

NSF Quantum Computing & Information Science Faculty Fellows (QCIS-FF)

PROGRAM SOLICITATION NSF 19-507



National Science Foundation

Directorate for Computer & Information Science & Engineering
Division of Computing and Communication Foundations
Office of Advanced Cyberinfrastructure

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

December 17, 2018

July 01, 2019

Submission Window Date(s) (due by 5 p.m. submitter's local time):

February 11, 2019 - February 25, 2019

September 17, 2019 - September 27, 2019

IMPORTANT INFORMATION AND REVISION NOTES

Any proposal submitted in response to this solicitation should be submitted in accordance with the revised *NSF Proposal & Award Policies & Procedures Guide* (PAPPG) (NSF 18-1), which is effective for proposals submitted, or due, on or after January 29, 2018.

SUMMARY OF PROGRAM REQUIREMENTS

General Information

Program Title:

NSF Quantum Computing & Information Science Faculty Fellows (QCIS-FF)

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). One of these ideas, "The Quantum Leap: Leading the Next Quantum Revolution," advances quantum technologies of the future: quantum computing, quantum communication, quantum simulations and quantum sensors. Recent advances in understanding and exploiting quantum mechanics are laying the foundation for generations of new discoveries that can benefit society in unforeseen ways. This "quantum revolution" requires a highly-trained workforce that can advance the envelope of what is possible, through research and development of practical solutions for quantum technologies. Academic faculty serve a vital role in the development of this workforce, by training the next generation of students while performing vital research.

The disciplines of computer science (CS), information science (IS), and computer engineering (CE) are at the nexus of the interdisciplinary breakthroughs needed to design advanced quantum computing, modeling, communication and sensing technologies. NSF recognizes that there is inadequate research capacity in the CS/CE disciplines in the realm of Quantum Computing & Information Science (QCIS).

The QCIS-Faculty Fellows (QCIS-FF) program therefore aims to grow academic research capacity in the computing and information science fields to support advances in quantum computing and/or communication over the long term. Specifically, QCIS-FF seeks to support departments and schools in U.S. institutions of higher education that conduct research and teaching in computer science, information science, and/or computer engineering, with the specific goal of encouraging hiring of tenure-track and tenured faculty in quantum computing and/or communication. Cross-disciplinary and multi-department hires are welcomed; however, intellectual ownership and primary assignment should be with the department primarily engaged in research and teaching activities for computer and information science and engineering. NSF funding will support the entire academic year salary and benefits of the newly recruited tenure-track or tenured faculty member for a duration of up to three years. Each proposal must request support for

only one faculty position. Total budget is not to exceed \$750,000 per proposal, with up to two awards per institution, across all departments in any given institution.

Proposals in response to this solicitation are to be submitted by the department chair/head or his/her designee. The grants will be awarded as continuing grants, subject to assessment each year, and the funding will be released in one-year increments only if the award conditions are met, as noted in this solicitation. NSF strongly encourages proposals from universities that do not have established quantum computing and/or communication activities, as well as hires that foster cross-departmental synergies.

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.

- Dmitri Maslov, Program Director, CISE/CCF, telephone: (703) 292-8910, email: dmaslov@nsf.gov
- Vipin Chaudhary, Program Director, CISE/OAC, telephone: (703) 292-2254, email: vipchaud@nsf.gov

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

- 47.070 --- Computer and Information Science and Engineering

Award Information

Anticipated Type of Award: Continuing Grant

Estimated Number of Awards:

Anticipated Funding Amount: \$6,750,000

Subject to the availability of funds

Eligibility Information

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:

Proposals are solicited from departments of computer science, information science, and/or computer engineering. PIs are restricted to the Department Chairs/Heads, or persons acting in such or similar capacities. A PI may submit no more than one proposal per deadline.

Limit on Number of Proposals per Organization: 2

Limit on Number of Proposals per PI or Co-PI: 1

Proposal Preparation and Submission Instructions

A. Proposal Preparation Instructions

- **Letters of Intent:** Not required
- **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.
 - 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).

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

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

December 17, 2018

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February 11, 2019 - February 25, 2019

September 17, 2019 - September 27, 2019

Proposal Review Information Criteria

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

Award Conditions:

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

Reporting Requirements:

Additional reporting requirements apply. Please see the full text of this solicitation for further information.

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I. INTRODUCTION

In 2016, 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 research (see https://www.nsf.gov/news/special_reports/big_ideas/index.jsp). One of these Big Ideas is "Quantum Leap (QL): Leading the Next Quantum Revolution." The QL Big Idea aims to exploit quantum mechanics to observe, manipulate, and control the behavior of particles and energy at atomic and subatomic scales, resulting in next-generation technologies for sensing, computing, modeling, and communicating. Recent advances in understanding and exploiting quantum mechanics are laying the foundation for generations of new discoveries that can benefit society in unforeseen ways. This "quantum revolution" requires a highly-trained workforce that can advance the envelope of what is possible, through research and development of practical solutions for quantum technologies. Academic faculty serve a vital role in the development of this workforce, by training the next generation of students while performing vital research.

A key thrust of the QL Big Idea is the development of a well-trained workforce capable of pursuing advanced research and development in quantum technologies. In particular, a recent focus on quantum information science, with an emphasis on quantum computation and communication, has prompted a renewed interest in the need for increased capacity in departments that support research and teaching of computer science (CS), information science (IS), and/or computer engineering (CE). NSF recognizes that there is inadequate research capacity in the CS/IS/CE disciplines in the realm of Quantum Computing & Information Science (QCIS).

This solicitation aims to strengthen QCIS efforts, grow the workforce with QCIS expertise, and more closely integrate QCIS faculty with quantum information science faculty in other departments as well as faculty in other disciplines. Doing so will accelerate advances in QCIS, including the transition of QCIS knowledge and technologies to practice.

II. PROGRAM DESCRIPTION

The QCIS-Faculty Fellows (QCIS-FF) program seeks to encourage departments and schools in U.S. universities that teach computer science, information science, and/or computer engineering curricula to hire new, full-time faculty in either tenure-track or tenured roles in quantum computing and/or communication. The intent of the program is to increase the research and teaching capacity in academic institutions in the QCIS domain. Therefore, CS/IS/CE departments that do not have an established set of faculty lines in QCIS are particularly encouraged to apply to this program.

Given the inherent multi-disciplinary nature of research in quantum information science, faculty hires are also expected to be able to transcend CS/IS/CE departmental boundaries to work with quantum researchers in other departments, e.g., physics and chemistry. NSF encourages proposals to demonstrate how the department fosters such cross-departmental activities. Cross-disciplinary and multi-department hires are welcomed; however, intellectual ownership and primary assignment of the hired faculty should be with the CS/IS/CE departments. Proposals should demonstrate how the new faculty positions are not going to stand alone, but rather will be well integrated into a multi-disciplinary plan to advance QCIS. The plan should encompass research as well as educational efforts in QCIS.

The QCIS-FF program is envisioned to accept proposals in 2018 and 2019, with application deadlines noted in this solicitation. Institutions that have not received prior funding from this program will be prioritized during subsequent years of the program.

The QCIS-FF program is intended to add to the existing academic workforce in quantum computing and communication. As such, the program will be able to support the hires of faculty who do not currently hold tenure-track or tenured academic positions, or support faculty hired from overseas, but will not support hiring of existing faculty from eligible U.S. institutions (e.g., lateral faculty movement).

NSF funding will support the entire academic year salary and benefits of a single tenure-track or tenured faculty member for a duration of up to three years. The total request per position cannot exceed \$750,000.

Proposals must specifically address the following aspects:

- a. The commitment of the department, school, and university to building, growing, and sustaining a long-term interdisciplinary effort in QCIS;
- b. The integration of the quantum faculty with the rest of the department;
- c. How the new hire enhances cross-departmental research collaborations such as those across physics, mathematics, material sciences, electrical engineering, and computer and information science; and
- d. How the new hire enables creation and support of educational programs in QCIS, including cross-disciplinary course offerings at both the undergraduate and graduate levels.

The department chair/head or his/her designee should serve as PI for the proposal. The total budget is not to exceed \$750,000 per proposal, with up to two proposals per institution per QCIS-FF deadline, and a limit of two awards per institution over the lifetime of this program.

The award will be made as a continuing grant, and the funding will be released in one-year increments, with a letter from the department chair annually affirming departmental support for the hired faculty along these aspects:

1. The hired faculty continuing his/her full-time tenure-track or tenured employment with the institution receiving the award;
2. The continued support of the institution as well as the satisfactory performance of the hired faculty in educational and research activities in QCIS and toward tenure;
3. Demonstration of interdisciplinary research collaborations that advance the state of QCIS research; and
4. A detailed statement of contributions to QCIS over the preceding year by the faculty supported by the award.

CISE is committed to enhancing the community's awareness of and overcoming barriers to Broadening Participation. This solicitation supports meaningful actions that address the longstanding underrepresentation of various populations including women, minorities (African-Americans/Blacks, Hispanic Americans, American Indians, Alaska Natives, Native Hawaiians, Native Pacific Islanders), and persons with disabilities, in computing fields. To this end, this solicitation encourages proposers to discuss their broadening participation plans for faculty recruitment in this domain.

A biennial PI meeting will be organized starting in 2020. Attendance is mandatory for all beneficiaries (defined as faculty supported by an award resulting from this solicitation) of this program.

III. AWARD INFORMATION

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

IV. ELIGIBILITY INFORMATION

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:

Proposals are solicited from departments of computer science, information science, and/or computer engineering. PIs are restricted to the Department Chairs/Heads, or persons acting in such or similar capacities. A PI may submit no more than one proposal per deadline.

Limit on Number of Proposals per Organization: 2

Limit on Number of Proposals per PI or Co-PI: 1

V. PROPOSAL PREPARATION AND SUBMISSION INSTRUCTIONS

A. Proposal Preparation Instructions

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

Submitters will receive feedback from program staff indicating either encourage or discourage. An encourage finding generally indicates that the proposal appears to be responsive to the program guidelines and is a candidate for further development relative to the solicitation. A discourage finding generally indicates that the project is typically not responsive to the program, is more suited to another NSF opportunity, or has serious conceptual flaws that would not benefit from further development as a full submission. The feedback provided pursuant to the preliminary proposal is advisory only; submitters of both "encouraged" and "discouraged" preliminary proposals are eligible to submit full proposals.

Submission of a Preliminary Proposal is required to be eligible to submit a Full Proposal. Preliminary proposals must be submitted, via FastLane, by 5 p.m. submitter's local time on the due date for preliminary proposals.

Preliminary proposals are started in the same way as new full proposals. Proposers must be sure to check the box "If this is a preliminary proposal then check here" in the middle of the Cover Sheet. This box appears on the Cover Sheet just under the section labeled "Previous NSF Award." Check the box to indicate that you are submitting a preliminary proposal and then submit the three pieces (Cover Sheet, Project Description, and one Biographical Sketch) as detailed below.

No collaborative preliminary proposals are allowed.

Required components of the preliminary proposal are given below. Page limitations given here will be strictly enforced. Proposers should review the most current NSF *Proposal & Award Policies & Procedure Guide (PAPPG)* for specific information on format for the required sections.

The preliminary proposal should consist of three elements: Cover Sheet, Project Description, and Biographical Sketch. No other

sections are required or may be included in the preliminary proposal.

Cover Sheet. The PI and all co-PIs should be indicated. The budget indicated on the Cover Sheet should be the overall project budget total. The Project Title on the Cover Sheet should begin with "QCIS-FF Preliminary" followed by a colon, then the title of the project. For example, **QCIS-FF Preliminary: Title**.

Project Description (2-page limit). The following information is required at the beginning of the Project Description: Project Title and Project Personnel (a list of the PI and co-PIs, and their departmental affiliations).

This section should also contain a concise description of all aspects that a full proposal must address, and in sufficient detail to permit assessment of the ideas, the intent, the value, and the integration.

Biographical Sketch (2-page limit). A Biographical Sketch of the PI is required.

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. 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. 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). 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.

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.

Cover Sheet: Enter the preliminary proposal number associated with this full proposal in the box "Show Related Preliminary Proposal No. If Applicable."

Proposal Titles: Proposal Titles must indicate the QCIS-FF program followed by a colon, then the title of the project. For example, **QCIS-FF: Title**.

Collaborative proposals are not allowed in response to this solicitation. Subawards may not be requested as part of budgets in proposals submitted to this solicitation.

Project Summary: 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.

Please provide between 2 and 6 keywords at the end of the overview in the Project Summary. CISE personnel will use this information in implementing the merit review process. The keywords should describe the main scientific/engineering areas explored in the proposal. Keywords should be prefaced with "Keywords" followed by a colon, and keywords should be separated by semi-colons. Keywords should be of the type used to describe research in a journal submission. They should be included at the end of the overview in the project summary and might appear, for example, as **Keywords: quantum computation, hardware design, quantum repeaters**.

Project Description: Describe the research and education activities to be undertaken in **up to 15 pages**. Describe curriculum development activities, in a separate section (included in these page limits) titled "Curriculum Development Activities." All proposals should seek to transcend the barriers that separate CS/IS/CE disciplines from other scientific disciplines that pursue the study of quantum information science, and describe these efforts in a separate, clearly-identifiable section in the Project Description. A clear description of the hiring process and the strategy to provide adequate interdisciplinary support and mentoring to the newly hired faculty should be presented. Section II of this solicitation provides other information that needs to be addressed in the Project Description.

Supplementary Documents: In the Supplementary Documents section, upload the following information where relevant:

(1) List of Project Personnel and Partner Institutions

Provide current, accurate information for all personnel and institutions involved in the project. NSF staff will use this information in the merit review process to manage reviewer selection. The list must include all PIs and co-PIs. This list should be numbered and include (in this order) Full name, Organization(s), and Role in the project, with each item separated by a semi-colon. Each person listed should start a new numbered line. For example:

1. Mary Smith; XYZ University; PI
2. John Jones; University of PQR; co-PI

(2) Data Management Plan (required)

Proposals must include a Supplementary Document of no more than two pages labeled "Data Management Plan." This Supplementary Document should describe how the proposal will conform to NSF policy on the dissemination and sharing of research results.

See Chapter II.C.2.j of the PAPPG for full policy implementation.

For additional information on the Dissemination and Sharing of Research Results, see: <https://www.nsf.gov/bfa/dias/policy/dmp.jsp>.

For specific guidance for Data Management Plans submitted to the Directorate for Computer and Information Science and Engineering (CISE), see: https://www.nsf.gov/cise/cise_dmp.jsp.

(3) Documentation of Collaborative Arrangements of Significance to the Proposal through Letters of Collaboration

Quantum information science is inherently interdisciplinary, and collaborations can be a useful vehicle to promote interdisciplinary interactions. There are two types of collaborations, one involving individuals/organizations that are included in the budget, and the other involving individuals/organizations that are not included in the budget. Collaborations that are included in the budget should be described in the Project Description. Any substantial collaboration with individuals/organizations not included in the budget should be described in the Facilities, Equipment and Other Resources section of the proposal (see PAPPG Chapter II.C.2.i). In either case, whether the collaborator is included in the budget, a Letter of Collaboration from each named participating organization other than the submitting institution should be provided at the time of submission of the proposal. Such letters should explicitly state the nature of the collaboration, appear on the organization's letterhead and be signed by the appropriate organizational representative. These letters must not otherwise deviate from the restrictions and requirements set forth in the PAPPG Chapter II.C.2.j.

Please note that letters of support may not be submitted. Such letters do not document collaborative arrangements of significance to the project, but primarily convey a sense of enthusiasm for the project and/or highlight the qualifications of the PI or co-PI. Reviewers will be instructed not to consider these letters of support in reviewing the merits of the proposal.

(4) Other Specialized Information

Research in Undergraduate Institutions (RUI) Proposals: PIs from predominantly undergraduate institutions should include a RUI Impact Statement and Certification of RUI Eligibility in this section.

No other Supplementary Documents, except as permitted by the NSF PAPPG, are allowed.

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

Cost Sharing:

Inclusion of voluntary committed cost sharing is prohibited.

C. Due Dates

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

December 17, 2018

July 01, 2019

- **Submission Window Date(s)** (due by 5 p.m. submitter's local time):

February 11, 2019 - February 25, 2019

September 17, 2019 - September 27, 2019

The proposals are due by 5 p.m. submitter's local time. Preliminary proposals are required.

D. FastLane/Grants.gov Requirements

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. 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. 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

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/.

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

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

Additional review criteria specific to this solicitation are:

- a. The commitment of the department, school, and university to building, growing, and sustaining a long-term interdisciplinary effort in quantum computing and information science;
- b. Integration of the quantum faculty with the rest of the department;
- c. How the new hire enhances cross-departmental research collaborations such as those across physics, mathematics, material sciences, electrical engineering, and computer and information science; and
- d. How the new hire enables creation and support of educational programs in QCIS, including cross-disciplinary course offerings at both undergraduate and graduate levels.

Yearly Assessment criteria: Awards will be issued as continuing grants, with annual increments tied to yearly assessments. Approval of the yearly increments will be conditional upon:

- a. The hired faculty continuing his/her full-time tenure-track or tenured employment with the institution receiving the award;
- b. The continued support of the institution as well as the satisfactory performance of the hired faculty in educational and research activities in QCIS and toward tenure;
- c. Demonstration of interdisciplinary research collaborations, by both the department as well as by the faculty supported through the award, that advance the state of QCIS research; and
- d. A detailed statement of contributions to QCIS over the preceding year by the faculty supported by the award. These contributions and their relevance to QCIS will be evaluated internally by NSF.

B. Review and Selection Process

Proposals submitted in response to this program solicitation will be reviewed by Ad hoc Review and/or Panel Review, or Internal NSF Review.

Preliminary and full proposals will be reviewed in accordance with the standard NSF criteria described above, including Intellectual Merit and Broader Impacts.

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

A. Notification of the Award

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

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. Paper copies may be obtained from the NSF Publications Clearinghouse, telephone (703) 292-7827 or by e-mail from 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.

Special Award Conditions:

The PI of the award should be the department head or her/his designee. If the department head role changes to a different person, then that person shall name themselves or confirm a designee to act as the PI of the award.

Any faculty hired as part of the award activity must be added as a co-PI on the award within a month of joining the institution.

C. Reporting Requirements

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=pappg.

Annual reports should make it clear how the yearly assessment criteria are met (See Section VI. "Additional Solicitation Specific Review Criteria").

VIII. AGENCY CONTACTS

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:

- Dmitri Maslov, Program Director, CISE/CCF, telephone: (703) 292-8910, email: dmaslov@nsf.gov
- Vipin Chaudhary, Program Director, CISE/OAC, telephone: (703) 292-2254, email: vipchaud@nsf.gov

For questions related to the use of FastLane, contact:

- FastLane Help Desk, telephone: 1-800-673-6188; e-mail: 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.

IX. OTHER INFORMATION

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

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,
Alexandria, VA 22314
- **For General Information**
(NSF Information Center): (703) 292-5111
- **TDD (for the hearing-impaired):** (703) 292-5090
- **To Order Publications or Forms:**
Send an e-mail to: 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
National Science Foundation
Alexandria, VA 22314

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