Program Announcement
To DOE National Laboratories

LAB 11-571

Office of Science
Office of Fusion Energy Sciences (FES)
Office of Advanced Scientific Computing Research (ASCR)

Scientific Discovery through Advanced Computing: Scientific Computation Application Partnerships in Fusion Energy Science

GENERAL INQUIRES ABOUT THIS LAB ANNOUNCEMENT SHOULD BE DIRECTED TO:

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SUMMARY:

The Office of Fusion Energy Sciences (FES) and the Office of Advanced Scientific Computing Research (ASCR) of the Office of Science (SC), U.S. Department of Energy (DOE), hereby announce their interest in receiving peer reviewable proposals from interdisciplinary teams to the Scientific Discovery through Advanced Computing (SciDAC) program, for Scientific Computation Application Partnerships (hereafter, Partnerships) in the area of fusion energy sciences. The FES SciDAC portfolio focuses on the development and application of high physics fidelity simulation codes that can advance the fundamental science of magnetically confined plasmas by fully exploiting leadership class computing resources and contribute to the FES goal

of developing the predictive capability needed for a sustainable fusion energy source. The specific areas of interest under this Announcement are:

1. Edge Physics
2. Multiscale Integrated Modeling, and
3. Materials Science

More specific information on each area of interest is included in the Description of Topical Areas section under SUPPLEMENTARY INFORMATION below.

A companion Financial Assistance Opportunity Announcement (DE-FOA-0000571) will also be posted.

SUPPLEMENTARY INFORMATION:

Scientific Discovery through Advanced Computing

The Scientific Discovery through Advanced Computing (SciDAC) program accelerates progress in computational science by breaking down the barriers between disciplines and fostering productive partnerships between domain scientists and computational scientists (e.g., applied mathematicians and computer scientists) who are capable of exploiting the capabilities of leadership class computational systems (by which we mean those existing at or planned in the next five years for the Oak Ridge and Argonne Leadership Computing Facilities, or the high performance production computational systems at the National Energy Research Scientific Computing Center, or similar computing facilities.) These partnerships enable scientists to conduct complex scientific and engineering computations at a level of fidelity needed to simulate real-world conditions. In particular, the key components of SciDAC are SciDAC Institutes and SciDAC Partnerships; the latter is addressed in this Announcement. The Institutes will be the foundation for efforts by applied mathematicians and computer scientists to systematically address technical challenges that are inherent to the scale of new architectures and that are common across a wide range of science applications. The Institutes are responsible for developing new methods, algorithms and libraries spanning a wide range of SciDAC applications. The recently awarded SciDAC Institutes http://science.energy.gov/ascr/research/scidac/scidac-institutes/ are as follows:

- FASTMath: Frameworks, Algorithms, and Scalable Technologies for Mathematics (Director: Lori Diachin, Lawrence Livermore National Laboratory). Topics covered include structured and unstructured mesh tools and mesh-solver interfaces, particle methods, linear and nonlinear solvers, time integration, eigensolvers, and differential variational inequalities.
- SUPER: Sustained Performance, Energy and Resilience (Director: Robert Lucas, University of Southern California). Topics covered include performance engineering (including modeling and autotuning), energy efficiency, resilience, and optimization.
- QUEST: Quantification of Uncertainty in Extreme Scale Computations (Director: Habib Najm, Sandia National Laboratories). Topics covered include inverse problems, reduced stochastic representations, forward uncertainty propagation, fault tolerance, and experimental design and model validation.

A successful Partnership will:

1. Exploit leadership class computing resources to advance scientific frontiers in an area of strategic importance to the Office of Science, and
2. Effectively link to the intellectual resources in applied mathematics and computer science, expertise in algorithms and methods, and scientific software tools at one, or more, SciDAC Institutes.

Although not required, it is expected that all Partnerships funded under this Announcement, will request, and will receive funds from both FES and ASCR to meet proposed objectives.

Reviewers of proposals submitted to this Announcement will be asked to comment upon the feasibility, benefits, and management of the proposed collaborations between the fusion scientists supported by FES on the one hand, and the computational scientists (i.e., applied mathematicians and computer scientists/engineers) supported by ASCR on the other.

Description of Topical Areas

1. Edge Physics

Proposals are solicited for the development and application of advanced simulation codes to address the multiphysics and multiscale challenges associated with the plasma edge region of magnetically confined plasmas. The plasma edge, defined as the region from the top of the pedestal just inside the last closed flux surface to the material walls, plays a critical role in determining the performance of magnetic confinement devices such as the tokamak. Conditions at the plasma edge also determine the magnitude and distribution of particle and energy fluxes to the material walls, including the deposition of large impulsive heat loads due to localized magnetohydrodynamic (MHD) instabilities and other transient events, which directly impact the lifetimes of the wall components. Proposals responsive to this Announcement should employ highly scalable simulation codes based on first-principles physical models and should integrate the most important physical processes on overlapping temporal and spatial scales. The physical models implemented in the simulation codes should be valid in the collisionality and other parameter ranges of relevance encountered in current experiments and anticipated in ITER and future burning plasma devices, and should also be able to handle the complex geometries and magnetic topologies characterizing the plasma edge region of magnetic confinement systems. Areas of interest include transitions to enhanced confinement regimes, the predictive understanding of the edge pedestal formation and structure, and the physics of Edge Localized Modes and their suppression or mitigation via external control techniques. Simulation codes should be able to exploit the massive concurrency of the SC leadership class computing facilities and not merely their high capacity. Explicit development of computational frameworks to enable and facilitate the coupling and integration of component modules is not part of this solicitation, although the reasonable allocation of resources to adapt, maintain, and extend existing computational frameworks, including those developed by the Fusion Simulation Prototype Centers or "proto-FSPs", is permissible.

2. Multiscale Integrated Modeling

Proposals are solicited for the development and application of advanced integrated simulation codes focusing on the prediction, control, and mitigation of performance-limiting or integrity-threatening instabilities and other off-normal events in tokamak plasmas, including sawteeth, Resistive Wall Modes, Tearing Modes, Neoclassical Tearing Modes, and instabilities leading to plasma disruptions. Such simulations require the dynamical modeling—including profile evolution and modeling of active control mechanisms—of a significant part of the discharge from startup to shutdown, as well as the nonlinear coupling of multiple physical processes (transport of particles, momentum and energy, macroscopic instabilities, interaction with energetic particle populations, heating, current drive and fueling sources, interaction with wall originated neutral and impurity species, etc.) spanning multiple regions of different dimensionality (such as core and edge) on overlapping spatial and temporal scales. While developing a full Whole Device Modeling (WDM) simulation capability is beyond the scope of this announcement, proposals responsive to this Announcement are expected to integrate the most critical physical processes for each focus area across all relevant regions and on all relevant temporal and spatial scales, using an appropriately justified combination of first principles models and high physics fidelity reduced models. As noted also in Topic 1, simulation codes should be able to exploit the massive concurrency of the SC leadership class computing facilities and not merely their high capacity. Explicit development of computational frameworks to enable and facilitate the coupling and integration of component modules is not part of this solicitation, although the reasonable allocation of resources to adapt, maintain, and extend existing computational frameworks, including those developed by the Fusion Simulation Prototype Centers or "proto-FSPs", is permissible.

3. Materials Science

Proposals are solicited for the development and application of advanced simulation codes to predict the properties, behavior, response, and lifetimes of near-surface and bulk materials in the challenging fusion environment. Developing advanced materials that can withstand the extreme fusion environment; characterized by high heat and particle fluxes, high neutron fluxes and fluences, and high temperatures and mechanical stresses; and deepening the fundamental understanding of the various mechanisms limiting the performance and lifetimes of existing and proposed materials, are among the most significant challenges facing the fusion program. Advanced simulations have a unique role to play, considering the significant extrapolation necessary to bridge the gap from the existing parameter space to the fusion energy regime due to the absence of fusion-relevant neutron sources and plasma material interactions test stands. Areas of focus include: a) the multiscale and multiphysics modeling of the radiation induced microstructural evolution of bulk structural materials and the resulting changes in their physical and mechanical properties; and b) the prediction of the near-surface plasma facing materials multiscale response to normal and transient particle and energy fluxes, including sputtering erosion, re-deposition (including tritium co-deposition), dust formation, microstructure and phase evolution, and the impact of these effects on the properties and lifetimes of these materials. Work addressing issues associated with the use of liquid metals as either plasma facing or blanket materials is also of interest. Simulation codes should be based on high physics fidelity models, ranging from first principles approaches to appropriately justified reduced descriptions. Work primarily focused on the modeling of the

scrape off layer plasma is not part of this Announcement. As noted also in Topics 1 and 2, simulation codes should be able to exploit the massive concurrency of the SC leadership class computing facilities and not merely their high capacity.

Additional Considerations

Verification and Validation and Data Sharing

A strong verification and validation (V&V) component is essential for these efforts and therefore proposers 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 proposers are expected to share data and other supporting information in a timely fashion with other researchers. Proposers are expected to follow the FES data sharing guidelines for large-scale computational projects which can be found at: http://science.energy.gov/~/media/fes/pdf/program-documents/Data_sharing_guidelines_feb_2007.pdf

Coordination with SciDAC Institutes, FES SciDAC Centers, and other Program Elements

Proposers must provide specific plans for establishing partnerships with the SciDAC Institutes to systematically address the applied math and computer science challenges that are inherent to the scale of new architectures or common across applications. In addition, proposers should detail their plans to establish partnerships maximizing synergy and leverage with other FES supported efforts, such as theory and computational groups, including FES SciDAC Centers, and experiments. Proposers must be explicit about the benefits that they expect to receive from these engagements. Successful proposers will be expected to establish close coordination with other large scale simulation efforts in the areas of integrated modeling or computational materials that may be undertaken by FES in collaboration with other SC Program Offices and, at DOE's direction, adjust annual project goals and priorities within their original scope of work to maximize synergy and be responsive to the needs of these larger scale efforts. Finally, reviewers will examine (see Merit Review Criteria below) the collaborations for, among others, duplication of effort.

Management structure

The proposers must identify a management structure that enables an effective collaboration among the participants from various disciplines. The structure and management must be sufficiently flexible to adapt quickly to changing technical challenges and scientific needs. To that end, the proposers must identify a Lead Principal Investigator, Principal Investigator(s), and Senior/Key Personnel. Furthermore, they should specify the requested level of support from FES or ASCR for each task. Note that some tasks may have both science and computational science components. Typical duties, responsibilities and authorities for each category are provided below:

- **Lead Principal Investigator -** The Lead Principal Investigator must be employed by the Lead institution and will serve as the primary contact responsible for communications with the DOE Program Officers on behalf of all of the Principal Investigators in the Partnership.
- **Principal Investigator -** A Principal Investigator (PI) is the individual designated by the collaborating institution and empowered with the appropriate level of authority and responsibility for the proper conduct of the research within that organization. These

authorities and responsibilities include the appropriate use of funds and administrative requirements such as the submission of scientific progress reports to DOE.

- **Senior/Key Personnel -** A senior/key person is an individual who contributes in a substantive, measurable way to the scientific or technical development or execution of the project.

Additional Guidance to Proposers

- Leadership class computation should accelerate scientific discovery in areas of strategic importance to DOE
    - Proposers must explain the benefits from leadership class computation
        - Impacts on Science (*how does it advance the FES mission?*)
        - Advancements in Computational Science (*how does it advance the ASCR mission?*)
        - Is the whole result larger than the sum of its parts?
    - Proposed research must employ state-of-the-art approaches enabling the effective use of the DOE leadership class computing resources
    - Proposers must identify metrics that will allow progress and contributions to be measured
- To that end, proposers must build and manage interdisciplinary, multi-institutional collaborations; in particular:
    - Proposers must identify collaborations with researchers in the recently selected SciDAC Institutes, avoiding duplication of resources available at the Institutes; the goal is to build the functionality of a vertically integrated enterprise but with common resources found in the SciDAC Institutes
    - Proposers may propose non-duplicative Applied Math/Computer Science expertise to supplement topics for which resources are provided by the Institutes, as well as expertise in topics for which no resources were provided by the Institutes.

Post-Award Process

Upon notification of award, the Lead Principal Investigators of the successful projects will be asked to join the Executive Council of the SciDAC Institutes Directors (see DE-FOA-0000505 or LAB 11-505 for a further description of the Executive Council). This group will be chartered to develop and submit an operating plan to DOE that will describe the processes, procedures, and metrics to be used for coordination and communication between the Partnership and the Institutes. The operating plan will also include processes for the review and, as appropriate, redirection and reprioritization of tasks within the Partnership. Additional guidance will be provided in the award notification letter.

Additional Resources

1. *Magnetic Fusion Energy Sciences Research Needs Workshop (ReNeW) report, June 2009,* http://science.energy.gov/~/media/fes/pdf/workshop-reports/Res_needs_mag_fusion_report_june_2009.pdf

2. *Scientific Grand Challenges in Fusion Energy Sciences and the Role of Computing at the Extreme Scale workshop, March 2009,* http://science.energy.gov/~/media/ascr/pdf/program-documents/docs/Fusion_report.pdf
3. *Fusion Simulation Project (FSP) Workshop report, May 2007,* http://science.energy.gov/~/media/fes/pdf/workshop-reports/Fsp_workshop_report_may_2007.pdf

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. Collaborative proposals submitted from different institutions, which are directed toward a single SciDAC Partnership, should clearly indicate they are part of a proposed collaboration and contain the Abstract for that SciDAC Partnership research project. In addition, such proposals must describe the work and the associated budget for the research effort being performed under the leadership of the Principal Investigator at that participating institution. Each collaborating Institution submitting a proposal must use the same title.

Preproposal

Preproposals are **REQUIRED** and must be submitted by September 9, 2011, 11:59 PM Eastern Time. **Failure to submit a preproposal by an applicant will preclude the full proposal from due consideration.** The preproposal should be submitted electronically by E-mail to John.Mandrekas@science.doe.gov and John.Sauter@science.doe.gov. **Please include "Preproposal for LAB 11-571" in the subject line.**

Preproposals 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 preproposal in response to LAB 11-571; (b) Lead PI information: name, institutional affiliation, telephone number, fax number, and e-mail address; and, (c) names and institutions of all Institutional PIs, and senior collaborators or consultants (excluding postdoctoral associates). Since among the purposes of the preproposal is to facilitate FES and ASCR in planning the merit review and the selection of peer-reviewers without conflicts of interest, it is important that proposers ensure their list of supported or unsupported participants is as comprehensive as possible.

Preproposals will be reviewed by FES and ASCR program officials for responsiveness to this Announcement and the SciDAC program, eligibility of the proposer organization, and qualification of the proposer's personnel for carrying out a large-scale computational research activity. Only those proposers who receive notification from DOE encouraging a full proposal may submit a formal proposal. No other formal proposals will be considered.

DATES

Full proposals submitted in response to this Announcement must be received by **October 26, 2011, 11:59 p.m. Eastern Time**, to be accepted for merit review and to permit timely consideration for award in Fiscal Year 2012.

Please see the SUBMISSION section below (2.1) for further instructions on the method of submission for the proposal.

PROGRAM FUNDING:

Awards are expected to be made for a period of five years at a funding level appropriate for the proposed scope, with out-year support contingent on the availability of appropriated funds and satisfactory progress. Funding for the final two years is contingent upon satisfactory completion of a progress review during the third year of each project. Five-year SC-total (FES and ASCR) funding up to $6,600,000 per year is expected to be available. This amount refers to the total available funding for both the Lab Announcement and the associated Cooperative Agreements subject to appropriation of funds by Congress. DOE is under no obligation to pay for any costs associated with the preparation or submission of a proposal. DOE reserves the right to fund, in whole or in part, any, all, or none of the proposals submitted in response to this Announcement. Although a SciDAC Partnership may be supported by a single award, FES and ASCR expect each Partnership to be a collaboration comprised of several separate awards. FES and ASCR reserve the right to make fewer awards than would be possible at $6,600,000 per year, if an insufficient number of proposals are judged to be of suitable scientific quality or of sufficient relevance to the programs.

The instructions and format described should be followed. You must reference Program Announcement LAB 11-571 on all submissions and inquiries about this program.

OFFICE OF SCIENCE
GUIDE FOR PREPARATION OF SCIENTIFIC/TECHNICAL PROPOSALS
TO BE SUBMITTED BY NATIONAL LABORATORIES

Proposals from National Laboratories submitted to the Office of Science (SC) as a result of this Program Announcement will follow the Department of Energy Field Work Proposal process with additional information requested to allow for scientific/technical merit review. The following guidelines for content and format are intended to facilitate an understanding of the requirements necessary for SC to conduct a merit review of a proposal. Please follow the guidelines carefully, as deviations could be cause for declination of a proposal without merit review.

1. Evaluation Criteria

Proposals 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. Included within each criterion are specific questions that the merit reviewers will be asked to consider:

1) **Scientific and/or Technical Merit of the Project**
    - **a.** Does the proposed research address an important and relevant problem in fusion energy science where breakthrough advances can be enabled by the use of leadership class computing resources?
    - b. What science will become feasible with this collaboration that is not feasible now?
    - c. Does the project demonstrate a functional partnership among the indicated domain scientists, applied mathematicians, and computer scientists?
    - **d.** Does the research plan contain appropriate performance metrics that will allow progress and contributions to be measured?

2) **Appropriateness of the Proposed Method or Approach**
    - **a.** Is the conceptual and mathematical framework of the science application being addressed adequately developed and appropriate?
    - b. Does the proposed research employ or lead to state-of-the-art approaches that effectively exploit leadership class computing resources available to DOE researchers?
    - **c.** Are there significant potential problems in the proposed method or approach? If so, are the applicant's plans to address these problems—including the consideration of alternative strategies—adequate?
    - d. Does the proposed research recognize mathematical, algorithmic, or architectural challenges arising in computations at this scale?

3) **Competency of Applicant's Personnel and Adequacy of Proposed Resources**
    - a. Does the applicant have a proven record of success in managing diverse teams of scientific and technical experts and delivering results for advanced computational science research?
    - **b.** Has the applicant identified a credible and fruitful collaboration between domain scientists and computational scientists (i.e., applied mathematicians and computer scientists)?
    - **c.** Are any of the computational scientists identified in the proposal also engaged in work for the SciDAC Institutes? For those who are not in the Institutes, is their work duplicative of work supported by the Institutes?
    - **d.** Are the roles and intellectual contributions of the Lead Principal Investigator and the FES/ASCR Principal Investigators and each senior/key personnel adequately described?

4) **Reasonableness and Appropriateness of the Proposed Budget**
    - a. Is the applicant's requested budget appropriate?
    - **b.** Does the requested budget support the applicant's specified management structure in a meaningful way?

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 a proposal constitutes agreement that this is acceptable to the investigator(s) and the submitting institution.

2. Summary of Proposal Contents

- Field Work Proposal (FWP) Format (Reference DOE Order 412.1A) (DOE ONLY)
- Proposal Cover Page – **Scientific Discovery through Advanced Computing: Scientific Computation Application Partnerships in Fusion Energy Science (LAB 11-571)**
- Table of Contents
- Budget (DOE Form 4620.1) and Budget Explanation
- Abstract (one page)
- Narrative (main technical portion of the proposal, including background/introduction, proposed research and methods, timetable of activities, and responsibilities of key project personnel – 26-page limit
- Literature Cited
- Biographical Sketch(es)
- Description of Facilities and Resources
- Other Support of Investigator(s)
- Appendix (optional)

2.1 Submission Instructions

Have your LAB administrator submit the entire LAB proposal and FWP via Searchable FWP (https://www.osti.gov/fwp). All submissions and inquiries about this Program Announcement must reference Program Announcement LAB 11-571. If you have questions about who your LAB administrator is or how to use Searchable FWP, please contact the Searchable FWP Support Center.

3. Detailed Contents of the Proposal

Adherence to type size and line spacing requirements is necessary for several reasons. No researcher should have the advantage, or by using small type, of providing more text in his or her proposal. Small type may also make it difficult for reviewers to read the proposal. Proposals must have 1-inch margins at the top, bottom, and on each side. Type sizes must be at least 11 point. Line spacing is at the discretion of the researcher but there must be no more than 6 lines per vertical inch of text. Pages should be standard 8 1/2" x 11" (or metric A4, i.e., 210 mm x 297 mm).

3.1 Field Work Proposal Format (Reference DOE Order 412.1A) (DOE ONLY)

The Field Work Proposal (FWP) is to be prepared and submitted consistent with policies of the investigator's laboratory and the local DOE Operations Office. Additional information is also requested to allow for scientific/technical merit review.

3.2 Proposal Cover Page

The following proposal cover page information may be placed on plain paper. No form is required.

Title of proposed project:
SC Program announcement title and number: **Scientific Discovery through Advanced Computing: Scientific Computation Application Partnerships in Fusion Energy Science (LAB 11-571)**
Name of laboratory:
Name of principal investigator (PI):
Position title of PI:
Mailing address of PI:
Telephone of PI:
Fax number of PI:
Electronic mail address of PI:
Name of official signing for laboratory*:
Title of official:
Fax number of official:
Telephone of official:
Electronic mail address of official:
Requested funding for each year; total request:
Use of human subjects in proposed project:
If activities involving human subjects are not planned at any time during the proposed project period, state "No"; otherwise state "Yes", provide the IRB Approval date and Assurance of Compliance Number and include all necessary information with the proposal should human subjects be involved.
Use of vertebrate animals in proposed project:
If activities involving vertebrate animals are not planned at any time during this project, state "No"; otherwise state "Yes" and provide the IACUC Approval date and Animal Welfare Assurance number from NIH and include all necessary information with the proposal.
Signature of PI, date of signature:
Signature of official, date of signature*:

* The signature certifies that personnel and facilities are available as stated in the proposal, if the project is funded.

3.3 Table of Contents

Provide the initial page number for each of the sections of the proposal. Number pages consecutively at the bottom of each page throughout the proposal. Start each major section at the top of a new page. Do not use unnumbered pages, and do not use suffices, such as 5a, 5b.

3.4 Budget and Budget Explanation

A detailed budget is required for the entire project period and for each fiscal year. It is preferred that DOE's budget page, Form 4620.1 be used for providing budget information*. Modifications of categories are permissible to comply with institutional practices, for example with regard to overhead costs.

A written justification of each budget item is to follow the budget pages. For personnel this should take the form of a one-sentence statement of the role of the person in the project. Provide a detailed justification of the need for each item of permanent equipment. Explain each of the other direct costs in sufficient detail for reviewers to be able to judge the appropriateness of the amount requested.

Further instructions regarding the budget are given in section 4 of this guide.

* Form 4620.1 is available at web site: http://www.science.doe.gov/grants/budgetform.pdf

3.5 Abstract

Summarize the proposal in one page. Give the project objectives (in broad scientific terms), the approach to be used, and what the research is intended to accomplish. State the hypotheses to be tested (if any). At the top of the abstract give the lead DOE National Laboratory, project title, names of all the investigators and their institutions, and contact information for the principal investigator, including e-mail address.

3.6 Narrative (main technical portion of the proposal, including background/introduction, proposed research and methods, timetable of activities, and responsibilities of key project personnel).

The narrative comprises the research plan for the project and is limited to a **maximum of 26 pages**. It should contain enough background material in the Introduction, including review of the relevant literature, to demonstrate sufficient knowledge of the state of the science. The major part of the narrative should be devoted to a description and justification of the proposed project, including details of the methods to be used. It should also include a timeline for the major activities of the proposed project, and should indicate which project personnel will be responsible for which activities. It is important that the 26-page technical information section provide a complete description of the proposed work, because reviewers are not obliged to read the Appendices. Proposals exceeding these page limits may be rejected without review or the first 26 pages may be reviewed without regard to the remainder.

The page count of 26 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 26-page technical information section provide a complete description of the proposed work, since reviewers are not obliged to read the Appendices. Letters of endorsement from

unfunded collaborators should also be included, if applicable. Please do not submit general letters of support as these are not used in making funding decisions and can interfere with the selection of peer reviewers.

Background and Recent Accomplishments

- Background – explanation of the importance and relevance of the proposed work.
- Recent Accomplishments – this subsection is mandatory for renewal proposals and should summarize the proposed work and the actual progress made during the previous funding period.

Proposed Research and Tasks

In addition to the technical description of the proposed work and tasks, include a discussion of schedule, milestones, and deliverables.

Is this a Collaboration? If yes, please list ALL Collaborating Institutions/PIs and indicate which ones will also be submitting proposals. Also indicate the Lead PI who will be the point of contact and coordinator for the combined research activity. The Lead proposal must contain an additional page with a budget table (see example below) that shows the requested annual budgets for each collaborating institution and also an explanation (with another, e.g., chart, table) of which tasks will expect FES support and which tasks will expect ASCR support (some tasks may require both FES and ASCR support). Each institution submitting a proposal should have the same title as the Lead PI/institution.

Partnership	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Total**
(Start by Lead Institution) Name of the Institution and the Principal Investigator	$(FES)/$(ASCR)	$(FES)/$(ASCR)	$(FES)/$(ASCR)	$(FES)/$(ASCR)	$(FES)/$(ASCR)	$(FES)/$(ASCR)
Name of the Institution and the Principal Investigator	$(FES)/$(ASCR)	$(FES)/$(ASCR)	$(FES)/$(ASCR)	$(FES)/$(ASCR)	$(FES)/$(ASCR)	$(FES)/$(ASCR)
Name of the Institution and the Principal Investigator	$(FES)/$(ASCR)	$(FES)/$(ASCR)	$(FES)/$(ASCR)	$(FES)/$(ASCR)	$(FES)/$(ASCR)	$(FES)/$(ASCR)
Total	$(FES)/$(ASCR)	$(FES)/$(ASCR)	$(FES)/$(ASCR)	$(FES)/$(ASCR)	$(FES)/$(ASCR)	$(FES)/$(ASCR)

Example budget table ($ in thousands)

3.7 Literature Cited

Give full bibliographic entries for each publication cited in the narrative. Each reference must include the names of all authors (in the same sequence in which they appear in the publication), the article and journal title, book title, volume number, page numbers, and year of publication.

Include only bibliographic citations. Principal investigators should be especially careful to follow scholarly practices in providing citations for source materials relied upon when preparing any section of the proposal.

3.8 Biographical Sketches

This information is required for senior personnel at the institution submitting the proposal and at all subcontracting institutions (if any). The biographical sketch is limited to a maximum of two pages for each investigator and must include:

Education and Training. Undergraduate, graduate and postdoctoral training, provide institution, major/area, degree and year.

Research and Professional Experience. Beginning with the current position list, in chronological order, professional/academic positions with a brief description.

Publications. Provide a list of up to 10 publications most closely related to the proposed project. For each publication, identify the names of all authors (in the same sequence in which they appear in the publication), the article title, book or journal title, volume number, page numbers, year of publication, and website address if available electronically. Patents, copyrights and software systems developed may be provided in addition to or substituted for publications.

Synergistic Activities. List no more than five professional and scholarly activities related to the effort proposed.

To assist in the identification of potential conflicts of interest or bias in the selection of reviewers, the following information must also be provided in each biographical sketch.

> *Collaborators and Co-editors:* A list of all persons in alphabetical order (including their current organizational affiliations) who are currently, or who have been, collaborators or co-authors with the investigator on a research project, book or book article, report, abstract, or paper during the 48 months preceding the submission of the proposal. For publications or collaborations with more than 10 authors or participants, only list those individuals in the core group with whom the Principal Investigator interacted on a regular basis while the research was being done. Also, include those individuals who are currently or have been co-editors of a special issue of a journal, compendium, or conference proceedings during the 24 months preceding the submission of the proposal. Finally, list any individuals who are not listed in the previous categories with whom you are discussing future collaborations. If there are no collaborators or co-editors to report, this should be so indicated.
>
> *Graduate and Postdoctoral Advisors and Advisees:* A list of the names of the individual's own graduate advisor(s) and principal postdoctoral sponsor(s), and their current organizational affiliations. A list of the names of the individual's graduate students and postdoctoral associates during the past five years, and their current organizational affiliations.

3.9 Description of Facilities and Resources

Facilities to be used for the conduct of the proposed research should be briefly described. Indicate the pertinent capabilities of the institution, including support facilities (such as machine shops), that will be used during the project. List the most important equipment items already available for the project and their pertinent capabilities. Include this information for each subcontracting institution (if any).

3.10 Other Support of Investigators

Other support is defined as all financial resources, whether Federal, non-Federal, commercial, or institutional, available in direct support of an individual's research endeavors. Information on active and pending other support is required for all senior personnel, including investigators at collaborating institutions to be funded by a subcontract. For each item of other support, give the organization or agency, inclusive dates of the project or proposed project, annual funding, and level of effort (months per year or percentage of the year) devoted to the project.

3.11 Appendix

Information not easily accessible to a reviewer may be included in an appendix, but **do not use the appendix to circumvent the page limitations of the proposal.** Reviewers are not required to consider information in an appendix, and reviewers may not have time to read extensive appendix materials with the same care they would use with the proposal proper.

The appendix may contain the following items: up to five publications, manuscripts accepted for publication, abstracts, patents, or other printed materials directly relevant to this project, but not generally available to the scientific community; and letters from investigators at other institutions stating their agreement to participate in the project (do not include letters of endorsement of the project).

4. Detailed Instructions for the Budget (DOE Form 4620.1 "Budget Page" may be used).

4.1 Salaries and Wages

List the names of the principal investigator and other key personnel and the estimated number of person-months for which DOE funding is requested. Proposers should list the number of postdoctoral associates and other professional positions included in the proposal and indicate the number of full-time-equivalent (FTE) person-months and rate of pay (hourly, monthly or annually). For graduate and undergraduate students and all other personnel categories such as secretarial, clerical, technical, etc., show the total number of people needed in each job title and total salaries needed. Salaries requested must be consistent with the institution's regular practices. The budget explanation should define concisely the role of each position in the overall project.

4.2 Equipment

DOE defines equipment as "an item of tangible personal property that has a useful life of more than two years and an acquisition cost of $50,000 or more." Special purpose equipment means equipment which is used only for research, scientific or other technical activities. Items of needed equipment should be individually listed by description and estimated cost, including tax, and adequately justified. Allowable items ordinarily will be limited to scientific equipment that is not already available for the conduct of the work. General purpose office equipment normally will not be considered eligible for support.

4.3 Domestic Travel

The type and extent of travel and its relation to the research should be specified. Funds may be requested for attendance at meetings and conferences, other travel associated with the work and subsistence. In order to qualify for support, attendance at meetings or conferences must enhance the investigator's capability to perform the research, plan extensions of it, or disseminate its results. Consultant's travel costs also may be requested.

4.4 Foreign Travel

Foreign travel is any travel outside Canada and the United States and its territories and possessions. Foreign travel may be approved only if it is directly related to project objectives.

4.5 Other Direct Costs

The budget should itemize other anticipated direct costs not included under the headings above, including materials and supplies, publication costs, computer services, and consultant services (which are discussed below). Other examples are: aircraft rental, space rental at research establishments away from the institution, minor building alterations, service charges, and fabrication of equipment or systems not available off- the-shelf. Reference books and periodicals may be charged to the project only if they are specifically related to the research.

a. Materials and Supplies

The budget should indicate in general terms the type of required expendable materials and supplies with their estimated costs. The breakdown should be more detailed when the cost is substantial.

b. Publication Costs/Page Charges

The budget may request funds for the costs of preparing and publishing the results of research, including costs of reports, reprints page charges, or other journal costs (except costs for prior or early publication), and necessary illustrations.

c. Consultant Services

Anticipated consultant services should be justified and information furnished on each individual's expertise, primary organizational affiliation, daily compensation rate and number of days expected service. Consultant's travel costs should be listed separately under travel in the budget.

d. Computer Services

The cost of computer services, including computer-based retrieval of scientific and technical information, may be requested. A justification based on the established computer service rates should be included.

e. Subcontracts

Subcontracts should be listed so that they can be properly evaluated. There should be an anticipated cost and an explanation of that cost for each subcontract. The total amount of each subcontract should also appear as a budget item.

4.6 Indirect Costs

Explain the basis for each overhead and indirect cost. Include the current rates.