

# Spectrum Innovation Initiative: National Radio Dynamic Zones (SII-NRDZ)

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## PROGRAM SOLICITATION NSF 22-579



### National Science Foundation

Directorate for Mathematical and Physical Sciences  
Division of Astronomical Sciences

Directorate for Computer and Information Science and Engineering  
Division of Computer and Network Systems

Directorate for Engineering  
Division of Electrical, Communications and Cyber Systems

Directorate for Geosciences  
Division of Atmospheric and Geospace Sciences  
Office of Polar Programs

Directorate for Social, Behavioral and Economic Sciences

Directorate for Biological Sciences

Directorate for Education and Human Resources

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

June 21, 2022

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## IMPORTANT INFORMATION AND REVISION NOTES

NSF has a Memorandum of Agreement (MOA) with the National Telecommunications and Information Administration (NTIA), U.S. Department of Commerce, and the Federal Communications Commission (FCC). Under the MOA, NSF may share information from proposals with NTIA, FCC or both, discuss the shared information with NTIA and the FCC, and may request feedback from NTIA and the FCC on proposals. See supplementary information in Section II of Program Description.

Restrictions on Letters of Collaboration apply; see Section V.A of Proposal Preparation Instructions.

### Important Information

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.

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## SUMMARY OF PROGRAM REQUIREMENTS

### General Information

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#### Program Title:

Spectrum Innovation Initiative: National Radio Dynamic Zones (SII-NRDZ)

#### Synopsis of Program:

The electromagnetic spectrum is an essential resource for many sectors of society and the economy. Commercial applications (e.g., wireless communication, navigation, and telemetry) compete for spectrum access with scientific activities (e.g., radio astronomy, earth observation, geospace sciences, and polar research) and other vital spectrum-dependent services (e.g., air traffic control). Ongoing technological progress has created a situation where each application, activity, and service seeks additional spectrum access. Potential benefits from additional spectrum access include faster communications, new astronomical and scientific discoveries, more energy-efficient cities, increased highway capacity and safety, and more accurate weather predictions. Achieving these benefits calls for increased use of dynamic spectrum sharing –

ways to enable diverse spectrum users to safely operate closer together in space or frequency or to trade spectrum access more rapidly than is possible with traditional spectrum management approaches. The goal of this Spectrum Innovation Initiative: National Radio Dynamic Zones (SII-NRDZ) program is to advance the use of dynamic spectrum sharing.

The unifying concept investigated in SII-NRDZ is the radio dynamic zone: an area or volume with automatic spectrum management mechanisms that control electromagnetic energy entering, escaping, or occupying the zone. SII-NRDZ seeks to perform extended (6- to 12-month) field trials of various types of radio dynamic zone spectrum sharing at sites where the field trials will enhance spectrum access for facilities or applications. The field trials will mature understanding and capability towards wider use of spectrum sharing, and towards eventual establishment of a permanent highly capable National Radio Dynamic Zone somewhere in the USA. The National Radio Dynamic Zone is envisioned to support a facility for at-scale research and experimentation on systems that use or manage spectrum in innovative ways.

SII-NRDZ is an interdisciplinary program that seeks to foster collaboration among spectrum sharing researchers; domain experts with knowledge of specific applications, scientific activities, or instruments; site or mission experts who understand the operations of specific facilities or systems; spectrum regulatory specialists; and others. The SII-NRDZ program includes two types of projects. SII-NRDZ research studies are traditional NSF grants for investigation of spectrum sharing solutions and risk analysis techniques, or for investigation of applications and sites for radio dynamic zone field trials. SII-NRDZ Engineering and Execution Lead awards are cooperative agreements for work to mature results of the research studies into robust implementations and to lead the planned extended field trials.

The SII-NRDZ goal to advance the use of dynamic spectrum sharing requires the evolution of spectrum management practice. The key to spectrum management evolution is ensuring trust by stakeholders who rely on current interference prevention mechanisms and seek to protect future options. SII-NRDZ program activities are designed to help build the trust that is critical for progress.

#### **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.*

- John M. Chapin, telephone: (703) 292-8222, email: [SII@nsf.gov](mailto:SII@nsf.gov)
- Jonathan V. Williams, telephone: (703) 292-2455, email: [SII@nsf.gov](mailto:SII@nsf.gov)
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- Jenshan Lin, telephone: (703) 292-7360, email: [SII@nsf.gov](mailto:SII@nsf.gov)
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- Robert D. Fleischmann, telephone: (703) 292-7191, email: [SII@nsf.gov](mailto:SII@nsf.gov)
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- Li Yang, telephone: (703) 292-2677, email: [SII@nsf.gov](mailto:SII@nsf.gov)

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

- 47.041 --- Engineering
- 47.049 --- Mathematical and Physical Sciences
- 47.050 --- Geosciences
- 47.070 --- Computer and Information Science and Engineering
- 47.074 --- Biological Sciences
- 47.075 --- Social Behavioral and Economic Sciences
- 47.076 --- Education and Human Resources

## **Award Information**

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**Anticipated Type of Award:** Standard Grant or Continuing Grant or Cooperative Agreement

**Estimated Number of Awards:** 8 to 12

SII-NRDZ Studies: Approximately 6-10 awards, depending on availability of funds and quality of proposals received; standard or continuing grants up to a maximum of \$500,000 – \$2,000,000 and 3 years duration, depending on topic. See full text of the solicitation for details.

SII-NRDZ Engineering and Execution Lead Phase 1: Approximately 2 awards, depending on availability of funds and quality of proposals received; cooperative agreements up to a maximum of \$500,000 and 2 years duration.

**Anticipated Funding Amount:** \$10,000,000

## **Eligibility Information**

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#### **Who May Submit Proposals:**

Proposals may only be submitted by the following:

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

organizations in the U.S. associated with educational or research activities.

**Who May Serve as PI:**

There are no restrictions or limits.

**Limit on Number of Proposals per Organization:**

There are no restrictions or limits.

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

An individual may serve as PI or co-PI on no more than one proposal submitted to this solicitation, with the following exception: An individual may serve as PI or co-PI on multiple SII-NRDZ-Study proposals if no more than one of them includes work on SII-NRDZ-Study Area 1.

In cases where an individual appears as PI or co-PI in more than one proposal and the exception does not apply, only the first submitted proposal will be accepted; all other proposals involving that individual will be Returned Without Review (RWR).

## Proposal Preparation and Submission Instructions

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**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](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](https://www.nsf.gov/publications/pub_summ.jsp?ods_key=grantsgovguide)).

**B. Budgetary Information**

- **Cost Sharing Requirements:**

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

Not Applicable
- **Other Budgetary Limitations:**

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

**C. Due Dates**

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

June 21, 2022

## Proposal Review Information Criteria

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**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

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**Award Conditions:**

Additional award conditions apply. Please see the full text of this solicitation for further information.

**Reporting Requirements:**

Additional reporting requirements apply. Please see the full text of this solicitation for further information.

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## I. INTRODUCTION

The electromagnetic spectrum is an essential resource for many sectors of society and the economy. Commercial applications (e.g., wireless communication, navigation, and telemetry) compete for spectrum access with scientific activities (e.g., radio astronomy, earth observation, geospace sciences, and polar research) and other vital spectrum-dependent services (e.g., air traffic control). Ongoing technological progress has created a situation where each application, activity, and service seeks additional spectrum access. Potential benefits from additional spectrum access include faster communications, new astronomical and scientific discoveries, more energy-efficient cities, increased highway capacity and safety, and more accurate weather predictions. Achieving these benefits calls for increased use of dynamic spectrum sharing – ways to enable diverse spectrum users to safely operate closer together in space or frequency or to trade spectrum access more rapidly than is possible with traditional spectrum management approaches. The goal of this Spectrum Innovation Initiative: National Radio Dynamic Zones (SII-NRDZ) program is to advance the use of dynamic spectrum sharing.

The unifying concept investigated in SII-NRDZ is the radio dynamic zone: an area or volume with automatic spectrum management mechanisms that control electromagnetic energy entering, escaping, or occupying the zone. SII-NRDZ seeks to perform extended (6- to 12-month) field trials of various types of radio dynamic zone spectrum sharing at sites where the field trials will enhance spectrum access for facilities or applications. The field trials will mature understanding and capability towards wider use of spectrum sharing, and towards eventual establishment of a permanent highly capable National Radio Dynamic Zone somewhere in the USA. The National Radio Dynamic Zone is envisioned to support a facility for at-scale research and experimentation on systems that use or manage spectrum in innovative ways.

This solicitation describes two proposal opportunities. The section on SII-NRDZ Studies invites proposals to investigate spectrum sharing solutions, risk analysis techniques, or applications and sites for radio dynamic zone field trials. Researchers and domain experts in the following areas are encouraged to form interdisciplinary proposal teams.

- Spectrum sharing, monitoring, enforcement, and management
- Systems engineering, control, analysis, and prototyping
- Reliability and cybersecurity analysis and engineering
- Spectrum-dependent applications, scientific activities, or instruments
- Operations and constraints of specific facilities or systems
- Interference issues, mitigations, and spectrum access opportunities

The section on SII-NRDZ Engineering and Execution Lead Phase 1 invites proposals from teams interested to mature approaches pioneered in the SII-NRDZ studies into robust implementations and lead the SII-NRDZ program field trials.

NSF anticipates that researchers and domain experts whose SII-NRDZ Study work is selected for a field trial will be invited and supported to participate in engineering, preparatory, and field trial activities under the leadership of the Engineering and Execution Lead.

### Selected List of Acronyms

CFR	Code of Federal Regulations
Co-PI	Co-Principal Investigator
EEL	Engineering and Execution Lead
FCC	Federal Communications Commission
MOA	Memorandum of Agreement
NCAR	National Center for Atmospheric Research
NRDZ	National Radio Dynamic Zone
SII-NRDZ-EEL	SII-NRDZ Engineering and Execution Lead
SII-NRDZ-STUDY	SII-NRDZ Radio Dynamic Zone Study
NSF	National Science Foundation
NTIA	National Telecommunications and Information Administration
PI	Principal Investigator
SII-NRDZ	Spectrum Innovation Initiative: National Radio Dynamic Zones

## II. PROGRAM DESCRIPTION

This solicitation describes two proposal opportunities, referred to as follows.

- *SII-NRDZ-STUDY*: proposals for research studies including prototyping and risk analysis of spectrum sharing solutions, investigation of applications and sites for radio dynamic zones, and field testing to inform future field trials
- *SII-NRDZ-EEL Phase 1*: proposals for planning and SII-NRDZ program participation by teams interested to serve as the SII-NRDZ Engineering and Execution Lead

### INFORMATION RELEVANT TO BOTH OPPORTUNITIES

**Radio Dynamic Zones:** A radio dynamic zone is a spatial volume and potentially noncontiguous frequency range with automatic spectrum management mechanisms that control electromagnetic energy entering, escaping, or occupying the zone. A radio dynamic zone supports spectrum sharing through providing one or more functions such as the following.

- Dynamic Transmission Function: Protect receivers outside the radio dynamic zone from interference caused by transmitters inside the zone.
- Dynamic Protection Function: Protect receivers inside the radio dynamic zone from interference caused by transmitters outside the zone.
- Dynamic Coexistence Function: Protect receivers inside the radio dynamic zone from interference caused by transmitters inside the zone.

A more detailed description of radio dynamic zones and associated concepts is given in the supplementary information below. Proposers are encouraged to use the terminology and concepts defined in the supplemental information in SII-NRDZ proposals.

**Site Types:** A *SII-NRDZ site* is an area or volume, potentially extending to orbit, where the SII-NRDZ program operates a radio dynamic zone. SII-NRDZ sites are likely to begin operation with limited frequencies then incrementally add more frequencies to the radio dynamic zone over time. The *future national facility site*, which may or may not be a SII-NRDZ site, is the location of an envisioned future national user facility for at-scale research and experimentation on systems that use or manage spectrum in innovative ways. NSF envisions eventual establishment of a permanent highly capable radio dynamic zone called *the National Radio Dynamic Zone* to support the envisioned national user facility.

**Priority Scenarios:** The table below describes four scenarios for radio dynamic zone spectrum sharing that are of particular interest for potential SII-NRDZ field trials.

Topic	Application	Function	Desired benefits of zone
1	Research and experimentation on advanced communications, sensing, and spectrum management systems	Dynamic Transmission	Operate experimental advanced systems with few spectrum constraints and with little delay to coordinate spectrum access
2	Radio telescope observations	Dynamic Protection	Mitigate growing interference to current instrumentation and enable broadband spectrum access for next-generation instrumentation
3	Satellite-based active/passive radio sensing for terrestrial environmental and space research	Any	Mitigate growing interference to satellite-borne instruments through coordination with terrestrial wireless communications
4	Surface or airborne radar for science, weather, radiolocation, or safety	Any	Improve spectrum efficiency by improving coexistence of radar and communications services operating co- and adjacent-channel

**Broader Impact Goals:** The overall goal of this Spectrum Innovation Initiative: National Radio Dynamic Zones (SII-NRDZ) program is to advance the use of dynamic spectrum sharing. This translates into four primary broader impact goals: in the near term, to achieve one or more of the benefits listed in the preceding table; in the medium term, to enable wider use of spectrum sharing; in the long term, to establish a research facility that accelerates innovation in spectrum sharing; and overall, to build trust in spectrum sharing. The broader impact goals are described in more detail in the supplementary information below. Proposers are encouraged to consider how their work can be structured to contribute to these goals.

**Spectrum Access and Regulatory Interactions:** The most significant external risk to achieving the broader impact goals of SII-NRDZ is the challenge of gaining access to the radio spectrum required for field trials. Proposed SII-NRDZ projects are encouraged to treat spectrum access as a key risk and to consider integrated technical/regulatory strategies to overcome it.

NSF will establish a feedback loop between SII-NRDZ technical work and spectrum regulators to inform future spectrum sharing regulation, identify regulatory obstacles and solutions, and mitigate spectrum access risks for the field trials. The feedback loop may include piloting new regulatory processes in parallel with SII-NRDZ program research. SII-NRDZ projects are encouraged to interact with regulators over the course of the project and to incorporate regulatory feedback into project work. SII-NRDZ-STUDY projects need not initiate regulatory interactions. In the first part of the program, for roughly 18 months, NSF will act as the primary point of contact for regulators and will establish interaction opportunities for program participants. Thereafter, NSF anticipates the SII-NRDZ-EEL will take the lead role.

Further discussion of spectrum access risk mitigation and potential regulatory interactions appears in the supplementary information.

**Intellectual Property:** Valuable intellectual property may be developed in SII-NRDZ projects. The field trial at each SII-NRDZ site may incorporate intellectual property from multiple SII-NRDZ awardees. Widespread deployment of SII-NRDZ spectrum sharing mechanisms may therefore depend on the successful management of intellectual property rights and on cooperation among SII-NRDZ awardees. Proposals should include an IP management plan, as a Supplementary Document, that supports the broader impact goals of SII-NRDZ. Various approaches can be used to promote SII-NRDZ information sharing and access to intellectual property, including, but not limited to open source, non-exclusive or limited licensing, tiered access, consortiums, or patent pools. Each proposer is encouraged to use its own discretion to independently develop an IP management plan that it believes will best address the SII-NRDZ broader impact goals.

**Privacy:** Spectrum monitoring can raise concerns about the privacy of spectrum users not participating in the research project, particularly if raw (so called "I/Q") data is stored. As specified in [NSF PAPPG Chapter II.C.2.j](#), a proposal's data management plan should describe provisions for appropriate protection of privacy in dissemination and sharing of research results. In addition, proposals for projects that include spectrum monitoring are encouraged to describe, in the project description, how privacy will be protected in the collection, processing, storage and use of spectrum monitoring data within the project.

**NRDZ Community Open Meetings:** The SII-NRDZ program will sponsor NRDZ Community Open Meetings, nominally every 6 months alternating virtual and in-person, for information exchange and to stimulate collaboration. All proposed SII-NRDZ projects are encouraged to plan to participate. Industry, academic,

regulatory, and other government stakeholders will be invited to observe and comment. Meeting proceedings will inform key NSF decisions such as which sites and applications to select for field trials.

**Solicitation requirements:** The program description below includes certain solicitation requirements. They are flagged with the underlined word "must." A proposal not meeting these requirements is non-compliant and will be Returned Without Review (RWR).

## **SII-NRDZ-STUDY: RADIO DYNAMIC ZONE STUDIES**

NSF invites SII-NRDZ-STUDY proposals to investigate spectrum sharing solutions, risk analysis techniques, or applications and sites for radio dynamic zone field trials. NSF encourages interdisciplinary team proposals; see list of areas given in the Introduction.

NSF seeks proposed projects that are structured to maximize the chance for translation of the research results into a SII-NRDZ field trial or future national facility. Key factors for this include generating progressively refined interim results; participating in NRDZ Community Open Meetings; adapting research work in response to feedback received and learnings from other projects; and collaborating with the SII-NRDZ-EEL teams to benefit from their professional competencies and educate them on the ongoing research.

SII-NRDZ-STUDY proposals are invited in the following areas. A proposal may cover multiple areas and may request up to the sum of the amounts listed for those areas, but the request must not exceed \$2,000,000 even if all three areas are covered.

1. Prototyping and risk analysis of an end-to-end, generally applicable spectrum sharing solution that may be used in SII-NRDZ field trials (\$1,500,000)
2. Investigation of applications and sites for SII-NRDZ field trials, or for a future national facility (\$500,000)
3. Field testing of spectrum sharing to inform a potential SII-NRDZ field trial (\$250,000)

SII-NRDZ-STUDY proposals should clearly identify, in the proposal summary, which area or areas are covered by the planned project.

### **SII-NRDZ-STUDY Area 1: Prototyping and risk analysis of an end-to-end, generally applicable spectrum sharing solution**

Proposals including SII-NRDZ-STUDY Area 1 must include both prototyping and risk analysis, and must investigate an end-to-end, generally applicable solution.

An "end-to-end" solution is one that integrates all technical and non-technical components required for a radio dynamic zone. See the supplementary information for an illustrative list of potentially relevant components. Prototypes may use simplified implementations or models of components whose full implementation is not necessary to assess the quality of the proposed solution.

A "generally applicable" solution is one that applies to multiple spectrum sharing scenarios. A solution is still considered generally applicable if it requires investment to specialize or validate its components prior to deployment for a particular scenario. Projects must investigate the proposed solution's performance and characteristics in at least two of the priority scenarios listed in the earlier table.

Projects may investigate end-to-end solutions using a variety of experimental methods including analysis, modeling and simulation, and emulation (i.e., hardware or software-defined radios exchanging radio frequency signals via a wired channel emulator). Proposers that plan to use modeling and simulation as the primary experimental method should consider how to model aggregate interference with sufficient accuracy; this may require upgrading existing simulator infrastructure.

Projects must perform risk analysis of the proposed solution that includes analysis of the likelihood of excursions beyond quantitative spectrum management targets, in the context of potential deployment for one of the scenarios. Quantitative management targets are discussed below in the supplementary information. Projects are encouraged to perform additional risk analysis such as the following.

- Potential severity, duration, or impact of interference
- Security vulnerabilities that enable malicious actors to abuse the radio dynamic zone control mechanisms to cause or amplify harm to others
- Security vulnerabilities that enable malicious actors to remain unidentified when deliberately causing interference

Projects are encouraged to investigate innovative risk analysis methods. Innovations are particularly of interest that enable analysis of interference or vulnerabilities arising from sources such as software bugs, hardware faults or other equipment malfunctions, spurious emissions, out-of-band emissions, and intermodulation effects. Analysis of the proposed solutions and creation of innovative analysis methods will help build trust in spectrum sharing and facilitate approval of SII-NRDZ field trials and other spectrum sharing deployments by spectrum regulators.

Synergies between solution prototyping and risk analysis work are encouraged. One area of innovation of interest is to identify features in the spectrum sharing solution, or design constraints on participating systems, that can be introduced to simplify the risk analysis. Evaluation of the benefits of such synergies may inform future regulatory requirements.

Other research topics relevant to prototyping and risk analysis of an end-to-end solution include but are not limited to the following.

- On-line prediction of potential interference, and rapid detection and identification of the source of interference, drawing on spectrum monitoring data and on telemetry from spectrum users
- On-line computation of constraints on the operation of spectrum users that minimizes interference while also minimizing impact on mission goals
- Methods to limit the likelihood, severity, duration, or impact of interference, including interference resulting from software bugs, hardware faults or other equipment malfunctions, spurious emissions, out-of-band emissions, intermodulation effects, or malicious attacks
- Hardware components such as tunable high fidelity notch filters, antennas that can adjust harmonics without affecting performance in the primary band, and other equipment that could be retrofitted to devices inside or outside the zone to enhance dynamic spectrum sharing capability without device redesign or replacement
- Collection or obfuscation of spectrum monitoring data in ways that protect privacy and operational security while acquiring and preserving the information needed for zone management
- Bounding the performance of artificial intelligence/machine learning subsystems used in spectrum sharing mechanisms, and assessing the bias that may be present in training data
- Approaches to simplify the regulatory complexities of spectrum sharing

### **SII-NRDZ-STUDY Area 2: Investigation of applications and sites**

Proposals including SII-NRDZ-STUDY Area 2 must cover both an application and a potential SII-NRDZ site. NSF particularly invites proposals for projects that investigate the potential for establishing a radio dynamic zone in support of applications, facilities, or instruments that today experience interference issues or spectrum challenges that impair their performance.

Projects may start with multiple candidate SII-NRDZ sites or related applications and narrow the focus to a single candidate site and application partway through the investigation. Proposers that wish to investigate multiple dissimilar applications or sites, or to investigate a single site as both a SII-NRDZ field trial site and the future national facility site, must submit multiple independent SII-NRDZ-STUDY proposals.

Proposers are encouraged to propose a comprehensive investigation covering the research and analysis work relevant to potential selection of the candidate application and site for a SII-NRDZ field trial or as a future national facility site. Essential topics for investigation are the following.

- Ways to use radio dynamic zone spectrum sharing that maximize benefits to the selected application, minimize costs to other stakeholders, and that are realistically deployable at the selected site in the required timeframe given technical, economic, regulatory, political, and environmental constraints
- Roadmap of spectrum bands and radio dynamic zone features or capabilities, identifying which should or could be activated for spectrum sharing in which order, with analysis of impacts to co- and adjacent-band incumbent services and licensees and derived requirements on SII-NRDZ radio dynamic zone solutions

Additional research and analysis topics that may be relevant include the following.

- Design of experiments that could be performed during development or field trial of a radio dynamic zone spectrum sharing solution to demonstrate its capability to operate safely at the site and to provide benefits to the selected application
- Quantitative trade-off curves between performance or quality attributes of radio dynamic zone spectrum sharing solutions and benefits for the selected application, based in part on characterization of interference susceptibility of system and receiver designs
- Interference monitoring and characterization, or collection of other data sets, that help drive requirements for or determine the potential benefits and costs of implementing a radio dynamic zone
- Social/economic impacts on neighbors, and appropriate mitigations
- Assessment of need for an Environmental Impact Statement prior to deployment or operation of the envisioned radio dynamic zone
- Financial support options for long-term sustainment of the radio dynamic zone

The focus of SII-NRDZ-STUDY Area 2 work on conducting a comprehensive investigation including consideration of a wide range of constraints, and potential project engagement with neighbor communities to identify effective mitigations to potential impacts, creates the opportunity to expose students involved in the project to a number of topics not normally covered in engineering coursework and to develop new educational approaches or pathways for enhancing student understanding and capability. NSF invites proposers to consider including educational innovation in Area 2 projects.

Subject to quality of proposals received, NSF will prioritize Area 2 funding to achieve coverage of the following five scenarios.

- The four priority scenarios listed in the earlier table
  - NSF seeks investigation of applications and sites where it is possible to conduct an extended field trial starting no more than 5 years after initiation of the SII-NRDZ-STUDY Area 2 investigation
- Research and experimentation on systems that use or manage spectrum in innovative ways, at the future national facility site
  - The site may require substantial investment after the SII-NRDZ program has completed to reach operational capability, for example in land acquisition and construction, technology development, or regulatory innovation

### **SII-NRDZ-STUDY Area 3: Field Testing**

SII-NRDZ-STUDY Area 3 funding supports early field testing of radio dynamic zone spectrum sharing prior to an extended SII-NRDZ field trial. Proposed field testing must be relevant to a potential future SII-NRDZ field trial. Proposed field tests may use spectrum sharing solutions other than SII-NRDZ-STUDY Area 1 prototypes, e.g., drawing from earlier NSF NRDZ investments.

An early field test can be relevant to a potential SII-NRDZ field trial in multiple ways, for example through gathering data that informs design of the field trial, assists in gaining regulatory approval, or reduces risk through better understanding the behavior of a prototype solution.

### **SII-NRDZ-EEL PHASE 1: ENGINEERING AND EXECUTION LEAD**

The SII-NRDZ Engineering and Execution Lead (SII-NRDZ-EEL) provides the careful engineering and management needed for successful field trials and for effective engagement with skeptical spectrum stakeholders. The SII-NRDZ-EEL draws on SII-NRDZ-STUDY prototypes and research results as the basis for implementing a robust, high-performance, generally applicable radio dynamic zone spectrum sharing solution. The SII-NRDZ-EEL is the scientific and operational lead for design, execution, and analysis of SII-NRDZ field trials. The SII-NRDZ-EEL structures its activities to lay the foundation for future wider use of radio dynamic zone spectrum sharing, with the intent of evolving into the builder and operator of the future national user facility for research and experimentation on advanced wireless and spectrum management systems.

SII-NRDZ-EEL Phase 1 awards will be cooperative agreements. Phase 1 includes activities such as the following.

- Support collaborations as invited by SII-NRDZ-STUDY teams to learn about their work and to provide feedback on implementation issues
- Perform long-lead technical investigations related to the SII-NRDZ toolkit (described in the supplementary information)
- Participate in NRDZ Community Open Meetings and provide assessments to NSF after each meeting regarding the most productive path forwards for the SII-NRDZ program
- Plan and prepare a SII-NRDZ Engineering and Execution Lead Phase 2 proposal

SII-NRDZ-EEL Phase 2 is described in the supplementary information. NSF anticipates inviting SII-NRDZ-EEL Phase 1 awardees to submit a SII-NRDZ-EEL Phase 2 proposal approximately 1 year after the start of SII-NRDZ-EEL Phase 1. Details of the process and requirements for Phase 2 proposals will be provided at that time. NSF anticipates making a single SII-NRDZ-EEL Phase 2 award.

SII-NRDZ-EEL Phase 1 proposals must describe the qualifications of the proposing organization or team to perform a SII-NRDZ-EEL Phase 2 project. Relevant qualifications include organizational access to professional competence in topics that may become necessary for success in SII-NRDZ-EEL Phase 2, such as the following.

- Systems engineering, software engineering, hardware/software integration, sustainment, and user support
- Validation and field testing of complex hardware/software systems
- Operation and construction of complex facilities
- Spectrum regulations, the processes for approval of unusual or innovative spectrum uses, interactions with federal regulators, and the processes for achieving regulatory changes
- Compliance with federal environmental, spectrum management, security, and financial oversight regulations

- Technical and stakeholder community building and engagement
- Public outreach and community engagement processes

NSF anticipates requesting that SII-NRDZ-EEL Phase 1 awardees undergo financial qualification review for the SII-NRDZ-EEL Phase 2 proposal early in the Phase 1 project. NSF may request participation in other Phase 2 proposal preparatory processes during the Phase 1 project.

## SUPPLEMENTARY INFORMATION

### SII-NRDZ Broader Impact goals

The overall goal of the Spectrum Innovation Initiative: National Radio Dynamic Zones (SII-NRDZ) program is to advance use of dynamic spectrum sharing. This translates into four primary broader impact goals.

#### 1. (Near term) Enhance spectrum access for facilities or applications

SII-NRDZ field trials will be selected in part because of the benefits they provide for facilities or applications. Specific broader impacts of interest related to this goal are the benefits of enhancing spectrum access for wireless research, radio astronomy, and satellite-borne active/passive radio sensing for terrestrial environmental and space research; and the benefits of improving spectrum efficiency for radar and communications services operating co- and adjacent-channel.

#### 2. (Medium term) Enable wider use of spectrum sharing

SII-NRDZ seeks to enable wider use of spectrum sharing, including for applications and sites other than the specific ones selected for field trials. Specific broader impacts of interest related to this goal are the following.

- Enable spectrum sharing mechanisms to be more easily approved by regulatory authorities, through developing innovative analysis techniques for interference and security risks
- Address unique workforce needs in government and industry related to innovating with a keen awareness of wireless spectrum issues, through creating opportunities for students to learn about technical/regulatory interactions and other real-world factors that affect the design and impact of spectrum sharing innovations, or through developing innovative educational approaches or pathways
- Inform regulation and identify regulatory obstacles and solutions for future spectrum sharing, through establishing a feedback loop between SII-NRDZ technical work and spectrum regulators
- Overcome non-technical barriers to adoption of spectrum sharing, through analyzing economic, social, and incentive issues associated with its adoption by private and public sector entities and its acceptance by the general population
- Reduce the cost and risk of engineering spectrum sharing or spectrum management solutions for new applications and sites, through creating reusable components and tools

#### 3. (Long term) Establish a research facility that accelerates innovation in spectrum sharing

SII-NRDZ lays the groundwork to establish a future national facility that uses a highly capable radio dynamic zone – the National Radio Dynamic Zone – to support at-scale research and experimentation on systems that use or manage spectrum in innovative ways. Specific broader impacts of interest related to this goal are the following.

- Enable NSF and partners to initiate work towards establishing the future national facility and the National Radio Dynamic Zone, through studying application issues and potential sites
- Provide the focus for ongoing activity and investment needed to sustain momentum over the long time required to establish the capability, through growing an organization capable of building and operating the national facility

#### 4. (Overall) Build trust in spectrum sharing

The SII-NRDZ goal to advance the use of dynamic spectrum sharing requires the evolution of spectrum management practice. The key to spectrum management evolution is ensuring trust by stakeholders who rely on current interference prevention mechanisms and seek to protect future options. SII-NRDZ program activities help build the trust in the spectrum sharing mechanisms and associated enabling regulations that is critical for progress.

### Spectrum access risks and regulatory interactions

The most significant external risk to achieving the broader impact goals of SII-NRDZ is the challenge of gaining access to the radio spectrum required for field trials.

A federal body relevant for SII-NRDZ field trials that impact any federal spectrum is the Technical Subcommittee (TSC) of the Interdepartment Radio Advisory Committee (IRAC) (<https://www.ntia.doc.gov/page/technical-subcommittee-tsc>), which provides advice to the National Telecommunications and Information Administration. NSF may request that the SII-NRDZ-EEL, supported by SII-NRDZ-STUDY subject matter experts, participate in an IRAC TSC feasibility study of solutions proposed for use in SII-NRDZ field trials.

Proposers may wish to consider the following optional project activities that can help mitigate spectrum access risks.

*SII-NRDZ-STUDY Area 1:* Investigate how to gain approval to operate the proposed solution within the current regulatory structures of the Federal Communications Commission and the National Telecommunications and Information Administration, for example via waivers or via proposals for changes in the Part 96 rules, NTIA Manual of Regulations and Procedures for Federal Radio Frequency Management (Redbook), or legislation.

*SII-NRDZ-STUDY Area 2:* For potential SII-NRDZ field trials, evaluate creative actions that the SII-NRDZ-EEL could perform, in partnership with the site operator, to substantially increase spectrum access for field trials even if these actions do not involve radio dynamic zone capability. Examples include leasing spectrum, borrowing it from a federal agency, or enhancing willingness of nearby spectrum users to enter sharing arrangements through investment in monitoring equipment at their sites or connected to their antennas.

Evaluate creative experiments that the SII-NRDZ-EEL could perform, in an initial smaller-scale deployment, to generate data supporting the spectrum access requests and cooperative arrangements needed for full field trials. Examples include conducting missions of the NSF/NCAR Earth Observing Laboratory aircraft near a SII-NRDZ site, partnering with cellular operators to deploy dedicated base stations near a SII-NRDZ site, flying dedicated CubeSats, performing drive testing, or identifying a satellite that has outlived its primary mission and adjusting its operations to serve as a potential affected system.



For a potential future national facility site, consider creative institutional, organizational, and regulatory structures that will preserve broad spectrum access for the facility as terrestrial and orbital spectrum usage continues to increase in coming decades.

*SII-NRDZ-STUDY Area 3:* For field testing prior to full-scale field trials, file requests for any necessary Experimental License, Special Temporary Authority, or other regulatory support as soon as possible after the project launches. Consider creative experiments like those described above for Area 2.

*SII-NRDZ-EEL Phase 1:* Include substantial time for a senior spectrum regulatory expert in Phase 1, even though EEL regulatory support activities are unlikely to start before Phase 2, to provide consulting to the study projects, begin establishing relationships with regulators and the broader community on SII-NRDZ topics, and do the long-lead creative thinking about regulatory options for the path forwards that will enable program success.

## **SII-NRDZ-EEL Phase 2**

NSF anticipates inviting SII-NRDZ-EEL Phase 1 awardees to submit a SII-NRDZ-EEL Phase 2 proposal approximately 1 year after the start of SII-NRDZ-EEL Phase 1. For planning purposes, the following preliminary description of SII-NRDZ-EEL Phase 2 is provided.

SII-NRDZ-EEL Phase 2 is anticipated to start with a base effort up to 4 years long. The base effort is anticipated to include activities such as the following.

- Use SII-NRDZ-STUDY research results and prototypes as the basis for design, engineering, and test of a toolkit of components (open architecture, with as many non-proprietary components as possible) that can be specialized and integrated to implement customized radio dynamic zone spectrum sharing solutions for various sites and applications
- Use SII-NRDZ-STUDY application analysis and research results and the toolkit components as the basis for building and validating a radio dynamic zone solution for the first designated field trial
- Deploy and support operation of the radio dynamic zone solution at the designated site
- Plan, execute, and analyze the results of trials or operational campaigns of the solution at the designated site
- Serve as the spectrum regulatory expert for program participants and primary point of contact for federal spectrum regulators for all SII-NRDZ program activities; provide spectrum access and conduct activities needed for regulatory approval of program activities; provide opportunities for regulators to learn about SII-NRDZ program activities and engage with research studies and field trial activities at an appropriate level
- Participate in NRDZ Community Open Meetings to share solution engineering, site deployment, trial operation, field trial experimental results and lessons learned with the community
- Support annual review by a committee convened by NSF
- Foster an engaged community of researchers, practitioners, and industrial partners through activities such as collaboration opportunities and interaction events; maintaining an open repository of artifacts and experimental data; sharing of data, software, tools, and instrumentation; and leading an open-source process, that could later be spun off into an independent community-driven activity, for contribution of additional toolkit components and updates by third parties

NSF anticipates inviting the SII-NRDZ-EEL Phase 2 awardee to submit a proposal for a Phase 2b award (up to 3 years long) approximately 1 year after the start of Phase 2. The Phase 2b effort is anticipated to include activities such as the following.

- Use SII-NRDZ-STUDY analysis and research results and the toolkit components as the basis for integrating and specializing radio dynamic zone solutions for additional designated field trials, providing feedback to enhance quality and capabilities of the toolkit
- Validate the integrated solutions, potentially through controlled field tests
- Deploy the radio dynamic zone solution at each designated field trial site; plan, execute, and analyze the results of field trials for each designated application at each designated site
- Augment any base effort activities with additional resources and deliverables as required to support the Phase 2b activities

*Participation in SII-NRDZ-EEL Phase 2 proposals:* NSF anticipates encouraging the SII-NRDZ-EEL Phase 2 awardee to provide SII-NRDZ-STUDY team members the opportunity (e.g. via subawards, consultant or intern positions) to participate in implementation work and field trials that draw on their research results. NSF anticipates encouraging the SII-NRDZ-EEL Phase 2 awardee to partner with the operators of facilities studied in SII-NRDZ-STUDY projects to carry out the field trials.

To ensure equal opportunity for SII-NRDZ-EEL Phase 2 proposers, NSF anticipates prohibiting SII-NRDZ-STUDY team members, and facilities studied in SII-NRDZ-STUDY projects, from being included directly or as subawardees in SII-NRDZ-EEL Phase 2 proposals except as specified in the invitation to submit.

## **Radio Dynamic Zones and associated concepts and definitions**

Work on radio dynamic zones requires participation of multiple communities, each of which has its own terminology. To enhance clarity, the following definitions are provided. Proposers are encouraged to use this terminology in proposals to reduce confusion during the merit review process.

Where not otherwise qualified, the term *system* refers to a system that intentionally transmits or receives radiated electromagnetic energy in some aspect of its operation. The term may refer to a system at any level of maturity, from early experimentation to commercial operation. The term includes all elements that can affect transmission or reception behavior, such as supporting databases, even if not co-located with the transceiver.

*Interference* is defined as in US and international regulations: "The effect of unwanted energy due to one or a combination of emissions, radiations, or inductions upon reception in a radio communication system, manifested by any performance degradation, misinterpretation, or loss of information which could be extracted in the absence of such unwanted energy," with the modification that it applies to impacts on all systems including radars and passive scientific receivers. (The quoted text appears identically in 47 CFR Section 2.1; NTIA "Manual of Regulations and Procedures for Federal Radio Frequency Management (Redbook)" Sep 2017 Sections 6.1.1 and 8.2.3; and International Telecommunication Union Radio Regulations Chapter 1 Section 1.169.)

*Harmful interference* is defined as in the same set of regulations: "Interference which endangers the functioning of a radio navigation service or of other safety services or seriously degrades, obstructs, or repeatedly interrupts a radio communication service operating in accordance with Radio Regulations," with the same modification.

An *interference event* or *harmful interference event* involves two or more systems. Those causing or contributing to the interference or harmful interference through intentional or unintentional emissions are called *source systems*, while those experiencing interference are called *affected systems*. (The term "victim" traditionally used in some communities to denote affected systems has sufficiently negative connotation in other communities that it should be avoided.)

Traditionally, harmful interference among independent systems has been prevented by static separation in frequency, space, or time, which involves establishing fixed limits on intentional transmission power and out of band emissions. *Spectrum sharing* is the operation of independent systems close enough together that dynamic mechanisms are required to prevent harmful interference. A *potential source system* or *potential affected system* is a system operating in a shared spectrum band that may be involved in a future harmful interference event if the dynamic mechanisms fail to prevent it. Potential sources that must be

managed by the dynamic mechanisms include those not assigned to the shared spectrum band but causing or contributing to interference in the band through out of band, unintentional or spurious emissions.

A *radio dynamic zone* is a spatial volume and potentially noncontiguous frequency range with automatic spectrum management mechanisms that control electromagnetic energy entering, escaping, or occupying the zone. A radio dynamic zone supports spectrum sharing through providing one or more *functions* such as the following.

- *Dynamic Transmission Function*: Protect receivers outside the radio dynamic zone from interference caused by transmitters inside the zone
- *Dynamic Protection Function*: Protect receivers inside the radio dynamic zone from interference caused by transmitters outside the zone
- *Dynamic Coexistence Function*: Protect receivers inside the radio dynamic zone from interference caused by transmitters inside the zone

Automatic management is provided by a mechanism called the *zone management system*, which may be a local control system, a centralized national service, a distributed mechanism implemented by systems in the zone, or some other realization. *Participating systems* are the systems connected to the zone management system via interfaces for telemetry, control, or advice. There may be potential source systems and potential affected systems that do not participate.

The zone management system manages electromagnetic energy considering systems and operations inside the radio dynamic zone and in a potentially noncontiguous spatial volume and frequency range surrounding it called the *dynamic coordination region*. The dynamic coordination region is the smallest spatial volume and frequency range that includes all potential source systems and potential affected systems outside the radio dynamic zone. Some systems in the dynamic coordination region may be participating systems.

Radio dynamic zone implementations include technical and non-technical components such as the following.

- Technical elements such as architecture, standards, software applications, hardware devices, tools, system designs, and control algorithms
- Methods and supporting technical elements for monitoring and characterizing radio frequency interference, and for detecting and identifying rogue emitters
- Human and organizational processes for radio dynamic zone operations and for spectrum management activities
- Applications of approved regulatory structures or proposals for regulatory changes
- Model contracts and business processes for interactions among spectrum users
- Integration into external spectrum management and other control systems

Automated spectrum management requires quantitative *management targets* which, if achieved, imply that there is no harmful interference. These targets normally place limits on the aggregate impact of all potential source systems. It is the zone management system's responsibility to determine the limit on each individual system, so that the aggregate limit is respected.

Management targets established in regulation may be specified in multiple ways including the following.

- *Surface power limits*: Maximum power density levels at a specified surface, which may or may not be the radio dynamic zone boundary, are specified on a band-by-band basis; the limits may be static or adjustable based on context
- *Receiver power limits*: Maximum power density levels are specified at (potentially moving) affected system locations

Management targets established through *access level agreements* among spectrum users may be specified in the same ways or more richly. Examples include the following.

- Limits on metrics at upper system layers that correlate more closely to interference impact than power density levels
- Time-based or operating mode-based constraints
- Barter or compensation provisions for spectrum access or for excursions beyond agreed limits

An access level agreement normally exists on top of, and must respect, underlying regulatory management targets whose limits protect other spectrum users not party to the agreement. The zone management system may be tasked to facilitate, monitor, or implement aspects of the access level agreement such as information sharing or transfer of compensation between spectrum users.

A radio dynamic zone may provide *deterministic or best-effort service*. Deterministic service offers guarantees (barring faults or malicious action), while best-effort service minimizes the probability of unexpected loss of spectrum access and the severity and duration of interference events. Deterministic service is normally only possible in cases where all interacting spectrum users are required to comply with guidance by the zone management system. Best-effort service is necessary in the presence of non-participating, telemetry-only, or partially cooperating spectrum users. In primary/secondary spectrum sharing, the zone management system provides deterministic service to primary users and best-effort service to secondary users.

### **Proposal Handling**

In addition to the standard NSF proposal processing and review procedures described in Section VI below, the following steps may occur.

Pursuant to the MOA with the NTIA and FCC, NSF may share information from proposals with NTIA, FCC or both, may discuss the shared information with NTIA and the FCC, and may request feedback from NTIA and the FCC on the merit of proposals.

## **III. AWARD INFORMATION**

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**Anticipated Type of Award:** Standard Grant or Continuing Grant or Cooperative Agreement

**Estimated Number of Awards:** 8 to 12

SII-NRDZ Studies: Approximately 6-10 awards, depending on availability of funds and quality of proposals received; standard or continuing grants up to a maximum of \$500,000 – \$2,000,000 and 3 years duration, depending on topic. See full text of the solicitation for details.

SII-NRDZ Engineering and Execution Lead Phase 1: Approximately 2 awards, depending on availability of funds and quality of proposals received; cooperative agreements up to a maximum of \$500,000 and 2 years duration.

**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

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### Who May Submit Proposals:

Proposals may only be submitted by the following:

- Institutions of Higher Education (IHEs) - Two- and four-year IHEs (including community colleges) accredited in, and having a campus located in the US, acting on behalf of their faculty members. Special Instructions for International Branch Campuses of US IHEs: If the proposal includes funding to be provided to an international branch campus of a US institution of higher education (including through use of subawards and consultant arrangements), the proposer must explain the benefit(s) to the project of performance at the international branch campus, and justify why the project activities cannot be performed at the US campus.
- Non-profit, non-academic organizations: Independent museums, observatories, research labs, professional societies and similar organizations in the U.S. associated with educational or research activities.

### Who May Serve as PI:

There are no restrictions or limits.

### Limit on Number of Proposals per Organization:

There are no restrictions or limits.

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

An individual may serve as PI or co-PI on no more than one proposal submitted to this solicitation, with the following exception: An individual may serve as PI or co-PI on multiple SII-NRDZ-Study proposals if no more than one of them includes work on SII-NRDZ-Study Area 1.

In cases where an individual appears as PI or co-PI in more than one proposal and the exception does not apply, only the first submitted proposal will be accepted; all other proposals involving that individual will be Returned Without Review (RWR).

## V. PROPOSAL PREPARATION AND SUBMISSION INSTRUCTIONS

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### A. Proposal Preparation Instructions

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**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](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](mailto: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](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](mailto:nsfpubs@nsf.gov).

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

**Collaborative Proposals.** All collaborative proposals submitted as separate submissions from multiple organizations must be submitted via Research.gov. PAPPG Chapter II.D.3 provides additional information on collaborative proposals.

See PAPPG Chapter II.C.2 for guidance on the required sections of a full research proposal submitted to NSF. Please note that the proposal preparation instructions provided in this program solicitation may deviate from the PAPPG instructions.

Letters of Collaboration with Federal Communications Commission and National Telecommunications and Information Administration are not allowed.

Letters of Collaboration with centers funded under NSF solicitation 21-558 (Spectrum Innovation Initiative: National Center for Wireless Spectrum Research (SII-Center)) are not allowed unless the letter states that the center's collaboration is non-exclusive.

Proposal titles must have the format "SII-NRDZ: Your Project Name".

Refer to Section II, Program Description, for additional proposal preparation instructions.

## B. Budgetary Information

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### Cost Sharing:

Inclusion of voluntary committed cost sharing is prohibited.

### Other Budgetary Limitations:

SII-NRDZ Studies: standard or continuing grants up to a maximum of \$500,000 - 2,000,000 and 3 years duration, depending on topic. See Section II for details.

SII-NRDZ Engineering and Execution Lead Phase 1: cooperative agreements up to a maximum of \$500,000 and 2 years duration.

Each proposal budget must include funding for travel for a PI or Co-PI and up to three other project participants to attend an annual two-day NRDZ Community Open Meeting in the Washington, DC area during the award period.

## C. Due Dates

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

June 21, 2022

## D. Research.gov/Grants.gov Requirements

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### 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](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](mailto: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](mailto: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

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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/](https://www.nsf.gov/bfa/dias/policy/merit_review/).

Proposers should also be aware of core strategies that are essential to the fulfillment of NSF's mission, as articulated in *Building the Future: Investing in Discovery and Innovation - NSF Strategic Plan for Fiscal Years (FY) 2018 – 2022*. These strategies are integrated in the program planning and implementation process, of which proposal review is one part. NSF's mission is particularly well-implemented through the integration of research and education and broadening participation in NSF programs, projects, and activities.

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

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

## A. Merit Review Principles and Criteria

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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**

Achieving the goal of the SII-NRDZ program to advance use of dynamic spectrum sharing requires coordinated and focused activity by program participants. Given this context, all proposals must clearly address the following solicitation-specific review criteria through well-identified proposal elements.

SII-NRDZ-STUDY All Areas:

1. How effectively does the proposed project support one or more of the broader impact goals identified for the SII-NRDZ program?
2. How effective is the proposed plan for interaction with and responding to information provided by other SII-NRDZ program participants and stakeholders?
3. How effective is the plan for mitigating spectrum access risk?

SII-NRDZ-STUDY Area 1 (prototyping and risk analysis):

4. How generally applicable is the proposed solution?
5. What is the potential for the proposed solution or components to be used in SII-NRDZ field trials?

SII-NRDZ-STUDY Area 2 (application and site investigation):

6. What is the potential for the selected application and site to be used for a SII-NRDZ field trial (investigation of a SII-NRDZ site) or for the future national facility (investigation of a future national facility site)?

SII-NRDZ-STUDY Area 3 (field tests):

7. How much benefit will the proposed field tests provide for the design, approval, or risk reduction of a potential SII-NRDZ field trial?

SII-NRDZ-EEL Phase 1:

8. How effective is the proposed plan for interaction with and responding to information provided by other SII-NRDZ program participants and stakeholders?
9. How qualified is the proposed team to successfully perform a SII-NRDZ Engineering and Execution Lead Phase 2 project?

## **B. Review and Selection Process**

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Proposals submitted in response to this program solicitation will be reviewed by 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**

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### **A. Notification of the Award**

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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**

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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](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](mailto: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](https://www.nsf.gov/publications/pub_summ.jsp?ods_key=pappg).

#### **Special Award Conditions:**

SII-NRDZ Engineering and Execution Lead Phase 1: Special conditions may be negotiated in the Cooperative Agreement relating to the period of performance, statement of work, awardee responsibilities, NSF responsibilities, and other topics.

Any cooperative agreement awarded in response to this solicitation will contain the following term and condition:

#### **Ensuring Adequate COVID-19 Safety Protocols**

(a) This clause implements Section 3(b) of Executive Order 14042, "Ensuring Adequate COVID Safety Protocols for Federal Contractors", dated September 9, 2021 (published in the Federal Register on September 14, 2021, 86 FR 50985). Note that the Department of Labor has included "cooperative agreements" within the definition of "contract-like instrument" in its rule referenced at Section 2(e) of this Executive Order, which provides:

For purposes of this order, the term "contract or contract-like instrument" shall have the meaning set forth in the Department of Labor's proposed rule, "Increasing the Minimum Wage for Federal Contractors," 86 Fed. Reg. 38816, 38887 (July 22, 2021). If the Department of Labor issues a final rule relating to that proposed rule, that term shall have the meaning set forth in that final rule.

(b) The awardee must comply with all guidance, including guidance conveyed through Frequently Asked Questions, as amended during the performance of this award, for awardee workplace locations published by the Safer Federal Workforce Task Force (Task Force Guidance) at <https://www.saferfederalworkforce.gov/contractors/>

(c) *Subawards*. The awardee must include the substance of this clause, including this paragraph (c), in subawards at any tier that exceed the simplified acquisition threshold, as defined in Federal Acquisition Regulation 2.101 on the date of subaward, and are for services, including construction, performed in whole or in part within the United States or its outlying areas. That threshold is presently \$250,000.

(d) *Definition*. As used in this clause -

*United States or its outlying areas* means —

- (1) The fifty States;
- (2) The District of Columbia;
- (3) The commonwealths of Puerto Rico and the Northern Mariana Islands;
- (4) The territories of American Samoa, Guam, and the United States Virgin Islands; and
- (5) The minor outlying islands of Baker Island, Howland Island, Jarvis Island, Johnston Atoll, Kingman Reef, Midway Islands, Navassa Island, Palmyra Atoll, and Wake Atoll.

(e) The Foundation will take no action to enforce this article, where the place of performance identified in the award is in a U.S. state or outlying area subject to a court order prohibiting the application of requirements pursuant to the Executive Order (hereinafter, "Excluded State or Outlying Area"). A current list of such Excluded States and Outlying Areas is maintained at <https://www.saferfederalworkforce.gov/contractors/>.

## **C. Reporting Requirements**

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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](https://www.nsf.gov/publications/pub_summ.jsp?ods_key=pappg).

SII-NRDZ Engineering and Execution Lead Phase 1: Special reporting requirements may be negotiated in the Cooperative Agreement related to interactions with SII-NRDZ-STUDY awardees, NRDZ Community Open Meetings, preparation for a potential SII-NRDZ-EEL Phase 2 proposal, and other topics.

## VIII. AGENCY CONTACTS

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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:

- John M. Chapin, telephone: (703) 292-8222, email: [SII@nsf.gov](mailto:SII@nsf.gov)
- Jonathan V. Williams, telephone: (703) 292-2455, email: [SII@nsf.gov](mailto:SII@nsf.gov)
- Murat Torlak, telephone: (703) 292-7748, email: [SII@nsf.gov](mailto:SII@nsf.gov)
- Alexander Sprintson, telephone: (703) 292-8950, email: [SII@nsf.gov](mailto:SII@nsf.gov)
- Jenshan Lin, telephone: (703) 292-7360, email: [SII@nsf.gov](mailto:SII@nsf.gov)
- Zhengdao Wang, telephone: (703) 292-7823, email: [SII@nsf.gov](mailto:SII@nsf.gov)
- Lawrence S. Goldberg, telephone: (703) 292-8339, email: [SII@nsf.gov](mailto:SII@nsf.gov)
- Patrick D. Smith, telephone: (703) 292-8032, email: [SII@nsf.gov](mailto:SII@nsf.gov)
- Lisa M. Winter, telephone: (703) 292-8519, email: [SII@nsf.gov](mailto:SII@nsf.gov)
- Nancy A. Lutz, telephone: (703) 292-7280, email: [SII@nsf.gov](mailto:SII@nsf.gov)
- Robert D. Fleischmann, telephone: (703) 292-7191, email: [SII@nsf.gov](mailto:SII@nsf.gov)
- Robert C. Moore, telephone: (703) 292-7990, email: [SII@nsf.gov](mailto:SII@nsf.gov)
- Li Yang, telephone: (703) 292-2677, email: [SII@nsf.gov](mailto:SII@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](mailto:fastlane@nsf.gov)
- Research.gov Help Desk e-mail: [rgov@nsf.gov](mailto: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](mailto:support@grants.gov).

## IX. OTHER INFORMATION

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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>.

### Related Programs:

Topics related to SII-NRDZ are also in scope of the Spectrum and Wireless Innovation enabled by Future Technologies (SWIFT) program.

## ABOUT THE NATIONAL SCIENCE FOUNDATION

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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.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](mailto:nsfpubs@nsf.gov)
  - or telephone: (703) 292-8134
- **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  
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