

NQIAC Report on Renewing the National Quantum Initiative: Recommendations for Sustaining American Leadership in Quantum Information Science

Advanced Scientific Computing Advisory Committee (ASCAC) Meeting

June 13, 2023

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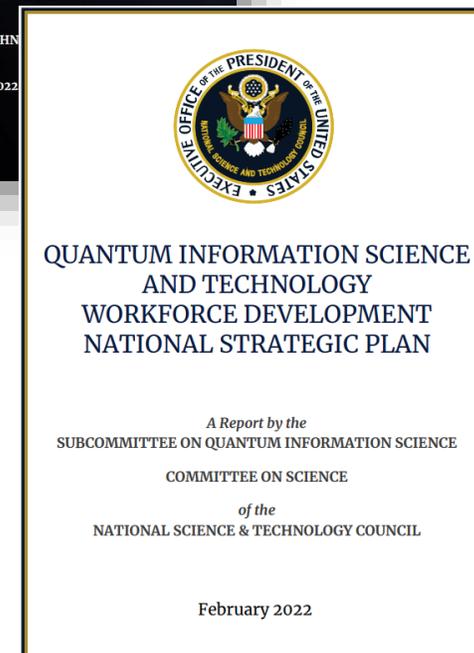
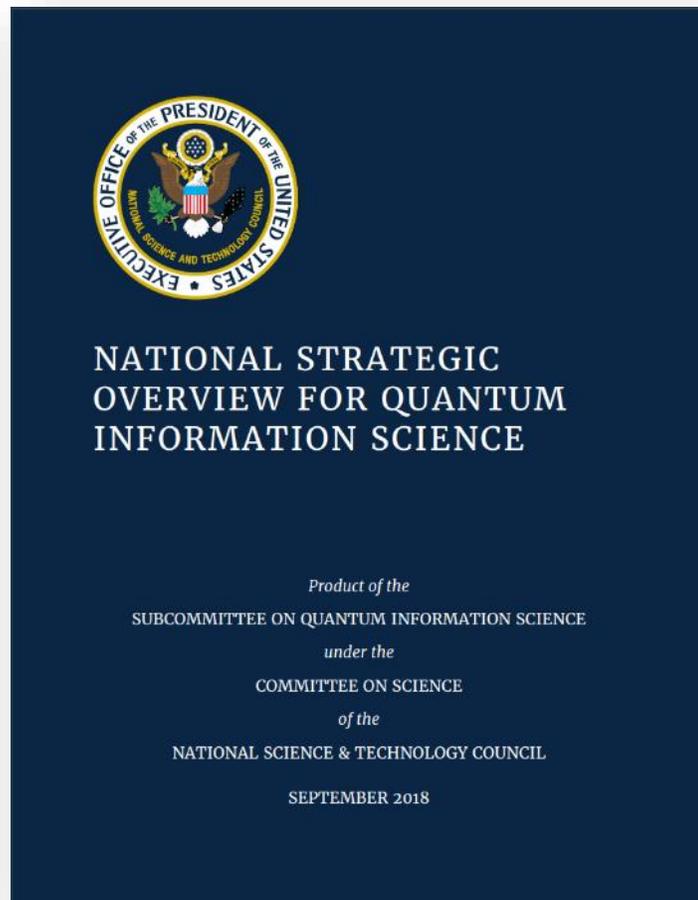


National Quantum Coordination Office

- Dr. Charles Tahan, Director
- Dr. Gretchen Campbell, Deputy Director
- Dr. Tanner Crowder, Policy Analyst
- Dr. Thomas Wong, Quantum Liaison

U.S. National Strategy for Quantum Information Science

1. Take a **science-first** approach
2. Provide the key **infrastructure**
3. Build a quantum-capable and diverse **workforce**
4. Nurture the nascent quantum **industry**
5. Balance **economic** and **national security**
6. Continue to develop **international collaboration** and cooperation



Find all NQI strategy documents on [quantum.gov](https://www.quantum.gov)

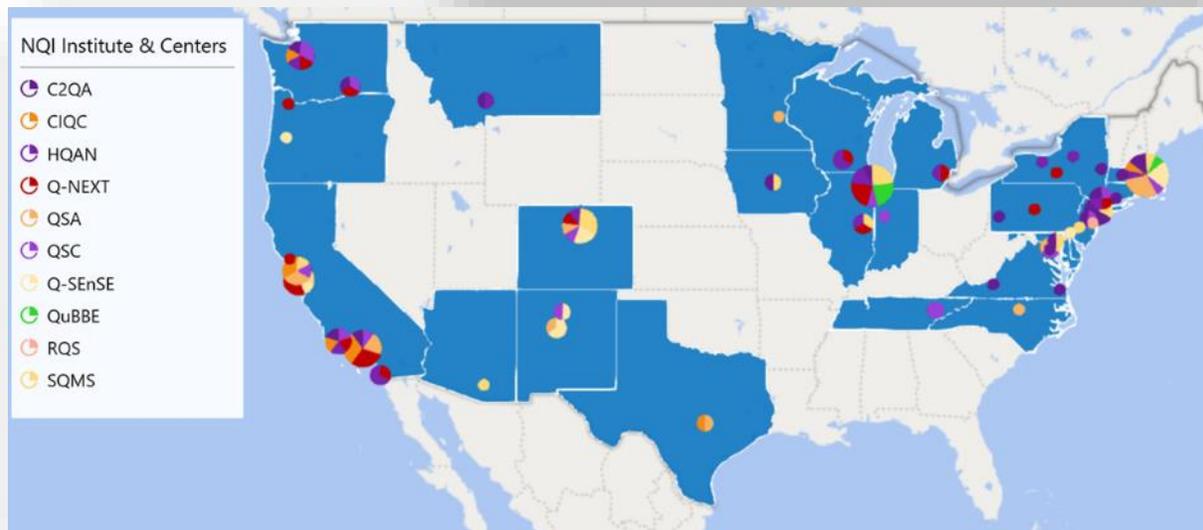
Getting the Science Right

by understanding the applications and timelines by which QIST will benefit our society, and roadblocks we must overcome to get there.

Infrastructure

- 5 DOE National QIS Research Centers
- 5 NSF Quantum Leap Challenge Institutes (+2 FY21)
- 3 DOD/IC QIS Centers (+1 FY21)

U.S. National QIS Centers and Institutes



5 NSF Quantum Leap Institutes

- CIQC: Challenge Institute for Quantum Computation
- Q-SEnSE: Quantum Systems through Entangled Science and Engineering
- HQAN: Hybrid Quantum Architectures and Networks
- QuBBE: Quantum Sensing for Biophysics and Bioengineering
- RQS: Institute for Robust Quantum Simulation

5 DOE QIS Research Centers

- Q-NEXT: Next Generation Quantum Science and Engineering
- C2QA: Co-design Center for Quantum Advantage
- SQMS: Superconducting Quantum Materials and Systems Center
- QSA: Quantum Systems Accelerator
- QSC: The Quantum Science Center



National Quantum Initiative Advisory Committee

- Established by Sec. 104 of the NQI Act
- Advises the—
 - President
 - NSTC Subcommittee on Quantum Information Science (SCQIS)
 - NSTC Subcommittee on Economic and Security Implications of Quantum Science (ESIX)
- Conducts independent assessments of the NQI, including any recommendations for improvements, through reports submitted to the President and appropriate committees of Congress



NQIAC & NQCO



National Quantum Initiative Advisory Committee



Kathryn Ann Moler
Stanford
Co-Chair



Charles Tahan
OSTP
Co-Chair



Jamil Abo-Shaeer
Vector Atomic



Fred Chong
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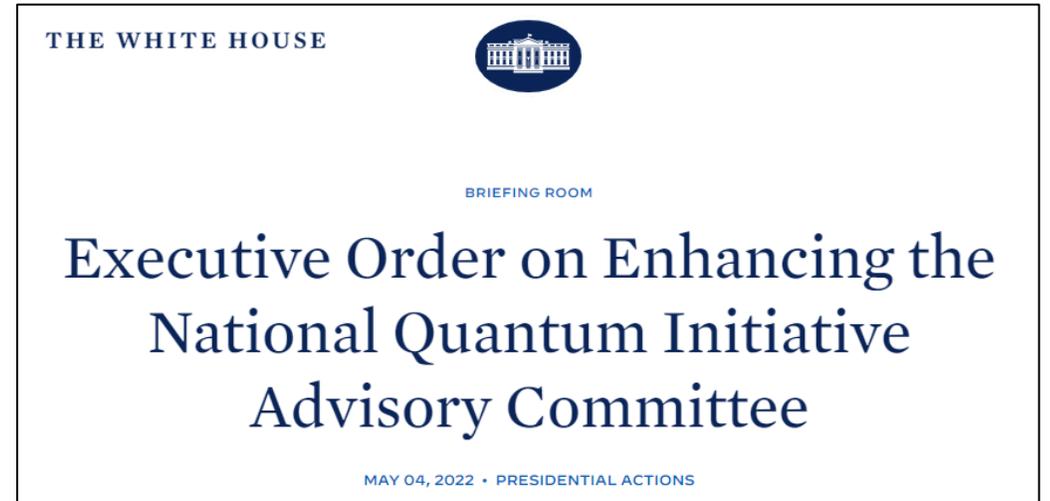


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NIST



Timeline

- May 4, 2022: NQIAC elevated to a Presidential advisory committee
- Dec. 9, 2022: Membership announced
- Dec. 16, 2022: First meeting (public)
- Jan. 2023: Subcommittee meetings begin
- Mar. 24, 2023: Draft findings and recommendations deliberated publicly
- May 19, 2023: Final findings and recommendations deliberated and approved publicly
- June 2, 2023: Report published



Report: Renewing the NQI



A Report of the

National Quantum Initiative Advisory Committee

June 2023

Renewing the National Quantum Initiative:
Recommendations for Sustaining American
Leadership in Quantum Information Science

➤ *Renewing the National Quantum Initiative: Recommendations for Sustaining American Leadership in Quantum Information Science*

- 3 Findings
- 4 Overarching Recommendations
- 9 Detail Recommendations

➤ Available at <https://www.quantum.gov/about/nqi/ac/>



Findings

1. In its first five years, the NQI has increased the United States' capacity in quantum information science and technology (QIST) R&D.
2. The development of QIST is critical to U.S. economic and national security.
3. Key scientific, engineering, and systems integration challenges remain and must be solved for the United States to realize the full economic impacts and benefits of QIST.



Overarching Recommendations

- A. To ensure U.S. leadership in QIST, **the NQI Act should be reauthorized and expanded**. All authorized QIST programs in the NQI Act, the CHIPS and Science Act, and other relevant legislation should be funded at the authorized levels.
- B. To ensure that the United States leads in QIST discovery, innovation, and impact, efforts should be increased to **attract, educate, and develop U.S. scientists and engineers in QIST-related fields**, improve and accelerate pathways for foreign QIST talent to live and work in the United States, and increase support for research collaboration with partner nations.
- C. To safeguard the security and competitiveness of U.S. advances in QIST, the United States should develop policies that thoughtfully **promote and protect U.S. leadership in QIST; expand domestic center-scale and single principal investigator QIST research activities and infrastructure; and evaluate and improve the reliability of global supply chains for QIST**.
- D. To realize the potential of QIST for society, the NQI must **accelerate the development of valuable technologies**. This goal will require **new programs in engineering research and systems integration** that will enable a virtuous cycle of **maturing and scaling of quantum systems to useful applications** through multisector partnerships and engagement with end-users.



Detailed Recommendations: Summary

1. Reauthorize and appropriate the NQI Act
2. Expand research
3. Fund industry-led partnerships
4. Invest in equipment and infrastructure
5. Promote international cooperation
6. Promote and protect U.S. QIST R&D
7. Strengthen supply chains
8. Develop domestic talent
9. Attract and retain foreign talent



House Science Committee Hearing on the NQI

- On June 7, 2023, the House Committee on Science, Space, and Technology (HSST) held a full hearing on *Advancing American Leadership in Quantum Technology*.
- “The purpose of this hearing is to evaluate the state of quantum research, development, and technology (RD&T) in the United States. The hearing will serve as an opportunity to review and discuss the first five years of the National Quantum Initiative Act (NQIA), the economic value of quantum science and its applications, the national security importance of developing quantum capabilities, and what policies should be considered in the next five years. The hearing will help inform legislation to reauthorize NQIA programs that expire on September 30, 2023.”

<https://science.house.gov/2023/6/full-committee-hearing>



FULL COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY
HEARING CHARTER

“Advancing American Leadership in Quantum Technology”

Wednesday, June 7, 2023

10:00 a.m.

2318 Rayburn House Office Building



House Science Committee Hearing on the NQI

The NQCO testimony included 5 recommendations for strengthening the NQI:

1. **Reauthorize the NSF and DOE quantum information science research and education centers.** Remove the limit on the number of centers authorized for these agencies. Provide support to enable fundamental science research, applied research, demonstration, and commercialization.
2. Support NSF programs to **expand and broaden participation in quantum information science**, including potential new mid-career development programs and potential bridge programs focused on preparing post-baccalaureate students for graduate programs in quantum information science and engineering.
3. Strengthen the whole-of-government approach of the original National Quantum Initiative Act by **expanding the authorized core agencies**, which were initially NSF, DOE, and NIST. In particular, the need for a **dedicated international fund** to follow-up on U.S. commitments to international cooperation, led OSTP to recommend including the State Department in the National Quantum Initiative Act. **The National Institutes of Health (NIH), the National Aeronautics and Space Administration (NASA), and the Department of Homeland Security (DHS)** also have important roles to play, for example, in both terrestrial and space-based quantum sensing. We welcome further integration of the DOD and the IC research funding organizations and laboratories, which have played an important role in the development of quantum information science in this country since the beginning.



House Science Committee Hearing on the NQI

- 4. Begin translating discoveries in quantum information science to commercial utility and agency missions** through lab-to-market engineering and systems integration programs and public-private partnerships. In particular, the **NSF Directorate for Technology, Innovation and Partnerships (TIP)** offers a new pathway to focus technology development and engineering for promising applications. Other opportunities include those previously authorized in the CHIPS and Science Act such as the **DOE Quantum Network Infrastructure Research Program** and the **Quantum User Expansion for Science and Technology** program (QUEST). A **NIST Center for Quantum Engineering Research** could conduct engineering research to accelerate scientific breakthroughs and accelerate quantum technology transfer.
- 5. Prioritize funding to upgrade the aging infrastructure of laboratory facilities** and create and equip new laboratories with the tooling necessary to engage in cutting edge quantum information science research. High-quality research capital is essential for the United States to remain competitive with world-wide investments and to recruit and retain the best talent.



Detailed NQIAC Recommendations

Detailed Recommendations

- RECOMMENDATION 1: The United States should renew the NQI to support U.S. quantum information science, technology, and engineering, and signal intent to extend the NQI beyond its initial ten-year authorization.
 - Recommendation 1A: Authorization for NQI centers should be renewed for at least five years, with existing Centers charged to review and refresh their R&D goals, and all authorized funds should be appropriated.
 - Recommendation 1B: CHIPS and Science Act-authorized funding for QIST should be appropriated, and semiconductor research and manufacturing capabilities should be leveraged for QIST.



Detailed Recommendations

- RECOMMENDATION 2: The United States should expand the NQI to increase support for fundamental research in quantum information science and engineering.
 - Recommendation 2A: Federal agencies should be authorized to establish additional nimble and focused NQI Centers, as needed, to address newly emerging scientific questions.
 - Recommendation 2B: In addition to the NQI Centers, agency programs to fund quantum information science (QIS) research activities led by a single principal investigator or only a few principal investigators should be authorized and appropriated.
 - Recommendation 2C: The NQI should increase support for fundamental research in engineering to accelerate the development of quantum technologies for future scientific and commercial applications, including by establishing QIST Centers that focus on engineering of integrated and scaled systems for a variety of quantum platforms and technologies.
 - Recommendation 2D: Federal agencies should increase investment in R&D for quantum computer science and software engineering, including in quantum algorithms, applications, software and software development tools, and error correction.



Detailed Recommendations

- RECOMMENDATION 3: New Federal programs should help fund industry-led partnerships to develop and advance scaled-up, integrated quantum systems for mission- and commercial-grade technologies, and new mechanisms to fund such programs should be defined and authorized as needed.
- RECOMMENDATION 4: Agencies should expand investment in small- and mid-scale infrastructure in support of Federally-funded research that includes support for staff, equipment, maintenance, and operating costs, to ensure that facilities meet the needs of QIST projects.
- RECOMMENDATION 5: The U.S. Government should provide new dedicated funding to ensure that international cooperation statements result in productive collaborative activities between participating nations.



Detailed Recommendations

- RECOMMENDATION 6: The Nation must simultaneously accelerate progress in QIST and protect quantum technologies from malign actors.
 - Recommendation 6A: Governmental entities should implement only protective measures that are clear, appropriately targeted, and compatible with the goal of facilitating progress in QIST for the benefit of the Nation and the world.
 - Recommendation 6B: U.S. Government entities should frequently reassess the efficacy of protective measures as QIST advances. This review process should entail thorough consideration of the balance between managing risk and impeding progress.
 - Recommendation 6C: The U.S. Government should work with partner nations to establish shared measures for ensuring supply chain resilience and for protecting QIST. It should avoid unilateral controls when they impede the ability of U.S. industry to compete in the global marketplace.
 - Recommendation 6D: Once the new post-quantum cryptography (PQC) standards are published, the United States should proceed expeditiously with migration to PQC in the public and private sectors. The U.S. Government should provide appropriate resources to accomplish this task effectively, thoroughly, and efficiently.



Detailed Recommendations

- RECOMMENDATION 7: The U.S. Government should facilitate efforts to strengthen, diversify and secure QIST supply chains domestically and in collaboration with partner nations. As QIST progresses, measures to de-risk and secure international supply chains should be continually updated.
 - Recommendation 7A: The Department of Commerce, in coordination with industry, should develop and maintain a QIST supply chain risk analysis and a plan for strengthening, diversifying, and securing supply chains for key QIS technologies.
 - Recommendation 7B: The U.S. Government should follow and potentially expand the Department of Energy roadmap for addressing critical isotope and rare element needs for QIS R&D to ensure future supplies, as some isotope production requires substantial lead time.
 - Recommendation 7C: Federal agencies should actively support the development of QIST-enabling technologies to help de-risk the domestic QIST supply chain.



Detailed Recommendations

- RECOMMENDATION 8: Domestic talent in QIST should be expanded through educational and training programs at all levels.
 - Recommendation 8A: Federal agencies should create additional fellowships and traineeships for U.S. citizens and permanent residents pursuing QIST-related degrees with a focus on broadening participation.
 - Recommendation 8B: All previously authorized QIST education and training programs should be appropriated.
 - Recommendation 8C: The National Science Foundation should fund the development of a consolidated set of outreach programs, allowing QIST principal investigators to tap into these programs for their “broader impacts” on Federally-funded work for more cohesive and scalable impact.
 - Recommendation 8D: The National Science Foundation should lead a holistic, systematic study of quantum workforce needs, trends, and education capacity. This study should be conducted and monitored biennially for the duration of the NQI to ensure U.S. leadership in QIST and competitiveness in the burgeoning quantum industry.
- RECOMMENDATION 9: Employment of foreign talent in the U.S. QIST workforce should be facilitated and expedited through revised immigration policies and processes, thereby enhancing U.S. economic competitiveness and national security.

