

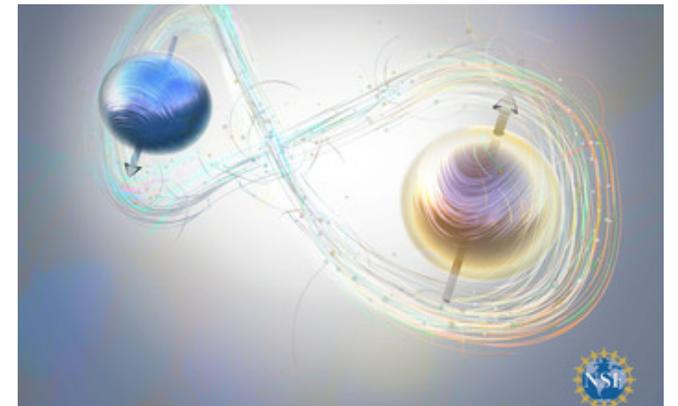
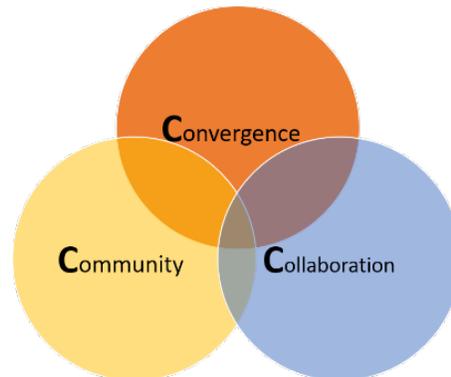
Quantum Information Science and Engineering at NSF



C. Denise Caldwell
Division Director, Division of Physics
Co-Chair NSF Quantum Stewardship Steering Committee

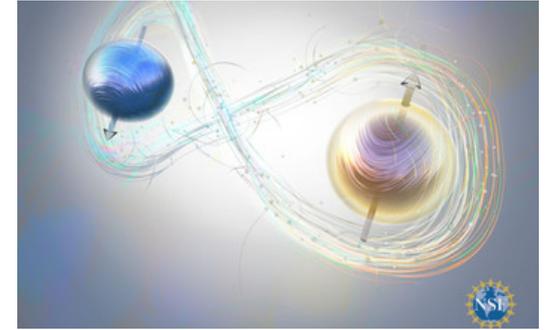
https://www.nsf.gov/mps/quantum/quantum_research_at_nsf.jsp

https://www.nsf.gov/news/factsheets/Factsheet_Quantum-proof7_508.pdf



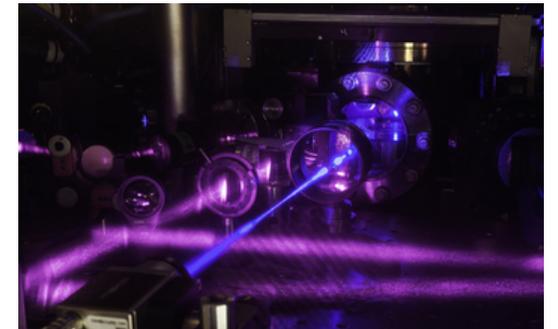
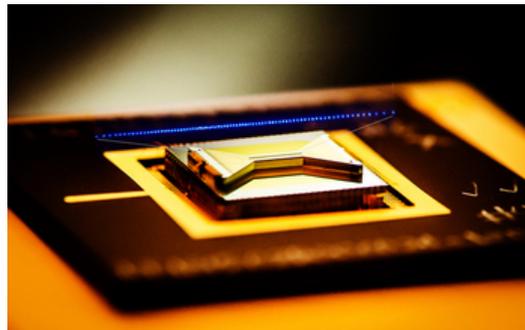


NSF and the NQI

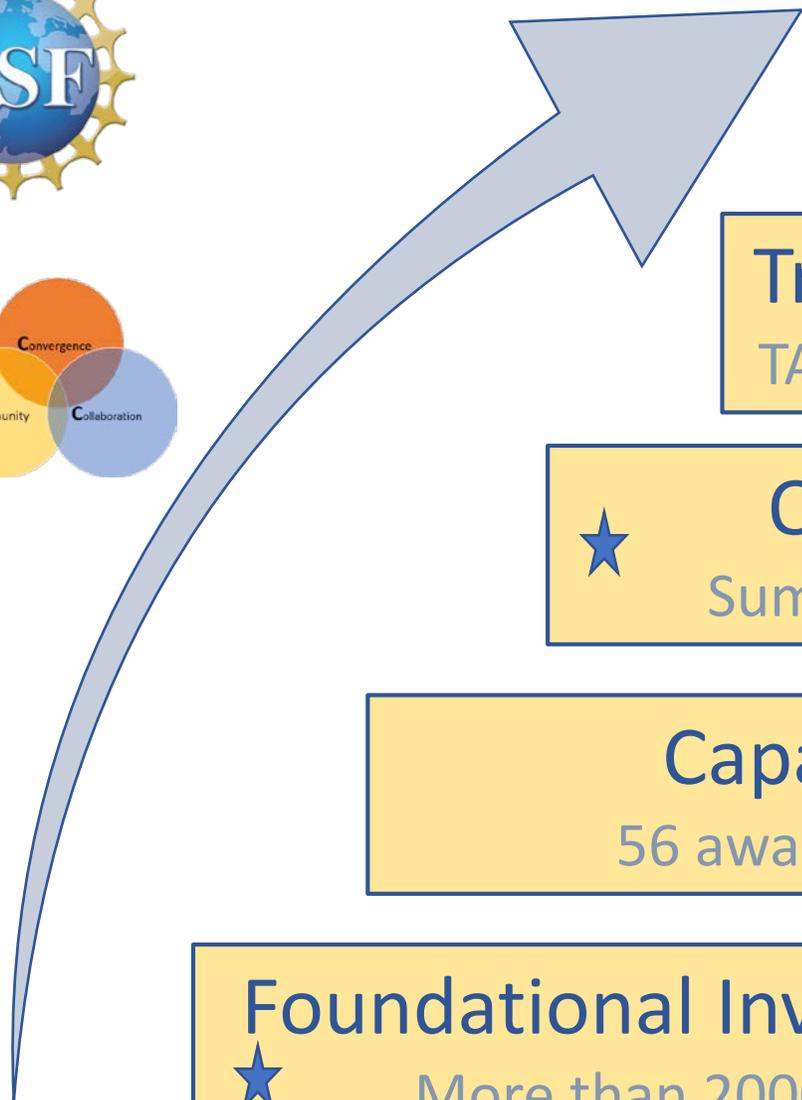


Sec. 301: The Director of the National Science Foundation shall carry out a basic research and education program on quantum information science and engineering, including the competitive award of grants to institutions of higher education or eligible nonprofit organizations (or consortia thereof).

Sec. 302: The Director of the National Science Foundation, in consultation with other Federal departments and agencies, as appropriate, shall award grants to institutions of higher education or eligible nonprofit organizations (or consortia thereof) to establish at least 2, but not more than 5, Multidisciplinary Centers for Quantum Research and Education (referred to in this section as “Centers”).



Building a Convergent Quantum Community



★ **Convergent Quantum Centers**
Challenge Institutes & Foundries

Transformational Collaborative Research
TAQS Small Team Awards, 19 awards, totaling \$35.5M

★ **Quantum Workforce Development**
Summer Schools, Triplets, Faculty Fellows, Q2Work

Capacity Building Across Disciplines
56 awards made in FY 2016-18, totaling over \$35M

★ **Foundational Investments in QIS – 40 Years & Counting**
More than 2000 awards & 1200 unique PIs in multiple areas



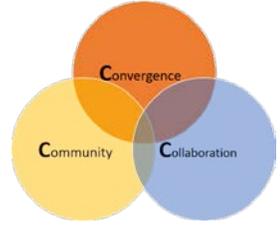
Quantum Leap Challenge Institutes (QLCI)



- Support **large-scale projects** driven by a ***cross-disciplinary challenge research theme*** for the frontiers of quantum information science and engineering.
- Maintain a timely and bold research agenda aimed at making **breakthroughs** on compelling challenges in a 5-year period.
- Conceptualize, develop, and implement **revolutionary** new approaches and technologies for quantum information processing.
- Enable the development of a **well-trained workforce** with strong cross-disciplinary skill sets needed for quantum information science and engineering.



QLCI Phase One Awardees



NSF Quantum Leap Challenge Institute for Hybrid Quantum Architectures and Networks

Lead PI: Brian DeMarco, University of Illinois Develop practical hardware & software for multi-node heterogeneous quantum processors & short-scale quantum networks

NSF Quantum Leap Challenge Institute for Present and Future Quantum Computing

Lead PI: Daniel Stamper-Kurn, University of California, Berkeley Tackle far-reaching questions at the heart of general-purpose quantum computation

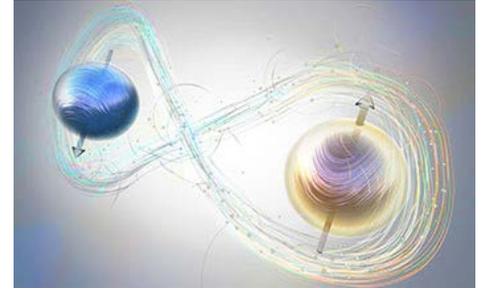
NSF Quantum Leap Challenge Institute for Enhanced Sensing and Distribution Using Correlated Quantum States

Lead PI: Jun Ye, University of Colorado Develop fundamental improvements in quantum sensing with broader implications for quantum simulation and information processing

See https://www.nsf.gov/news/special_reports/announcements/072120.jsp



Quantum Information Science and Engineering An Industry of the Future



Strong disciplinary programs in MPS/CHE,DMR,DMS,PHY; CISE/CCF; ENG/ECCS + **Centers**

Quantum Leap Challenge Institutes: 3 now; Second phase of competition underway

Foundry: “Enabling Quantum Leap: Q-AMASE-i: Quantum Foundry at UCSB”; A. Bleszynski-Jayich; \$25M over 6 years. (Led by MPS/DMR)

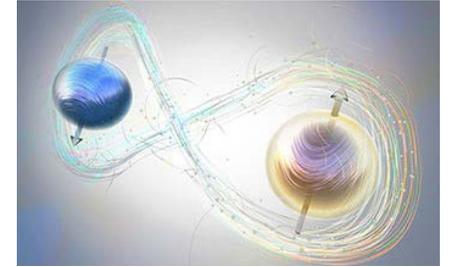
Computer: “PFCQC: STAQ: Software-Tailored Architecture for Quantum Co-Design”, K. Brown, Duke U; \$15M over 5 years (Led by MPS/PHY)

Computer: “Collaborative Research: EPiQC: Enabling Practical-scale Quantum Computing”, F. Chong, U Chicago; \$10M over 5 years (Led by *Expeditions in Computing* program in CISE)

Network: “NSF Engineering Research Center for Quantum Networks (CQN)”, S. Guha, U of Arizona; \$26M over 5 years (Led by EEC in ENG)



Investment Focus



Budget Increase: \$142.87M in FY 2020 CP to \$226.36 in FY 2021 Request

Expand Capacity:

Increase diversity of types of awardee institutions involved (e.g. RUI, HBCU)

Increase geographical distribution of awardee institutions (e.g. not just East Coast, West Coast)

Further broaden disciplinary focus of participants (e.g. add more engineers, computer scientists)

Identify more potential partners (e.g. other agencies, industry)

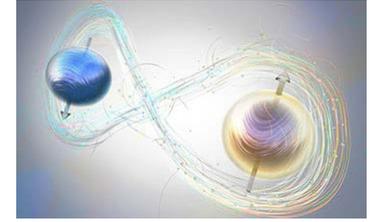
Bring in more end-user communities (e.g. greater involvement from biologists)

Grow Workforce:

New Quantum Workforce Development Working Group has taken on the challenge: Develop a roadmap to address near-term and long-term diverse workforce needed to retain US leadership in QISE – New announcements in clearance



Workforce



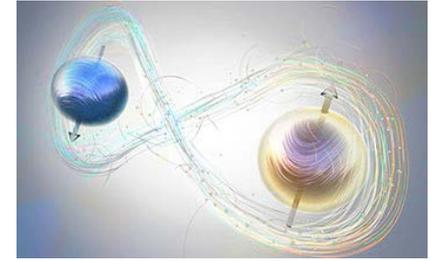
TRIPLETS: “Convergence QL: Workshop Series: Cross-Sector Connections in Quantum Leap”; “Quantum Information Science and Engineering Network” of “triplets” of students, faculty, industry partners to work on Quantum Leap challenges, U. Chicago, <https://qisenet.uchicago.edu/>

NSF Quantum Computing and Information Science Faculty Fellows (QCIS-FF) to encourage departments and schools in U.S. universities to hire new, full-time faculty in either tenure-track or tenured roles in quantum computing and/or communication; 13 awards to date.

National Q12 Education Partnership An NSF and OSTP co-sponsored workshop connecting the communities of university and industry researchers, secondary school and college educators, and representatives from educational and professional organizations produced a list of ["Key Concepts for Future Quantum Information Science Learners"](#). These form the basis of the new Q2Work partnership <https://q12education.org> led by Emily Edwards, UIUC, and Diana Franklin, UoC, that has been assembled to enable the recommendations.



Expanding Outward



[Dear Colleague Letter: Enabling Quantum Computing Platform Access for NSF Researchers with Amazon Web Services, IBM, and Microsoft Quantum](#)

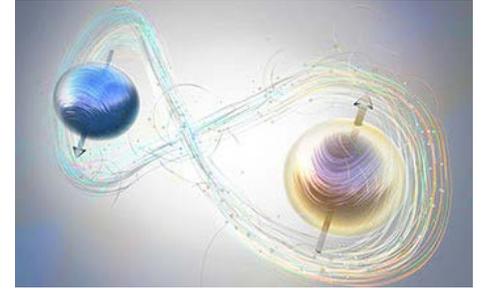
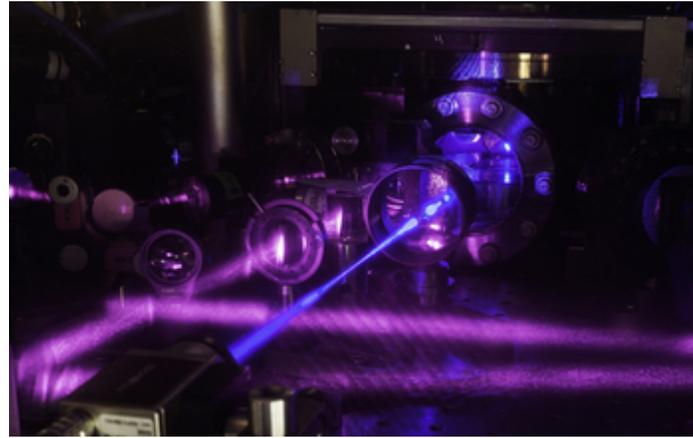
Support for students to implement quantum computing calculations on cloud-based platforms

[Dear Colleague Letter: International Collaboration Supplements in Quantum Information Science and Engineering Research](#)

Support to add a new - or strengthen an existing - international dimension to an award

[NSF Convergence Accelerator Phase I and II](#) — Quantum Technology (Track C)

Support for projects that bridge the gap between state-of-the-art fundamental research generating lab proof of concept architectures, devices, and theories and current industry efforts to build a universal quantum computer.



Discussion

