

**PROGRAM ANNOUNCEMENT  
TO DOE NATIONAL LABORATORIES**



**U. S. Department of Energy  
Office of Science  
Nuclear Physics**

**Nuclear Data Interagency Working Group / Research Program**

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## **REGISTRATIONS**

### **A. 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 pre-proposals, letters of intent, and proposals directly into PAMS.

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](mailto: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.

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](mailto:sc.pams-helpdesk@science.doe.gov). All submission and inquiries about this DOE National Laboratory Program Announcement should reference **LAB 17-1763**.

## 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-proposals, and proposals before the deadline.

## **Section I – DOE NATIONAL LABORATORY OPPORTUNITY DESCRIPTION**

**GENERAL INQUIRIES ABOUT THIS ANNOUNCEMENT SHOULD BE DIRECTED TO:**

### **Technical/Scientific Program Contacts:**

#### **DOE Office of Nuclear Physics, and general information:**

Dr. Ted Barnes, Office of Nuclear Physics  
Program Manager, Nuclear Data and Nuclear Theory Computing  
301-903-3212  
[ted.barnes@science.doe.gov](mailto:ted.barnes@science.doe.gov)

#### **DOE Isotope Program:**

Dr. Dennis R. Phillips, Office of Nuclear Physics, DOE Isotope Program  
Program Manager, Isotope Production Research  
301-903-7866  
[dennis.phillips@science.doe.gov](mailto:dennis.phillips@science.doe.gov)

#### **DOE Office of Nuclear Energy:**

Dr. Dan Funk, Office of Nuclear Energy  
Program Manager, Office of Accelerated Innovation in Nuclear Energy  
301-903-3845  
[dan.funk@nuclear.energy.gov](mailto:dan.funk@nuclear.energy.gov)

#### **NNSA / Defense Nuclear Nonproliferation Research and Development (NA-22):**

Dr. Donald Hornback, NNSA/NA-22  
Program Manager, Nuclear Nonproliferation Research and Development  
202-586-6522  
[donald.hornback@nnsa.doe.gov](mailto:donald.hornback@nnsa.doe.gov)

#### **DHS / Domestic Nuclear Detection Office (DNDO):**

Dr. Namdoo Moon, Transformational & Applied Research  
Program Manager, Shielded SNM Detection Portfolio  
202-254-7627  
[namdoo.moon@hq.dhs.gov](mailto:namdoo.moon@hq.dhs.gov)

## **SUMMARY**

The Offices of Nuclear Physics (NP), Nuclear Energy (NE), and the Isotope Program (IP) of the Office of Science (SC), and the Office of Defense Nuclear Nonproliferation Research and Development (NA-22) of the National Nuclear Security Administration (NNSA), of the Department of Energy (DOE), and the Domestic Nuclear Detection Office (DNDO) of the Department of Homeland Security (DHS) hereby announce their interest in receiving applications to the *Nuclear Data Interagency Working Group / Research Program* for research projects intended to address nuclear data needs in areas of particular interest to these Offices, as described in this DOE National Laboratory Program Announcement.

A related Funding Opportunity Announcement (DE-FOA-0001763) may be published at <https://www.Grants.gov>.

## **SUPPLEMENTARY INFORMATION**

### **Program Objective**

The range of applications of Nuclear Physics in modern society is broad indeed. Notable examples of these applications include nuclear medicine, and the associated production, testing, distribution and use of isotopes in medical diagnostics and treatment; nuclear reactors, which have applications including the generation of electrical power, the production of isotopes, and tests of the properties of materials using neutrons; national security and nonproliferation applications, such as safeguards, nuclear forensics, and the detection of special nuclear materials (SNM); and applications to more familiar industrial problems, such as the use of radioisotopes in geological resource surveys.

All of these applications require accurate quantitative information regarding the properties of nuclei and their interactions with matter and radiation. In reference to the applications cited above, without the appropriate nuclear data, one would not be able to determine the correct dose levels of medical isotopes in procedures involving nuclear medicine, nuclear reactor design and operation would suffer from problematic uncertainties, and one could not predict the sensitivity of novel remote sensing techniques.

Extensive databases dedicated to nuclear data do already exist, notably those developed and maintained by the DOE Office of Nuclear Physics (NP) through the US Nuclear Data Program (USNDP) at Brookhaven National Laboratory (BNL). However, a close and critical examination of the existing nuclear data often finds that it is inadequate for current applications. This may be due for example to limits on the sensitivity of experiments that were carried out in previous decades, studies that accessed only a few experimental parameters (such as limited beam energies or angular coverage), or attempts to constrain a large number of parameters with limited data. One may also require information about the nuclear properties of materials that simply did not exist previously, or that were never adequately studied under conditions that are now considered important (such as new medical isotopes).

From the viewpoint of NP, this Announcement was originally motivated by the 2014 USNDP Review, which confirmed that experimental efforts to address gaps in nuclear data are within the scope of the USNDP program. This is expressed in the updated USNDP Mission Statement, which states that

*“The mission of the United States Nuclear Data Program (USNDP) is to provide current, accurate, authoritative data for workers in pure and applied areas of nuclear science and engineering. This is accomplished primarily through the compilation, evaluation, dissemination, and archiving of extensive nuclear datasets. The USNDP also addresses gaps in the data, through targeted experimental studies and the use of theoretical models.”*

This identification of an experimental role for the USNDP was followed by NP-sponsored reviews of nuclear data needs that could be addressed through such an experimental program, both for applications [1] and for basic research [2].

Accordingly, the purpose of the research program associated with this Announcement is to support new experiments that will provide new nuclear data where needed in areas in which the existing data is inadequate or does not exist, and to insure that the new data is transferred to the appropriate nuclear databases in a timely manner.

One problem with updating our nuclear data through new experiments is that these experiments can be quite demanding on the limited resources available for this type of applied research. Fortunately, recent “Nuclear Data Needs” reviews [1,2] show that there are often similar data needs associated with different applications, so there can be considerable economic benefit in different federal offices jointly supporting a given set of new nuclear data measurements. This advantage of a combined measurement program was the original motivation for the formation of the Nuclear Data Interagency Working Group, and is a primary motivation for this Announcement.

This Announcement invites researchers to submit proposals for new nuclear data experiments, ideally after discussions with the appropriate Program Managers listed at the beginning of this Section, under Technical/Scientific Program Contacts. As discussed elsewhere in this Announcement, proposals will be reviewed by NP, using reviewers proposed by the interested Offices or Agencies. Following a successful review, the interested Offices or Agencies will discuss the proposal with the PI, and will provide suitable funding for the components of the proposed work that they wish to support.

Since this Announcement is intended to address gaps in our databases in a timely manner, we request that each proposal include support for a named USNDP staff member, the “USNDP POC,” who will be associated with the experiment and will be responsible for transferring the data generated by the experiment to the appropriate USNDP databases.

Data generated from authorizations under this Announcement must be made publicly available through the USNDP databases. Submission of data to the USNDP databases does not confer Government ownership of the data.

### **Nuclear Data Needs by Office**

In the following we review the principal areas and topics in which each of the participating Offices perceives a need for improved nuclear data. We encourage potential PIs to review this section when preparing their proposals, and to discuss topics of interest with the relevant Program Managers. In this manner, the PIs may be able to identify “cross-cut” nuclear data needs that will increase the probability of attracting support from multiple Offices. The Offices, their associated Program Managers, and descriptions of the specific nuclear data needs are given below.



**DOE Office of Nuclear Physics / Nuclear Data:**

Dr. Ted Barnes ([ted.barnes@science.doe.gov](mailto:ted.barnes@science.doe.gov))

The Office of Nuclear Physics (NP) has two general goals in this Announcement:

- 1) To improve the effectiveness of USNDP databases in addressing the needs of the broad community of nuclear data users, and
- 2) To address nuclear data needs of special interest to NP researchers.

Regarding part 1), NP would anticipate supporting activities that involve the identification of the most important data needs in the USNDP databases, planning experimental activities to address these needs, assisting with the preparation of preprints and publications, and transferring new data to the appropriate USNDP archives. These activities would involve the participation of USNDP through a USNDP POC, so formulation of this component of a proposal will likely require communication with Ted Barnes, DOE-NP Program Manager for Nuclear Data ([ted.barnes@science.doe.gov](mailto:ted.barnes@science.doe.gov)) and Alejandro Sonzogni, NNDC Chair ([sonzogni@bnl.gov](mailto:sonzogni@bnl.gov)).

In part 2), the NP-specific topics that might be proposed for nuclear data experiments are summarized in the recent 2015 Long Range Plan for Nuclear Science [3]. These general topics are Quantum Chromodynamics, Nuclei and Nuclear Astrophysics, and Fundamental Symmetries and Neutrinos. Measurements of quantities that are needed to advance our experimental research programs in these areas would be especially appropriate for this Announcement. As examples, recent “pilot” programs in nuclear data experiment (and theory) supported by NP include extended measurements of beta decays required to model antineutrino fluxes and decay heat from nuclear reactors, using the ORNL MTAS; measurements of nuclear structure and radiative transitions in medical isotopes using BLIP (BNL) and Gammasphere (ANL); measurements of medical isotope production cross sections at LANL and LBNL; and a nuclear theory “Topical Collaboration” study of nuclear fission and r-process nucleosynthesis, co-funded by NNSA (NA-22) and NP.

**DOE Isotope Program:**

Dr. Dennis R. Phillips ([dennis.phillips@science.doe.gov](mailto:dennis.phillips@science.doe.gov))

The Isotope Program Mission is to assure the availability of radioactive and enriched stable isotopes that are in short supply. We work to accomplish this within the limits of existing technical assets, capabilities, and budgets.

We support the generation of nuclear data that are important to the accomplishment of our mission. We do this in the context of our existing R&D program. The needed data are cross sections/excitation functions for reactor neutron capture (n, gamma and n, fission), high energy neutron reactions (n, xnp) in accelerators and reactors, charged particle reactions (p, xnp; heavy ion, xnp), and electron accelerator-based phototransmutation reactions (gamma, xnp)

Nuclear data relevant to the types of reactions described in the previous paragraph are all used in the design of targets for practical radioisotope production. These data are essential to predicting yields of desired isotopes and impurities during irradiations.

The highest priority data are p, xnp reaction cross sections, n, xnp reaction cross sections; and gamma, xnp reaction cross sections. To reiterate, the data of interest are those specifically related to production of radioisotopes that are in short supply for research and applications.

A detailed list of the specific reactions of interest to isotope production activities is included in Section IX, Appendix A. These include charged particle reactions, photonuclear reactions, and neutron reactions. The reactions are listed in the Appendix according to priority, based upon requests to NIDC for specific isotopes, input from Federal Workshops, and isotopes captured in the 2015 Nuclear Data Needs Whitepaper.

**DOE Office of Nuclear Energy:**

Dr. Dan Funk ([dan.funk@nuclear.energy.gov](mailto:dan.funk@nuclear.energy.gov))

The Office of Nuclear Energy conducts research and deploys scientific results, expertise, computational tools and other advanced capabilities otherwise not commercially available for use in advancing nuclear power as a resource capable of meeting the Nation's clean energy, environmental, and national security needs. NE's leading-edge work on modelling and simulation is being made available to help accelerate early stage concepts relevant to small modular reactors, and advanced reactors across several technology areas.

NE also conducts high-priority activities to not only expand and enhance the research done through its Nuclear Science User Facilities, but also to apply new capabilities and technologies to the advancement of nuclear fuels, fuels cycles, and fuel disposition. A primary focus for NE is engagement with industry and other users through the Gateway for Accelerated Innovation in Nuclear (GAIN); please see <https://gain.inl.gov/>.

NE is interested in proposals that address nuclear data needs in these mission areas, provided that these needs are clearly demonstrated to be a limiting factor in nuclear fuel and reactor design, analysis, safety, and licensing calculations. Use of sensitivity and uncertainty analysis methods in proposed efforts is encouraged to demonstrate these needs.

Some nuclear data needs for NE may be found in the NEA Nuclear Data High Priority Request List [4]. As another example, a recent study by TerraPower to quantify the impact of uncertainties in nuclear data on the design of key safety and operational parameters of the Traveling Wave Reactor [5] highlights a particular area of nuclear data needs relevant to NE's mission. In this study, TerraPower found that the very large uncertainties (up to 40%) in several neutron cross sections reduced confidence in certain reactor safety parameters, and prevented quantifying control rod worth to within a few percent. To mitigate these uncertainties, new, more precisely determined differential cross section data and associated uncertainties are needed for certain high-priority nuclides and reactions, including:

- $^{238}\text{U}$  inelastic scattering
- $^{235}\text{U}$  capture in the intermediate energy range
- $^{23}\text{Na}$  and  $^{56}\text{Fe}$  elastic scattering

For the near term,  $^{238}\text{U}$  inelastic scattering is the highest priority need for this highlighted area, as well as for several other NE program areas. The generation of new nuclear data and associated covariance data to address additional needs may also be of interest to NE, but such proposals must clearly demonstrate a relevant application within NE's research scope.

**DOE NNSA/Defense Nuclear Nonproliferation Research and Development (DNN R&D):**  
 Dr. Donald Hornback ([donald.hornback@nnsa.doe.gov](mailto:donald.hornback@nnsa.doe.gov))

Defense Nuclear Nonproliferation R&D (DNN R&D, also known as NA-22) seeks to support the broader interagency effort to improve the state of nuclear data. Specifically, DNN R&D is interested in supporting nuclear data efforts that directly enhance nonproliferation through improved SNM detection capabilities, nuclear forensics, and safeguards. We are looking to support modest efforts as individual NA-22 projects, or to team with interagency partners for larger efforts. When appropriate, funded efforts are expected to result in peer-reviewed publications and to have explicitly identified evaluation components to ensure inclusion of results in nuclear data libraries, such as ENDF and ENSDF.

Applicants who have concerns regarding the implications of classified material should contact Dr. Hornback ([donald.hornback@nnsa.doe.gov](mailto:donald.hornback@nnsa.doe.gov)) for assistance.

**Department of Homeland Security (DHS) / Domestic Nuclear Detection Office (DNDO):**  
 Dr. Namdoo Moon ([namdoo.moon@hq.dhs.gov](mailto:namdoo.moon@hq.dhs.gov))

The Domestic Nuclear Detection Office (DNDO) in DHS supports transformational technologies to detect radiological / nuclear threats for homeland security. DNDO is seeking improvements in photofission nuclear data for active interrogations.

Photofission nuclear data measurement requirements include, but are not limited to:

1. Photofission cross-section measurements with higher precision and reasonable energy increments up to 20 MeV are required for  $^{235}\text{U}$ ,  $^{238}\text{U}$ , and  $^{239}\text{Pu}$  SNM isotopes.
2. Angular distribution and energy spectrum of the delayed neutron and gamma, and prompt neutron.

This data will be published in scientific journals and submitted to the National Nuclear Data Center for inclusion in their databases.

## **Budget and Budget Justification Special Instructions**

Here we provide some special instructions regarding budget formulation that are specific to this Announcement.

A proposal submitted in response to this Announcement should normally include a request for support for a specified USNDP staff member, the “USNDP POC,” who will be associated with the experiment, and will be responsible for transferring data generated in the experiment to the appropriate USNDP databases in a timely manner. These activities should be described both in the proposal narrative and in the Data Management Plan (DMP); see Appendix 6. It may be useful to contact Ted Barnes, DOE-NP Program Manager for Nuclear Data ([ted.barnes@science.doe.gov](mailto:ted.barnes@science.doe.gov)) and Alejandro Sonzogni, NNDC Chair ([sonzogni@bnl.gov](mailto:sonzogni@bnl.gov)) to make appropriate arrangements with USNDP. In certain circumstances, such as a proposal that already includes suitable USNDP staff as participants in the experiment, it may be possible to waive the requirement of having a specified USNDP POC.

The budget should not propose a partition of the requested funding between Offices; in the event of a successful application, if necessary this partition will be arranged by the Program Managers in consultation with the PI. Each supporting Office would then independently provide funding through their preferred funding mechanism, subject to the availability of funding.

Each institution should also submit a detailed Budget Justification for their individual budgets. For applications that envision receiving funding from more than one Office, this budget justification may include a discussion of the separate Scope of Work that might be supported by each Office, for example through a partition of the Scope of Work into Tasks.

We recommend that PIs discuss their budget plans with the relevant Program Managers before submission of an application. (See the **Technical/Scientific Program Contacts** at the top of Section I.)

## **Collaboration**

Collaborative applications submitted from different institutions must clearly indicate they are part of a collaborative project/group. Every partner institution must submit an application through its own sponsored research office. Each collaborative group can have only one lead institution. Each application 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 application must contain a unique budget corresponding to the expenditures for that application’s submitting institution only.
- Each application must contain a unique budget justification corresponding to the expenditures for that application’s submitting institution only.

Our 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.

### **Collaboration vs. Subawards**

The following points of advice to applicants may be helpful:

1. Both collaborative applications and proposed subawards are methods by which multiple institutions can work together to reach the scientific objectives described in this Announcement.
  - a. Collaborative applications are assembled from multiple identical applications submitted by the proposing institution. Such applications may be submitted under this Announcement in PAMS [or the related FOA (DE-FOA-0001763) in Grants.gov]. The multiple applications will be assembled into one joint collaborative proposal, which will be merit-reviewed as one proposal, with recommendations to fund or decline the application made at the level of each independent application.
  - b. Subawards exist when multiple institutions work together to submit one application with a designated prime awardee and multiple potential subawardees.
  - c. DOE National Laboratories may be proposed as subawardees, but the value of any such proposed subaward will be removed from any such prime award: DOE will make separate awards to its laboratories.
2. Choose the appropriate structure based on the nature of the scientific work being proposed. If multiple institutions will be functioning as a network of peer-level researchers, a collaborative structure would be more appropriate. If multiple institutions will be functioning with leadership and direction coming from one institution, a subaward arrangement would be more appropriate.
3. A well-thought-out research plan and its associated budget(s) should leave no confusion about which institution will do which parts of the research.

References:

[1] “Nuclear Data Needs and Capabilities for Applications” (LBNL, May 27-29, 2015); <https://bang.berkeley.edu/events/NDNCA/whitepaper> .

[2] “Nuclear Data Needs and Capabilities for Basic Science” (Univ. of Notre Dame, Aug. 10-11, 2016); [http://meetings.nscl.msu.edu/2016ND\\_workshop/ND-WhitePaper2017.pdf](http://meetings.nscl.msu.edu/2016ND_workshop/ND-WhitePaper2017.pdf) .

[3] “Reaching for the Horizon; the 2015 Long Range Plan for Nuclear Science” (Kitty Hawk, Apr. 16-20, 2015).

[4] “NEA Nuclear Data High Priority Request List;” <https://www.oecd-nea.org/hprl>

[5] N. Touran, “Sensitivities and Uncertainties due to Nuclear Data in a Traveling Wave Reactor” (NEA/OECD/WPEC SG 39 Meeting, May 10, 2016).

All entities submitting applications to this Announcement must recognize the moral and legal obligations to comply with export controls and policies that relate to the transfer of knowledge that has relevance to the production of special nuclear materials (SNM) and technologies with potential dual use. Please see 10 CFR 810 for further information.

This Announcement is to support scientific endeavors that could be described in scholarly publications. Do not submit applications containing restricted data or unclassified nuclear information as defined in the Atomic Energy Act of 1954, as amended, 42 USC 2011 et seq., 10 CFR 1017, 10 CFR 1045.

## **Section II – AWARD INFORMATION**

### **A. TYPE OF AWARD INSTRUMENT**

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

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

### **B. ESTIMATED FUNDING**

It is anticipated that approximately \$1,500,000 per year will be available under this Announcement and the related FOA DE-FOA-0001763, contingent on satisfactory peer review and the availability of appropriated funds. Following the first year award, out-year support will be contingent on the availability of appropriated funds, progress of the research, and programmatic needs. Awards are expected to begin in Fiscal Year 2018.

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

### **C. MAXIMUM AND MINIMUM AWARD SIZE**

(See B. Estimated Funding section above.)

The award size will depend on the number of meritorious applications and the availability of appropriated funds. Multi-institution collaborations will receive funding through separate awards at each participating institution.

The anticipated maximum and minimum award values are described below:

#### **Ceiling**

\$750,000 per year

#### **Floor**

\$150,000 per year

### **D. EXPECTED NUMBER OF AWARDS**

(See B. Estimated Funding Section above.)

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 Section above.)

It is anticipated that award sizes may range from \$150,000 per year to \$750,000 per year, typically less than \$500,000 per year.

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 section above.)

Research Awards are expected to be made for a period of two to five years, as befits the project. Out-year funding will depend upon suitable progress and the availability of appropriated funds.

## **G. TYPE OF PROPOSAL**

DOE will accept new DOE National Laboratory Proposals under this 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**

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

A Letter of Intent (LOI) is required, and must be submitted by **05/12/2017 at 5 PM Eastern time**. For a collaborative proposal, only the lead institution should submit the LOI.

The LOI must be submitted electronically through the DOE Office of Science Portfolio Analysis and Management System (PAMS) website <https://pamspublic.science.energy.gov/>. It is important that the LOI be a single file with extension .pdf, .docx, or .doc. The filename should not exceed 50 characters. The Principal Investigator (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.**

The LOI is intended to help in planning the review and the selection of potential reviewers for the application. Accordingly, the LOI should include the following:

- A cover sheet containing the name and mailing address of the lead institution; the planned title of the research application; the name, e-mail address, and telephone number of the Principal Investigator, additional Senior Investigator(s), and Senior/Key personnel expected to be involved in the planned application.
- An abstract page that summarizes the proposed research.
- (For collaborations) A collaboration list that specifies the collaborating institutions, identifies the local PI at each institution, and provides contact information.

An encourage/discourage response will be sent to each PI who submitted an LOI by **05/26/2017 at 5 PM Eastern time**.

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

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. (If you have been an Office of Science merit reviewer or if you have previously submitted a proposal, you may already be linked to an institution in PAMS. If this happens, you will be taken 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 do not need to enter the exact name of the institution, but you should enter a word or phrase contained within the institution name. (If your institution has a frequently used acronym, such as ANL for Argonne National Laboratory or UCLA for the Regents of the University of California, Los Angeles, you may find it easiest to 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.
- If, after searching, you think your institution is not currently in the database, click the “Cannot Find My Institution” button and enter the requested institution information into PAMS. Click the “Create Institution” button. PAMS will add the institution to the system, associate your profile with the new institution, and return you to the “Institutions – List” page when you are finished.

## 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 Principal Investigator (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](mailto: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.

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](mailto:sc.pams-helpdesk@science.doe.gov). All submission and

inquiries about this Laboratory Announcement should reference **LAB 17-1763**.

## C. CONTENT AND PROPOSAL FORMS

### PROPOSAL DUE DATE

**July 21, 2017 at 5:00 PM Eastern Time**

Files that are attached to the forms must be in Adobe Portable Document Format (PDF) 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.

### LETTERS

Letters of Support are not requested and should not be included in the application.

### 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 – 20 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](mailto:sc.pams-helpdesk@science.doe.gov). All submissions and inquiries about this Program Announcement should reference **LAB 17-1763** proposals submitted in response to this Program Announcement

must be submitted to PAMS no later than **07/21/2017, 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 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. 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](mailto: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](mailto:sc.pams-helpdesk@science.doe.gov). All submissions and inquiries about this Program Announcement should reference **LAB 17-1763**.

## 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 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)

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 Program Announcement Number: **LAB 17-1763**
- DOE/Office of Science Program Office: **Nuclear Physics**
- DOE/Office of Science Program Office Technical Contact: **Ted Barnes**
- Technical/Scientific Program Contact(s) (top of Section I):
- PAMS Letter of Intent Tracking Number:

## COVER PAGE SUPPLEMENT FOR COLLABORATIONS (PART OF PROJECT NARRATIVE ATTACHED TO FIELD 8 ON THE FORM)

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.

The Office of Science 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 principal investigator on the same line.
- Indicate the lead PI 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 on the following chart 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.

Collaborative Proposal Information								
	Names	Institution	Year 1 Budget	Year 2 Budget	Year 3 Budget	Year 4 Budget	Year 5 Budget	Total Budget
Lead PI								
Co-PI								
Co-PI								
Co-PI								

Example budget table (\$ in thousands)

\* Note that collaborating proposals must be submitted separately.

**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.

<p><b>For Collaborative Proposals Only:</b> Each collaborating institution must submit an identical common narrative. Collaborative proposals will necessarily be longer than single-institution proposals. The common narrative may exceed the page limit described for the research narrative by 50%; <i>i.e.</i>, if the page limit is 20 pages, a collaboration is subject to a limit of 30 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 refer to parts of the common narrative to further identify each</p>
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collaborating institution's activities in the joint project. There should be no ambiguity about each institution's role and participation in the collaborative group.

The Office of Science 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 project director/principal investigator (PD/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. 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 no more than 5 professional and scholarly activities related to the effort proposed.

**Identification of Potential Conflicts of Interest or Bias in Selection of Reviewers:** 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 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.

**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 consider.

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 lead principal investigator and each principal investigator, including subawardees, 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. Include the award number, title of the funded research project, and the name of the PI for the project. Briefly describe the research being performed and explicitly identify any overlaps 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 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, regulations, and DOE orders and policies. There is no requirement to share proprietary data.

**PLEASE NOTE:** One novel and very important purpose of this program is to provide a direct, rapid link between the new nuclear data experiments being supported and the USNDP databases, so that the new nuclear data generated by the experiment can be made publicly available in a timely manner. Accordingly, except in special circumstances, each application to this Announcement should identify and include appropriate support for a named USNDP staff member, the “USNDP POC,” who will be associated with the experiment, participate in the plans for new data generation, and be responsible for making the new data available in the appropriate USNDP databases. Information regarding the identity of the USNDP POC and their planned activities should be included in the DMP. For additional information regarding this aspect of the proposal, please contact Ted Barnes, DOE-NP Program Manager for Nuclear Data ([ted.barnes@science.doe.gov](mailto:ted.barnes@science.doe.gov)) and Alejandro Sonzogni, NNDC Chair ([sonzogni@bnl.gov](mailto:sonzogni@bnl.gov)).

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/>

- This appendix should not exceed 5 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 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**

**05/12/2017 at 5 PM Eastern Time**

You are encouraged to submit your Letter of Intent well before the deadline.

### **2. Application Due Date**

**07/21/2017 at 5 PM Eastern Time**

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

### **3. Late Submissions**

Applications 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.

## **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**

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, 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](mailto:sc.pams-helpdesk@science.doe.gov). All submission and inquiries about this DOE National Laboratory Program Announcement should reference **LAB 17-1763**.

### **3. Proposal Receipt Notices**

Upon submission, the PI will receive an email from the PAMS system <[PAMS.Autoreply@science.doe.gov](mailto: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 Program 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.

- 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; and
- Importance of the Proposed Nuclear Data for Applications and Research.

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 Program 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 a 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**

- What is the scientific innovation of proposed research?
- What is the likelihood of achieving valuable results?
- How might the results of the proposed work impact the direction, progress, and thinking in relevant scientific fields of research?
- How does the proposed work compare with other efforts in its field, both in terms of scientific and/or technical merit and originality?
- Is the Data Management Plan suitable for the proposed research and to what extent does it support the validation of research results?

#### APPROPRIATENESS OF THE PROPOSED METHOD OR APPROACH

- How logical and feasible are the research approaches?
- Does the proposed research employ innovative concepts or methods?
- 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?

#### COMPETENCY OF APPLICANT'S PERSONNEL AND ADEQUACY OF PROPOSED RESOURCES

- What is 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?
- Does the proposed work take advantage of unique facilities and capabilities?

#### 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?

#### IMPORTANCE OF THE PROPOSED NUCLEAR DATA FOR APPLICATIONS AND RESEARCH

- What is the level of importance of the nuclear data that would be provided through this proposal to the applications and/or research communities?
- Has the PI selected the most important nuclear data in the chosen area that can be addressed experimentally using the proposed facilities? Are there additional, related nuclear data needs that the PI should also consider?

## **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 Officials will consider the following items, listed in no order of significance:

- Scientific and technical merit of the proposed activity as determined by merit review
- Availability of funds
- Relevance of the proposed activity to Office of Science priorities
- Ensuring an appropriate balance of activities within Office of Science programs
- The history of the investigator(s) and applicant institution(s)

### **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**

It is expected that awards will be announced in Fiscal Year 2017.

## **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](mailto:sc.pams-helpdesk@science.doe.gov). All submission and inquiries about this DOE National Laboratory Program Announcement should reference **LAB 17-1763**. 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 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 <a href="mailto:sc.pams-helpdesk@science.doe.gov">sc.pams-helpdesk@science.doe.gov</a>
Program Manager Scientific Contact	<p>DOE Office of Nuclear Physics (and general information) Dr. Ted Barnes 301-903-3212 <a href="mailto:ted.barnes@science.doe.gov">ted.barnes@science.doe.gov</a></p> <p>DOE Isotope Program Dr. Dennis R. Phillips 301-903-7866 <a href="mailto:dennis.phillips@science.doe.gov">dennis.phillips@science.doe.gov</a></p> <p>Office of Nuclear Energy Dr. Dan Funk 301-903-3845 <a href="mailto:dan.funk@nuclear.energy.gov">dan.funk@nuclear.energy.gov</a></p> <p>NNSA/Defense Nuclear Nonproliferation R&amp;D (NA-22): Dr. Donald Hornback 202-586-6522 <a href="mailto:donald.hornback@nnsa.doe.gov">donald.hornback@nnsa.doe.gov</a></p> <p>DHS / Domestic Nuclear Detection Office (DNDO): Dr. Namdoo Moon 202-254-7627 <a href="mailto:namdoo.moon@hq.dhs.gov">namdoo.moon@hq.dhs.gov</a></p>

## **Section VIII - OTHER INFORMATION**

### **A. MODIFICATIONS**

Notices of any modifications to this DOE National Laboratory Program 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 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.

**Section IX - APPENDICES/REFERENCE MATERIAL**

**Appendix A: 2016 Nuclear Data Needs List for Isotope Production**

The following tables summarize nuclear needs relevant to the production of radioisotopes important to applications and research.

**1. Charged particles**

a. Nuclear reactions for proton flux monitoring

Production cross sections are needed as a function of particle energy. Care must be taken in the 80-200 MeV range to address potential secondary neutron related concerns.

Nuclear reaction	Energy range
$^{nat}\text{Nb}(p,4n)^{90}\text{Mo}$	Up to 200 MeV
$^{nat}\text{Cu}(p,xn)^{62,64}\text{Zn}$	Up to 200 MeV
$^{nat}\text{Ti}(p,x)^{48}\text{V}$	Up to 200 MeV

b. Excitation functions for isotope production

Production cross sections are needed as a function of particle energy.

Isotope	Target	Incident particle	Measurement type	Energy range
$^{236}\text{Np}$	$^{235}\text{U}$	d	Excitation functions for production of $^{236m,236g}\text{Np}$	Up to 50 MeV
		d	Excitation functions for production of co-produced impurity: $^{234,235}\text{Np}$	Up to 50 MeV
	$^{236}\text{U}$	p	Excitation functions for production of $^{236m,236g}\text{Np}$	Up to 30 MeV
		p	Excitation functions for production of co-produced impurity: $^{234,235,237}\text{Np}$	Up to 30 MeV
	$^{236}\text{U}$	d	Excitation functions for production of $^{236m,236g}\text{Np}$	Up to 50 MeV

		d	Excitation functions for production of co-produced impurity: $^{234,235,237,238}\text{Np}$	Up to 50 MeV
	$^{238}\text{U}$	p	Excitation functions for production of $^{236\text{m},236\text{g}}\text{Np}$	Up to 50 MeV
		p	Excitation functions for production of co-produced impurity: $^{234,235,237,238,239}\text{Np}$	Up to 50 MeV
$^{93\text{m}}\text{Nb}$	$^{94}\text{Zr}$	p	Excitation function for production of $^{93\text{m}}\text{Nb}$	Up to 70 MeV
		p	Excitation functions for production of co-produced impurities: $^{91\text{g},92\text{g},93\text{g},94\text{g}}\text{Nb}$	Up to 70 MeV
$^{202}\text{Pb}$	$^{203}\text{Tl}$	p	Excitation functions for production of $^{202\text{m},202\text{g}}\text{Pb}$	Up to 200 MeV
		p	Excitation functions for production of co-produced impurities: $^{198,199,200,201,203}\text{Pb}$	Up to 200 MeV
	$^{205}\text{Tl}$	p	Excitation functions for production of $^{202\text{m},202\text{g}}\text{Pb}$	Up to 200 MeV
		p	Excitation functions for production of co-produced impurities: $^{198,199,200,201,203,204,205}\text{Pb}$	Up to 200 MeV
$^{205}\text{Pb}$	$^{206}\text{Pb}$	p	Excitation functions for production of $^{205}\text{Bi}$ , $^{205}\text{Pb}$	Up to 200 MeV
	$^{206}\text{Pb}$	p	Excitation functions for production of co-produced impurities: $^{198,199,200,201,202,203,204,205,206,207}\text{Bi}$	Up to 200 MeV
	$^{204}\text{Pb}$	p	Excitation functions for production of co-produced impurities: $^{198,199,200,201,202,203,204}\text{Bi}$	Up to 200 MeV
	$^{207}\text{Pb}$	p	Excitation functions for production of $^{205}\text{Bi}$ and co-produced impurities: $^{198,199,200,201,202,203,204,206,207}\text{Bi}$	Up to 200 MeV
	$^{208}\text{Pb}$	p	Excitation functions for production of $^{205}\text{Bi}$ and co-produced impurities: $^{198,199,200,201,202,203,204,206,207,208}\text{Bi}$	Up to 200 MeV
$^{134}\text{Ce}$	$^{\text{nat}}\text{La}$	p	Excitation function for production of $^{134}\text{Ce}$	Up to 200 MeV

		p	Excitation functions for production of co-produced impurities: $^{132,133,133,137,139}\text{Ce}$	Up to 200 MeV
$^{72}\text{Se}$	$^{75}\text{As}$	p	Excitation function for production of $^{72}\text{Se}$	Up to 100 MeV
		p	Excitation functions for production of co-produced impurities: $^{70,71,73,75}\text{Se}$	Up to 100 MeV
$^{47}\text{Sc}$	$^{50}\text{Ti}$	p	Excitation function for production of $^{47}\text{Sc}$	Up to 50 MeV
		p	Excitation functions for production of co-produced impurities: $^{43,44,46,48,49}\text{Sc}$	Up to 50 MeV
$^{67}\text{Cu}$	$^{70}\text{Zn}$	p	Excitation function for production of $^{67}\text{Cu}$	Up to 50 MeV
		p	Excitation functions for production of co-produced impurities: $^{61,62,64,66}\text{Cu}$	Up to 50 MeV
$^{119}\text{Te}$	$^{\text{nat}}\text{Sb}$	p	Excitation functions for production of $^{119\text{m},119\text{g}}\text{Te}$	Up to 100 MeV
		p	Excitation functions for production of co-produced impurities: $^{116,117,118,121\text{m,g},123\text{m}}\text{Te}$	Up to 100 MeV
	$^{121}\text{Sb}$	p	Excitation functions for production of $^{119\text{m},119\text{g}}\text{Te}$	Up to 100 MeV
		p	Excitation functions for production of co-produced impurities: $^{116,117,118,121\text{m},121\text{g},123\text{m}}\text{Te}$	Up to 100 MeV
$^{117\text{m}}\text{Sn}$	$^{\text{nat}}\text{Sb}$	p	Excitation function for production of $^{117\text{m}}\text{Sn}$	Up to 100 MeV
		p	Excitation functions for production of co-produced impurities: $^{113,119\text{m},121\text{m},121\text{g}}\text{Sn}$	Up to 100 MeV
	$^{121}\text{Sb}$	p	Excitation function for production of $^{117\text{m}}\text{Sn}$	Up to 100 MeV
		p	Excitation functions for production of co-produced impurities: $^{113,119\text{m}}\text{Sn}$	Up to 100 MeV

Other nuclear data needs for intermediate energy production of medical isotopes captured in the 2015 Nuclear Data Needs Whitepaper are listed below. Excitation functions are needed up to 100 MeV (preferably up to 200 MeV) for production of the primary isotope and for all co-produced isotopic impurities. In each case the main production nuclear reaction is indicated but it should be noted that in some cases more than one nuclear reaction contribute to the production of a particular isotope or isotopic impurity. The needs listed below are considered important but of slightly lower priority.

Non-standard $\beta^+$ emitters	SPECT radionuclides and generator parents	Therapeutic radionuclides
$^{55}\text{Mn}(p,4n)^{52}\text{Fe}$	$^{124}\text{Xe}(p,pn)^{123}\text{Xe}$	$^{68}\text{Zn}(p,2p)^{67}\text{Cu}$
$^{59}\text{Co}(p,3n)^{57}\text{Ni}$	$^{124}\text{Xe}(p,2p)^{123}\text{I}$	$^{107}\text{Ag}(p,\alpha n)^{103}\text{Pd}$
$^{68}\text{Zn}(p,\alpha n)^{64}\text{Cu}$	$^{45}\text{Sc}(p,2n)^{44}\text{Ti}$	$^{232}\text{Th}(p,x)^{225}\text{Ac}$
$^{71}\text{Ga}(p,4n)^{68}\text{Ge}$	$^{69}\text{Ga}(p,2n)^{68}\text{Ge}$	
$^{75}\text{As}(p,3n)^{73}\text{Se}$	$^{\text{nat}}\text{Br}(p,x)^{72}\text{Se}$	
$^{85}\text{Rb}(p,3n)^{83}\text{Sr}$		
$^{88}\text{Sr}(p,3n)^{86}\text{Y}$		
$^{125}\text{Te}(p,2n)^{124}\text{Te}$		

## 2. Photons

### a. Excitation functions for isotope production

Production cross sections are needed as a function of photon energy.

Nuclear reaction	Photon energy range
$^{48}\text{Ti}(\gamma,p)^{47}\text{Sc}$	Up to 50 MeV
$^{48}\text{Ti}(\gamma,pn)^{46}\text{Sc}$	Up to 50 MeV
$^{48}\text{Ca}(\gamma,n)^{47}\text{Ca}$	Up to 50 MeV
$^{48}\text{Ca}(\gamma,p)^{47}\text{K}$	Up to 50 MeV
$^{68}\text{Zn}(\gamma,p)^{67}\text{Cu}$	Up to 50 MeV
$^{68}\text{Zn}(\gamma,pn)^{66}\text{Cu}$	Up to 50 MeV

$^{68}\text{Zn}(\gamma, \text{pn})\ ^{66}\text{Cu}$	Up to 50 MeV
$^{77}\text{Se}(\gamma, \text{p})\ ^{76}\text{As}$	Up to 50 MeV
$^{78}\text{Se}(\gamma, \text{p})\ ^{77}\text{As}$	Up to 50 MeV
$^{78}\text{Se}(\gamma, \text{pn})\ ^{76}\text{As}$	Up to 50 MeV
$^{187}\text{Os}(\gamma, \text{p})\ ^{186}\text{Re}$	Up to 50 MeV
$^{189}\text{Os}(\gamma, \text{p})\ ^{188}\text{Re}$	Up to 50 MeV
$^{190}\text{Os}(\gamma, \text{p})\ ^{189}\text{Re}$	Up to 50 MeV
$^{196}\text{Pt}(\gamma, \text{p})\ ^{195}\text{Ir}$	Up to 50 MeV
$^{196}\text{Pt}(\gamma, \text{n})\ ^{195\text{m}}\text{Pt}$	Up to 50 MeV
$^{197}\text{Au}(\gamma, \text{pn})\ ^{195\text{m}}\text{Pt}$	Up to 50 MeV
$^{197}\text{Au}(\gamma, \text{n})\ ^{196}\text{Au}$	Up to 50 MeV
$^{162}\text{Dy}(\gamma, \text{p})\ ^{161}\text{Tb}$	Up to 50 MeV
$^{162}\text{Dy}(\gamma, \text{pn})\ ^{160}\text{Tb}$	Up to 50 MeV
$^{226}\text{Ra}(\gamma, \text{n})\ ^{225}\text{Ra}$	Up to 50 MeV
$^{226}\text{Ra}(\gamma, 2\text{n})\ ^{224}\text{Ra}$	Up to 50 MeV

### b. Activation of converter materials

Production cross sections are needed as a function of photon energy for all activation products, with the highest priority on the major gamma dose drivers (both long-lived and short-lived).

Converter materials	Photon energy range
Tungsten	Up to 50 MeV
Tantalum	Up to 50 MeV
Gold	Up to 50 MeV
Copper	Up to 50 MeV
Stainless steel	Up to 50 MeV

Aluminum	Up to 50 MeV
Magnesium	Up to 50 MeV
Lead	Up to 50 MeV
Rhenium	Up to 50 MeV
Platinum	Up to 50 MeV

### 3. Neutrons

#### a. Nuclear reactions for fast neutron flux characterization

Production cross sections are needed as a function of neutron energy.

Nuclear reaction	Energy range
$^{209}\text{Bi}(n,3n)^{207}\text{Bi}$	Up to 200 MeV
$^{209}\text{Bi}(n,4n)^{206}\text{Bi}$	Up to 200 MeV
$^{209}\text{Bi}(n,5n)^{205}\text{Bi}$	Up to 200 MeV
$^{209}\text{Bi}(n,6n)^{204}\text{Bi}$	Up to 200 MeV
$^{\text{nat}}\text{Lu}(n,xn)^{173}\text{Lu}$	Up to 200 MeV
$^{\text{nat}}\text{Lu}(n,xn)^{172}\text{Lu}$	Up to 200 MeV
$^{\text{nat}}\text{Lu}(n,xn)^{171}\text{Lu}$	Up to 200 MeV
$^{\text{nat}}\text{Lu}(n,xn)^{170}\text{Lu}$	Up to 200 MeV
$^{\text{nat}}\text{Lu}(n,xn)^{169}\text{Lu}$	Up to 200 MeV
$^{169}\text{Tm}(n,3n)^{167}\text{Tm}$	Up to 200 MeV
$^{169}\text{Tm}(n,4n)^{166}\text{Tm}$	Up to 200 MeV
$^{169}\text{Tm}(n,5n)^{165}\text{Tm}$	Up to 200 MeV

b. Fast neutron induced reactions: Isotope production via threshold reactions

Production cross sections are needed as a function of neutron energy.

Nuclear reaction	Energy range
$^{232}\text{Th}(n,x)^{225}\text{Ac}$	Up to 200 MeV
$^{232}\text{Th}(n,x)^{227}\text{Ac}$	Up to 200 MeV
$^{36}\text{S}(n,x)^{32}\text{Si}$	Up to 200 MeV
$^{\text{nat}}\text{K}(n,x)^{32}\text{Si}$	Up to 200 MeV
$^{37}\text{Cl}(n,x)^{32}\text{Si}$	Up to 200 MeV
$^{35}\text{Cl}(n,x)^{32}\text{Si}$	Up to 200 MeV
$^{68}\text{Zn}(n,x)^{67}\text{Cu}$	Up to 200 MeV
$^{70}\text{Zn}(n,\alpha)^{67}\text{Ni}$	Up to 200 MeV
$^{50}\text{Ti}(n,x)^{47}\text{Sc}$	Up to 200 MeV
$^{50}\text{Ti}(n,\alpha)^{47}\text{Ca}$	Up to 200 MeV
$^{226}\text{Ra}(n,2n)^{225}\text{Ra}$	Up to 200 MeV

Other nuclear data needs for fast neutron production of medical isotopes captured in the 2015 Nuclear Data Needs Whitepaper are listed below. These measurements are also considered important but of slightly lower priority. Excitation functions are typically needed up to 200 MeV.

$^{32}\text{S}(n,p)^{32}\text{P}$ $^{47}\text{Ti}(n,p)^{47}\text{Sc}$ $^{64}\text{Zn}(n,p)^{64}\text{Cu}$	$^{67}\text{Zn}(n,p)^{67}\text{Cu}$ $^{89}\text{Y}(n,p)^{89}\text{Sr}$ $^{105}\text{Pd}(n,p)^{105}\text{Rh}$	$^{149}\text{Sm}(n,p)^{149}\text{Pm}$ $^{153}\text{Eu}(n,p)^{153}\text{Sm}$ $^{159}\text{Tb}(n,p)^{159}\text{Gd}$	$^{161}\text{Dy}(n,p)^{161}\text{Tb}$ $^{166}\text{Er}(n,p)^{166\text{m},166\text{g}}\text{Ho}$ $^{169}\text{Tm}(n,p)^{169}\text{Er}$	$^{175}\text{Lu}(n,p)^{175}\text{Yb}$ $^{177}\text{Hf}(n,p)^{177\text{m,g}}\text{Lu}$
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c. Low energy neutron reactions: Isotope production via reactors

Energy-resolved cross sections as well as effective cross sections for both thermal neutrons and epi-thermal neutrons are needed for production at U.S. based reactors (*e.g.* HFIR and ATR).

Nuclear reaction	Nuclear reaction	Nuclear reaction
<p><b>Data for production of <sup>229</sup>Th and other isotopes</b></p> <p><sup>227</sup>Ra(n,γ)<sup>228</sup>Ra - confirmation measurement needed</p> <p><sup>228</sup>Ra(n,γ)<sup>229</sup>Ra</p> <p><sup>228</sup>Ac(n,γ)<sup>229</sup>Ac</p> <p><sup>227</sup>Th(n,γ)<sup>228</sup>Th - confirmation measurement needed</p> <p><sup>228</sup>Th(n,γ)<sup>229</sup>Th - confirmation measurement needed</p> <p><sup>229</sup>Th(n, γ)<sup>230</sup>Th - confirmation measurement needed</p> <p><sup>229</sup>Th(n,fission) - confirmation measurement needed</p> <p><sup>227</sup>Th(n,fission) - confirmation measurement needed</p> <p><sup>187</sup>W(n,γ)<sup>188</sup>W - reported value not reliable</p> <p><sup>133</sup>Ba(n,γ)<sup>134</sup>Ba - confirmation measurement needed</p> <p><sup>107</sup>Ag(n,γ)<sup>108</sup>Ag → <sup>108</sup>Cd(n, γ)<sup>109</sup>Cd - confirmation measurements needed</p>	<p><b>Data for SHE target isotopes production</b></p> <p><sup>248</sup>Cm(n,γ) low energy resonances</p> <p><sup>249</sup>Bk(n,γ)</p> <p><sup>250</sup>Cf (n,γ) and <sup>250</sup>Cf (n,f)</p> <p><sup>251</sup>Cf(n,γ) and <sup>251</sup>Cf (n,f) – first resonance</p>	<p><b>Data for <sup>252</sup>Cf production</b></p> <p><sup>245</sup>Cm(n,γ)</p> <p><sup>247</sup>Cm(n,γ)</p> <p><sup>248</sup>Cm(n,γ)</p> <p><sup>249</sup>Bk(n,γ)</p> <p><sup>250</sup>Cf(n,g) and <sup>250</sup>Cf (n,f)</p> <p><sup>251</sup>Cf(n,g) and <sup>251</sup>Cf (n,f)</p> <p><sup>252</sup>Cf(n,X) - resonance near 1eV in particular</p>

In addition to the tabulations above, further information on the present status and future needs for nuclear data relevant to the production and medical applications of radionuclides may be found in this review article: Qaim, S.M., *Nuclear data needs for production and applications of radionuclides: Present status and future needs*. Nucl. Med. Biol., 2017; 44:31-49.