

**DEPARTMENT OF ENERGY
OFFICE OF SCIENCE
ADVANCED SCIENTIFIC COMPUTING RESEARCH**



**ACCELERATED RESEARCH IN QUANTUM COMPUTING
(ARQC)**

**DOE NATIONAL LABORATORY PROGRAM ANNOUNCEMENT NUMBER:
LAB 19-2081**

ANNOUNCEMENT TYPE: INITIAL

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Pre-Proposal Response Date:	Not Applicable
Submission Deadline for Proposals:	05/31/2019 at 5 PM Eastern Time

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REGISTRATIONS

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

The Department of Energy (DOE) Office of Science (SC) 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>.

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

To access PAMS, you may use the Internet Explorer, Firefox, Google Chrome, or Safari browsers.

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 SC 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.

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 submissions and inquiries about this DOE National Laboratory Announcement should reference **LAB 19-2081**.

UPDATES AND REMINDERS

RECOMMENDATION

The DOE SC encourages you to register in all systems as soon as possible. You are also encouraged to submit letters of intent and proposals well before the deadline.

DATA MANAGEMENT PLAN

The SC Statement on Digital Data Management, published at <http://science.energy.gov/funding-opportunities/digital-data-management/>, governs proposals submitted under this Announcement. Compliance is detailed in Section IV of this Announcement.

ACKNOWLEDGMENT OF FEDERAL SUPPORT

SC published guidance about how its support should be acknowledged at <http://science.energy.gov/funding-opportunities/acknowledgements/>.

AVOIDING ERRORS

The following advice is compiled from actual experiences of applicants for SC awards.

- Please ensure that the research narrative is comprised of one and only one Portable Document Format (PDF) file, including all appendices, when it is uploaded.
- When using the PAMS website at <https://pamspublic.science.energy.gov>, please avoid using the back-arrow button in your web browser to navigate.
- Please ensure that the proposal contains no personally identifiable information (PII).
- Please ensure that the budget is calculated using the applicable negotiated indirect cost and fringe benefit rates.

Section I – DOE NATIONAL LABORATORY OPPORTUNITY DESCRIPTION

GENERAL INQUIRIES ABOUT THIS ANNOUNCEMENT SHOULD BE DIRECTED TO:

Technical/Scientific Program Contacts:

Dr. Ceren Susut
301-903-0366
Ceren.Susut-Bennett@science.doe.gov

SUMMARY

The DOE SC program in Advanced Scientific Computing Research (ASCR) hereby announces its interest in receiving proposals, from large multi-disciplinary teams (requesting support of more than \$2 million per year) with the potential to dramatically accelerate research in quantum computing (QC).

Submitted proposals must follow the guidelines and criteria provided in the supplementary information below and the following sections. Letters of Intent (LOIs) are required and must be submitted according to the guidelines in the following sections. No responses will be sent to the LOIs. Proposals submitted on behalf of investigators that did not submit an LOI; proposals that do not follow the guidelines and criteria established below; or proposals requesting support for out-of-scope topics, may be declined without merit review.

SUPPLEMENTARY INFORMATION

BACKGROUND

The ASCR mission is to discover, develop, and deploy computational and networking capabilities to analyze, model, simulate and predict complex phenomena important to the DOE and the advancement of science. A major objective of the ASCR basic research portfolio is to enable DOE-mission science proposals to take full advantage of the current, emerging and future high-end computing systems.

In the rapidly evolving field of Beyond Moore's Law computing, quantum computing emerged as one of the most promising computing technologies in recent years. Since early 2014, ASCR has been engaging a broad community, through a series of roundtable discussions and workshops, to assess the viability of quantum computing technologies to meet the computational requirements of DOE-supported research for the public's benefit. [1], Other workshops and roundtable discussions sought to evaluate how a quantum testbed might facilitate the advancement of quantum computing for science applications [2] and to identify research challenges and opportunities in the development and deployment of quantum networks [3].

In FY 2017, ASCR pioneered SC's investments in quantum information science (QIS) with two new initiatives: Quantum Algorithm Teams (QATs) that stimulate early investigations of

quantum simulation and quantum machine learning algorithms by focusing on research topics with relevance to problems of interest to SC and Quantum Testbed Pathfinder projects that advance quantum computing hardware optimized for applications relevant to DOE's science and energy mission.

In FY 2018, ASCR expanded its QIS efforts by additional investments in Quantum Testbed Pathfinder program and by starting 2 new efforts: multi-disciplinary Quantum Computing Application Teams (QCATs) with expanded concentrations on algorithms, software stack and verification and validation methods and Quantum Testbeds for Science that provide external researchers to novel, early-stage quantum computing resources not available through other means.

A worldwide effort is underway to build practical quantum information processing devices and characterizing and exploiting the full range of capabilities of these devices carries an enormous practical significance and relevance to quantum physics, chemistry, biology and beyond. Much progress has been made, in recent years, in the development of quantum algorithms, programming languages and software tools but the need to address basic research knowledge gaps persists as recognized by The National Quantum Initiative Act [4], signed into law on December 21st, 2018.

ARQC TEAMS

Goals and Research Objectives

ARQC Teams are invited to submit proposals for the development, support, complementing, or deployment of the following objectives:

- Basic research foundations in quantum algorithms and in quantum computer science. It is expected that the proposed teams will be structured around these two main topics and will describe processes by which the results, capabilities and resources of the QATs and QCATs will be incorporated into a robust core basic research agenda.
- Mechanisms for taking on cross-cutting algorithmic and computer science challenges across quantum computing topics for DOE and SC relevant application-specific research.
- Tools and resources to facilitate the use of diverse hardware technologies and architectures.
- Mechanisms for providing a bridge between QIS and classical applied mathematics and computer science communities.
- Plans for engaging and interacting with (as appropriate) the DOE-supported QIS community.

While prototype quantum computing systems currently exist and the qubits that they support are scaling up; the hardware technologies and the proposed architectures vary and the applications that these early systems are useful for are limited. On the other hand, the potential of future QC platforms for tackling major challenges including a number of SC designated grand challenges (including, but not limited to, those described at <https://science.energy.gov/bes/efrc/research/grand-challenges/>) led to considerable progress in algorithm and software tools development. Many of these algorithms and tools remain application and architecture-specific.

As the prototype systems become more robust, the algorithms that could only be analyzed theoretically become mappable onto real hardware. The tight coupling between the research on QC algorithms and the research on software tools will be crucial to ensure the efficiency of the software tools in implementing the algorithms. Moreover, the application and architecture specificities that may currently offer an advantage to the algorithms and tools in terms of proving their usefulness will become constraints in exploring the true potential of QC for science. As described below, while the proposed work of each ARQC Team is expected to be architecture and application-aware, it is not expected to be architecture and application-specific.

Architecture-aware: The QC architectures and the underlying hardware technologies are expected to remain diverse in the foreseeable future. It is also expected for quantum computers to intimately interface with classical computers. Specifically hybrid approaches will be needed to overcome the main limitations of early architectures such as noise. In the absence of robust fault tolerance, approximate and probabilistic computing paradigms on classical machines will need to be adopted to use these early architectures. It is important for ARQC Teams to stay aware of these and other emerging architecture trends and include the breadth and depth of knowledge, expertise, tools and resources to address algorithm and computer science research challenges associated with architectures from noisy intermediate scale quantum (NISQ) machines to hybrid classical-quantum technologies.

Application-aware: SC has made significant investments in QIS in recent years. It is important for the ARQC Teams to be aware of these projects and their algorithm and software needs. More information on the SC-funded QIS projects can be found here: <https://www.ornl.gov/qispi2018/abstract.htm>.

Additionally recent SC-sponsored workshops identified a number of grand challenge problems with relevance to DOE and SC missions, which can be tackled by quantum computing and quantum simulations [1-3, 5-9]. It is also important for the ARQC Teams to stay aware of these grand challenge problems and for their proposed work to stay relevant to tackle these challenges.

ARQC Teams will take a broader view of quantum computer science and quantum algorithms and devise overarching research strategies that are not constrained by a specific application or a specific architecture. On the other hand, the proposed Teams will be equipped with tools, resources and capabilities that will facilitate potential interactions with other SC-funded QIS projects. For this purpose, the proposers may identify groups of researchers (also see section for Primary Topic Area Lead(s) under Management Structure), within the proposed ARQC Teams, who will focus their efforts on cross-cutting issues across closely related application areas (e.g. chemistry-materials, field theories, etc.).

ARQC TEAMS AND COMMUNITY RELATIONSHIPS

ASCR QIS Community: ARQC Teams will embody a wide array of expertise, resources, capabilities and tools across disciplines including applied mathematics, computer science, physics, etc. to 1) support a robust ASCR QIS core basic research program, 2) make a meaningful impact proposal-specific QIS research within the DOE and SC mission-space, 3)

facilitate the use of diverse hardware and architectures and, 4) effectively engage with different communities. To achieve these goals, the proposed Teams are expected to be comprised of QIS experts who were not traditionally supported by ASCR along with applied mathematicians and computer scientists who may have a record of funding from ASCR but not necessarily with expertise in QIS. It is therefore essential for ARQC Teams to have a well-defined approach to create effective synergies among team members who represent starkly different communities unaccustomed to working together.

ASCR expects that two ARQC Teams working in close coordination will be needed to explore this promising area. Representative examples include, but are not limited to:

ARQC-Algorithms: Basic research into quantum algorithms for analog and digital QC including: Novel approaches, understanding, methods and tools that enable the development and improvement of algorithms that work on diverse architectures. Basic research into classical algorithms that work in tandem with quantum algorithms or simulate quantum computers. Mechanisms for leveraging algorithms basic research to impact application-specific QIS research.

ARQC-Computer Science: Basic research into the implementation and optimization of programming, mapping and resource management for a variety of QC systems from NISQ machines to hybrid classical-quantum technologies including: Development and improvement of high-level programming languages, compilers coupled with simulation tools, debuggers, libraries and I/O tools; novel approaches for algorithm resource and precision analysis; robust verification and validation methods; efficient communication between quantum and classical processing. Basic research into the interplay among the layers of the QC toolchain. Mechanisms for leveraging computer science basic research to impact application-specific QIS research.

Active collaboration between the ARQC Teams is essential for the success of the ARQC program. Consequently, a proposed Team must not only make a compelling case for its own intrinsic capabilities, but also describe processes for effectively leveraging expertise and results from the other potential Team. ARQC Teams are expected to collaborate and coordinate their activities with QATs and QCATs [10]. Applicants must clearly describe the processes that they will use to incorporate the results, capabilities and resources of these projects.

Where appropriate, ARQC Teams are also encouraged to collaborate and coordinate their activities with the ASCR Quantum Testbeds and the SC QIS Centers that are expected to be funded in the upcoming years. More information about these Centers can be found in The National Quantum Initiative Act [4].

ADMINISTERING AN ARQC TEAM

Management Structure: The applicants must identify a management structure that enables effective collaboration among the participants from various disciplines. The structure and management must be sufficiently flexible to adapt quickly to changing technical challenges and scientific needs. The ARQC Team management plan must use appropriate metrics and a timeline

to measure technical progress and contributions over the course of the project, and outline a risk mitigation strategy. The plan must also describe the communication and coordination processes among different parts of the Team, with the other ARQC Team(s), QATs and QCATs as well as the Team's strategy for outreach and impact to the SC-funded QIS projects. To underpin the plan, the proposed Teams may choose to identify points of contacts assigned to work with the other ARQC Team(s), QATs and QCATs and groups of researchers who will focus their efforts on cross-cutting QC issues across closely related application areas of strategic importance to DOE/SC. Additionally, each ARQC Team must identify a Team Director, a Deputy Team Director, Leads for Primary Topic Areas, Principal Investigator [PI(s)], and Senior/Key Personnel. Typical duties, responsibilities and authorities for the participants are provided below. These are collectively referred to as Team Members:

- **Team Director:** The ARQC Team Director will be the Lead PI and must be employed by the Lead Institution. The ARQC Team Director will serve as the primary contact responsible for communications with the DOE Program Manager on behalf of all of the PI's in the Team.
- **Deputy Team Director:** The Deputy Team Director will assist the Team Director in leading the project and will serve as the secondary contact for the DOE program management.
- **Leads for Primary Topic Areas:** The leads for Primary Topic Areas will be responsible of leading and coordinating the members, research and technologies under their topic areas. These Primary Topic Areas may include cross-cutting QC issues across closely related application areas of strategic importance to DOE/SC. The Leads will also work together to build synergies and merged capabilities (as applicable) among the topic areas and to avoid duplicative work.
- **PI:** A PI is the individual designated by the research organization and empowered with the appropriate level of authority and responsibility for the proper conduct of the research within that organization. These authorities and responsibilities include the appropriate use of funds and administrative requirements such as the submission of scientific progress reports to DOE. When an organization designates more than one PI, it identifies them as individuals who share the authority and responsibility for leading and directing the research, intellectually and logistically.
- **Senior/Key Personnel (as many as needed):** A senior/key person is an individual who contributes in a substantive, measurable way to the scientific/technical development or execution of the project. This definition includes, but is not limited to, the ARQC Team Director, the Deputy Team Director, the Leads for Primary Topic Areas and the PI's.

The Letter of Intent must include a table listing all personnel and their collaborators as described below (Section IV – PROPOSAL AND SUBMISSION INFORMATION). The proposal must include, in addition, tables of the institutional and primary topic area budgets as described in Section IV.

PI Meeting: The selected awardees may be asked to attend periodic PI meetings and participate in coordination activities with other ASCR or SC-funded QIS projects. Applicants should anticipate a need for travel to effectively communicate with other QIS researchers and request appropriate funding in their budgets.

Out-of-Scope Topics: Proposals dedicated to the following items will be considered nonresponsive and may be declined without merit review:

- Basic research within the mission space of other SC programs,
- Research and/or technology R&D funded by other ASCR sub programs or any research scope that is duplicative of active SC awards,
- Research geared towards a specific science problem or a specific architecture,
- Research and engineering for devices, hardware and architecture,
- Research targeting quantum annealers with little relevance to other QC technologies,
- Research for quantum communication, networking, and key distribution,
- Research for cryptography and cryptanalysis.

Open Science: SC is dedicated to promoting the values of openness in Federally-supported scientific research, including, but not limited to, ensuring that research may be reproduced and that the results of Federally-supported research are made available to other researchers. These objectives may be met through any number of mechanisms including, but not limited to, data access plans, data sharing agreements, the use of archives and repositories, and the use of various licensing schemes.

Collaboration: Collaborative proposals submitted from different institutions must clearly indicate they are part of a collaborative project/group. Every partner institution must submit an proposal through its own sponsored research office. Each collaborative group can have only one lead institution. Each proposal within the collaborative group, including the narrative and all required appendices and attachments, must be identical with the following exceptions:

- Each proposal must contain a correct cover page for the submitting institution only.
- Each proposal must contain a unique budget corresponding to the expenditures for that proposal's submitting institution only.
- Each proposal must contain a unique budget justification corresponding to the expenditures for that proposal's submitting institution only.

SC's intent is to create from the various proposals associated with a collaborative group one document for merit review that consists of the common, identical proposal materials combined with a set of detailed budgets from the partner institutions. Thus, it is very important that every proposal in the collaborative group be identical (including the title) with the exception of the budget and budget justification pages.

Collaborative proposals from institutions other than DOE National Laboratories should be submitted following the above rules in response to the companion announcement, DE-FOA-0002081. Each proposal within the collaborative group submitted in response to a Laboratory Announcement and its companion FOA, including the narrative and all required appendices and attachments, must be identical with the following exceptions:

- Each proposal must contain a correct SF-424 (R&R) cover page for the submitting institution only.
- Each proposal must contain a unique budget corresponding to the expenditures for that proposal's submitting institution only.

- Each proposal must contain a unique budget justification corresponding to the expenditures for that proposal's submitting institution only.

REFERENCES:

- [1] "Quantum Computing for Science", February 2015.
<http://science.energy.gov/~media/ascr/pdf/programdocuments/docs/ASCRQuantumReport-final.pdf>
- [2] "Quantum Testbeds Stakeholder Workshop", February 2017.
<https://science.energy.gov/~media/ascr/pdf/programdocuments/docs/2017/QTSWReport.pdf>
- [3] "Quantum Networks for Open Science Workshop", September 2018.
- [4] "The National Quantum Initiative Act".
<https://www.congress.gov/bill/115th-congress/house-bill/6227>
- [5] "Grand Challenges at the Interface of QIS, Particle Physics and Computing", December 2014.
https://science.energy.gov/~media/hep/pdf/files/Banner%20PDFs/QIS_Study_Group_Report.pdf
- [6] "Opportunities for Quantum Computing in Chemical and Materials Sciences", October-November 2017.
https://science.energy.gov/~media/bes/pdf/reports/2018/Quantum_computing.pdf
- [7] "Opportunities For Basic Research For Next-Generation Quantum Systems" October 2017.
https://science.energy.gov/~media/bes/pdf/reports/2018/Quantum_systems.pdf
- [8] "Quantum Computing for Theoretical Nuclear Physics", November 2017.
http://www.int.washington.edu/PROGRAMS/17-66W/QuantumComputing_NUCLEARPHYSICS_FINAL_pdf.pdf
- [9] "Fusion Energy Sciences Roundtable on Quantum Information Science", May 2018.
https://science.energy.gov/~media/fes/pdf/workshop-reports/FES-QIS_report_final-2018-Sept14.pdf
- [10] QAT and QCAT project websites:
<https://qat4chem.lbl.gov/>
<https://hdaqds.ornl.gov>
<https://qoalas.sandia.gov/>
- [11] "National Strategic Overview for Quantum Information Science".
<https://www.whitehouse.gov/wp-content/uploads/2018/09/National-Strategic-Overview-for-Quantum-Information-Science.pdf>

Section II – AWARD INFORMATION

A. TYPE OF AWARD INSTRUMENT

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

Any awards made under this Announcement will be subject to the provisions of the contract between DOE and the awardee National Laboratory.

DOE will consider funding multi-institution collaborations under this Announcement.

B. ESTIMATED FUNDING

DOE anticipates that the total value of authorizations made under this Program Announcement will be between \$35 and \$25 million. DOE expects that, subject to the availability of future year appropriation, between \$5 and \$15 million will be used to support cooperative agreements under the companion FOA.

DOE is under no obligation to pay for any costs associated with the preparation or submission of a proposal. DOE reserves the right to fund, in whole or in part, any, all, or none of the proposals submitted in response to this DOE National Laboratory Announcement.

The total budget of a collaboration may not be lower than \$2,000,000 per year or higher than \$5,000,000 per year. A proposed collaboration with a total budget outside these limits may be declined without merit review.

C. MAXIMUM AND MINIMUM AWARD SIZE

(See B. Estimated Funding section above.)

The award size will depend on the availability of appropriated funds.

Ceiling

\$2,500,000 per year

Floor

\$250,000 per year

D. EXPECTED NUMBER OF AWARDS

(See B. Estimated Funding above.)

Approximately 2 to 3 collaborations are expected to be funded, with the number of collaborating

institutions depending on the nature of the proposed collaborations.

The exact number of awards will depend on the number of meritorious proposals and the availability of appropriated funds.

E. ANTICIPATED AWARD SIZE

(See B. Estimated Funding above.)

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

F. PERIOD OF PERFORMANCE

(See B. Estimated Funding above.)

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

Continuation funding (funding for the second and subsequent budget periods) is contingent on: (1) availability of funds appropriated by Congress and future year budget authority; (2) progress towards meeting the objectives of the approved proposal; (3) submission of required reports; and (4) compliance with the terms and conditions of the award.

G. TYPE OF PROPOSAL

DOE will accept only 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. SC will request FWPs later from those selected for funding consideration under this Announcement.

Section III – ELIGIBILITY INFORMATION

A. ELIGIBLE APPLICANTS AND TOPICS

This is a DOE National Laboratory-only Announcement. FFRDCs from other Federal agencies are not eligible to submit in response to this Program Announcement.

B. COST SHARING

Cost sharing is not required.

C. ELIGIBLE INDIVIDUALS

Eligible individuals with the skills, knowledge, and resources necessary to carry out the proposed research as a PI 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.

D. LIMITATIONS ON SUBMISSIONS

ARQC Team Director

Proposals with more than one investigator, including proposals with multiple institutions, must designate one and only one investigator as the Team Director, who will exercise overall scientific control and direction of the proposed research. The Team Director must be employed by or have a written agreement in place to be hired by the Lead Institution. If the proposed Team Director will not be employed by the lead organization at the time of award, the proposal may be declined without further review.

Limitation on the Number of Proposals: An individual may participate in no more than two proposals and may be the Team Director on no more than one proposal. An institution may be the Lead Institution on no more than one proposal. There is no limitation on the number of proposals in which an institution may participate. If any of the following cases occur, the last received proposal that matches a qualified LOI (as described in Section IV, Part B.2, below) will be accepted and all other proposals will be declined without merit review:

- More than two proposals are received with the same individual identified as a Team Member in any role including the Team Director,
- Or
- More than one proposal is received with the same individual identified as a Team Director,
- Or
- More than one proposal is received with the same institution identified as the Lead Institution,

Section IV – PROPOSAL AND SUBMISSION INFORMATION

A. ADDRESS TO REQUEST PROPOSAL PACKAGE

Proposal submission instructions are available in this Announcement on the DOE SC PPAMS. 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 required and must be submitted by the due date. No responses will be sent to the Letters of Intent.

LETTER OF INTENT DUE DATE

05/01/2019 at 5:00 PM Eastern Time

The LOI is to help in planning the review and the selection of potential reviewers for the proposal. For this purpose, the LOI must include the following information:

At the top of the first page:

Title of LOI
Team Director Name, Job Title
Lead Institution
Phone Number, Email Address
Laboratory Announcement Number: LAB 19-2081

Only one LOI should be submitted for the entire project by the Lead Institution/Team Director.

In addition, the Lead Institution on the full proposal must be the same as on the LOI. The Team Director should not be changed unless unavoidable and only minor edits should be made, if necessary, to the title. If necessary, the applicant may make changes to other senior/key personnel and other participating institutions, although DOE discourages extensive changes.

This information should be followed by a clear and concise description of the objectives and technical approach of the proposed research. The LOI 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.

The LOIs must include the following two Tables, which will not count toward the two-page

limit:

Table 1: Team Members (Team Director, Deputy Team Director, Leads for Primary Topic Areas, PI's and Senior/Key Personnel) on the proposal and institutional affiliations

Team Members			Institution
Last Name	First Name	Title	Institution Name

Table 2: Collaborators of Team Members

Collaborator			Institution
Last Name	First Name	Title	Institution Name

For all team members, Table 2 must include collaborative co-investigators including co-authors of the past 48 months, co-editors of the past 24 months, graduate and postdoctoral advisors/advisees, and close associations.

Table 2 should exclude all personnel at any of the institutions listed in Table 1.

It is important that the LOI be a single file with extension .pdf, .docx, or .doc.

The LOI must be submitted electronically through the DOE SC PAMS website <https://pamspublic.science.energy.gov/>. It is important that the LOI be a single file with extension .pdf, .docx, or .doc. The PI and anyone submitting on behalf of the PI must register for an account in PAMS before it will be possible to submit a letter of intent. **All PIs and those submitting LOIs on behalf of PIs are encouraged to establish PAMS accounts as soon as possible to avoid submission delays.**

You may use the Internet Explorer, Firefox, Google Chrome, or Safari browsers to access PAMS.

Please see A. DOE SC PAMS under Registrations, above, for instructions about how to register in PAMS.

Submit Your Letter of Intent:

- Create your letter of intent 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 / 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 Letter of Intent” from the dropdown.

- On the Submit Letter of Intent page, select the institution from which you are submitting this LOI 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 PI per LOI; 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 LOI. Save the LOI for later work by clicking the “Save” button at the bottom of the screen. It will be stored in “My Letters of Intent” for later editing.
- Enter a title for your letter of intent.
- Select the appropriate technical contact from the Program Manager dropdown.
- To upload the LOI 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 LOI to DOE.
- Upon submission, the PI will receive an email from the PAMS system <PAMS.Autoreply@science.doe.gov> acknowledging receipt of the LOI.

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

WARNING: The PAMS website at <https://pamspublic.science.energy.gov> will permit you to edit a previously submitted LOI in the time between your submission and the deadline. If you choose to edit, doing so will remove your previously submitted version from consideration. If you are still editing at the time of the deadline, you will not have a valid submission. Please pay attention to the deadline.

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) or (301) 903-9610, email: sc.pams-helpdesk@science.doe.gov. All submission and inquiries about this Laboratory Announcement should reference **LAB 19-2081**.

2. Pre-proposal

A pre-proposal is not required.

C. CONTENT AND PROPOSAL FORMS

PROPOSAL DUE DATE

05/31/2019 at 5:00 PM Eastern Time

Files that are attached to the forms must be PDF files unless otherwise specified in this announcement. Attached PDF files 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.

WARNING: The PAMS website at <https://pampspublic.science.energy.gov> will permit you to edit a previously submitted proposal in the time between your submission and the deadline. If you choose to edit, doing so will remove your previously submitted version from consideration. If you are still editing at the time of the deadline, you will not have a valid submission. Please pay attention to the deadline.

RESUBMISSION OF PROPOSALS

Proposals submitted under this Announcement may be withdrawn from consideration by using SC's PAMS website at <https://pampspublic.science.energy.gov>. Proposals may be withdrawn at any time between when the Laboratory submits the proposal and when DOE makes the proposal available to merit reviewers. Such withdrawals take effect immediately and cannot be reversed.

After a proposal is withdrawn, it may be resubmitted, if this Announcement is still open for the submission of proposals. Such resubmissions will only count as one submission if this Announcement restricts the number of proposals from an applicant.

SC will usually consider the last submission, according to its timestamp, to be the intended version. Please consult with your program manager to resolve any confusion about which version of a proposal should be considered.

IMPROPER CONTENTS OF PROPOSALS

Proposals submitted under this Announcement will be stored in controlled-access systems, but they may be made publicly available if an award is made, and they will be made available to merit reviewers. As such, it is critical that Laboratories follow these guidelines:

- Do not include information subject to any legal restriction on its open distribution, whether classified, export control, or unclassified controlled nuclear information.
- Do not include sensitive and protected personally identifiable information, including social security numbers, birthdates, citizenship, marital status, or home addresses. Pay particular attention to the content of biographical sketches and curriculum vitae.
- Do not include letters of support from Federal officials.
- Do not include letters of support on Federal letterhead. Letters that are not letters of support (such as letters confirming access to sites, facilities, equipment, or data; or letters from

- cognizant Contracting Officers) may be on Federal letterhead.
- Clearly mark all proprietary or trade secret information.

DEPARTURE OF TEAM DIRECTOR

The actions to take upon the end of the team director's relationship with the Lead Institution are controlled by the date.

- If the proposal due date has not passed, the Lead Institution must withdraw any proposal for a Team Director whose relationship with the Lead Institution has ended.
- If the proposal due date has passed, the Lead Institution must consult with the DOE program manager identified in the Announcement. Depending on many factors, the proposal may be withdrawn or a new Team Director could be proposed.

These guidelines apply whenever the Team Director's relationship with the Lead Institution has ended, whether from leaving for industry, transferring to another institution, or passing away.

LETTERS

Letters of support are discouraged and will not be reviewed by DOE.

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

Completed proposals must be submitted into the DOE SC 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 19-2081**. Full proposals submitted in response to this Program Announcement must be submitted to PAMS no later than **05/31/2019**, at 5:00 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 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. 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. SC 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 19-2081**.

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 may only have one annual budget period.

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 must 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 must be a self-contained document that identifies the name of the applicant, the 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 must 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)

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.

- The project title:
- Applicant/Institution:
- Street Address/City/State/Zip:
- Postal Address:
- Administrative Point of Contact name, telephone number, email:
- Lead PI name, telephone number, email:
- DOE National Laboratory Announcement Number: **LAB 19-2081**
- DOE/SC Program Office: **Advanced Scientific Computing Research**
- DOE/SC Program Office Technical Contact: Dr. Ceren Susut
- PAMS Letter of Intent Tracking Number:

COVER PAGE SUPPLEMENT FOR COLLABORATIONS

(PART OF PROJECT NARRATIVE)

Collaborative proposals submitted from different institutions must clearly indicate they are part of a collaborative project/group. Every partner institution must submit a proposal through its own sponsored research office. Each collaborative group can have only one Lead Institution. Each proposal within the collaborative group, including the narrative and all required appendices and attachments, must be identical with one exception:

- Each proposal must contain the correct “cover-page” information for the submitting institution only.
- Each proposal must contain a unique budget corresponding to the expenditures for that proposal’s submitting institution only.
- Each proposal must contain a unique budget justification corresponding to the expenditures for that proposal’s submitting institution only.

SC will use the multiple proposals associated with a collaborative group to create one consolidated document for merit review that consists of the common, identical proposal materials combined with a set of detailed budgets from the partner institutions. It is very important that every proposal in the collaborative group be identical (including the title) with the exception of the budget and budget justification pages.

If the project is a collaboration, provide the following information on a separate page as a supplement to the cover page.

- List all collaborating institutions by name with each institution’s PI on the same line.
- Indicate the Team Director who will be the point of contact and coordinator for the combined research activity.
- Provide a statement explaining the leadership structure of the collaboration.
- Include a description of each collaborating institution’s facilities, equipment, and resources that will be made available to the collaborative group.
- Include a table modeled below (Table 1) providing summary budget information from all collaborating institutions. Provide the total costs of the budget request in each year for each institution and totals for all rows and columns.

Table 1

Collaborative Proposal Information								
	Names	Institution	Year 1 Budget	Year 2 Budget	Year 3 Budget	Year 4 Budget	Year 5 Budget	Total Budget
Team Director								
PI								
PI								
PI								

Example budget table (\$ in thousands)

* Note that collaborating proposals must be submitted separately.

In addition, the following three tables must be included as supplements to the cover page: Note Tables 2 & 3 are the same (possibly updated) as those submitted in the LOI.

Table 2: Team Members (Team Director, Deputy Team Director, Leads for Primary Topic Areas, PI and Senior/Key Personnel) on the proposal and institutional affiliations

Team Members			Institution
Last Name	First Name	Title	Institution Name

Table 3: Collaborators of Team Members

Collaborator			Institution
Last Name	First Name	Title	Institution Name

For all team members, Table 3 must include collaborative co-investigators including co-authors of the past 48 months, co-editors of the past 24 months, graduate and postdoctoral advisors/advisees, and close associations.

Table 3 should exclude all personnel at any of the institutions listed in Table 1.

Table 4: Budget by Primary Topic Areas

Primary Topic Area	Lead for Primary Topic Area	Year 1 Budget	Year 2 Budget	Year 3 Budget	Year 4 Budget	Year 5 Budget	Total Budget
Total							

Tables 1-4 will not count in the proposal page limitation.

PROJECT NARRATIVE (NO MORE THAN 20 PAGES LONG)

The project narrative **must not exceed 20 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. This page limit does not apply to the Cover Page, Budget Page(s), Budget Justification, biographical material, publications and references, and appendices, each of which may have its own page limit.

Do not include any Internet addresses (URLs) that provide supplementary or additional information that constitutes a part of the proposal. Merit reviewers are not required to access Internet sites; however, Internet publications in a list of references will be treated identically to

print publications. See Part VIII.D for instructions on how to mark proprietary proposal information. To attach a Project Narrative, click “Add Attachment.”

Background/Introduction: Explanation of the importance and relevance of the proposed work as well as a review of the relevant literature.

Proposed Research and Methods: Identify the hypotheses to be tested (if any) and details of the methods to be used including the integration of experiments with theoretical and computational research efforts.

Timetable of Activities: Timeline for all major activities including milestones and deliverables.

Project Management Plan: Multi-institutional proposals must include a project management plan that clearly indicates the roles and responsibilities of each organization and indicates how activities will be coordinated and communicated among team members.

Project Objectives: This section should provide a clear, concise statement of the specific objectives/aims of the proposed project.

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 major part of the narrative should be devoted to a description and justification of the proposed project, including details of the method to be used. It should also include a timeline for the major activities of the proposed project, and should indicate which project personnel will be responsible for which activities. There should be no ambiguity about which personnel will perform particular parts of the project, and the time at which these activities will take place.

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.

For Collaborative Proposals: Each collaborating institution must submit an identical common narrative (No more than 20 pages). The common narrative must identify which tasks and activities will be performed by which of the collaborating institutions in every budget period of the proposed project. The budget and the budget justification—which are unique to each collaborating institution—may be augmented by a statement of work to further identify each collaborating institution’s activities in the joint project. There should be no ambiguity about each institution’s role and participation in the collaborative group.

SC will use the multiple proposals associated with a collaborative group to create one consolidated document for merit review that consists of the common, identical proposal materials combined with a set of detailed budgets from the

partner institutions. It is very important that every proposal in the collaborative group be identical (including the title) with the exception of the budget and budget justification pages.

APPENDIX 1: BIOGRAPHICAL SKETCH

Provide a biographical sketch for the PI and each senior/key person 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.

- Provide the biographical sketch information as an appendix to your project narrative.
- Do not attach a separate file.
- The biographical sketch appendix will not count in the project narrative page limitation.
- The biographical information (curriculum vitae) for each person must not exceed 2 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 biographical information (curriculum vitae) must include the following items within its page limit:

- **Education and Training:** Undergraduate, graduate and postdoctoral training, provide institution, major/area, degree and year.
- **Research and Professional Experience:** Beginning with the current position list, in chronological order, professional/academic positions with a brief description.
- **Publications:** Provide a list of up to 10 publications most closely related to the proposed project. For each publication, identify the names of all authors (in the same sequence in which they appear in the publication), the article title, book or journal title, volume number, page numbers, year of publication, and website address if available electronically. Patents, copyrights and software systems developed may be provided in addition to or substituted for publications.
- **Synergistic Activities:** List no more than 5 professional and scholarly activities related to the effort proposed.

In addition, the biographical sketch must include information to permit DOE to identify individuals who are conflicted with or potentially biased (favorably or unfavorably) against the investigator. Include a section entitled "**Identification of Potential Conflicts of Interest or Bias in Selection of Reviewers**" that will not count in a page limit: Provide the following information in this section:

- **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 PI 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.

Personally Identifiable Information: Do not include sensitive and protected personally identifiable information including social security numbers, birthdates, citizenship, marital status, or home addresses. Do not include information that a merit reviewer should not make use of.

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 PI and senior/key persons, including subawardees, for ongoing projects and pending proposals. List all sponsored activities or awards requiring a measurable commitment of effort, whether paid or unpaid.

For every activity, list the following items:

- The sponsor of the activity or the source of funding
- The award or other identifying number
- The title of the award or activity
- The total cost or value of the award or activity, including direct and indirect costs. For pending proposals, provide the total amount of requested funding.
- The award period (start date – end date).
- The person-months of effort per year being dedicated to the award or activity
- Briefly describe the research being performed and explicitly identify any overlaps or synergies with the proposed research.

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). For example, your paper may be listed as, “A Really Important New Result,” A. Aardvark et. al. (MONGO Collaboration), PRL 999. 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. For proposed investigations requiring access to experimental user facilities maintained by institutions other than the applicant, please provide a document from the facility manager confirming that the researchers will have access to the facility. 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 major items of 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 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 SC 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 SC 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 SC 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, regulations, and DOE orders and policies. There is no requirement to share proprietary data.

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

- This appendix should not exceed 3 pages 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)
- Do not attach a separate file.
- This appendix will not count in the project narrative page limitation.

APPENDIX 7: OTHER ATTACHMENT

If you need to elaborate on your responses to questions 1-6 on the “Other Project Information” document, please provide the Other Attachment information as an appendix to your project narrative. 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.

- 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 must 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 must be included after the budget pages. The justification must 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

05/01/2019 5:00 PM Eastern Time

You are encouraged to submit your Letter of Intent well before the deadline. Letters of intent may be submitted at any time between the publication of this Announcement and the stated deadline.

2. Pre-proposal Due Date

A pre-proposal is not required.

3. Proposal Due Date

05/31/2019 5:00 PM Eastern Time

You are encouraged to transmit your proposal well before the deadline. Proposals may be submitted at any time between the publication of this Announcement and the stated deadline.

4. Late Submissions

Proposals received after the deadline will not be reviewed or considered for award.

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.

Computing Resources: Proposals may not request funding for computing resources. The allocation of High Performance Computing (HPC) resources available to individual projects is contingent on review and award through the processes as described at https://science.energy.gov/~media/ascr/pdf/incite/docs/Allocation_process.pdf. Within the available computational resources, every effort will be made to ensure that successful proposals will have the resources needed to support their efforts. It is also expected that ARQC Teams will exploit existing prototype quantum or hybrid computing systems or the ones that will be built during the period of performance.

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. SC 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

You must complete the one-time registration process (all steps) before you can submit your first proposal through PAMS. Registration instructions appear in the front matter of 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, 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 Program Announcement should reference **LAB 19-2081**.

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 Program Announcement has been submitted; (3) all mandatory requirements are satisfied; (4) the proposed project is responsive to the objectives of the Lab Announcement and is composed of multi-disciplinary teams, 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.

- Scientific and/or Technical Merit of the Project;
- Appropriateness of the Proposed Method or Approach;
- Competency of Applicant's Personnel and Adequacy of Proposed Resources; Reasonableness and Appropriateness of the Proposed Budget

Merit reviewers will be asked to evaluate one additional criterion of equal significance to the criteria established by regulation

- Strength of the Management Plan.

The evaluation process will also 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, the balance of activities within the program, and the utility of the proposed activities to the broader scientific community. Note that external peer reviewers are selected with regard to both their scientific expertise and the absence of conflict-of-interest issues. Both Federal and non-Federal reviewers may be used, and submission of an proposal constitutes agreement that this is acceptable to the investigator(s) and the submitting institution.

The questions below are provided to the merit reviewers to elaborate the criteria:

SCIENTIFIC AND/OR TECHNICAL MERIT OF THE PROPOSED RESEARCH

- Assess how the proposed ARQC Team will develop and support basic research foundations in quantum algorithms and quantum computer science.
- Assess how the proposed ARQC Team will develop, support, complement or deploy mechanisms for taking on cross-cutting algorithmic and computer science challenges across DOE/SC relevant application-specific quantum computing research. Is the proposed scope

relevant and applicable to multiple and different quantum computing applications?

- Is the proposed work sufficiently aware of quantum computing architecture trends such as hybrid approaches? To what extent, will the tools and resources developed by the proposed ARQC Team facilitate the use of diverse current and future hardware technologies and architectures?
- Is the Data Management Plan suitable for the proposed research; to what extent does it make the data available and useful to the scientific community?

APPROPRIATENESS OF THE PROPOSED METHOD OR APPROACH

- Assess the processes that the proposed ARQC Team will use (as appropriate) to make connections to and leverage advances from non-QIS communities including classical applied mathematics and computer science, and approximate and probabilistic computing communities.
- Evaluate the appropriateness of the performance metrics that will allow progress and contributions to be measured over the course of the research.
- Evaluate the proposed Team's plans for incorporating the results, capabilities and resources of QATs and QCATs.

COMPETENCY OF APPLICANT'S PERSONNEL AND ADEQUACY OF PROPOSED RESOURCES

- Do the Team Director and the other Team Members have a proven record of research in the disciplines needed for success in this project?
- Is there duplicative work among the Primary Topic Areas of the Team? Does the applicant identify the proposed synergistic activities and merged capabilities among different parts of the Team?
- Assess the proposed plan for the utilization of existing or planned prototype quantum or hybrid computing systems within the period of performance.

REASONABLENESS AND APPROPRIATENESS OF THE PROPOSED BUDGET

- Are the requested budget and the distribution of the funds among Primary Topic Areas appropriate?
- How does the requested budget relate to the proposed specified management structure?

STRENGTH OF THE MANAGEMENT PLAN

- Is there a clear lead organization and a qualified Team Director?
- Evaluate the comprehensiveness of the management plan and the organizational structure that delineates the roles and responsibilities of the Team Members.
- Evaluate the proposed approach to create a well-integrated, interdisciplinary team in order to address the project goals. Does the team include expertise in QIS, computer science and applied mathematics?
- Evaluate the proposed Team's plans to effectively communicate and coordinate its activities to the potential ARQC Team(s), other ASCR-funded QIS projects and ASCR program management as well as for outreach to the broader QIS community.

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. Program Policy Factors

The Selection Official may consider any of the following program policy factors in making the selection, listed in no order of significance:

- Availability of funds
- Relevance of the proposed activity to SC priorities
- Ensuring an appropriate balance of activities within SC programs
- Performance under current awards
- Participation with multi-institutional teams

3. Selection

The Selection Official will consider the findings of the merit review and may consider any of the Program Policy Factors described above.

4. 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

It is anticipated that the award selection will be completed by September 1st, 2019. It is expected that awards will be made in Fiscal Year 2019.

DOE is interested in seeing projects supported under this Announcement begin work by September 30th, 2019.

Section VI - AWARD ADMINISTRATION INFORMATION

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 from the award investigator will be required and will be due 90 days before the end of each budget year.

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, 9:00 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 Program Announcement should reference **LAB 19-2081**.

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 Program 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
Program Manager Scientific Contact	Advanced Scientific Computing Research, SC-21.1 Dr. Ceren Susut 301-903-0366 Ceren.Susut-Bennett@science.doe.gov

C. DEPARTMENT OF ENERGY, OFFICE OF INSPECTOR GENERAL HOTLINE:

The Office of Inspector General (OIG) maintains a Hotline to facilitate the reporting of allegations of fraud, waste, abuse, or mismanagement in DOE programs or operations. If you wish to report such allegations, you may call, send a letter, or email the OIG Hotline ighotline@hq.doe.gov. Allegations may be reported by DOE employees, DOE contractors, or the general public. OIG contact information is available at <http://energy.gov/ig/services>.

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.energy.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 proposal, consents to the use of non-Federal reviewers/administrators. Non-Federal reviewers must sign conflict of interest and non-disclosure 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.