

Center for Quantum Networks

NSF Engineering Research Center



Center Organization, Management and Sustainability

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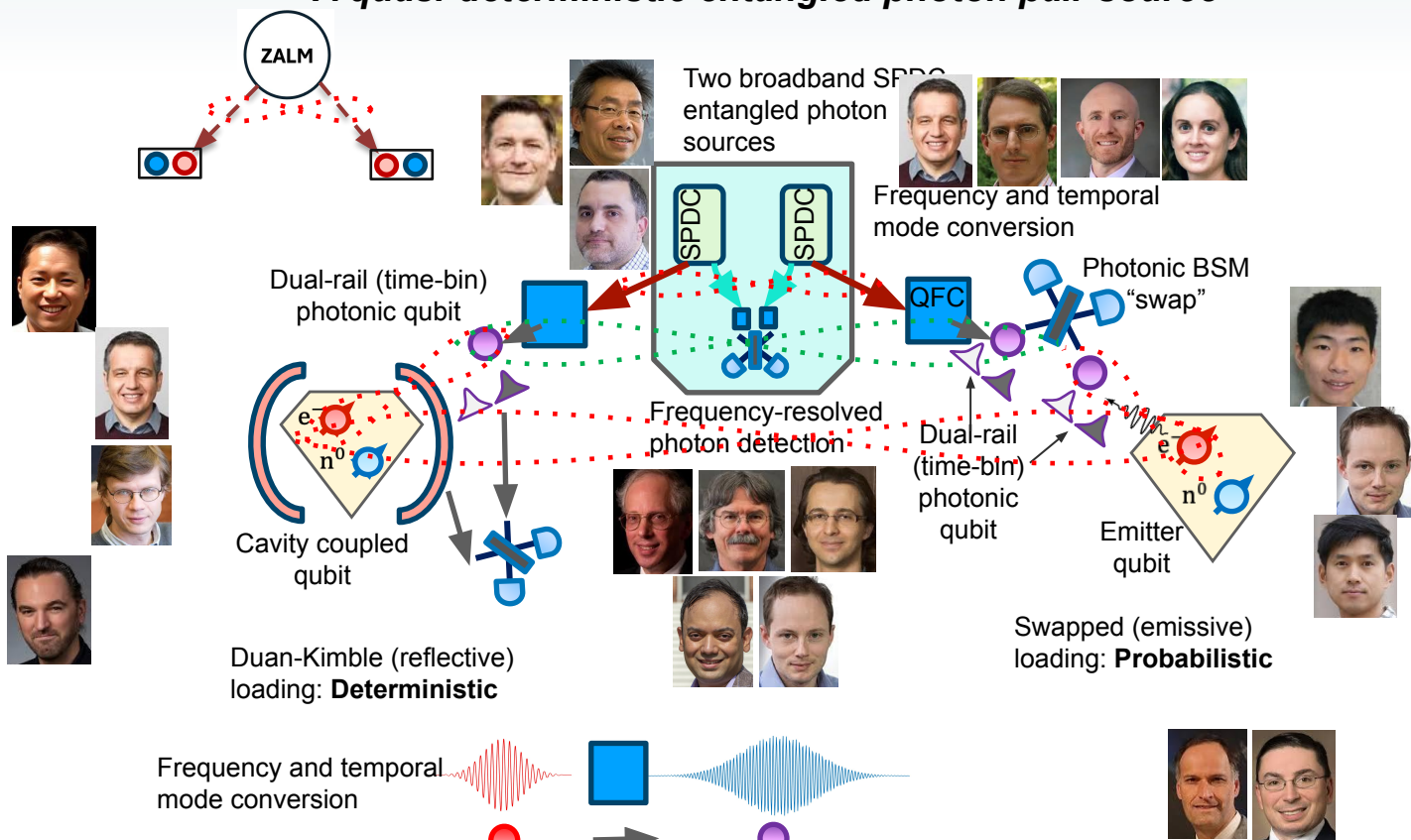
Changes during Y5 and beyond

- CQN was awarded Y6, but was asked to rebid Y7-10
 - Chaohan Cui, Tucson testbed lead, now research faculty at UMD
 - Matt Eichenfield moving to CU Boulder, starting Jan 2026
 - MARQI a natural integration home given ion + color center work
 - Connecting with the vibrant MD Capital of Quantum Initiative
 - Tucson testbed: infrastructure to stay: L3 experiment, bulk ZALM with dispersion engineering and QFC for hybrid memory (Mehmet) to continue in Tucson. Quantum memory + QFC work transitioning to UMD
 - LT + EXCOM, in discussions with UArizona and UMD administration, decided to rebid Y7-10 proposal with UMD as lead
 - MIT, UArizona, Harvard, UMass Amherst to stay core partners
 - UMD signatory to current IPMP. UMD to lead new IPMP for Y7-10
 - New faculty: Daniel Soh and Xiaodong Yan, UArizona, Robert Niffenegger, UMass
 - Testbed Leads: Chaohan (UMD), Chao (Boston), Stefan (Virtual)
- Work packages versus Thrusts
 - Thrusts as a way to coin / track projects
 - Work packages as a way to organize ourselves day to day



Zero-Added-Loss Multiplexing (ZALM): WP1

A quasi-deterministic entangled photon pair source





Multiplexed Quantum Memories: WP2

Scalable platforms: 1. thousands (ions) to **millions** (SiVs) individually addressable qubits, 2. **efficient qubit-photon interface**, 3. high-fidelity **quantum logic**

Reconfigurable photonic integrated waveguides coupled to color centers

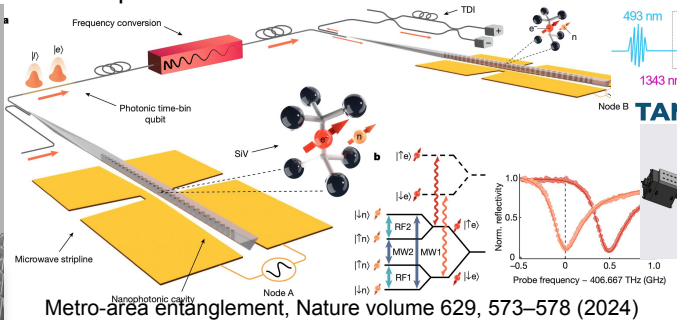
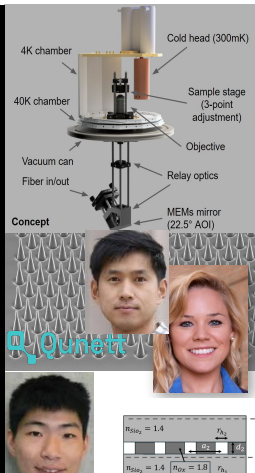
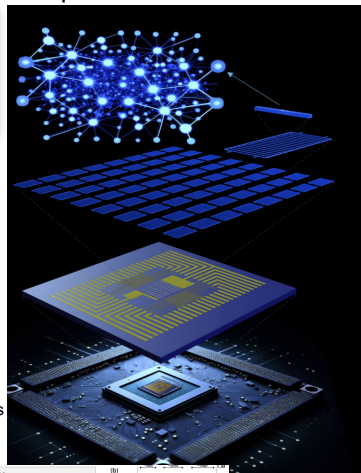
Color centers in diamond nanopillars and a MEMS scanner with fiber tip

Color centers in nanophotonic diamond cavities integrated with telecom fiber

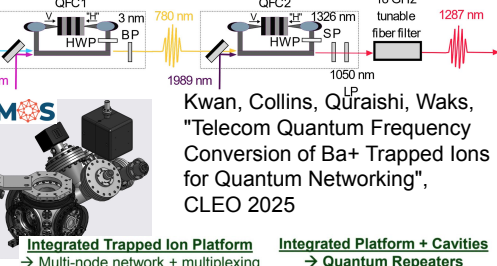
Trapped ion qubits strongly coupled to a cavity with efficient optical interface



Superconducting electronics,
Nature Electronics
volume 8, 375
(2025)

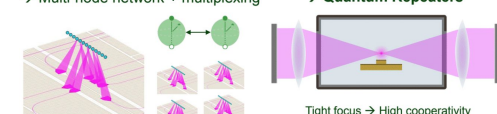


Metro-area entanglement, Nature volume 629, 573–578 (2024)

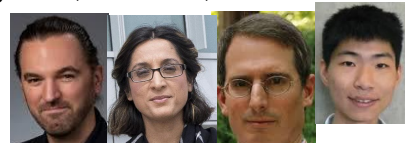


Kwan, Collins, Quraishi, Waks,
"Telecom Quantum Frequency
Conversion of Ba⁺ Trapped Ions
for Quantum Networking",
CLEO 2025

Integrated Trapped Ion Platform
→ Multi-node network + multiplexing
Integrated Platform + Cavities
→ Quantum Repeaters



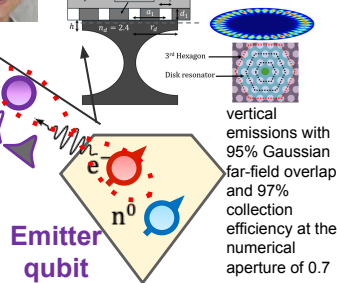
Niffenegger et al., Nature 2020, arXiv:2402.16742



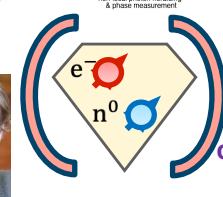
Optically addressable molecular-spin
qubit diluted in a host matrix; US
Patent Application #18845790 (2025)

"Low-dimensional solid-state
single-photon emitters",
Nanophotonics, 14(11):1687-1713,
(2025)

Programmable quantum matter, arXiv:2509.02992 (2025)
Chip integrated photonic control, Optica Vol. 10, Issue 5,
pp. 634-641 (2023)
Optical strain tuning, Xue, ..., Cui, Guha, Eichenfield,
Fan, Nature Communications 16 (1), 6275 (2025)
Spectral tuning, Nature Communications volume 16,
Article number: 8829 (2025)



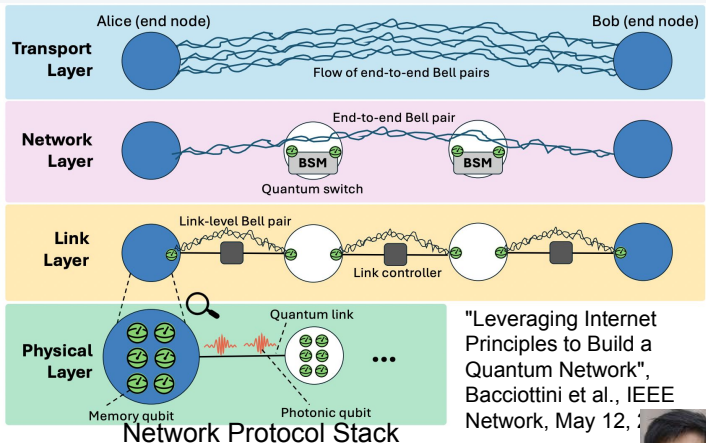
Long-baseline interferometry
arXiv:2509.09464 (2025)



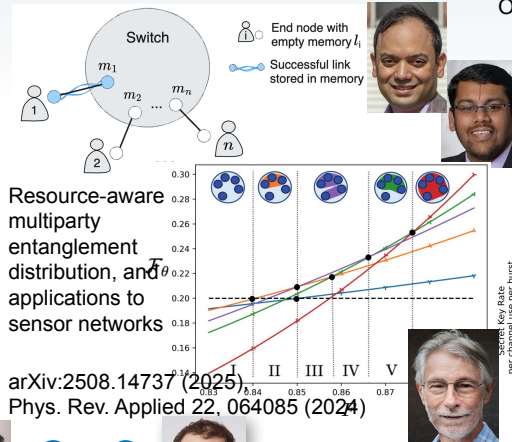
Cavity
coupled
qubit



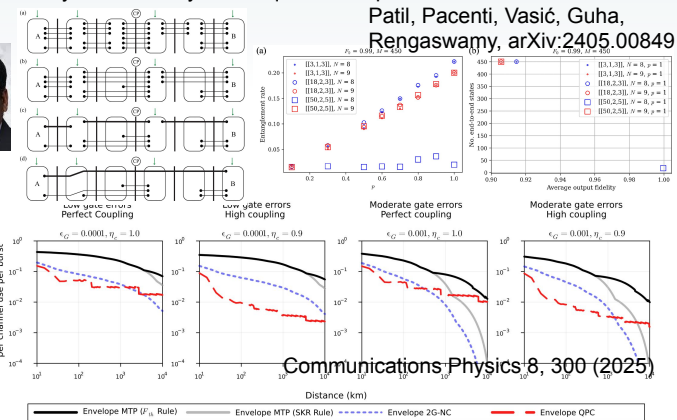
System integration and performance evaluation: WP3



"Leveraging Internet Principles to Build a Quantum Network", Bacciottini et al., IEEE Network, May 12, 2025



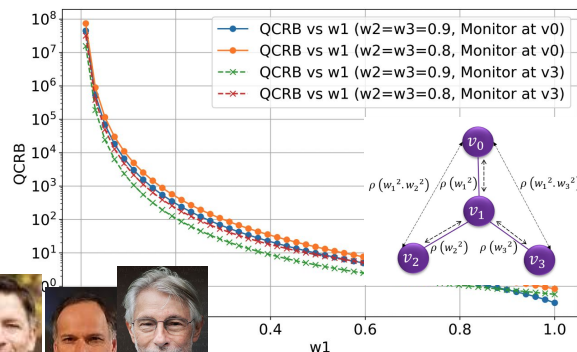
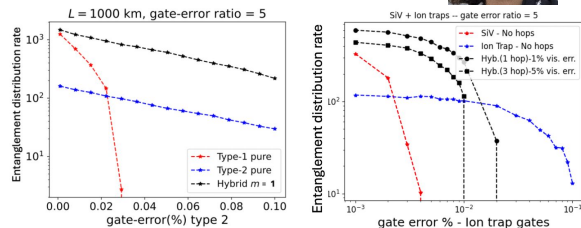
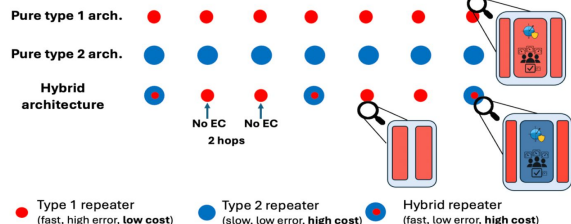
One-way and two-way coded quantum repeaters



Optimal monitor placement in quantum network tomography, Ragunathan, De Andrade, Towsley, Dey, Kilper, Marchetti, IEEE QCE2024



Hybrid quantum repeater architectures



"Hybrid repeaters with encoding for long distance entanglement distribution", Haldar, Guha, Towsley, Rozpedek; IEEE QCE 2025

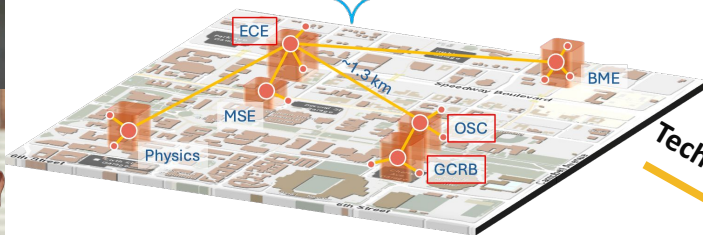


Tucson → Maryland testbed

Birth of the Tucson Testbed: NSF INQUIRE
Remote programmable AI-powered QREAL receiver

Characterizing SiC-4H SiV quantum memory
QuaCTUS - Tucson Testbed Simulator

Superadditive capacity using Green Machine
Characterizing SiV color center quantum memory
Quantum frequency conversion
Integrated quantum memory devices



- Including trapped-ion technology and workforce
- Testbed connected to broad end-users, programs and technologies

Establishing the central quantum hub
First entanglement distribution in Tucson
New space and cryostat
Time domain interferometer
Cryostat-compatible confocal scanning microscope
Supporting systems for quantum network



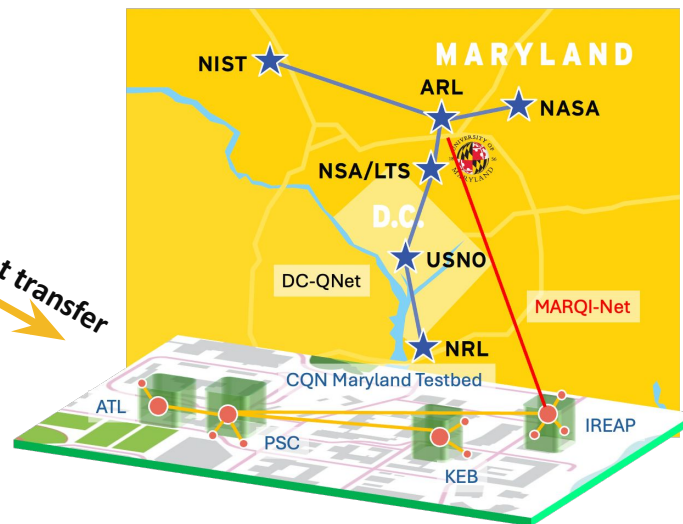
Dr. Chaohan Cui,
UMD Research
Faculty

2020

2025

2030

Technology/equipment transfer



Boston Testbed

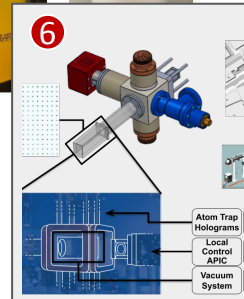
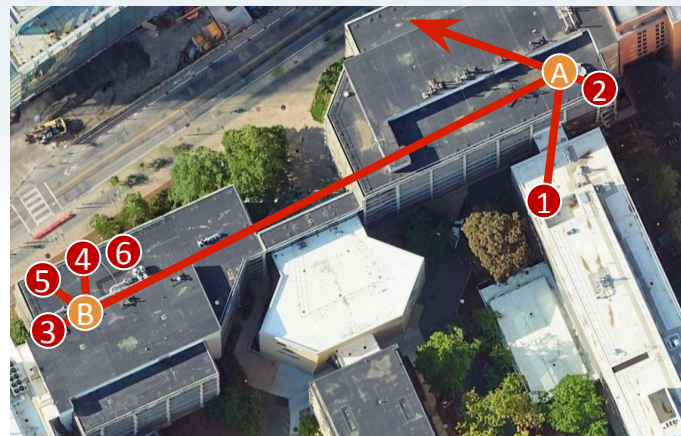
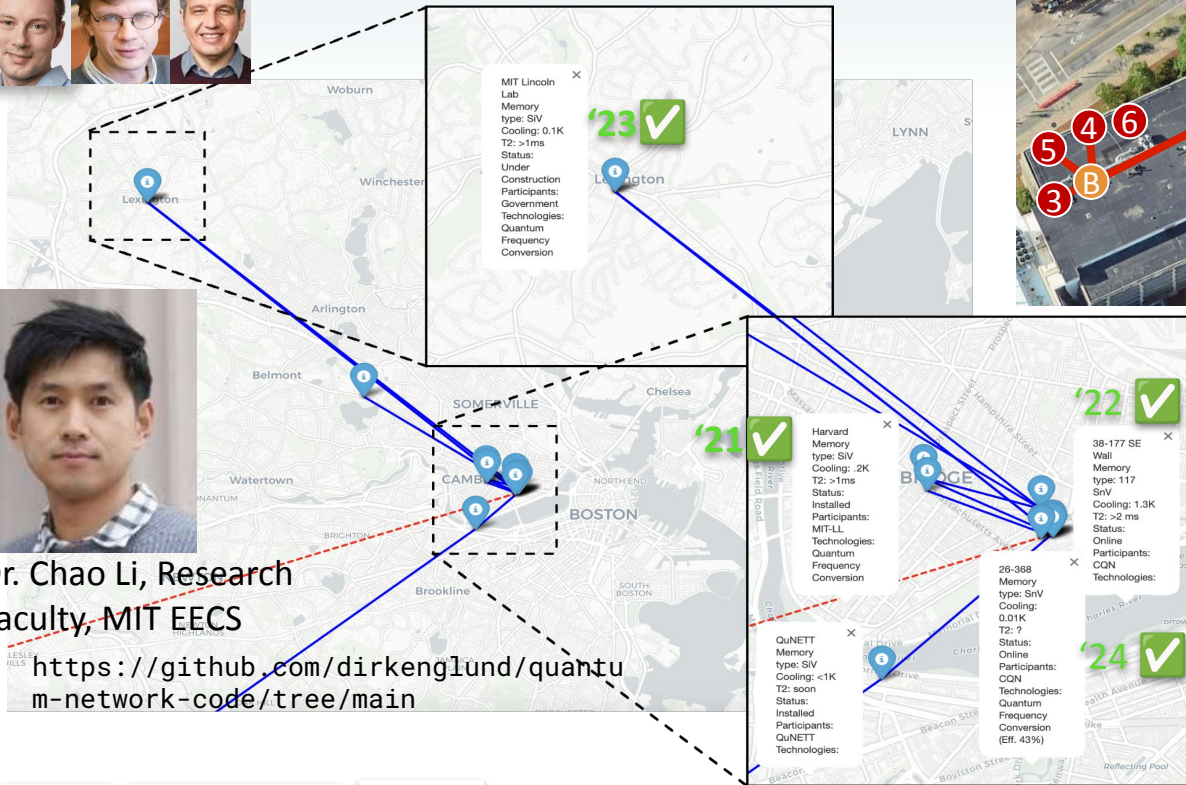


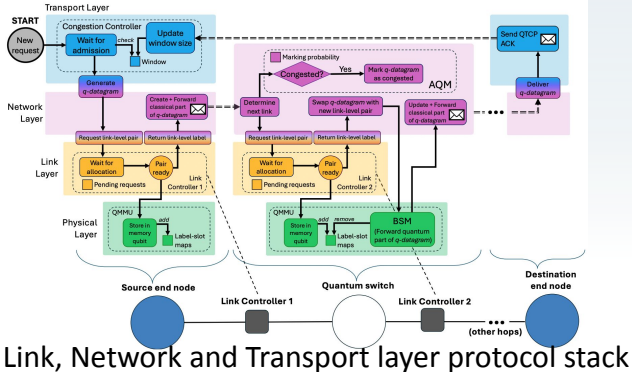
Dr. Chao Li, Research
Faculty, MIT EECS

<https://github.com/dirkenglund/quantum-network-code/tree/main>



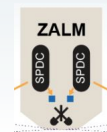
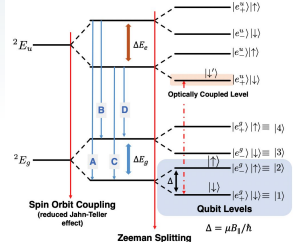
Sandia National Laboratories



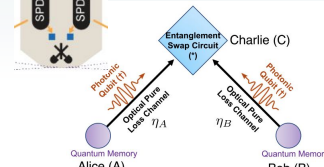


Virtual Testbed

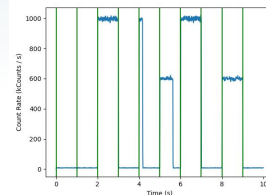
Decoherence models



Physical layer link models

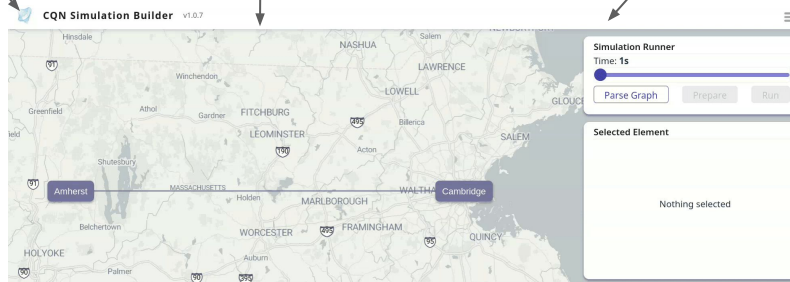
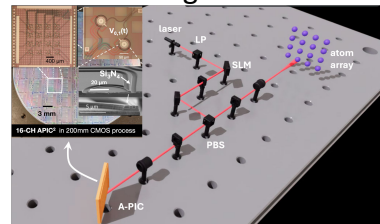


FPGA Controlled color center

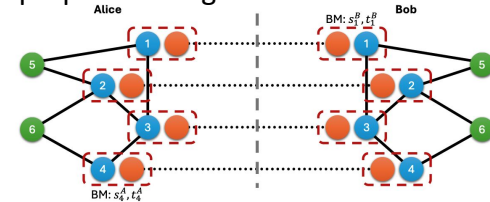


Dr. Stefan Krastanov,
UMass Amherst

Hardware Co-designed Quantum Optimal Control with Digital Twin Model of Programmable PIC

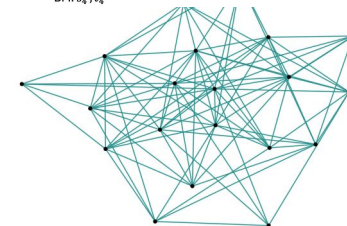
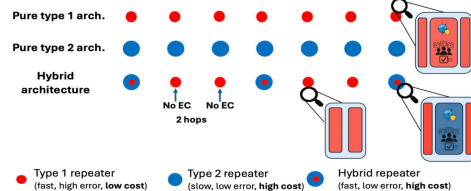


Measurement based entanglement distillation and resource state preparation algorithm

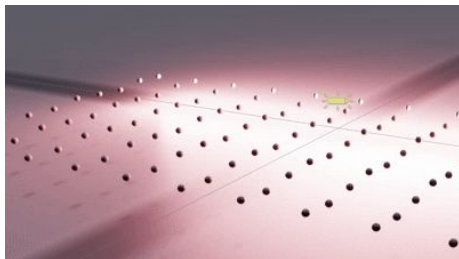


Hybrid quantum repeater architecture

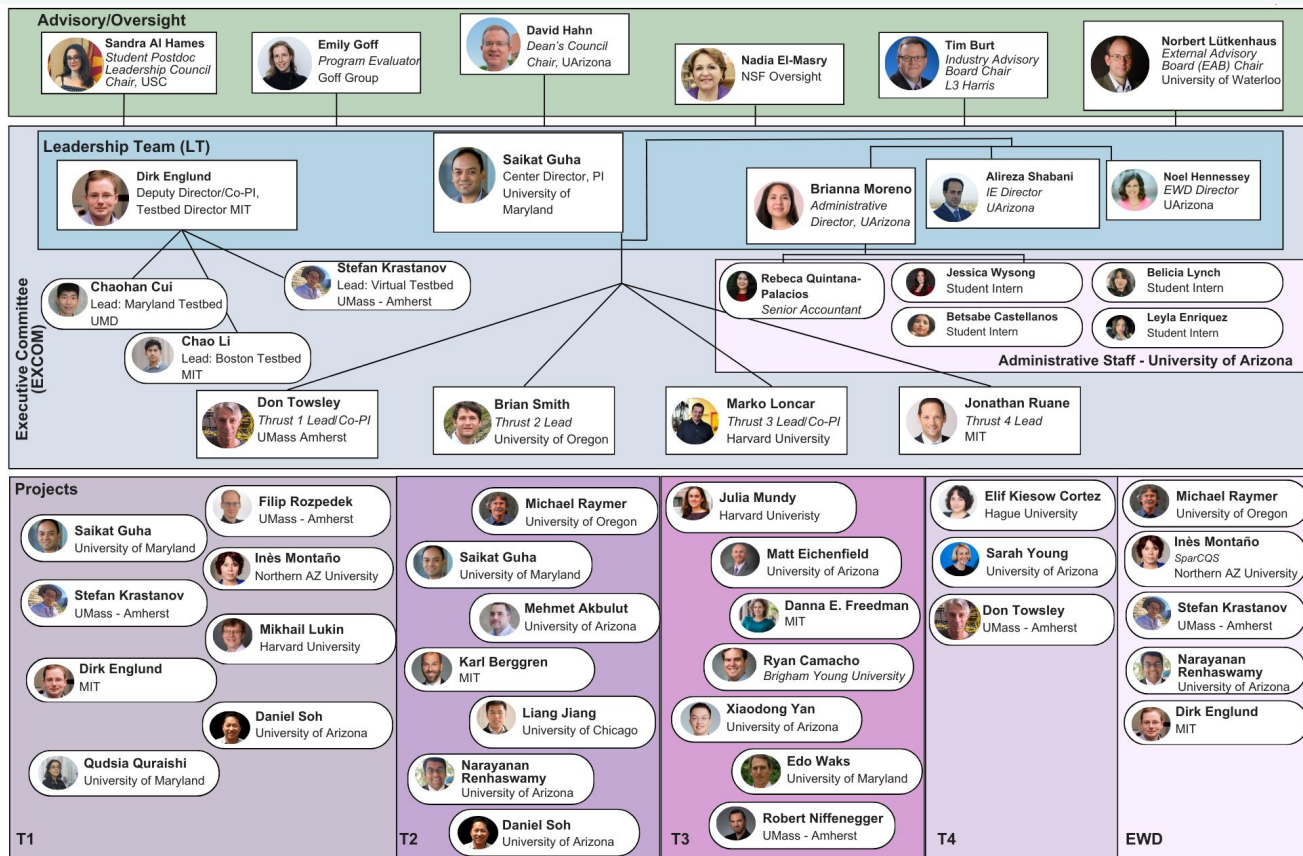
Architectures combining Hybrid and Pure repeaters



Physics informed digital twin with NVIDIA Omniverse & Zemax Ansys team



Center Organization Y7-10





Center Sustainability

Space

1. New facility in Zupnik Hall (2026) will have laboratories dedicated to CQN, within a broader quantum-technology collaborative space.
2. In discussions with Brian Anderson, acting Dean Optical Sciences, UArizona to keep GCRB floor 4 as quantum collaborative space

Education

1. UArizona Certificate in for approvals. Dean Graham will facilitate the roll out of a certificate in QISE, available to DMV area industry, via UMD's well-established Maryland Applied Graduate Engineering (MAGE) that offers similar programs in AI and other topics.
2. CQN faculty to contribute to UArizona QISE MS, UMD QSE minor, UOregon QISE Minor, ..., and cross-campus teaching
3. Winter School - a fee-bearing live quantum networking annual school

Industry

1. The CQN IPP maturing into a standalone "IUCRC-like" nationally-distributed academic-industry R&D consortium
2. More individual company <> university master research agreements
3. Joint CRAD opportunities, including DoD, SBIRs, and VC funded
4. More spin-outs on the horizon (3 that I am aware of!) building off of CQN IP and personnel

Testbeds

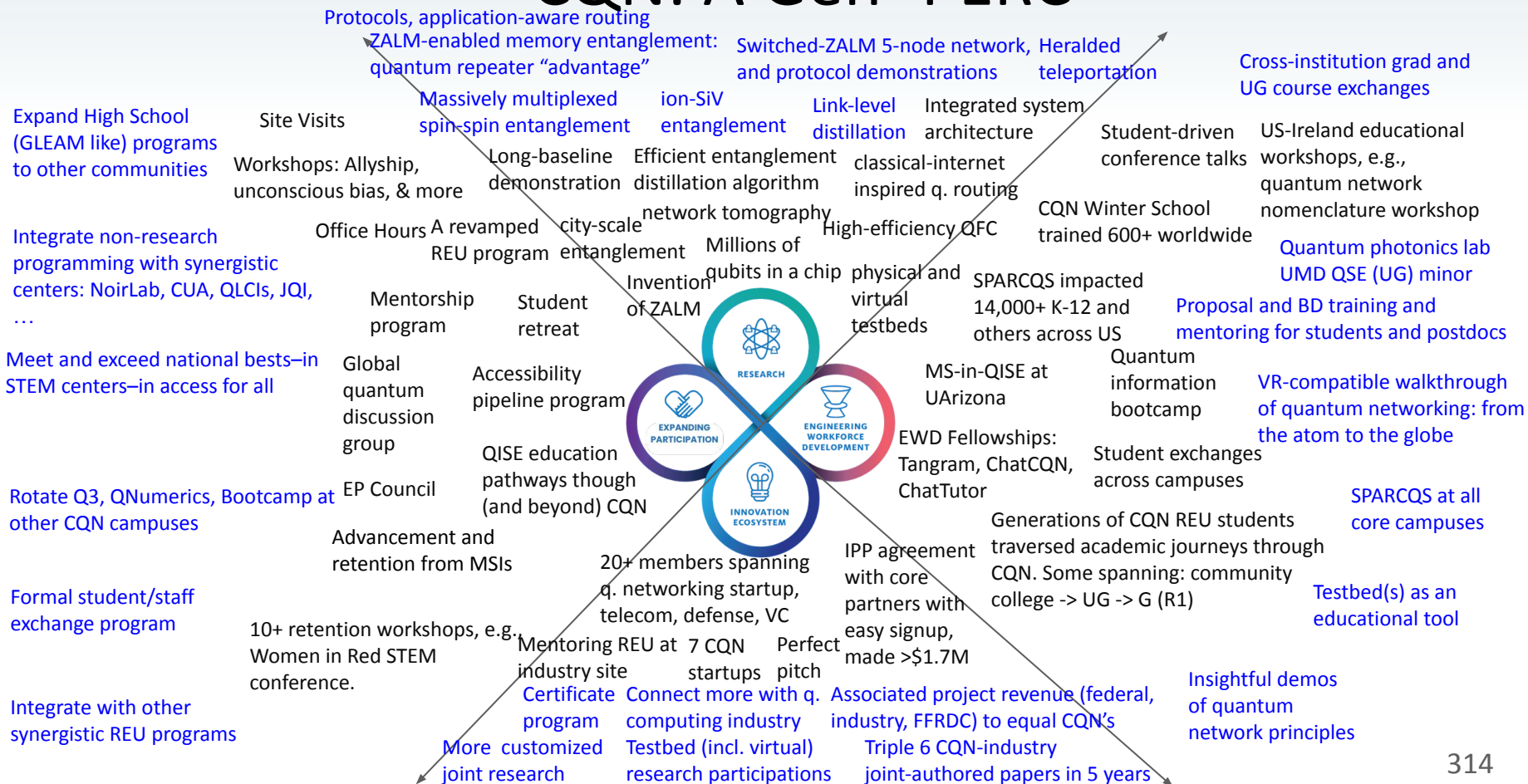
1. Fee-bearing access to virtual and physical testbeds (on contracted projects basis)
2. IP bearing subsystems: licensing revenue

Federal opportunities (partial list) stringing groups of CQN faculty together

1. NQVL (efforts led by Brian Smith, Dirk Englund)
2. Space-assisted long range heralded entanglement MTSLT (planning stage)
3. DoE: PiQSci program on quantum network protocols, spatial entangled probes for bio-sensing (awarded)
4. ONR Entanglement assisted sensor networks MURI (selected)
5. NSF STC bringing together IoT, quantum, networking, control, and AI (going up for SV)
6. ARO MURI on Quantum Network Science (option awarded)
7. DARPA HARQ / Hybrid architectures (I am aware of at least 6 distinct full proposal submissions that CQN faculty are involved in. All the best!)
8. New NST-TIP effort on quantum photonics (planning stage)



CQN: A Gen-4 ERC





Thank you!

CQN Annual Retreat, Tucson 2024

