NSF National Quantum Virtual Laboratory (NQVL)

Quantum Science and Technology Demonstrations (QSTD): I. Pilot Phase

PROGRAM SOLICITATION

NSF 23-604

National Science Foundation
Directorate for Biological Sciences
Directorate for Computer and Information Science and Engineering
Directorate for STEM Education
Directorate for Engineering
Directorate for Mathematical and Physical Sciences
Directorate for Technology, Innovation and Partnerships

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

October 06, 2023

April 09, 2024

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

November 30, 2023

June 11, 2024

IMPORTANT INFORMATION AND REVISION NOTES

Any proposal submitted in response to this solicitation should be submitted in accordance with the *NSF Proposal & Award Policies & Procedures Guide* (PAPPG) that is in effect for the relevant due date to which the proposal is being submitted. The NSF PAPPG is regularly revised and it is the responsibility of the proposer to ensure that the proposal meets the requirements specified in this solicitation and the applicable version of the PAPPG. Submitting a proposal prior to a specified deadline does not negate this requirement.

SUMMARY OF PROGRAM REQUIREMENTS

General Information

Program Title:

NSF National Quantum Virtual Laboratory (NQVL)
Quantum Science and Technology Demonstrations (QSTD): I. Pilot Phase

Synopsis of Program:

The National Quantum Initiative (NQI) Act[1] aims to ensure the continuing leadership of the United States (U.S.) in quantum information science and technology. In conformance with the NQI goals, an argument[2 3 4 5] was set forth for a renewed emphasis on identifying and fostering early adoption of quantum technologies to transform the field of Quantum Information Science and Engineering (QISE) and to accelerate broader impacts on society. A systematic approach to maturing quantum technology platforms by integrating end-users and potential customers from other fields of science and engineering and other sectors of the economy into cycles of research, development, and demonstration should result in lowering the barriers for end-users to pioneer new applications. NSF support for use-inspired and translational research in QISE, combined with its existing strength in support of the underlying foundational research, is anticipated to accelerate development of a market for quantum technologies.

With this program solicitation, the Foundation is introducing the National Quantum Virtual Laboratory (NQVL) concept as an overarching shared infrastructure designed to facilitate the translation from basic science and engineering to the resultant technology, while at the same time emphasizing and advancing its scientific and technical value. The NQVL aims to develop and utilize use-inspired and application-oriented quantum technologies. In the process, NQVL researchers will explore quantum [6]

frontiers , foster QISE workforce education and training, engage in outreach activities at all levels, and promote broadening participation, diversity, equity, and inclusion in QISE, thereby lowering barriers at all entry points of the research enterprise. The engagement of the entire United States (U.S.) QISE community will be necessary for this initiative to succeed, and, indeed, the project is designed to include participation from a full spectrum of organizations who have expertise to contribute. In particular, NSF recognizes that the involvement of industry partners is essential and will welcome these to be a part of the overall structure. Partnerships with other U.S. Federal agencies under the NQI umbrella are also encouraged.

This solicitation lays out a vision for the entire NQVL program that includes Quantum Science and Technology Demonstration (QSTD) projects, support for enabling technologies through Transformative Advances in Quantum Systems (TAQS), as well as a central coordination hub. Proposals for Pilot phase QSTDs are solicited at this time.

It is required that prospective PIs contact the NQVL Program Officer(s) as soon as possible, but not later than two weeks before submitting a proposal in response to this solicitation, to ascertain that the focus and budget of their proposal is appropriate for this solicitation.

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[1] H.R.6227 - National Quantum Initiative Act, https://www.congress.gov/bill/115th-congress/house-bill/6227

[2] Accelerating Progress Towards Practical Quantum Advantage, A National Science Foundation Project Scoping Workshop (2022), https://arxiv.org/abs/2210.14757

[3] Quantum Computer Systems for Scientific Discovery, PRX Quantum 2, 017001 (2021) https://doi.org/10.1103/PRXQuantum.2.017001

[4] Development of Quantum InterConnects for Next-Generation Information Technologies, PRX Quantum 2, 017002 (2021) https://doi.org/10.1103/PRXQuantum.2.017002

[5] Quantum Simulators: Architectures and Opportunities, PRX Quantum 2, 017003 (2021) https://doi.org/10.1103/PRXQuantum.2.017003

[6] Quantum Frontiers: Report on Community Input to the Nation's Strategy for Quantum Information Science, https://www.quantum.gov/wp-content/uploads/2020/10/QuantumFrontiers.pdf

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.

- National Quantum Virtual Laboratory, telephone: (703) 292-8235, email: NQVL@nsf.gov
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Applicable Catalog of Federal Domestic Assistance (CFDA) Number(s):

- 47.041 --- Engineering
- 47.049 --- Mathematical and Physical Sciences
- 47.070 --- Computer and Information Science and Engineering
- 47.074 --- Biological Sciences
- 47.076 --- STEM Education
- 47.084 --- NSF Technology, Innovation and Partnerships

Award Information

Anticipated Type of Award: Standard Grant

Estimated Number of Awards: 10

An estimated up to 5 Quantum Science and Technology Demonstration (QSTD) Pilot awards will be granted in each of the two competition rounds. The number of awards will depend on the availability of funds and the quality of the proposals.

Anticipated Funding Amount: $10,000,000

This solicitation pertains only to the Pilot phase of the NQVL program. QSTD Pilot awards may be funded at a level up to $1,000,000 for 12 months.

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.
- Non-profit, non-academic organizations: Independent museums, observatories, research laboratories, professional societies and similar organizations located in the U.S. that are directly associated with educational or research activities.

Who May Serve as PI:

The PI must be a faculty member at the Lead Organization or permanent staff person from a non-profit, non-academic organization with authority to act on behalf of the organization. Co-PIs listed on the Cover Sheet may be from organizations other than the Lead Organization.

Limit on Number of Proposals per Organization: 1

Up to **one** (1) QSTD Pilot proposal may be submitted per Lead Organization.

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

An individual may serve as PI or co-PI on no more than **one** (1) QSTD Pilot proposal.

Proposal Preparation and Submission Instructions

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 Proposal Submission:** Not required
- **Full Proposals:**
  - Full Proposals submitted via Research.gov: *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

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

October 06, 2023

April 09, 2024

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

  November 30, 2023

  June 11, 2024

Proposal Review Information Criteria

Merit Review Criteria:

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

Award Administration Information

Award Conditions:

Standard NSF award conditions apply.

Reporting Requirements:

Standard NSF reporting requirements apply.

TABLE OF CONTENTS

I. INTRODUCTION

The translation from basic knowledge to new, scalable technologies that can provide solutions to real-world problems is a multi-step process that requires prototyping, validation, at-scale testing, and eventual full-scale demonstration. As an approach to achieving this goal for quantum-related technologies, NSF is introducing with this solicitation the National Quantum Virtual Laboratory (NQVL) concept. The overarching goal of the NQVL is the demonstration of practical quantum advantage, the actual application of the tools of Quantum Information Science and Engineering (QISE) to problems that will enable solutions that classical approaches can only solve much less efficiently or not at all.

The NQVL vision is to support a highly accessible shared research infrastructure framework that draws on the full spectrum of expertise throughout the Nation to rapidly translate QISE ideas formulated in the laboratory through prototyping, validation, at-scale testing, and eventual full-scale deployment. A co-design approach will facilitate the quick transfer of discoveries from one phase to the next, enable the rapid identification of gaps, and draw on the talent necessary to close these gaps. A key focus of the program will be to develop education and workforce development strategies that promote broad participation, diversity, equity, and inclusion in QISE by expanding access to state-of-the-art

resources and prototypes to all parts of the U.S. research ecosystem. While the completed NQVL will consist of a set of primary nodes defined by the major Quantum Science and Technology Demonstration projects defined below, the overall structure is designed to serve as a resource for the community at large, with movement into and out facilitated through a central coordination body.

The successful translation of QISE research under the NQVL will require the integration of several layers, from fundamental principles to prototypes to applications, utilizing a convergent, systems engineering, and co-design approach. The co-design of enabling technologies (e.g., reliable materials fabrication, scalable device manufacturing, dependable quantum interconnects, or robust software stack) and sufficiently mature physical platforms will result in Quantum Science and Technology Demonstrations (QSTD) for scientific discovery that will be made available for use by the broad scientific community. Users will identify applications that can be co-designed with a rapid cycle of system upgrades, resulting in the transition of ideas that are still in the early conceptual stages into prototypes that are in level of readiness that they can be handed off to the private sector.

The NQVL is envisioned as having three components, though only the Pilot phase of the first component below is the focus of this initial solicitation:

- NQVL:QSTD – Quantum Science and Technology Demonstration projects. These projects will make up the scientific and engineering core of the activities that combine to form a federated NQVL infrastructure and are expected to pass through three phases: Pilot, Design, and Implementation. Given the project nature of the NQVL:QSTD activity it is expected that the participants will proceed through all three project development phases.

  Each NQVL:QSTD project is expected to define a quantum advantage goal and a projected pathway for achieving that goal. It is expected that this pathway will have a focus on the design and integration of quantum systems co-designed with applications developed by a broad and diverse user community. Through this process of systems design and prototyping, the project will connect the underlying basic scientific knowledge to an application that is identified by this end-user community and fostered by direct interactions between these users, the systems engineers, and the basic science developers. Those activities will be complemented by appropriately scaled education and workforce development plans for training a diverse quantum workforce.

- NQVL:TAQS – NSF aims to provide resources to support research and development of enabling technologies identified by the NQVL:QSTD projects as they mature through the various phases. NSF envisions doing this through the mechanism of the Transformative Advances in Quantum Systems (TAQS) program as an independent funding opportunity that will address critical needs of the NQVL infrastructure as well as contribute to expanding the access to the Laboratory to a wider community.

- NQVL:Central – NQVL Planning and Coordination. NSF anticipates support for one NQVL Central Hub that will perform three distinct functions: i) promote collaboration and networking between the NQVL project teams; ii) promote engagement with the broad QISE community, partnerships with others and outreach activities to the general public; and iii) facilitate community oversight and the development of success metrics and benchmarks. The first function will enable the identification and potential exchange of component parts among the teams, especially in the Implementation phase. The other two functions recognize the need for greater accountability to the wider QISE community and to the public.

  As such, NQVL:Central will be called upon to serve as the intellectual hub for the growing QISE academic community. The NQVL Central Hub will also facilitate connections between the units of the NQVL and the activities of other agencies as well as establish mechanisms for industrial participation in the QSTD goals. The NQVL Central Hub will connect with the Quantum Economic Development Consortium (QED-C) and professional societies whose membership includes existing and potential practitioners in QISE. The NQVL Central Hub will host workshops and scientific programs that foster connections and dissemination throughout the QISE community. Lastly, the NQVL Central Hub will be asked to develop and maintain a Strategic Plan for NQVL investments, a living community document designed to keep abreast with evolving trends in the field, progress toward community goals, management and coordination, and implementation of new directions.

The development of the NQVL is expected to take place over a number of years. **The present solicitation concerns only the Pilot phase of the QSTD project components of the NQVL.** Separate solicitations will be issued for the future phases and the other components of NQVL, depending on the progress in this first phase. Nonetheless, even at the Pilot phase, it is critical to keep in mind the full project development as described below while formulating plans, especially as many of the general requirements will apply to each phase. Support for the QSTD-enabling technology development part of the NQVL program will be on an as-needed basis as the subject of future NSF funding opportunities.

The NQVL program is intended as a national, community-driven effort that supports the smooth integration and translation from fundamental science and engineering to use-inspired applications. Building on the continued and sustained support of fundamental research from existing NSF programs, the NQVL will draw together expertise and talent from a broad range of disciplines to enable the creation and application of functional quantum devices and systems. Coordination will be provided through a federated infrastructure that serves much like a laboratory, but without the physical colocation of all assets and infrastructure, to identify roles and resource needs and establish mechanisms to enable all members of this virtual laboratory to communicate and function together as one coordinated unit. The federated NQVL structure, which will be developed and led by the community, should enable anyone to become engaged and contribute to advances in QISE.

II. PROGRAM DESCRIPTION

Note: The full NQVL program will be implemented in multiple iterations, each with its own solicitation. **The present solicitation applies only to the Pilot phase of the Quantum Science and Technology Demonstration (QSTD) component.** The full scope across all three phases of this component is outlined here to help prospective proposers decide on the scale and scope of their proposals to this solicitation within the context of anticipated future goals for the entire program.

The Quantum Science and Technology Demonstration (QSTD) projects form the scientific and technological core efforts the NQVL is designed to enable. Each QSTD project will have identified a technology goal that has the potential for demonstrating quantum advantage that could lead to translation in the near term. Each project will also have identified a potential pathway for achieving this goal, including the basic science from which the pathway derives, the participants and skill-sets critical for the success of the project, and the user community that will derive the benefit. The phase-wise development that is planned for each project recognizes that this is a fluid process. Plans proposed at the beginning will have to be modified as detailed design and then implementation proceeds. Challenges are to be expected and must be addressed in the time allowed. Additional members with special expertise may need to be included to address these gaps. Feedback from potential users may suggest modifications necessary to deliver a useful end product. And systems engineering steps along the way may dictate changes and/or suggest improvements that speed up the process. The NQVL infrastructure provides the framework through which these changes can be implemented smoothly and quickly. In addition, the NQVL infrastructure will foster essential collaboration, coordination, and cooperation between the various QSTD projects, which might have a different technology focus. This will help identify gaps that apply to more than just a single project, thus magnifying the impact of developments along the way. Activities in areas of common interest or capabilities that benefit more than one QSTD project may be supported separately to maximize synergies and optimize resource allocations. It is also possible that these supporting developments could in turn lead to their own applications independently of the quantum advantage goal. Support for the acquisition or development and implementation of research infrastructure may also be included. The QSTD projects will also develop effective strategies for education and workforce development.

The QSTD projects fall into the category of long-duration NSF investments that require substantial funding over multiple award cycles. They are expected to be developed in three phases: Pilot, Design, and Implementation. Each phase will be the subject of a separate solicitation and will evolve into the next as the projects are refined and increasingly focused on prototype development and future translation.

1. The **Pilot phase** is focused on the development of the conceptual design of the QSTD project. Specifically, the team will:

- Refine the science questions;
- Define requirements and prioritize research objectives;
- Identify enabling technologies and risks;
- Identify critical partnerships and dependencies;
- Develop top-down cost and contingency estimates;
- Formulate initial risk assessment;
- Draft initial Project Execution Plan; and
- Draft initial Workforce Development Plan.

In the Pilot phase, each QSTD team will convene a QISE community town hall meeting seeking community input, foster an open scientific dialogue, collect baseline data to aid in the development of a diverse workforce development plan, and ensure the broad participation of the entire QISE community. The outcome of this activity, in addition to addressing the specific requirements, will be a QISE Strategic Plan for addressing the topic of the QSTD Pilot. The QISE Strategic Plans are living documents that will be updated as needed. It is expected that the plans to accomplish the proposed scope of work, the methods involved, and the Pilot team may evolve over the course of the various phases. The Pilot phase will be 12 months duration at a funding level of up to $1,000,000 per project.

NSF strongly suggests that the Pilot teams secure the services of a professional Project Manager.

2. The **Design phase** is focused on the preliminary design development of the QSTD project.

A successful Design proposal will incorporate the QSTD preliminary project design, demonstrate technical readiness, and include planning for the total anticipated QSTD project lifetime. Design proposals must also include an appropriately scaled Project Execution Plan (PEP) describing how the project will be managed, the scope of work in a Work Breakdown Structure (WBS) format along with a WBS dictionary, the budget estimate and basis of estimate for each WBS element, and the risk or uncertainty in the budget estimate accompanied by the methodology for risk and budget contingency estimation. A resource-loaded schedule may also be required to support the proposed QSTD system integration funding profile. Projection of implementation costs should be revisited in an updated plan for the implementation component of the QSTD project. The Design phase may take up to two years at a cost of $2,000,000 per year.

Specifically, the team will:

- Develop enabling technology;
- Update risk analysis, develop risk mitigation strategies;
- Develop bottom-up cost and contingency estimates;

- Develop preliminary operations cost;
- Develop Project Management Control System;
- Develop preliminary Project Execution Plan;
- Develop preliminary Workforce Development Plan; and
- Identify key staff.

NSF requires that each Design team includes a professional Project Manager as part of the project leadership.

3. The **Implementation phase** includes the final design of the first-generation QSTD system, followed by the system integration and subsequent operations of this initial prototype, while at the same time pursuing the development of the enabling technology for the next-generation QSTD system.

The Implementation phase includes two components: first-generation design completion, assembly, and operations (Gen-1) and next-generation technology development (Gen-n). The Gen-1 component will proceed in two stages, locking in the final design (Final Design stage), followed by developing the first prototype and assembling and enabling the first users, or operations (Operations stage). It is expected that the subsequent Gen-n phase will proceed simultaneously with the Operations stage as the developers build off the experience gained with actual use, as envisioned in the co-design approach.

For the *Final Design stage*, the QSTD proposal demonstrates that the enabling research and technology development for the first-generation QSTD system integration project is completed, and that bid packages for major contracts or acquisitions have been completed. The QSTD system integration budget estimate for the first-generation QSTD is refined so that it is based substantially on externally provided information rather than internal engineering estimates (vendor quotes, budgetary estimates, etc.) Key staff members needed to manage project activities are recruited and ready to commence system integration. Commitments from external partners in the activity are confirmed. The largest and most complex projects are encouraged to use appropriately scaled Earned Value Management reporting during system integration and should prepare an Earned Value Management System during this phase in readiness for system integration.

During the Final Design stage, with a duration of two (2) years, the team will:

- Harden key technologies;
- Refine bottom-up cost and contingency estimates;
- Finalize risk assessment and mitigation plan;
- Finalize Project Management plan;
- Develop Project Execution Plan (PEP);
- Finalize Workforce Development Plan (WDP); and
- Complete recruitment of key staff.

During the Final Design stage, the team may have Monthly Oversight meetings with NSF Program staff. The team may be required to submit Intermediate Reports monthly via Research.gov.

NSF will conduct a site visit panel review of each Implementation project eighteen (18) months into the award period. The purpose of the review would be to assess the progress made by the team, provide feedback, and evaluate the readiness of the team to advance to the Operations stage of the QSTD Implementation phase.

During the *Operations stage*, the team activities will focus on:

- System integration, testing, commissioning of the QSTD;
- Operations and user support once a QSTD system is accepted by NSF; and
- Development of the technology needed for and design for the next-generation QSTD.

During all activities in the Implementation phase, the team may have Monthly Oversight meetings with NSF Program staff. The team will be required to submit Intermediate Reports quarterly via Research.gov.

NSF may conduct annual site visit panel reviews of each QSTD:Implementation project in the Operations stage. The purpose of the review would be to assess the progress made by the team and provide feedback.

QSTD awards for projects in the Implementation phase will be in the form of cooperative agreements that contain terms and conditions specific to the nature and risks associated with the project.

Each phase of the QSTD projects will follow on the previous phase and constitutes the next step in the refinement of the project. At each phase proposals will be invited only from those teams, or combinations thereof, who have participated in the previous phase. The Implementation phase can be expected to last for five years, with a possibility of one renewal, at a cost between $7,000,000 and $10,000,000 per year.

The following language applies to the technical review of all phases of all QSTD projects:

Scientific Review

Proposals are considered first based on their science goals and their potential of translation from laboratory to practice. Given the significant resources required to execute an QSTD project and the fact that a QSTD project will extend for more than a single award cycle, the scientific goals and the specific outcomes must be compelling and clearly articulated in the proposal. NSF proposal review panels will conduct a comparative review of all proposals submitted to the NQVL program in a given fiscal year. The review panels may be asked to consider the programmatic balance of investments across the full NQVL program.

Technical and Project Management Review

The feasibility of the proposed activities will be reviewed thoroughly. Given the scale and complexity of most large NSF investments a separate panel may assess the implementation plans outlined in the proposal. As QSTD proposals will likely include acquisition, technology development or fabrication activities, the proposal review may consider technical readiness, risk mitigation, project management plans, budgets, and schedules. For long-duration projects with a lifetime possibly exceeding a single award period, contingent on selection in a subsequent development phase, the technical review may also consider performance schedules and the planning for the total anticipated number of system integration and development cycles in the QSTD project, including possible operations. For renewal proposals, the record of success in achieving any previous set of milestones will be taken into consideration. As needed, these reviews may involve site visits. In all cases, the technical review panel will be asked to consider and provide guidance to the Program on the appropriate duration of the award and milestones needed to evaluate progress.

Workforce Development Plan Review

The NQVL program seeks to identify and promote effective education and workforce development strategies that promote broad participation, diversity, equity, and inclusion in QISE thereby lowering barriers at all entry points of the research enterprise. All three phases of the QSTD project development process, i.e. the Conceptual, Preliminary, and the Final Designs of the QSTD project, are required to include appropriately scaled education and workforce development plans for training a diverse workforce in QISE. Examples of activities part of the Workforce Development Plan (WDP) may include, but are not limited to: i) QISE-centric curricula (K through Graduate level); ii) opportunities for students to interact with industry partners, for example through collaboration on research projects, internships, fellowships or entrepreneurial activities; iii) effective and evidence based educational approaches leading to development of skilled and diverse QISE workforce through formal and informal education; or iv) up-skilling and re-skilling working professionals. A dedicated WDP review will be conducted at each stage of the QSTD project development process. The WDP implementation will be reviewed annually once the QSTD:Implementation project reaches the Operations stage. The Workforce Development Plan is intended as a living document that will be updated as needed.

Award Oversight

QSTD awards beyond the Pilot phase will be made through cooperative agreements that contain terms and conditions specific to the nature and risks associated with the project. These may involve site visits or mid-term reviews, and NSF approval of changes in management or schedule. Oversight will include monitoring progress towards any milestones established during the technical review. The duration of support will be determined based on the scientific goals of the project with input from the technical review and will consider the financial burden on the NQVL program. Proposals for continued support may involve both scientific and technical review, as appropriate at the time of the proposal submission. Appropriate close-out should be planned. For the largest investments a close-out phase may be described in the cooperative agreement.

General Review Criteria

All QSTD proposals will be evaluated using the NSF merit review criteria concerning intellectual merit and broader impacts, as well as an assessment as to how well the proposed QSTD project will address the stated science goals and QSTD impacts. Consideration of all QSTD begins by evaluating and prioritizing the science goals within the NQVL, and by determining the feasibility of the implementation plan. For each of the relevant phases – Pilot, Design, and Implementation – the associated deliverables from the previous phase will be reviewed before advancing on to the next phase. At each phase of development, the NSF may choose to provide support through the next phase or end its involvement. At successive development phases, the reviews will be increasingly more detailed and will involve an increasing level of commitment from the NSF. Project planning must take into account the total project lifetime. The NSF investment in any one QSTD project is of finite duration.

NSF has as one of its over-arching principles the fostering of a diverse and inclusive membership within the scientific community. All QSTD proposals submitted through any of the solicitations issued as part of the NQVL program will be required to identify steps that will be taken to promote this goal and can expect to be reviewed as to how well this is being addressed.

Review of the QSTD proposal and subsequent oversight of QSTP awards will scale with the size and complexity of the proposed project as described in the NSF 21-107, 2021 Research Infrastructure Guide (RIG), or subsequent revisions in effect at time of proposal submission found at: https://www.nsf.gov/bfa/lfo/lfo_documents.jsp. Prospective PIs are strongly encouraged to familiarize with Chapter 5 of the Research Infrastructure Guide (RIG) for guidance on planning and oversight requirements relevant to QSTD projects. The guidelines listed here follow standard practices for activities of this scope.

The three development phases of a QSTD project will be conducted in the following sequence:

1. **Pilot phase:** NSF will support two cohorts of up to a total number of ten (10) Pilot projects with a duration of twelve months, at the level of up

to $1,000,000 per project. The number of awards will depend on the availability of funds and the quality of the proposals.

Nine (9) months into the project, NSF will conduct a panel review of each Pilot project. The purpose of the review would be to assess the progress made by the team, provide feedback, and evaluate the readiness of the team to advance to the Design phase of the QSTD development process. As the QSTD Pilot teams are expected to collaborate, coordinate, and cooperate with each other, synergies are strongly encouraged. Following upon an agreed-upon understanding and the selection of a Lead Organization, QSTD Pilot teams may also choose to consolidate prior to submitting a QSTD Design proposal to advance to the Design phase.

2. **Design phase:** NSF aims to support up to eight (8) Design projects with a duration of up to two (2) years, at the level of up to $2,000,000 per year. The number of awards will depend on the availability of funds and the quality of the proposals.

Nine (9) months into the project, NSF will conduct a site visit panel review of each Design project. The purpose of the review would be to assess the progress made by the team, provide feedback, and evaluate the readiness of the team to advance to the Implementation phase of the QSTD development process. The site visit would focus on the technical and project management review of the Design project.

The Design project is eligible for a second year of NSF support. Therefore, a second site visit panel review may be conducted twelve (12) months later.

As was the case for the Pilot phase, following upon an agreed-upon understanding, the selection of a Lead Organization, and approval by the NSF, QSTD Design teams may also choose to consolidate prior to submitting a QSTD Implementation proposal to advance to the Implementation phase.

3. **Implementation phase:** NSF aims to support up to six (6) Implementation projects with a duration of five (5) years. The level of NSF support for QSTD Implementation projects will scale with the complexity of the QSTD project but is expected to range between $7,000,000 to $10,000,000 per project per year. The number of awards will depend on the availability of funds and the quality of the proposals. The QSTD Implementation projects are eligible for a one-time five-year renewal.

NSF requires that the leadership of each Implementation team separates roles and responsibilities with respect to the scientific and project management components of the QSTD project. The Project Manager will be solely in charge with delivering each QSTD generation on time and on budget.

Each QSTD Implementation team will maintain the QISE Strategic Plans on the specific topic of the QSTD project. QISE community town hall meetings may be convened at annual intervals. Specific details may be project dependent and will be captured in the QSTD Community Outreach plan with the overarching goal of fostering an open scientific dialogue and ensuring the broad participation of the entire QISE community.

As indicated above, the QSTD Implementation teams are expected to collaborate, coordinate, and cooperate with each other. Synergies are strongly encouraged.

Based on the quality of the submissions, availability of funding and number of awards made, NSF anticipates releasing the funding opportunity announcements for the subsequent QSTD development phases in upcoming fiscal years.

III. AWARD INFORMATION

Anticipated Type of Award: Standard Grant

Estimated Number of Awards: 10

An estimated up to 5 Quantum Science and Technology Demonstration (QSTD) Pilot awards will be granted in each of the two competition rounds. The number of awards will depend on the availability of funds and the quality of the proposals.

Anticipated Funding Amount: $10,000,000

This solicitation pertains only to the Pilot phase of the NQVL program. QSTD Pilot awards may be funded at a level up to $1,000,000 for 12 months.

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.

- Non-profit, non-academic organizations: Independent museums, observatories, research laboratories, professional societies and similar organizations located in the U.S. that are directly associated with educational or research activities.

Who May Serve as PI:

The PI must be a faculty member at the Lead Organization or permanent staff person from a non-profit, non-academic organization with authority to act on behalf of the organization. Co-PIs listed on the Cover Sheet may be from organizations other than the Lead Organization.

Limit on Number of Proposals per Organization: 1

Up to **one** (1) QSTD Pilot proposal may be submitted per Lead Organization.

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

An individual may serve as PI or co-PI on no more than **one** (1) QSTD Pilot proposal.

Additional Eligibility Info:

Organization Limit: Although an NQVL:QSTD project is expected to be multi-organizational, a single organization must serve as the lead and all other organizations as subawardees.

V. PROPOSAL PREPARATION AND SUBMISSION INSTRUCTIONS

A. Proposal Preparation Instructions

Letters of Intent *(required)*:

A Letter of Intent (LOI) is required to facilitate the NSF review process. The LOI must be submitted via Research.gov no later than the LOI deadline date.

Please note the following conditions:

- LOIs must be submitted through Research.gov (not Grants.gov);
- A Minimum of one PI and up to four co-PIs are allowed; and
- A list of all Participating Organizations for the purpose of the Pilot phase of the QSTD project is required.

The Lead Organization cannot change after submission of the Letter of Intent.

Project Title: The title should begin with "NQVL:QSTD:Pilot: (insert the rest of the title and the Project's acronym)". The title should reflect the science and technology focus of the proposed QSTD project.

Keywords: In order of decreasing emphasis, list four keywords that represent the scientific interdisciplinary content in the proposal.

Lead PI and Point of Contact for NSF Inquiries: Include the Lead PI's name, organization, department, phone number, and e-mail address. The Lead PI will serve as the Point of Contact for NSF inquiries.

Other Senior Project Personnel: Identify up to four co-PIs. Include their names, organizations, departments, and e-mail addresses. The executive leadership team will be limited to the Lead PI and co-PIs. The latter may come from domestic partner organizations.

Participating Organizations: The Lead Organization (not PI) is binding throughout the process. Other partners may change. Include the names, organizations, departments, and e-mail addresses of all senior personnel at partner organizations.

Synopsis (max 2,500 characters in this section, including spaces): Upload brief statements of the vision and goals of the proposed QSTD project, its potential for QSTD impact, and an integrated plan for the QSTD project. Include an overview of the research and technology development program, such as major thrust areas, goals, and fundamental gaps or barriers in knowledge/technology that it meets. Although the Community Outreach, Workforce Development, and Diversity, Equity and Inclusion plans are foundational components of a QSTD, they do not need to be described in detail in the LOI for the Pilot phase of the QSTD project.

Letter of Intent Preparation Instructions:

When submitting a Letter of Intent through Research.gov 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 0 and Maximum of 4 Other Senior Project Personnel are permitted
- A Minimum of 0 and Maximum of 4 Other Participating Organizations are permitted
- Keywords is required when submitting Letters of Intent
- Submission of multiple Letters of Intent is not permitted

Full Proposal Preparation Instructions: Proposers may opt to submit proposals in response to this Program Solicitation via Research.gov or Grants.gov.

- Full Proposals submitted via Research.gov: Proposals submitted in response to this program solicitation should be prepared and submitted in accordance with the general guidelines contained in the *NSF Proposal and Award Policies and 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) 292-8134 or by e-mail from nsfpubs@nsf.gov. The Prepare New Proposal setup will prompt you for the program solicitation number.
- 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) 292-8134 or by e-mail from nsfpubs@nsf.gov.

See PAPPG Chapter II.D.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.

Additional Information for *all* NQVL Proposals

Although more than one organization may participate in a QSTD proposal, a single organization must accept overall management responsibility for the project. The proposal must be submitted by one organization, with funding provided to any other organization through subawards. The use of the collaborative proposal mechanism is not permitted for QSTD proposals. Subawards are not limited to IHE institutions but may be made to any group identified as eligible for funding by NSF as described in the NSF Proposal and Award Policies and Procedures Guide (PAPPG).

Letters of Support/Endorsement are not permitted.

Letters of Collaboration

Letters of collaboration are limited to stating the intent to collaborate. Endorsements or evaluations of the proposed project are not allowed. The Project Description should document the need for and nature of collaborations, such as intellectual contributions to the project, permission to access a site, an instrument, or a facility, offer of samples and materials for research, logistical support to the research and education program, or mentoring of U.S. students at a foreign site. Letters of collaboration should be included only when the involvement of the external collaborator is critical for the success of the proposed research. Letters of collaboration must follow the following format and be included in the Other Supplementary Documents section of the proposal:

> "If the proposal submitted by Dr. [insert the full name of the Principal Investigator] entitled [insert the proposal title] is selected for funding by the NSF, it is our intent to collaborate and/or commit resources as detailed in the Project Description.
>
> Specifically, our contributions to the project would include:
>
> [followed by a succinct list]."

Departure from this format may result in the proposal being returned without review.

Letters of Membership

Letters of Membership in a scientific collaboration, identifying the individual to be a member of a formal collaboration operating under a set of collaboration bylaws, to be sent by the collaboration's spokesperson or equivalent also are allowed. They must follow this single-sentence format and be included in the Other Supplementary Documents section of the proposal:

> "The [Name of PI's Organization] group is a member in good standing of the [Name of Collaboration], including Dr. [insert the full name of the Principal Investigator] as a member of that group."

Departure from this format may result in the proposal being returned without review.

Data Management Plan

In addition to the PAPPG requirements regarding the management and sharing of data products resulting from NQVL activities, and in alignment with the National Science and Technology Council report on "Guidance for Implementing National Security Presidential Memorandum 33 (NSPM-33)" and the National Security Memorandum 10 (NSM-10), NQVL proposals should also include in the Data Management Plan a description of how any proprietary information or intellectual property will be managed. This description may include a discussion of how data will be shared with project partners and affiliates, how access to the data will be managed, and how the sensitivity of various data sets will be assessed. Research security concerns are relevant for NQVL projects because quantum technologies have the potential to impact U.S. economic and national security interests.

Collaborators and Other Affiliations Information

PIs should carefully follow the instructions regarding preparation of the Collaborators and Other Affiliations (COA)form provided at https://www.nsf.gov/bfa/dias/policy/coa.jsp. A COA form in **.xlsx format *only*** must be submitted as a Single Copy Document for each individual identified as senior personnel of the QSTD team. For large collaborations or authorships, the form should only list those people with whom the senior personnel have collaborated in a direct and substantive way. Senior personnel with questions regarding whom they should list in their COA form should contact the cognizant NQVL Program Officer(s). Note in this context that listing a collaboration name or providing a collaboration URL is not sufficient.

Proposals that deviate from the required elements of this solicitation (or other items listed in the PAPPG) may be returned without review.

Additional Information for QSTD Proposals

PIs are required to contact the NQVL Program Officer(s) at National Quantum Virtual Laboratory, telephone 703-292-8235 or email: NQVL@nsf.gov as soon as possible, but not later than two weeks before submitting a proposal in response to this solicitation, in order to determine the level of readiness for submission to the Pilot phase as well as the appropriate structure of the QSTD proposal in terms of possible supplementary documents and/or page-limit extensions.

PIs should consult Chapter 5 of the Research Infrastructure Guide (RIG) for guidance on planning and oversight requirements relevant to QSTD projects.

Additional Information for QSTD Pilot Proposals

Specific to the QSTD Pilot phase competition, PIs are reminded that the goal of the NQVL program is to accelerate progress towards demonstrations of practical quantum advantage, using a convergent, systems engineering, and co-design approach. The Program is committed to support use-inspired scientific research and technology development for the benefit of the national economy and to strengthen the Nation's strategic, scientific, and technological preeminence.

The QSTD Pilot proposal must clearly describe:

- **What:** QSTD vision describing the specific Science and/or Technology area that is focus of the translation to be supported under the NQVL program and who might be the potential users.
- **Why:** Scientific and technology challenges that can be addressed effectively only by a QSTD project.
- **How:** Plan of activities to address technical challenges.
- **Who:** Team with the organizational, scientific, technical, and sociocultural skills, trusted and respected by the QISE community.
- **Readiness:** Evidence that the QSTD project is feasible in the time and with the resources afforded by the NSF NQVL program.
- **Community:** Plans for engaging the QISE community in the QSTD planning and execution and for fostering workforce development and addressing promoting diversity, equity, and inclusion among the participants.
- **Partnerships:** Dependencies. Synergies. Leverage other NQI-relevant investments by NSF or other U.S. Federal agencies. Public-private partnerships.
- **Management and Coordination:** Roles and responsibilities of all senior personnel. Deliverables. Timeline. Milestones.
- **Outcomes.**
- **Metrics of Success.**

The QSTD Pilot proposal must include the draft conceptual QSTD project design, contingency, and the planning for the total anticipated number of system integration and development cycles in the QSTD project, including possible operations, as appropriate. A QSTD Pilot proposal must include a full statement of the science and technology goals, and sufficient technical detail to appropriately review the proposal. The NQVL program will review the scientific merit on a competitive basis that includes the potential cost to the program of conducting the QSTD development that would be enabled by the instrumentation. The affordability of fabrication should be supported by parametric top-down budget estimates to provide a cost range.

B. Budgetary Information

Cost Sharing:

Inclusion of voluntary committed cost sharing is prohibited.

C. Due Dates

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

  October 06, 2023

  April 09, 2024

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

  November 30, 2023

  June 11, 2024

D. Research.gov/Grants.gov Requirements

For Proposals Submitted Via Research.gov:

To prepare and submit a proposal via Research.gov, see detailed technical instructions available at: https://www.research.gov/research-web/content/aboutpsm. For Research.gov user support, call the Research.gov Help Desk at 1-800-381-1532 or e-mail rgov@nsf.gov. The Research.gov Help Desk answers general technical questions related to the use of Research.gov systems. 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: https://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 Research.gov system for further processing.

Proposers that submitted via Research.gov may use Research.gov 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 *Leading the World in Discovery and Innovation, STEM Talent Development and the Delivery of Benefits from Research - NSF Strategic Plan for Fiscal Years (FY) 2022 - 2026*. 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.D.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.D.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 other underrepresented groups 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

Pilot phase: The NSF proposal review process will review the scientific merit on a competitive basis that includes:

- technical readiness of the proposed QSTD project;
- potential cost of the proposed QSTD project; and
- expected QSTD impacts vis-à-vis the goals of the NQVL Program.

The Program may seek additional reviews to evaluate the technical scope and costs at a level commensurate with conceptual design.

B. Review and Selection Process

Proposals submitted in response to this program solicitation will be reviewed by Ad hoc Review and/or 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 or the Division of Acquisition and Cooperative Support 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 an NSF Grants and Agreements Officer. 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) 292-8134 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=pappg.

Administrative and National Policy Requirements

Build America, Buy America

As expressed in Executive Order 14005, Ensuring the Future is Made in All of America by All of America's Workers (86 FR 7475), it is the policy of the executive branch to use terms and conditions of Federal financial assistance awards to maximize, consistent with law, the use of goods, products, and materials produced in, and services offered in, the United States.

Consistent with the requirements of the Build America, Buy America Act (Pub. L. 117-58, Division G, Title IX, Subtitle A, November 15, 2021), no funding made available through this funding opportunity may be obligated for an award unless all iron, steel, manufactured products, and construction materials used in the project are produced in the United States. For additional information, visit NSF's Build America, Buy America webpage.

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.

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:

- National Quantum Virtual Laboratory, telephone: (703) 292-8235, email: NQVL@nsf.gov
- Bogdan Mihaila, telephone: (703) 292-8235, email: bmihaila@nsf.gov
- Almadena Y. Chtchelkanova, telephone: (703) 292-8910, email: achtchel@nsf.gov
- Dominique M. Dagenais, telephone: (703) 292-2980, email: ddagenai@nsf.gov
- Pradeep P. Fulay, telephone: (703) 292-2445, email: pfulay@nsf.gov
- Vinod K. Lohani, telephone: (703) 292-2330, email: vlohani@nsf.gov
- Matthew McCune, telephone: (703) 292-2906, email: mamccune@nsf.gov
- Engin Serpersu, telephone: (703) 292-7124, email: eserpers@nsf.gov

For questions related to the use of NSF systems contact:

- NSF Help Desk: 1-800-673-6188
- Research.gov Help Desk e-mail: rgov@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 https://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 (FASED) 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.F.7 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

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