

Addressing Systems Challenges through Engineering Teams (ASCENT)

PROGRAM SOLICITATION NSF 23-541

REPLACES DOCUMENT(S): NSF 22-534



National Science Foundation
Directorate for Engineering
Division of Electrical, Communications and Cyber Systems

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

February 01, 2023

LOI Deadline

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

April 19, 2023

Full Proposal Deadline

IMPORTANT INFORMATION AND REVISION NOTES

Revisions from [NSF 22-534](#) include:

- Submission of a preliminary proposal is no longer required.
- Submission of a Letter of Intent (LOI) is required for this ASCENT competition.
- Additional instructions are included for LOI preparation.
- In FY23 ASCENT will focus on clean energy and energy efficiency for climate change mitigation, the two research themes are: (i) Integrated Electronic Systems enabled by WBG/UWBG Semiconductors for Climate Change Mitigation; (ii) Integrated Power Systems for Clean Energy.

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

SUMMARY OF PROGRAM REQUIREMENTS

General Information

Program Title:

Addressing Systems Challenges through Engineering Teams (ASCENT)

Synopsis of Program:

The Electrical, Communications and Cyber Systems Division (ECCS) supports enabling and transformative engineering research at the nano, micro, and macro scales that fuels progress in engineering system applications with high societal impact. This includes fundamental engineering research underlying advanced devices and components and their seamless penetration in power, controls, networking, communications, or cyber systems. The research is envisioned to be empowered by cutting-edge computation, synthesis, evaluation, and analysis technologies and is to result in significant impact for a variety of application domains in healthcare, homeland security, disaster mitigation, telecommunications, energy, environment, transportation, manufacturing, and other systems-related areas. ECCS also supports new and emerging research areas encompassing 5G and Beyond Spectrum and Wireless Technologies, Quantum Information Science, Artificial Intelligence, Machine Learning, and Big Data.

ECCS, through its ASCENT program, offers its engineering community the opportunity to address research issues and answer engineering challenges associated with complex systems and networks that are not achievable by a single principal investigator or by short-term projects and can only be achieved by interdisciplinary research teams. ECCS envisions a connected portfolio of transformative and integrative projects that create synergistic links by investigators across its three ECCS clusters: Communications, Circuits, and Sensing-Systems (CCSS), Electronics, Photonics and Magnetic Devices (EPMD), and Energy, Power, Control, and Networks (EPCN), yielding novel ways of addressing challenges of engineering systems and networks. ECCS seeks proposals that are bold and ground-breaking, transcend the perspectives and approaches typical of disciplinary research efforts, and lead to disruptive technologies and methods or enable significant improvement in quality of life.

- ASCENT supports fundamental research projects involving at least three collaborating PIs and co-PIs, up to four years in duration, with a total budget between \$1 million and \$1.5 million.
- ASCENT proposals must highlight the engineering leadership focus of the proposal within the scope of ECCS programs.
- ASCENT proposals must articulate a fundamental research problem with compelling intellectual challenge and significant societal impact. The topic at the heart of the proposal must lie within the scope of at least one of the three ECCS clusters (CCSS, EPMD, EPCN). Research proposals spanning multiple clusters are highly encouraged.
- ASCENT proposals must demonstrate the need for a concerted research effort by an integrated and interdisciplinary team, and strongly justify the interdisciplinary nature of the proposed work. They should include a timeline for research activities, with a strong justification of the explicit mechanisms for frequent communication between team members and effective assessment to achieve proposed goals.

Assuming sufficient funding is provided in the NSF budget, it is anticipated that the ASCENT competition will continue with research themes and priorities subject to changing in the subsequent years.

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.

- Premjeet Chahal, telephone: (703) 292-7264, email: pchahal@nsf.gov
- Supriyo Bandyopadhyay, telephone: (703) 292-5392, email: sbandyop@nsf.gov
- Aranya Chakraborty, telephone: (703) 292-8113, email: achakrab@nsf.gov
- Jenshan Lin, telephone: (703) 292-7360, email: jenlin@nsf.gov
- Usha Varshney, telephone: (703) 292-5385, email: uvarshne@nsf.gov

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

- 47.041 --- Engineering

Award Information

Anticipated Type of Award: Standard Grant or Continuing Grant

Estimated Number of Awards: 4 to 6

4 to 6 each from \$1,000,000 to \$1,500,000 for a period of four years.

Anticipated Funding Amount: \$6,000,000

The number of awards and award size/duration are subject to the availability of funds and the quality of the proposals.

Eligibility Information

Who May Submit Proposals:

Proposals may only be submitted by the following:

- Institutions of Higher Education (IHEs) - Two- and four-year IHEs (including community colleges) accredited in, and having a campus located in the US, acting on behalf of their faculty members. Special Instructions for International Branch Campuses of US IHEs: If the proposal includes funding to be provided to an international branch campus of a US institution of higher education (including through use of subawards and consultant arrangements), the proposer must explain the benefit(s) to the project of performance at the international branch campus, and justify why the project activities cannot be performed at the US campus.

Who May Serve as PI:

PIs or co-PIs must hold primary, full-time, paid appointments in research or teaching positions at US-based campuses/offices of IHEs eligible to submit to this solicitation (see above), with exceptions granted for family or medical leave, as determined by the submitting institution.

A minimum of three PIs or co-PIs must participate in each proposal. Each PI/co-PI is expected to contribute complementary expertise relevant to the project proposed. Investigators/Senior Personnel with expertise in fabrication, testing, or other sciences may be considered, where appropriate.

If there are strong collaborations with industry, the Grant Opportunities for Academic Liaison with Industry (GOALI) type of proposal can be used in conjunction with this solicitation. See PAPPG Chapter II.F.5 for additional information and guidance.

Limit on Number of Proposals per Organization:

There are no restrictions or limits.

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

No individual may be a PI, Co-PI, or Senior Personnel on more than one ASCENT proposal in the current review cycle. Please be advised that if an individual's name appears in any of the above-mentioned capacities on more than ONE proposal, all submittals after the first proposal (based on time- stamp) will be returned without review. No exceptions will be made.

Proposal Preparation and Submission Instructions

A. Proposal Preparation Instructions

- **Letters of Intent:** Submission of Letters of Intent is required. Please see the full text of this solicitation for further information.
- **Preliminary Proposal Submission:** Not required
- **Full Proposals:**
 - Full Proposals submitted via Research.gov: *NSF Proposal and Award Policies and Procedures Guide (PAPPG)* guidelines apply. The complete text of the PAPPG is available electronically on the NSF website at: https://www.nsf.gov/publications/pub_summ.jsp?ods_key=pappg.
 - Full Proposals submitted via Grants.gov: *NSF Grants.gov Application Guide: A Guide for the Preparation and Submission of NSF Applications via Grants.gov* guidelines apply (Note: The *NSF Grants.gov Application Guide* is available on the Grants.gov website and on the NSF website at: https://www.nsf.gov/publications/pub_summ.jsp?ods_key=grantsgovguide).

B. Budgetary Information

- **Cost Sharing Requirements:**

Inclusion of voluntary committed cost sharing is prohibited.
- **Indirect Cost (F&A) Limitations:**

Not Applicable
- **Other Budgetary Limitations:**

Not Applicable

C. Due Dates

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

February 01, 2023
LOI Deadline
- **Full Proposal Deadline(s)** (due by 5 p.m. submitter's local time):

April 19, 2023
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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 goal of the ASCENT program is to support the engineering research community as it fulfills its unique leadership role in advancing engineering and the economic prosperity of the nation. ASCENT proposals must clearly frame a cutting-edge convergent approach to a research challenge that critically involves one or more ECCS cluster research areas. The integration of disciplinary expertise not typically engaged in ECCS-funded projects is encouraged. ASCENT is intended to support ambitious and far-reaching fundamental engineering research projects that may exceed the scope and strain the resources of an individual ECCS core program. ASCENT supports multi-investigator projects with a duration up to four years and a total budget from \$1,000,000 to \$1,500,000.

ASCENT proposals must demonstrate the need for a convergent engineering research effort by an integrated team and must include a research integration plan and a timeline for research activities, with convincing mechanisms for frequent and effective communication between team members. ASCENT proposals should articulate plans by which the proposed engineering research will address critical societal needs, and to specifically highlight the role of the proposed project in advancing that goal.

II. PROGRAM DESCRIPTION

The ASCENT program will support high-quality and ambitious fundamental research projects that involve the research areas of one or more ECCS clusters and are unsuitable for smaller teams or shorter durations. The ASCENT program is intended to produce results leading to disruptive technologies that lay the foundation for novel scientific and technological concepts to enable significant improvements in the environment, health, quality of life, and national prosperity. Integral to every ASCENT project must be an element to communicate the leadership role of engineering in addressing critical societal needs. **A compelling and innovative research problem, critically involving one or more ECCS cluster research areas must lie at the heart of an ASCENT proposal**, although integration of disciplinary expertise outside ECCS core disciplines is encouraged. ECCS core topics may be determined from current ECCS cluster descriptions described below, or by consulting with an ECCS Program Officer. The ASCENT program is not intended to support technology translation, although project outcomes may ultimately lead to commercialization.

ECCS Cluster Descriptions:

The **Communications, Circuits, and Sensing-Systems (CCSS)** Cluster supports innovative research in circuit and system hardware and signal processing techniques. CCSS also supports system and network architectures for communications and sensing to enable the next-generation cyber-physical systems (CPS) that leverage computation, communication, and sensing integrated with physical domains. CCSS invests in micro- and nano-electromechanical systems physical, chemical, and biological sensing systems, neurotechnologies, and high-speed communications & sensing circuits and systems for a variety of application domains including healthcare, medicine, communications, disaster mitigation, homeland security, intelligent transportation, manufacturing, energy, and smart buildings. CCSS encourages research proposals based on emerging technologies and applications for communications and sensing such as high-speed communications of terabits per second and beyond, sensing and imaging covering microwave to terahertz frequencies, personalized health monitoring, secured wireless connectivity and sensing for the Internet of Things, and dynamic-data-enabled autonomous systems through real-time sensing and learning.

The **Electronics, Photonics and Magnetic Devices (EPMD)** Cluster supports innovative research on novel devices based on the principles of electronics, optics and photonics, optoelectronics, magnetics, opto- and electromechanics, electromagnetics, and related physical phenomena contributing to a broad range of application domains including information and communications, imaging and sensing, healthcare, Internet of Things, energy, infrastructure, and manufacturing. The program encourages research based on emerging technologies for miniaturization, integration, and energy efficiency as well as novel material-based devices with new functionalities, improved efficiency, flexibility, tunability, wearability, and enhanced reliability.

The **Energy, Power, Control, and Networks (EPCN)** Cluster supports innovative research in modeling, optimization, machine learning, adaptation, and control of networked multi-agent systems, higher-level decision making, and dynamic resource allocation, as well as risk management in the presence of uncertainty, sub-system failures, and stochastic disturbances. EPCN also emphasizes electric power systems, including generation, transmission, storage, and integration of renewable energy sources into the grid; power electronics and drives; battery management systems; hybrid and electric vehicles; and understanding of the interplay of power systems with associated regulatory & economic structures and with consumer behavior.

For details on ECCS Cluster descriptions, please refer to the website at <https://www.nsf.gov/div/index.jsp?div=ECCS>.

ASCENT 2023: Enhanced energy efficiency for climate change mitigation

This year's ASCENT focuses on the major topic of climate change. Climate change due to long-term shifts in temperatures and weather patterns alters the atmosphere's composition. These climatic changes have become a global concern over the last few decades as they affect life in various ways. These changes are currently associated with human activities as the main driver, primarily due to the burning of fossil fuels (such as coal, oil, and gas) which produces heat-trapping gases. This solicitation focuses on the National priority of climate change mitigation and reducing greenhouse gas emissions towards a carbon-free clean electricity sector. Combined electricity production and transportation sectors are responsible for nearly half of greenhouse gas emissions. Currently, 60% of our electricity comes from burning fossil fuels, and almost all transportation sectors depend on it. The future of transportation is dependent on electric energy. In addition, electricity consumption by the Information and Communication Technology (ICT) sector is increasing rapidly. The U.S. Energy Information Administration (EIA) projects that global electricity production needs to increase ~ 50% by 2050. Over the next few decades, there is a critical need for a fossil-free electricity sector to meet the growing demand by addressing energy efficiency, fuel switching, and end-use.

The most cost-effective way to reduce energy use and cut emissions is by improving the electricity sector's overall efficiency, which will assist in combating climate change and enhancing energy security. To address these National priorities, this ASCENT solicitation seeks proposals under the following two research themes:

Theme 1: Integrated Electronic Systems enabled by WBG/UWBG Semiconductors for Climate Change Mitigation.

Many figure-of-merits of semiconductor device performance scale nonlinearly with bandgap. Wide-bandgap (WBG) and Ultrawide-bandgap (UWBG) semiconductors have long been known to have many advantages over their narrow-bandgap counterparts in high-power electronics, RF systems, optoelectronic systems, quantum information processing, and harsh-environment applications. The electrical and thermal properties of WBG/UWBG semiconductors enable the design of circuits and systems with performance well beyond what can be obtained using their narrow-bandgap counterparts (e.g., Si). This theme seeks proposals on novel approaches for heterogeneous integration of systems involving WBG/UWBG devices for enhanced functionality and efficiency compared to the state-of-the-art.

Examples of topics include, but are not limited to:

- RF communication, radar, and imaging systems;
- Sensor systems for extreme environments of temperature, pressure, and radiation; and
- Ultra-high-capacity optical communication systems.

Theme 2: Integrated Power Systems for Clean Energy.

This theme aims to stimulate multi-faceted fundamental research on modeling, control, sensing and cyber-security of an autonomous electric power grid, with its seamless and massive integration with power electronics, renewables, storage, and charging stations for electric vehicles. Cross-cutting research on power electronics, rare-earth-free electric motors, controls and optimization, wireless power transfer, communications, networking, etc., are expected to form integral components of proposals submitted under this theme. The outcomes of the research should include energy-efficient integrated power systems for clean energy.

Examples of topics include, but are not limited to:

- Power systems integrated with grid-connected converter architectures;
- Power electronics-enabled energy storage systems for the grid and electric vehicles;
- Next-generation wireless power transfer (WPT) and on-board fast charging systems; and
- Integrated power modules for clean energy systems.

Proposals should clearly articulate the energy efficiency advantage(s) that will be achieved using the proposed devices/circuits/systems compared to the state-of-the-art technologies.

Teams and Timelines:

The ASCENT program is intended for projects requiring a concerted effort by teams of researchers with diverse and complementary expertise, that may include integration of expertise beyond that described in ECCS core program descriptions. ASCENT proposals must therefore clearly demonstrate that a successful outcome requires the coordinated efforts of all the participants and, furthermore, must establish that the outcomes will be greater than the outcomes of independent projects. ASCENT proposals should demonstrate the need for persistent effort, and the long-term value of building an extensive knowledge base and developing researchers with deep subject matter expertise.

In recognition of the importance of concerted effort, ASCENT proposals must include a Supplementary Document detailing the investigator's Research Integration Plan and its timeline, as outlined in section V.A. of this solicitation.

III. AWARD INFORMATION

Anticipated Type of Award: Continuing Grant or Standard Grant

Estimated Number of Awards: 4 to 6 each from \$1,000,000 to \$1,500,000 for a period of four years

Anticipated Funding Amount: \$6,000,000

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:

Proposals may only be submitted by the following:

- Institutions of Higher Education (IHEs) - Two- and four-year IHEs (including community colleges) accredited in, and having a campus located in the US, acting on behalf of their faculty members. Special Instructions for International Branch Campuses of US IHEs: If the proposal includes funding to be provided to an international branch campus of a US institution of higher education (including through use of subawards and consultant arrangements), the proposer must explain the benefit(s) to the project of performance at the international branch campus, and justify why the project activities cannot be performed at the US campus.

Who May Serve as PI:

PIs or co-PIs must hold primary, full-time, paid appointments in research or teaching positions at US-based campuses/offices of IHEs eligible to submit to this solicitation (see above), with exceptions granted for family or medical leave, as determined by the submitting institution.

A minimum of three PIs or co-PIs must participate in each proposal. Each PI/co-PI is expected to contribute complementary expertise relevant to the project proposed. Investigators/Senior Personnel with expertise in fabrication, testing, or other sciences may be considered, where appropriate.

If there are strong collaborations with industry, the Grant Opportunities for Academic Liaison with Industry (GOALI) type of proposal can be used in conjunction with this solicitation. See PAPPG Chapter II.F.5 for additional information and guidance.

Limit on Number of Proposals per Organization:

There are no restrictions or limits.

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

No individual may be a PI, Co-PI, or Senior Personnel on more than one ASCENT proposal in the current review cycle. Please be advised that if an individual's name appears in any of the above-mentioned capacities on more than ONE proposal, all submittals after the first proposal (based on time- stamp) will be returned without review. No exceptions will be made.

V. PROPOSAL PREPARATION AND SUBMISSION INSTRUCTIONS

A. Proposal Preparation Instructions

Letters of Intent (*required*):

Submission of a Letter of Intent (LOI) is mandatory. LOIs must be submitted via Research.gov. The LOI allows the NSF to examine the proposals with respect to the eligibility requirements and to categorize proposals in order to prepare for the proposal review process. Letters of Intent are not otherwise reviewed for merits and no feedback is provided to the submitters.

Enter the requested core LOI information as prompted by Research.gov. In the "Synopsis" field briefly describe the intellectual merit, broader impacts, and objectives of proposed research. In the "Other Comments" field outline a clear need for a larger project budget to complete the proposed work. Note that the LOIs are restricted to the number of data fields and the number of characters that can be entered in Research.gov.

Submission of multiple Letters of Intent involving the same PIs and co-PIs is not permitted.

Letter of Intent Preparation Instructions:

When submitting a Letter of Intent through Research.gov in response to this Program Solicitation please note the conditions outlined below:

- Submission by an Authorized Organizational Representative (AOR) is not required when submitting Letters of Intent.
- Submission of multiple Letters of Intent is not permitted

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

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

See PAPPG Chapter II.D.2 for guidance on the required sections of a full research proposal submitted to NSF. Please note that the proposal preparation

instructions provided in this program solicitation may deviate from the PAPPG instructions.

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

Collaborative Proposals. All proposals with collaborators from one or more institutions must be submitted as a single proposal with subaward(s) administered by the submitting organization. The type of collaborative proposals by a simultaneous submission from multiple organizations with each organization requesting a separate award will not be accepted. PAPPG Chapter II.E.3 provides additional information on collaborative proposals.

The following information supplements the guidelines and requirements in the NSF PAPPG and NSF Grants.gov Application Guide and apply to full proposals submitted to this solicitation:

Full proposals will be accepted only from PIs who have submitted a Letter of Intent in the current review cycle. Submission of full proposals by PIs that did not submit a Letter of Intent will be returned without review.

Proposers should select either the "Research" or "GOALI" proposal type as appropriate in Research.gov.

Senior Personnel: NSF policy allows proposers to identify a PI and a maximum of four co-PIs on a proposal. A minimum of three PIs/co-PIs must be identified for ASCENT proposals. Additional investigators should be listed on the project summary page and entered as Other Senior Personnel.

Title of Proposed Project: The title for the proposed project must begin with "ASCENT:". The title must state clearly and succinctly the major theme(s) of the project. Titles of proposals involving **GOALI**, must begin with "GOALI: ASCENT:".

Project Summary (one-page limit): The Project Summary consists of an overview, a statement on the intellectual merit of the proposed activity, and a statement on the broader impacts of the proposed activity. Provide the following information.

1. In the *Overview* section using the first line to specify the **Research Theme selected:** 1) Integrated Electronic Systems enabled by WBG/UWBG Semiconductors for Climate Change Mitigation; or 2) Integrated Power Systems for Clean Energy. State the objectives of the project and research aims that support those objectives.
2. Provide a succinct summary of the intellectual merit of the proposed project. This should include the scope of the research and the interdisciplinary and transformative nature of the proposed research.
3. Describe the broader impacts of the proposed work, including the potential long-term impact on national needs or a grand challenge.

Project Description (15-page limit): The project description must adhere to the requirements defined in Chapter II of the PAPPG. Proposers are encouraged to consider the Additional Solicitation-Specific Review Criteria when preparing the project description. In addition to the requirements in the PAPPG, **the Project Description must contain, as a separate section of less than a page, a section labeled "Addressing ASCENT Solicitation-Specific Review Criteria"**. This section should provide a description of how the ASCENT solicitation-specific review criteria (see VI.A.3) are addressed in the proposal and include references to other relevant sections in the proposal for additional details. Proposals not meeting this requirement will be returned without review.

Budget: Develop a realistic project budget that is consistent with the proposed activities. Provide detailed budget justifications separately for each sub-awardee institution involved if applicable. Proposed budgets must include funds for travel by at least one PI or co-PI and at least one graduate student or researcher to attend a biennial one-day grantees' meeting in the Washington, DC area, held within the first two years of the award and two years thereafter.

Facilities, Equipment, and Other Resources: Provide a description of available facilities and procedures for their use/access, if applicable. For projects requiring additional equipment, justify the need for these resources in the context of the innovative work proposed.

Supplementary documents must include the following Special Information:

Research Integration Plan. A Research Integration Plan is required for all projects. **The Research Integration Plan must be submitted as a Supplementary Document and may not exceed two pages. Proposals that fail to submit a Research Integration Plan will be returned without review.** The Research Integration Plan must be labeled "Research Integration Plan" and should include the following:

1. Provide a list of the PI, co-PIs, and Senior Personnel, with a description of the expertise each person brings to the project and how this expertise will be applied to achieve convergent research.
2. Identify the key disciplines involved to achieve the objectives of the proposed research, explain the importance of each discipline and why formation of the engineering team is necessary for the creation of new knowledge and discovering solutions on systems level as proposed.
3. Outline the management approach to the integration of these disciplines, including responsibilities, means of communication, management of personnel within the project team, management of intellectual property resulting from the project, project assessment, risk mitigation measures, and timeline of activities. The management plan should also describe how students will be engaged in and trained through collaborative research across the multiple disciplines.

Other Supplementary documents are limited to the specific types of documents listed in the PAPPG, including as appropriate:

1. **Letters of Collaboration:** For proposals involving substantial collaboration with individuals not included in the budget, proposers should include letters confirming the collaborations. Letters of collaboration should follow the format instructions specified in PAPPG Chapter II.C.2.j. For GOALI proposals, a GOALI-Industrial co-PI Confirmation Letter from the industrial partner must be submitted with the full proposal.
2. Proposals that include support for postdoctoral researchers must provide a **postdoctoral researcher mentoring plan** (limited to one page); and
3. Proposals must include a **Data Management Plan** (DMP; limited to two pages). The DMP should clearly articulate how the investigators plan to manage and disseminate both the physical and digital data generated by the project, taking advantage of emerging information technologies and cyberinfrastructure. The plan must include sufficient detail for evaluation of its appropriateness during merit review. For Engineering Directorate guidance on DMP, see https://nsf.gov/eng/general/ENG_DMP_Policy.pdf.

B. Budgetary Information

Cost Sharing:

Inclusion of voluntary committed cost sharing is prohibited.

C. Due Dates

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

February 01, 2023

LOI Deadline

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

April 19, 2023

Full Proposal Deadline

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 Research.gov for further processing.

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

VI. NSF PROPOSAL PROCESSING AND REVIEW PROCEDURES

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

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

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

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

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

the programs, projects, and activities it considers and supports.

A. Merit Review Principles and Criteria

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

1. Merit Review Principles

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

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

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

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

2. Merit Review Criteria

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

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

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

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

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

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

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

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

Additional Solicitation Specific Review Criteria

Reviewers will be asked to comment on:

- The extent to which the project scope presents a compelling large-scale convergent engineering research problem that critically integrates more than

one ECCS research area.

- The degree to which the Research Integration Plan and Project Description demonstrates the commitment of the participating investigators to work synergistically to accomplish the project objectives including engaging and training students in collaborative and convergent research.
- The degree to which the Research Integration Plan demonstrates that the participating investigators have the necessary expertise covering related research fields sufficient to accomplish the project objectives.
- The extent to which the project scope justifies the requested budget and is unsuitable for smaller teams or shorter duration.

B. Review and Selection Process

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

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

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

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

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

VII. AWARD ADMINISTRATION INFORMATION

A. Notification of the Award

Notification of the award is made to *the submitting organization* by an NSF Grants and Agreements Officer. Organizations whose proposals are declined will be advised as promptly as possible by the cognizant NSF Program administering the program. Verbatim copies of reviews, not including the identity of the reviewer, will be provided automatically to the Principal Investigator. (See Section VI.B. for additional information on the review process.)

B. Award Conditions

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

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

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

Administrative and National Policy Requirements

Build America, Buy America

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

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

C. Reporting Requirements

For all multi-year grants (including both standard and continuing grants), the Principal Investigator must submit an annual project report to the cognizant Program Officer no later than 90 days prior to the end of the current budget period. (Some programs or awards require submission of more frequent project reports). No later than 120 days following expiration of a grant, the PI also is required to submit a final project report, and a project outcomes report for the general public.

Failure to provide the required annual or final project reports, or the project outcomes report, will delay NSF review and processing of any future funding increments as well as any pending proposals for all identified PIs and co-PIs on a given award. PIs should examine the formats of the required reports in advance to assure availability of required data.

PIs are required to use NSF's electronic project-reporting system, available through Research.gov, for preparation and submission of annual and final project reports. Such reports provide information on accomplishments, project participants (individual and organizational), publications, and other specific products and impacts of the project. Submission of the report via Research.gov constitutes certification by the PI that the contents of the report are accurate and complete. The project outcomes report also must be prepared and submitted using Research.gov. This report serves as a brief summary, prepared specifically for the public, of the nature and outcomes of the project. This report will be posted on the NSF website exactly as it is submitted by the PI.

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

VIII. AGENCY CONTACTS

Please note that the program contact information is current at the time of publishing. See program website for any updates to the points of contact.

General inquiries regarding this program should be made to:

- Premjeet Chahal, telephone: (703) 292-7264, email: pchahal@nsf.gov
- Supriyo Bandyopadhyay, telephone: (703) 292-5392, email: sbandyop@nsf.gov
- Aranya Chakraborty, telephone: (703) 292-8113, email: achakrab@nsf.gov
- Jenshan Lin, telephone: (703) 292-7360, email: jenlin@nsf.gov
- Usha Varshney, telephone: (703) 292-5385, email: uvarshne@nsf.gov

For questions related to the use of NSF systems contact, contact:

- NSF Help Desk: 1-800-673-6188
- Research.gov Help Desk e-mail: rgov@nsf.gov

For questions relating to Grants.gov contact:

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

IX. OTHER INFORMATION

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

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

ABOUT THE NATIONAL SCIENCE FOUNDATION

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

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

accounts for about one-fourth of Federal support to academic institutions for basic research.

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

Facilitation Awards for Scientists and Engineers with Disabilities (FASSED) provide funding for special assistance or equipment to enable persons with disabilities to work on NSF-supported projects. See the *NSF Proposal & Award Policies & Procedures Guide* Chapter II.F.7 for instructions regarding preparation of these types of proposals.

The National Science Foundation has Telephonic Device for the Deaf (TDD) and Federal Information Relay Service (FIRS) capabilities that enable individuals with hearing impairments to communicate with the Foundation about NSF programs, employment or general information. TDD may be 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:

Suzanne H. Plimpton
Reports Clearance Officer
Policy Office, Division of Institution and Award Support
Office of Budget, Finance, and Award Management
National Science Foundation
Alexandria, VA 22314

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