



Quantum Information Science and Engineering

Opening Remarks for EPSCoR Workshop on Quantum Computing and QISE

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NSF QISE Partners:

CISE – Directorate for Computer Information Science and Engineering

ENG – Directorate for Engineering

EDU – Directorate for STEM Education

TIP – Directorate for Technology, Innovation and Translation

NSF-Wide Investment Focus

Build on Multiple Decades of Core Investments:

- ❖ More than 3000 awards and 2000 unique PI's over 40 years
- ❖ NSF Big Idea – Quantum Leap
- ❖ NSF Emerging Industry – QISE
- ❖ ~\$330M FY22 Actuals in QISE

Expand Participation:

- ❖ Broaden disciplinary focus of participants
- ❖ Bring in more end-user communities
- ❖ Increase geographical distribution of awardee institutions
- ❖ Increase diversity of types of awardee institutions
- ❖ Identify more potential partners

Grow Workforce:

- ❖ Address near-term and long-term diverse workforce needed to retain US leadership in QISE



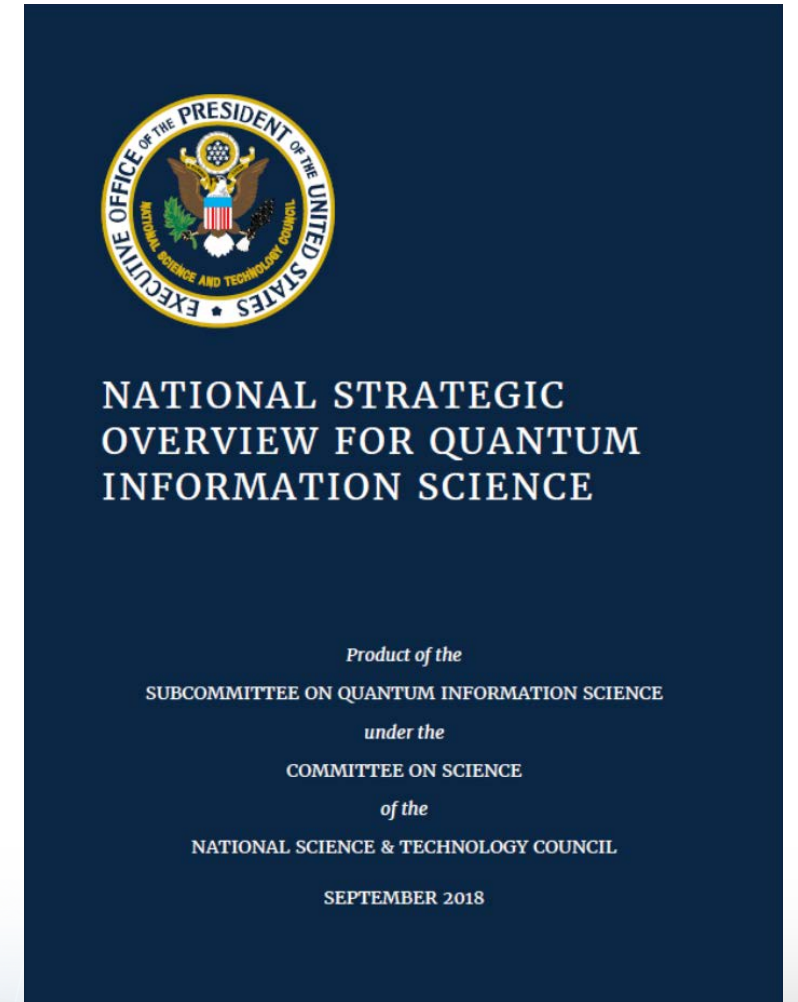
U.S. National Strategy for QIS - Overview

NSF Co-chairs the White House OSTP NSTC subcommittee on Quantum (NSF, DOE, NIST)

Six QIS policy thrusts:

1. Use a science-first approach to QIS R&D
2. Build a quantum-capable, diverse workforce
3. Nurture nascent quantum industry
4. Provide key infrastructure
5. Balance economic and national security
6. Encourage international cooperation

Input into the National Quantum Initiative (NQI)



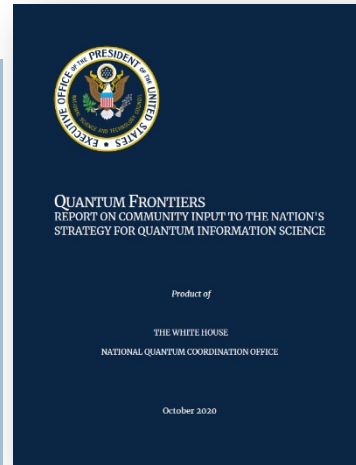
Learn more at: <https://www.quantum.gov>



U.S. National Strategy for QIS - Expanded

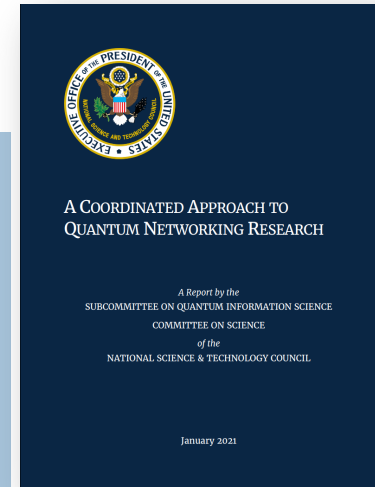
Quantum Frontiers / 2020

1. Pioneer Applications that Benefit Society
2. Build the Discipline of Quantum Engineering
3. Use Targeted Materials Science for QIST
4. Explore Quantum Simulation Applications
5. Advance Precision Measurements with QIST
6. Entanglement Distribution Applications
7. Mitigate Quantum Errors (Suppress / Correct)
8. Understand the Universe via QIST



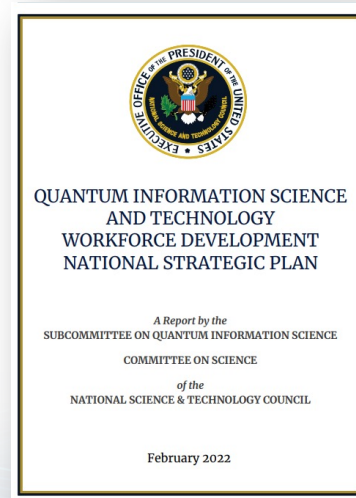
Quantum Networking Strategy / 2021

- 1: Continue Research on QN Applications
- 2: Prioritize Cross-Beneficial Core Components
- 3: Improve Classical Technologies for QIS R&D
- 4: Leverage “Right-Sized” Quantum Testbeds
- 5: Increase Interagency Coordination
- 6: Establish Timetables for R&D Infrastructure
- 7: Facilitate International Cooperation on QN



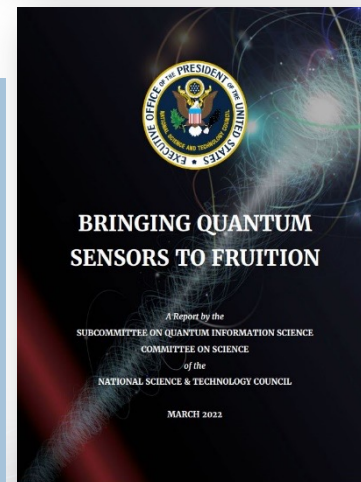
Workforce Development Strategy / 2022

1. Develop and maintain an understanding of the workforce needs in the QIST ecosystem with both short-term and long-term perspectives;
2. Introduce broader audiences to QIST through public outreach and education;
3. Address QIST-specific gaps in professional education and training opportunities;
4. Make careers in QIST and related fields more accessible and equitable.



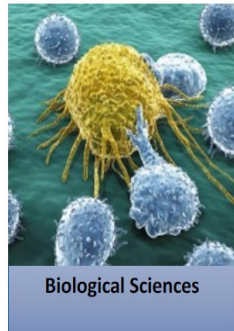
Quantum Sensing Strategy / 2022

1. QIST R&D leaders should partner with end-users to raise the TRL of new quantum sensors
2. Agencies using sensors should test quantum prototypes jointly with QIST R&D leaders
3. Develop broadly applicable components and subsystems
4. Streamline tech transfer and acquisition practices

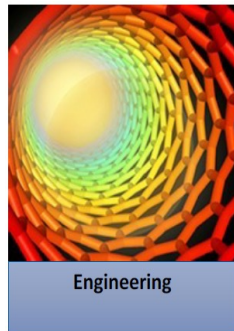


Learn more at: <https://www.quantum.gov>

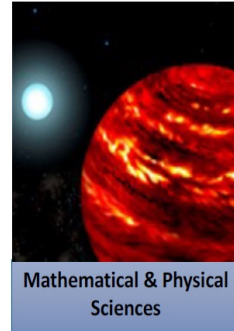
NSF Awards for QIS foster scientific breakthroughs and develop the talent that is essential for U.S. leadership in QIS



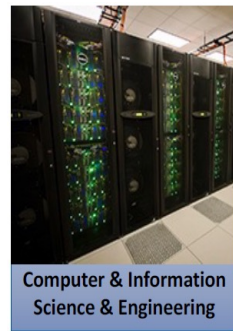
BIO



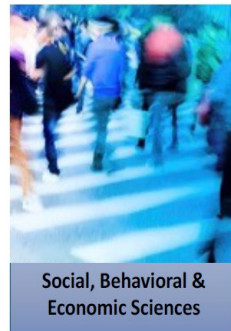
ENG



MPS



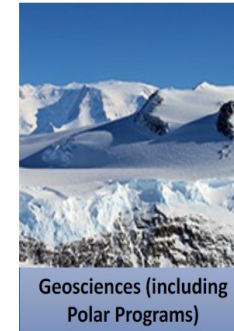
CISE



SBE



EDU



GEO



TIP

Core and Crosscutting QIS Programs Include:

- 20+ Core Programs in 9 Directorates
- Quantum Leap Challenge Institutes
- TAQS programs: Incubator; Interconnects; Sensing
- Expand-QISE: Broadening Participation

Programmatic Goals in QIS:

- Advance Science and Engineering in *Quantum Frontiers*
- Enable Multidisciplinary Collaboration
- Develop Workforce in the Context of Cutting-Edge Research
- Translate Basic Research into End-User Capabilities



QISE

CORE to address NQI Act

- Core programs, especially in MPS, ENG, CISE
- Transformational Advances in Quantum Systems (TAQS)
 - Idea Incubator
 - Quantum Interconnects
 - Quantum Sensors

Centers and Institutes

- Quantum Leap Challenge Institutes
- ERC, STC, PFC, MRSEC, Expeditions
- New Mexico Center for Quantum Information and Control (CQUIC)



Education and Workforce

- Q2Work and Q-12 Partnership
- graduate students - GRFP
- Expand-QISE NSF 23-551
- NRT program in EDU
- NSF 21-033 "Dear Colleague Letter: Advancing Quantum Education and Workforce Development"

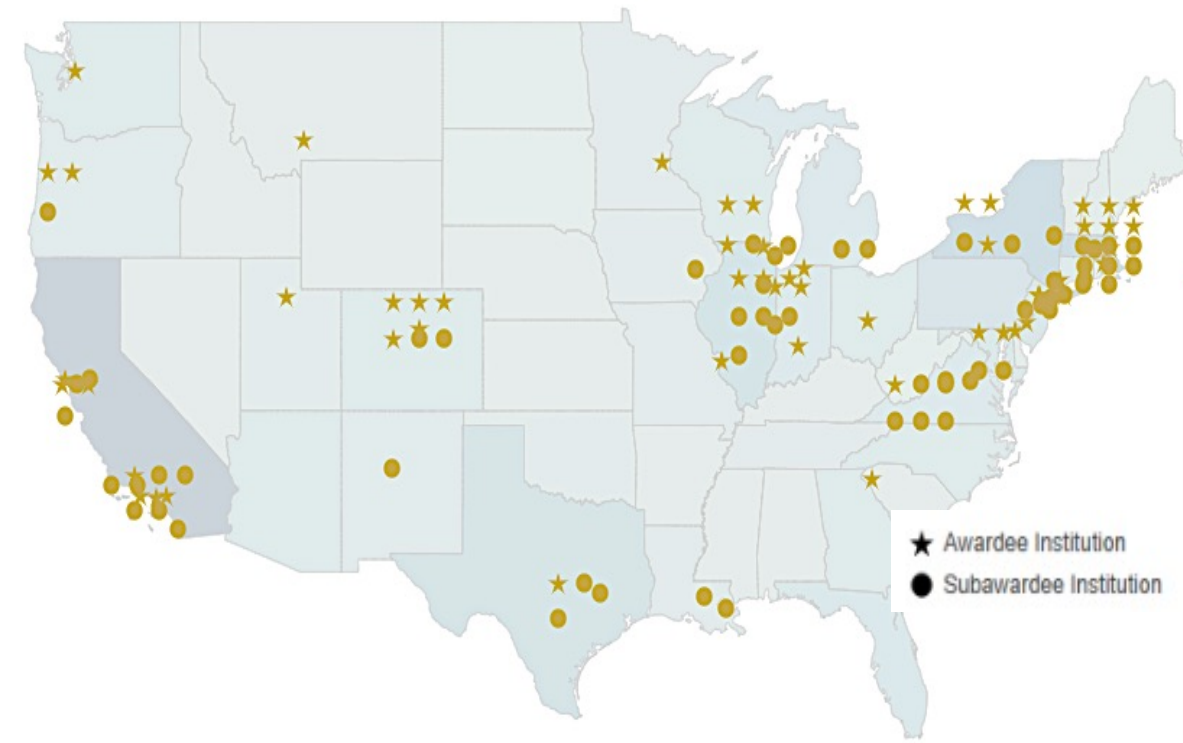
Access to Infrastructure and Resources

- Quantum Foundries (Mon-Ark)
- 2D materials Foundries
- Computing Platform Access
- National Quantum Virtual Laboratory



NSF TAQS Programs

Transformational Advances in Quantum Systems



For examples see NSF Award Search

- <https://www.nsf.gov/awardsearch/>
- Keyword: TAQS



Goal: Innovative interdisciplinary research for incubating new ideas, concepts, and technologies

❖ focus on quantum functionality

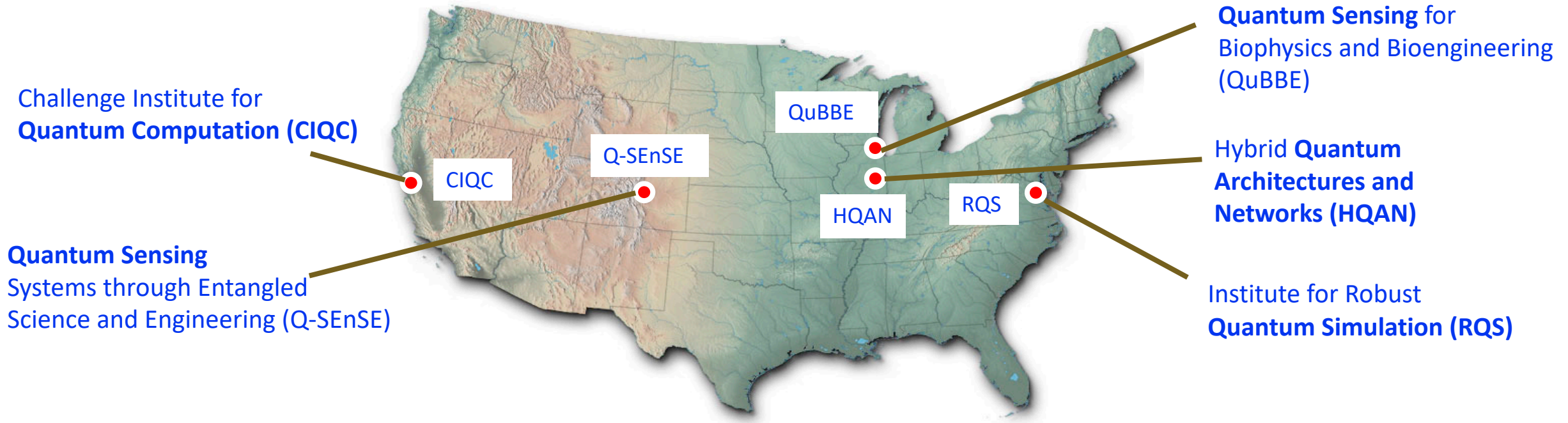
❖ result in experimental demonstrations and/or proof-of-concept validations

How: Interdisciplinary teams required (minimum of 3 different areas). Research topic goals vary.

Programs:

- **TAQS Pilot** (RAISE-TAQS) NSF 18-035
 - \$25 Million for 24 Awards started in 2018
- **Quantum Idea Incubator** (QII-TAQS) NSF 19-532
 - \$25 Million for 19 Awards started in 2019
- **Quantum Interconnects** (QuIC-TAQS) NSF 21-553
 - \$25 Million for 10 Awards started in 2021
- **Quantum Sensors** (QuSeC-TAQS) NSF 22-630
 - \$25 Million for 10-12 Awards - NEW in 2023

Quantum Leap Challenge Institutes



5 QLCI sites, \$25M per institute over 5 years



31 institutions



252 sr. researchers & technicians



67 industry affiliates



112 early career researchers



12 government labs



403 students



Access to Quantum Materials and Resources: Foundries and Materials Innovation Platforms

2 Q-AMASE-I Quantum Foundry Awards:

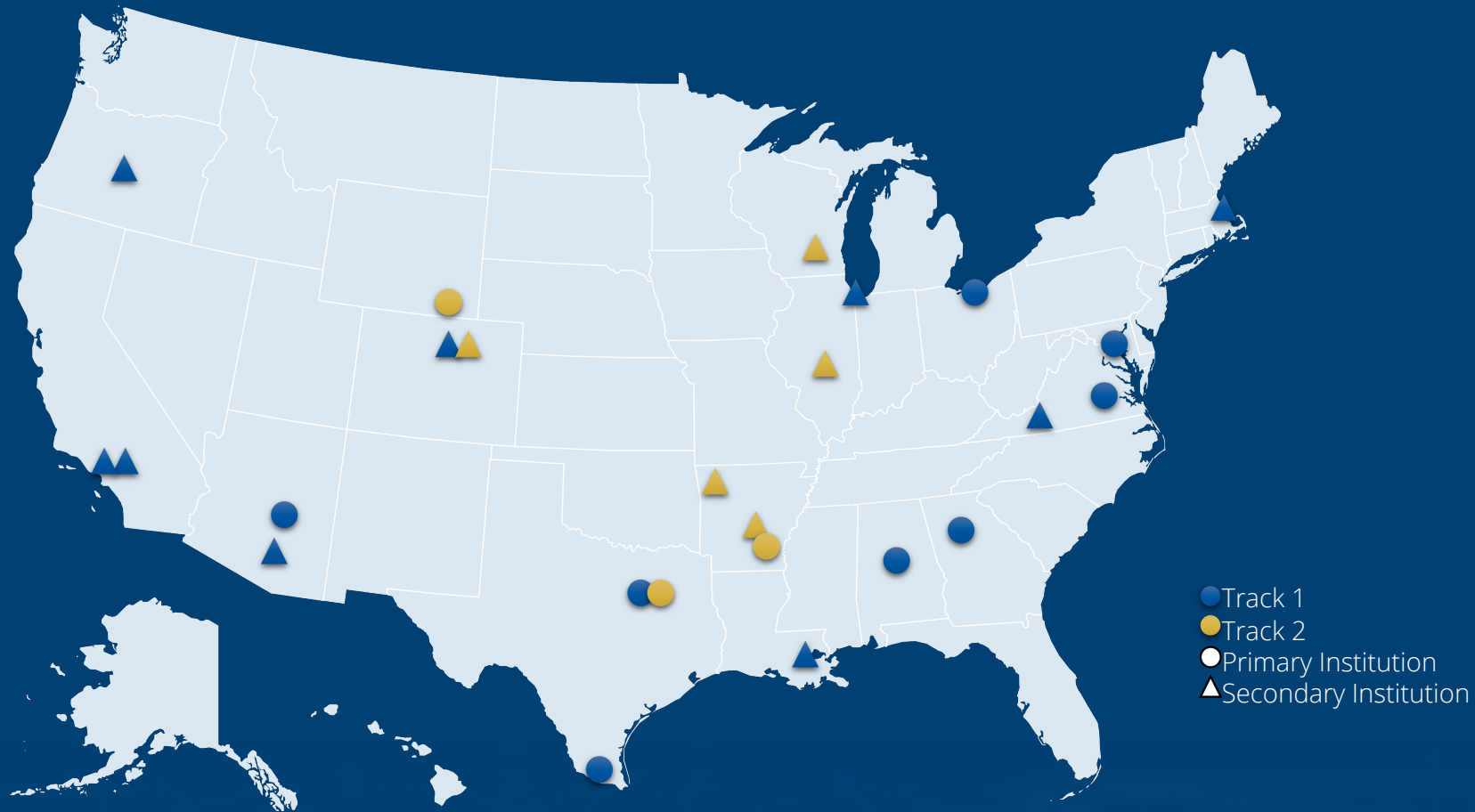
- UC Santa Barbara
- Montana State/U Arkansas
- Growing new quantum materials for the QISE community
- Industry engagement through internships, workshops, networking events such as Quantum Industry Showcase
- Education and workforce development goals for the next generation of quantum scientists and engineers

2 Materials Innovation Platforms

- Growing new quantum and semiconductor materials
- New materials include bulk crystals
- Engagement through internships, workshops, networking events
- Community of practitioners – new samples, growth recipes, data, access to characterization, access to theoreticians



Expanding Capacity in Quantum Information Science and Engineering (Expand-QISE) – NEWEST PROGRAM



- First cohort, 11 awards (\$21.4M)
- 8 Track 1 awards
- 3 Track 2 awards
- 3 HBCUs, 3 HSIs, 3 EPSCOR states
- Focus Areas:
 - Quantum Fundamentals,
 - Quantum Metrology and Control
 - Co-Design and Quantum Systems
 - Education and Workforce Development (ALL)

Track 1:
Full proposals: April 07, 2023

Link:
<https://beta.nsf.gov/funding/opportunities/expanding-capacity-quantum-information-science>





Thank You !

Contact Information:
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Useful Resources:

National Strategy for QIS: <https://quantum.gov>

NSF Landing Page for QIS: <https://nsf.gov/quantum>