Division of Physics: Investigator-Initiated Research Projects (PHY)

PROGRAM SOLICITATION
NSF 16-566

REPLACES DOCUMENT(S):
NSF 15-579

National Science Foundation

Directorate for Mathematical & Physical Sciences
Division of Physics

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

October 26, 2016

Last Wednesday in October, Annually Thereafter

Atomic Molecular and Optical Physics - Experiment and Theory; Elementary Particle Physics - Experiment; Gravitational Physics - Experiment and Theory; Integrative Activities in Physics; and Particle Astrophysics - Experiment

October 26, 2016

Fourth Wednesday in October, Annually Thereafter

Physics of Living Systems

November 14, 2016

Nuclear Physics - Experiment and Theory

December 01, 2016

First Thursday in December, Annually Thereafter

Elementary Particle Physics - Theory; Particle Astrophysics and Cosmology - Theory; Quantum Information Science

February 01, 2017

First Wednesday in February, Annually Thereafter

Accelerator Science

November 13, 2017

Nuclear Physics - Experiment and Theory

November 09, 2018

Second Friday in November, Annually Thereafter

Nuclear Physics - Experiment and Theory

IMPORTANT INFORMATION AND REVISION NOTES

This solicitation also has deadlines rather than target dates. Multiple deadlines will be visible in FastLane and grants.gov; PIs are responsible for selecting the correct deadline for the program to which they are submitting their proposal.

This division-wide solicitation supercedes version NSF15-579. The solicitation follows most of the requirements in the NSF Proposal & Award Policies & Procedures Guide (PAPPG), but has additional requirements listed below. These are specified in the sub-section labeled Additional Information in section (V.A) Proposal Preparation Instructions with further Additional Solicitation Specific Review Criteria specified in section (VI.A) Merit Review Principles and Criteria below. These relate primarily to proposers who anticipate having multiple sources of support, proposals involving significant instrumentation development and/or long-duration efforts, and proposals with letters of collaboration. Proposals received after a program deadline will only be considered in next year's funding cycle. Note that programs are listed after their associated deadlines. All proposals submitted to the Physics Division that are not governed by another solicitation (such as CAREER and MRI) should be submitted to this solicitation; otherwise they will be returned without review. Research at Undergraduate Institutions (RUI) proposals should be submitted through the RUI solicitation by the deadlines in this PHY solicitation according to the closest disciplinary match. RUI proposals should also follow the additional requirements specified in the sub-section labeled Additional Information in section (V.A) Proposal Preparation Instructions below.

The Plasma Physics Program is governed by a separate solicitation (NSF15-601). However, proponents of potential large investment activities otherwise within the scope of the Plasma Physics program are strongly encouraged to contact the cognizant Program Director before submitting a proposal.

Any proposal submitted in response to this solicitation should be submitted in accordance with the revised *NSF Proposal & Award Policies & Procedures Guide* (PAPPG) (NSF 17-1), which is effective for proposals submitted, or due, on or after January 30, 2017.

SUMMARY OF PROGRAM REQUIREMENTS

General Information

Program Title:

Division of Physics: Investigator-Initiated Research Projects (PHY)

Synopsis of Program:

The Division of Physics (PHY) supports physics research and education in the nation's colleges and universities across a broad range of physics disciplines that span scales of space and time from the largest to the smallest and the oldest to the youngest. The Division is comprised of disciplinary programs covering experimental and theoretical research in the following major subfields of physics: Accelerator Science; Atomic, Molecular and Optical Physics; Computational Physics; Elementary Particle Physics; Gravitational Physics; Integrative Activities in Physics; Nuclear Physics; Particle Astrophysics; Physics of Living Systems; Plasma Physics (supported under a separate solicitation); and Quantum Information Science.

Additional Information

The Physics Division strongly encourages single proposal submission for possible co-review rather than multiple submissions of proposals with slight differences to several programs.

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.

- Vyacheslav (Slava) Lukin, Accelerator Science; Plasma Physics, telephone: (703) 292-7382, email: vlukin@nsf.gov
- Alex Cronin, telephone: (703) 292-5302, email: acronin@nsf.gov
- John Gillaspy, Atomic, Molecular and Optical Physics - Experiment, telephone: (703) 292-7173, email: jgillasp@nsf.gov
- Michael J. Cavagnero, Atomic, Molecular and Optical Physics - Theory, telephone: (703) 292-2163, email: mcavagne@nsf.gov
- Bogdan Mihaila, Computational Physics; Nuclear Physics - Theory, telephone: (703) 292-8235, email: bmihaila@nsf.gov
- Saul Gonzalez Martirena, Elementary Particle Physics - Experiment, telephone: (703) 292-2093, email: sgonzale@nsf.gov
- James Shank, Accelerator Science; Elementary Particle Physics - Experiment, telephone: (703) 292-8343, email: jshank@nsf.gov
- Keith R. Dienes, Elementary Particle Physics - Theory; Particle Astrophysics and Cosmology - Theory, telephone: (703) 292-5314, email: kdienes@nsf.gov
- Pedro Marronetti, Gravitational Physics - Experiment and Theory, telephone: (703) 292-7372, email: pmarrone@nsf.gov
- Kathleen McCloud, Integrative Activities in Physics, telephone: (703) 292-8236, email: kmccloud@nsf.gov
- Allena K. Opper, Nuclear Physics - Experiment, telephone: (703) 292-8958, email: aopper@nsf.gov
- Jean Cottam Allen, Particle Astrophysics (Cosmic Phenomena) - Experiment, telephone: (703) 292-8783, email: jcallen@nsf.gov
- James Whitmore, Particle Astrophysics (Underground Physics) - Experiment, telephone: (703) 292-8908, email: jwhitmor@nsf.gov
- Krastan B. Blagoev, Physics of Living Systems, telephone: (703) 292-4666, email: kblagoev@nsf.gov
- Mark Coles, Projects and Facilities, telephone: (703) 292-4432, email: mcoles@nsf.gov

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

- 47.049 --- Mathematical and Physical Sciences

Award Information

Anticipated Type of Award: Standard Grant or Continuing Grant

Estimated Number of Awards: 300

Anticipated Funding Amount: $90,000,000

Pending availability of funds, approximately $90M will be committed for the total budget of all new awards in each cycle.

Eligibility Information

Who May Submit Proposals:

The categories of proposers eligible to submit proposals to the National Science Foundation are identified in the *NSF Proposal & Award Policies & Procedures Guide* (PAPPG), Chapter I.E.

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:

None. However, the Physics Division strongly encourages single proposal submission for possible co-review rather than multiple submissions of proposals with slight differences to several programs.

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=papp.
  - 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: http://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

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

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Proposal Review Information Criteria

Merit Review Criteria:

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

Award Administration Information

Award Conditions:

Standard NSF award conditions apply.

Reporting Requirements:

Standard NSF reporting requirements apply.

TABLE OF CONTENTS

I. INTRODUCTION

The Division of Physics (PHY) supports physics research and education in the nation's colleges and universities across a broad range of physics disciplines that span scales of space and time from the largest to the smallest and the oldest to the youngest. The Division is comprised of disciplinary programs covering experimental and theoretical research in the following major subfields of physics: Accelerator Science; Atomic, Molecular and Optical Physics; Computational Physics; Elementary Particle Physics; Gravitational Physics; Integrative Activities in Physics; Nuclear Physics; Particle Astrophysics; Physics of Living Systems; Plasma Physics (supported under a separate solicitation); and Quantum Information Science.

PHY Mission: To support fundamental research across the intellectual frontiers of physics, to support research that has broader impacts on other fields of science and on the health, economic strength, and defense of society, to enhance education at all levels and share the excitement of science with the public through integration of education and research, and to steward the physics community so as to maintain the intellectual capital essential for future advances. Modes of support include single investigator awards, group awards, centers and institutes, some interdisciplinary in nature, and several national user facilities, as well as research equipment/instrumentation development grants.

PHY Science: Physics research probes the properties of matter at its most fundamental level, the interactions between particles, and the organization of constituents and symmetry principles that lead to the rich structure and phenomena that we observe in the world around us. Physics seeks a deep understanding of processes that led to the formation of the cosmos, to the structure of matter at the very shortest distance scales where quantum effects dominate, and to the structure of atomic and molecular systems that shape and control the everyday world of chemistry and biological systems. Because of the breadth and scope of physics, it forms part of the core educational curriculum in most sciences and in engineering.

Physics research encompasses both theoretical and experimental studies, has very profound connections with fundamental mathematics, and underlies most of the other physical sciences. Collaboration with the other scientific disciplines is very important to the continued health and excitement of physics, some examples being in biological physics at the molecular and cellular levels, in quantum information science at the physics-computer science interface, and in the large-scale structure and evolution of the universe (cosmology). PHY will continue to emphasize the importance of interdisciplinary research.

Physics also supports the development of new tools and techniques needed to expand and refine our understanding of physical systems - from particle accelerators to probe physics at the energy and short-distance frontier, to femtosecond lasers to probe and control atomic and molecular systems, to LIGO, a new window on cosmological events ranging from the birth of the universe to the death throes of stars. The extraordinary sensitivity required for some of the instrumentation demands new technology development. For example, LIGO requires a displacement sensitivity of one thousandth of the diameter of the proton to observe gravitational waves from explosive cosmological processes! Such development is clearly a very high-risk endeavor. The payoff for such investments can also be very high, both scientifically and to the economic and technological future of the nation. For example, the development and application of femtosecond lasers now permits radically improved laser surgery and microelectronics fabrication, and points the way towards full quantum control of physical and chemical processes. PHY encourages research that pushes the envelope of technology as well as the reach of science and sees this also as an investment in developing the scientific leaders of the future.

Proposals with scope covering topics within the purview of programs outside of the Physics Division may be co-reviewed with the relevant Divisions as appropriate and at the discretion of the cognizant Program Officer.

II. PROGRAM DESCRIPTION

This solicitation covers three possible award types:

- individual investigator and group awards with standard time cycles;
- midscale instrumentation; and
- awards that anticipate long-term support.

For standard individual investigator and group awards that follow the usual cycles for competitive renewal, proposals must follow the requirements of the NSF Proposal & Award Policies & Procedures Guide (PAPPG) plus specific additional requirements included in this solicitation. See **Additional Information** under *Proposal Preparation Instructions* and **Additional Solicitation Specific Review Criteria** under *Merit Review Principles and Criteria.*

Proposals that involve significant investments either because they request significant instrumentation or because they involve activities that can span several renewal cycles are considered large investments by the Division and may involve additional instructions and additional review. See the section on **Large Investments** below**.**

The Physics Division invites research proposals in the following areas:

Accelerator Science [Program Description]

Atomic Molecular and Optical Physics - Experiment [Program Description]

Atomic Molecular and Optical Physics - Theory [Program Description]

Elementary Particle Physics - Experiment [Program Description]

Elementary Particle Physics - Theory [Program Description]

Gravitational Physics - Experiment [Program Description]

Gravitational Physics - Theory [Program Description]

Integrative Activities in Physics [Program Description]

Nuclear Physics - Experiment [Program Description]

Nuclear Physics - Theory [Program Description]

Particle Astrophysics - Experiment [Program Description]

Particle Astrophysics and Cosmology - Theory [Program Description]

Physics of Living Systems [Program Description]

Quantum Information Science [Program Description]

The following sections apply to proposals associated with activities whose duration typically covers several award cycles (Long-Term Investments), and/or involve instrumentation acquisition or development (Midscale Instrumentation).

Large Investments

Large investments are viewed by the Physics Division as activities that require support from an individual or multiple programs that is substantial compared to the programs' budget. Designation of an activity as a large investment, and therefore subject to the Guidelines, is made by the Program Directors in consultation with the Division Director.

Some of these large investments entail the acquisition or development of instrumentation. Large investments may also come in the form of long-duration efforts that require substantial funding over multiple award cycles while not necessarily requesting significant investments in a single award cycle. Activities that receive this designation typically aim to achieve a focused goal and may involve several individual or group awards. Large investments are not defined by a specific dollar amount, as these will vary by program. However, in all cases these projects require significant commitments from the individual programs, and therefore require special consideration. The largest of these investments may involve midscale funding, which is allocated by the Division Director. Two modes are described below: A) Miscale Instrumentation and B) Long-duration activities.

The following language applies both to Midscale Instrumentation and Long-Duration activities.

Scientific Review

Proposals are first considered on the basis of their science goals. Because the investment will substantially impact the budget of any individual program and because the impact will likely extend for more than a single award cycle, the science goals must be of high priority within the program. Standard proposal review panels prioritize a proposal compared to other proposals received that year. To appropriately prioritize a proposal involving a potentially large investment, the review panel may be asked to additionally consider the programmatic balance of investments across the full program. In some cases, a special panel may be required to consider and prioritize the proposed investment.

Technical Review

The feasibility of the proposed activities must also be thoroughly reviewed. Given the scale and complexity of most large investments a separate panel may be required to assess implementation plans. For some proposals, including those with instrument development and/or fabrication, the review may consider technical readiness, risk mitigation, management plans, budgets and schedules. For long-duration efforts where the lifetime of the project is expected to exceed a single award period, the review may consider performance schedules, lifecycle planning, and, for renewal proposals, the record of success in achieving any previously set milestones. 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 Directors on the appropriate duration of the award and milestones needed to evaluate the project's progress.

Award Oversight

Awards for long-term investments may 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. Depending on the nature of the project and the recommendations from the technical reviews, initial awards may be made for 3 to 5 years. The duration of support will be determined based on the scientific goals of the project with input from the technical review and taking into account the financial burden on the programs. Proposals for continued support may involve both scientific and technical review, as appropriate at the time of the request. Appropriate close-out should be planned in advance. For the largest investments a close-out phase may be described in the cooperative agreement.

New activities involving large investments will be governed by this solicitation. Currently funded projects that involve long-term investments will be subject to these same procedures if they apply for renewed support in order to determine whether the science continues to be of high priority within the programs and whether the implementation plans are sound.

Proponents of potential large investment activities are strongly encouraged to contact Program Directors before submitting proposals. Program Directors can advise potential PIs on the financial viability of the project and on the review process.

Midscale Instrumentation

Midscale instrumentation represents some of the largest investments within the Physics Division. All instrumentation development with costs exceeding $4 million falls under this category, but complex instrumentation activities costing less than this amount may also be governed by this language. Proponents should contact the Program Directors for the relevant program(s) for details. The guidelines listed here follow standard practices for activities of this scope.

Requests for midscale instrumentation support may involve a sequence of development phases and reviews. For the most complex cases, these are designated by the following stages:

- conceptual design;
- preliminary design;
- final design.

Less complex cases may skip development stages.

All proposals are evaluated using the NSF merit review criteria concerning intellectual merit and broader impacts, as well as an assessment as to how well the proposed instrumentation will address the stated science goals. Consideration of all midscale instrumentation requests begins by evaluating and prioritizing the science goals within the individual programs and determining the feasibility of the implementation plan. For each of the relevant phases listed above, the associated proposal will be reviewed before passing on to the next stage. At each stage of development, the Physics Division may choose to provide support through the next phase or end its involvement. At successive development phases, the reviews will be increasingly detailed and will involve an increasing level of commitment from the Division. Project planning must take into account the total project lifecycle The Division investment in instrument development is of finite duration, and at the completion of fabrication, the Division involvement ends; program funding may support project operations. As appropriate, these stages of development will be coordinated with funding partners in other agencies or organizations.

For further information, see *Additional Information for Midscale Instrumentation* under **Proposal Preparation Instructions.**

Long-Duration Efforts

Long-duration efforts, while not necessarily requesting significant investments in a single award cycle, over time require substantial funding. Activities that receive this designation typically aim to achieve a focused goal (such as a single high-precision measurement) and may also include several individual or group awards. Proposals for these activities should indicate expected lifetimes as well as appropriate milestones. Reviews of these proposals may consider performance schedules, and, for renewal proposals, the record of success in achieving any previously set milestones. Investigators who anticipate a long-duration effort should contact Program Directors for the relevant program(s).

III. AWARD INFORMATION

Anticipated Type of Award: Continuing Grant or Standard Grant

Estimated Number of Awards: 300

Anticipated Funding Amount: $90,000,000 Pending availability of funds, approximately $90M will be committed for the total budget of all new awards in each cycle.

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:

The categories of proposers eligible to submit proposals to the National Science Foundation are identified in the *NSF Proposal & Award Policies & Procedures Guide* (PAPPG), Chapter I.E.

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:

None. However, the Physics Division strongly encourages single proposal submission for possible co-review rather than multiple submissions of proposals with slight differences to several programs.

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 Grants.gov or via the NSF FastLane system.

- Full proposals submitted via FastLane: Proposals submitted in response to this program solicitation should be prepared and submitted in accordance with the general guidelines contained in the *NSF Proposal & Award Policies & Procedures Guide* (PAPPG). The complete text of the PAPPG is available electronically on the NSF website at: https://www.nsf.gov/publications/pub_summ.jsp?ods_key=papp. Paper copies of the PAPPG may be obtained from the NSF Publications Clearinghouse, telephone (703) 292-7827 or by e-mail from nsfpubs@nsf.gov. Proposers are reminded to identify this program solicitation number in the program solicitation block on the NSF Cover Sheet For Proposal to the National Science Foundation. Compliance with this requirement is critical to determining the relevant proposal processing guidelines. Failure to submit this information may delay processing.

- Full proposals submitted via Grants.gov: Proposals submitted in response to this program solicitation via Grants.gov should be prepared and submitted in accordance with the *NSF Grants.gov Application Guide: A Guide for the Preparation and Submission of NSF Applications via Grants.gov*. The complete text of the *NSF Grants.gov Application Guide* is available on the Grants.gov website and on the NSF website at: (http://www.nsf.gov/publications/pub_summ.jsp?ods_key=grantsgovguide). To obtain copies of the Application Guide and Application Forms Package, click on the Apply tab on the Grants.gov site, then click on the Apply Step 1: Download a Grant Application Package and Application Instructions link and enter the funding opportunity number, (the program solicitation number without the NSF prefix) and press the Download Package button. Paper copies of the Grants.gov Application Guide also may be obtained from the NSF Publications Clearinghouse, telephone (703) 292-7827 or by e-mail from nsfpubs@nsf.gov.

In determining which method to utilize in the electronic preparation and submission of the proposal, please note the following:

Collaborative Proposals. All collaborative proposals submitted as separate submissions from multiple organizations must be submitted via the NSF FastLane system. PAPPG Chapter II.D.3 provides additional information on collaborative proposals.

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.

Additional Information for All Proposals

For PIs who anticipate having other concurrent sources of support (including but not limited to grants from other agencies or private foundations, and laboratory appointments), proposals should clearly explain how the proposed work is distinct from other funded activities. The proposal should also articulate the nature of commitments (such as deliverables, specific projects) associated with other sources of support. These commitments should be presented in the Project Description or in the Current/Pending Support section. [Note that the FastLane web interface for Current/Pending Support is not adequate for providing this information. A separate Current/Pending Support file upload will be needed.] The proposal review process will include an assessment of the proposers' ability to carry out the proposed research in light of these commitments. PIs who have applied to more than one agency with very similar proposals will be expected to withdraw all other applications should one of these proposals be funded.

The Theoretical Nuclear Physics Program will be participating in a pilot program during FY2017 that will employ a streamlined budget process for proposals. Further details are available at the program description site.

Letters of Support/Endorsement are not permitted.

Letters of Collaboration

Letters of collaboration limited to stating the intent to collaborate and not containing endorsements or evaluation of the proposed project are 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 **must** 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.

Letters of Membership

Letters of Membership in a scientific collaboration, to be sent by the collaboration's spokesperson or equivalent also are allowed. They **must** follow this single-sentence format:

"The [Name of PI's Institution] group is a member in good standing of the [Name of Collaboration], including you as a member of that group."

The NSF Proposal & Award Policies & Procedures Guide (PAPPG) now requires a supplemental document for each person listed as senior personnel listing their collaborators (see PAPPG sect II.C.1.e). For large collaborations, proposers must individually list the members with whom the person works directly. It is not sufficient just to name the collaboration or provide a URL pointing to a list of collaborators.

Research at Undergraduate Institutions

Research at Undergraduate Institutions (RUI) proposals should be submitted by the deadlines in this solicitation according to the closest disciplinary match. RUI proposals should also follow the Additional Information requirements specified above.

Additional Information for Midscale Instrumentation

This section applies to proposals for support of instrumentation acquisition or development at the level of $4 million and above. This language may also apply to requests for lesser amounts if the cognizant Program Director concludes that the complexity of the instrumentation merits this approach. Investigators should

first contact the Program Director for their physics discipline to determine the appropriate development stage of the proposed project, as well as the appropriate structure of the proposal in terms of possible supplementary documents and/or page-limit extensions.

Midscale instrumentation requests follow a plan of development phases or stages as described below. Some of these stages may be combined as appropriate, but investigators should be aware of these stages when planning proposals. Depending on the maturity of the project, a proposal requesting Midscale or complex instrumentation support has additional requirements as follows:

Conceptual Design: At Conceptual Design, the instrumentation proposal must include the conceptual project design, scope contingency, and total project lifecycle planning including operations and close-out. This proposal must include a full statement of the science goals and sufficient technical detail to appropriately review the project. The associated disciplinary program will review the scientific merit on a competitive basis that includes the potential cost to the program of conducting the experiment 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.

Preliminary Design: At Preliminary Design, the instrumentation proposal must contain the preliminary design and include the total project lifecycle planning. For the largest projects this is expected to include a Project Execution Plan (PEP) describing how the project will be managed, the scope 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 is also required in order to support the proposed construction funding profile. Projection of operating costs should be revisited in an updated plan for the operations phase.

Final Design: At this stage, the instrumentation proposal demonstrates that enabling R&D is completed, and that bid packages for major contracts or acquisitions have been completed. The fabrication budget estimate 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 construction activities are recruited and ready to commence fabrication. Commitments from external partners in the activity are confirmed. The largest and most complex projects (with total fabrication costs exceeding $10M) will be required to provide Earned Value Management reporting during construction, and should prepare an Earned Value Management System during this phase in readiness for fabrication.

B. Budgetary Information

Cost Sharing:

Inclusion of voluntary committed cost sharing is prohibited.

C. Due Dates

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

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D. FastLane / Grants.gov Requirements

For Proposals Submitted Via FastLane:

To prepare and submit a proposal via FastLane, see detailed technical instructions available at: https://www.fastlane.nsf.gov/a1/newstan.htm. For FastLane user support, call the FastLane Help Desk at 1-800-673-6188 or e-mail fastlane@nsf.gov. The FastLane Help Desk answers

general technical questions related to the use of the FastLane system. Specific questions related to this program solicitation should be referred to the NSF program staff contact(s) listed in Section VIII of this funding opportunity.

For Proposals Submitted Via Grants.gov:

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

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

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

VI. NSF PROPOSAL PROCESSING AND REVIEW PROCEDURES

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

A comprehensive description of the Foundation's merit review process is available on the NSF website at: http://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 *Investing in Science, Engineering, and Education for the Nation's Future: NSF Strategic Plan for 2014-2018*. These strategies are integrated in the program planning and implementation process, of which proposal review is one part. NSF's mission is particularly well-implemented through the integration of research and education and broadening participation in NSF programs, projects, and activities.

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

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

A. Merit Review Principles and Criteria

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

1. Merit Review Principles

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

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

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

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

2. Merit Review Criteria

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

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

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

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

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

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

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

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

Additional Solicitation Specific Review Criteria

Additional Criterion for all Proposals

For PIs who anticipate having other concurrent sources of support (including but not limited to grants from other agencies or private foundations, and laboratory appointments), the proposal review process will include an assessment of the proposers' ability to carry out the proposed research in light of commitments associated with these other sources of support.

Proposals that request support for large investments – either midscale instrumentation or long-duration support – have additional review criteria, as described below.

Additional Criteria for Midscale Instrumentation

Conceptual Design: The proposal must include a full statement of the science goals and sufficient technical detail to appropriately review the project. The associated disciplinary program will review the scientific merit on a competitive basis that includes the potential cost to the program of conducting the experiment that would be enabled by the instrumentation. The program may seek additional reviews to evaluate the technical scope and costs at a level commensurate with conceptual design.

Preliminary Design: The review at this stage will focus on project-related aspects such as budgets and project management, and will evaluate, as appropriate to this level, a Project Execution Plan (PEP) describing how the project will be managed, the scope 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 is also required in order to support the proposed construction funding profile.

Final Design: The review at this stage will focus on reliability of costs and technical readiness, as evidenced by the following. At this stage, the instrumentation proposal demonstrates that enabling R&D is completed, and that bid packages for major contracts or acquisitions have been completed. The fabrication budget estimate 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 construction activities are recruited and ready to commence fabrication. Commitments from external partners in the activity are confirmed. The largest and most complex projects (with total fabrication costs exceeding $10M) will be required to provide Earned Value Management reporting during construction, and should prepare an Earned Value Management System during this phase in readiness for fabrication.

Additional Criteria for Long-Duration Efforts

For long-duration efforts, the review may consider performance schedules, lifecycle planning, and, for renewal proposals, the record of success in achieving any previously set milestones. As needed, these reviews may involve site visits.

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 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 http://www.nsf.gov/awards/managing/award_conditions.jsp?org=NSF. Paper copies may be obtained from the NSF Publications Clearinghouse, telephone (703) 292-7827 or by e-mail from nsfpubs@nsf.gov.

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

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=papp.

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:

- Vyacheslav (Slava) Lukin, Accelerator Science; Plasma Physics, telephone: (703) 292-7382, email: vlukin@nsf.gov
- Alex Cronin, telephone: (703) 292-5302, email: acronin@nsf.gov
- John Gillaspy, Atomic, Molecular and Optical Physics - Experiment, telephone: (703) 292-7173, email: jgillasp@nsf.gov

- Michael J. Cavagnero, Atomic, Molecular and Optical Physics - Theory, telephone: (703) 292-2163, email: mcavagne@nsf.gov
- Bogdan Mihaila, Computational Physics; Nuclear Physics - Theory, telephone: (703) 292-8235, email: bmihaila@nsf.gov
- Saul Gonzalez Martirena, Elementary Particle Physics - Experiment, telephone: (703) 292-2093, email: sgonzale@nsf.gov
- James Shank, Accelerator Science; Elementary Particle Physics - Experiment, telephone: (703) 292-8343, email: jshank@nsf.gov
- Keith R. Dienes, Elementary Particle Physics - Theory; Particle Astrophysics and Cosmology - Theory, telephone: (703) 292-5314, email: kdienes@nsf.gov
- Pedro Marronetti, Gravitational Physics - Experiment and Theory, telephone: (703) 292-7372, email: pmarrone@nsf.gov
- Kathleen McCloud, Integrative Activities in Physics, telephone: (703) 292-8236, email: kmccloud@nsf.gov
- Allena K. Opper, Nuclear Physics - Experiment, telephone: (703) 292-8958, email: aopper@nsf.gov
- Jean Cottam Allen, Particle Astrophysics (Cosmic Phenomena) - Experiment, telephone: (703) 292-8783, email: jcallen@nsf.gov
- James Whitmore, Particle Astrophysics (Underground Physics) - Experiment, telephone: (703) 292-8908, email: jwhitmor@nsf.gov
- Krastan B. Blagoev, Physics of Living Systems, telephone: (703) 292-4666, email: kblagoev@nsf.gov
- Mark Coles, Projects and Facilities, telephone: (703) 292-4432, email: mcoles@nsf.gov

For questions related to the use of FastLane, contact:

- FastLane Help Desk, telephone: 1-800-673-6188; e-mail: fastlane@nsf.gov.

For questions relating to Grants.gov contact:

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

IX. OTHER INFORMATION

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

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

ABOUT THE NATIONAL SCIENCE FOUNDATION

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

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

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

Facilitation Awards for Scientists and Engineers with Disabilities (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 http://www.nsf.gov

- **Location:** 4201 Wilson Blvd. Arlington, VA 22230
- **For General Information** (703) 292-5111

(NSF Information Center):

- **TDD (for the hearing-impaired):** (703) 292-5090
- **To Order Publications or Forms:**

  Send an e-mail to: nsfpubs@nsf.gov

  or telephone: (703) 292-7827
- **To Locate NSF Employees:** (703) 292-5111

PRIVACY ACT AND PUBLIC BURDEN STATEMENTS

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

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

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