Office of Science
Financial Assistance
Funding Opportunity Announcement
DE-PS02-07ER07-29

National Spherical Torus Experiment
Collaborative Research on Configuration Optimization

The Office of Fusion Energy Sciences (OFES) of the Office of Science (SC), U.S. Department of Energy (DOE), hereby announces its interest in receiving applications for collaborative research on the National Spherical Torus Experiment (NSTX) at Princeton Plasma Physics Laboratory. The NSTX program addresses two of the long term goals of the OFES program: **Configuration Optimization** and developing a **Predictive Capability for Burning Plasmas**. Applications for collaborative research must support the NSTX Program by addressing key scientific issues related to these goals, such as Macroscopic Stability, Multi-Scale Transport Physics, Plasma Boundary Interfaces, Waves and Energetic Particles, and Start-up, Ramp-up and Sustainment without a Solenoid, and Integration of Physics and Operational Requirements for Achieving Burning Plasma Conditions. To be considered for funding, applicants must have discussed their proposed research with the NSTX National Research Program Leaders and must include a Record of Discussion that specifies the benefits of proposed research to the NSTX research program and the interface support required to carry it out. Applications to renew on-going NSTX collaborative research must include a list of project goals from the previous statement of work and a summary of the actual accomplishments.

LETTER OF INTENT DUE DATE: September 11, 2007

A Letter of Intent (LOI) to submit an application is **REQUIRED** and should be submitted by September 11, 2007. **Failure to submit a Letter of Intent by an applicant may preclude the full application from due consideration.** The Letter of Intent should be submitted electronically by E-mail to: John.Sauter@science.doe.gov and Steve.Eckstrand@science.doe.gov. Please include "Letter of Intent for Announcement DE-PS02-07ER07-29" in the subject line.

The purpose of the Letter of Intent (LOI) is to facilitate the OFES in planning the peer review and the selection of potential reviewers for the proposal. For this purpose, the LOI must include a one-page abstract of the proposed research and list the names and institutional affiliations of Principal Investigators, any Co-Principal Investigators, key investigators, collaborators or consultants, so as to identify any potential conflict of interest in the selection of qualified reviewers for the application.

APPLICATION DUE DATE: October 11, 2007, 8 PM Eastern Time

Applications must be submitted using Grants.gov, the Funding Opportunity Announcement can be found using the CFDA Number, 81.049 or the Funding Opportunity Announcement number, DE-PS02-07ER07-29. Applicants must follow the instructions and use the forms provided on Grants.gov.

PROGRAM MANAGER:

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SUPPLEMENTARY INFORMATION:

The NSTX is a major facility designed to study the physics of fusion plasmas confined in a very low aspect-ratio Spherical Torus (ST) configuration. The long-term programmatic goals of the NSTX program are to evaluate the attractiveness of a compact ST configuration, such as a Component Test Facility (CTF), as a cost-effective element in the development of practical fusion power, and to contribute to resolving important issues in predicting the physics of burning plasmas anticipated in ITER. This addresses two of the long term goals of the Office of Fusion Energy Sciences (OFES) program: Configuration Optimization and developing a Predictive Capability for Burning Plasmas. ITER participation and a CTF are included in the USDOE 20-year strategic plan for the Fusion Energy Sciences Program (http://www.sc.doe.gov/bes/archives/plans/SCSP_12FEB04.pdf). In support of the above goals, the scientific objective of the National Spherical Torus Experiment (NSTX) is to understand the physics of the ST, which is characterized by strong magnetic field curvature and high toroidal beta (the ratio of the average plasma pressure to the applied toroidal magnetic field pressure) due to its very low aspect ratio. These unique properties extend and complement the normal aspect ratio tokamak in addressing several overarching scientific issues in magnetic fusion energy science. These issues are defined by the 2005 FESAC Priorities Panel report (http://www.ofes.fusion.doe.gov/more_html/FESAC/PP_Rpt_Apr05R.pdf) and can be organized into the following topical areas: Macroscopic Stability, Multi-Scale Transport Physics, Plasma Boundary Interfaces, Waves and Energetic Particles, and Start-up, Ramp-up and Sustainment without a Solenoid, and Integration of Physics and Operational Requirements for Achieving Burning Plasma Conditions.

More detailed information on the NSTX program is available in the peer reviewed five-year research program for NSTX starting in FY 2004, which is available at http://nstx.pppl.gov/Pages_folder/research_folder/5YrPlan.html.

An NSTX Program Letter providing updated information on the NSTX research priorities and collaboration opportunities during the next three years, based on the advice of the NSTX Program Advisory Committee, will be available on August 20 at http://nstx.pppl.gov/nstx/NSTX_Program_Letters/.

Research on NSTX is carried out by a national research team, which includes scientific personnel from many of the leading U.S. fusion research institutions. Researchers from outside of PPPL are involved in nearly all areas of research on NSTX. The following research areas are included in this solicitation.

- **I.** Macroscopic Stability
- **II.** Multi-Scale Transport Physics
- **III.** Plasma Boundary Interfaces
- **IV.** Waves and Energetic Particles
- **V.** Start-up, Ramp-up, and Sustainment without a Solenoid
- **VI.** Integration of Physics and Operational Requirements

The following sections provide a brief description of the high-priority research topics in each research area in the NSTX Program during FY 2008-2010, the time frame for which collaborative research proposals are being solicited.

NSTX Research Priorities for FY 2008-2010

The projected NSTX priorities for FY 2008-2010 are provided below and grouped in the following scientific areas:

I. Macroscopic Stability - role of magnetic structure in plasma confinement and the limits to plasma pressure in sustained magnetic configurations.

> I-1. *Optimize error field correction and resistive wall mode (RWM) control to produce stable, shaped, toroidally rotating plasmas above the "no-wall" pressure limit - relevant to CTF.*
>
> I-2. *Identify and understand modes that tear magnetic field surfaces and limit plasma pressure and energy confinement as the plasma pressure increases above the "no-wall" limit.*
>
> I-3. *Model and test advanced methods for control of Resistive Wall Modes (RWM) and error fields, and assess the impact of possible off-midplane control coils on macroscopic stability.*
>
> I-4. *Understand dissipation mechanisms responsible for RWM stabilization via rotation.*
>
> I-5. *Assess the feasibility of non-magnetic sensors for diagnosis and control of the plasma boundary, the plasma-material interface, and plasma instabilities.*

II. Multi-Scale Transport Physics - physical processes that govern the confinement of heat, momentum, and particles in plasmas.

> II-1. *Determine relationship between local high-k turbulence and electron heat transport.*

II-2. *Measure poloidal rotation and determine radial electric field shear at low aspect ratio to compare to neoclassical theory and to theory for low-k turbulence suppression and transport barrier formation.*

II-3. *Establish plasma rotation and momentum transport properties, including momentum pinch, in sustained high-beta plasmas relevant to ITER and CTF.*

II-4. *Assess particle fueling and transport, and compare to existing theories, with application to fueling and density control requirements for NSTX lithium program, ITER, and CTF.*

III. Plasma Boundary Interfaces - interface between fusion plasma and its lower temperature plasma-facing material surroundings.

III-1. *Characterize the H-mode pedestal, scrape-off layer, and divertor plasma at low pedestal collisionality with ITER-level heat fluxes and relevance to CTF.*

III-2. *Assess the requirements for edge heat and particle control with ITER-level heat fluxes and relevance to CTF for time scales beyond the current redistribution times*.

III-3. *Model and assess the impact of resonant magnetic perturbations (RMP) on edge localized mode stability and divertor heat and particle exhaust.*

III-4. *Characterize the effects of lithium wall coatings and the liquid lithium divertor module on recycling and particle control, and the requirements for core fueling.*

III-5. *Model and assess experimentally the impact of off-normal events (disruptions, ELMs) on liquid lithium surfaces in the divertor.*

IV. Waves and Energetic Particles - use of electromagnetic waves and energetic particles to sustain and control high-temperature plasmas.

IV-1. *Characterize and simulate the transport of supra-Alfvénic fast ions due to fast-ion driven oscillations relevant to ITER and CTF.*

IV-2. *Exploit improved coupling efficiency of launched fast plasma waves at high ion cyclotron harmonic frequencies (n=10-15), with emphasis on simulating and enhancing plasma performance in advanced operating scenarios.*

IV-3. *Extend present theory of the physics of mode conversion between electron Bernstein waves in the over-dense plasma and externally propagating electromagnetic waves, to determine conditions for heating and current drive in over-dense plasmas. For example, investigate 2D equilibrium effects and/or improved edge damping models.*

V. Start-up, Ramp-up and Sustainment without solenoid - physical processes of magnetic flux generation and sustainment.

V-1. *Develop operating conditions that allow transition from Coaxial Helicity Injection (CHI) plasmas to standard inductively and non-inductively sustained toroidal plasmas.*

V-2. *Develop scenarios for solenoid-free ramp-up to substantial plasma currents via heating and current drive by neutral beam injection and high harmonic fast wave.*

V-3. *Explore the impact of increased electron-cyclotron pre-ionization and heating power on CHI plasma formation and on plasma current generation from ramped poloidal magnetic fields.*

V-4. *Explore new plasma start-up techniques on NSTX, such as plasma-gun startup.*

VI. Integration of Physics and Operational Requirements - physics synergy of external control and self-organization of the plasma.

VI-1. *Develop understanding of the evolution of high non-inductive current fraction plasmas with high-beta, high-bootstrap-fraction, and sustained conditions relevant to CTF and advanced operations in ITER, and how these plasmas could be achieved through a variety of tools, with integration of physics issues in categories I-V.*

VI-2. *Develop and simulate advanced plasma shape control techniques for plasma conditions relevant to CTF.*

Program Funding

It is anticipated that up to $1.4 million from DOE/OFES for new collaborative research awards during FY 2008, contingent upon the availability of funds. Multi-year funding of grant awards is expected, with out-year support contingent upon the availability of appropriated funds in future years, progress of the research, and continuing program need. It is expected that up to 10 awards will be made, depending on the size of the awards. Most awards will be for 3 years and will range from $50,000 to $300,000 per year (total costs). DOE is under no obligation to pay for any costs associated with preparation or submission of applications.

Collaboration

Because NSTX is a collaborative national program, all applicants must collaborate with researchers from other institutions who are part of the NSTX National Research Team, which includes researchers from Princeton Plasma Physics Laboratory, industry, universities, and other DOE National Laboratories, as appropriate. Thus, applications submitted in response to this notice must include a Record of Discussion indicating the benefits of proposed research to the planned NSTX research program, the interface support required by the proposed collaborative work, and a description of how the proposed work will be integrated into the overall NSTX program.

In addition, applications for research projects involving multiple outside institutions, such as universities, industry, and non-profit organizations, will be considered 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.

The Application

Adherence to type size and line spacing requirements is necessary for several reasons. No applicants should have the advantage of providing more text in their applications by using small type. Small type may also make it difficult for reviewers to read the application. The project narrative must not exceed twenty pages of technical information, including text and figures, when printed using standard 8.5" by 11" paper with 1 inch margins (top, bottom, left, and right) and font not smaller than 11 point. The page count of 20 does not include the Face Page and Budget Pages, the Title Page, the biographical material and publication information, or any Appendices. However, it is important that the technical information section provide a complete description of the proposed work, because reviewers are not obliged to read the Appendices. Applications exceeding these page limits may be rejected without review.

Applicants are asked to use the following ordered format:

- **Project Abstract Page**; single page only, should contain:
    - Title
    - PI name
    - Abstract text should concisely describe the overall project goal in one sentence, and limit background/significance of project to one sentence. Short descriptions of each individual aim should focus on what will actually be done.
- **Budget pages** for each year and a summary budget page for the entire project period.
- **Budget Explanation**
- **Background and Recent Accomplishments** (recent accomplishments subsection is mandatory for renewal applications, but optional for new applications)
- **Project Description, 20 pages or less**, exclusive of attachments. Applications with Project Descriptions longer than 20 pages will be returned to applicants and will not be reviewed for scientific merit. The project description should be a clear statement of the work to be undertaken and should include: objectives for the period of the proposed work and expected significance; relation to the longer-term goals of the NSTX project; and relation to the present state of knowledge in the field. The statement should outline the general plan of work, including project scheduled, milestones and deliverables, and an adequate description of methods and procedures.
- **Literature Cited**
- **Biographical Sketches** (please limit to 2 pages per senior investigator)
- **Facilities and Resources** description
- **Current and Pending Support** for each senior investigator
- **Letters of Support** from (unfunded) collaborators (if applicable)

Please do not submit general letters of support as these are not used in making funding decisions.

Posted on the Office of Science Grants and Contracts Web Site
August 8, 2007.