Program Announcement
To DOE National Laboratories

LAB 11-580

Office of Science
Office of High Energy Physics (HEP)
Office of Advanced Scientific Computing Research (ASCR)

Scientific Discovery through Advanced Computing: High Energy Physics

GENERAL INQUIRES ABOUT THIS LAB ANNOUNCEMENT SHOULD BE DIRECTED TO:

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SUMMARY:

The Office of High Energy Physics (HEP) 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 computational high energy physics. Proposals should propose three year research plans and demonstrate how the proposed research will advance the HEP mission (http://science.energy.gov/hep/about) by fully exploiting leadership class computing resources (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 (http://science.energy.gov/ascr/facilities/)).

The specific areas of interest under this Program Announcement to DOE National Laboratories (Announcement) are Cosmic Frontier Scientific Simulations (CFSS), Lattice Gauge Theory Research (LGTR), and Accelerator Science Modeling and Simulation (ASMS) (http://science.energy.gov/hep).

Partnerships are encouraged to request joint funding from HEP and ASCR Offices under this Announcement. Partnerships should request at least half of their funding from HEP and the balance from ASCR and support their proposed funding distribution in the budget justification. Although there is no minimum requirement for requested funding from ASCR, all proposers should provide their plans for engagement with the SciDAC Institutes (http://science.energy.gov/ascr/research) as applicable. Applicants may also submit non – partnership computational high energy physics proposals only to HEP through this Announcement. Additional details and guidelines are provided below.

A companion Funding Opportunity Announcement, DE-FOA-0000580, will also be posted on the Office of Science Grants and Contracts web site at: http://www.science.doe.gov/grants .

PROPOSAL DUE DATE:

Formal proposals submitted in response to this Progam Announcement to DOE National Laboratories must be submitted from the Laboratory to the site office through Searchable FWP by **Monday, January 9, 2012, 11:59 p.m. Eastern Time**, to be accepted for merit review and to permit timely consideration for award in Fiscal Year 2012. **Each proposal should be in a single PDF file. The first few pages of the PDF should be the Field Work Proposal followed in the same PDF by the full technical proposal. You are encouraged to transmit your proposal well before the deadline. PROPOSALS RECEIVED AFTER THE DEADLINE WILL NOT BE REVIEWED OR CONSIDERED FOR AWARD.**

SUBMISSION INSTRUCTIONS:

LAB administrators should submit the entire LAB proposal and Field Work Proposal (FWP) via searchable FWP (https://www.osti.gov/fwp). Questions regarding the appropriate LAB administrator or other questions regarding submission procedures can be addressed to the Searchable FWP Support Center. All submission and inquiries about this Program Announcement must reference Program Announcement LAB 11-580.

SUPPLEMENTARY INFORMATION:

The mission of the High Energy Physics (HEP) program is to understand how the universe works at its most fundamental level, which is done by discovering the elementary constituents of matter and energy, probing the interactions between them, and exploring the basic nature of space and time. A world-wide program of particle physics research is underway to explore the universe and try to answer fundamental questions (http://science.energy.gov/hep/research/questions-for-the-universe/) such as: *Are there undiscovered principles of nature, such as new symmetries or new physical laws? How can we solve the mystery of dark energy? What is dark matter? What are neutrinos telling us? What happened to the antimatter?* The DOE HEP program focuses on three

scientific frontiers: *Energy, Intensity, and Cosmic Frontiers*, along with overarching research in Theory and Technology Research and Development (R&D) to unravel these deep fundamental questions about the dynamic universe. Studies at the three frontiers complement each other by accessing different natural symmetries and particle interactions through their respective specialized windows.

Computational research and expertise are critical to the success of many elements of the HEP mission. On the experimental side, advanced simulation is needed at all stages of an experiment – from planning and constructing accelerators and detectors, to computationally intensive experimental research and data analysis. Theoretical research is also strongly dependent on computation. In addition, scientific simulation and advanced computing help extend the boundaries of science to regions not directly accessible by experiment, observations or traditional theory.

This Announcement invites new research proposals in Cosmic Frontier Scientific Simulations (CFSS), Lattice Gauge Theory Research (LGTR), and Accelerator Science Modeling and Simulation (ASMS) that will advance the HEP mission by fully exploiting leadership class computing resources. Proposed computational research under this program should specify the new science that the research will make possible and make the case why advanced computing is needed for success.

Cosmic Frontier Scientific Simulations (CFSS)

DOE participates in ground and space-based experiments and telescopes to *understand the nature of dark matter and dark energy* and to *discover new phenomena* via particle astrophysics. Proposals to this program should specify how the proposed research might help solve some of these fundamental mysteries of the universe.

Advanced simulations play a vital role in this cosmic frontier research providing fundamental insights into theories and models of the universe, and optimizing analysis of data. Such simulations require the use of large scale, high performance computing, appropriate advanced computing algorithms, tools, expertise, and reliability. In the case of HEP cosmic frontier experiments, computation and simulation are needed not only to analyze and interpret the results, but also to enrich the scientific contribution of experiments. For example, studies of baryon acoustic oscillations, galaxy cluster counts and 3-D distributions, weak gravitational lensing, supernova explosions, and the Lyman–alpha forest, (needed in part to understand the nature of dark energy), the cosmic microwave background, and the indirect and direct detection of dark matter all rely heavily on accurate state of the art computational simulations. An initiative that maximizes and consolidates efficient use of available computing resources and expertise to simulate the universe and the evolution of its structure has the potential to significantly strengthen theory and modeling for HEP cosmic frontier research. This can further optimize the discovery potential of experiments coming on-line in the next decade.

Research proposals that seek to make significant advances in HEP Cosmic Frontier research through application of advanced computational methods are encouraged. The scientific scope of this Announcement includes computational research in particle astrophysics and cosmology,

dark energy, and dark matter; as well as detailed understanding of the related astrophysical phenomena that are used as probes of fundamental cosmological parameters.

Lattice Gauge Theory Research (LGTR)

Precision energy and intensity frontier accelerator-based experiments can provide insight into many of the fundamental questions mentioned above, including: *Are there undiscovered principles of nature, such as new symmetries or new physical laws?* Answers to such questions are enabled by theoretical research that guides the interpretation of experimental results. Proposals to this program should specify how the proposed research might help advance our understanding of fundamental particle interactions and develop more robust theoretical models that can be tested for new or undiscovered principles of nature.

Lattice Gauge Theories (LGTs) are a class of theoretical models which allow us to understand fundamental interactions that we are familiar with today, as well as to explore new physics beyond - the - Standard Model (BSM) of particle physics. The theoretical techniques used describe space time on a discrete lattice and have the unique ability to enable otherwise intractable calculations of strongly coupled physical systems. Theoretical research in these areas is strongly dependent on advanced computing software and resources, including novel architectures.

Research proposals that seek to make significant advances in HEP research in this class of theories through application of advanced computational methods are encouraged. The scientific scope of this Announcement includes computational research in Lattice Gauge Theories including Lattice Quantum Chromodynamics (LQCD); their applications to various strongly coupled systems; LGT simulations in non-QCD-like theories to enable investigations of dynamical symmetry breaking; LQCD enabled searches for BSM effects entering quark and lepton processes via loop effects; and comparisons to beyond-the-Standard Model predictions and searching for inconsistencies in measurements of parameters in BSM theories.

Accelerator Science Modeling and Simulation (ASMS)

High energy physics research via the energy and intensity frontiers is strongly dependent on the use of high-energy and high-intensity particle beams produced in accelerators (http://science.energy.gov/hep/research/advanced-technology-r-and-d/advanced-technology-rd-more-info/). This technology underlies our search for answers to many of the fundamental questions about the nature of the universe. This makes accelerator research and development (R&D), along with the associated computational modeling and simulation, a key component of the HEP Program. Proposals to this program should specify how the proposed research might help develop these technologies to the point that we can make fundamentally new advances in HEP accelerator-based Energy and Intensity Frontier experiments.

Research proposals that seek to make significant advances in accelerator science and the physics of particle beams to overcome the energy and intensity limitations of present day accelerators through application of advanced computational methods are encouraged. The scientific scope of this Announcement includes computational research in advanced particle accelerator concepts;

the physics of particle beams; electromagnetic studies of accelerator components; simulations to improve efficiency and operation of current accelerators and their upgrades – as they pertain to HEP mission.

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. These partnerships enable scientists to conduct complex scientific and engineering computations at a level of fidelity required for scientific discovery. In particular, the key components of SciDAC are SciDAC Institutes and SciDAC Partnerships; the latter are 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.

Successful Partnerships will:

1. Exploit leadership class computing resources to advance scientific frontiers in an area of strategic importance to the Office of Science, and
2. Build and manage interdisciplinary, multi-institutional collaborations that 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.

Successful Partnerships may:

1. Employ non-duplicative computational science expertise to supplement topics for which resources are provided by the Institutes,
2. Employ computational science expertise in topics for which no resources were provided by the Institutes.

ADDITIONAL SUBMISSION INFORMATION:

Multi institutional proposals that involve a significant fraction of the relevant research community in the development of new algorithms, architectures, and computational techniques to provide truly new or unique scientific capabilities are encouraged.

Research plans may include, but are not limited to: scaling and performance of codes, data management, preservation and storage, creation of innovative algorithms, development and accessibility of software libraries, and other necessary tools and techniques relevant for advancing the science or facilitating computational precision results for the relevant HEP community.

Proposals that have strong science or computational synergies with NNSA or additional Offices within SC, for example BES (Basic Energy Sciences), HEP (Fusion Energy Sciences), and NP (Nuclear Physics) should clearly identify the scope and areas of collaboration with other projects funded by, or submitted to these Offices, through their SciDAC or other Solicitations
Non – partnership proposals that maximally utilize leadership class computing submitted only to HEP through this Announcement will also be considered.

Management Structure:

Partnership proposals must propose a management structure for the research that will enable an effective collaboration among physicists, computer scientists and applied mathematicians. The management plan should be sufficiently flexible to adapt quickly to changing technical challenges and scientific needs. An overall Project Director (employed by the lead institution), Project co-Directors for Science and for Computation, the Principal Investigators, and other Senior/Key Personnel and their roles should be identified. Non-partnership proposals should also propose an effective management structure but are not required to follow this specific organizational template.

Proposal Organization:

The Lead proposers must provide the comprehensive project description along with abstracted information about each collaborating proposal task, identification of the principal Science and Computational Science tasks or milestones, the requested support from HEP and ASCR associated with each of these tasks, and a list of all collaborating institutions/PIs, and a budget table that shows the requested annual budgets for each collaborating institution with a break

down of requested funding from HEP and ASCR respectively, as appropriate (see Budget Table example below). The budget justification narrative should explain and support the proposed funding distribution.

Each collaborating proposal should contain the comprehensive proposal summary with an extra paragraph summarizing the work in the collaborating proposal, and describe details for the home institution and its participants.

Proposal selection criteria will also include other appropriate factors such as impacts on HEP scientific priorities, how the proposal advances the HEP mission, the efficient utilization and benefits of leadership class computing, and the additional ASCR criteria for partnership proposals. Reviewers of partnership proposals also will be asked to comment upon the feasibility, benefits, and management of the proposed collaborations between the HEP research scientists and the applied mathematicians and computer scientists/engineers. More details on the review process can be found at (http://science.energy.gov/hep/funding-opportunities/peer-merit-review-policies/review-and-selection-of-research-projects/).

Further Guidance to Applicants:

1. Proposals must be formulated as three–year projects with specific goals and deliverables that demonstrate the impact on science.
2. Proposals must have a plan that will ensure effective and timely postings of accomplishments on a website.
3. Proposals must indicate any proposed graduate and post graduate training activities.

Post-Award Process

Upon notification of award, the Project Director 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 (to DOE) an operating plan 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.

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.

PROGRAM FUNDING:

It is anticipated that up to $4,000,000 per year will be available under this Announcement in FY 2012, contingent on satisfactory merit review and the availability of appropriated funds. Awards are expected to be made for a period of three years at a funding level appropriate for the proposed scope, with out-year support contingent on the availability of appropriated funds and satisfactory research progress. The SC-total funding target for this three-year program is approximately $4,000,000 per year. 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.

HEP and ASCR expect to support between one and four SciDAC Partnerships. Although a SciDAC Partnership may be supported by a single award, HEP and ASCR expect each Partnership to be a collaboration comprised of several separate awards. HEP and ASCR reserve the right to make fewer awards than would be possible at $4,000,000 per year, if insufficient applications 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 11-580 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 DOE 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:

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
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 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
- 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 – 30-page limit (5 pages for collaborators)
- 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 11-580. 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: High Energy Physics (LAB 11-580)**
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 30 pages** (submitted by the lead institution and **5 pages** for collaborators). 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 30-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 will be rejected without review.

The page count of 30 (and 5 for collaborators) does not include the Cover Page and Budget Pages, the Title Page, the biographical material and publication information, or any Appendices. However, it is important that the 30-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 HEP support and which tasks will expect ASCR support (some tasks may require both HEP 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**	**Total**
(Start by Lead Institution) Name of the Institution and the Principal Investigator	$(HEP)/$(ASCR)	$(HEP)/$(ASCR)	$(HEP)/$(ASCR)	$(HEP)/$(ASCR)
Name of the Institution and the Principal Investigator	$(HEP)/$(ASCR)	$(HEP)/$(ASCR)	$(HEP)/$(ASCR)	$(HEP)/$(ASCR)
Name of the Institution and the Principal Investigator	$(HEP)/$(ASCR)	$(HEP)/$(ASCR)	$(HEP)/$(ASCR)	$(HEP)/$(ASCR)
Total	$(HEP)/$(ASCR)	$(HEP)/$(ASCR)	$(HEP)/$(ASCR)	$(HEP)/$(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.