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# *Providing the Tools for Scientific Discovery and Basic Energy Research: The Department of Energy's Science Mission*


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Chairwoman Lummis, Ranking Member Swalwell and distinguished members of the subcommittee, thank you for holding this important hearing and for inviting me to participate as a witness.

My name is Horst Simon and I am the Deputy Director of the Lawrence Berkeley National Laboratory (Berkeley Lab), a Department of Energy (DOE) Office of Science multipurpose laboratory managed by the University of California. My scientific area of expertise is High Performance Computing, a field in which I have worked for over 30 years. Before becoming Deputy Director I served as the Director for the National Energy Research Scientific Computing Center (NERSC) and as the Associate Laboratory Director for Computing Sciences at Berkeley Lab. I am one of the editors of the Top500 List of the world's most powerful supercomputers.

Berkeley Lab is the oldest laboratory in the DOE Office of Science complex, tracing its founding by Ernest Orlando Lawrence to 1931. The Lab is a center of world-leading research in many fields, including astrophysics, biology for energy solutions, high performance computing and materials science. Operating five national scientific user facilities, including the world's most powerful electron microscope, the Lab is host to around 10,000 scientists and students that visit the Lab annually to conduct their research.

The Lab enjoys a tremendous symbiotic relationship with the University of California, Berkeley – close to 300 of our researchers have joint appointments as professors on campus. The relationship with the University of California and with local industry creates unparalleled education and training opportunities for students at all stages of their studies. Hundreds of undergrad, graduate and doctoral students are at the Lab everyday preparing for their future research careers. We are also fortunate to draw upon the intellectual and technological capital of the San Francisco Bay Area to advance our mission.

Considering the economic and national security challenges facing our nation, there are few issues as critical to the nation's wellbeing as the vitality and productiveness of our innovation ecosystem. I am honored to be here today as a part of this distinguished panel and am delighted to offer my views on a very important aspect of that ecosystem – the Department of Energy Office of Science and its national laboratories.

My comments are divided primarily into two categories.

1. I will attempt to describe for the Committee what national laboratories are, why they are important and how they serve a fundamental and foundational role in the nation's innovation ecosystem. Although I work at Berkeley Lab, I will utilize examples and describe issues from throughout the Office of Science laboratory complex.

2. I will comment on the draft bill that the committee is considering. Many of these comments are based on discussions I have had over many months with my colleagues at Berkeley Lab and at other labs. Some of my comments are, however, based on my own professional experience and are my opinions solely – not the views of Berkeley Lab or the Department of Energy.

**What are the Office of Science national laboratories and why are they important to the nation's economic and national security?**

The course of humanity often runs along well-worn ruts uninterrupted except when redirected by extraordinary events or by extraordinary individuals facing extraordinary challenges. Such was the case during the first third of the 20th century in the United States, when a core group of outstanding scientists and their colleagues in non-scientific fields, working on the frontiers of physics, unknowingly laid the scientific and infrastructure foundation for the modern national laboratory. With an entrepreneurial, team-science approach, scientific leaders like Ernest Orlando Lawrence, Enrico Fermi, and Alfred Loomis begged, borrowed and otherwise found the resources to establish a new type of research enterprise – one no longer dependent on the single principal investigator and a small team of post doctoral and graduate students. Rather, they crafted large, multidisciplinary teams whose members pulled together in lockstep toward common scientific goals.

For Lawrence, a young professor at the University of California, his singular focus was on developing and perfecting the cyclotron, a particle accelerator with great potential for deciphering the riddles of physics and for unveiling secrets to a host of scientific mysteries. To build the cyclotron and to capture it's scientific potential, Lawrence brought together a diverse and capable team of scientists, engineers, machinists, accountants, administrative staff, students, post docs and other disciplines that did not normally mix at such a scale. It was a productive undertaking that led to remarkable results – results that won the Nobel Prize, captured the imagination of the general public and caught the attention of officials in Washington.

With the advent of World War II and the pressing need to establish technological supremacy in the fight against fascism, the federal government, armed with unprecedented funding for science and technology development, turned to the giants of research for their help. From Lawrence's Berkeley "Rad Lab" and Loomis' laboratory of the same name at M.I.T., to Fermi's nuclear physics lab at the University of Chicago, the federal government enlisted the help of the best and brightest to meet the challenges of war. The Manhattan Project was stood up and the rest, as they say, "is history." In the process, and unwittingly, the mold of the national laboratory was set.

The mold was big team science using big scientific tools to tackle big societal problems. Although the times have changed, and although the challenges and opportunities facing our nation are not the same as they were in 1939, the fundamental role of our national laboratories in the U.S.'s innovation ecosystem is as important, or more important, today as back then.

Today, the legacy of these scientific superstars, the federal government's initial and ongoing investment, and the public service of thousands of dedicated scientists, engineers, managers, administrators and others is a network of national laboratories that is unmatched and envied by the rest of the world. The Office of Science oversees ten national laboratories – each with a unique set of expertise, resources, facilities and users – each providing world-class scientific capabilities to a diverse set of researchers from around the nation and the world. From unraveling the mysteries of the universe – space, time, mass and energy – and leading the world in the development of high performance computing, to creating new materials and biological processes that advance transformational energy solutions and aid in environmental cleanup, the national laboratories and the Office of Science are an irreplaceable part of the nation's innovation ecosystem.

Keeping with the management structure set in place during the Manhattan Project, the labs are still operated by universities, private sector companies and other organizations on behalf of the Department of Energy. Dubbed management and operating contractors (or M&O contractors), entities such as the University of California, Battelle Memorial Institute, Stanford University and others provide DOE with access to researchers who are often at the top of their fields, students training to become the next generation's scientists, and the intellectual freedom to push the boundaries of knowledge and pave the way for transformational discoveries. The M&O contracting model has been extremely effective and efficient – leading to extraordinary scientific accomplishments at the national laboratories. At Berkeley Lab, for instance, the close proximity of a world leading research lab to a world leading research university has led to a remarkable symbiosis of academic entrepreneurialism and societal-scale mission objectives. Like Lawrence's early achievements, the results continue to be remarkable – 13 Nobel Prizes and a current roster of researchers that makes up about 3 percent of the National Academy of Sciences, and research that is consistently recognized as world class across many disciplines.

**Build and operate national scientific user facilities**

From Lawrence's accelerators to Fermi's nuclear research reactors, a central role of the national laboratory has been, and remains, to conceive of, design, build and operate unique scientific tools and machines. DOE's Office of Science, as steward of today's national science laboratories and as the major funder of the physical sciences in the United States, operates thirty-one national scientific user facilities (full list is attached to this testimony). The facilities include light sources that peer into materials at the molecular and atomic scale to determine structure and chemistry, accelerators that collide subatomic particles at speeds approaching the speed of light, some of the world's most powerful supercomputers, facilities that sequence and reveal secrets of plant and microbial genomes, and the world's most powerful electron microscopes.

These tools, including the Advanced Light Source at Berkeley Lab, the Spallation Neutron Source at Oak Ridge, and the Center for Nanoscale Materials at Argonne National Laboratory provide tens of thousands of American researchers access to critical scientific capabilities that help them to maintain the nation's scientific leadership. These researchers come from both academia and industry; are funded by a host of federal agencies, philanthropic organizations and companies; and come from every state in the union and the District of Columbia. Thus, a substantial amount of the funding provided to the national laboratories for the operation of these facilities is expended in support of research conducted by non-DOE users, mostly from universities. The facilities are made available at no charge to researchers doing nonproprietary work. In other words, their research must be published and made available to the broader scientific community.

The user facilities also provide irreplaceable capabilities and expertise to companies working to develop new products and processes for commercial applications. From semiconductor research to speeding new pharmaceutical solutions to patients, the user facilities have become a critical component in industrial R&D. All sizes of companies, Fortune 500 as well as startups and medium size enterprises, utilize these special scientific tools. For many of them, the user facilities have become an important part of their R&D programs. If companies keep their research private, they pay a fee at an hourly rate for their use of the facility.

A few examples provide a good glimpse of the value of these facilities to the nation.

> <u>GE and the Oak Ridge Leadership Computing Facility</u>
> General Electric (GE) collaborated with Oak Ridge Leadership Computing Facility researchers to utilize the Cray XK7 Titan supercomputer, one of the world's most powerful computers, to conduct very large molecular simulations, not feasible on smaller systems, to better understand why ice forms on various material surfaces, such as the blade of wind turbines. The formation and accumulation of ice on wind turbine blades limits where wind turbines can be deployed safely and effectively, despite the availability of abundant wind.
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> GE ran hundreds of simulations of million-molecule water droplets on Titan that examined freezing behavior across many different surface and temperature combinations (typical studies can only simulate 1,000 molecule droplets). Results are revealing surface and temperature combinations that hold the most promise for reducing debilitating ice formation. This in turn is helping experimentalists better focus their research so they can reduce the number of time-consuming and costly physical experiments.
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> <u>Argonne and New Material that Dents Diamonds</u>
> At Argonne National Laboratory's Advanced Photon Source, a remarkable tool for examining materials at the atomic and molecular level, an international team of

scientists created a new super-hard form of carbon. Carbon materials, such as graphene, graphite, buckyballs and nanontubes, display a remarkable range of mechanical, electronic and electrochemical properties that make them sought-after materials for advanced products in electronics and nanotechnology.

Led by scientists with the Carnegie Institute of Washington's Geophysical Laboratory, the research team made up of researchers from Argonne, Jilin University, the University of Nebraska at Lincoln, Stanford University and SLAC National Accelerator Laboratory, created a carbon material that is comparable to diamond in its inability to be compressed. Not only is the new material incredibly strong – it can dent diamond, the hardest substance on Earth – it is also able to retain its new super-hard form even when the high pressure that created it was removed. Researchers and potential industrial users are excited by the new material's ability to maintain its super-hard status without continual pressure – a key requirement for commercial applications.

The World's Most Powerful Electron Microscope and Lighter, Stronger Alloys
Researchers at Berkeley Lab's National Center for Electron Microscopy employed the world's most powerful electron microscope to discover how nanoparticle size can be controlled to make stronger metal alloys. Their findings provided an atomic-scale view into the properties of metal nanoparticles in aluminum, yielding a high-strength, lightweight, potentially heat- and corrosion-resistant alloy for use in airplane engines and other aerospace applications. These new microstructures could lead to the next generation of lightweight aerospace and automotive aluminum alloys.

## World leading research for DOE mission objectives

The DOE Office of Science national user facilities are obviously a competitive asset of America's research and innovation enterprise. The robust utilization of these facilities by researchers from throughout the research community – academia, industry and other research institutions – is strong evidence of their value to the nation. They are irreplaceable. What may not be as obvious as the importance of the brick and mortar facilities, but is just as critical to their success and to the success of our nation's innovation enterprise, are the research programs at the national laboratories and at universities funded by the Office of Science.

As I mentioned previously, DOE's Office of Science is the largest funder of the physical sciences in the United States – and, perhaps in the world. The physical sciences include such fields as material sciences, chemistry, physics and geology. Most people believe that the National Science Foundation or other science agencies make up the majority of federal investments in these areas – yet, this is a mistaken belief. Communicating science effectively is always a difficult challenge – we try, but we could do much better. Under Pat Dehmer's leadership, the Office of Science, and the national laboratories, are improving our outreach. We hope that you will help us by reaching out to your colleagues and educating them about the important work of the Office of Science.

As a critical tool in advancing its scientific mission, the Office of Science is also the nation's steward of pushing the frontiers of scientific computing – high performance computing for science and technology. As a practitioner in this field for many years, I have witnessed firsthand the ever-increasing value of computing to science and to addressing the challenges we face as a nation and those that we face as citizens of the world. Computing, through simulation, modeling and data analysis, has become the third leg, along with theory and experimentation, in the three-legged stool of research.

Additionally, the Office of Science is the largest funder of non-human related biological research – such as research into energy solutions and environmental remediation. This is another often well-kept secret.

The physical sciences, computing and biology each helps to advance key DOE and Office of Science mission needs and objectives. All are focused on research and technology development unique to DOE, but applicable to the broader research ecosystem. They make new discoveries possible and lead to a better understanding of the world around us and to solutions to some of our thorniest problems. Additionally, a robust Office of Science research program is necessary to ensure that scientists, engineers and facility operators at the national user facilities remain at the front end of science in their respective fields. In my observations, the value of the user facilities to visiting researchers, whether from NSF, NIH, NASA or elsewhere, is directly correlated to the skill and expertise of the user facility scientific staff. Not investing in the research mission and building the scientific chops of laboratory scientists would be wasting the great federal investment in these national assets.

**Solving societal challenges through team science**

Attacking problems of scale is a legacy for the national laboratories that was established by Lawrence and his colleagues. As described earlier, the mold was big team science using big scientific tools to tackle big societal problems. Today, one of the most enviable aspects of the national laboratory system remains its ability to organize multidisciplinary teams and bring their intellectual and technological knowhow to bear on complicated research challenges. The national laboratories have a flexibility that doesn't exist at most research universities, and the ability to focus on research that industry would never undertake – at least not today, not since the demise of the great industrial labs of Bell, Xerox and others. Consequently, the labs are fertile ground for forming collaborations and teams to address contemporary challenges in an immediate and fundamental way.

As with the national user facilities, a few good examples illustrate the value of DOE team science.

Joint BioEnergy Institute and High Throughput Spectrometry

Researchers at the Joint BioEnergy Institute (JBEI) at Berkeley Lab, a DOE Office of Science Bioenergy Research Center, have developed an advanced technology to dramatically speed up and lower the cost of developing lignocellulosic biofuels. Led by researchers from JBEI, the effort required a team-based approach from the start. JBEI is a great example of team science as it includes researchers from four national laboratories and three universities, with a dynamic and important industry advisory council. Gathered under one roof, plant physiologists, microbial engineers, computer scientists and others from these institutions work together seamlessly toward JBEI's scientific and technology objectives. Drawing from its diversity and depth of research capabilities this group tackled this project in a very Lawrence-inspired team science mode.

Their success was a new high-speed chemical screening system, with the complicated name High Throughput Nanostructure-Initiator Mass Spectrometry (NIMS), that makes novel use of miniaturization, lasers, specialized chemistries and robotics. NIMS can precisely determine the molecular composition of tens of thousands of samples deposited on a single silicon slide. Each tiny sample is shot with a laser and analyzed in a split second. By working at speeds 100 times faster than that of conventional probes NIMS can cost-effectively profile thousands of samples in a split second.

High Throughput NIMS is being used at JBEI to screen for enzymes that can be used to modify lignocellulose for the production of advanced biofuels that could replace gasoline, diesel and jet fuel on a gallon-for-gallon basis. This technology was recognized with an R&D100 Award by *R&D Magazine.*

The Relativistic Heavy Ion Collider and Discovery Science

At Brookhaven National Laboratory, more than 1,000 scientists from around the world collaborate on research at the Relativistic Heavy Ion Collider (RHIC). At RHIC, thousands of light-speed particle collisions take place each second, recreating the extraordinary conditions of the early universe, as detectors track the subatomic debris to gain clues about the building blocks of matter. When RHIC started operations in June 2000, physicists expected they'd see telltale signatures of elementary particles behaving like a gas. Instead there were many unexpected findings. Working in smaller groups to analyze pieces of data from two large experiments, RHIC physicists concluded that what they were seeing was a liquid. And not just any liquid, but the most perfect liquid ever created, flowing with virtually no resistance. This stunning surprise has opened up a large number of new questions that scientists are now working to answer.

This research—too large, complex, and costly to be conducted by any individual institution—is a classic example of "big team" science. Investments of time, expertise, and money from across the globe divide the challenge of addressing complicated questions of physics into manageable chunks. Likewise, collaboration members—often working from their home institutions—sift through subsets of RHIC data to explore small pieces of the bigger puzzle, sharing insights, discussing implications, preparing publications, and exploring new questions via email and at meetings.

Development of Advanced Materials Gets Boost from Supercomputers

In a new, technology-enabled form of team science, the Materials Project – an open-access database developed by Berkeley Lab and MIT for materials research – is working with the medium sized company Intermolecular, Inc. to enhance modeling capabilities and accelerate the speed of new material development by tenfold or more over conventional approaches. New materials are key to addressing challenges in energy, healthcare and national security.

Located at the National Energy Research Scientific Computing Center (NERSC), the Materials Project was designed to be an open and accessible tool for scientists and engineers working in both the public and private sectors and now has more than 4,000 users who can explore the properties of 35,000 different materials. This helps scientists avoid the typical trial and error and educated guesses with a systematic approach to designing materials for better batteries, solar cells, electric vehicles, hydrogen storage, catalyst design, and fuel cells.

Using conventional approaches, it takes about 18 years to conceptualize and commercialize a new material. The Materials Project is meant to address this bottleneck by using a genomics approach to materials science – it uses NERSC's supercomputers to characterize the properties of all known materials and thus takes some of the guesswork out of materials design. Intermolecular, based in San Jose, California, will provide data from its proprietary high-throughput combinatorial experimentation and characterization toolset to the Materials Project to enable it to develop better predictive materials models.

## National Laboratories are just one part of our national innovation ecosystem

As intimated previously, the DOE Office of Science and its national laboratories are just one part, although a fundamental part, of the nation's innovation ecosystem. American innovation is underpinned by people, ideas and tools – it is this organic system that is envied by and unmatched in the world. The core components of this innovation ecosystem are universities, national laboratories and industry. Like the national laboratory complex, this ecosystem grew out of a World War II and post-World War II commitment made by the federal government to support scientific research.

In today's highly competitive global environment, the U.S. innovation ecosystem is one of our nation's most precious assets. The federal government has a fundamental responsibility to keep this ecosystem healthy, because it gives the nation a powerful competitive edge, providing solutions to major national challenges and fueling economic growth. At the same time, universities and laboratories have a fundamental responsibility to be sensible stewards of taxpayer funds, conduct first-rate research on key scientific and technological problems with intellectual rigor and efficient use of resources, and strive to transfer the results of this research to markets for the benefit of society as a whole.

The particular roles of the national laboratories in the nation's innovation ecosystem have been examined previously; to recap, they are:

- Build and maintain unique, large-scale and world-leading research tools that are utilized broadly by university and industrial researchers
- Assemble and nurture multi-disciplinary teams of scientific experts to meet federal needs and address national priorities by attacking R&D challenges of scale
- Serve as an irreplaceable on-the-job training ground for undergraduate, graduate and post-doctoral students, faculty, and early career scientists

Important as these roles are to the foundation that underpins the U.S.'s innovation ecosystem, they are only as vital and as strong as the other parts of the foundation.

Universities educate and train the scientists, engineers and teachers that make up the ranks of researchers and technology developers across the national laboratory complex and within industry. Professors and their students drive the generation of new ideas by performing cutting-edge research in an academic environment that rewards creative thinking and discovery science. Universities also play a critical role in weaving key issues of policy and society into research and development.

Industry delivers technological advances to the marketplace and to society by making strategic, early investments in new technology. With an employee base of scientific and engineering talent produced by universities and trained at national laboratories, industry drives commerce and innovation that helps businesses remain globally competitive. This talent gives companies the in-house research capabilities to harness the scientific advances and technology developed at universities and at national laboratories – including the utilization of the unique research tools of the national laboratories – to move technologies to the marketplace.

The federal commitment to each of these areas – through the DOE Office of Science for national laboratories, the NSF, NIH, NIST, NASA and others for universities and industry, and research incentives, public-private partnerships, and technology transfer for industry – is equally necessary to making the ecosystem healthy and vital. So, the next time you think about, or speak about, the federal support for science, I hope that you will consider the entire universe of what it takes to make the U.S. research enterprise successful.

**Comments on the proposed EINSTEIN America Act**

Finally, I will turn this testimony's attention to the draft EINSTEIN America Act, legislation that would reauthorize the DOE Office of Science. First, let me applaud the Members and staff of the Subcommittee, and of the full Committee, for your foresight and wisdom in taking up this legislation and thereby signaling your support for the Office of Science and the great work that it does. Although the Office of Science operates some of the most famous and most distinguished laboratories in the world and has demonstrated its ability to deliver great science and technological advancement for the nation time and time again, it often does not get the recognition it deserves. It needs and deserves the full attention of the Congress. Thank you for this recognition.

As I mentioned at the beginning of this testimony, my comments about the legislation are derived from a combination of discussions with colleagues at Berkeley Lab and elsewhere, and my own bias. That said, my views today are my own and do not represent the views of Berkeley Lab or of the DOE. I still hope that you find them useful. For ease of following, the comments below are divided into the sections and subsections of the draft provisions on which I am commenting – I will not address every section of the bill.

Section 102. Basic Energy Sciences (BES)

My testimony earlier described the irreplaceable symbiotic relationship between the Office of Science's national scientific user facilities and its research program. As with the Office of Science, much of the magic of BES's success stems from the careful balance of resources between its facilities and its research program. The BES provisions of the EINSTEIN America Act could perhaps more directly address and support this reality and thereby more clearly reflect the balance between these areas. Research programs within BES that this Committee has endorsed in the past, with strong bipartisan support, such as the Energy Frontier Research Centers and the Energy Innovation Hubs, have shown great results and offer continuing progress. These programs have harnessed, at labs and at universities, multidisciplinary approaches to addressing tough fundamental science questions. I believe that the bill would benefit and be a stronger document with more attention paid to the research portfolio of BES.

Section 103. Advanced Scientific Computing Research (ASCR)

Advanced scientific computing is the third leg in the three-legged stool of modern research. I made this point earlier in the testimony. Computing applications in modeling and simulation are becoming breathtaking in their capabilities and utilization. Likewise, the amount of and complexity of data for computation research are skyrocketing. At NERSC, which is utilized by around 5,000 users from across the nation, we've seen an explosion in the size and complexity of data sets and the creative applications of the researchers. The Materials Project that I mentioned earlier is a great example of the power of data to advance science. Not only are high performance computers needed to store and analyze data, they make possible new methods of conducting team science in exciting ways. As a nation we must meet head-on the opportunities for scientific advancement that computing makes possible. We cannot afford to lag behind other countries in the development of our computational resources. Computing speeds up the pace of research and of applying research to the real world. It speeds up commercial development of technologies and provides a critical competitive advantage. The U.S. no longer has the research and technology lead we once enjoyed. We must invest in new computational technologies and we must do so now – hopefully staying ahead of the curve instead of falling behind it. I applaud the Committee for its attention to the matter and to Congressman Hultgren and the cosponsors of his legislation, including our Congresswoman, Barbara Lee, Congresswoman Lofgren and Ranking Member Swalwell. Thank you for your support of this important initiative.

Section 104. High Energy Physics (HEP)

For starters, I recognize that high energy physics is hard to understand – I am not a physicist and will gladly admit that the often esoteric nature of physics research is beyond an easy grasp. That said, discovery science, such as the research funded by DOE's Office of Science High Energy Physics program is the proverbial seed corn for the transformative scientific and technological advancements of the future. Research that leads to incremental changes, changes at the margin, are more easily discussed, digested and understood. Research on the outer edges of our knowledge and understanding of the universe and its constituent parts – energy, mass, space and time – is by its very nature much harder to understand. Yet, without it and without funding it properly, we are at great danger for sacrificing the future of our children, grandchildren and their progeny. I am not just talking about U.S. global competitiveness, although it would suffer immensely, but also about our ability as humans to adapt, improve, succeed and create a better world. Fundamental, discovery science makes possible the seemingly impossible. As for the HEP provisions in the draft legislation, I suggest adding language comparable to the underground research subsections regarding other fields of physics in which the U.S. enjoys international leadership, such as in the cosmic frontier that looks to the universe to unravel the mysteries of our world.

Section 105. Biological and Environmental Research (BER)

Getting the word out about the important role the Office of Science plays in biological research through BER is a big challenge. This is unfortunate because BER funds critical biological research which is not significantly funded by any other federal agency – biological research into energy solutions, environmental remediation and the effects on humans of energy production. There is a broad misunderstanding that all biology-related research is funded through NIH. This is a dangerous misconception that inadvertently ignores whole areas of science that offer great promise to address many of our toughest challenges. Other countries, our global competitors, are focusing a great deal of resources and attention to this area – however, we currently lead the field and should continue to do so. I have no specific comments regarding the legislative draft in this area, but do have a few general observations. First, our capabilities and knowledge in the biological sciences have grown exponentially over the past couple of decades. We are poised to make great advances that will have direct and positive implications for DOE's core mission needs.

Second, researchers now have the capability and expertise to look at whole biological systems – whether they are local, regional or worldwide – from the microscopic to the large. And last, biology is poised to become an extremely data-intensive science. DOE and the Office of Science are well poised to productively harness this phenomenon by bringing together its biological research and supercomputing assets and expertise. As a nation, we should focus on developing the capability to analyze, learn and lead on the science of the microbe to the biome – that is from the microscopic to the large systems level.

Section 109. External Relations

The health and safety of our employees, guests and neighbors is our primary task and we place it above all other issues. That said, systems and processes to ensure and safeguard the health and safety of our lab and local community have become burdensome and have focused too much on reporting and not enough on results. The external regulation of the DOE Office of Science national laboratories is an issue that has been discussed for many years. At places like Berkeley Lab, students and researchers may work part of the day at UC Berkeley and the remainder of the day at Berkeley Lab, yet work under different EH&S regulations at each institution. The same researchers are doing the same type of scientific work, with federal funding – possibly from DOE in both cases – but they are regulated differently on how they perform that work depending upon where they are standing. It is a confusing and needlessly onerous situation. Charles Shank, a former Director of Berkeley Lab, testified before the Congress on this issue in 2002 and reported on the successful results of external regulation pilot studies at Berkeley Lab with the Nuclear Regulatory Commission and with the Occupational Health and Safety Administration. Both pilots led these agencies to conclude that they could safely and effectively manage the oversight of the Lab in their respective areas of responsibility. I would suspect that they would come to the same conclusion today. However, as Director Shank warned the Committee in 2002, and I quote, "would external regulation be layered on top of current DOE orders? We fear a world of overlapping and redundant responsibilities that would make it difficult for us to do our work…. Let me be perfectly clear on this point: a layered, redundant oversight, subjecting the laboratories to regulatory oversight by … the DOE and NRC and OSHA, would result in a more expensive and confusing ES&H climate." Director Shank's testimony is attached for your review and consideration.

Science Laboratories Infrastructure (SLI)

Science Laboratories Infrastructure is not mentioned in the bill. This is unfortunate, as SLI plays an irreplaceable role in upgrading the facilities and infrastructure of the national laboratories. Without it, labs would not be able to renew their facilities and ensure that employees have access to safe and modern research infrastructure. At Berkeley Lab, for instance, SLI has funded and plans to continue funding improvements that correct or replace seismically unsafe building stock. I encourage the Members of the Committee and staff to consider adding a section to the legislation that recognizes and authorizes this important function and funding vehicle.

**Conclusion**

Again, thank you for inviting me to participate in this important hearing. I look forward to your questions. Please never hesitate to let me know how I may be of assistance.