

Expeditions in Training, Research, and Education for Mathematics and Statistics through Quantitative Explorations of Data (EXTREEMS-QED)

PROGRAM SOLICITATION

NSF 12-606



National Science Foundation

Directorate for Mathematical & Physical Sciences
Division of Mathematical Sciences
Office of Multidisciplinary Activities

Office of Cyberinfrastructure

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

December 14, 2012

November 06, 2013

First Wednesday in November, Annually Thereafter

IMPORTANT INFORMATION AND REVISION NOTES

Important Reminders: A revised version of the *NSF Proposal & Award Policies & Procedures Guide* (PAPPG), [NSF 11-1](#), was issued on October 1, 2010 and is effective for proposals submitted, or due, on or after January 18, 2011. Please be advised that the guidelines contained in [NSF 11-1](#) apply to proposals submitted in response to this funding opportunity.

Cost Sharing: The PAPPG has been revised to implement the National Science Board's recommendations regarding cost sharing. Inclusion of voluntary committed cost sharing is prohibited. In order to assess the scope of the project, all organizational resources necessary for the project must be described in the Facilities, Equipment and Other Resources section of the proposal. The description should be narrative in nature and must not include any quantifiable financial information. Mandatory cost sharing will only be required when explicitly authorized by the NSF Director. See the PAPP Guide Part I: *Grant Proposal Guide (GPG) Chapter II.C.2.g(xi)* for further information about the implementation of these recommendations.

Data Management Plan: The PAPPG contains a clarification of NSF's long standing data policy. All proposals must describe plans for data management and sharing of the products of research, or assert the absence of the need for such plans. FastLane will not permit submission of a proposal that is missing a Data Management Plan. The Data Management Plan will be reviewed as part of the intellectual merit or broader impacts of the proposal, or both, as appropriate. Links to data management requirements and plans relevant to specific Directorates, Offices, Divisions, Programs, or other NSF units are available on the NSF website at: <http://www.nsf.gov/bfa/dias/policy/dmp.jsp>. See [Chapter II.C.2.j](#) of the GPG for further information about the implementation of this requirement.

Postdoctoral Researcher Mentoring Plan: As a reminder, each proposal that requests funding to support postdoctoral researchers must include, as a supplementary document, a description of the mentoring activities that will be provided for such individuals. Please be advised that if required, FastLane will not permit submission of a proposal that is missing a Postdoctoral Researcher Mentoring Plan. See [Chapter II.C.2.j](#) of the GPG for further information about the implementation of this requirement.

SUMMARY OF PROGRAM REQUIREMENTS

General Information

Program Title:

Expeditions in Training, Research, and Education for Mathematics and Statistics through Quantitative Explorations of Data (EXTREEMS-QED)

Synopsis of Program:

The long-range goal of EXTREEMS-QED is to support efforts to educate the next generation of mathematics and statistics undergraduate students to confront new challenges in computational and data-enabled science and engineering (CDS&E). EXTREEMS-QED projects must enhance the knowledge and skills of most, if not all, the institution's mathematics and statistics majors through training that incorporates computational tools for analysis of large data sets and for modeling and simulation of complex systems.

Funded activities are expected to provide opportunities for undergraduate research and hands-on experiences centered on CDS&E; result in significant changes to the undergraduate mathematics and statistics curriculum; have broad institutional support and department-wide commitment that encourage collaborations within and across disciplines; and include professional development activities for faculty or for K-12 teachers.

EXTREEMS-QED is a joint effort of the Directorate of Mathematical and Physical Sciences and the Office of Cyberinfrastructure at the National Science Foundation. The Office of Cyberinfrastructure is interested in supporting educational activities that incorporate cyberinfrastructure considerations at a fundamental level, and in efforts that leverage and advance major NSF investments in cyberinfrastructure. Cyberinfrastructure consists of advanced computing systems, data storage systems, instruments and data repositories, visualization environments, and people, all linked together by software and high performance networks to improve research productivity and enable breakthroughs not otherwise possible. Examples of NSF investments in cyberinfrastructure can be found at [http://www.nsf.gov/od/oci/cif21/cybinf_list.jsp].

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.

- Jennifer Pearl, MPS/DMS, telephone: (703) 292-4492, email: jslimowi@nsf.gov
- Annalisa Calini, MPS/DMS, telephone: (703) 292-2189, email: acalini@nsf.gov
- Nandini Kannan, MPS/DMS, telephone: (703) 292-8584, email: nkannan@nsf.gov
- Mark Suchman, OD/OCI, telephone: (703) 292-8061, email: msuchman@nsf.gov

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

- 47.049 --- Mathematical and Physical Sciences
- 47.080 --- Office of Cyberinfrastructure

Award Information

Anticipated Type of Award: Standard Grant or Continuing Grant

Estimated Number of Awards: 4 to 6 NSF anticipates making 4-6 awards, with some projects having 5 year duration and some having 2-3 year duration. It is not anticipated that particular projects will receive support from the EXTREEMS-QED program for longer than five years in total.

Anticipated Funding Amount: \$4,000,000 subject to the availability of funds

Eligibility Information

Organization Limit:

Proposals may only be submitted by the following:

- Universities and Colleges -- Universities and four-year colleges accredited in and having a campus located in the US, acting on behalf of their faculty members. Two-year colleges or community colleges may serve as non-lead organizations in collaborative proposals or receive support via subcontracts.

PI Limit:

None Specified

Limit on Number of Proposals per Organization:

None Specified

Limit on Number of Proposals per PI:

None Specified

Proposal Preparation and Submission Instructions

A. Proposal Preparation Instructions

- **Letters of Intent:** Not Applicable
- **Preliminary Proposal Submission:** Not Applicable
- **Full Proposals:**
 - Full Proposals submitted via FastLane: NSF Proposal and Award Policies and Procedures Guide, Part I: Grant Proposal Guide (GPG) Guidelines apply. The complete text of the GPG is available electronically on the NSF website at: http://www.nsf.gov/publications/pub_summ.jsp?ods_key=gpg.
 - Full Proposals submitted via Grants.gov: NSF Grants.gov Application Guide: A Guide for the Preparation and Submission of NSF Applications via Grants.gov Guidelines apply (Note: The NSF Grants.gov Application Guide is available on the Grants.gov website and on the NSF website at: http://www.nsf.gov/publications/pub_summ.jsp?ods_key=grantsgovguide)

B. Budgetary Information

- **Cost Sharing Requirements:** Inclusion of voluntary committed cost sharing is prohibited.
- **Indirect Cost (F&A) Limitations:** Not Applicable
- **Other Budgetary Limitations:** Not Applicable

C. Due Dates

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

December 14, 2012

November 06, 2013

First Wednesday in November, Annually Thereafter

Proposal Review Information Criteria

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

Award Administration Information

Award Conditions: Standard NSF award conditions apply.

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

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I. INTRODUCTION

The new field of computational and data-enabled science and engineering (CDS&E) has emerged as a third pillar of scientific investigation that complements theory and experimentation. CDS&E is now clearly recognizable as a distinct intellectual and technological discipline lying at the intersection of applied mathematics, statistics, computer science, core science and engineering disciplines. It is dedicated to the development and use of computational methods, data mining, and management systems to enable scientific discovery and engineering innovation. In particular, CDS&E is exerting a transformational influence on research and learning through the use of computers to model, simulate, measure, and visualize complex scientific and engineering concepts; to create resources for scientific investigation and education both formal and informal; and to foster interdisciplinary collaborations.

Examples of mathematical and statistical research in CDS&E include, but are not limited to:

- Sophisticated computational/statistical modeling for simulation, prediction, and assessment in computationally intensive, data-intensive scientific problems (arising, for example, in astronomy, health sciences, energy, economics, climate modeling, genetics, finance, social networks, etc.).
- State-of-the-art tools and theory for knowledge discovery from massive, complex, and dynamic data sets.
- General theory and algorithms for advancing large-scale modeling of problems that present particular computational difficulties, such as strong heterogeneities and anisotropies, multi-physics coupling, multi-scale behavior, stochastic forcing, uncertainty parameters or dynamic data, and long-time behavior.
- Novel end-to-end scientific scenarios to exploit cutting edge cyberinfrastructure (e.g., advanced computing and data systems, software frameworks, middleware, workflow systems, visualization capabilities, and networks) that are driven by mathematical and statistical challenges.
- Computational and data-enabled approaches to the study of mathematical, statistical, and stochastic properties of networks.
- Computational and data-enabled approaches to the study of analytical, topological, algebraic, geometric and number-theoretic structures.

- Computational and data-enabled approaches to the mathematical and statistical challenges of uncertainty quantification.

Unfortunately, the interdisciplinary demands of CDS&E training often lead it to be under-developed within the current structure of U.S. educational institutions. The long-range goal of EXTREEMS-QED is to enhance the ability of the mathematics and statistics community within universities and colleges to educate the next generation of undergraduate students to confront new challenges in CDS&E. EXTREEMS-QED projects must enhance the knowledge and skills of most, if not all, the institution's mathematics and statistics majors through training that incorporates computational tools for analysis of large data sets and for modeling and simulation of complex systems. EXTREEMS-QED projects may have components that enhance the knowledge and skills of non-majors as well. Strongly competitive proposals will have the potential to transform both departmental and institutional culture.

The program posits the importance of early interdisciplinary research experiences and innovative curricula in CDS&E. EXTREEMS-QED challenges institutions to create new learning environments and experiences that immerse students in CDS&E while energizing and sustaining the professional growth of faculty in CDS&E.

II. PROGRAM DESCRIPTION

Funded activities are expected to:

- Provide opportunities for undergraduate research and hands-on experiences centered on CDS&E;
- Result in significant changes to the undergraduate mathematics and statistics curriculum;
- Have broad institutional support and department-wide commitment that encourage collaborations within and across disciplines;
- Include professional development activities for faculty or for K-12 teachers;
- Where appropriate leverage and advance the use of existing cyberinfrastructure resources (e.g. data archives, networks) for data exploration.

The duration of projects may be up to five years. In general, projects of five-year duration are encouraged; however, institutions may submit proposals for shorter terms (for example, smaller projects of two to three years).

Long-term projects will be reviewed in the third year and fourth- and fifth-year funding will be contingent upon the outcome of the review. A site visit and/or a PI meeting are possible mid-term review mechanisms.

A. PROJECT COMPONENTS

All EXTREEMS-QED proposals must include objectives and detailed plans for (1) Research, (2) Education and Training, and (3) Faculty Professional Development or Outreach. Projects may choose to place more emphasis on one (or more) of the components. A description of the three components is provided below:

1. **Research.** CDS&E-centered undergraduate research and hands-on activities. These activities should be of longer duration than summer research experiences, resulting in long-term engagement in research and allowing mutual reinforcement between the research and classroom components. Team research experiences, partnerships with other academic and non-academic institutions, and inter- and multi-disciplinary activities are encouraged and are a priority for EXTREEMS-QED.

Examples include, but are not limited to:

- Exploring the mathematical, statistical, or computational foundations of CDS&E;
- Understanding the role of computational and statistical tools in advancing mathematics and statistics theory;
- Applying CDS&E-related tools to other fields of knowledge;
- Exploration of existing, ideally remote, data sets using new mathematical and statistical tools and cyberinfrastructure.

Here, research is interpreted broadly to include all forms of discovery learning, at levels appropriate to the students, through which students are introduced to the excitement of the scientific research process. These should motivate students to pursue and persist in what can be challenging aspects of scientific endeavor. For the purposes of this program, it is not necessary that research topics be original or that student research experiences lead to publishable results, but the content should be substantial and intellectually stimulating.

2. **Education and Training.** Enhancements to the undergraduate curriculum that contribute to the training of the next-generation of mathematics and statistics majors grounded in CDS&E. Training activities, centered on CDS&E, for students pursuing minors in mathematics and statistics are encouraged.

Examples include, but are not limited to:

- Developing minors/majors, certificate programs, or joint programs in CDS&E;
- Incorporating CDS&E content in existing courses or developing new courses in CDS&E areas (e.g., data structures, algorithms, and software for science and engineering, scientific computation, and analysis and visualization of big data sets);
- Creating CDS&E capstone experiences, such as practical, internships, or multidisciplinary projects;
- CDS&E training activities, designed as part of existing courses or as components of teacher training, for mathematics and statistics undergraduates pursuing a teaching career.
- Engaging students in quantitative explorations with data through innovations in general education courses in STEM fields.

Interdepartmental curricular initiatives are encouraged.

3. **Faculty Professional Development or Outreach.** CDS&E-centered training activities for college faculty or K-12 teachers.

Examples include, but are not limited to:

- CDS&E-specific training for faculty and mentors;
- Lectures/workshops on current and emerging challenges in CDS&E;
- Collaboration with CDS&E experts from other universities, institutes, national laboratories, or industry;
- Workshops on integrating CDS&E content in the curriculum;
- Pedagogical strategies for CDS&E content;
- Developing CDS&E-driven student activities at the K-12 level (e.g., competitions, group projects, science fairs).

B. IMPORTANT PROJECT FEATURES

All EXTREEMS-QED projects should strengthen the educational capacity, infrastructure, and culture at participating institutions, as reflected by the number and inclusiveness of participating mentors and students, the quality of their research experiences, the effectiveness of department-wide curricular initiatives, and the impact of outreach and faculty professional development activities. Projects should foster student learning and professional development and an appreciation for the integration of research and education. EXTREEMS-QED projects should contribute substantially to an enhanced and sustainable undergraduate educational enterprise that strengthens CDS&E training and education for mathematics and statistics students.

The use of evidence-based proven instructional practices is encouraged and should be documented. Please see Section IX for some examples of references that discuss proven practices.

EXTREEMS-QED encourages collaborations that bring together scientists from baccalaureate, masters, or PhD granting institutions. Collaborative involvement of minority-serving institutions, two-year colleges, industrial partners, or government laboratories is strongly encouraged.

Although projects may vary in the approaches they take, the number and type of academic institutions involved, and the number of participating faculty members, all competitive projects will have certain common features:

1. **Student Activities and Mentoring:** Instruction in effective oral and written communication (e.g. seminars, posters, research papers, project and consulting reports, and documentation of computer programs) should be an important component of the proposed student experience. Projects must include a description of the mentors' qualifications or plans for training of mentors. Broad participation of department faculty is encouraged. A schedule of the year-round long-term activities should be provided.
2. **Recruitment:** Describe in detail the recruitment plan for all participants. NSF is particularly interested in increasing the participation of women, underrepresented minorities, and persons with disabilities in the STEM disciplines. Underrepresented minorities are African-Americans, Hispanics, Native Americans, and Native Pacific Islanders. In EXTREEMS-QED awards, only those undergraduate students who are citizens or permanent residents of the United States or its possessions can be supported with NSF funds.
3. **Post EXTREEMS-QED Plan:** One of the main goals of the program is to facilitate lasting changes in the education and training of the next generation of mathematics and statistics undergraduate students, so that they are well-equipped to confront the new challenges in CDSE either in the workforce or in graduate school. Proposals should address the potential long-term effects of the proposed activities, including changes to the curriculum, development of new programs, and establishment of collaborations within and/or outside the institution. A clear plan for sustaining the program goals beyond the grant duration must be included.
4. **Dissemination/CDSE Community-Building:** Proposals should clearly address dissemination of information about project outcomes. Investigators of EXTREEMS-QED projects are expected to share the knowledge and experience gained in developing and assessing CDS&E educational innovations with the mathematics and statistics community. EXTREEMS-QED aims to create new models of education and training in CDS&E: dissemination to the mathematics and statistics community as well as a broader audience is therefore critical to the success of the program. This may be achieved in a number of ways, including websites, publications, publicly accessible databases, presentations, and workshops.
5. **Project Assessment, Evaluation and Reporting:** All projects should include an evaluation plan that describes both a strategy for continuous monitoring of the project to provide feedback for improvement (formative evaluation) and a strategy for evaluating the effectiveness of the project in achieving its goals and identifying positive and negative findings upon completion (summative evaluation). Proposals should identify specific goals and related expected measurable outcomes that will be used to track progress, guide the project, and evaluate its impact. Expected measurable outcomes must address student learning, contributions to CDS&E research and training, and community building.

The proposal must describe ways of assessing students' foundational knowledge in CDS&E and their ability to apply computational and statistical methods. The proposal must address the effect of curricular changes on student learning and performance, and the impact of faculty professional development or outreach activities on the department and institution. Please see Additional Reporting Requirements in Section VII.C.

More extensive projects may require experienced evaluators to conduct a comprehensive evaluation. Although not required, the principal investigator(s) may wish to engage educational research specialists in planning and implementing the project evaluation. Additionally, it is highly desirable to have a mechanism for tracking participating students beyond graduation in order to assess the impact of the CDS&E research, education and training on their career paths. For guidance, proposers may wish to consult the NSF on-line document, "User-Friendly Handbook for Project Evaluation" (NSF 02-57), [<http://www.nsf.gov/pubs/ods/getpub.cfm?nsf02057>].

III. AWARD INFORMATION

Anticipated Type of Award: Continuing Grant or Standard Grant

Estimated Number of Awards: 4 to 6 NSF anticipates making 4-6 awards, with some projects having 5 year duration and some having 2-3 year duration. It is not anticipated that particular projects will receive support from the EXTREEMS-QED program for longer than five years in total.

Anticipated Funding Amount: \$4,000,000, subject to the availability of funds

IV. ELIGIBILITY INFORMATION

Organization Limit:

Proposals may only be submitted by the following:

- Universities and Colleges -- Universities and four-year colleges accredited in and having a campus located in the US, acting on behalf of their faculty members. Two-year colleges or community colleges may serve as non-lead organizations in collaborative proposals or receive support via subcontracts.

PI Limit:

None Specified

Limit on Number of Proposals per Organization:

None Specified

Limit on Number of Proposals per PI:

None Specified

V. PROPOSAL PREPARATION AND SUBMISSION INSTRUCTIONS

A. Proposal Preparation Instructions

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

- Full proposals submitted via FastLane: Proposals submitted in response to this program solicitation should be prepared and submitted in accordance with the general guidelines contained in the NSF Grant Proposal Guide (GPG). The complete text of the GPG is available electronically on the NSF website at: http://www.nsf.gov/publications/pub_summ.jsp?ods_key=gpg. Paper copies of the GPG may be obtained from the NSF Publications Clearinghouse, telephone (703) 292-7827 or by e-mail from nsfpubs@nsf.gov. Proposers are reminded to identify this program solicitation number in the program solicitation block on the NSF Cover Sheet For Proposal to the National Science Foundation. Compliance with this requirement is critical to determining the relevant proposal processing guidelines. Failure to submit this information may delay processing.
- Full proposals submitted via Grants.gov: Proposals submitted in response to this program solicitation via Grants.gov should be prepared and submitted in accordance with the NSF Grants.gov Application Guide: A Guide for the Preparation and Submission of NSF Applications via Grants.gov. The complete text of the NSF Grants.gov Application Guide is available on the Grants.gov website and on the NSF website at: (http://www.nsf.gov/publications/pub_summ.jsp?ods_key=grantsgovguide). To obtain copies of the Application Guide and Application Forms Package, click on the Apply tab on the Grants.gov site, then click on the Apply Step 1: Download a Grant Application Package and Application Instructions link and enter the funding opportunity number, (the program solicitation number without the NSF prefix) and press the Download Package button. Paper copies of the Grants.gov Application Guide also may be obtained from the NSF Publications Clearinghouse, telephone (703) 292-7827 or by e-mail from nsfpubs@nsf.gov.

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

Collaborative Proposals. All collaborative proposals submitted as separate submissions from multiple organizations must be submitted via the NSF FastLane system. Chapter II, Section D.4 of the Grant Proposal Guide provides additional information on collaborative proposals.

The following instructions **supplement** the GPG or NSF Grants.gov Application Guide guidelines.

1. **Cover Sheet.** The title of the project should begin "EXTREEMS-QED:"
2. **Project Summary.** The project summary must clearly state the objectives of the proposed EXTREEMS-QED project in each of the three categories: Research, Education and Training, and Faculty Professional Development/Outreach.
3. **Project Description.** The project description is not to exceed 15 pages in length and must contain the following items:
 - a. Results from Prior NSF Support (if applicable).

- b. **Overview.** Provide a brief description of the objectives of the proposed EXTREEMS-QED project in each of the three categories: Research, Education and Training, and Faculty Professional Development/Outreach. The proposal should describe student, faculty, and outreach participation, the organizational structure and timetable, and evidence of organizational endorsement. *Letters of commitment from appropriate institutional administrators should be included as supplementary documents.*
 - c. **Project Components and Important Features.** Provide a detailed plan for the Research, Education and Training, and Faculty Professional Development/Outreach activities. See Section II.A of this solicitation for a list of examples. Describe key features of the project including Student Activities and Mentoring, Recruitment, Post EXTREEMS-QED Plan, Dissemination, and Assessment and Evaluation. See II.B for details. If appropriate, provide a clear list of cyberinfrastructure resources which will be leveraged through the project activities.
 - d. **Project Management.** Describe a clear management plan that includes mechanisms for dealing with possible changes in faculty participation over the course of the project.
4. **Biographical Sketches.** The standard guidelines for biographical material apply; however, senior personnel are encouraged to include publications with undergraduate co-authors (with the student labeled by an asterisk) and other activities or accomplishments relevant to a successful CDS&E activity. Senior personnel are the principal investigator, any co-principal investigators, and any other faculty/professionals who are anticipated to serve as research mentors. Postdoctoral scholars and graduate students are not senior personnel.
 5. **Project Budget.** The proposal should include a detailed project budget and budget justification, as described in the GPG or NSF Grants.gov Application Guide. The budget justification should explain and justify major cost items and any unusual situations/inclusions and address the cost-effectiveness of the project. The budget may include items such as faculty salaries (including course buy-outs), support for coordination activities, equipment, and other direct costs (e.g., materials, publication costs). The budget may include funds for student stipends. Funds for organizing/attending workshops for faculty professional development may also be included. In projects of duration three years or greater, funds should also be budgeted for the PI and an additional faculty member to travel to an awardees meeting in the third year of the award.
 6. **Supplementary Documentation.** While all material relevant to determining the quality of the proposed work must be included within the 15-page Project Description or as part of the budget justification, proposers may, as a part of the Supplementary Documentation, include letters showing collaborator commitments and organizational endorsement. In addition, for those projects whose deliverables include a final product, samples of these products (such as screen shots of software, sample teaching modules and other project deliverables) may be placed within the Supplementary Documentation section. These sample materials should be concise and relevant.

B. Budgetary Information

Cost Sharing: Inclusion of voluntary committed cost sharing is prohibited

Budget Preparation Instructions:

Other Budgetary Limitations:

NSF funds may not be used to support expenditures that would normally be made in the absence of an award, such as costs for routine teaching activities.

Total award sizes are limited to an average of \$200,000 per year (or \$250,000 per year when four-year colleges or universities collaborate with two-year colleges).

C. Due Dates

- **Full Proposal Deadline(s)** (due by 5 p.m. proposer's local time):
 - December 14, 2012
 - November 06, 2013
 - First Wednesday in November, Annually Thereafter

D. FastLane/Grants.gov Requirements

- **For Proposals Submitted Via FastLane:**

Detailed technical instructions regarding the technical aspects of preparation and submission via FastLane are available at: <https://www.fastlane.nsf.gov/a1/newstan.htm>. For FastLane user support, call the FastLane Help Desk at 1-800-673-6188 or e-mail fastlane@nsf.gov. The FastLane Help Desk answers general technical questions related to the use of the FastLane system. Specific questions related to this program solicitation should be referred to the NSF program staff contact(s) listed in Section VIII of this funding opportunity.

Submission of Electronically Signed Cover Sheets. The Authorized Organizational Representative (AOR) must electronically sign the proposal Cover Sheet to submit the required proposal certifications (see Chapter II, Section C of the Grant Proposal Guide for a listing of the certifications). The AOR must provide the required electronic certifications within five working days following the electronic submission of the proposal. Further instructions regarding this process are available on the FastLane Website at: <https://www.fastlane.nsf.gov/fastlane.jsp>.

- **For Proposals Submitted Via Grants.gov:**

Before using Grants.gov for the first time, each organization must register to create an institutional profile. Once registered, the applicant's organization can then apply for any federal grant on the Grants.gov website. Comprehensive information about using Grants.gov is available on the Grants.gov Applicant Resources webpage: http://www07.grants.gov/applicants/app_help_reso.jsp. In addition, the NSF Grants.gov Application Guide provides additional technical guidance regarding preparation of proposals via Grants.gov. For Grants.gov user support, contact the Grants.gov

Contact Center at 1-800-518-4726 or by email: support@grants.gov. The Grants.gov Contact Center answers general technical questions related to the use of Grants.gov. Specific questions related to this program solicitation should be referred to the NSF program staff contact(s) listed in Section VIII of this solicitation.

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

VI. NSF PROPOSAL PROCESSING AND REVIEW PROCEDURES

Proposals received by NSF are assigned to the appropriate NSF program where they will be reviewed if they meet NSF proposal preparation requirements. 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 who are experts in the particular fields represented by the proposal. These reviewers are selected by Program Officers charged with the 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.

A. NSF Merit Review Criteria

All NSF proposals are evaluated through use of the two National Science Board (NSB)-approved merit review criteria: intellectual merit and the broader impacts of the proposed effort. In some instances, however, NSF will employ additional criteria as required to highlight the specific objectives of certain programs and activities.

The two NSB-approved merit review criteria are listed below. The criteria include considerations that help define them. These considerations are suggestions and not all will apply to any given proposal. While proposers must address both merit review criteria, reviewers will be asked to address only those considerations that are relevant to the proposal being considered and for which the reviewer is qualified to make judgments.

What is the intellectual merit of the proposed activity?

How important is the proposed activity to advancing knowledge and understanding within its own field or across different fields? How well qualified is the proposer (individual or team) to conduct the project? (If appropriate, the reviewer will comment on the quality of the prior work.) To what extent does the proposed activity suggest and explore creative, original, or potentially transformative concepts? How well conceived and organized is the proposed activity? Is there sufficient access to resources?

What are the broader impacts of the proposed activity?

How well does the activity advance discovery and understanding while promoting teaching, training, and learning? How well does the proposed activity broaden the participation of underrepresented groups (e.g., gender, ethnicity, disability, geographic, etc.)? To what extent will it enhance the infrastructure for research and education, such as facilities, instrumentation, networks, and partnerships? Will the results be disseminated broadly to enhance scientific and technological understanding? What may be the benefits of the proposed activity to society?

Examples illustrating activities likely to demonstrate broader impacts are available electronically on the NSF website at: <http://www.nsf.gov/pubs/gpg/broaderimpacts.pdf>.

Mentoring activities provided to postdoctoral researchers supported on the project, as described in a one-page supplementary document, will be evaluated under the Broader Impacts criterion.

Additional Solicitation Specific Review Criteria

Transformative nature of the project: The potential to contribute to a paradigm-shifting integration of CDS&E into undergraduate STEM research, education and training. Development of model programs that enhance student learning and may be adapted easily by other sites. Impact on the training of faculty or K-12 teachers.

NSF staff also will give careful consideration to the following in making funding decisions:

Integration of Research and Education

One of the principal strategies in support of NSF's goals is to foster integration of research and education through the programs, projects, and activities it supports at academic and research institutions. These institutions provide abundant opportunities where individuals may concurrently assume responsibilities as researchers, educators, and students and where all can engage in joint efforts that infuse education with the excitement of discovery and enrich research through the diversity of learning perspectives.

Integrating Diversity into NSF Programs, Projects, and Activities

Broadening opportunities and enabling the participation of all citizens -- women and men, underrepresented minorities, and persons with disabilities -- 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.

B. Review and Selection Process

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

Reviewers will be asked to formulate a recommendation to either support or decline each proposal. 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 is striving to be able to tell

applicants whether their proposals have been declined or recommended for funding within six months. The time interval begins on the deadline or target date, or receipt date, whichever is later. The interval ends when the Division Director accepts the Program Officer's recommendation.

A summary rating and accompanying narrative will be completed and submitted by each reviewer. In all cases, reviews are treated as confidential documents. Verbatim copies of reviews, excluding the names of the reviewers, 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.

In all cases, after programmatic approval has been obtained, the proposals recommended for funding will be forwarded to the Division of Grants and Agreements for review of business, financial, and policy implications and 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.

VII. AWARD ADMINISTRATION INFORMATION

A. Notification of the Award

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

B. Award Conditions

An NSF award consists of: (1) the award letter, 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 letter; (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 letter. Cooperative agreements also are administered in accordance with NSF Cooperative Agreement Financial and Administrative Terms and Conditions (CA-FATC) and the applicable Programmatic Terms and Conditions. NSF awards are electronically signed by an NSF Grants and Agreements Officer and transmitted electronically to the organization via e-mail.

*These documents may be accessed electronically on NSF's Website at http://www.nsf.gov/awards/managing/award_conditions.jsp?org=NSF. Paper copies may be obtained from the NSF Publications Clearinghouse, telephone (703) 292-7827 or by e-mail from nsfpubs@nsf.gov.

More comprehensive information on NSF Award Conditions and other important information on the administration of NSF awards is contained in the *NSF Award & Administration Guide* (AAG) Chapter II, available electronically on the NSF Website at http://www.nsf.gov/publications/pub_summ.jsp?ods_key=aag.

C. Reporting Requirements

For all multi-year grants (including both standard and continuing grants), the Principal Investigator must submit an annual project report to the cognizant Program Officer at least 90 days before the end of the current budget period. (Some programs or awards require more frequent project reports). Within 90 days after 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 that PI. 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 FastLane, for preparation and submission of annual and final project reports. Such reports provide information on activities and findings, project participants (individual and organizational), publications, and other specific products and contributions. PIs will not be required to re-enter information previously provided, either with a proposal or in earlier updates using the electronic system. Submission of the report via FastLane constitutes certification by the PI that the contents of the report are accurate and complete. The project outcomes report 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 Award & Administration Guide* (AAG) Chapter II, available electronically on the NSF Website at http://www.nsf.gov/publications/pub_summ.jsp?ods_key=aag.

In addition to the FastLane reporting requirements, awardees will be required to report data relevant to the proposed measurable outcomes of the project annually for the duration of the grant. In particular, the awardee must include the following items in annual reports:

1. Number of undergraduate students engaged in EXTREEMS-QED research.
2. List of new courses and new programs developed, with number of students enrolled in each.
3. Number of individuals impacted by professional development and outreach activities, broken down by home institution.

4. List of cyberinfrastructure resources (if appropriate) created or leveraged through the project activities.

Grantees whose awards are of duration three years or longer will be required to report results of the project efforts during a site visit and/or at a third-year PI meeting held to share information on effective practices. Fourth- and fifth- year funding is contingent upon demonstration of satisfactory progress towards meeting the project goals.

VIII. AGENCY CONTACTS

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

General inquiries regarding this program should be made to:

- Jennifer Pearl, MPS/DMS, telephone: (703) 292-4492, email: jslimowi@nsf.gov
- Annalisa Calini, MPS/DMS, telephone: (703) 292-2189, email: acalini@nsf.gov
- Nandini Kannan, MPS/DMS, telephone: (703) 292-8584, email: nkannan@nsf.gov
- Mark Suchman, OD/OCl, telephone: (703) 292-8061, email: msuchman@nsf.gov

For questions related to the use of FastLane, contact:

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

For questions relating to Grants.gov contact:

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

IX. OTHER INFORMATION

The NSF Website provides the most comprehensive source of information on NSF Directorates (including contact information), programs and funding opportunities. Use of this Website by potential proposers is strongly encouraged. In addition, National Science Foundation Update is a free e-mail subscription service 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 Regional Grants Conferences. Subscribers are informed through e-mail when new publications are issued that match their identified interests. Users can subscribe to this service by clicking the "Get NSF Updates by Email" link on the [NSF web site](#).

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

Related Programs:

Two NSF programs that are related to EXTREEMS-QED are

[Transforming Undergraduate Education in Science, Technology, Engineering and Mathematics](#) and
[Computational and Data-Enabled Science and Engineering \(CDS&E\)](#).

The following resources are but a sample of the literature that provide information concerning evidence-based proven instructional practices in STEM fields:

"Engage to Excel: Producing One Million Additional College Graduates with Degrees in Science, Technology, Engineering, and Mathematics," President's Council of Advisors on Science and Technology, 2012.
http://www.whitehouse.gov/sites/default/files/microsites/ostp/pcast-engage-to-excel-final_feb.pdf.

"Discipline-Based Education Research: Understanding and Improving Learning in Undergraduate Science and Engineering," edited by Susan R. Singer, Natalie R. Nielsen, and Heidi A. Schweingruber, National Academies Press, 2012. http://www.nap.edu/catalog.php?record_id=13362

"Five High Impact Practices: Research on Learning Outcomes, Completion, and Quality," by Jayne E. Brownell and Lynn E. Swaner, Association of American Colleges and Universities, 2010.

Reports published by the American Association for the Advancement of Science which emanate from the "Understanding Interventions that Broaden Participation in Research Careers" workshops, 2007-2009.
<http://understanding-interventions.org/>

"New Challenges, New Strategies: Building Excellence in Undergraduate STEM Education", American Association for the Advancement of Science, 2009. <http://cliconference.org/files/2010/02/2009.pdf>

ABOUT THE NATIONAL SCIENCE FOUNDATION

The National Science Foundation (NSF) is an independent Federal agency created by the National Science Foundation Act of 1950,

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

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

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

Facilitation Awards for Scientists and Engineers with Disabilities provide funding for special assistance or equipment to enable persons with disabilities to work on NSF-supported projects. See Grant Proposal Guide Chapter II, Section D.2 for instructions regarding preparation of these types of proposals.

The National Science Foundation has Telephonic Device for the Deaf (TDD) and Federal Information Relay Service (FIRS) capabilities that enable individuals with hearing impairments to communicate with the Foundation about NSF programs, employment or general information. TDD may be accessed at (703) 292-5090 and (800) 281-8749, FIRS at (800) 877-8339.

The National Science Foundation Information Center may be reached at (703) 292-5111.

The National Science Foundation promotes and advances scientific progress in the United States by competitively awarding grants and cooperative agreements for research and education in the sciences, mathematics, and engineering.

To get the latest information about program deadlines, to download copies of NSF publications, and to access abstracts of awards, visit the NSF Website at <http://www.nsf.gov>

- **Location:** 4201 Wilson Blvd. Arlington, VA 22230
- **For General Information** (NSF Information Center): (703) 292-5111
- **TDD (for the hearing-impaired):** (703) 292-5090
- **To Order Publications or Forms:**
Send an e-mail to: nsfpubs@nsf.gov
or telephone: (703) 292-7827
- **To Locate NSF Employees:** (703) 292-5111

PRIVACY ACT AND PUBLIC BURDEN STATEMENTS

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

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

Suzanne H. Plimpton
Reports Clearance Officer
Division of Administrative Services
National Science Foundation
Arlington, VA 22230

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