THE OHIO STATE UNIVERSITY

CENTER FOR QUANTUM INFORMATION SCIENCE AND ENGINEERING

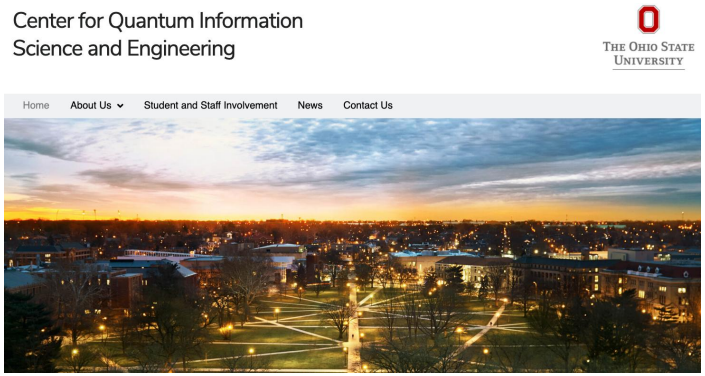
Quantum Center Overview

Ronald M. Reano
Professor, Department of Electrical and Computer Engineering
Co-Director, Center for Quantum Information Science and Engineering

quantum.osu.edu

GPN Quantum Partnership Workshop July 21, 2025

Center for Quantum Information Science and Engineering



Establish — OSU regional hub

Expertise — Reservoir of capability

Coordinate — Partnerships

Amplify — Impact of researchers

Facilitate — Training of students

Identify — Workforce needs

Accelerate — Pivot of faculty

Institutional Support

- CQISE internally funded $250K/year for 3 years
- $10M startup to support QISE faculty hires

Membership

- 42 faculty across OSU
- 6 departments in COE and ASC

Advisory board

- 6 faculty across OSU
- CSE, Chemistry, Math, Physics, ECE, MSE

Center initiatives and activities

- Education at undergraduate and graduate levels
- Infrastructure and test beds (networking, dil fridge, SNSPDs)
- Leverage for faculty hires
- Interdisciplinary post-doctoral fellow program
- Seminars, workshops, and student engagement
- External partnering via Partnership Seed Awards

CQISE Advisory Board

- Supports co-directors in center development and strategic planning

Pooya Hatami
Assistant Professor
Computer Science
and Engineering

Nandini Trivedi
Professor
Physics

Yingbin Liang
Professor
Electrical and
Computer Engineering

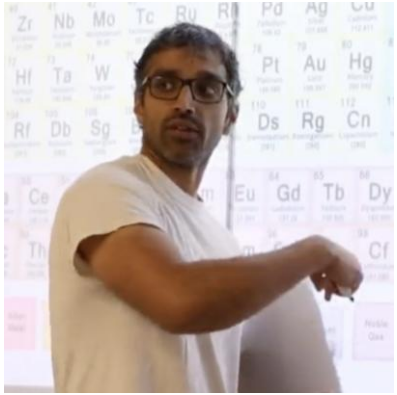
David Penneys
Associate Professor
Mathematics

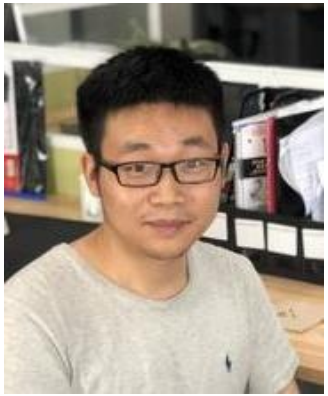
Alexander Sokolov
Assistant Professor
Chemistry
and Biochemistry

Roberto Myers
Professor
Materials Science
and Engineering

CQISE leverage for faculty hires

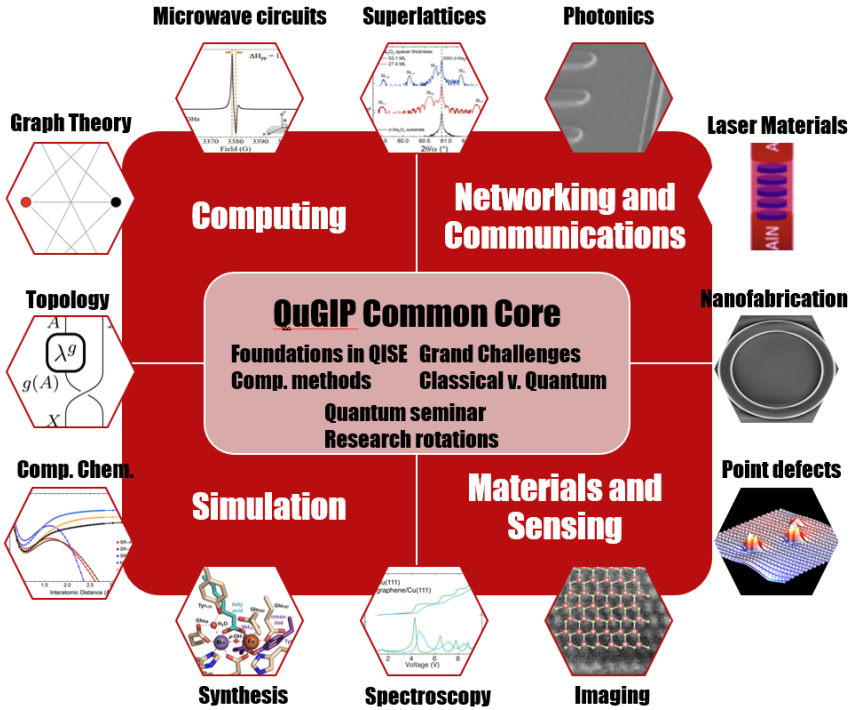
- **Youngseok Kim, ECE, 2025:** superconducting qubit quantum computing
- **Kevin Singh, Physics, 2024:** neutral atom quantum computing
- **Joseph Zadrozny, Chemistry, 2023:** metal ion spin-based quantum information
- **Kaifeng Bu, Mathematics, 2023:** quantum machine learning and resource theory





CQISE Education Initiatives: Interdisciplinary Graduate Program

Support: NSF NRT, $3M



Core faculty from 6 participating Departments across 2 Colleges: Physics, CBC, Math, ECE, CSE, MSE

- Professional MS and PhD options
- Interdisciplinary graduate courses
- Flexible track structure
- Industry engagement

Awarded 9/2023 (PI: Jay Gupta, Physics)
Co-PIs: Zahra Atiq (CSE), Roberto Myers (MSE), David Penneys (Math), Ronald M. Reano (ECE), Nandini Trivedi (Physics)

Quantum Graduate Interdisciplinary Program (QuGIP).

NSF National Quantum Virtual Laboratory (NQVL)

- 2024 $1M NSF NQVL Award (PI: E. Johnston-Halperin)
- OSU Physics/MSE and collaborators (MIT, University of Chicago, University of Iowa)
- Support to create a technology roadmap for the development of quantum sensing of molecular and materials structure and functional properties.

https://new.nsf.gov/news/nsf-national-quantum-virtual-laboratory-advances

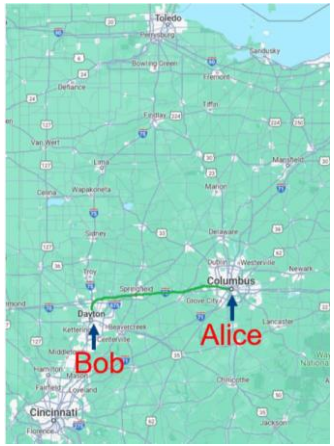
CQISE Quantum Networking Projects

Creating an intercity network for quantum information science and engineering in the State of Ohio

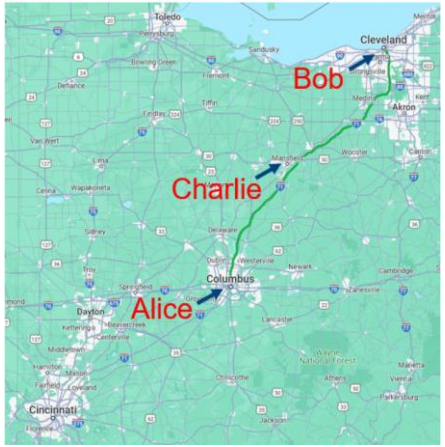
- Congressionally Funded Research Project (CFRP), Department of Education, 2023 - 2026, $1M
- PI: Ronald M. Reano, Co-PI: Ezekiel Johnston-Halperin, OARnet: Pankaj Shah, Mark Fulmer

Creating long distance quantum networks for cybersecurity in the state of Ohio

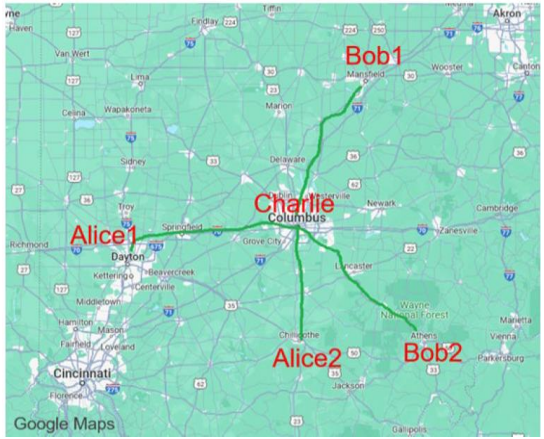
- Ohio Third Frontier Research Incentive, Ohio Department of Higher Education (ODHE), 2024 – 2025, $750k
- PI: Ronald M. Reano, Co-PI: Ezekiel Johnston-Halperin, OARnet: Pankaj Shah, Mark Fulmer



P2P QKD



MDI QKD CONCEPT



STAR NETWORK MDI QKD CONCEPT

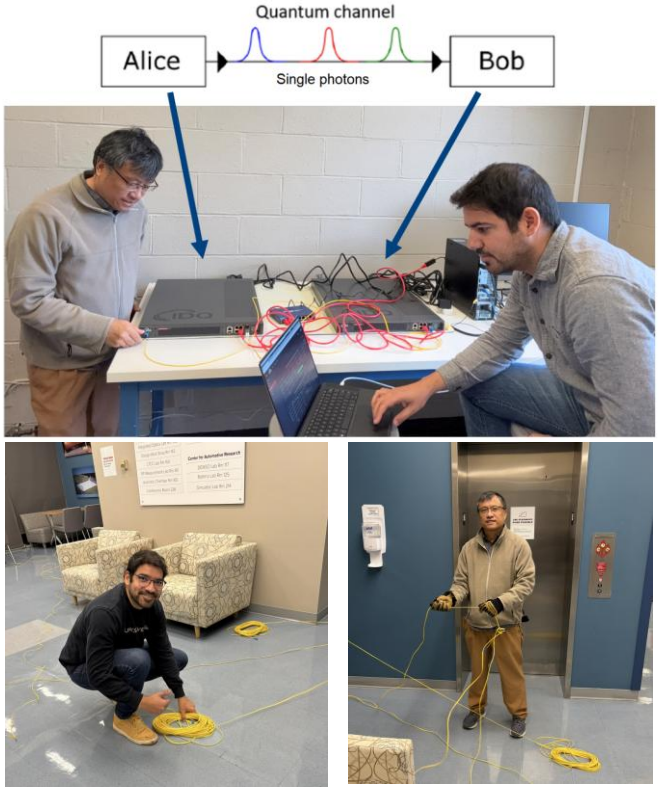
Emerging partnerships

- AFIT
- NGRC
- Cisco
- Honda
- Huntington Bank
- Columbus State
- Starlab

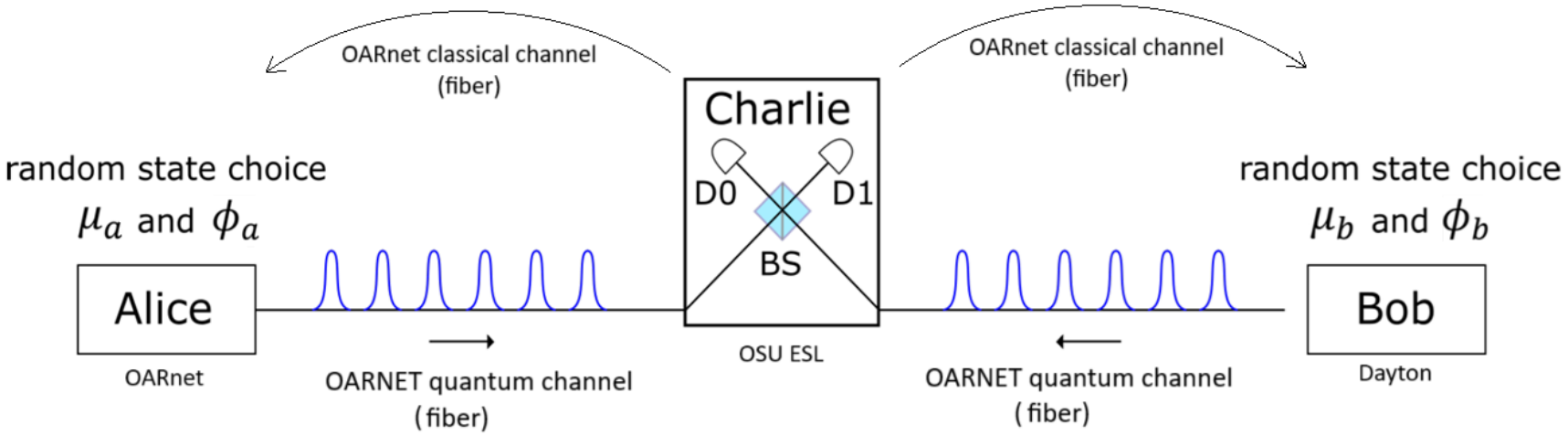
BB84 QKD at OSU

ALICE: OARnet, BOB: ESL, 1/2 mile walk

1.6 dB optical fiber loss at 1550 nm wavelength



Measurement Device Independent QKD (MDI-QKD)



Li et al, Physical Review Letters 2023

Measurement Device Independent QKD (MDI-QKD)

- Custom build based on discrete components underway to implement MDI-QKD over OARnet fiber

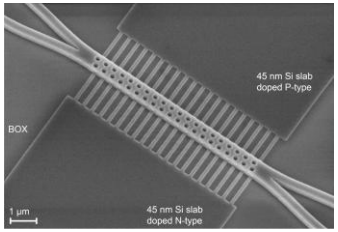
ALICE
Laser
Intensity modulator
Phase modulator
Beam splitters
Multiplexers
Variable optical attenuators
Single photon detectors
FPGAs

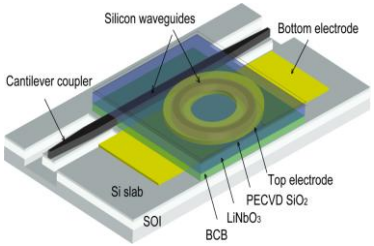
CHARLIE
Single photon detectors
Polarization controllers
Multiplexers
Beam splitters
FPGA

Bob
Laser
Intensity modulator
Phase modulator
Beam splitters
Multiplexers
Variable optical attenuators
Single photon detectors
FPGAs

Chip-scale integrated optics and photonics

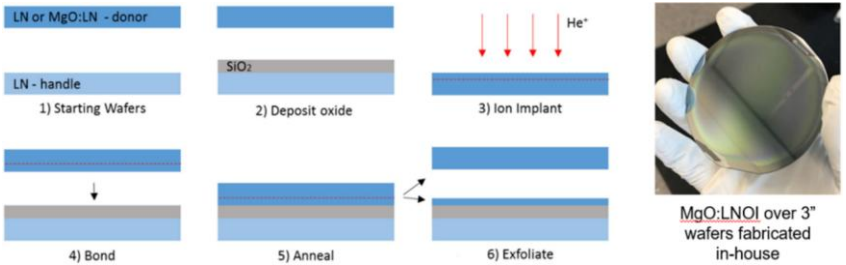
(1) Waveguides for enhanced light-matter interaction





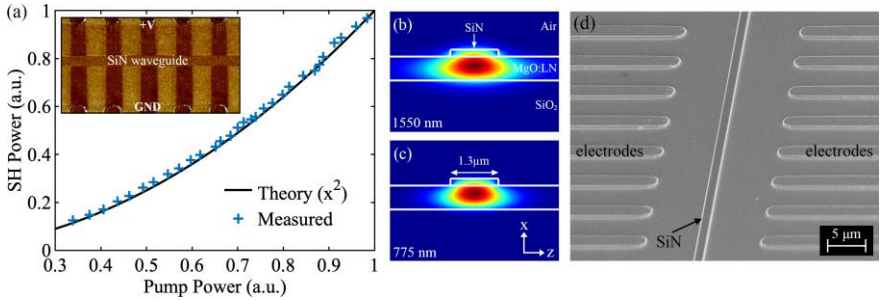
- Modulators, switches, polarization controllers, fiber to chip couplers, wavelength converters

(2) Wafer scale ion-slicing (NSF MRI CMP)



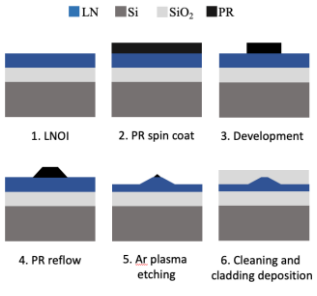
J. Nagy and R. M. Reano, Optical Material Express 2019

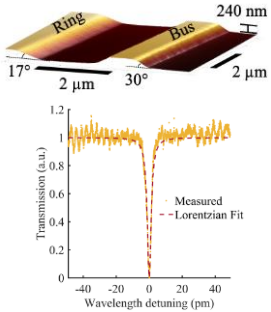
(3) Quasi-phase-matched periodic poling



J. Nagy and R. M. Reano, Optical Material Express 2020

(4) Low loss waveguides for conversion efficiency



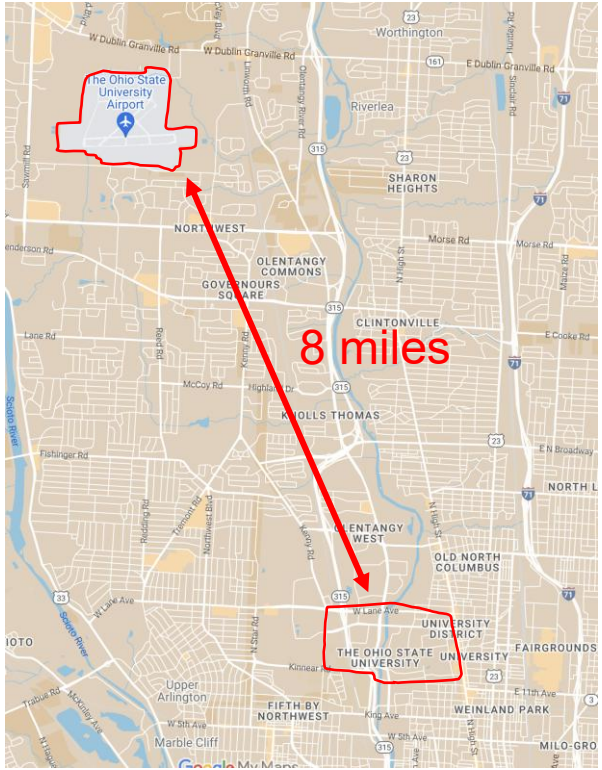


0.5 nm RMS
$Q_i = 10^6$

K. Prabhakar and R. M. Reano, IEEE Photonics Journal 2022

reano.1@osu.edu
u.osu.edu/reano.1
quantum.osu.edu

CQISE Research Initiatives: Ohio State and Starlab



ISS Ending in 2030

- Continuous Human (and American) presence since November 2000
- NASA now moving beyond Government Space Stations, to the Commercialization of low-Earth Orbit (LEO)
- Three awards made in December 2021 for Commercial, free-flying space stations in LEO

Nanoracks *Starlab*

- One-launch-operational commercial space-station, Q4/2027 Launch date
- 4 full-time crew, interior, exterior payloads
- 60kW, 350 m^3 volume
- In-Space-portion of the *George Washington Carver Science Park GWCSP*

Ohio and Ohio State

- Significant roles in *Starlab-GWCSP*
- **Ohio State** - global research community development, ground analogs, test facilities, STEM outreach, commercialization. Columbus, Ohio
- **Zin Technologies** - Research hardware development. Cleveland, Ohio
- **USRA** - Science Park Operations. Cleveland, Ohio

Terrestrial Analog Facility

- Full-up "physical twin" and support laboratories for flight, on OSU campus
- Proposed by Ohio State, in negotiation
- Integrated ground/flight domain for R&D, including quantum communications
- Experiment development, testing, procedures, prototyping, subsystems
- STEM education, outreach, engagement

CQISE Initiatives: Partnership seed awards

Goal: to connect OSU with external partners through small collaborative projects with the intent of growing the interaction into a larger award.

Martin Kong, OSU CSE and **Brookhaven Natl Labs**:
"Compiler-Assisted Physics-Driven Quantum Optimal Control for the 1+1 Field Theory Model"

Zhihui Zhu, OSU CSE and **Army Research Laboratory**:
"Nonconvex Optimization for Efficiently Characterizing Quantum Network"

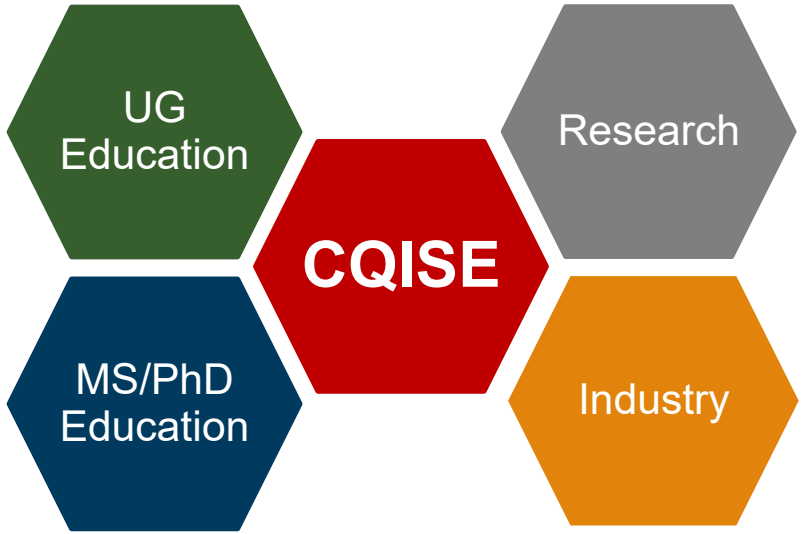
Chen Chen, OSU ISE and **Purdue University**:
"Quantum Computing Acceleration for Integer Programming"

2025 PSA Awards focused on support for cloud computing time with IBM Quantum

Connecting with industry

CQISE partnership with industry initiative

- **Industry/university consortium**
  - Membership based model
  - Annual meeting at OSU
  - Faculty/student projects with industry input
  - Summer short courses taught by faculty in Physics, ECE, Math
    - Quantum entanglement, networking, qubits, error correction, math methods
- Developing industry-university agreement documents
- Summer short courses piloted in 2024



CQISE Seminars, Workshops, Student Engagement

Goal: Create regularly occurring seminars, workshops, events

- Objective to educate our students and research community
- Focus on emerging challenges and opportunities

CQISE Student Board Organized

OSU-Battelle Faculty/Researcher Workshop

Quantum Center Dialogue monthly brown-bag

Post-doctoral fellowship program

Intel Quantum Software Development Kit in courses

quantum.osu.edu

Center for Quantum Information Science and Engineering

THE OHIO STATE UNIVERSITY

Home | About Us | Student and Staff Involvement | News | Contact Us