

# Enabling Quantum Leap: Quantum Idea Incubator for Transformational Advances in Quantum Systems (QII -TAQS)

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## PROGRAM SOLICITATION NSF 19-532

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REPLACES DOCUMENT(S):  
NSF 18-035

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National Science Foundation

**Letter of Intent Due Date(s) (required)** (due by 5 p.m. submitter's local time):

January 07, 2019

**Preliminary Proposal Due Date(s) (required)** (due by 5 p.m. submitter's local time):

February 22, 2019

**Full Proposal Deadline(s)** (due by 5 p.m. submitter's local time):

May 24, 2019

## IMPORTANT INFORMATION AND REVISION NOTES

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**Letters of Intent** submitted in response to this solicitation should be submitted in accordance with the *NSF Proposal & Award Policies & Procedures Guide (PAPPG) (NSF 18-1)*.

**Preliminary Proposals and Full Proposals** submitted in response to this solicitation should be submitted in accordance with the revised PAPPG (*NSF 19-1*), which is effective for proposals submitted, or due, on or after January 28, 2019.

## SUMMARY OF PROGRAM REQUIREMENTS

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### General Information

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**Program Title:**

Enabling Quantum Leap: Quantum Idea Incubator for Transformational Advances in Quantum Systems (QII - TAQS)

**Synopsis of Program:**

In 2016, the National Science Foundation (NSF) unveiled a set of "Big Ideas," 10 bold, long-term research and process ideas that identify areas for future investment at the frontiers of science and engineering (see [https://www.nsf.gov/news/special\\_reports/big\\_ideas/index.jsp](https://www.nsf.gov/news/special_reports/big_ideas/index.jsp)). The Big Ideas represent unique opportunities to position our Nation at the cutting edge of global science and engineering leadership by bringing together diverse disciplinary perspectives to support convergence research. As such, when responding to this solicitation, even though proposals must be submitted to the Directorate for Mathematical & Physical Sciences/Office of Multidisciplinary Activities (MPS/OMA), once received, the proposals will be managed by a cross-disciplinary team of NSF Program Directors.

The **Quantum Idea Incubator for Transformational Advances in Quantum Systems (QII - TAQS)** program is designed to support interdisciplinary teams that will explore highly innovative, original, and potentially transformative ideas for developing and applying quantum science, quantum computing, and quantum engineering. Proposals with the potential to deliver new concepts, new platforms, and/or new approaches that will accelerate the science, computing, and engineering of quantum technologies are encouraged. Breakthroughs in quantum sensing, quantum communications, quantum simulations, or quantum computing systems are anticipated. This Quantum Idea Incubator

solicitation aims to support the process of translating such ideas into reality.

This solicitation calls for proposals focused on interdisciplinary research that includes elements from the following thrust areas: (i) fundamental science such as, but not limited to, physics, chemistry, materials science, mathematics, biology, or geoscience, as well as foundational concepts and techniques in quantum information science and engineering; (ii) communication, computation, and modeling; and (iii) devices and engineered systems. Proposals must articulate how the project leverages and/or promotes advances in knowledge in the selected thrust areas. Proposals should be innovative and must focus on quantum functionality and must result in experimental demonstrations and/or transformative advances towards quantum systems and/or proof-of-concept validations. Competitive proposals will come from an interdisciplinary research team led by at least three investigators who collectively contribute synergistic expertise from one or more engineering domains, from mathematics, computational and/or computer and information science, and from one or more physical, chemical, biological, or materials science domains. Proposals will be judged on how likely the integrated effort is to lead to transformative advances in quantum systems. Both fundamental and applied topics are encouraged.

#### **Cognizant Program Officer(s):**

*Please note that the following information is current at the time of publishing. See program website for any updates to the points of contact.*

- Tania M. Paskova, telephone: (703) 292-2264, email: [tpaskova@nsf.gov](mailto:tpaskova@nsf.gov)
- Dominique Dagenais, telephone: (703) 292-2980, email: [ddagenai@nsf.gov](mailto:ddagenai@nsf.gov)
- Alexander Cronin, telephone: (703) 292-5302, email: [acronin@nsf.gov](mailto:acronin@nsf.gov)
- Evelyn Goldfield, telephone: (703) 292-2173, email: [egoldfie@nsf.gov](mailto:egoldfie@nsf.gov)
- Justin Holmer, telephone: (703) 292-8213, email: [jholmer@nsf.gov](mailto:jholmer@nsf.gov)
- Dmitri Maslov, telephone: (703) 292-4549, email: [dmaslov@nsf.gov](mailto:dmaslov@nsf.gov)
- Vipin Chaudhary, telephone: (703) 292-2254, email: [vipchaud@nsf.gov](mailto:vipchaud@nsf.gov)
- Khershed Cooper, telephone: (703) 292-7017, email: [khcooper@nsf.gov](mailto:khcooper@nsf.gov)
- Engin Serpersu, telephone: (703) 292-7124, email: [eserpers@nsf.gov](mailto:eserpers@nsf.gov)
- Chun-Hsi (Vincent) Huang, telephone: (703) 292-7877, email: [chuang@nsf.gov](mailto:chuang@nsf.gov)
- Maija Kukla, telephone: (703) 292-4940, email: [mkukla@nsf.gov](mailto:mkukla@nsf.gov)

#### **Applicable Catalog of Federal Domestic Assistance (CFDA) Number(s):**

- 47.041 --- Engineering
- 47.049 --- Mathematical and Physical Sciences
- 47.050 --- Geosciences
- 47.070 --- Computer and Information Science and Engineering
- 47.074 --- Biological Sciences
- 47.075 --- Social Behavioral and Economic Sciences
- 47.076 --- Education and Human Resources
- 47.079 --- Office of International Science and Engineering
- 47.083 --- Office of Integrative Activities (OIA)

## **Award Information**

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**Anticipated Type of Award:** Standard Grant or Continuing Grant

**Estimated Number of Awards:** 18 to 20

The final number of awards will depend on the availability of funds and the quality of the proposals.

**Anticipated Funding Amount:** \$26,000,000

Anticipated funding amount is pending availability of funds. Each project team may receive support of up to a total of \$2,000,000 over the project duration of 3 to 5 years. It is not expected that all awards will receive the maximum amount; the size of awards will depend upon the type of research program proposed. The budget must be commensurate with the scope of the project and thoroughly justified in the proposal.

## **Eligibility Information**

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#### **Who May Submit Proposals:**

Proposals may only be submitted by the following:

- Institutions of Higher Education (IHEs) - Two- and four-year IHEs (including community colleges) accredited in, and having a campus located in the US, acting on behalf of their faculty members. Special Instructions for International Branch Campuses of US IHEs: If the proposal includes funding to be provided to an international branch campus of a US institution of higher education (including through use of subawards and consultant arrangements), the proposer must explain the benefit(s) to the project of performance at the international branch campus, and justify why the project activities cannot be performed at the US campus.

#### **Who May Serve as PI:**

The lead Principal Investigator (PI) must be a faculty employed by the submitting organization. A minimum of one PI and two co-PIs must participate.

**Limit on Number of Proposals per Organization:**

There are no restrictions or limits.

**Limit on Number of Proposals per PI or Co-PI: 2**

No individual may appear as Senior Personnel (Principal Investigator, Co-PI, and Faculty Associate or equivalent) on more than two QII - TAQS preliminary proposals. In the event that any individual exceeds this limit, any proposal submitted to this solicitation with this individual listed as PI, co-PI, or Senior Personnel after the first two proposals are received at NSF will be returned without review. No exceptions will be made.

## Proposal Preparation and Submission Instructions

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**A. Proposal Preparation Instructions**

- **Letters of Intent:** Submission of Letters of Intent is required. Please see the full text of this solicitation for further information.
- **Preliminary Proposals:** Submission of Preliminary Proposals is required. Please see the full text of this solicitation for further information.
- **Full Proposals:**
  - Full Proposals submitted via FastLane: *NSF Proposal and Award Policies and Procedures Guide (PAPPG)* guidelines apply. The complete text of the PAPPG is available electronically on the NSF website at: [https://www.nsf.gov/publications/pub\\_summ.jsp?ods\\_key=pappg](https://www.nsf.gov/publications/pub_summ.jsp?ods_key=pappg).
  - Full Proposals submitted via Grants.gov: *NSF Grants.gov Application Guide: A Guide for the Preparation and Submission of NSF Applications via Grants.gov* guidelines apply (Note: The *NSF Grants.gov Application Guide* is available on the Grants.gov website and on the NSF website at: [https://www.nsf.gov/publications/pub\\_summ.jsp?ods\\_key=grantsgovguide](https://www.nsf.gov/publications/pub_summ.jsp?ods_key=grantsgovguide)).

**B. Budgetary Information**

- **Cost Sharing Requirements:**

Inclusion of voluntary committed cost sharing is prohibited.
- **Indirect Cost (F&A) Limitations:**

Not Applicable
- **Other Budgetary Limitations:**

Not Applicable

**C. Due Dates**

- **Letter of Intent Due Date(s) (required)** (due by 5 p.m. submitter's local time):

January 07, 2019
- **Preliminary Proposal Due Date(s) (required)** (due by 5 p.m. submitter's local time):

February 22, 2019
- **Full Proposal Deadline(s)** (due by 5 p.m. submitter's local time):

May 24, 2019

## Proposal Review Information Criteria

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**Merit Review Criteria:**

National Science Board approved criteria. Additional merit review considerations apply. Please see the full text of this solicitation for further information.

## Award Administration Information

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**Award Conditions:**

Additional award conditions apply. Please see the full text of this solicitation for further information.

**Reporting Requirements:**

Standard NSF reporting requirements apply.

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## I. INTRODUCTION

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The "Quantum Leap: Leading the Next Quantum Revolution" is one of NSF's "10 Big Ideas" that aims to empower U.S. researchers to propel the science and engineering of quantum phenomena through high-risk, high-pay off projects. As a part of the Quantum Leap, QII - TAQS research efforts are expected to explore innovative, original, and transformative ideas with potential to deliver new concepts, platforms, and/or breakthroughs that would accelerate innovation in quantum technologies for enabling quantum sensing, quantum communications, and/or quantum computing systems; and would contribute to training the next generation of a highly-trained workforce. The program serves as an idea incubator aiming to support the process for bringing these ideas into reality.

**Proposed activities** should explore new concepts involving quantum methods, algorithms, and/or materials that exploit quantum phenomena and enable novel efficient devices, circuits, and/or system architectures. The activities should be designed to accelerate fundamental understanding of the physical, chemical, biological, computational, or information-theoretic mechanisms that underlay quantum phenomena. To achieve these goals, a variety of approaches for generation, processing, communication with, and sensing of quantum states could be considered, including modeling, analysis, and computational simulations. Where appropriate, the proposed activities should include validation and verification through measurement, experimentation, and/or device demonstration.

**Research topics** of interest include discovery, understanding, and optimization of quantum phenomena and materials, as well as modeling, design, fabrication, and characterization of quantum devices and systems for various quantum technology applications. Discovery and understanding of quantum effects in nature that may lead to design of bio-inspired quantum devices may also be appropriate. Demonstration of superior functionalities for scalable and reproducible operation and integration of those functionalities into circuits for system delivery is encouraged. Specifically, research targeting the demonstration of longer coherence times, higher fidelity gates, and larger entanglement (both in physical space and the number of qubits used) is of interest. New concepts, devices, and systems for generation, communication, processing, and sensing of quantum information and entanglement are also of interest. Experimental demonstration could be materials manufacturing, characterization and machine-learning tools, integration with silicon-chip technology or other industrial technologies, or computational experiments, for example, evaluating the performance of quantum algorithms on quantum hardware. Research could also lead to demonstration of various quantum programming languages, algorithms, cryptographic protocols, software stacks architectures, or circuit synthesis and optimization.

**The education** of scientists and engineers with expertise in quantum technologies and advanced cyberinfrastructure who are able to work collaboratively with researchers on science (physics, chemistry, materials sciences, biology, computer science, and mathematics) and engineering topics, spanning both theoretical tools as well as experimental approaches, platforms, and testbeds, is crucially important for bringing new ideas into reality. Achieving this goal requires the development of a collaborative cross-sector approach to science and engineering, but also the development of new courses, curricula, and/or graduate degree programs that cross departmental boundaries and are meant to grow the workforce for the next generation quantum scientists and engineers. We encourage proposals with strong educational components that address these goals.

## II. PROGRAM DESCRIPTION

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Each of the proposals in response to this QII - TAQS solicitation should address at least three research topics as outlined above, which preferably come from at least two of the recommended thrust areas outlined below. Competitive proposals are expected to present a collaborative, integrated approach and make a compelling case for how the selected topics are unified to potentially deliver a breakthrough in quantum technologies.

**Recommended Thrust Areas:**

- **Fundamental Science**
- **Communication, Computation, and Modeling**
- **Devices and Engineered Systems**

**Thrust 1: Fundamental Science**

Quantum information science (QIS) is rapidly advancing as applications that use fundamental physical principles such as coherence, superposition, and entanglement are pioneered with ions, molecules, atoms, and atom-like systems (such as vacancy centers in diamond). Technologies such as superconducting qubits, quantum dots, and quantum optics are also advancing QIS, among others. Longer coherence times, higher-fidelity methods for quantum state preparation and readout, and more controlled methods to manipulate single and multiple qubit systems are enabling achievements such as the implementation of mathematical concepts, theoretical models, and computational algorithms, new uses for quantum simulation, applications for quantum communication networks, and quantum-enhanced measurement technologies. We encourage research that leads to better understanding of quantum chemistry, the role of quantum behavior in biological processes, high-temperature superconductivity, magnetism, topological matter, thermodynamics, quantum electrodynamical chemistry, large-scale entanglement generation and measurement, hybrid quantum systems, quantum annealing, quantum tomography, quantum control, quantum communication, quantum computation, and quantum simulation.

Foundational concepts and techniques for the design, analysis and development of systems and architectures for quantum information processing are of interest. Simulations that help to interpret the results of complex experiments, that describe the interaction of quantum systems with their environment, and that describe the interface of the conventional and quantum worlds are of interest.

New fundamental concepts and organizing principles are needed for assembling complex materials (including chemical systems, biomolecules, and soft matter), developing new materials, and validating theoretical predictions to gain advantage from such quantum phenomena. Despite the remarkable advances in quantum materials that have been recently demonstrated, much basic, fundamental research is needed both to identify new quantum materials with desirable properties and to solve the challenges affecting the synthesis, characterization, and control of the desired functionalities.

**Thrust 2: Communication, Computation, and Modeling**

Computer and computational science and engineering approaches will be needed when quantum system, device, and component-level design is made with higher levels of abstraction. This solicitation encourages work in various aspects of quantum communication and quantum computing, including developing and designing quantum algorithms, modeling and simulation of quantum systems and computations, studying/developing quantum programming languages and environments and approaches to compiling programs, developing applications suitable for a solution by a quantum computer, study of quantum architectures, quantum circuit synthesis and optimization, layout and scheduling, practical fault tolerance, and other work on developing the software stacks for quantum computers and integrating devices into systems. Communication challenges include but are not limited to aspects of on-chip communication, networking, establishing secure and/or efficient communication protocols, quantum information theory, and topics in communication complexity. Development of mathematical concepts and algorithms relating to quantum computing and communication as well as rigorous analyses are welcome. Work on integrating various aspects of quantum sensing, quantum communication, and quantum computation into systems is also of interest.

The solicitation encourages theory, modeling, and simulation focused on increasing the understanding and aiding the design of functional quantum devices at each level, from the most primitive quantum elements (e.g., atoms, spins, entangled photons, topological insulators), to quantum building blocks (e.g., qubits, quantum sensing elements, detectors), and finally to functional quantum systems. Theoretical innovations that lead to new quantum device concepts are strongly encouraged, particularly innovative ideas that accelerate the next stage in the quantum revolution.

This solicitation encourages the development of a quantum computer software stack that includes, but is not limited to, new operating systems, compilers, programming languages, and software development toolkits. Development of applications in various scientific areas is encouraged, especially when performance could exceed that of conventional systems. Testbeds for quantum computers to enable the above development are encouraged.

**Thrust 3: Devices and Engineered Systems**

With the concurrent advances achieved in fundamental quantum sciences, materials, and nanotechnology over the past decade, the engineering of quantum information devices, circuits, systems, and networks is becoming a reality. Many platforms and quantum functionalities, at different levels of maturity, are being actively explored. However, defining performance metrics and understanding key figure of merit requirements driven by applications such as quantum sensing, communication, computing, or simulation are in their infancy. Innovative frameworks that leverage the current state-of-the-art and realize quantum functions and systems that are practical and scalable, while achieving performance levels commensurate with the application requirements, are needed. New methodologies and system architectures for generation, propagation, communication, processing, and sensing of quantum information that integrate different devices and platforms are of interest. Identification of appropriate performance metrics, as well as modeling approaches and experimental platforms for evaluation and characterization of performance metrics, are also of interest. Such advances require understanding of fundamental quantum science, device design and characterization, fabrication tolerances, quantum signal communication and processing, and system integration. Design, development, and testing of the quantum systems is expected to provide benchmarks that can be used to compare different viable technology platforms, optimize performance, and define conditions that can lead to practical, robust, and scalable systems.

The manufacture of quantum materials and their integration into quantum devices and systems will require new approaches in materials engineering and processing, as well as designing and building across length scales, material sets, and functionalities. To achieve these

goals, novel concepts in advanced manufacturing, particularly nanomanufacturing, are needed. Nanomanufacturing methods involve top-down (lithography) and/or bottom-up (self-assembly) processes. For example, 2D quantum materials can be fabricated by atomically precise manufacturing using techniques as diverse as STM lithography and DNA origami. Atomic precision is needed for selective doping and tunable arrays, among other structures. Integral to basic research in quantum materials and device manufacturing is addressing manufacturability challenges such as scalability, customizability, reproducibility, controllability, yield, sustainability, and efficiency, supported by model-based experimental verification and process validation. The ultimate goal is to develop nanomanufacturing tools and platforms for quantum materials, devices, and systems with in-line and off-line metrology and closed-loop process control.

#### **QII - TAQS Programmatic Considerations:**

Among the programmatic considerations, the following features are deemed important under this QII - TAQS research solicitation in order to realize the promise of this field over the coming years:

- **Interdisciplinary and convergence:** Progress in this field will benefit tremendously from research that draws on multiple disciplines including physics, chemistry, biology, mathematics, computer sciences and engineering, and thus it is natural to enable scientists and engineers to work together more effectively in research teams involving theory, modeling, design, characterization, and/or device fabrication and testing. More diverse topics and approaches are encouraged.
- **Quantum functionality:** It is expected that proposed research will focus on quantum functionality by assessing aspects relevant to both fundamental and application concepts.
- **Experimental demonstration:** Examples of demonstrations include, but are not limited to quantum-device properties characterization or demonstration in a system, proof-of-concept of novel quantum functionalities, algorithms demonstration of quantum hardware, demonstration of quantum programming systems and/or software stacks, etc. Proposals in which experimental demonstration is not appropriate should clearly explain why this is the case and how the proposal is exceptionally strong in the other programmatic considerations.

The QII - TAQS program also encourages other activities with the potential to increase the impact of projects:

- **Educational and Training Initiatives:** Innovative, evidence-based curricular and training approaches are needed to develop a capable, globally-engaged workforce with the skills and knowledge to pursue research and development in quantum phenomena and quantum technologies. Proposals that address educational and training needs at the undergraduate or graduate level to build capacity in the quantum science and engineering workforce are encouraged.
- **Industrial Partnerships:** Reaching out to American industry partners will be critical to developing scalable techniques for advancing these new technologies and for training students who can work with the industrial partners. Creation of an academia-industry partnership in the development of new concepts and platforms, and subsequent commercialization of technologies based on QII - TAQS concepts, is therefore encouraged.
- **International Collaboration and Student Mobility:** We encourage collaboration with international scientific teams, from like-minded countries, who are leaders in the field. Travel support for the Principal Investigators and students may be considered under the proposal application, or through travel supplements during the course of the award. Opportunities for student mobility are encouraged in order to develop a globally-engaged workforce in this nascent technology sector.

### **III. AWARD INFORMATION**

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**Anticipated Type of Award:** Continuing Grant or Standard Grant

**Estimated Number of Awards:** 18 to 20

The final number of awards will depend on the availability of funds and the quality of the proposals.

**Anticipated Funding Amount:** \$26,000,000

Anticipated funding amount is pending availability of funds. Each project team may receive support of up to a total of \$2,000,000 over the project duration of 3 to 5 years. It is not expected that all awards will receive the maximum amount; the size of awards will depend upon the type of research program proposed. The budget must be commensurate with the scope of the project and thoroughly justified in the proposal.

Estimated program budget, number of awards, and average award size/duration are subject to the availability of funds.

### **IV. ELIGIBILITY INFORMATION**

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#### **Who May Submit Proposals:**

Proposals may only be submitted by the following:

- Institutions of Higher Education (IHEs) - Two- and four-year IHEs (including community colleges) accredited in, and having a campus located in the US, acting on behalf of their faculty members. Special Instructions for International Branch Campuses of US IHEs: If the proposal includes funding to be provided to an international branch campus of a US institution of higher education (including through use of subawards and consultant arrangements), the proposer must explain the benefit(s) to the project of performance at the international branch campus, and justify why the project activities cannot be performed at the US campus.

#### Who May Serve as PI:

The lead Principal Investigator (PI) must be a faculty employed by the submitting organization. A minimum of one PI and two co-PIs must participate.

#### Limit on Number of Proposals per Organization:

There are no restrictions or limits.

#### Limit on Number of Proposals per PI or Co-PI: 2

No individual may appear as Senior Personnel (Principal Investigator, Co-PI, and Faculty Associate or equivalent) on more than two QII - TAQS preliminary proposals. In the event that any individual exceeds this limit, any proposal submitted to this solicitation with this individual listed as PI, co-PI, or Senior Personnel after the first two proposals are received at NSF will be returned without review. No exceptions will be made.

## V. PROPOSAL PREPARATION AND SUBMISSION INSTRUCTIONS

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### A. Proposal Preparation Instructions

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#### Letters of Intent (required):

A one-page Letter of Intent is required. The letter should be submitted to MPS/OMA via FastLane no later than the date specified in this solicitation. The subject heading of the letter should include a brief title of the proposal and the name of the lead institution.

#### Letters of Intent must include the following:

- Proposal title - Title must be preceded by the words "QII - TAQS:".
- Team - Names, departmental and university affiliation, and expertise of the Principal Investigator and at least two co-Principal Investigators.
- Synopsis - Brief description of the specific goals of the proposal.

These Letters of Intent are not used as pre-approval mechanisms for the submission of preliminary proposals, and no feedback will be provided to the submitters. The Letters of Intent are used to assess the overall response to the solicitation, and they will help NSF to anticipate review requirements for preliminary proposals.

#### Letter of Intent Preparation Instructions:

When submitting a Letter of Intent through FastLane in response to this Program Solicitation please note the conditions outlined below:

- Submission by an Authorized Organizational Representative (AOR) is required when submitting Letters of Intent.
- A Minimum of 2 and Maximum of 4 Other Senior Project Personnel are permitted
- A Minimum of 0 and Maximum of 2 Other Participating Organizations are permitted
- Submission of multiple Letters of Intent is not permitted

**Preliminary Proposals (required):** Preliminary proposals are required and must be submitted to MPS/OMA via the NSF FastLane system, even if full proposals will be submitted via Grants.gov.

Preliminary proposals should include sufficient information to allow assessment of the main ideas and approaches and how they are appropriate as QII - TAQS proposal as opposed to existing programs. For the preliminary proposals, the review criteria will place a higher weight on: (i) convergence of diverse approaches to address cross-disciplinary topics;(ii) experimental realization, where appropriate; and (iii) transformative nature and impact of the proposed idea(s).

#### Preliminary Proposal Preparation Instructions:

Preliminary proposals must be submitted via FastLane in accordance with the instructions below. Preliminary proposals that are not compliant with this solicitation will be returned without review. It is the submitting organization's responsibility to ensure that the proposal is compliant with all applicable requirements. If there are multiple universities involved in a preliminary proposal, it must be submitted as a single proposal with subawards and not as separately submitted collaborative proposals. Preliminary proposals must contain the items listed below and strictly adhere to the specified page limitations. No additional information may be provided as an appendix or by links to web pages. Figures and tables must be included within the applicable page limit. Preliminary proposals must meet all formatting requirements specified in the NSF PAPPG.

Preliminary proposals must include the following items:

**Cover Sheet:** Select the QII - TAQS program solicitation number from the pull-down list. Check the box indicated for preliminary proposal. A minimum of three senior personnel must participate.

**Title of Proposed Project:** The title for the proposed QII - TAQS project must begin with "QII - TAQS Preliminary Proposal:".

**Project Summary:** The project summary may not be more than one page in length and must consist of three parts:

- In the Overview section, include the title of the project, the name of the PI and the lead institution, and a list of co-PIs and senior personnel along with their institutions;



- Provide a succinct summary of the *intellectual merit* of the proposed project. This should include the transformative nature of the proposed research and significant leap or paradigm shift it will achieve; and
- Describe the *broader impacts* of the proposed work, including the potential long-term impact on national needs.

Proposals that do not separately address in the project summary both intellectual merit and broader impacts will be returned without review.

**Project Description:** The project description of the preliminary proposal is limited to **five pages** and is to include the following subsections:

- **Vision and Goals:** Describe the vision and specific goals of the proposed research, explicitly addressing how the different PIs and research topics mesh together to achieve the research goals.
- **Approach and Methodology:** Describe the approach and methodology that will be used to achieve the research vision and goals.
- **Transformative Potential:** Describe the transformative aspects of the project, including how the synergy of experts from different disciplines in the proposed research will provide an opportunity for a significant leap or paradigm shift in fundamental scientific and/or engineering knowledge.

**References Cited:** Indicate with an asterisk any cited publications that resulted from prior research funded by NSF for the PI, or co-PI (s).

**Biographical sketches:** The standard NSF two-page biographical sketches must be prepared for the PI, co-PIs, and other senior personnel listed on the project summary page.

**Current and Pending Support:** Information for the PI, co-PIs, and senior personnel must be included.

**Budget:** The preliminary proposal will include a budget for each of the proposed years. FastLane will automatically provide a cumulative budget. Preliminary proposal budgets should not include detailed subaward budgets. However, the budget justification should include planned levels for subawards to any partner institution. Enter the anticipated total level of subaward support on line G5, Subawards.

**Supplementary Documents:** Include the following:

- A list of **key personnel involved** (maximum one page), with a succinct description of what each person uniquely brings to the project and how they are integrated to produce positive synergies.

**Single Copy Documents:** *Collaborators and Other Affiliations Information:* Proposers should follow the guidance specified in Chapter II.C.1.e of the [NSF PAPPG](#).

**Review of Preliminary Proposals and Invitation to Submit a Full Proposal:** The preliminary proposals will be reviewed by panels of external experts. Based on the reviews, a limited number of preliminary proposal teams will be invited to submit full proposals. By mid-April 2019, PIs should expect to receive a message from the QII - TAQS program, indicating whether or not a full proposal is invited for the project. Such an invitation is required for submission of a full proposal; full proposals submitted without an invitation will be returned without review.

**Full Proposal Preparation Instructions:** Proposers may opt to submit proposals in response to this Program Solicitation via Grants.gov or via the NSF FastLane system.

- Full proposals submitted via FastLane: Proposals submitted in response to this program solicitation should be prepared and submitted in accordance with the general guidelines contained in the *NSF Proposal & Award Policies & Procedures Guide* (PAPPG). The complete text of the PAPPG is available electronically on the NSF website at: [https://www.nsf.gov/publications/pub\\_summ.jsp?ods\\_key=pappg](https://www.nsf.gov/publications/pub_summ.jsp?ods_key=pappg). Paper copies of the PAPPG may be obtained from the NSF Publications Clearinghouse, telephone (703) 292-7827 or by e-mail from [nsfpubs@nsf.gov](mailto:nsfpubs@nsf.gov). Proposers are reminded to identify this program solicitation number in the program solicitation block on the NSF Cover Sheet For Proposal to the National Science Foundation. Compliance with this requirement is critical to determining the relevant proposal processing guidelines. Failure to submit this information may delay processing.
- Full proposals submitted via Grants.gov: Proposals submitted in response to this program solicitation via Grants.gov should be prepared and submitted in accordance with the *NSF Grants.gov Application Guide: A Guide for the Preparation and Submission of NSF Applications via Grants.gov*. The complete text of the *NSF Grants.gov Application Guide* is available on the Grants.gov website and on the NSF website at: ([https://www.nsf.gov/publications/pub\\_summ.jsp?ods\\_key=grantsgovguide](https://www.nsf.gov/publications/pub_summ.jsp?ods_key=grantsgovguide)). To obtain copies of the Application Guide and Application Forms Package, click on the Apply tab on the Grants.gov site, then click on the Apply Step 1: Download a Grant Application Package and Application Instructions link and enter the funding opportunity number, (the program solicitation number without the NSF prefix) and press the Download Package button. Paper copies of the Grants.gov Application Guide also may be obtained from the NSF Publications Clearinghouse, telephone (703) 292-7827 or by e-mail from [nsfpubs@nsf.gov](mailto:nsfpubs@nsf.gov).

See PAPPG Chapter II.C.2 for guidance on the required sections of a full research proposal submitted to NSF. Please note that the proposal preparation instructions provided in this program solicitation may deviate from the PAPPG instructions.

Based on the review of preliminary proposals, a limited number of PIs will be invited to submit a full proposal. Such an invitation is required for submission of a full proposal; full proposals submitted without an invitation will be returned without review.

**If multiple universities are involved in an invited full proposal, it must be submitted as a single full proposal with subawards, and not as separately submitted collaborative proposals.**

The full proposals will be reviewed by panels of outside experts. Both standard criteria (Intellectual Merit and Broader Impact), as well as Additional Solicitation Specific Review Criteria, will be given full consideration during the review and decision-making processes; each criterion is necessary but neither, by itself, is sufficient. Please consider all the details described in Section VI. NSF PROPOSAL PROCESSING AND REVIEW PROCEDURES.



## Special instructions for submitting to this Big Idea solicitation

**FastLane Users:** Proposers are reminded to identify the program solicitation number (located on the first page of this document) in the first block on the NSF Cover Sheet. Compliance with this requirement is critical to determining the relevant proposal processing guidelines. Please note that even though proposals must be submitted to the Directorate for Mathematical & Physical Sciences/Office of Multidisciplinary Activities, once received the proposals will be managed by a cross-disciplinary team of NSF Program Directors.

**Research.gov Users:** The Prepare New Proposal setup will prompt you for the program solicitation number (located on the first page of this document). Compliance with this requirement is critical to determining the relevant proposal processing guidelines. As stated previously, even though proposals must be submitted to the Directorate for Mathematical & Physical Sciences/Office of Multidisciplinary Activities, once received the proposals will be managed by a cross-disciplinary team of NSF Program Directors.

**Grants.gov Users:** The program solicitation number will be pre-populated by Grants.gov on the NSF Grant Application Cover Page, however you will need to locate the Division Code, Program Code, Division Name, and Program Name for the specific solicitation you are applying to by visiting <https://www.fastlane.nsf.gov/pgmannounce.jsp>. As stated previously, even though proposals must be submitted to the Directorate for Mathematical & Physical Sciences/Office of Multidisciplinary Activities, once received the proposals will be managed by a cross-disciplinary team of NSF Program Directors.

**Cover Sheet:** Select the QII - TAQS program solicitation number from the pull down list. Check the box indicated for full proposal. A minimum of three senior personnel must participate.

**Title of Proposed Project:** The title for the proposed QII - TAQS project must begin with "QII - TAQS:".

**Project Summary (one-page limit):** The Project Summary consists of an overview, a statement on the intellectual merit of the proposed activity, and a statement on the broader impacts of the proposed activity. Provide the following information:

- In the Overview section provide the title of the project, the name of the PI and the lead institution or organization, and a list of co-PIs and senior personnel along with their institutions and organization or both;
- A succinct summary of the **intellectual merit** of the proposed project. This should include the transformative nature of the proposed research and significant leap or paradigm shift it will achieve; and
- The **broader impacts** of the proposed work, including the potential long-term impact on national needs. Include a summary of plans to integrate education, outreach, or broadening participation activities in the project.

Proposals that do not contain the Project Summary, including an overview and separate statements on intellectual merit and broader impacts will not be accepted by FastLane or will be returned without review.

**Project Description (maximum 15 pages)** must include the following subsections:

- **Vision and Goals:** Describe the vision and specific goals of the proposed research, explicitly addressing how the different PIs and research topics mesh together to achieve the research goals.
- **Approach and Methodology:** Describe the approach and methodology that will be used to achieve the research vision and goals.
- **Proposed Research:** Describe the research topics that will be explored by the project and identify the associated QII - TAQS Thrust Area(s). Describe the activities envisioned and the expected outcome(s), as well as possible inter-relation and/or feedback between the different efforts/topics.
- **Transformative Potential:** Describe the transformative aspects of the project, including how the synergy of experts from different disciplines in the proposed research will provide an opportunity for a significant leap or paradigm shift in fundamental scientific and/or engineering knowledge.
- **Broader Impact:** Describe how the proposed project has long-term potential for significant impact on national needs. The proposal should also discuss effective ways in which education, outreach, and broadening participation activities are to be integrated within the research program to achieve societal impacts.
- **Management Plan:** Provide details on planned means of communication, data tracking, management of personnel within the project group, management of intellectual property resulting from the project, and timeline of activities.
- **Results from Prior NSF Support:** Please follow the guidance provided in the NSF Proposal & Award Policies & Procedures Guide (PAPPG) for reporting results from prior NSF support. Please also describe the prior research of each PI or co-PI funded by NSF that is directly relevant to the proposed project.

**References Cited:** Indicate with an asterisk any cited publications that resulted from prior research funded by NSF of the PI or co-PI (s).

**Biographical sketches:** The standard NSF two-page biographical sketches must be prepared for the PI, co-PIs, and other senior personnel listed on the project summary page.

**Current and Pending Support:** Information for the PI, co-PIs, and senior personnel must be included.

**Budget:** The proposal must include a budget for each of the proposed years. The system will automatically provide a cumulative budget. The Budget Justification should take whatever space is necessary to provide a breakdown of planned expenditures in composite budget categories such as Participant Support Costs, including projected head-counts for participants.

**Facilities, Equipment, and Other Resources:** Describe the internal and external resources (both physical and personnel) that the organization and its collaborators plan to provide to the project. Describe only those resources that are directly applicable. The description should be narrative in nature and must not include any quantifiable financial information.

**Supplementary Documents:** Include the following:

- A list of **key personnel involved** (maximum one page), with a succinct description of what each person uniquely brings to the project and how their expertise is to be integrated to produce positive synergies;
- Proposals must include a **Data Management Plan** (maximum two pages). The contents of the data management plan should include: (1) the types of data to be produced, (2) the standards that would be applied for data format and metadata content,

- and (3) access policies and provision;
- For proposals that include support for post-doctoral researchers, provide a **Postdoctoral Researcher Mentoring Plan** (maximum one page);
- **Means of sharing the outcome (optional)** of the research with the rest of the scientific community, e.g. publications, tool sets, models, designs, code, tutorials, websites and significant data bases, etc. (maximum two pages). The description should be specific and describe what, how, and when the community would have access to the outcome of the project. This is particularly important for the projects that will produce tangible research tools and resources; and
- **Broadening Participation Plan (optional)** - You may include additional detail about plans to broaden participation as a supplementary document (maximum two pages).

**Single Copy Documents:** *Collaborators and Other Affiliations Information:* Proposers should follow the guidance specified in Chapter II.C.1.e of the [NSF PAPPG](#).

## B. Budgetary Information

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### Cost Sharing:

Inclusion of voluntary committed cost sharing is prohibited.

## C. Due Dates

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- **Letter of Intent Due Date(s) (required)** (due by 5 p.m. submitter's local time):  
January 07, 2019
- **Preliminary Proposal Due Date(s) (required)** (due by 5 p.m. submitter's local time):  
February 22, 2019
- **Full Proposal Deadline(s)** (due by 5 p.m. submitter's local time):  
May 24, 2019

## D. FastLane/Grants.gov Requirements

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### For Proposals Submitted Via FastLane:

To prepare and submit a proposal via FastLane, see detailed technical instructions available at: <https://www.fastlane.nsf.gov/a1/newstan.htm>. For FastLane user support, call the FastLane Help Desk at 1-800-673-6188 or e-mail [fastlane@nsf.gov](mailto:fastlane@nsf.gov). The FastLane Help Desk answers general technical questions related to the use of the FastLane system. Specific questions related to this program solicitation should be referred to the NSF program staff contact(s) listed in Section VIII of this funding opportunity.

### For Proposals Submitted Via Grants.gov:

Before using Grants.gov for the first time, each organization must register to create an institutional profile. Once registered, the applicant's organization can then apply for any federal grant on the Grants.gov website. Comprehensive information about using Grants.gov is available on the Grants.gov Applicant Resources webpage: <http://www.grants.gov/web/grants/applicants.html>. In addition, the NSF Grants.gov Application Guide (see link in Section V.A) provides instructions regarding the technical preparation of proposals via Grants.gov. For Grants.gov user support, contact the Grants.gov Contact Center at 1-800-518-4726 or by email: [support@grants.gov](mailto:support@grants.gov). The Grants.gov Contact Center answers general technical questions related to the use of Grants.gov. Specific questions related to this program solicitation should be referred to the NSF program staff contact(s) listed in Section VIII of this solicitation.

**Submitting the Proposal:** Once all documents have been completed, the Authorized Organizational Representative (AOR) must submit the application to Grants.gov and verify the desired funding opportunity and agency to which the application is submitted. The AOR must then sign and submit the application to Grants.gov. The completed application will be transferred to the NSF FastLane system for further processing.

Proposers that submitted via FastLane are strongly encouraged to use FastLane to verify the status of their submission to NSF. For proposers that submitted via Grants.gov, until an application has been received and validated by NSF, the Authorized Organizational Representative may check the status of an application on Grants.gov. After proposers have received an e-mail notification from NSF, Research.gov should be used to check the status of an application.

## VI. NSF PROPOSAL PROCESSING AND REVIEW PROCEDURES

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Proposals received by NSF are assigned to the appropriate NSF program for acknowledgement and, if they meet NSF requirements, for review. All proposals are carefully reviewed by a scientist, engineer, or educator serving as an NSF Program Officer, and usually by

three to ten other persons outside NSF either as *ad hoc* reviewers, panelists, or both, who are experts in the particular fields represented by the proposal. These reviewers are selected by Program Officers charged with oversight of the review process. Proposers are invited to suggest names of persons they believe are especially well qualified to review the proposal and/or persons they would prefer not review the proposal. These suggestions may serve as one source in the reviewer selection process at the Program Officer's discretion. Submission of such names, however, is optional. Care is taken to ensure that reviewers have no conflicts of interest with the proposal. In addition, Program Officers may obtain comments from site visits before recommending final action on proposals. Senior NSF staff further review recommendations for awards. A flowchart that depicts the entire NSF proposal and award process (and associated timeline) is included in PAPPG Exhibit III-1.

A comprehensive description of the Foundation's merit review process is available on the NSF website at: [https://www.nsf.gov/bfa/dias/policy/merit\\_review/](https://www.nsf.gov/bfa/dias/policy/merit_review/).

Proposers should also be aware of core strategies that are essential to the fulfillment of NSF's mission, as articulated in *Building the Future: Investing in Discovery and Innovation - NSF Strategic Plan for Fiscal Years (FY) 2018 – 2022*. These strategies are integrated in the program planning and implementation process, of which proposal review is one part. NSF's mission is particularly well-implemented through the integration of research and education and broadening participation in NSF programs, projects, and activities.

One of the strategic objectives in support of NSF's mission is to foster integration of research and education through the programs, projects, and activities it supports at academic and research institutions. These institutions must recruit, train, and prepare a diverse STEM workforce to advance the frontiers of science and participate in the U.S. technology-based economy. NSF's contribution to the national innovation ecosystem is to provide cutting-edge research under the guidance of the Nation's most creative scientists and engineers. NSF also supports development of a strong science, technology, engineering, and mathematics (STEM) workforce by investing in building the knowledge that informs improvements in STEM teaching and learning.

NSF's mission calls for the broadening of opportunities and expanding participation of groups, institutions, and geographic regions that are underrepresented in STEM disciplines, which is essential to the health and vitality of science and engineering. NSF is committed to this principle of diversity and deems it central to the programs, projects, and activities it considers and supports.

## A. Merit Review Principles and Criteria

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The National Science Foundation strives to invest in a robust and diverse portfolio of projects that creates new knowledge and enables breakthroughs in understanding across all areas of science and engineering research and education. To identify which projects to support, NSF relies on a merit review process that incorporates consideration of both the technical aspects of a proposed project and its potential to contribute more broadly to advancing NSF's mission "to promote the progress of science; to advance the national health, prosperity, and welfare; to secure the national defense; and for other purposes." NSF makes every effort to conduct a fair, competitive, transparent merit review process for the selection of projects.

### 1. Merit Review Principles

These principles are to be given due diligence by PIs and organizations when preparing proposals and managing projects, by reviewers when reading and evaluating proposals, and by NSF program staff when determining whether or not to recommend proposals for funding and while overseeing awards. Given that NSF is the primary federal agency charged with nurturing and supporting excellence in basic research and education, the following three principles apply:

- All NSF projects should be of the highest quality and have the potential to advance, if not transform, the frontiers of knowledge.
- NSF projects, in the aggregate, should contribute more broadly to achieving societal goals. These "Broader Impacts" may be accomplished through the research itself, through activities that are directly related to specific research projects, or through activities that are supported by, but are complementary to, the project. The project activities may be based on previously established and/or innovative methods and approaches, but in either case must be well justified.
- Meaningful assessment and evaluation of NSF funded projects should be based on appropriate metrics, keeping in mind the likely correlation between the effect of broader impacts and the resources provided to implement projects. If the size of the activity is limited, evaluation of that activity in isolation is not likely to be meaningful. Thus, assessing the effectiveness of these activities may best be done at a higher, more aggregated, level than the individual project.

With respect to the third principle, even if assessment of Broader Impacts outcomes for particular projects is done at an aggregated level, PIs are expected to be accountable for carrying out the activities described in the funded project. Thus, individual projects should include clearly stated goals, specific descriptions of the activities that the PI intends to do, and a plan in place to document the outputs of those activities.

These three merit review principles provide the basis for the merit review criteria, as well as a context within which the users of the criteria can better understand their intent.

### 2. Merit Review Criteria

All NSF proposals are evaluated through use of the two National Science Board approved merit review criteria. In some instances, however, NSF will employ additional criteria as required to highlight the specific objectives of certain programs and activities.

The two merit review criteria are listed below. **Both** criteria are to be given **full consideration** during the review and decision-making processes; each criterion is necessary but neither, by itself, is sufficient. Therefore, proposers must fully address both criteria. (PAPPG Chapter II.C.2.d(i). contains additional information for use by proposers in development of the Project Description section of the proposal). Reviewers are strongly encouraged to review the criteria, including PAPPG Chapter II.C.2.d(i), prior to the review of a proposal.

When evaluating NSF proposals, reviewers will be asked to consider what the proposers want to do, why they want to do it, how they plan to do it, how they will know if they succeed, and what benefits could accrue if the project is successful. These issues apply both to the technical aspects of the proposal and the way in which the project may make broader contributions. To that end, reviewers will be

asked to evaluate all proposals against two criteria:

- **Intellectual Merit:** The Intellectual Merit criterion encompasses the potential to advance knowledge; and
- **Broader Impacts:** The Broader Impacts criterion encompasses the potential to benefit society and contribute to the achievement of specific, desired societal outcomes.

The following elements should be considered in the review for both criteria:

1. What is the potential for the proposed activity to
  - a. Advance knowledge and understanding within its own field or across different fields (Intellectual Merit); and
  - b. Benefit society or advance desired societal outcomes (Broader Impacts)?
2. To what extent do the proposed activities suggest and explore creative, original, or potentially transformative concepts?
3. Is the plan for carrying out the proposed activities well-reasoned, well-organized, and based on a sound rationale? Does the plan incorporate a mechanism to assess success?
4. How well qualified is the individual, team, or organization to conduct the proposed activities?
5. Are there adequate resources available to the PI (either at the home organization or through collaborations) to carry out the proposed activities?

Broader impacts may be accomplished through the research itself, through the activities that are directly related to specific research projects, or through activities that are supported by, but are complementary to, the project. NSF values the advancement of scientific knowledge and activities that contribute to achievement of societally relevant outcomes. Such outcomes include, but are not limited to: full participation of women, persons with disabilities, and underrepresented minorities in science, technology, engineering, and mathematics (STEM); improved STEM education and educator development at any level; increased public scientific literacy and public engagement with science and technology; improved well-being of individuals in society; development of a diverse, globally competitive STEM workforce; increased partnerships between academia, industry, and others; improved national security; increased economic competitiveness of the United States; and enhanced infrastructure for research and education.

Proposers are reminded that reviewers will also be asked to review the Data Management Plan and the Postdoctoral Researcher Mentoring Plan, as appropriate.

#### **Additional Solicitation Specific Review Criteria**

In addition to the two NSF review criteria (intellectual merit and broader impacts), additional criteria will be used in the review of both QII - TAQS preliminary and full proposals:

- **Interdisciplinary:** Does the proposed research involve the convergence of diverse fields of expertise to address an important topic?
- **Thrust Areas:** Does the proposed research include diverse research elements from the recommended thrust areas as described in Section II?
- **Proposal Focus:** Does the proposal focus on quantum functionality?
- **Experimental Demonstration:** Does the proposed research include a plan for experimental demonstration, when appropriate? Examples of demonstrations include, but are not limited to, quantum devices characterization or demonstration in a system, proof-of-concept of novel quantum functionalities, algorithms demonstration on quantum hardware, etc.
- **Transformative Potential:** Does the proposed research represent an opportunity for a significant leap or paradigm shift in fundamental scientific and/or engineering knowledge?
- **Educational Potential:** Additional consideration may be given to interesting education plans/curriculum development that would contribute to an increased convergent quantum research community.
- Responsiveness to "**Programmatic Considerations**" for QII - TAQS proposals as delineated in Section II. Program Description.

## **B. Review and Selection Process**

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Proposals submitted in response to this program solicitation will be reviewed by Panel Review.

Reviewers will be asked to evaluate proposals using two National Science Board approved merit review criteria and, if applicable, additional program specific criteria. A summary rating and accompanying narrative will generally be completed and submitted by each reviewer and/or panel. The Program Officer assigned to manage the proposal's review will consider the advice of reviewers and will formulate a recommendation.

After scientific, technical and programmatic review and consideration of appropriate factors, the NSF Program Officer recommends to the cognizant Division Director whether the proposal should be declined or recommended for award. NSF strives to be able to tell applicants whether their proposals have been declined or recommended for funding within six months. Large or particularly complex proposals or proposals from new awardees may require additional review and processing time. The time interval begins on the deadline or target date, or receipt date, whichever is later. The interval ends when the Division Director acts upon the Program Officer's recommendation.

After programmatic approval has been obtained, the proposals recommended for funding will be forwarded to the Division of Grants and Agreements for review of business, financial, and policy implications. After an administrative review has occurred, Grants and Agreements Officers perform the processing and issuance of a grant or other agreement. Proposers are cautioned that only a Grants and Agreements Officer may make commitments, obligations or awards on behalf of NSF or authorize the expenditure of funds. No commitment on the part of NSF should be inferred from technical or budgetary discussions with a NSF Program Officer. A Principal Investigator or organization that makes financial or personnel commitments in the absence of a grant or cooperative agreement signed by the NSF Grants and Agreements Officer does so at their own risk.

Once an award or declination decision has been made, Principal Investigators are provided feedback about their proposals. In all cases, reviews are treated as confidential documents. Verbatim copies of reviews, excluding the names of the reviewers or any reviewer-identifying information, are sent to the Principal Investigator/Project Director by the Program Officer. In addition, the proposer will receive an explanation of the decision to award or decline funding.

## VII. AWARD ADMINISTRATION INFORMATION

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### A. Notification of the Award

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Notification of the award is made to *the submitting organization* by a Grants Officer in the Division of Grants and Agreements. Organizations whose proposals are declined will be advised as promptly as possible by the cognizant NSF Program administering the program. Verbatim copies of reviews, not including the identity of the reviewer, will be provided automatically to the Principal Investigator. (See Section VI.B. for additional information on the review process.)

### B. Award Conditions

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An NSF award consists of: (1) the award notice, which includes any special provisions applicable to the award and any numbered amendments thereto; (2) the budget, which indicates the amounts, by categories of expense, on which NSF has based its support (or otherwise communicates any specific approvals or disapprovals of proposed expenditures); (3) the proposal referenced in the award notice; (4) the applicable award conditions, such as Grant General Conditions (GC-1)\*; or Research Terms and Conditions\* and (5) any announcement or other NSF issuance that may be incorporated by reference in the award notice. Cooperative agreements also are administered in accordance with NSF Cooperative Agreement Financial and Administrative Terms and Conditions (CA-FATC) and the applicable Programmatic Terms and Conditions. NSF awards are electronically signed by an NSF Grants and Agreements Officer and transmitted electronically to the organization via e-mail.

\*These documents may be accessed electronically on NSF's Website at [https://www.nsf.gov/awards/managing/award\\_conditions.jsp?org=NSF](https://www.nsf.gov/awards/managing/award_conditions.jsp?org=NSF). Paper copies may be obtained from the NSF Publications Clearinghouse, telephone (703) 292-7827 or by e-mail from [nsfpubs@nsf.gov](mailto:nsfpubs@nsf.gov).

More comprehensive information on NSF Award Conditions and other important information on the administration of NSF awards is contained in the *NSF Proposal & Award Policies & Procedures Guide* (PAPPG) Chapter VII, available electronically on the NSF Website at [https://www.nsf.gov/publications/pub\\_summ.jsp?ods\\_key=papppg](https://www.nsf.gov/publications/pub_summ.jsp?ods_key=papppg).

#### Special Award Conditions:

Grantees will be required to include appropriate acknowledgment of NSF support under the Quantum Leap Big Idea in any publication (including World Wide Web pages) of any material based on or developed under the project, in the following terms:

"This material is based upon work supported by the National Science Foundation the Quantum Leap Big Idea under Grant No. (Grantee enters NSF grant number)."

Grantees also will be required to orally acknowledge NSF support using the language specified above during all news media interviews, including popular media such as radio, television and news magazines.

### C. Reporting Requirements

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For all multi-year grants (including both standard and continuing grants), the Principal Investigator must submit an annual project report to the cognizant Program Officer no later than 90 days prior to the end of the current budget period. (Some programs or awards require submission of more frequent project reports). No later than 120 days following expiration of a grant, the PI also is required to submit a final project report, and a project outcomes report for the general public.

Failure to provide the required annual or final project reports, or the project outcomes report, will delay NSF review and processing of any future funding increments as well as any pending proposals for all identified PIs and co-PIs on a given award. PIs should examine the formats of the required reports in advance to assure availability of required data.

PIs are required to use NSF's electronic project-reporting system, available through Research.gov, for preparation and submission of annual and final project reports. Such reports provide information on accomplishments, project participants (individual and organizational), publications, and other specific products and impacts of the project. Submission of the report via Research.gov constitutes certification by the PI that the contents of the report are accurate and complete. The project outcomes report also must be prepared and submitted using Research.gov. This report serves as a brief summary, prepared specifically for the public, of the nature and outcomes of the project. This report will be posted on the NSF website exactly as it is submitted by the PI.

More comprehensive information on NSF Reporting Requirements and other important information on the administration of NSF awards is contained in the *NSF Proposal & Award Policies & Procedures Guide* (PAPPG) Chapter VII, available electronically on the NSF Website at [https://www.nsf.gov/publications/pub\\_summ.jsp?ods\\_key=papppg](https://www.nsf.gov/publications/pub_summ.jsp?ods_key=papppg).

## VIII. AGENCY CONTACTS

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Please note that the program contact information is current at the time of publishing. See program website for any updates to the points of contact.

General inquiries regarding this program should be made to:

- Tania M. Paskova, telephone: (703) 292-2264, email: [tpaskova@nsf.gov](mailto:tpaskova@nsf.gov)
- Dominique Dagenais, telephone: (703) 292-2980, email: [ddagenai@nsf.gov](mailto:ddagenai@nsf.gov)
- Alexander Cronin, telephone: (703) 292-5302, email: [acronin@nsf.gov](mailto:acronin@nsf.gov)
- Evelyn Goldfield, telephone: (703) 292-2173, email: [egoldfie@nsf.gov](mailto:egoldfie@nsf.gov)
- Justin Holmer, telephone: (703) 292-8213, email: [jholmer@nsf.gov](mailto:jholmer@nsf.gov)
- Dmitri Maslov, telephone: (703) 292-4549, email: [dmaslov@nsf.gov](mailto:dmaslov@nsf.gov)
- Vipin Chaudhary, telephone: (703) 292-2254, email: [vipchaud@nsf.gov](mailto:vipchaud@nsf.gov)
- Khershed Cooper, telephone: (703) 292-7017, email: [khcooper@nsf.gov](mailto:khcooper@nsf.gov)
- Engin Serpersu, telephone: (703) 292-7124, email: [eserpers@nsf.gov](mailto:eserpers@nsf.gov)
- Chun-Hsi (Vincent) Huang, telephone: (703) 292-7877, email: [chuang@nsf.gov](mailto:chuang@nsf.gov)
- Maija Kukla, telephone: (703) 292-4940, email: [mkukla@nsf.gov](mailto:mkukla@nsf.gov)

For questions related to the use of FastLane, contact:

- FastLane Help Desk, telephone: 1-800-673-6188; e-mail: [fastlane@nsf.gov](mailto:fastlane@nsf.gov).

For questions relating to Grants.gov contact:

- Grants.gov Contact Center: If the Authorized Organizational Representatives (AOR) has not received a confirmation message from Grants.gov within 48 hours of submission of application, please contact via telephone: 1-800-518-4726; e-mail: [support@grants.gov](mailto:support@grants.gov).

## IX. OTHER INFORMATION

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The NSF website provides the most comprehensive source of information on NSF Directorates (including contact information), programs and funding opportunities. Use of this website by potential proposers is strongly encouraged. In addition, "NSF Update" is an information-delivery system designed to keep potential proposers and other interested parties apprised of new NSF funding opportunities and publications, important changes in proposal and award policies and procedures, and upcoming NSF [Grants Conferences](#). Subscribers are informed through e-mail or the user's Web browser each time new publications are issued that match their identified interests. "NSF Update" also is available on [NSF's website](#).

Grants.gov provides an additional electronic capability to search for Federal government-wide grant opportunities. NSF funding opportunities may be accessed via this mechanism. Further information on Grants.gov may be obtained at <http://www.grants.gov>.

## ABOUT THE NATIONAL SCIENCE FOUNDATION

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The National Science Foundation (NSF) is an independent Federal agency created by the National Science Foundation Act of 1950, as amended (42 USC 1861-75). The Act states the purpose of the NSF is "to promote the progress of science; [and] to advance the national health, prosperity, and welfare by supporting research and education in all fields of science and engineering."

NSF funds research and education in most fields of science and engineering. It does this through grants and cooperative agreements to more than 2,000 colleges, universities, K-12 school systems, businesses, informal science organizations and other research organizations throughout the US. The Foundation accounts for about one-fourth of Federal support to academic institutions for basic research.

NSF receives approximately 55,000 proposals each year for research, education and training projects, of which approximately 11,000 are funded. In addition, the Foundation receives several thousand applications for graduate and postdoctoral fellowships. The agency operates no laboratories itself but does support National Research Centers, user facilities, certain oceanographic vessels and Arctic and Antarctic research stations. The Foundation also supports cooperative research between universities and industry, US participation in international scientific and engineering efforts, and educational activities at every academic level.

*Facilitation Awards for Scientists and Engineers with Disabilities (FASSED)* provide funding for special assistance or equipment to enable persons with disabilities to work on NSF-supported projects. See the *NSF Proposal & Award Policies & Procedures Guide* Chapter II.E.6 for instructions regarding preparation of these types of proposals.

The National Science Foundation has Telephonic Device for the Deaf (TDD) and Federal Information Relay Service (FIRS) capabilities that enable individuals with hearing impairments to communicate with the Foundation about NSF programs, employment or general information. TDD may be accessed at (703) 292-5090 and (800) 281-8749, FIRS at (800) 877-8339.

The National Science Foundation Information Center may be reached at (703) 292-5111.

The National Science Foundation promotes and advances scientific progress in the United States by competitively awarding grants and cooperative agreements for research and education in the sciences, mathematics, and engineering.

To get the latest information about program deadlines, to download copies of NSF publications, and to access abstracts of awards, visit the NSF Website at <https://www.nsf.gov>

- **Location:**

2415 Eisenhower Avenue,



- **For General Information**  
(NSF Information Center):

Alexandria, VA 22314  
(703) 292-5111

- **TDD (for the hearing-impaired):**

(703) 292-5090

- **To Order Publications or Forms:**

Send an e-mail to:

[nsfpubs@nsf.gov](mailto:nsfpubs@nsf.gov)

or telephone:

(703) 292-7827

- **To Locate NSF Employees:**

(703) 292-5111

## PRIVACY ACT AND PUBLIC BURDEN STATEMENTS

The information requested on proposal forms and project reports is solicited under the authority of the National Science Foundation Act of 1950, as amended. The information on proposal forms will be used in connection with the selection of qualified proposals; and project reports submitted by awardees will be used for program evaluation and reporting within the Executive Branch and to Congress. The information requested may be disclosed to qualified reviewers and staff assistants as part of the proposal review process; to proposer institutions/grantees to provide or obtain data regarding the proposal review process, award decisions, or the administration of awards; to government contractors, experts, volunteers and researchers and educators as necessary to complete assigned work; to other government agencies or other entities needing information regarding applicants or nominees as part of a joint application review process, or in order to coordinate programs or policy; and to another Federal agency, court, or party in a court or Federal administrative proceeding if the government is a party. Information about Principal Investigators may be added to the Reviewer file and used to select potential candidates to serve as peer reviewers or advisory committee members. See Systems of Records, [NSF-50](#), "Principal Investigator/Proposal File and Associated Records," 69 Federal Register 26410 (May 12, 2004), and [NSF-51](#), "Reviewer/Proposal File and Associated Records," 69 Federal Register 26410 (May 12, 2004). Submission of the information is voluntary. Failure to provide full and complete information, however, may reduce the possibility of receiving an award.

An agency may not conduct or sponsor, and a person is not required to respond to, an information collection unless it displays a valid Office of Management and Budget (OMB) control number. The OMB control number for this collection is 3145-0058. Public reporting burden for this collection of information is estimated to average 120 hours per response, including the time for reviewing instructions. Send comments regarding the burden estimate and any other aspect of this collection of information, including suggestions for reducing this burden, to:

Suzanne H. Plimpton  
Reports Clearance Officer  
Office of the General Counsel  
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