Future of Semiconductors (FuSe)

PROGRAM SOLICITATION
NSF 22-589

National Science Foundation

Directorate for Engineering
- Division of Civil, Mechanical and Manufacturing Innovation
- Division of Electrical, Communications and Cyber Systems

Directorate for Mathematical and Physical Sciences
- Division of Mathematical Sciences
- Division of Materials Research
- Division of Chemistry

Directorate for Computer and Information Science and Engineering
- Division of Computing and Communication Foundations
- Division of Computer and Network Systems

Directorate for Education and Human Resources
- Division of Graduate Education
- Division of Undergraduate Education

Directorate for Technology, Innovation and Partnerships

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

July 18, 2022

IMPORTANT INFORMATION AND REVISION NOTES

Innovating and migrating proposal preparation and submission capabilities from FastLane to Research.gov is part of the ongoing NSF information technology modernization efforts, as described in Important Notice No. 147. In support of these efforts, research proposals submitted in response to this program solicitation must be prepared and submitted via Research.gov or via Grants.gov, and may not be prepared or submitted via FastLane.

Any proposal submitted in response to this solicitation should be submitted in accordance with the revised *NSF Proposal & Award Policies & Procedures Guide* (PAPPG) (NSF 22-1), which is effective for proposals submitted, or due, on or after October 4, 2021.

SUMMARY OF PROGRAM REQUIREMENTS

General Information

Program Title:

Future of Semiconductors - Teaming for Co-Design Research Capacity (FuSe Teaming Grants) (FuSe)

Synopsis of Program:

The current state of semiconductor microelectronic systems is at a crossroads. Continued advances in the range and capabilities of our technologies as well as reducing their cost of applications across computing, sensing, and communications represent a tremendous opportunity. The technology has expanded following the trends in miniaturization long characterized by Moore's Law, underpinned by new materials, processes, devices, and architectures. The developments in these underpinning areas have often progressed independent of the application area, delaying their incorporation into the next-generation technologies. Closing that gap between the essential components in the technology stack, from materials through devices to systems, is now required to ensure further progress. The materials, devices and systems need to be *co-designed*, that is, designed with simultaneous consideration of as many elements of the technology chain as possible, spanning materials, devices, circuits, architectures, software, and applications.

Furthermore, developing a sufficient pool of diverse and multi-disciplinary talent suitable for workforce participation in the US is also essential for the future success of the semiconductor microelectronics field. In addition to fundamental and applied research, rapid developments in the vibrant field of semiconductors also offer new and unique opportunities and challenges when it comes to workforce preparation, education, and broadening participation. Co-design has been widely recognized in government and industry studies as means to accelerate advances in semiconductor technology. A holistic, co-design approach can more rapidly create high-performance, robust, secure, compact, energy-efficient, and cost-effective solutions. The technological challenges that are overcome by co-design approaches include: dramatically reducing the energy consumption of the existing computation and communication systems; reducing the impact of device and system manufacturing on

the environment; increasing performance speed and capacity; and developing novel computing systems.

Expediting the next and future generations of semiconductor systems will impact all aspects of modern life and all industries of our economy. The future of semiconductor manufacturing will require the design and deployment of diverse new technologies in materials, chemical and materials processes, devices, architectures through the development of application-driven systems, and engaging the full spectrum of talent in the academic community and industrial sectors. Partnerships between industry and institutions of higher education are essential to spur innovation and technology transfer, to inform the research needs, and to educate future researchers and train the future workforce.

The goal of this solicitation is to cultivate a broad coalition of researchers from across science and engineering communities to utilize a holistic, co-design approach to fundamental research and education and training, to enable rapid progress in new semiconductor technologies. Proposals are sought to support team-formation to articulate co-design visions for the future. Teaming grants are expected to support capacity building across the co-design platform, which positions investigators for future competitive larger research grants and possibly future center activity. Teaming grants can also support catalytic activities that foster stakeholder community networks to develop strategies that address the innovative co-design capacity of the U.S. for future semiconductors at the national research center level. Teaming grants prepares groups of complimentary researchers to respond to future calls for co-design research and potentially centers.

Initially, team formation is directed to the following three research areas identified for support in FY 2022 under this solicitation, as described in greater detail below:

- Collaborative Research in Domain-Specific Computing
- Advancing Function and Achieving High-Performance from Heterointegration
- New Materials for Energy Efficient, Enhanced-performance and Sustainable Semiconductor-based Systems

Future of Semiconductor Teaming Grants (*FuSe*-TG) - Awards will provide up to two years of support for up to $100,000 per participating organization on the proposal with a minimum of three organizations. Proposals can address any of the three topic areas above, or another research problem requiring co-design in the broad area of semiconductors. The Teaming Grants are intended to stimulate research capacity through multidisciplinary team building and the development of high-impact, fundamental research concepts. The Teaming Grants are appropriate for supporting a range of planning activities intended to identify, compose, educate, and foster a convergent research team that can effectively integrate multiple disciplinary perspectives, explore the co-design research platform, hone research gaps, questions, and hypotheses, and build synergistic collaborations that enhance or create a combined capacity to address *FuSe* co-design research challenges. Activities within the scope of this solicitation include but are not limited to, travel, student support, multidisciplinary workshops, data collection, preliminary experiments, and pilots. At the conclusion of any *FuSe*-TG, teams may have identified additional members for covering complementary areas and should be prepared to pursue a potential future well-defined research challenge ranging in scope and scale from multi-participant, interdisciplinary research grants up to future co-design centers. For example, Future of Semiconductor Centers for Co-Design may serve as national nexus points for collaborative efforts spanning institutions of higher education, federal agencies, semiconductor industry sectors including foundries, and other nonprofits/foundations in such areas. They would be directed towards the acceleration of the transition of innovations throughout the technology stack from materials to applications impacting many economic sectors, and nurture and grow the next generation of talent. *FuSe*-TG proposals for co-design centers must identify critical needs for solutions and address strategies guiding the proposed teaming activities. The anticipated outcomes for *FuSe*-TG award for co-design centers must include increased capacity of the semiconductor research and education, strengthened partnerships with industry and stakeholders, and broadened participation, which enables the teams to be better equipped to tackle, in the future, a center-scale, convergent, co-design research effort with large societal impact at the national level or in a global context.

For teaming grant activities, interdisciplinary teams commensurate with the scope of the proposed research, education plan, and budget are required. Proposals led by or including minority-serving institutions (https://www2.ed.gov/about/offices/list/ocr/edlite-minorityinst.html) are encouraged. Proposals must include expertise among the team members to carry out the proposed research, education, and workforce development activities. A diverse team and convergence research are expected.

Realizing the benefits of the fundamental co-design research approach supported under this solicitation requires the simultaneous education of a skilled technical workforce to transition new discoveries into U.S.-based industries. The National Science Board emphasizes this perspective in its report, "The Skilled Technical Workforce: Crafting America's Science and Engineering Enterprise." Therefore, proposers responding to this solicitation must include within the Project Description a section titled "Education and Workforce Development Plan" that describes proposed efforts to equip students and upskill the existing workforce needed for future technologies. It should also include an evaluation component, led by an appropriate expert, to assess the effectiveness of approach. The Education and Workforce Development Plan should describe the approaches developed by the team for education and training which are innovative, evidence-based, aligned with changing workforce and research needs, transferable, and dedicated to developing diverse and versatile professionals to support the semiconductor field. The plan should describe the population(s) to be served and specify the anticipated numbers of trainees supported. The plan should also include a timeline of progressive training elements.

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.

- Sankar Basu, (CISE/CCF), telephone: (703) 292-7843, email: fuse@nsf.gov
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Applicable Catalog of Federal Domestic Assistance (CFDA) Number(s):

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

Award Information

Anticipated Type of Award: Standard Grant or Continuing Grant

Estimated Number of Awards: 30

In FY 2022, depending on the quality of submissions and the availability of funds:

~ *FuSe* Teaming Grants will be awarded as Standard awards or Continuing grants for periods of up of two years and at up to $100,000 per participating organization, with a minimum of at least three participating organizations per project. The inclusion of minority-serving institutions and those organizations which contribute to research and training by focusing on the skilled technical workforce is encouraged.

Proposals Involving Multiple Organizations. The NSF PAPPG describes two kinds of collaborative proposal formats. This solicitation allows only a **single proposal** submission with subawards administered by the lead organization (PAPPG Chapter II.D.3.a). The other format of a collaborative proposal, in which each participating organization submits its own proposal, will not be accepted. For proposals involving multiple organizations, a lead organization must submit a proposal that describes the entire project. Funds may be distributed to other participating organizations as subawards from the lead organization. A budget on the standard NSF budget format and a budget justification should be included for each subawardee.

Anticipated Funding Amount: $10,000,000

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

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. Unaffiliated individuals are not eligible to submit proposals in response to this solicitation.

Who May Serve as PI:

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. Unaffiliated individuals are not eligible to submit proposals in response to this solicitation.

Limit on Number of Proposals per Organization:

There are no restrictions or limits.

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

An investigator may serve as PI or co-PI on only one proposal. In addition, they may serve as senior personnel on another proposal, for a total of at most two proposals submitted to this solicitation. If an investigator exceeds this limit, proposals received within the limit will be accepted based on the earliest date and time of proposal submission. The additional proposal submission(s) will be returned without review. This limitation includes proposals submitted by a lead organization and any subawards included as part of the proposal involving multiple organizations.

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 Research.gov: *NSF Proposal and Award Policies and Procedures Guide* (PAPPG) guidelines apply. The complete text of the PAPPG is available electronically on the NSF website at: https://www.nsf.gov/publications/pub_summ.jsp?ods_key=pappg.
  - Full Proposals submitted via Grants.gov: *NSF Grants.gov Application Guide: A Guide for the Preparation and Submission of NSF Applications via Grants.gov* guidelines apply (Note: The *NSF Grants.gov Application Guide* is available on the Grants.gov website and on the NSF website at: https://www.nsf.gov/publications/pub_summ.jsp?ods_key=grantsgovguide).

B. Budgetary Information

- **Cost Sharing Requirements:**

  Inclusion of voluntary committed cost sharing is prohibited.

- **Indirect Cost (F&A) Limitations:**

  Not Applicable

- **Other Budgetary Limitations:**

  Not Applicable

C. Due Dates

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

  July 18, 2022

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.

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I. INTRODUCTION

The Future of Semiconductors initiative *(FuSe)* is a cross-directorate program supported by NSF's Directorates for Computer and Information Science and Engineering (CISE), Engineering (ENG), Education and Human Resources (EHR), Technology, Innovation, and Partnerships (TIP) and Mathematical and Physical Sciences (MPS).

The goal of *FuSe* is to support fundamental research enabling the co-design of semiconductor materials, devices and systems that will propel the US semiconductor manufacturing and applications beyond the limits of Moore's law and discover new application spaces. "Co-design" is emphasized to encourage cross-fertilization among broad areas of research sponsored by the NSF, specifically research that crosses traditional directorate boundaries at the NSF (e.g., CISE, ENG, MPS, EHR, TIP, etc.) and that do not fit well with existing programs. Co-design simultaneously considers the device/system performance, manufacturability, recyclability, and impact on the environment.

The program seeks to develop new semiconductor systems through this intimate convergent co-design of the essential elements of the process, linking the critical components of the application in a single integrated process. Current practice focuses on independent research and discovery in each area separately and advances are often not effectively translated to practice. The *FuSe* program will support advances and research where parts or all of this application ecosystem, materials, devices and systems, are discovered and developed in an integrated way, which can better facilitate knowledge transfer between these research areas.

FuSe-TG proposals described in the Program Description, should demonstrate the need for sustained support of a multidisciplinary team using a convergence research approach. Lead proposals from minority-serving institutions are encouraged. Proposals must describe why the project team is appropriate to realize the project's goals and how the team will assure effective collaboration in the co-design process. A compelling rationale must be presented for the organization structure of the project. Therefore, proposers responding to this solicitation must include a "Project Management and Collaboration" section. *FuSe* complements existing research activities in the area, both within NSF and other federal agencies, but focuses on the co-design of one or more steps in the application development process. This approach should lead to the discovery of new applications and cross-fertilization to improve the performance in existing application areas, realize new application areas, while improving fabrication, design, security, energy efficiency and process sustainability. *FuSe*-TG proposals should provide a clear vision of the application area impacted by the research and can include ties to industry to enable rapid adoption of new discoveries. They should provide a vision statement describing the new capabilities that could be enabled by the proposed research, and the potential industrial and societal benefits.

The demand for greater information and communications technology (ICT) is projected to increase and requires a larger percentage of the world's total energy production. While ICT currently consumes only a minor percentage of the total energy used worldwide, it is increasing at a rapid rate. Along with greater energy demands are the associated increases in water consumption and greenhouse gas production, challenging the process sustainability. Thus, energy efficiency and sustainability should be a consideration in all proposals. Both experimental and computational approaches will be needed as well as potentially data mining and analytics to accelerate the co-design process.

All proposals should describe the implications of the proposed activities on the education of the skilled technical workforce in co-design approaches, and semiconductor industry. (Skilled technical workforce refers broadly to settings ranging from technical institutes and community colleges to advanced research.) The development of a skilled workforce versed in the organizational and technical aspects of co-design is critical for advancing semiconductor technologies and needs to be addressed. Therefore, proposers responding to this solicitation must include within the Project Description a section titled "Education and Workforce Development Plan" that describes planned efforts to equip students and upskill the existing workforce needed in the future technologies and includes an evaluation component to assess the effectiveness of approach.

The results of the *FuSe* program, when translated to practice, should lead to the formation of new industries and organizational structures, enable new capabilities among a broad range of industries, enhance U.S. competitiveness in developing and producing new products, bolster economic growth, benefit society at large, and educate students and other workforce participants with the skills required for leadership in the burgeoning industries. Results will help the manufacturing enterprise minimize environmental impact, reduce energy consumption in both the manufacture and use of semiconductor systems, manage waste, and optimize fabrication/design security and the use of resources.

Proposals to *FuSe-TG* should span research across several or all of the CISE, ENG, EHR, TIP and MPS directorates, and be compelling across the subdisciplines spanned. **Specifically, proposals submitted in response to this solicitation will address semiconductor research and workforce development in a broad sense, and they must integrate a combination of innovative tools and techniques from computational, engineering, materials sciences, mathematical and physical sciences.**

II. PROGRAM DESCRIPTION

***Future of Semiconductors* Teaming Grants (*FuSe-TG*)**

Fuse-TG proposals address team formation and collaboration towards co-design in one or more of the topic areas. The discussion of each topic area is not intended to be limiting, and these examples do not indicate they are of any particular interest to the NSF. They are presented only to illustrate possible considerations in each topic area.

Topic areas for teaming grants:

Topic 1: Collaborative Research in Domain-Specific Computing

Modern computing systems rely on a deep abstraction stack of technology ranging from high-level applications through computer and network systems, to circuits, devices, and materials. In this solicitation we invite proposals for the formation teams that reimagine computing systems by collaborating across traditional levels of the abstraction stack, or by breaking or circumventing that traditional stack completely. This can be done by considering new ways of looking at the traditional computing stack, by enabling enhanced communication across layers of the stack, or by approaching design from a completely new viewpoint. Taken as a whole, these approaches can be broadly categorized as **Domain-Specific Computing**. Examples of domains of interest are (but are not limited to):

- Application Domains:
  - Artificial intelligence and machine learning, brain-inspired computing, large data processing, financial computing, wireless next-G systems, graph-based, genomic, and sparse-data computing, etc.
- Computing Strategy Domains:
  - Non von Neumann architectures, self-organizing, self-correcting and adaptive architectures, approximate computing, Cloud-Edge-IoT computing continuum, virtualization in edge data centers, quantum inspired classical computing, Using machines and synchronization in oscillators, computing paradigms inspired by models of physics and biology, analog and mixed signal computing, tensor processing, privacy preserving, secure, trustworthy and error-tolerant approaches, etc.
- Technology Domains:
  - Processing in memory, non-volatile memory, 3D and/or 2.5D architectures, circuits and systems for 5G/6G, classical computing with probabilistic bits (p-bits), co-integration of CMOS with X technologies (X=emerging devices in significant numbers), emerging technologies for memory, logic, and interconnect, including non-charge-based devices and systems, novel design automation of micro- and nano- systems including AI/ML inspired methods, energy-efficient and sustainable approaches, etc.

The overall goal is to increase the performance, usability, sustainability, or other aspects of computing systems by exploiting the characteristics of a broad domain of interest. Successful proposals will explain why the proposed research is enabled exploring a specific domain, and how the proposed activities will

substantially improve chosen evaluation metrics. Project descriptions must be comprehensive, well-integrated, and convincing that the collaborative contributions of the project team will be greater than the sum of each individual contribution. Investigators are especially encouraged to seek out partnerships with diverse types of institutions of higher education that together can provide new and compelling approaches to the proposed research. Details should be included about how the chosen domain features are central to the research goals.

Topic 2: Advancing Function and Achieving High-Performance from Heterointegration

This topic aims to accelerate the adoption of advanced photonic, quantum, memory, energy, or sensing devices/components in the semiconductor technology to enable cutting-edge functionality. It supports team formation for the holistic co-design of heterogeneous systems across devices, circuits, and algorithms, by integrating novel components/materials compatible with CMOS (or future technologies). This topic would focus on co-design system-level strategies enabling the most robust, compact, energy-efficient, and cost-effective solutions that address how analog information is sensed, processed, stored, communicated, and actuated upon. The research addressed should include co-optimization of functionalities crossing boundaries of sensor, analog processing, digital processing, machine learning and detection etc., for smarter world-machine interfaces or sustained always-available communication.

Examples that embrace heterogeneous integration with advanced functionalities are (but are not limited to):

- CMOS platform integration with advanced analog hardware of photonic, quantum, memory, energy, or sensing technologies, for high energy efficiency, high speed, compact, tailored bandwidth/frequency/temperature, and scalable.
- Package platform integration with multiple analog hardware of photonic, quantum, memory, energy, or sensing technologies, enable to DC to THz operation, with energy-, size-, and cost-efficiency.
- Bioinspired sensing-to-action with machine learning architectures enabled by synapse or in memory computing that improve environment and health by balancing local processing power/energy and cost with global considerations.
- Microelectronics accelerating the adoption of wide-bandgap semiconductor technology and increasing the integration of power-conversion with sensing and communication, for high power density, high-bandwidth interconnects, and use in extreme environments.
- Millimeter wave and next-generation communications: Intelligent and active networks that effectively utilize bandwidth to maximize network capacity, integrated RF filters that are actively tunable, agile front-ends that enable rapid frequency hopping, short-range millimeter-wave/terahertz sensing and imaging, low-power communications and sensing, reconfigurable THz micro- and nanoelectronics.
- Secure analog/RF and mixed-signal technologies: Quantum communication. RF-to-photonic spectrum security for wireless systems operating from RF to optical frequencies, shared spectrum sensing for distributed system security architecture, high-speed communication physical layer security.

FuSe-Teaming grant proposals must describe the current state-of-the-art in the relevant application area, the specific challenges that will be addressed by the team formation and include the plans to validate or demonstrate the co-designs relevant to the current and advanced industry technologies. A device focused *FuSe-TG team* should address plans to develop methodologies or computer simulation tools to establish intrinsic performance limits of the targeted functionality. *FuSe-TG* proposals should articulate the underlining fundamental research and the innovation anticipated, in terms of models or tools that leads the heterointegration simulation or the analog mixed signal designs to productivity and predictability.

Topic 3: New Materials for Energy Efficient, Enhanced-performance and Sustainable Semiconductor-based Systems

The continued advances in microelectronic miniaturization with smaller and more powerful devices, is taxed with a concomitant increase in energy consumption. While the energy efficiency of computers has been steadily improving, this trend is being challenged with the massive increase of computations in all aspects of modern life. The field is currently approaching a paradigm shift as traditional Moore's law silicon transistor scaling is no longer yielding commensurate energy efficiency benefits. This comes at a time when much more computing power is needed to deal with emerging data-intensive applications that rely on artificial intelligence (AI) and machine learning (ML) to generate new sectors of the economy and to revitalize American manufacturing.

Advances in this area requires vertical integration of the essential components of the technology chain, from materials through devices to systems. Co-design should simultaneously consider as many elements of the technology chain as possible beginning from materials, devices, circuits, architectures, and proceeding all the way to software and applications. Furthermore, material discovery, synthesis, and use in devices should be carried out while recognizing the importance of scalability and manufacturability. Applying the principle of co-design, proposals should address manufacturability, such as how introducing a new material into a device impacts the choice of other materials in the device, chemical and manufacturing processing for those materials, subsequent device processing, device and system recyclability, and long-term environmental impact.

Team composition should address a convergent approach employing the co-design of scalable atomically precise material synthesis and processing with device design for energy efficient computing, sensing, and communication systems. Proposals that emphasize energy-efficient, sustainable device manufacturing processes using earth-abundant and nontoxic materials, minimizing water usage, and strives for zero waste are prioritized.

Potential areas of interest are (but are not limited to):

- Materials enabling logic functions that minimize ohmic energy losses by employing. superconductivity, spintronics, valleytronics, photonics, etc.
- Materials that enable new non von Neuman logic, such as brain inspired/neuromorphic computing including memristors, and/or negative capacitance.
- Materials with ultralow electrical conductivity such as NbAs, ultralow k dielectrics, or low metal contact resistances.
- Materials for high-efficiency power devices, such as wide-gap semiconductors.
- Materials for low-energy memory devices such as phase-change materials.
- Materials that enable electrical signal interfacing between biological materials and CMOS.
- Studies aimed at the control of the surface and interfacial properties of these materials to allow for the precise and reproducible positioning of nanoclusters from disparate materials on surfaces for the development of integrated devices.
- Processes that enable novel device architectures such as transistors based on carbon nanotubes, graphene, or other 2D and nanomaterials; hetero-integration of dissimilar materials via processes such as wafer bonding or vertical stacking; novel approaches to epitaxy; etc.
- Development of new transport characterization and high-resolution imaging technologies for the characterization of these materials at the atomic/molecular level and for the mapping of defects.

Components common to all proposals

FuSe-Teaming grant proposals must describe the current state of art in the relevant application area and the specific challenges that will be addressed by the proposed research. They must present a compelling rationale for the proposed research direction and team composition and provide a convincing plan for a technical approach for co-design to address these challenges. Proposals must clearly explain how the future research will ultimately improve existing devices, or lead to new device designs, devices or system capabilities that are not currently available. Proposals should be multidisciplinary and include appropriate metrics for performance and energy usage. While not a requirement, approaches that develop a potential path for manufacturing scale-up and translation into industry are desirable. Proposals should explicitly address the potential benefits and challenges of co-design within the application area to the economy, environment and to society.

FuSe Teaming Grants encourage individuals with compelling foundational scientific and technological expertise to identify one or more outstanding challenges, propose a research program, and assemble a team with pertinent research and teaming expertise. All *FuSe-TG* proposals must be directed to team formation towards a convergent, use-inspired, and advanced basic scientific understanding of proposed semiconductor research that can impact US industry including workforce development and sustainable manufacturing. The approaches envisioned in successful proposals will use cutting-edge engineering, computational, and scientific techniques to formulate and solve critical problems and demonstrate their feasibility. A variety of activities may be proposed, including pilot research projects to obtain preliminary results to strengthen a subsequent proposal to NSF; development of new partnerships, especially those involving industrial partners; workshops, webinars and other outreach and engagement forums; partnerships between organizations that serve different research specialties or different student demographics; and piloting new educational activities. Educational activities that focus on the skilled technical workforce and involve collaborations with two-year institutions of higher education are particularly encouraged across all Teaming Grants. The participation of minority-serving institutions in research and training is encouraged. At the conclusion of any *FuSe-TG*, researchers should be prepared to pursue a well-defined research challenge ranging in scope and scale from *FuSe*-research grants up to future co-design centers. For example, Future of Semiconductor Centers for Co-Design may serve as national nexus points for collaborative efforts spanning institutions of higher education, federal agencies, industry, and other nonprofits/foundations in such areas. They would be directed towards accelerating the transition of innovations throughout the computing stack from materials to applications impacting many economic sectors, and nurture and grow the next generation of talent.

Collaboration and convergence should go beyond traditional disciplinary, organizational, and geographic boundaries to build conceptually new connections and integrate research. Teaming Grants also are urged to conceptualize and pilot new modes for engaging the community in ways that can be scaled up to larger collaborations, through additional collaborations or increase in scope, and transformative science and engineering, possibly including the use of emerging large and medium scale infrastructure facilities for fabrication. The proposed semiconductor research team may target applications areas, e.g., Artificial Intelligence, Wireless next G, System security, Autonomous vehicles, or still other applications.

Teaming Grants are for durations of up to two years and up to $100,000 per participating organization, with a minimum of 3 organizations per project, serving to build multidisciplinary teams that develop communities and capacity for future co-design research projects. These activities may also include exploratory collaborative research needed to demonstrate a basis of confidence for new convergent approaches central to the future vision being pursued.

III. AWARD INFORMATION

Anticipated Type of Award: Continuing Grant or Standard Grant

Estimated Number of Awards: 30

In FY 2022, depending on the quality of submissions and the availability of funds:

~ *FuSe* Teaming Grants will be awarded as Standard awards or Continuing grants for periods of up of two years and at up to $100,000 per participating organization, with a minimum of at least three participating organizations per project. The inclusion of minority-serving institutions and those organizations which contribute to research and training by focusing on the skilled technical workforce is encouraged.

Proposals Involving Multiple Organizations. The Proposal & Award Policies & Procedures Guide (PAPPG) describes two kinds of collaborative proposal formats. This solicitation allows only a **single proposal** submission with subawards administered by the lead organization (Chapter II.D.3.a). The other format of a collaborative proposal, in which each participating organization submits its own proposal, will not be accepted. For proposals involving multiple organizations, a lead organization must submit a proposal that describes the entire project. Funds may be distributed to other participating organizations as subawards from the lead organization. A budget on the standard NSF budget format and a budget justification should be included for each subawardee.

Anticipated Funding Amount: $10,000,000

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. Unaffiliated individuals are not eligible to submit proposals in response to this solicitation.

Who May Serve as PI:

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Limit on Number of Proposals per Organization:

There are no restrictions or limits.

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

An investigator may serve as PI or co-PI on only one proposal. In addition, they may serve as senior personnel on another proposal, for a total of at most two proposals submitted to this solicitation. If an investigator exceeds this limit, proposals received within the limit will be accepted based on the earliest date and time of proposal submission. The additional proposal submission(s) will be returned without review. This limitation includes proposals submitted by a lead organization and any subawards included as part of the proposal involving multiple organizations.

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 Research.gov or Grants.gov.

- Full Proposals submitted via Research.gov: Proposals submitted in response to this program solicitation should be prepared and submitted in accordance with the general guidelines contained in the *NSF Proposal and Award Policies and Procedures Guide* (PAPPG). The complete text of the PAPPG is available electronically on the NSF website at: https://www.nsf.gov/publications/pub_summ.jsp?ods_key=pappg. Paper copies of the PAPPG may be obtained from the NSF Publications Clearinghouse, telephone (703) 292-8134 or by e-mail from nsfpubs@nsf.gov. The Prepare New Proposal setup will prompt you for the program solicitation number.
- Full proposals submitted via Grants.gov: Proposals submitted in response to this program solicitation via Grants.gov should be prepared and submitted in accordance with the *NSF Grants.gov Application Guide: A Guide for the Preparation and Submission of NSF Applications via Grants.gov*. The complete text of the *NSF Grants.gov Application Guide* is available on the Grants.gov website and on the NSF website at: (https://www.nsf.gov/publications/pub_summ.jsp?ods_key=grantsgovguide). To obtain copies of the Application Guide and Application Forms Package, click on the Apply tab on the Grants.gov site, then click on the Apply Step 1: Download a Grant Application Package and Application Instructions link and enter the funding opportunity number, (the program solicitation number without the NSF prefix) and press the Download Package button. Paper copies of the Grants.gov Application Guide also may be obtained from the NSF Publications Clearinghouse, telephone (703) 292-8134 or by e-mail from nsfpubs@nsf.gov.

See PAPPG Chapter II.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.

In addition to the content specified in the PAPPG, including the requirement for a separate section labeled "Broader Impacts", the Project Description should contain specific additional sections with the following titles required, as indicated and described in the above Sections I and II:

1. Education and Workforce Development Plan
2. Project Management and Collaboration

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):

  July 18, 2022

D. Research.gov/Grants.gov Requirements

For Proposals Submitted Via Research.gov:

To prepare and submit a proposal via Research.gov, see detailed technical instructions available at: https://www.research.gov/research-portal/appmanager/base/desktop?_nfpb=true&_pageLabel=research_node_display&_nodePath=/researchGov/Service/Desktop/ProposalPreparationandSubmission.html. For Research.gov user support, call the Research.gov Help Desk at 1-800-673-6188 or e-mail rgov@nsf.gov. The Research.gov Help Desk answers general technical questions related to the use of the Research.gov 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: 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 Research.gov may use Research.gov to verify the status of their submission to NSF. For proposers that submitted via Grants.gov, until an application has been received and validated by NSF, the Authorized Organizational Representative may check the status of an application on Grants.gov. After proposers have received an e-mail notification from NSF, Research.gov should be used to check the status of an application.

VI. NSF PROPOSAL PROCESSING AND REVIEW PROCEDURES

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

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

Proposers should also be aware of core strategies that are essential to the fulfillment of NSF's mission, as articulated in *Leading the World in Discovery and Innovation, STEM Talent Development and the Delivery of Benefits from Research - NSF Strategic Plan for Fiscal Years (FY) 2022 - 2026* . These strategies are integrated in the program planning and implementation process, of which proposal review is one part. NSF's mission is particularly well-implemented through the integration of research and education and broadening participation in NSF programs, projects, and activities.

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

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

A. Merit Review Principles and Criteria

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

1. Merit Review Principles

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

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

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

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

2. Merit Review Criteria

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

The two merit review criteria are listed below. **Both** criteria are to be given **full consideration** during the review and decision-making processes; each criterion is necessary but neither, by itself, is sufficient. Therefore, proposers must fully address both criteria. (PAPPG Chapter II.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 other underrepresented groups in science, technology, engineering, and mathematics (STEM); improved STEM education and educator development at any level; increased public scientific literacy and public engagement with science and technology; improved well-being of individuals in society; development of a diverse, globally competitive STEM workforce; increased partnerships between academia, industry, and others; improved national security; increased economic competitiveness of the United States; and enhanced infrastructure for research and education.

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

Additional Solicitation Specific Review Criteria

- Does the proposal present a set of activities that will prepare the team for a future proposal of appropriate scale and scope, as envisioned by the team? For example, for those Teaming Grants wishing to build toward a center-scale project in the future, do the proposed Teaming-Grant activities offer a path toward that goal?
- Is the proposed teaming strategy appropriate for developing a potential competitive FuSe research capacity?

For *FuSe*-TG proposals addressing teaming for potential Center proposals:

- Does the proposed research address a complex and capacity issue for the future of semiconductors that requires co-design research at a center scale?
- Are the proposed strategies for engaging and developing the stakeholder community appropriate?
- Are minority-serving institutions, community colleges, and those organizations which contribute to research and training by focusing on the skilled technical workforce included?
- Does the proposal demonstrate a commitment to engaging underrepresented groups and diverse organization types?

B. Review and Selection Process

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

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

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

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

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

VII. AWARD ADMINISTRATION INFORMATION

A. Notification of the Award

Notification of the award is made to *the submitting organization* by an NSF Grants and Agreements Officer . Organizations whose proposals are declined will be advised as promptly as possible by the cognizant NSF Program administering the program. Verbatim copies of reviews, not including the identity of the reviewer,

will be provided automatically to the Principal Investigator. (See Section VI.B. for additional information on the review process.)

B. Award Conditions

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

*These documents may be accessed electronically on NSF's Website at https://www.nsf.gov/awards/managing/award_conditions.jsp?org=NSF. Paper copies may be obtained from the NSF Publications Clearinghouse, telephone (703) 292-8134 or by e-mail from nsfpubs@nsf.gov.

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

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:

- Sankar Basu, (CISE/CCF), telephone: (703) 292-7843, email: fuse@nsf.gov
- Geoffrey Brown, (TIP), telephone: (703) 292-4749, email: fuse@nsf.gov
- Erik N. Brunvand, (CISE/CNS), telephone: (703) 292-2767, email: fuse@nsf.gov
- James H. Edgar, (MPS/EPM), telephone: (703) 292-2053, email: fuse@nsf.gov
- Ruyan Guo, (ENG/ECCS), telephone: (703) 292-7718, email: fuse@nsf.gov
- George M. Janini, (MPS/CHE), telephone: (703) 292-4971, email: fuse@nsf.gov
- Thomas F. Kuech, (ENG/CMMI), telephone: (703) 292-2218, email: fuse@nsf.gov
- Vinod K. Lohani, (EHR/DGE), telephone: (703) 292-2330, email: fuse@nsf.gov
- Rosa Lukaszew, (ENG/ECCS), telephone: (703) 292-8103, email: fuse@nsf.gov
- Eleanor Sayre, (EHR/DUE), telephone: (703) 292-2330, email: fuse@nsf.gov
- Birgit Schwenzer, (MPS/DMR), telephone: (703) 292-4771, email: fuse@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) 292-8143
- **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:

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Office of Budget, Finance, and Award Management
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