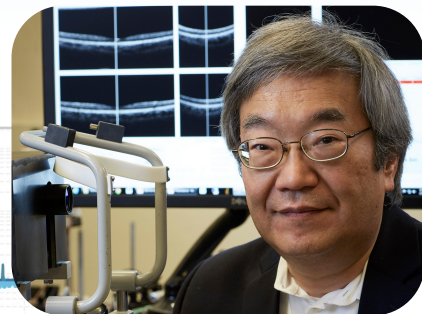
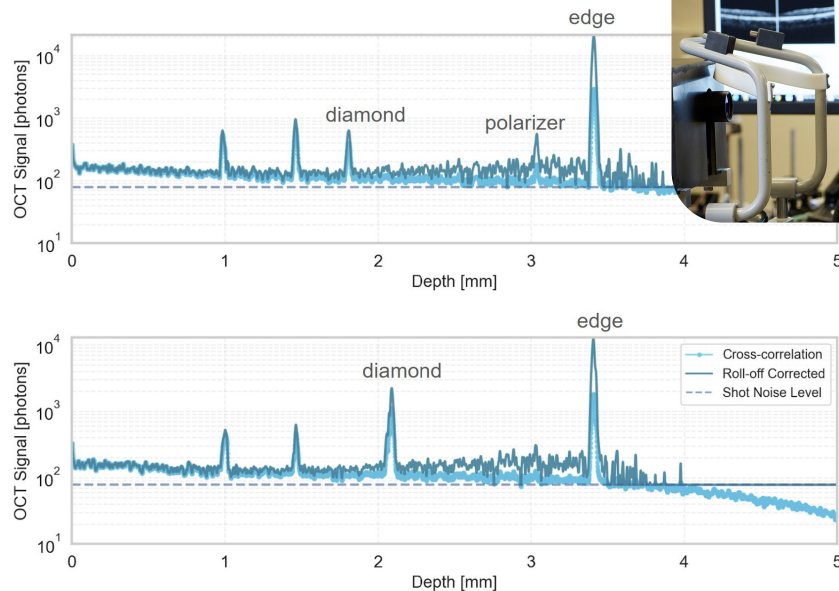
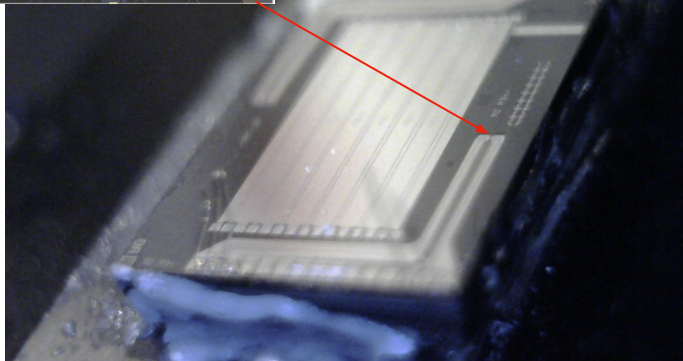
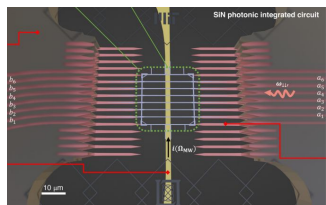
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Cryo-vacuo MEMS Scanner QuMemory Module



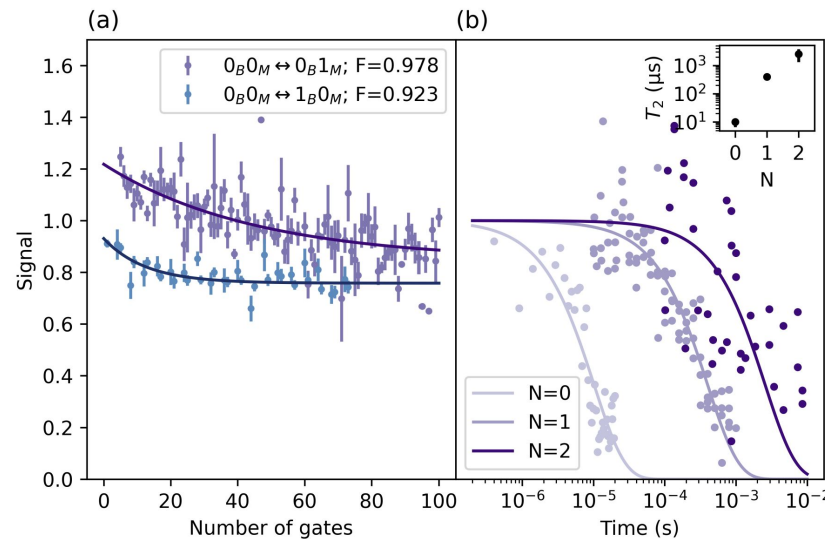
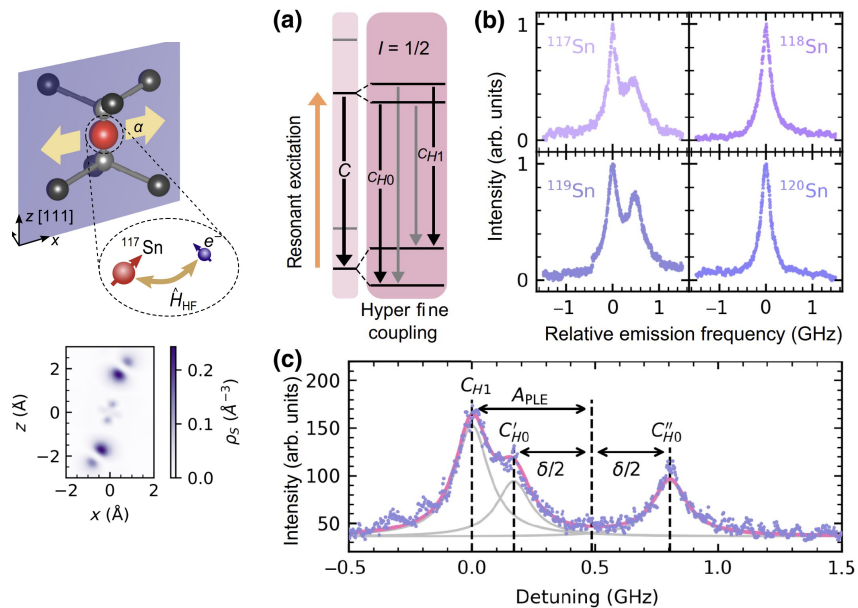
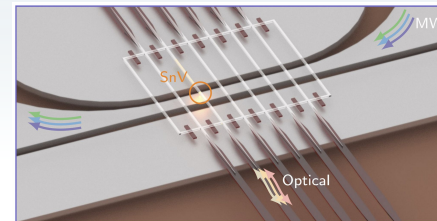
Team: Chao Li, Vikash Kumar, Yin Min Goh, Dan Kilper, John Donegan, Dirk Englund et al.
Publication: to be submitted (2025)

OCT for PIC – Towards Single Photon and Single Emitter Regime



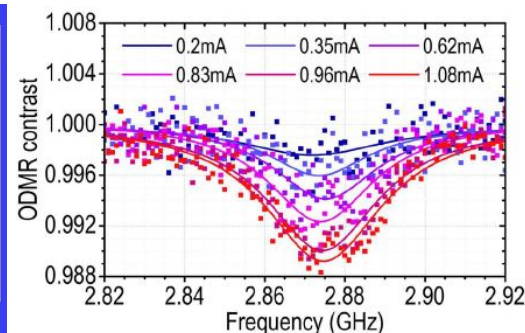
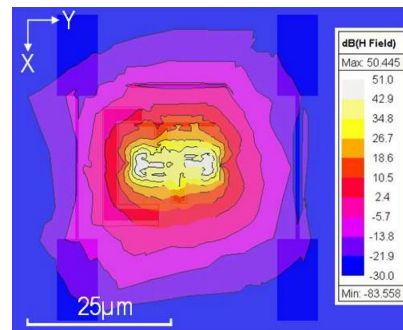
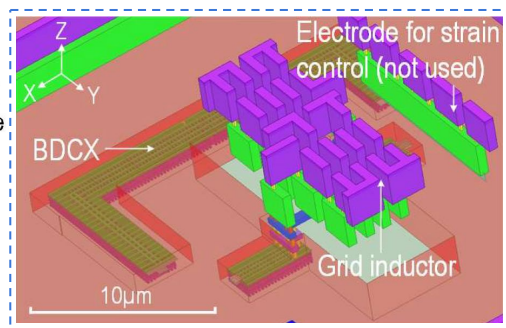
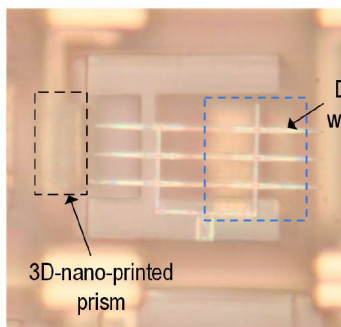
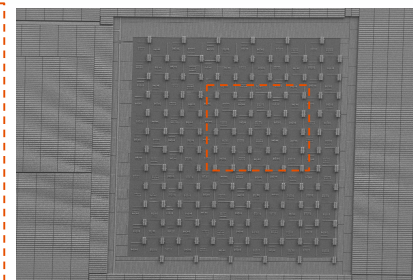
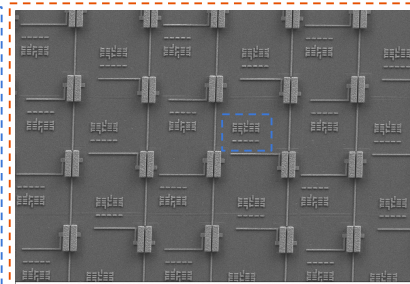
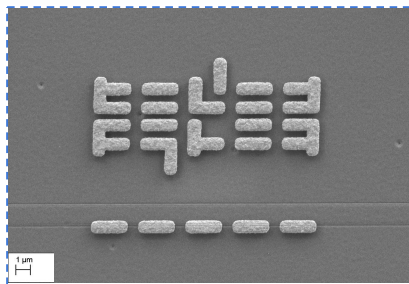
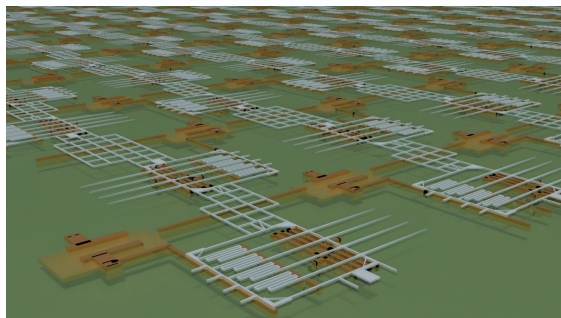
Team: Yin Min Goh, Chao Li, Yunchan Hwang, James Fujimoto, Dirk Englund et al.
Publication: to be submitted (2025)

Hyperfine Electro-Nuclear Spin-Photon Interface



Team: IBW Harris, I Christen, SM Patomäki, H Raniwala, P. Benjamin Dixon, Mete Atatüre, Karl Berggren, Dirk Englund, et al.
Publication: PRX Quantum (2023) & Manuscript Under Review (2025)

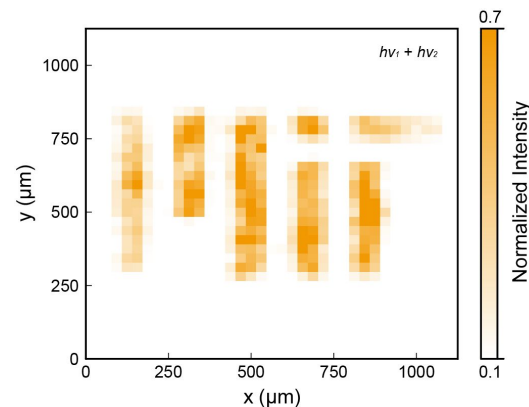
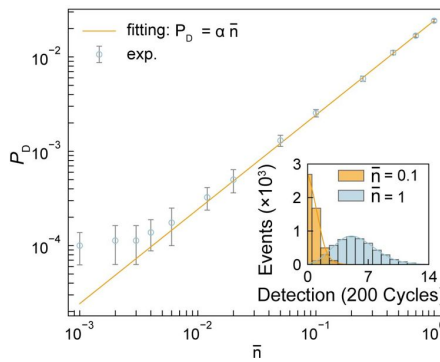
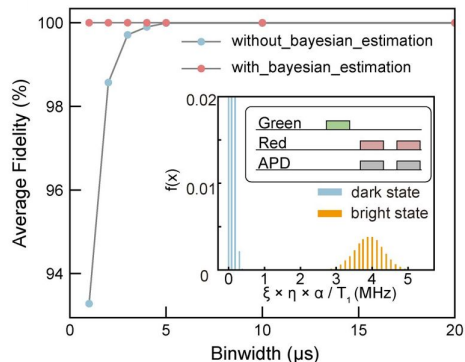
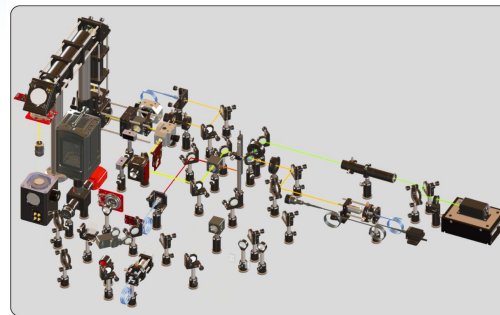
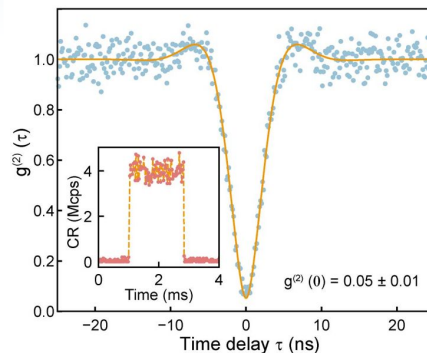
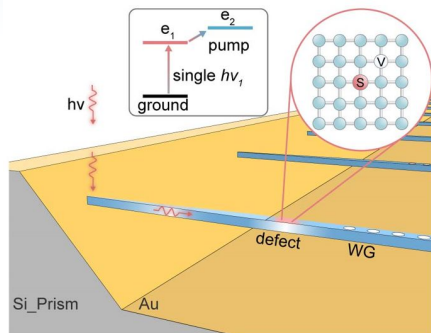
CMOS Platform for Scalable Heterogeneous Integration



Team: Yuyang (Asher) Han, Jinchun Wang, Ruonan Han, Dirk Englund, et al.

Publication: ISSCC (2026), Accepted

Quantum Imager: Diamond-Color-Center Single-Photon Detector

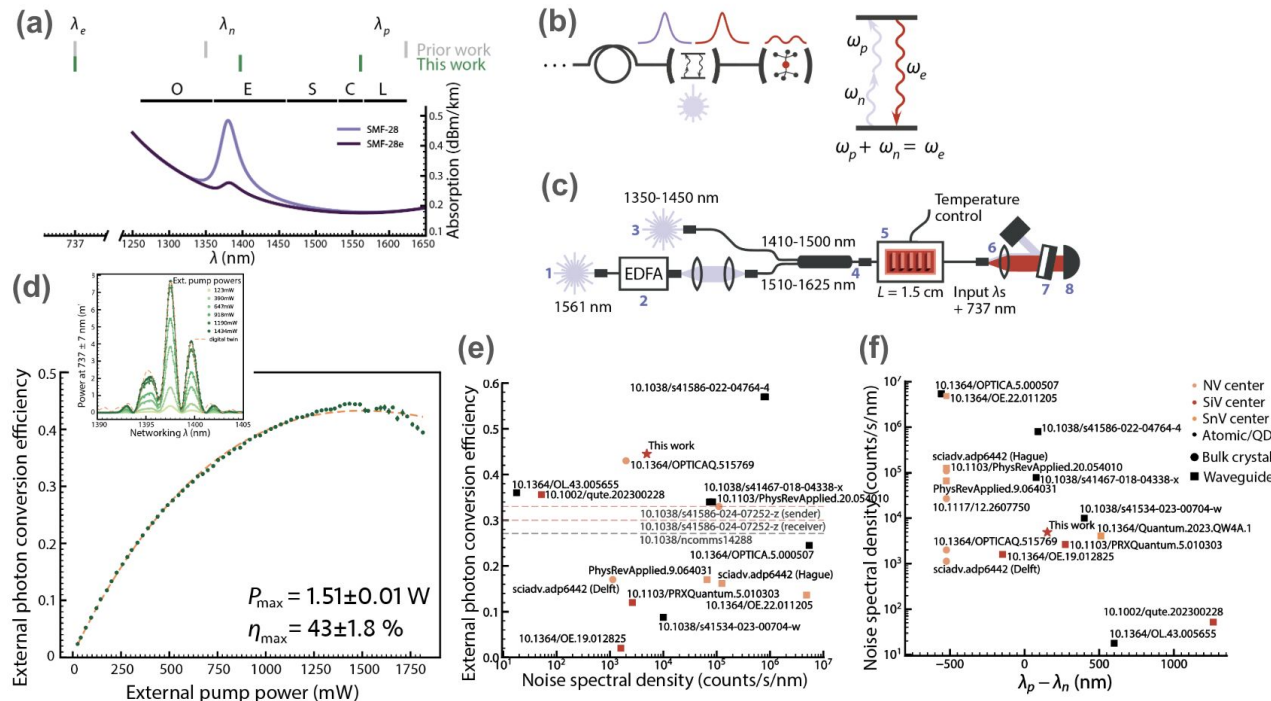


Team: Yong Hu, Ian Berkman, Dirk Englund, et al.

Publication: to be submitted (2025)



Quantum Frequency Conversion

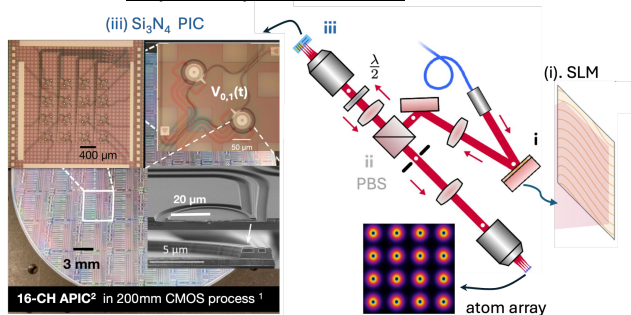


Team: Sofia Patomaki, Dirk Englund, Franco Wong et al.

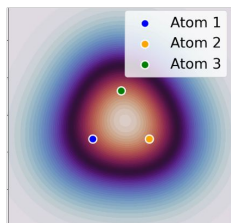
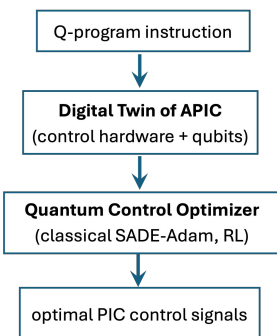
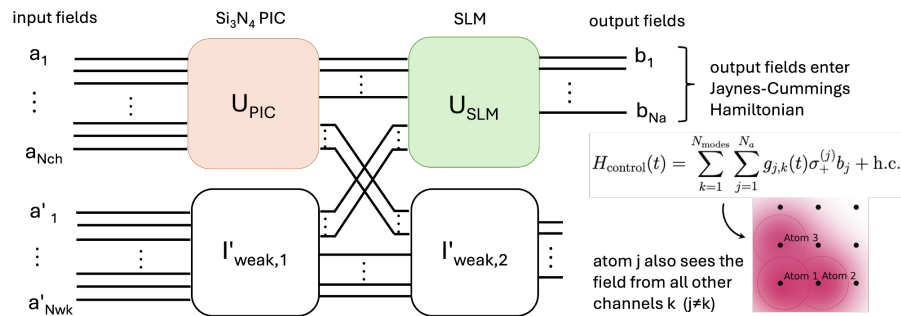
Publication: to be submitted (2025)

Hardware Co-Designed Optimal Control via Reinforcement Learning

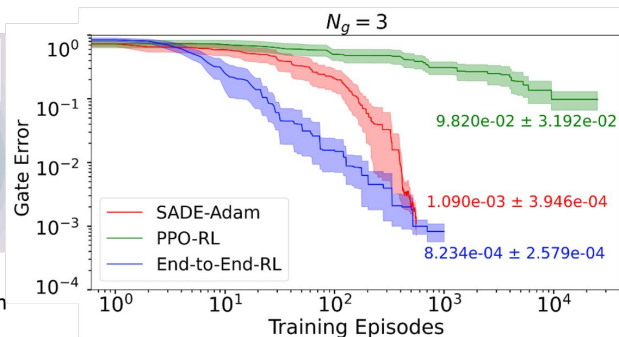
Physical System of APIC



Digital Twin of APIC



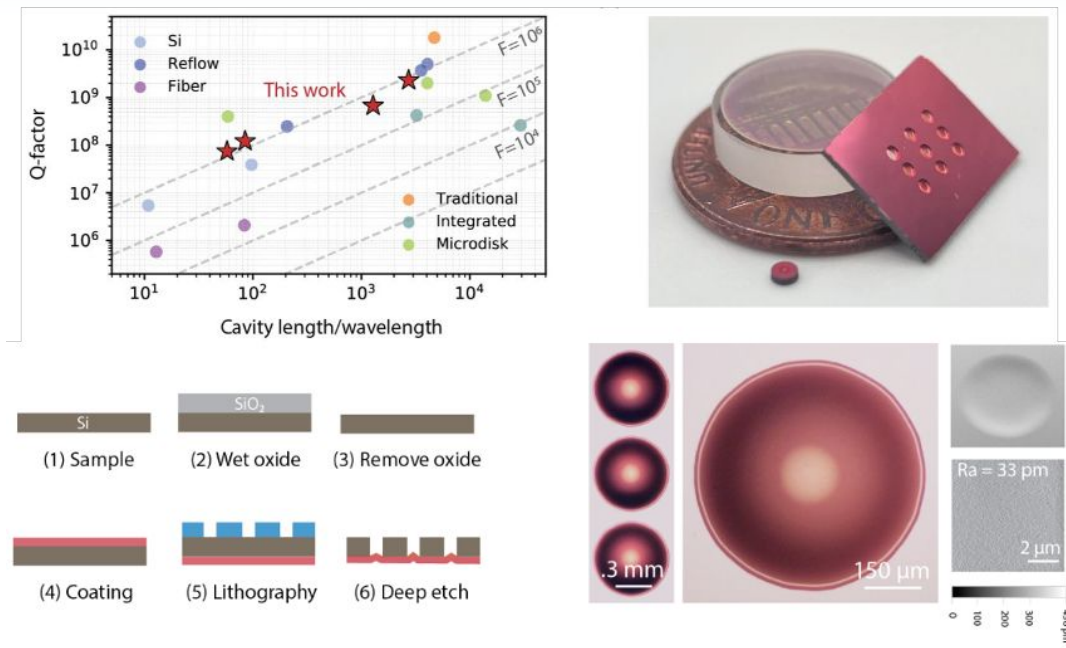
- beam waist 2.0 μm
- atom spacing 3.0 μm
- T_{1q-gate} set to 100 ns



- DT model serves as env. for RL
- U_{target} = R₁ ⊗ R₂ ⊗ R₃
- R_i: single-qubit gate, random Clifford
- each curve shows the average over 5 random sets (shaded region shows std. deviation)

Team: Qian Ding and Dirk Englund
Publication: under review (2025)

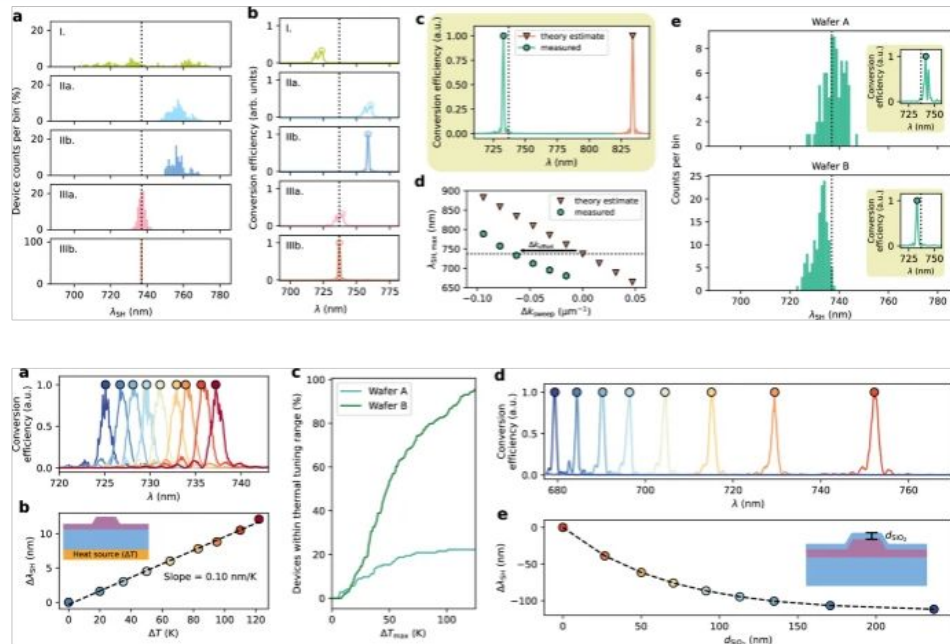
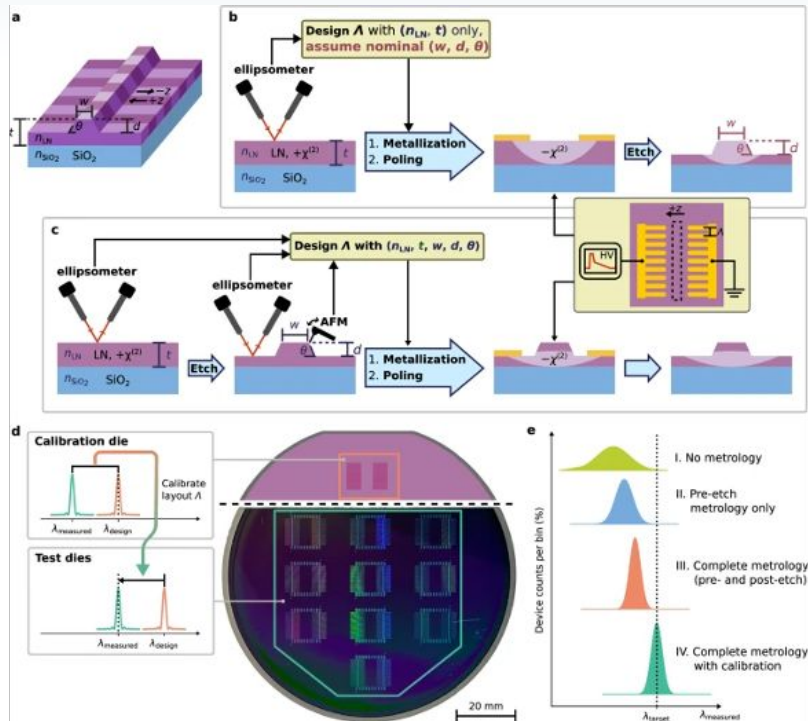
Scalable high-finesse microcavities for neutral atom network links



Team: S. Ding, B. Grinkemeyer, M.D. Lukin, M. Lončar, et al.
Publication: Manuscript under review (2025)



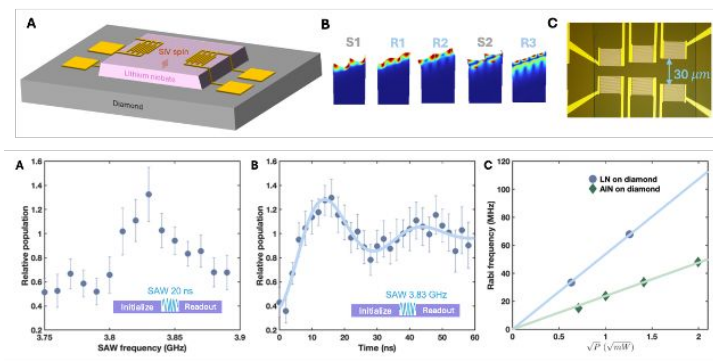
Wafer-scale wavelength-accurate fabrication of PPLN for SiV frequency conversion



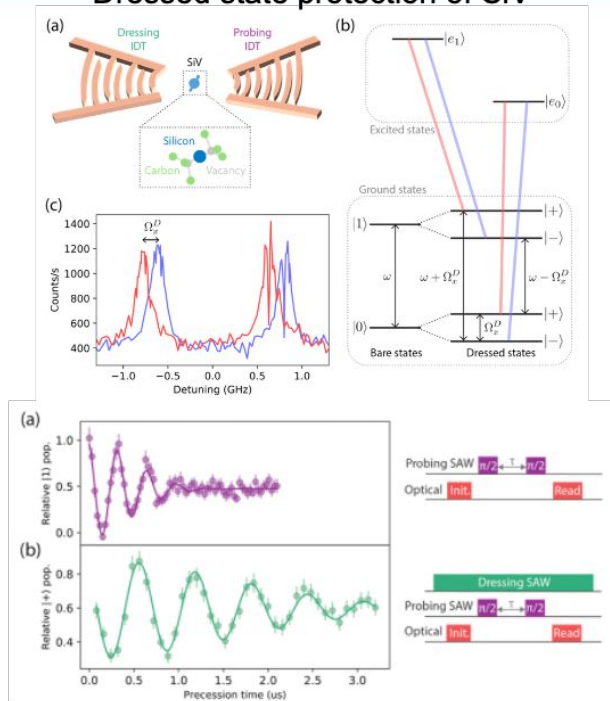
Team: C.J. Xin, N. Sinclair, M. Lončar, et al.
Publication: Communications Physics (2025)

Dressed state protection of SiV and LN-diamond integration

LN on diamond for fast SiV acoustic control



Dressed state protection of SiV

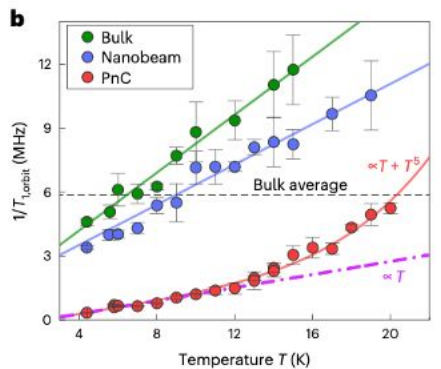
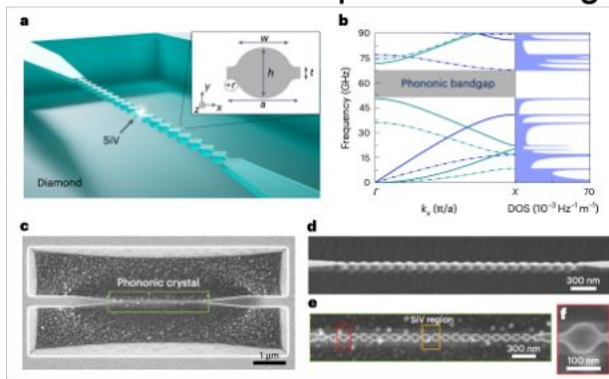


Team: E. Cornell, Z. Xu, B. Pingault, M. Lončar, et al.

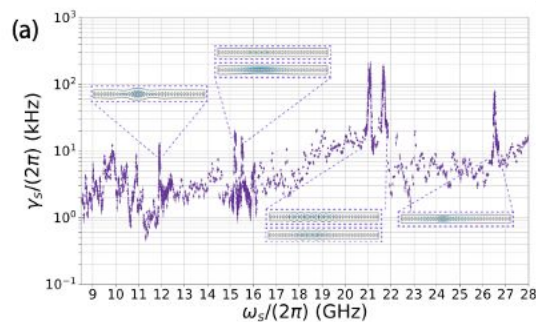
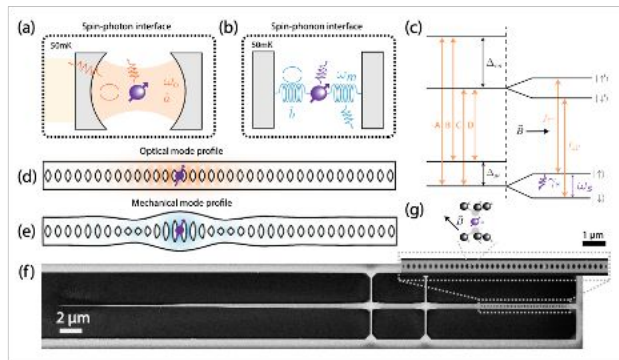
Publication: Manuscript under review (2025); Manuscript under review (2025)

Spin-phonon interaction using phononic crystal cavities

SiV orbital state protection using a phononic crystal cavity

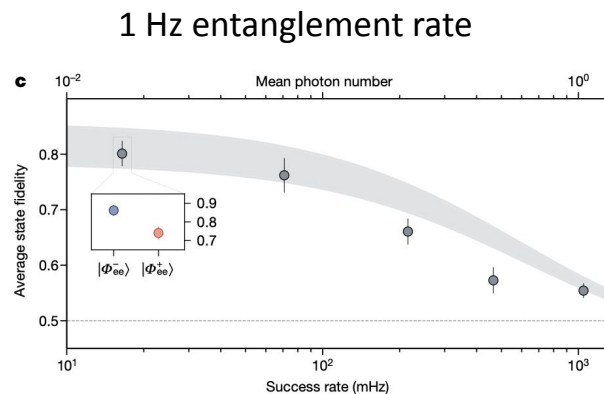
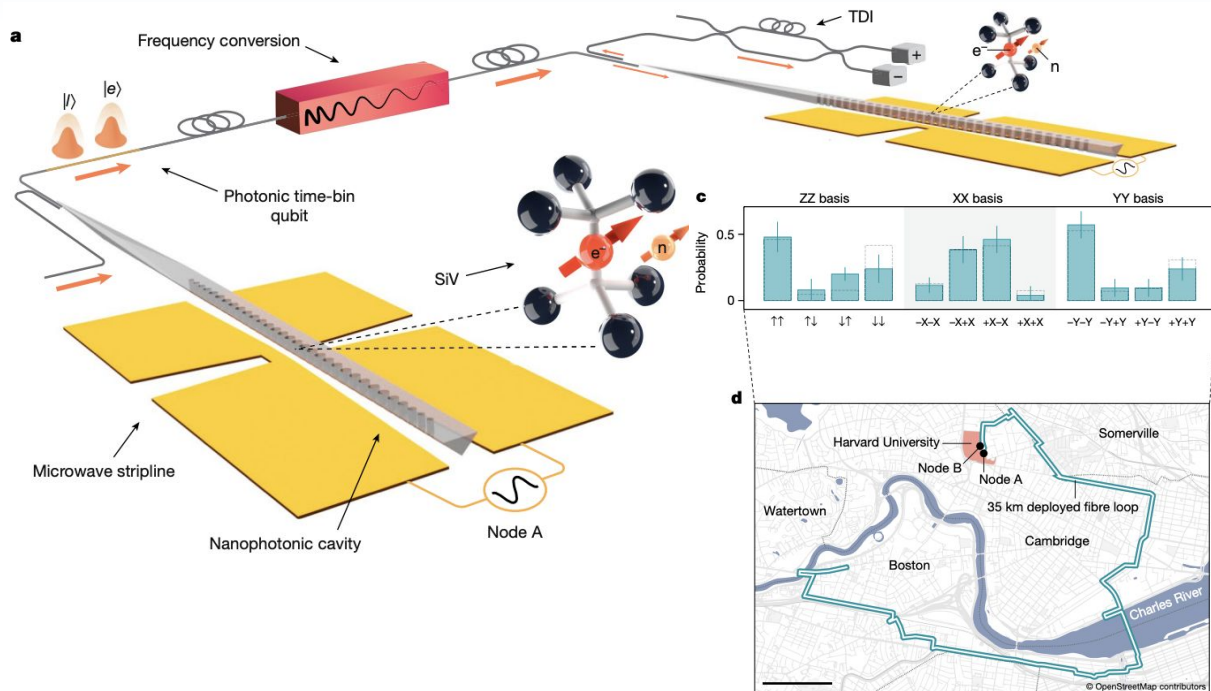


Acoustic Purcell effect using SiV



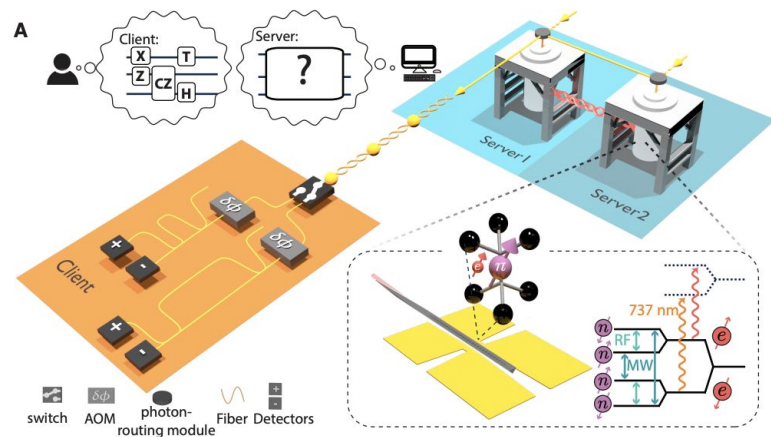
Team: K. Kuruma, G. Joe, M. Haas, B. Pingault, M. Lončar, et al.
Publication: Nature Physics (2025); Manuscript under review (2025)

SiV-SiV entanglement over a 35 km metropolitan fiber

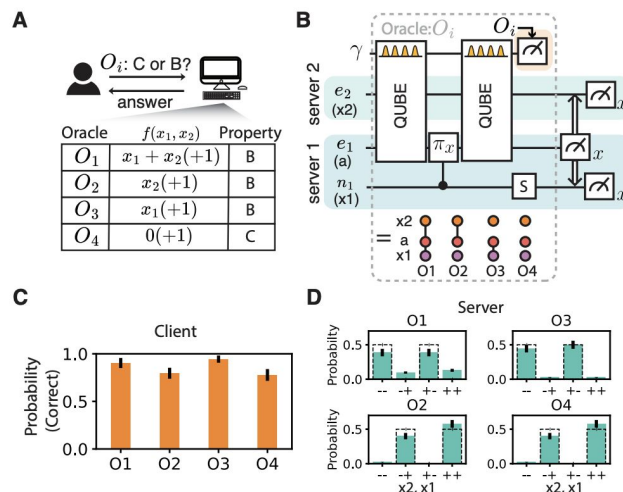


Team: C. Knaut, A. Suleymanzade, Y.-C. Wei, D. Assumpcao, P.-J. Stas, M. Lukin et al.
Publication: Nature (2024)

Distributed Blind Quantum Computing with an SiV Quantum Network

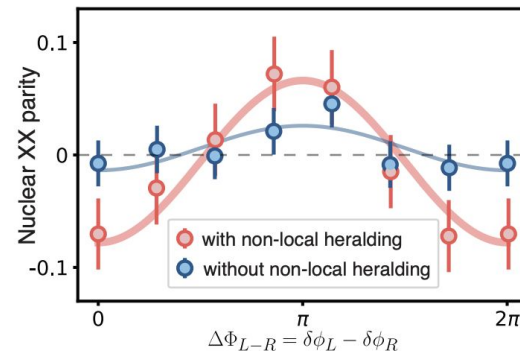
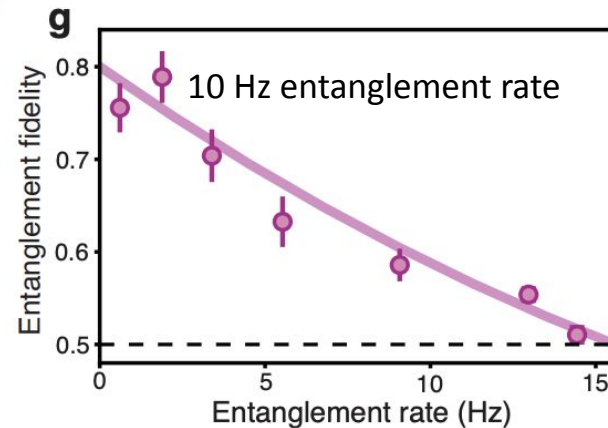
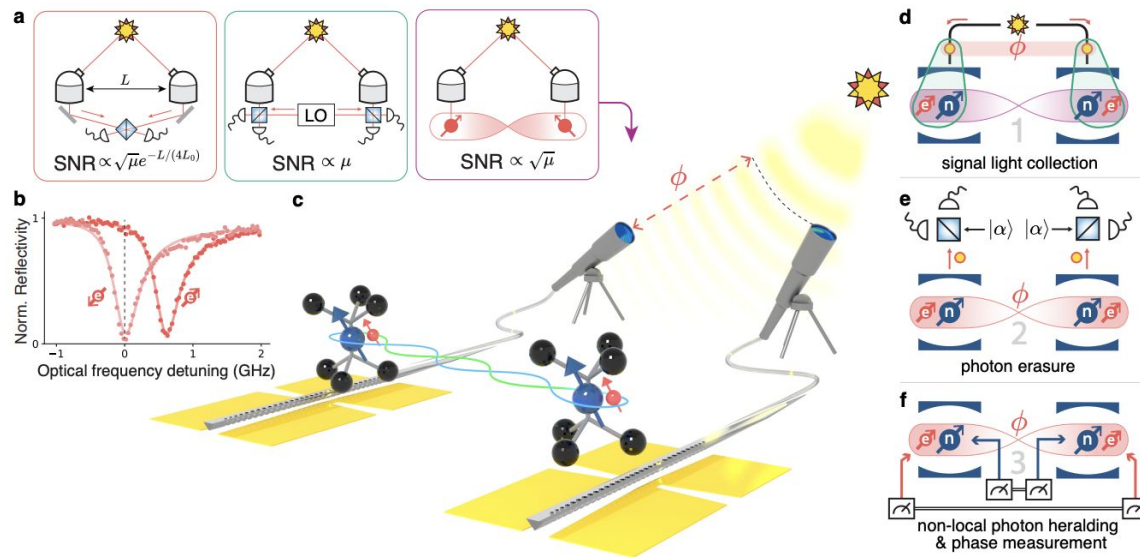


Distributed Deutsch-Jozsa type algorithm with blind oracles



Team: Y.-C. Wei, P.-J. Stas, A. Suleymanzade, G. Baranes, M. Lukin et al.
Publication: Science (2025)

Entanglement Assisted Non-Local Optical Interferometry



Team: P.-J. Stas, Y.-C. Wei, M. Sirotin, M. Lukin et al.
Publication: Under Review (2025)



AI-Driven Robotics for Quantum Optics

• Plan in twin → simulate → act → measure → infer

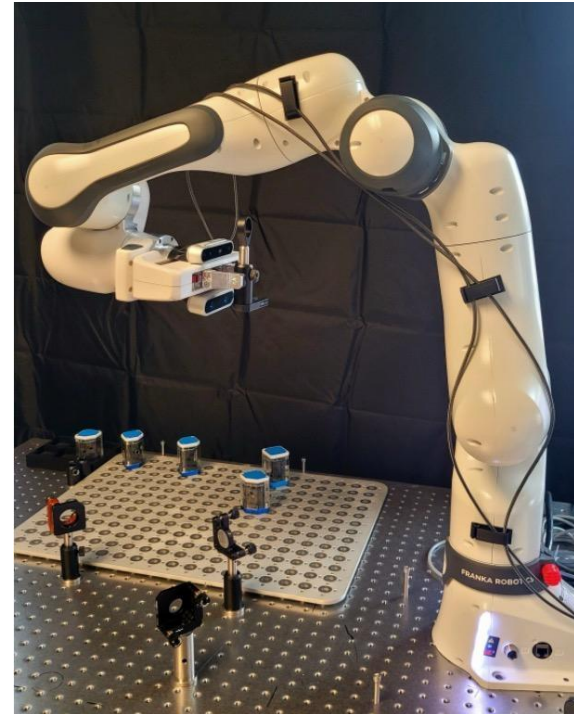
Action rule:
$$a^* = \arg \max_{a \in A} V_{\theta}(a)$$

(cost, design, safety, time,..)

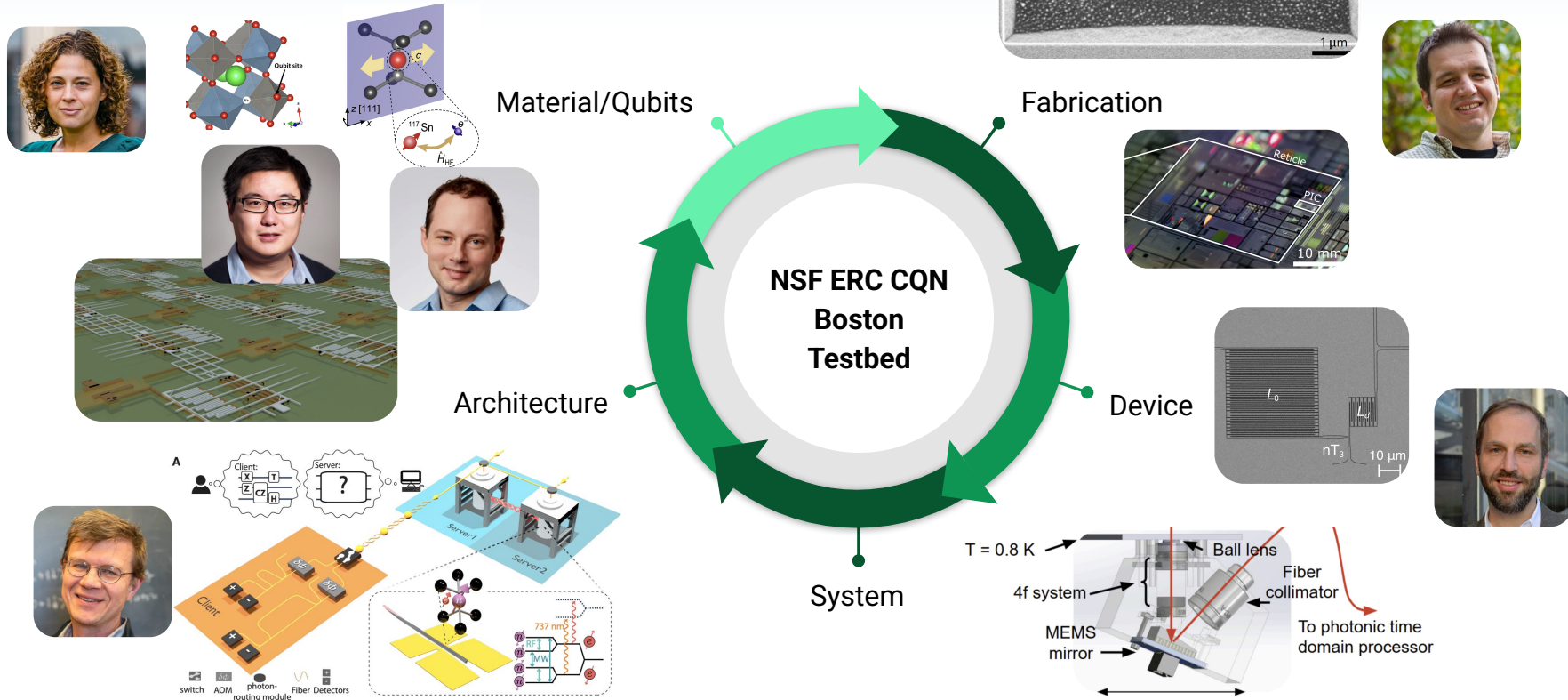
- Design and search: $V_{\theta}(a) = E_y [\text{information gain on } \theta]$
Compute in the twin
(integrates over y and posterior updates).
selected action **can be non-obvious/under-explored**
if that maximizes expected information about θ .

- Reduce Sim → Real Gap

Calibrate twin parameters (actuators, sensors, noise, etc) with real data;
iterate plan → execute → fit until action rankings agree and task-level
 Δ metrics are within tolerance (e.g., $\leq 10\%$ or $\text{MAE} \leq 50 \mu\text{m} / 0.2^\circ$).



CQN Boston Testbed Synergy Cycle





Year 6-10 Boston Testbed

- 2026 — Develop the MEMS-scanner QuMemory module and integrate the ZALM entanglement source
- 2027 — Integrate with other subsystems (nanopillar arrays, cavity arrays, CMOS backplanes) and deploy new nodes at BBN and QuNett
- 2028 — Demonstrate heralded teleportation across newly added BBN, QuNett links
- 2029 — Benchmark ZALM entanglement-generation scaling and optimize toward the target rate
- 2030 — Provide open-access tooling/APIs for system tomography and benchmarking

Create deployable modules that expand geographic distribution and lower barriers to co-development.

