National Quantum Initiative Advisory Committee

December 16, 2022

Federal Advisory Committee Act (FACA) Considerations

Dr. Tom Wong

NQIAC Designated Federal Officer (DFO)

Program Manager in QIS, Advanced Scientific Computing Research, Office of Science, DOE

December 16, 2022

FACA Considerations

- The NQIAC is a federal advisory committee
- Federal advisory committees are authorized by and subject to the:
  - Federal Advisory Committee Act (FACA) of 1972
  - General Services Administration FACA Implementing Regulations ("GSA Final Rule")

1. Meetings must be public (except in limited exemptions) and include an opportunity for public comment.
   a) Subcommittees can do preparatory work in closed meetings, e.g., gathering information, conducting research, or analyzing relevant issues or facts in preparation for a meeting of the advisory committee, or to draft position papers for deliberation by the advisory committee.
   b) Subcommittees must report back to the full advisory committee. The advisory committee cannot adopt recommendations developed by a subcommittee without deliberation.
   c) No requests for public comment were submitted for today's meeting.
2. Minutes must be taken and certified
3. Have a Designated Federal Officer (DFO) who is responsible for managing the day-to-day operations of an advisory committee and whose responsibilities include: ensuring compliance with FACA; calling, attending, and adjourning all committee and subcommittee meetings; preparing agendas; and maintaining records

National Quantum Initiative Advisory Committee

December 16, 2022

Update on the National Quantum Initiative

Charles Tahan
Assistant Director for Quantum Information Science
Director, National Quantum Coordination Office
Office of Science and Technology Policy

whitehouse.gov/ostp
www.quantum.gov
@WHOSTP

"As new technologies continue to evolve, we'll work together with our democratic partners to ensure that new advances in areas from biotechnology, to quantum computing, 5G, artificial intelligence, and more are used to lift people up, to solve problems, and advance human freedom." – President Biden

Background photo by L. Whitman

QIST Continues to be a National Priority

- ***Getting the science right*** by understanding the applications and timelines by which quantum information science and technology will benefit our society, and roadblocks we must overcome to get there;

- ***Enhancing American competitiveness*** by accelerating technology development toward useful economic and mission applications while also protecting our national security; and

- ***Enabling our people*** by building the necessary talent pipeline and ensuring that this field creates new opportunities for all Americans.

"This increase in research and development funding is going to ensure that the United States leads the world in the industries of the future: quantum computing, to artificial intelligence, to advanced biotechnology." - President Biden

Aug 9, 2022: Signing of the CHIPS and Science Act

Presidential Actions This Year

BRIEFING ROOM

Executive Order on Enhancing the National Quantum Initiative Advisory Committee

MAY 04, 2022 • PRESIDENTIAL ACTIONS

"Quantum information science (QIS) can enable transformative advances in knowledge and technology for industry, academia, and government. Accordingly, the National Quantum Initiative (NQI), which aims to ensure the continued leadership of the United States in QIS and its technology applications, is a substantial and sustained national priority."

"The NQI Program encompasses contributions from across the Federal Government, … with membership on SCQIS or ESIX"

BRIEFING ROOM

National Security Memorandum on Promoting United States Leadership in Quantum Computing While Mitigating Risks to Vulnerable Cryptographic Systems

MAY 04, 2022 • STATEMENTS AND RELEASES

Policy: Balance the competing opportunities and risks of quantum computers by (1) maintaining U.S. leadership in QIS; and (2) mitigating the threat of CRQCs through a timely and equitable transition to PQC.

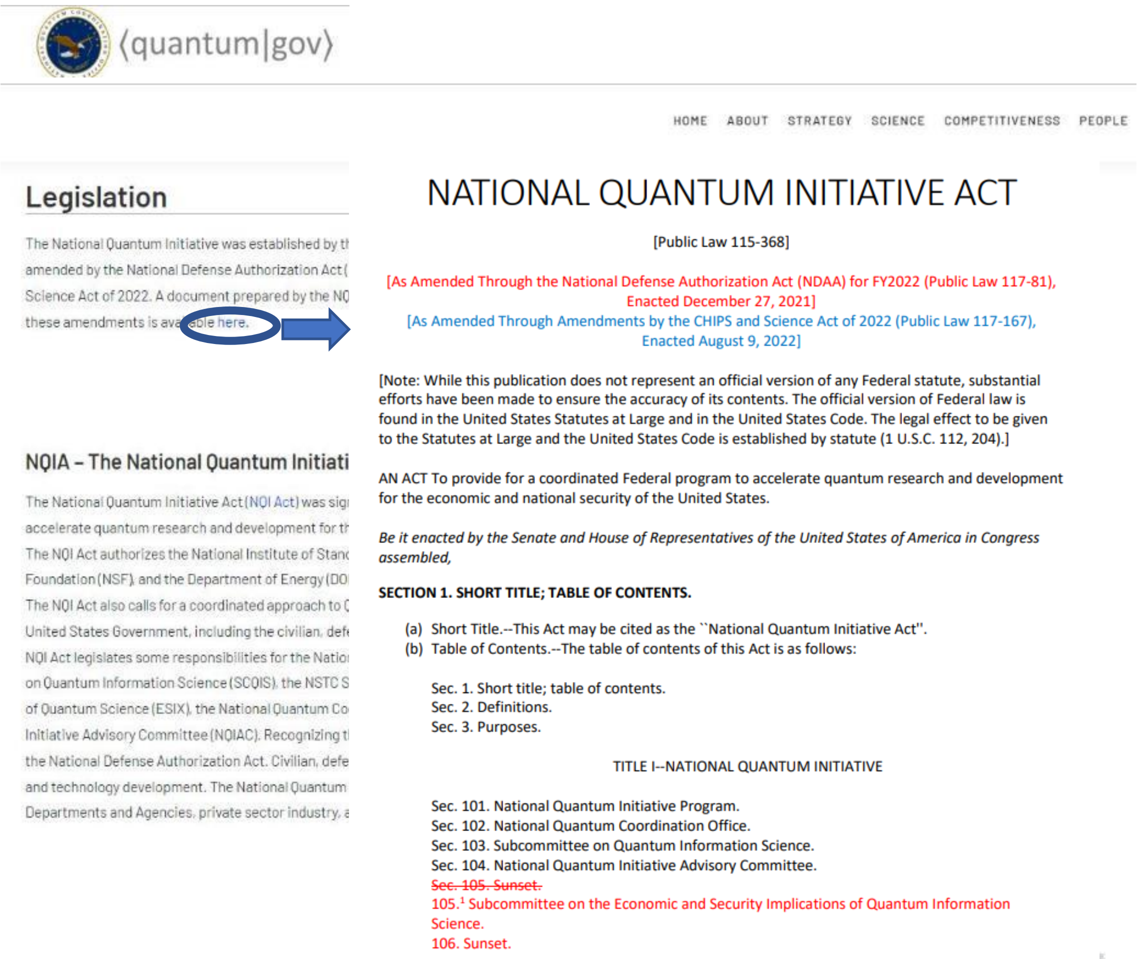
Promotion: The United States must pursue a whole-of-government and whole-of-society strategy to harness the economic and scientific benefits of QIS.

Mitigating Risks: The United States must prioritize the timely and equitable transition of cryptographic systems to QRC.

Protecting US Tech: The U.S. Gov must work to safeguard relevant quantum R&D and intellectual property (IP) and to protect relevant enabling technologies and materials.

Congressional Actions This Year

- **National Defense Authorization Act FY22**
  - o Amended the NQI to formally establish ESIX Subcommittee
    - – "review and assess any economic or security implications of such investments; assess the export of technology associated with quantum information science and recommend…"
- **CHIPS (approp) and Science Act (auth)**
  - o Amended the NQI Act
    - – QN-IWG to update QN Strategy
    - – DOE Quantum Network Infrastructure R&D Program
    - – DOE QUEST Program
    - – Incorporating QISE into STEM Curriculum
    - – NIST development and standardization of quantum and post-quantum cryptography
  - o NSF to carry out program on Next Generation Quantum Leaders, leveraging the Q-12 Partnership.



NATIONAL QUANTUM INITIATIVE ACT

[Public Law 115-368]

[As Amended Through the National Defense Authorization Act (NDAA) for FY2022 (Public Law 117-81), Enacted December 27, 2021]

[As Amended Through Amendments by the CHIPS and Science Act of 2022 (Public Law 117-167), Enacted August 9, 2022]

[Note: While this publication does not represent an official version of any Federal statute, substantial efforts have been made to ensure the accuracy of its contents. The official version of Federal law is found in the United States Statutes at Large and in the United States Code. The legal effect to be given to the Statutes at Large and the United States Code is established by statute (1 U.S.C. 112, 204).]

AN ACT To provide for a coordinated Federal program to accelerate quantum research and development for the economic and national security of the United States.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled,

SECTION 1. SHORT TITLE; TABLE OF CONTENTS.

(a) Short Title.--This Act may be cited as the ``National Quantum Initiative Act''.
(b) Table of Contents.--The table of contents of this Act is as follows:

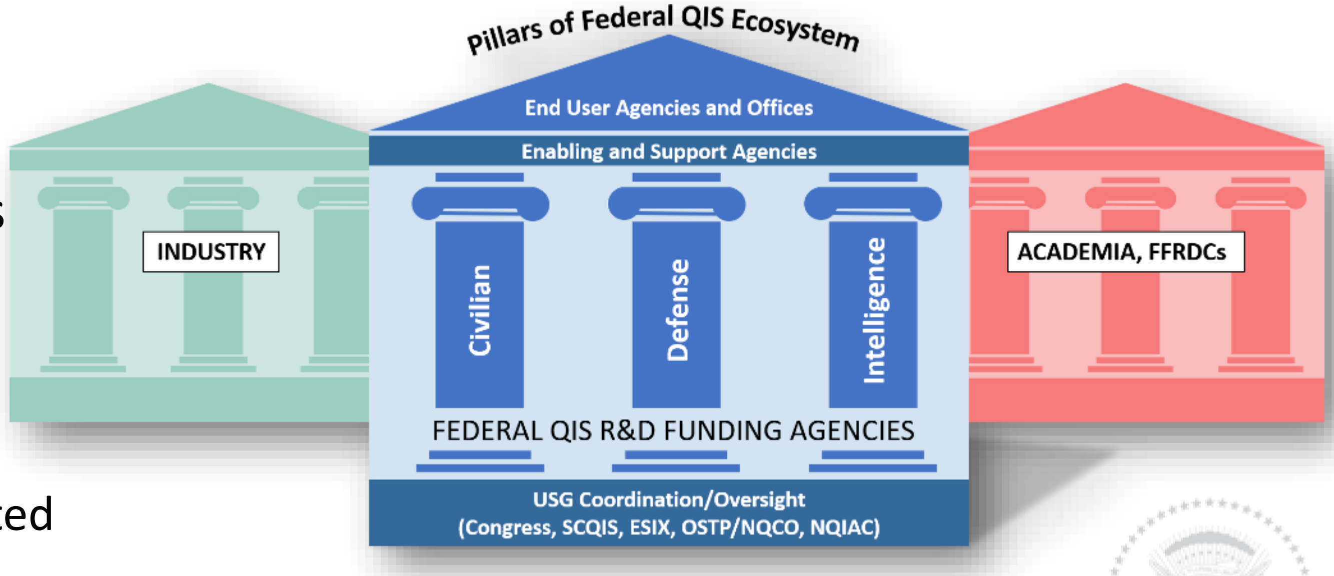
https://www.quantum.gov/wp-content/uploads/2022/08/NQIA2018-NDAA2022-CHIPS2022.pdf

The U.S. has a Federal Approach to Science Funding

- **The United States' science policy is the responsibility of many organizations** throughout the federal government.
  - Legislative/Congress <> Executive Office of the President <> Federal Agencies

- **Federal agencies implement** according to legislation/funding, their mission, and funding models

- Examples of **coordination**:
  - Bilateral coordination between Agencies
  - OMB, NSC, OSTP
  - NSTC Committees and Subcommittees
    - Reports, Working Groups, Task Forces
  - National Coordination Offices (NCO)
    - Reports, Initiatives, Workshops, as legislated



Coordinating a National Quantum Initiative (NQI)

NQI COORDINATING BODIES

NSTC Subcommittee on Quantum Information Science (SCQIS)*

Co-Chairs from:

NSF NIST

NSTC Subcommittee on Economic and Security Implications of Quantum Science (ESIX)**

Co-Chairs from:

National Quantum Coordination Office (NQCO)*

NQCO
- Carries out the daily coordination activities needed of the NQI program
- Provides support to the subcommittees and NQIAC
- Oversees interagency coordination of the NQI Program.
- **Staffed by employees on detail from NIST, DOD, DOE, and NSA.**

NQI Advisory Committee*

NQIAC (Presidential FACA)
- Committee composed of experts from industry, academia, and Federal labs
- Tasked with providing an independent assessment of and making recommendations

Quantum Economic Development-Consortium (non-gov)

Participating Agencies

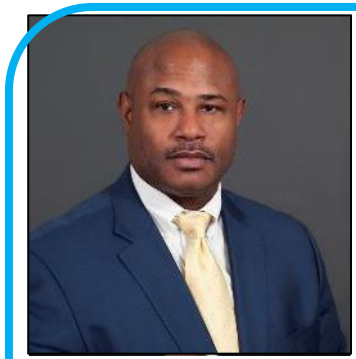
NASA USDA NOAA NIH National Institutes of Health U.S.ARMY U.S. AIR FORCE DARPA

The NQI is a whole-of-government approach to ensuring American leadership in QIS

* from National Quantum Initiative Act (PL 115-368) 2018
** from National Defense Authorization Act for FY'22 (PL 117-81)

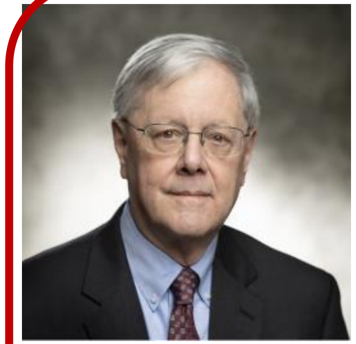
NQI Oversight

NSTC Subcommittee Co-Chairs:



Sean Jones
NSF

Jim Kushmerick
NIST



Steve Binkley & Barb Helland
DOE

Charles Tahan
OSTP

John Burke
DOD

Barry Barker
LPS

SCQIS

NQCO

ESIX

Denise Caldwell
NSF

Brad Blakestad
LPS

Corey Stambaugh
NQCO/NIST

Gretchen Campbell
NQCO/NIST

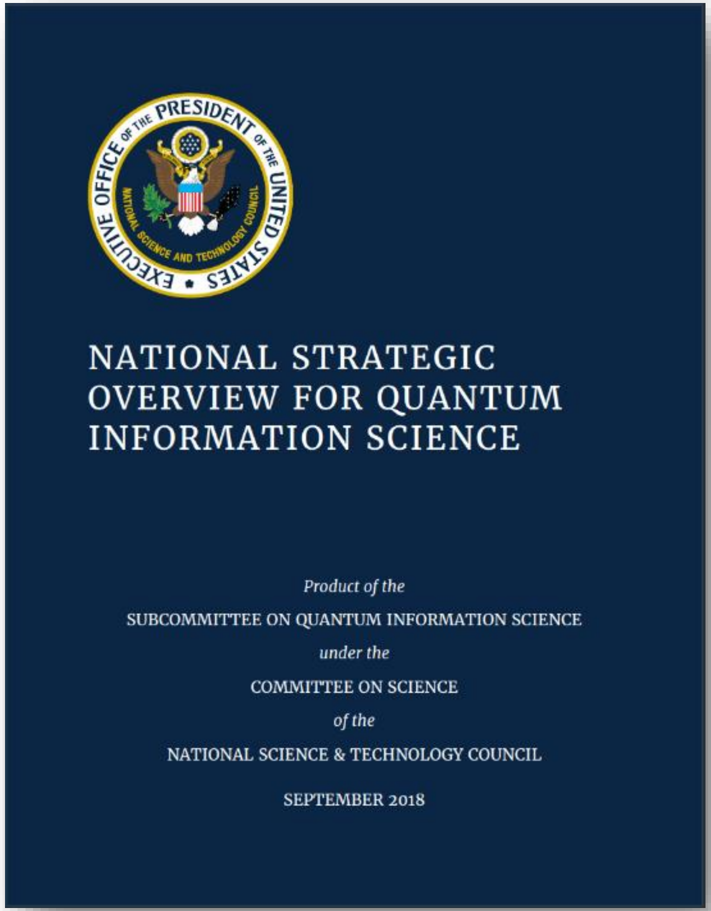
Tanner Crowder
NQCO/NRL

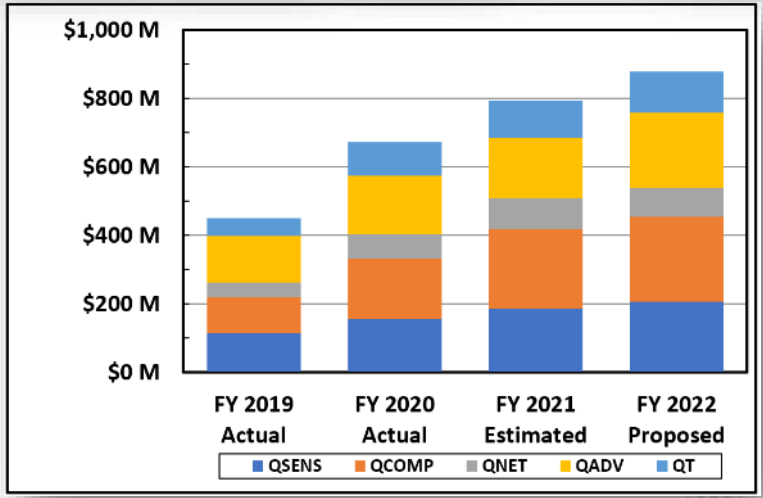
Tom Wong
NQCO/DOE

Alex Cronin
NSF (former NQCO)

National Strategy for QIST Continues to Evolve and Expand

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





FY21 NQI Annual Report

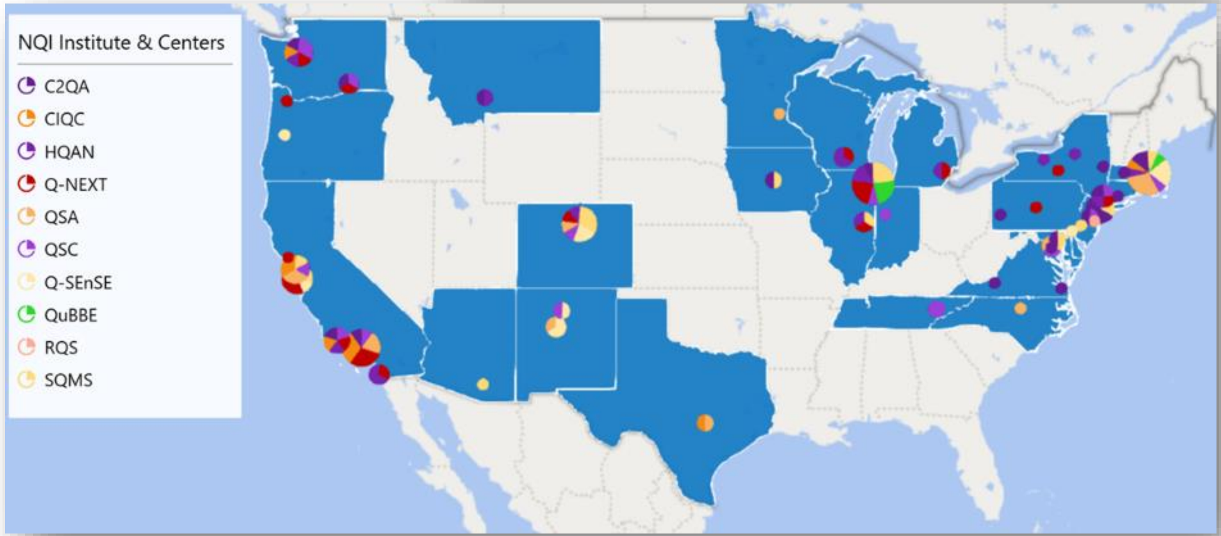
Find all our strategy documents on quantum.gov

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.

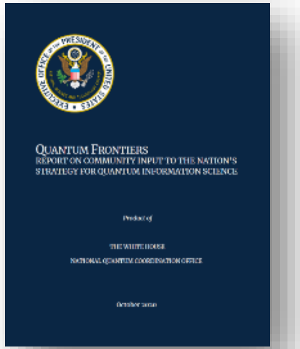
Infrastructure

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



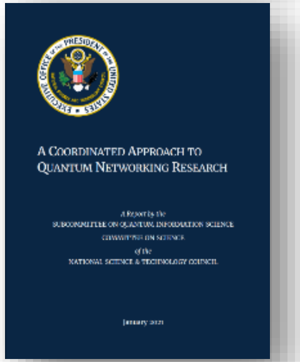
Quantum Frontiers

1. QIST to Benefit Society
2. Building Quantum Engineering
3. Materials Science for QIST
4. Quantum Mechanics using Quantum Simulations
5. QIST for Precision Measurement
6. Quantum Entanglement for New Applications
7. Quantum Errors
8. The Universe through Quantum Information



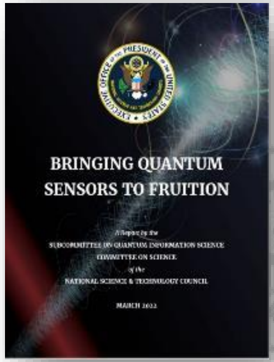
Quantum Networking

TR 1: Continue Research on Use Cases
TR 2: Prioritize Cross-Beneficial Core Components
TR 3: Improve Classical Capabilities
TR 4: Leverage "Right-Sized" Quantum Testbeds
PR 1: Increase Interagency Coordination
PR 2: Establish Timetables for R&D Infrastructure
PR 3: Facilitate International Cooperation



Quantum Sensing

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



Agency Implementation: Solicitations Listed on Quantum.Gov this Year

QUANTUM COMPUTING / R&D FUNDING OPPORTUNITIES

IARPA Launching New Program on Entangled Logical Qubits

(July 22, 2022) The Intelligence Advanced Research Projects Activity (IARPA) is launching a new program on Entangled Logical Qubits (ELQ). It is a four-year program scheduled to start in the ...

NSF / QUANTUM COMPUTING / R&D FUNDING OPPORTUNITIES

NSF Funds Access to Cloud-based Quantum Computing Platforms

(June 3, 2022) The National Science Foundation, in conjunction with Amazon Web Services (AWS), IBM, and Microsoft, is promoting the availability of cloud-based access to quantum-computing platforms to advance research ...

QUANTUM SENSING / R&D FUNDING OPPORTUNITIES

DOE BER Releases FOA for Quantum-Enabled Imaging and Sensing for Bioenergy

The DOE SC program in Biological and Environmental Research (BER), through its Bioimaging Research effort, announced its interest in receiving applications to advance fundamental research or use-inspired technologies of new ...

R&D FUNDING OPPORTUNITIES / WORKFORCE

AFOSR Funding Opportunities in STEM Education, Quantum Welcomed

(March 21, 2022) The Air Force Office of Scientific Research (AFOSR) has two funding opportunities involving STEM education, which could include quantum information science: STEM FOA: This announcement explicitly encourages ...

R&D FUNDING OPPORTUNITIES / WORKFORCE

LPS Supports Young Investigator Program in QIS

(March 17, 2022) The Laboratory for Physical Sciences (LPS), which hosts a National Quantum Information Science Research Center called the LPS Qubit Collaboratory (LQC), is partnering with the Air Force ...

NASA's Space Communications and Navigation (SCaN) program office seeks to enhance faculty professional knowledge and leadership experience by offering two 10-week summer fellowship opportunities for educators who are interested in ...

INTERNATIONAL / NSF / R&D FUNDING OPPORTUNITIES

NSF Funding for International Collaboration in Quantum

(August 18, 2022) The National Science Foundation (NSF) released a Dear Colleague Letter on July 21, 2022 on International Collaboration Supplements in Quantum Information Science and Engineering Research. With this ...

QUANTUM COMPUTING / R&D FUNDING OPPORTUNITIES

ARL and LPS release BAA on Quantum Computing in the Solid State

(January, 18 2022) A new Broad Agency Announcement (BAA) for the QC-S5 program, BAA # W911NF-22-S-0006 has been released. The U.S. Army Research Office (ARO), in collaboration with the Laboratory ...

INFRASTRUCTURE / R&D FUNDING OPPORTUNITIES / WORKFORCE

ExpandQISE Solicitation: Invitation to a Connections-Building Workshop

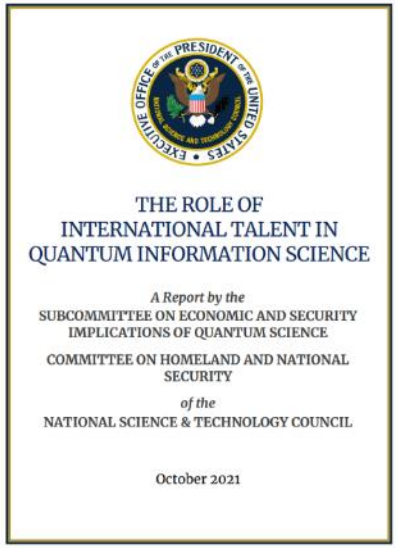
(Feb. 27, 2022) ExpandQISE Solicitation: Invitation to a connections-building workshop. The recently issued program solicitation NSF 22-561 "Expanding Capacity in Quantum Information Science and Engineering (ExpandQISE)" aims to increase research ...

Enhancing Competitiveness

by accelerating technology development toward useful economic and mission applications while also protecting our national security.

Industry and Security

Oct 5, 2021: White House Summit on Quantum Industry and Society


THE ROLE OF INTERNATIONAL TALENT IN QUANTUM INFORMATION SCIENCE

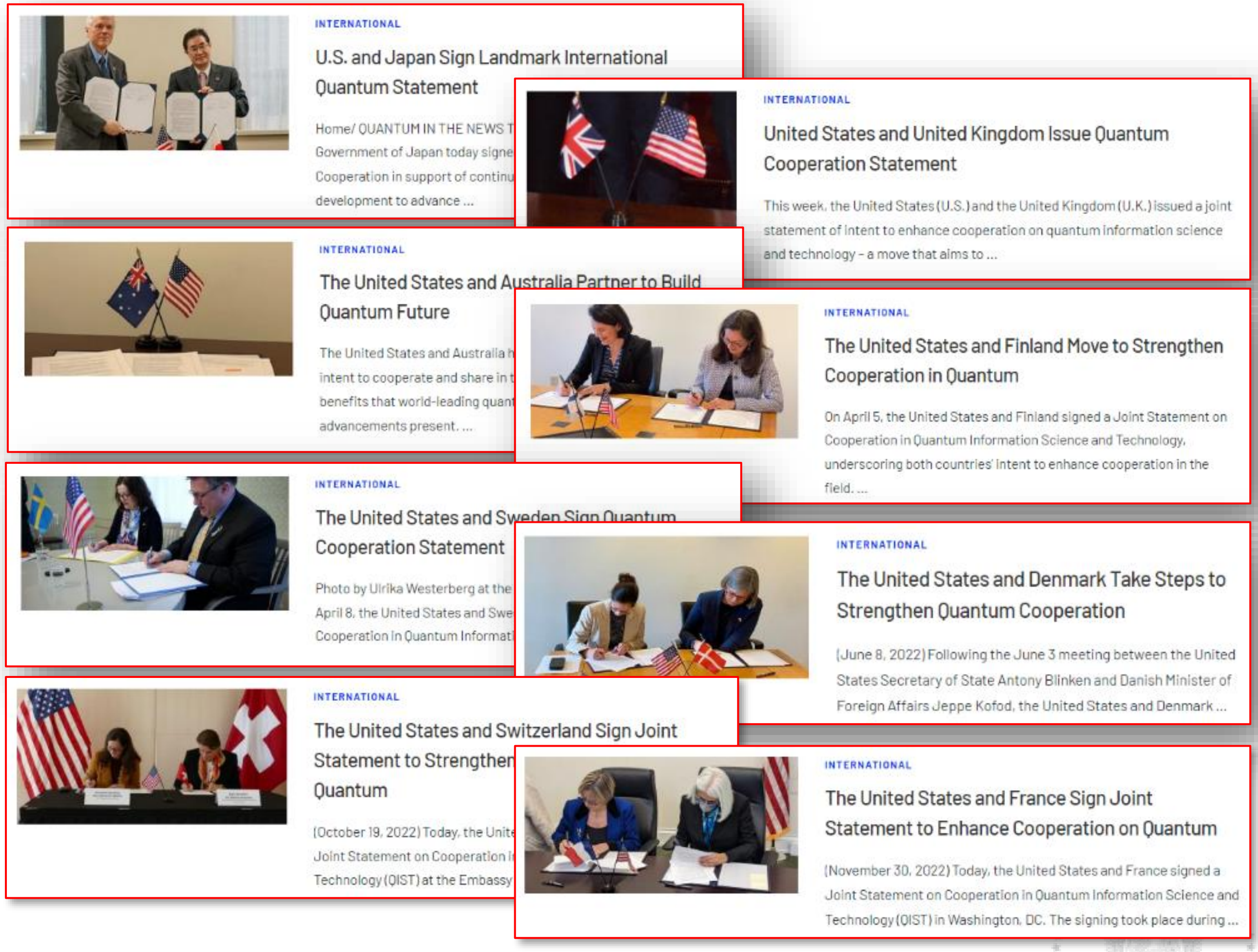
A Report by the
SUBCOMMITTEE ON ECONOMIC AND SECURITY IMPLICATIONS OF QUANTUM SCIENCE
COMMITTEE ON HOMELAND AND NATIONAL SECURITY
of the
NATIONAL SCIENCE & TECHNOLOGY COUNCIL

October 2021


SUMMARY OF THE WORKSHOP ON CYBERSECURITY OF QUANTUM COMPUTING

- **Products from the Subcommittee on Economic and National Security Implications of Quantum Science (ESIX)**
- **ESIX to "review and assess any economic or security implications of such investments; assess the export of technology associated with quantum information science…"**

International Cooperation


INTERNATIONAL
U.S. and Japan Sign Landmark International Quantum Statement
Home/ QUANTUM IN THE NEWS T
Government of Japan today signe
Cooperation in support of continu
development to advance ...

INTERNATIONAL
United States and United Kingdom Issue Quantum Cooperation Statement
This week, the United States (U.S.) and the United Kingdom (U.K.) issued a joint statement of intent to enhance cooperation on quantum information science and technology - a move that aims to ...

INTERNATIONAL
The United States and Australia Partner to Build Quantum Future
The United States and Australia h
intent to cooperate and share in t
benefits that world-leading quant
advancements present. ...

INTERNATIONAL
The United States and Finland Move to Strengthen Cooperation in Quantum
On April 5, the United States and Finland signed a Joint Statement on Cooperation in Quantum Information Science and Technology, underscoring both countries' intent to enhance cooperation in the field. ...

INTERNATIONAL
The United States and Sweden Sign Quantum Cooperation Statement
Photo by Ulrika Westerberg at the
April 8, the United States and Swe
Cooperation in Quantum Informat

INTERNATIONAL
The United States and Denmark Take Steps to Strengthen Quantum Cooperation
(June 8, 2022) Following the June 3 meeting between the United States Secretary of State Antony Blinken and Danish Minister of Foreign Affairs Jeppe Kofod, the United States and Denmark ...

INTERNATIONAL
The United States and Switzerland Sign Joint Statement to Strengthen Quantum
(October 19, 2022) Today, the Unite
Joint Statement on Cooperation i
Technology (QIST) at the Embassy

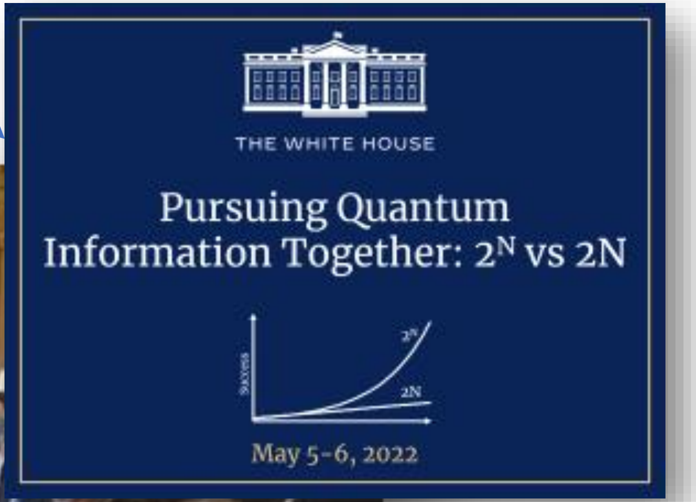
INTERNATIONAL
The United States and France Sign Joint Statement to Enhance Cooperation on Quantum
(November 30, 2022) Today, the United States and France signed a Joint Statement on Cooperation in Quantum Information Science and Technology (QIST) in Washington, DC. The signing took place during ...

8 bilateral quantum statements

Strengthening International Quantum Cooperation Underpinned by Shared Values for the Quantum Ecosystem

- Science and the Global Economy
- Growing the Quantum Workforce and a Quantum Aware Society
- Shaping a Healthy Global Ecosystem

Multilateral quantum dialogues
White House, May 2022
London, Nov 2022
AUKUS, QUAD, NATO (DIANA)....



Agency actions


ear Colleague Letter: International Collaboration
upplements in Quantum Information Science and
ngineering Research

INTERNATIONAL / NSF / R&D FUNDING OPPORTUNITIES

NSF Funding for International Collaboration in Quantum

(August 18, 2022) The National Science Foundation (NSF) released a Dear Colleague Letter on July 21, 2022 on International Collaboration Supplements in Quantum Information Science and Engineering Research. With this ...

Enabling Our People

by building the necessary talent pipeline and ensuring that this field creates new opportunities for all Americans.

QIST WORKFORCE DEVELOPMENT

QUANTUM INFORMATION SCIENCE AND TECHNOLOGY WORKFORCE DEVELOPMENT NATIONAL STRATEGIC PLAN

A Report by the
SUBCOMMITTEE ON QUANTUM INFORMATION SCIENCE
COMMITTEE ON SCIENCE
of the
NATIONAL SCIENCE & TECHNOLOGY COUNCIL

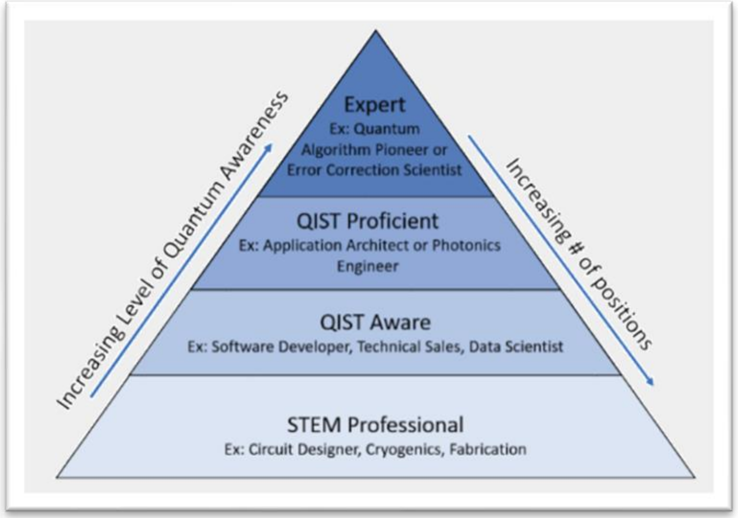
February 2022

BRIEFING ROOM

White House Office of Science & Technology Policy and U.S. National Science Foundation Host "Quantum Workforce: Q-12 Actions for Community Growth" Event, Release Quantum Workforce Development Plan

FEBRUARY 01, 2022 • PRESS RELEASES

Inspire	Educate	Experiences	Careers
Motivate students and broaden public understanding via foundational education and outreach. Examples include: • Q-12 Partnership • World Quantum Day	Develop and deploy formal and informal approaches. Examples include: • Quantum 101 • QIST Minors • QIST Masters	Grow confidence through unique opportunities. Examples include: • Internships • Externships • Hands-On Research • After School Programs	Make people aware of the impactful and diverse options in QIST and encourage them to pursue careers in: • Industry • Academia • Government



National Q-12 Education Partnership

Bringing together tech companies, professional societies, and academics to work across the quantum and STEM ecosystems to promote equitable learning opportunities for all ages and grow a diverse quantum-ready workforce to ensure that the quantum innovators of tomorrow can accelerate discoveries, invent new technologies, and drive societal change.

http://q12education.org/

Access to learning resources	Careers outreach	Teacher Support	Prep for future curricula
• High-quality, age-appropriate learning materials and tools. • Quantum activities in the classrooms. • Pathways and content for students, teachers, and families to learn about QISE	• Quantum Profiles. • Community blog to share programs in quantum + STEM • Explain quantum jobs and career pathways • Events that connect QISE researchers with students and teachers	• Summer teacher development workshops in QIS. • QIS Teacher Townhalls to understand community needs. • Teacher success stories bringing quantum into their classroom.	• NSF QIS Key Concepts for future learners. • Teacher-driven working groups to connect Key Concepts to Chemistry, Math, Physics, and C.S. • Network of teachers and programs.

https://worldquantumday.org/
https://www.quantum.gov/world-quantum-day/

SUMMARY OF WORKSHOP ON QUANTUM RECRUITMENT IN THE FEDERAL GOVERNMENT

Product of
The National Quantum Coordination Office

January 2022

SUMMARY OF THE NATIONAL Q-12 EDUCATION PARTNERSHIP KICK-OFF EVENT

Product of
The National Quantum Coordination Office

December 2020

Live on entanglementexchange.org

Entanglement Exchange

The development of the next generation of scientists and engineers benefits humanity and is necessary to expand the field of quantum information science and technology. The Entanglement Exchange represents a commitment to facilitate this exchange of students, researchers, and professionals in the field.

Quantum is a global endeavor. International cooperation and collaboration through people exchanges are key to combine the expertise, ingenuity, and creativity of all people to expand humanity's fundamental understanding of quantum information and thereby accelerate the realization of new technologies for the benefit of society.

These partnerships begin with personal experiences. The Entanglement Exchange represents a beginning step in creating more opportunities to work alongside each other from joint graduate fellowships to postdoctoral opportunities to visits and sabbaticals.

This website links to Entanglement Exchange pages hosted by several countries. Each page will be maintained to help individuals looking for international research experiences, both inward and outward, to or from the respective quantum ecosystems.

- Australia
- Canada
- Denmark
- Finland
- France
- Germany
- Japan
- Netherlands
- Sweden
- Switzerland
- United Kingdom
- United States

NEWS

11/30/2022 - Entanglement Exchange Links Quantum Researchers Across Twelve Nations

Entanglement Exchange Links Quantum Researchers Across Twelve Nations

New website is a portal for international exchange opportunities in quantum information science

November 30, 2022

Australia, Canada, Denmark, Finland, France, Germany, Japan, the Netherlands, Sweden, Switzerland, the United Kingdom, and the United States are proud to launch the Entanglement Exchange, a portal for highlighting international exchange opportunities for students, postdocs, and researchers in quantum information science (QIS).

QIS is an emerging field that harnesses quantum physics for information processing, and it promises technological breakthroughs such as quantum computers, quantum networks, and quantum sensors, each of which offer capabilities beyond traditional devices. The field has been developing for decades, but in recent years, the pace of discovery has accelerated through programs and initiatives to invest in QIS research and development.

In May 2022, a roundtable meeting on Pursuing Quantum Information Together was held in Washington between the twelve countries. This meeting highlighted the importance of international cooperation in QIS to accelerate discovery, share resources, and jointly address global challenges. Recognizing the benefits of international partnerships and the global nature of science, the idea for the Entanglement Exchange was proposed as a follow-up action.

Working together, the countries identified exchange opportunities in QIS and developed the Entanglement Exchange to help distribute information about those opportunities. In November 2022, the countries

Quantum in CHIPS & CHIPS for Quantum

Quantum in the CHIPS and Science Act of 2022

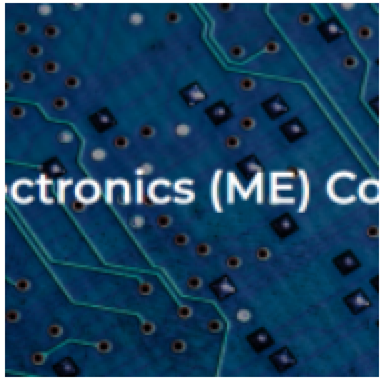
(8/9/2022)

NQIA, QIS Budget

(August 9, 2022) Ensurir
science right, enhancin
created by this new fielc

Quantum-specific programs authorized by the CHIPS and Science Act	Lead Agencies	Annual Authorization of Appropriations	Timeframe
Quantum Science Network	DOE	$100,000,000	2023-2027
Quantum User Expansion for Science and Technology Program	DOE	$30,000,000*	2023-2027
Quantum Networking and Communications Research and Standardization	NIST	$15,000,000	2023-2027
Next Generation Quantum Leaders Pilot Program	NSF	$8,000,000	2023-2026
Annual Authorized Investment		$153,000,000	

+ authorizations for $++ for NSF, DOE, …



DoD Funding for Prototyping Quantum Technologies

(9/19/2022)

Infrastructure, R&D Funding Opportunities

(September 19, 2022) The Office of the Undersecretary of Defense, Research & Engineering (OUSD(R&E))'s Microelectronics program will soon be supporting domestic prototyping capability in six application areas, including quantum technology. The end-state goal to develop a national network of regional innovation…

Considering opportunities for QIST in the implementation of the CHIPS Act

Looking Forward

➢ New organizations

- NSF TIP
- ARPA-H
- CHIPS office

➢ New legislation

- NDAA ESIX tasks
  - Research security, export controls
- CHIPS implementation
  - DOD Commons
  - Commerce/NIST NSTC, etc
- Science Act appropriation?
- NQI Reauthorization?

➢ New directives

- NSM-10 on Quantum Computing / EO on NQIAC
  - Promote (R&D, workforce/ed, partnerships)
  - PQC implementation
  - Innovative protection (Technology Protection Plans, etc)
- EO on NQI Advisory Committee
  - Report to Congress

NATIONAL QUANTUM COORDINATION OFFICE

Quantum.gov

The NQI Act

National Quantum Initiative Advisory Committee (NQIAC) Meeting
December 16, 2022

Dr. Corey Stambaugh
Senior Policy Advisor
Office of Science and Technology Policy
The White House

whitehouse.gov/ostp
@WHOSTP
www.quantum.gov

National Quantum Coordination Office

- **Dr. Charles Tahan** (IC), Director
- **Dr. Gretchen Campbell** (NIST), Deputy Director
- **Dr. Corey Stambaugh** (NIST), Senior Policy Advisor
- **Dr. Tanner Crowder** (DOD), Policy Analyst
- **Dr. Thomas Wong** (DOE), Quantum Liaison

The NQI Program

The NQI Program, established pursuant to section 101 of the NQI Act, *encompasses contributions from across the Federal Government*, as exemplified by the QIS research, development, demonstration, and training activities pursued by executive departments and agencies with *membership on either* the National Science and Technology Council (NSTC) Subcommittee on Quantum Information Science (*SCQIS*) or the NSTC Subcommittee on Economic and Security Implications of Quantum Science (*ESIX*).

-Executive Order on Enhancing the NQIAC

National Quantum Initiative Act

Sec. 2. Definitions.
Sec. 3. Purposes.
TITLE I—NATIONAL QUANTUM INITIATIVE (NQI)
- Sec. 101. NQI Program.
- Sec. 102. National Quantum Coordination Office.
- Sec. 103. Subcommittee on QIS.
- Sec. 104. NQI Advisory Committee.
- Sec. 105. Subcommittee on the Economic and Security Implications of QIS.
- Sec. 106. Sunset.

TITLE II—NIST QUANTUM ACTIVITIES
- Sec. 201. NIST activities and quantum consortium.

TITLE III—NSF QUANTUM ACTIVITIES
- Sec. 301. QIS research and education program.
- Sec. 302. Multidisciplinary Centers for Quantum Research and Education.

TITLE IV—DOE QUANTUM ACTIVITIES
- Sec. 401. QIS Research program.
- Sec. 402. NQI Science Research Centers.
- Sec. 403. DOE quantum network infrastructure R&D program.
- Sec. 404. DOE quantum user expansion for S&T program.

Purpose: ensure the continued leadership of the U.S. QIST applications by–

(1) supporting R&D, demonstration, and application of QIST by--
- (A) expanding QIST workforce pipeline;
- (B) promoting multidisciplinary curriculum and research opportunities for QIS;
- (C) addressing basic research knowledge gaps;
- (D) promoting infrastructure for QIST research, testing and education; and
- (E) stimulating development of quantum-based technologies;

(2) improving coordination of Federal QIST R&D;
(3) maximizing the effectiveness of the U.S. Government QIST R&D, and demonstration programs;
(4) promoting collaboration; and
(5) promoting the development of international standards for QIST security–
- (A) facilitate innovation and commercialization; and
- (B) meet economic and national security goals

National Quantum Initiative

Sec. 102 Quantum Coordination Office (NQCO)

- Support SCQIS, ESIX, and NQIAC;
- Oversee interagency coordination
- Ensure coordination among QIS Consortia & Centers;
- Conduct public outreach and serve as the point of contact on Federal civilian QIST activities;
- Promote access to and early application of the technologies.

Sec. 103 NSTC Subcommittee on QIS (SCQIS)

- Coordinate Fed. Agency QIST R&D programs, & information sharing on R&D, standards, education;
- Establish goals and priorities of the NQI Program;
- Assess U.S. QIS workforce, global outlook for QIS R&D, and infrastructure; & make recommendations;
- Propose a budget for the NQI Program that ensures a balanced QIS research portfolio and appropriate effort;
- Report on Quantum Networking and Communications
- Strategic Plan and Annual Program Budget Reports.

Sec. 105 NSTC Subcommittee on Economic and Security Implications of QIS (ESIX)

- Track, review, and assess Federal QIS R&D investments for economic and security implications, and make recommendations for investment strategies;
- Review and assess investments for risks or other foreign threats, and recommend goals and priorities, including appropriate protections
- Assess export controls for QIS and related technologies, and make recommendations that protect the economic and security interests of the U.S.

National Quantum Initiative

Sec. 104 Advisory Committee (NQIAC)

- Advise and provide recommendations for improving the NQI Program
- Conduct independent assessments of:
  - trends or developments in QIST:
  - progress implementing the Program;
  - management, coordination, implementation, & activities;
  - if activities, goals and priorities maintain U.S. leadership in QIST;
  - if need exists to revise the Program;
  - if opportunities for international cooperation
  - if national security, societal, economic, legal, and workforce
  - concerns are adequately addressed by the NQI Program.

Sec. 106 Sunset

(a) In General.– The authority to carry out sections 101, 102, 103, 104, and 105 shall terminate on the date that is 11 years after the date of enactment of this Act.

(b) Extension.--The President may continue the activities under such sections if the President determines that such activities are necessary to meet national economic or national security needs

NQI Act: Title II - NIST

Quantum Activities

- Expand QIST R&D to advance commercial development of QT
- Use programs to train scientist
- Establish or expand collaborative ventures to advance QISE
- carry out research on development and standardization of quantum cryptography and post-quantum classical cryptography
- carry out research on development and standardization of quantum networking, communications, and sensing technologies and applications;
- provide technical review and assistance to other Federal agencies, as appropriate, for the development of quantum networking infrastructure standards;
- Authorized $15M/yr for FY23 to FY27 for blue text

Quantum Consortium

- Convene quantum consortium to address future measurement, standards, cyber security, and other needs to advance QIST industry
- Goals is to assess current needs, identify R&D gaps, and make recommendations NIST-

---

- Authorized $80M/yr for FY19-FY23

NQI Act: Title III - NSF

QIS R&D Program

- Support basic QISE research
- Support workforce development in all aspects of QIS&E
  - Improve teaching and learning of QISE at all levels
  - Increase participation
- Authorized to establish graduate traineeships.
- NSF Incorporating QISE Into STEM Curriculum
  - look at programs to increase the integration of QISE into the STEM curriculum at all education levels, including community colleges.
    - Includes methods to conceptualize QISE for K-12 and strengthen math and science

Multidisciplinary Centers for Quantum Research and Education

- Establish up to 5 centers
  - Advance QISE
  - Support curriculum and workforce development in QISE
  - Foster innovation by engaging industry in these areas .
  - 5 years w/option 5 more
  - continuing to advance QIS&E
- Authorized $50M/yr from FY19-FY23

NSF QIS Workforce Evaluation and Acceleration

NASEM report to assess the state of QIS education and skills training at all education levels and identify gaps in meeting current and future workforce needs, including with respect to **elementary, middle, and high-school**.

NSF Quantum Education Pilot Program

NSF, building on the NSF's role in **the National Q-12 Education partnership** and programs such as **Q2Work Program**, shall make awards to carry out a pilot program, known as the 'Next Generation Quantum Leaders Pilot Program' for the education and training of the next generation of students and teachers in the fundamental principles of quantum mechanics. (Authorized $8M/yr)

NQI Act: Title IV - DOE

Quantum Information Science Research Program

- Carry out a basic research program on QIS, leveraging the collective body of knowledge from existing QIS research;
- Provide research experiences and training for undergraduate and graduate students in QIS

Quantum Information Science Centers

- Establish and operate National QIS Research Centers to conduct basic R&D to accelerate scientific advances in QIST
- Authorized $125M/yr for FY19-FY23 (for centers)

DOE quantum network infrastructure R&D program.

- R&D, and demonstration program to accelerate innovation in quantum network infrastructure
- Authorized $100M/yr for FY23-FY27

DOE quantum user expansion for S&T program.

- QUEST program: encourage and facilitate access to U.S. quantum computing hardware and cloud services for research
    - To enhance the U.S. quantum research enterprise, educate the workforce; to accelerate U.S. quantum computing capabilities; and advance the relevant domestic supply chains, manufacturing processes, and associated simulations or modeling capabilities.
- Authorized $30M/yr for each (inc. by 5%/yr) for FY23-FY27

National Defense Authorization Acts

National Defense Authorization Acts for FY 2019, FY 2020, and FY2022 (PL 115-232) & (PL 116–92)
describe the Defense QIS and Technology R&D Program

Defense QIS and Technology R&D Program

…develop and manage a portfolio of fundamental and applied quantum information science and technology and engineering research initiatives that is stable, consistent, and balanced across scientific disciplines.

…establish and support appropriate research, innovation, and industrial base, including facilities, workforce, and infrastructure, to support the needs of Department of Defense missions and systems related to QIST.

Requirements:

- Strategic Plans
- Coordination on
  - QIST R&D
  - Training
  - Infrastructure
- QIS Center(s)

Quantum Science is one of DoD's 11 top modernization priority areas

Science First

National Quantum Initiative Advisory Committee (NQIAC) Meeting
December 16, 2022

Tanner Crowder
Policy Analyst, National Quantum Coordination Office
Office of Science and Technology Policy
The White House

whitehouse.gov/ostp
@WHOSTP
www.quantum.gov

National Quantum Coordination Office

- **Dr. Charles Tahan** (IC), Director
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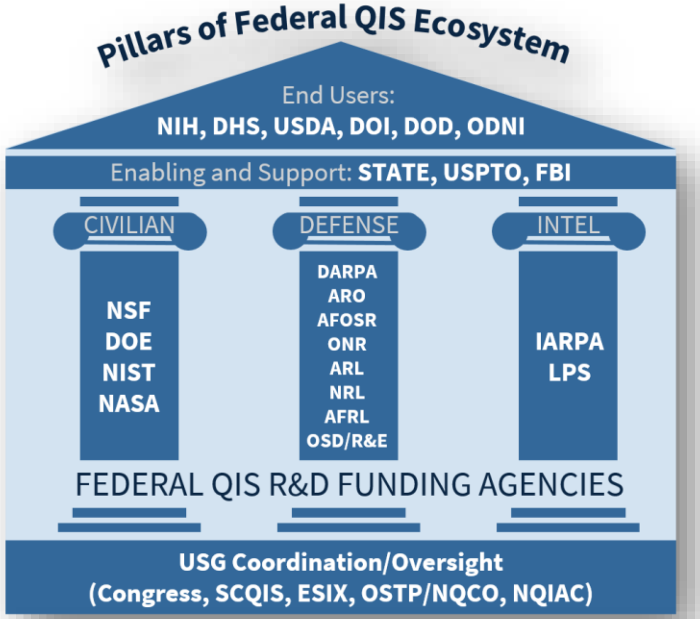
- **Dr. Thomas Wong** (DOE), Quantum Liaison

Federal Agencies in the QIS Ecosystem

Technical leaders from across the interagency compose the NSTC Subcommittees working groups that develop policy recommendations and aid in coordination.



CIVILIAN
- National Science Foundation (NSF)
- Department of Energy (DOE)
- National Institute of Standards and Technology (NIST)
- National Aeronautics and Space Administration(NASA)

DEFENSE
- Defense Advanced Research Projects Agency (DARPA)
- Army Research Office (ARO)
- Air Force Office of Scientific Research (AFOSR)
- Office of Naval Research (ORN)
- Army Research Lab (ARL)
- Naval Research Lab (NRL)
- Air Force Research Lab (ARFL)
- Office of the Secretary of Defense/Research and Engineering (OSD/R&E)

INTELLIGENCE
- Intelligence Advanced Research Projects Activity (IARPA)
- Laboratory For Physical Sciences (LPS)

END USERS
- National Institutes of Health (NIH)
- Department of Homeland Security (DHS)
- United States Department of Agriculture (USDA)
- United States Geological Survey (DOI/USGS)
- Department of Defense (DOD)
- Office of the Director of National Intelligence (ODNI)

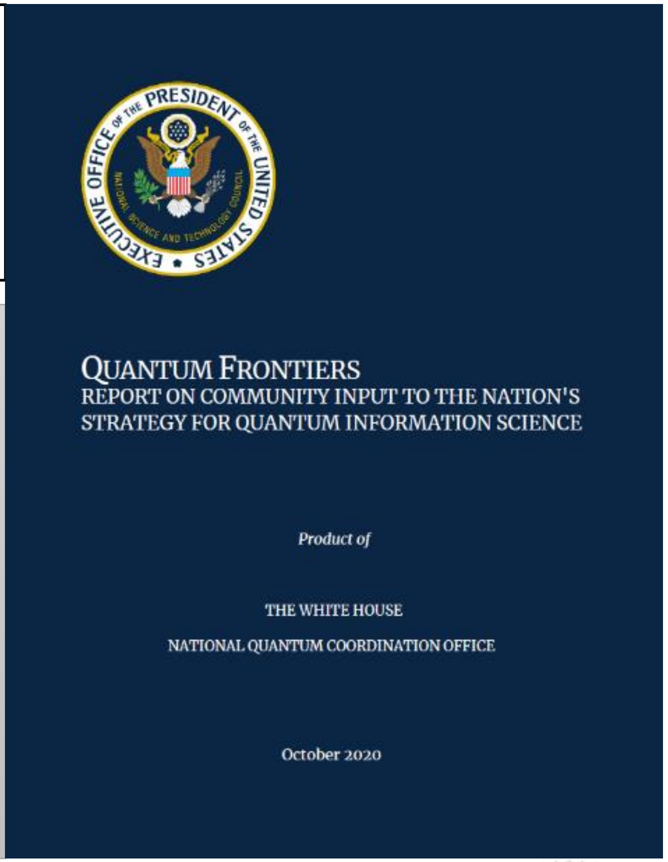
ENALBING AND SUPPORT
- Federal Bureau of Investigation (FBI)
- U.S. Patent and Trade Office (USPTO)
- Department of State (STATE)

Getting the Science Right – Quantum Frontiers

Synthesizes feedback from NSF Request for Information (RFI) on National Strategic Overview and multiple Workshops held by Agencies in 2018/2019

The Eight Frontiers are:

1. Expanding Opportunities for Quantum Technologies to Benefit Society
2. Building the Discipline of Quantum Engineering
3. Targeting Materials Science for Quantum Technologies
4. Exploring Quantum Mechanics through Quantum Simulations
5. Harnessing Quantum Information Technology for Precision Measurement
6. Generating and Distributing Quantum Entanglement for New Applications
7. Characterizing and Mitigating Quantum Errors
8. Understanding the Universe through Quantum Information


QUANTUM FRONTIERS
REPORT ON COMMUNITY INPUT TO THE NATION'S STRATEGY FOR QUANTUM INFORMATION SCIENCE

Product of

THE WHITE HOUSE

NATIONAL QUANTUM COORDINATION OFFICE

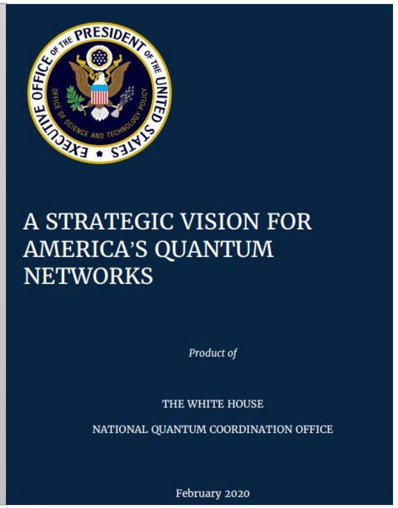
October 2020

The quantum frontiers capture the technical areas where the key technical challenges can be found toward the various mission and practical objectives within QIST.

A Coordinated Approach to Quantum Networking

Two goals from Strategic Vision of QNs:

1. Five Years: Demonstrate the foundational science and key technologies to enable quantum networks.
2. Twenty Years: Leverage networked quantum devices to enable new capabilities not possible with classical technology, while advancing our understanding of the role entanglement plays.

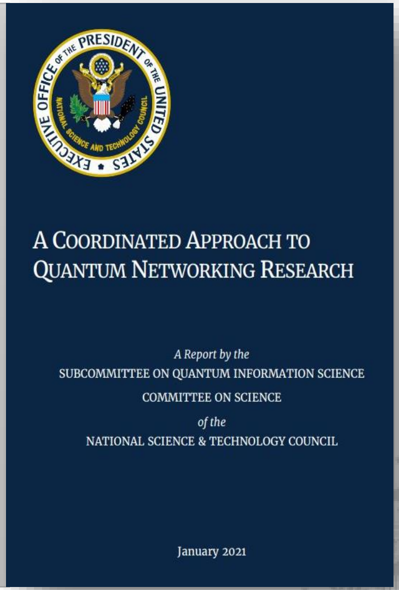


Technical Recommendations:

1. Continue research on use cases for quantum networks
2. Prioritize cross-beneficial core components for quantum networks
3. Improve classical capabilities to support quantum networks
4. Leverage “right-Sized” quantum networking testbeds

Programmatic Recommendations:

1. Increase interagency coordination on quantum networking R&D
2. Establish timetables for quantum networking R&D infrastructure
3. Facilitate international cooperation on quantum networking R&D



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A Coordinated Approach to Quantum Networking

Quantum Networking IWG

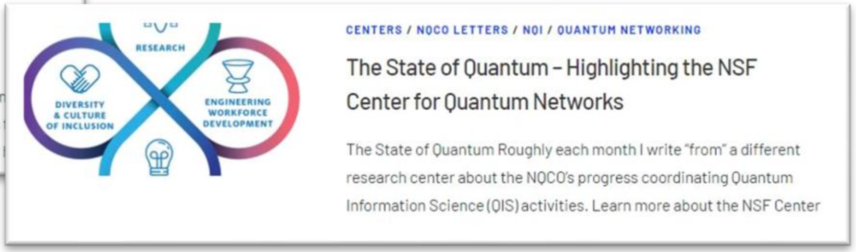
Co-Chairs

Tanner Crowder, OSTP
Kathy-Anne Soderberg, AFRL
Laura Sinclair, NIST

Members

Grace Metcalfe, AFOSR	**Eleanor Rieffel, NASA**
Mike Hayduk, AFRL	**Tom Reinecke, NRL**
Fredrick Fatemi, ARL	**Gerry Borsuk, NRL**
Paul Kunz, ARL	**Roberto Diener, ONR**
Brian Kirby, ARL	**Josh Bienfang, NIST**
Sara Gamble, ARO	**Alan Migdall, NIST**
Allyson O'Brien, DARPA	**Ollie Slattery, NIST**
Tatjana Curcic, DARPA	**Tom Jenkins, NRO**
Carol Hawk, DOE	**Morgan Stern, NSA**
Lali Chatterjee, DOE	**Alex Cronin, NSF**
Gerry Baumgartner, LTS	**Dominique Dagenais, NSF**
Anne-Marie Richards, LTS	**Bogdan Mihaila, NSF**
John Lekki, NASA	**Ann Von Lehmen, NSF**
Angela Hodge, NASA	

The QN-IWG includes representation from: OSTP, NIST, NASA, NSF, DOE, DARPA, ARL, ARO, AFRL, AFOSR, NRL, NRO, NSA, NSpC



CHIPS and Science Act: The Quantum Networking(QN) IWG shall report to Congress a plan for the advancement of QN tech in the U.S. including:

1) Updating A Coordinated Approach to Quantum Networking Research.
2) Federal partnership with the private sector and interagency collaboration
3) Protection of national security interests relating to the advancement of QN.
4) Assessment of the U.S. position in the global QNC race.
5) Recommendations to Congress for legislative action pertaining to (1)-(4)

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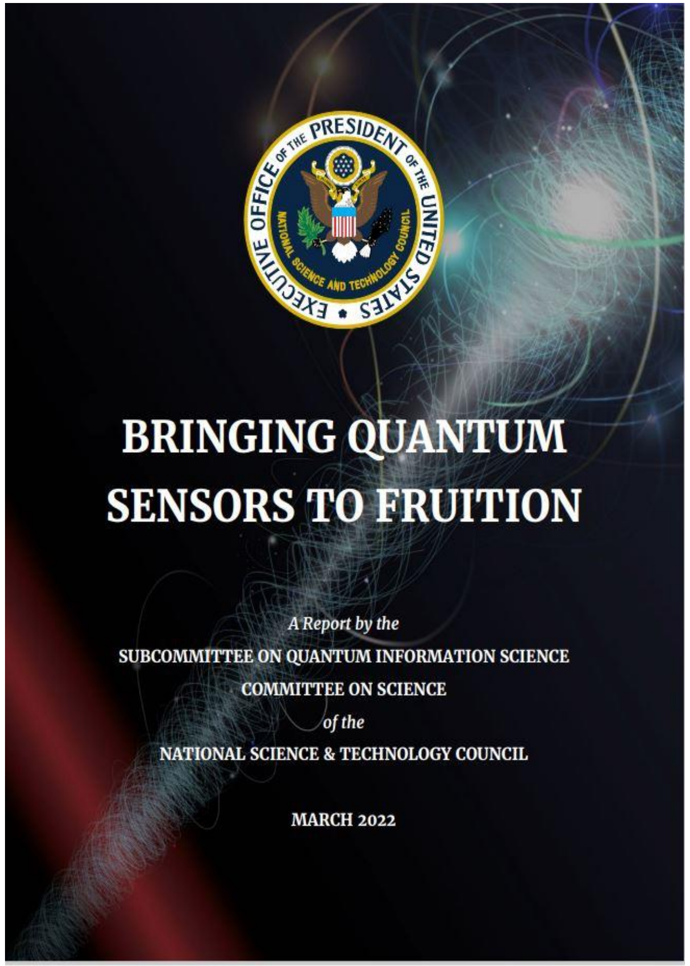
Bringing Quantum Sensors to Fruition

"The realization of new quantum sensors is a tangible, near-term objective that should be catalyzed by agencies represented on the Subcommittee on QIS as part of the NQI program."

Recommendations:

1. Accelerate the development of new quantum sensing approaches and prioritize partnerships with end users.
2. Conduct feasibility studies and jointly test quantum prototypes.
3. Develop broadly applicable components and subsystems, to facilitate the development of quantum technologies and promote economies of scale.
4. Streamline technology transfer and acquisition practices to encourage the development and early adoption of quantum sensor technologies.



Quantum Sensors Effort

Co-Chairs from End-User IWG

Jalal Mapar, DHS
Geetha Senthil, NIH
Corey Stambaugh, OSTP

Co-Chairs from Science IWG

Denise Caldwell, NSF
Alexander Cronin, OSTP

Participants

Ernest Wong, DHS
John Burke, DOD
Grace Metcalfe, AFOSR
Spencer Olson, AFRL
Maxwell Gregoire, AFRL
Paul Kunz, ARL
Fredrik Fatemi, ARL
Peter Reynolds, ARO
Tatjana Curcic, DARPA
Joanna Ptasinski, Navy
Stephen Potashnik, Navy
Craig Hoffman, NRL
Gerald Borsuk, NRL
Roberto Diener, ONR
Jean-Luc Cambier, OUSD(R&E)
Jon Hoffman, DOD
Athena Sefat, DOE
Lali Chatterjee, DOE
Ashton Flinders, USGS
Tim Quinn, DOI USGS
Karen Van Dyke, DOT
Tom Walsh, FBI
Michael Di Rosa, IARPA
Nicole Bohannon, LPS
Rupak Biswas, NASA
Bradley Carpenter, NASA
Gurusingham Sittampalam, NIH
Kartik Srinivasan, NIST
John Kitching, NIST
Derek Van Westrum, NOAA
Dan Roman, NOAA
Nadia El-Masry, NSF
Kelsey Cook, NSF
John Gillaspy, NSF
Jim Edgar, NSF
Yi Pei, OMB
Phil Purdy, USDA
Tanner Crowder, OSTP

Bringing Quantum Sensors to Fruition

Quantum Sensor and Atomic Clock Programs have a long history, with sustained investments:

- The Chip Scale Atomic Clock (CSAC) program, initiated by DARPA and catalyzed by a 2001 NIST workshop took 10 years and over $100M
- The NSF Laser Interferometer Gravitational-Wave Observatory (LIGO) is the result of over four decades of basic R&D and over $1B
- Improving SWaP for biomedical imaging, such as magnetoencephalography (MEG)

The Sensors Strategy has had a catalyzing effect:

- The NSF Quantum Sensing Challenges for Transformational Advances in Quantum Systems program solicitation
- NIH established a Quantum Sensing Scientific Interest Group and organizing workshops.
- DHS exploring potential applications of QIST, such as tunnel detection, and long- and short-range sensing.

Image Source: https://images.nimh.nih.gov/public_il/image_details.cfm?id=80

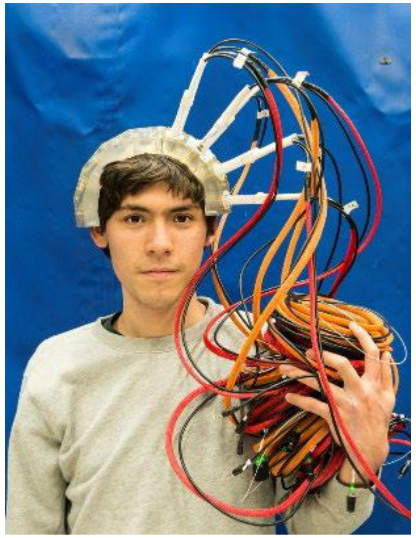


Image Source: https://www.nist.gov/news-events/news/2016/07/detecting-brain-waves-atomic-vapor

Workforce

National Quantum Initiative Advisory Committee (NQIAC) Meeting

December 16, 2022

Dr. Corey Stambaugh

Senior Policy Advisor

Office of Science and Technology Policy

The White House

whitehouse.gov/ostp

@WHOSTP

www.quantum.gov

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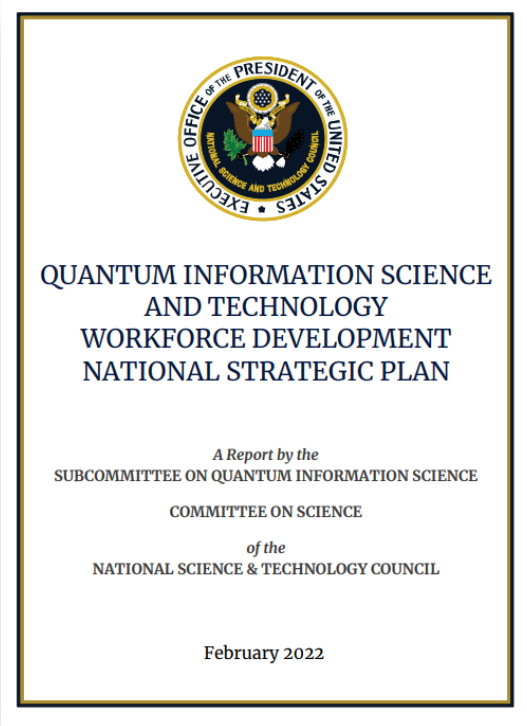
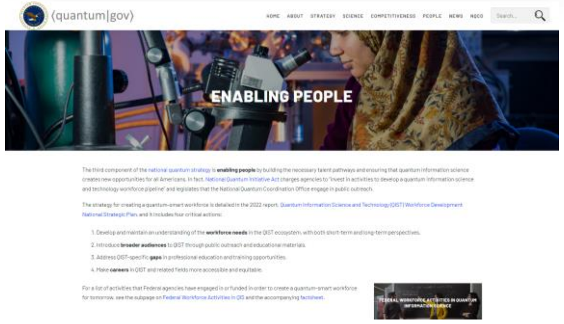
Enabling People - Strategy


QUANTUM INFORMATION SCIENCE AND TECHNOLOGY WORKFORCE DEVELOPMENT NATIONAL STRATEGIC PLAN

A Report by the
SUBCOMMITTEE ON QUANTUM INFORMATION SCIENCE
COMMITTEE ON SCIENCE
of the
NATIONAL SCIENCE & TECHNOLOGY COUNCIL

February 2022



QIST Workforce Development Vision

The United States should develop a diverse, inclusive, and sustainable workforce that possesses the broad range of skills needed by industry, academia, and the U.S. Government, while being able to scale and adapt as the QIST landscape evolves.

The strategic approach to realizing this vision is organized around four broad actions:

1: Develop and maintain an understanding of the workforce needs in the QIST ecosystem;

2: Introduce broader audiences to QIST through public outreach and education;

3: Address QIST-specific gaps in professional education and training opportunities;

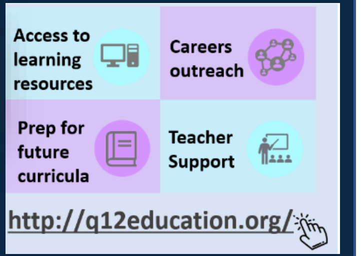
4: Make careers in QIST and related fields more accessible and equitable.

Inspire + Education + Experiences => Careers

INSPIRE

National Q-12 Education Partnership

- Teaching Resources
- K-12 Framework for Phys, CS, Math & Chem



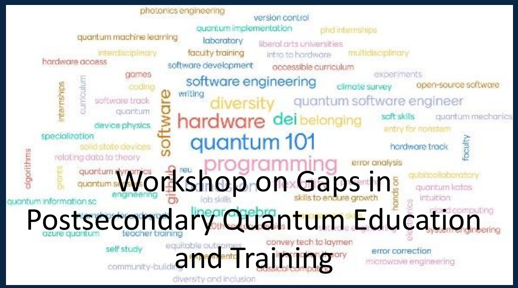
100k Views
Search:
This is quantum q12

100's of teachers

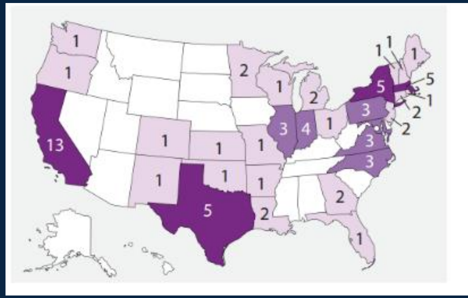
QUANTIME

20k+ students

EDUCATION AND TRAINING

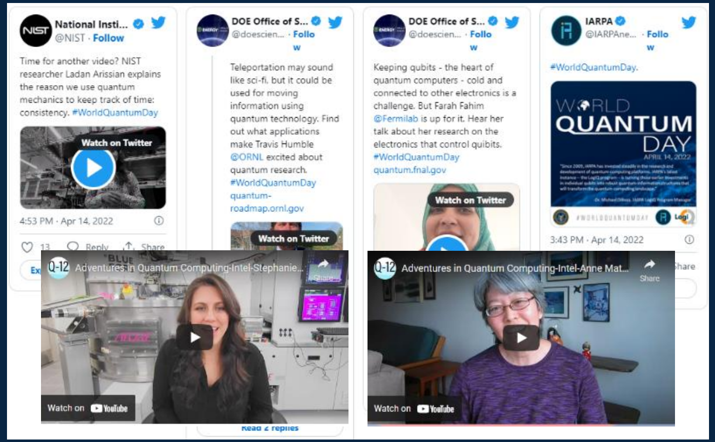


Convergent Undergraduate Education in Quantum Science, Technology, Engineerin Arts and Mathematics



Summer of Quantum
SHORT COURSE

ACCESSIBLE EXPERIENCES AND CAREERS



Public Outreach

Expanding Capacity in Quantum Information Science and Engineering (ExpandQISE)

ADVANCED SCIENTIFIC COMPUTING RESEARCH - REACHING A NEW ENERGY SCIENCES WORKFORCE (ASCR-RENEW)

FUNDING OPPORTUNITY ANNOUNCEMENT (FOA) NUMBER: DE-FOA-0002767

SUMMARY OF WORKSHOP ON QUANTUM RECRUITMENT IN THE FEDERAL GOVERNMENT

Product of
The National Quantum Coordination Office

Enabling People - Federal Workforce Activities in QIS

⟨quantum|gov⟩

FEDERAL WORKFORCE ACTIVITIES IN QUANTUM INFORMATION SCIENCE

OVERVIEW

The 2018 National Strategic Overview for Quantum Information Science (QIS) identifies **creating a quantum-smart workforce for tomorrow** as a key policy area. The strategy for creating this workforce is detailed in the 2022 report, Quantum Information Science and Technology (QIST) Workforce Development National Strategic Plan, and it includes four critical actions:

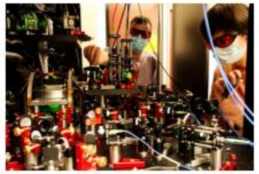
1. Develop and maintain an understanding of the **workforce needs** in the QIST ecosystem, with both short-term and long-term perspectives.
2. Introduce **broader audiences** to QIST through public outreach and educational materials.
3. Address QIST-specific **gaps** in professional education and training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

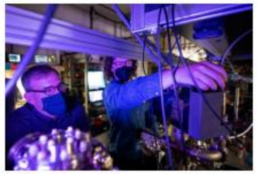
QUANTUM INFORMATION SCIENCE AND TECHNOLOGY WORKFORCE DEVELOPMENT NATIONAL STRATEGIC PLAN

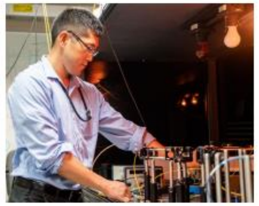
One of the primary mechanisms for coordinating Federal workforce activities in QIST is through the National Science and Technology Council (NSTC) Subcommittee on Quantum Information Science (SCQIS) **Interagency Working Group on Workforce (IWG-WF)**.

This factsheet gives some examples of activities that Federal agencies have engaged in or funded in order to create a quantum-smart workforce for tomorrow. At the **K-12** level, the activities include identifying QIST concepts and integrating them into existing K-12 courses, developing and curating approachable quantum lessons and activities, providing professional development for teachers, and engaging in public outreach about QIST and QIST careers. For **undergraduate** and **graduate** students, the activities increasingly involve scholarships, fellowships, and research opportunities, while providing additional on-ramps to QIST through summer schools. For **postdoctoral** scholars and **professionals**, activities include fellowships, summer schools, research opportunities, and funding for institutions traditionally underrepresented in the Federal research portfolio.

See quantum.gov for more information







There are a number of workforce development efforts underway across all sectors. To show the breadth of activities, here is a *small sample* of efforts that agencies have engaged in or funded.

K-12

- Q-12 Education Partnership of industry, academia, and government (OSTP & NSF spearheaded)
- Workshop on nine Key Concepts for Future QIS Learners (NSF funded)
- Frameworks for including QIS topics in high school physics, computer science, math, and chemistry courses (NSF funded)
- Classroom activities (e.g., Q-12 QuanTime)
- Professional development for teachers (e.g., NSF-funded Quantum for All and QuEST)
- Videos about quantum careers (e.g., for World Quantum Day, Q-12 Careers)
- High school summer internships at Government Labs (e.g., NIST SHIP) and universities (e.g., ARO High School Apprenticeship Program)
- Summer schools (e.g., National QIS Centers, AFRL Quantum STEM Summer Camp, NSF-funded Quantum for All and QuEST)

UNDERGRADUATE

- Scholarships (e.g., DOD SMART)
- Curriculum development (e.g., NSF-funded QuSTEAM)
- Summer research (e.g., NSF REU, NIST SURF, Naval Research Enterprise Internship Program, Pathways Program, AFRL Scholars Program)
- Summer schools (e.g., LPS Qubit Collaboratory, NSF-funded STAQ Virtual School)

GRADUATE

- Fellowships (e.g., ARO/LPS Quantum Computing Research Fellowship, DOD SMART, DOD National Defense Science and Engineering Graduate Fellowship, DOE CSGF) and funding through academic Principal Investigators
- Research at National QIS Research Centers (NSF, DOE, DOD, NSA), Government Labs (e.g., NIST, NASA, LPS, DOD), National Labs (DOE), and joint research institutes (e.g., JILA, JQI, LPS, QuICS)
- Research with academic and industry partners (e.g., NSF QISE-NET)
- Workshop on Gaps in Postsecondary Quantum Education and Training (LPS)
- Summer schools (e.g., DOE LANL Summer School Fellowship, DOE QSC Center, DOE C2QA Center)

POSTDOCTORAL

- Fellowships (e.g., LQC Postdoctoral Fellowship, NRC Fellowship, ODNI IC Postdoctoral Research Fellowship)
- Summer schools (e.g., NSF/DOE QS3)

PROFESSIONAL

- Faculty fellowships (e.g., NSF QCIS-FF)
- Summer research at Government Labs (e.g., Army, Navy, and Air Force Summer Faculty Fellowships)
- Career fairs (e.g., DOE Centers QIS Career Fair)
- Funding underrepresented universities in QIST (e.g., NSF ExpandQIS, DOE ASCR-RENEW, DOD/HBCU Quantum Sensing Center)
- Summer schools (e.g., AFRL/RI Short Courses)

Image Credits: [Banner] J.T. Consoli, U. Maryland [Pictures Top to Bottom] R. Hahn, Fermilab; LPS; Kaufman Group, CU Boulder, QSA; Argonne National Lab; K. Houser, UC Berkeley, QSA; NASA

Celebrating: QIS Concepts *to* Q-12 Education *to* K-12 Framework *to* QuanTime *to* Quantum Profiles

NQCO SCQIS Workforce Working Group

NSF Key Concepts Workshop

New NSF Programs

- Q2Work, 2 teacher conferences on quantum (Summer 2020)
- Convergence Accelerators for QIS Education
- QIS outreach embedded in centers and programs
- High School Students Learning QIS

http://q12education.org/

National Q-12 Education Partnership

Growing the Quantum Workforce.

Q-12 Education Partnership

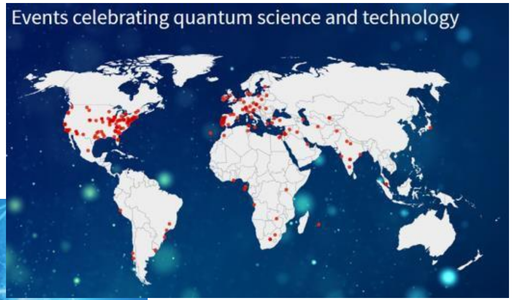
- Announced August 2020
- 13 initial members: industry, professional societies, and academia
- Commits to expanding access to K-12 quantum learning tools
- Will work with the community to nurture a diverse and innovative quantum workforce

Teach and Student Engagement

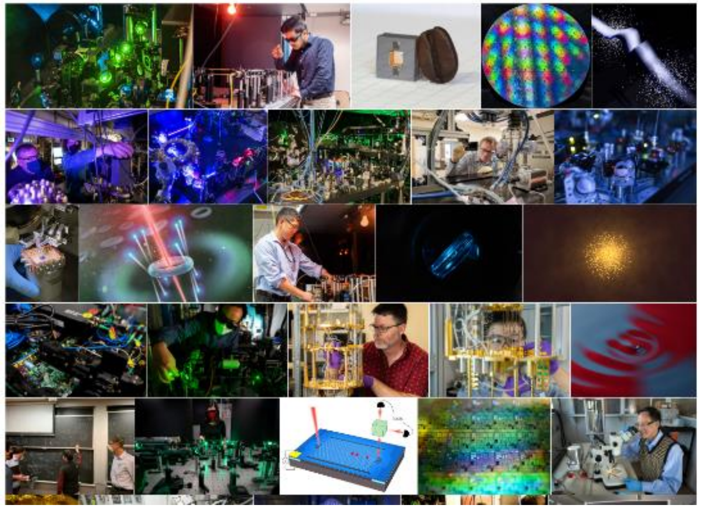
- Teacher Workshops
- Career Videos
- Quantum Crossing
- QuanTime

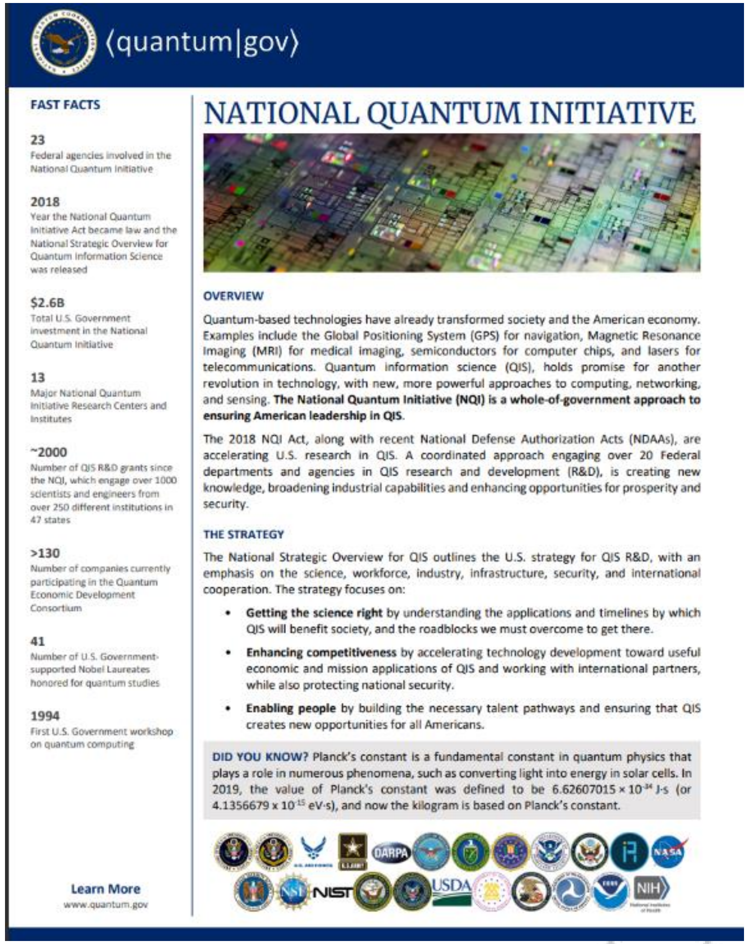
QIS Key Concepts for Early Learners: K-12 Framework

QUANTIME



quantum.gov/world-quantum-day





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FAST FACTS

23
Federal agencies involved in the National Quantum Initiative

2018
Year the National Quantum Initiative Act became law and the National Strategic Overview for Quantum Information Science was released

$2.6B
Total U.S. Government investment in the National Quantum Initiative

13
Major National Quantum Initiative Research Centers and Institutes

~2000
Number of QIS R&D grants since the NQI, which engage over 1000 scientists and engineers from over 250 different institutions in 47 states

>130
Number of companies currently participating in the Quantum Economic Development Consortium

41
Number of U.S. Government-supported Nobel Laureates honored for quantum studies

1994
First U.S. Government workshop on quantum computing

Learn More
www.quantum.gov

NATIONAL QUANTUM INITIATIVE

OVERVIEW

Quantum-based technologies have already transformed society and the American economy. Examples include the Global Positioning System (GPS) for navigation, Magnetic Resonance Imaging (MRI) for medical imaging, semiconductors for computer chips, and lasers for telecommunications. Quantum information science (QIS), holds promise for another revolution in technology, with new, more powerful approaches to computing, networking, and sensing. **The National Quantum Initiative (NQI) is a whole-of-government approach to ensuring American leadership in QIS.**

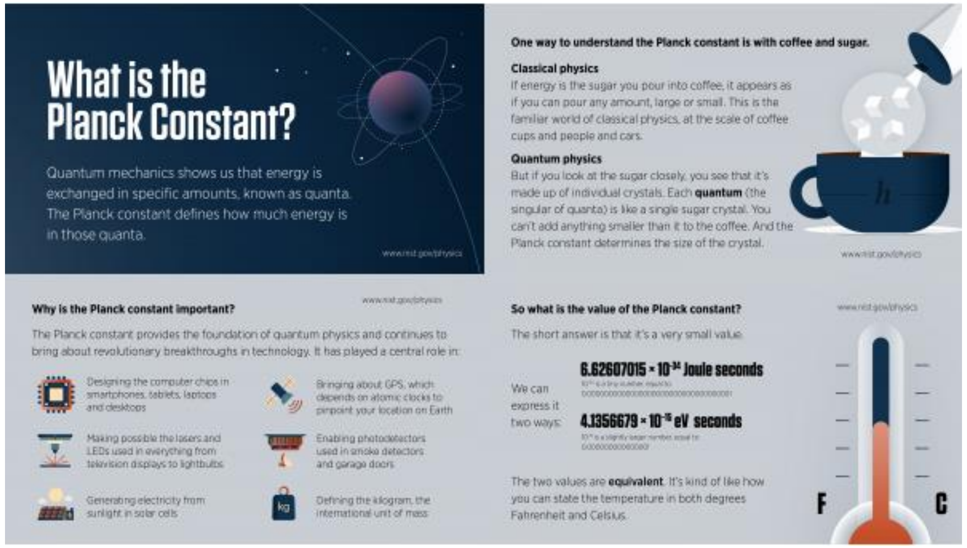
The 2018 NQI Act, along with recent National Defense Authorization Acts (NDAAs), are accelerating U.S. research in QIS. A coordinated approach engaging over 20 Federal departments and agencies in QIS research and development (R&D), is creating new knowledge, broadening industrial capabilities and enhancing opportunities for prosperity and security.

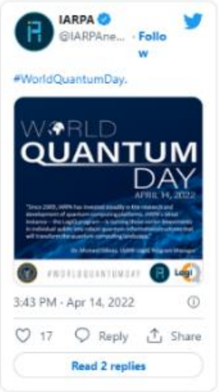
THE STRATEGY

The National Strategic Overview for QIS outlines the U.S. strategy for QIS R&D, with an emphasis on the science, workforce, industry, infrastructure, security, and international cooperation. The strategy focuses on:

- **Getting the science right** by understanding the applications and timelines by which QIS will benefit society, and the roadblocks we must overcome to get there.
- **Enhancing competitiveness** by accelerating technology development toward useful economic and mission applications of QIS and working with international partners, while also protecting national security.
- **Enabling people** by building the necessary talent pathways and ensuring that QIS creates new opportunities for all Americans.

DID YOU KNOW? Planck's constant is a fundamental constant in quantum physics that plays a role in numerous phenomena, such as converting light into energy in solar cells. In 2019, the value of Planck's constant was defined to be $6.62607015 \times 10^{-34}$ J·s (or $4.1356679 \times 10^{-15}$ eV·s), and now the kilogram is based on Planck's constant.





Thanks to all that contributed to make this a success!!!

Security and International

National Quantum Initiative Advisory Committee (NQIAC) Meeting
December 16, 2022

Gretchen Campbell
Deputy Director, National Quantum Coordination Office
Office of Science and Technology Policy
The White House

whitehouse.gov/ostp
@WHOSTP
www.quantum.gov

National Quantum Coordination Office

- **Dr. Charles Tahan** (IC), Director
- **Dr. Gretchen Campbell** (NIST), Deputy Director
- **Dr. Corey Stambaugh** (NIST), Senior Policy Advisor
- **Dr. Tanner Crowder** (DOD), Policy Analyst
- **Dr. Thomas Wong** (DOE), Quantum Liaison

Enabling Competitiveness – Quantum Computing

National Security Memorandum

BRIEFING ROOM

National Security Memorandum on Promoting United States Leadership in Quantum Computing While Mitigating Risks to Vulnerable Cryptographic Systems

MAY 04, 2022 • STATEMENTS AND RELEASES

Sec. 1: Policy

- Quantum computers hold the **potential to drive innovations** across the American economy
- Yet alongside its potential benefits, **quantum computing also poses significant risks** to the economic and national security of the United States.
- In order to **balance** the competing opportunities and risks of quantum computers, it is the policy of the United States (1) to **maintain United States leadership** in QIS; and (2) to mitigate the threat of CRQCs through a timely and equitable **transition to PQC.**

Sec. 2: Promotion

- Pursue a **whole-of-government/society strategy to harness the economic and scientific benefits of QIS**, and the security enhancements provided by QRC.
- **R&D**: encourage transformative and fundamental scientific discoveries through investments in core QIS research programs.
- **Workforce**: foster the next generation of scientists and engineers with quantum-relevant skill sets, including those relevant to QRC.
- **Partnerships**: promote domestic partnerships and professional and academic collaborations with overseas allies and partners.

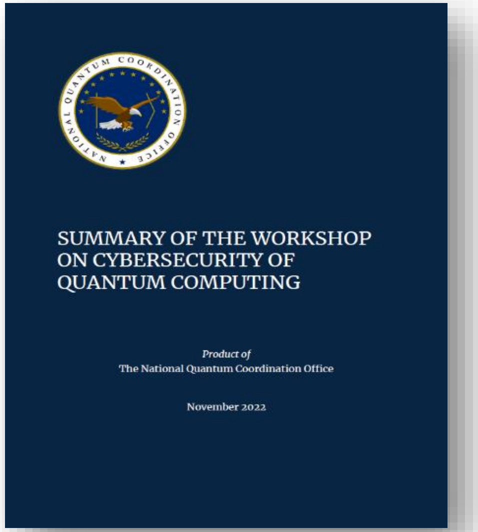
Sec. 3: Mitigating Risks to Encryption

- U.S. must prioritize the timely and **equitable transition of cryptographic systems to QRC.**
- Central to this effort will be an emphasis on **cryptographic agility**, to reduce the transition time and to allow for updates for future cryptographic standards.
- Series of deadlines for federal agencies to support the transition

Sec. 4: Protecting U.S. Technology

- U.S. Gov must work to **safeguard relevant quantum R&D and intellectual property (IP)** and to protect relevant enabling technologies and materials.
- Agencies responsible for either promoting or protecting QIS and related technologies should **understand the security implications** of QC
- U.S. should ensure the protection of U.S.-developed quantum technologies from theft by our adversaries.

Cybersecurity Workshop



EXECUTIVE OFFICE OF THE PRESIDENT
OFFICE OF MANAGEMENT AND BUDGET
WASHINGTON, D.C. 20503

THE DIRECTOR

November 18, 2022

M-23-02

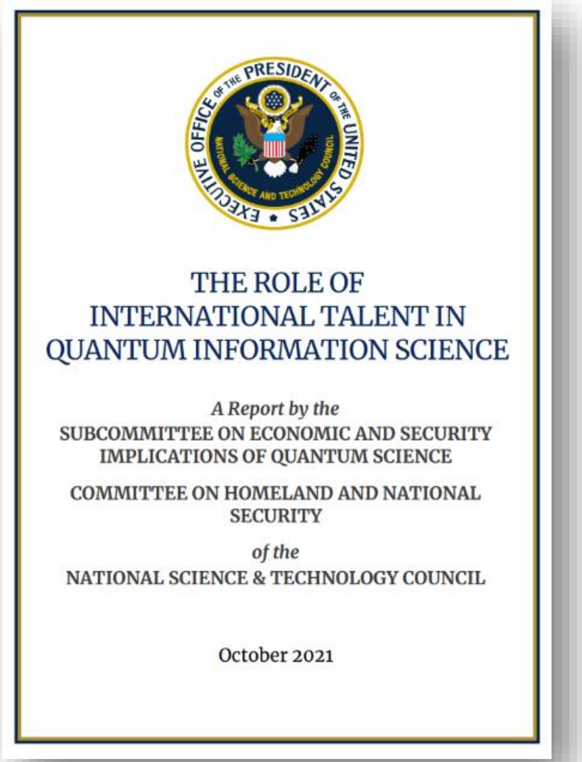
MEMORANDUM FOR THE HEADS OF EXECUTIVE DEPARTMENTS AND AGENCIES

FROM: Shalanda D. Young, Director

SUBJECT: Migrating to Post-Quantum Cryptography

This memorandum provides direction for agencies to comply with National Security Memorandum 10 (NSM-10), *on Promoting United States Leadership in Quantum Computing While Mitigating Risk to Vulnerable Cryptographic Systems* (May 4, 2022).[1]

Enabling Competitiveness – People and Research Security


THE ROLE OF INTERNATIONAL TALENT IN QUANTUM INFORMATION SCIENCE

A Report by the
SUBCOMMITTEE ON ECONOMIC AND SECURITY IMPLICATIONS OF QUANTUM SCIENCE
COMMITTEE ON HOMELAND AND NATIONAL SECURITY
of the
NATIONAL SCIENCE & TECHNOLOGY COUNCIL

October 2021

1st report by ESIX:
NSA, DOE, DOD, OSTP, DARPA, ODNI, NRL, IARPA, NASA, AFRL, ARL, NSF, DHS, OMB, NIST, NSC, DOS, & FBI

Recommendation 1: **Develop and support policies that welcome talented individuals from all over the world**, while implementing appropriately balanced protections that mitigate potential research security concerns.

> **The U.S. Government should cooperate and collaborate with partners and allies to increase the global pool of talent** through international agreements.

Recommendation 2: Collaboration with allies and partners to ensure a vibrant and secure international QIST ecosystem that is underpinned by shared values and principles.

Recommendation 3: Augment National Strategic Overview with QIST Workforce Strategy

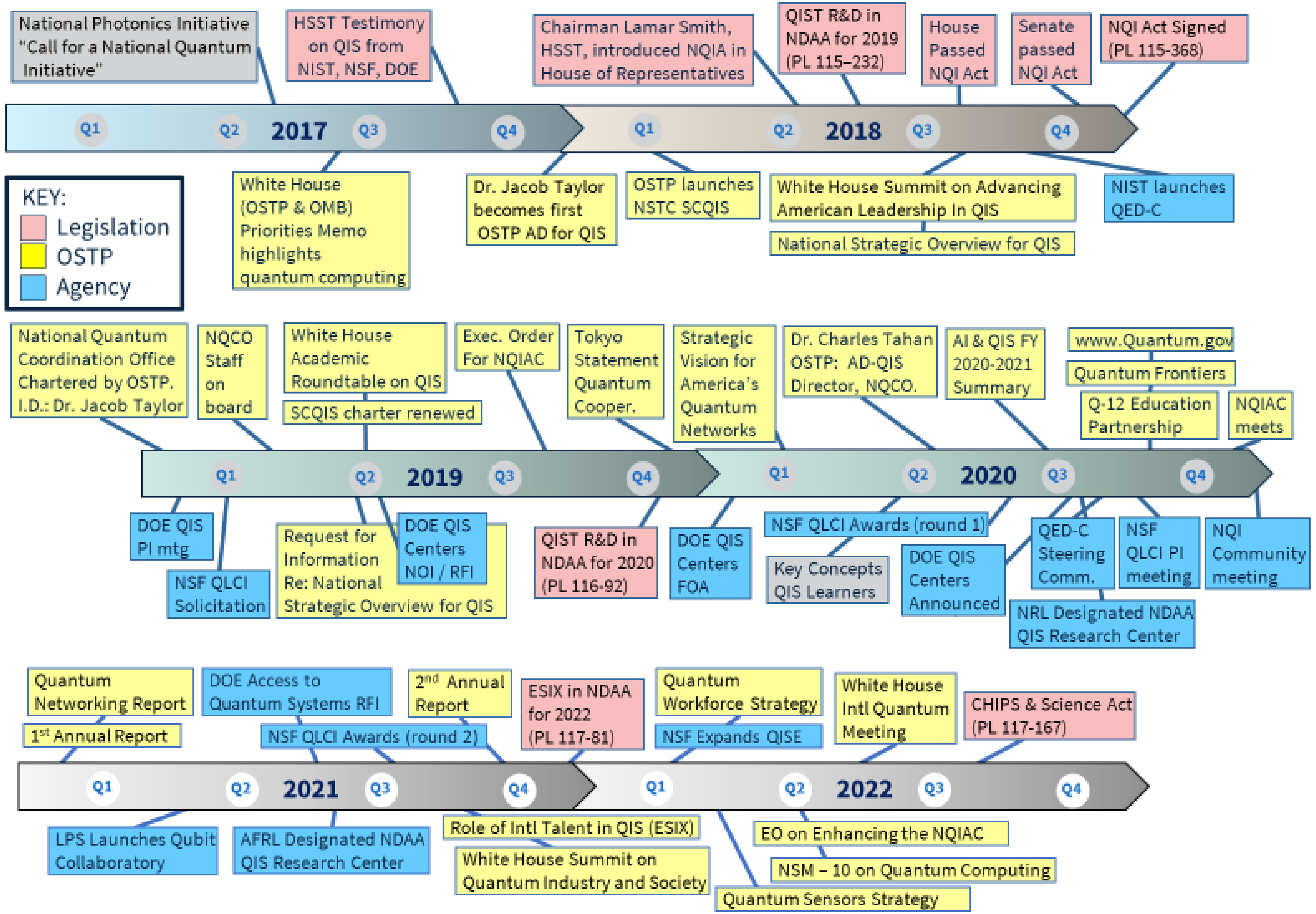
Recommendation 4: Federal organizations that fund research, development, and acquisition of QIST should develop coordinated, comprehensive technology protection

Entanglementexchange.org

In response to FY 2022 NDAA, ESIX WGs are addressing:

- Assess Federal QIS investment's impact on national and economic security
- Assess export controls related to QIST
- Assess any CI risks to Federal QIS investments

Establishing and Implementing the NQI



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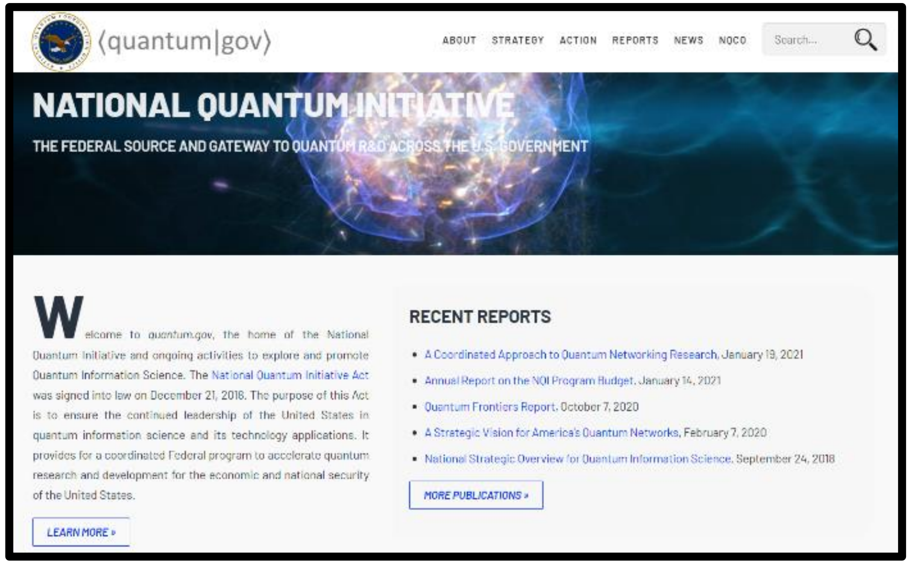
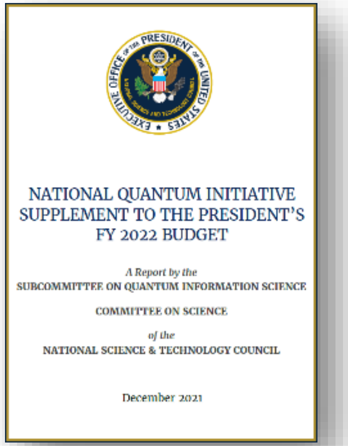


www.quantum.gov ***@WHOSTP***

Questions
or
Feedback?



Annual Report

<u>SCQIS</u>

Co-Chairs:

J. Stephen Binkley, DOE
Sean Jones, NSF
James Kushmerick, NIST
Charles Tahan, OSTP

Executive Secretary:

Denise Caldwell, NSF

<u>ESIX</u>

Co-Chairs:

J. Stephen Binkley, DOE
Barry Barker, NSA
John Burke, DOD
Charles Tahan, OSTP

Executive Secretary:

Brad Blakestad, NSA

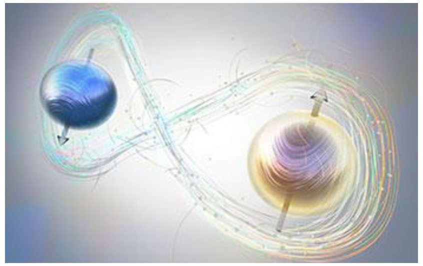
<u>National Quantum Coordination Office (OSTP)</u>

Charles Tahan – Director of NQCO and AD for QIS at OSTP
Gretchen Campbell – Deputy Director for NQCO
Corey Stambaugh – Senior Policy Advisor
Tanner Crowder – Policy Analyst
Thomas Wong – Quantum Liaison

National Quantum Initiative Advisory Committee

December 16, 2022

Transformational Advances in Quantum Systems (TAQS Series)



- *Goal:* **Innovative interdisciplinary research for incubating new ideas, concepts, and technologies**
- *How:* **Interdisciplinary teams required (minimum of 3 different areas). Research topic goals vary.**
- *Why:* **Building and growing a community of cross-disciplinary QL research teams**

- **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

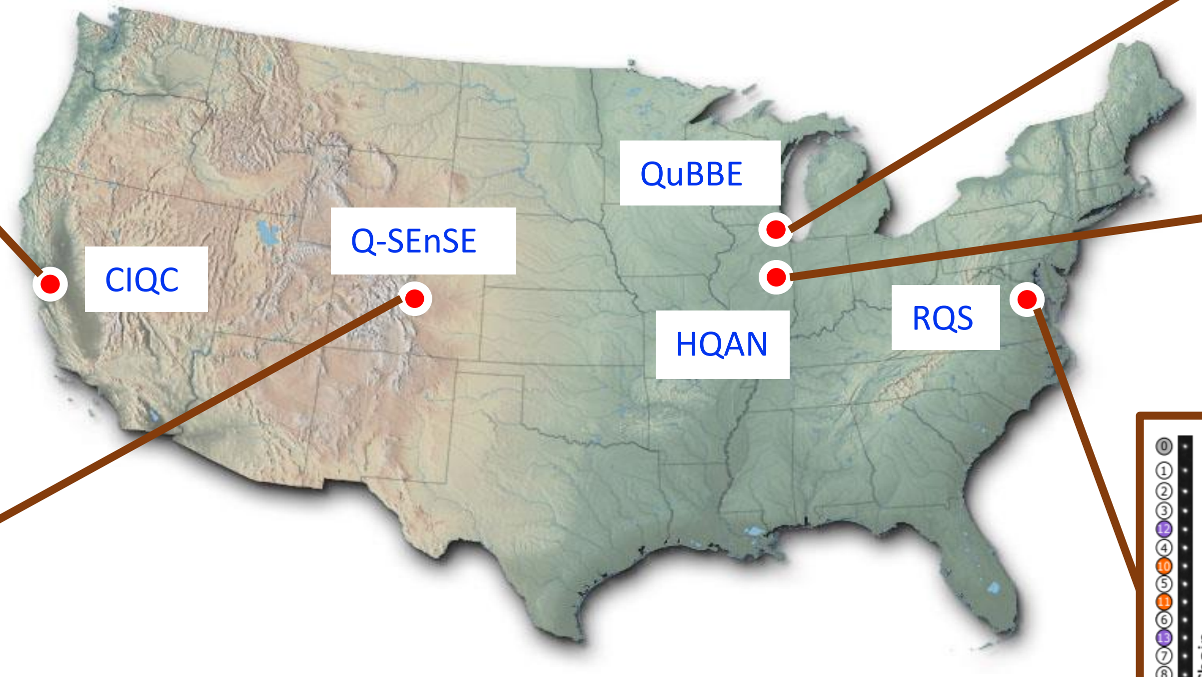
NSF Quantum Leap Challenge Institutes

National Quantum Initiative Centers include 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

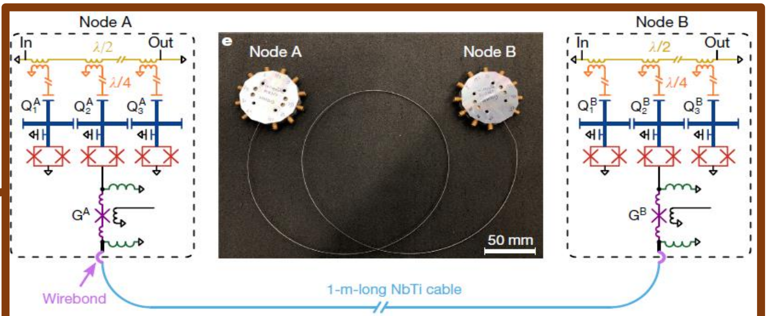
New qubits

Atomic clocks

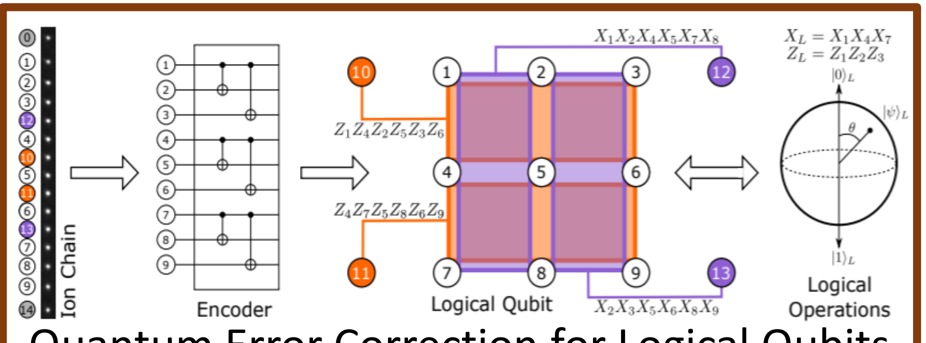


$125M over 5 years

Quantum Academy

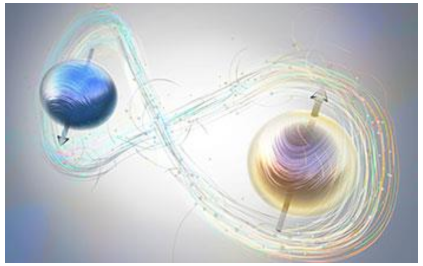


Quantum Network Interconnects



Quantum Error Correction for Logical Qubits

Expanding Capacity in Quantum Information Science and Engineering (ExpandQISE) NSF 22-561



Goal: Increase research capacity and broaden participation in Quantum Information Science and Engineering (QISE)

- Proposals are **research proposals** and reviewed on the quality of the research proposed
- Each proposal **must include** a specific activity in Education and Workforce Development that accompanies the scientific thrust

- **Track 1 is designed for individual PIs** initiating planning for a research program in QISE, **paired with an external co-PI** with deep QISE research expertise. Awards are up to $800,000 total per award for a duration up to 3 years. 8 awards in FY 2022.
- **Track 2 is designed for small- to medium-scale teams** of 2 to 5 collaborators, also **paired with one or more external Co-PIs** with deep QISE research expertise. Awards are up to $5,000,000 total per award for a duration up to 5 years. 3 awards in FY 2022.

Quantum Information Science at the Department of Energy Office of Science

Barbara Helland

Associate Director,

Advanced Scientific Computing Research

December 16, 2022

QIS Crosses the Technical Breadth of the Office of Science

ASCR

Quantum Algorithms; Computer Science; Networking; Testbeds

BES

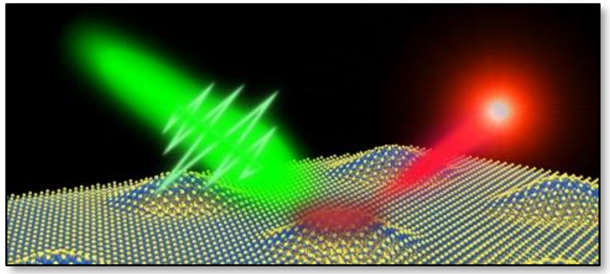
Quantum Systems and Computing; QIS Infrastructure; Coherence and Entanglement

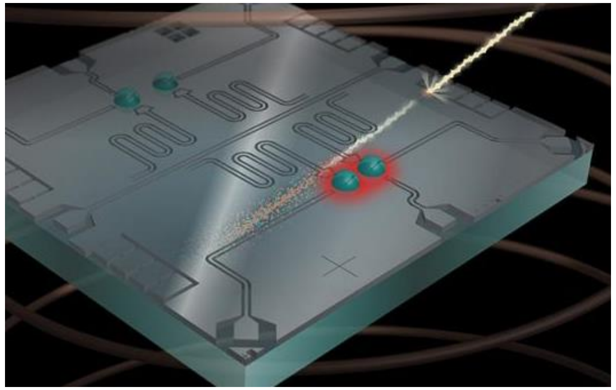
BER

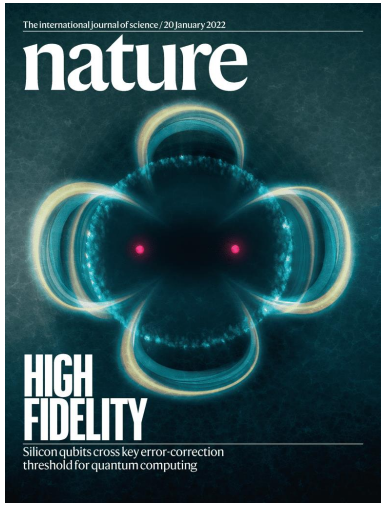
New Concepts for Biological Imaging, Sensors, and Measurement

FES

Qubit Synthesis; Quantum Computing for Plasmas; Quantum Sensing







HEP

Quantum Sensors, Systems, and Computing; Cosmos & Qubits

NP

Quantum Computing and QCD, Simulators, Sensors, Clocks, Radiation & Qubits

IP

Isotope Research, Production, and Enrichment

Creating Five National QIS Research Centers

- ✓ Significant National Impact
- ✓ Major Cross-Cutting Challenge
- ✓ Science and Technology Innovation Chain
- ✓ QIS Ecosystem Stewardship
- ✓ Multi-Disciplinary Leadership
- ✓ Collaborative Management Structure
- ✓ Well-Structured Plan and Metrics

1200	600	80	24
Experts	Students & Postdocs	Institutions	States + DC + Canada Italy

https://science.osti.gov/Initiatives/QIS

ASCR FY2022 **Chips and Science Act** (Section 10104)

Amendments to the National Quantum Initiative Act – Authorization, not appropriation

- Sec. 403. Department of Energy Quantum Network Infrastructure Research and Development Program:
  - The Secretary shall carry out a research, development and demonstration program to accelerate innovation in quantum network infrastructure in order to –
    1) Facilitate the advancement of distributed quantum computing systems through the internet and intranet
    2) Improve the precision of measurements of scientific phenomena and physical imaging technologies
    3) Develop secure national quantum communication technologies and strategies
    4) Demonstrate quantum networking utilizing the Department of Energy’s Energy Science Network User Facility
    5) Advance the relevant domestic supply chains, manufacturing capabilities and associated simulations and modeling capabilities…
- Sec. 404 Department of Energy Quantum User Expansion for Science and Technology program
  - The Secretary shall establish and carry out a program, to be known as the ‘Quantum User Expansion for Science and Technology or QUEST program’, to encourage and facilitate access to United States quantum computing hardware and quantum computing clouds for research purposes –
  1) To enhance the United States quantum research enterprise
  2) To educate the future quantum computing workforce;
  3) To accelerated the advancement of United States quantum computing capabilities; and
  4) To advance the relevant domestic supply chains, manufacturing processes, and associated simulation or modeling capabilities…

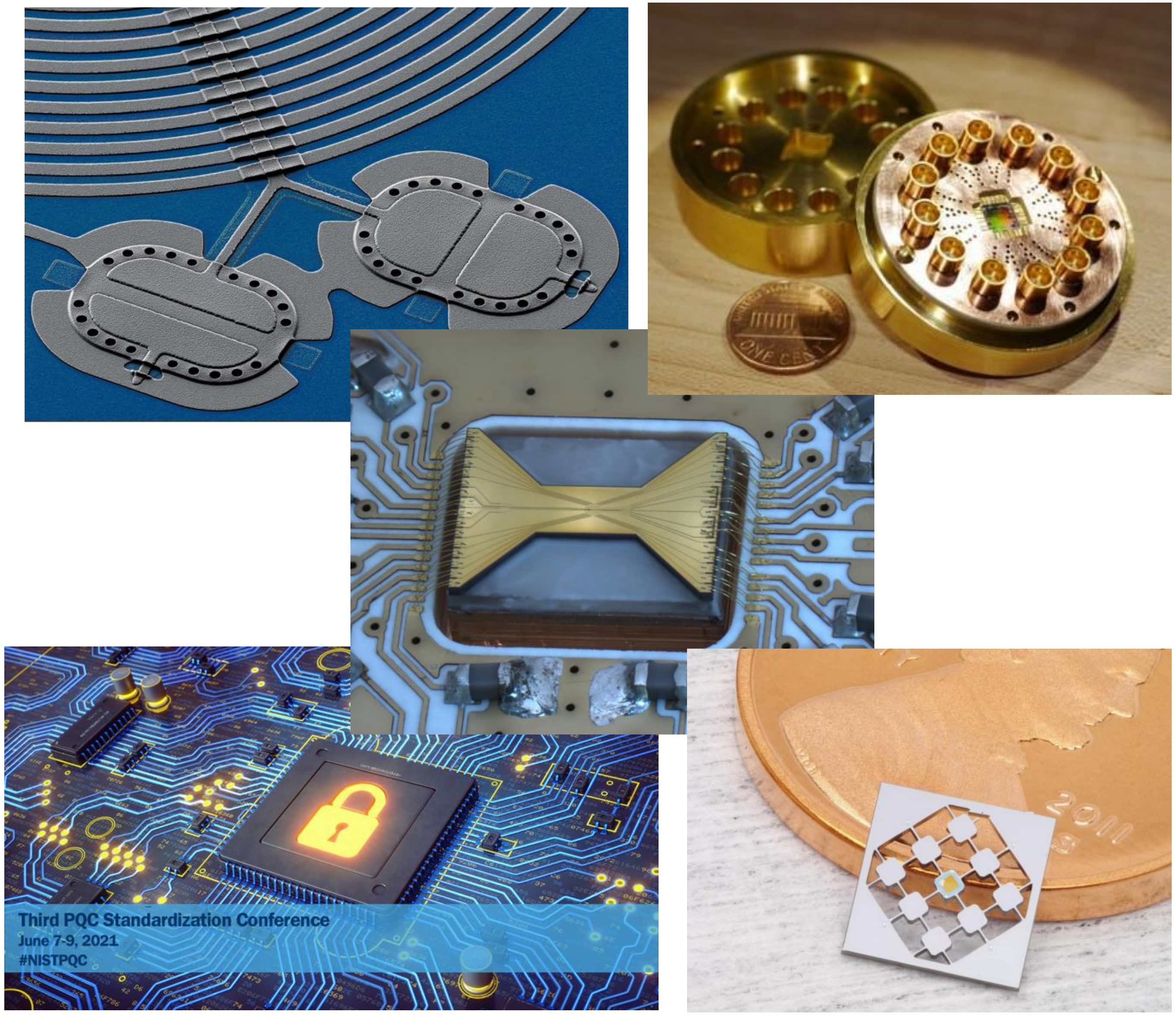
NIST and the NQI

James Kushmerick, Director
Physical Measurement Laboratory

NIST QIST Research

NIST QIST R&D activities span the full NQI Program:

- Quantum Sensing and Precision Measurement e.g. optical atomic clocks (compact and high-performance) for time keeping and navigation, nano-mechanical and opto-mechanical devices, atomic magnetometers, chemical and biological systems.
- Quantum Networking e.g. quantum repeater, quantum transduction, optical networks (both quantum and classical, fiber and free-space), single photon sources and detectors.
- Quantum Computing e.g. improving qubit performance across all major platforms, benchmarking, error correction, new technologies for scaling.
- Fundamental Quantum Science e.g. quantum simulation, understanding complex quantum systems, searches for ‘beyond Standard Model’ physics e.g. dark matter, tests of gravity and quantum mechanics.
- Enabling Technologies e.g. integrated photonics, meta-materials, optical frequency combs, and control electronics.
- Risk Mitigation e.g. post-quantum cryptography.



NIST’s Joint Research Institutes

JILA
CU-Boulder and NIST

29 research groups with
~250 postdocs & students
https://jila.colorado.edu/

Established in 1962 as a Joint Institute of NIST and the University of Colorado

University of Colorado Boulder

jqi JOINT QUANTUM INSTITUTE

Established in 2006 as a Joint Institute of NIST and the University of Maryland

35 research groups with
~180 postdocs & students
https://jqi.umd.edu/

University of Maryland 1856

Joint Center for Quantum Information and Computer Science

16 research groups with
~80 postdocs & students
https://quics.umd.edu/

Established in 2014 as a Joint Institute of NIST and the University of Maryland

NIST Established QED-C

Quantum Economic Development Consortium (QED-C) es
International, and led by the US quantum industry.

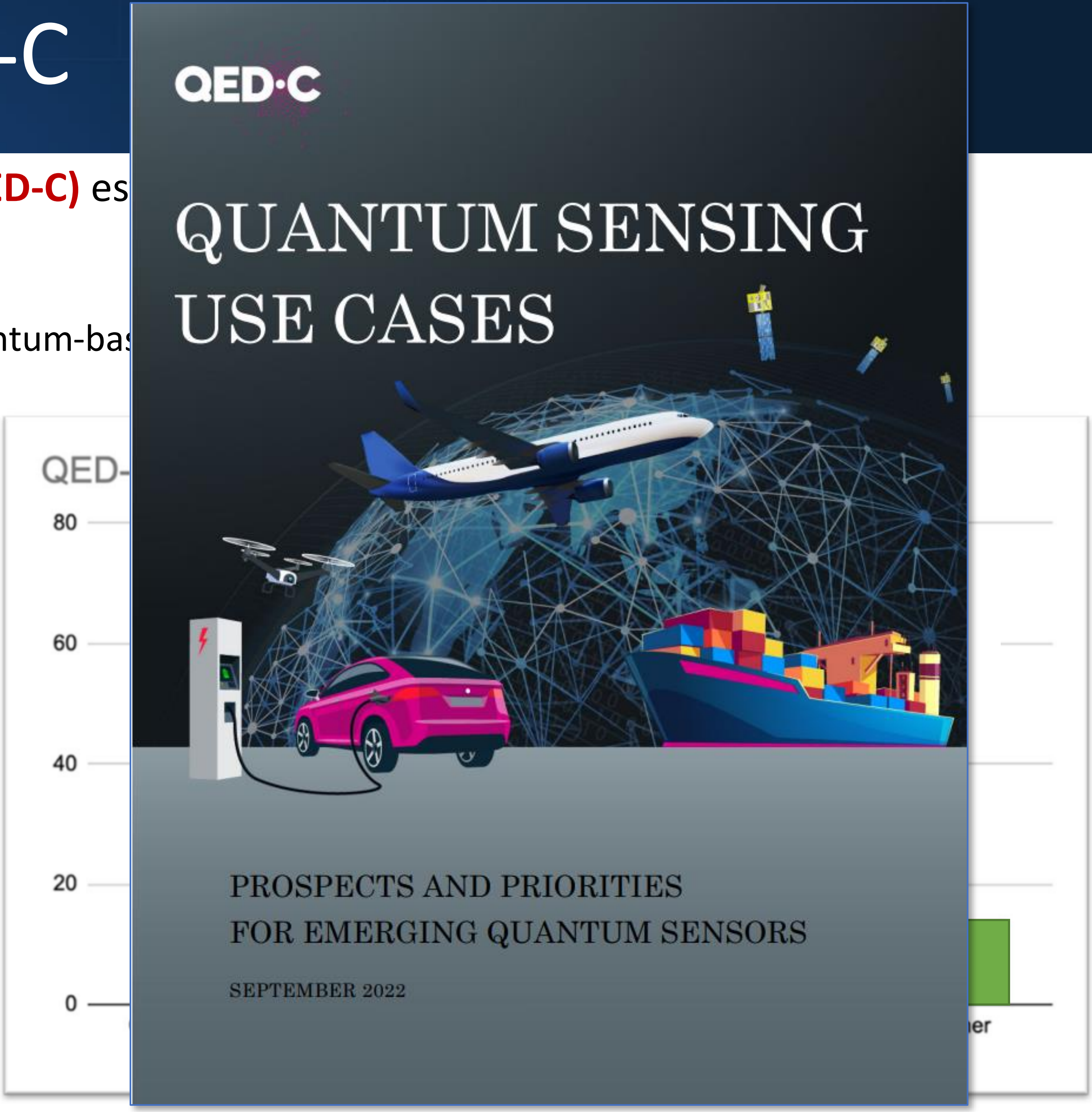
Mission: "To enable and grow a robust commercial quantum-bas
in the United States."

Targeting Gaps: Workforce, Enabling Tech, Use Cases, National Security, Emerging Standards, Legal & Policy

Activities: Plenary meetings, workshops, webinars, studies, reports, roadmaps, & pre-competitive R&D.

FY23 Budget: ~$5M for core operations (approx. 50% membership fees + 50% gov funding). Also ~$6M for R&D projects (50% industry + 50% gov funding)

International: Corporate-Tier-2 members from 35 other countries, and partnering with non-US quantum industry consortia, for a trusted global community.



Questions?

USD(R&E)

Quantum in the DoD

John H. Burke
Principal Director for Quantum Science
16 Dec 2022

Controlled by: OUSD(R&E)
Category: Dist. A, Public Released

Quantum Science, Technology, and Engineering

Quantum Science
Knowledge-driven

- Processes, Controls & Materials
- Harnessing Entanglement (e.g. quantum networking)
- Quantum Computer Science

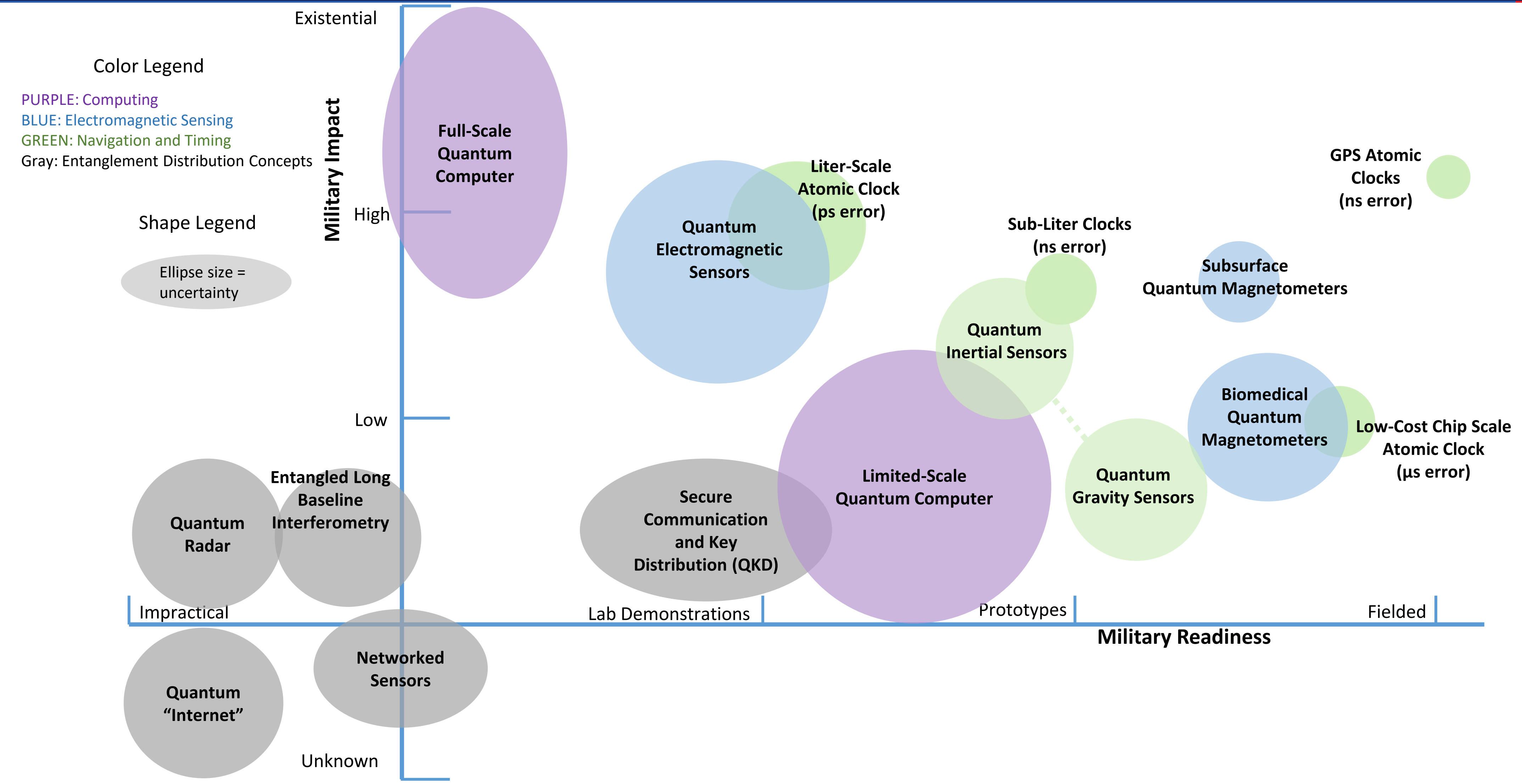
Quantum Technology
Applications-driven

- Navigation & Timing
- Spectrum, Imaging, & Detection
- Computing

Quantum Engineering
Process-Driven

- Specialized Components
- Integration & Architectures

Current State of Quantum Technology Readiness



LABORATORY FOR PHYSICAL SCIENCES

National Quantum Initiative Advisory Committee

December 16, 2022

NQIAC CHARGE

NQIAC Duties

BRIEFING ROOM

Executive Order on Enhancing the National Quantum Initiative Advisory Committee

MAY 04, 2022 • PRESIDENTIAL ACTIONS

"Quantum information science (QIS) can enable transformative advances in knowledge and technology for industry, academia, and government. Accordingly, the National Quantum Initiative (NQI), which aims to ensure the continued leadership of the United States in QIS and its technology applications, is a substantial and sustained national priority."

"The NQI Program encompasses contributions from across the Federal Government, … with membership on SCQIS or ESIX"

- Advise and make recommendations for improvements to the NQI Program
- Conduct independent assessments of
  (A) trends or developments in QIST;
  (B) progress made implementing the Program;
  (C) management, coordination, implementation, and activities of the Program;
  (D) if activities, goals and priorities maintain U.S. leadership in QIST;
  (E) if need exists to revise the Program;
  (F) opportunities for international cooperation on QIST R&D and standards
  (G) if national security, societal, economic, legal, and workforce concerns are adequately addressed by the Program.

Next Steps

Advise and make recommendations for improvements to the NQI Program

NQIAC Subcommittees:

- Science and Infrastructure
- Security and International
- Workforce and Industry

What are we missing in our long-term thinking? Discussion:

1. Science
   - *Are we focusing on the right, hard problems while leaving enough room for exploration and surprise?*
2. Infrastructure
   - *Are we taking advantage of the nation's resources (people, facilities, partnerships) sufficiently?*
3. Workforce
   - *Are we producing the right skillsets and amount of talent and how do we modulate this over time?*
4. Industry
   - *How do we ensure commercial applications will thrive and that good careers exist long-term?*
5. Economic and Security Implications
   - *How do we protect US investments in this technology while still being fast/first?*
6. International Cooperation
   - *What are we missing in our international collaborations?*

National Quantum Initiative Advisory Committee

December 16, 2022