PROGRAM ANNOUNCEMENT
TO DOE NATIONAL LABORATORIES

U. S. Department of Energy
Office of Science

Early Career Research Program

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UPDATES AND REMINDERS

DATA MANAGEMENT PLAN

The Office of Science has published a new Statement on Digital Data Management, published at http://science.energy.gov/funding-opportunities/digital-data-management/, which governs applications submitted under this DOE National Laboratory Announcement, and is detailed in Part IV of this DOE National Laboratory Announcement.

ACKNOWLEDGMENT OF FEDERAL SUPPORT

The Office of Science published guidance about how its support should be acknowledged at http://science.energy.gov/funding-opportunities/acknowledgements/.

RECOMMENDATION

The Office of Science encourages you to register in all systems as soon as possible. You are also encouraged to submit letters of intent, pre-applications, and applications well before the deadline.

Section I – DOE NATIONAL LABORATORY OPPORTUNITY DESCRIPTION

GENERAL INQUIRIES ABOUT THIS ANNOUNCEMENT SHOULD BE DIRECTED TO:

Technical/Scientific Program Contact:
Questions regarding the specific program areas/technical requirements can be directed to the program managers listed for each program within the DOE National Laboratory Announcement.

Administrative Contact (questions about program rules):
Questions about program rules should be sent to early.career@science.doe.gov

SUMMARY

The Office of Science of the Department of Energy hereby invites grant applications for support under the Early Career Research Program in the following program areas: Advanced Scientific Computing Research (ASCR); Biological and Environmental Research (BER); Basic Energy Sciences (BES), Fusion Energy Sciences (FES); High Energy Physics (HEP), and Nuclear Physics (NP). The purpose of this program is to support the development of individual research programs of outstanding scientists early in their careers and to stimulate research careers in the areas supported by the DOE Office of Science.

SUPPLEMENTARY INFORMATION

The mission of the DOE Office of Science is to deliver the scientific discoveries and major scientific tools to transform our understanding of nature and advance the energy, economic, and national security of the United States. The Office of Science is the Nation's largest Federal sponsor of basic research in the physical sciences and the lead Federal agency supporting fundamental scientific research for energy.

The Office of Science accomplishes its mission and advances national goals by supporting:

- The frontiers of science—discovering nature's mysteries from the study of subatomic particles, atoms, and molecules that are the building blocks of the materials of our everyday world to the DNA, proteins, and cells that are the building blocks of entire biological systems; each of the programs in the Office of Science supports research to probe the most fundamental questions of its disciplines.

- The 21st Century tools of science—providing the Nation's researchers with 26 state-of-the-art national scientific user facilities, the most advanced tools of modern science, enabling the U.S. to remain at the forefront of science, technology, and innovation.

- Science for energy and the environment—advancing a clean energy agenda through fundamental research on energy production, conversion, storage, transmission, and use and through advancing our understanding of the earth and its climate; targeted investments include the three DOE Bioenergy Research Centers (BRCs), the Energy

Frontier Research Centers (EFRCs), two Energy Innovation Hubs, and atmospheric process and climate modeling research.

Early Career Research Program opportunities exist in the following Office of Science research programs. Additional details about each program, websites, and technical points of contacts are provided in the materials that follow.

I. Advanced Scientific Computing Research (ASCR)

(a) Applied Mathematics
(b) Computer Science
(c) Next Generation Networking for Science

II. Biological and Environmental Research (BER)

(a) Systems biology-enabled research on the role of microbes and microbial communities in the plant-soil-environment interactions
(b) Improved Understanding of Tropical Forest Ecosystems to Climate Change
(c) Human Component of Earth System Models

III. Basic Energy Sciences (BES)

(a) Materials Chemistry
(b) Biomolecular Materials
(c) Synthesis and Processing Science
(d) Experimental Condensed Matter Physics
(e) Theoretical Condensed Matter Physics
(f) Physical Behavior of Materials
(g) Mechanical Behavior and Radiation Effects
(h) X-ray Scattering
(i) Neutron Scattering
(j) Electron and Scanning Probe Microscopies
(k) Atomic, Molecular, and Optical Sciences (AMOS)
(l) Gas Phase Chemical Physics (GPCP)
(m) Computation and Theoretical Chemistry
(n) Condensed Phase and Interfacial Molecular Science (CPIMS)
(o) Catalysis Science
(p) Separations and Analysis
(q) Heavy Element Chemistry (HEC)
(r) Geosciences Research
(s) Solar Photochemistry
(t) Photosynthetic Systems
(u) Physical Biosciences
(v) Nanoscale Science Research Centers and Electron-Beam Microcharacterization Centers Research
(w) Accelerator and Detector Research
(x) X-ray Instrumentation and Technique Development
(y) Neutron Scattering Instrumentation and Technique Development

IV. Fusion Energy Sciences (FES)

(a) Magnetic Fusion Energy Science Experimental Research
(b) Magnetic Fusion Energy Science Theory and Simulation
(c) High-Energy-Density Plasma Science
(d) General Plasma Science Experiment and Theory
(e) Fusion Nuclear Science, Materials Research and Enabling R&D Programs for Fusion

V. High Energy Physics (HEP)

(a) Experimental Research at the Energy Frontier in High Energy Physics
(b) Experimental Research at the Intensity Frontier in High Energy Physics
(c) Experimental Research at the Cosmic Frontier in High Energy Physics
(d) Theoretical Research in High Energy Physics
(e) Accelerator Science and Technology Research & Development in High Energy Physics
(f) Detector Research and Development in High Energy Physics

VI. Nuclear Physics (NP)

(a) Medium Energy Nuclear Physics
(b) Heavy Ion Nuclear Physics
(c) Low Energy Nuclear Physics
(d) Nuclear Theory
(e) Nuclear Data and Nuclear Theory Computing
(f) Accelerator Research and Development for Current and Future Nuclear Physics Facilities
(g) Isotope Development and Production for Research and Applications

I. Advanced Scientific Computing Research (ASCR)

Program Website: http://science.energy.gov/ascr/

The mission of the Advanced Scientific Computing Research (ASCR) program is to advance applied mathematics and computer science; deliver the most advanced computational scientific applications in partnership with disciplinary science; advance computing and networking capabilities; and develop future generations of computing hardware and tools for science, in partnership with the research community, including U.S. industry. The strategy to accomplish this has two thrusts: developing and maintaining world-class computing and network facilities for science; and advancing research in applied mathematics, computer science, and advanced networking.

Some priority areas for ASCR are listed below:

- To develop mathematical descriptions, models, methods and algorithms to accurately describe and understand the behavior of complex systems involving processes that span vastly different time and/or length scales.
- To develop the underlying concepts and software to make effective use of computers at extreme scales
- To transform extreme scale data from experiments and simulations into scientific insight

The computing resources and high-speed networks required to meet Office of Science needs exceed the state-of- the-art by a significant margin. Furthermore, the algorithms, software tools, the software libraries and the distributed software environments needed to accelerate scientific discovery through modeling and simulation are beyond the realm of commercial interest. To establish and maintain DOE's modeling and simulation leadership in scientific areas that are important to its mission, ASCR operates Leadership Computing facilities, a high-performance production computing center, and a high-speed network and implements a broad base research portfolio to solve complex problems on computational resources that are on a trajectory to reach well beyond hundreds of petaflops within a few years.

For the purposes of the Early Career Research Program, proposed research must be in either Applied Mathematics, Computer Science, or Next Generation Networking for Science and be responsive to their respectively specified topic areas.

(a) Applied Mathematics
Technical Contact: Steven Lee, 301-903-5710, Steven.Lee@science.doe.gov

This program supports basic research leading to fundamental mathematical advances and computational breakthroughs across DOE and Office of Science missions. Applied Mathematics research includes and supports efforts to develop robust mathematical models, algorithms and numerical software for enabling predictive scientific simulations of DOE-relevant complex systems. For this solicitation, the specific topic areas of interest are listed here:

1. Scalable solvers for next-generation high-performance computing: basic research in the design, synthesis, analysis, and demonstration of algorithms that provide numerical solutions to mathematical models of physical systems with relevance to the DOE missions. Solver research opportunities include new classes of algorithms that need to be developed: communication/synchronization hiding and reducing algorithms; mixed-precision-arithmetic algorithms; fault-tolerant and resilient algorithms; energy-efficient algorithms; stochastic algorithms; algorithms with reproducibility. A key research characteristic is that the results will also be useful for exascale simulations;
2. Rigorous mathematical and computationally efficient approaches for analyzing and extracting information and insight from large-scale datasets relevant to the DOE missions. Of particular interest are computational approaches addressing the integration of observational data, experimental data, simulation and/or models;
3. Innovative mathematics research to improve the fidelity and predictability of continuous and/or distributed complex systems that accurately capture the physics and/or subcomponent interactions across vastly different time and length scales.

The preproposal's and proposal's responsiveness to this solicitation in these topic areas will be based on addressing all of the following criteria: (a) advances and innovations in mathematical models, methods and/or numerical algorithms, (b) mathematical and algorithmic challenges arising in simulations at scale, and (c) relevance of proposed research to DOE missions and/or scientific grand challenges.

Topics that are out of scope include:

- Pre-proposals and Proposals with primary emphasis on Tailoring or implementation of existing numerical methods for specific scientific problems;
- High Performance Computing (HPC) implementation or "framework" for scientific or engineering calculations that are primarily based on specific programming models or architectures; or
- Solutions for specific scientific or engineering problems that are not applicable to a broader class of problems.

(b) Computer Science
Technical Contact: Robinson Pino, 301-903-1263, Robinson.Pino@science.doe.gov

This program supports research to advance the development, operation and systems management of Leadership Class and production high performance computing facilities at DOE National Labs, application software development for scientific modeling and simulation at exascale and beyond, high performance computing systems architecture and software, and scientific data management and analysis at scale.

Topics of interest for this solicitation are focused on the following key research challenges for exascale platforms, namely:

1. Understanding the causes, frequency, and impact of various types of hard and soft faults and the detection and categorization thereof;
2. Methods that ensure scientific computing integrity through the correctness of application results in the presence of errors/faults, including but not limited to machine learning, self-healing, and heterogeneous paths of computation;
3. Visual analytic methods and environments for petabyte to exabyte multi-scale, multi-physics scientific data sets from simulations and/or experimental platforms; visual analytic environments to support understanding of HPC system and/or application behavior at extreme scale; and/or software visualization of highly parallel codes;
4. Innovative programming models for developing applications on exascale platforms, exploiting unprecedented parallelism, heterogeneity of memory systems (e.g. Non-Uniform Memory Access (NUMA), non-coherent shared memory, hybrid memory cube, scratchpads), and heterogeneity of processing (e.g., Graphics Processing Units (GPUs), accelerators, big-small cores, processing in memory and near memory);
5. Algorithms and methods that support automated and semi-automated refinements from high-level specification of an application to low-level code, optimized at runtime to different HPC platforms. The focus is on enabling performance portability of applications developed for exascale computing and beyond.

Pre-proposals and proposals must explain their relevance to current and future high performance computing platforms as well as their relevance to the mission of the Office of Science and the Advanced Scientific Computing Research programs.

Topics that are out of scope include:

- Pre-proposals and Proposals with primary emphasis on hardware design;
- All aspects of social computing, natural language processing / understanding / generation and/or analysis, generalized research in human-computer interaction, discipline-specific data analytics and informatics;
- Research focused on the World Wide Web and/or Internet; or
- Research that is only applicable to hand-held, portable, desktop, embedded or cloud computing.

Research and applications not specific and justified in the context of current and future supercomputing facilities supported by ASCR (i.e., Argonne Leadership Computing Facility (ALCF), National Energy Research Scientific Computing Center (NERSC), Oak Ridge Leadership Computing Facility (OLCF)).
http://science.energy.gov/ascr/facilities/

(c) Next Generation Networking for Science
Technical Contact: Richard Carlson, 301-903-9486, Richard.Carlson@science.doe.gov

This program supports research that advances the development, operation, and management of High Performance Networks and Distributed Computing environments. These environments include traditional compute, storage, and visualization resources, but extend deep into numerous scientific communities that operate unique scientific instruments. These globally distributed resources are interconnected via high-performance networks that operate at or above 100 Gbps. For this solicitation topics of interest are:

1. Advanced network architectures and protocols that develop an information-centric science discovery service as opposed to today's data-centric services.
2. Rigorous modeling and simulation capabilities for evaluating the performance, security, and/or operational capabilities of Software Defined Networks (SDN).
3. Advanced analysis or modeling tools that can accurately describe why a distributed application or workflow achieves the observed performance with actionable suggestions when performance is below expectations.

Topics that are out-of-scope include:

- Pre-proposals and Proposals with a primary goal of developing hardware components, Intelligent Network Interface Cards, or network acceleration hardware;
- Technologies that optimize wireless or other low-speed network infrastructures;
- Pre-proposals and Proposals with a primary focus on development or deployment activities; or
- Pre-proposals and Proposals that suggest incremental upgrades to existing network architectures, protocols, tools, or services.

II. Biological and Environmental Research (BER)

Program Website: http://science.energy.gov/ber/

The mission of the Biological and Environmental Research (BER) program is to support fundamental research and scientific user facilities to achieve a predictive understanding of

complex biological, climatic, and environmental systems for a secure and sustainable energy future.

Biological Systems Science
Biological Systems Science at DOE focuses on genome-enabled biology to support fundamental research to identify the foundational principles that drive biological systems. To address the DOE mission in sustainable bioenergy development, Biological Systems Science programs bring omics-driven tools of modern systems biology to bear on the challenges associated with the development of plant feedstocks as a sustainable alternative to fossil fuels.

Recent advances in systems biology and -omics technologies are beginning to elucidate the complex networks and molecular mechanisms of plant and microbial growth, development, and metabolism. It is now possible to apply these tools to study the influence of bioenergy crops on ecosystems to help develop a sustainable "bioenergy agriculture" for the cost effective production of cellulosic biofuels. A deep understanding of crop-soil-microbiome interactions will allow us to predict and mitigate the environmental impacts of energy production as well as optimize feedstock production in the face of a changing climate.

BER is only seeking Biological Systems Science research in the following area:

(a) Systems biology-enabled research on the role of microbes and microbial communities in the plant-soil-environment interactions.

Program Manager: Pablo Rabinowicz, 301-903-0379, pablo.rabinowicz@science.doe.gov

Applications are requested for fundamental, systems biology-driven research aimed at understanding the contribution of microbes and microbial communities to bioenergy feedstock plant performance, adaptation, and abiotic stress tolerance, and the environmental impacts of introducing bioenergy cropping systems, to enable the integrated development of sustainable bioenergy feedstock systems in terrestrial ecosystems. Proposed studies could include but are not limited to: microbiome dynamics associated with particular bioenergy feedstock plants over time and across soil types and climates; microbial effects on soil and plant health, and their changes during crop establishment/growth; host-symbiont specificity; mechanisms controlling C and nutrient cycling in the belowground systems of bioenergy crops. Proposals that include the development of integrative modeling to advance a systems-level understanding of the plant-soil-microbiome ecosystem are encouraged.
Projects focused on the following areas will not be considered: research that seeks to increase starch content for improved nutrient qualities, to facilitate digestion and fermentation, or to increase grain or food yields for human consumption; applications targeting aquatic systems (e.g., algae); projects to develop life cycle analysis (LCA) models; applications focused primarily on plant genome or metagenomic sequencing.
Annual Meeting: If a project is funded, beginning in the first year of funding, one or more project participants will be required to attend an annual investigator meeting, generally held in the Washington DC area. Reasonable travel expenses may be included as part of the project budget.

Climate and Environmental Sciences
The Climate and Environmental Sciences Division (CESD) focuses on advancing a robust predictive understanding of Earth's climate and environmental systems and to inform the development of sustainable solutions to the Nation's energy and environmental challenges. There are five goals which frame the Division's programs and investments: (a) synthesize new process knowledge and innovative computational methods that advance next generation, integrated models of the human-earth system; (b) develop, test and simulate process-level understanding of atmospheric systems and terrestrial ecosystems, extending from bedrock to the top of the vegetative canopy; (c) advance fundamental understanding of coupled biogeochemical processes in complex subsurface environments to enable systems-level prediction and control; (d) enhance the unique capabilities and impacts of the ARM and EMSL scientific user facilities and other BER community resources to advance the frontiers of climate and environmental science; and (e) identify and address science gaps that limit translation of CESD fundamental science into solutions for DOE's most pressing energy and environmental challenges.

Two scientific user facilities exploited by the CESD research programs include the Atmospheric Radiation Measurement (ARM) Climate Research Facility (ACRF) and the Environmental Molecular Sciences Laboratory (EMSL) provide the broad scientific community with technical capabilities, scientific expertise, and unique information to facilitate science in areas of importance to DOE. The Atmospheric Radiation Measurement Climate Research Facility provides key observational data to the climate research community on the radiative properties of the atmosphere, especially clouds and aerosols. This national user facility includes highly instrumented ground stations, a mobile facility, and an aerial vehicles program. Environmental Molecular Sciences Laboratory (EMSL) houses an unparalleled collection of state-of-the-art capabilities, including a supercomputer and over 60 major instruments, providing integrated experimental and computational resources for discovery and technological innovation in the environmental molecular sciences.
BER is only seeking Climate and Environmental Sciences research in the following areas:

(b) Improved Understanding of Tropical Forest Ecosystems to Climate Change
Program Manager: Daniel Stover, 301-903-0289, Daniel.Stover@science.doe.gov

Tropical ecosystems, with approximately 40% of Earth's land surface area and 25% of terrestrial carbon, critically regulate many Earth system processes. These forested ecosystems cycle more carbon dioxide and water than any other biome and play important roles in determining Earth's energy balance, which drives global systems of temperature and precipitation. Despite the negative impact of widespread disturbance (e.g., deforestation, land-use change, drought and fire), tropical forest ecosystems continue to benefit Earth's atmosphere and climate system by mitigating climatic warming through carbon sequestration and evaporative cooling. Of great concern, however, are the vulnerability of tropical forests and their feedback to rapid or prolonged shifts resulting from a changing climate. It is currently unclear how increasing temperature, changes in precipitation regimes, and disturbance will affect the structure, function and feedbacks of these nutrient poor ecosystems. Although understanding of tropical forest systems is improving, their representation in climate models lags significantly behind that of temperate systems. Tropical forests ecosystems are responsible for numerous biases in Earth system models (ESMs), which currently disagree on the direction or degree of climate–carbon

cycle feedbacks in tropical forests. Improving ESMs will require a coordinated effort by scientists from many disciplines.

Proposed research should seek to reduce critical uncertainties in model representation of tropical forest ecosystems. Specifically, the goal should be to improve the representation and understanding of tropical forest function and feedbacks to a changing climate, which includes complex interactions of biogeochemical cycles, hydrology, belowground processes, vegetation dynamics and disturbance. Applications that propose process-level experimental, analysis, or modeling studies must indicate a clear path toward the incorporation of the improved process level understanding into Earth system models. Additionally, as tropical forest processes span a wide range of temporal and spatial scales, applicants are encouraged to address important multi-scale interactions of ecosystem components and to utilize a hierarchy of approaches, as needed. Applications should also address uncertainty characterization of the measurements and/or model components.

Proposed research that is focused primarily on atmospheric, marine or aquatic systems and properties will not be considered.

Proposals may be synergistic with existing DOE supported activities, (e.g., Next Generation Ecosystem Experiment (NGEE) Tropics (http://tes.science.energy.gov/research/ngeetropics.shtml), Accelerated Climate Model for Energy (ACME) (http://climatemodeling.science.energy.gov/projects/accelerated-climate-modeling-energy), and The International Land Model Benchmarking Project (ILAMB) (http://www.bgc-feedbacks.org/)) however, they should demonstrate their unique and complementary contribution, rather than merely extending an existing effort.

If a project is funded, beginning in the first year of funding, awardees will be required to attend an annual investigator meeting, generally held in the Washington DC area. Reasonable travel expenses may be included as part of the project budget.

REFERENCES

U.S. DOE. 2012. Climate and Environmental Sciences Division, Strategic Plan, DOE/SC-0151, U.S. Department of Energy Office of Science. http://science.energy.gov/~/media/ber/pdf/CESD-StratPlan-2012.pdf

U.S. DOE. 2012. Research Priorities for Tropical Ecosystems Under Climate Change, DOE/SC-0153, U.S. Department of Energy Office of Science. http://science.energy.gov/~/media/ber/pdf/NGEE-Tropics_LR.pdf

(c) Human Component of Earth System Models
Program Manager: Dorothy Koch, 301-903-0105, Dorothy.Koch@science.doe.gov

During the past decades, Earth system models have become increasingly sophisticated, in terms of not only improved representations of physical, chemical, biogeochemical, and dynamical processes, but also with uncertainty quantification methodologies and algorithmic complexities

derived from working within multi-scale systems using e.g. adaptive meshes. The "human component" of Earth system models, albeit important, has historically been dominated as a one-way coupling, i.e., where earth system model outputs serve as inputs to human impacts assessments or where integrated assessment models provide inputs to Earth system models. During recent years, it has become increasingly apparent that human activities must often be considered as an interdependent component of the Earth system, and important feedbacks may be derived from a combination of "integrated assessment" (IA) and "impact, adaptation, and vulnerability" (IAV) modeling as part of the Earth system.

Proposals are invited that develop one or more in-depth representation in which climate and human systems both impact one another and co-evolve. The representation should be appropriate for implementation in global climate or Earth system models, with complexity and coupling methodology appropriate for the spatial and temporal scales of the feedbacks. The proposed project should include plans to implement the representation into a global climate model, to validate coupled system improvements and to conduct experiments that would demonstrate the importance of the coupled system feedbacks. System thresholds and tipping points should be considered. Relevance of the research to DOE mission and science should be articulated. The goal is to advance new modeling constructs, methods, and topics at appropriate spatial and temporal scales for climate projections in Earth system and climate models of principal interest to DOE.

Proposals may be synergistic with existing DOE supported activities, (e.g., Accelerated Climate Model for Energy (ACME) (http://climatemodeling.science.energy.gov/projects/accelerated-climate-modeling-energy)) however they should demonstrate their unique and complementary contribution, rather than merely extending an existing effort.

REFERENCES

U.S. DOE. 2012. Climate and Environmental Sciences Division, Strategic Plan, DOE/SC-0151, U.S. Department of Energy Office of Science. http://science.energy.gov/~/media/ber/pdf/CESD-StratPlan-2012.pdf

III. Basic Energy Sciences (BES)
Program Website: http://science.energy.gov/bes/

The mission of the Basic Energy Sciences (BES) program is to support fundamental research to understand, predict, and ultimately control matter and energy at the electronic, atomic, and molecular levels in order to provide the foundations for new energy technologies and to support DOE missions in energy, environment, and national security. The portfolio supports work in the natural sciences by emphasizing fundamental research in materials sciences, chemistry, geosciences, and biosciences. BES-supported scientific facilities provide specialized instrumentation and expertise that enable scientists to carry out experiments not possible at individual laboratories.

More detailed information about BES sponsored research can be found at the BES website listed above. There you will find BES-sponsored workshop reports that address the current status and

possible future directions of some important research areas. Also, Principal Investigators' Meetings Reports contain abstracts of BES supported research in topical areas associated with Division-sponsored technical conferences. Finally, the websites of individual BES Divisions may also be helpful. The following web pages are listed for convenience:
BES FY2014 Summary Report:
http://science.energy.gov/~/media/bes/pdf/reports/files/BES2014SR_rpt.pdf
BES FY 2014 Research Descriptions:
http://science.energy.gov/~/media/bes/pdf/reports/2015/BES_FY2014_research_summaries.pdf
BES Workshop Reports:
http://science.energy.gov/bes/news-and-resources/reports/
Materials Sciences and Engineering Division Principal Investigators' Meetings:
http://science.energy.gov/bes/mse/principal-investigators-meetings/
Chemical Sciences, Geosciences, & Biosciences Division Principal Investigators' Meetings:
http://science.energy.gov/bes/csgb/principal-investigators-meetings/
Scientific User Facilities Division web page:
http://science.energy.gov/bes/suf/

This year, many of the core research areas are limiting early career proposals to a subset of topics within their regular research programs. In those cases, the intention is to rotate topics on an annual basis. Proposed research must be responsive to a supported topic in one of the core research areas listed below:

(a) Materials Chemistry
Technical Contacts: Michael Sennett, 301-903-6051, Michael.Sennett@science.doe.gov (select this PM in PAMS) and Craig Henderson, 301-903-0805, Craig.Henderson@science.doe.gov

This program supports scientific research on materials with a focus on the *chemical synthesis, chemical control, and chemical dynamics* of material composition and structure across the range of length scales from atomic to mesoscopic, with a view to elucidating fundamental aspects of materials' structure-property relationships. The major programmatic focus is on the discovery, design and synthesis of novel, energy-relevant materials with an emphasis on the *chemistry* and *chemical* control of composition and structure across the range of length scales from atomic to mesoscopic, and consequent materials properties.

Recent BES Basic Research Needs (and other) workshops and reports have articulated those areas of the materials sciences that are most relevant to energy. All of the reports variously identify the overarching goal of fundamental materials chemistry research as providing the *knowledge* needed to *design and produce* new materials with *tailored properties from first principles.* This program will therefore emphasize research on the chemistry-based discovery, synthesis and transformations of materials and/or morphologies with the goal of providing fundamental knowledge with the potential to enable the development next generation energy technologies.

The program particularly encourages hypothesis-driven proposals in the following areas:

- **Applied Materials Theory – Computational approaches to predictive design of materials**
- **Directed Assembly – Control of material morphology at multiple length scales**
- **Polymer/Organic Thermoelectrics – Basic science, new materials and understanding**
- **Nanoscience/Nanomaterials – Fundamental effects of the nanoscale, 2D materials**
- **Hybrid Inorganic/Organic Perovskite Halides – Basic science, properties beyond photovoltaics**

The program will NOT support the following categories of research: Proposals aimed at *optimization* of material properties for any applications, nanoparticle synthesis as a primary goal, proposals related to energetic materials (i.e. propellants and explosives), proposals that have device fabrication and testing as a primary goal, and proposals focused on *developing* materials for specific applications.

The program will NOT consider applications this year on the following topics, but these topics will be considered in next year's Early Career Research Program competition:

- **Solid State Chemistry – Novel materials composition/morphology**
- **Surface and Interfacial Chemistry – Elucidation of phenomena, control of transport**
- **Novel Molecular Solids and Polymers – Synthesis and characterization**
- **Materials Chemistry Dynamics – Evolution of structure/properties**
- **Porous Materials – Synthesis-structure-properties**

For DOE national laboratory applicants, the proposed research must fit within the BES Materials Sciences and Engineering (MSE) Division funded programs at the laboratory of the applicant.

(b) Biomolecular Materials
Technical Contact: Michael Markowitz, 301-903-6779, mike.markowitz@science.doe.gov

This activity supports basic research in the discovery, design and synthesis of functional materials and complex structures based on principles and concepts of biology. Since biology provides a blueprint for translating atomic and nanoscale phenomena into mesoscale materials that display complex yet well-coordinated collective behavior, the major programmatic focus is on the hypothesis-driven creation of energy-relevant versions of these materials optimized for harsher, non-biological environments. Major scientific areas include: Harnessing or mimicking the energy-efficient synthesis approaches of biology to generate new, optimized materials capable of operating under a broad range of non-biological conditions; bioinspired self-assembly to form materials that are far from equilibrium and display novel and unexpected properties; adaptive, resilient materials with self-repairing capabilities; and development of science-driven tools and techniques for characterization of biomolecular and soft materials.

Recent BES Basic Research Needs (and other) workshops and reports have clearly identified mastering the capabilities of living systems as a Grand Challenge that could provide the knowledge base to discover, design, and synthesize new materials with totally new properties for

next-generation energy technologies. Biomolecular Materials research activity seeks to advance the ability for materials that can (i) self-repair; (ii) regulate, clean, and sequester impurities; and (iii) tolerate abuse. For the early career program, two separate topics (A and B shown below) are planned for alternate fiscal years. **For this announcement, only applications focused on Topic** B **will be considered**.

> Topic A (Planned for alternate years): New pathways for bio-inspired materials discovery that link scalable physical and chemical processes with the synthesis and assembly strategies of biology to predictably create new polymeric, inorganic, and hybrid functional materials *in vitro* with controllable morphology and energy harvesting, conversion, or storage properties are sought.
>
> Topic B (this year): The activity will also expand research on predictive, managed assembly incorporating error-correcting and defect managing mechanisms to create materials optimized for non-biological conditions that can (i) respond to environmental stresses without losing function; (ii) self-repair without external input; (iii) spontaneously assemble and disassemble; (iv) coordinate collective behavior in response to multiple signals; and (v) self-replicate.

In addition, enhanced integration of theory and experiment leading to new design ideas and opportunities for discovery will be emphasized. The program **will not** support projects aimed at optimization of materials properties for any applications, device fabrication, sensor development, tissue engineering, and biomedical research.

Examples of research funded in this program are found in Biomolecular Materials Principal Investigators' Meeting Reports at the link, http://science.energy.gov/bes/mse/principal-investigators-meetings/, under "Biomolecular Materials". BES-sponsored workshop reports outlining the current challenges and needs in this field can also be found on the following web page links: http://science.energy.gov/~/media/bes/pdf/reports/files/OFMS_rpt.pdf, http://science.energy.gov/~/media/bes/pdf/reports/files/gc_rpt.pdf, and http://science.energy.gov/~/media/bes/pdf/reports/files/bm_rpt.pdf.

For DOE national laboratory applicants, the proposed research must fit within the BES Materials Sciences & Engineering (MSE) Division funded programs at the laboratory of the applicant.

(c) Synthesis and Processing Science
Technical Contact: Bonnie Gersten, 301-903-0002, bonnie.gersten@science.doe.gov

This program supports basic research on materials to understand the physical phenomena and unifying principles that underpin materials synthesis including diffusion, nucleation, and phase transitions, often using *in situ* diagnostics, and developing new techniques to synthesize materials with tailored structure and properties. An important element of this activity is the development of real-time monitoring tools that probe the dynamic environment and the progression of structure and properties as a material is formed. This information is essential to understand the underlying physical mechanisms and to gain atomic level control of material

synthesis and processing.

Recent BES Basic Research Needs (and other) workshops and reports have identified the challenges in synthesis and processing that are most relevant to next-generation energy technologies. In particular, the Grand Challenges for the field include the ability to control and design materials with tailored and revolutionary properties through energy efficient processes and precise control even under far-from-equilibrium conditions.

This year's activity invites proposals on the synthesis and processing of complex thin films with atomic control with novel physical properties. Hypothesis-driven proposals that integrate a creative experimental methodology with a first-principles theoretical-based approach to accelerate progress in understanding unifying principles for synthesis and discovery of new materials are of particular interest. In alternate years, the plan is to invite proposals on synthesis preparation techniques for high-quality single crystal and bulk materials with novel physical properties; understanding the contributions of the precursor states to the processing of bulk materials; and mild processing techniques for the assembly of 1D nanostructured materials into larger scale structures. The focus of this activity on materials discovery and design by physical means is complementary to the BES Materials Chemistry and Biomolecular Materials research activities, which emphasize chemical and biomimetic approaches.

The program **will not** support projects aimed at *optimization* of material properties for specific applications, device fabrication, nanoparticle synthesis as a primary goal, or materials focused on hydrogen storage technologies. In addition, projects that mainly focus on tribology, fluid dynamics or engineering scale-up and development will not be supported. For this year, projects involving the synthesis or processing of bulk materials or the assembly of 1D nanostructured materials into larger structures **will not** be supported.

For DOE national laboratory applicants, the proposed research must fit within the BES Materials Science and Engineering (MSE) Division funded programs at the laboratory of the applicant.

(d) Experimental Condensed Matter Physics
Technical Contact: Michael Pechan, 301-903-0540, Michael.Pechan@science.doe.gov

The Experimental Condensed Matter Physics (ECMP) program supports research that will advance our fundamental understanding of the relationships between intrinsic electronic structure and the properties of complex materials.
Early Career calls in ECMP will alternate annually between the following focus areas:

1. Interface physics with an emphasis on non-equilibrium electronic, structural and magnetic states between dissimilar materials;
2. Phenomena in bulk, mesoscale, nanoscale and low-dimensional materials dominated by long range electronic, structural and magnetic states.

For this year, topics in focus area 1 will be considered. Topics in focus area 2 will be considered next year.

The ECMP Program does not support proposals on electrochemistry, thermoelectric materials or photovoltaic materials; nor does it support projects aimed at materials optimization or device development.

For DOE national laboratory applicants, the proposed research must fit within the BES Materials Sciences and Engineering (MSE) Division funded programs at the laboratory of the applicant.

(e) Theoretical Condensed Matter Physics
Technical Contact: James Davenport, 301-903-0035, james.davenport@science.doe.gov or Matthias Graf, 301-903-0874, matthias.graf@science.doe.gov

This program supports research in Theoretical Condensed Matter Physics with an emphasis on quantum materials, materials discovery, systems out of equilibrium (including transport and ultra-fast response), and fundamental research in materials related to energy technologies. Examples of current research include strongly correlated electron systems, quantum phase transitions, computational and data driven materials design, magnetism, superconductivity, optical response, semiconductor physics, thermoelectric materials, and neutron and photon scattering. Novel, physics based computational techniques are supported along with techniques relevant to nanoscale and mesoscale systems. **This year, proposals are only sought in the areas of quantum materials and systems out of equilibrium. Next year, the plan is to invite proposals in the areas of high-throughput computations, data driven materials discovery, and materials theory/modeling solely related to energy technologies.**

For DOE national laboratory applicants, the proposed research must fit within the BES Materials Sciences and Engineering (MSE) Division funded programs at the laboratory of the applicant.

(f) Physical Behavior of Materials
Technical Contact: Refik Kortan, 301-903-3308, refik.kortan@science.doe.gov

This program supports research to understand the Physical Behavior of Materials. This year, the program invites early career proposals in the topical areas of two-dimensional materials and photovoltaic materials. The applicants should heavily emphasize the impactful fundamental science aspects of their projects and these projects should be centered around hypothesis driven fundamental research that is transformative in nature. This program also supports theory, modeling, and simulation activities, especially in combination with experimental research. In alternate years, the plan is to invite proposals involving other research areas that focus on the behavior of materials in response to external stimuli which includes thermoelectric materials and light-matter interactions in the fields of plasmonics and metamaterials.

For DOE national laboratory applicants, the proposed research must fit within the BES Materials Sciences and Engineering (MSE) Division funded programs at the laboratory of the applicant.

(g) Mechanical Behavior and Radiation Effects
Technical Contact: John Vetrano, 301-903-5976, john.vetrano@science.doe.gov

This activity supports hypothesis-driven basic research to understand defects in materials and their effects on the properties of strength, structure, deformation, and failure. Defect formation, growth, migration, and propagation are examined by coordinated experimental and modeling efforts over a wide range of spatial and temporal scales. For the early career program, topics in this technical area annually alternate between radiation effects and mechanical behavior in materials. This year, the emphasis is on radiation effects on materials. Topics include fundamental studies of radiation resistance of structural materials, radiation effects on mechanical and physical properties, and radiation in conjunction with additional environments such as stress and a corrosive medium. For all proposed research, the radiation aspect should be the key topic to be studied. Proposals in mechanical behavior in materials will be considered in next year's Early Career Research Program solicitation.

The long-term goals of this program are to develop the scientific underpinning that will allow the development of predictive models for the design of materials having superior radiation resistance, and to understand how materials can be manipulated by radiation. Increasingly, radiation is used as a probe to gain a greater understanding of fundamental atomistic behavior of materials. Incoming fluxes can be uniquely tuned to generate a materials response that can be detected *in situ* over moderate length and time scales. Materials also sustain damage after long times in high-radiation environments typical of current and projected nuclear energy reactors and in geological waste storage. As nuclear energy continues to play a large role in U.S. energy generation, these issues need to be addressed at a fundamental level.

Proposals in the areas of high-dose studies and radiation effects on concrete/cement will not be accepted. For DOE national laboratory applicants, the proposed research must fit within the BES Materials Science and Engineering (MSE) Division funded programs at the laboratory of the applicant.

(h) X-ray Scattering
Technical Contact: Lane Wilson, 301-903-5877, lane.wilson@science.doe.gov

This activity supports basic research on the fundamental interactions of photons with matter to achieve an understanding of atomic, electronic, and magnetic structures and excitations and their relationships to materials properties. The main emphasis is on x-ray scattering, spectroscopy, and imaging research, primarily at major BES-supported user facilities. Instrumentation development and experimental research directed at the study of ultrafast physical phenomena in materials, is an integral part of the portfolio. Based on programmatic priorities, this activity **will not** support ultra-fast source development, but will focus on the application of ultra-fast probe interactions with materials and the resulting connection to materials dynamics.

Advances in x-ray scattering and ultrafast sciences will continue to be driven by scientific opportunities presented by improved source performance and optimized instrumentation. The x-ray scattering activity will continue to fully develop the capabilities at the DOE facilities by providing support for instrumentation, technique development and research. A continuing theme

in the scattering program will be the integration and support of materials preparation (especially when coupled to *in situ* investigation of materials processing) as this is a core competency that is vital to careful structural measurements related to materials properties. New investments in ultrafast science will focus on research that uses radiation sources associated with BES facilities and beam lines but also includes materials research employing ultra short pulse x-ray, electron beam and THz radiation probes created by conventional tabletop laser sources.

For DOE national laboratory applicants, the proposed research must fit within the BES Materials Science and Engineering (MSE) Division funded programs at the laboratory of the applicant.

(i) Neutron Scattering
Technical Contact: P. Thiyagarajan (Thiyaga), 301-903-9706,
p.thiyagarajan@science.doe.gov

This activity supports basic research on the fundamental interactions of neutrons with matter to achieve an understanding of the atomic, electronic, and magnetic structures and excitations of materials and their relationship to macroscopic properties. Major emphasis is on the advancement of techniques and application of neutron scattering and spectroscopy for materials research, primarily at BES-supported user facilities. The goal is to foster strong interaction between the neutron scattering experiments, theory and high performance computation to accelerate fundamental understanding needed for predictive design of advance materials for future energy needs.

The focus of this topic in this year's Early Career Research Program will be on the science at mesoscale where materials macroscopic properties are manifested. Characterizing and controlling the patterns and evolution of mesoscale heterogeneity are keys to optimizing and exploiting a wide range of materials performance and functionality. *In situ* research can measure structure and properties dynamically during synthesis and use of materials in appropriate environment and operational conditions, yielding direct data for comparison to predictions. The program will develop novel approaches that will exploit the unique aspects of neutron scattering and *in situ* capabilities to investigate materials with hierarchical structures and excitations in a wide range of length and time scales. A continuing theme of this program is the integration of material synthesis, neutron scattering experiments, and computational modeling as this is vital for careful neutron scattering measurements on high quality model systems and modeling for an in-depth understanding of the relationship between the "structure and dynamics" and macroscopic properties.

Based on programmatic priorities, applications focused on superconductivity (both conventional and unconventional) and correlated electron materials will not be considered in the Neutron Scattering activity in the Early Career Research Program.

For DOE national laboratory applicants, the proposed research must fit within the BES Materials Science and Engineering (MSE) Division funded programs at the laboratory of the applicant.

(j) Electron and Scanning Probe Microscopies
Technical Contact: Jane Zhu, 301-903-3811, jane.zhu@science.doe.gov

This activity supports basic research in materials sciences using microscopy and spectroscopy techniques. The research includes experiments and theory to understand the atomic, electronic, and magnetic structures and properties of materials. This activity also supports the development of new instrumentation and techniques, including ultrafast diffraction and imaging techniques, to advance basic science and materials characterizations for energy applications. The goal is to develop a fundamental understanding of materials through advanced microscopy and spectroscopy.

This research program builds upon the tremendous advancements in microscopy capabilities in the recent decades and use imaging and spectroscopy methods to understand functionality and fundamental processes from atomistic to mesoscopic scales. New methods and approaches could provide an array of opportunities for groundbreaking science. These include the possibilities of understanding and controlling nano or meso-scale inhomogeneity; new phenomena emerging at the nanoscale; imaging the functionality of materials and understanding the electronic structure, spin dynamics, magnetism, phase transitions and transport properties from atomistic to mesoscopic scales; understanding the interplay between charge, orbital, spin and lattice in complex materials; and solving material problems using advanced in situ analysis capabilities or combination of multiple probes. The combined new experimental and theoretical capabilities will enable the fundamental understanding of atomic origins of materials properties. **Applications for the early career program this year are limited to the scanning probe microscopy and spectroscopy area.** Research in the electron microscopy and spectroscopy area will be considered next year.

Based on programmatic priorities, this activity does not support projects aimed at technique development without science goals. Examples of research funded in this category can be found in the Electron and Scanning Microscopies Principal Investigators' Meetings' Reports at http://science.energy.gov/bes/mse/principal-investigators-meetings/.

For DOE national laboratory applicants, the proposed research must fit within the BES Materials Sciences and Engineering (MSE) Division funded programs at the laboratory of the applicant.

(k) Atomic, Molecular, and Optical Sciences (AMOS)
Technical Contact: Tom Settersten, 301-903-8428, thomas.settersten@science.doe.gov

This program supports basic experimental and theoretical research aimed at understanding the structural and dynamical properties of atomic and molecular systems. The research emphasizes fundamental interactions of these systems with photons and electrons to characterize and control their behavior. The goal is to develop accurate quantum mechanical descriptions of dynamical processes such as chemical bond breaking and forming, interactions in strong fields, and electron correlation. Topics of interest include the development and application of novel, ultrafast optical probes of matter; the interactions of atoms and molecules with intense electromagnetic fields; and quantum control of atomic and molecular systems. Projects involving technical development of sources or instrumentation must include a well-integrated scientific research focus.

The AMOS activity will continue to support science that advances DOE and BES mission priorities. Closely related experimental and theoretical efforts will be encouraged. AMOS will continue to have a prominent role at BES facilities in understanding and controlling the interaction of intense, ultrafast x-ray pulses with matter. Key targets for greater investment include attosecond science, ultrafast x-ray science, and ultrafast electron diffraction from molecular systems.

The program emphasizes ultrafast, strong-field, short-wavelength science, and correlated dynamics in atoms and molecules. Examples are the use of high-harmonic generation or its variants as soft x-ray sources, intense, ultrafast x-ray science at the Linac Coherent Light Source (LCLS), development and characterization of femtosecond and attosecond pulses of x-rays at synchrotrons as well as accelerator-based and table-top sources. Applications of these light sources include ultrafast imaging of chemical reactions, diffraction and harmonic generation from aligned molecules, and inner-shell photoionization of atoms and molecules. Coherent control of nonlinear optical processes and tailoring of quantum mechanical wave functions with lasers will continue to be of interest, particularly in molecular systems. Experimental and theoretical tools will be used to study low-energy electron-molecule interactions in the gas and condensed phases.

The AMOS program **is not** accepting applications in the areas of quantum information science, nanoscience, bioscience, and ultracold science.

For DOE national laboratory applicants, the proposed research must fit within the BES Chemical Sciences, Geosciences, and Biosciences (CSGB) Division funded programs at the laboratory of the applicant.

(l) Gas Phase Chemical Physics (GPCP)
Technical Contact: Wade Sisk, 301-903-5692, wade.sisk@science.doe.gov

The Gas Phase Chemical Physics (GPCP) Program supports research that improves our understanding of the dynamics and rates of chemical reactions at energies characteristic of combustion and the chemical and physical properties of key combustion intermediates. The overall aim is the development of a fundamental understanding of chemical reactivity enabling validated theories, models and computational tools for predicting rates, products, and dynamics of chemical processes involved in energy utilization by combustion devices. Important to this aim is the development of experimental tools for discovery of fundamental dynamics and processes affecting chemical reactivity. Combustion models using this input are developed that incorporate complex chemistry with the turbulent flow and energy transport characteristics of real combustion processes.

Major thrust areas supported by the GPCP program include: quantum chemistry, reactive molecule dynamics, chemical kinetics, spectroscopy, thermochemistry, predictive combustion models, combustion diagnostics, and soot formation & growth. For the early career program, two separate sets of topics (shown below) are planned for alternate fiscal years.

For this announcement, **only applications focused on the following topics will be considered this year** (open this year):

- quantum chemistry (electronic structure and chemical dynamics)
- chemical dynamics (collisional and reactive)
- chemical kinetics (experimental/computational rates and reaction mechanisms)
- spectroscopy
- thermochemistry

The following topics **will not be considered** this year (but will be open in alternate years):

- predictive combustion models employing computational fluid dynamics
- combustion diagnostics (particularly laser diagnostics)
- soot particle formation & growth

The GPCP program **does *not*** support research in the following areas: non-reacting fluid dynamics and spray dynamics, data-sharing software development, end-use combustion device development, and characterization or optimization of end-use combustion devices.

The focus of the GPCP program is the development of a molecular-level understanding of gas-phase chemical reactivity of importance to combustion. The desired evolution is to multi-phase predictive capabilities that span the microscopic to macroscopic domains enabling the computation of individual molecular interactions as well as their role in complex, collective behavior in real-world devices. Currently, increased emphasis in gas-phase chemical physics is on validated theories and computational approaches for the structure, dynamics, and kinetics of open shell systems, experimental measurements of combustion reactions at high pressures, better insight into soot particle growth and an improved understanding of the interaction of chemistry with fluid dynamics.

For DOE national laboratory applicants, the proposed research must fit within the BES Chemical Sciences, Geosciences, and Biosciences (CSGB) Division funded programs at the laboratory of the applicant.

(m) Computation and Theoretical Chemistry
Technical Contact: Mark Pederson, 301-903-9956, mark.pederson@science.doe.gov

Computation and Theoretical Chemistry emphasizes sustained development and integration of new and existing theoretical and massively parallel computational approaches for the accurate and efficient prediction of processes and mechanisms relevant to the BES mission especially in relation to providing groundwork for computational design of molecular- to meso- scale materials and processes. Part of the focus is on next-generation simulation of processes that are so complex that efficient computational implementation must be accomplished in concert with development of theories and algorithms. Efforts should be tightly integrated with the research and goals of BES, especially the chemical physics programs, and should provide fundamental solutions that enhance or enable conversion to clean, sustainable, renewable, novel or highly efficient energy use. Efforts should include application to real molecular- and nano- scale

systems. This may include the development or improvement of reusable computational tools that enhance analysis of measurements at the DOE facilities or efforts aimed at enhancing accuracy, precision, and applicability or scalability of all variants of quantum-mechanical simulation methods. This includes the development of spatial and temporal multi-scale/multistage methodologies that allow for time-dependent simulations of resonant, non-resonant and dissipative processes as well as rare events. Development of capabilities for simulation: of light-matter interactions, conversion of light to chemical energy or electricity, and the ability to model and control externally driven electronic and spin-dependent processes in real environments are encouraged. These phenomena may be modeled using a variety of time-independent and time-dependent simulation approaches. Examples include:

- Practical predictive methods for excited-state phenomena in complex molecular systems
- Nontraditional or novel basis sets, meshes and approaches for quantum simulation.
- Simulation and coupling of all interactions/scales in a system including: electronic, vibrational and atomistic structure, dissipative interactions, interactions between matter, radiation, fields and environment, spin-dependent and magnetic effects and the role of polarization, solvation and weak interactions.

Current interest includes applications to (i) energy storage, (ii) solar light harvesting including sunlight-to-fuel, (iii) interfacial phenomena, (iv) selective carbon-dioxide/gas separation, storage and capture (v) next-generation combustion modeling, (vi) reactivity and catalysis (vii) molecular and nano- scale electronic-, spin- and energy transport (viii) quantum simulation of biologically inspired mechanisms for energy management and (ix) alternative fuel.

Methods and/or investigations that do not require consideration of electronic rearrangements or coupling of electronic and vibrational degrees of freedom to external stimuli are not supported by this program.

For this year, the Computation and Theoretical Chemistry program will support efforts that focus upon improving the fundamental underpinnings of computational and theoretical methods for description of particle-particle, including many-body, interactions. Methods that do so by decreasing the number of empirical parameters in an existing capability, (2) increasing the computational/algorithmic efficiency of a specific existing capability, or (3) removing known fundamental issues from existing capabilities are of special interest. Methods that seek improvements of existing empirical parameterizations through introduction of additional empirical parameters, even if based upon results from other theoretical methods or experiment, will be discouraged.

For DOE national laboratory applicants, the proposed research must fit within the BES Chemical Sciences, Geosciences, and Biosciences (CSGB) Division funded programs at the laboratory of the applicant.

(n) Condensed Phase and Interfacial Molecular Science (CPIMS)
Technical Contact: Gregory Fiechtner, 301-903-5809, gregory.fiechtner@science.doe.gov

The CPIMS program emphasizes basic research at the boundary of chemistry and physics, pursuing a molecular-level understanding of chemical, physical, and electron- and photon-driven processes in aqueous media and at interfaces. With its foundation in chemical physics, the impact of this crosscutting program on DOE missions is far reaching, including energy utilization, catalytic and separation processes, energy storage, and environmental chemical and transport processes. Experimental and theoretical investigations in the gas phase, condensed phase, and at interfaces aim at elucidating the molecular-scale chemical and physical properties and interactions that govern chemical reactivity, solute/solvent structure and transport. Studies of reaction dynamics at well-characterized metal and metal-oxide surfaces and clusters lead to the development of theories on the molecular origins of surface-mediated catalysis and heterogeneous chemistry. Studies of model condensed-phase systems target first-principles understanding of molecular reactivity and dynamical processes in solution and at interfaces. Fundamental studies of reactive processes driven by radiolysis in condensed phases and at interfaces provide improved understanding of radiation-driven chemistry in nuclear fuel and waste environments.

Basic research is also supported to develop new experimental and theoretical tools that push the horizon of spatial and temporal resolution needed to probe chemical behavior selectively at interfaces and in solution, enabling studies of composition, structure, bonding and reactivity at the molecular level. The transition from molecular-scale chemistry to collective phenomena in complex systems is also of interest, including the effects of solvation on chemical structure and reactivity. In this manner, the desired evolution for supported research is toward predictive capabilities that span the microscopic to mesoscale domains enabling the computation of individual molecular interactions as well as their role in complex, collective behavior in real-world devices.

Some examples of support received by Early Career Research Program applicants include (1) studies of free-radical reactions at interfaces of aqueous aerosols, (2) studies that combine molecular electronics with ultrafast microscopy to pursue an understanding of electron transport in single molecules and at ultrafast time scales, (3) studies for understanding surface and subsurface adsorption at the molecular level to control chemical reactivity and selectivity, (4) studies that visualize interfacial electronic phenomena occurring on femtosecond timescales and submicron length scales, (5) studies that employ high resolution photoelectron imaging to gain an understanding of the mechanisms and molecular requirements for efficient exciton multiplication through singlet fission, and (6) studies that employ nonlinear soft x-ray spectroscopy to advance the understanding of ion solvation and charge transfer at electrochemical interfaces. More examples of research funded in this program are found in CPIMS Meeting Reports at the link http://science.energy.gov/bes/csgb/principal-investigators-meetings/, under “Condensed-Phase and Interfacial Molecular Science”.

The CPIMS program **does not** fund research in bulk fluid mechanics or fluid dynamics, applications such as the development of micro-scale devices, studies for which synthesis as a primary goal, research related to development of propellants and explosives, and research that is of principle importance to medical sciences and applications.

For DOE national laboratory applicants, the proposed research must fit within the BES Chemical Sciences, Geosciences, and Biosciences (CSGB) Division funded programs at the laboratory of the applicant.

(o) Catalysis Science
Technical Contact: Viviane Schwartz, 301-903-0448, Viviane.Schwartz@Science.doe.gov

This activity develops the fundamental scientific principles enabling catalyst design and chemical transformation control for energy-related catalytic processes. Research includes the identification of the elementary steps of catalytic reaction mechanisms and their kinetics; the synthesis of catalytic sites and their environment at the atomic and molecular level; the study of structure-reactivity relationships of inorganic, organic, or hybrid catalytic materials in solution or supported on solids; the dynamics of catalyst structure relevant to catalyst reactivity, selectivity and stability; the experimental determination of potential energy landscapes for catalytic reactions; the development of novel spectroscopic techniques and structural probes for *in situ* characterization of catalytic processes; and the development and application of theory, modeling, and simulation for determining catalyst structure/function and catalytic pathways.

The primary goal for all submissions must be to understand and control reaction mechanisms of full catalytic cycles relevant to energy applications. For phenomenological catalysis to evolve into predictive catalysis, the principles connecting catalytic structure, activity, selectivity, and reaction mechanisms must be clearly and thoroughly identified. This activity **encourages hypothesis-driven** proposals in all classical areas of catalysis but this year in particular in the following areas:

- Catalytic mechanistic studies involving novel inorganic, organic, hybrid, and bio-inspired catalysts;
- Surface science investigations of well-defined model systems that clearly pertain to practical catalysts and energy-relevant catalytic reactions;
- Catalytic mechanisms, pathways, and bond rearrangements in electrochemical and photoelectrochemical conversions of complex molecules into chemicals and fuels (with the exception of solar photochemical or electrochemical oxidation of water and all types of CO or CO_2 conversions);
- Fast and ultrafast characterization of reaction intermediates and transition states.

New strategies for design of selective catalysts for fuel and chemical production from both fossil and renewable biomass feedstocks are of interest. Selective and low-temperature activation of alkanes, carbohydrates and other multifunctional molecules are also encouraged. However, the program **will not consider** applications on the following topics:

- Process or reactor design and optimization;
- Environmental and engineering aspects of chemical or energy technologies;
- Proposals to study primarily the synthesis of materials, catalysts or organometallic complexes, or primarily the development of computational or experimental characterization methods;
- High-throughput methods with the purpose of synthesizing, characterizing, or screening catalysts;
- Enzyme-catalyzed reactions and catalytic synthesis of pharmaceuticals or fine chemicals that do not pertain to energy applications.

For DOE national laboratory applicants, the proposed research must fit within the BES Chemical Sciences, Geosciences, and Biosciences (CSGB) Division funded programs at the laboratory of the applicant.

Examples of research funded in catalysis can be found in Catalysis Science Program Meeting Reports at the link 'Chemical Sciences, Geosciences, & Biosciences Division Principal Investigators' Meetings', http://www.science.energy.gov/bes/csgb/principal-investigators-meetings/ (search for "catalysis" in the book title) and in the BES Research Summaries (http://www.science.energy.gov/bes/news-and-resources/program-summaries/). A 2007 BESAC-sponsored workshop, Basic Research Needs: Catalysis for Energy, outlining the current challenges and needs in this field can also be found on the 'Basic Research Needs Reports' web page link (http://www.science.energy.gov/~/media/bes/pdf/reports/files/cat_rpt.pdf.) The report content is current except for the exclusions noted above.

(p) Separations and Analysis
Technical Contact: Larry Rahn, 301-903-2508, larry.rahn@science.doe.gov

The overall goal of this activity is to obtain a predictive understanding, at molecular and nanoscale dimensions, of the basic chemical and physical principles involved in separations systems and chemical analysis tools, so that innovative approaches to DOE mission-related problems may be discovered and advanced. A range of multidisciplinary experimental and computational approaches are employed in basic research, inspired by the common fundamental underpinnings associated with a wide range of energy related chemical recognition, separation and analysis problems. These include processing, production and utilization of current and future petroleum, bio, solar, and nuclear fuels, as well as carbon capture, chemical processing with improved efficiency and/or selectivity, and production of strategic energy-relevant materials. The basic research needs in many of these areas are analyzed in workshop reports found at links listed at the beginning of this section, (III. Basic Energy Sciences (BES)).

This year's activity invites hypothesis-based proposals focused on analytical research enabling temporal and chemical observation and characterization at the nano- and molecular-scale that directly impact areas of research supported by BES. The proposed research is expected to extend the state of the art or offer entirely new approaches with particular emphasis on enabling grand challenge science identified in workshops and reports (see above). Included is the underlying science needed to achieve true chemical imaging, i.e., the ability to selectively image desired

chemical moieties at the molecular scale and to do so with temporal resolution that allows one to follow physical and chemical processes relevant to energy science.

Proposals focused on separations science research are not supported at this time, but will be supported in next year's Early Career Research Program.

Based on programmatic priorities this activity **does not** support engineering scale up or development of narrowly defined processes, devices or sensors, activities directed at lab-on-a-chip development, or research that is directed toward medical applications; as these areas are more appropriately supported through other federally funded programs.

For DOE national laboratory applicants, the proposed research must fit within the BES Chemical Sciences, Geosciences, and Biosciences (CSGB) Division funded programs at the laboratory of the applicant.

Research funded in this category in the recent past can be found in Separations and Analysis PI Meeting Reports at http://science.energy.gov/bes/csgb/principal-investigators-meetings. For actinide related research, see the description below of BES Heavy Element Chemistry.

(q) Heavy Element Chemistry (HEC)
Technical Contact: Philip Wilk, 301-903-4537, philip.wilk@science.doe.gov

This activity supports basic research on the chemistry of the actinide elements and beyond; typically uranium, neptunium, plutonium, americium, and curium; but also includes the minor actinides and superheavy elements. The unique molecular bonding of these elements is explored using experiment and theory to elucidate electronic and molecular structure as well as reaction thermodynamics. Emphasis is placed on addressing the f-electron challenge; the chemical and physical properties of these elements to determine solution, interfacial and solid-state bonding and reactivity; fundamental transactinide chemical properties; and the fundamental science underpinning the extraction and separation of the actinides.

Resolving the role of the f-electrons is one of the three grand challenges identified in *Basic Research Needs for Advanced Nuclear Energy Systems*,* the report of the Basic Energy Sciences Workshop (July 31 – August 3, 2006) on this topic. Research to address this challenge is pursued in this program and includes efforts aimed at implementing for the elements beyond actinium, quantum-mechanical theories that more adequately describe spin-orbit interactions and relativistic effects as well as efforts to expand our ability to predict heavy element chemical behavior under conditions relevant to all stages of fuel processing.

Synthetic research is pursued within this program on molecules that contain heavy elements, with a focus on gaining a fundamental understanding of how the f-electrons participate in bonding. Ligand synthesis to separate and sequester the actinides is also pursued with an aim not just toward improving all stages of the nuclear fuel cycle, but most importantly to understand how the actinides interact with complexants, which might lead to novel new separations.. Spectroscopic research on the chemical bonding and reactivity of all manner of energy-relevant heavy-element containing molecules is also pursued within this program. Better characterization

and modeling of the interactions of actinides at liquid-solid and liquid-liquid interfaces is motivated by deepening our understanding of the fundamental science underpinning areas within the DOE mission.

Based on programmatic priorities, the HEC program does not fund research on: the processes affecting the transport of subsurface contaminants, the form and mobility of contaminants including wasteforms, projects focused on the use of heavy-element surrogates, projects aimed at optimization of materials properties including radiation damage, device fabrication, or biological systems; which are all more appropriately supported through other DOE programs.

For DOE national laboratory applicants, the proposed research must fit within the BES Chemical Sciences, Geosciences, and Biosciences (CSGB) Division funded programs at the laboratory of the applicant.

* http://science.energy.gov/~/media/bes/pdf/reports/files/anes_rpt.pdf

Program and Abstracts for the 2015 Heavy Element Chemistry and Separations Science Principal Investigators' Meeting:
http://science.energy.gov/~/media/bes/csgb/pdf/docs/Chemical%20Transformations/Separations%20and%20Analysis/HEC_Abstract_Book_2015.pdf

(r) Geosciences Research
Technical Contact: Larry Rahn, 301-903-2058, larry.rahn@science.doe.gov

This activity supports basic experimental and theoretical research in geochemistry and geophysics. Geochemistry research emphasizes fundamental understanding of geochemical processes and reaction rates, focusing on aqueous solution chemistry, nanoscale geochemical processes, mineral-fluid interactions including chemical-mechanical coupling, and isotopic distributions and migration in natural systems. Geophysical research focuses on developing new approaches to understanding the subsurface physical properties, including stress and transport, of fluids, rocks, and minerals. Also included is the development of techniques for determining such properties at a distance including advancement of understanding of wave propagation physics in complex media and the fluid dynamics of complex fluids through porous and fractured subsurface rocks. The activity seeks new research efforts that will advance measurement of subsurface properties and related geochemical processes in porous and fractured media, laboratory scale investigations of reactive multiphase transport including chemical-mechanical interactions and surrogate materials, and advanced simulation and validation approaches leading to new fundamental understanding of the complex and heterogeneous mineral/fluid/particle interfacial processes that govern transformations and transport in the subsurface. Geosciences activities seek to link analytical capabilities and chemical investigations with computational capabilities to provide improved understanding of geophysical processes occurring at natural time and length scales. The Geosciences research activity focuses on fundamental physical sciences research. Studies targeting particular single applications such as exploitation of a single resource, or remediation of a particular waste/contaminant type **will not** be considered. Applicants in those cases should consult the appropriate DOE technology program. The Geosciences program held a major workshop in 2007 that is still highly relevant to illustrate our

fundamental sciences approach to DOE mission needs:
http://science.energy.gov/~/media/bes/pdf/reports/files/geo_rpt.pdf

BES Geosciences project abstracts for the most recent principal investigators' meeting can be found through the following link:
http://science.energy.gov/~/media/bes/csgb/pdf/docs/Geosciences/2014_Geoscience_Models_Where_are_the_Rocks_Program.pdf

For DOE national laboratory applicants, the proposed research must fit within the BES Chemical Sciences, Geosciences, and Biosciences (CSGB) Division funded programs at the laboratory of the applicant.

(s) Solar Photochemistry
Technical Contacts: Mark Spitler, 301-903-4568, mark.spitler@science.doe.gov (select this PM in PAMS) and Chris Fecko, 301-903-1303, christopher.fecko@science.doe.gov

This activity supports fundamental, molecular-level research on solar energy capture and conversion in the condensed phase and at interfaces. These investigations of solar photochemical energy conversion focus on the elementary steps of light absorption, charge separation, charge transport within a number of chemical systems, and the harvesting of this energy in usable form. Supported research encompasses experimental, as well as theoretical and computational approaches to problems in solar energy. Although the long term mission of this Program is an understanding of the science behind the transduction of solar energy, it is recognized that fundamental research in the interaction of light, matter and electrons in these systems is essential to the achievement of Program goals.

Supported research areas of interest this year will not include solar-driven production of electricity, a topic which will be of interest next year. It will deal with organic and inorganic photochemistry, photoinduced electron and energy transfer in the condensed phase and across interfaces, photoelectrochemistry, and artificial assemblies for charge separation and transport that mimic natural photosynthetic systems. An enhanced theory and modeling effort is needed for rational design of these artificial solar conversion systems. It will also deal with the research challenges in the photo-initiated catalysis of fuels production. Knowledge gained in research on charge separation and electron transfer needs to be applied in a meaningful way to activation of small molecules including, among others, CO_2 in its reduction to fuels, the fixation of N_2, and H_2O in its oxidation or reduction via transformative catalytic cycles. This spans the range from dark catalytic reactions to those driven by the energy of an absorbed photon and in both homogeneous and heterogeneous environments. The major scientific challenge for photoelectrochemical energy conversion for fuel generation is that small band gap semiconductors capable of absorbing solar photons are susceptible to oxidative degradation, whereas wide band gap semiconductors, which are resistant to oxidative degradation in aqueous media, absorb too little of the solar spectrum. Also of emphasis is research on the principles of new hybrid systems that feature molecular catalysis at solid surfaces and of new nanoscale structures for the photochemical generation of fuels.

Another regime of chemistry initiated through creation of high energy excited states is highly ionizing radiation, as can be produced through electron pulse radiolysis, to investigate reaction dynamics, structure, and energetics of short-lived transient intermediates in the condensed phase. Among many topics, fundamental research is of interest in areas which have a long term impact upon the understanding of radiolytic degradation of nuclear tank waste, the reactivity of solid surfaces in reactor coolant systems, and the chemistry of reagents used in separations processes in nuclear cycles.

Solar Photochemistry does not fund research on device development or optimization. Not of interest during this year's Early Career Research Program are proposals that involve the chemistry and physics of subsystems and systems for the production of electricity.

For DOE national laboratory applicants, the proposed research must fit within the BES Chemical Sciences, Geosciences, and Biosciences (CSGB) Division funded programs at the laboratory of the applicant.

(t) Photosynthetic Systems
Technical Contact: Stephen Herbert, 301-903-0383, stephen.herbert@science.doe.gov

This activity supports basic research on the capture and conversion of solar energy to chemically stored forms of energy in plants, algae, and photosynthetic microbes. Topics of study include but are not limited to light harvesting, exciton transfer, electron and proton transfer, and photosynthetic reduction of carbon dioxide. Such studies will enhance understanding of the intermolecular forces governing molecular assembly in photosynthetic systems; the structural and mechanistic features of photosynthetic complexes; and the physical and chemical rules that underlie biological mechanisms of photoprotection and self-repair.

Photosynthetic Systems **does not** fund research in: 1) prokaryotic systems related to human/animal health or disease; 2) development or optimization of devices and/or processes; 3) development or optimization of microbial strains or plant varieties for biofuel/biomass production. Projects should ideally be hypothesis-driven; projects that develop or rely primarily on high-throughput screening approaches **will not** be supported nor will theory/modeling projects that lack experimental verification.

For DOE national laboratory applicants, the proposed research must fit within the BES Chemical Sciences, Geosciences, and Biosciences (CSGB) Division-funded programs at the laboratory of the applicant.

(u) Physical Biosciences
Technical Contact: Robert Stack, 301-903-5652, robert.stack@science.doe.gov

This activity supports basic research that combines the tools of the physical sciences with biochemical and molecular biological approaches to further our understanding of the ways plants and/or non-medical microbes capture, transduce, and store energy. Research supported includes studies that investigate the mechanisms by which energy transduction systems are assembled and maintained, the processes that regulate energy-relevant chemical reactions within the cell, the

underlying biochemical and biophysical principles determining the architecture of biopolymers and the plant cell wall, and active site protein chemistry that provides a basis for highly selective and efficient bioinspired catalysts.
Funding consideration will be limited to proposals that will lead to a greater understanding of the structure, function, and mechanisms of enzymes and enzyme systems that catalyze multi-electron redox reactions (e.g. CO_2 reduction). How is the flow of electrons in biological systems gated and controlled?

Physical Biosciences **does not** fund research in: 1) animal systems; 2) prokaryotic systems related to human/animal health or disease; 3) development and/or optimization of devices and/or processes; 4) development and/or optimization of microbial strains or plant varieties for biofuel/biomass production; 5) cell wall breakdown or deconstruction; 6) transcriptional or translational regulatory mechanisms and/or processes; 7) environmental remediation and/or identification of environmental hazards. Projects should ideally be hypothesis-driven; projects that develop or rely primarily on high-throughput screening approaches **will not** be supported nor will theory/modeling projects that lack experimental verification.

For DOE national laboratory applicants, the proposed research must fit within the BES Chemical Sciences, Geosciences, and Biosciences (CSGB) Division-funded programs at the laboratory of the applicant.

All submitted proposals must clearly state the energy relevance of the proposed research: How will the knowledge gained from the proposed project better our understanding of the structure, function, and/or mechanistic aspects of energy-relevant biological redox reactions at the molecular level?

(v) Nanoscale Science Research Centers and Electron-Beam Microcharacterization Centers Research
Technical Contact: George Maracas, 301-903-1264, george.maracas@science.doe.gov

This research area supports work that advances the instruments, techniques, and capabilities of the existing BES Scientific User Facilities and/or contributes to capabilities of future facilities in this area. Research topics that develop and exploit the unique potential of co-located facilities within and across the BES scientific user facilities are encouraged. We do not intend to support applications to establish new, unrelated types of facilities or to develop techniques that do not relate to the missions of the Nanoscale Science Research Center or Electron Beam Microcharacterization Centers.

For DOE national laboratory applicants, the proposed research must fit within the BES Scientific User Facilities (SUF) Division funded programs at the laboratory of the applicant.

Five Nanoscale Science Research Centers (NSRCs) support the synthesis, processing, fabrication, and analysis of materials at the nanoscale: the Center for Nanophase Materials Sciences at Oak Ridge National Laboratory (ORNL), the Molecular Foundry at Lawrence Berkley National Laboratory (LBNL), the Center for Integrated Nanotechnologies at Sandia National Laboratory (SNL)/Los Alamos National Laboratory (LANL), the Center for Nanoscale

Materials at Argonne National Laboratory (ANL), and the Center for Functional Nanomaterials at Brookhaven National Laboratory (BNL). These centers are the Department of Energy's premier user facilities for interdisciplinary research at the nanoscale, serving as the basis for a national program that encompasses new science, new tools for synthesis, fabrication, and analysis, and new computing approaches and capabilities. As such, research is supported across the spectrum of scientific and engineering disciplines to understand and exploit unique and phenomena materials at the nanoscale, including materials for energy conversion, structured materials derived from or inspired by nature, hard and crystalline materials (including the structure of macromolecules), magnetic and soft materials (including polymers and ordered structures in fluids), and nanoscale materials integration. Tools for probing nanoscale materials and phenomena are increasingly multi-modal, to enable characterization of electrical, optical, and/or magnetic properties on the same sample with high resolution over a range of length scales. The ability to characterize functional nanoscale materials in-situ, under operating conditions, is also increasingly important, from, for example, battery electrode charging/discharging, to catalysts at high pressures and temperatures, to biologically-inspired, soft, and/or hybrid materials in liquid environments.

New approaches to probe at the nanoscale, notably leveraging complementary modalities at the electron-beam, x-ray, and neutron facilities are of particular interest. Theory and modeling closely coupled with experiment to advance and accelerate the understanding of nanoscale phenomena, provide insights to inform materials by design, and develop and implement new capabilities leveraging the most advanced computational resources are also encouraged.

In the area of electron-beam microcharacterization the focus is on the development of next generation electron-beam instrumentation and on conducting corresponding research. Electron scattering has key attributes that give such approaches unique advantages and make them complementary to x-ray and neutron beam techniques. These characteristics include strong interactions with matter (allowing the capture of meaningful signals from very small amounts of material, including single atoms under some circumstances) and the ability to readily focus the charged electron beams using electromagnetic lenses. The net result is unsurpassed spatial resolution and the ability to simultaneously obtain structural, chemical, and other types of information from sub-nanometer regions, allowing study of the fundamental mechanisms of catalysis, energy conversion, corrosion, charge transfer, magnetic behavior, and many other processes dynamically and at short time scales. All of these are fundamental to understanding and improving materials for energy applications and the associated physical characteristics and changes that govern performance.

Allowed topics for instrumentation and technique development efforts are limited to scanning, transmission, and scanning transmission electron microscopes, atom probes and related field ion instruments, related surface characterization apparatus and scanning probe microscopes, and ancillary tools such as spectrometers, detectors, and advanced sample preparation equipment. For guidance on the types of projects previously funded, please refer to currently funded **BES Research Summaries** (http://www.science.energy.gov/bes/news-and-resources/program-summaries/). Also, see the Future of Electron Scattering and Diffraction report (http://science.energy.gov/bes/news-and-resources/reports/).

(w) Accelerator and Detector Research
Technical Contact: Eliane Lessner, 301-903-9365, eliane.lessner@science.doe.gov

This program supports work that advances the instruments, techniques, and capabilities of the existing and/or future BES Scientific User Facilities. We do not intend to support applications to establish new, unrelated types of facilities or to develop techniques that do not relate to the missions of the light sources and neutron scattering centers.

For DOE national laboratory applicants, the proposed research must fit within the BES Scientific User Facilities (SUF) Division funded programs at the laboratory of the applicant.

In the accelerator and detector research program, the objective is to improve the output and capabilities of light sources and neutron scattering facilities that are the most advanced of their kind in the world. This program supports basic research in accelerator physics and X-ray and neutron detectors. An excellent reference for accelerator physics needs for light sources can be found in *Nuclear Instruments and Methods in Physics Research Section A: Accelerators, Spectrometers, Detectors and Associated Equipment, Volume 618, Issues 1-3*. Research is supported that aims at developing methods and techniques that will strongly benefit the next generation of free electron lasers (FELs) and storage-ring-based light sources. Development studies of loss control methods in high-intensity proton sources to neutron spallation facilities are also supported.

To fully exploit the fluxes delivered by all these sources, new detectors capable of acquiring data several orders of magnitude faster than current rates are required. A detailed discussion of opportunities and needs for neutron and photon detector development at the existing and future BES facilities can be found in the Neutron and Photon Detector Workshop report at http://www.science.energy.gov/bes/news-and-resources/reports/workshop-reports/

This program strongly interacts with BES programmatic research that uses synchrotron radiation and neutron sources.

(x) X-ray Instrumentation and Technique Development
Technical Contact: Peter Lee, 301-903-8484, Peter.Lee@science.doe.gov
This program supports work that advances the instruments, techniques, and capabilities of the existing and/or contributes to capabilities of future BES supported light source facilities. This program **will not** support proposals to establish new, unrelated types of facilities or to develop techniques not applicable to BES x-ray light source facilities. For laboratory applicants, the proposed research must fit within the BES Scientific User Facility Division (SUFD) funded programs at the laboratory of the applicant.
The unique properties of the light source facilities include, for storage-ring based synchrotron sources, a continuous spectrum, high flux, and brightness and, for the Linac Coherent Light Source (LCLS), ultra short pulses, high peak power, and high coherence, making them indispensable tools for the exploration of matter. The wide range of emitted photon wavelengths provide incisive probes for advanced research. The three broad categories of experimental measurement techniques performed at the light sources - spectroscopy, scattering, and imaging - probe the fundamental parameters by which we perceive the physical world (energy, momentum,

position, and time). By exploiting the short pulse lengths of these light sources, especially the LCLS, each technique can also be performed in a timing fashion.
In order to fully exploit the wide range of capabilities of these x-ray light source facilities, this program will encourage the development of imaginative concepts for new types of x-ray instruments as well as innovative uses of existing instruments, especially in the area of novel instrumentation for new experimental capabilities, development of advanced x-ray optics[1] and novel approaches to data visualization and analysis.

[1] Report for the X-ray Optics for BES Light Source Facilities Workshop, http://science.energy.gov/~/media/bes/pdf/reports/files/BES_XRay_Optics_rpt.pdf

(y) Neutron Scattering Instrumentation and Technique Development
Technical Contact: James J. Rhyne, 301-903-6827, James.Rhyne@science.doe.gov

This program supports work that advances instrumentation and technique capabilities of the existing and/or future BES supported neutron scattering facilities.

Thermal neutron scattering is a unique and effective tool for probing many aspects of the atomic structure and dynamics of materials. It is particularly well-suited for determining the atomic positions of both light and heavy atoms in solid or soft matter systems. In addition the neutron scatters from magnetic moments in the material thus providing information on the magnetic structure. The neutron energy is well-matched to that of elementary atomic and magnetic excitations (spin waves and phonons) in a material and, via inelastic scattering, can provide data crucial for understanding dynamics in a variety of systems including superconductors, magnetic, and multi-ferroic materials.

In order to fully exploit the wide range of capabilities of the BES neutron scattering facilities, this program will encourage the development of imaginative concepts for new types of scattering instruments as well as innovative uses of existing instruments, advanced optics, sample environments, and novel approaches to data visualization and analysis.

Note: This program **will not** support proposals to establish new, unrelated types of facilities or to develop techniques not applicable to BES neutron scattering facilities.

For DOE national laboratory applicants, the proposed research must fit within the BES Scientific User Facility (SUF) Division funded programs at the laboratory of the applicant.

IV. Fusion Energy Sciences (FES)

Program Website: http://science.energy.gov/fes/

The mission of the Fusion Energy Sciences (FES) program is to expand the fundamental understanding of matter at very high temperatures and densities and to build the scientific foundation needed to develop a fusion energy source. This is accomplished through the study of plasma, the fourth state of matter, and how it interacts with its surroundings.

The National Research Council report *Plasma Science: Advancing Knowledge in the National Interest* has recognized that plasma science has a coherent intellectual framework unified by

physical processes that are common to many subfields. Because of the wide range of plasma densities and temperatures encountered in fusion applications, it is valuable to support plasma science across many of its subfields in order to advance the fusion energy mission. Accordingly, the FES program has four strategic goals:

- Advance the fundamental science of magnetically confined plasmas to develop the predictive capability needed for a sustainable fusion energy source;
- Support the development of the scientific understanding required to design and deploy the materials needed to support a burning plasma environment;
- Pursue scientific opportunities and grand challenges in high-energy-density plasma science to better understand our universe, and to enhance national security and economic competitiveness, and;
- Increase the fundamental understanding of basic plasma science, including both burning plasma and low temperature plasma science and engineering, to enhance economic competiveness and to create opportunities for a broader range of science-based applications.

To address these strategic goals, the Fusion Energy Sciences program supports research on the specific topics below:

(a) Magnetic Fusion Energy Science Experimental Research
Technical Contact: Mark Foster, 858-455-3360, mark.foster@science.doe.gov

This Experimental Research program seeks to utilize existing unique magnetic fusion research facilities to develop the physics knowledge needed to advance the FES energy mission. The effort requires operation of a set of diversified experimental facilities, ranging from smaller-scale university experiments to large national facilities that involve extensive collaborations. The extensive plasma diagnostic systems operating on these facilities provide the experimental data required to study fusion science, basic plasma physics, and fusion energy production and to validate theoretical understanding and computer models, leading ultimately to a predictive understanding of plasma properties, including their dynamics and interactions with surrounding materials. Operation of major fusion facilities will be focused on science issues relevant to ITER design and operation, burning plasma physics, magnetic confinement, and other high priority plasma physics issues.

The research needs of the magnetic fusion energy sciences component of this program were detailed in the report of a community-wide Research Needs Workshop (ReNeW) *Research Needs for Magnetic Fusion Energy Sciences* (http://science.energy.gov/~/media/fes/pdf/workshop-reports/Res_needs_mag_fusion_report_june_2009.pdf). This report describes the scientific research required during the ITER era to develop the knowledge needed for a practical fusion power source.

Research in this area also involves small-scale facilities that explore emerging concepts for plasma confinement and stability, address critical issues that may affect the tokamak concept (e.g. plasma disruptions, impulsive heat loads, and operational maintenance and complexity), and investigate topics common to all fusion power plant concepts (e.g. interactions between plasma

and material surfaces, and material science issues associated with the high fluxes of heat, charged-particles, and neutrons in a fusion power plant).

The program also supports development of ITER-relevant diagnostic systems, advanced diagnostic capabilities to enable close coupling of experiments and theory/computations, and sensors or actuators required for active control of plasma properties to optimize device operation and plasma performance.

Scientists from the U.S. also participate in leading experiments on fusion facilities abroad and conduct comparative studies to supplement the scientific understanding they can obtain from domestic facilities.

(b) Magnetic Fusion Energy Science Theory and Simulation
Technical Contact: John Mandrekas, 301-903-0552, john.mandrekas@science.doe.gov

The Plasma Theory and Modeling program focuses on advancing the scientific understanding of the fundamental physical processes governing the behavior of magnetically confined plasmas and on using this knowledge to improve the design and performance of future fusion power reactors. Among the fundamental problems addressed by this program are the macroscopic stability and dynamics of fusion plasmas, with a strong focus on the prediction, avoidance, control and mitigation of deleterious or performance-limiting macroinstabilities; the understanding and controlling of the multiscale, collisional, and turbulent physical mechanisms responsible for the loss of heat, momentum, and particles from the confining region; the interaction of externally launched radiofrequency waves designed to heat and drive current with the background plasma and surrounding structures; the nonlinear interaction between background plasma, various instabilities, and energetic particle populations, including the alpha particles generated by the fusion reactions, and its impact on the confinement of these particles and the overall plasma performance; and the effect of multiscale and multiphysics processes at the plasma edge on the plasma performance and on the interaction and interface of the hot plasma boundary with the material walls. The efforts supported by this program provide the foundations for integrated simulations of fusion systems and range from analytical work to the development and application of advanced simulation codes capable of exploiting the potential of next generation high performance computers.

(c) High-Energy-Density Plasma Science
Technical Contact: Sean Finnegan, 301-903-4920, sean.finnegan@science.doe.gov

High-energy-density laboratory plasma (HEDLP) physics is the study of ionized matter at extremely high density and temperature, specifically when matter is heated and compressed to a point that the stored energy in the matter reaches approximately 100 billion Joules per cubic meter (the energy density of a hydrogen molecule). This corresponds to a pressure of approximately 1 million atmospheres or 1 Mbar. Systems in which free electrons play a significant role in the dynamics and for which the underlying assumptions and methods of traditional ideal-plasma theory and standard condensed matter theory do not apply (e.g., Warm Dense Matter at temperatures of a few eV) can have pressures as low as 0.1 Mbar and are also considered HED plasmas. Discovery-driven scientific explorations of high-energy-density states

of matter are being supported in this program. Topical examples being emphasized include (1) high-energy-density hydrodynamics, (2) radiation-dominated dynamics and material properties, (3) magnetized high-energy-density plasmas, (4) nonlinear optics of plasmas and laser-plasma interactions, (5) relativistic HED plasmas and intense beam physics, and (6) warm dense matter.

(d) General Plasma Science Experiment and Theory
Technical Contact: Nirmol Podder, 301-903-9536, nirmol.podder@science.doe.gov

The General Plasma Science program addresses fundamental issues in basic plasma science and engineering that can have impact in other areas or disciplines in which improved understanding of the plasma state is needed. Dynamic growth in new research areas, fostered by the development of new investigative techniques and tools, continues to present exciting opportunities for future research and development. General plasma science is a broad, multidisciplinary field that spans many science issues such as interaction of waves with plasmas, plasma kinetics, properties, and processes, magnetic reconnection and particle acceleration, physics of non-neutral and dusty plasmas, chaos, turbulence, and structure in plasmas. Areas of research responsive to this subprogram may include: (1) energy conversion, heating, and particle energization processes in astrophysical, solar, and space plasmas, (2) collective effects and properties of dusty, non-neutral and antimatter plasmas, (3) improved understanding of the interaction of plasma with biomaterials, and (4) improved understanding and control of plasma kinetics in the synthesis of nanomaterials.

(e) Fusion Nuclear Science, Materials Research and Enabling R&D Programs for Fusion
Technical Contact: Barry Sullivan, 301-903-8438, barry.sullivan@science.doe.gov

The Fusion Nuclear Science, Materials Research and Enabling R&D programs support the advancement of fusion science for both the near and long-term by carrying out research on technological topics that: (1) enable domestic experiments to achieve their full performance potential and scientific research goals; (2) permit scientific exploitation of the performance gains being sought from physics concept improvements; (3) allow the U.S. to enter into international collaborations, thus gaining access to experimental conditions not available domestically; (4) develop the technology and materials required for future fusion facilities, and (5) explore the science underlying these technological advances. Due to the harshness of the fusion environment and the significant challenge to overcome it, one of the four major goals of the FES program is to support the development of the scientific understanding required to design and deploy the materials and technology needed to support a burning plasma environment. Given this goal, these programs are interested in research that addresses the development of materials for use in fusion. This includes the following research topics: development of tungsten as a plasma facing material, plasma material interactions, fabrication, joining and cooling of plasma facing materials, development of both solid and liquid blanket concepts that can breed tritium and provide necessary heat transfer capabilities, and development of ferritic steels and oxide-dispersion strengthened steels as first wall structural materials.

V. High Energy Physics (HEP)

Program Website: http://science.energy.gov/hep/

The mission of the High Energy Physics (HEP) program is to understand how the universe works at its most fundamental level by discovering the elementary constituents of matter and energy, probing the interactions between them, and exploring the basic nature of space and time.

The scientific objectives and priorities for the field recommended by the High Energy Physics Advisory Panel (HEPAP) are detailed in its recent long-range strategic Particle Physics Project Prioritization Plan (P5), available at: http://science.energy.gov/~/media/hep/hepap/pdf/May%202014/FINAL_P5_Report_Interactive_060214.pdf.

The HEP program focuses on three scientific frontiers:

- *The Energy Frontier,* where powerful accelerators are used to create new particles, reveal their interactions, and investigate fundamental forces;

- *The Intensity Frontier,* where intense particle beams and highly sensitive detectors are used to pursue alternate pathways to investigate fundamental forces and particle interactions by studying events that occur rarely in nature, and to provide precision measurements of these phenomena; and

- *The Cosmic Frontier,* where non-accelerator-based experiments observe the cosmos and detect cosmic particles, making measurements of natural phenomena that can provide information about the nature of dark matter, dark energy, and other fundamental properties of the universe that impact our understanding of matter and energy.

Together, these three interrelated and complementary discovery frontiers offer the opportunity to answer some of the most basic questions about the world around us. Also integral to the mission of HEP are three cross-cutting research areas that enable new scientific opportunities by developing the necessary tools and methods for discoveries:

- *Theoretical High Energy Physics,* where the vision and mathematical framework for understanding and extending the knowledge of particles, forces, space-time, and the universe are developed;

- *Accelerator Science and Technology Research and Development,* where the technologies and basic science needed to design, build, and operate the accelerator facilities essential for making new discoveries are developed; and

  Detector Research and Development, where the basic science and technologies needed to design and build the High Energy Physics detectors essential for making new discoveries are developed.

The three frontiers and the three cross-cutting research areas are collectively the six research subprograms supported by HEP. Proposed research should address specific research goals in one or more of the six research subprograms, and explain how the research or technology development supports the broad scientific objectives and mission of the HEP program. Principal investigators should submit their proposal to the HEP subprogram that they consider to be the best "fit" to the preponderance of their research effort. Applications for support of generic detector R&D efforts should be directed to the Detector Research and Development research area described below. However, applicants proposing physics studies and pre-conceptual R&D efforts directed towards a specific experiment within an experimental frontier should submit their application to the relevant HEP scientific frontier research area.

Proposals should not attempt to bolster the case for facilities not currently approved for funding or not expected to be available during the course of the work.

(a) Experimental Research at the Energy Frontier in High Energy Physics
Technical Contact: Abid Patwa, 301-903-0408, abid.patwa@science.doe.gov

This research area seeks to support studies of fundamental particles and their interactions using proton-(anti)proton collisions at the highest possible energies. This is accomplished through direct detection of new phenomena or through sensitive measurements that probe the Standard Model and new physics beyond it. In particular, applications are sought for physics research utilizing data being collected at the Large Hadron Collider (LHC) by the ATLAS and CMS experiments. This research area also provides graduate and postdoctoral research training for the next generation of scientists, and equipment and computational support for physics research activities. Applications addressing physics studies and pre-conceptual R&D directed towards specific future Energy Frontier experiments are also accepted. Support for Heavy Ion Physics research is not provided under this research area.

(b) Experimental Research at the Intensity Frontier in High Energy Physics
Technical Contact: Glen Crawford, 301-903-4829, glen.crawford@science.doe.gov

This research area seeks to support precision studies that are sensitive to new physics at very high energy scales, beyond what can be directly probed with energy frontier colliders. Often these studies involve observing rare processes that require intense particle beams. In addition, recent advances in neutrino physics have opened the first window beyond the Standard Model of particle physics, perhaps signaling significant new properties of neutrinos that will have wide-ranging impact in particle physics and cosmology. This research area includes studies of high intensity electron-positron collisions; studies of the fundamental properties of neutrinos produced by a variety of sources, including accelerators and nuclear reactors; and studies of rare processes using high intensity beams on fixed targets. In addition, this research area includes searches for proton decay. This research area also provides graduate and postdoctoral research training for the next generation of scientists, and equipment and computational support for physics research activities. Applications addressing physics studies and pre-conceptual R&D directed towards specific future Intensity Frontier experiments are also accepted. Support for LHCb research or studies of neutrinoless double beta decay is not provided under this research area.

(c) Experimental Research at the Cosmic Frontier in High Energy Physics
Technical Contact: Kathy Turner, 301-903-1759, kathy.turner@science.doe.gov

This research area seeks to support studies using observations of the cosmos and naturally occurring cosmic particles to understand fundamental particles and fields. Studies of the nature of dark energy, using spectroscopic and imaging surveys, as well as direct-detection searches for dark matter particles are major activities in this program. This area also supports measurements of the cosmic microwave background that are used to explore the nature of inflation in the early universe, and to provide information on the nature of dark energy and neutrino mass. In addition, this research area uses cosmic rays and photons to search for indirect signals of dark matter, the presence of primordial antimatter and other fundamental phenomena related to the properties of particles, space and matter. Applications are particularly being sought for physics research activities on DOE-supported Cosmic Frontier experiments or projects, including efforts directed towards specific future experiments.

This program provides support for scientists to participate in these research areas, including graduate and postdoctoral research training for the next generation of scientists, and equipment and computational efforts to support the physics research activities. Research aimed at developing techniques or understanding experimental data within the context of theoretical models, expressly for or with an experimental research collaboration, *is* included in this area.

Studies of gravitational physics, classical astrophysics phenomena, or fundamental symmetries are not included in this research area.

(d) Theoretical Research in High Energy Physics
Technical Contact: Simona Rolli, 301-903-0504, simona.rolli@science.doe.gov

This research area supports activities that range from detailed calculations of the predictions of the Standard Model, to the extrapolation of current knowledge to a new level of understanding, and the identification of the means to experimentally verify such predictions. Thus a thriving theory program is essential for identifying new directions and opportunities for the field. Topics studied in theoretical high energy physics research include, but are not limited to: phenomenological and theoretical studies that support experimental HEP research at the Energy, Intensity and Cosmic Frontiers, both in understanding the data and in finding new directions for experimental exploration; development of analytical and numerical computational techniques for these studies; and construction and exploration of theoretical frameworks for understanding fundamental particles and forces at the deepest level possible. This research area also provides graduate and postdoctoral research training for the next generation of scientists and computational resources needed for theoretical calculations. Activities that rely on experimental data, performed expressly for or with an experimental research collaboration, are not included in this research area.

(e) Accelerator Science and Technology Research & Development in High Energy Physics
Technical Contact: L.K. Len, 301-903-3233, lk.len@science.doe.gov

The accelerator technology R&D subprogram develops the next generation of particle accelerators and related technologies that are essential for discoveries in HEP. This research area supports world-leading research in the physics of particle beams and long-range, exploratory research aimed at developing new concepts. This research area also provides graduate and postdoctoral research training, equipment for experiments and related computational efforts.

Topics studied in the accelerator science and technology R&D subprogram include, but are not limited to: accelerator and beam physics, including analytic and computational techniques for modeling particle beams and simulation of accelerator systems; novel acceleration concepts; the science of high gradients in accelerating cavities and structures; high-power radio-frequency sources; high-brightness beam sources; and beam instrumentation. Also of interest are superconducting materials and conductor development; innovative magnet design and development of high-field superconducting magnets; as well as associated testing and cryogenic systems. R&D proposals, which are focused on accelerator applications outside of high-energy physics, are now coordinated through the Accelerator Stewardship program and are outside the scope of this particular FOA.

(f) Detector Research and Development in High Energy Physics
Technical Contact: Helmut Marsiske, 301-903-6989, helmut.marsiske@science.doe.gov

The detector R&D subprogram develops the next generation of instrumentation for HEP. It supports research leading to fundamental advances in the science of particle and radiation detection, and the development of new experimental techniques. This is typically long-term, "generic" R&D that is high-risk, but has the potential for wide applicability and/or high-impact.

Topics studied in the detector R&D research area include, but are not limited to: low-mass, high channel density charged particle tracking detectors; high resolution, fast-readout calorimeters and particle identification detectors; techniques for improving the radiation tolerance of particle detectors; detectors for photons from ultraviolet to infrared wavelengths; detectors for cosmic microwave background radiation; detectors and experimental techniques for ultralow-background experiments; and advanced electronics and data acquisition systems. In addition, this research area develops next-generation computational tools and techniques in support of experimental HEP research. Support for graduate and postdoctoral research training, engineering and other technical efforts, and equipment and computational efforts required for experimental detector R&D and fabrication *is* included in this research area.

VI. Nuclear Physics (NP)

Program Website: http://science.energy.gov/np/

The mission of the Nuclear Physics (NP) program is to discover, explore, and understand all forms of nuclear matter. Although the fundamental particles that compose nuclear matter—quarks and gluons—are themselves relatively well understood, exactly how they interact and combine to form the different types of matter observed in the universe today and during its

evolution remains largely unknown. It is one of the enduring mysteries of the universe: What, really, is matter? What are the units that matter is made of, and how do they fit together to give matter the properties we observe? To solve this mystery, the NP program supports experimental and theoretical research—along with the development and operation of particle accelerators and advanced technologies—to create, detect, and describe the different forms and complexities of nuclear matter that can exist, including those that are no longer commonly found in our universe. In executing this mission, nuclear physics focuses on three broad yet tightly interrelated areas of inquiry. These areas are described in *The Frontiers of Nuclear Science* http://science.energy.gov/np/nsac/, a long range plan for nuclear science released in 2007 by the Nuclear Science Advisory Committee (NSAC). The three frontiers are: Quantum Chromodynamics, Nuclei and Nuclear Astrophysics, and Fundamental Symmetries and Neutrinos. Specific questions within these frontiers are addressed by the research activities of subprograms supported by the Office of Nuclear Physics as described below. (An updated NSAC long range plan is in preparation, and should be completed late in 2015.) In addition, the NP isotope subprogram produces and/or distributes stable and radioactive isotopes that are critical for the Nation and supports research into production techniques for such isotopes.

The NP program supports the development of the tools and capabilities that make fundamental research possible, including accelerator research and development for current and future nuclear physics facilities. It also supports applications of nuclear science and technology to help bridge the gap between basic nuclear physics research and applied science, and an initiative on advanced detector technology research and development. Research, development and fabrication of equipment directed toward research in any NP subprogram may be proposed, but applications including such extensive projects requiring detailed review of scope, budget and schedule beyond the procedures for this announcement will not be considered. Proposals should not attempt to bolster the case for facilities or major items of equipment not currently approved for funding or not expected to be available during the course of the work. Under this announcement, NP does not support investigations into the development of nuclear reactors for purposes outside the scope of the NP subprograms described below.

Applications are solicited for research in any of the NP subprograms and areas described below.

(a) Medium Energy Nuclear Physics
Technical Contact: Gulshan Rai, 301-903-47022, gulshan.rai@science.doe.gov

The Medium Energy subprogram of Nuclear Physics focuses primarily on questions having to do with the first frontier of Nuclear Physics, Quantum Chromodynamics (QCD), especially regarding the spectrum of excited mesons and baryons, and the behavior of quarks inside the nucleons (neutrons and protons). Specific questions that are being addressed include: *What does QCD predict for the properties of excited mesons and baryons? What governs the transition of quarks and gluons into pions and nucleons? What is the role of gluons and gluon self-interactions in nucleons and nuclei?* and *What is the internal landscape of the nucleons?*

This subprogram also supports investigations of some aspects of the second and third frontiers, Nuclei and Nuclear Astrophysics, and Fundamental Symmetries and Neutrinos. Research in these areas addresses questions including: *What is the nature of the nuclear force that binds*

protons and neutrons into stable nuclei? Why is there now more visible matter than antimatter in the universe? and *What are the unseen forces that were present at the dawn of the universe, but disappeared from view as the universe evolved?*

In pursuing these topics the Medium Energy subprogram supports several experimental research programs, notably at the Thomas Jefferson National Accelerator Facility (TJNAF), the Relativistic Heavy Ion Collider (RHIC), the High Intensity Gamma-Ray Source (HIGS) and at other international facilities. Two major goals of the Medium Energy research program at TJNAF are the discovery of "exotic mesons" which carry gluonic excitations, and the experimental study of the substructure of the nucleons using high-energy electron beams. At RHIC, the goals are to elucidate how much the spin of gluons contributes to the proton's spin and study the spin-flavor structure of sea quarks in polarized proton-proton collisions.

(b) Heavy Ion Nuclear Physics
Technical Contact: James Sowinski, 301-903-7587, james.sowinski@science.doe.gov

The Heavy Ion subprogram supports experimental research that investigates the frontier of Quantum Chromodynamics (QCD) by attempting to recreate and characterize new and predicted forms of matter and other new phenomena that might occur in extremely hot, dense nuclear matter and which have not existed since the Big Bang. This subprogram addresses what happens when nucleons "melt." QCD predicts that nuclear matter can change its state in somewhat the same way that ordinary matter can change from solid to liquid to gas. The fundamental questions addressed include: *What are the phases of strongly interacting matter, and what roles do they play in the cosmos? What governs the transition of quarks and gluons into pions and nucleons? What determines the key features of QCD, and what is their relation to the nature of gravity and spacetime?* Experimental research is carried out primarily using the U.S. Relativistic Heavy Ion Collider (RHIC) facility and the Large Hadron Collider (LHC) at the European Organization for Nuclear Research (CERN).

(c) Low Energy Nuclear Physics
Technical Contact: Cyrus Baktash, 301-903-0258, cyrus.baktash@science.doe.gov

The Low Energy subprogram aims primarily at answering the overarching questions associated with the second frontier identified by NSAC— Nuclei and Nuclear Astrophysics. These questions include: *What is the nature of the nucleonic matter? What is the origin of simple patterns in complex nuclei? What is the nature of neutron stars and dense nuclear matter? What is the origin of the elements in the cosmos? What are the nuclear reactions that drive stars and stellar explosions?* Major goals of this subprogram are to develop a comprehensive description of nuclei across the entire nuclear chart, to utilize rare isotope beams to reveal new nuclear phenomena and structures unlike those that are derived from studies using stable ion beams, and to measure the cross sections of nuclear reactions that power stars and spectacular stellar explosions and are responsible for the synthesis of the elements. The subprogram also investigates aspects of the third frontier of Fundamental Symmetries and Neutrinos. Questions addressed in this frontier include: *What is the nature of the neutrinos, what are their masses, and how have they shaped the evolution of the universe? Why is there now more matter than antimatter in the universe? What are the unseen forces that were present at the dawn of the*

universe but disappeared from view as the universe evolved? The subprogram seeks to measure, or set a limit on, the neutrino mass and to determine if the neutrino is its own antiparticle. Experiments with cold neutrons also investigate the dominance of matter over antimatter in the universe, as well as other aspects of Fundamental Symmetries and Interactions.

(d) Nuclear Theory
Technical Contact: George Fai, 301-903-8954, george.fai@science.doe.gov

The Nuclear Theory subprogram supports theoretical research at universities and DOE national laboratories with the goal of improving our fundamental understanding of nuclear physics, interpreting the results of experiments, and identifying and exploring important new areas of research. This subprogram addresses all of the field's scientific frontiers described in NSAC's long range plan, as well as the specific questions listed for the experimental subprograms above. Theoretical research on QCD (the fundamental theory of quarks and gluons) addresses the questions of how the properties of the nuclei, hadrons, and nuclear matter observed experimentally arise from this theory, how the phenomenon of quark confinement arises, and what phases of nuclear matter occur at high densities and temperatures. In Nuclei and Nuclear Astrophysics, theorists investigate a broad range of topics, including calculations of the properties of stable and unstable nuclear species, the limits of nuclear stability, the various types of nuclear transitions and decays, how nuclei arise from the forces between nucleons, and how nuclei are formed in cataclysmic astronomical events such as supernovae and neutron star mergers. In Fundamental Symmetries and Neutrinos, nucleons and nuclei are used to test the Standard Model, which describes the interactions of elementary particles at the most fundamental level. Theoretical research in this area is concerned with determining how various (beyond) Standard Model aspects can be explored through nuclear physics experiments, including the interactions of neutrinos, unusual nuclear transitions, rare decays, and high-precision studies of cold neutrons.

(e) Nuclear Data and Nuclear Theory Computing
Technical Contact: Frank E (Ted) Barnes, 301-903-3212, ted.barnes@science.doe.gov

This subarea includes the National "Nuclear Data" effort, as well as several activities that facilitate the application of high performance computing to Nuclear Physics. The US Nuclear Data Program (USNDP) collects, evaluates, and disseminates nuclear physics data for basic and applied nuclear research, maintains open databases of scientific information gathered over the past 100+ years of research in nuclear physics, and addresses gaps in the data through targeted experimental studies and the use of theoretical models. "Nuclear Theory Computing" includes the NP component of the ASCR program Scientific Discovery through Advanced Computing (SciDAC), which promotes the use of supercomputers at national laboratories and universities to solve computationally challenging problems of great current interest. Recent topics in computational nuclear physics investigated under SciDAC include the theory of quarks and gluons on a lattice (LQCD), studies of a wide range of applications of models of nuclei and nuclear matter, and the development of theoretical techniques for incorporating lattice QCD results in traditional many-body nuclear physics calculations.

(f) Accelerator Research and Development for Current and Future Nuclear Physics Facilities
Technical Contact: Manouchehr Farkhondeh, 301-903-4398, manouchehr.farkhondeh@science.doe.gov

The Nuclear Physics program supports a broad range of activities aimed at research and development related to the science, engineering, and technology of heavy-ion, electron, and proton accelerators and associated systems. Areas of interest include the R&D technologies of the Brookhaven National Laboratory's Relativistic Heavy Ion Collider (RHIC), with heavy ion and polarized proton beams; the development of a possible future electron-ion collider; linear accelerators such as the Continuous Electron Beam Accelerator Facility (CEBAF) at the Thomas Jefferson National Accelerator Facility (TJNAF); and development of devices and/or methods that would be useful in the generation of intense rare isotope beams for the next generation rare isotope beam accelerator facility, the Facility for Rare Isotope Beams (FRIB) currently under construction at Michigan State University. Also of interest is R&D in accelerator science and technology in support of next generation Nuclear Physics accelerator facilities such as an electron-ion collider.

(g) Isotope Development and Production for Research and Applications
Technical Contact: Dennis Phillips, 301-903-7866, dennis.phillips@science.doe.gov

The mission of the Isotope Development and Production for Research and Applications subprogram (Isotope Program) is to support isotope production and research into novel technologies for production of isotopes to assure availability of critical isotopes that are in short supply to address the needs of the Nation. The program provides facilities and capabilities for the production and/or distribution of research and commercial stable and radioactive isotopes. The scientific and technical staff associated with general isotope production and isotope production research are also supported. Isotopes are made available by using unique facilities stewarded by the Isotope Program at Brookhaven National Laboratory, Los Alamos National Laboratory, and Oak Ridge National Laboratory. The Program also coordinates and supports isotope production at a suite of university, national laboratory, and other federal accelerator and reactor facilities throughout the Nation to promote a reliable supply of isotopes domestically. Topics of interest are focused on the development of advanced, cost-effective and efficient technologies for producing, processing, recycling and distributing isotopes in short supply. This includes technologies for production of radioisotopes using reactor and accelerator facilities and new technologies for enriching stable isotopes. Excluded from this call are proposals related to the production of Mo-99, as this isotope is under the purview of the NNSA Office of Materials Management and Minimization. More information about the Isotope Program may be found at http://science.energy.gov/np/research/idpra/.

Section II – AWARD INFORMATION

A. TYPE OF AWARD INSTRUMENT

DOE anticipates awarding laboratory work authorizations under this DOE National Laboratory Announcement.

B. ESTIMATED FUNDING

It is anticipated that up to $10,000,000 per year will be available under this DOE National Laboratory Announcement, contingent on satisfactory peer review and the availability of appropriated funds. Between 15 and 25 awards are anticipated, and applicants should request project support for five years, with out-year support contingent on the availability of appropriated funds, progress of the research, and programmatic needs. Awards are expected to begin in **FY 2016**.

DOE reserves the right to fund, in whole or in part, any, all, or none of the proposals submitted in response to this DOE National Laboratory Announcement.

C. MAXIMUM AND MINIMUM AWARD SIZE

The award size will depend on the number of meritorious proposals and the availability of appropriated funds.

Ceiling
None

Floor
$2,500,000 over five years

D. EXPECTED NUMBER OF AWARDS

DOE anticipates making 15-25 awards under this DOE National Laboratory Announcement. The exact number of awards will depend on the number of meritorious applications and the availability of appropriated funds.

E. ANTICIPATED AWARD SIZE

While the minimum award size is $2,500,000, DOE expects the typical award size will be $2,500,000 over five years. Applicants are encouraged to propose research expenditures as close to the funding minimum as possible. Typical budgets will be $500,000 per year for five years. The size of a national laboratory award is commensurate with the requirement to charge twelve-month annual salaries (compared with professors, who are partially paid by academic institutions). Thus, a minimum of 50% and up to 100% of the Principal Investigator's salary should be proposed.

F. PERIOD OF PERFORMANCE

DOE anticipates making awards with a project period of five years.

G. TYPE OF PROPOSAL

DOE will accept new DOE National Laboratory Proposals under this DOE National Laboratory Announcement. Please only submit a PAMS lab technical proposal in response to this announcement; do not submit a DOE Field Work Proposal (FWP) at this time. The Office of Science will request FWPs later from those selected for funding consideration under this announcement.

Section III – ELIGIBILITY INFORMATION

A. ELIGIBLE APPLICANTS AND TOPICS

Only DOE National Laboratories are eligible to apply.

The Principal Investigator must be a full-time, permanent, non-postdoctoral national laboratory employee as of the deadline for the proposal. No more than ten (10) years can have passed between the year the Principal Investigator's Ph.D. was awarded and the year of the deadline for the proposal. For the present competition, those who received doctorates no earlier than 2005 are eligible.

There can be no co-Principal Investigators.

Each Principal Investigator may only submit one Office of Science Early Career Research Program proposal per annual competition. Additionally, a Principal Investigator may not participate in more than three Office of Science Early Career Research Program competitions.

Participation in the competition is defined as submission of a full proposal. In rare cases, it is necessary to withdraw a proposal early in the process; proposals withdrawn prior to being sent for merit review by the DOE Office of Science will not count as a submission.

The act of submitting a proposal implies that the submitting institution has checked, confirmed, and certifies that the Principal Investigator is eligible. No additional certifying documentation is required.

Proposals must be submitted through a DOE national laboratory. A companion funding opportunity announcement (DE-FOA-0001386) describes the Early Career Research Program opportunity for tenure-track untenured assistant professors and tenure-track untenured associate professors at U.S. academic institutions. An employee with a joint appointment between a university and a DOE national laboratory must apply through the institution that pays his or her salary and provides his or her benefits; the eligibility criteria above must also be met.

Eligibility exemptions **will not** be granted.

Each proposal must be accompanied by a letter from the national laboratory director to the technical point of contact confirming that the proposed research idea fits within the scope of Office-of-Science-funded programs at the national laboratory. Proposing research that falls within this category ensures that investigators have the opportunity to belong to or join, at the laboratory's discretion, funded research groups. Investigators funded under this program are allowed to charge as little as 50 % of their time to the award, freeing up time to develop or maintain funded collaborations within the lab over the course of the award. Making sure that investigators have potential connections with Office-of-Science funded programs encourages the laboratory to actively plan to address funding transition issues that may arise when an award ends.

Proposals from DOE National Laboratories should not (a) attempt to revive previously terminated research areas within the laboratory or (b) topically isolate investigators.

While there is no limit on the number of preproposals from a DOE national laboratory in a given year, each laboratory is responsible for ensuring that the research ideas submitted in its preproposals fit within the scope of Office-of-Science-funded programs at the national laboratory.

B. COST SHARING

Cost sharing is not required.

C. ELIGIBLE INDIVIDUALS

There is NOT a U.S. citizenship requirement for the Principal Investigator or any project participants.

Principal Investigators of early career awards from other agencies or entities are eligible, but the proposed research must have a scope different from that already funded by the other organization.

Principal Investigators who have received awards previously under the Office of Science Early Career Research Program are not eligible.

If an investigator is a current recipient of a DOE Presidential Early Career Award for Scientists and Engineers (PECASE) and is selected for an award under this DOE National Laboratory Announcement, the laboratory must forgo any remaining years of funding for the current PECASE when the new award begins.

If a Principal Investigator has multiple doctorates, the discipline of the one they have earned within the ten-year eligibility window should be relevant to the proposed research.

Letters of recommendation are not allowed. Proposals that include recommendation letters will be subject to elimination from consideration during DOE's initial review.

The Principal Investigator must be employed in the eligible position as of the closing date for this announcement.

Eligible individuals with the skills, knowledge, and resources necessary to carry out the proposed research as a Principal Investigator are invited to work with their organizations to develop a proposal. Individuals from underrepresented groups as well as individuals with disabilities are always encouraged to apply.

Section IV – PROPOSAL AND SUBMISSION INFORMATION

A. ADDRESS TO REQUEST PROPOSAL PACKAGE

Proposal submission instructions are available in this announcement on the DOE Office of Science Portfolio Analysis and Management System (PAMS). Screenshots showing the steps in DOE National Laboratory proposal submission are available in the PAMS External User Guide, accessible by navigating to https://pamspublic.science.energy.gov and clicking on the "PAMS External User Guide" link.

Proposals submitted outside of PAMS will not be accepted.

B. LETTER OF INTENT AND PRE-PROPOSAL

1. Letter of Intent

A Letter of Intent is not required.

2. Pre-proposal

PRE-PROPOSAL DUE DATE
09/10/2015, 5 PM Eastern Time

ENCOURAGE/DISCOURAGE DATE
10/08/2015, 5 PM Eastern Time

A preproposal is required and must be submitted by 09/10/2015 at 5 PM Eastern Time. The preproposal must be submitted electronically through the DOE Office of Science Portfolio Analysis and Management System (PAMS) website https://pamspublic.science.energy.gov/.

Note: Make sure you choose "View / Respond to DOE National Laboratory Announcements." Do not choose "View / Respond to Funding Opportunity Announcements." If you choose the latter, you will respond to the wrong solicitation, and your preproposal might not be considered.

While there is no limit on the number of preproposals from a DOE national laboratory in a given year, each laboratory is responsible for ensuring that the research ideas submitted in its preproposals fit within the scope of Office-of-Science-funded programs at the national laboratory.

Preproposals will be reviewed for responsiveness of the proposed work to the research topics identified in this DOE National Laboratory Announcement. DOE will send a response by email to each applicant encouraging or discouraging the submission of a full proposal by 10/08/2015. Applicants who have not received a response regarding the status of their preproposal by this date are responsible for contacting the program to confirm this status. **Only those applicants that receive notification from DOE encouraging a full proposal may submit full proposals.** No other full proposals will be considered.

The pre-proposal attachment should include, at the top of the first page, the following information:

Title of Preproposal
Principal Investigator Name, Job Title
Institution
PI Phone Number, PI Email Address
Year Doctorate Awarded: XXXX
Number of Times Previously Applied†:
DOE National Laboratory Announcement Number: **LAB 15-1386**

† Indicate how many times the PI has previously submitted a full proposal in the Office of Science Early Career Research Program. The program has been offered in six previous years, FY 2010 – FY 2015. Participation in the competition is defined as submission of a full, formal proposal. A PI who has participated in three past Office of Science Early Career Research Program competitions is not eligible.

This information should be followed by a clear and concise description of the objectives and technical approach of the proposed research. The preproposal may not exceed two pages, with a minimum text font size of 11 point and margins no smaller than one inch on all sides. Figures and references, if included, must fit within the two-page limit.

Only one preproposal per Principal Investigator is allowed.

To help the Office of Science avoid conflicts of interest in identifying potential reviewers, a one-page list of the Principal Investigator's collaborators, co-editors, and graduate/postdoctoral advisors and advisees must be submitted with the preproposal. The one-page list should be the last page in the preproposal file and will not count against the two-page limit for the pre proposal. Further guidance on how to prepare this list is included in the next two paragraphs:

Collaborators and Co-editors: List, in alphabetical order, all persons, including their current organizational affiliations, who are, or who have been, collaborators or co-authors with the Principal Investigator on a research project, book or book article, report, abstract, or paper during the 48 months preceding the closing date of this announcement. 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, list any individuals who are currently or have been in the past co-editors with the Principal Investigator on a special issue of a journal, compendium, or conference proceedings during the 24 months the closing date of this announcement. If there are no collaborators or co-editors to report, state "None."

Graduate and Postdoctoral Advisors and Advisees: List the names of the Principal Investigator's own graduate advisor(s) and principal postdoctoral sponsor(s) and their current organizational affiliations. Also list the names of the Principal Investigator's graduate students and postdoctoral associates during the past five years and their current organizational affiliations.

Since the Office of Science will never use individuals from your institution as reviewers, you may omit them from the preproposal list to save space. Listing collaborators on your preproposal is to help us identify reviewers and does not affect the decision to encourage or discourage submission of a full proposal.

Those preproposals that are encouraged are used to help the Office of Science begin planning for the full proposal peer review process. The intent of the Office of Science in discouraging submission of certain full proposals is to save the time and effort of applicants in preparing and submitting full proposals not responsive to this DOE National Laboratory Announcement.

The Principal Investigator will be automatically notified when the preproposal is encouraged or discouraged. The DOE Office of Science Portfolio Analysis and Management System (PAMS) will send an email to the Principal Investigator from PAMS.Autoreply@science.doe.gov, and the status of the preproposal will be updated at the PAMS website https://pamspublic.science.energy.gov/. Notifications are sent as soon as the decisions to encourage or discourage are finalized.

It is important that the preproposal be a single file with extension .pdf, .docx, or .doc. The preproposal must be submitted electronically through the DOE Office of Science Portfolio Analysis and Management System (PAMS) website https://pamspublic.science.energy.gov/. The Principal Investigator and anyone submitting on behalf of the Principal Investigator must register for an account in PAMS before it will be possible to submit a preproposal. All PIs and those submitting preproposals on behalf of PIs are encouraged to establish PAMS accounts as soon as possible to avoid submission delays.

To access PAMS, you may use the Internet Explorer, Firefox, Google Chrome, or Safari browsers. For best results, we recommend the use of Internet Explorer.

Registering to PAMS is a two-step process; once you create an individual account, you must associate yourself with ("register to") your institution. Detailed steps are listed below.

Create PAMS Account:

- To register, click the "Create New PAMS Account" link on the website https://pamspublic.science.energy.gov/.
- Click the "No, I have never had an account" link and then the "Create Account" button.
- You will be prompted to enter your name and email address, create a username and password, and select a security question and answer. Once you have done this, click the "Save and Continue" button.
- On the next page, enter the required information (at least one phone number and your mailing address) and any optional information you wish to provide (e.g., FAX number, website, mailstop code, additional email addresses or phone numbers, Division/Department). Click the "Create Account" button.
- Read the user agreement and click the "Accept" button to indicate that you understand your responsibilities and agree to comply with the rules of behavior for PAMS.

- PAMS will take you the "Having Trouble Logging In?" page. (Note: If you reviewed for or were listed as PI on a prior submission to the Office of Science but have not previously created an account, you may already be linked to an institution in PAMS. If this is the case, PAMS will take you to the PAMS home page.)

Register to Your Institution:

- Click the link labeled "Option 2: I know my institution and I am here to register to the institution." (Note: If you previously created a PAMS account but did not register to an institution at that time, you must click the Institutions tab and click the "Register to Institution" link.)
- PAMS will take you to the "Register to Institution" page.
- Type a word or phrase from your institution name in the field labeled, "Institution Name like," choose the radio button next to the item that best describes your role in the system, and click the "Search" button. A "like" search in PAMS returns results that contain the word or phrase you enter; you need not enter the exact name of the institution, but you should enter a word or phrase contained within the institution name. (Hint: If your institution has an acronym, such as ANL for Argonne National Laboratory or UCLA for the Regents of the University of California, Los Angeles, you may search for the acronym under "Institution Name like." Many institutions with acronyms are listed in PAMS with their acronyms in parentheses after their names.)
- Find your institution in the list that is returned by the search and click the "Actions" link in the Options column next to the institution name to obtain a dropdown list. Select "Add me to this institution" from the dropdown. PAMS will take you to the "Institutions – List" page.
- If you do not see your institution in the initial search results, you can search again by clicking the "Cancel" button, clicking the Option 2 link, and repeating the search.
- All DOE National Laboratories have established profiles in PAMS, so please keep searching until you find your laboratory.

Submit Your Pre-Proposal:

- Create your pre-proposal (called a preproposal in PAMS) outside the system and save it as a file with extension .docx, .doc, or .pdf. Make a note of the location of the file on your computer so you can browse for it later from within PAMS.
- Log into PAMS and click the Proposals tab. Click the "View / Respond to DOE National Laboratory Announcements" link and find the current announcement in the list. Click the "Actions/Views" link in the Options column next to this announcement to obtain a dropdown menu. Select "Submit Preproposal" from the dropdown. Note: Make sure you choose "View / Respond to DOE National Laboratory Announcements." Do not choose "View / Respond to Funding Opportunity Announcements." If you choose the latter, you will respond to the wrong solicitation, and your preproposal might not be considered.
- On the Submit Preproposal page, select the institution from which you are submitting this preproposal from the Institution dropdown. If you are associated with only one institution in the system, there will only be one institution in the dropdown.
- Note that you must select one and only one Principal Investigator (PI) per preproposal; to do so, click the "Select PI" button on the far right side of the screen. Find the appropriate PI from the list of all registered users from your institution returned by PAMS. (Hint: You may

have to sort, filter, or search through the list if it has multiple pages.) Click the "Actions" link in the Options column next to the appropriate PI to obtain a dropdown menu. From the dropdown, choose "Select PI."

- If the PI for whom you are submitting does not appear on the list, it means he or she has not yet registered in PAMS. For your convenience, you may have PAMS send an email invitation to the PI to register in PAMS. To do so, click the "Invite PI" link at the top left of the "Select PI" screen. You can enter an optional personal message to the PI in the "Comments" box, and it will be included in the email sent by PAMS to the PI. You must wait until the PI registers before you can submit the preproposal. Save the preproposal for later work by clicking the "Save" button at the bottom of the screen. It will be stored in "My Preproposals" for later editing.
- Enter a title for your preproposal.
- Select the appropriate technical contact from the Program Manager dropdown.
- To upload the preproposal file into PAMS, click the "Attach File" button at the far right side of the screen. Click the "Browse" (or "Choose File" depending on your browser) button to search for your file. You may enter an optional description of the file you are attaching. Click the "Upload" button to upload the file.
- At the bottom of the screen, click the "Submit to DOE" button to save and submit the preproposal to DOE.
- Upon submission, the PI will receive an email from the PAMS system <PAMS.Autoreply@science.doe.gov> acknowledging receipt of the preproposal.

You are encouraged to register for an account in PAMS at least a week in advance of the preproposal submission deadline so that there will be no delays with your submission.

For help with PAMS, click the "External User Guide" link on the PAMS website, https://pamspublic.science.energy.gov/. You may also contact the PAMS Help Desk, which can be reached Monday through Friday, 9 AM – 5:30 PM Eastern Time. Telephone: (855) 818-1846 (toll free) or (301) 903-9610, Email: sc.pams-helpdesk@science.doe.gov. All submission and inquiries about this DOE National Laboratory Announcement should reference **LAB 15-1386.**

Preproposals submitted outside PAMS will not be considered.

C. CONTENT AND PROPOSAL FORMS

PROPOSAL DUE DATE
11/19/2015, 5 PM Eastern Time

Note: PDF files attached in PAMS must be plain files consisting of text, numbers, and images without editable fields, signatures, passwords, redactions, or other advanced features available in some PDF-compatible software. Do not attach PDF portfolios.

Concurrent submission of a proposal to other organizations for simultaneous consideration will not prejudice its review. However, you can only be funded once by the federal government for a given scope of work. Thus, if both proposals are selected for funding, you will only be able to

accept one award. To avoid this situation, you can submit proposals for completely different scopes of work to the two agencies.

LETTERS

Letters of recommendation are not allowed. Proposals that include recommendation letters will be subject to elimination from consideration during DOE's initial review.

Each proposal must be accompanied by a letter from the national laboratory director to the technical point of contact confirming that the proposed research idea fits within the scope of Office-of-Science-funded programs at the national laboratory.

Optional letters of collaboration for unfunded or funded collaborations may be placed in Appendix 7 (Other Attachments). Letters of collaboration should state the intention to participate, but they should not be written as recommendation or endorsement letters, which are not allowed.

Each optional letter of collaboration may contain two and only two sentences and must use the following format:

Dear <Principal Investigator Name>:

If your proposal entitled, "<Proposal Name>," is selected for funding under the DOE Office of Science Early Career Research Program, it is my intent to collaborate in this research by <Complete Sentence With a Very Short Description of What the Collaborator Offers to Do or Provide>. Thank you for the opportunity to participate.

Sincerely,

<Collaborator's Name and Signature Block>

1. Summary of Proposal Contents and Information about PAMS

Each DOE National Laboratory proposal will contain the following sections:

- Budget, entered into PAMS as structured data using the PAMS budget form
- Abstract (one page), entered into PAMS as a separate pdf
- Budget justification, entered into PAMS as a separate pdf
- Proposal, combined into a single pdf containing the following information:
    - Proposal Cover Page
    - Project Narrative (main technical portion of the proposal, including background/introduction, proposed research and methods, timetable of activities, and responsibilities of key project personnel – 15 page limit)
    - Appendix 1: Biographical Sketch(es)
    - Appendix 2: Current and Pending Support
    - Appendix 3: Bibliography and References Cited

- Appendix 4: Facilities and Other Resources
- Appendix 5: Equipment
- Appendix 6: Data Management Plan
- Appendix 7: Other Attachments (optional)

SUBMISSION INSTRUCTIONS

Full proposals must be submitted into the DOE Office of Science Portfolio Analysis and Management System (PAMS). For help with PAMS, click the "External User Guide" link on the PAMS website, https://pamspublic.science.energy.gov/. You may also contact the PAMS Help Desk, which can be reached Monday through Friday, 9:00 AM – 5:30 PM Eastern Time. Telephone: (855) 818-1846 (toll free number) or (301) 903-9610, Email: sc.pams-helpdesk@science.doe.gov. All submissions and inquiries about this Program Announcement should reference **LAB 15-1386.** Full proposals submitted in response to this Program Announcement must be submitted to PAMS no later than 11/19/2015 at 5 PM Eastern Time.

All PIs and those submitting on behalf of PIs are encouraged to establish PAMS accounts as soon as possible to ensure timely submissions**.** To register, click "Create New PAMS Account" on the website https://pamspublic.science.energy.gov/ and follow the instructions for creating an account.

The following information is provided to help with proposal submission. Detailed instructions and screen shots can be found in the user guide. To find the user guide, click the "External User Guide" link on the PAMS home page. Onscreen instructions are available within PAMS.

- Log into PAMS. From the proposals tab, click the "View DOE National Laboratory Announcements" link and find the current announcement in the list. Click the "Actions/Views" link in the Options column next to this announcement to obtain a dropdown menu. Select "Submit Proposal" from the dropdown.
- Note that you must select one and only one Principal Investigator (PI) per proposal; to do so, click the "Select PI" button on the far right side of the screen. Find the appropriate PI from the list of all registered users from your institution returned by PAMS. (Hint: You may have to sort, filter, or search through the list if it has multiple pages.) Click the "Actions" link in the Options column next to the appropriate PI to obtain a dropdown menu. From the dropdown, choose "Select PI."
- If the PI for whom you are submitting does not appear on the list, it means he or she has not yet registered in PAMS. For your convenience, you may have PAMS send an email invitation to the PI to register in PAMS. To do so, click the "Invite PI" link at the top left of the "Select PI" screen. You can enter an optional personal message to the PI in the "Comments" box, and it will be included in the email sent by PAMS to the PI. You must wait until the PI registers before you can submit the proposal.
- New This Year: You must select one and only one Sponsored Research Official/Business Official/Administrative Official (SRO/BO/AO) per proposal; to do so, click the "Select SRO/BO/AO" button on the far right side of the screen. Find the appropriate SRO/BO/AO from the list of all registered users from your institution returned by PAMS. (Hint: You may

have to sort, filter, or search through the list if it has multiple pages.) Click the "Actions" link in the Options column next to the appropriate SRO/BO/AO to obtain a dropdown menu. From the dropdown, choose "Select SRO/BO/AO."

- If the SRO/BO/AO for whom you are submitting does not appear on the list, it means he or she has not yet registered in PAMS. For your convenience, you may have PAMS send an email invitation to the SRO/BO/AO to register in PAMS. To do so, click the "Invite SRO/BO/AO" link at the top left of the "Select SRO/BO/AO" screen. You can enter an optional personal message to the SRO/BO/AO in the "Comments" box, and it will be included in the email sent by PAMS to the SRO/BO/AO. You must wait until the SRO/BO/AO registers before you can submit the proposal.
- Save the proposal for later work by selecting "Save" from the dropdown at the bottom of the screen and then clicking the "Go" button. It will be stored in "My Proposals" for later editing. As a minimum, you must complete all the required fields on the PAMS cover page before you can save the proposal for the first time.
- The cover page, budget, and attachments sections of the lab proposal are required by PAMS before it can be submitted to DOE.
- Complete the sections in PAMS one at a time, starting with the cover page and following the instructions for each section.
- Click the "+View More" link at the top of each section to expand the onscreen instructions. On the budget section, click the "Budget Tab Instructions" link to obtain detailed guidance on completing the budget form.
- Save each section by selecting either "Save" (to stay in the same section) or "Save… and Continue to the Next Section" (to move to the next section) from the dropdown menu at the bottom of the screen, followed by clicking the "Go" button.
- If you save the proposal and navigate away from it, you may return later to edit the proposal by clicking the "View My Existing Proposals" or "My Proposals" links within PAMS.
- You must enter a budget for each annual budget period.
- You must also enter a budget for each proposed sub-award. The sub-award section can be completed using the same steps used for the budget section.
- In the attachments section of the lab proposal, the abstract, the budget justification, and the proposal narrative are required and must be submitted as separate files.
- You must bundle everything other than the budget, abstract, and budget justification into one single PDF file to be attached under "Proposal Attachment."
- Do not attach anything under "Other Attachments."
- To upload a file into PAMS, click the "Attach File" button at the far right side of the screen. Click the "Browse" (or "Choose File" depending on your browser) button to search for your file. You may enter an optional description of the file you are attaching. Click the "Upload" button to upload the file.
- Once you have saved all of the sections, the "Submit to DOE" option will appear in the dropdown menu at the bottom of the screen.
- To submit the proposal, select "Submit to DOE" from the dropdown menu and then click the "Go" button.
- Upon submission, the PI will receive an email from the PAMS system <PAMS.Autoreply@science.doe.gov> acknowledging receipt of the proposal.

- The proposal will also appear under My Proposals with a Proposal Status of "Submitted to DOE."

Please only submit a PAMS lab technical proposal in response to this announcement; do not submit a DOE Field Work Proposal (FWP) at this time. The Office of Science will request FWPs later from those selected for funding consideration under this announcement.

For help with PAMS, click the "External User Guide" link on the PAMS website, https://pamspublic.science.energy.gov/. You may also contact the PAMS Help Desk, which can be reached Monday through Friday, 9:00 AM – 5:30 PM Eastern Time. Telephone: (855) 818-1846 (toll free number) or (301) 903-9610, Email: sc.pams-helpdesk@science.doe.gov. All submissions and inquiries about this Program Announcement should reference **LAB 15-1386.**

2. Detailed Contents of the Proposal

BUDGET AND BUDGET EXPLANATION

The budget must be submitted into PAMS using the PAMS budget form. Research proposed under this announcement should have five annual budget periods. Please enter the following budget period start and end dates into PAMS for proposals submitted to this announcement:

- Budget Period 1: 8/1/2016 – 7/31/2017
- Budget Period 2: 8/1/2017 – 7/31/2018
- Budget Period 3: 8/1/2018 – 7/31/2019
- Budget Period 4: 8/1/2019 – 7/31/2020
- Budget Period 5: 8/1/2020 – 7/31/2021

PAMS will calculate the cumulative budget totals for you.

A written justification of each budget item is to follow the budget pages. The budget justification should be placed in a separate, single pdf document and attached on the appropriate screen in PAMS. Further instructions regarding the budget and justification are given below and in the PAMS software.

PROJECT SUMMARY/ABSTRACT (NO MORE THAN ONE PAGE)

The project summary/abstract must contain a summary of the proposed activity suitable for dissemination to the public. It should be a self-contained document that identifies the name of the applicant, the Principal Investigator (PI), the project title, the objectives of the project, a description of the project, including methods to be employed, the potential impact of the project (i.e., benefits, outcomes). This document must not include any proprietary or sensitive business information as the Department may make it available to the public. The project summary must not exceed 1 page when printed using standard 8.5" by 11" paper with 1" margins (top, bottom, left and right) with font not smaller than 11 point. The one-page project summary/abstract should be placed in a separate, single pdf document and attached on the appropriate screen in PAMS.

The abstract may be used to prepare publicly accessible reports about DOE-supported research.

DOE COVER PAGE
(PART OF PROJECT NARRATIVE PDF)

The following proposal cover page information may be placed on a plain page. No form is required. This cover page will not count in the project narrative page limitation.

- **Institution:**
- **Street Address/City/State/Zip:**
- **Principal Investigator (PI):**
- **Position Title of PI:**
- **Business Mailing Address of PI:**
- **Telephone Number of PI:**
- **Email of PI:**
- **DOE National Laboratory Announcement Number: LAB 15-1386**
- **DOE/Office of Science Program Office (ASCR, BER, BES, FES, HEP, or NP):**
- **Topic Area*:**
- **Topic Area Program Manager:**
- **Year Doctorate Awarded:**
- **Number of Times Previously Applied†:**
- **PAMS Preproposal Number:**
- **PECASE Eligible**: (Yes or No)?**
  Proposal Contains Data Management Plan in Appendix 6§: (Yes or No)?

* The topic area can be found in Part I, Supplementary Information, of this DOE National Laboratory Announcement. For example, the topic area might be Synthesis and Processing Science or Magnetic Fusion Energy Science Theory and Simulation. Please select from the list in Part I.

† Indicate how many times the PI has previously submitted a full proposal in the Office of Science Early Career Research Program. The program has been offered in five previous years, FY 2010 – FY 2015. Participation in the competition is defined as submission of a full, formal proposal. A PI who has participated in three past Office of Science Early Career Research Program competitions is not eligible.

** The White House Office of Science and Technology Policy may ask federal agencies each year to nominate candidates for the Presidential Early Career Awards for Scientists and Engineers (PECASE). Investigators from the top proposals in the Office of Science Early Career Research Award competition may be nominated for PECASE if they are eligible. A PI is PECASE-eligible if he or she is, as of the closing date of this DOE National Laboratory Announcement, a U.S. citizen, U.S. national or permanent resident and if she or he has not received a PECASE previously through any agency. PECASE eligibility is not required for an award under the current DOE National Laboratory Announcement.

§ The Office of Science will decline without review any proposal without a data management plan.

PROJECT NARRATIVE (NO MORE THAN 15 PAGES LONG)

The project narrative **must not exceed 15 pages** of technical information, including charts, graphs, maps, photographs, and other pictorial presentations, when printed using standard 8.5" by 11" paper with 1 inch margins (top, bottom, left, and right). The font must not be smaller than 11 point. Merit reviewers will only consider the number of pages specified in the first sentence of this paragraph.

The Project Narrative comprises the research plan for the project. 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 narrative should provide a clear, concise statement of the specific objectives/aims of the proposed project. 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.

Do not include any Internet addresses (URLs) that provide supplementary or additional information that constitutes a part of the proposal. Using Internet sites in an attempt to avoid page limits will fail: The content of those sites will not be reviewed. See Part VIII.D for instructions on how to mark proprietary proposal information.

APPENDIX 1: BIOGRAPHICAL SKETCH

Provide a biographical sketch for the Principal Investigator (PI) as an appendix to your technical narrative. As part of the sketch, provide information that can be used by reviewers to evaluate the PI's potential for leadership within the scientific community. Examples of information of interest are invited and/or public lectures, awards received, scientific program committees, conference or workshop organization, professional society activities, special international or industrial partnerships, reviewing or editorship activities, or other scientific leadership experiences. The biographical information (curriculum vitae) must not exceed 3 pages when printed on 8.5" by 11" paper with 1 inch margins (top, bottom, left, and right) with font not smaller than 11 point and must include the following:

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. An abbreviated style such as the Physical Review Letters (PRL) convention for citations (list only the first author) may be used for publications with more than 10 authors.

Synergistic Activities: List professional and scholarly activities related to the effort proposed. Some examples might be invited and/or public lectures, awards received, scientific program committees, conference or workshop organization, professional society membership and/or activities, special international or industrial partnerships, reviewing or editorship activities, or other scientific leadership experiences.

Collaborators and Co-editors: List in alphabetical order all persons, including their current organizational affiliation, who are, or who have been, collaborators or co-authors with you on a research project, book or book article, report, abstract, or paper during the 48 months preceding the submission of this 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, list any individuals who are currently, or have been, co-editors with you on a special issue of a journal, compendium, or conference proceedings during the 24 months preceding the submission of this proposal. If there are no collaborators or co-editors to report, state "None."

Graduate and Postdoctoral Advisors and Advisees: List the names and current organizational affiliations of your graduate advisor(s) and principal postdoctoral sponsor(s). Also, list the names and current organizational affiliations of your graduate students and postdoctoral associates during the past 5 years.

Personally Identifiable Information: Do not include sensitive personally identifiable information such as a Social Security Number, date of birth, or city of birth. Do not include information that a merit reviewer should not make use of.

- Do not attach a separate file.
- This appendix will not count in the project narrative page limitation.

APPENDIX 2: CURRENT AND PENDING SUPPORT

Provide a list of all current and pending support (both Federal and non-Federal) for the Principal Investigator(s) (PI) for ongoing projects and pending proposals. For each organization providing support, show the total award amount for the entire award period (including indirect costs) and the number of person-months per year to be devoted to the project by the PI. Do not list start-up funds provided to the PI by the employing academic institution. If the PI has submitted a similar research proposal to an early career program at another agency or foundation, she or he should provide a few sentences explaining the similarities and/or differences with the current Early Career Research Program proposal. Provide the Current and Pending Support as an appendix to your project narrative. Concurrent submission of a proposal to other organizations for simultaneous consideration will not prejudice its review.

- Do not attach a separate file.

- This appendix will not count in the project narrative page limitation.

APPENDIX 3: BIBLIOGRAPHY & REFERENCES CITED

Provide a bibliography of any references cited in the Project 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. For research areas where there are routinely more than ten coauthors of archival publications, you may use an abbreviated style such as the Physical Review Letters (PRL) convention for citations (listing only the first author). Include only bibliographic citations. Applicants should be especially careful to follow scholarly practices in providing citations for source materials relied upon when preparing any section of the proposal. Provide the Bibliography and References Cited information as an appendix to your project narrative.

- Do not attach a separate file.
- This appendix will not count in the project narrative page limitation.

APPENDIX 4: FACILITIES & OTHER RESOURCES

This information is used to assess the capability of the organizational resources, including subawardee resources, available to perform the effort proposed. Identify the facilities to be used (Laboratory, Animal, Computer, Office, Clinical and Other). If appropriate, indicate their capacities, pertinent capabilities, relative proximity, and extent of availability to the project. Describe only those resources that are directly applicable to the proposed work. Describe other resources available to the project (e.g., machine shop, electronic shop) and the extent to which they would be available to the project. Please provide the Facility and Other Resource information as an appendix to your project narrative.

- Do not attach a separate file.
- This appendix will not count in the project narrative page limitation.

APPENDIX 5: EQUIPMENT

List equipment already available for this project and, if appropriate, identify location and pertinent capabilities. Provide the Equipment information as an appendix to your project narrative.

- Do not attach a separate file.
- This appendix will not count in the project narrative page limitation.

APPENDIX 6: DATA MANAGEMENT PLAN

Provide a Data Management Plan (DMP) that addresses the following requirements:

1. DMPs should describe whether and how data generated in the course of the proposed research will be shared and preserved. If the plan is not to share and/or preserve certain data,

then the plan must explain the basis of the decision (for example, cost/benefit considerations, other parameters of feasibility, scientific appropriateness, or limitations discussed in #4). At a minimum, DMPs must describe how data sharing and preservation will enable validation of results, or how results could be validated if data are not shared or preserved.

2. DMPs should provide a plan for making all research data displayed in publications resulting from the proposed research open, machine-readable, and digitally accessible to the public at the time of publication. This includes data that are displayed in charts, figures, images, etc. In addition, the underlying digital research data used to generate the displayed data should be made as accessible as possible to the public in accordance with the principles stated in the Office of Science Statement on Digital Data Management (http://science.energy.gov/funding-opportunities/digital-data-management/). This requirement could be met by including the data as supplementary information to the published article, or through other means. The published article should indicate how these data can be accessed.
3. DMPs should consult and reference available information about data management resources to be used in the course of the proposed research. In particular, DMPs that explicitly or implicitly commit data management resources at a facility beyond what is conventionally made available to approved users should be accompanied by written approval from that facility. In determining the resources available for data management at Office of Science User Facilities, researchers should consult the published description of data management resources and practices at that facility and reference it in the DMP. Information about other Office of Science facilities can be found in the additional guidance from the sponsoring program.
4. DMPs must protect confidentiality, personal privacy, Personally Identifiable Information, and U.S. national, homeland, and economic security; recognize proprietary interests, business confidential information, and intellectual property rights; avoid significant negative impact on innovation, and U.S. competitiveness; and otherwise be consistent with all applicable laws, and regulations. There is no requirement to share proprietary data.
5. Applications must meet the published additional requirements of the program office to which the application is submitted, as identified on the DOE Cover Page of the application. Program office requirements will be considered during merit review and award selection. Advanced Scientific Computing Research (ASCR) and Biological and Environmental Research (BER) have published additional requirements, available through http://science.energy.gov/funding-opportunities/digital-data-management/. Applications will not be transferred between program offices.

DMPs will be reviewed as part of the overall Office of Science research proposal merit review process. Applicants are encouraged to consult the Office of Science website for further information and suggestions for how to structure a DMP: http://science.energy.gov/funding-opportunities/digital-data-management/

- Do not attach a separate file.
- This appendix will not count in the project narrative page limitation.

APPENDIX 7: OTHER ATTACHMENTS

Information not easily accessible to a reviewer may be included in this appendix, but do not use this appendix to circumvent the page limitations of the proposal. Reviewers are not required to consider information in this appendix, and reviewers may not have time to read extensive appendix materials with the same care they would use with the proposal proper. Do not include scientific publications. Although the preference of this program is to support PI-led efforts without paid collaborators, if a funded or unfunded collaboration is proposed, an optional letter of collaboration may be included in this appendix. Letters of collaboration should state the intent to participate and nothing else. They should not be written as recommendation or endorsement letters, which are not allowed. Each optional letter of collaboration may contain two and only two sentences and must use the following format:

Dear <Principal Investigator Name>:

If your proposal entitled, "<Proposal Name>," is selected for funding under the DOE Office of Science Early Career Research Program, it is my intent to collaborate in this research by <Complete Sentence With a Very Short Description of What the Collaborator Offers to Do or Provide>. Thank you for the opportunity to participate.

Sincerely,

<Collaborator's Name and Signature Block>

- Do not attach a separate file.
- This appendix will not count in the project narrative page limitation.

3. Detailed Instructions for the Budget

Budgets are required for the entire project period. A budget form should be completed for each budget period of the award, and a cumulative budget form for the entire project period will be populated by PAMS. A detailed budget justification narrative should be included after the budget pages. The justification should cover labor, domestic travel, equipment, materials and supplies, and anything else that will be covered with project funds.

To edit a section on the budget, click the edit icon () for each section on the page. Remember to save all budget periods before moving on to the next section. You can save the budget periods by selecting "Save All Budget Periods" from the dropdown on the lower right corner of the PAMS budget entry screen and then clicking the "Go" button. You can also save any data entry page in PAMS using the blue diskette icon ( ) in the floating toolbar on the bottom of the screen.

Section A. Senior/Key Person (Required)
For each Senior/Key Person, enter the appropriate information. List personnel, salary funds, and the number of months that person will be allocated to the project. Also include a written narrative in the budget justification that fully justifies the need for requested personnel.

Section B. Other Personnel
List personnel, salary funds, and the number of months that person will be allocated to the project. Also include a written narrative in the budget justification that fully justifies the need for requested personnel.

Section C. Equipment Description
For the purpose of this budget, equipment is designated as an item of property that has an acquisition cost of $5,000 or more and an expected service life of more than one year. (Note that this designation applies for proposal budgeting only and differs from the DOE definition of capital equipment.) List each item of equipment separately and justify each in the budget justification section. Allowable items ordinarily will be limited to research equipment and apparatus not already available for the conduct of the work. General-purpose office equipment, such as a personal computer, is not eligible for support unless primarily or exclusively used in the actual conduct of scientific research.

Section D. Travel
In the budget justification, list each trip's destination, dates, estimated costs including transportation and subsistence, number of staff traveling, the purpose of the travel, and how it relates to the project. Indicate whether travel cost estimates are based upon quotes from travel agencies; upon past experience of similar number of trips to similar travel destinations; or something else (describe). 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.

Section E. Participant/Trainee Support Costs:
If applicable, submit training support costs. Educational projects that intend to support trainees (precollege, college, graduate and post graduate) must list each trainee cost that includes stipend levels and amounts, cost of tuition for each trainee, cost of any travel (provide the same information as needed under the regular travel category), and costs for any related training expenses. Participant costs are those costs associated with conferences, workshops, symposia or institutes and breakout items should indicate the number of participants, cost for each participant, purpose of the conference, dates and places of meetings and any related administrative expenses. In the budget justification, indicate whether trainee cost estimates are based upon past experience of support of similar number of trainees on similar projects; past experience of support of similar number of participants attending similar conferences/workshops/symposia; or something else (describe).

Section F. Other Direct Costs:
Enter Other Direct Costs information for each item listed.

- **Materials and Supplies:** Enter total funds requested for materials and supplies in the

appropriate fields. In the budget justification, indicate general categories such as glassware, and chemicals, including an amount for each category (items not identified under "Equipment"). Categories less than $1,000 are not required to be itemized. In the budget justification, indicate whether cost estimates are based upon past experience of purchase of similar or like items; quotes/catalog prices of similar or like items; or something else (describe).

- **Publication Costs:** Enter the total publication funds requested. The proposal budget may request funds for the costs of documenting, preparing, publishing or otherwise making available to others the findings and products of the work conducted under the award. In the budget justification, include supporting information. In the budget justification, indicate whether cost estimates are based upon past experience of purchase of similar or like items; vendor quotes of similar publication services; or something else (describe).
- **Consultant Services:** Enter total funds requested for all consultant services. In the budget justification, identify each consultant, the services he/she will perform, total number of days, travel costs, and total estimated costs. In the budget justification, indicate whether consultant cost estimate is based upon previous experience/quotes for similar or like services; or something else (describe).
- **ADP/Computer Services:** Enter total funds requested for ADP/Computer Services. The cost of computer services, including computer-based retrieval of scientific, technical and education information may be requested. In the budget justification, include the established computer service rates at the proposing organization if applicable. In the budget justification, indicate whether cost estimates are based upon quotes/past experience of purchase of similar computer services; established computer service rates at the proposing institution; or something else (describe).
- **Subawards/Consortium/Contractual Costs:** Enter total costs for all subawards/consortium organizations and other contractual costs proposed for the project. In the budget justification, justify the details.
- **Equipment or Facility Rental/User Fees:** Enter total funds requested for Equipment or Facility Rental/User Fees. In the budget justification, identify each rental/user fee and justify. In the budget justification, indicate whether cost estimates are based upon past experience with similar or like items; vendor quotes of similar items; or something else (describe).
- **Alterations and Renovations:** Enter total funds requested for Alterations and Renovations.
- **In the budget justification**, itemize by category and justify the costs of alterations and renovations, including repairs, painting, removal or installation of partitions, shielding, or air conditioning. Where applicable, provide the square footage and costs.
- **Other:** Add text to describe any other Direct Costs not requested above. Enter costs associated with "Other" item(s). Use the budget justification to further itemize and justify.

Section G. Direct Costs

This represents Total Direct Costs (Sections A thru F) and will be calculated by PAMS.

Section H. Other Indirect Costs
Enter the Indirect Cost information for each field. Only four general categories of indirect costs are allowed/requested on this form, so please consolidate if needed.

Section I. Total Direct and Indirect Costs
This amount will be calculated by PAMS (Sections G + H)

D. SUBMISSIONS FROM SUCCESSFUL APPLICANTS

If selected for award, DOE reserves the right to request additional or clarifying information.

E. SUBMISSION DATES AND TIMES

1. Letter of Intent Due Date

A letter of intent is not required.

2. Pre-proposal Due Date

09/10/2015, 5 PM Eastern Time

You are encouraged to submit your preproposal well before the deadline.

3. Proposal Due Date

11/19/2015, 5 PM Eastern Time

You are encouraged to transmit your proposal well before the deadline.

Modifications to the proposal are not allowed after the proposal due date.

4. Late Submissions

Delays in submitting letters of intent, preproposals, and proposals may be unavoidable. DOE has accepted late submissions when applicants have been unable to make timely submissions because of technological disruptions, significant natural disasters, and severely incapacitating or life-threatening illnesses. Other circumstances may or may not justify late submissions. Unacceptable justifications include but are not limited to the following:

- Failure to begin submission process early enough.
- Failure to provide sufficient time to complete the process.
- Failure to understand the submission process.
- Failure to understand the deadlines for submissions.
- Failure to satisfy prerequisite registrations.
- Unavailability of administrative personnel.

The applicant is responsible for beginning the submission process in sufficient time to accommodate reasonably foreseeable incidents, contingencies, and disruptions.

Applicants must email early.career@science.doe.gov to discuss the option of a late submission in the case of unavoidable circumstances.

DOE notes that not all requests for late submission will be approved.

F. FUNDING RESTRICTIONS

Funding for all awards and future budget periods are contingent upon the availability of funds appropriated by Congress and the availability of future-year budget authority.

Support for paid collaborators of the Principal Investigator will be considered only in rare cases where a collaborator (either early career or senior) brings something unique to the project. However, preference will be given to Principal-Investigator-led efforts without paid collaborators for which the budget covers research support staff (e.g., students and postdoctoral fellows), travel, supplies, equipment, and other expenses necessary for the Principal-Investigator-led project.

Preference will be given to proposals without subawards with the exception of those that propose small subawards for essential supporting work such as sample analysis. Subawards that pay salary for scientific collaborators outside the proposing institution are discouraged.

Execution of the annual funding is solely at the discretion of the principal investigator in accordance with the DOE-approved budget.

G. OTHER SUBMISSION AND REGISTRATION REQUIREMENTS

1. Where to Submit

Proposals must be submitted through PAMS to be considered for award.

Please only submit a PAMS lab technical proposal in response to this announcement; do not submit a DOE Field Work Proposal (FWP) at this time. The Office of Science will request FWPs via the Searchable FWP system later from those selected for funding consideration under this announcement.

2. Registration Process

ONE-TIME REGISTRATION PROCESS

DOE Office of Science Portfolio Analysis and Management System (PAMS)

The DOE Office of Science performs many functions for DOE national laboratory proposals in the Portfolio Analysis and Management System (PAMS), which is available at https://pamspublic.science.energy.gov.

There are many activities that you can perform in PAMS, and more functionality will be added throughout the near future. DOE national laboratories will submit preproposals, letters of intent, and proposals directly into PAMS.

You must register in PAMS to submit a preproposal, letter of intent, or DOE national laboratory proposal.

To access PAMS, you may use the Internet Explorer, Firefox, Google Chrome, or Safari browsers. For best results, we recommend using Internet Explorer.

Notifications sent from the PAMS system will come from the PAMS email address <PAMS.Autoreply@science.doe.gov>. Please make sure your email server/software allows delivery of emails from the PAMS email address to yours.

Registering to PAMS is a two-step process; once you create an individual account, you must associate yourself with ("register to") your institution. Detailed steps are listed below.

1. CREATE PAMS ACCOUNT:

To register, click the "Create New PAMS Account" link on the website https://pamspublic.science.energy.gov/.

- Click the "No, I have never had an account" link and then the "Create Account" button.
- You will be prompted to enter your name and email address, create a username and password, and select a security question and answer. Once you have done this, click the "Save and Continue" button.
- On the next page, enter the required information (at least one phone number and your mailing address) and any optional information you wish to provide (e.g., FAX number, website, mailstop code, additional email addresses or phone numbers, Division/Department). Click the "Create Account" button.
- Read the user agreement and click the "Accept" button to indicate that you understand your responsibilities and agree to comply with the rules of behavior for PAMS.
- PAMS will take you the "Having Trouble Logging In?" page. (Note: If you reviewed for or were listed as PI on a prior submission to the Office of Science but have not previously created an account, you may already be linked to an institution in PAMS. If this is the case, PAMS will take you to the PAMS home page.)

2. REGISTER TO YOUR INSTITUTION:

- Click the link labeled "Option 2: I know my institution and I am here to register to the institution." (Note: If you previously created a PAMS account but did not register to an

institution at that time, you must click the Institutions tab and click the "Register to Institution" link.)

- PAMS will take you to the "Register to Institution" page.
- Type a word or phrase from your institution name in the field labeled, "Institution Name like," choose the radio button next to the item that best describes your role in the system, and click the "Search" button. A "like" search in PAMS returns results that contain the word or phrase you enter; you need not enter the exact name of the institution, but you should enter a word or phrase contained within the institution name. (Hint: If your institution has an acronym, such as ANL for Argonne National Laboratory or UCLA for the Regents of the University of California, Los Angeles, you may search for the acronym under "Institution Name like." Many institutions with acronyms are listed in PAMS with their acronyms in parentheses after their names.)
- Find your institution in the list that is returned by the search and click the "Actions" link in the Options column next to the institution name to obtain a dropdown list. Select "Add me to this institution" from the dropdown. PAMS will take you to the "Institutions – List" page.
- If you do not see your institution in the initial search results, you can search again by clicking the "Cancel" button, clicking the Option 2 link, and repeating the search.
- All DOE National Laboratories have established profiles in PAMS, so please keep searching until you find your laboratory.

3. Proposal Receipt Notices

Upon submission, the PI will receive an email from the PAMS system <PAMS.Autoreply@science.doe.gov> acknowledging receipt of the proposal.

4. Viewing Submitted Proposals

Upon submission, the proposal will appear under My Proposals for the PI and the Submitter with a Proposal Status of "Submitted to DOE."

Section V - PROPOSAL REVIEW INFORMATION

A. CRITERIA

1. Initial Review Criteria

Prior to a comprehensive merit evaluation, DOE will perform an initial review to determine that (1) the applicant is eligible for the award; (2) the information required by the DOE National Laboratory Announcement has been submitted; (3) all mandatory requirements are satisfied, , including attachment of a data management plan; (4) the proposed project is responsive to the objectives of the DOE National Laboratory Announcement, and (5) the proposed project is not duplicative of programmatic work. Proposals that fail to pass the initial review will not be forwarded for merit review and will be eliminated from further consideration.

2. Merit Review Criteria

Proposals will be subjected to scientific merit review (peer review) and will be evaluated against the following criteria, 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; and
4. Reasonableness and Appropriateness of the Proposed Budget.

The following announcement-specific evaluation criteria will also be used during the scientific merit review (peer review):

5. Relevance to the mission of the specific program (e.g., ASCR, BER, BES, FES, HEP, or NP) to which the proposal is submitted.
6. Potential for leadership within the scientific community.

The evaluation process will include program policy factors such as the relevance of the proposed research to the terms of the DOE National Laboratory 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.

The following questions will be posed to reviewers for each of the review criteria listed above:

1. Scientific and/or Technical Merit of the Project
What is the scientific innovation of proposed research? How does the proposed research compare with other research in its field, both in terms of scientific and/or technical merit and originality? How might the results of the proposed research impact the direction, progress, and thinking in relevant scientific fields of research? What is the likelihood of achieving influential

results? Is the Data Management Plan suitable for the proposed research and to what extent does it support the validation of research results?

2. Appropriateness of the Proposed Method or Approach
Does the proposed research employ innovative concepts or methods? How logical and feasible are the research approaches? Are the conceptual framework, methods, and analyses well justified, adequately developed, and likely to lead to scientifically valid conclusions? Does the applicant recognize significant potential problems and consider alternative strategies?

3. Competency of Applicant's Personnel and Adequacy of Proposed Resources
Does the proposed work take advantage of unique facilities and capabilities? What are the past performance and potential of the Principal Investigator (PI)? How well qualified is the research team to carry out the proposed research? Are the research environment and facilities adequate for performing the research?

4. Reasonableness and Appropriateness of the Proposed Budget
Are the proposed budget and staffing levels adequate to carry out the proposed research? Is the budget reasonable and appropriate for the scope?

5. Relevance to the mission of the specific program (e.g., ASCR, BER, BES, FES, HEP, or NP) to which the proposal is submitted
How does the proposed research contribute to the mission of the program in which the proposal is being evaluated?

6. Potential for leadership within the scientific community
Scientific leadership can be defined very broadly and can include direct research contributions. How has the PI demonstrated the potential for scientific leadership and creative vision? How has the PI been recognized as a leader?

For criterion 5, the missions of the program areas are:

Advanced Scientific Computing Research (ASCR): To advance applied mathematics and computer science; deliver the most advanced computational scientific applications in partnership with disciplinary science; advance computing and networking capabilities; and develop future generations of computing hardware and tools for science, in partnership with the research community, including U.S. industry. The strategy to accomplish this has two thrusts: developing and maintaining world-class computing and network facilities for science; and advancing research in applied mathematics, computer science, and advanced networking.

Biological and Environmental Research (BER): To support fundamental research and scientific user facilities to achieve a predictive understanding of complex biological, climatic, and environmental systems for a secure and sustainable energy future.

Basic Energy Sciences (BES): To support fundamental research to understand, predict, and ultimately control matter and energy at the electronic, atomic, and molecular levels in order to provide the foundations for new energy technologies and to support DOE missions in energy, environment, and national security.

Fusion Energy Sciences (FES): To expand the fundamental understanding of matter at very high temperatures and densities and to build the scientific foundation needed to develop a fusion energy source. This is accomplished through the study of plasma, the fourth state of matter, and how it interacts with its surroundings.

High Energy Physics (HEP): To understand how the universe works at its most fundamental level by discovering the elementary constituents of matter and energy, probing the interactions between them, and exploring the basic nature of space and time.

Nuclear Physics (NP): To discover, explore, and understand all forms of nuclear matter. Although the fundamental particles that compose nuclear matter—quarks and gluons—are themselves relatively well understood, exactly how they interact and combine to form the different types of matter observed in the universe today and during its evolution remains largely unknown.

In addition to providing narrative comments associated with each of the six merit review criteria, each reviewer will be asked to provide an overall integer numerical rating between 1 and 6 for each proposal, where the scale follows:
Strongly Encourage Funding (5 or 6);
Encourage Funding (3 or 4); or
Discourage Funding (1 or 2).

B. REVIEW AND SELECTION PROCESS

1. Merit Review

Proposals that pass the initial review will be subjected to a formal merit review and will be evaluated based on the criteria above.

2. Selection

The Selection Official will consider the merit review recommendations, program policy factors, programmatic priorities, and the amount of funding available.

If a principal investigator is a current recipient of a DOE Presidential Early Career Award for Scientists and Engineers (PECASE) and is selected for an award under this DOE National Laboratory Announcement, the institution must forgo any remaining years of funding for the current PECASE when the new award begins.

3. Discussions and Award

The Government may enter into discussions with a selected applicant for any reason deemed necessary. Failure to resolve satisfactorily the issues identified by the Government will preclude award to the applicant.

C. ANTICIPATED NOTICE OF SELECTION AND AWARD DATES

DOE is striving to make **selections under this program within 6 months**. The time interval begins on the date proposals are due. **Awards are expected to be made in Fiscal Year 2016**.

Section VI - AWARD ADMINISTRATION INFORMATION

Office of Science Early Career Research Program investigators intending to transfer to a new institution must submit a request for transfer along with a new proposal. If the scope of work has not changed, the award can be transferred. If the scope of work has changed, the new proposal will be subject to merit review as described below. Transfer awards will be for the remaining award period only, and the requested budget cannot exceed the remaining budget for the original award. If a laboratory employee transfers to a university, the requested budget should be as close to $150,000 per year as possible for each remaining year. While a transfer proposal can be submitted any time of the year, it should be submitted at least six months before the transfer to allow time for execution of merit review. To transfer an award to an academic institution, the investigator must move into a tenure-track or tenured position at the academic institution. To transfer an award to a DOE National Laboratory, the investigator must move into a full-time, permanent, non-postdoctoral national laboratory position.

To retain an award at a DOE National Laboratory, the investigator must remain in a full-time, permanent, non-postdoctoral national laboratory position.

Execution of the annual funding is solely at the discretion of the principal investigator in accordance with the DOE-approved budget.

The award period is five years, conditional on adequate annual progress and appropriation of funds. At the end of this period, the DOE national laboratory employing the principal investigator has the primary responsibility to address funding transition issues that arise when the award ends.

A minimum of 50% and up to 100% of the Principal Investigator's salary must be charged to the award annually.

A. AWARD NOTICES

1. Notice of Selection

Selected Applicants Notification: DOE will notify applicants selected for award. This notice of selection is not an authorization to begin performance.

Non-selected Notification: Organizations whose proposals have not been selected will be advised as promptly as possible. This notice will explain why the proposal was not selected.

2. Notice of Award

A work authorization/contract modification issued by the contracting officer is the authorizing award document.

B. REPORTING

Annual progress reports and a final technical report from the award investigator will be required.

Annual progress reports will be due 90 days before the end of each budget year.

A final technical report will be required 90 days after the award ends.

Section VII - QUESTIONS/AGENCY CONTACTS

A. QUESTIONS

For help with PAMS, click the "External User Guide" link on the PAMS website, https://pamspublic.science.energy.gov/. You may also contact the PAMS Help Desk, which can be reached Monday through Friday, 9AM – 5:30 PM Eastern Time. Telephone: (855) 818-1846 (toll free) or (301) 903-9610, Email: sc.pams-helpdesk@science.doe.gov. All submission and inquiries about this DOE National Laboratory Announcement should reference **LAB 15-1386.**

Please contact the PAMS help desk for technological issues with the PAMS system.

Questions regarding the specific program areas and technical requirements may be directed to the technical contacts listed for each program within the DOE National Laboratory Announcement or below.

Please contact the program staff with all questions not directly related to the PAMS system.

B. AGENCY CONTACTS

PAMS Customer Support	855-818-1846 (toll-free) 301-903-9610 sc.pams-helpdesk@science.doe.gov
Administrative Contact	Questions about program rules should be sent to early.career@science.doe.gov.
Program Manager Scientific Contact	Questions regarding the specific program areas/technical requirements can be directed to the program managers listed for each program within the DOE National Laboratory Announcement.

Section VIII - OTHER INFORMATION

A. MODIFICATIONS

Notices of any modifications to this DOE National Laboratory Announcement will be posted on the Grants and Contracts website (http://science.doe.gov/grants/).

B. GOVERNMENT RIGHT TO REJECT OR NEGOTIATE

DOE reserves the right, without qualification, to reject any or all proposals received in response to this DOE National Laboratory Announcement and to select any proposal, in whole or in part, as a basis for negotiation and/or award.

C. COMMITMENT OF PUBLIC FUNDS

The Contracting Officer is the only individual who can make awards or commit the Government to the expenditure of public funds. A commitment by other than the Contracting Officer, either explicit or implied, is invalid.

D. PROPRIETARY PROPOSAL INFORMATION

Patentable ideas, trade secrets, proprietary or confidential commercial or financial information, disclosure of which may harm the applicant, should be included in a proposal only when such information is necessary to convey an understanding of the proposed project. The use and disclosure of such data may be restricted, provided the applicant includes the following legend on the first page of the project narrative and specifies the pages of the proposal which are to be restricted:

"The data contained in pages _____ of this proposal have been submitted in confidence and contain trade secrets or proprietary information, and such data shall be used or disclosed only for evaluation purposes."

To protect such data, each line or paragraph on the pages containing such data must be specifically identified and marked with a legend similar to the following:

"The following contains proprietary information that (name of applicant) requests not be released to persons outside the Government, except for purposes of review and evaluation."

E. EVALUATION AND ADMINISTRATION BY NON-FEDERAL PERSONNEL

In conducting the merit review evaluation, the Government may seek the advice of qualified non-Federal personnel as reviewers. The Government may also use non-Federal personnel to conduct routine, nondiscretionary administrative activities. The applicant, by submitting its application, consents to the use of non-Federal reviewers/administrators. Non-Federal reviewers must sign conflict of interest agreements prior to reviewing a proposal. Non-Federal personnel conducting administrative activities must sign a non-disclosure agreement.

F. AVAILABILITY OF FUNDS

Funds are not presently available for this award. The Government's obligation under this award is contingent upon the availability of appropriated funds from which payment for award purposes can be made. No legal liability on the part of the Government for any payment may arise until funds are made available to the Contracting Officer for this award and until the awardee receives notice of such availability, to be confirmed in writing by the Contracting Officer.