

**Office of Science  
Financial Assistance  
Funding Opportunity Announcement  
DE-FOA-0000316**

***Scientific Discovery through Advanced Computing: Advanced  
Simulation of Fusion Plasmas***

**SUMMARY:**

The Fusion Energy Sciences (FES) Program of the Office of Science (SC), U.S. Department of Energy (DOE), hereby announces its interest in receiving Cooperative Agreement applications from interdisciplinary teams for the development and application of high performance scientific simulation codes under the SC Scientific Discovery through Advanced Computing (SciDAC) program. The FES SciDAC portfolio focuses on the creation of high physics fidelity simulation codes that can advance scientific discovery in fusion plasma science and contribute to the FES goal of developing a validated predictive capability for magnetically confined plasmas by fully exploiting the emerging capabilities of petascale and beyond computing resources and associated progress in software and algorithm development.

The specific areas of interest under this Funding Opportunity are:

1. Electromagnetic waves in plasmas
2. Magnetohydrodynamics
3. Plasma turbulence and transport, and
4. Energetic particles in plasmas

More specific information on each area of interest is outlined in the general and program specific supplementary information below.

All teams planning to submit applications for new or renewal funding in Fiscal Year 2011 should submit in response to this announcement. Partnerships among Academic Institutions, National Laboratories, and Private Industry are strongly encouraged.

A companion Program Announcement to DOE Laboratories (LAB 10-316) will be posted on the SC Grants and Contracts web site at: [http://www.science.doe.gov/grants/LAB10\\_316.html](http://www.science.doe.gov/grants/LAB10_316.html)

**PREAPPLICATIONS:**

Preapplications are **REQUIRED** and must be submitted by April 23, 2010, 11:59 PM Eastern Time. **Failure to submit a preapplication by an applicant will preclude the full application from due consideration.** The preapplication should be submitted electronically by E-mail to John.Mandrekas@science.doe.gov and John.Sauter@science.doe.gov. **Please include "Preapplication for DE-FOA-0000316" in the subject line.**

Preapplications should include cover page information, a brief description of the proposed work (1-2 pages, including text with minimum font size 11 point, figures, and references), and a one-page curriculum vitae from each Principal Investigator (PI), co-Principal Investigator (co-PI), and senior collaborator or consultant. The cover page should include: (a) A statement that the document is a preapplication in response to Funding Opportunity DE-FOA-0000316; (b) PI information: name, institutional affiliation, telephone number, fax number, and e-mail address; and, (c) names and institutions of all co-PIs, and senior collaborators or consultants (excluding postdoctoral associates). Since among the purposes of the preapplication is to facilitate FES in planning the merit review and the selection of peer-reviewers without conflicts of interest, it is important that applicants ensure their list of supported or unsupported participants is as comprehensive as possible.

Preapplications will be reviewed by FES program officials for responsiveness to this Funding Opportunity and the SciDAC program, eligibility of the applicant organization, and qualification of the applicant's personnel for carrying out a large-scale computational research activity. Only those applicants who receive notification from DOE encouraging a full application may submit a formal application. **No other formal applications will be considered.**

**APPLICATION DUE DATE:** May 20, 2010, 11:59 PM Eastern Time

Formal applications submitted in response to this FOA must be received by May 20, 2010, 11:59 PM Eastern Time, to permit timely consideration of awards in Fiscal Year 2011. **You are encouraged to submit your application well before the deadline. APPLICATIONS RECEIVED AFTER THE DEADLINE WILL NOT BE REVIEWED OR CONSIDERED FOR AWARD.**

#### **IMPORTANT SUBMISSION INFORMATION:**

The full text of the Funding Opportunity Announcement (FOA) is located on FedConnect. Instructions for completing the Grant Application Package are contained in the full text of the FOA which can be obtained at: <https://www.fedconnect.net/FedConnect/?doc=DE-FOA-0000316&agency=DOE>. To search for the FOA in FedConnect click on "Search Public Opportunities". Under "Search Criteria", select "Advanced Options", enter a portion of the title "Scientific Discovery through Advanced Computing: Advanced Simulation of Fusion Plasmas", then click on "Search". Once the screen comes up, locate the appropriate Announcement.

In order to be considered for award, Applicants must follow the instructions contained in the Funding Opportunity Announcement.

**WHERE TO SUBMIT:** Applications must be submitted through [Grants.gov](http://Grants.gov) to be considered for award.

You cannot submit an application through Grants.gov unless you are registered. Please read the registration requirements carefully and start the process immediately. Remember you have to update your CCR registration annually. If you have any questions about your registration, you

should contact the Grants.gov Helpdesk at 1-800-518-4726 to verify that you are still registered in [Grants.gov](http://www.grants.gov).

Registration Requirements: There are several one-time actions you must complete in order to submit an application through Grants.gov (e.g., obtain a Dun and Bradstreet Data Universal Numbering System (DUNS) number, register with the Central Contract Registry (CCR), register with the credential provider, and register with Grants.gov). See <http://www.grants.gov/GetStarted>. Use the Grants.gov Organization Registration Checklist at <http://www.grants.gov/assets/OrganizationRegCheck.pdf> to guide you through the process. Designating an E-Business Point of Contact (EBiz POC) and obtaining a special password called an MPIN are important steps in the CCR registration process. Applicants, who are not registered with CCR and Grants.gov, should allow at least 21 days to complete these requirements. It is suggested that the process be started as soon as possible.

**IMPORTANT NOTICE TO POTENTIAL APPLICANTS:**

When you have completed the process, you should call the Grants.gov Helpdesk at 1-800-518-4726 to verify that you have completed the final step (i.e. Grants.gov registration).

**Questions:** Questions relating to the registration process, system requirements, how an application form works, or the submittal process must be directed to Grants.gov at 1-800-518-4726 or support@grants.gov. Part VII of the FOA explains how to submit other questions to the Department of Energy (DOE).

**GENERAL INQUIRIES ABOUT THIS FOA SHOULD BE DIRECTED TO:**

**Technical/Scientific Program Contact:**

**Dr. John Mandrekas**, Office of Fusion Energy Sciences, SC-24.2

PHONE: (301) 903-0552

E-MAIL: John.Mandrekas@science.doe.gov

**SUPPLEMENTARY INFORMATION:**

**Scientific Discovery through Advanced Computing**

The SC SciDAC program goes beyond the scientific computing and computational science research embedded in the core programs of the SC Program Offices and invests in a portfolio of coordinated research efforts directed at exploiting the emerging capabilities of high performance "ultrascale" computing. The research projects in this portfolio respond to the extraordinary difficulties of realizing sustained peak performance for those scientific applications that require ultrascale computing capabilities to accomplish their research goals. They respond also to the need for developing collaborative software environments where distributed resources and expertise are combined to address complex questions that no single institution or investigator can manage alone. Research funded under the SciDAC portfolio is enabling teams of University, Laboratory, and Private Industry researchers to solve some of the most challenging scientific problems in the SC core programs at a level of accuracy and detail never before achieved. A complete description of the SciDAC program can be found at: <http://www.scidac.gov/>

## **Description of topical areas**

### **1. Electromagnetic waves in plasmas**

Applications are solicited for the development and application of large-scale scalable simulation codes for the study of the propagation, absorption, interaction, and control of radiofrequency (RF) waves in various frequency ranges and regimes in burning plasmas. Topics of interest include RF coupling and loading of antennas to reactor-grade edge plasmas including 3D effects, wave-particle interactions including interactions with energetic particle populations, RF sheath formation and interaction with plasma facing components and other structures, and RF-generated flows. Increased integration of RF codes with Fokker-Plank, energetic particle, extended MHD, and plasma turbulence codes is also desirable.

### **2. Magnetohydrodynamics**

Applications are solicited for the development and application of scalable, non-linear, time dependent, extended magnetohydrodynamic (MHD) codes to model the macroscopic dynamics of reactor-grade tokamak plasmas. Application areas include, but are not limited to, Edge Localized Modes (ELMs) and their control using Resonant Magnetic Perturbations (RMPs) or other techniques, disruption mitigation, nonlinear evolution and control of Resistive Wall Modes (RWMs), and sawteeth oscillations. Increased integration with energetic particle and plasma turbulence codes allowing the study of the effect of MHD modes on energetic particle confinement is also desirable.

### **3. Plasma Turbulence and Transport**

Applications are solicited for the development and application of high-performance nonlinear gyrokinetic simulation codes for the study of plasma turbulence and transport in magnetically confined plasmas. The proposed work should focus on understanding, predicting, and controlling the transport of ion and electron thermal energy, momentum, and particles (including impurity species) from the core and edge of magnetically confined plasmas in toroidal configurations, with emphasis on burning plasmas and ITER. The codes should include all relevant physics-such as electromagnetic effects, non-adiabatic species, and realistic collision operators-and should be able to simulate plasmas in experimentally relevant geometries. Codes based both on the Particle-In-Cell (PIC) and the continuum or Eulerian methodologies are of interest. Close collaboration with theorists should be established to ensure the underlying gyrokinetic formulation is appropriate for the proposed tasks. Increased integration allowing evolution of profiles and other relevant parameters on the transport time scale is also desirable.

### **4. Energetic particles in plasmas**

Applications are solicited for the development and application of large-scale scalable simulation codes for the study of energetic particle effects in strongly self-heated burning plasmas. The proposed work should focus on developing a predictive understanding of the nonlinear coupling and interaction between energetic particle driven Alfvén modes and the background thermal plasma, including interaction with core stability and core plasma turbulence, in the small normalized fast ion gyro-radius regime anticipated in ITER and reactor-grade plasmas and the effects of this interaction on the energetic

particle and background plasma confinement. Further integration of energetic particle effects on the longer time scales characterizing core stability and transport is also desirable for a self-consistent assessment of their impact on plasma performance.

## **Additional Considerations**

### Applied Math, Computer and Computational Science Application Components

In addition to descriptions of the physical models in the various simulation codes, applications should include information on the proposed mathematical algorithms, computer science methods, and data management and visualization techniques. Applicants should include information on the readiness of their codes to run on today's leadership computing facilities supported by the Office of Science-including results from realistic scaling studies, if available. In particular, applicants should address the question of how access to increasingly powerful computational resources will make a difference in achieving their targeted research goals and how it will enhance the overall physics fidelity of their simulation models. To facilitate the review process, the applied mathematics and computer / computational science components of each application should be included in a separate section.

### Verification and Validation

A strong verification and validation (V&V) component is essential for this effort and therefore applicants should discuss their V&V plans in sufficient detail. In addition, since cross-benchmarking of different codes is an indispensable and often-used verification tool for large-scale simulation codes, successful applicants are expected to share data and other supporting information in a timely fashion with other researchers. Applicants are expected to follow the FES data sharing guidelines for large-scale computational projects which can be found at: [http://www.ofes.fusion.doe.gov/FusionDocuments/OFES\\_DataSharingGuidelines.pdf](http://www.ofes.fusion.doe.gov/FusionDocuments/OFES_DataSharingGuidelines.pdf).

### Coordination with the Fusion Simulation Program

The Fusion Simulation Program (FSP) is an FES-led computational initiative aimed at the development of an experimentally validated integrated simulation capability for magnetically confined fusion plasmas in the regimes relevant for practical fusion energy. Currently undergoing a detailed design study, the full program is expected to be launched in the latter part of FY 2011. The success of the FSP will depend critically on synergistic collaborations with the FES SciDAC Centers whose computational modules will be among the building blocks of the larger integrating effort. Accordingly, successful applicants are expected to establish close coordination with the FSP and with the other FES SciDAC Centers and adjust annual Center goals to be consistent with FSP research needs.

### Management Plan

The scope and complexity of these projects will require close collaboration among researchers from the computational and theoretical plasma physics, computer and computational science, and applied mathematics disciplines. Applicants should outline their plans for the implementation of

an appropriate management plan for fostering coordination and collaboration among the key researchers and across the relevant disciplines.

#### References for additional discussion and insight

1. *Magnetic Fusion Energy Sciences Research Needs Workshop (ReNeW) report, June 2009*, <http://www.science.doe.gov/ofes/ReNeW%20report%20press.pdf>
2. *Scientific Grand Challenges in Fusion Energy Sciences and the Role of Computing at the Extreme Scale workshop, March 2009*, <http://extremecomputing.labworks.org/fusion/index.stm>
3. *Fusion Simulation Project (FSP) Workshop report, May 2007*, <http://www.science.doe.gov/ofes/ProgramDocuments/reports/FSPWorkshopReport.pdf>

#### **Program Funding**

It is anticipated that up to a total of \$4,100,000 will be available for multiple awards in Fiscal Year 2011, contingent upon the availability of appropriated funds for this program. The above funding amount refers to the total available funding for both the Cooperative Agreements and the associated Lab Announcement LAB 10-316. At this funding level, 4-5 awards are anticipated. Depending on the quality of the applications, this supports one award for each of the four major topical areas and a possible second award in one area where complementary approaches are deemed essential for reducing risk. Funding will be available annually for up to five years, with outyear support contingent on the availability of funds, progress of the research, and programmatic needs. Funding for the final two years is contingent upon satisfactory completion of a progress review during the third year of each project. At this time, a redirection of focus and task reprioritization within the original scope of work of the Cooperative Agreements may become necessary to respond to the FSP needs.

DOE is under no obligation to pay for any costs associated with the preparation or submission of an application. DOE reserves the right to fund, in whole or in part, any, all, or none of the applications submitted in response to this FOA.

#### **Collaboration**

Collaborative research projects with other institutions, such as universities, industry, non-profit organizations, and Federally Funded Research and Development Centers (FFRDCs), including the DOE National Laboratories, are encouraged under this Announcement. Applications submitted from different institutions, which are directed at a single research activity, should clearly indicate they are part of a proposed collaboration and contain a brief description of the overall research project. However, each application must have a distinct scope of work and a qualified principal investigator who is responsible for the research effort being performed at his or her institution. Further information on preparation of collaborative applications may be accessed via the Internet at: <http://www.science.doe.gov/grants/Colab.html>.

#### **Merit Review**

Applications will be subjected to scientific merit review (peer review) and will be evaluated against the following evaluation criteria which are listed in descending order of importance codified at 10 CFR 605.10(d):

1. Scientific and/or Technical Merit of the Project;
2. Appropriateness of the Proposed Method or Approach;
3. Competency of Applicant's Personnel and Adequacy of Proposed Resources; and
4. Reasonableness and Appropriateness of the Proposed Budget.

The evaluation process will include program policy factors such as the relevance of the proposed research to the terms of the announcement and the agency's programmatic needs. Note that external peer reviewers are selected with regard to both their scientific expertise and the absence of conflict-of-interest issues. Both Federal and non-Federal reviewers may be used, and submission of an application constitutes agreement that this is acceptable to the investigator(s) and the submitting institution.

The Catalog of Federal Domestic Assistance (CFDA) number for this program is 81.049, and the solicitation control number is ERFAP 10 CFR Part 605.

Posted on the Office of Science Grants and Contracts Web Site  
March 30, 2010.