QUANTUM INFORMATION SCIENCE (QIS)

Quantum Information Science Funding[1]
(Dollars in Millions)

	FY 2019 Actual	FY 2020 (TBD)	FY 2021 Request
BIO	$1.05	-	$3.12
CISE	12.10	-	14.60
ENG	10.19	-	27.84
GEO	-	-	-
MPS	82.50	-	180.80
SBE	0.30	-	-
Total	**$106.14**	**-**	**$226.36**

[1] Funding for QIS and QL overlaps in some areas. Thus, it should not be summed across presentations.

Overview

Research in Quantum Information Science (QIS) will advance fundamental understanding of uniquely quantum phenomena that can be harnessed to promote information processing, transmission, and measurement in ways that classical approaches do less efficiently, or not at all. Current and future QIS applications differ from prior applications of quantum mechanics, such as lasers, transistors, and magnetic resonance imaging, by using distinct quantum phenomena—superposition and entanglement—that do not have classical counterparts. The development of these new applications will form the basis of one of the major technological revolutions of the 21st century. Building upon more than two decades of exploratory discovery, NSF investment in QIS will help propel the Nation forward as a leading developer of quantum technology. These investments are a key component of the Administration's National Quantum Initiative (NQI) to coordinate and expand America's world-leading position in fundamental quantum research.

An effective national strategy for QIS requires use of the full spectrum of talent cross the Nation. In addition, international cooperation with like-minded countries is critical to ensure that discoveries, and their resulting technologies, provide for economic growth and national security. Foundational activities that serve as idea factories will continue to be supported. There will also be special stewardship activities targeting all major areas of computers, communications, sensors, and networking. Special attention as to how these areas connect with each other will accelerate development in all of them and lead to advances in quantum computers, quantum communications networks, quantum sensors that enhance resolution and detection capabilities significantly, and networks that can connect components of quantum systems without loss of fidelity. Continued investments will be made to leverage our understanding of quantum phenomena observed in nature to enable bioinspired design of novel sensing and computing devices. Outreach to fields beyond the core of QIS will identify end users of this new technology and help establish the market for new tools and applications from security to biomedical. Ultimately, this work will allow quantum technology to become established on a sound footing and play a recognizable role in the US economy.

Goals

1. Answer key science and engineering questions in order to facilitate the translation of fundamental knowledge into technological applications.
2. Deliver proof-of-concept devices, applications, tools, or systems with a demonstrable quantum advantage over their classical counterparts that will form the basis of a revolutionary 21st century technology.

3. Empower the full spectrum of talent to which NSF has access to build the capacity necessary to achieve goals one and two and generate the quantum-literate workforce that will implement the results of these breakthroughs.

FY 2021 Investments

Workforce Development: The development of a broad-based, diverse workforce is a primary. Proposed activities include: (1) expansion of the highly successful joint industry-academia graduate program to additional hubs; (2) support for Research Experience for Undergraduates sites and supplements to existing awards dedicated to quantum; (3) support for summer schools and targeted programs to expand participation across the Nation, especially to groups and geographic locations that are not currently heavily involved; (4) support for a faculty fellows program to grow capacity in the computer science community related to quantum computing; and (5) support for personnel exchange with international partners.

Centers: NSF will continue its investment in the quantum foundries and Quantum Leap Challenge Institutes initiated in FY 2020 and add additional Quantum Leap Challenge Institutes following a second round of competition in FY 2021. Institutes will seek industry partnerships as well as like-minded international partners whose investments complement our own.

Quantum Simulators: Development and use of quantum simulators has promise for connecting quantum developers with communities that have extensive computational needs. Earlier NSF investment in quantum simulators has resulted in several promising directions that are ready for further exploitation. NSF would enable this through a meta-program, a convergent approach that has proven to have enhanced flexibility in making real-time adjustments to accommodate new areas of science.

Quantum Sensors: Quantum sensors offer the most recognized near-term end-user applications of second-generation quantum technologies. Potential users cover the scientific spectrum, from precision measurements in physics to high-resolution imaging in biology to seismology in earth sciences. Exploiting the potential offered by quantum-based sensors relies on establishing close connections between the builders and the users. NSF would achieve this through a series of Research Coordination Networks and "Dear Colleague" letters emphasizing areas of mutual interest.

Quantum Interconnects: While the exact implementation of quantum processing nodes and qubits is still the topic of research and debate, the information between the quantum processing nodes will most likely be carried by photons. Therefore, interfacing different types of qubits with photons is critical for the realization of scalable distributed quantum computational systems as well as for coherent connections between quantum platforms dedicated to computing, communication, and/or sensing. NSF will support convergent and cross-disciplinary teams of engineers, computer scientists, and physical scientists to develop basic research results that enable emerging quantum computing systems to interface with each other as well as with existing traditional computing systems.

Quantum Computing: Much progress has been made in superconducting and ion-trap quantum computing architectures, and NSF continues to invest in ways to scale these by at least a factor of ten or more. However, there is yet no single platform that has emerged as the leading contender, and multiple architectures might simultaneously co-exist to support distinct types of quantum computations enabled by each. NSF will continue exploring alternative quantum computing architectures that could emerge as viable options in the future as well as the basic underpinnings and limits of quantum computing as defined by the underlying physical processes and architectures. At the same time, in collaboration with industry, NSF will support researcher access to quantum systems and platforms to experiment in specific domains.