

Center for Quantum Networks

NSF Engineering Research Center

Engineering Workforce Development

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Funded by National Science Foundation Award #1941583



UNIVERSITY OF
MARYLAND

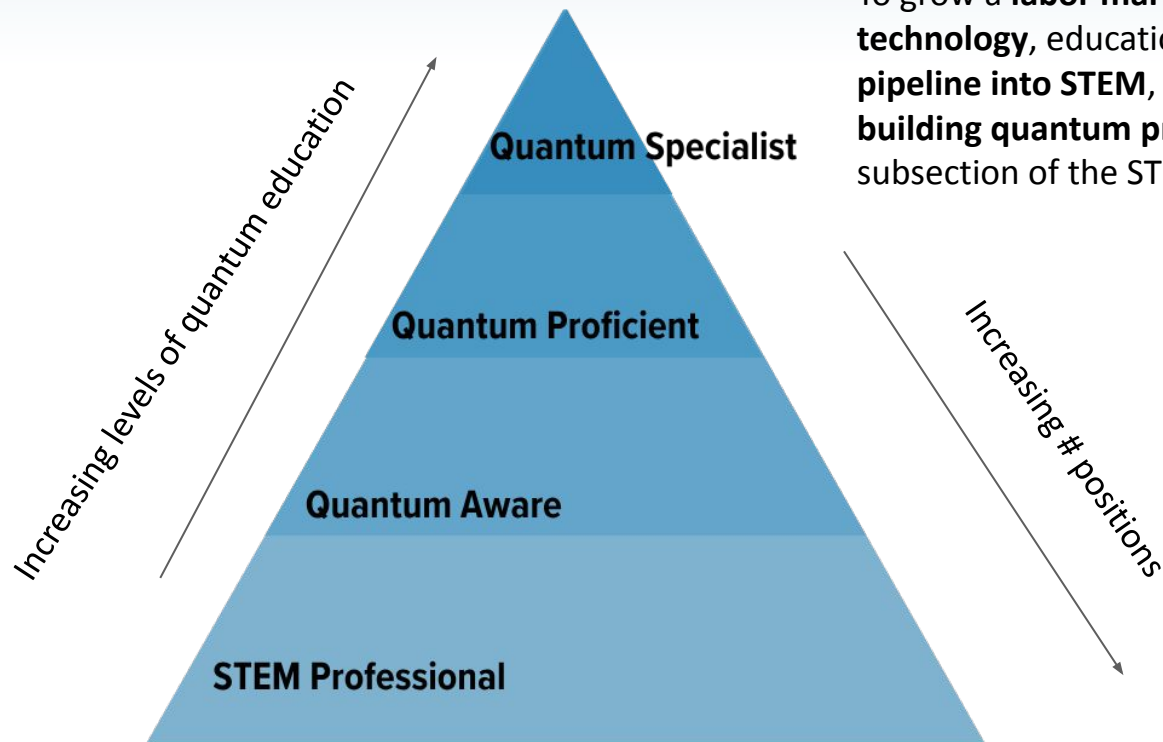
University of
Massachusetts
Amherst RE REVOLUTIONARY



NAU
NORTHERN
ARIZONA
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UNIVERSITY OF
OREGON



To grow a **labor market supportive of quantum science and technology**, education initiatives should focus on a **broad pipeline into STEM**, introducing learners to QSE and **building quantum proficiency** and expertise with a smaller subsection of the STEM workforce.



STRATEGY

INSPIRE

Engage learners in **new exploration** of quantum science and engineering

- Community and K12 outreach
- Online short courses
- Undergraduate bootcamps



STRATEGY

INSPIRE

EDUCATE

Provide **coursework**, **workshops**, and **formalized learning** to enhance knowledge and credentials of STEM/QSE professionals

- Graduate degree programs and certificates
- Undergraduate coursework and QSE minors
- Innovative collaborative course offerings



STRATEGY

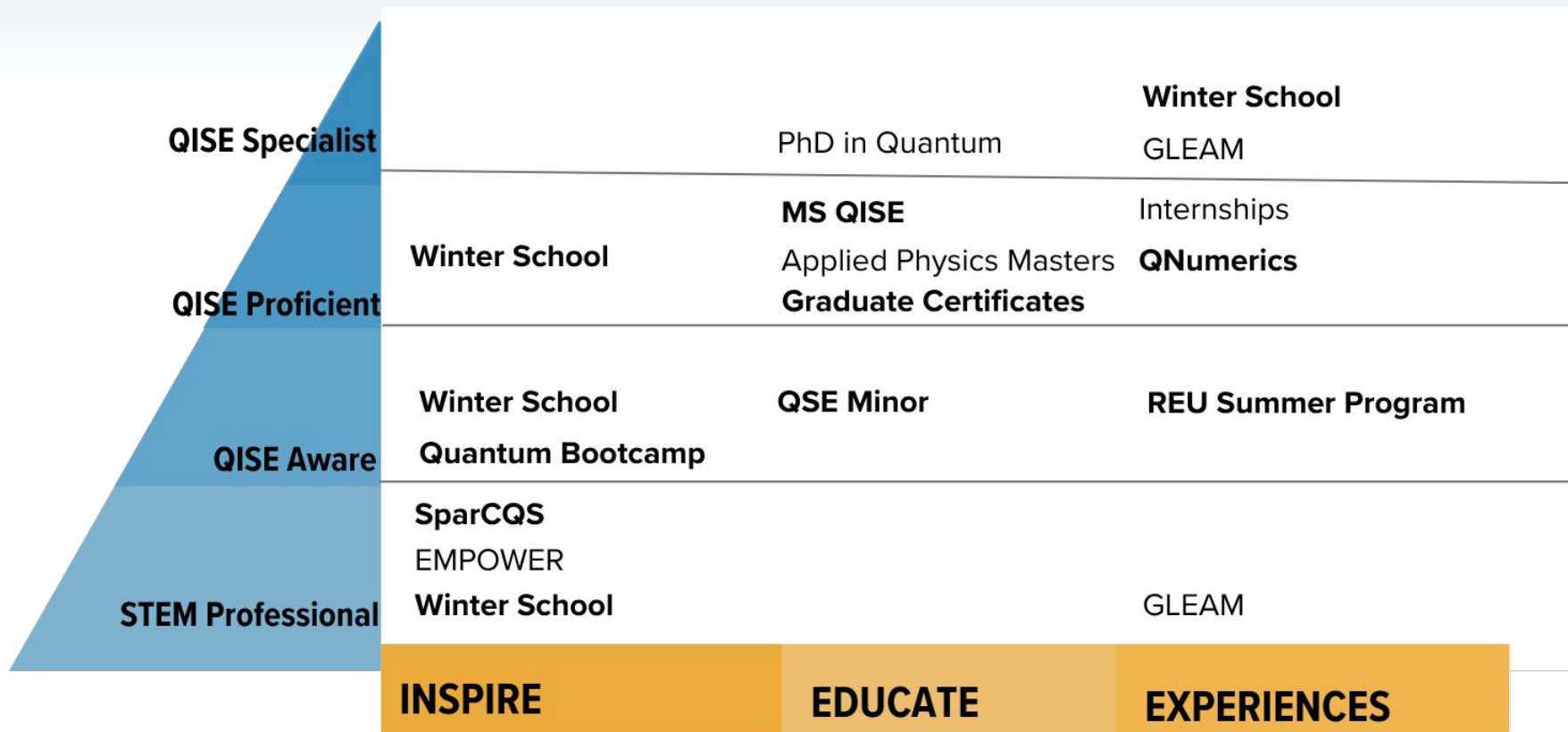
INSPIRE

EDUCATE

EXPERIENCES

Cultivate **experiential learning opportunities** with industry and academic partners

- Research Experiences for Undergraduates
- Industry internship opportunities/partnerships with our IAB
- Young Scholars mentored research



SparCQS

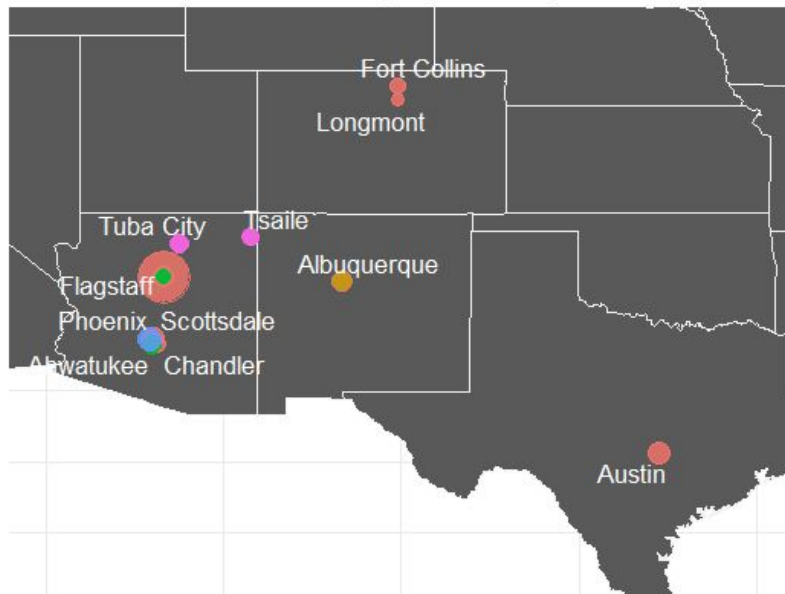


SparCQS @ Barrett Jackson
01/20/2024



SparCQS Events and Learners in 2024-25

Southwest Region (AZ-TX-CO)



Target Group

- Community
- Community College
- High School
- K12
- Middle School
- Primary School



INSPIRE

EDUCATE

EXPERIENCES



Winter School

- **January 6th - 10th**
- Cultivates graduate student teaching and curriculum development skills
 - Based on the Science Literacy Program established at UOregon
- **7,001** registrations in 2025

****Winter School 2026****
January 5-9

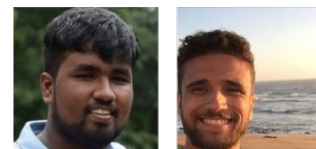
	Mon.	Tues.	Wed.	Thurs.	Fri.
MORNING	The Physics Behind the Quantum Internet	Information in a Photon	Principles of Quantum Networks	Exploring & Designing Quantum Networks via Digital Twin Simulations	Quantum Network Integrated Devices & Systems
AFTERNOON	Getting Up to Speed on Quantum Networks	Theory of Quantum Channels	Error Correction for Quantum Networks	Integrated Photonics Platforms for Quantum Networks	Molecular Design with Relevance to Quantum Networks

LEVEL 1 no experience

LEVEL 2 some quantum + undergraduate math

LEVEL 3 upper division undergraduate math

LEVEL 4 graduate quantum



INSPIRE

EDUCATE

EXPERIENCES



Community College Webinar

February 24th-28th | 15 participants

October 13th-18th | 25 participants

Mon	Student Panel
Tue	Advisor Q & A
Wed	Industry Storytelling
Thur	Career Development



Objective:

- Introduce community college students to quantum science and engineering majors and career opportunities
- Bring community college students into REU opportunities

Future Goals:

- Develop programming for community colleges across the country
- Incorporate other Center institutions

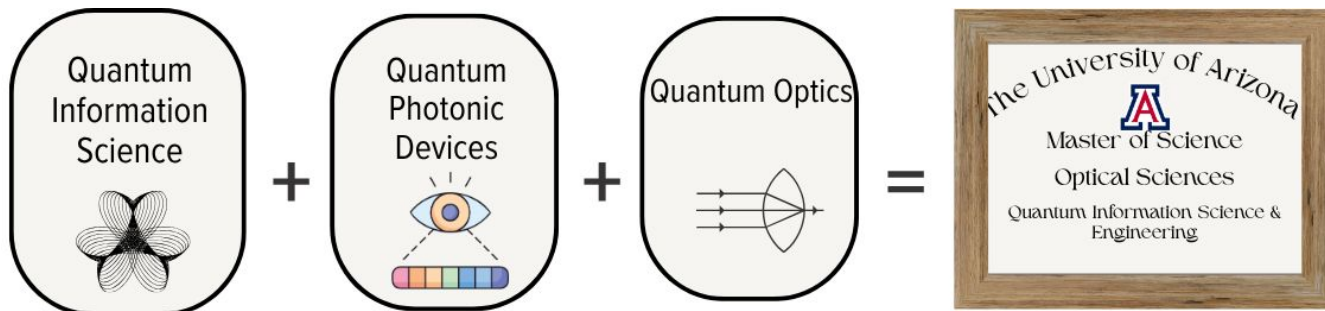
INSPIRE

EDUCATE

EXPERIENCES



CQN Graduate Certificates



Three online, stackable certificates
developed for professional
re-training in response to industry

- ➡ Quantum Optics
- ➡ Quantum Information Science
- ➡ Quantum Photonic Devices

Three certificates contain the
coursework for a **full Masters in Optical
Sciences QISE subplan**

INSPIRE

EDUCATE

EXPERIENCES

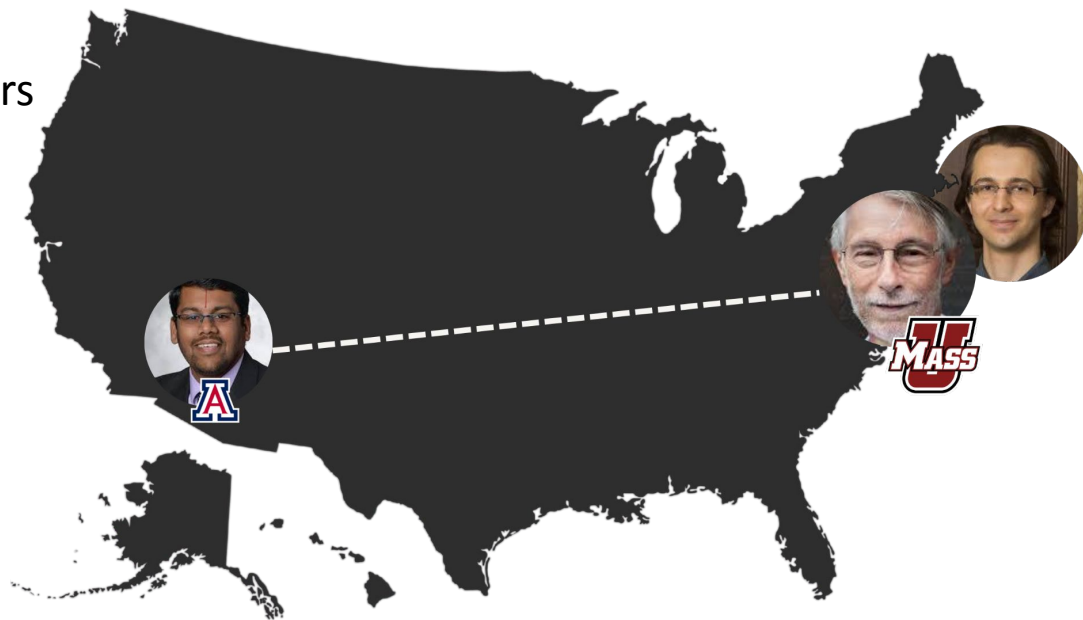


Synergistic Graduate Coursework

Two CQN Institutions; **Three** professors

One course in Error Correction for
Quantum Computing

Students from each institution take
the same course together



INSPIRE

EDUCATE

EXPERIENCES



QNumerics

Virtual Testbed Coding School

July 14th - 18th | 80 learners (30 UMass, 50 external)

Daily Schedule from **9am to 10:30pm** with long breaks between sessions

	Mon.	Tues.	Wed.	Thurs.	Fri.
MORNING	introduction	state-vector simulation	optimal control of quantum systems	efficiently simulating large circuits	discrete-event simulation
AFTERNOON	high-performance programming	simulating quantum dynamics: pt I	GPU acceleration	tensor networks	simulating quantum networks
EVENING	linear algebra	simulating quantum dynamics: pt II	hack-a-thon: GPU + Piccolo	hack-a-thon: tensor networks	hack-a-thon: HPC + quantum networks



INSPIRE

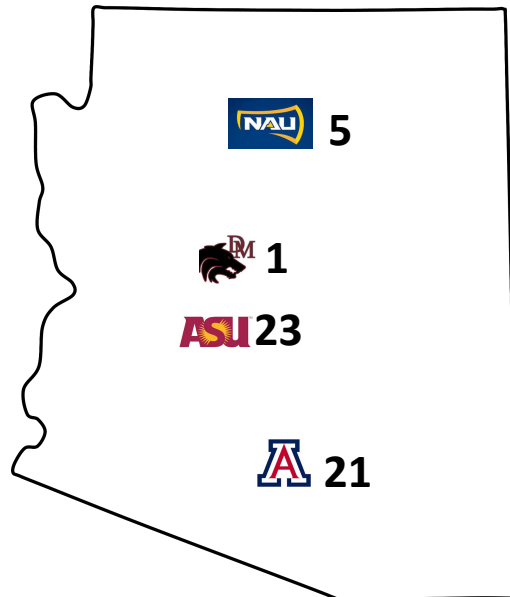
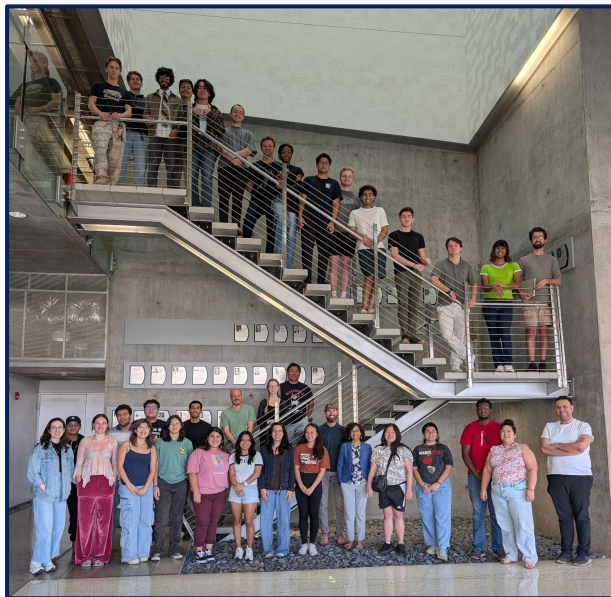
EDUCATE

EXPERIENCES



Quantum Bootcamp

August 17th - 22nd | 50 participants from across Arizona



INSPIRE

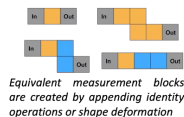
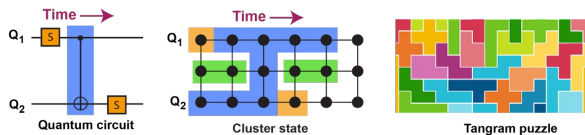
EDUCATE

EXPERIENCES



EWD Challenges

Tangram



The game interface at the start – minimal blocks for the Clifford gates, CZ, SWAP, identity, and Pauli measurements are given. Intermediate stage – player can drag and drop fundamental blocks, append identity gates and rotate the selected block.



Two equivalent solutions of a quantum circuit challenge



Final screen – Correct solution that minimizes filled area ranks higher.

Q3 Initiative



Future Fellowships



INSPIRE

EDUCATE

EXPERIENCES



Research Experiences for Undergraduates



- **17** participants across **7** academic and industry sites
- Team building kickoff at the University of Arizona campus before students
- Weekly professional development workshops throughout the summer
- *Next Steps Week* during final week focused on graduate school opportunities and continuing undergraduate research
- **~135** applicants
 - New integration with the NSF ETAP system
- **4** community college transfer students
- **13** students from low-income backgrounds
- **2** students returning from prior years
 - Brizia Chavez (UOregon)
 - Aaron Bordeaux (Harvard)

Research Experiences for Undergraduates

Leo Herrera

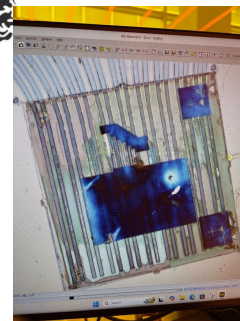
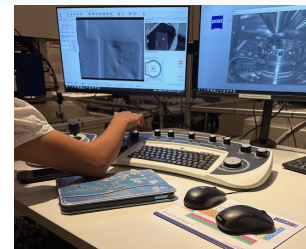
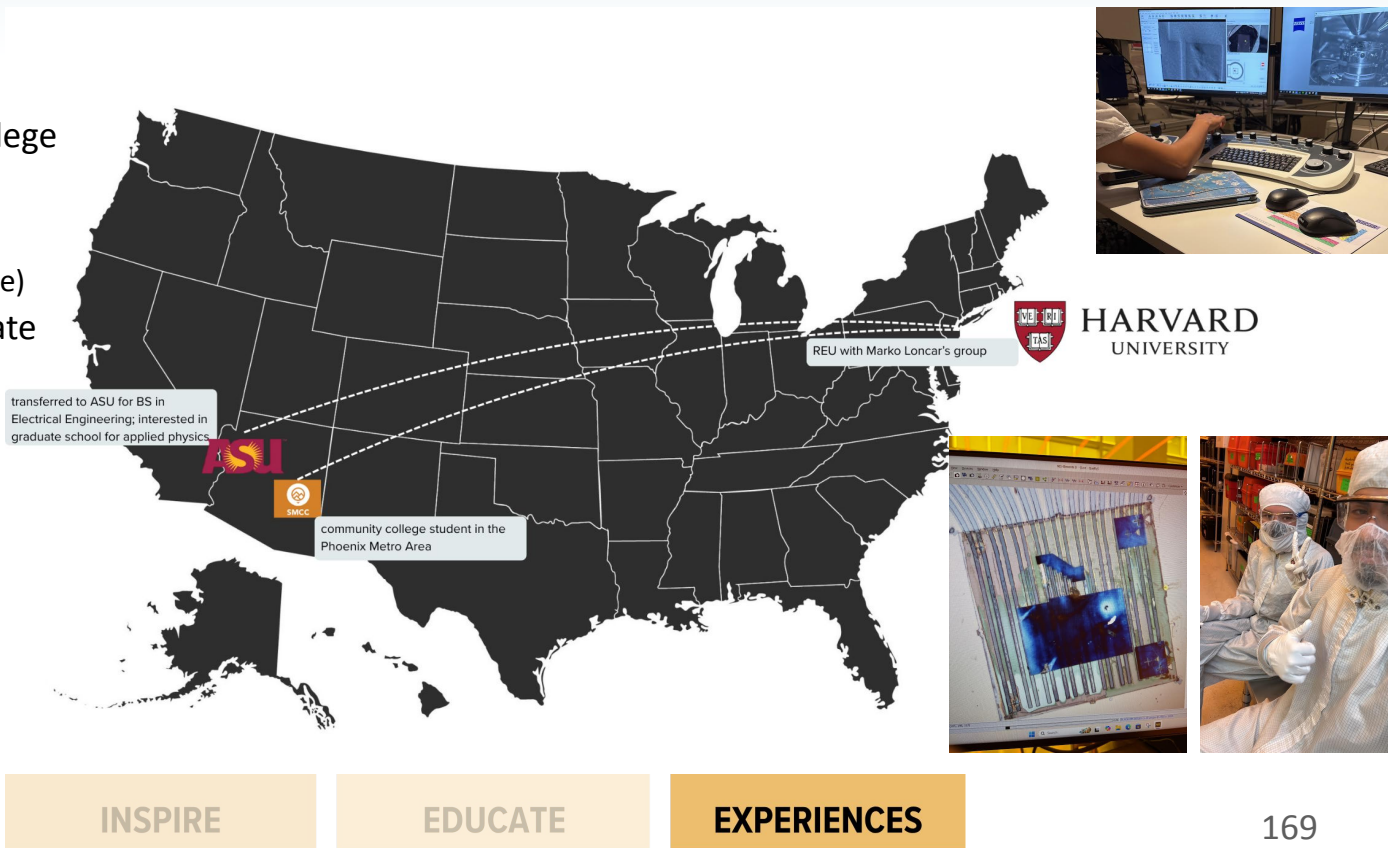
First in his family to attend college

Pell recipient

Community College transfer

(South Mountain CC to Arizona State)

Cultivated interest in graduate school at REU





Research Experiences for Undergraduates

Nano-electromechanical actuation device made for diamond defect applications

Leonardo Herrera¹, Katie Barajas², Marko Lončar²

¹South Mountain Community College, Phoenix, Arizona

²Harvard John A. Paulson School of Engineering & Applied Sciences, Cambridge, MA

NSF Engineering Research for Quantum Networks, NSF EEC-1941583



National
Science
Foundation

ASU Arizona
State
University



SOUTH MOUNTAIN
COMMUNITY COLLEGE



Harvard John A. Paulson
School of Engineering
and Applied Sciences

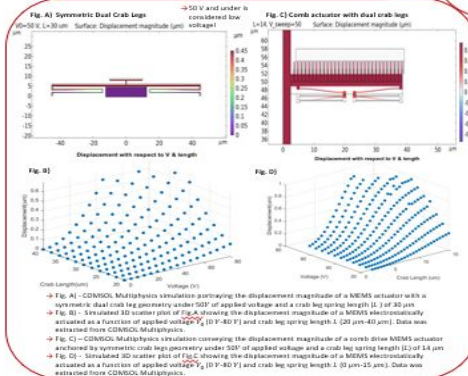


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Abstract

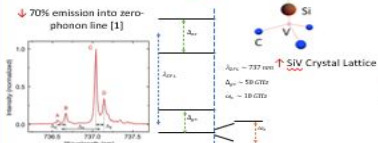
The silicon vacancy center in diamond (SiV^-) has proven to be an ideal platform for quantum systems due to long coherence time for spin states, bright emission into the zero-phonon line, and stability in nanostructures. While nanostructures enhance properties of the SiV^- , recent work has demonstrated the ability to tune SiV^- properties through engineering electromechanical devices in diamond. By introducing electromechanically actuated structures, we open up the possibility to develop mechanisms for photon routing and tuning, enabling the progression of quantum node efficiency and scalability. Inspired by work done in other material platforms, we present progress toward a tunable directional coupler consisting of two coupled waveguides whose distance is adjusted by an external voltage. This design is tailored for SiV^- platform applications including photon routing via directional coupling, tunable gaps for cavity coupling, and related quantum photonic operations.

Micro-electromechanical structure (MEMS) actuation in SiV Platforms



SiV for Quantum Networks

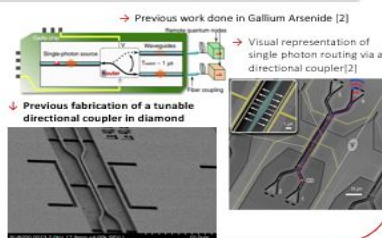
→ Why Silicon Vacancy Centers (SiV^-)?



→ Motivation: Introduce a versatile and energy efficient electromechanically actuated directional coupler to SiV platforms to enable the progression of quantum node efficiency and scalability.[1]

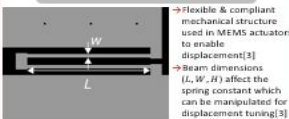
Background

Previous Application of a Directional Coupler

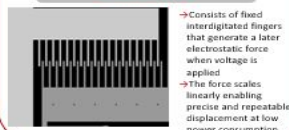


MEMS Structures

Crab Leg



Comb Drive



Outlook

→ Demonstrate single-photon routing in SiV center platforms

→ Long Term:

→ Further enhance directional coupler to enable on-chip photon entanglement and other fully integrated photonic applications

References

- [1] T. W. O'Leary et al., "Optical properties of silicon-vacancy spins in diamond," *Adv. Opt. Technol.*, vol. 4, no. 1, p. 101, Feb. 2014.
- [2] T. W. O'Leary et al., "Nonreciprocal single-photon routing," *Optica*, vol. 6, no. 4, pp. 530–535, Apr. 2019.
- [3] T. W. O'Leary et al., "Nonreciprocal single-photon routing," *Optica*, vol. 6, no. 4, pp. 530–535, Apr. 2019.

Acknowledgements

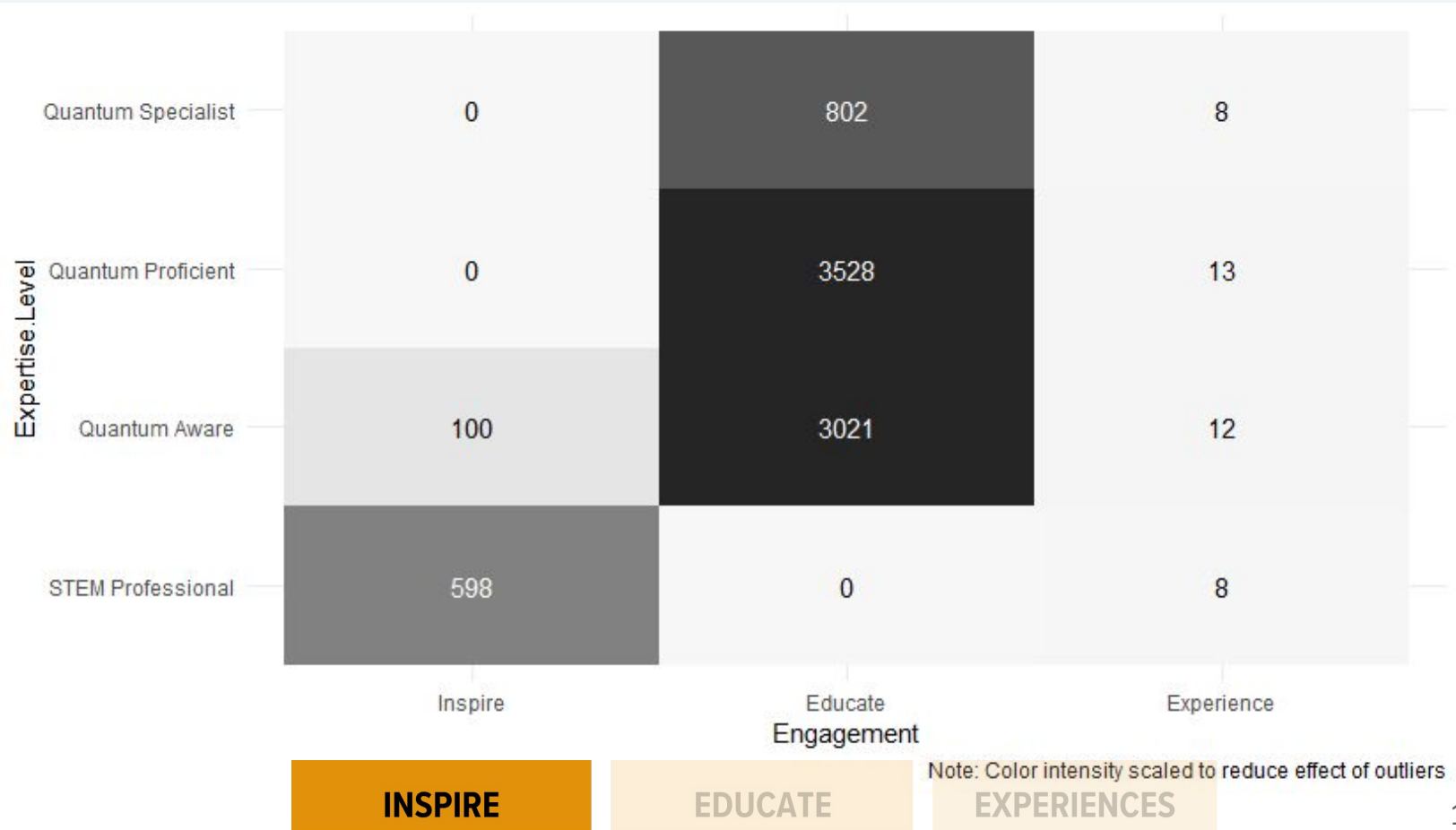
Thank you to my funding sources, NSF & CQN, for giving me this once in a lifetime experience of conducting research at Harvard University. Also, thank you to Marko Lončar and his research group for welcoming me into the group for the summer. Thank you, Katie Barajas, for mentoring me throughout my journey. I couldn't have done it without you!

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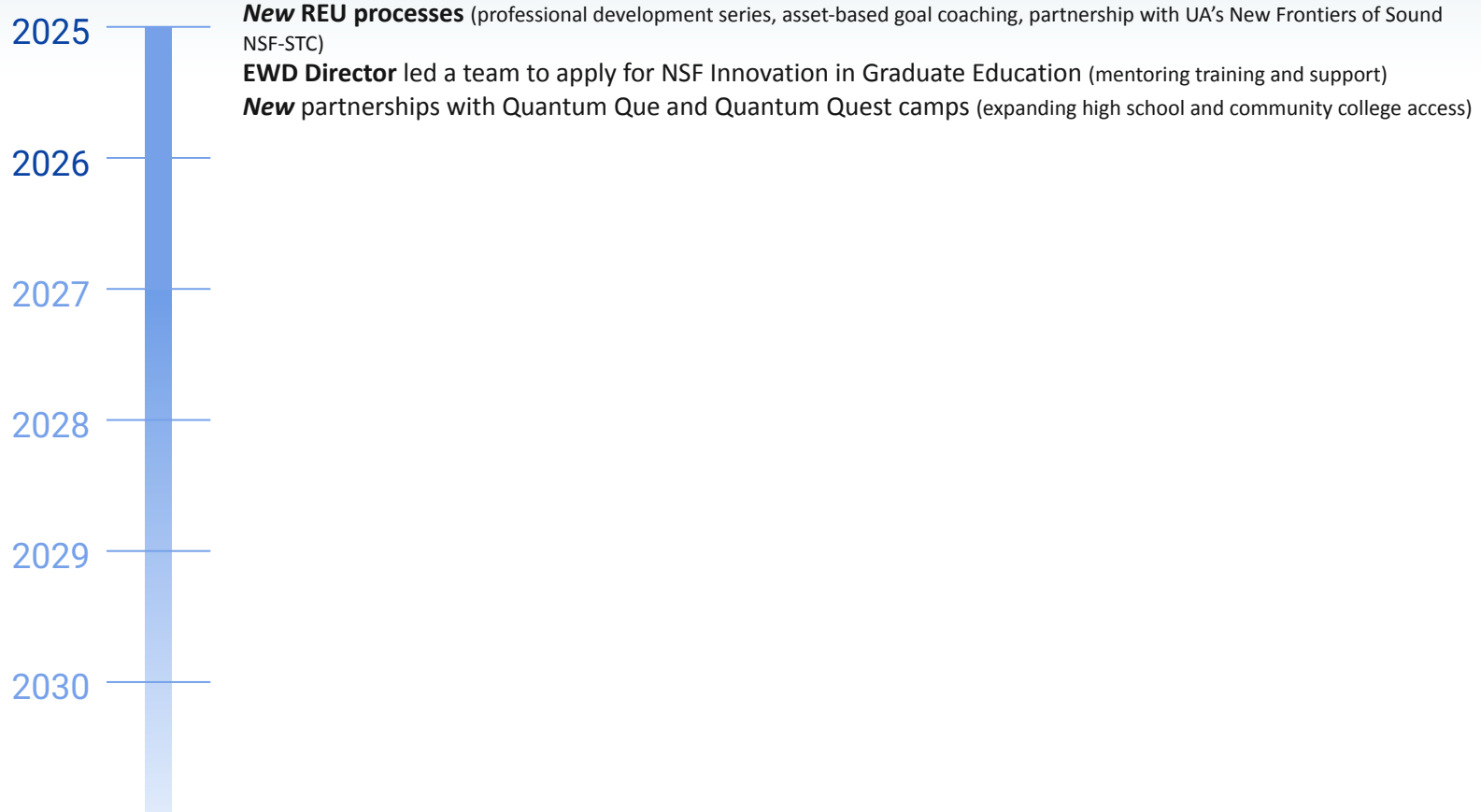
LinkedIn Profile







Years 5-10 Goals (EWD)





Years 5-10 Goals (EWD)



2025

New REU processes (professional development series, asset-based goal coaching, partnership with UA's New Frontiers of Sound NSF-STC)
EWD Director led a team to apply for NSF Innovation in Graduate Education (mentoring training and support)
New partnerships with Quantum Que and Quantum Quest camps (expanding high school and community college access)

2026

Winter School will be used to promote graduate **certificates**, **master's** programs, and **PhD** programs across the Center
REU Mentors will benefit from **new** mentor training and support framework

2027

New graduate certificate programs at UA (Quantum Photonic Devices, Quantum Optics, Quantum Information Science)
EWD Challenges provide critical leadership opportunities (outreach demonstration development, REU retention)

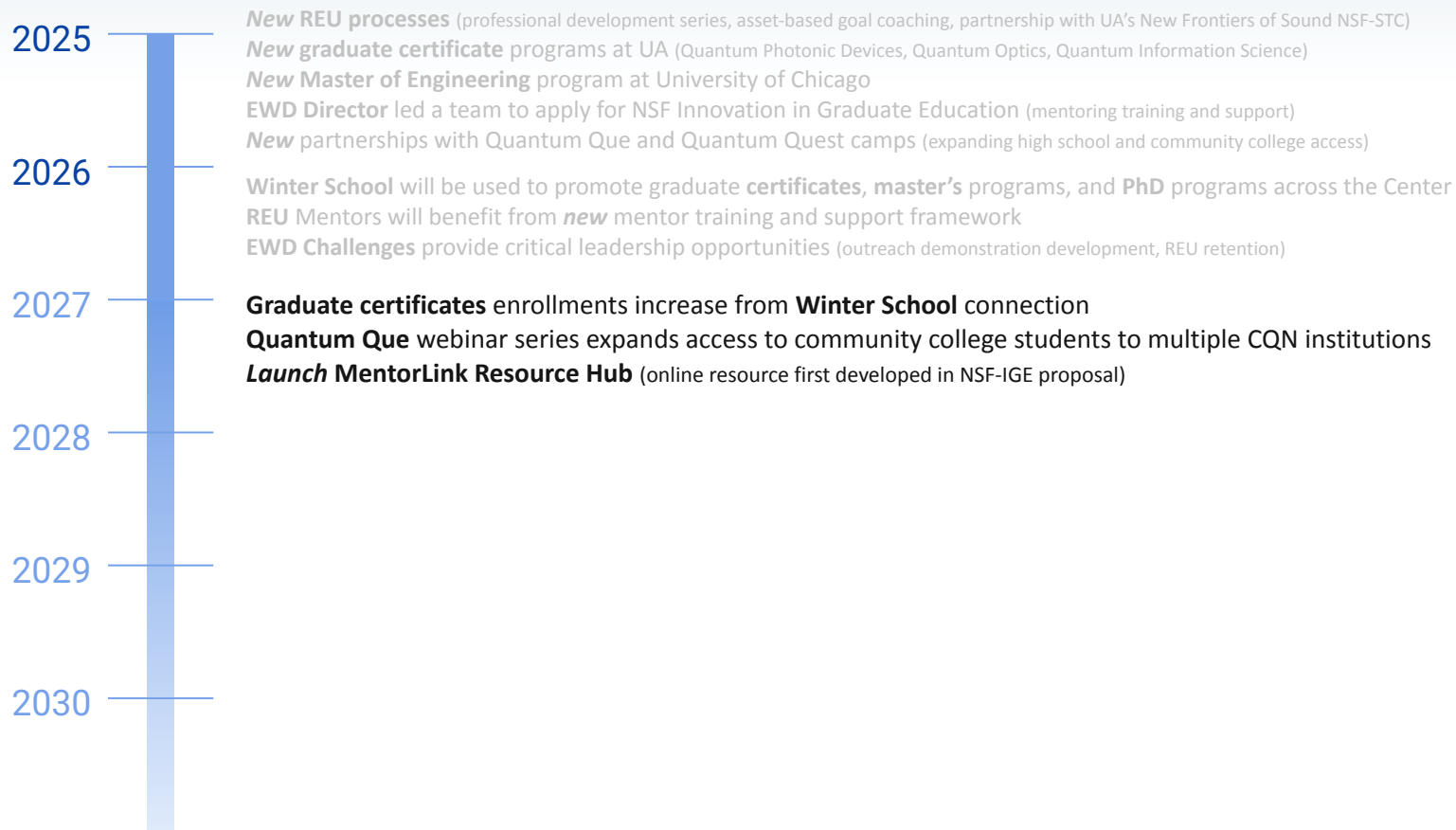
2028

2029

2030

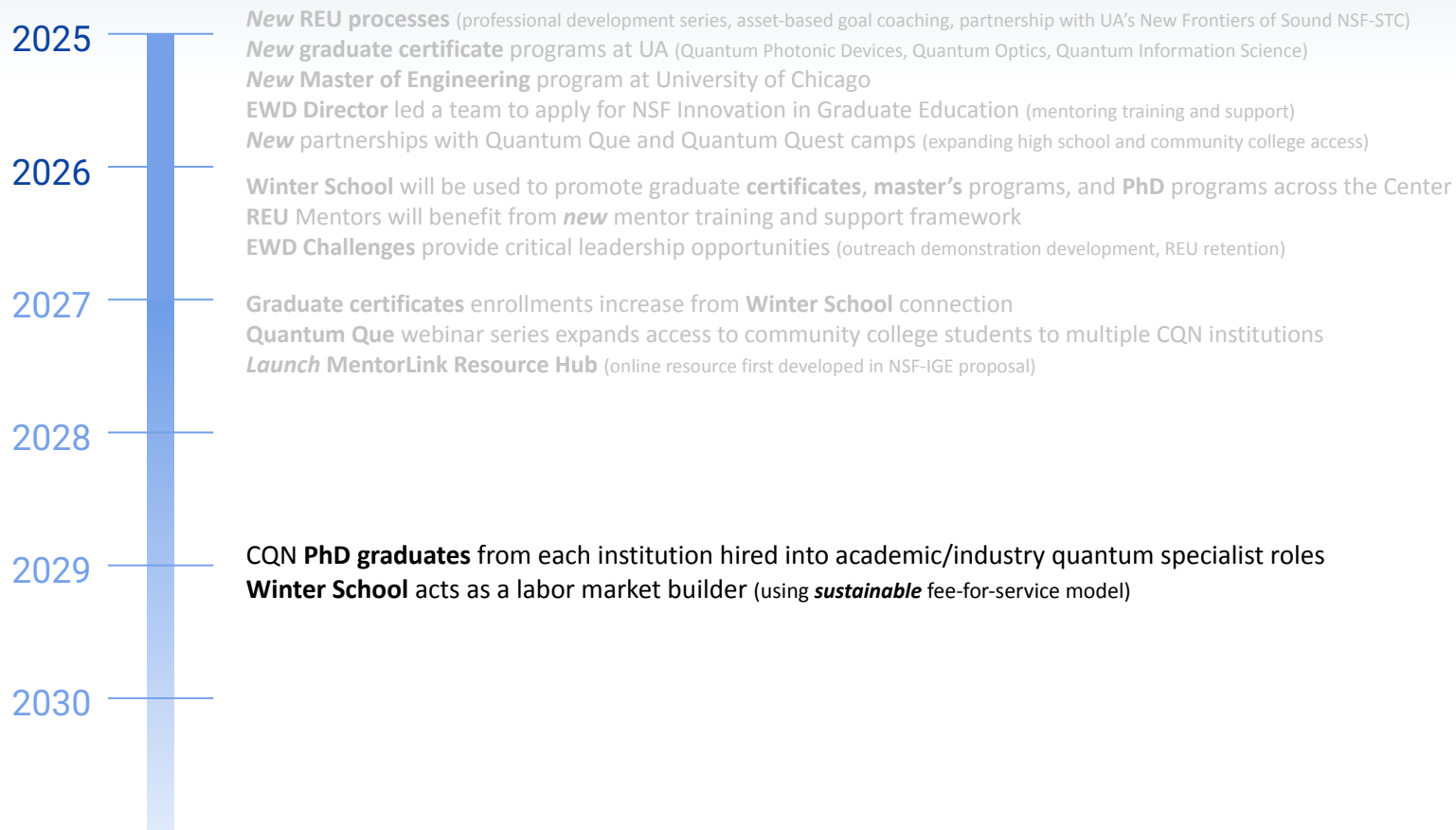


Years 5-10 Goals (EWD)





Years 5-10 Goals (EWD)





Years 5-10 Goals (EWD)

