Office of Science User Facilities

Lessons from the COVID Era and Visions for the Future

Report from the December 2020 Roundtable

U.S. DEPARTMENT OF ENERGY | Office of Science

U.S. Department of Energy
Office of Science User Facilities Roundtable

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About the Roundtable

In December 2020, the U.S. Department of Energy Office of Science convened a virtual Roundtable of its scientific user facilities to discuss facility challenges and lessons learned during the COVID-19 pandemic as well as facility responses, best practices, and innovations that could be adopted going forward. Roundtable participants included facility staff, users, and user executive committee chairs. This report summarizes their discussions, which encompassed topics such as user research and facility operations in virtual and physically distanced contexts; user training and engagement; computation, data, and network resources; and crosscutting issues.

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About the Office of Science

The U.S. Department of Energy Office of Science's mission is to deliver scientific discoveries and major scientific tools to transform our understanding of nature and advance the energy, economic, and national security of the United States. The Office of Science is the nation's largest federal sponsor of basic research in the physical sciences. Through its stewardship of 10 national laboratories, investment in fundamental research on the frontiers of science, and support for 28 world-class scientific user facilities, the Office of Science is a critical component of the nation's discovery pipeline.

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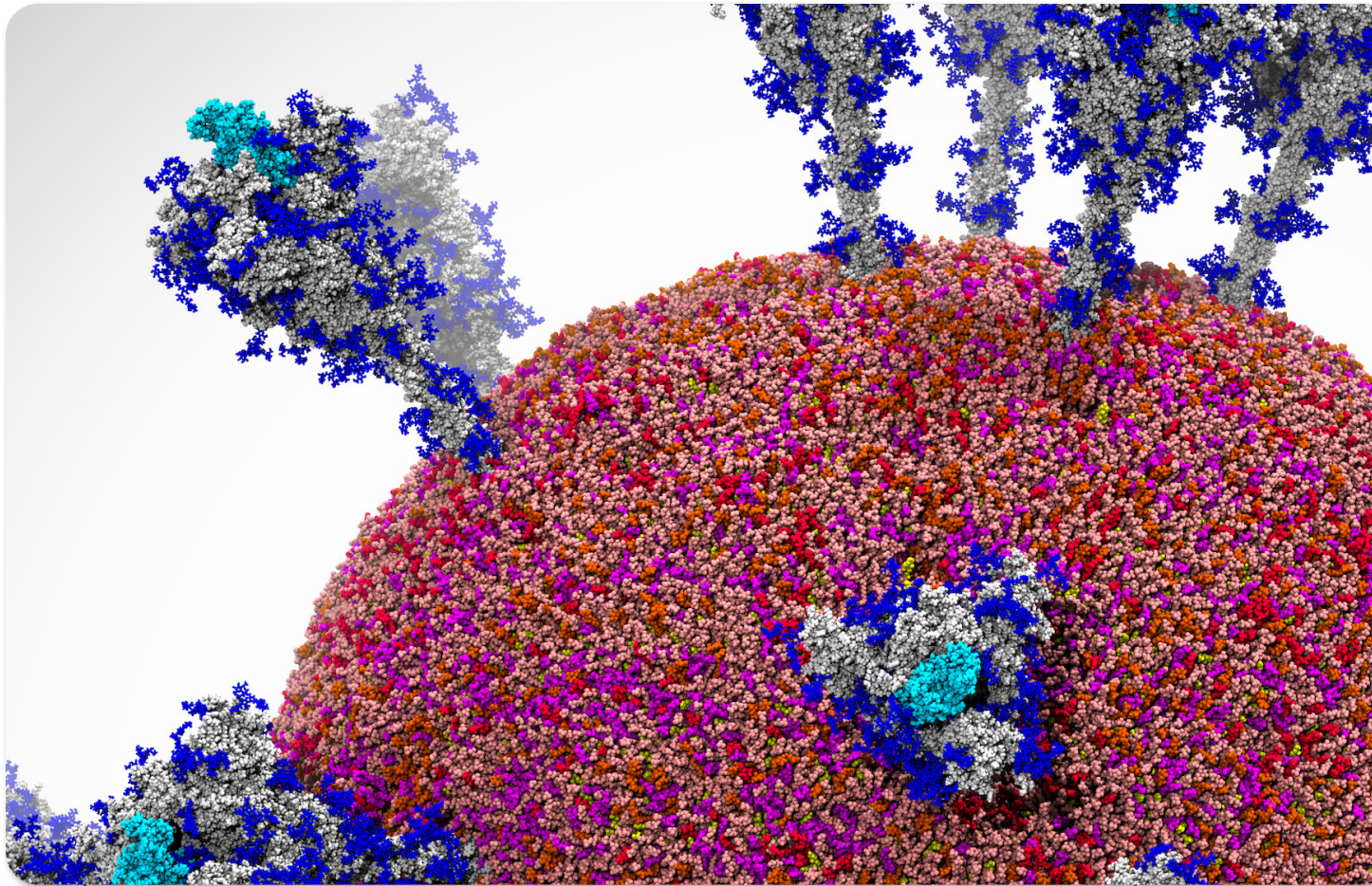
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Contents

Executive Summary

The COVID-19 pandemic has disrupted many aspects of daily life, including the research enterprise in the United States and globally. During this time, the scientific user facilities supported by the U.S. Department of Energy (DOE) Office of Science rapidly adapted to meet the research community's needs under COVID-19 restrictions, successfully operating and supporting important scientific experiments. Most Office of Science user facilities primarily serve users onsite (i.e., researchers perform experiments at the facility and collaboratively interact with facility staff). For this group of facilities, the extreme limitations to onsite physical presence due to COVID-19 had major impacts on operations and the ability to serve users. Other user facilities conventionally serve users

Capturing lessons learned during pandemic-era operations is vitally important, along with identifying opportunities to provide even stronger, more resilient, and more enabling user facilities in the future.

remotely or via "mail-in" modes of operation and thus were able to continue core operations, albeit at reduced capacity because of no or fewer onsite staff. For both groups, however, the inability to train users, conduct experiments with them (either hands-on or remotely), discuss results, or mentor students would have seriously jeopardized scientific progress in many cases if not for the facilities' rapid response to COVID limitations. The pandemic has especially affected early career scientists, postdoctoral researchers, and students who are under time pressure to deliver their science and build collaborative networks.

During the pandemic, Office of Science user facilities immediately responded with innovations that enabled their science programs to continue and modified many operations to create safe working conditions for staff while providing support for users. Capturing lessons learned during pandemic-era operations is vitally important, along with identifying opportunities to provide even stronger, more resilient, and more enabling user facilities in the future. To this end, the Office of Science convened facility staff, user executive committee chairs, and users from across its user facilities to participate in a virtual roundtable. The roundtable was organized into six panels: User Research in Virtual Contexts; User Research in Physically Distanced Contexts; Facility Operations in Physically Distanced or Virtual Contexts;

User Training and Engagement; Computation, Data, and Network Resources; and Crosscutting Issues.

Participants identified key opportunities, lessons learned, and best practices that the user facilities should share and adopt to enhance efficiencies and improve productivity. They acknowledged that the balance between cost/impacts and benefits of remote user access will be different for each facility and that each must decide the right balance for its user community. Participants also noted that opportunities emerging from increased remote and virtual collaboration, enhanced automation, autonomous controls, and robotics could open up new ways of performing complex experiments, collaborating, and accelerating scientific breakthroughs. Moreover, these new approaches to facility operations could catalyze the development of new tools to engage and support broader user communities, enhance experiment execution, and improve operational infrastructure.

Finally, roundtable participants noted that as the pandemic continues, further opportunities will emerge for providing the best possible science environment for user communities. They agreed that the roundtable is an excellent starting point for capturing observations, challenges, and opportunities and that continually updated best practices and lessons learned should be shared across the Office of Science user facility complex.
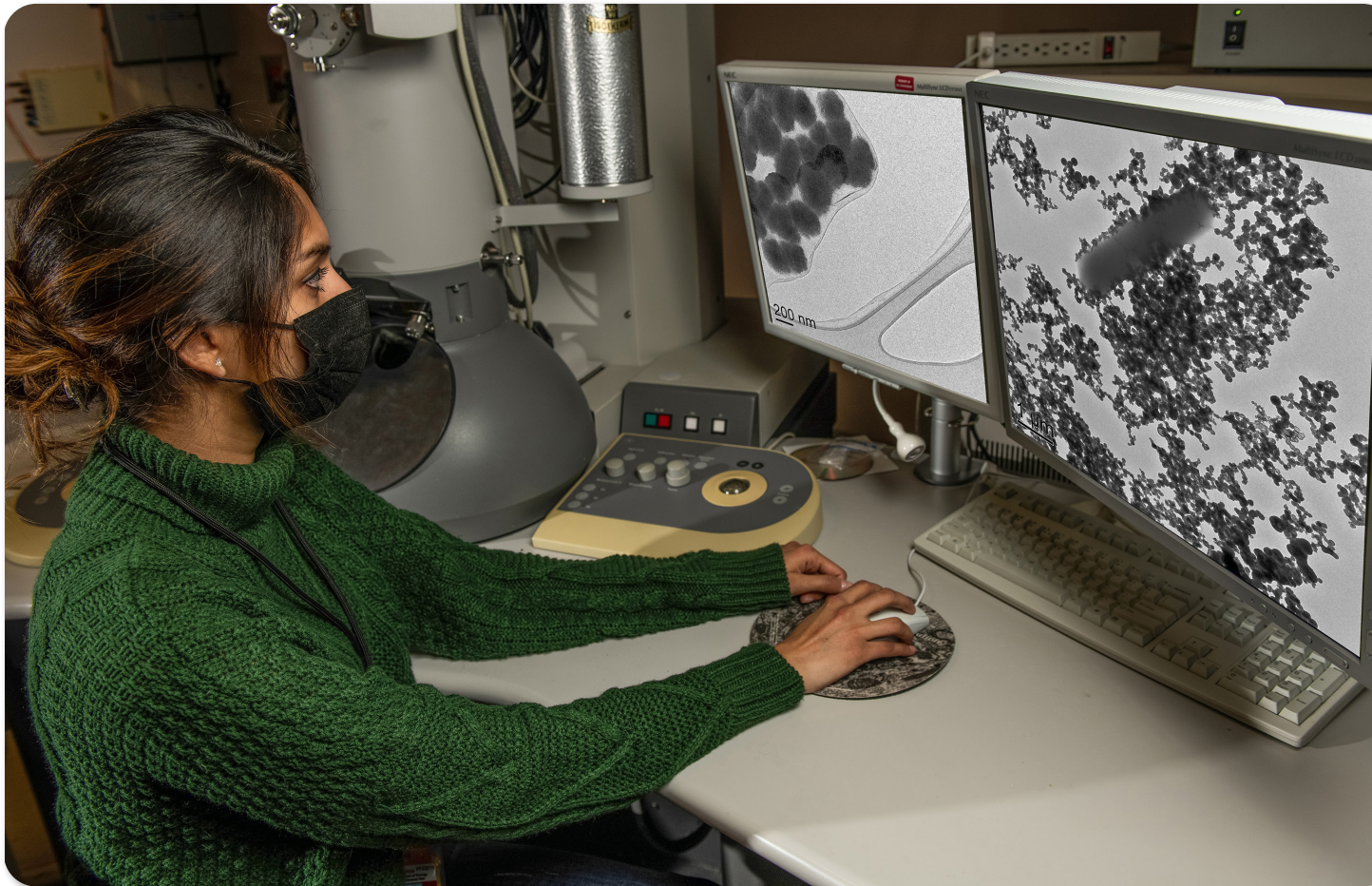
Chapter 1
User Facility Impacts and Responses to COVID-19

In late 2019, doctors in Wuhan, China, realized a potential crisis was emerging as they treated large numbers of patients for pneumonia for which the underlying pathology was not understood. On January 9, 2020, the World Health Organization and Chinese authorities announced that a novel coronavirus—subsequently named Severe Acute Respiratory Syndrome Coronavirus 2, or SARS-CoV-2—was responsible for this outbreak and the disease now known as COVID-19. In the United States, travel-related cases of COVID-19

Fig. 1.1. Virtual Operations Take Off. A user of the Center for Nanophase Materials Sciences at Oak Ridge National Laboratory (ORNL) interacts with a staff member in the clean room during an augmented reality session using HoloLens virtual reality glasses. At the onset of the COVID-19 pandemic, many Office of Science user facilities began limiting in-person user experiences, concentrating instead on virtual operations. [Courtesy ORNL]

emerged in late January, and U.S. health professionals identified the first cases of community transmission in late February, indicating that the disease had been spreading unchecked in the country for some time. The World Health Organization declared a global health emergency on January 30, and the United States quickly followed suit on February 3, first declaring a public health emergency and then on March 13, a national emergency. Deaths in China alone quickly exceeded those worldwide from the 2003 SARS outbreak, and the first U.S. death appears to have occurred in early February. Global travel was restricted in early February, and various U.S. jurisdictions issued stay-at-home orders in mid-March, upending the normal conduct of society.

The U.S. Department of Energy (DOE) Office of Science (SC) supports 28 scientific user facilities (see Appendix A, p. 32). As DOE launched research efforts to combat COVID-19, these facilities quickly felt the impacts of the pandemic and the restrictions to limit virus spread. As a result, they rapidly curtailed onsite activities for both staff and users. Across the different facilities and user communities, responses ranged from canceling, postponing, or abridging in-person user experiences to shifting to virtual operations (see Fig. 1.1, this page). These different responses arose because the scientific scope and manner in which the user facilities support their research communities vary tremendously across the

facility portfolio. At one end of the spectrum, the leadership computing facilities, supported by SC's Advanced Scientific Computing Research program, normally operate with facility staff onsite and users fully remote. At the other end, the nanoscale science research centers, supported by the Basic Energy Sciences program, typically operate almost entirely with users onsite. This range of operations across the portfolio is illustrated in Fig. 1.2, p. 3, which schematically indicates how each facility's staff and users shifted in response to the pandemic.

Users, user program administrators, scientific staff, and operations staff have adapted with remarkable creativity and resilience to the dramatic and abrupt change in their ability to work. As medical therapeutics and vaccines bring the pandemic under control, life is expected to return to some semblance of normalcy. However, capturing the insights from user, administrator, and staff experiences of the last year is imperative for the Office of Science to fuel both near-term tactical improvements and a long-term vision for an even stronger, more resilient, and impactful user facility enterprise that enables an even broader spectrum of users. The COVID-19 pandemic thus has presented an opportunity to consider permanent changes to user facility operations.

To leverage this opportunity, in December 2020 SC held a virtual roundtable discussion of lessons learned during

Fig. 1.2. Pandemic-Induced Shifts of Staff and Users to Remote Work by DOE Office of Science (SC) User Facilities. SC user facilities have diverse operation models and experienced significant disruptions because of the pandemic. Despite these challenges, they found ways to continue to conduct research and support users. There are two broad trends in how operations shifted from before the pandemic (orange circles) to fall 2020 (purple circles). In one case, facilities that had many remote users before the pandemic continued to support these users, but facility staff shifted to working remotely (blue arrow). In the other case, facilities that had mostly onsite users shifted both facility staff and users to working remotely (green arrow).

the pandemic and what they mean for the future of the user facilities. The discussion included participants from the user facilities and representative users (see agenda and participants in Appendices B–C beginning on p. 34). Prior to the roundtable, facilities submitted responses to a request for factual information on their experiences and status under the pandemic. These factual status documents informed the roundtable discussion and are included in this report (see Appendix D, p. 38). The roundtable itself was organized into a series of panels with questions that helped facilitate and guide discussion (see sidebar, Roundtable Panels and Questions, p. 4).

The observations, challenges, and opportunities identified from each panel's discussions are synthesized in this report:

- Ch. 2: Staff and Users
- Ch. 3: Facility Operations
- Ch. 4: Computing and Data Resources
- Ch. 5: Strategic Issues

This document represents the user facility community's response and reactions to the ongoing pandemic. These reactions will continue to evolve over the next months to years as user facilities grapple with the consequences of the international COVID crisis. The information and ideas captured herein provide a solid platform upon which to strengthen the user facility enterprise. By extending the lessons learned during the pandemic, user facilities can enhance their ability to deliver impactful scientific and technical results and serve SC user communities.

Roundtable Panels and Questions

User Research in Virtual Contexts

- What approaches are user facilities invoking today to provide productive user research experiences in a virtual context? What works and what does not?
- Who is a "real user" in a virtual context?
- What is a world-class virtual research experience today and in the future, and what tools or technologies are required to deliver that?
- What are the resource impacts in delivering virtual research experiences?
- What are the cybersecurity implications of virtual user research?
- Are there unique considerations for remote access by foreign nationals or users not based in the United States?
- What are the impacts or opportunities for international participants in U.S. user facilities?
- What lessons can DOE learn from international facilities, other domestic user facilities, and the National Virtual Biotechnology Laboratory?
- How are early career, student, and postdoctoral users affected in this new environment?

User Research in Physically Distanced Contexts

- What are the impacts of physical distancing protocols on in-person research at the user facilities (for users, scientific staff, and operations staff)?
- What are the implications of a sole in-person user for a project rather than a small team?
- What approaches are large collaborations taking?
- What are the implications for publication authorship in these contexts?
- How are early career, student, and postdoctoral users affected in this new environment?
- What best practices have been identified for bringing staff and users back onsite?

Facility Operations in Physically Distanced or Virtual Contexts

- What challenges have operations staff encountered in the shift to physically distanced protocols?
- What are the risks (e.g., cybersecurity) and opportunities (e.g., automation) that remote control of operations provides?
- How are user-access controls being addressed?
- What infrastructure modifications are needed to accommodate both operations and user research (e.g., HVAC and interpersonal shielding)?
- Are special considerations needed for users with sensitive or proprietary information?

- How are materials being managed?
- How are interactions with vendors, suppliers, and maintenance personnel being conducted?
- How are facility reliability and up-time impacted, and what best practices exist to maintain operational excellence?
- What are best practices for mitigating impacts on vulnerable staff groups (e.g., early career and caregivers)?
- How are staff training and development being conducted under physical distancing?
- Are there increased efficiencies that could become permanent?
- How are project durations or allocation policies affected during COVID-19?

User Training and Engagement

- What approaches are user facilities taking to train users and engage user communities accustomed to in-person experiences? What works and what does not?
- How are early career scientists, students, and postdoctoral researchers affected in this new environment?
- Are new approaches required to onboard and train new users? If so, could these approaches be leveraged to broaden user access or for other benefits?
- How can user facilities more fully participate in virtual research program meetings and increase awareness of new capabilities?
- How are user facilities conducting outreach, including user meetings, in a virtual context to engage with existing and potential users?
- How are educational programs (e.g., internships) being conducted?

Computation, Data, and Network Resources

- What has the COVID era revealed about the needs for virtual access to computational, data management and analysis, software, and network resources?
- What improvements or enhancements should be sought now and in the future?
- From a qualitative and strategic standpoint, what human and technical resources are required to affect these improvements?

Crosscutting Issues

- How can we best manage remote or virtual teams and maintain team alignment, coordination, and dynamics?
- Are there key issues related to facility workforce retention, remote work, or work-life integration?
- How do we ensure equity among users and staff and onsite and remote operations (e.g., selection of a subset of users for return to onsite operations)?

Chapter 2
Staff and Users

U.S. Department of Energy (DOE) Office of Science (SC) user facilities have different operational models depending on the type of work performed at each facility. Because of these differences, staff responsibilities and user experiences range widely—from data- and computation-centric facilities with fully remote users, to accelerator facilities whose users work onsite for extended periods of time, to facilities that fall between these two extremes. Users of data and computation facilities have been largely unaffected during the pandemic. However, users at other facilities have been greatly impacted, including

those at high-energy accelerator facilities involving large collaborations as well as users of instruments, laboratories, and beamlines requiring hands-on participation. Regardless of operational model, a common factor among all facilities has been their success in accommodating additional virtual users. All have had to overcome similar challenges to provide effective virtual user experiences, ensure reliable computer connectivity to onsite resources, coordinate support by local staff, and maintain user engagement.

Many of the COVID-related challenges faced by the research community as a whole have disproportionately affected some user facility staff, along with students and early career scientists. For example, some staff were unable to effectively work from home during the shelter-in-place period because of the nature of their jobs. Also impacted are staff who have young children or other family obligations that require time investment while juggling remote work. In many cases, facilities have had to develop new work activities or approaches while also modifying user projects due to limited onsite staffing levels and the remote nature of interactions. For students and early career researchers, networking, training, and building personal and professional relationships are even more critical than for established researchers. Although these interactions are possible in a remote environment, they can be harder to achieve and feel less organic.

2.1 Observations

COVID Impacts on All Facility Types

The COVID-19 pandemic affected a range of operations across SC user facilities. All facilities acknowledged impacts on their work models, even those already accustomed to operating with a remote user base. Such facilities include those that support remote computational work or provide specific "mail-in" experimental capabilities like those available at light sources, neutron sources, the nanoscale science research centers (NSRCs), Joint Genome Institute (JGI), Environmental Molecular Sciences Laboratory (EMSL), and Atmospheric Radiation Measurement (ARM) user facility (see Fig. 2.1, p. 7). Facilities supporting remote users could often maintain core operations with reduced staffing during the pandemic but required significant rebalancing between staff who could readily work from home and those required to be onsite.

For the facilities typically providing in-person access for users, most were able to conduct a significant level of

remote operations. However, for all these facilities, the number of staff available to support remote user experiments was insufficient to maintain overall productivity. For facilities where users work directly with the capabilities (e.g., build their own custom setups or conduct large science experiments in nuclear physics), the loss of physical access had negative effects. Impacts included reduced operational productivity, the inability to execute ongoing upgrades, and a significant increase in staff effort.

Some facilities were never designed to significantly support remote user operations. For example, the NSRCs, neutron and light sources, and large physics experiments were set up primarily for onsite user work. These facilities depend on users to perform work at the facility and have collaborative interactions with facility staff. They typically operate on a 24-hour schedule, including weekends. Consequently, there simply are not enough staff to enable these facilities to support the same volume of experiments remotely or to transition to completely mail-in operations. Working with virtual users—particularly new users unfamiliar with instruments and resources—requires considerably more effort from staff. In addition, the types of activities that a user can accomplish remotely are limited. For many complex experiments, the user has unique knowledge that is difficult to replicate remotely. Several facilities were not able to operate at 100% efficiency because of these restrictions (i.e., reduced staffing for each experiment and fewer constructive interactions to tap into user expertise).

Complex Experiments and Research Productivity

For large physics experiments, users typically contribute to experiment construction and operation, and their absence is very difficult to mitigate. As a result, major research efforts often had to be deferred or delayed during the pandemic. Given the inherently collaborative nature of complex experiments requiring substantive iteration, there is a longer-term risk to science quality and the potential to regress to performing simpler measurements rather than transformational experiments. These risks result from both onsite limitations and controls at the DOE national laboratories as well as challenges users may have in accessing tools at their own laboratories. Difficulties in accessing all layers of the research infrastructure—from facility-level capabilities to local computing resources—is a common theme that has limited research productivity during the pandemic.

Fig. 2.1. Arctic Mission Continues with Minimized Impact from Pandemic. The 2019–20 Multidisciplinary Drifting Observatory for the Study of Arctic Climate (MOSAiC) expedition used the icebreaker R/V Polarstern as its central observatory. The Atmospheric Radiation Measurement (ARM) user facility provided more than 50 instruments for MOSAiC. During the deployment, teams of rotating personnel monitored the instruments onsite with a focus of studying changes in the Arctic climate. Due to international travel restrictions during COVID-19, the ship periodically had to leave the floes to pick up rotations of scientists. [Courtesy ARM and Los Alamos National Laboratory]

Staffing Adjustments

To comply with COVID-19 restrictions, facilities have had to adapt staffing levels and responsibilities, implementing measures such as approved onsite staffing quotas and social distancing. Staff with primarily lab-based roles, such as providing scientific support to users or operating and developing instruments, kept productive by shifting to offline or remote work in support of users. This work included data analysis, quality control, and uploading; manuscript drafting; and procedure and proposal writing. Managers worked with staff to define projects, provide training, or assign other tasks in lieu of hands-on engineering or technical work. In several cases, the national laboratories developed platforms enabling researchers and groups to post short-term job opportunities with other projects for staff adversely impacted by COVID restrictions. Flexibility in schedules has helped facilities manage resource

availability and their staff manage responsibilities outside the work environment. Regular virtual communications between supervisors and staff have ensured that staff are productive and remain connected to their facility and its mission.

Training and Interactions for Users and Facility Staff

A COVID-era challenge has been the inability to conduct hands-on training, particularly for early career researchers. Facilities are using numerous teleconferencing tools (e.g., Zoom, BlueJeans, Discord, Teams, Slack, and Skype), but these tools, along with virtual tours, seminars, or even augmented reality (see Fig. 2.2, p. 8), cannot replicate hands-on, in-person user experiences with a diverse team of experts. This limitation is especially true for new-user training and for training on complex equipment. In situations where in-person training

Fig. 2.2. Solutions for Remote Work. Using 360° smart video conferencing, onsite staff work with remote users on experiments at the Linac Coherent Light Source during the pandemic. [Courtesy SLAC National Accelerator Laboratory]

is possible, restrictions on staff interactions and group sizes have made it more time consuming and required additional planning and scheduling. Another concern is the potential for user facilities to become viewed as service entities or staff to be perceived as a "pair of hands" replaceable with automation.

This changing model of interaction between staff members and users has both negative and positive impacts. A notable problem is increased stress among staff members in this environment. Of particular concern is the isolation of early career staff members and those without local social ties. Approaches to mitigate these challenges include maintaining regular virtual interactions and offering greater flexibility in setting up virtual mentoring relationships to support early career staff, which has been very successful. Facilities also are experimenting with communication tools and practices to try to bridge the gap in providing valuable training and interactions between staff and users, but there is a learning curve in delivering these effectively. Facilitating live text or video chatting can provide more interactions between users and staff, and continuous live feeds (text or telepresence) can help simulate face-to-face experiences for both groups.

Random and planned in-person interactions drive scientific progress. Although many collaboration tools can aid

virtual interactions, user engagement approaches that can effectively replicate in-person experiences remain challenges. Virtual forums that are as engaging as in-person interactions are needed for gathering groups of multidisciplinary experts. If this need is not met, there is a long-term risk of slowing scientific progress.

Even for users and staff who can efficiently work remotely, the lack of hands-on user access, which is vital for the development of a well-trained scientific workforce, is a challenge. For many facilities, a large fraction of their user communities was originally trained at a facility, and these in-person experiences affect decisions about which research areas or careers to pursue. User facilities also are important places for researchers to casually interact in person and develop a professional network. A number of issues emerging from COVID-related impacts need to be evaluated and addressed in new operational models for the national laboratories. These include the impact of isolation on mental health, the overall rate of progress that can be maintained in scientific research when conducted remotely, and institutional identity.

The absence of in-person interactions particularly affects the development of early career staff. These scientists are under more pressure to perform research in a shorter period of time, and limited access has

significantly slowed their progress. Similarly, the physical presence at a user facility provides an opportunity for cross-training related to scientific best practices. Facilities are trying to mitigate this gap by extending appointments for postdoctoral researchers as needed and prioritizing time for postdoctoral experimental work in the laboratory. Hiring, recruiting, and onboarding of new staff have continued during the pandemic, with a shift to remote onboarding and work assignments as appropriate. However, there are clear challenges for new staff in growing professional networks and making strong connections to the facility.

Work-Life Balance

Finally, the pandemic has heavily disrupted work-life balance. For staff who can readily work from home, eliminating time-consuming commutes has improved both work-life balance and productivity. Nonetheless, many staff and users working from home have experienced significant challenges, such as managing remote education, a lack of childcare support, and limited access to the facilities required to conduct their research. For many facility staff and users, personal and professional activities have become conjoined while working remotely because of the plethora of online communication tools and 24/7 internet access. Consequently, both users and facility staff face burnout created by the "always on" perception. Early career researchers or those with care responsibilities appear to be most impacted.

2.2 Challenges

For both facility staff and users, shifting from onsite to virtual operations presents a number of challenges to efficient, productive, and world-class research in the short and long terms. Operating experiments safely and effectively with, in some cases, dramatically fewer onsite participants requires changing an historical operating model that has successfully produced world-leading scientists and scientific results for decades. Experimental science is currently very challenging in a remote environment because, for many facilities, operations are predicated on the availability of people onsite.

User Facility Staffing Models

Staffing models at many user facilities rely on the user as an active onsite participant in experiments. If the shift to virtual operations continues, facilities must find ways to mitigate the increased demands on staff to support user experiments and to meet mandatory safety requirements.

During the pandemic, staff took on additional duties beyond their regular work commitments, both for work and to manage their personal responsibilities. Interactions in a virtual environment do not take place in the same manner or with the same efficiency as those that occur in person. Electronic logbooks and recorded chats can help transfer information from one shift team to the next, but these mechanisms need improvement to assist staff and users with real-time decision-making. For some experiments (such as in particle physics), both staff and users participating from all over the world can work remotely, with no real "day shift" or face-to-face handoff between shifts. Sharing the successful approaches used by these teams could improve operational outcomes and user and staff experiences across the DOE user facilities complex.

In addition to scientific staff, support personnel have been affected by COVID limitations, with significant impacts on the availability of electrical, carpentry, and custodial services. The lack of technical staff onsite during the pandemic has increased the workload for essential facility workers, particularly infrastructure and operations staff tasked with gathering information, power-cycling equipment, checking rack status, and more for the technical system administrators working remotely. Additionally, these staff are having to manage vendor interactions for longer-than-expected equipment maintenance and installation.

Managing when a workday starts and ends has become a challenge at all facilities, since both users and facility staff are frequently working nonstandard schedules (i.e., nights and weekends) from home, which can lead to an overwhelming stream of communications. Remote work can also affect staff availability for user support, particularly if users are onsite. Both staff and users are facing additional personal responsibilities and stressors, which may also affect their ability to perform or be onsite. Some staff may lack a strong local support network or be living alone or away from family. Improvements to remote work environments are needed to enhance the ability to engage with experiments and colleagues.

Current and Future Staffing Pipelines

Most user facilities rely on years of in-person experience to train the next generation of staff scientists. Finding ways to reduce the pandemic's impact on the pipeline of future staff who are currently early career scientists is critical to the long- and short-term health of user communities and facility staff. Reduced
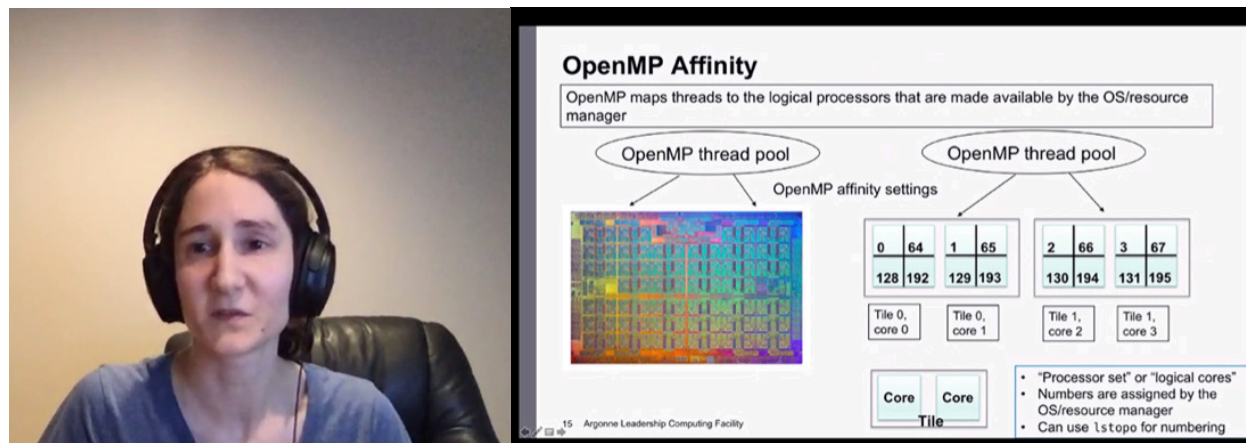
Fig. 2.3. Virtual Format Boosts Meeting and Workshop Participation. Argonne National Laboratory (ANL) computational scientist Colleen Bertoni provides an overview of the OpenMP programming model at a virtual Argonne Leadership Computing Facility workshop in May 2020. Capitalizing on the benefits of virtual meetings, including increased attendance, is an opportunity for facilities going forward. [Courtesy ANL]

opportunities for hands-on experience in troubleshooting, operating, and understanding complex experiments will affect the careers of future staff scientists and, in the longer term, the expertise needed for progress in the field. Overcoming these limitations is a challenge, along with finding ways for late career staff to continue to contribute safely while training and mentoring their early career successors.

User and Staff Engagement and Connection in the Virtual World

An ongoing challenge for many facilities is maintaining staff engagement, team dynamics, and enthusiasm through connection to the facility mission while working remotely. Similarly, finding ways to effectively engage remote users is critical for continuing to operate world-class experiments and maintaining the needed levels of users and staff. To expand the user base in the short term, processes and materials for training and self-help need to be developed. Another challenge for some users is the lack of a sense of belonging. A remote working environment can diminish the stimulating effect of working at a national laboratory and being surrounded by world-class researchers. Remote access can improve opportunities for some users who may not otherwise be able to travel to a national laboratory. However, translating that access to a successful career outcome requires ensuring that all users have the necessary elements for productive remote engagement. The careers of some students and postdoctoral researchers

are clearly being affected by delayed graduations, virtual job searches, and fewer available positions.

Communications, Conferences, and Workshops

Effective and consistent communications to staff and users during the pandemic have been difficult, as rules governing onsite staffing levels, mask usage, social distancing, and travel restrictions dynamically change. Adding to this challenge are the constantly shifting (and sometimes contradictory) requirements from local, state, and federal authorities.

Remote conferences became a necessity during the pandemic (see Fig. 2.3, this page) and, as described in Section 2.3, p. 11, provide distinct new opportunities. Nevertheless, there are challenges related to the level and quality of participant engagement that need to be addressed. For example, international conferences and collaboration meetings across global time zones are often out of sync with people's work schedules. In a virtual format, there also are fewer opportunities to connect, meet, and have side conversations that grow professional networks, especially for early career researchers. Holding productive virtual discussions in question/answer forums has also proven difficult, and inequity in connectivity and infrastructure bandwidth affects the meeting experience and participation of users with fewer resources.

Training and Onboarding Staff and Users

Most user facilities have experience with online user training, which they are likely to expand in the future. For some training modules, the pandemic has made the value of training reciprocity, where training at one facility satisfies training requirements at another facility, more apparent. While training reciprocity may seem to be an obvious benefit, individual rules and regulations across laboratories have limited its success. Consequently, the network of SC user facilities—each operating within the parameters of a host institution—face some challenges in following the trend of an increasingly integrated and broadly interconnected user community.

In many cases, the pandemic has made training and onboarding new staff and users much more difficult. In particular, virtual training on certain instrumentation is harder or impossible. Social distancing rules also can strongly impact the effectiveness of onsite training for students, postdocs, new staff, and early career scientists. Training of accelerator and experiment operators presents additional challenges because of concerns about potential group quarantines that would impact operations. In all cases, planning and executing training that is either virtual or a hybrid of virtual and onsite require more effort than purely onsite training. This shifts additional burden to staff who execute remote instrument training, reducing the time they have for other work.

2.3 Opportunities

The pandemic has forced user facilities to introduce operational modes that enable users to benefit from the facilities without the need to be physically present. Adopting these operational modes more permanently will provide new opportunities to users, staff, and the facilities overall. More efficient, flexible access and improved productivity have the potential to benefit the entire user facility ecosystem. At the same time, workloads need to be carefully evaluated to identify work that reasonably can be transferred from users to facility staff. In the absence of major health concerns, childcare and social distancing challenges can be remediated.

Opportunities to ensure the next generation of staff are experts in remote and virtual collaboration, enhanced automation, autonomous controls, and robotics could open up wholly new ways of performing complex research, interacting with users, and accelerating scientific breakthroughs—which are hallmarks of SC user facilities.

Reaching a Broader User Community

Virtual platforms enable user facilities to reach a wider community. For example, remote operations can increase access for international and other researchers whose travel costs would otherwise limit their participation in facility experiments. Moreover, a larger research team consisting of both onsite and remote users can engage in remote experiments. To continue serving users in this increasingly virtual world, SC user facilities will have to adjust how they design their software, instruments, and processes and how they staff their facilities. Automation, virtual reality tools, and virtual environments are being developed to provide users with an "at the facility" experience. Although such tools will benefit the scientific community in general, user facilities have the opportunity to lead in the development of tools including augmented reality and telepresence robots, which will also enable facilities to maintain manageable staffing levels for operations and user support.

Providing easier access to a facility (e.g., through simpler scheduling) lowers the barrier for new user experiments and benefits researchers by providing easier ways to leverage multiple techniques across facilities. Streamlining logistics and access can also increase the user base by facilitating opportunities for new collaborations. These new modes of interacting and performing research can increase the talent pool by removing travel and relocation requirements. In addition, reducing travel to user facilities whenever possible helps lessen the climate impacts of the user facility program, since air travel in particular contributes significantly to greenhouse gas emissions.

Facilities have observed that core platform capabilities that multiple users can access in parallel or simultaneously, whether onsite or remote, can catalyze collaborations. These considerations provide additional motivation for user facilities to become innovators in networking and collaborating between onsite and remote teams.

Streamlining and Standardizing User Onboarding and Training

User facilities tend to develop their own training modules and processes for user onboarding. In a remote environment, users will have a greater opportunity to perform experiments at multiple facilities across the country. Generating common software and databases for onboarding users and standardizing universal training across facilities could dramatically reduce redundancies (e.g., general employee radiological training and cybersecurity are required for all light source users). By

producing virtual training content and enabling cross-facility participation, facilities can create long-term, broadly used resources that will further contribute to user mobility between facilities. Also, many facilities are reporting higher levels of participation in online training courses. Developing the appropriate training materials and easy-to-navigate online content may lead to a broader reach of these materials even when users are allowed to return onsite.

Embracing Hybrid Conferences as the Future

The pandemic has made the value of virtual conferences clear. Recognizing this value is especially important for user facilities that regularly hold user meetings and training workshops. Virtual meetings provide an opportunity for many more attendees to participate and lower the barrier for attracting top-notch speakers. In fact, many facilities have observed increased participation in workshops, tutorials, and user meetings held remotely. However, the level of attendee engagement for virtual meetings is clearly subpar compared to in-person events.

Post-pandemic, there is an opportunity to balance the positive aspects of remote and in-person events through hybrid conferences. Such conferences provide the opportunity for in-person networking and social interaction while enabling the creation of long-term resources, such as podcasts and videos, that can be used for future conferences and workshops. However, it will be important to achieve a balance for hybrid events that ensures both the in-person venue is attractive and the experience for virtual users is still engaging. To be successful, creative new approaches will be needed for software and hardware. Over the past year, facilities have tried many such approaches (some more successful than others), and there is a tremendous opportunity to share best practices across facilities to optimize both the onsite and virtual experiences. A broader exchange of ideas between user facilities on experiences with different conferencing platforms will help drive the necessary innovation in this area.

Helping Early Career Scientists, Postdocs, Students, and Underserved Populations Succeed

The pandemic has been especially challenging for early career scientists, postdoctoral researchers, and students. Ensuring their future success is a responsibility of DOE and the user facilities. For example, prioritizing in-person experiences for these groups, along with new users, will be important. Employers and

funding agencies have the opportunity to encourage other helpful approaches such as "freezing the clock" for early career scientists (as well as early career grant opportunities). In the remote environment, establishing a closer-knit mentoring system for all students, postdocs, and early career scientists is important, as is increasing the availability of group mentoring. Classroom or virtual trainings could be enhanced with more interactive ways of engaging students (e.g., through polls, videos, and podcasts), and networking could be improved with more creative social media approaches. As virtual communication becomes increasingly routine, focusing on skills needed for effectively writing and presenting in the remote world will be necessary. Also, since remote experiments do not require local access to a facility, a special focus can provide more opportunities for foreign nationals, minorities, and other underserved populations.

Re-Evaluating the Roles of User Facility Staff

The added responsibilities of user facility staff in the remote environment are not sustainable in the long term. Given the current disruption of established modes of operation, SC and its user facilities have an opportunity to rethink the roles and responsibilities of facility staff to promote exciting and rewarding careers post-pandemic. In the short term, expectations on staff productivity need to be set to minimize staff burnout. In the longer term, establishing core office hours and rotating on- and offsite assignments may result in more flexible work schedules that help staff better balance work and other responsibilities. These measures could lead to a more profound re-evaluation of staffing profiles that could include more technician-level staff to keep 24-hour experiments running. This opportunity could open a path for a new generation of skilled technical workers who can operate and troubleshoot complex machines in the future.

Mentoring and Continued Education

User facilities have long played an important role in mentoring and educating researchers. Many of the ways facilities traditionally have done this—by providing onsite experiences—have not been available during the pandemic. As facilities transition back into a more conventional mode of operation, retaining lessons learned will be important. Remote access has forced facilities to explore formal mentorship programs that create ways in which early career scientists feel a sense of belonging. As facilities are learning to provide the necessary teaching and training to remote users, there are opportunities to apply the lessons from these approaches to a broader context of training the next generation of researchers.

Chapter 3
Facility Operations

Starting in March 2020, Office of Science (SC) user facility operations changed in response to national and local restrictions related to the COVID-19 pandemic. Restrictions varied from state to state and over time, resulting in the need for graded and flexible approaches to facility operations, building occupancy for staff and users, and mission work. Developing these approaches required actively engaging occupational health professionals to ensure protocols for protecting staff health reflected the evolving understanding of the pandemic. To enable resumption of activities while keeping staff safe, facility leadership teams developed clear communication of pandemic protocols and

expectations for staff and users through consensus of stakeholders and occupational health professionals.

3.1 Observations

Operational Changes

To mitigate virus spread and create safe working conditions for staff, facilities implemented a number of operational changes. Many facilities restricted access, initially moving to teleworking for all staff and then allowing a limited number of staff to return onsite after enhancing cleaning protocols and reconfiguring or demarcating work spaces to maintain social distancing and personnel occupancy limits. Some facilities set up temperature checks and hand sanitizing stations at entrances or modified HVAC systems to improve airflow.

Several factors reduced facility operational efficiency. For example, due to the need for physical distancing, many facilities reconfigured workflows to be conducted serially rather than in parallel with multiple workers, which increased the time required to complete tasks. Additionally, with few staff onsite, expert staff needed for consultation or problem-solving were not always available. Also, complex experiments required redesign or engineering innovations so that work could be executed with fewer hands or with virtual tools. In other cases, some facilities delayed complex experiments or changed the scope of work to be performed. COVID-19 infections and quarantining requirements also affected staff availability to complete operational tasks.

Health, Safety, and Security

To ensure the health of onsite users and staff, facilities implemented daily health screens, use of face masks (see Fig. 3.1, p. 15), and increased cleaning and sanitization. Some national laboratories also instituted viral testing and occupational contact tracing with fast turnaround times. To minimize spread to others, affected staff quarantined until they received test results. Early in the pandemic, procuring personal protective equipment (PPE) and cleaning supplies was difficult for some laboratories, which impacted decisions about the work that staff could safely execute. Labs or offices were shut down and thoroughly cleaned and disinfected if staff performing work in those spaces tested positive. Particularly worth noting is that in the initial stages of the pandemic, the understanding of disease epidemiology and transmission mechanisms was quite poor, leading to significant anxiety and fear in both users and staff concerning their personal safety.

Remote Access

Facilities deployed remote communication tools to minimize the number of staff onsite or in the same physical space. Effectively using these and other virtual tools required facilities to integrate many disparate capabilities and processes, such as control of remote computation and instrument resources, video conferencing and electronic logbooks to transfer information between users and local staff, sample handling procedures, data management and analysis tools, and user training. Some facilities employed telepresence capabilities that included hand-carried tablets, augmented reality goggles, or robots. These tools enabled staff or users working remotely to be "in the room" with facility staff operating the instruments. In some cases, this ability increased collaboration because many more people could clearly view the instrument from remote locations.

Having already established practices for a mix of onsite and remote teams, existing large collaborations were better prepared for pandemic-era operations and thus adapted quickly to fewer onsite users. However, in some cases, revisions were needed to collaborator responsibility agreements, such as the requirement for institutions to provide individuals to staff shifts. In-house staff and in-residence users formed a responsible core team to prepare and execute experiments.

Some facilities could operate and collect data from instruments remotely, requiring only sample changes onsite. However, the ability to operate instruments remotely was sometimes impossible or limited to facility staff because of either technical limitations of the equipment or cybersecurity concerns related to allowing users remote access. Even when possible, remote operations often were limited to simple workflows. Also, facilities in some cases could not perform certain basic functions (e.g., accelerator or reactor operations) remotely due to operational risks.

For remote data users, operations were largely unaffected because the mechanisms and security to access data were already in place.

Vendors and Subcontractors

During the pandemic, facilities continued to require vendors onsite for maintaining and installing equipment. Interactions with vendors became more strategic and planned as greater coordination was needed due to limited onsite access. Vendors also had to abide by their own companies' policies, occasionally delaying their
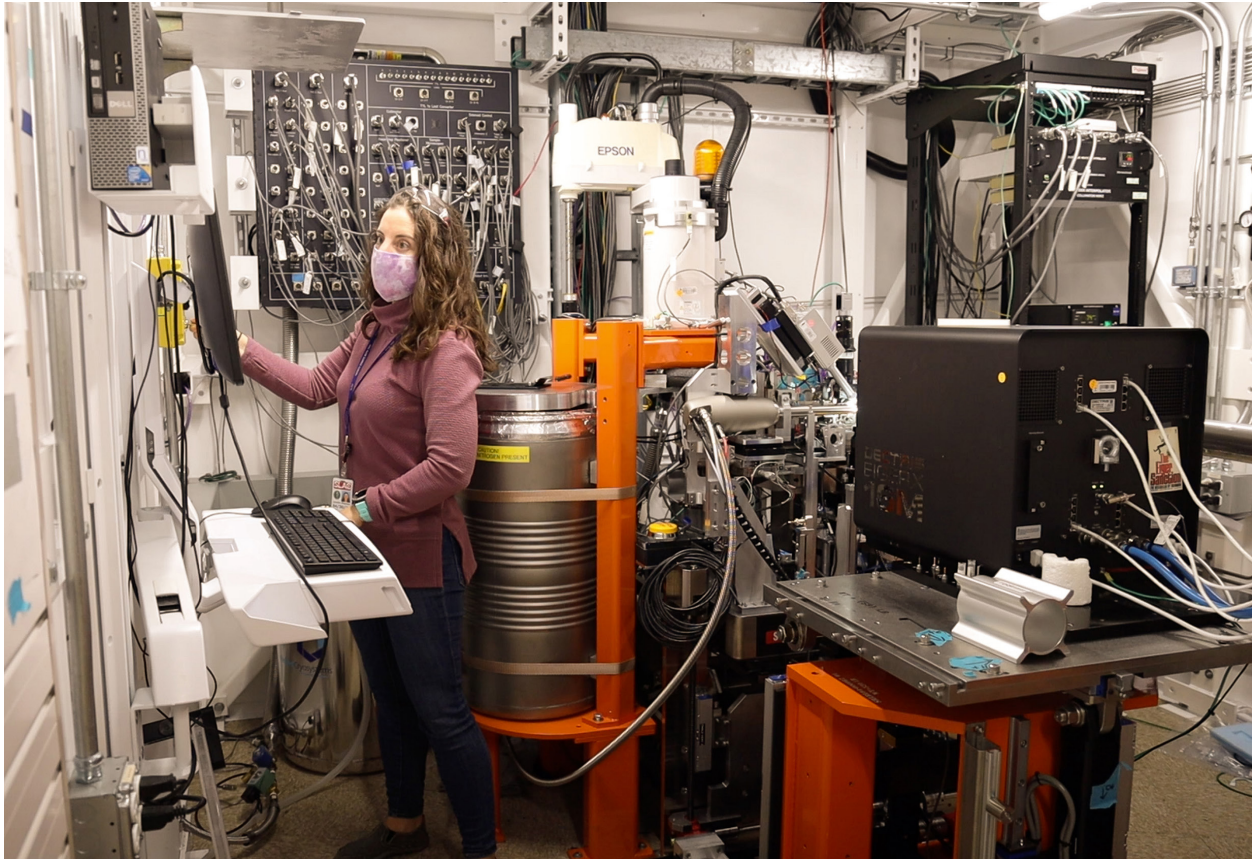
Fig. 3.1. Facility Research in the COVID Era. Jeney Wierman, a scientist at Stanford Synchrotron Radiation Lightsource (SSRL) wears a protective face covering during work at SSRL. She and other researchers used SSRL beamline 12-1 to examine the atomic structure and function of different components of SARS-CoV-2, the virus that causes COVID-19. [Courtesy SLAC National Accelerator Laboratory]

visits because of travel restrictions. Additional safety training was often needed to familiarize vendors with onsite rules. Travel restrictions also delayed visits to vendor sites for quality assurance audits.

State and local rules regarding the definition of essential work affected many construction projects. Once these projects were allowed to continue, they had to be operated and managed differently. In addition, the coordination and planning of site visits shifted to online versus in-person meetings. Work also had to be planned to meet requirements of social distancing, impacting the number of subcontractors onsite.

3.2 Challenges

Modified operations presented a plethora of challenges for user facilities during the pandemic related

to management, onsite and remote work, and facility maintenance and construction (see Fig. 3.2, p. 16).

User Facility Management of Schedules, Staffing, and Future Operations

An early challenge during the pandemic was to identify how facility management communicated with staff and users. Rules, practices, and schedules—often rapidly changing—had to be communicated even as the scientific understanding behind them developed. Maintaining the engagement of both the user community and staff during such uncertainty is an ongoing challenge for facility management.

Another challenge for management is scheduling experiments, which take much longer in the pandemic era. Contributing to longer experiments are several factors,

Fig. 3.2. Facility Construction Continues During the Pandemic. Workers at the Facility for Rare Isotope Beams (FRIB) at Michigan State University move a cryomodule into the linear accelerator (linac) tunnel. As the start of user operations in early 2022 nears, the FRIB team commissioned the entire linac, including all 46 cryomodules, in April 2021. The commissioning team was distributed to five separate control rooms to comply with COVID-19 workplace safeguards. [Courtesy Michigan State University]

including the inability to perform work in parallel due to physical distancing and limited staffing rules, working in time-limited shifts, longer troubleshooting response times resulting from the absence of needed expertise onsite, working in PPE, and more frequent breaks and inefficiencies due to stress. Experiments with remote participation also are more inefficient because of the limitations of remote tools and the lack of "experiment bonding" that comes from hands-on familiarity. Understanding these new, longer experiment times is required for effective scheduling and must be internalized by both staff and users to avoid burnout.

Coordinating sufficient staffing and user coverage is another challenge related to scheduling. Fewer staff and users onsite (and also restrictions such as curfews) can mean 24/7 operation is not possible. Moreover, onsite staff and user presence may be unpredictable because of, for example, personal or family illness and childcare arrangements. If schedule mitigation measures are not effective, groups of staff could be off work simultaneously.

Because of COVID-19 disruptions, many facilities face the challenges of re-planning experiments and transparently communicating the prioritization process to users. Consideration may be given to prioritizing onsite user research by early career scientists, students, and postdocs. These groups are most likely to have time-critical studies and face career disruption, which could negatively impact the scientific field and future of the facility. However, such prioritization must not affect the scientific diversity of facility research.

Ongoing long-term challenges for facility management include maintaining an awareness of the changing pandemic landscape and effectively navigating an equitable transition to pre-pandemic levels of operation. Pandemic-related constraints and issues will vary depending on the particular situations of staff and users (e.g., childcare, homeschooling, individuals' health, vaccine availability, and local regulations). Alleviation of these concerns will be a slow process.

Finally, facilities must understand the impact of the fundamental shift of the user facility model toward

more remote operation. Will remote users continue to remain a significant proportion of the user community? If so, is the staffing and funding model for the facilities appropriate? There is value to the facility being a nexus for scientists, as onsite users benefit the facilities by supplementing staff and providing creative input to the facility and other active experiments. However, with remote access as an option, users may not come onsite in the numbers they did before. Lessons learned from large collaborations show the value of having onsite users. Consequently, such collaborations have incentivized users to come onsite by making it an authorship requirement. User facilities may need to consider similar methods to incentivize users to return.

These management challenges are not easily met. A consensus among user facilities is that local and front-line staff and users have assumed an unsustainable level of additional responsibilities to enable experiments during the pandemic. Addressing staffing and schedule challenges is crucial, along with managing expectations for productivity.

Onsite Facility Work

Onsite challenges relate primarily to creating a safe working environment while maintaining scientific excellence by not compromising facility operations. Providing a safe work environment is essential to implementing any return-to-work strategy, which includes ensuring adequate PPE and cleaning supplies, suitable ventilation in all work areas (potentially requiring HVAC modifications), sufficient spacing between workstations, and visual cues to encourage physical distancing in shared areas.

As staff and users return to work, the next challenge is to establish the tools for them to communicate with each other at a physical distance (see Fig. 3.3, this page) or with staff and users who remain offsite. Conventional face-to-face methods would need to be replaced with telepresence and communication tools, and equipment needs to be purchased and personnel trained in its use. Layouts of cameras, microphones, and monitors in control rooms, for example, may need to be reconsidered with communication in mind.

A significant concern is the impact of physical distancing and reduced occupancy on safety. Many safety management practices depend on the presence of multiple people, and some regular tasks cannot be carried out in a physically distanced context. Facilities are responsible for identifying and solving such safety matters early.

Fig. 3.3. Physical Distancing at User Facilities. Brookhaven National Laboratory (BNL) staff, users, and students maintain safe distancing as they work on a new detector for use in the Relativistic Heavy Ion Collider starting in 2023. [Courtesy BNL]

Solutions may include adopting remote communication tools (such as cameras) or lifting aids, but these all require appropriate training and procedures.

Sample management is a challenge, especially if the samples are time sensitive. Inefficiencies of working in the pandemic has led to an increased backlog of samples that need to be stored. In addition, sample deliveries from users have become unpredictable due to constraints at users' home institutions or disruption to supply chains or delivery services. These disruptions also may delay delivery of other items necessary for building or maintaining hardware.

Multiple facilities' initial response to pandemic limitations was to limit research activities to only simple experiments and defer complicated ones. To keep scientific progress and research quality high, facilities must overcome the challenge of complicated experiments, which may require redesigning apparatuses, changing procedures, and incorporating engineering solutions that enable work within physical distancing guidelines and with reduced onsite staffing. This final challenge is possibly the hardest to address. There is a danger of user facilities being underutilized as "easier" experiments appear to be progressing. Moreover, many facilities have postponed experiments that require more hands-on work or direct user engagement that might lead to more creative, higher-impact results.

Fig. 3.4. Creative Solutions to Operational Challenges. Normally, dozens of researchers and technicians work in the control room of the DIII-D National Fusion Facility while running experiments, but COVID-19 has limited such interactions. To continue operations, the DIII-D team developed and deployed innovative solutions, including Discord, an application that emerged from the world of video gaming. The DIII-D Discord server has been a key tool enabling the facility to continue operating even though most of the researchers are working remotely. [Courtesy General Atomics]

Coping with New Requirements for Remote Facility Work

The pandemic necessitated remote operations because of travel disruptions and efforts to reduce onsite occupancy. Facilities with existing remote access capabilities for instruments were able to continue operating at (or close to) normal levels (see Fig. 3.4, this page). Other facilities faced the challenge to implement or improve remote access. For many facilities, developing remote capabilities will require substantial effort. A short-term solution could be to conduct some experiments remotely through an onsite staff member or through a single onsite user who follows instructions. However, true remote control of instruments by offsite users is required beyond the short term so that the limited number of onsite personnel can be better utilized. Also, remote operations have their own challenges. For example, efforts to enable instruments for remote operation are often hampered by closed-source software

that cannot be networked or brought onto a common control platform.

Another challenge is the need to transfer and analyze data during experiments. Existing data management policies and infrastructure at some facilities may assume users are onsite. Such facilities must review and revise these activities to suit remote users. Also, giving users more remote access to certain systems could remove bottlenecks created by staff currently handling many data management and computational analysis activities for remote users. Facilities may need to develop data storage, computational space, and analysis tools for the extremely large datasets that may not be transferable to users' home institutions on time scales required for an experiment.

In many cases, substantial onsite resources are needed to support systems for users who no longer can conduct experiments onsite. Investments also are needed in

(1) automation to reduce onsite interactions, (2) offsite data pipelining and access capabilities, and (3) improved machine protection systems that do not require onsite personnel to monitor remote operations for faults.

Maintenance and Staff Training

In the short term, facilities may prioritize resuming user operations over maintenance activities. Deferred preventative maintenance, however, could impact future facility availability. Understanding priorities and tradeoffs between maintenance and user operations is a persistent challenge faced by user facility management.

Another challenge confronting facilities is skill transfer between staff, which is more difficult under physical distancing constraints and may not be perceived as "essential" work. Without such cross-training, unique skills could be lost, affecting long-term facility operation. Rather than cross-training in person, facilities may need to develop effective training documentation to pass on operational knowledge to less experienced staff. However, this approach is likely to be less effective than "learning on the job."

3.3 Opportunities

Many aspects of pandemic-related changes to facility operations are mitigation strategies, but others may present opportunities for improvements, including expanding remote capabilities for users and staff, automating routine tasks, and broadening access to underserved or international communities.

Beyond addressing COVID-19 challenges, responses such as physical or social distancing, reduced occupancy, and PPE for virus protection are not greatly beneficial in the long term. These approaches may produce cultural changes useful for mitigating colds and flu, but there is no obvious benefit to facilities maintaining these rules post-pandemic.

Expanded Remote User Capabilities

Remote user operation is not possible for all types of user facilities. By their very nature, computing facilities serve remote users, but other facilities have highly complex user-built and -operated experiments. However, there is a distinct middle ground at some facilities such as light and neutron sources where users operate standardized equipment and execute standardized procedures. Investment in software and automation in some cases fully puts experiment operation in the hands of remote users. Examples of successful automation

already exist at some of these facilities but are not sufficient to enable all experiments to proceed in an automated way. Thus, there is an opportunity to expand remote capabilities. Another benefit of this expansion would be the potential to increase access to underserved institutions and broaden international reach, though such remote users do not gain hands-on facility experience.

Shifting operations to fully remote users should be considered only in conjunction with a re-evaluation of user facility and staff roles. Many facilities need users to complement low staff numbers and cannot operate remotely 24/7 without increasing staff. Also, user facilities consider it their responsibility to train and educate users—aspects that are lost when users are not onsite. In the long term, this gap could reduce the trained pool of scientists with hands-on experience. However, with strategic selection of onsite individuals, a facility's remit to train the next generation could still be met.

Increased Staff Efficiency and Innovation Through Automation

The same tools that enable remote users also enable staff to work from home, which can result in more rapid support outside of core hours when staffing onsite is typically limited. Investments in a common and remotely accessible control system and in software programming ultimately can automate certain tasks, reducing operating costs and improving experiment speed and reliability in the long term. Increased automation of routine tasks, in particular, would enable staff to focus more on instrument or technique improvements, innovations, and the underlying science.

Hybrid Operations

Even for complex experiments that can never be conducted fully remotely, some remote or teleworking capabilities would be beneficial. In the future, a useful operation model for such experiments may involve a single well-trained user working onsite to represent a team and communicating remotely with that team during the experiment. The shift toward combining remote and onsite participation (versus fully onsite) could save users time and money. However, this shift is at the expense of facility budgets, since investments would be required in remote-access infrastructure, increased staffing, and staff with different skillsets. Beyond this report, DOE should create opportunities to identify best practices and share common solutions for operating in fully remote or hybrid onsite/remote user modes.
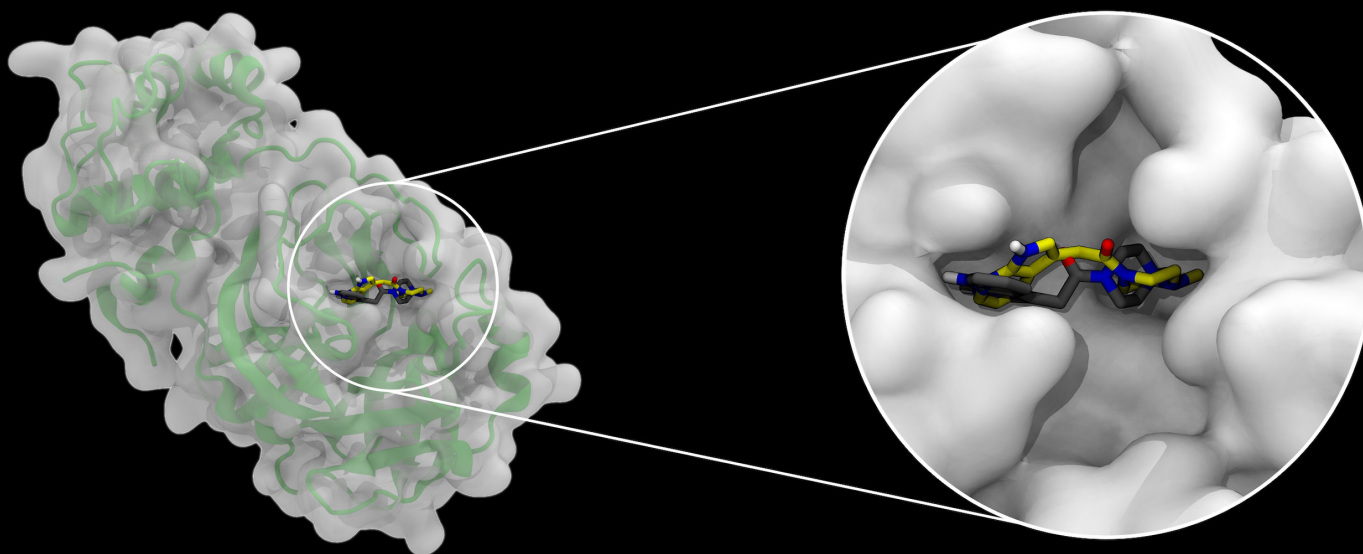
Chapter 4
Computing and Data Resources

Data, computing, and networking infrastructure are critical for scientific productivity; they are the substrates the research community uses to explore, create, and share information. Within the DOE Office of Science's (SC) national user facility infrastructure, both staff and users have well-established protocols to easily access and analyze data. The pandemic has disrupted these protocols. A change in work locations for staff and users has caused a corresponding shift of SC-managed data and computing infrastructure

Fig. 4.1. **Video Conferencing Becomes the Norm.** The Exascale Computing Project Hardware and Integration team—composed of staff from the Argonne Leadership Computing Facility, National Energy Research Scientific Computing Center, Oak Ridge Leadership Computing Facility, and other DOE assets—meets regularly via Zoom calls to discuss progress. Facility staff and users have increasingly relied on video chats and live texting to interact during stay-at-home orders.

to home offices and residential networks. This geographic displacement and the shift to virtual work have created new strains on laboratory and home computing infrastructures, impinging on scientific productivity.

The resource challenges staff and users face in a virtual context are diverse but share a few commonalities. First, security guidelines can limit remote access to resources, as well as the ability of users and staff to connect with each other. Second, improved training, interfaces, and tools are needed to facilitate the hybrid collaborations between remote and onsite users that are necessary to complete experiments. Finally, there is unequal access to computational resources, forcing some users and staff to resort to using laptops and WiFi to accomplish the work they previously did onsite with more powerful systems, thereby limiting the scale and speed with which they can perform tasks.

To operate successfully with a remote workforce and user base, facilities must offer users and staff an array of capabilities. Offsite collaborators, for example, need full and secure access to the entire user facility data system. Similarly, staff and users need full and secure access to a facility's entire analysis toolset, including visualization codes, data analysis codes, and complex simulation codes. Also essential are ways to seamlessly communicate with offsite locations, including shared

video and hands-free integrated audio enabling *ad hoc*, time-sensitive, complex, and dynamic interactions (see Fig. 4.1, this page). Remote participants also need capabilities for easily sharing complex scientific visualizations and for interactively discussing results.

4.1 Observations

Although the resource constraints that face users operating in virtual contexts are numerous and diverse, three important themes have emerged: secure remote collaborations, more costly user support in terms of both time and staffing, and disparate access to remote data and computational resources.

Secure Remote Collaborations

Cybersecurity is a concern. During the pandemic, the virtual private networks (VPNs) that facilities used to keep resources safe presented a new barrier to staff and users' ability to access the instruments, systems, and data they previously accessed directly. Facilities with many remote users—such as those supported by DOE's Advanced Scientific Computing Research (ASCR) and Biological and Environmental Research (BER) programs—were less affected by this shift, already having in place the staff, hardware, and software systems required to support offsite access. For many facilities, however, remote access has become a

new offering they must provide to users, representing an additional support and infrastructure burden.

Identity Management. Onboarding new users requires facilities to create secure user accounts for the first time, which is a nontrivial effort. For some facilities, determining how to implement identity management for users, including ensuring multifactor authentication, is a major concern to address before enabling access to computing systems. Having each user facility become an identity provider is probably undesirable. Instead, facilities could consider partnerships with projects like CI Logon or Globus to support federated identity management and the associated provisioning workflows.

Isolated, Secure Networks. Another key issue is that the security models for many instruments are designed for local-only access. These systems are not simple to patch, and the security track record of such specialized tools is not great. For example, operating a piece of equipment may require using specialized vendor software that only runs on outdated and unsupported versions of Windows. For this reason, and because of other potentially sensitive equipment on the same networks, facilities are very reluctant to open up certain instruments for remote access, even if the facilities could license and install control software on remote laptops. Complicating matters further are the potential risks when operating equipment remotely, including instrument damage, safety issues, and getting machinery stuck in positions that require corrective action by onsite staff. Consequently, remote operations require increased robustness and resilience along the entire chain of dependencies, especially for instruments whose primary mode of operations is remote. There is no one-size-fits-all solution for these challenges, and each user facility and national laboratory will have to develop new security architectures where possible to manage the risks.

Diverse Policies. Security policies at different user facilities can limit effective remote collaboration. Laboratory rules about collaboration tools such as Zoom, Slack, Discord, Microsoft Teams, and Google are diverse and often incompatible, requiring some facilities to find suboptimal workarounds. There are also limitations on the use of cloud services for sharing data. These seemingly trivial issues create a constant friction that impedes collaboration and reduces productivity. A user facility's policy must be to allow a scientist to work remotely without penalty, retaining the same rights and privileges as when working onsite.

User Support: Training and Troubleshooting

User support must also operate differently in a fully virtual context. Some adjustments have been easy, such as replacing phone help desks with Zoom office hours and improving documentation to help onboard new users. However, training in general has been more challenging, especially for specialized equipment, which has always been done in person.

One challenge in training users is the ability to create secure, on-demand training environments for them that cannot be easily abused. Several tools do exist including ISLET,[1] an isolated, scalable, and lightweight environment for training used by the National Science Foundation's Extreme Science and Engineering Discovery Environment (XSEDE). However, there will always be a need to customize training environments, which requires additional facility resources. Although conferences have had many successes, they too are finding training to be more difficult.

In addition to training limitations, the ability to troubleshoot problems is considerably more constrained as offsite experts and users debug issues through Zoom. Although screen sharing is sufficient to solve software problems, hardware issues may require additional intervention. For example, when the ability to physically inspect equipment is limited, offsite experts must either walk a nonexpert through their debugging process or ask them to send pictures or video (e.g., of blinking lights or experimental setups). One way to mitigate these training and troubleshooting challenges is to provide onsite staff with augmented reality headsets that enable staff technicians and engineers to co-view a workspace while still observing social-distancing protocols. However, the problems with real-time training and troubleshooting remain largely unsolved with temporary solutions using Zoom and an iPad or laptop.

Access to Data and Computing Resources

The pandemic has revealed the need for more highly usable, accessible, and reliable data and computational resources for staff and users. Users of high-performance computing (HPC) capabilities, some of which came online during the pandemic, have plenty of resources for large-scale computation (see Fig. 4.2, p. 23). Those with HPC accounts sometimes use the login nodes for generic small computation, but others have traditionally depended on resources that are now

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[1] ISLET: https://dl.acm.org/doi/abs/10.1145/2792745.2792762

Fig. 4.2. New High-Performance Computing Resource Launches During the Pandemic. Computational biologist Lee Ann McCue works on Tahoma, the Environmental Molecular Sciences Laboratory's newest supercomputer that came online in October 2020. [Courtesy Pacific Northwest National Laboratory]

unavailable to them (e.g., offline computation near equipment or workstations onsite). Some users and even staff without access to login nodes or allocations to HPC systems have been limited to performing computational tasks on their laptops using home WiFi networks. Not only do such setups limit storage and computation, they also greatly constrain data transfer capabilities. Similar to their European colleagues, some facility staff and users have asked for a unified file system with experimental data and the ability to mount virtual machines with the file system. Such capabilities would enable most users to perform all their scientific data analysis remotely without copying huge datasets over slow internet connections; this approach would also solve software availability challenges.

Data Management Systems. Access to highly available computing resources must be coupled with access to the data generated at each user facility. Data need to be moved from systems co-located with instruments to storage resources co-located with remotely accessible

computing. The ability to create what industry calls a "data lake" for user facilities could enable more facile, intuitive access to data when coupled with robust data and metadata management services.

Need for High-Quality User Interfaces. Remote access also makes staff and users more dependent upon web- or command line–based interfaces to facility resources. The quality of user interfaces correlates with higher productivity and reduced cognitive load. A limited number of well-designed interfaces to access many common data and computing resources will also increase productivity, eliminating the need for staff and users to switch contexts to address different parts of their experimental workflows.

4.2 Challenges

The greatest obstacle to effective virtual communities involves the ability to share information seamlessly and securely among geographically dispersed participants.

Included in this challenge are capabilities for accessing via secure networks the distributed pools of data generated by instruments, leveraging computing infrastructure with proprietary software to analyze instrument data, and collaborating with users and staff to ensure multi-month experiments are completed successfully.

Secure Remote Collaborations

Several security-related challenges have emerged during the pandemic, including determining how to credential remote first-time users, dealing with varying rules about collaboration tools across the user facility complex, and remotely connecting instruments designed with assumptions of local access only. Additionally, there is the potential for increased cybersecurity threats when enabling remote connections.

Access to Data and Computing

Not all user facilities and users have equal access to remote data and computational resources. ASCR facilities or the cloud may have a role in supplementing and supporting these facilities and users in a virtual context.

As staff and users' work has shifted offsite during the pandemic, there has been a corresponding expansion of SC-managed infrastructure to home offices and residential networks. This shift, when coupled with increased and simultaneous WiFi usage from other household members, puts enormous pressure on home networks that are not optimized for science. Network unreliability makes being productive or engaging with colleagues via video conference nearly impossible.

Due to physical distancing constraints, fewer staff and users are allowed onsite. Consequently, the ability to troubleshoot problems is considerably more limited. Although screen sharing is sufficient to solve software problems, hardware issues may require additional intervention.

4.3 Opportunities

User facilities can leverage modular components that exploit the convergence of physical and logical communication channels so that phone, audio, video, email, messaging, screen sharing, and data can be incorporated into a common collaboration framework. Facilities need to implement rich presence via integration of "virtual worlds," using information from environmental sensors, social networking tools, and directory services. This integration would enable people, places, roles, and data streams to be identified, located, scheduled, and connected into a

flexible collaboration ecosystem. Facilities should be able to construct collaborative applications from modular components, deploy them into real working environments, and evaluate and modify them based on experiences.

To realize this connected vision, user facilities must collaborate on foundational infrastructure needs in identity management, networking, data, and computing. There is also an opportunity to develop new data stewardship and user-centered design roles at facilities to maximize scientific productivity and impact.

Federated Identity Management

In some cases, facilities can use existing practices and tools to address some of the challenges with remote collaboration. For example, many research collaborations already use CI Logon[2] and Globus Auth[3] for identity management and account provisioning. To address other challenges, new tools and training may be adopted or developed.

Collaboration Tools

Another opportunity relates to investing in virtual and augmented reality technologies to aid hybrid collaborations. Not only could such technologies provide solutions to current challenges, they also may pay dividends in the future. Facilities may be able to establish a standard set of approved and supported tools to collaborate across the SC complex to improve interoperability between user facilities and the user community.

Data Management Systems

The ability to find, access, and reuse data stored in pools of geographically and logically distinct storage resources is critical to ensuring a high level of scientific productivity for staff and users. In the ideal case, a user facility's data archives need to contain all raw, processed, and simulation data. All data stored on facility resources should be available in an accessible and timely manner to all members of a scientific team. Moreover, data analysis performed by offsite researchers should, wherever practical, be written back into the user facility's main data repository. For complex and highly coupled systems such as SC user facilities, data access limitations ideally must not fragment or impede scientific teams and programs.

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[2] https://www.cilogon.org

[3] https://www.globus.org/tags/globus-auth

To support these activities, user facilities will require data management systems that integrate all data, enabling researchers to use a common set of tools to work across the broadest range of applications. Artificial distinctions between data structures made based on their origin lead to redundant efforts and impede scientific progress. Support is required for all needed data types and structures. Such systems should allow for the storage of all calibrations, geometry, setup information, and analysis assumptions, giving users a complete view of all data. Data management systems should also include complete metadata (data about the data) for every data object that documents, for example, where the data came from, when it was written, and who was responsible for it, as well as basic information such as the data type, size, and structure, creating a coherent self-descriptive data structure.

Distributed and Interoperable Computing Resources

SC user facilities have an opportunity to collaborate or negotiate with cloud service providers to offer users extra resources and improved user interfaces, provided the facilities can securely export data between systems. Facilities may also be able to deploy a distributed network of connected and interoperable computing resources that enable all scales of computing, data exploration, and analysis. Seamlessly connecting a user with data and computing enables more uniform and egalitarian data exploration and analysis capabilities. With collaboration among all its user facilities, DOE SC

is in a position to facilitate all aspects of the data life-cycle across its facility complex, including simulations, experiment design, data generated at scientific instruments, data analysis, and data archiving for future use. Data management tools that provide transparent data movement among these facilities would enable users to log in from anywhere to focus on the science.

New Roles at DOE User Facilities

SC user facilities have the opportunity to embrace user-centered design as a discipline to ensure that the systems they build and maintain meet the needs of users and staff. Central to this idea is that system and interface designs are heavily informed by user input, research, and testing. User facilities should leverage established best practices in this area whenever they write software.

Data stewardship presents another critical staffing opportunity. User facilities generate exabytes of unique, irreplaceable data. The key to making these data findable, accessible, interoperable, and reusable (FAIR) and to creating public reusable research (PuRe) data from facility use starts with the design of a data management infrastructure to support the whole data lifecycle. It is the responsibility of data stewards to ensure that systems and data are developed and maintained according to established policies. Placing these individuals at the facilities will provide a link between the experiments that generate the data and the long-term preservation of the data for the broader scientific community.
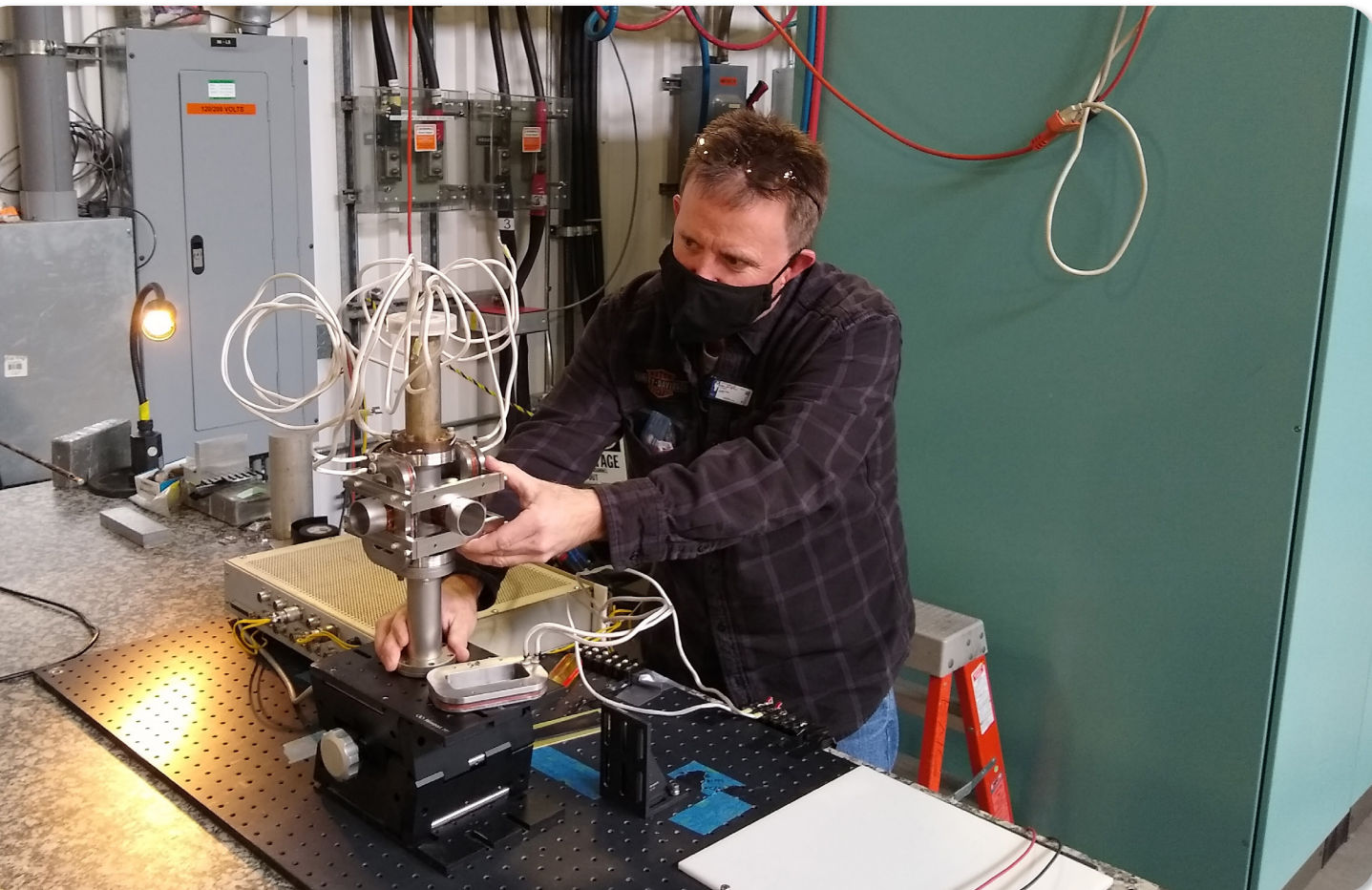
Chapter 5
Strategic Issues

As part of the Office of Science (SC) user facility roundtable, participants considered facility responses to the pandemic and evaluated which actions should be retained post-pandemic to improve user access and increase facility impact. Although it can be easy to assume that additional remote access is beneficial for all users and facilities, undertaking a careful cost/benefit analysis is essential to better understand if this assumption is correct. Long before the pandemic, several communities successfully transitioned to predominantly remote access, such as users of macromolecular crystallography beamlines at SC light sources. These experiments are highly standardized, however, but can be

an instructive case study for longer-term consideration of costs and benefits (see Fig. 5.1, p. 28).

5.1 Observations and Challenges

Advantages of Remote User Access

The primary benefit associated with remote access or virtual collaboration is the democratization of science achieved by providing access to a wider group of prospective users who typically would be unable to leverage facility resources because of travel or funding constraints.

As described throughout this report, there are numerous examples of increased virtual access. Benefits include higher conference and workshop attendance; increased collaborations facilitated by more inclusive virtual discussions; and an expansion of the user base by removing constraints imposed by the physical location of instruments, people, computational resources, or data. Increased remote access can also positively affect the user community by enabling greater participation from non-R1 schools,[1] Established Program to Stimulate Competitive Research (EPSCoR)[2] states, international users, and others.

Tools developed during the pandemic may continue to be particularly useful for simple, proof-of-principle, or time-sensitive experiments in which travel costs or time may be barriers that dissuade prospective users from engaging with the facility. Remote access for first-time users could also be an effective strategy for developing relationships that lead to greater onsite access later. Conversely, the macromolecular crystallography community has found that having users first perform experiments onsite before transitioning to remote access is highly beneficial in terms of user training and understanding. In addition, more than 30,000 researchers use SC facilities every year; converting some fraction of user trips to virtual access not only would lower costs for users, but also would considerably reduce greenhouse gas emissions and other negative environmental factors related to travel.

The Downside of Remote User Access

Although not entirely prohibitive, the potential downsides of increased remote user access should not be ignored.
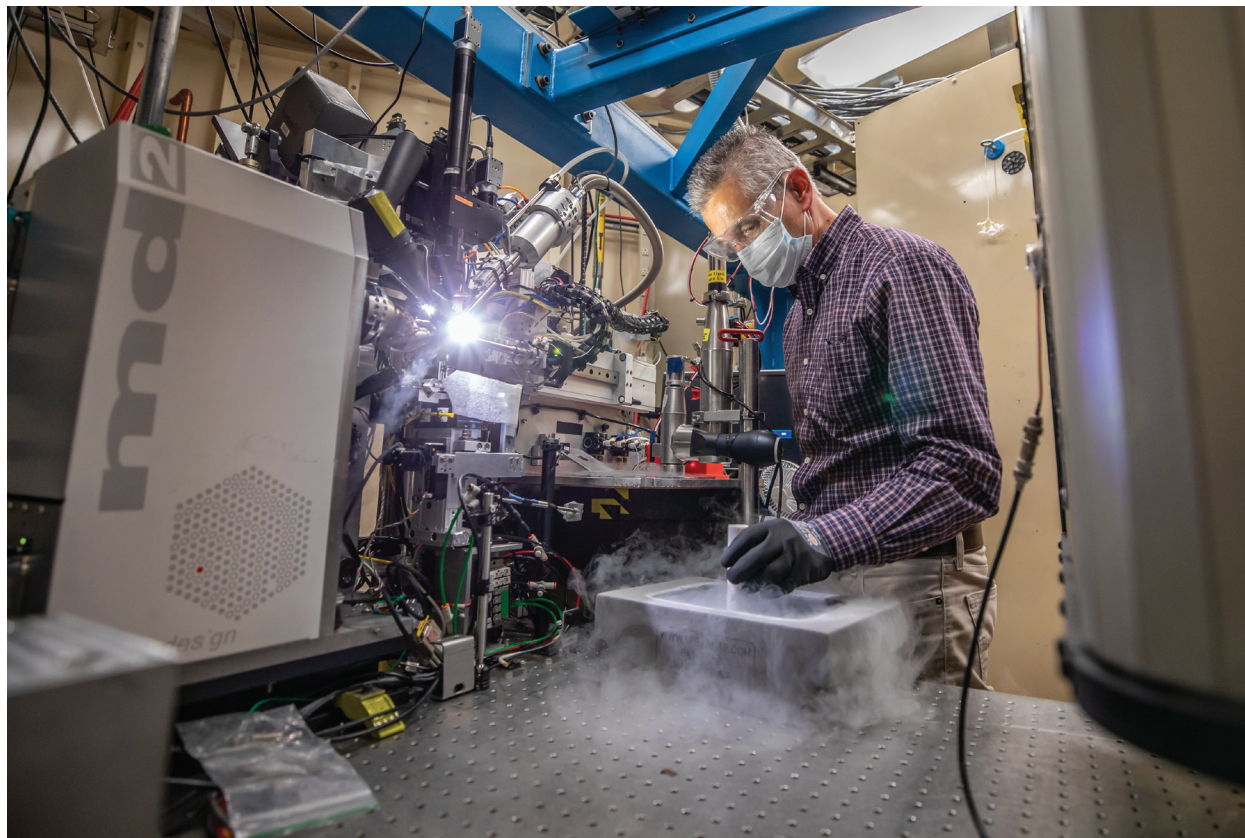
First, more remote access could shift labor costs from the user to the facility (absent facility robotics or automated systems). The increased burden of running experiments for a virtual user community could also decrease the time that staff can spend on tasks such as maintenance, improvements, and novel developments. Any reduced maintenance is a stewardship concern that can also impact safety. Moreover, less time for improvements and novel development decreases creativity and may represent a major loss if not managed well. Mediating these issues may not be possible without increasing onsite staffing.

Remote user access may also lower the integration of the user base into the facility's culture and knowledge pool. In some cases, users are responsible for equipment design, construction, assembly, and configuration. These activities require significant, iterative interactions with laboratory staff engineers, for example, to evaluate structural safety and pressure systems, check for compatibility with existing equipment, and other tasks. In these and other cases, users often are the "onsite experts" for equipment, software, and other systems of general use to the community. Assuming that users can no longer remain onsite for multi-year periods, transferring this knowledge to support a remote program will be a challenge. In addition, as staff perform more work on behalf of users, existing challenges related to authorship and intellectual property may be exacerbated.

The lack of onsite user training and experience will challenge efforts to develop and maintain a capable and knowledgeable workforce. Although users can run experiments remotely in some cases, continually training the scientific community on hardware construction, maintenance, and operations is critical. Lack of direct interaction with and training of users reduces the pool of prospective employees for a facility. In a virtual environment, this challenge can affect large, complex, and custom experiments in particular. If more experiments are transitioned to remote operations, scientific advances will continue. However, the next generation of students and postdoctoral researchers will lack hands-on experience troubleshooting complex experiments and the opportunity to learn from facility experts.

Onsite hardware training is important, both to understand the resulting data and to learn how to adequately evaluate uncertainties. When staff spend more time running experiments for virtual users, they have less time to assist them in understanding and evaluating experimental results. Increased staffing or staff time could be

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[1] R1 is a classification that indicates U.S. universities that engage in the highest levels of research activity.

[2] The federal EPSCoR program is designed to build capabilities in underserved regions of the country that will enable them to compete more successfully for federal R&D funding (science.osti. gov/bes/epscor/About/).

Fig. 5.1. Successful History of Remote Access. Beamline scientist Marc Allaire performs X-ray macromolecular crystallography work at the Advanced Light Source in June 2020 to improve atomic-level understanding of the SARS-CoV-2 virus. With predomi-nantly remote users, the X-ray macromolecular crystallography community could offer useful insights as other facilities evaluate user access options going forward. [Courtesy Lawrence Berkeley National Laboratory]

a solution, but developing an appropriate infrastructure to enhance hybrid in-person and virtual meetings may help as well.

Facilities also have noted that experiments during the pandemic tend to be less ambitious to accommodate remote operations, lower the burden on facility staff, and minimize sample handling challenges. This response is likely to affect scientific outcomes in the long term if continued.

Remote and virtual team alignment will require clear leadership as well as more formalized and regular meetings to replace the frequent onsite interactions that occur naturally when people are working in the same space. Facilities anticipate that keeping teams aligned virtually will require more structure and management, along with appropriate technology. Facilities need to consider and implement management and interaction

structures for remote and virtual teams, giving particular attention to time requirements for these activities.

Hybrid Onsite and Remote Access

As access modes and preferences evolve, facilities probably will increasingly encounter situations with a mixture of both onsite and remote users. With this mixed-mode access, facilities will need to define and enable equity between onsite and offsite participants. This includes considering credit, workload, and other factors, as well as addressing intangibles such as inclu-sive communication between staff and participants. For instance, it will be important not to exclude remote par-ticipants from essential *ad hoc* discussions that might occur between onsite individuals. Some facilities have found that communication tools that work well when all participants are distributed and remote do not work as

well when some members of a team are co-located and others are distributed and remote.

Overall, virtual user access could potentially broaden the user base at the expense of the depth of user engagement. In addition, virtual users could become less invested in the success of a facility, a challenge that could be prevented with the right telepresence or virtual collaboration tools, which are yet to be developed.

5.2 Opportunities

Balancing Remote and Onsite User Access

For each facility, the balance between cost, impacts, and benefits of remote user access will be different, and each facility must decide where the line is drawn between remote and onsite user operation. Once facilities have a holistic understanding of how these decisions will impact them, then they and their sponsor can decide how best to distribute staffing resources to scientists and technicians. Facilities will then need to work to mitigate unavoidable impacts, such as reduced training and knowledge transfer between either users and staff or existing users and new users that normally would occur during onsite work.

Facilities should also be aware that some users may overuse remote access solely to save time or travel costs. While an increase in remote work may be very desirable for some facilities, it may not be desirable or feasible for others.

The development of facility- or experiment-specific rubrics could aid in determining whether a user project could or should be conducted remotely. Such analyses should consider the costs of onsite versus remote work, including training costs, risks to hardware, and staff and user time. The value to the user should be considered as well, taking into account the advantages and disadvantages discussed throughout this report.

Investing in Tools to Improve Virtual Interactions

Facilities should consider investing in the right infrastructure to support remote or virtual access. Sponsors in consultation with user facility communities should also consider whether targeted funding opportunities could accelerate innovation and progress for necessary physical and digital infrastructure. Enriching virtual collaboration using appropriate tools could improve the balance of value between remote or onsite access for both users and facilities. That is, investing in the right tools could

enhance remote user access and increase the impact of the user facility system.

User facilities, users, and other stakeholders including sponsors have a great opportunity to work together to determine a common set of virtual collaboration requirements and establish best practices for virtual participation with facilities. Partnerships with the private sector are also possible for the development of novel platforms that truly enable scientific collaboration.

Many meetings, conferences, and workshops are scheduled to remain online-only events in the short term. Organizers thus face the challenges of selecting the appropriate video conferencing and interaction tools and coordinating meeting schedules that accommodate participants from multiple time zones and reduce video conference fatigue. Interactions with outside groups, such as professional societies and conferences, have been challenging in a virtual-only environment. With reduced opportunities to exhibit and conduct outreach through face-to-face conversations at conferences, users are the best ambassadors for promoting user facility capabilities. Supporting users with outreach materials, such as slides about the facility, overview text for posters, and facility talking points, provides an avenue for facility participation in professional conferences in lieu of or in addition to exhibiting.

Even after the pandemic is over, moving toward hybrid meetings that are in person and have a robust virtual component will benefit both the facilities and the user community and maintain the increase in attendance seen in online-only events during the COVID era. Evidence indicates that users are much more willing to attend a single facility's annual meeting remotely, suggesting that facilities should continue that approach and develop effective hybrid meeting formats and supporting technology platforms. Successful hybrid events will likely have benefits for the broader scientific community as well.

Enhancing Data Handling and Assessing Facility Metrics

In conjunction with facilitating remote access to data collection, facilities and sponsors could take this opportunity to improve data curation and stewardship. Remote access must occur through a network built on institutional information technology (IT) and cloud services. Therefore, automated data retrieval and archiving could be additional features added to IT infrastructures with minimal additional work. These features could benefit the

user community immediately while also improving access to large datasets for emerging data sciences fields.

There is also an opportunity to re-evaluate facility metrics to better incorporate and reflect remote collaborations and new user engagement modalities. The highly connected nature of SC user facilities is a great benefit, and a better understanding of how some users exploit this interconnectivity would be helpful. As access modes evolve, current metrics used to assess each facility could be re-examined and adjusted to holistically reflect and appropriately assess new paradigms of user access and research across the SC facility complex.

Training and Credentials

As part of a broader push toward remote access, SC could encourage user facilities to develop reciprocal online training and credentialing that enable users to satisfy the requirements of multiple user facilities more easily and jointly. This training would lower the burden on facilities for developing and maintaining individual training materials and for administering training for experienced users. Consistent training across facilities might also reduce errors and confusion that arise from inconsistent expectations among facilities. Also, an emphasis on online training could reduce users' travel time by allowing them to train before arriving onsite. The

pandemic has demonstrated that online attendance at training events is effective.

Likewise, universal credentialing can potentially streamline user access to multiple sites with minimal redundant collection of information. It also can facilitate training reciprocity, enable the SC user facility complex to more easily track users' productivity, and allow sponsors to better understand facility utilization by users.

Future All-Facility Meetings

Facility directors have expressed an interest in hearing about other facilities' challenges and strategies. During the SC roundtable, participants noted and appreciated that, for the first time, all SC user facilities were involved in the same meeting. The exchange of information was beneficial and enlightening, allowing facility directors and staff to better understand the entire DOE system, the challenges faced by other facilities, and the strategies employed to meet those challenges.

SC should consider having periodic meetings of all the facilities to facilitate exchange of ideas and information and create opportunities for facility staff to connect. Such meetings can provide a way to share and develop best practices across facilities. Because the pandemic has normalized remote meeting attendance, the cost of attending such a meeting is significantly lower.
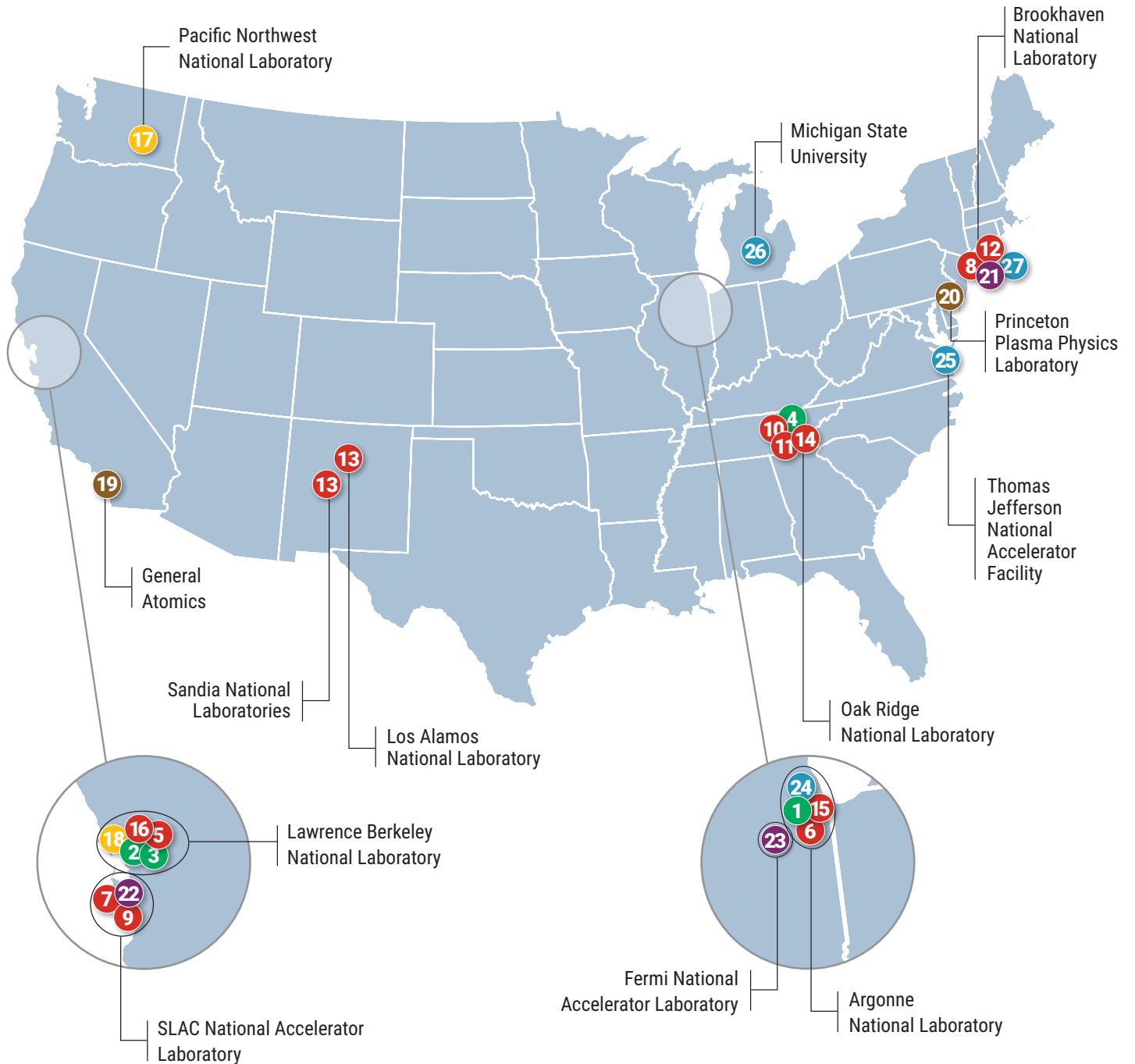
Appendix Contents

U.S. Department of Energy
Office of Science User Facilities, FY 2021

Pacific Northwest
National Laboratory

Brookhaven
National
Laboratory

Michigan State
University

Princeton
Plasma Physics
Laboratory

General
Atomics

Thomas
Jefferson
National
Accelerator
Facility

Sandia National
Laboratories

Los Alamos
National Laboratory

Oak Ridge
National Laboratory

Lawrence Berkeley
National Laboratory

Fermi National
Accelerator Laboratory

Argonne
National Laboratory

SLAC National Accelerator
Laboratory

Advanced Scientific Computing Research (ASCR)

1 **Argonne Leadership Computing Facility (ALCF)**
Argonne National Laboratory

2 **Energy Sciences Network (ESnet)**
Lawrence Berkeley National Laboratory

3 **National Energy Research Scientific Computing Center (NERSC)**
Lawrence Berkeley National Laboratory

4 **Oak Ridge Leadership Computing Facility (OLCF)**
Oak Ridge National Laboratory

Basic Energy Sciences (BES)

LIGHT SOURCES

5 **Advanced Light Source (ALS)**
Lawrence Berkeley National Laboratory

6 **Advanced Photon Source (APS)**
Argonne National Laboratory

7 **Linac Coherent Light Source (LCLS)**
SLAC National Accelerator Laboratory

8 **National Synchrotron Light Source II (NSLS-II)**
Brookhaven National Laboratory

9 **Stanford Synchrotron Radiation Lightsource (SSRL)**
SLAC National Accelerator Laboratory

NEUTRON SOURCES

10 **High Flux Isotope Reactor (HFIR)**
Oak Ridge National Laboratory

11 **Spallation Neutron Source (SNS)**
Oak Ridge National Laboratory

NANOSCALE SCIENCE RESEARCH CENTERS

12 **Center for Functional Nanomaterials (CFN)**
Brookhaven National Laboratory

13 **Center for Integrated Nanotechnologies (CINT)**
Sandia National Laboratories and
Los Alamos National Laboratory

14 **Center for Nanophase Materials Sciences (CNMS)**
Oak Ridge National Laboratory

15 **Center for Nanoscale Materials (CNM)**
Argonne National Laboratory

16 **The Molecular Foundry (TMF)**
Lawrence Berkeley National Laboratory

Biological and Environmental Research (BER)

● **Atmospheric Radiation Measurement (ARM) User Facility**
Multi-Site Global Network

17 **Environmental Molecular Sciences Laboratory (EMSL)**
Pacific Northwest National Laboratory

18 **Joint Genome Institute (JGI)**
Lawrence Berkeley National Laboratory

Fusion Energy Sciences (FES)

19 **DIII-D National Fusion Facility**
General Atomics

20 **National Spherical Torus Experiment Upgrade (NSTX-U)**
Princeton Plasma Physics Laboratory

High Energy Physics (HEP)

21 **Accelerator Test Facility (ATF)**
Brookhaven National Laboratory

22 **Facility for Advanced Accelerator Experimental Tests (FACET)**
SLAC National Accelerator Laboratory

23 **Fermilab Accelerator Complex**
Fermi National Accelerator Laboratory

Nuclear Physics (NP)

24 **Argonne Tandem Linac Accelerator System (ATLAS)**
Argonne National Laboratory

25 **Continuous Electron Beam Accelerator Facility (CEBAF)**
Thomas Jefferson National Accelerator Facility

26 **Facility for Rare Isotope Beams (FRIB)**
Michigan State University

27 **Relativistic Heavy Ion Collider (RHIC)**
Brookhaven National Laboratory

Office of Science User Facilities Roundtable Agenda

Panels

Panel 1: User Research in Virtual Contexts

Panel 2: User Research in Physically Distanced Contexts

Panel 3: Facility Operations in Physically Distanced or Virtual Contexts

Panel 4: User Training/Engagement

Panel 5: Computation, Data, and Network Resources

Panel 6: Crosscutting Issues

Agenda times are in ET.
Plenary and breakout sessions via Zoom.

Wednesday, December 2, 2020		
12:00 p.m. – 12:10 p.m.	Welcome/Charter	Harriet Kung, DOE
12:10 p.m. – 12:40 p.m.	Opening Remarks	Nigel Mouncey, LBNL Lijuan Ruan, BNL Stephen Streiffer, ANL
12:40 p.m. – 12:50 p.m.	International Perspective, ATLAS, Large Hadron Collider, CERN	Srini Rajagopalan, BNL
12:50 p.m. – 1:00 p.m.	Light Sources Remote Access Working Group	Dula Parkinson, LBNL
1:00 p.m. – 1:10 p.m.	Nanoscale Science Research Centers	Karren More, ORNL
1:10 p.m. – 1:20 p.m.	Atmospheric Radiation Measurement User Facility	Nicki Hickmon, ANL
1:20 p.m. – 1:30 p.m.	Oak Ridge Leadership Computing Facility	Ashley Barker, ORNL
1:30 p.m. – 1:55 p.m.	Q&A/Discussion	Srini Rajagopalan, BNL Dula Parkinson, LBNL Karren More, ORNL Nicki Hickmon, ANL Ashley Barker, ORNL
1:55 p.m. – 2:05 p.m.	Break	
2:05 p.m. – 3:10 p.m.	Panels 1-5 Breakouts	Panel Leads
2:50 p.m. – 3:10 p.m.	Panel 6 Breakout	Panel Leads
3:10 p.m. – 4:00 p.m.	Reconvene for Discussion	Co-chairs
4:00 p.m.	Adjourn	

Tuesday, December 8, 2020		
1:00 p.m. – 1:05 p.m.	Welcome/Opening Remarks	Nigel Mouncey, LBNL
1:05 p.m. – 1:20 p.m.	Panel 1 Update – User Research in Virtual Contexts	Debbie Bard, LBNL Richard Buttery, General Atomics
1:20 p.m. – 1:35 p.m.	Panel 2 Update – User Research in Physically Distanced Contexts	Hans Christen, ORNL Christine Clarke, SLAC
1:35 p.m. – 1:50 p.m.	Panel 3 Update – Facility Operations in Physically Distanced or Virtual Contexts	Mike Lindgren, FNAL Gert Patello, PNNL
1:50 p.m. – 2:05 p.m.	Panel 4 Update – User Training/Engagement	Rolanda Jundt, PNNL Lisa Miller, BNL
2:05 p.m. – 2:20 p.m.	Panel 5 Update – Computation, Data, and Network Resources	Kjiersten Fagnan, LBNL Jini Ramprakash, ANL
2:20 p.m. – 2:35 p.m.	Panel 6 Update – Crosscutting Issues	Cynthia Keppel, JLab Adam Rondinone, LANL
2:35 p.m. – 3:00 p.m.	Discussion	Stephen Streiffer, ANL
3:00 p.m.	Adjourn	

Tuesday, December 15, 2020		
12:00 p.m. – 12:15 p.m.	Welcome/Opening Remarks	Co-chairs
12:15 p.m. – 12:45 p.m.	Panel 1 Report – User Research in Virtual Contexts	Debbie Bard, LBNL Richard Buttery, General Atomics
12:45 p.m. – 1:15 p.m.	Panel 2 Report – User Research in Physically Distanced Contexts	Hans Christen, ORNL Christine Clarke, SLAC
1:15 p.m. – 1:45 p.m.	Panel 3 Report – Facility Operations in Physically Distanced or Virtual Contexts	Mike Lindgren, FNAL Gert Patello, PNNL
1:45 p.m. – 2:00 p.m.	Break	
2:00 p.m. – 2:30 p.m.	Panel 4 Report – User Training/Engagement	Rolanda Jundt, PNNL Lisa Miller, BNL
2:30 p.m. – 3:00 p.m.	Panel 5 Report – Computation, Data, and Network Resources	Kjiersten Fagnan, LBNL Jini Ramprakash, ANL
3:00 p.m. – 3:30 p.m.	Panel 6 Report – Crosscutting Issues	Cynthia Keppel, JLab Adam Rondinone, LANL
3:30 p.m. – 4:00 p.m.	Discussion/Wrap Up	Co-chairs
4:00 p.m.	Adjourn	

Office of Science User Facilities Roundtable Participants

Co-Chairs

Nigel Mouncey
LBNL (JGI, BER)

Lijuan Ruan
BNL (RHIC, NP)

Stephen Streiffer
ANL (APS, BES)

User Research in Virtual Contexts

Debbie Bard
LBNL (NERSC, ASCR), Co-Lead

Richard Buttery
General Atomics (DIII-D, FES), Co-Lead

Ahmed Diallo
PPPL (NSTX-U, INFUSE, FES)

Cynthia Keppel*
JLab (CEBAF, NP)

Jonathan Lang
ANL (APS, BES)

Emma McBride
SLAC (LCLS user, BES)

Adam Slagell
LBNL (ESnet, ASCR)

Indara Suarez
Boston University (CMS, HEP)

Jerry Tuskan
ORNL (JGI user, BER)

User Research in Physically Distanced Contexts

Hans Christen
ORNL (SNS/HFIR/NSRC, BES), Co-Lead

Christine Clarke
SLAC (FACET, HEP), Co-Lead

Mike Carpenter
ANL (ATLAS, NP)

Mary Convery
FNAL (Fermilab Accelerator Complex, HEP)

Rajesh Maingi
PPPL (NSTX-U, FES)

Douglas Mans*
PNNL (EMSL, BER)

Bronson Messer
ORNL (OLCF, ASCR)

Tom Rabedeau
SLAC (SSRL, BES)

Adam Rondinone*
LANL (CINT, BES)

Matthew Whitaker
Stony Brook University (NSLS-II user, BES)

* Also member of Crosscutting issues panel

Facility Operations in Physically Distanced or Virtual Contexts

Mike Lindgren
FNAL (Fermilab Accelerator Complex, HEP), Co-Lead

Gert Patello
PNNL (EMSL, BER), Co-Lead

Siegfried Glenzer
SLAC (MEC, FES)

Nicki Hickmon
ANL (ARM, BER)

Mike Martin
LBNL (ALS, BES)

Ben Maxwell
LBNL (NERSC, ASCR)

Michiko Minty
BNL (RHIC, NP)

Mark Palmer*
BNL (ATF, HEP)

Brad Sherrill
Michigan State University (FRIB, NP)

User Training/Engagement

Rolanda Jundt
PNNL (ARM, BER), Co-Lead

Lisa Miller
BNL (NSLS-II, BES), Co-Lead

Ashley Barker
ORNL (OLCF, ASCR)

Gavin Davies
University of Mississippi (Fermi UEC, HEP)

Charles Greenfield*
General Atomics (DIII-D, FES)

Terry Law
PNNL (EMSL, BER)

Janell Thomson
ORNL (SNS/HFIR, BES)

Xiaochao Zheng
University of Virginia (JLab user, NP)

Computation, Data, and Network Resources

Kjiersten Fagnan
LBNL (JGI, BER), Co-Lead

Jini Ramprakash
ANL (ALCF, ASCR), Co-Lead

Chin Guok*
LBNL (ESnet, ASCR)

Paul Mantica
Michigan State University (FRIB, NP)

Dave Schissel
General Atomics (DIII-D, FES)

Liz Sexton-Kennedy
FNAL (CIO, HEP)

Jana Thayer
SLAC (LCLS, BES)

Crosscutting Issues

Cynthia Keppel
JLab (CEBAF, NP), Co-Lead

Adam Rondinone
LANL (CINT, BES), Co-Lead

Charles Greenfield
General Atomics (DIII-D, FES)

Chin Guok
LBNL (ESnet, ASCR)

Douglas Mans
PNNL (EMSL, BER)

Mark Palmer
BNL (ATF, HEP)

With thanks to these Science and Technology Policy Fellows from the American Association for the Advancement of Science (AAAS):

Saswata Hier-Majumder	Emily Smith
Adam Iaizzi	Michael Tennenbaum
Wayne Kontur	Jordan Thomas
Brandon Rohnke	

* Also member of Crosscutting Issues panel

December 2020 Factual Status Documents

To inform Roundtable discussions, all Office of Science user facilities submitted responses to a request for factual information on their experiences and status during the pandemic. These responses, or Factual Status Documents, from each facility are included in this appendix, along with the questions posed by the Office of Science as part of its request for information (see below).

Office of Science User Facilities Roundtable

Factual Status Document

To facilitate planning and conversation at the Office of Science User Facilities Roundtable planned for December 2020, please provide brief responses to the questions below. A paragraph or two per question is appropriate. Please send responses to Natalia Melcer, natalia.melcer@science.doe.gov, and Ben Brown, ben.brown@science.doe.gov, by COB Friday, November 20, 2020.

1. How has the COVID-19 pandemic affected your facility? At what fraction of facility capacity are you currently operating? What is the distribution between virtual access and physical onsite access? How have facility operations been impacted? Have there been disproportionate impacts on any staff? Has any action been taken to minimize the impact on early career staff or other vulnerable staff groups?

2. What approaches are you taking to provide productive user research experiences and services in a virtual context?

3. What, if any, changes to physical access have you implemented or considered for users, vendors, or maintenance personnel?

4. Have you identified any lessons learned as a result of the COVID-19 pandemic?

5. What has the COVID-19 pandemic revealed about the needs for virtual access to computational, data management/analysis, software, and network resources or other types of instrumentation?

6. User Project Administration: Have project award periods been extended and if so, does this impact future proposal calls and facility operating costs (including budget carryover across the fiscal year)? Have there been any changes to allocation policies?

7. What have been the impacts on annual user facility meetings, strategic planning workshops, and short courses and schools (to train students, early career researchers, or future users)?

8. Please provide any other comments or ideas as input for the roundtable.

Advanced Scientific Computing Research

Argonne Leadership Computing Facility (ALCF)

Argonne National Laboratory

ALCF provides the computational science community with a world-class computing capability dedicated to breakthrough science and engineering.

Contact: info@alcf.anl.gov

ASCR

1. How has the COVID-19 pandemic affected your facility? At what fraction of facility capacity are you currently operating? What is the distribution between virtual access and physical onsite access? How have facility operations been impacted? Have there been disproportionate impacts on any staff? Has any action been taken to minimize the impact on early career staff or other vulnerable staff groups?

The COVID-19 pandemic has had little to no effect on the facility regarding the facility's user-facing side. We are operating at full capacity since all our facility user access is 100% remote. The operations team has had full access to the facility to perform the required hands-on maintenance when needed. The operations team removed our old supercomputer Mira, installed a new 200-petabyte file system, and stood up two new machines (Crux and ThetaGPU) during the pandemic.

The facility, with respect to the staff, has seen many challenges. Face-to-face interactions have been replaced by an increase in video-based meeting. Informal brainstorming sessions are no longer possible and extremely challenging in remote mode. Those with caregiving responsibilities who lost standard support networks (e.g., schools, daycare, family networks) by the pandemic took on added duties in addition to their regular work commitments. We have emphasized flexibility to all supervisors and staff during this period. We have encouraged frequent conversations with staff about how things are going and facilitated flexible work schedules. Argonne National Laboratory (ANL) has started numerous initiatives to alleviate the issues faced by caregivers. ANL has rolled out a caregiving vacation program that allows for vacation donations by members of the Argonne community to a pool of days that other staff members can draw from as needed. Argonne has modified part-time work policies to adjust to the shifting needs of staff. Early career staff have lost out on face-to-face mentoring and engagement in conferences. We have extended postdoctoral appointments as needed to accommodate challenges in the job market.

2. What approaches are you taking to provide productive user research experiences and services in a virtual context?

The ALCF user research experience has not changed during the pandemic except for face-to-face interaction at workshops. We are usually a remote-only access facility. We have moved a few of our larger, typically in-person workshops and training events to entirely virtual. We have not needed to cancel any of them, although we shifted a few dates during the early stay-at-home days of the pandemic. We have seen increased participation in a few of the workshops and training sessions.

ASCR

3. What, if any, changes to physical access have you implemented or considered for users, vendors, or maintenance personnel?

There have been no changes for users, given the way we typically operate. There were a few delays in new user access due to the way certain portions of the user application were processed in the early days of the stay-at-home order. User account processing is now back to expected timelines.

As mentioned earlier, the operations team has had full access to the facility during the pandemic. When needed, we have accommodated vendor access to the site. The challenges have been travel and the vendor's operating policies during this period.

4. Have you identified any lessons learned as a result of the COVID-19 pandemic?

Lessons learned during the COVID-19 pandemic have been many. Starting with the need to be co-located, the facility and staff have continued to be productive. This experience has demonstrated that all the teams do not need to be in the same place simultaneously. This will likely allow for increased flexibility in remote working moving for-ward. Flexible hours and work schedules have not been an issue. Our staff was not prepared for an extended work period at home, and accommodations were needed to help provide productive and ergonomic environments.

5. What has the COVID-19 pandemic revealed about the needs for virtual access to computational, data management/analysis, software, and network resources or other types of instrumentation?

Since our user community has historically been full remote access, there have been little to no changes needed. As mentioned earlier, changes have mainly been in how we deliver training and hold workshops.

6. User Project Administration: Have project award periods been extended and if so, does this impact future proposal calls and facility operating costs (including budget carryover across the fiscal year)? Have there been any changes to allocation policies?

We have not needed to change allocation policies, and no awards were extended as a result of COVID.

7. What have been the impacts on annual user facility meetings, strategic planning workshops, and short courses and schools (to train students, early career researchers, or future users)?

Involvement and ability to hold user meetings, strategic planning workshops, and short courses are the one area we needed to adapt due to the pandemic. We have transitioned all training and workshops to online virtual meet-ings. We have not had to cancel any. Given the rest of the world has also transitioned into virtual events, we have let our staff participate in a larger number of these activities than would have been previously possible.

8. Please provide any other comments or ideas as input for the roundtable.

What policies at the DOE level need to be able to accommodate a more distributed workforce?

Advanced Scientific Computing Research

Energy Sciences Network (ESnet)

Lawrence Berkeley National Laboratory

ESnet is a high-speed network serving thousands of DOE researchers and collaborators worldwide.

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1. How has the COVID-19 pandemic affected your facility? At what fraction of facility capacity are you currently operating? What is the distribution between virtual access and physical onsite access? How have facility operations been impacted? Have there been disproportionate impacts on any staff? Has any action been taken to minimize the impact on early career staff or other vulnerable staff groups?

The COVID-19 pandemic has impacted ESnet in the following ways:

- Work productivity.
- Schedule delays on projects.
- Daily manner in which we all interact.

We've had to remain flexible and adjust expectations. Currently, 100% of the facility capacity is operating remotely with approximately 15 staff coming onsite in a staggered schedule to assist with shipping, receiving, administration, and resolving technical issues. Overall, there have been minimal impacts to facility operations; when we have encountered impacts, we have been able to work through a solution. Some projects that are not essential to the maintenance and operation of the production network or ESnet6 Project have been reprioritized or delayed due to the limited number of staff onsite during the pandemic. A small number of staff members experienced disproportionate impacts due to delayed medical procedures or the lack of childcare. Individual work schedule flexibility and temporary reassignment of resources have been the primary methods of managing these impacts.

Since March 2020, two surveys have been conducted. Results showed that while some of the staff feel more productive, many others are experiencing a higher-than-normal level of stress. To help minimize this impact, ESnet has implemented additional safety and ergonomics measures and flexibility in schedules, when possible.

Check-ins with staff occur regularly, both in a group setting and individual one-on-one meetings, to help determine what additional resources or flexibility may be needed to support them. Half-hour, all-staff meetings are held every Friday morning, which gives a good forum to discuss safety and other issues. Early career or new staff members typically have more frequent check-ins with supervisors, particularly if their experience in the organization thus far has been 100% remote.

Because of travel limitations, our community interactions have taken a different approach. Informal conversations about research, strategy, or collaboration now occur through scheduled virtual meetings rather than through informal gatherings at conferences or meetings.

Larger workshops and other previously planned events have been virtualized. Events dependent on in-person interaction have been postponed until late CY2021.

2. What approaches are you taking to provide productive user research experiences and services in a virtual context?

ESnet continues to pursue research and support user research experiences using its testbed. The ESnet testbed can be used remotely, and it has seen use over the pandemic period, albeit reduced. The research as well as the data is available remotely for the users.

In addition, ESnet researchers can take advantage of virtual conferences, recording and sharing video talks, and discussion platforms like Zoom and Slack.

3. What, if any, changes to physical access have you implemented or considered for users, vendors, or maintenance personnel?

Most of our work can occur remotely, but when required to perform onsite work, we are following Lawrence Berkeley National Laboratory (LBNL) mandated training, policies, and procedures. In general, there is a core group of approximately 15 staff who stagger their onsite work to follow social distancing and associated safe procedures. The process and procedures followed are determined by the laboratory.

We are not currently allowing users or affiliates to come physically to the site, and being onsite is not required for them to get their work done. Interaction with ESnet personnel is through video and chat collaboration tools.

For locations that host our equipment, whether it be a commercial site or laboratory, vendors or maintenance personnel are following the safety guidelines requested by that site. We help coordinate that to ensure all processes and procedures are followed.

4. Have you identified any lessons learned as a result of the COVID-19 pandemic?

Yes, several lessons learned have been identified and implemented. Staff meetings occur weekly. Any new ideas or changes to policy are discussed, and recommendations are made. Additionally, LBNL has weekly leadership and safety meetings where information is shared, and collaboration occurs across divisions.

The biggest lesson learned is the importance of active listening and keeping the connection alive with the employees through clear and frequent communication when everyone is working remotely. Having put this in practice in March 2020 through clear decision-making and communication has really helped manage the stress level of the employees through this pandemic. Investing in tools and infrastructure to make remote employees productive has also been effective and a lesson learned.

5. What has the COVID-19 pandemic revealed about the needs for virtual access to computational, data management/analysis, software, and network resources or other types of instrumentation?

The reliance on network resources has been highlighted by the pandemic, particularly for DOE and laboratory staff working from home and accessing resources at their place of employment over the network. ESnet has added new peering arrangements with key commodity providers that serve specific home networks, increased peering locations to decrease latency for some sites, and updated routing configurations to utilize more efficient or resilient paths.

We also produced a document for chief information officers across the laboratories to guide people on the importance of home WiFi networks and broadband access. This is equally important in having people work effectively from home.

6. User Project Administration: Have project award periods been extended and if so, does this impact future proposal calls and facility operating costs (including budget carryover across the fiscal year)? Have there been any changes to allocation policies?

To date, ESnet has not experienced any impacts to extended project award periods or changes to allocation policies.

ESnet6 project is exploring schedule delays and potentially increased costs, but all projected cost increases and delays are well within the planned contingency for the project.

7. What have been the impacts on annual user facility meetings, strategic planning workshops, and short courses and schools (to train students, early career researchers, or future users)?

One major impact was to our annual staff retreat, which was scheduled to occur in spring 2020. We were unable to host this due to COVID-19 restrictions, which restricted travel and large gatherings. In its place, we hosted a three-hour Zoom retreat in May.

During the spring/summer months of 2020, we hosted one of two annual requirements workshops remotely. These workshops are essential to understanding scientific needs and forecasting our network capacity for planning and budgeting.

ESnet had planned to host its first User Facility Meeting in Q4 of 2020. This meeting was specifically designed as an in-person meeting. The meeting is now postponed indefinitely.

In May 2020, we kicked off our annual student program and hosted four students. Unfortunately, we had planned two additional student hires, but because international remote work was not supported, we were unable to continue with their appointments.

In October 2020, we hosted our biannual ESnet Site Coordinator Conference remotely to update our sites on the status of our organization and projects and learn about any user challenges.

Our quarterly leadership retreats have been delayed, but the result has not prevented us from making progress on internal initiatives, such as our most recent initiative to stand-up a central way of aligning and managing objectives and goals across the organization through a tool called WorkBoard.

8. Please provide any other comments or ideas as input for the roundtable.

We should examine not just best practices for the pandemic but capture new practices that we should adopt long term.

Best practices for running virtual conferences/user meetings should be captured.

Advanced Scientific Computing Research

National Energy Research Scientific Computing Center (NERSC)

Lawrence Berkeley National Laboratory

NERSC is the mission high-performance computing facility for the DOE Office of Science and is a world leader in accelerating scientific discovery through computation.

Contact: ragerber@lbl.gov

1. **How has the COVID-19 pandemic affected your facility? At what fraction of facility capacity are you currently operating? What is the distribution between virtual access and physical onsite access? How have facility operations been impacted? Have there been disproportionate impacts on any staff? Has any action been taken to minimize the impact on early career staff or other vulnerable staff groups?**

We are running at normal capacity/capability.

Distribution between virtual access and physical access is dependent on responsibility. The network team is working about 30% onsite. Facility team is about 25% onsite. The operations team is 40% onsite. Storage is onsite 5% to 10% of the time with a stronger reliance on contractors, vendors, and NERSC operations to assist with hardware installation, problem resolution, and de-installation. Onsite visits may be done on weekends as staff juggle going onsite with needs at home. Others come onsite as needed but have minimal onsite time.

Facility operations have been significantly impacted.

- For example, the installation of the second phase of the Community File System had to be coordinated with the NERSC-9 construction schedule to comply with Alameda County health orders about physical distancing. Physical installation therefore took longer due to safety planning and reliance on in-state staff.

- Rotating onsite visits were initiated during the shelter in place to perform limited human monitoring of the facility. The building management system is very effective in sending alerts about problems that have already occurred but not as much in predicting looming issues. Maintenance activities were put on hold for several weeks, and a change in workload had to be quickly developed to keep people working on productive activities. We initiated a combination of catching up on paperwork, formalizing management and tracking systems, and initiating career-growth training.

- Communications onsite are tougher in noisy locations like the computer room and mechanical space with operating equipment. We have had to develop better planning and pre-activity communication to eliminate close physical proximity for communication. We are examining use of Bluetooth communication devices to facilitate communication without impacting safety of personal protective equipment like electrical safety clothing and hoods.

Staff with children where both parents work or single-parent households have had more difficulty balancing work/life. Many children need assistance with Zoom connections for classes, and many are only in classes a few hours a day. This can significantly affect staff who need to come onsite—especially single parents.

We are mindful of staff and postdoctoral researchers who might not have a strong local support network or may be living alone or away from family. Supervisors check in regularly, and we try to accommodate requests to temporarily work out of the area. We have weekly Zoom social events and Slack channels for people to share common interests and ask questions.

2. What approaches are you taking to provide productive user research experiences and services in a virtual context?

Our users always access our systems remotely, so this has not changed this year.

The main change has been in how we provide support to our users. We have stopped providing phone support (as that required the physical handover of a phone), and we introduced dedicated drop-in office hours on Zoom.

We are participating in the national COVID-19 High Performance Computing Consortium as a resource provider. We are supporting additional COVID research through our Director's Discretionary Reserve (DDR) allocation process. We have assigned a staff liaison to each project to help with code and workflow porting and optimization and to help teams quickly navigate NERSC administrative procedures.

3. What, if any, changes to physical access have you implemented or considered for users, vendors, or maintenance personnel?

Users don't have physical access to our system, so little has changed from the user perspective.

Staff are working remotely unless they need to be onsite for an operational reason.

Vendors and contractors need to comply with laboratory regulations to come onsite, register in advance so we can monitor the numbers of people in the workspace, and complete Subcontractor Job Hazard Analyses and training as needed. Additional NERSC staff time has been needed to develop safety plans and coordinate with other onsite work prior to larger projects starting.

Construction work on the NERSC-9 Facility Upgrade is operating under a special safety plan to ensure the safety of workers and staff who may be in the building. The plan is an amendment to the Site-Specific Safety Plan required of all contractors and follows the guidelines of our county health department. All workers undergo a daily symptom check before starting work and must perform work while maintaining physical distancing whenever possible. The building is strictly partitioned into the construction area and areas available to building residents.

4. Have you identified any lessons learned as a result of the COVID-19 pandemic?

The pandemic has revealed opportunities to adopt more maintenance processes that are 100% remote-operated or can be performed remotely with the assistance of an onsite operations staff member.

We have moved our NERSC Exascale Science Application Program code performance hackathon activities online and distributed activities over weeks instead of days. We are finding that there are certain advantages to this approach (e.g., permitting more time for thoughtful analysis) and may integrate a hybrid approach in the future.

Although most work can be performed remotely, physical powering of some nodes is still required. We are working to provide remote capability for this type of access.

5. What has the COVID-19 pandemic revealed about the needs for virtual access to computational, data management/analysis, software, and network resources or other types of instrumentation?

NERSC has been able to operate essentially as usual from a user's perspective.

6. User Project Administration: Have project award periods been extended and if so, does this impact future proposal calls and facility operating costs (including budget carryover across the fiscal year)? Have there been any changes to allocation policies?

There were no changes in project awards for 2020 due to COVID.

The NERSC DDR was used to supply allocation awards for COVID research, and thus did not impact the planned Office of Science research. This happened because the pandemic started early in the year—before the DDR had been allocated to other strategic projects. Had the urgent need arisen later in the year, we might have had to displace other research.

7. What have been the impacts on annual user facility meetings, strategic planning workshops, and short courses and schools (to train students, early career researchers, or future users)?

Training and tutorials have been 100% virtual with good attendance (in many cases better than our in-person training sessions):

- DL4Sci webinars had more than 1,500 registrants to whole series and over 300 attendees for individual webinars.
- SC20 tutorials also moved virtual (e.g., Deep Learning at Scale). There was good attendance, but the hands-on components were significantly negatively impacted.
- The annual facility user's group meeting was held online.
- NERSC briefings with Office of Science program managers are being held exclusively online.

8. Please provide any other comments or ideas as input for the roundtable.

The pandemic has revealed a divide between staff whose jobs can be done 100% remotely and those whose jobs cannot. This will have to factor into any future decisions around returning to the office or expanding remote work opportunities—and how they are valued.

Advanced Scientific Computing Research

Oak Ridge Leadership Computing Facility (OLCF)

Oak Ridge National Laboratory

OLCF provides the computational science community with world-class computing dedicated to breakthrough science and engineering.

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1. How has the COVID-19 pandemic affected your facility? At what fraction of facility capacity are you currently operating? What is the distribution between virtual access and physical onsite access? How have facility operations been impacted? Have there been disproportionate impacts on any staff? Has any action been taken to minimize the impact on early career staff or other vulnerable staff groups?

Overall, OLCF has been able to maintain mostly seamless operations, providing computing resources to the user community at the same capacity as before the COVID-19 pandemic. All user access to the facility occurred remotely, or virtually, pre-COVID, and users continue to access our computing resources in the same way. User assistance has remained seamless, and we have been able to adapt our training resources to all virtual without any issues. However, one area that has seen moderate impact is in facility operations.

Facility operations have been impacted periodically due to OLCF and vendor staff positive cases or exposure to positive cases and subsequent quarantines identified through contact tracing. Most of the impact has been to the amount of support personnel available, which includes services like electrical, carpentry, and custodial support. These issues have been overcome through careful planning of work. The lack of technical staff onsite during the pandemic has increased the workload for essential staff, particularly infrastructure and operations staff. The 24/7/365 infrastructure and operations staff have accepted more loading including to gather information, power cycle equipment, and check rack status for technical system administrators working remotely. Care has been taken to protect operations support staff by removing other personnel from the control room, using call-in turnover instead of face-to-face turnover, separating day shift workers from shift workers, and limiting access to the operational control room. In addition, training guides were created, and four staff members were trained to these guides as emergency fill-in staff for any COVID contact tracing/quarantine impacts on the 24/7/365 staff.

2. What approaches are you taking to provide productive user research experiences and services in a virtual context?

In addition to maintaining traditional high-performance computing (HPC) research, OLCF joined the COVID-19 HPC Consortium, a unique private-public effort spearheaded by the White House Office of Science and Technology Policy, DOE, and IBM to bring together federal government, industry, and academic leaders who are volunteering compute time and resources on their world-class machines for COVID-19 research. Through traditional programs and the HPC Consortium, 2,206,200 Summit node-hours have been allocated to 21 projects to date (1,669,665 hours have been consumed).

Additionally, OLCF purchased two new Summit cabinets furnished with high-memory CPUs and NVIDIA V100 GPU nodes with 32 GB of high-bandwidth memory with supplemental federal funding for COVID-19–related research provided by DOE through the CARES Act. Many users have benefited from these new nodes. For example, computational scientists at OLCF used the power of NVIDIA GPU computing and BlazingSQL, a new engine for GPU-accelerated queries using the SQL language, to substantially speed up big data analysis (10x), such as is needed for their work on drug discovery for COVID-19.

3. What, if any, changes to physical access have you implemented or considered for users, vendors, or maintenance personnel?

ORNL has made laboratory-wide physical access restrictions and facility-use restrictions during the pandemic. As for the centers, we have separated all essential personnel into different offices, removed craft support from an "open" shop environment into individual separated cubicles, separated work into single- or multiperson work (eliminates contact between staff), and implemented protections and trained additional personnel for 24/7/365 operations. Vendor access to the centers is controlled through the ORNL process for campus access. However, the center manager created a division-wide COVID questionnaire, which is given to any vendor needing access. The vendor completes the questionnaire and returns it to the center and ORNL Medical. ORNL Medical then works with the center to discuss the scope of work, restrictions for travel, and how to eliminate contact between traveling vendors and ORNL staff. Many other operational items have changed.

4. Have you identified any lessons learned as a result of the COVID-19 pandemic?

In the past, we have had week-long, hands-on hackathons that were held locally. We continue to run those hackathons, but we have moved them to a virtual environment. In doing so, we are now breaking up the event over two weeks, as we learned that staying focused and productive on a Zoom call for five straight days is challenging. Plus, breaking the training over two weeks better accommodates participants' schedules. Holding these events virtually has made it easier for organizers to find mentors, as it doesn't require travel and as big of a time commitment. As such, we may continue to hold this series virtually in the future.

5. What has the COVID-19 pandemic revealed about the needs for virtual access to computational, data management/analysis, software, and network resources or other types of instrumentation?

Some important needs have been revealed through this experience. For example, it's clear that training documents and how-tos need to be thorough and as specific as possible because face-to-face questions about access, data management, and software resources cannot be answered in person. Additionally, we have learned that setting up virtual capabilities to work with VPN access, especially to work within cybersecurity requirements, are essential for effective remote virtual access.

6. User Project Administration: Have project award periods been extended and if so, does this impact future proposal calls and facility operating costs (including budget carryover across the fiscal year)? Have there been any changes to allocation policies?

As a remote computing facility, our users are still able to login and carry out their research on our resources, and we have kept all OLCF systems in full production during the pandemic. However, as expected, a small number of teams have been impacted personally by the virus and have requested short extensions for their projects. We have been able to accommodate those extensions without impact to future proposal calls and/or operating budgets. To date, we have not had to make any changes to our normal allocation policies and processes.

7. What have been the impacts on annual user facility meetings, strategic planning workshops, and short courses and schools (to train students, early career researchers, or future users)?

OLCF has continued training efforts and moved all planned events to a virtual setting. As most of our users are remote, we have always had a virtual component to many of our training and user events. For example, we host

a monthly conference call for all OLCF users that has always been conducted virtually using tools like Webex and Zoom. We also host an annual OLCF User Meeting on the ORNL campus but always provided a call-in number for those who could not travel. This year, we held the entire User Meeting virtually and had about the same number of attendees as in previous years. In fact, we saw an uptick in the number of questions and comments from the audience. We believe that comes from the fact that some people feel more comfortable asking their question in a virtual setting over raising their hand and drawing attention to themselves in a public setting. OLCF also hosts a series of hands-on, week-long hackathons where we bring members of teams together and pair them with an expert; together they work over the week to improve and accelerate their code so that it runs better on our supercomputers. We were a bit trepidatious about virtualizing this series, but we have now conducted several of these events and the teams are still making progress and reporting great results. So, while we still hope to have in-person events in the future for the networking interaction, we do believe we have continued to be successful in advancing our training goals during this time.

8. Please provide any other comments or ideas as input for the roundtable.

[No response]

BES

Basic Energy Sciences

Light Sources

Advanced Light Source (ALS)

Lawrence Berkeley National Laboratory

ALS is one of the world's brightest sources of reliable vacuum-ultraviolet light and soft X-rays, enabling a wide variety of scientific disciplines.

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1. How has the COVID-19 pandemic affected your facility? At what fraction of facility capacity are you currently operating? What is the distribution between virtual access and physical onsite access? How have facility operations been impacted? Have there been disproportionate impacts on any staff? Has any action been taken to minimize the impact on early career staff or other vulnerable staff groups?

After a two-week full shutdown and shelter in place, facility operations were restarted on March 31 for COVID-related research at a few beamlines. The accelerator was initially operated by a minimum number of personnel onsite with system experts on call when needed. The number of available user days was gradually increased from two days per week to now about five days a week, and additional staff were brought onsite to support three shifts of accelerator operations per day, our normal operations model. A large fraction of the accelerator work planned for the summer shutdown had to be postponed, leading to project delays including the ALS upgrade. Recovered shifts due to the shortened shutdown were made available for COVID and other critical research. New safety protocols and training of staff in the use of half-face respirators allowed critical maintenance and R&D work to continue, but overall work effectiveness has been reduced during the pandemic, leading to deferred work (e.g., some planned accelerator improvements).

User research was initially limited to COVID research only in April and May. Starting in June with the first Return-to-Work Pilot, additional beamline staff were brought onsite to start doing some fraction of research, including user research, with the beamline staff in control of what was and wasn't feasible. Work on beamline construction and upgrade projects resumed but was limited to activities that were compatible with social distancing. As pilots progressed, the ALS moved to a density model of occupancy where each beamline's workspace was evaluated, and the majority were allowed one person to work on each beamline, up to two shifts per day, with at least 30 minutes between shifts. This allowed staff and resident affliates to be scheduled to do experiments on all beamlines.

The impact on our work and staff has been massive. Complex projects had to be postponed, new safe work processes had to be developed and executed with additional personal protective equipment worn. The number of user experiments we can support is well below normal numbers because some experiments are not suitable for remote operation, and the ALS does not have a suffcient number of beamline scientists to run user mail-in experiments for five days a week in three shifts. The majority of our staff are continuing to telework, sometimes in less-than-optimal work environments. The number of staff onsite has slowly increased from less than 10% to now about 30% to 50%

of our normal population. Planning and communication moved almost entirely to teleconferencing and messaging apps, which are suitable for some tasks but not ideal for quick communication. The pandemic also resulted in a large increase in administrative work (e.g., to prioritize access and ensure adherence to new policies). Changes and overall uncertainty required increased communication among staff, supervisors, and leadership to respond to staff concerns and update them about measures put in place to minimize the possibility of exposure to COVID. LBNL produced new guidance for supervisors and staff. Line managers have actively reached out to staff to develop individualized work models that take into account the worker's personal situation and the facility's needs. We have prioritized access for trained early career staff and students, but we are currently unable to onboard new users because of social distancing requirements and travel restrictions.

2. What approaches are you taking to provide productive user research experiences and services in a virtual context?

We are running limited user operations with an emphasis on remote and mail-in sample measurements. Each beamline scientist has made an evaluation of which remote control capabilities are possible for which types of experiments. They span from full control by a remote user, to a remote user collaborating in real time with the experimenter physically present at the ALS via Zoom, screen sharing, and similar tools, to mail-in samples where ALS staff mount the samples and take the data, which is then sent to the user. Each beamline is currently limited to one person at a time, up to two shifts per day. Complex experiments requiring two or more people are mostly not being done at present. A small number of primarily local users have been allowed to come onsite, taking one of the shifts allowed per day. Those individuals follow the same COVID training and precautions that LBNL staff must follow. Because they need to work alone at the beamline, this is only currently available to users who are previously trained and experienced with the beamline and end station.

3. What, if any, changes to physical access have you implemented or considered for users, vendors, or maintenance personnel?

This is constantly changing and evolving based on state, county, and LBNL guidelines. As of this writing, LBNL has commissioned a building-density report, which has evaluated the density with which buildings and the site may be occupied while still complying with required COVID controls. LBNL plans to work towards a maximum site-density goal of ~2,400 people, which is about 50% of normal. LBNL is currently at 1,750 and is planning on holding at that number until 2021 due to the recent increase in reported COVID cases. The ALS has already achieved its maximum allowed density of 119 within this model in the ALS complex of three buildings. The ALS works with its various stakeholders weekly to schedule the following week's access to the complex to ensure that occupancy remains within the allowable limit set forth by LBNL. To date, maintenance access to the facility has not been disrupted. The planning cycle discussed above allows us to prioritize access to the facility for maintenance staff on maintenance days and scientific staff on user operations days. Limiting factors on the science side are the density of the ALS experimental floor and our need to limit each beamline to one staff member or user at a time to comply with COVID controls.

Vendor and user access was nonexistent at first. Currently we can bring in vendors as needed, and handfuls of users are being brought in with enhanced coordination. They are required to comply with our COVID controls and count toward our total density numbers. LBNL is currently releasing a COVID Exposure Prevention Plan that will likely make it more diffcult for vendors to gain facility access. A particular challenge here, and also highly relevant to our users, is access restrictions for people who are not from San Francisco Bay Area counties or who may be from a COVID hot spot, either local or not.

We have developed a robust process to request, approve, and plan access to the ALS facility that appears to be working within the limitations set forth by LBNL. We estimate the effort required to manage this process at 2.5 full-time equivalents.

BES

4. Have you identified any lessons learned as a result of the COVID-19 pandemic?

The pandemic severely impacted our user operations, which for many classes of experiments rely on the personal interaction of users and ALS staff at the beamline; and it forced us to rethink many of our work processes. Some classes of routine experiments can be conducted remotely or by staff on mail-in samples if the infrastructure for teleoperation is in place. Some beamlines, especially those offering macromolecular crystallography, have been operating in this mode for a long time. Further developing this infrastructure could lead to additional efficiencies in the operation of beamlines even after the current pandemic. However, we also realized that more complex and collaborative experiments require direct, local collaboration of facility and user scientists. The ALS does not have a suffcient number of staff to ensure a continuous operation of beamlines without the local presence of trained users. The pandemic also encouraged us to explore the use of new communication technologies for meetings and workshops, which allowed us to communicate more broadly and inclusively (e.g., by reaching user groups who are usually not participating in our user meeting but are eager to join town halls and workshops online).

5. What has the COVID-19 pandemic revealed about the needs for virtual access to computational, data management/analysis, software, and network resources or other types of instrumentation?

In a survey of beamline staff, very few responded that the current level of virtual access is high, and when we proposed a series of possible developments to improve the experience for remote users, virtual access to computational resources was given as the highest priority for a majority of respondents. Respondents indicated that deploying these kinds of tools would not only increase the amount of science that would be practical at the facility (assuming we continue to operate in a mode that requires remote access), but it also would allow a change in the balance of participation in experiments between users and staff. Currently, in a significant number of cases, staff are doing most or all of the experiments. Deploying virtual access could reduce the overwork some staff are experiencing while allowing users to take a more significant role.

This scenario actually holds true in terms of virtual access to data acquisition computers, as well as for access to data management/analysis computing resources. Because of a lack of smooth access to these resources, staff are doing more for users both in terms of experiments and in terms of data analysis. The pandemic has really brought into focus the question of what the role of users is and should be during and after a beam time experiment.

ALS staff have had conversations with members of the Remote Access Working Group launched by BES light sources as well as with others at a few synchrotrons to learn what is being done in this area, and we are starting to develop plans for solutions. One of the major LBNL cybersecurity concerns is how we are going to implement identity management, including ensuring multifactor authentication, before allowing access to our computing systems.

6. User Project Administration: Have project award periods been extended and if so, does this impact future proposal calls and facility operating costs (including budget carryover across the fiscal year)? Have there been any changes to allocation policies

Since the majority of the allocated beam time during cycle-1 of 2020 has been lost due to the pandemic, all active General User and Approved Program proposals were extended by one cycle. The September 2020 Call for General User Proposals and the July 2020 Call for Approved Program Proposals were cancelled, reducing the inflow of new proposals, which are competing for a massively reduced number of shifts and resulting in a reduced and more manageable workload on users, reviewers, and staff. Allocation of beam time has changed: only projects that are feasible under the conditions in fall are prioritized to receive beam time in the order of their proposal score. ALS beamline staff request additional information from PIs about the feasibility of the experiment as a mail-in experiment and communicate with users about the schedule for their experiment. There have been no cost impacts for the facility.

7. What have been the impacts on annual user facility meetings, strategic planning workshops, and short courses and schools (to train students, early career researchers, or future users)?

The 2020 User Meeting was held in August, which allowed time to switch from the planned onsite event to a fully virtual meeting. All presentations, workshops, tutorials, and poster session aspects of the usual meeting were

translated into Zoom format. The only thing missing was the informal interaction between users and staff, which is a valuable aspect of an onsite meeting. We had fewer requests to organize workshops than usual. The meeting was reformatted from three long days to four shorter days. The after-meeting survey showed that the meeting virtual format was popular, especially with the younger audience who perhaps would have been unable to attend an onsite meeting. Two of the workshops were tutorial style, and other workshops had training elements. All sessions of the meeting, including workshops, had higher attendance levels than usual. Discussions are starting for the 2021 User Meeting, and pandemic uncertainty is leading us to prepare for a second virtual meeting. Strategic planning workshops have continued as usual but using teleconferencing tools and this approach has been generally effective.

8. Please provide any other comments or ideas as input for the roundtable.

The pandemic challenges our operations model in various ways. A roundtable discussion about the following topics would be beneficial:

- Development of common tools, which enable remote use of facility resources, requires investments in robotics, automation, secure access to computing resources by users, shipping and handling and tracking of samples, and use of artificial intelligence for routine tasks.

- Access models that benefit longer-term, deeply collaborative work between users and facility scientists that advance the most complex and most impactful experiments. These complex experiments require a continuous engagement of users at the facility and a community of trained expert users. Current social distancing requirements curtail the training of new users and early career scientists.

- Sustainable operation models, which are cognizant of the increased need for beamline staff to support remote and mail-in user operations while also developing new remote-access tools.

BES

Basic Energy Sciences

Light Sources

Advanced Photon Source (APS)

Argonne National Laboratory

APS is one of only four third-generation, hard X-ray synchrotron radiation light sources in the world, which has brought about new discoveries in a wide range of scientific fields.

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1. How has the COVID-19 pandemic affected your facility? At what fraction of facility capacity are you currently operating? What is the distribution between virtual access and physical onsite access? How have facility operations been impacted? Have there been disproportionate impacts on any staff? Has any action been taken to minimize the impact on early career staff or other vulnerable staff groups?

COVID Pandemic Affecting Facility:

- The APS modified operations in remaining online through the beginning of the COVID-19 pandemic and its associated impacts; the most notable impacts beginning in earnest by late March 2020 for the northeast region of Illinois.

- The facility pivoted quickly to a drastically reduced operational and experimental footprint, first permitting only mail-in and remote (virtual) access experiments related to COVID and proprietary pharmaceutical research.

- In April 2020, as an example, the APS averaged only 30 to 50 employees/staff onsite (includes both APS Operations and APS Upgrade (APS-U) Project personnel in this figure) and approximately three to five beamlines enabled for COVID and proprietary pharmaceutical research. Except for emergency maintenance activities as required, the accelerator complex was mostly operated remotely with only one or two control room operators onsite, and the few operating beamlines were accessed remotely.

- Normal, pre-COVID ranges are 600+ employees/staff onsite on a given weekday between APS Operations and APS-U Project and a total of 68 beamline end stations enabled for research.

- A slight expansion occurred in late May to permit non-COVID research, still under the restriction of mail-in and remote access only. Beginning in mid-September 2020, a very limited number of onsite users were allowed (limited to only Argonne employees that already had permission to work onsite, such that overall Argonne site occupancy did not increase), with caps of no more than two persons per experimental station with masking and social distancing.

- As of this writing, 55 end stations (out of 65 possible) are currently enabled for experimental research, the vast majority of which are operating as remote-access beamlines.

- Of the 55 enabled end stations, many are not running at 100% efficiency due to the higher demand on the limited beamline staff with the onsite user restrictions.

Fraction of facility capacity currently operating and distribution between virtual and physical onsite access:

- The APS delivered 4,853 hours out of a scheduled 5,000 hours (97.1% availability) for FY20. Not included in these figures is an additional 583 hours that the APS delivered to users in FY20 by completely deferring a previously scheduled April/May 2020 shutdown period.

- In the highest utilization period to date, the APS has a total of 55 out of 65 end stations enabled for experiments.

- User program: Almost all access since COVID restrictions were put in place has been virtual, with a handful of onsite Argonne users and external onsite users who required physical access. In FY19, APS reported to BES a total of 5,426 unique users (4,396 onsite and 1,030 remote users—includes remote access and mail-ins). For FY20, we reported 4,016 unique users (2,926 onsite and 1,090 remote users). Note for both years, these statistics include only one user per remote-access experiment. BES has issued new guidance for revised counts of remote users in FY20, but to be consistent between fiscal years we are usin g the FY19 rubric. Impact was heaviest during the first part of the pandemic when the number of users dropped to perhaps 10% of normal. Operating beamlines have returned to between 70% and 100% utilization. We have also seen a significant decrease in first-time users of the APS, which typically comprised ~35% of unique users annually pre-COVID but was down to 30% in FY20.

- During Limited Operations, the APS has had roughly one-third of its normal employee base onsite at any given time, with approximately two-thirds working virtually. This ratio is approximately the same for Argonne National Laboratory (ANL) as a whole during Limited Operations.

Impact to facility operations and disproportionate impacts on any staff:

- Facility remains underutilized from experimental station and user figures above. Response times to emergent accelerator and infrastructure events (e.g., IT issues have suffered from reduced onsite employee presence both in the APS and central Argonne operations.) This has reduced X-ray availability by approximately five percentage points and increased time to recover from faults significantly.

- Maintenance has been deferred, with a whole shutdown period (~35 days in duration) postponed, in order for the facility to remain online for COVID research. Overall, the pandemic's impact has forced scheduled shutdown periods to be less productive than normal, as COVID controls add overhead to work execution and are necessary out of an abundance of caution for employee health and wellness.

- Beamline operations staff have been disproportionately impacted. The increase in remote-access experiments, coupled with very few onsite users besides APS staff, translates into local beamline staff performing far more tasks onsite (e.g., sample preparation, mount, adjustment, setup data collection, monitor experiment) than normal pre-COVID operations.

- We are concerned that career development for postdocs and early career staff has been significantly slowed.

- Staff with caregiving responsibilities have been impacted, although for beamline scientists this impact is perversely balanced against some reduction in the demanding nature of being onsite to support users.

- A moderate number of staff have temporarily relocated away from the Chicago area. Some of these staff have indicated that they may not return, generally for family reasons.

Action taken to minimize impact on early career staff or other vulnerable groups:

- Early and aggressive action was taken at the beginning of minimum safe operations (min-safe) to provide computing and other telework resources to technician and design/drafting groups to enable them to be productive remotely. Many of these roles are jobs that are predominantly onsite, hands-on work in a normal pre-COVID work environment.

- ANL implemented a variety of benefits modifications to accommodate vulnerable groups, such as additional caregiver benefits and vacation donation programs. Chief among these accommodations to minimize impact

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has been the availability of COVID testing onsite via the Argonne Health and Employee Wellness Clinic, with testing results available typically in 24 hours.

- Hiring and onboarding have continued with supervisors remotely indoctrinating new hires up to a point of requiring site access when needed for hands-on tutorials.

- We continue to work to provide virtual opportunities to replace normal onsite scientific activities such as seminars and group meetings. COVID has also significantly disrupted networking opportunities requiring travel; DOE is still working to establish processes for oversight of virtual interactions that take the place of travel.

- Argonne has put in place policies to extend postdoctoral appointments beyond normal terms, but this is subject to available funding.

2. What approaches are you taking to provide productive user research experiences and services in a virtual context?

The coronavirus pandemic has forced a new paradigm on the way light source user facilities are operating. Site-access restrictions dictated by COVID-19 at most national laboratories have required that user facilities offer more remote-access and mail-in capabilities to be able to best utilize these valuable resources. Although a majority of macromolecular crystallography (MX) beamlines at BES light sources have supported remote-access and mail-in modes for many years, this was not the case for a majority of non-MX beamlines. Thus, beamline staff have been working arduously to make these modes viable. Since the beginning of the pandemic, various levels of remote access/mail in have been achieved on roughly 50% to 80% of non-MX beamlines. In a relatively short time of eight months, many technical, operational, and policy issues were worked out to facilitate remote access. This has been a significant investment (made possible in part by funding received through DOE from the CARES Act), but we believe it will pay off in the long term because remote/mail-in access modes will remain long after the pandemic damps down and site-access restrictions are relaxed.

To assist in the conversion of beamlines to remote-access capabilities, BES light source directors chartered the Remote Access Working Group (RAWG) to discuss and compare strategies to improve remote user access to experiments on light source beamlines. The charter encompasses:

- Ways to improve real-time communication between remote user teams and beamline staff.
- Remote access of beamline control systems for data collection and/or motion control.
- Robotic control of some beamline functions.

The RAWG collected experiences in these areas and presented initial findings to light source directors. Once the information is curated, it will be posted on a webpage currently in development. The RAWG is also planning to organize seminar series and educational videos to help the user community utilize remote-access tools. In addition, the RAWG has conducted a survey of beamlines/instruments to help determine current capabilities and guide future investments in remote access. The survey will be subsequently extended to the broader user community.

We have successfully moved a number of facility training opportunities online. This has significantly increased participation (in some cases by 50% to 100%), albeit at the loss of hands-on components.

3. What, if any, changes to physical access have you implemented or considered for users, vendors, or maintenance personnel?

Changes to physical site access:

- Any personnel onsite:
  - During min-safe, site access was strictly controlled by means of an access roster, which each research directorate maintained.
  - In Limited Operations, individual site access continues to be tracked daily to adhere to directorate population caps established in coordination with the operations office.

- o Population density maps ("heat maps") are available by building or other defined location set.
- o From min-safe forward, individual work restart packages have had to be submitted for significant restart work or activity not covered under the original min-safe work scope. This included listing individuals by name who would need access to the site to restart and perform the work scope.
- o All employees must perform a health self-check daily by answering five questions provided via an Argonne mobile phone app or lanyard card.
- o All employees must adhere to a litany of COVID prevention protocol: face coverings, maximum physical distancing, increased hand washing and respiratory etiquette, a graded approach governed by Environment, Safety, and Health personnel for permitting close-proximity work (<6 ft for >10 min cumulative), no sharing of tools, wiping down high-touch surfaces and shared work spaces, adhering to floor markings for distancing and traffic flow, adhering to posted occupancy caps by room and type, and minimizing total time and interactions onsite before returning home.
- o All employees have been asked to sign an Argonne Health Pact, similar to other national laboratories, in further pledging they will adhere to site protocol for COVID prevention.
- o Contact-tracing wearables, which can provide a dataset of close-proximity interactions, are in the process of being piloted. This has the benefit of providing a more definitive and unbiased list of close contacts who would require quarantine in the event of a positive COVID case that requires contact tracing.

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- Maintenance Personnel
  - o As an example, Argonne building maintenance and facilities employees' onsite presence was drastically reduced during min-safe to the same degree as programmatic employees.
  - o During laboratory limited operations, onsite totals have increased to roughly 60% of total available facilities division personnel onsite at any given time.

- Vendors
  - o Contractor and vendor site visits/physical accesses were similarly restricted at the outset of min-safe, numbering only about 125 contractors/vendor/deliveries per day.
  - o At the time of this writing, with the Laboratory under Limited Operations, these have increased to approximately 200+ per day.
  - o Contractor and vendors continue to be required to abide by all Argonne site COVID controls.
  - o Contractor Safety Orientation documentation has long been updated to incorporate COVID controls and was further enhanced for electronic delivery and completion, which was not available prior to the pandemic.
  - o Contractor Job Safety Analysis updates to meet Argonne site COVID controls are required prior to any contractor/vendor coming onsite since late March 2020.

- Users:
  - o During min-safe, no onsite users were permitted, and APS users were limited to mail-in and remote-access experiments only.
  - o With the October 1 start of the 2020-3 user run, APS has permitted onsite experimenters. It is limited to Argonne employees at present and capped on a per-experimental-end-station basis.
  - o External (non-Argonne) users have only been permitted by exception, following both associate laboratory director and DOE Argonne Site Office approval. These exceptions have been minimal (<10) since the start of the October 1 user run.
  - o We added several new processes to accurately capture COVID research metrics (e.g., number of users, number of beam time hours used) for reporting purposes.
  - o We added COVID training as a requirement for all onsite users through our experiment safety review process.

4. Have you identified any lessons learned as a result of the COVID-19 pandemic?

Lessons Learned from the COVID pandemic:

- The APS nimbly and quickly moved to a majority telecommuter base in late March 2020, in response to the pandemic's impact and DOE and state mandates.
- Telecommuting resources were largely in place at Argonne and the APS, although not used anywhere near current utilization levels. IT network load, VPN availability, and application performance has been good through this intense increase in usage.
- COVID prevention protocol has largely been effective using a graded approach by task while making other controls mandatory. Physical distancing has been the most difficult to control, as personnel tend to drift to pre-COVID postures onsite. Technology aids such as contact tracing wearables may be helpful aids and will be piloted onsite soon.
- The APS has benefited from a measured return of staff onsite during min-safe and limited operations, with a vast majority of employees continuing to telecommute.
- Supplemental CARES Act funding has been very valuable in converting beamlines to remote access to increase utilization and productivity during a period of limited operations.
- The overall impact to operations from the pandemic has been substantial, as a scientific user facility the size of the APS thrives on onsite, in-person coordination and interactions.
- The biggest hurdles looking forward are finding ways to effectively train new users and mitigating the impact on early career staff of loss of scientific, networking, and career development activities.

5. What has the COVID-19 pandemic revealed about the needs for virtual access to computational, data management/analysis, software, and network resources or other types of instrumentation?

The COVID-19 pandemic revealed enormous needs in all these areas. Equally important, it pointed out that sheer technical capability and/or sophistication in each of the area is not sufficient for successful execution of experiments. Integration of software, data management/analysis, and communication tools are all critically important to deliver scientific results. This requires strong collaboration and tight integration among various technical groups, such as IT, controls, and experimental personnel. Use of new types of instrumentation such as sample handling robots have gained popularity on non-macromolecular crystallography light source beamlines because of their versatility and straightforward integration with controls software.

Collaborative robots or cobots are being used more frequently on light source beamlines. Cobots are well suited for assisting non-routine experiments. They are equipped with grippers, cameras, force sensors, and communication ports. Augmented reality and mobile telepresence robots driven by remote users or staff might prove to be attractive ways to mitigate lack of physical presence. The current situation is very likely to significantly accelerate adoption of these technologies, perhaps by years.

6. User Project Administration: a. Have project award periods been extended and if so, does this impact future proposal calls and facility operating costs (including budget carryover across the fiscal year)?

Due in part to the large number of active proposals in the APS General User (GU) Program, we have not extended the length of GU proposals. APS GU proposals are active up to two years. We have advised the GU community to resubmit their existing proposal or submit an updated proposal if their current proposal expired, and time was not allocated due to COVID-19. The exceptions to this are APS Partner User Proposals. These are proposals where the partnering GU has invested in the facility in return for beam time. We are honoring our original beam time commitments for these proposals and extending the expiration date if the investments have already been made into the

facility. The pandemic will not impact future calls for proposals and have a minimal effect on facility operating costs, assuming we operate the facility for the DOE agreed-upon amount of time for the fiscal year.

6b. Have there been any changes to allocation policies?

Since COVID-19 has forced most experiments to be run in a mail-in or remote-access arrangement, and this was not known when the original proposal was submitted pre-pandemic, we could not allocate beam time based only on the review score the proposal received. Instead, we had to consider the feasibility of running the experiment in a mail-in/remote-access mode. This required beamline staff to work with users to make this determination. Proposals that could be run via mail-in or remotely were given priority to ensure that the facility was being utilized as effectively as possible.

7. What have been the impacts on annual user facility meetings, strategic planning workshops, and short courses and schools (to train students, early career researchers, or future users)?

Certainly, there have been impacts on our annual User Meeting and schools/short courses. Since these were originally planned to be onsite, some meetings/courses had to be cancelled. Others were quickly converted to virtual meetings/courses. Although not meeting face to face and not having the hands-on experience that was planned are clearly a minus, there were some actual positive impacts to virtual meetings. The annual Neutron/X-ray Scattering School (NXSchool)—supported by DOE/BES and hosted jointly by APS/ANL and SNS/ORNL—is typically limited to 60 graduate students due to hands-on experiments that are part of the school and travel costs. By going virtual, all 256 students who applied to the 2020 NXSchool were invited to the virtual lectures. Similarly, attendance at the virtual APS User Meeting Workshops, normally associated with our (cancelled) User Meeting, was higher than previous onsite workshops, most likely due to zero travel costs.

8. Please provide any other comments or ideas as input for the roundtable.

[No response]

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Basic Energy Sciences

Light Sources

Linac Coherent Light Source (LCLS)

SLAC National Accelerator Laboratory

LCLS is the world's first hard X-ray free electron laser facility capable of producing X-rays that are both very intense and clumped into ultrafast pulses.

Contact: lcls-user-office@slac.stanford.edu

1. How has the COVID-19 pandemic affected your facility? At what fraction of facility capacity are you currently operating? What is the distribution between virtual access and physical onsite access? How have facility operations been impacted? Have there been disproportionate impacts on any staff? Has any action been taken to minimize the impact on early career staff or other vulnerable staff groups?

a. LCLS operations status:

o We are running a near-normal schedule of experiments since our restart in mid-August. But only 10% of non-SLAC National Accelerator Laboratory (SLAC) users are onsite, compared to prior years at ~100%. In a normal year, LCLS has up to 1,000 users. Our plan for FY21 was to increase (taking advantage of the dual undulators and high levels of multiplexing), but this will now be reduced due to the constraints of physical and temporal spacing between user groups (e.g., to avoid an excessive burden on local staff).

o Experiments are being executed at reduced efficiency due to fewer users and staff onsite. In particular, there has been a substantial impact on response times to operational failures or specialized problems, since staff are typically not onsite and because work requires preplanning and approval if it involves multiple staff together. This has affected the overall availability of beam time and has compromised the viability of some individual experiments.

o The ambitiousness of some experiments has had to be reduced (e.g., to use less-complex samples or instrument setups). This allows an experiment to proceed with only partial user presence but impacts the scientific outcomes.

o We are seeing a gradual erosion of the connection of staff with the facility and situational awareness of what is happening at LCLS.

b. Mitigations for user operations:

o Underway:

i. An array of improvements to remote-access functionality have been implemented (funded in part by CARES Act investments), as described at: https://confluence.slac.stanford.edu/display/PCDS/COVID19+-+Tools+for+Remote+Participation+in+Experiments

ii. A Remote Access Working Group (RAWG) was established with other BES light sources to share best practices and coordinate future developments.

o Potential short-term actions (one to six months) are investments to:

i. Increase staff deployment to front-line experimental delivery (e.g., technicians, RAs, sample delivery, controls, IT staff).

ii. Enhance remote-control and data systems, including: full implementation of multiscreen projection of data displays to users; extended NoMachine functionality to broaden the range of actions (and users) available for remote operation of instrumentation; deployment of all-room microphone pickup in control rooms (e.g., multichannel, multiview); investments in augmented reality headsets for online staff, projecting heads-up displays for the wearer; and enabling full two-way information exchange with remote users.

iii. Increase the deployment of redundant systems to mitigate the impact of failures in systems that enable and enhance remote-user participation (e.g., event receivers, compute nodes).

o Potential medium-term actions (6 to 18 months) are investments in:

i. Building hutch test-stands to provide a representative, full-functionality environment to develop, debug, and train with the advanced controls and data systems.

ii. Development of virtual hutch simulators to provide a robust training ground for users (and staff) and test out non-standard modes of operation without risk.

iii. Deployment of enhanced automation systems (requiring less hands-on intervention) to relieve the burden on local staff and provide a more robust experimental setup.

iv. Cognitive artificial intelligence research into intelligent data screens (learned systems that respond to the anticipated needs of users based on prior experience of what variables/screen are needed in a given situation).

v. Increased robustness in machine protection systems to allow enhanced remote control to more staff/users.

vi. Communications tools with minimal latency for more natural multiway interactions ("Beyond Zoom," learning from fields as diverse as online choirs).

vii. Better design and definition of experiments via detailed Start-to-End (S2E) modeling [Lightsource Unified Modeling Environment (LUME)].

c. Impact on staff:

o Overall, there has been a marked increase on operational duties for beamline staff and related personnel [e.g., controls, data aquisition (DAQ), sample preparation], who now must perform almost all of the duties that otherwise would have been shared with the user teams.

o It has been much more difficult to train new staff or learn new skills with social distancing in onsite labs. This has left the more expert staff with a larger burden to set up or execute work. This problem will amplify with time and could become a serious issue for knowledge distribution, knowledge retention, and skill development for early career staff.

o The most disadvantaged are students, postdocs, and new staff (who typically have a less-well-defined, day-to-day role and also are more likely to be isolated at home).

o There is less opportunity for direct interaction among accelerator staff, instrument staff, and users, with very little opportunistic/serendipitous interaction and casual participation in ongoing work or seeing a problem emerge and be solved. Since X-ray Free-Electron Laser science is inherently collaborative, requiring deep iteration during an experiment, there is a longer-term risk to the quality of the science and a regression to performing simpler measurements rather than transformational experiments.

o Mitigations:

i. Underway: LCLS has implemented remote learning opportunities such as a weekly journal club and an engineering school, as well as a focused effort to ensure rotation of early career staff onsite.

      ii.   Underway: Good use has been made of "permanently on" Zoom rooms as a default space for staff to interact. This best practice is being rolled out more widely across groups.

      iii. Suggested short term: Creation of a series of short videos of key activities as training tools (similar to those at SSRL: https://smb.slac.stanford.edu/users_guide/tutorials/)

      iv. Suggested medium term: The "hutch test-stands" and virtual "hutch simulators" mentioned above would provide invaluable tools for training.

2. What approaches are you taking to provide productive user research experiences and services in a virtual context?

a. LCLS has deployed remote participation tools allowing constant direct communication between remote and onsite experimenters. Remote users can see what the onsite researchers see in terms of controls and online data feedback. This has proven reasonably effective. See: https://confluence.slac.stanford.edu/display/PCDS/COVID19+-+Tools+for+Remote+Participation+in+Experiments

b. However, it is very hard to train and inform while on Zoom and do the work (and a particular mentality is needed to provide a useful running commentary). It is more difficult for users to ask, "what's that?!" while remote. Mitigations include an explicit staffing approach to delineate tasks to onsite staff: selecting a driver of instrument operations, a documenter for robust logging of information, and a discussion lead to ensure high levels of engagement with remote users, including real-time assessments of "what just happened?"

c. Remote participation enables broader collaborations, allowing users who would otherwise be unable to travel to SLAC (due to costs, logistics, or competing commitments) to participate more fully. It has also allowed new user groups to gain knowledge of LCLS—helping to broaden the user community for the longer term.

d. We are seeking to accelerate the development and application of S2E models and virtual training environments, although this requires greater resources and user engagement.

3. What, if any, changes to physical access have you implemented or considered for users, vendors, or maintenance personnel?

a. Onsite access for users is currently allowed if deemed critical to the viability of the experiment, and subject to numerous protocols (including PCR testing for close engagement with others).

4. Have you identified any lessons learned as a result of the COVID-19 pandemic?

a. There is an increased value in high-quality advanced planning for all aspects of pre-beam tests and with-beam activities, albeit this places further burden on the staff. In the future, this could include options for offline tests using the hutch test-stands proposed above and virtual simulation environments/S2E models.

b. The pandemic highlighted a need for better ways to train staff and users with documentation and training videos that do not require close proximity and can be used at any time.

c. Sample preparation is an area that demands expert staff, sometimes on a sample-by-sample basis. This is a big challenge, which requires a deeper bench strength at SLAC and investments in new systems that are more robust and amenable to offline testing and remote operation.

5. What has the COVID-19 pandemic revealed about the needs for virtual access to computational, data management/analysis, software, and network resources or other types of instrumentation?

a. LCLS already has web services, a data management system, and a data analysis infrastructure that allow for virtual access to all the resources necessary to analyze data. In most cases, all the same resources are available to users doing analysis at home. We provide a data management system that transparently moves data across storage systems, automatically archives it, and associates each dataset with the metadata required for organization and analysis. The electronic logbook provides a service to track comments and annotations on datasets and analysis results by both remote and onsite individuals.

a. However, running the DAQ and configuring/watching the online monitoring (AMI) cannot be done as well remotely as at the beamline. Although users can run online monitoring on the offline system on recorded data, the latency is high enough to impair the real-time response desired during experiments. As such, onsite beamline scientists have to take responsibility for operating the DAQ and configuring AMI. This places an additional burden, and operations are not currently sufficiently automated to allow for fully remote operations. A human in the hutch will be required for some time and for reasons not limited to the DAQ.

b. A lack of common policies for software tools, even within the DOE complex and even with widely deployed software (e.g., Zoom, Slack, Google-suite), has driven the need to find workarounds that can be far from optimum.

c. Mitigations:

   o Future optimizations to transition responsibility from the onsite individual to offsite should include the development of a broad suite of additional canned analysis workflows that display results on the web (electronic logbook) and the ability to run AMI via a web interface.

   o Since communications can be via Zoom, Slack, electronic logbook, phone, and email, it is up to the PI and beamline scientist to set expectations about the mode of communications appropriate in each channel. This often means that conversations happen in a side channel so that not all the participants of an experiment benefit from the discussion. There is a need to drive the sociology of what should be recorded and deploy intelligent capture and search tools. Best-practices documents (maybe instrument-specific) are needed.

   o Implement permission controls mechanisms to rapidly onboard new users remotely and create/authorize user accounts 24/7 while in compliance with screening (e.g., FACTS, training). Federated identities would help. There is an analogy to the accelerator approach to ensure security of access to critical systems (e.g., cryo).

6. User Project Administration: Have project award periods been extended and if so, does this impact future proposal calls and facility operating costs (including budget carryover across the fiscal year)? Have there been any changes to allocation policies?

a. Approximately 25% of experiments previously scheduled for Run 18 will have to be carried over to Run 19 due to a combination of: restrictions by the user institution (e.g., sample preparation), postponement of instrument commissioning at LCLS, and the need to find a reasonable operational burden over the first few months of operation in the COVID era. This will reduce the number of proposals for Run 19 that can be accepted. Allocation policies will remain tied to scientific impact/potential, subject to (more complex) logistical constraints.

b. The financial impact is mostly associated with the need for increased resources for operations (at the expense of development projects and with issues associated with sustainability of workload on the current staff).

7. What have been the impacts on annual user facility meetings, strategic planning workshops, and short courses and schools (to train students, early career researchers, or future users)?

a. Virtual conferences and workshops are possible, but they require different strategies for success than those held in person. Brainstorming, free-form discussion of ideas, and *ad hoc* meetings are much more constrained, as is the ability for early career researchers to make themselves known (e.g., via poster presentations).

b. Adoption of common tools for brainstorming/documenting would be valuable (Google Docs are frequently used for this purpose, but use can be limited by some institutions).

c. Similarly, we need to develop protocols for when to use which tool (e.g., Slack, electronic logbook, Zoom, email), along with consistency of when to use threads, when to make a new channel, etc.

8. Please provide any other comments or ideas as input for the roundtable.

Follow up with Leila Takayama (University of California, Santa Cruz) regarding telepresence at work: https://www.youtube.com/watch?v=tTz3CdYxoDQ&ab_channel=CITRIS

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Basic Energy Sciences

Light Sources

National Synchrotron Light Source II (NSLS-II)

Brookhaven National Laboratory

NSLS-II is a state-of-the-art synchrotron light source allowing scientists to probe the fundamental properties of matter, paving the way to new scientific discoveries and innovations.

Contact: hill@bnl.gov

1a. How has the COVID-19 pandemic affected your facility?

Broadly, it has impacted the facility in several ways:

- Onsite user program dramatically reduced. Quantity and quality of remote user program are below what would have been accomplished under an onsite user program. This will result in a reduced scientific impact of the facility.
- Staff are stressed by the additional burden placed on them by the remote user program, by the difficulty in carrying out their job functions under these conditions, by the reduced connection to their colleagues and the facility, and by the stresses it adds to their personal lives. This is leading to burn out.
- Reliability of the facility is being impacted because of deferred preventative maintenance, longer response times to faults, and longer repair times under social distancing rules.

1b. At what fraction of facility capacity are you currently operating?

The accelerator is currently operating as normal. (In FY20 we operated additional hours to accommodate COVID-19 research. Fewer hours will be offered in FY21 to catch up on deferred maintenance and upgrades.)

As of November 2020, all 28 beamlines are operating; however, user operations are dominated by remote experiments. This increases the load on beamline staff, and we are therefore running about 50% of the number of experiments that we normally would.

1c. What is the distribution between virtual access and physical onsite access?

Each beamline may allocate up to two proposals with one onsite user each during the September–December 2020 cycle. All other users are remote. This distribution is likely to continue into the January–April 2021 cycle.

1d. How have facility operations been impacted?

Impacts have been broad, but to date are chronic, not acute. They include:

- Delayed reaction to faults and trends has impacted reliability of facility.

- Schedule delays in numerous improvement projects, particularly those involving onsite presence of outside vendors (e.g., for installation). This will have a long-term knock-on effect on facility performance.
- Staff effectiveness is compromised because of
    - Lack of horizontal communication between groups at the peer level.
    - Implementation of complex work under social distancing rules.
    - Personal protective equipment impacting well-being of staff (e.g., restricted breathing, fogging of glasses).
    - Staff becomes less familiar with machine hardware during long periods of telework.

1e. Have there been disproportionate impacts on any staff?

There are inequities between those staff who can efficiently telework and those who cannot. This plays out in several ways—from fears about performance evaluations being impacted to inequities in out-of-state travel. Those who can telework can afford to quarantine and therefore travel to see families. Those who cannot telework must take vacation to quarantine or leave without pay, impacting their ability to travel.

In addition, new hires are disproportionately affected, finding it hard to grow professional networks and make strong connections to the facility.

Early career staff are more vulnerable to what is effectively a pause in their career, affecting their long-term prospects.

1f. Has any action been taken to minimize the impact on early career staff or other vulnerable staff groups?

Flexibility is provided for staff where appropriate. Flexible work schedules and teleworking have been made available to all staff including vulnerable individuals and caregivers.

Early career staff including postdocs and students are back onsite.

2. What approaches are you taking to provide productive user research experiences and services in a virtual context?

NSLS-II is currently enacting an aggressive plan to start a mail-in program for all beamlines that is as efficient as possible while also complying with all Department of Transportation shipping regulations.

Remote access to as many beamlines as possible using remote desktop technology. It is building remote access data management and analysis tools to enable users to analyze their data remotely and interactively.

3. What, if any, changes to physical access have you implemented or considered for users, vendors, or maintenance personnel?

The changes to physical access we have implemented are (1) entry doors are locked to control access, and (2) numbers are limited on any given day. COVID training is mandatory prior to return to work. We have a limited user program: one user per experiment, and one to two experiments per beamline.

4. Have you identified any lessons learned as a result of the COVID-19 pandemic?

Lessons learned that have been identified by the pandemic are:

- Benefits from virtual experience. Increased communication, including weekly all-hands meetings. Vertical communication has been good.
- Negative consequences. Horizontal (between groups) and informal communication has suffered or is missing. Growing disconnection with facility.

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Best practices:

- Increased communication via internet meetings.
- Periodic safety refreshers.
- Expanding skills of onsite staff to reduce calls of experts onsite.
- Frequent facility tours to detect failures early.
- Splitting operating staff into teams to reduce risks of whole crew falling sick.

5. What has the COVID-19 pandemic revealed about the needs for virtual access to computational, data management/analysis, software, and network resources or other types of instrumentation?

- Data collection software needs to be rapidly pushed towards being remote ready using up-to-date frameworks. Current stopgap solutions are not robust for the long term. Need to rapidly push towards a more virtual presence type of beamline experience.
- COVID-19 has heightened and accelerated (but not changed) the need for virtual access to data management and analysis tools. Access to data and analysis needs to be the same experience both at the home institution and the facility.
- COVID-19 has highlighted the need to provide easy remote authentication with the facility in a manner that is compliant with current cybersecurity best practices and also to rapidly provision accounts for users.
- COVID-19 has highlighted some of the challenges posed by cybersecurity requirements in using new modern cloud-based collaboration tools.

6. User Project Administration: Have project award periods been extended and if so, does this impact future proposal calls and facility operating costs (including budget carryover across the fiscal year)? Have there been any changes to allocation policies?

All proposals with cancelled beam time were extended by one four-month cycle including partner user proposals. Cancelled proposals were not given priority in future cycles. We did not cancel any proposal calls and hence have a backlog of proposals that did not get beam time.

Allocations were previously done solely on scientific merit but now a "remote-access plan" is also considered (i.e., users with projects that can run remotely may be prioritized over better scored projects that must be done with users onsite).

7. What have been the impacts on annual user facility meetings, strategic planning workshops, and short courses and schools (to train students, early career researchers, or future users)?

The NSLS-II Users' Meeting in May 2020 had over 1,500 registered attendees; for in-person meetings, we average 300 to 400 attendees. Virtual training courses have had more attendees than onsite counterparts from previous years. For example, we've held macromolecular X-ray crystallography, small-angle X-ray scattering, and extended X-ray absorption fine structure workshops and been able to accommodate three times the number of participants.

8. Please provide any other comments or ideas as input for the roundtable.

A few salient points are as follows:

- Remote operations are a significant burden on beamline staff. This will need to be addressed in the long term.
- Enabling technologies (hardware and software) need to be improved and made robust and easy to use.
- The difficulty in performing training remotely will have important consequences, first in training new users such as graduate students and postdocs and second in developing next-generation facility staff who typically come from the experienced user pool.

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- There is a fear that as users become more physically distanced, the role of beamline scientists will be reduced to that of service providers. This would be to the detriment of quality and impact of user science. It would also represent a recruitment and retention issue for beamline scientists who are motivated by their role in the science.

- Facility reliability metrics will suffer and that needs to be understood and accommodated in some way.

Appendix: More detailed actions the facility has taken to protect staff and users.

The following best practices have been identified for bringing staff and users back onsite. The NSLS-II has developed tailored Recovery Plans for staff, students, postdocs, and users. Spaces and jobs have been evaluated for the potential for transmission of COVID-19. Density levels were established; wellness screens and barriers were installed. Hygiene products were purchased for different spaces and jobs; consideration was given for people who work in only one location and for staff who work in many locations. Schedules and density levels were monitored and adjusted based on the phase of the Recovery Plan. The light sources coordinated plans to ensure a consistent approach for users. The Recovery Plan is a living document, evolving as conditions change during the pandemic.

Infrastructure modifications needed to accommodate both operations and user research (e.g., HVAC, interpersonal shielding) are: Hand sanitizer stations were installed at main entrances and around the experimental floor for personnel use. Small-size portable hand sanitizers were made available to staff to refill and take with them. Wipe stations were installed at the main entrances to the experimental floor so that personnel can take wipes to their locations. Additionally, sprays and paper towels were made available to all personnel. Wellness screens were installed at front desks of all buildings to provide a barrier between visitors/staff and our administrative staff who support operations. Cubicle walls were raised to provide a barrier between staff who sit adjacent to each other. Some computer stations are being moved to accommodate the Centers for Disease Control social distancing requirements. HVAC modifications were made to increase outside air flow, and filters were changed to increase the minimum efficiency reporting value where appropriate. Plastic curtains were hung in some spaces to provide barriers at the beamlines. Construction of "touch-down" workstations are being considered for staff who have to be onsite concurrently and cannot socially distance while at the permanent workstation.

Interactions with vendors, suppliers, and maintenance personnel are being conducted as follows: Vendors, suppliers, and maintenance personnel are approved for work through BNL's Resumption of Operations Plan based on the phase of operations and authorized through the NSLS-II Recovery Plan. All vendors, suppliers, and maintenance personnel must follow local, regional, state, and federal guidelines. BNL has set up processes to ensure that guidelines are implemented, and site access is approved on a case-by-case basis (e.g., travel advisories, quarantine, test requirements). Several mission-critical vendors are international vendors. Specifically, BNL has prepared National Interest Exception Letters for Vendors to seek exceptions to Presidential Proclamations for Travelers from the Schengen Area, United Kingdom, and Ireland. Additionally, letters have been prepared designating companies as essential workers under state guidelines so that they may travel to BNL under state exceptions for quarantine. While we wait for international travel permission, we're conducting interactions through remote access. Following laboratory processes for remote access, we provide the capability to support testing and commissioning of equipment.

Staff training and development are being conducted under physical distancing as follows: Staff training and development continue in a virtual environment. BNL's Training and Qualification Program has transitioned to a virtual classroom environment. Supervisors continue meeting with their staff and find ways for staff to engage with each other in formal and informal virtual settings. BNL's mentoring program continues with virtual meetings. Battelle's Communities of Practice and Laboratory Operation Leadership Academy have transitioned to virtual settings.

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Basic Energy Sciences

Light Sources

Stanford Synchrotron Radiation Lightsource (SSRL)

SLAC National Accelerator Laboratory

> *SSRL produces intense X-rays as a resource for researchers to study our world at the atomic and molecular level, allowing for research and advances in energy production, environmental remediation, nanotechnology, new materials, and medicine.*
>
> **Contact:** pcm1@slac.stanford.edu

1a. How has the COVID-19 pandemic affected your facility?

SSRL shut down for several days after Bay Area counties declared a shelter-in-place public health order in mid-March 2020. When the light source reopened, it initially operated only a few of ~30 experimental stations and focused exclusively on COVID-related research. Operational beamlines were run remotely, and both the light source and accelerator were staffed by only a few onsite personnel. This mode of operation continued for several months, although ten beamlines were ultimately reopened for periodic use, still focusing on COVID-related experiments. SSRL shortened and moved forward the start date of its annual summer downtime to permit resumption of operations in September 2020, thus providing needed capacity for COVID science that month when other DOE synchrotrons were scheduled to be down. Since September, a growing number of beamlines have been restarted for user science via remote access and experiments performed on user samples by SSRL staff. In October 2020, SSRL began piloting a program to bring a small number of local users (e.g., Stanford postdocs and graduate students) to the light source. SLAC National Accelerator Laboratory (SLAC) is now in Phase 2 of its recovery of operations. It is anticipated that our onsite user program will be expanded in the coming months, although the pace will be dictated by laboratory policy in consultation with the DOE Bay Area Site Office.

Operational changes necessitated by the pandemic caused beam time previously allocated for hundreds of user experiments during the March to July period to be cancelled. Some of these experiments are now being performed in our FY21 run by SSRL staff. Restrictions on the number of personnel allowed to access the SLAC site slowed progress on four beamline construction/commissioning projects, although many design tasks were completed remotely, and hands-on work has now resumed. SSRL scientists were unusually active in writing proposals for research grant funding during the shelter-in-place period, and this is likely to result in some growth in science project funding for the directorate. During this period, SSRL beamline engineers and scientists were also able to create hardware designs and software to enable increased remote-access capabilities and automation across the light source. As these new capabilities are delivered to users and further refined, the long-term productivity of our operations may be enhanced.

1b. At what fraction of facility capacity are you currently operating?

The SPEAR3 accelerator is operating on a normal schedule consisting of 24/7 user operations with accelerator physics or machine maintenance scheduled for two days every two weeks. The full beamline complement is

operating though in many cases at reduced efficiency, owing to limited staffing that precludes fully effective 24/7 beamline operation for mail in samples when staff are performing the experiments (see 1c.).

1c. What is the distribution between virtual access and physical onsite access?

Through the beginning of October 2020, there was no physical onsite access to SSRL for users. Experiments were run either with full remote access or partial remote access with user support and/or through sample mail-in with staff performing the experiments. A pilot project with onsite presence by users from Stanford University was implemented in October, and as of mid-November is enabling approximately six users access to SSRL beamlines. An expansion of this pilot to include regional users is planned for the coming months.

1d. How have facility operations been impacted?

The run schedule was revised starting from the beginning of the shelter-in-place mandate in mid-March. Initially, SSRL was shut down for one week then restarted with curtailed operations of 4.25 days/week for several weeks. The summer downtime started earlier than originally planned, and the downtime duration was shortened in order to restart operations in September, when other U.S. light sources were down. Overall, the total hours of scheduled beam for the FY20 run were reduced from 5,092 to 4,680 hours. Off site work led to increased downtime of the accelerators and poorer run statistics.

As noted in response to question 1a., beamline operations were restricted to COVID-related research during the shelter-in-place period March 23 through July 15. Ultimately, a total of 10 beamlines were engaged in COVID-related research, only the few crystallography beamlines were operated continuously during this period. Following the SPEAR3 restart in early September, the full complement of beamlines has been operating, though in many cases with reduced efficiency as noted above.

In addition to restricted SPEAR3 and beamline operations, the shelter in place adversely impacted maintenance and project activities, owing to the minimal onsite staff presence. While engineering and design productivity was relatively unaffected during the shelter in place, all but absolutely essential technician activity onsite halted. This delayed most accelerator and beamline projects three to six months. Additionally, advancing and shortening the SPEAR3 accelerator down schedule to facilitate September operations resulted in significant deferred maintenance. The six-week SPEAR3 down scheduled for March–April 2021 should permit completion of the deferred maintenance activities.

1e. Have there been disproportionate impacts on any staff? Has any action been taken to minimize the impact on early career staff or other vulnerable staff groups?

Disproportionate impacts of the pandemic have been felt by staff members who (1) were unable to effectively work from home during the shelter-in-place period because of the nature of their jobs; (2) will continue to work remotely for the foreseeable future; and (3) are often early in their careers and have young children or other family obligations that have required an unusual time investment since the shelter in place was declared. For SSRL staff in category (1), managers worked creatively with the staff members to define training and study activities that they could complete in lieu of hands-on engineering or technical work. In order to maintain morale and provide opportunities for problem-solving and strategy development, which are difficult to do in virtual meetings, staff in category (2) have been permitted by SLAC to meet in person in small socially distanced groups. With worsening local public health indicators as of mid-November, these meetings are likely to be suspended for some weeks or months. For SSRL staff in category (3), managers have been strongly encouraged to adjust work schedules and assignments to provide scheduling flexibility so that both family and work obligations can be balanced to the greatest extent possible.

2. What approaches are you taking to provide productive user research experiences and services in a virtual context?

There has been a significant development of software tools for remote-access experimentation, either acceleration of previous initiated projects or the creation of new approaches. It includes beamlines serving biological small

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angle X-ray scattering, X-ray absorption spectroscopy, X-ray fluorescence imaging, and materials scattering/diffraction. New software has also been developed for enhancement of detector readout and data reduction for X-ray scattering for additional use towards the driving on experimental strategies. On some of the spectroscopic and scattering beamlines, the development of automated data acquisition software and script-based data acquisition macros has been key to the successful remote data acquisition. Other areas of development include robotics for sample changes for experiments that allow a high standardization and approaches to multiple sample delivery systems for higher throughput with minimized staff interactions.

Beamline scientists have provided extensive communication with users in an all-out effort to gather information on sample availability, scheduling, experimental approaches, data acquisition, and onsite and virtual support before, during, and after the beam time. Staff have also given users specialized sample holders for efficient and safe transfer between their institution and SSRL, mounted and transferred samples, and provided shipping service to return samples to users after the completion of the beam time. This also includes support for transfer of data to the users.

This mode of operation has resulted in an enormous increase in staff workload and is not sustainable in the future within a 24/7 operations approach. More resources are required for development of beamline specific robotics, automation, software, and data analysis for remote access. Additional communications mechanisms need to be developed and implemented. More beamline scientists and technical support staff are needed to provide a workable user support structure for the community and a long-term work-life balance environment for the highly skilled and dedicated staff. Additionally, the development of hardware and software to support remote and virtual experiments has thus far focused on developing solutions for highly standardized measurements and samples. Solutions to enable *in situ* and *operando* measurements have largely not been developed, and they would require a substantial increased resourcing if these measurements were to be accessible in a virtual environment. This is of particular importance as, increasingly, both internal and user-funded projects are predicated on the use of *in situ* and *operando* characterization tools.

The SSRL Macromolecular Crystallography Program has for many years supported a large majority (>95%) of users remotely using robotics for the exchange of cryogenically preserved samples coupled with highly automated experimental systems and a robust remote desktop environment. However, the staff have been working to expand the capabilities of this remote program to support more complex experiments. Developments have been accelerated that enable safe transport, robotic exchange, and data collection using samples at elevated temperatures and controlled humidity, as these will help many Macromolecular Crystallography Program users who cannot complete their experiments with cryopreserved samples alone. The first remote experiments using these new systems have been performed, and while they were successful, improvements to this new program (termed "remote access at physiologically relevant temperatures") are ongoing. These include enhancements to the control software, user instructions, and support protocols, as there are more "sample" issues when samples are not cryopreserved.

A side effect of the switch to more off site work for the program support staff is an overall increase in use of Zoom conferencing tools with each other and with remote users. The use of Zoom conferencing, rather than phone calls or email to start user beam time and to answer user questions, has expanded the amount of people receiving and giving instruction, the quality of remote instruction, and overall improved communication.

3. What, if any, changes to physical access have you implemented or considered for users, vendors, or maintenance personnel?

Initial changes to the experimental floor included signage, barriers at specific beamlines, and floor markings. We limit users/staff to one person per beamline unless otherwise approved by the safety office. All users are required to attend a safety briefing prior to their beam time. Normally, this is a general overview of safety, but we now include specifics on expectations/signage regarding COVID. Additionally, laboratory occupancy has been restricted to 250 ft^2 per person, consistent with Stanford University guidance.

4. Have you identified any lessons learned as a result of the COVID-19 pandemic?

Major lessons learned include: (1) Effective work planning, tools for automating experiments, and use of virtual meetings and other communication tools can enable unexpectedly high levels of scientific productivity when onsite staff numbers are low. (2) Productive work over the long term will not be sustainable unless onsite users are able to participate in experiments because of the unusually heavy demands that many sample mail-in experiments place on staff. (3) Feelings of isolation can arise during long-term remote working, and managers need to be watchful of this and creative in finding ways to build morale of remote workers. (4) Having greater time away from the day-to-day responsibilities of training users and preparing for user beam time provided SSRL staff with the opportunity to design new capabilities, pursue new scientific directions, and explore funding opportunities that may have a long-term positive impact on the light source.

5. What has the COVID-19 pandemic revealed about the needs for virtual access to computational, data management/analysis, software, and network resources or other types of instrumentation

As described in section 2, the need for remote-access tools has been amply demonstrated. While in some areas there has been rapid development of new approaches, there is an extraordinary need for continued development—both under the current COVID-impacted science approaches as well as leading into the future. This includes software for automation; safe access to controlling beamlines from outside SSRL; video streams enabling monitoring of in-hutch instrumentation; optimization of instrumentation such as beamline optics, detectors, and sample alignment; more sophisticated machine protection system for safer remote operation including interlocking; status reporting and display of instrumentation components and data; interactive data acquisition with real-time display of data and current instrument condition as well as online data reduction and analysis; management of large data volumes and transfer; web and other communications interfaces; direct communications tools such as Zoom; or other interactive setups. The development of virtual assistants to aid remote users in optimizing experiments will also be crucial, as staff are less able than ever to provide on-the-floor training for users. The development of machine-learning approaches to aid in both instrument optimization and design of experiment and sample selection will not only increase the efficiency of virtual operations, but it will likely provide opportunities to increase the user facility productivity as onsite measurements become feasible. Networks will be impacted by both the increased need for immediate data and image interactions as well as the transfer of data to the user with high frequency (as well as to collaborators).

As for instrumentation—automation will require new approaches to experiments in several areas, and development of robotics or other ways of higher automation will be key developments—particularly as we move towards the development of robotics to support virtual *in situ* and *operando* measurements. Feedback systems to beamline optics to enable automated optimization is another area that will require both instrumentation and software developments.

6. User Project Administration: Have project award periods been extended and if so, does this impact future proposal calls and facility operating costs (including budget carryover across the fiscal year)? Have there been any changes to allocation policies?

We have offered a one-year proposal extension to users whose planned experiments were impacted by the pandemic. To maintain continuity and avoid confusion to the user community, we have maintained our traditional, published deadlines for new proposals and beam time requests. We are noticing a decrease in the number of new proposals and beam time requests submitted this year compared to this time last year:

	2020	2019
New Proposals Received	224	348
Beam Time Requests Received (Demand)	2,583	2,678
Beam Time Requests/Experiments Scheduled	1,102	1,938

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Regarding carryforward of funds, the level of SSRL's unencumbered balance from FY20 is such that funding is not an immediate concern. SSRL can support future user proposals, although our efficiency in delivering on the science goals of these proposals may be reduced given the need to direct increasing staff time, M&S, and capital expenditures to building and refining tools to support remote access going forward.

7. What have been the impacts on annual user facility meetings, strategic planning workshops, and short courses and schools (to train students, early career researchers, or future users)?

Several meetings previously planned to be held onsite over the past year were changed to a virtual format due to the pandemic, including the SSRL Synchrotron X-ray Spectroscopy and Imaging Summer School (September 8–10, 2020), and the annual joint SSRL/LCLS Users' Meeting (September 28–October 9, 2020). By holding the school and users' meeting virtually, we were able to expand our reach to a much larger and broader community as evidenced by the increased participation (over 1,750 people registered for the annual users' meeting, which featured more than 22 focused workshops). The summer school garnered ~800 attendees from 45 countries. A post-school survey indicates satisfaction with the remote model, which has helped us develop permanent online training material. Many of the talks at the summer school and users' conference workshops were recorded so these presentations continue to be available as a resource to the user community.

- https://conf.slac.stanford.edu/exafs-2020/
- https://www.youtube.com/channel/UC3sd8ZqQkNfDK11jM8cOWzw/videos
- https://events.bizzabo.com/SLAC-UsersMeeting-2020

Two annual user training/outreach schools were postponed to 2021: the RapiData 2020 Structural Biology School and the SSRL X-ray Scattering School. Both provide advanced training to new and experienced users. The 78th Pittsburgh Diffraction Conference scheduled for September 2020 was cancelled.

8. Please provide any other comments or ideas as input for the roundtable.

Post-pandemic, user science conducted at SSRL is likely to proceed along two parallel paths. On one path, increasing automation of experiments, development of tools for on-the-fly data analysis, and experimental optimization, for example, will serve the needs of a portion of our user community that will increasingly access SSRL remotely. In parallel, some of our users will need both these tools and capabilities for more complex and bespoke experiments that involve *in situ* and *operando* characterization, in many cases using multiple methods simultaneously to probe complex phenomena at relevant time scales. Meeting the needs of both kinds of users will be both an exciting opportunity and a challenge.

Basic Energy Sciences

Neutron Sources

Spallation Neutron Source (SNS)
High Flux Isotope Reactor (HFIR)

Oak Ridge National Laboratory
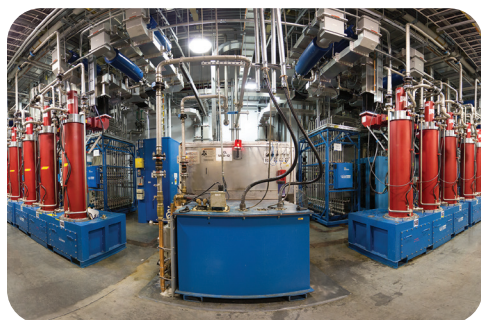
SNS is a next-generation spallation neutron source for neutron scattering that is currently the most powerful neutron source in the world.

Contact: andersenkh@ornl.gov

HFIR is the highest flux reactor-based neutron source in the United States and is a major neutron scattering user facility as well as the world's leading source of elements heavier than plutonium for research, medicine, and industrial applications.

Contact: andersenkh@ornl.gov

1. How has the COVID-19 pandemic affected your facility? At what fraction of facility capacity are you currently operating? What is the distribution between virtual access and physical onsite access? How have facility operations been impacted? Have there been disproportionate impacts on any staff? Has any action been taken to minimize the impact on early career staff or other vulnerable staff groups?

The facility is now operating at near capacity after a gradual start in the spring: all instruments are running and performing user experiments through remote access, discretionary time, mail-in, and proof-of-principle modes. Some complex sample environments are not fully deployed, and some types of experiments are not possible (i.e., excessive staff time demands, complex sample environments). These types of experiments have explicitly been excluded in the most recent proposal call.

SNS ran 699 experiments in FY20, down only slightly from the 780 experiments run in FY19, with the decrease concentrated in the early months of the pandemic. Despite near-capacity operation, actual throughput/efficiency is reduced due to the absence of the users' participation and the need for social distancing (especially during sample environment installation).

2. What approaches are you taking to provide productive user research experiences and services in a virtual context?

We immediately launched the COVID-19 Special Rapid Access program, accepting 15 unique experiments that instrument scientists performed on behalf of users.

We immediately deployed "remote-access experiment" mode (now falling into the new definition of remote user), in which the user provides guidance to the instrument scientist via telecommunications channels (e.g., phone, video conference, email, text, Slack). We ran 206 remote-access experiments in FY20, 133 at SNS and 73 at HFIR. There were 246 external users from 84 institutions. We are developing true remote experimentation (user remotely controlling instrument) with the first instruments to be piloted in early CY21.

3. What, if any, changes to physical access have you implemented or considered for users, vendors, or maintenance personnel?

No external users (from outside of ORNL) are allowed access. Each ORNL directorate independently manages their onsite participation to less than 50%—users from other directorates are allowed to perform experiments only if their own directorate approves their onsite presence and only if they can perform the experiments independently (i.e., social distancing is possible). Students and subcontractors are allowed access after associate laboratory director approval.

Vendors and maintenance personnel are allowed on a case-by-case basis.

4. Have you identified any lessons learned as a result of the COVID-19 pandemic?

Opportunity to accelerate the already planned implementation of remote experiments. Bottlenecks in sample environment staffing identified; across organization: "one-deep" problems identified.

5. What has the COVID-19 pandemic revealed about the needs for virtual access to computational, data management/analysis, software, and network resources or other types of instrumentation?

The pandemic has revealed immediate need in redefinition of procedures and access control, such as authentication of remote users. Firewall issues related to remote control of instruments need to be resolved. Much of the software is designed to rely on multiple monitors/windows simultaneously, which is hard to implement in a remote environment. Data management/analysis is not significantly different from prior situation given the relatively small datasets and the users' remote access to data after experiments.

6. User Project Administration: Have project award periods been extended and if so, does this impact future proposal calls and facility operating costs (including budget carryover across the fiscal year)? Have there been any changes to allocation policies?

SNS/HFIR always strived to carry over proposals to a future cycle if the experiment is postponed or canceled at no fault of the user. Given that experiments take longer and that some previously approved experiments cannot be run (e.g., sample environment, staffing needs), a significant amount of carryover has accumulated. Two instruments at SNS and one at HFIR did not accept proposals for 2021-A due to carryover. The 16 SNS instruments participating in the 2021-A call have a total of 380 previously awarded beam days carrying over to 2021, compared to 230 carryover days reported in the previous year's 2020-A cycle.

7. What have been the impacts on annual user facility meetings, strategic planning workshops, and short courses and schools (to train students, early career researchers, or future users)?

User Meeting: SNS/HFIR hold onsite user meetings in years that alternate with the American Conference on Neutron Scattering, which was held virtually in 2020 in a highly successful format. Many Neutron Sciences Directorate staff participated, presenting three invited talks, 18 contributed talks, and 15 posters. The conference included two town hall meetings of particular importance to SNS and HFIR: one hosted by the SNS-HFIR User Group focused

on enhancing user engagement, the other presented the draft version of the data analysis plan. These town hall meetings were attended by a combined audience of over 270.

Other workshops, tutorials, and short courses have also been moved online, generally with significantly increased participation. Nevertheless, the lack of an in-person component in the courses is a significant disadvantage as it doesn't allow a hands-on teaching experience.

Strategy workshops are much more difficult to accomplish and have been largely postponed.

8. Please provide any other comments or ideas as input for the roundtable.

[No response]

BES

Basic Energy Sciences

Nanoscale Science Research Centers

Center for Functional Nanomaterials (CFN)

Brookhaven National Laboratory

CFN is one of five nanoscale science research centers created by the U.S. Department of Energy to investigate, understand, and exploit the unique characteristics of materials and phenomena at the nanoscale.

Contact: ctblack@bnl.gov

1. How has the COVID-19 pandemic affected your facility? At what fraction of facility capacity are you currently operating? What is the distribution between virtual access and physical onsite access? How have facility operations been impacted? Have there been disproportionate impacts on any staff? Has any action been taken to minimize the impact on early career staff or other vulnerable staff groups?

Along with all of Brookhaven National Laboratory (BNL), CFN transitioned to minimum safe operations (min-safe) in March and remained in that condition until June. The facility gradually resumed operations in June, implementing new work practices to mitigate the COVID-19 workplace hazard. CFN is currently operating with daily onsite populations of 35 staff members and 15 users, which is approximately half the typical number.

CFN is ramping up new methods for remote support of user science, which is detailed in our answer to question 2. A majority of CFN support for user science still takes place through onsite engagements. However, staff are also supporting users in data analysis and preparing manuscripts, which are done remotely. CFN users continue to access the Computational Facility remotely, as before.

CFN is managing onsite staff and user populations much more closely than previously to maintain appropriately low building occupancy during operational hours (Monday – Friday, 8:00 a.m. – 6:00 p.m.). For staff and users, this has made days onsite more valuable and has resulted in additional work planning for experiments. Staff are utilizing weekend hours for those who need additional time onsite. CFN is not supporting weekend or after-hours shifts for users at this time.

Managers are prioritizing onsite access for early career staff, postdocs, and students who require time in the laboratories for their work. Newly hired staff members and postdoctoral researchers have also faced additional challenges in meeting new colleagues, settling into their new positions, and establishing their network of contacts and collaborators.

2. What approaches are you taking to provide productive user research experiences and services in a virtual context?

The CFN has created a new initiative called Remote@CFN to develop improved modes of engagement with off-site users. This builds upon existing success in support of remote users of the Theory/Computation Facility who

access the CFN computer cluster and collaborate remotely with CFN staff, as well as a selective mail-out program where CFN staff produce unique materials and samples necessary for user science. These new efforts will enable a broader remote program where user samples are measured by CFN staff interacting with users remotely; remote operation modes enabling users to control CFN experimental tools; and improved offsite access to user data and CFN analytics software.

This work is embodied in four interconnected approaches. We are deploying remote-engagement tools, including video conference and telepresence systems, to facilitate participation of remote users in onsite experiments. We are installing automation and remote monitoring solutions, enabling more efficient remote staff and user experiments. We are developing remote operation (especially remote desktop) solutions so that participants can control advanced synthesis and measurement tools from offsite. We are connecting CFN tools to institutional systems to enable remote data and software access, providing cloud access to user data and web-based analytics tools through a Jupyter notebook environment.

3. What, if any, changes to physical access have you implemented or considered for users, vendors, or maintenance personnel?

CFN has implemented a roster system for scheduling facility occupancy for staff, users, and vendors during operational hours. At this time, after-hours and weekend access is limited to staff and is scheduled using the CFN roster system. In addition to using the roster to schedule facility populations, CFN reports occupancy levels to BNL for institution-wide counts.

CFN staff plan their onsite work schedules in two-week blocks. This biweekly scheduling system helps ensure that CFN meets BNL-approved occupancy levels. Users are also scheduled in two-week blocks, which allows users sufficient time for advance planning and staff the ability to coordinate their schedules to be onsite when needed.

There have been no changes to physical CFN access requirements for vendors, users, or maintenance personnel.

4. Have you identified any lessons learned as a result of the COVID-19 pandemic?

Virtual meetings have allowed CFN to continue to engage with users and staff while maintaining cohesion and reducing stress. We have learned that staff who joined around the time of the pandemic are struggling the most since it is harder to build strong connections at work during this time, so we have made an effort to provide additional support to our postdocs (through groups and quarterly lunches with the CFN director) and to convert most of our group-building events to a virtual or adapted format (i.e., coffee breaks, departmental retreat, holiday gatherings). In the process, we have also learned that social virtual events benefit from having direction or even a guest speaker. Having a 'planned meeting' structure is more important in a virtual setting in order to meet goals and have a positive impact. It forces us to be much more conscientious about group management, staff mentoring, and project management.

To address the need for users to have an informal setting to connect with CFN staff, CFN will begin holding monthly virtual office hours starting in January, where research groups will take turns in having one or two staff briefly describe new or underutilized capabilities during the virtual coffee break and provide an opportunity for users to interact with staff in an informal setting. A similar idea will be explored at the directorate level to help new staff explore collaborations and build connections across BNL.

COVID-19 represents an unprecedented challenge that was difficult to plan for, but we have learned that consistent and honest communication has allowed for the successful implementation and adoption of safety guidelines to minimize COVID-19 exposure. Flexibility and the rapid revision of laboratory policies (e.g., telework, timecards, property passes) was crucial in enabling a fast and safe response to the work-from-home guidelines. We will continue to work on processes and access that still need to be improved for both staff and users to minimize the interruption of user support or internal research.

BES

5. What has the COVID-19 pandemic revealed about the needs for virtual access to computational, data management/analysis, software, and network resources or other types of instrumentation?

The pandemic has revealed the need and opportunity for expanded remote user programs. In exceptional circumstances, a robust remote program allows science and user support to continue (albeit with restrictions). However, advanced remote programs also represent a unique opportunity to broaden the range of users that a facility engages and to provide users with a host of more advanced engagement modes. To emphasize: remote engagement serves the interests of diversity, equity, and inclusiveness by greatly lowering the barrier to take advantage of user facility resources (eliminating travel costs) and broadening the geographic spread and diversity of the user community.

Advanced automation, remote control, and offsite data/compute access greatly accelerate staff and user science alike by providing additional methods for efficiently conducting experiments, streamlining routine experiments, and liberating staff/tool time to focus on high-impact complex experiments.

6. User Project Administration: Have project award periods been extended and if so, does this impact future proposal calls and facility operating costs (including budget carryover across the fiscal year)? Have there been any changes to allocation policies?

After onsite user operations were suspended in March, CFN extended General User Projects that were expiring at the end of April by four months (through the end of August). Rapid Access Proposals and Additional Time Requests were also extended by the same amount of time.

Extending the project periods did not impact future proposal calls. The Call for Proposals for projects to start during September to December 2020 was extended to allow users and CFN staff more time to explore and familiarize themselves with the functionalities of a newly implemented new proposal system.

Proposals and additional time requests for the work period May to August 2020 were allocated per current policy because at that time BNL was expected to operate under min-safe until April 14. Once BNL extended min-safe beyond May, CFN contacted all users on allocated projects to determine if their project, or a subset thereof, could be carried out remotely.

Proposals and additional time requests for the work period September to December 2020 were allocated per current policy.

7. What have been the impacts on annual user facility meetings, strategic planning workshops, and short courses and schools (to train students, early career researchers, or future users)?

CFN and NSLS-II held their joint user meeting remotely this year, with over 1,000 registered attendees—approximately three to four times more than in a typical (onsite) year. The meeting had much wider participation, especially from foreign countries. However, the virtual meeting lacked effective means for networking and the interpersonal interactions that lead to new experiments and collaborations. Similarly, this year's virtual meeting was missing a poster session, in which students and postdocs typically present their research and engage in productive discussions.

8. Please provide any other comments or ideas as input for the roundtable.

More virtual facility tours (either prerecorded or live) can be valuable for users to learn about the resources available. Prerecorded short courses (with live Q&A) may also be useful to attract more users.

We have found users, students, and staff to be diligent about following the new safe work practices and guidelines for using the facility. They have been very receptive to correcting their behavior when required (e.g., pulling up masks, washing hands, stepping back).

Basic Energy Sciences

Nanoscale Science Research Centers

Center for Integrated Nanotechnologies (CINT)

Sandia National Laboratories and Los Alamos National Laboratory

CINT focuses on exploring the path from scientific discovery to the integration of nanostructures into the micro- and macro-worlds.

Contact: jsnelso@sandia.gov

1. How has the COVID-19 pandemic affected your facility? At what fraction of facility capacity are you currently operating? What is the distribution between virtual access and physical onsite access? How have facility operations been impacted? Have there been disproportionate impacts on any staff? Has any action been taken to minimize the impact on early career staff or other vulnerable staff groups?

COVID has significantly impacted operations in the near and long term. Initially, CINT-Gateway closed to users and sent almost all staff to work from home. The CINT-Core facility was closed to users, but Core staff, postdocs, and students were allowed to work at 50% onsite capacity through staggered schedules and off-normal work hours. As COVID became better understood, we allowed CINT-Gateway facility staff to return to work and authorized restart of individual laboratories, a process which took approximately two months. CINT then reopened to local users, then in-state users, and finally out-of-state users. Because our state (New Mexico) has an inbound quarantine, the number of out-of-state users is low. Users do not want to quarantine after arriving in New Mexico unless they will stay at CINT for an extended period. The distribution between virtual and physical access is currently weighted heavily towards virtual and mail-out users.

Operationally, CINT is now functioning largely as it was pre-pandemic with the exception of reduced user presence. Both CINT facilities will close to users between 11/26/2020 and 12/6/2020 to minimize onsite exposure after the Thanksgiving holiday weekend; exceptions will be considered for users with time-critical experiments. All our experimental facilities are running, and all staff are approved to be onsite to conduct experiments. The host national laboratories (Los Alamos National Laboratory and Sandia National Laboratories) expect staff to work from home when not required to be onsite. Early career staff were certainly impacted—first, by not being allowed onsite to conduct experiments or set up laboratories; and second, limited access to users impacted their ability to collaborate and publish. The former limitation is now rectified, but the latter is still impacting.

2. What approaches are you taking to provide productive user research experiences and services in a virtual context?

We generally conduct our work using mail-out and mail-in modes with heavy utilization of teleconferencing platforms. As an experimental facility, we would typically have users coming and going on a regular basis according to their experimental needs. Fewer users are onsite, and the ones who are coming from outside the host laboratories

are more heavily weighted to users who are consistently onsite rather than periodically onsite. The more periodic users seem to prefer virtual interactions.

3. What, if any, changes to physical access have you implemented or considered for users, vendors, or maintenance personnel?

During the initial months of the pandemic, non-CINT personnel were not allowed onsite. After restart, offsite users now require management approval and consideration of COVID intensity in the home communities, while out-of-state users and vendor technicians require upper management approval and consideration of COVID intensity in their home states.

4. Have you identified any lessons learned as a result of the COVID-19 pandemic?

Overall productivity at our facility is dependent on man-hours working in the laboratory. With reduced user presence and a higher expectation of virtual user interactions, total man-hours in the laboratory are decreased, and demand on staff and technician time has increased. We are considering ways to compensate for this.

We have also learned that some host-laboratory policies conflict with or inhibit some virtual user interactions, including limitations on cloud services for sharing data and telecommunications platforms.

5. What has the COVID-19 pandemic revealed about the needs for virtual access to computational, data management/analysis, software, and network resources or other types of instrumentation?

We have learned that many stand-alone instruments are difficult for conducting virtual user work and are largely limited to a teleconference call in the presence of the instrument. Remote users have difficulty analyzing data on proprietary platforms—such as analyzing data from an instrument that requires access to software from the original instrument manufacturer, normally done while sitting at the instrument. Often, these instruments are not networked due to cybersecurity concerns, so remote log-in cannot be done. Or, if they are networked, remote log in is not allowed due to cybersecurity concerns.

6. User Project Administration: Have project award periods been extended and if so, does this impact future proposal calls and facility operating costs (including budget carryover across the fiscal year)? Have there been any changes to allocation policies?

All projects initiated during the spring proposal call were automatically extended for six months. Further, due to a potential bottleneck of current active projects being extended and limited onsite capacity, we did not hold our standard fall proposal call. Instead, we are taking proposals through the rapid-access route on a continuous basis.

7. What have been the impacts on annual user facility meetings, strategic planning workshops, and short courses and schools (to train students, early career researchers, or future users)?

We have largely been able to conduct or participate in these meetings as expected, only virtually. CINT held its annual user meeting with three days of parallel symposia, virtual workshops, and poster sessions. Poster sessions seemed to be less effective, while symposia were quite effective. Overall turnout was about twice that of a normal in-person meeting. We learned lessons about which platforms work best through our own experience and discussion with other facilities. If we have another virtual annual meeting, it will definitely be improved. Part of our challenge is getting host-laboratory approval to use certain cloud platforms like Whova.

Our staff are fully able to participate in society meetings and conferences virtually.

8. Please provide any other comments or ideas as input for the roundtable.

[No response]

Basic Energy Sciences

Nanoscale Science Research Centers

Center for Nanophase Materials Sciences (CNMS)

Oak Ridge National Laboratory

CNMS integrates nanoscale science research with neutron science, synthesis science, and theory, modeling, and simulation.

Contact: morekl1@ornl.gov

1a. How has the COVID-19 pandemic affected your facility?

CNMS is following all Oak Ridge National Laboratory (ORNL) access rules, which currently limit staff access to a maximum of 50% staff working onsite at the same time. At CNMS, this translates to 50% ORNL staff working in our facilities—each CNMS group carefully controls laboratory access schedules so that CNMS plus ORNL staff/users do not exceed the onsite limits imposed by ORNL. No external visitors (including facility users) are permitted onsite, so all experiments are conducted remotely/virtually.

1b. At what fraction of facility capacity are you currently operating?

CNMS is operating at full capacity—every experiment is being conducted using some form of remote access. Typically, this requires that a CNMS staff member work onsite in the laboratory to operate an instrument or synthesize materials with the user(s) participating via online (virtual) access. Some instruments can be operated 100% remotely (many CNMS microscopes, for example, can be operated this way by staff or a user). This requires considerable scheduling effort to ensure that only one to two people are working in all CNMS laboratories at the same time; laboratory schedules are updated weekly to ensure social distancing guidelines are enforced.

1c. What is the distribution between virtual access and physical onsite access?

The only users permitted to work at CNMS are ORNL internal users—these account for ~30 of current users. All external users must work virtually/remotely, which is the largest fraction of user work currently (70%).

1d. How have facility operations been impacted?

At the start of the pandemic, CNMS was not operational at all since most ORNL staff (including essentially all CNMS staff) were required to work from home for nearly two months. This period was very detrimental and left user research (as well as ORNL research) at a standstill. Once staff were slowly permitted to return to work onsite (on a part-time basis), we were able to begin implementing remote/virtual access procedures. We started with many CNMS microscopes (easiest to use for remote operations) and are now extending these efforts to synthesis and cleanroom activities through different virtual means (e.g., virtual reality glasses, video conferencing, online access.)

1e. Have there been disproportionate impacts on any staff?

The major impact has been felt by all staff who do the majority of their work in laboratories. This was especially strong at the start of the pandemic. Many technicians did not have work they could do from home and were thus expected to work onsite. New staff were impacted because in some cases they did not have sufficient work to do from home. Postdocs felt a significant amount of stress because of their limited appointment times and the inability to perform the experiments they needed to start and complete. Part-time onsite access for two to three days per week has alleviated much of the anxiety for postdocs and R&D staff.

1f. Has any action been taken to minimize the impact on early career staff or other vulnerable staff groups?

ORNL (and therefore CNMS) has worked to increase the number of people approved for onsite access. Rather than allowing a strict number of people to work onsite, everyone who needs to work in a laboratory is now approved to work onsite for two to three days per week as long as the total number of people working on campus (sitewide) does not exceed 50%. CNMS has met these criteria since spring, enabling R&D staff and postdocs to keep up with their laboratory experiments/work.

2. What approaches are you taking to provide productive user research experiences and services in a virtual context?

CNMS has actively engaged users to participate in experiments remotely—staff are reaching out to users and encouraging interactions. CNMS has extended two proposal cycles set to expire so that staff and users can catch up with work that may be delayed or was cancelled in the early days of the pandemic (delays due to ORNL-CNMS limitations or restrictions at the user institutions). CNSM is actively undertaking steps to make all our capabilities available to users virtually; and at this point, we are near 100% capable of remote access. CNMS has also instituted new means to survey users to get immediate feedback regarding successes or weaknesses they may encounter during this difficult time so that leadership can address any problems in a timely manner.

3. What, if any, changes to physical access have you implemented or considered for users, vendors, or maintenance personnel?

CNMS only has one means by which to invite local-area users or service engineers to work onsite, which is via ORNL Medical and chief operating officer/associate laboratory director approval allowing them to come onsite to work for two weeks. This requires putting a workplan in place for experiments or service that must be accomplished during the onsite work period. No users from outside the local area are currently permitted to work onsite; service personnel that travel to ORNL from outside a 75-mile radius require additional DOE approval for travel on the subcontract. All badge requests for such visits are now entered for each visit to the laboratory rather than allowing continuous badge access to control access to campus.

4. Have you identified any lessons learned as a result of the COVID-19 pandemic?

The most important lesson learned is that we can operate very successfully by implementing remote/virtual access, and now we are prepared for future incidences to move immediately into this mode of operation. However, we prefer to operate with users onsite since this is much more rewarding for both CNMS staff and users.

5. What has the COVID-19 pandemic revealed about the needs for virtual access to computational, data management/analysis, software, and network resources or other types of instrumentation?

CNMS transitioned relatively quickly to remote/virtual operation of many of our experimental capabilities; the pandemic revealed that there can be many instances where remote operation may be ideal for specific circumstances (e.g., rapid access, instruments going down unexpectedly such that sessions had to be cancelled and rescheduled for future access). CNMS already remotely operated much of its infrastructure for computation/data analysis/theory.

6. User Project Administration: Have project award periods been extended and if so, does this impact future proposal calls and facility operating costs (including budget carryover across the fiscal year)? Have there been any changes to allocation policies?

CNMS extended several previous proposal calls that were due to expire for an additional 12 months to allow users who experienced difficulties over the previous several months to perform delayed experiments. This did not affect any future (current) proposal calls or CNMS operating costs (including budget carryover). There have been no changes to allocation policies (sessions are scheduled as before, being mindful of when CNMS staff can work onsite and minimizing the number of people working close together—abiding by strict ORNL access schedules put in place for this purpose). While instrument time allocation policies have not changed, there have been delays in serving all our users, and we have scheduled remote sessions several months out. This is primarily due to reduced staff time at the laboratory.

7. What have been the impacts on annual user facility meetings, strategic planning workshops, and short courses and schools (to train students, early career researchers, or future users)?

All planned CNMS meetings and workshops were conducted virtually (and very successfully) on the same dates as originally planned, so impact has been very low. Virtual participation in all events was very high, in fact.

8. Please provide any other comments or ideas as input for the roundtable.

CNMS implemented remote/virtual operation for many capabilities early on, which minimized impact to user operations. Staff have worked tirelessly to engage users and ensure many experiments can be conducted remotely whenever possible and to work with users to perform their work.

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Basic Energy Sciences

Nanoscale Science Research Centers

Center for Nanoscale Materials (CNM)

Argonne National Laboratory

> *CNM focuses on research in advanced materials, complex oxides, nanophotonics, and bio-inorganic hybrids.*
>
> **Contact:** arslan@anl.gov

1. How has the COVID-19 pandemic affected your facility? At what fraction of facility capacity are you currently operating? What is the distribution between virtual access and physical onsite access? How have facility operations been impacted? Have there been disproportionate impacts on any staff? Has any action been taken to minimize the impact on early career staff or other vulnerable staff groups?

As with all facilities, CNM has been impacted by COVID-19. While Illinois was in shelter in place, the CNM was closed to all research other than remote theory work. Now, we are operating at 25% capacity for staff rotations, and only 10 Argonne National Laboratory employee users per shift per day (two shifts per day). No external users are currently allowed back at the CNM. The 25% staff capacity balances the 50/50 model of helping onsite and remote users half the time and performing core science half of the time. Most of the user work is currently performed remotely. Operations staff continue to be able to help scientific staff with operational needs.

The early career staff, postdocs, and graduate students [including our Office of Science Graduate Student Research (SCGSR) Program student] have been most heavily impacted. They have higher pressure to perform research in a shorter period, and limited access has significantly slowed their progress. We are trying to mitigate this by extending postdoc appointments as needed and prioritizing time for them in the laboratory for experimental work. Should this impact the promotion of an early career staff in the upcoming months or year, I am confident that a case can be made to extend the evaluated time of work.

2. What approaches are you taking to provide productive user research experiences and services in a virtual context?

We have invested in many new tool "add-ons" to enable productive user research remotely. In addition to cameras and video conferencing hardware, we have also invested heavily in remotely accessible software for many different tools. Now, most of our electron microscopes and many of the nanofabrication tools in the cleanroom can be logged into by external users to acquire data. Importantly, this capability is also available on our hard X-ray nanoprobe beamline. We have already assisted many users across the country to log in and take their own data once our staff load the samples.

3. What, if any, changes to physical access have you implemented or considered for users, vendors, or maintenance personnel?

The CNM already had a robust prox access system, enabling us to view which laboratories were accessed by whom and when. Now, we have improved the system with new apps and software that combine all the rooms scanned in for each person, allowing us to trace the movement of staff and users throughout the day. Not only does this help ensure that occupants are accessing only the laboratories requested previously, but it also helps us understand contact tracing and close contacts should a COVID-positive case arise. We have learned throughout the pandemic that people can't remember, for example, who they spoke to or exactly where they were three days ago. This system removes the guess work.

Vendors are spaced out in their visits to not overlap in areas close to one another or close to users and staff. Their visits are tracked closely now at the directorate level. Occupancy limits are in place for every laboratory, and our users, staff, and vendors have all done a great job in respecting those limits and maintaining social distance.

4. Have you identified any lessons learned as a result of the COVID-19 pandemic?

Although there will always be the need for most user science experiments to be performed onsite by the user, an enhanced remote-access effort could be a means to simultaneously increase our user facility impact, while performing the user work with enhanced productivity and environmental friendliness (due to less travel). Remote access could also be used to enhance the impact of user scientist experiments post visit, for example to resolve any issues to the experiments following user analysis, and/or to perform additional theory/simulation work.

5. What has the COVID-19 pandemic revealed about the needs for virtual access to computational, data management/analysis, software, and network resources or other types of instrumentation?

It brought to light that there is much more we could have been doing even before the pandemic to make our tools more accessible to the world. Not only could this potentially enable a higher number of users around the globe to take advantage of our unique capabilities, it could also provide important teaching resources for schools and other education organizations for which it is too expensive or difficult to travel. It also enables a virtual "closer look"—a student in a large group of people would be able to access, hear, or learn about a particular scientific concept.

6. User Project Administration: Have project award periods been extended and if so, does this impact future proposal calls and facility operating costs (including budget carryover across the fiscal year)? Have there been any changes to allocation policies?

Our theory and modeling proposals have run normally without any changes. We have been extending non-theory proposals that started work pre-COVID and had their safety paperwork on file by three months on a continuous basis (e.g., if we were still in limited operations mode when the first three months expired, then we are continuously extending them by another three months). We have been holding our proposal calls as normal with three cycles per year. The summer cycle was down about 60%. While the fall cycle was back to normal, a large percentage of the proposals were for our computing cluster. Staff began working on the existing, active user proposals a few months ago in remote operation or mail-in modes. Soon we will need to manually canvas which of these projects are now complete and can be closed out. Staff are now also handling the new proposals in remote operation and mail-in modes as they are able.

7. What have been the impacts on annual user facility meetings, strategic planning workshops, and short courses and schools (to train students, early career researchers, or future users)?

The joint Advanced Photon Source (APS)/CNM Users Meeting was planned for April 2020. Due to the short time between going into minimum safe mode, the meeting was canceled rather than held virtually at that time. We opted to hold some of the workshops and short courses virtually in August and September 2020. We are now planning a

BES

fully virtual joint APS/CNM Users Meeting for May 2021. We held our annual Users Executive Committee virtually in May 2020 and held another mid-year meeting with them virtually in November 2020.

8. Please provide any other comments or ideas as input for the roundtable.

One of the biggest challenges we face moving forward is how to train new users on equipment in person. While we have taken advantage of making videos, training over video conference, and standing six feet apart with appropriate personal protective equipment, it remains a challenge for complex equipment that needs more in-person, hands-on training for longer periods of time.

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Basic Energy Sciences

Nanoscale Science Research Centers

The Molecular Foundry (TMF)

Lawrence Berkeley National Laboratory

TMF is fully equipped with state-of-the-art, sometimes one-of-a-kind instruments providing laboratories for materials science, physics, chemistry, biology, and molecular biology.

Contact: foundry-useroffice@lbl.gov

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1. How has the COVID-19 pandemic affected your facility? At what fraction of facility capacity are you currently operating? What is the distribution between virtual access and physical onsite access? How have facility operations been impacted? Have there been disproportionate impacts on any staff? Has any action been taken to minimize the impact on early career staff or other vulnerable staff groups?

The San Francisco Bay Area began a shelter in place on March 17, 2020, causing Lawrence Berkeley National Laboratory (LBNL), including its user facilities, to enter a "safe-and-stable standby" mode through May 31. During this period, technical personnel occasionally came onsite to maintain equipment, but no research was performed with the exception of three COVID-related projects—two of which were in support of user projects and one that was related to the National Virtual Biotechnology Laboratory (NVBL). Starting June 1, LBNL began limited onsite research operations with periodic increases in the number of researchers allowed onsite per day. Gradual increases in daily badge-ins proceeded throughout the summer. During this time, the Molecular Foundry was also able to include outside users, off-hours work, and shift work (i.e., morning, afternoon, off hours) starting in July. In October, researchers were allowed to use multiple facilities/floors at the Foundry; and in November, limited cubicle/office work as well as distanced meetings were accommodated. Throughout this time, capabilities to provide remote access to our laboratories were expanded and staff continued to work remotely, including with users.

Prior to the pandemic, one would expect 150 to 200 researchers physically at the Foundry at any given time during normal business hours and probably double that in terms of total headcount in a day. These numbers reflect the roughly 700 to 800 researchers who are either on staff or on active proposals at any given time. In June, the Foundry was limited to 25 people per day (~10% capacity), which expanded to ~40 per shift in July (~25% capacity), ~50 per shift in August (~33% capacity), ~60 per shift in October (~40% capacity), and ~70 per shift in November (~50% capacity). Access was provided on an as-needed basis for staff and users. Access considerations and other details are outlined on a special page on the Foundry website. Researchers who were not allowed onsite continued their work virtually. Operations staff, with the exception of the Environment, Health, and Safety team and researchers performing theory and computational work, have generally not been allowed onsite.

2. What approaches are you taking to provide productive user research experiences and services in a virtual context?

All staff remain available virtually to our users. In addition, users have been allowed limited access to the Foundry since July. Access has been prioritized for researchers:

- Working on topics related to the fight against COVID-19.
- Working on DOE and LBNL research priorities.
- Working on projects with urgent timelines including student graduation or finalizing a grant or publication.
- Working on projects that have the potential for broad scientific or economic impacts.

In addition, the Foundry has required that all onsite researchers must have the ability to operate equipment independently to avoid side-by-side work, consistent with physical distancing requirements and work-alone policies. Unfortunately, this has prevented access to first-time or inexperienced users and those performing more complex and novel experiments.

To better accommodate those researchers who cannot come onsite, as well as provide in-depth training to enable onsite access, the Foundry has performed research using several methods and tools it has developed during the pandemic including:

- Remote operation of equipment.
- Remote access to data and analysis tools.
- Video collaboration, including in the laboratory.
- Telepresence robots.
- Augmented-reality goggles and custom training modules.
- Remote intercom systems (like walkie-talkies).

3. What, if any, changes to physical access have you implemented or considered for users, vendors, or maintenance personnel?

All personnel that access Molecular Foundry facilities are required to:

- Wear masks at all times with the exception of single-use offices with the door shut, outside when 30 ft from others, or when eating.
- Maintain 6-ft distance separation at all times unless wearing a respirator.
- Clean all surfaces prior to and after work.
- Multiple safety training modules.
- Daily symptom check.
- Daily prework meeting at the group level.
- Weekly all-hands meeting at the Foundry level.
- Health pledge.

Recently, LBNL has implemented a new policy that identifies people traveling from higher-risk areas. These people require greater scrutiny and approval and may require a 14-day quarantine, testing, or other measures.

4. Have you identified any lessons learned as a result of the COVID-19 pandemic?

Telework and virtual meetings can often be sufficiently effective and, on balance, sometimes preferable. This approach would be most impactful by lowering the cost and time barriers to travel for users who are not local and need to access the Foundry's research community. Optimizing remote access would do much to help the Foundry fully realize its mission of facilitating great ideas no matter where they come from.

As demonstrated in our virtual user meeting and proposal review meetings, remote access can also allow high-demand subject matter experts who might otherwise not be able to participate in discussions, events, or seminars. Finally, it could provide for greater telecommuting options, particularly for our operations staff.

However, as a knowledge-based user facility that is built on multidisciplinary collaboration, there is no substitute for having researchers in the same room. The relationship building, spontaneous idea exchange, and multipronged cross-disciplinary discussions have all suffered during this time.

5. What has the COVID-19 pandemic revealed about the needs for virtual access to computational, data management/analysis, software, and network resources or other types of instrumentation?

The pandemic has forced all LBNL researchers to spend a significant amount of time working from home. LBNL's VPN infrastructure has worked very well for access to online resources, and Zoom conferencing has been an adequate replacement for both meetings, and in some cases, remote microscope sessions. For example, at the Foundry, one common pandemic access pattern is for a staffer to run the experiment while one or more users connect remotely over Zoom where they can see the data as it is collected and give advice related to the sample and what data they would like to collect. Additionally, many of our local users are already microscope trained and can, therefore, run an experiment while our staff offers remote support over Zoom or telepresence robot. However, many instruments require hands-on alignment and, due to limited staff time, this remote user option is not always feasible. Thus, we are looking for solutions to motorize and automate such hands-on alignment, but additional resources are likely required to implement such automation and remote-control solutions.

Once the experiments have been completed, we have had issues accessing and disseminating the research data. LBNL has no unified online data storage or data management resources, and online access to data is random and sporadic. Many of our experimental PCs are not connected to the internet and require physical access to copy data. Additionally, various proprietary analysis software packages from the vendors cannot be accessed or used remotely. This highlights LBNL's strong need for data and software management tools that can be accessed remotely. Users for every class of experiment at LBNL should be able to access all their data through a secure and centralized web interface. It would be even more useful if users could also launch virtual machines that can access this central data repository to perform data analysis remotely. This would allow most users to perform all their scientific data analysis without needing to copy huge datasets over slow internet connections, and it would solve the software availability problem. National scientific facilities in other countries have far outpaced LBNL in this regard (e.g., FTP and web data management at the Diamond Light Source in the United Kingdom, where all instruments upload experimental data automatically for secure remote access). Setting up such a system for data management would also allow far more users to access and use high-performance computing (HPC) resources, since NERSC and other facilities would have a single common entry point for data access.

6. User Project Administration: Have project award periods been extended and if so, does this impact future proposal calls and facility operating costs (including budget carryover across the fiscal year)? Have there been any changes to allocation policies?

At the beginning of the pandemic, the Foundry's user office did several things to provide flexibility to our users including delaying the spring proposal call deadline and providing automatic extensions to all active proposals. Since that time, additional extension requests have also been accommodated.

In addition to the reduced laboratory activity, over the course of the Foundry's two proposal calls during the pandemic we have seen a reduction in proposals submitted to the Foundry—approximately 70% to 80% normal. This is likely caused by several factors including reduced access to users' home institutions, travel restrictions, and Foundry access restrictions.

The Foundry has seen financial savings associated with the lack of staff travel, and reduced research activity has led to significant savings in laboratory consumables. Some savings have been redirected to investments in

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deferred equipment recapitalization, though installation of equipment is delayed and/or more costly due to laboratory occupancy restrictions and other LBNL priorities.

However, the pandemic has brought about additional costs. Investments in remote-access capabilities have not been trivial. Service contract expenses have continued, but services have not been used due to limited vendor travel and access. Since staff are at home, they are not exposed to normal health risks and cannot travel, so the Foundry is not seeing the normal savings associated with sick and vacation leave. Along the same lines, few people are making career changes, so there are fewer savings associated with attrition (i.e., the delay in hiring replacements).

7. What have been the impacts on annual user facility meetings, strategic planning workshops, and short courses and schools (to train students, early career researchers, or future users)?

In general, all normal events and meetings have continued virtually—at least in some form. They have all been modified to accommodate the virtual format, which generally means shorter sessions with larger participant lists but sometimes less substantial engagement. Our annual user meeting is a good example. The agenda and other details can be found here. On the other hand, our spring and fall proposal review board meetings saw little change to their structure and productivity. There were time and cost savings, but they came at the expense of missed networking, brainstorming, and outreach opportunities. Other events, like our seminar series and some of our community-building activities that are more reliant on interpersonal interactions, have suffered more dramatically and were either postponed or have seen a significant drop-off in participation.

8. Please provide any other comments or ideas as input for the roundtable.

[No response]

Atmospheric Radiation Measurement (ARM) User Facility

Global Network

ARM is a multi-platform scientific user facility with instruments at fixed and varying locations around the globe for obtaining continuous field measurements of atmospheric data.

Contact: info@arm.gov

1a. How has the COVID-19 pandemic affected your facility?

The ARM facility provides measurements from a network of atmospheric observatories that are not colocated with DOE national laboratories. The main effect of COVID-19 has been restricted access to these atmospheric observatories—by users and by ARM staff. In the case of users, this has resulted in postponing field campaigns, while for staff this has impacted their ability to visit sites to attend to issues such as instruments exhibiting operational issues.

1b. At what fraction of facility capacity are you currently operating?

The ARM facility is operating at nearly full capacity, approximately 90%. The six ARM observatories have continued to operate through the pandemic with the exception of a one-month period of significantly reduced operations at the ARM Southern Great Plains observatory in Oklahoma when there was a stay-at-home order in that state and many instruments were taken offline. Several instruments at the Oliktok observatory are normally shut down during the winter and returned to service in the spring. Those instruments did not return to service this year. Continued operations included remote operations as part of the MOSAiC field campaign in the central Arctic thanks to careful logistical planning.

However, we have been impacted in our ability to support smaller field campaigns, mostly involving user guest instruments, at our long-term observatories. In FY20, there were 37 small field campaigns planned for long-term observatories. Of these, 15 were carried out, several with a reduction in scope. The remaining campaigns were postponed.

1c. What is the distribution between virtual access and physical onsite access?

In FY20, there were approximately 1,000 users. Just under 75% of these users were data users who engaged with the facility by downloading data from the ARM data center collected at ARM observatories. Some 20% of ARM users were remote or virtual users who engaged with ARM resources but did not visit an ARM observatory, while 5% were onsite users.

The number of data users was similar to FY19, but the proportion of remote and onsite users was roughly reversed in comparison to FY20.

1d. How have facility operations been impacted?

There have been delays to instrument repairs due to travel restrictions, particularly at our more remote sites. These delays impacted travel by ARM staff and instrument vendors. In addition, two instruments were impacted when instruments were returned to a laboratory, and access to that laboratory was restricted. There were several instrument intercomparison activities planned (Eddy Correlation and Aerosol Chemical Speciation Monitor) at ARM sites and at another institution. These activities had to be postponed, impacting our understanding of data quality. One significant instrument procurement was postponed (atmospheric emitted radiance interferometer or AERI) because the vendor was shut down for COVID. There has also been some impact of reduced operation due to positive COVID-19 tests. During a one-week period, a staff reduction due to a positive case resulted in a reduction of radiosonde launches from four to two per day.

1e. Have there been disproportionate impacts on any staff?

Staff who manage ARM instruments have been particularly challenged because they are not typically based near ARM observatories, but many are accustomed to traveling to ARM observatories on a regular basis to conduct work with their instruments. We have taken steps to mitigate this by setting up video links with the instrument leads to work with onsite instrument technicians.

1f. Has any action been taken to minimize the impact on early career staff or other vulnerable staff groups?

We have not. ARM is distributed across nine laboratories, and we have relied on individual laboratories to work with local staff.

2. What approaches are you taking to provide productive user research experiences and services in a virtual context?

For the most part, this has not been necessary because 75% of our users engage solely with our data without ever visiting an ARM observatory and another 5% to 10% engage remotely with site staff. We have worked with a few users who had planned to visit ARM observatories to modify their experiments so they could be conducted remotely. Most of the remaining cases have been postponed as noted above.

3. What, if any, changes to physical access have you implemented or considered for users, vendors, or maintenance personnel?

We have been making more frequent and effective use of video links so that technical staff can work with onsite staff on problem resolution. For onsite staff and the few visitors that have been approved, we have implemented additional check-in procedures and mask requirements allowing some onsite work to be conducted.

4. Have you identified any lessons learned as a result of the COVID-19 pandemic?

By making use of videoconferencing and online training, we have been able to significantly increase the types of support that can be provided by onsite technicians—work that would have normally involved travel by laboratory staff or vendors to remote field sites.

5. What has the COVID-19 pandemic revealed about the needs for virtual access to computational, data management/analysis, software, and network resources or other types of instrumentation?

We already had very good virtual access to computational, data management, software, and network resources because of the distributed nature of ARM staff. We also have remote access to instruments in most cases. So, in this regard, ARM was well prepared for the pandemic.

BER

6. User Project Administration: (a) Have project award periods been extended and if so, does this impact future proposal calls and facility operating costs (including budget carryover across the fiscal year)?

As noted above, over half of ARM's approved small field campaigns have been postponed until at least the spring. In some cases, this is not expected to have a downstream impact on future calls due to the limited scope of those activities. However, in cases where the delayed campaign is associated with a limited resource, delaying the campaign has meant reducing the scope of subsequent proposal calls.

This delay in activities is not expected to have a significant impact on operating costs.

We are currently reviewing the possibility of postponing the deployment of an entire observatory, currently planned for 2021, until 2022. This would represent a significant opportunity cost as that observatory (one of six) would not be deployed for a year and may reduce interagency synergies. This campaign involves collaboration with several other agencies, and it is expected that not all would be able to reschedule for 2022. This delay would likely also result in increased carryover as there would be significantly reduced travel and other field costs in 2021.

6b. Have there been any changes to allocation policies?

To date there has been no change in the allocation of facility resources to users or ARM staff.

7. What have been the impacts on annual user facility meetings, strategic planning workshops, and short courses and schools (to train students, early career researchers, or future users)?

The annual ARM user facility meeting was planned for June and was moved to a virtual format this year. Aspects of the meeting went very well, and in some ways, we received more feedback than we might have otherwise (through chat and Q&A functions); however, there were definitely negative impacts. There were fewer breakout sessions with small group discussions, there was no poster session to highlight science results, and we missed holding an annual new user lunch organized by our user executive committee.

We typically exhibit at the American Geophysical Union fall meeting. This is an important outreach event for us. We typically see 500 to 600 people including current and potential users. This year we will be exhibiting virtually but do not expect the event to be nearly as effective. We had similarly planned to exhibit at the European Geophysical Union meeting this year because we just conducted a pair of major field campaigns with strong links to the European Union. That meeting will also be virtual this year, so we again will be disappointed in having a reduced opportunity for engagement with that community—though we will try to engage virtually.

Strategic planning workshops have been less impacted so far because we had just finished an intensive string of workshops and were ready for a short hiatus. That said, we did postpone one collaborative workshop. That workshop will hopefully be held virtually in the spring, but we did lose a year with that activity. As we begin to think about workshops again, we will certainly be thinking about conducting these meetings virtually.

We ran summer schools for early career scientists in 2018 and 2019 and had not planned to run an event in 2020, so we have not had an impact there so far. However, we wanted to conduct a school in 2021 in association with a planned field campaign in Houston. Because of the challenges with travel, it seems unlikely that it will be possible to follow through with that activity.

We will be tackling the topics of user engagement and early career scientist engagement during COVID with our user executive committee in the coming months.

8. Please provide any other comments or ideas as input for the roundtable.

There are six ARM atmospheric observatories. The first and longest operating observatory is in north central Oklahoma. This site is usually the most readily accessible observatory and has the most extensive support services for users. As a result, this site has long served as a testbed where new capabilities are piloted prior to deployment in more challenging and remote environments. While ARM has many unique characteristics as a user facility, this environment for prototyping new capabilities may be a model that is relevant to other settings.

Biological and Environmental Research

Environmental Molecular Sciences Laboratory (EMSL)

Pacific Northwest National Laboratory

EMSL provides the capabilities to obtain a mechanistic understanding of physical, chemical, and intra- and intercellular processes and interactions and to incorporate this information into numerical models to better understand how biological, environmental, atmospheric, and energy systems function at higher spatial and temporal scales.

Contact: emsl@pnnl.gov

BER

1. **(a) How has the COVID-19 pandemic affected your facility? (b) At what fraction of facility capacity are you currently operating? (c) What is the distribution between virtual access and physical onsite access? (d) How have facility operations been impacted? (e) Have there been disproportionate impacts on any staff? (f) Has any action been taken to minimize the impact on early career staff or other vulnerable staff groups?**

1a. In terms of overall operations, EMSL was impacted. At the onset of COVID the state of Washington was placed under a mandated work-from-home order, which placed the lab and EMSL in a minimum safe operations (min-safe) mode for approximately three weeks:

- Instruments maintained in operational readiness state
- Plants maintained
- Sample loss mitigated for onsite samples
- No Samples received or onsite users

Following the mandated work-from-home order, EMSL was moved into essential operations for almost eight weeks. This allowed approved activities that brought critical capabilities of EMSL's back online to ensure mission-critical or time-critical samples and research could continue:

- Processing of backlog samples
- Sample prep and loading of instruments
- Largely remote operation of NMR and MS
- Resumed installation of Krios cryo-EM, 800 MHz solution-state NMR, and Tahoma

Currently, Benton County is in Phase 2, and EMSL is operating in limited operations mode:

- All EMSL capabilities fully online
- All staff approved for lab activities
- Sample receipt resumed

- Approved personnel limits for lab spaces has, however, limited our overall capacity for performing work.

- Onsite users within 300-mile driving radius are allowed; air travel is still subject to DOE guidance. However, a drafted process for additional air/train travel outside of 300 miles is being developed with the Pacific Northwest Site Office (PNSO) and BER.

Cascade/Tahoma were operational throughout the entirety for remote computational work.

1b. That is difficult to ascertain. EMSL capabilities are 100% operational and all lab activities have been given approval by PNSO for onsite work. However, we are restricted as to the number of staff we are physically allowed to have in each lab space concurrently. As a result, activities have been staged and staggered using a scheduling tool to ensure we do not exceed the maximum number of staff per lab. Our capacity is between 70% to 80%. This is due to a combination of the staging of lab activities at EMSL and delayed researcher work. EMSL surveyed current users in late summer 2020 on COVID impact to their EMSL research projects at the time and projected impact looking forward into FY2021. 66% of respondents (71 responses, 45.8% response) stated a current and future delay in research, with ~70% of those respondents stating that the impact has limited their research to 50% capacity. Additionally, 45% of respondents are forecasting that this impact would continue for 6 to 12 months into FY2021, and another 34% stated an ongoing impact of 3 to 6 months in FY2021. Currently EMSL has an onsite user policy restricting travel to those who can travel to EMSL within a 300-mile driving radius; no air travel to EMSL is allowed. For FY 2020, EMSL had 213 onsite users and 553 remote users (compared to 317 onsite and 260 remote users in FY 2019). Between March 2020 and October 2020 during the height of maximum telework and COVID restrictions, EMSL had 190 onsite users (164 were from PNNL) and 451 remote users.

1c. Other than the 3-week mandatory min-safe shutdown, EMSL operations have been available at 100%, although as stated in 1b, capacity is still below 100%. We have been quite successful in maintaining upgrades, installs, and facility maintenance to ensure operational readiness. For example, the Krios cryo-TEM commissioning, the 800-MHz NMR, and Tahoma installations all continued throughout the shutdown and limited operations. From the user project support perspective, during the min-safe/mission-critical stage, EMSL was able to fully support 158 user projects—samples previously received and queued and/or data analysis-focused work. At this point, all user projects are fully supported with the main limitations arising from the PI's institutional or field-site restrictions affecting their ability to process samples.

1d. EMSL high-performance computing operations and computation, modeling, simulation staff were essentially unaffected and remained 100% active. Staff whose skills were directly aligned with supporting COVID-19 research—largely omics and imaging work utilizing nuclear magnetic resonance, mass spectrometry, and electron microscopy instruments, as well as sample prep for these instruments—were able to be more rapidly brought online and had less of an overall impact. Staff whose skills were focused more on the science of material/molecular transformations and transport (environmental work) were affected more heavily, both in terms of getting the lab activities approved by the site office and inability of researchers to get access to field sites to gather samples for analyses. Many of these staff were kept operational and productive by pivoting to support data analyses efforts and off-line/remote work in support of user projects—paper drafting, proposal writing, data analyses/QC/uploading work, etc.

Staff most impacted were those whose sole roles are lab-based: instrument development staff and technical staff performing routine instrument operational maintenance (nitrogen and helium fills, vacuum checks, etc.) These staff have focused skill sets not easily transferrable to remote research support. Some lab-based activities to ensure instrument readiness and safe-state operation were approved, however, with minimal onsite staff numbers. We also made attempts to have a single person maintain the activities. Currently, these activities have largely resumed, and productivity is not currently an issue for these staff. In total, 24 EMSL staff required DOE-approved C-time support for a total of 3,538 hours from April 4 to September 26, 2020.

1e. DOE-approved C-time support was prioritized for staff who were solely lab based (i.e., technicians, support staff, crafts). PNNL also implemented a platform for researchers and groups to post short-term job opportunities and individual "hot skills" to help connect staff who were adversely impacted to other project opportunities for maximum productivity during COVID restrictions.

BER

2. What approaches are you taking to provide productive user research experiences and services in a virtual context?

    a. Proposal peer review panels were held entirely virtually via Zoom.

    b. User Executive Committee Meeting, User Integration Meeting, and EMSL Summer School were all held virtually with overwhelming support and engagement by users—the integration meeting and summer school both had over 500 registrants and more than 300 daily attendees for these multiday meetings.

    c. Access to Tahoma, Cascade, and Aurora are completely accessible via remote connections. These systems were 100% operational throughout.

    d. Access to user data through the EMSL User Portal/MyEMSL for analyses was 100% operational throughout. This was bolstered further by focusing remote work efforts to QC'ing data (enhanced assignment of metadata through communications with PIs on existing samples in the analytical queues) and uploading to MyEMSL providing a "front-loading" of data and results for users where possible—largely results of automated workflows and instruments (mass spectroscopy, nuclear magnetic resonance, and electron microscopy).

3. What, if any, changes to physical access have you implemented or considered for users, vendors, or maintenance personnel?

    a. Access to EMSL is currently restricted to only approved facilities and lab-based activities. All EMSL staff have been approved for access under one or more of these overarching activities. Vendor interactions, for example, the instrument installations, are also approved activities by the DOE site office. This access, however, is constrained because of the approved personnel limits assigned to each space (lab, office, maintenance) according to Centers for Disease Control guidance, square footage, and activity performed. This limits overall access to the facility and lab space, as activities must be staged to abide by the space approved personnel limits.

    b. Users had been prohibited onsite until approximately mid-May. At that time, EMSL moved (with DOE site office approval) to limited onsite access for users who resided within a 300-mile driving radius. No users requiring air travel were permitted. Currently, discussions with the DOE site office, PNNL leadership, and BER are ongoing to approve a travel policy for onsite users requiring air travel to be ready if and when DOE travel bans/restrictions are lifted.

    c. During the mandated work from home phase, prox access to the building was completely disabled for all staff, users, and visitors to mitigate unnecessary access without approval. As onsite activity was ramped up, prox access was resumed with a passive monitoring of daily total building occupancy (based on prox access reads) and cross-referencing with approved activities and associated staffing levels for the activities. This is part of a larger PNNL site staffing plan and managing onsite staff levels. However, as a user facility, essentially all of EMSL activities have been approved, recognizing the mission critical capabilities EMSL provides to DOE SC research efforts.

4. Have you identified any lessons learned as a result of the COVID-19 pandemic?

    a. Current "collaborative" tools for engaging in discussions are ok but likely not optimal in a fully permanent remote operational mode.

    b. Old fashioned telephone calls are extremely productive.

    c. Standardization and automation provide a clearer path for serving in a remote/virtual operations landscape from the aspect of reproducibility/quality as well as ability for remote access/control of experimental analyses.

    d. One big take away: Just because EMSL is open and available at 100% capacity, if the rest of the country and researchers cannot get into their labs and field sites. to gather and send samples, our productivity and impact is out of our control. Do facilities themselves need experimental capabilities to conduct research for/with users remotely?

    e. Carryover funding is hard to project as progress on user projects is complicated by facility operational status and capacity, PI institutional operations and sample collection, and state/federal restrictions. But what is easy to project is that carryover funding and extensions for user projects will become the norm should COVID remain persistent or these changes in operation are permanent.

BER

f. Physically distanced working refers to both remote and onsite work. Capabilities to enhance both are needed. It is likely still indeterminant what those would be beyond video conferencing.

5. What has the COVID-19 pandemic revealed about the needs for virtual access to computational, data management/analysis, software, and network resources or other types of instrumentation?

a. Access to remote "insensitive" instrument operation and monitoring is well served with current internet service provider and network access. However, for operation of highly sensitive operations/movements, remote operation will require such capabilities as 5G ultra-low latency/high-fidelity connections to enable remote operation, or advanced artificial intelligence and machine learning (AI/ML)-driven automation will need to be deployed.

b. Fast turn-around computing for urgent needs [i.e., access to high-performance computing (HPC) with negligible queue wait times].

c. HPC resources managed to accommodate many small, discrete jobs (e.g., simulations of structure and properties of many thousands of small molecules).

d. Data management infrastructure designed to store and share multimodal experimental data and simulation data with enough appropriate metadata to (1) promote data reuse and (2) support AI/ML.

e. Users (and even staff) who do not necessarily have access to the cluster login nodes (because they don't have an allocation on the HPC system) found themselves scrounging for cycles. In essence, you're either an HPC user or you hoard workstations under desks for these purposes. Stuff that HPC users do on login nodes, non-HPC users generally must do on their laptops. Remote-only made this worse for sure.

6. User Project Administration: Have project award periods been extended and if so, does this impact future proposal calls and facility operating costs (including budget carryover across the fiscal year)? Have there been any changes to allocation policies?

a. Yes, automatic 6-month extensions were granted to EMSL smaller scope 1-year exploratory projects, as those were most immediately impacted. Other 2-year, large-scale research projects were considered on case by case basis. Extensions granted: 69 (66 Call Responders; 3 Capacity), with carryover funding of $1,650,436. The budget allocated to support the projects that could not be completed due to COVID shutdowns was carried over for the automatic extensions and did not impact the level of support provided to new or continuing project work in FY2021. Similarly, the budget for future calls would not be impacted should carryover of funds be needed from FY2021 to FY2022. In terms of instrument allocations, EMSL has capacity available on most instruments after call awards that would be directed to ensure full support for current projects and FY2022 awards.

b. Award policies remain unchanged. The number of instrument hours currently available after supporting the projects accepted under the annual calls might be impacted, limiting what is available throughout the rest of the year for general proposal requests (limited scope, capacity, etc.). Longer term, however, should additional extensions be required due to COVID restrictions, the impact to our ability to consider general proposals would be significant.

7. What have been the impacts on annual user facility meetings, strategic planning workshops, and short courses and schools (to train students, early career researchers, or future users)?

a. None have been delayed or cancelled.

b. All moved to virtual setting.

c. As a result of the virtual platform, EMSL was able to dramatically increase outreach and engagemen. Specific efforts were made to garner "open conference" approval for EMSL summer school and integration meetings, which allowed anyone to register and attend the workshops and meetings. However, hands on training for future meetings or summer schools would be impacted dependent on the intended focus of the training.

8. Please provide any other comments or ideas as input for the roundtable.

[No response]

BER

Biological and Environmental Research

Joint Genome Institute (JGI)

Lawrence Berkeley National Laboratory

JGI provides genome sequencing, genome data acquisition, and genome analyses in support of DOE mission needs in bioenergy, carbon cycling and biosequestration, and biogeochemical processes.

Contact: nmouncey@lbl.gov

1. How has the COVID-19 pandemic affected the JGI? At what fraction of facility capacity are you currently operating? What is the distribution between virtual access and physical onsite access? How have facility operations been impacted? Have there been disproportionate impacts on any staff? Has any action been taken to minimize the impact on early career staff or other vulnerable staff groups?

JGI is located on the main campus of Lawrence Berkeley National Laboratory (LBNL) in the Integrative Genomics Building (IGB). Following a county health department order, LBNL began a curtailed operations mode on March 17, where only mission-critical personnel were allowed onsite. JGI completely shut down onsite operations from March 17 until June 1 when we began a phased return to onsite work in accordance with the LBNL onsite capacity limits. While generation of new DNA sequence data, as well as other experimental data types requiring laboratory access, was severely impacted during this time, data processing and analyses of data generated prior to the shutdown continued with minimal disruptions through remote work.

Since June 1, LBNL and JGI have undergone a phased resumption of onsite activities that began at 25% of JGI production capacity for DNA sequencing, DNA synthesis, and single-cell omics and metabolomics. Activities then increased stepwise to 50% (July), 60% (August), and 80% (November to current). JGI aims to achieve a minimum of 80% of normal capacity through the end of FY21. JGI has prioritized its onsite activities to focus on COVID-19 R&D, support for user projects, and strategic internal science projects (in order of prioritization).

Impact on users: As a user facility where users are remote, nearly all JGI's normal user interactions are through shipping of experimental samples and electronic transfer of resulting data; therefore, the main difference in JGI's user experience is the reduced capacity, which in turn results in longer cycle times for some of JGI's products.

Impact on staff: There have been major impacts on the daily work of JGI staff, including the inability of laboratory workers to be onsite full time (e.g., IGB and LBNL capacity limits, social distancing requirements), deprioritization of R&D and access limitations for associated internal science-related staff, and a requirement for all nonlaboratory work to occur from home, resulting in a 100% telework schedule since March for many of our staff members. Staff who have childcare, home schooling, caregiver, or other critical responsibilities have been supported through administrative leave.

To protect early career staff as a vulnerable staff group as onsite capacity has increased, there has been a focus on providing early career scientists and postdocs access to the IGB with particular consideration of their project

requirements and career objectives. These include recipients of Presidential Early Career for Scientists and Engineers, Early Career Research Program, and Early Career Laboratory-Directed Research and Development awards.

JGI has continued with its hiring practices through the pandemic and has recruited more than 20 new staff since March. There have been issues with relocation, but these have largely been resolved.

2. What approaches are you taking to provide productive user research experiences and services in a virtual context?

JGI is continuing to perform data generation and analyses as quickly and safely as possible. The JGI Project Management Office has maintained regular communications with users to initiate new project calls, discuss sample provision and shipping, and assist with data products. In all aspects of JGI, there has and continues to be a major increase in use of video teleconferencing.

3. What, if any, changes to physical access have you implemented or considered for users, vendors, or maintenance personnel?

JGI users typically do not come onsite, and interactions with users are normally predominately through virtual means. For vendors and maintenance personnel, initially, like IGB staff, no access was granted during the shelter in place. As we returned to work, we provided access "slots" for vendors to enable their entry to LBNL with the limited staffing approved for onsite work. This was critical for machine maintenance and developing critical methods in instrumentation. LBNL has just implemented a new policy to keep vendors and staff safe during the pandemic.

4. Have you identified any lessons learned as a result of the COVID-19 pandemic?

Setting the tone early on all aspects of safety is critical (and being overly conservative is an embraced approach). It is easier to loosen requirements than to increase them.

A fraction of meetings that are typically face to face and require air travel can be accomplished through video calls.

Productivity for many staff members is as high, if not higher, for a substantial proportion of staff that are otherwise office workers at the IGB. Many staff appreciate a better work-life balance due to flexible work schedules and not having substantial commutes.

One-size-fits-all requirements don't always work (e.g., LBNL-wide mandate for "tailgate" daily morning check-ins doesn't readily apply to routine molecular biology laboratory workers nor data analysts). However, many groups have found new ways to communicate regularly among themselves (e.g., the use of group-specific Slack channels).

Laboratory automation is critical to enable continued user facility operation with minimal staffing. Investments in this area have the additional benefit of long-term reduction in cost of operation and building capacity in the National Virtual Biotechnology Laboratory including responses to national emergencies.

5. What has the COVID-19 pandemic revealed about the needs for virtual access to computational, data management/analysis, software, and network resources or other types of instrumentation?

This has not been a major issue for JGI, given the normal high level of computational activities that JGI engages in. Some staff have suffered, though, from suboptimal internet bandwidth.

6. User Project Administration: Have project award periods been extended and if so, does this impact future proposal calls and facility operating costs (including budget carryover across the fiscal year)? Have there been any changes to allocation policies?

JGI is working flexibly with users to assess delays on the user side in providing samples as well as delays on the JGI side in the processing of submitted samples due to capacity limitations. JGI has sufficient freezer storage

BER

capacity to receive and store samples from user projects until they can be processed through JGI's pipelines. This will help manage supply chains as well as ensure that JGI's equipment runs at full capacity.

All user calls for JGI, including the main call (the annual Community Science Program call) were conducted throughout 2020, as in other years, through submission of letters of intent and full proposals, review panels, and awarding of projects.

7. What have been the impacts on annual user facility meetings, strategic planning workshops, and short courses and schools (to train students, early career researchers, or future users)?

The 2020 JGI Annual User Meeting, originally scheduled for late March 2020 as an in-person meeting, was cancelled. Various other events, such as our advisory committee meetings and our JGI–University of California, Merced, summer internship program, were held in virtual formats. JGI has launched a series of "Integrated Micro-bial Genomes and Microbiomes" webinars to provide information to new and existing users on JGI's capabilities and user projects and also two podcast series, "Genome Insider" and "Natural Prodcast," to share information about user projects.

8. Please provide any other comments or ideas as input for the roundtable.

COVID-19 has greatly affected JGI users, many of whom are academic laboratories dealing with their own access and labor issues. This has resulted in delayed timelines for many of our large-scale projects as the collaborating laboratories have not been able to grow and isolate biomaterials for many of our projects.

Fusion Energy Sciences

DIII-D National Fusion Facility

General Atomics
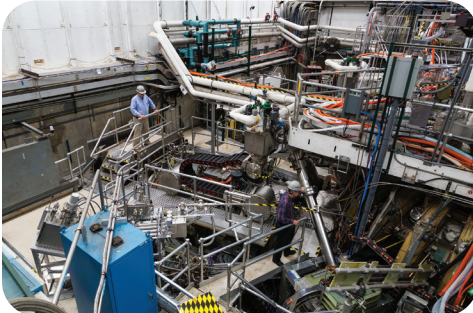
DIII-D, the largest magnetic fusion user facility in the United States, is a tokamak confinement device with significant engineering flexibility to explore the optimization of the advanced tokamak approach to fusion energy production.

Contact: nycum@fusion.gat.com

1. How has the COVID-19 pandemic affected your facility? At what fraction of facility capacity are you currently operating? What is the distribution between virtual access and physical onsite access? How have facility operations been impacted? Have there been disproportionate impacts on any staff? Has any action been taken to minimize the impact on early career staff or other vulnerable staff groups?

The DIII-D facility normally operates with about 60 operations staff present onsite and, during experiments, as many as 40 to 60 scientists and diagnosticians participating. COVID-19 has had significant impact on our facility. Experiments were stopped for a period of two to three months in spring 2020 to assess the impact of COVID-19 restrictions and to implement additional safety measures or protocols.

Since July 2020, we have been able to operate at approaching-normal capacity with adjustments for reduced staff attendance and remote working arrangements, and some additional time to commission the full complement of systems. However, troubleshooting and repair of equipment take significantly longer by up to 50%, due to social distancing measures and reduced staff attendance. The rate of experiment execution on a particular day is now modestly impacted (~20% level) by the extra time needed under remote participation and safe operation protocols. Discussions between scientific team members and with operations support members can be slightly slower through videoconference, though the new tools discussed in Question 2 work pretty well.

At a high level, staff have been asked to work remotely when possible. This is working quite well, especially for scientists who are carrying out experiments from home. Many people, especially operations staff, cannot work remotely due to the need to "touch" equipment. Those who work onsite are working under strict requirements to practice social distancing, wear face coverings, and keep their work areas sanitized. In a small number of cases, jobs require people to work in closer proximity, and personal protective equipment has been made available to keep those workers safe. With these restrictions, most of the operations staff continue to work onsite. However, onsite participation by scientists is very low (as this can be done mostly remotely).

Finally, increased use of General Atomics technical staff has been necessary in order to support systems from collaborative institutions when their providers cannot be onsite. Another factor here is the aim to keep total onsite numbers down, so tasks are consolidated to a smaller group of personnel. This works well.

FES

2. What approaches are you taking to provide productive user research experiences and services in a virtual context?

We have reinvented scientific operation of the facility to deliver a largely remote participation engagement. Tools have been made available for effectively working remotely during experiments. These include Zoom (already in use for videoconferencing), Discord (for real-time communication among participants), and new web tools to duplicate aspects of the "onsite experience," including audio and replication of control-room displays in web browsers. Some of these tools were already in use on a more occasional basis prior to COVID-19, since DIII-D is a highly collaborative facility with international colleagues joining experiments and meetings remotely.

We have stepped up web-based coordination of scientific activities—with specific efforts to organize information about the program and ongoing planning in an accessible way, ensure email distribution lists are up to date, and pay particular attention to engagement of new and early career personnel to draw them into ongoing planning and analysis of studies with regular meetings, invited tasks, and meeting-facilitation skills. Supervisors and area leaders have been asked to bear these in mind, invite and draw in input, set tasks, and update their websites. We feel it important that individual contributors and particularly early career and training participants are not left in limbo.

3. What, if any, changes to physical access have you implemented or considered for users, vendors, or maintenance personnel?

Access to the facility is discouraged for those who do not need to be onsite to perform job functions. Procedures describing all the safety protocols have been written and added to required safety training for all personnel. Personnel must pass a test to indicate they have assimilated this information prior to building access. The control room, usually a crowded space, is now limited to 15 people, socially distanced, with some overflow space available in a reconfigured conference room. We have also provided tablet computers for technicians to use while performing some maintenance and set-up tasks on diagnostics, for example, under video supervision of the responsible officer who is working remotely.

4. Have you identified any lessons learned as a result of the COVID-19 pandemic?

Not surprisingly, there is a learning curve for the new tools and procedures. A few people waited until the day of their experiment to start learning them; this obviously doesn't work well. It is also important that people who are using the same tools learn a new and appropriate "etiquette" for using them in a cooperative rather than disruptive way. There are small things here too; before COVID-19, the session leader and his/her team would often work for up to several hours on analysis and discussion of next steps. When we first moved to this model, we had an issue with others calling meetings right after operations ended. We have asked people to reserve that time for the usual analysis and discussion.

These enhanced remote-participation tools will certainly be used in the future, even when staff can return to work normally. They have the potential to facilitate more collaborative engagement from a wider national team without the obligation and overhead of travel—although this is generally most efficiently achieved if the participant has had previous onsite engagement and learned the tools and contacts of our facility.

5. What has the COVID-19 pandemic revealed about the needs for virtual access to computational, data management/analysis, software, and network resources or other types of instrumentation?

This has not been a large issue for us. Access to most of these resources was already open for remote collaborators, as the facility has invested in such tools over the years. In many cases, the need was for increased capacity rather than new capabilities. We have had to work around some issues in reconciling the need to access some operational systems remotely with the need to maintain cybersecurity. It has also been helpful to provide easily automated web access to some key outputs from the facility such as plant status displays and traces of key measurements (that are routinely displayed in the control room). Good web information and access systems are key.

FES

6. User Project Administration: Have project award periods been extended and if so, does this impact future proposal calls and facility operating costs (including budget carryover across the fiscal year)? Have there been any changes to allocation policies?

We are not aware that this kind of impact has occurred with the exception of increased manning of onsite technician support to ensure systems can be operated without a much wider range of specialists onsite. This and the fact that some tasks now take more time (see Question 1) mean that additional full-time equivalent support may be needed while working under COVID-safe protocols, if project progression rates are to be maintained at usual levels (noting some slowing flagged in Question 1).

7. What have been the impacts on annual user facility meetings, strategic planning workshops, and short courses and schools (to train students, early career researchers, or future users)?

To date, none of these facility-specific meetings had been planned and so there have been no such impacts. Our group research planning activity ("Research Opportunities Forum") has in recent years already been held largely via Zoom, so it will not be impacted. Much of our training and meetings are already provided with remote participation, including student/postdoc events.

See also notes under Question 2 on impacts and steps needed for effective engagement and training of staff.

8. Please provide any other comments or ideas as input for the roundtable.

Learning to continue our research with COVID-19 restrictions has been challenging, but we also see a great deal of value in it. We are looking forward to ITER becoming the largest research program in DOE FES and are anticipating that a great deal of our work on ITER will be carried out remotely. Learning to operate the facility this way gives us a good head start on preparing for that. It may also help us further develop DIII-D as a user facility for a larger cross section of the national program, as our experimental groups outreach and engage to a wider range of local facilities, modeling groups, and international partner facilities.

FES

Fusion Energy Sciences

National Spherical Torus Experiment Upgrade (NSTX-U)

Princeton Plasma Physics Laboratory
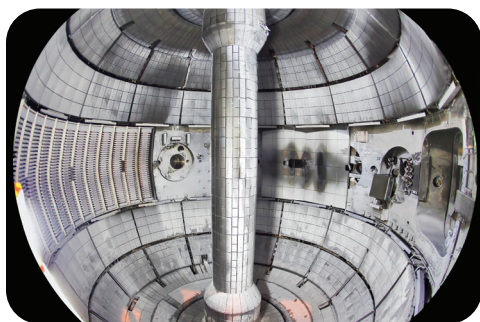
NSTX-U is a magnetic confinement fusion facility employing a spherical torus confinement configuration to explore the potential stability and confinement advantages of this compact tokamak concept.

Contact: kaye@pppl.gov

1. How has the COVID-19 pandemic affected your facility? At what fraction of facility capacity are you currently operating? What is the distribution between virtual access and physical onsite access? How have facility operations been impacted? Have there been disproportionate impacts on any staff? Has any action been taken to minimize the impact on early career staff or other vulnerable staff groups?

The effect of the pandemic on facility operations is not applicable to NSTX-U since we are in the process of upgrading our facility, and operations were suspended in June 2016. Operations are not scheduled to resume until FY22 at the earliest. The pandemic will impact the schedule for resumption of operations, and we are assessing that impact.

The NSTX-U research staff have been working primarily from home since mid-March 2020 due to curtailment of onsite activities caused by the COVID pandemic. Since the NSTX-U device is presently in "Recovery," research from not operating that facility has not been impacted. Researchers are now engaged in analysis of data from previous NSTX and NSTX-U experiments as well as from collaborations in which they have been involved during the Recovery period. Productivity and remote communications have been good. On rare occasions, researchers have needed to go onsite for diagnostic work. In most of these cases, the visits were only of days duration; in one case, there is continued onsite access by the Thomson scattering diagnostician for long-lead activities required to be completed prior to commencement of operations. What has been impacted are the visits that were planned by our researchers to collaborating institutions both domestically and internationally; these, for the most part, have been cancelled. In some cases, the cancellations have affected the implementation of diagnostics on these facilities; and in other cases, they have impacted onsite (at those institutions) participation in experiments.

Remote interactions among the researchers during curtailment of onsite activities have been good (through Zoom). Zoom meetings are ubiquitous, and they include weekly seminars for the NSTX-U group, lab colloquia, special seminars, and small group meetings (both formal and informal lunchtime meetings). These, for the most part, have kept the researchers engaged and connected, although it is clear that extra effort is needed to accomplish this for early career physicists. Especially for these younger researchers, their mentors are making special efforts to communicate with them often (several times a week) and to ensure that their work is leading to publications. We also have biweekly meetings among the NSTX-U research heads to identify any issues that need attention. As many

of the NSTX-U researchers are involved in the ST40 public-private partnership collaboration, we hold biweekly meetings among these researchers and the ST40 staff.

2. What approaches are you taking to provide productive user research experiences and services in a virtual context?

Zoom conferencing has been the backbone of offsite interactions among the researchers, and this has been quite successful.

3. What, if any, changes to physical access have you implemented or considered for users, vendors, or maintenance personnel?

Princeton Plasma Physics Laboratory (PPPL) is operating with an onsite head-count limit and will not return to routine operations until the state of New Jersey approves return to work at pre–COVID-19 levels.

Physical onsite access requires permission from department heads and upper management. Most of the researchers require only one-time visits onsite to pick up resources from their offices. A few researchers require targeted visits that may last a day to a few days for specific activities, such as packing and shipping equipment and assessing port space on the NSTX-U device. There is one researcher and his engineer who need continued onsite access to work on a long–lead time diagnostic required for Day 1 operation of NSTX-U.

4. Have you identified any lessons learned as a result of the COVID-19 pandemic?

One lesson learned is that it is possible to work from home and still be productive. This involves mostly analysis tasks, but a number of researchers, who have been involved in operating experiments offsite were able to participate remotely in an effective fashion. This holds for participation that was "incidental." Those who are involved in actually leading experiments require more technical capability than can be had at home; in those cases, there have been approved requests by these researchers to lead these experiments from the "remote control room" that is set up at PPPL. PPPL requires limiting the number of researchers in this room to comply with social distancing guidelines. The other lesson learned is that it is essential to maintain lines of communication among researchers, especially with the early career physicists.

It is very important to have continued interactions with direct reports virtually on a regular basis and periodic technical meetings on loosely connected scientific endeavors. Because some of these operate on a longer time scale, it is easy for researchers to prioritize other areas that need immediate attention. This can be accomplished partly by regular technical seminars, as well as encouraging staff to prepare for and participate in virtual conferences in the same way as physical conferences.

FES

5. What has the COVID-19 pandemic revealed about the needs for virtual access to computational, data management/analysis, software, and network resources or other types of instrumentation?

There have been no additional needs identified in terms of how to go about virtual access. There have been needs for expanding VPN access (and having a reliable VPN client) and for streamlining the Computer Help Desk ticketing system so that issues can be resolved more quickly. There are enhanced interactions with the IT staff working on resolving the issues.

6. Project Administration: Have project award periods been extended and if so, does this impact future proposal calls and facility operating costs (including budget carryover across the fiscal year)? Have there been any changes to allocation policies?

Project awards for collaborators that support the NSTX-U facility have not yet been extended/revised due to the pandemic. There is a likelihood that future proposal awards will be impacted (i.e., delayed) due to the pandemic, since plans for awarding run time on NSTX-U will be delayed as a result of NSTX-U coming back online later than originally planned.

7. What have been the impacts on annual user facility meetings, strategic planning workshops, and short courses and schools (to train students, early career researchers, or future users)?

NSTX-U researchers and potential researchers have engaged successfully in strategic planning workshops via Zoom. These workshops formed the basis for developing the content of the recently reviewed Five-Year Research Plan. Zoom has also been successfully used for the NSTX-U Program Advisory Committee (PAC) meeting, participation in training and education seminars, PACs of other facilities, Fusion Energy Sciences Advisory Committee meetings, and CPP strategic planning. While not as effective as face-to-face meetings, these virtual meetings are productive. It is important to point out that even before COVID onsite curtailment, Zoom was used to augment local meetings quite effectively, so this is essentially just an expansion of Zoom use.

8. Please provide any other comments or ideas as input for the roundtable.

[No response]

High Energy Physics

Accelerator Test Facility (ATF)

Brookhaven National Laboratory
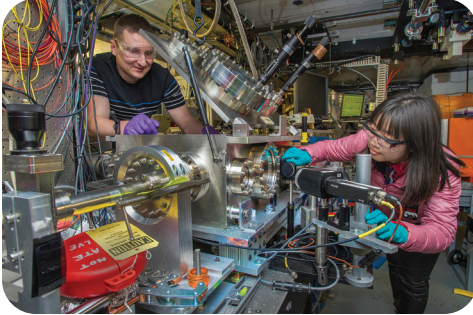
ATF provides users with high power lasers synchronized with high brightness electron beams, providing a testbed for exploring the science of particle acceleration and radiation generation, and for developing new accelerator technologies.

Contact: mpalmer@bnl.gov

1. How has the COVID-19 pandemic affected your facility? At what fraction of facility capacity are you currently operating? What is the distribution between virtual access and physical onsite access? How have facility operations been impacted? Have there been disproportionate impacts on any staff? Has any action been taken to minimize the impact on early career staff or other vulnerable staff groups?

Brookhaven National Laboratory's (BNL) ATF has been impacted by approximately three months (late March to late June) of FY20 with the facility in a down state due to the minimum safe operations period at BNL followed by just over three months where it was impossible to bring any non-local users onsite for the experimental program.

While the facility has been in operation during the first quarter of FY21, this has been at reduced efficiency. The reduced efficiency appears primarily in two ways—first, we cannot support non-local experimental teams at the typical rate; second, the number of user hours required to execute a given experiment has often increased. The first issue results in a bias in user hours towards experimental teams that have better access to the laboratory (i.e., those with BNL staff as part of the experimental collaboration or where local New York universities are a primary institution). The second issue is a result of social distancing requirements in tight spaces around beamlines and experimental chambers. This forces many steps to be done sequentially—as opposed to in parallel with more personnel in close proximity. Thus, while the facility is delivering at least 80% of its targeted user hours, the rate of progress on most individual experiments is noticeably reduced.

Virtual access is difficult given the types of experiments that operate at the ATF. During FY21-Q1, we project that roughly 10% of the ATF user experiment portfolio will be amenable to remote operations for a significant portion of the research effort.

To date, COVID impacts on specific categories of staff have been relatively limited. We have been able to maintain support for the research programs of junior staff members and have coordinated our schedule to ensure that these staff have been able to continue their experimental programs. Of course, the rate of progress for these efforts is typically slower than originally envisioned.

2. What approaches are you taking to provide productive user research experiences and services in a virtual context?

Where possible, we are supporting experiments for remote running. Because of the complexity of a typical ATF experiment, we are only able to do this for a very limited number of active user experiments (~10%).

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In the area of workforce training, the facility has supported multiple virtual training experiences for interns and university students. In combination with universities moving to virtual learning environments, this appears to have been quite effective in maintaining engagement with the accelerator and laser physics training typically provided by the ATF.

3. What, if any, changes to physical access have you implemented or considered for users, vendors, or maintenance personnel?

BNL has a detailed process for site access for each of the above categories of visitors. Each requires explicit permission to access the site while Brookhaven continues in a mode of limited operations. Furthermore, out-of-state visitors are required to follow visitor protocols (e.g., testing, quarantining) as currently required by the state of New York. While onsite, all visitors are required to follow detailed COVID-19 protocols as specified in required laboratory training. This includes following the laboratory's social distancing, masking, and associated work-planning protocols throughout their visit.

4. Have you identified any lessons learned as a result of the COVID-19 pandemic?

At the ATF, where hands-on engagement is typically required, a key lesson learned has been the option of having users execute setups under well-controlled conditions but allowing for an extended period of measurements that may be carried out by facility staff. In multiple cases, this has helped us leverage user investment to complete key measurements. While this does not support a completely virtual capability for the types of experiments executed at the ATF, this approach potentially offers greater flexibility and efficiency for our user community, both through the remainder of the pandemic and beyond. We intend to continue exploring our options in this area.

5. What has the COVID-19 pandemic revealed about the needs for virtual access to computational, data management/analysis, software, and network resources or other types of instrumentation?

Improved access to the ATF's standard instrumentation would significantly enhance our ability to support remote operation with our users after the initial installation of their experiment is complete. We intend to explore remote virtual-viewing capabilities for users to support modifications to experimental setups (e.g., through the use of technology such as the Microsoft HoloLens setup) and improved access to ATF control system readouts to interpret experimental data.

6. User Project Administration: Have project award periods been extended and if so, does this impact future proposal calls and facility operating costs (including budget carryover across the fiscal year)? Have there been any changes to allocation policies?

While there have been no fundamental changes to allocation policies at the ATF, we have tried to offer flexibility to highly ranked experiments that qualify for being awarded user time. This includes the option of delaying the official start of the experiment until a time frame when the ATF can actually serve these users. Because many ATF experiments require unique installations, the start of certain experiments was precluded for much of FY20.

7. What have been the impacts on annual user facility meetings, strategic planning workshops, and short courses and schools (to train students, early career researchers, or future users?

All user and planning meetings, as well as reviews, have been held virtually. This appears to be working reasonably. In general, hands-on workforce training has been severely limited with students, interns, and many early career researchers having very limited site and facility access options. ATF staff have adapted all training materials for the virtual environment and has provided online sessions throughout the pandemic to continue our workforce training role. Unfortunately, these sessions cannot fully make up for the hands-on experience to students and trainees that we usually provide.
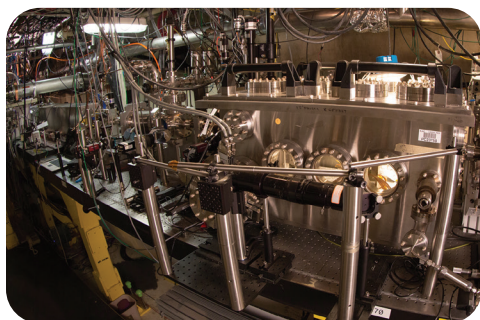
8. Please provide any other comments or ideas as input for the roundtable.

[No response]

HEP

Facility for Advanced Accelerator Experimental Tests (FACET)

SLAC National Accelerator Laboratory

FACET is an accelerator-based user facility where experiments in beam-driven plasma wakefield particle acceleration are carried out.

Contact: yakimenk@slac.stanford.edu

1. How has the COVID-19 pandemic affected your facility? At what fraction of facility capacity are you currently operating? What is the distribution between virtual access and physical onsite access? How have facility operations been impacted? Have there been disproportionate impacts on any staff? Has any action been taken to minimize the impact on early career staff or other vulnerable staff groups?

Currently the facility is commissioning upgrades that were implemented as the FACET-II project. Commissioning progress incurs marginal delays due to the necessity to call in support staff rather than have staff already onsite.

All FACET staff have returned to work onsite for those activities that cannot be performed from home.

Approximately 10% of users are onsite, the majority of which are in-house users. A typical level during the scientific program in previous years was 50% of users onsite.

2. What approaches are you taking to provide productive user research experiences and services in a virtual context?

The control system is accessible from offsite as are all electronic logbooks and the data repositories. New solutions developed as a response to the pandemic include a Zoom/video connection to the operations staff in the Accelerator Control Room.

3. What, if any, changes to physical access have you implemented or considered for users, vendors, or maintenance personnel?

The facility follows SLAC National Accelerator Laboratory (SLAC) institutional policy for site access and work performance, including setting occupancy limits and reviewing jobs with consideration given to mitigating virus exposure.

4. Have you identified any lessons learned as a result of the COVID-19 pandemic?

[No response]

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5. What has the COVID-19 pandemic revealed about the needs for virtual access to computational, data management/analysis, software, and network resources or other types of instrumentation?

Remote/virtual tools have long been in place, primarily driven by staff needs to provide support for the physically large accelerator complex (both onsite and offsite) and the need of users to access and analyze data once they have returned to their institutions.

6. User Project Administration: Have project award periods been extended and if so, does this impact future proposal calls and facility operating costs (including budget carryover across the fiscal year)? Have there been any changes to allocation policies?

There have not been changes to allocation policies.

7. What have been the impacts on annual user facility meetings, strategic planning workshops, and short courses and schools (to train students, early career researchers, or future users)?

There was a Program Advisory Committee held in October 2020. This was 100% virtual. The scientific review was conducted successfully, but the format limited the opportunity for discussion between user groups.

The Advanced Accelerator Concepts workshop in summer 2020 has been reorganized as a virtual seminar series.

8. Please provide any other comments or ideas as input for the roundtable.

[No response]

HEP

High Energy Physics

Fermilab Accelerator Complex

Fermi National Accelerator Laboratory

Fermilab consists of four accelerators that work together to provide world-class particle beams for experiments at the Intensity Frontier.

Contact: fermilab@fnal.gov

1. How has the COVID-19 pandemic affected your facility? At what fraction of facility capacity are you currently operating? What is the distribution between virtual access and physical onsite access? How have facility operations been impacted? Have there been disproportionate impacts on any staff? Has any action been taken to minimize the impact on early career staff or other vulnerable staff groups?

The pandemic and State of Illinois response caused an early termination of beam operations for the Fermi National Accelerator Laboratory (Fermilab) FY20 run. New work practices in accelerator operations and Office of Science user facility support have been established to work remotely in an effective manner and to develop COVID protocols for onsite work. The complex shutdown started two months early and is just restarting beam operations for the FY21 run period. The accelerator facilities are in commissioning operations now and expect to continue to operate to deliver to the plan. In the Accelerator Division, most scientists and administrative staff continue to work remotely, but much of the technical staff are onsite doing hands-on work. The percentage onsite daily grew over time but never exceeded 50%; with the shutdown complete, the number of employees needed onsite each day has slightly reduced. All work that can be done remotely is. Very few external users are onsite working on maintenance or upgrades to the experiments. Operations are presently running at close to planned effectiveness, but we are in an early stage of the annual run. Repairs take longer because of the additional work planning required. Considerable focus has been made on identifying critical-risk personnel and taking work planning steps to mitigate their potential risk.

2. What approaches are you taking to provide productive user research experiences and services in a virtual context?

Much of the data expected to be delivered was in the experimenters' hands when the shutdown started, so users had at least partial datasets in most cases. Some test beam users have been delayed because their time was scheduled for after the facility stopped beam operations. They will be rescheduled for FY21 if time is available and the testing is still needed. Extensive use of virtual meeting spaces and continued computing facility operations has allowed the users to continue being scientifically productive. The Fermilab Accelerator Science and Technology facility's Integrable Optics Test Accelerator program was able to complete the annual run plan.

HEP

3. What, if any, changes to physical access have you implemented or considered for users, vendors, or maintenance personnel?

Fermilab has implemented a system for granting permission for physical access to the site based on the work to be performed according to the level of operations allowed. The restrictions on work have changed in response to changes in the pandemic and according to improved work planning and control. Most users are still working virtually, and the typical number of employees onsite each day is around 700 of a population of ~1,800. Screening for COVID symptoms or exposure is done at entry, and testing is available. All employees and users are trained in the COVID-19 protocols developed and implemented by the laboratory. For vendors and maintenance services, similar restrictions apply. Vendors and maintenance providers are allowed access to the site if they are deemed essential.

4. Have you identified any lessons learned as a result of the COVID-19 pandemic?

FY20 Accelerator Operations were terminated earlier than planned, and Fermilab was essentially closed at the beginning of the pandemic. Shutdown preparations were done remotely, and only a small number of people were onsite to monitor and respond to issues. We must have personnel present at our facility to monitor accelerator conditions to keep the complex in a safe state. When the State of Illinois reduced the restrictions, we were able to gradually increase onsite presence to do the scheduled summer shutdown work needed. Lessons learned were that with enhanced work planning and controls, many tasks could be done safely with reduced personnel density by examining the tasks and also by appropriate scheduling and communications. Considerable effort in developing remote working has mitigated the impact of reduced onsite personnel and has generally worked well.

5. What has the COVID-19 pandemic revealed about the needs for virtual access to computational, data management/analysis, software, and network resources or other types of instrumentation?

The main control room has historically often been crowded during beam commissioning and during down periods in operations. The need to reduce operations staff in the room to reduce COVID risks was clear. People have made use of video tools to communicate and have refurbished remote control rooms so that machine experts can commission and monitor machines from there.

6. User Project Administration: Have project award periods been extended and if so, does this impact future proposal calls and facility operating costs (including budget carryover across the fiscal year)? Have there been any changes to allocation policies?

Operations plans for high energy physics experiments usually span several years. No long-term changes to operational plans in terms of beam delivery have been made.

7. What have been the impacts on annual user facility meetings, strategic planning workshops, and short courses and schools (to train students, early career researchers, or future users)?

Most of these are still occurring but are being done virtually. The big annual neutrino conference saw a dramatic increase in attendance over prior years. There have been successful adjustments made to hold virtual workshops. The U.S. Particle Accelerator School (US-PAS) will conduct classes remotely in January 2021. The normal summer intern programs were either cancelled or done remotely, which was not a desirable outcome.

8. Please provide any other comments or ideas as input for the roundtable.

The ability to find ways to work remotely and to control exposure while onsite has been reasonably successful, and we are restarting beam operations now. There will be more understanding of the outcome after we have operated the accelerator in this mode for a few months.

Nuclear Physics

Argonne Tandem Linac Accelerator System (ATLAS)
Argonne National Laboratory
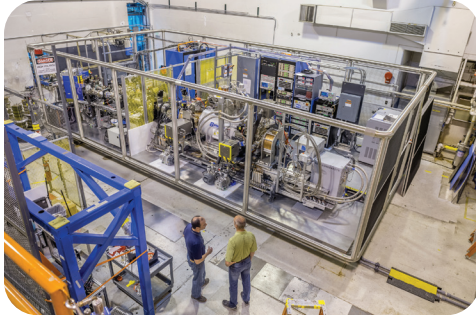
ATLAS is a leading facility for nuclear structure research in the United States, providing a wide range of beams for nuclear reaction and structure research to users worldwide.

Contact: savard@anl.gov

1. How has the COVID-19 pandemic affected your facility? At what fraction of facility capacity are you currently operating? What is the distribution between virtual access and physical onsite access? How have facility operations been impacted? Have there been disproportionate impacts on any staff? Has any action been taken to minimize the impact on early career staff or other vulnerable staff groups?

The ATLAS facility was shut down for about three months early in the pandemic and restarted at the end of June with minimal staff onsite and no user access. Onsite staff were expanded in early October, allowing access to pre-approved users with scheduled experiments. The facility is running 24 hours per day for five days a week since it restarted operation. Essentially, all users have been remote users due initially to onsite-access restrictions and now to various travel limitations. The facility has operated reliably under this scenario, but we initially limited ourselves to simpler experiments and took a few months before scheduling some of the harder radioactive beam or high-intensity stable beam experiments. There can, however, on occasion, be additional delays addressing equipment failures because of the reduced staff onsite and the more difficult communications. There have been no known COVID cases among ATLAS staff, but on various occasions, employees have been asked to stay home for two weeks because of close relatives testing positive. No subgroup has been depleted enough to stop operation, but this is a constant concern. There has been no known COVID transmission within the facility. We have tried to minimize impact on staff and have made it easier for short-term staff such as postdocs and students to obtain extensions to complete their work.

2. What approaches are you taking to provide productive user research experiences and services in a virtual context?

There have been significant efforts to improve the capabilities for remote monitoring of experiments by outside users (within the bounds of what is allowed by cybersecurity). This includes data taking and online analysis but also in some cases control of some of the hardware to limit the need for onsite intervention when remote users are covering "virtual" experimental shifts.

3. What, if any, changes to physical access have you implemented or considered for users, vendors, or maintenance personnel?

Outside users had no access to the facility during the shutdown and the first two to three months of the restart of operation. Access is now possible and is provided to a list of users with previous training who are on scheduled

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experiments. The list is provided to the laboratory a month in advance. The users must, in addition to their normal training, take the Argonne National Laboratory (ANL) COVID training, follow the basic guidelines for COVID prevention that apply to all ANL employees such as not reporting to work if they have symptoms and being briefed on facility COVID controls before they are granted access. The required personal protective equipment is available for all entering the facility. Day passes were also available for short trips by vendors and other outside visitors, but this has been stopped recently as a result of tightening state regulations.

4. Have you identified any lessons learned as a result of the COVID-19 pandemic?

We believe the prioritization put in place for the ATLAS research program and most decisions taken were the right ones in the framework in which they were taken, but it is clear we did not expect this situation would last for such an extended period of time. Operation wise, two main issues encountered were (1) more difficult communications between groups and (2) delays created by not having all required expertise available onsite when issues occur, especially when tuning beam to new experiments. Both can be addressed by requesting a slightly larger onsite staff presence when operating the facility. This can be done safely with the measures that have been put in place and would greatly improve efficiency and engagement.

5. What has the COVID-19 pandemic revealed about the needs for virtual access to computational, data management/analysis, software, and network resources or other types of instrumentation?

Remote monitoring of experiments required more access and control than was available for most experimental systems at ATLAS. Concerted effort has been made to improve this situation. The network resources already in place were sufficient to address these needs.

6. User Project Administration: Have project award periods been extended and if so, does this impact future proposal calls and facility operating costs (including budget carryover across the fiscal year)? Have there been any changes to allocation policies?

Some larger ATLAS instruments involve coordinated efforts with the user community that must be synchronized with activities at other facilities. A large amount of communication and cooperation has allowed schedules to be modified in a way to minimize the impact on all facilities involved and maximize return to the user community.

7. What have been the impacts on annual user facility meetings, strategic planning workshops, and short courses and schools (to train students, early career researchers, or future users)?

An overall community meeting was held remotely by ANL in August 2020, covering all main national laboratory and university activities in the field. Over 500 people registered, which is significantly larger than the number of participants present in person in a normal year. This was a positive development that we will try to implement when returning to in-person meetings. However, a target-making school that was to be attached to the community meeting had to be postponed since it contained a large hands-on component that cannot be done remotely.

8. Please provide any other comments or ideas as input for the roundtable.

[No response]

Continuous Electron Beam Accelerator Facility (CEBAF)

Thomas Jefferson National Accelerator Facility

CEBAF is a world-leading facility in the experimental study of hadronic matter, used by scientists to probe the interior of the nucleus to study its properties.

Contact: lorelei@jlab.org

1. How has the COVID-19 pandemic affected your facility? At what fraction of facility capacity are you currently operating? What is the distribution between virtual access and physical onsite access? How have facility operations been impacted? Have there been disproportionate impacts on any staff? Has any action been taken to minimize the impact on early career staff or other vulnerable staff groups?

On March 28, Thomas Jefferson National Accelerator Facility (JLab) operations were shut down, interrupting the four experiments that were in production data-taking. Restoration of operations began June 8, with resumption of the experiments in July. Operational changes for some experiments were implemented, with only one shift expert present in the counting room during the day and swing shifts from 7 a.m. to 11 p.m. The overnight shift was manned as usual with two people: a shift expert and a worker. We also relied on local collaborators who could travel to the laboratory for shifts. A monitoring camera was installed in each experiment's counting room as an extra safety precaution.

The scheduled accelerator run was completed September 11, followed by the initiation of a long-scheduled maintenance period to install an upgrade to the accelerator cryogenics system. The scheduled down period now extends until May 2021. Presently there are about 300 out of 730 staff working onsite executing work that is considered high priority.

2. What approaches are you taking to provide productive user research experiences and services in a virtual context?

Requests from users that require onsite access for high-priority activities are reviewed by JLab, and permission is granted on a case-by-case basis.

3. What, if any, changes to physical access have you implemented or considered for users, vendors, or maintenance personnel?

All personnel working onsite must complete training regarding daily health self-check procedures, wearing masks at all times in public locations, and maintaining social distancing. Any work that involves closer than six feet in distance between personnel requires special personal protective equipment (PPE).

4. Have you identified any lessons learned as a result of the COVID-19 pandemic?

Having a site-level pandemic response plan was critical to a timely and internally well-coordinated response. PPE supply chains are fragile, critical to continued laboratory operations, and a continuing source of concern.

5. What has the COVID-19 pandemic revealed about the needs for virtual access to computational, data management/analysis, software, and network resources or other types of instrumentation?

Our user community has a strong tradition of remote access to data and computational resources so there has been minimal impact. Nevertheless, the experience during this period has helped us realize that improvements could be made to enhance remote access to data acquisition systems as well as computational and data management resources. Collaboration software has allowed users to maintain their productivity, but the lack of uniformity of access has been a problem for some. Users need uniform access to software for video/teleconferencing, screen-sharing capabilities, virtual whiteboards, file-sharing applications, and the ability to simultaneously work on documents.

6. User Project Administration: Have project award periods been extended and if so, does this impact future proposal calls and facility operating costs (including budget carryover across the fiscal year)? Have there been any changes to allocation policies?

We have continued to accept and review proposals for future experiments and projects. The schedule for future operations has been delayed several months due to the COVID impacts. Budget impacts have been minimal.

7. What have been the impacts on annual user facility meetings, strategic planning workshops, and short courses and schools (to train students, early career researchers, or future users)?

Our annual user meeting was successfully held remotely, as was our Program Advisory Committee meeting. The Hampton University Graduate Summer School, normally hosted at JLab, was canceled this year.

8. Please provide any other comments or ideas as input for the roundtable.

[No response]

NP

Nuclear Physics

Facility for Rare Isotope Beams (FRIB)

Michigan State University

> *FRIB is a next-generation nuclear structure and nuclear astrophysics accelerator due to come online in 2022.*
>
> **Contact:** glasmach@frib.msu.edu

[Facility not yet operational.]

NP

Relativistic Heavy Ion Collider (RHIC)

Brookhaven National Laboratory

RHIC is a world-class scientific research facility used by hundreds of physicists worldwide to study what the universe may have looked like in the first few moments after its creation.

Contact: denisovd@bnl.gov

1a. How has the COVID-19 pandemic affected your facility?

The pandemic has brought about the need for establishing new work practices in accelerator operations and Office of Science user facility support. These measures include:

- Establishing efficient and effective methods for remote administration, training, work planning, work briefing approval, supervision, and accelerator and experiment operations.
- Integrating COVID protocol to all onsite work including enhanced personal protective equipment, social distancing, staggered work hours and groups, and added hygiene measures.

The pandemic presented challenges for the RHIC experimental program and upgrade schedules. These arose from loss of access to the Brookhaven National Laboratory (BNL) site during the minimum safe operational period (min-safe) in spring 2020, subsequent limited accessibility to the laboratory by colleagues from external institutions, restricted access of these colleagues to their own local laboratories, the increased effort required to authorize necessary external users to allow access onsite to work on upgrades, and the continued reduction in the presence of external users.

1b. At what fraction of facility capacity are you currently operating?

The accelerator facilities have continued to operate at full capacity and effectiveness.

1c. What is the distribution between virtual access and physical onsite access?

In the Accelerator Division at the Collider-Accelerator Department (C-AD), a large percentage (>90%) of the technical staff and ~20% professional and administrative personnel are onsite. All other work is done virtually (telework). At the Medical Isotope Research and Production Program (MIRP), onsite staffing is ~50% with the remaining 50% working virtually. Personnel are rotated through the week. In the physics department, most of the personnel associated with upgrade projects are currently working onsite, while research scientists and information technologists are predominantly working virtually. In addition, a significant number of external users are onsite working on upgrades to the experiments, though not at the level planned before the pandemic.

1d. How have facility operations been impacted?

Following the adjustments mentioned above, operations is presently running at full effectiveness. At MIRP, due to the pandemic, an Accelerator Readiness Review was held virtually. This required us to develop video walkdowns

of the facilities and live video streaming of activities. We used BlueJeans to perform interviews and set up breakout rooms for focused discussions and interviews. Indico was used for the agenda, presentations, and links to break-out sessions. SharePoint was used to give access to documentation for the review.

1e. Have there been disproportionate impacts on any staff?

Operations support groups took on many additional tasks related to restoration of normal operations under COVID protocols. For experiments and projects, local experimental groups took on additional scope to compensate for reduction in outside users from experimental collaborations, both in the operation of STAR shifts as detailed below and in upgrade projects.

1f. Has any action been taken to minimize the impact on early career staff or other vulnerable staff groups?

In the Accelerator Division, each group has taken individual measures. In general, the approach has involved enhanced communications (often daily during the initial phases of the pandemic; then less, depending on need and establishment of more formalized group meetings). At MIRP, early career researchers are being given the priority to come onsite to complete their research. Similar measures have been taken in the physics department, especially for technical personnel for whom the remote operation during minimum operations in the spring was an unfamiliar work environment. We put in place virtual seminars, coffee breaks, and social lunches in an attempt to compensate for the lack of informal in-person knowledge transfer and opportunities for visibility that especially affects early career staff.

2. What approaches are you taking to provide productive user research experiences and services in a virtual context?

BNL's Nuclear and Particle Physics (NPP) Directorate has developed several approaches to make a user's research experience as productive as possible, consistent with the necessary and important safety considerations due to the COVID pandemic.

When New York infection rates started climbing in mid-March, our first response was to transition the laboratory into a min-safe configuration. This transition started on March 20, with the termination of beam operations for all NPP user facilities, in particular, RHIC beam operations. The official transition to min-safe occurred on March 23. As knowledge about the virus itself was in a nascent state, BNL's approach for the users was primarily to communicate with them often, passing on information regarding possible future facility operations resumption dates as public and laboratory knowledge increased. This communication included both virtual weekly meetings with RHIC users and email communications. During this min-safe phase, BNL computing facilities associated with the NPP user programs were maintained in an operational state so that user research, code development, websites, and data analysis could proceed without user access to the site. To allow for the timely resumption of facility operations if/when conditions allowed, the RHIC collider was kept at operating temperatures. Necessary utilities (e.g., water cooling systems, vacuum systems) were also evaluated regarding which should be left operational and which shutdown.

A few months into min-safe as knowledge about the virus (e.g., transmission vectors) was expanding, BNL (with DOE input and approval) started to bring the NASA Space Radiation Laboratory (NSRL) facility back online for specific mission-critical user needs. During this period, BNL also continued the approach of communicating with NPP facility users about schedule information, travel, and access policies and procedures as they were developing. Plans and policies were developed with the users on modified facility operations, both for BNL staff as well as users. The policies and plans were tuned to minimize the number of people who would need to be onsite, minimize the close interactions between individuals onsite, and implement virtual means to incorporate offsite users into the operations of their research programs onsite.

In June, with DOE permission, BNL started bringing the RHIC program back online, along with additional NSRL users, and started the restart process for the Tandem facility. NSRL users, when possible, shipped their equipment

or samples to NSRL, and BNL facility staff performed their measurements/exposures and provided them with the data. For most NSRL user programs, staff worked with the users to accomplish all the forms and approvals necessary to get them onsite to run their programs. Some NSRL work was scaled down in both volume and scope to comply with the low-density occupation of the facility. Some users have been able to quarantine before coming onsite; others used the new negative-test method now employed by the state. Several have opted to simplify their science to enable us to carry out irradiations for them and return their samples. More complicated research requiring in-person investigators has been delayed to next spring or summer, whenever conditions allow. For the RHIC program, which for the 2020 run is the STAR Detector facility, the number of detector operations staff onsite was reduced from the usual four-person shift to a three-person shift, with two of the people being at the STAR site and one in continuous virtual contact from offsite. Due to the difficulties with travel and policies to minimize site access to non-BNL staff, staffing of the onsite shifts was primarily done by BNL staff who are also STAR collaborators. Also allowed to take onsite shifts were users staying for protracted periods onsite as well as those collaborators within New York (e.g., local Stony Brook University). Other RHIC program users could remain involved in the program via the computing facilities, the weekly program-wide as well as STAR-specific virtual meetings, and the continuous virtual connection to the STAR Control Room.

With the end of FY20 RHIC program operations in mid-September, the user effort drops the onsite detector operations work; and the onsite work shifts to detector maintenance, fabrication, assembly, and installation. With careful planning and full compliance with the policies and procedures for allowing users onsite, we've managed to get the users needed for the ongoing sPHENIX Detector project and the STAR Forward Upgrade project to continue on schedule. The NSRL and Tandem user programs are continuing as we approach mid-November, again with careful compliance with the policies and procedures for user site access.

At MIRP, all meetings were made virtual starting in late February. The group was spread out to minimize interactions (including refurbishing office space), and they were encouraged to minimize face-to-face meetings. As mentioned above, we took the Nuclear Chemistry Summer School virtual, both lecture and lab, exposing 24 students to nuclear and radiochemistry. Further, we have provided virtual experiences for three undergraduate students working on targetry separations and Monte Carlo analysis.

Virtual coffee breaks were organized to allow staff and users to interact in a more casual atmosphere. Communication was enhanced by use of social media–inspired tools such as chat services (Mattermost, provided by the Scientific Data and Computing Center) to keep regular contact with employees and users alike.

The experimental collaborations have long employed tools like BlueJeans (and now Zoom) to enable remote collaborators to participate fully in technical and scientific activities. As an example, sPHENIX has held online tutorials to show collaborators how to use the simulation and computing infrastructure. One particular technical development—the use of virtual machines—allows remote collaborators to run code on their own hardware in an environment identical to what they would find at BNL.

3. What, if any, changes to physical access have you implemented or considered for users, vendors, or maintenance personnel?

Brookhaven has implemented a system that considers physical access to the site based on the work to be performed. A certain number of users have been incorporated into Brookhaven's Restoration of Operations Plan (ROOP) following BNL's shutdown near the beginning of the pandemic, but additional users, guests, and visitors must apply for access using a form that requires the applicant to indicate the scope of the work and the facility where the work will be performed, when the work will be performed, and from where the user will be coming from to use Brookhaven facilities. The requirements for access are tied to New York travel requirements. Local (i.e., New York) users and users from states contiguous to New York (i.e., New Jersey, Connecticut, Massachusetts, Pennsylvania, and Vermont) are not required to test or quarantine to gain access to the facilities; however, users from other states must follow New York state quarantine requirements (negative COVID-19 test within 24 hours of departure for New York and negative test on the third day after arrival in New York) before being allowed on the Brookhaven site. For certain users, an exemption to New York state quarantine requirements, per New York State

regulations, may be available based on whether the proposed work is critical to Brookhaven's mission, including work that is necessary to secure the protection of life and property of BNL, work that supports statutory requirements or requirements of its prime contract, work that is necessary for the inspection of systems or equipment if those systems or equipment are integral to security or proper functioning of the mission, and work related to the BNL Mission Essential Functions directly as defined by DOE orders. All users, guests, and visitors must be trained in BNL COVID-19 protocols as part of their ROOP.

For vendors and maintenance services, similar restrictions apply. Local vendors and maintenance providers are allowed access to the site, while vendors from outside the local area must follow New York State quarantine requirements, although the exemption process is available for mission-critical services.

4. Have you identified any lessons learned as a result of the COVID-19 pandemic?

Maintaining the continuity of accelerator operations was paramount to completing the science agenda for RHIC and NSRL in FY20; specifically, we have a mandated presence at our facility in order to operate beams in the accelerators. Organizing the operations staff in cohorts and isolating the Main Control Room area were two measures taken to help us meet experimental goals without further interruptions. Unfortunately, summer heat and storm conditions highlighted the shortcomings of HVAC and power distribution, with a noted reduction in accelerator availability during a period usually devoted to maintenance and upgrades.

As each job is documented and reviewed, many reveal lessons to be learned. Examples are:

- Increased and enhanced work control, especially with outside departments (notably Facilities and Operations (F&O) support).
- Increased communication and accountability with F&O supervision and administration.
- Increased coordination for and control of the execution and timing of all work at C-AD.
- Overhaul of maintenance and repair methods to maximize efficiency and minimize COVID exposure.
- New access, work timing, and execution protocol.

The pandemic has helped identify which forms of activity can be conducted online, which require in-person access, and which activities can benefit from a combination of the two. These lessons can potentially significantly increase productivity, save resources, and enhance worker satisfaction.

5. What has the COVID-19 pandemic revealed about the needs for virtual access to computational, data management/analysis, software, and network resources or other types of instrumentation?

Concerning accelerator operations to accommodate the larger number of remote users, we had to expand and improve the tools used for remote computer connections. Specifically, we procured more dedicated NX servers (expanded from three to five), increased the number of user NX servers (a new approach that allowed some people to connect directly to their desktop system), and added a load-balancing system.

Facility users who have valid guest appointments at BNL have had full access to computational, data management/analysis, and software resources before the COVID onset, and this same level of access has been maintained through the COVID period. Because of the vast size of datasets for some user programs (e.g., RHIC and ATLAS), the extensive collaboration software and database infrastructures, and large user population (thousands across the RHIC experiments and ATLAS), remote access is standard for these users. Use of various video conferencing platforms (e.g., Zoom, BlueJeans, Microsoft Teams) has expanded significantly. This increased use is for the interactions of facility users with NPP staff, but it also includes use in user-group meetings and user-program conferences. For STAR users, a camera with a 360-degree microphone was installed in the STAR control room. This allowed subsystem experts and operations staff to easily communicate with limited personnel (typically a single person in the control room itself, the second onsite shifter in an adjacent room). This was run with a continuous video meeting on the shift leader's desk. An unanticipated, but very useful benefit of this new system was that multiple experts could be online simultaneously and discuss among themselves and with the shift leader how

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to respond and resolve any issues. It also freed the shift leader from having to answer phones to deal one on one with anyone who needed to interact with the control room. This mechanism for remote communication will be maintained beyond the COVID period.

An issue with these remote-access tools is choosing which of the different currently active platforms is most appropriate in each situation, since each of these platforms has a somewhat different distinction between employee and user access.

6. User Project Administration: Have project award periods been extended and if so, does this impact future proposal calls and facility operating costs (including budget carryover across the fiscal year)? Have there been any changes to allocation policies?

Within the C-AD Accelerator Division, user project schedules and completion dates have not been formally extended. As such, at this time, there haven't been any impacts on future proposal calls and facility operating costs.

At MIRP, the hot cell upgrade project schedule has been delayed due to COVID.

7. What have been the impacts on annual user facility meetings, strategic planning workshops, and short courses and schools (to train students, early career researchers, or future users)?

All user facility meetings, planning workshops, short courses, and facility-related schools have been held virtually since the second quarter of CY2020. One should add to this list of missed in-person gatherings the physics conferences that went virtual during this period. While this impacts all the people who would usually attend these meetings, primarily in person, it has the largest negative impact on the students, early career researchers, and future users. Attending meetings such as these give early career students, researchers, and users an opportunity to not only experience the presentations given by established members of their field, it also allows them opportunities to personally meet, interact with, and make their existence known to them. Often it is by being present for the post-presentation question-and-discussion periods that people gain insight into possible issues or questions about what was presented and how it may impact the future paths and prospects for the topic discussed. Opportunities for discussions with other attendees during the meeting breaks, at impromptu meals together, and at poster sessions are important avenues for early researchers to learn and get to know others in the field. The loss of in-person opportunities for these people to compose and present talks on their own work removes an important part of their education and training in how to give an impactful presentation. For those looking to find their first position post-education, or to find their next position, attendance at in-person meetings presents opportunities to gain visibility, as well as discuss openings with potential employers. While virtual meetings remove some cost barriers, such as travel and high registration fees, and are attempting to replicate some of the informal interactions with innovations such as virtual poster sessions and breakout rooms, they currently do not provide the same opportunities for students, early career researchers, and future users to learn and increase their visibility as in-person meetings.

At MIRP, the Nuclear Chemistry Summer School had to be held virtually this year including lectures and labs. The Canvas platform was used. The DOE Isotope Program has developed a national Virtual Seminar Series to allow young investigators to present and network.

8. Please provide any other comments or ideas as input for the roundtable.

With present adaptations, work progression has recovered to full capacity and efficiency. Challenges remain in some areas such as maintaining vigilance and preventing "Pandemic Fatigue."

We've enhanced a "Wear Your Mask Campaign" and are continuing activities such as expanding offsite work implementation and onsite technical staff who are available for project and group assistance. Additional supervisory-level communications are occurring via the Tuesday Planning Meeting and ESF and F&O weekly planning meetings.

One notable effect of travel restrictions has been the interruption of international workshops. Specific to the benefit of operations are the Accelerator Reliability Workshop and Workshop on Accelerator Operations, each a biennial

series. Compared to symposia and conferences, the workshops draw more effective results from collaborative presentations, breakout sessions, open discussions, and poster sessions; moreover, the retreat-style congregation allows for many spinoff conversations and exchange of ideas. Specific improvements to our operations have been implemented as a direct result of such interaction. Looking forward, it is difficult to conceive of any comparable benefit from a remote version of the workshops; yet, it is highly desired to keep providing these workshops in some way, shape, or form.

Non-local new hires must receive DOE approval before they can relocate to the Brookhaven site. This process can take several weeks and has generally taken longer for international new hires than for domestic hires. Many new hires have been onboarded remotely—completing training, participating in meetings, and completing work that can be done without visiting the site.

The challenges of dealing with and adapting to something like the COVID pandemic, where little is known as it starts and the impact and understanding change rapidly, are significant. When faced with something like this, one of the most important things that a user facility can do is provide information to their user community that is timely, and as accurate and factual as possible. As the situation changes and the impacts on the facility and users change, it is important to communicate with users in a timely fashion.

While virtual meetings have their limits, they are an effective venue for keeping users involved in the facility as well as an avenue for users to ask questions.

Advertising seminars to wider communities than a single laboratory or single university can provide opportunities for interaction among distributed researchers with common interests.

One issue with holding virtual meetings on an international scale is scheduling. Finding an appropriate time zone for all to attend especially has hindered our ability to maintain normal conference formats, often reducing them to partial days with shorter discussion, or the opposite: extreme to long workdays, ensuring partial attendance.

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Appendix E
Image Credits

Front Cover

New High-Performance Computing Resource Launches. Computational biologist Lee Ann McCue works on Tahoma, the newest supercomputer at the Environmental Molecular Sciences Laboratory. Tahoma came online during the pandemic. [Courtesy Pacific Northwest National Laboratory]

Facilities Provide COVID Insights. Scientists at the Spallation Neutron Source and High Flux Isotope Reactor are using neutron capabilities to understand the structure and behavior of SARS-CoV-2, the virus responsible for COVID-19. These and other studies across Office of Science user facilities have contributed significantly to the nation's R&D response to the pandemic. [Courtesy Oak Ridge National Laboratory]

Careful Planning Ensures Work Continues. Brookhaven National Laboratory (BNL) staff, users, and students have followed COVID safety protocols while working on a new detector for the 2023 sPHENIX upgrade to the Relativistic Heavy Ion Collider. [Courtesy BNL]

Back Cover

Light Sources Adapt to Pandemic Limitations. Changsoo Chang, a macromolecular crystallographer at the Advanced Photon Source's Structural Biology Center, loads a sample "puck" with protein crystals into a dewar. Scientists at the center received an Argonne National Laboratory (ANL) impact award for their research on SARS-CoV-2. [Courtesy ANL]
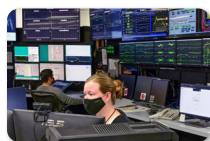
Social Distancing at the DIII-D National Fusion Facility. Staff follow guidelines for safe working conditions in the DIII-D control room, seen here. [Courtesy General Atomics]

A New Way of Working. Maria Dzunkova, a researcher at the DOE Joint Genome Institute, studies soil bacteriophages (i.e., viruses that attack bacteria) during the facility's first week of return to work. [Courtesy Lawrence Berkeley National Laboratory]

Chapter Front Images
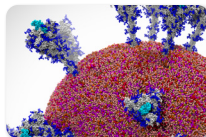
SARS-CoV-2 Modeling. Researchers used an artificial intelligence–based workflow to simulate the spike protein within the SARS-CoV-2 viral envelope. They discovered a mechanism that the virus uses to evade detection and characterized interactions between the spike protein and the ACE2 receptor. [Courtesy Argonne National Laboratory, University of California–San Diego, and Oak Ridge National Laboratory]
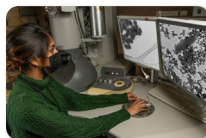
Adjusting Onsite and Remote Access. Neerja Zambare, a researcher at the Environmental Molecular Sciences Laboratory (EMSL), studies microbe-mineral interactions. Between March and October 2020, EMSL hosted 190 onsite users and 451 remote users. [Courtesy Pacific Northwest National Laboratory]
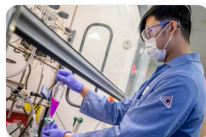
Color-Change Masks. Zeming Wang works with a florescent mixture as part of research to create a marker that binds to SARS-CoV-2, causing a color change that could be leveraged to determine if masks are contaminated. [Courtesy Lawrence Berkeley National Laboratory]

Light Sources Adapt to Pandemic Limitations. (See Back Cover image credit)
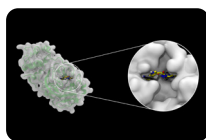
Rapid COVID-19 Molecular Docking. To identify potential drug therapies, researchers used resources from the Oak Ridge Leadership Computing Facility to simulate, in less than 24 hours, how more than 1 billion compounds bind with two structures of the SARS-CoV-2 main protease. [Courtesy Oak Ridge National Laboratory]

Facility Maintenance in the COVID Era. Mike Beck checks the alignment of a new "Wien quad" magnet used to correct optical astigmatism of Wien filters, which control the spin polarization of the electron beam in the Continuous Electron Beam Accelerator Facility. [Courtesy Thomas Jefferson National Accelerator Facility]

Appendix F

Acronyms and Abbreviations

AI	artificial intelligence
ALCF	Argonne Leadership Computing Facility
ALS	Advanced Light Source
ANL	Argonne National Laboratory
APS	Advanced Photon Source
APS-U	Advanced Photon Source-Upgrade
ARM	Atmospheric Radiation Measurement User Facility
ASCR	Office of Advanced Scientific Computing Research
ATF	Accelerator Test Facility
ATLAS	Argonne Tandem Linac Accelerator System
BER	Office of Biological and Environmental Research
BES	Office of Basic Energy Sciences
BNL	Brookhaven National Laboratory
C-AD	Collider-Accelerator Department
CARES Act	Coronavirus Aid, Relief, and Economic Security Act (2020)
CEBAF	Continuous Electron Beam Accelerator Facility
CFN	Center for Functional Nanomaterials
CINT	Center for Integrated Nanotechnologies
CMS	Compact Muon Solenoid
CNM	Center for Nanoscale Materials
CNMS	Center for Nanophase Materials Sciences
cryo-EM	cryo-electron microscopy
cryo-TEM	cryo-transmission electron microscopy
DAQ	data acquisition
DDR	Director's Discretionary Reserve
DIII-D	DIII-D National Fusion Facility
DOE	U.S. Department of Energy
EMSL	Environmental Molecular Sciences Laboratory
EPSCoR	Established Program to Stimulate Competitive Research
ESnet	Energy Sciences Network
F&O	facilities and operations
FACET	Facility for Advanced Accelerator Experimental Tests
FAIR	findable, accessible, interoperable, and reusable
Fermilab	Fermi National Accelerator Laboratory (FNAL)
FES	Office of Fusion Energy Sciences
FNAL	Fermi National Accelerator Laboratory (Fermilab)
FRIB	Facility for Rare Isotope Beams
GU	general user
HEP	Office of High Energy Physics
HFIR	High Flux Isotope Reactor
HPC	high-performance computing
IGB	Integrative Genomics Building

JGI	Joint Genome Institute
JLab	Thomas Jefferson National Accelerator Facility
LBNL	Lawrence Berkeley National Laboratory
LCLS	Linac Coherent Light Source
Linac	linear accelerator
LUME	Lightsource Unified Modeling Environment
MIRP	Medical Isotope Research and Production Program
ML	machine learning
MOSAiC	Multidisciplinary Drifting Observatory for the Study of Arctic Climate
MS	mass spectrometry
MX	macromolecular crystallography
NERSC	National Energy Research Scientific Computing Center
NMR	nuclear magnetic resonance
NP	Office of Nuclear Physics
NPP	Nuclear and Particle Physics
NSLS-II	National Synchrotron Light Source II
NSRC	nanoscale science research center
NSTX-U	National Spherical Torus Experiment Upgrade
NVBL	National Virtual Biotechnology Laboratory
OLCF	Oak Ridge Leadership Computing Facility
ORNL	Oak Ridge National Laboratory
PAC	program advisory committee
PNNL	Pacific Northwest National Laboratory
PNSO	Pacific Northwest Site Office
PPE	personal protective equipment
PPPL	Princeton Plasma Physics Laboratory
PuRe	public reusable research
RAWG	Remote Access Working Group
RHIC	Relativistic Heavy Ion Collider
ROOP	Restoration of Operations Plan
S2E	start-to-end
SARS-CoV-2	Severe Acute Respiratory Syndrome Coronavirus 2
SC	Office of Science
SCGSR	Office of Science Graduate Student Research Program
SLAC	SLAC National Accelerator Laboratory
SNS	Spallation Neutron Source
SSRL	Stanford Synchrotron Radiation Lightsource
TMF	The Molecular Foundry
XSEDE	Extreme Science and Engineering Discovery Environment, National Science Foundation