Report of the Committee of Visitors

For the Basic Energy Sciences

Scientific User Facilities Division

to the

Basic Energy Sciences Advisory Committee

Review of Fiscal Years 2016, 2017, 2018

Rockville, Maryland
April 10-12, 2019

Executive Summary

A Committee of Visitors (COV), under the guidance of the Basic Energy Sciences Advisory Committee (BESAC), reviewed the programs of the Scientific User Facilities (SUF) Division within the Department of Energy (DOE), Office of Basic Energy Sciences (BES) for the fiscal years (FY) 2016, 2017, and 2018. The COV was chaired by Prof. Anthony Rollett. Seventeen members of the committee met at the Rockville Hilton to review the management processes of SUF on April 10-12, 2019.

The charge to the COV was from Dr. Marc Kastner, acting chair of BESAC. The charge was: (i) For the scientific user facilities including the accelerator and detector program, assess the efficacy and quality of the processes used to solicit, review, recommend, and document proposal actions and to monitor active projects, programs and facilities. (ii) Within the boundaries defined by DOE missions and available funding, comment on how the award process has affected the breadth and depth of portfolio elements, the national and international standing of the portfolio elements, and the preparedness to meet future challenges.

The format of the review was similar to that used in prior COVs. The COV Panels reviewed the 3 classes of research facilities within the SUF Division plus the construction projects.

The COV commends the Division staff and program managers for their dedication, professionalism, and skill. That the positive findings of the COV greatly outweigh the negative is testimony to the individuals who make the process work. The COV found that the best science is being funded and that the science and individuals are of both national and international caliber.

The staff, program managers, and BES management are thanked for their help before and during this COV, and for the flawless organization. The entire COV process was conducted in an efficient and productive manner. All involved responded in a timely manner to the many questions and requests for information during the COV process.

The COV makes the following specific major recommendations:

- The current very lean staffing for SUFD means that attention must be paid to workload and succession planning.
- SUFD (and BES in general) is encouraged to work with the Laboratories and facilities to improve workforce diversity at the user facilities. Although most, if not all of the laboratories that house user facilities have implemented procedures for improving diversity, SUFD is encouraged to address the cultural issues.
- The Accelerator and Detector Research (ADR) program is highly effective and is important for the long-term development of the user. All white papers should be entered into the Office of Science Portfolio Analysis and Management System

(PAMS).

- The Committee feels that significant improvements in existing facilities are possible with the development in software analytical tools, high throughput hardware (e.g., robotics) and better support at existing instruments. The Center for Advanced Mathematics for Energy Research Applications (CAMERA) project is a highly successful example and use of its software should be encouraged especially for new or upgraded beamlines.
- SUFD should find new ways to inform potential industrial users of how the user facilities can solve problems that standard tools cannot address, such as in-situ and in-operando characterization for materials development.

Table of Contents

1. Introduction

This report documents the findings from a Committee of Visitors (COV) that was assembled under the auspices of the Basic Energy Sciences Advisory Committee (BESAC) to evaluate the processes and programs of the Scientific User Facilities (SUF) Division in the Office of Basic Energy Sciences (BES). The COV met at the Rockville Hilton in Rockville, Maryland, from April 10-12, 2019. This was the sixth in the series of COV reviews of the SUF Division; the first held in 2004, with subsequent reviews in 2007, 2010, 2013, and 2016.

2. The Charge to the Committee of Visitors

The charge to the COV was established in a letter from the Acting Chair of BESAC, Dr. Marc Kastner, to Prof. Anthony Rollett, who had agreed to chair the COV. The letter is attached as Appendix I. The charge was to address the operations of the SUF Division during the fiscal years 2016, 2017, and 2018. The components of the Division that the COV was asked to review were:

1. Light Sources including the Accelerator and Detector Research Program and Early Career Research Program,
2. Neutron Sources including the Early Career Research Program,
3. Nanoscale Science Research Centers including the Early Career Research Program, and
4. Construction Projects.

The COV was asked to focus on the following major elements:

(1) For the scientific user facilities including the accelerator and detector program, assess the efficacy and quality of the processes used to:
   (a) solicit, review, recommend, and document proposal actions, and
   (b) monitor active projects, programs and facilities.

(2) Within the boundaries defined by DOE missions and available funding, comment on how the award process has affected:
   (a) the breadth and depth of portfolio elements
   (b) the national and international standing of the portfolio elements
   (c) the preparedness to meet future challenges (e.g., instrumentation, data management and computation).

3. The Committee Membership

The COV membership was selected by the COV chair, Prof. Anthony Rollett, in consultation with the chair of BESAC and the Division leadership. The members were chosen to represent a cross-section of experts in scientific fields relevant to the activities supported by the SUF Division. A balance was achieved between academic (10), national laboratory (6), and industry (1) members; and between those that have previously served on a SUF COV and those that have not (3 and 14, respectively). Five of the committee members also serve on BESAC.

Given the size of the Division and the breadth of programmatic areas, a sizable committee was assembled. The COV consisted of a total of 17 members and were divided among 4 panels.

The following COV members served as the leaders for the Panels: Ben Feinberg (Construction

Projects), Yan Gao (Light Sources/Accelerator and Detector Research), Despina Louca (Neutron Sources), and Cynthia Friend (Nanoscience Centers).

A full listing of the COV members and their panel assignments is given in Appendix II and Appendix III, respectively.

4. The Review Process

The COV assembled at the Rockville Hilton at 8:30 AM on Wednesday, April 10, 2019 and adjourned at 12:00 PM on Friday, April 12, 2019. The agenda for the COV is attached as Appendix IV.

Prior to convening in Rockville, each COV member was supplied with the link to access the SUF Division COV documents in PAMS that included a comprehensive set of information pertaining to: the COV process, the core activities of the Division, and a copy of the 2016 SUF Division COV report and the response from BES. This comprehensive documentation was found to be useful in setting the stage for the actual COV and enabled the panel members to be prepared for the COV. Additional information was also supplied to each member during the COV meeting which included copies of the plenary presentations, and a more detailed overview of each of the Division's programs.

The COV began with a reiteration of the charge from the BESAC chair, Dr. Marc Kastner. Dr. Harriet Kung, the Director of BES, followed with an overview of BES, and Dr. James Murphy presented an overview of the SUF Division. The panel members were then presented with some details of the overall review process by the COV Chair, Prof. Anthony Rollett, before adjourning to their panel breakout rooms.

The first breakout session began with an overview of the programs by the SUF program managers. Each panel was supplied with electronic files via PAMS or laptops to evaluate the SUF Division processes.

For grants, proposals were distributed among four types of programmatic decisions: easy awards, easy declines, difficult awards, and difficult declines. The panels were free to request any additional materials (including folders for other proposals) or information that they felt would help them in their evaluation process.

For the facility operations, the panels considered the triennial reviews and monthly status call materials. For construction projects, the panel reviewed documentation related to critical decision project reviews, status reviews, special reviews, monthly reports, conference call notes, and review presentations.

This year the COV also considered proposals under two funding opportunity announcements: early career proposals across the SUF Division and quantum information science proposals for the nanoscience centers.

The remainder of the first day was spent reviewing files and preparing preliminary comments. In the morning of the second day, the panel members refined their comments and drafted preliminary findings. During the afternoon of the second day, the panels finalized the findings and prepared materials for the final report. The entire COV then met in executive session to discuss and reach consensus on the major findings and recommendations.

In the morning of the third day, the COV Chair and panel leads met and presented the major findings and recommendations to BES management, SUF Division management, and the SUF Division program managers.

The written reports from the panels (Appendix V - Appendix VIII) and the conclusions and recommendations drawn from the executive session provided the basis for this report.

5. Major Findings of the COV

The Committee has the following to say with respect to the charge to the COV:

(1a) Concerning the efficacy and quality of the processes used to solicit, review, recommend, and document proposal actions, the Committee finds that SUFD's processes are effective and properly administered. The PAMS system is an important component of the system that also was effectively used by the COV.

(1b) Concerning the efficacy and quality of the processes used to monitor active projects, programs and facilities, the Committee finds SUFD performance to be outstanding with recent recognition providing external validation.

(2a) Concerning how the award process has affected the breadth and depth of portfolio elements, the Committee finds that the process for Early Career Awards is contributing to advancement of several areas under SUFD. The COV discussed several aspects of the awards including the small number of awards that have been made over the review period. Understanding that each early career award represents a substantial financial commitment, the Committee suggests that additional means be found to provide opportunities to junior staff for innovation.

(2b) Concerning how the award process has affected the national and international standing of the portfolio elements, the Committee found it challenging to identify objective evidence for benchmarking. The Committee understands that there will be a charge to BESAC to address this issue. It is also true that information is available on machine performance, user statistics and output, which could be included in COV and/or Triennial Review briefings.

(2c) Concerning how the award process has affected the preparedness to meet future challenges (e.g., instrumentation, data management and computation), the Committee finds that, in certain areas, the process has been outstandingly effective. The CAMERA is a particularly promising joint activity between BES and ASCR on applied mathematics and software that partly arises out of the BESAC report on Mesoscale Science. The ADR program is successful and is clearly important for the long-term health of all the user facilities.

The COV highlights the following findings:

- The Committee was pleased to find that the 2016 recommendations had been acted upon. The increase in travel support for program directors from BES is commendable. However, it is important to ensure these resources provide the opportunity for all program directors to attend professional society meetings so that they engage the community and stay abreast of the developments as well as the challenges in their respective fields. Attendance at professional society meetings is also an important mechanism for the community to learn about the capabilities at the DOE user facilities.
- The inclusion of budget reviews in the triennial facility reviews has been implemented and appears to be a more efficient approach (by eliminating a separate budget review process). Speeding up the transmission of the review results to the facilities has occurred which is important for allowing the facilities to respond in a timely fashion. The use of best practices in enabling industry to make best use of the facilities is commendable.
- The Committee commends SUFD for its effective leadership of its set of world-class user facilities, the breadth of which is impressive and is a strongly distinctive feature of how BES supports science in the U.S. The quality of the user facilities is evidenced by the large (and increasing) numbers of users, their positive evaluations and the high quality of their scientific output that often directly involves the facility scientists.
- SUFD has an effective set of systems and practices in place that provide a transparent means of managing the user facilities.
- The Triennial facility review process was found to be highly effective in all sectors.
- Several facilities have overcome significant technical challenges on their path to full performance.
- The diversity of the user body appears to be similar to that in the physical sciences and engineering. The user facility staff and management, however, are noticeably less diverse.
- Recapitalization is an ever-present need and particularly so for the Nanoscale Science Research Centers. The Committee commends SUFD for the current effort and fully supports the case for seeking additional funds so as to meet the scientific challenges laid out in, e.g., recent BES reports.
- Expanded beamline internship opportunities for students and postdocs could increase the pipeline of new facility staff.
- The Committee commends the work of the light sources staff in planning for the data explosion that is coming because of, e.g., higher resolution, higher read-out rate detectors. There is also an opportunity for all the user facilities to provide leadership in data reproducibility, data reliability, data transparency and ways to efficiently turn raw data into information.
- The information that the COV needed to conduct the review was readily available. The combination of PAMS (for viewing proposals and related documents) with the laptops

(for, e.g., Triennial Reviews) provided efficient access. BES staff made themselves available for discussion on a regular basis, which was very helpful. It was, however, difficult to find information on performance metrics for the instruments (beamlines).

6. Major Recommendations of the COV

The COV makes the following major recommendations:

- The current very lean staffing for SUFD means that attention must be paid to workload and succession planning.
- SUFD (and BES in general) is encouraged to work with the Laboratories and facilities to improve workforce diversity at the user facilities. Although most, if not all of the laboratories that house user facilities have implemented procedures for improving diversity, SUFD is encouraged to address the cultural issues.
- The Accelerator and Detector Research (ADR) program is highly effective and is important for the long-term development of the user. All white papers should be entered into PAMS.
- The Committee feels that significant improvements in existing facilities are possible with the development in software analytical tools, high throughput hardware (e.g., robotics) and better support at existing instruments. The Center for Advanced Mathematics for Energy Research Applications (CAMERA) project is a highly successful example and use of its software should be encouraged especially for new or upgraded beamlines.
- SUFD should find new ways to inform potential industrial users of how the user facilities can solve problems that standard tools cannot address, such as in-situ and in-operando characterization for materials development.

Appendix I: Charge from the Acting Chair of BESAC to the Chair of the COV

SCIENCE PHILANTHROPY ALLIANCE

Advancing basic science—The foundation of our future

Dr. Anthony D Rollett
Department of Materials Science and Engineering
Carnegie Mellon University
Wean Hall 3313
5000 Forbes Ave.
Pittsburgh, Pennsylvania 15213

September 27, 2018

Dear Dr. Rollett:

The Basic Energy Sciences Advisory Committee (BESAC) has been charged by the Department of Energy's Office of Science to assemble a Committee of Visitors (COV) to review the management processes for the Scientific User Facilities Division of the Basic Energy Sciences (BES) program. Thank you for agreeing to chair this BESAC COV panel. Under your leadership, the panel should provide an assessment of the processes used to solicit, review, recommend, and document proposal actions and monitor active projects and programs.

The panel should assess the operations of the Division's programs during the fiscal years 2016, 2017, and 2018. The panel may examine any files from this period. The components of the Division that you are being asked to review are:

(1) Synchrotron Light Sources including the Accelerator and Detector Research Program and Early Career Research Program
(2) Neutron Sources including the Early Career Research Program
(3) Nanoscale Science Research Centers including the Early Career Research Program
(4) Construction Projects

You will be provided with background material on these program elements prior to the meeting. The COV is scheduled to take place Wednesday, April 10, 2019 through Friday, April 12, 2019.

A presentation to BESAC is requested at the Summer BESAC 2019 meeting (July 11-12, 2019). Following acceptance of the report by the full BESAC committee, the COV report with findings and recommendations will be presented to the Director of the Office of Science.

The Basic Energy Sciences Advisory Committee has given the panel the following charge:

(1) For the scientific user facilities including the accelerator and detector program, assess the efficacy and quality of the processes used to:
    (a) solicit, review, recommend, and document proposal actions and
    (b) monitor active projects, programs and facilities.

(2) Within the boundaries defined by DOE missions and available funding, comment on how the award process has affected:
   (a) the breadth and depth of portfolio elements
   (b) the national and international standing of the portfolio elements
   (c) the preparedness to meet future challenges (e.g., instrumentation, data management and computation).

If you have any questions regarding BESAC or its legalities, please contact Katie Runkles, Office of Basic Energy Sciences at (301) 903-6529 or via e-mail at Katie.Runkles@science.doe.gov. Rocio Meneses, the Program Assistant for the Scientific User Facilities Division, will provide logistical support for the COV meeting. She may be contacted by phone at (301) 903-7792 or via e-mail at Rocio.Meneses@science.doe.gov. For questions related to the Division, contact James Murphy at (301) 903-0839, or via e-mail at James.Murphy@science.doe.gov.

Sincerely,

Marc Kastner

Marc Kastner, Chair (Acting)
Basic Energy Sciences Advisory Committee

cc:
H. Kung, DOE/BES
J.B. Murphy, DOE/BES
K. Runkles, DOE/BES
R. Meneses, DOE/BES

Appendix II: COV Members and Contact Information

Last Name	First Name	Affiliation	E-Mail
Baer	Don	Pacific Northwest National Laboratory (Retired)	don.baer@pnnl.gov
Bampton	Angus	Pacific Northwest National Laboratory	angus.brampton@pnnl.gov
Bergmann	Uwe	SLAC National Accelerator Laboratory	bergmann@slac.stanford.edu
Chen	Lin	Northwestern University	l-chen@northwestern.edu
Feinberg**	Ben	Lawrence Berkeley National Laboratory	B_feinberg@lbl.gov
Friend**	Cynthia	Harvard University	friend@fas.harvard.edu
Gao**	Yan	GE Global Research	gaoy@ge.com
Louca**	Despina	University of Virginia	Dl4f@virginia.edu
Nguyen	Dinh	Los Alamos National Laboratory	dcnguyen@lanl.gov
Olsen	Bradley	Massachusetts Institute of Technology	bdolsen@mit.edu
Pozzo	Lilo	University of Washington	dpozzo@uw.edu
Rivers	Mark	University of Chicago	rivers@cars.uchicago.edu
Robertson	Ian	University of Wisconsin	ian.robertson@wisc.edu
Rollett*	Anthony	Carnegie Mellon University	rollett@andrew.cmu.edu
Rosenkranz	Stephan	Argonne National Laboratory	srosenkranz@anl.gov
Stout	Dan	Michigan State University	stout@frib.msu.edu
Zuo	Jian-Min (Jim)	University of Illinois, Urbana-Champaign	jianzuo@illinois.edu

* COV Chair ** Panel Leads

Appendix III: COV Panel Assignments

Panel 1: Construction Projects

Feinberg	Ben	Panel Lead	Lawrence Berkeley National Laboratory	B_feinberg@lbl.gov
Bampton	Angus	Subject Matter Expert	Pacific Northwestern National Laboratory	Angus.bampton@pnnl.com
Stout	Dan	Subject Matter Expert	Michigan State University	stout@frib.msu.edu

Panel 2: Light Sources/Accelerator & Detector Research

Gao	Yan	Panel Lead	GE Global Research	gaoy@ge.com
Bergmann	Uwe	Subject Matter Expert	SLAC National Accelerator Laboratory	bergmann@slac.stanford.edu
Chen	Lin X	Subject Matter Expert	Northwestern University	l-chen@northwestern.edu
Nguyen	Dinh	Subject Matter Expert	Los Alamos National Laboratory	dcnguyen@lanl.gov
Rivers	Mark	Subject Matter Expert	University of Chicago	rivers@cars.uchicago.edu

Panel 3: Neutron Sources

Louca	Despina	Panel Lead	University of Virginia	Dl4f@Virginia.edu
Olsen	Bradley	Subject Matter Expert	Massachusetts Institute of Technology	bdolsen@mit.edu
Pozzo	Lilo	Subject Matter Expert	University of Washington	dpozzo@uw.edu
Rosenkranz	Stephen	Subject Matter Expert	Argonne National Laboratory	srosenkranz@anl.gov

Panel 4: Nanoscience Centers

Friend	Cynthia	Panel Lead	Harvard University	friend@fas.harvard.edu
Baer	Don	Subject Matter Expert	Pacific Northwestern National Laboratory (Retired)	don.baer@pnnl.gov
Robertson	Ian	Subject Matter Expert	University of Wisconsin	ian.robertson@wisc.edu
Zuo	Jian-Min (Jim)	Subject Matter Expert	University of Illinois	jianzuo@illinois.edu

Appendix IV: COV Agenda

Agenda
Committee of Visitors for the
BES Scientific User Facilities Division
April 10-12, 2019, Rockville Hilton

Wednesday, April 10, 2019

Time	Activity	Participants/Lead	Location
7:30 AM - 8:30am	Continental Breakfast Available		Outside Eisenhower
8:30am 8:45am	Welcome, Charge to the Committee	Marc Kastner, BESAC Chair	Eisenhower
8:45am - 9:15am	SC-BES Overview	Harriet Kung, BES Associate Director	Eisenhower
9:15am - 10:15am	Scientific User Facilities Overview & PAMS Demo (T.Crockett)	James Murphy, SUF Division Director	Eisenhower
10:15am - 10:45am	Committee Executive Session	Anthony Rollett, COV Chair	Eisenhower
10:45am - 11:00am	Break and disperse to panel rooms		
11:00am - 12:00pm	**Panel Overviews:** • BES presentations (30 mins) • Review Files		
Panel Breakouts	**Construction Projects: Panel 1** Members: Ben Feinberg, Dan Stout, Angus Bampton	**Panel 1** - Ben Feinberg, Lead SUF Staff: Phil Kraushaar, Ed Stevens	Jackson
	Light Sources, Accelerator & Detector Research: Panel 2 Members: Yan Gao, Uwe Bergmann, Lin Chen, Dinh Nguyen, Mark Rivers	**Panel 2** - Yan Gao, Lead SUF Staff: Peter Lee, Eliane Lessner	Lincoln
	Neutron Sources: Panel 3 Members: Despina Louca, Brad Olsen, Lilo Pozzo, Stephan Rosenkranz	**Panel 3** – Despina Louca, Lead SUF Staff: Thiyaga Thiyagarajan	Truman
	Nanoscience Centers: Panel 4 Members: Cynthia Friend, Don Baer, Ian Robertson, Jian-Min Zuo	**Panel 4** – Cynthia Friend, Lead SUF Staff: George Maracas	Monroe
12:00pm - 1:00pm	Working Lunch		Food Outside Eisenhower
1:00pm - 4:30pm **Panel Breakouts**	**Same Breakout Panels and Meeting Locations as Listed Above** Review Files and Formulate Panel Comments *****Afternoon refreshments will be available outside Eisenhower @ 2:30*****		
4:30pm - 5:00pm	Committee Executive Session	Anthony Rollett, COV Chair	Eisenhower
5:00pm - 6:00pm	COV and BES General Discussion	COV Panel Leads & Chair and BES Management	Truman
6:00pm -	Dinner		On your own

Agenda
Committee of Visitors for the
BES Scientific User Facilities Division
April 10-12, 2019, Rockville Hilton

Thursday, April 11, 2019

Time	Activity	Participants/Lead	Location
7:30 AM - 8:30am	Continental Breakfast Available		Outside Eisenhower
8:30am - 9:00am	Committee Executive Session	Anthony Rollett, COV Chair	Eisenhower
9:00am - 11:30am **Panel Breakouts**	**Construction Projects: Panel 1** Members: Ben Feinberg, Dan Stout, Angus Bampton	**Panel 1** - Ben Feinberg, Lead SUF Staff: Phil Kraushaar, Ed Stevens	Jackson
	Light Sources, Accelerator & Detector Research: Panel 2 Members: Yan Gao, Uwe Bergmann, Lin Chen, Dinh Nguyen, Mark Rivers	**Panel 2** - Yan Gao, Lead SUF Staff: Peter Lee, Eliane Lessner	Lincoln
	Neutron Sources: Panel 3 Members: Despina Louca, Brad Olsen, Lilo Pozzo, Stephan Rosenkranz	**Panel 3** – Despina Louca, Lead SUF Staff: Thiyaga Thiyagarajan	Truman
	Nanoscience Centers: Panel 4 Members: Cynthia Friend, Don Baer, Ian Robertson, Jian-Min Zuo	**Panel 4** – Cynthia Friend, Lead SUF Staff: George Maracas	Monroe
	• Review Files • Formulate Panel Comments/Findings ***Refreshments will be available outside Eisenhower***		
11:30am - 1:00pm	Lunch		Outside Eisenhower
12:30pm - 1:30pm	Committee Executive Session Preliminary Panel Findings	COV Panel Leads and Chair	Eisenhower
1:30pm - 5:00pm	**Report Preparation and Panel Breakouts**	Panel 1 Lead & Members	Jackson
		Panel 2 Lead & Members	Monroe
		Panel 3 Lead & Members	Lincoln
		Panel 4 Lead & Members	Truman
	Report Preparation: • Formulate Panel Final Comments • Prepare Draft Panel Report		
5:00pm - 5:30pm	Committee Executive Session Preliminary Panel Findings	COV Panel Leads and Chair	Jackson
5:30pm - 6:00pm	COV and BES General Discussion	COV Chair & Panel Leads / BES Management	Jackson
6:00pm -	Dinner		On your own

Friday, April 12, 2019

Time	Activity	Participants/Lead	Location
7:30 AM - 8:30am	Continental Breakfast Available		Outside Eisenhower
8:30am - 9:00am	Committee Executive Session	COV members	Eisenhower
9:00am - 9:30am	Closeout	COV members and BES staff	Eisenhower
9:30am	Adjourn (Except Panel Leads & COV Chair) - Thank you!		
9:30am - noon	Panel Leads complete written draft report		

Appendix V: Summary Reports from Panel 1

Construction Projects

BES COMMITTEE OF VISITORS (COV) Reviewing the
Scientific User Facilities Division
Fiscal Years 2016, 2017, and 2018

A. Implementation of Previous COV Recommendations

Responses to previous COV recommendations were provided.

B. Efficacy and Quality of the Review and Monitoring Processes

Purpose and Scope of the 2019 COV Review

The Construction Project subpanel reviewed and assessed the efficacy and quality of the processes used by SUFD to monitor active construction and Major Items of Equipment (MIE) projects. A total of 6 construction and MIE projects were reviewed, as summarized in Table 1.

		Critical Decision Status		Performance Metrics				
Project Name	Current TPC	Latest Approved	Approval Date	% Complete	Cum CPI	CUM SPI	Status Date	CD-4 Date
NEXT	$90M	Complete	8/4/2017	100%	0.93	1.00	Aug-17	Aug-2017
APS-U	$815M	CD-2	12/9/2018	25.5%	1.00	0.97	Feb-19	Mar-2026
LCLS-II	$1,045M	CD-3	3/21/2016	84.0%	0.98	0.95	Feb-19	Jun-2022
ALS-U	$330M-$495M	CD-1	9/21/2018	N/A	N/A	N/A	Sep-18	Mar-2026
LCLS-II-HE	$290M-$480M	CD-1	9/21/2018	N/A	N/A	N/A	Sep-18	Oct-2028
PPU	$184M-$320M	CD-1/ CD-3a	10/4/2018	N/A	N/A	N/A	Oct-18	Jun-2027

Table 1. The project portfolio falling within the scope of SUFD responsibility during the 2016 - 2018 review reference period. The table also indicates some of the metrics used by the Construction Program managers to monitor project performance.

During 2016-2018, SUFD managed approximately $235 million to $369 million of construction project work (both line items and MIEs) annually. Construction activity has been very high, almost double the amount of the prior 3-year period. Table 2 shows the annual funding during the review period, and, for comparison, the current funding. Staffing to support the management of these projects has not increased.

$M	2016	2017	2018	2019
BES Construction Funding	235.8	232.5	369	437
Share of total BES budget	13%	12%	18%	
Increase over 2016			56%	85%

Table 2. Total BES construction funding by Fiscal Year.

Construction Project Review Process Description
The subpanel identified the key relevant processes in this area, including DOE Order 413.3B and the SC-28 Office of Project Assessment (OPA)-led peer reviews of projects, and reviewed and assessed the efficacy and quality of their use by SUFD staff. The subpanel discussed the elements of the charge with SUFD staff and management, OPA management, and reviewed records and detailed reports on the projects identified within the scope of the COV.

Metrics and User Definitions
Metrics utilized to evaluate the construction projects and MIE component for the COV include standard cost and schedule indices (Table 1) for the projects that are in progress, and final costs, schedules, and delivered scopes versus approved baselines for completed projects.

FINDINGS:

- The projects included in the COV review are being executed at Lawrence Berkeley National Laboratory, SLAC National Accelerator Laboratory, Argonne National Laboratory, Brookhaven National Laboratory, and Oak Ridge National Laboratory.
- Tailoring and use of long lead procurements have been used to maintain overall project schedules.
- Within SUFD, resources for Program Manager travel have increased. This was a prior COV recommendation.
- Review of Material/Documentation: Project documentation was made available to the review team. The files were organized in accordance with the major deliverables as defined by the DOE Order 413.3B process. The files were complete and orderly. Even though the Office of Science (SC) is exempt from DOE Order 413.3B, the expectation to adhere to the SC Summary of Major Requirements is being followed by the Construction Projects Management Team, as required by SC management.
- Project documentation appeared to be using the most current OPA guidance and templates. Lessons learned are submitted by projects upon project completion, and these are archived in BES project files.
- Projects selected for execution are peer-reviewed in accordance with the DOE Order 413.3B Critical Decision criteria and OPA process. The program is responsible for initiating project status reviews. BES and OPA work together to develop review teams to address questions that BES determines are appropriate. BES aims to have one per year and will initiate reviews more frequently as circumstances dictate.
- Fourteen separate (Independent Project Review and Critical Decision) reviews have been conducted for ongoing projects within the portfolio between FY 2016 and FY 2018. Topical and mini-reviews have been conducted as needed to address emerging items.
- Other processes used to monitor project progress include weekly Federal Project Director (FPD)/Construction Program Manager calls, bi-weekly/monthly project phone calls,

problem-specific reporting, structured ad-hoc calls to focus on risk areas, and Watch-list reporting as appropriate.

- Performance reporting is captured in the Department's Project Assessment and Reporting System (PARS) system. Project-specific Monthly reports are evaluated by Program Managers to assess earned value performance and milestone accomplishment.
- Government Performance Results Act (GPRA) performance goal for Cost Performance and Schedule Performance measured by CPI and SPI thresholds is ±10 %. The weighted performance of projects reviewed by the committee was within the acceptable range for the FY 2016-2018 reporting period.
- Federal Project Directors report to SC Field Operations while the Construction Program Managers report to BES.

COMMENTS:

- Overall Construction and Major Item of Equipment monitoring has been excellent.
- Overall project performance in the review period has been positive. For example, one of the projects within the portfolio, NEXT, completed all scope within budget and schedule objectives. The NSLS-II project, completed during the previous review period, received the Project Management Institute's Project of the Year Award in 2016, an international competition.
- SUFD project performance could benefit from a Lessons Learned (LL) database that incorporates the individual project LL reports throughout the Office of Science projects.
- SUFD projects are benefiting from the tailoring of Critical Decisions to allow specific scope items to proceed before CD-2. We agree with SUFD Program Managers that this tailoring is most beneficial when the particular scope is treated as a baseline.
- SUFD Program Managers would benefit from project performance metrics that are tailored to project phases, such as technical short-term milestones, in addition to the Earned Value Management System (EVMS) reporting. These changes should be anticipated and documented in the Project Execution Plans (PEP) such as in, e.g., the Communication Management Plan of the APS-U PEP.
- Consistency of data requirements over the multiple projects and management personnel is a challenge.
- In this period with a significant number of ongoing construction projects, succession planning for Construction Program Management personnel is essential. Given the small staff in the program, any new personnel should have significant experience with large science projects. Use of the Office of Science Project Leadership Institute is encouraged. Continuity of program management was commented on in the 2016 COV and continues to be an area in need of management attention.
- While communication between the FPD and the Construction Program Managers has been excellent, a good practice has been to ask for input into FPD performance appraisals. SUFD has responded positively, and we encourage expansion of this process.

RECOMMENDATIONS:

- Work with the Office of Project Assessment to develop an Office of Science project-wide searchable database for Lessons Learned, using the Lessons Learned reports required of the projects.
- If project data beyond mandated metrics are needed, provide consistent templates and/or examples.

Appendix VI: Summary Reports from Panel 2

Light Sources, Accelerator and Detector R&D

BES COMMITTEE OF VISITORS (COV) Reviewing the
Scientific User Facilities Division
Fiscal Years 2016, 2017, and 2018

BES is doing an excellent job in providing stewardship to the operation of the five light sources under a $500M budget, with personnel and resources constraints, while keeping a delicate balance between overseeing the facilities while giving sufficient autonomy to the facilities.

A. Implementation of Previous COV Recommendations

The 2016 COV report included the following recommendation:

> **Modify the facility triennial review process to explicitly include benchmarking against international peer facilities.**

The BES response to this recommendation was:

> **BES concurs with the recommendation and will include this assessment as part of the prepared materials for the triennial facility operation reviews.**

However, due to the complexity of international benchmarking and the difficulty in comparing different funding mechanisms among BES and international facilities, this assessment will be included in a new charge to BESAC. The committee notes that some facilities already obtain benchmark information for their beamlines as part of the periodic beamline reviews by their Scientific Advisory Committees.

The 2016 COV report included the following recommendation:

> **Keep a written record of questions, answers and action items associated with monthly teleconferences with facility directors.**

While this has imposed some additional work on the facilities to produce these notes, we learned that these have proven useful. Upper management in BES who cannot participate in the teleconferences do read the notes.

Prior to the 2016 COV, SUFD had decided to include a budget review as part of each triennial review. The 2016 COV report included the following recommendation:

> **Consider how to incorporate effective and efficient budget reviews into triennial facility reviews.**

To address this recommendation, the triennial review panels now include two reviewers with budget management expertise. However, the budget information provided to the committee is limited to a single very detailed spreadsheet which is a template provided to the facility in advance of the review. The information in this table is too detailed for most committee members. We learned that SUFD has a mechanism to automatically extract this information into a concise summary table. However, this summary table is currently being produced only after the triennial

review.

RECOMMENDATION:

SUFD should distribute the summary budget table as part of the triennial review material.

B. Efficacy and Quality of the Review and Monitoring Processes

Triennial Reviews

FINDINGS:

- BES provided a comprehensive and well-reasoned response to the previous COV findings.
- The triennial reviews of facilities (and bi-monthly conference calls) and budget reviews are generally very well organized and provide a highly detailed and very valuable picture of facility performance.

COMMENTS:

- We applaud the BES effort to streamline and standardize the triennial review process of the facilities. The letters from the reviewers are very informative as they highlight issues that should be addressed by facility management. BES uses these letters to identify the most important issues that the facilities need to address. This level of review is clearly essential for the health of the facilities.
- With the goal of improving the efficiency of these reviews, BES should consider asking reviewers to identify which areas they would like to see more details for, and which areas of the presentations were less useful.
- The breakout sessions were well designed to allow direct interaction between the reviewers and facility personnel including beamline scientists and other technical staff.

RECOMMENDATIONS:

- Continue the optimization of the triennial reviews as they are important activities. For example, there could be a discussion with the facility directors of what is viewed as least efficient and what is currently missing.
- Continue to reduce the time between the review date and the report to the facilities.

Accelerator & Detector Research

With four major upgrades in facilities in progress (LCLS-II, LCLS-II-HE, APS-U, ALS-U) the need for further advances in accelerators and detectors is imminent and critical. For instance, the development of low-emittance, high-repetition-rate electron guns, rugged photocathodes and superconducting undulators will enable X-ray free electron lasers to operate at high repetition rates producing higher X-ray flux and thus higher demand on X-ray instrumentation and detectors. In addition, ADR has expanded its scope to include research on X-ray optics and machine learning. We also feel that there is room for major improvements at many beamline instruments. Given the moderate size of the ADR budget, which is currently about $13M per year (less than 1% of the total BES budget), this program has been very successful at bringing important capabilities to the Laboratories. For example, the Ultrafast Electron Diffraction (UED) capability, which was recently added to the LCLS User Program, was initially started with funding from ADR. We note: 1) the scope of ADR portfolio has been increased; and 2) ADR needs to support the development of the aforementioned critical advances in order to stay ahead of the international competition. Continued and preferably increased support should result in an excellent return of investment

that will have significant impact on future capabilities of the U.S. light sources.

Staff Career Development

We recognize the importance of scientific and technical staff at light sources, as they play a crucial role for the success of the light sources. It is commendable that the staff morale and career development have been added to the line items for the triennial reviews. We recognize that this is primarily the responsibility of the facility and lab directors; however, BES might be able to play a role in facilitating such efforts. One suggestion is to get the facility directors together, for example, during one of the annual meetings, where they could discuss ideas about what works and what does not. Besides defining the balance of user support and research and development, this could include discussion of how to encourage the pursuit of funding and research opportunities and how to establish different career paths within the facility and across the lab. While it is not the goal to create a one-size-fits-all solution within or between the labs and facilities, such discussions might lead to some exchange of ideas of how to develop and retain motivated, engaged, and appreciated staff.

We offer some specific ideas for recruitment and career development at the BES light sources:

1. Manage the workload to provide a certain percentage of "release time" for scientific staff (from aiding users) and funding for equipment so that they can have their own R&D activities that may be high risk but with potential of long term pay-off for the facilities.
2. Clearly define staff roles, responsibilities, and career opportunities. Enable parallel career paths for scientific staff members who seek to develop scientific research programs and others who pursue technical advances using different metrics in their evaluations. This is particularly important for newer light sources with up to 80% of staff with just a few years of employment.
3. Provide guidance and training to staff on pursuing funding opportunities within the Lab (such as Laboratory Directed Research and Development), within DOE (such as ADR and early career), and beyond BES.
4. Provide opportunities for staff to mentor postdocs, graduate students, or interns through DOE fellowships or other means.

Succession Planning and Education for the Next Generation of Scientific Staff at the BES Light Sources

There is a need to train future beamline scientists in the U.S. Many of the required skills are not currently enabled by typical graduate student training. Even students who come to the light sources doing experiments as users, may not fully appreciate the facility operations and may not develop their innovative ideas owing to limited understanding of the capabilities of the various beamlines. Therefore, education programs targeting the training of future beamline scientists may benefit light source development in the long run.

Here are some specific ideas:

1. Continue to improve the current summer schools for scattering to provide training for beginners for the overview of different X-ray and neutron-based tools.
2. Expand graduate student research opportunities targeted at working with beamline scientists at light sources. This will expose them to technique development when working with beamline scientists. Such arrangements could enable their thesis work to take full advantage of user facilities and gain both scientific and technical knowledge needed to become a successful beamline scientist.

Industrial Use of the Facilities

While the light sources have seen tremendous improvement in performance in the last two decades, the percentage of industrial users has declined markedly, from close to 20% in 1990 to 3.5% in 2018. The number of industrial users has been between 400 and 600 in last decade. A large portion of the industrial users are from pharmaceutical companies, and the real concern here is the declining number of users from non-pharmaceutical companies. The 2016 COV report recommended improvement in this regard.

All the light sources have made notable efforts to reach out to industrial users. For example, dedicated links for industrial users can be easily found on the websites of all synchrotron sources. All the synchrotron sources have designed dedicated proposal formats for industrial users. We commend the serious efforts put forth by all the facilities.

We recognize the importance of making light sources more useful for industry, as the impact to the U.S. economy can be better or more directly appreciated when U.S. companies spend sizable efforts at the DOE user facilities. This can help BES explain to Congress the importance of scientific user facilities.

As each light source has its unique characteristics, their techniques may benefit different industrial sectors.

We recognize part of the problem is due to shrinking R&D investment from U.S. companies. Another barrier is that the current general user proposal system may not be well matched to industrial needs. The committee applauds efforts being made to set up high throughput capabilities such as a mail-in service for powder diffraction. Overall, there is lack of communication between current industrial users and the facility operators.

RECOMMENDATION:

The committee recommends a roundtable discussion on the industrial use of light sources because, with careful planning, such a roundtable can lead to actionable items.

C. Breadth and Depth of the Portfolio Elements

The breadth and depth of portfolio elements are driven by the facilities under the guidance of BES through Basic Research Needs and Grand Challenge reports. In the big picture, the major portfolio elements including the five light sources have both breadth and depth to meet the current needs, while the facility upgrades will strategically meet the future challenges and appear well managed and on track. This balance should continue of highly productive workhorse beamlines and advanced beamlines for new techniques.

D. Preparedness to Meet Future Challenges

The U.S. built the first hard X-ray free-electron laser (XFEL) and will soon be home to the first high-repetition-rate XFEL, i.e. the LCLS-II. Currently, there is major international competition, including the construction of new XFELs in Europe and East Asia. In terms of advanced technologies, Europe currently has the world's brightest electron sources, i.e., ones with highest current and lowest beam emittance, and Japan has the most advanced X-ray optics. Brighter electron sources will enable the next-generation of XFEL facilities to reach higher X-ray photon energies and operate at lower electron beam energy. Better X-ray optics will improve the X-ray throughput to the users. It will be very useful to have a comprehensive list of electron and XFEL beam parameters from different XFELs around the world in order to benchmark the LCLS-II against the international

XFELs.

APS-U is building the lowest emittance storage ring in the world, and ALS-U will be the first fully transverse coherent source of synchrotron radiation in the soft X-ray region. Both upgrades are critical for the U.S. to maintain its competitiveness in synchrotron radiation research.

A key element to prepare for the future is data, from data storage to data analysis. CAMERA, the joint project between BES and ASCR, is an excellent model. Considering the widespread development of artificial intelligence and machine learning, we recommend BES to look for ways to enhance the visibility of CAMERA and expand the CAMERA model.

Appendix VII: Summary Reports from Panel 3

Neutron Sources

BES COMMITTEE OF VISITORS (COV) Reviewing the
Scientific User Facilities Division
Fiscal Years 2016, 2017, and 2018

The neutron sub-committee was charged with evaluating the results from the triennial review of the two neutron sources at Oak Ridge National Laboratory, the Spallation Neutron Source (SNS) and the High Flux Isotope Reactor (HFIR), including the Early Career Research program. SNS and HFIR are unique resources for the scientific community that are supported by the BES program to accelerate discovery and push the envelopes of scientific learning. BES manages these world-leading neutron sources with cutting-edge neutron scattering capabilities. Both facilities have been operating reliably in the review window of FY 2016-2018 (almost 100% reliability for HFIR and over 90% for SNS). The committee evaluated all the information provided from the triennial review, along with the early career awards. The committee looked at the response from DOE based on the reviews and the laboratory response and action items. It is important to note that with regard to the neutron facilities, a major reorganization has taken place that seems to have been poorly received by the staff, reducing morale. After the triennial review, the ORNL neutron science directorate underwent yet another reorganization to mitigate some of the problems raised by the review, but it is not clear that this was effective.

A. Implementation of Previous COV Recommendations

From the 2013 and 2016 COVs, there was a recommendation for interagency collaboration with DOC, NIH, and NSF in order to facilitate structuring the user facility portfolio. While the DOE has expressed openness to this type of collaboration, no concrete action has been taken.

Given the relatively small number of neutron facilities in the U.S., the committee continues to feel that coordination is important to promote increased development in their capabilities. As the key provider of neutron capabilities in the U.S., DOE should have a keen interest in playing a significant role in this process. In light of the proposed Second Target Station (STS) at ORNL and the recommendation in a recent National Academies report[†] to convene an interagency working group to assess the neutron scattering needs of the U.S. for the next 50 years, it is timely and appropriate to convene such a working group. Such a group should look broadly at the entire U.S. complement of neutron sources and scattering instruments and assess the future needs of the wider community.

RECOMMENDATION:
The committee recommends that BES pursue interagency collaboration in support of the U.S. neutron scattering community.

Another recommendation from the previous COV was to be mindful of how facility transitions, outage periods, and closure of facilities can affect the national neutron scattering scientific user

[†] Reducing the Use of Highly Enriched Uranium in Civilian Research Reactors, Committee on the Current Status of and Progress Toward Eliminating Highly Enriched Uranium Use in Fuel for Civilian Research and Test Reactors, National Academies Press, 2016, http://www.nap.edu/catalog/21818/reducing-the-use-of-highly-enriched-uraniumin-civilian-research-reactors.

community and productivity.

The committee feels that BES is mindful of the user community and responded to this previous recommendation with acknowledgement and awareness of this impact. In particular, the recent rebuild of POWGEN and planned DISCOVER and VENUS instruments at SNS address capabilities that were lost with the closure of the Lujan Center. To further improve these processes, the committee feels that it is also important to gain input and comments from the user community early in the process of structuring a closure, transition, or facility outage. Early community involvement, before a decision and its timing are finalized, will help to mitigate the negative impact of these necessary changes to operational availability.

B. Efficacy and Quality of the Review and Monitoring Processes

Triennial Review and Monitoring Processes

FINDINGS:

- The COV found the triennial review process to be thorough, effective, and well presented in the reports. The findings and recommendations by the committee were also well represented in DOE's response to the Laboratory. The response from the Laboratory to the triennial review findings was also thorough and appropriate.
- There is evidence that DOE staff is following up on the recommendations outlined in the triennial review during their regular operation conference calls. The COV also has good confidence that DOE staff is taking into account findings with seriousness and continuing to work to sustain and improve the leadership status of neutron scattering facilities in the U.S.
- There was some concern that some of the most valuable metrics for performing peer-instrument comparisons may be obscured in the large amount of data that is provided for facility assessment and evaluation.

RECOMMENDATIONS:

- It is suggested that the most effective metrics for evaluation of facility operations and instrument performance be highlighted during future triennial reviews. For example, a comparison of the 'Ratio of Beam Days to Publication' with peer instruments serving the same scientific community in similar research areas, can be a great metric for the evaluation of all the parameters that contribute to successful experimentation (e.g. neutron flux, instrument reliability, staff support, software quality and user education). Such metrics should be compared between instruments at DOE facilities (e.g., between all small angle neutron scattering instruments) and with peer-instruments at other facilities.

Early Career Award Proposal Review Processes

FINDINGS:

- The COV evaluated the portfolio of Early Career proposals submitted to the SUFD Neutron Scattering program and was impressed by the quality and diversity of proposals that were received. The program also included a healthy mix of facility and university researchers as well as good diversity of applicants (e.g. gender distribution).
- The COV found a need for clearer communication with the scientific community regarding expectations for scientific scope of proposals submitted to the SUFD Neutron Scattering Facilities program versus the BES Materials Sciences and Engineering (MSE) Neutron

Scattering program. For example, some Early Career Award Proposals submitted to the SUFD program could also fit well within the MSE program.

RECOMMENDATIONS:

- The COV suggests that there could be more effective communication with the scientific community to help direct Early Career proposals to the appropriate programs.
- Encourage Early Career applications that tackle the development of new data analysis methods. For example, to include the use of data sciences and machine learning to facilitate increased instrument efficiency and scientific productivity. Growth in this aspect of the scientific portfolio will be essential for sustaining leadership of U.S. facilities in neutron analysis.

COV Processes Related to Neutron Scattering Programs

FINDINGS:

- The committee found the COV processes for evaluation to be generally effective at assessing the effectiveness of the programs and the portfolio.
- The committee felt that there was a lack of benchmarking data provided to effectively compare DOE-sponsored neutron facilities to other national and international peer facilities. This information is essential to assessing quality and performance.

RECOMMENDATIONS:

- Continue to include at least one member of the triennial review committee on the COV. Participation of triennial reviewers within the COV provided context that would be impossible to obtain in an efficient manner from the extensive documentation that results from the triennial review process.
- Identify and provide metrics for peer-facility comparison and evaluation. Some useful metrics may include 'Ratio of Beam Days to Publication' for similar instruments at different facilities. Alternatively, instrument scientists may be asked to qualitatively/quantitatively compare the performance of their instrument with respect to similar instruments at peer facilities.

C. Breadth and Depth of the Portfolio Elements

FINDINGS:

- The scientific initiatives are distributed across seven topics: biological systems, soft matter, chemistry/catalysis, computing/modeling/analytics, high pressure science, materials, and quantum materials, all of which are strongly impacted by neutron science. The portfolio presented at the triennial review strongly emphasizes hard matter. For example, the HFIR posters have a 4:1 hard:soft ratio. The ratio is even higher for the SNS, although counting is complicated by the number of instrumentation posters.
- The portfolio represents a substantial investment in improving the quality of the neutron sources, especially as represented by the capital investment in and ongoing progress of the PPU construction project, which help to maintain the world-class stature of American neutron sources.
- Investments have focused on new instrumentation (such as VENUS) and improved source quality with great success. In addition, there have been substantial investments in improving operational hours and reliability (SNS power, resolved issues with target,

improved reliability to over 90 %, and continued HFIR extremely high reliability during the review period) with great success. All of these advances are highly commended.

- Automation, big data, and software are less emphasized as part of the portfolio. For example, only new instrumentation proposals have been funded in the Early Career program. As another example, these topics are also not mentioned in the 2019 Oak Ridge National Laboratory Neutron Sciences Annual Plan.
- The committee feels there is substantial opportunity for improving scientific output and quality based upon rapid advances in automation, machine learning, and data sciences that are not fully being captured. An example is the CAMERA project being piloted by the light sources, something that is not replicated at the neutron facilities.
- There are opportunities for emphasizing the role of automation, mail-in, and other novel scheduling in order to improve experimental throughput on many existing instruments, improving access and scientific output. Given the high fixed cost of facility operation, improved throughput and efficiency of existing operations provides a highly effective method to add value.
- Substantial concerns were raised in the triennial review about communication, morale, and organizational structure at the neutron facilities. The BES leadership has identified these concerns, and an action plan is being developed by ORNL to address these issues. The committee thinks this is a very high priority due to the critical role that human resources play in programmatic execution.
- There is a lack of diversity among the neutron facility staff. Only one female is in a leadership role as per the ORNL Neutron Sciences Directorate organization chart.
- Flexibility for the instrument scientists in terms of access to instrument time to develop their own scientific programs and advances in instrument capability has been and will continue to be critical to the evolution of the program portfolio and capabilities.
- The long-term health of the facilities is intimately linked with workforce development, and SUFD has an important role to play in the education of the next generation workforce.

RECOMMENDATIONS:

- Data storage, reduction, and analysis should be treated as an integral part of new technique development and instrument commissioning. Proposals for new technique development such as through the Early Career program could include these elements as integral aims, and proposals for new instruments should include digital construction as an integral piece. An instrument should not be certified as CD-4 until its digital footprint, as well as its physical footprint, is complete.
- The facilities have made substantial advances in data sciences. Continued developments of data reduction, storage, and analysis capabilities on existing instruments will be necessary to maintain competitiveness and improve efficiency. Data scientists should be embedded within research groups in order to provide data and software support joint with the necessary domain expertise to provide effective solutions. The committee has observed that these types of experts are present in some of the groups in the ORNL Neutron Sciences Directorate organization chart, but not all. These individuals should be clearly identified on the organization chart.
- The DOE should take a more active role in encouraging diversity at the neutron facilities. This will play a critical role in maintaining the quality of the facilities in the future by attracting the top talent.
- Projects involving automation and high throughput on instruments should be prioritized in order to fully capitalize on the large fixed cost investment.

- More transparency is recommended regarding the down selection of the early career proposals that are either rejected or awarded. Compared to other divisions, the proposal count is small in any given year.

Appendix VIII: Summary Reports from Panel 4

Nanoscience Centers

BES COMMITTEE OF VISITORS (COV) Reviewing the
Scientific User Facilities Division
Fiscal Years 2016, 2017, and 2018

The five Nanoscale Science Research Centers (NSRCs) provide important capabilities for the broad BES research community. The NSRCs have a unique role when compared to other large-scale BES user facilities by providing important support of a wide range of external users and in support of the other facilities, e.g., light sources. Materials synthesis, fabrication of novel devices, and electron-beam characterization are examples of the unique capabilities of the NSRCs. The impact of the NSRCs is clear from the number and quality of publications and the continuous increase in the user base. Originally founded between 2006-2008, the NSRCs face the challenge of maintaining and developing cutting-edge equipment that will drive forward new priority research directions.

A. Efficacy and Quality of the Review and Monitoring Processes

The NSRCs are primarily evaluated through the triannual review process. There were only a limited number of proposals derived from the Quantum Information Science (QIS) lab FOA and the Early Career awards.

Solicitation processes

FINDING:
The solicitation of proposals through the lab-based QIS FOA and the Early Career awards were appropriately managed.

Review processes

FINDINGS:

- The triennial reviews of all five NSRCs were relatively uniform and identified strengths and challenges in the various NSRCs. Overall, the process works well.
- The balance of backgrounds of reviewers for the triennial reviews among academics, national labs and industrial researchers was not uniform across the 5 NSRCs. A balanced group of reviewers could elicit more industrial engagement and yield a more comprehensive review.
- The primary performance metrics used in the triennial reviews combine the number of publications and the journal impact factor. These are appropriate metrics although the emphasis on number of publications may impede high risk/high reward instrument development projects.
- The 2016 triennial reviews did not include an evaluation of practices for data management and accessibility.
- Workforce diversity was not explicitly evaluated in triennial reviews.

- The QIS proposals were reviewed appropriately with 15 pre-proposals received, 10 invited and 7 funded.
- Early career proposals were evaluated appropriately. Strong proposals were not funded due to the extreme competition for limited funds.

RECOMMENDATIONS:

- Triennial reviews should evaluate FAIR[†] principles of data accessibility to assure that NSRCs establish state-of-the-art practices.
- Triennial reviews should evaluate NSRC workforce diversity achievements and plans.
- Reviewers should be selected from a balance of backgrounds uniformly across the 5 NSRCs.

Communications - Management

FINDINGS:

- Communication between the BES Program Manager and the Directors of the NSRCs is robust and effective, which ensures smooth and effective management.
- Issues identified in the triennial reviews are addressed and have been monitored by BES management.

B. Breadth and Depth of the Portfolio Elements

FINDING:

The NSRCs provide an array of critical capabilities for BES research that have clear impact. They have a unique role when compared to other large-scale BES user facilities by providing important support of a wide range of external users. Materials synthesis, fabrication of novel devices, and electron-beam characterization are examples of the unique capabilities of the NRSCs. The NSRCs also serve as a bridge to other facilities.

Outreach

FINDING:

The NSRC portal was developed in response to the 2016 COV report. Efforts to disseminate information at national meetings have also been launched by NSRC management.

COMMENT:

The improved outreach efforts most likely contribute to the continuing increase in user base.

Merger of Electron Beam Microcharacterization Centers (EBMCs) with NSRCs

FINDINGS:
The merger of the EBMCs and NSRCs was recent at the time of the last triennial reviews. The mergers were appropriate and should lead to synergistic work. For example, the merger of the National Center for Electron Microscopy (NCEM) and the Molecular Foundry (TMF) at Lawrence

[†] The FAIR data management principles include Findable, Accessible, Inter-operable & Re-useable. In addition, FAIR data management includes not only raw and processed data, but also the algorithms, tools, and workflows that led to the resulting processed data.

Berkeley National Laboratory has been smooth, leading to the recent development of a fast 2-D electron detector. The merger of the Electron Microscopy Center (EMC) and the Center for Nanoscale Materials (CNM) at Argonne National Laboratory did not go smoothly at the beginning.

COMMENT:
Updated information on the progress of these mergers is expected in the upcoming triennial reviews.

C. National and International Standing of the Portfolio Elements

FINDINGS:

The 5 NSRCs provide world-class support for BES research. Their leading role is illustrated by the large and growing user base which includes international researchers from 35 countries, accounting for ~7 % of all users.

- The 5 NSRCs provide a family of facilities in materials characterization, synthesis/fabrication and theory.
- The NSRCs all support interdisciplinary research that benefits both in-house and outside research communities.
- The needs of users have been met through development and acquisition of new capabilities.
- Valuable training of staff, postdocs, and students is provided which will develop future scientific leaders.

COMMENT:

Continuous development and innovation are critical to maintaining this leadership position.

D. Preparedness to Meet Future Challenges

FINDINGS:

Steps have been taken to position the 5 NSRCs to meet future challenges through recapitalization of equipment and development of new tools to meet the needs of emerging science opportunities in BES. A significant amount of recapitalization and associated "retirement" of some existing equipment is necessary to maintain world-leading capabilities at the NSRCs. Development of new, cutting-edge tools, possibly in conjunction with larger facilities (e.g., light sources, neutron sources, or supercomputing facilities), is also critical for the future.

- The guideline of using ~10 % of each NSRC budget for recapitalization of equipment is a positive step.
- Utilization of funds appropriated to BES to solicit and fund new programs in QIS created opportunities for new directions.
- There is a proposed recapitalization project for the 5 NSRCs in the FY 2020 Request, which will provide differentiation of their capabilities and further improvement in their tool sets.
- Examples of creative partnerships with industry or with other lab entities for acquisition of new equipment is a mechanism for improving tool sets. University-based microscopy centers often enter into partnerships with local companies, e.g., which give the latter access to the facility.

- The previous triennial reviews highlighted needs for additional theory. There are some efforts for “near real-time” data analysis to guide measurements, which has demonstrated a significant increase in the efficiency of data acquisition and analysis. Overall, tighter coupling of theory, experiment, computation and applied mathematics, such as is found in the CAMERA project, will advance the capabilities of the NSRCs in the future.
- Data reproducibility, accessibility, and transparency are critical to building robust databases for nanoscience and nanotechnology. The NSRCs have the potential to play world leading roles in developing protocols to address this challenge.
- BES conducts community workshops that contribute to strategic planning for the NSRCs.

RECOMMENDATIONS:

- BES should utilize recapitalization efforts to refine the strategic directions and further differentiate the 5 NSRCs.

COMMENTS:

The NSRCs have adjusted their budgets to address the DOE directive of providing at least 10 % of their budget for recapitalization. While recapitalization is vital to the future mission and success of the NSRCs, this cost along with staff salaries is constraining the NSRCs, which will limit their ability to serve the user community. Future strategic planning exercises should identify unique capabilities available at each NSRC within the constraints of the budget. As noted above, the committee supports the ongoing effort to differentiate the NSRCs.