Focused Research Hubs in Theoretical Physics (FRHTP)

PROGRAM SOLICITATION
NSF 20-605

REPLACES DOCUMENT(S):
NSF 16-501, NSF 14-570

National Science Foundation

Directorate for Mathematical and Physical Sciences
Division of Physics

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

January 15, 2021

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 20-1), which is effective for proposals submitted, or due, on or after June 1, 2020.

SUMMARY OF PROGRAM REQUIREMENTS

General Information

Program Title:

Focused Research Hubs in Theoretical Physics (FRHTP)

Synopsis of Program:

Focused Research Hubs in Theoretical Physics (FRHTP) are designed to enhance significant breakthroughs at an intellectual frontier of physics by providing resources beyond those available to individual investigators, so as to promote a collaborative approach to a focused topic while promoting the preparation of scientists at the beginning of their independent scientific careers. Although interdisciplinary aspects may be included, the bulk of the effort must fall within the purview of the Division of Physics. The successful hub will demonstrate: (1) the potential to advance science; (2) the enhancement of the development of early career scientists; (3) creative, substantive activities aimed at enhancing education, diversity, and public outreach; (4) potential for broader impacts, e.g., impacts on other field(s) and benefits to society; (5) a synergy or value-added rationale that justifies a group approach.

The FRHTP will be funded for an initial duration of five years. The intent is that the research topics proposed are at the stage that the scientific goals of the hub can be achieved in the first five years of the project. The FRHTP awards will provide support only for postdoctoral researchers plus general support for hub-related activities. The FRHTP are not intended to provide additional support for senior personnel (individual PIs), graduate or undergraduate students. Instead, the FRHTP is intended to support postdoctoral researchers and enable collaborative interactions via support for travel, collaboration meetings and workshops.

Topics for the FY 2021 competition:

Proposals may only be submitted in the specific topic(s) listed in this solicitation, which define particular areas in theoretical physics in which the Division of Physics sees a need for a focused research hub. Future versions of this solicitation will allow response on different theoretical physics topics. It is expected that one award will be funded in each hub topic.

The specific hub topics for this solicitation are:

1. Theoretical Atomic, Molecular and Optical Physics (TAMOP)

   The TAMOP focused research hub will support theoretical work to advance theoretical AMO physics and lead in motivating and explaining new experimental work in AMO and other areas of science within the purview of the Division of Physics.

2. Quantum Information Science (QIS)

   The QIS focused research hub will support theoretical work to explore quantum applications that will push the frontiers of quantum-

based information, transmission, and manipulation within the purview of the Division of Physics. This activity will advance the goals of the "Quantum Leap", one of the NSF 10 Big Ideas for Future NSF Investment.

3. Theoretical Nuclear Physics (TNP)

   The TNP focused research hub will support theoretical work in the area of **Models and Simulations for Nuclear Astrophysics** relevant to research within the purview of the Division of Physics. This activity will advance the goals of the "Windows on the Universe", one of the NSF 10 Big Ideas for Future NSF Investment.

It is strongly recommended that prospective PIs contact the FRHTP Program Officer(s) to ascertain that the focus and budget of their proposed FRHTP are appropriate for this solicitation.

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.

- Bogdan Mihaila, telephone: (703) 292-8235, email: bmihaila@nsf.gov
- Robert Forrey, telephone: (703) 292-5199, email: rforrey@nsf.gov

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

- 47.049 --- Mathematical and Physical Sciences

Award Information

Anticipated Type of Award: Cooperative Agreement

Estimated Number of Awards: 3

Estimated program budget, number of awards and average award size/duration are subject to the availability of funds. The FRHTP award is expected to be at the level of $250,000 - $850,000 per year. Three awards are expected in FY 2021 depending upon the availability of funds and the quality of proposals received. A maximum of one award will be made in each FRHTP topic.

Anticipated Funding Amount: $3,750,000 to $10,250,000

A total FRHTP award for five years must lie in the range of $1,250,000 - $4,250,000, with $250,000 - $850,000 in FY 2021, pending 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:

There are no restrictions or limits.

Limit on Number of Proposals per Organization:

There are no restrictions or limits.

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

Any one individual may be the Principal Investigator (PI) or co-Principal Investigator (co-PI) for only one proposal. Individuals may be listed as participating senior investigators on more than one proposal.

Proposal Preparation and Submission Instructions

A. Proposal Preparation Instructions

- **Letters of Intent:** Not required
- **Preliminary Proposal Submission:** Not required
- **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:**

  Other budgetary limitations apply. Please see the full text of this solicitation for further information.

C. Due Dates

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

  January 15, 2021

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 Division of Physics of the Directorate for Mathematical and Physical Science of the National Science Foundation (NSF) expects to make a small number of awards for Focused Research Hubs in Theoretical Physics (FRHTP). These theory hubs will focus on an area of recognized or emerging importance to theoretical physics for which its success depends in a crucial way upon a group effort. The Division of Physics employs the individual investigator award as the principal mechanism for supporting fundamental research. The Division of Physics also recognizes that there are research needs that can only be met appropriately by teams of researchers. The advantages of pooled insights, complementary expertise, diverse points of view, and shared tasks make a

successful research team more than the sum of its parts. A dedicated mode of support for such scientifically focused multi-investigator projects with an emphasis on postdoctoral research support is provided by this activity.

II. PROGRAM DESCRIPTION

The goal of these theory hubs is to foster cutting edge research, serve as a focus for theoretical physics, enhance the visibility of the field, and foster the development of the next-generation of scientists in theoretical physics. The successful hub will bring together diverse groups to promote connections leading to cutting edge science, while fostering a vibrant environment at all levels from student to senior investigator.

The successful theory hub will:

1. advance theoretical science
2. enhance the development of early career scientists
3. support creative, substantive activities aimed at enhancing education, diversity, and public outreach
4. have potential for broader impacts, e.g., impacts on other field(s) and benefits to society
5. have a synergy or value-added rationale that justifies the FRHTP

The FRHTP will advance science beyond what is possible for single investigators. Maximum flexibility in the design of the hub funded through the program is essential, so the specific organization of the hub is left to the creativity of the principal investigators. Proposals to the program will be judged by the two standard NSF criteria of intellectual merit and broader impact. In addition to this, major deciding factors in determining whether the hub qualifies for funding are the scientific goals, synergy and value added that justifies large-scale support. **The proposal must present a compelling case that the FRHTP can achieve its scientific goals within a five-year time frame.**

The FRHTP is expected to provide an exceptionally stimulating environment for education. The theory hub should actively seek to enhance the participation of underrepresented groups in the scientific enterprise. Underrepresented groups include women, persons with disabilities, African Americans, Hispanics, Native Americans, Alaska Natives, Native Hawaiians, and other Pacific Islanders. The FRHTP should reach out to involve junior researchers and the public in ways that increase science interest and literacy.

Activities supported through the hub must be within the purview of the Division of Physics. Interdisciplinary projects that connect this physics area to other disciplines and physics sub-fields not within the purview of the Division of Physics may also be considered, although the bulk of the effort must fall within the topical area of the theory hub indicated below.

Topics for the FY 2021 competition:

Proposals may only be submitted in the specific topic(s) listed in this solicitation, which define particular areas in theoretical physics in which the Division of Physics sees a need for a focused research hub. Future versions of this solicitation will allow response on different theoretical physics topics. It is expected that one award will be funded in each hub topic.

The specific FRHTP topics for this solicitation are:

1. Theoretical Atomic, Molecular and Optical Physics (TAMOP)

   The TAMOP focused research hub will be an intellectual center to advance theoretical AMO physics and lead in motivating and explaining new experimental work in AMO and other areas of science within the purview of the Division of Physics. The goal of this FRHTP is to foster cutting-edge research, serve as a focus for theoretical AMO science, and to enhance the visibility of the field. It will bring together diverse groups both inside and outside of the AMO community to promote connections leading to frontier science, while fostering a vibrant environment at all levels from student to senior investigator.

2. Quantum Information Science (QIS)

   The QIS focused research hub will support theoretical work to explore quantum applications that will push the frontiers of quantum-based information, transmission, and manipulation within the purview of the Division of Physics.

3. Theoretical Nuclear Physics (TNP)

   The TNP focused research hub will support theoretical work in the area of **Models and Simulations for Nuclear Astrophysics** relevant to research within the purview of the Division of Physics.

It is strongly recommended that prospective PIs contact the FRHTP Program Officer(s) to ascertain that the focus and budget of their proposed FRHTP are appropriate for this solicitation.

III. AWARD INFORMATION

Anticipated Type of Award: Cooperative Agreement

Estimated Number of Awards: 3

Estimated program budget, number of awards and average award size/duration are subject to the availability of funds. The FRHTP award is expected to be at the level of $250,000 - $850,000 per year. Three awards are expected in FY 2021 depending upon the availability of funds and the quality of proposals received. A maximum of one award will be made in each FRHTP topic.

Anticipated Funding Amount: $3,750,000 - $10,250,000

A total FRHTP award for five years must lie in the range of $1,250,000 - $4,250,000, with $250,000 - $850,000 in FY 2021, pending 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:

There are no restrictions or limits.

Limit on Number of Proposals per Organization:

There are no restrictions or limits.

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

Any one individual may be the Principal Investigator (PI) or co-Principal Investigator (co-PI) for only one proposal. Individuals may be listed as participating senior investigators on more than one proposal.

Additional Eligibility Info:

While more than one institution may participate in a single proposal, a single institution must accept overall management responsibility for the hub. Although collaborations between institutions are strongly encouraged, the proposal must be submitted by only one institution with funding provided to the other institutions through subawards; separately submitted collaborative proposals are not permitted.

V. PROPOSAL PREPARATION AND SUBMISSION INSTRUCTIONS

A. Proposal Preparation Instructions

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

- 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) 292-8134 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) 292-8134 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.

For submissions involving multiple institutions, the proposal should be submitted from only one institution, with funding for participating institutions made through subawards. **Proposals should not be submitted using the separately submitted collaborative proposal mode.**

The instructions below supplement the guidelines in the NSF Proposal & Award Policies & Procedures Guide (PAPPG) or NSF Grants.gov Application Guide.

1. **Project Description**. The Project Description is **limited to no more than 30 pages**.

Please note that per guidance in the PAPPG, the Project Description must contain, as a separate section within the narrative, a section labeled "Broader Impacts". You can decide where to include this section within the Project Description.

a. Executive Summary. Provide a clear rationale for and description of the proposed hub and its potential impact. Briefly describe the institutional setting of the

hub, its proposed scope and organization, activities in research and education and their integration, any collaborative activities with industry or other sectors, links with related major research centers on or off campus, and management plan. **Limit: 3 pages.**

b. Results from Prior NSF Support. Describe achievements under prior NSF support that pertain to the present proposal. **Limit: 5 pages.**

c. Hub Description: Provide a concise description of the long-term research goals and intellectual focus, and describe the planned research activities in sufficient detail to enable their scientific merit and significance to be assessed. Discuss how the hub will foster cutting edge science. In all cases, **describe the role and intellectual contribution of each senior participant in the hub**, and briefly outline the resources available or planned to accomplish the stated goals. The need for a hub approach involving several investigators and the means of achieving this should be clearly established. Interactions with other groups and institutions should be described.

d. Human Resources and Diversity. Describe the proposed activities of the hub in the development of early career scientists. Specifically address how these efforts will impact the participation of traditionally underrepresented groups (underrepresented groups include women, persons with disabilities, African Americans, Hispanics, Native Americans, Alaska Natives, Native Hawaiians, and other Pacific Islanders) which is a high-priority goal of the Division of Physics and of NSF. Outline plans for seminar series, colloquia, workshops, conferences, visitor programs, summer schools, and related activities, as appropriate.

e. Shared Facilities. Describe the shared facilities and infrastructure to be established. Describe plans for maintaining and operating the facilities, including staffing, and plans for ensuring access to outside participants. Distinguish clearly between existing facilities and those still to be acquired or developed. **Limit: 2 pages.**

f. Collaboration with Other Sectors. Describe any proposed interactions and collaborations with other institutions and sectors, including national laboratories and industry, as appropriate. Define the goals of the collaboration, and describe the planned activities. Describe the roles in these collaborations of any participants that have been listed as participating senior investigators. List the senior collaborating participants, the mechanisms planned to stimulate and facilitate knowledge transfer, and the potential long-term impact of the collaborations. A letter of collaboration is required from external collaborators as supplementary information - for form of letter see 4b. **Limit: 2 pages.**

g. International Collaboration. Describe the nature of any planned international collaboration and the expected international and scientific or engineering benefits to the research and education programs. **Limit: 1 page.**

h. Management. Describe the plans for administration of the hub, including the functions of key personnel, the process for selection of postdoctoral researchers, and the role of any advisory committee, executive committee, program committee, or their equivalent. Describe plans for administering the educational programs and outreach activities of the hub, as appropriate. **Limit: 2 pages.**

2. **Budget**: The FRHTP awards provide support only for postdoctoral researchers and hub-related activities. The FRHTP are not intended to provide additional support for senior personnel (individual PIs), graduate or undergraduate students. Instead, the FRHTP is intended to support postdoctoral researchers and provide an environment that fosters collaborative interactions. The FRHTP will enable the hub activities by providing support for travel, collaboration meetings and workshops.

3. **Facilities, Equipment and Other Resources**. In addition to requirements in the PAPPG, this section should outline institutional and other commitments to the hub, for example, space, faculty and staff positions, capital equipment, access to existing facilities, commitments for collaboration and outreach programs, and other commitments. The description should be narrative in nature and not include any quantifiable financial information.

4. **Supplementary Documentation**. In addition to the requirements in the PAPPG, the following information must be provided:

a. A one-paragraph statement (not to exceed one-half page) from each of the major participants that have been listed as participating senior investigators outlining how they view their role in the hub. This must be specific and not a general letter of support.

b. Letters of Collaboration – Letters of support should not be submitted, as they are not a standard component of an NSF proposal. On the other hand, letters of collaboration, limited to stating the intent to collaborate and not containing endorsements or evaluation of the proposed project, are allowed. Letters of collaboration should follow the single-sentence format:

> "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 my intent to collaborate and/or commit resources as detailed in the Project Description."

Departure from this format may result in the proposal being returned without review. The Project Description should document the need for and nature of collaborations.

5. **Single Copy Documents.**

a. **Project Personnel (a text-searchable single PDF document, to be submitted as an Additional Single Copy Document):** List all Senior Personnel in the project. For each person, provide the last name, first name, and institution/organization. In the main body of the proposal, a corresponding biographical sketch should be provided for all individuals included on this list, as instructed in Chapter II.C.2.f of the PAPPG.

b. **Collaborators and Other Affiliations Information:** Proposers should follow the guidance specified in Chapter II.C.1.e of the NSF PAPPG. The list should include each PI, Co-PI, other Senior Personnel, and all sub-awardees who would receive funds through the FRHTP award. 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 FRHTP Program Officer. Note in this context that listing a collaboration name or providing a collaboration URL is not sufficient.

No other items or appendices are to be included. ***Full proposals containing items other than those required above or by the PAPPG will not be reviewed.***

B. Budgetary Information

Cost Sharing:

Inclusion of voluntary committed cost sharing is prohibited.

Other Budgetary Limitations:

A total FRHTP award for five years must be in the range of $1,250,000 - $4,250,000, with $250,000 - $850,000 in FY 2021, pending availability of funds.

C. Due Dates

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

  January 15, 2021

D. FastLane/Research.gov/Grants.gov Requirements

For Proposals Submitted Via FastLane or Research.gov:

To prepare and submit a proposal via FastLane, see detailed technical instructions available at: https://www.fastlane.nsf.gov/a1/newstan.htm. To prepare and submit a proposal via Research.gov, see detailed technical instructions available at: https://www.research.gov/research-portal/appmanager/base/desktop?_nfpb=true&_pageLabel=research_node_display&_nodePath=/researchGov/Service/Desktop/ProposalPreparationandSubmission.html. For FastLane or Research.gov user support, call the FastLane and Research.gov Help Desk at 1-800-673-6188 or e-mail fastlane@nsf.gov or rgov@nsf.gov. The FastLane and Research.gov Help Desk answers general technical questions related to the use of the FastLane and 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 FastLane system for further processing.

Proposers that submitted via FastLane or 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 *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

In addition to the NSB approved merit review criteria, reviewers of the hub proposals will be asked to use the following criteria.

The FRHTP proposal must exhibit synergy or value-adding features that justify hub support, rather than an equivalent level of support for individual investigators or small groups.

Reviewers will be asked to assess the following criteria to evaluate the theory hub as a whole:

- Synergy and interconnections within the hub: Benefits of a multi-investigator, hub approach; the synergy among the investigators; and the potential for cross fertilization.
- Institutional setting and rationale for the hub: Relationship to existing and planned institutional programs and capabilities in physics research and

education; intellectual breadth of the proposed program; potential for stimulating creative interaction and collaboration. Potential for institutional, national, and international impact.
- Achievements under prior NSF support, where applicable.
- Evidence of clear scientific goals; evidence that the hub can achieve scientific goals in the first five years of the project.
- Potential effect on the infrastructure of science and engineering, particularly in fostering a broadly interactive approach to cutting-edge research and the development of early career scientists, fostering an open climate for students and postdoctoral researchers, and fostering increased participation in research and education on the part of women and members of underrepresented groups.
- Management plan and budget. Likely effectiveness of the proposed management plan, including mechanisms for selection of topics and internal allocation of resources, process for selection of postdoctoral researchers, plans for self-evaluation, and plans and potential for maintaining a flexible and innovative program. Appropriateness of the requested budget.

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 Reverse Site Review.

Proposals submitted in response to this program solicitation will be reviewed by ad hoc review and/or panel review and/or reverse site review.

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

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

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

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

VII. AWARD ADMINISTRATION INFORMATION

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) 292-8134 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.

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:

- Bogdan Mihaila, telephone: (703) 292-8235, email: bmihaila@nsf.gov
- Robert Forrey, telephone: (703) 292-5199, email: rforrey@nsf.gov

For questions related to the use of FastLane or Research.gov, contact:

- FastLane and Research.gov Help Desk: 1-800-673-6188

  FastLane Help Desk e-mail: fastlane@nsf.gov.

  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.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) 292-8569
- **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 System of Record Notices, NSF-50, "Principal Investigator/Proposal File and Associated Records," and NSF-51, "Reviewer/Proposal File and Associated Records." 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