

## THE QUANTUM LEAP (QL)

QL Funding			
(Dollars in Millions)			
	FY 2018	FY 2019	FY 2020
	Actual	(TBD)	Request
<b>Stewardship Activities (MPS)</b>	-	-	<b>\$30.00</b>
<b>Foundational Activities</b>	<b>\$90.37</b>	-	<b>\$36.00</b>
BIO	-	-	1.00
CISE	6.83	-	2.00
ENG	9.60	-	2.00
MPS	73.94	-	30.00
OISE	-	-	1.00
<b>Total</b>	<b>\$90.37</b>	-	<b>\$66.00</b>

### Overview

The QL Big Idea will build upon and extend our existing knowledge of the quantum world to observe, manipulate, and control, from first principles, the behavior of particles at atomic and subatomic scales. It will enable discoveries in both naturally-occurring and engineered quantum systems and develop next-generation quantum technologies and devices for sensing, information processing, communications, and computing. These advances will unleash the potential of the Nation's quantum-based scientific enterprise to enhance the Nation's well-being, economy, and security.

NSF envisions a platform for the advancement of our fundamental understanding of how quantum phenomena at subatomic scale are manifested at the macroscopic scale. Discovery will lead to new methods of characterization and control, enhance predictive and modeling capabilities, and lead to new computing and networking paradigms. A cross-disciplinary approach combining expertise from multiple NSF scientific areas and a strong coupling of experimentation, computation, and theory will facilitate progress. Cross-disciplinary approaches will help identify the knowledge and skills necessary for the responsible conduct of quantum research to make fundamental advances in quantum science. Educational research on the learning and teaching of quantum concepts will contribute to the development of the future quantum workforce.

QL investments will empower U.S. scientists and engineers to advance quantum technologies and understanding, which will in turn lead to the discovery of novel materials, tools, devices, algorithms, simulations, systems, and programming paradigms, as well as new and creative application domains, along with a quantum-capable workforce. NSF's level of investment in QL is strongly aligned with Administration priorities on Quantum Information Science (QIS) and the National Quantum Initiative and will consolidate and expand the U.S.' world-leading position in fundamental quantum research and deliver proof-of-concept devices, applications, tools, or systems with a demonstrable quantum advantage over their classical counterparts. NSF will also broadly engage scientific, engineering, and educational communities, building a human capital foundation in pursuit of a better understanding of quantum phenomena.

Through a subcommittee of the National Science and Technology Council on QIS, NSF coordinates QL activities with other federal agencies and regularly holds meetings to assess and recommend government-wide strategies. Consistent with and crucial to its mission, NSF will seek to form partnerships with other federal agencies, industry, private foundations, national laboratories, and existing centers in order to leverage NSF investments in QL. NSF will seek to increase international cooperation with like-minded partners consistent with the Office of Science and Technology Policy National Strategic Overview for the closely connected area of QIS.

## Goals

1. Understand fundamental limitations in time, distance, and scale for entanglement and coherence of quantum states.
2. Learn from quantum phenomena in naturally-occurring and engineered quantum systems, including emergent behavior, complexity, the quantum-classical boundary, and theoretical foundations.
3. Galvanize the science and engineering community to enable quantum discoveries, devices, systems, and technologies that surpass classical capabilities.

## FY 2020 Investments

QL activities will focus on enabling advances in selected priority areas, sustaining the NSF QL community, building on outcomes from FY 2018 and FY 2019 activities, and adjusting emphases, as warranted. In FY 2020, a particular focus will be on team efforts to address important challenges in QIS, including but not limited to quantum computing and communications. Funding mechanisms will include targeted solicitations, Dear Colleague Letters, and other existing mechanisms such as Research Advanced by Interdisciplinary Science and Engineering, EAearly-concept Grants for Exploratory Research, Industry-University Cooperative Research Centers, and Ideas Labs. NSF also will continue coordination and leveraging of quantum-related activities with external stakeholders, including other federal agencies and the private sector.

A Quantum Idea Incubator, prototyped in FY 2018 through the RAISE funding mechanism, was established in FY 2019 through the solicitation “Enabling Quantum Leap: Quantum Idea Incubator for Transformational Advances in Quantum Systems (QII-TAQS)<sup>1</sup>”. QII-TAQS established collaborations to develop functional demonstrations of quantum devices, systems, and/or applications, that will continue to receive funding in FY 2020. A Quantum Challenge Institutes solicitation, “Quantum Leap Challenge Institutes (QLCI)<sup>2</sup>”, supporting center-scale quantum activities, was issued in February 2019 and will continue to expand in FY 2020. QLCI research will identify and address science and engineering challenges in addressing fundamental at-scale problems in quantum communication, quantum computing, quantum sensing, and quantum simulations. Other QL activities in FY 2020 include increasing support for accelerated quantum materials design, synthesis, characterization, and translation for quantum devices, systems, and networks as part of the FY 2019 solicitation, “Enabling Quantum Leap: Convergent Accelerated Discovery Foundries for Quantum Materials Science, Engineering, and Information (Q-AMASE-i)<sup>3</sup>.”

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<sup>1</sup> [www.nsf.gov/publications/pub\\_summ.jsp?ods\\_key=nsf19532](http://www.nsf.gov/publications/pub_summ.jsp?ods_key=nsf19532)

<sup>2</sup> [www.nsf.gov/publications/pub\\_summ.jsp?org=NSF&ods\\_key=nsf19559](http://www.nsf.gov/publications/pub_summ.jsp?org=NSF&ods_key=nsf19559)

<sup>3</sup> [www.nsf.gov/funding/pgm\\_summ.jsp?pims\\_id=505504](http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=505504)