Virtual Member Day Hearing for Energy and Water Appropriations Subcommittee

Written Testimony of Congressman Bill Foster (IL-11)

Monday, May 3, 2021

Thank you for the opportunity to submit written testimony to the House Energy and Water Appropriations Subcommittee. My written testimony will touch on seven topics under the jurisdiction of the Subcommittee that I hope the Committee will consider as it begins work on the Appropriations process: strong and sustained funding for the DOE Office of Science; efforts to prevent the spread of Asian carp into the Great Lakes region (the Brandon Road Lock & Dam Project); the ongoing Advanced Photon Source Upgrade; the Long-Baseline Neutrino Facility/Deep Underground Neutrino Experiment (LBNF/DUNE); The Chicago Quantum Exchange; the Aurora Project at the Argonne Leadership Computing Facility; and low-enriched uranium naval fuel research and development .

1. The Office of Science at the Department of Energy

Over the last year, the DOE Office of Science has demonstrated tremendous value for the country in helping to confront major challenges. The DOE Office of Science played a critical role in our nation's response to COVID-19 by pulling together multi-disciplinary teams from DOE national laboratories, industry, and academia to, among other things, expedite discovery of antivirals, provide support to Federal, state and local decision-makers to more accurately forecast disease transmission, and address supply chain bottlenecks for PPE, test kits, and ventilators. The DOE Office of Science has continued to make important discoveries in fundamental science and early-stage energy technologies necessary to achieve ambitious net-zero goals to decarbonize the electricity sector and the economy. The DOE Office of Science has also made significant investments in Industries of the Future and emerging technologies, like new national quantum centers, to create future jobs and train a highly skilled science and technology workforce that is essential for the United States to compete globally. That is why I believe funding for the DOE Office of Science must be a priority in fiscal year 2022.

As the nation's primary sponsor of research in the physical sciences, the DOE Office of Science has built—and maintains—a unique collection of 27 large-scale, cutting-edge, one-of-a-kind user facilities relied upon by more than 36,000 researchers annually. Nearly half of these users are university faculty and students from all 50 states. Others come from U.S. industry and many are conducting research for other key federal science agencies, such as the National Institutes of Health (NIH), the National Science Foundation (NSF), and the Department of Defense (DOD). Without these critical facilities, thousands of users would be forced to move their job-creating research activities overseas or terminate their research altogether.

The DOE Office of Science also supports a first-rate workforce of more than 22,000 research scientists, engineers, and support personnel who work as teams on long-term solutions to some of the nation's greatest challenges and who are ready to tackle pressing problems at a moment's notice. Moreover, it plays a unique and critical role in the education of the next generation of

American scientific talent, including thousands of graduate students and postdoctoral researchers at hundreds of U.S. institutions who depend upon DOE Office of Science support and facilities for their research and training.

This collection of research, facilities, and scientific talent has enabled the DOE Office of Science to contribute greatly to our quality of life, our health, and our security. The DOE Office of Science has been integral to the development of several innovative technologies, including MRI machines and PET scans, new composite materials for military hardware and motor vehicles, medical and industrial isotopes, drop-in biofuel technologies, DNA sequencing technologies, more aerodynamic and fuel efficient long-haul trucks, electric vehicle battery technology, an artificial retina, newer and safer nuclear reactor designs, 3-D models of pathogens for vaccine development, tools to manufacture nanomaterials, and better sensors and detectors for biological, chemical, and radioactive materials. The DOE Office of Science's long-standing leadership in high performance computing has enabled countless scientific discoveries.

Looking ahead, Office of Science-supported fundamental research will form the foundation for future energy technologies. The current imperative—energy systems that meet our energy security, economic, and environmental challenges—requires continued, robust investments in all areas of fundamental research to advance all energy systems, including energy storage, negative emission technologies, advanced nuclear, hydrogen, fusion, renewables such as wind and solar, carbon capture, storage and utilization, and next-generation fuels. The Office of Science is also one of the lead federal agencies in advancing critical industries of the future, including quantum information science, artificial intelligence, next-generation high performance computing, microelectronics, advanced communications networks, and biotechnology. These critical investments are major pillars of local and regional economies and can serve as the foundation for ensuring a just transition to clean energy. It is clear that continued innovation and the jobs of the future depend on the Office of Science's ability to maintain U.S. leadership in these critical science and technology areas. As other countries continue to make significant investments in science and technology and specifically in the physical sciences, it is more important than ever to sustain funding for the Office of Science.

By prioritizing funding for DOE scientific research—thereby supporting both the human and physical capital—Congress will preserve our capacity to innovate, reduce our dependence on foreign sources of energy, enhance our competitive edge in the global economy, improve our quality of life, ensure our national security, and create good American jobs well into the future. For these reasons, I urge you to make strong and sustained funding for the DOE Office of Science one of your highest priorities in fiscal year 2022.

2. **<u>The Brandon Road Lock & Dam Project *(Asian Carp Barrier)*</u>**

As you consider the Fiscal Year 2022 Appropriations bill, I recommend you include language urging the United States Army Corps of Engineers (USACE) to further invest in the necessary efforts to prevent the entrance of Asian Carp and other invasive species into the Great Lakes Basin.

The enormous destructive potential if Asian Carp enter the Great Lakes and all its tributaries has resulted in strong bipartisan support of critical steps being taken to advance these efforts. This includes authorizing and providing the first year of funding for the Preconstruction, Engineering, and Design phase of the Great Lakes and Mississippi River Interbasin Study, Brandon Road Lock and Dam project. However, we also recognize that the preventative measures we currently have in place are temporary obstacles, and it is therefore critical there is no delay in the efforts to complete the Brandon Road Lock and Dam project.

Asian carp, considered nuisance species by the Aquatic Nuisance Species Task Force, have voracious appetites, can grow to weigh 100 pounds and four feet long, and quickly expand their habitats. They have decimated native fish populations throughout the Mississippi River basin. The importance of protecting our vulnerable Great Lakes freshwater system from this disastrous invasive species cannot be overstated. The timely completion of the work at Brandon Road Lock and Dam in Joliet, Illinois, is an essential step in the process to safeguard the Great Lakes ecosystem and economy, which provides drinking water to over 30 million Americans and supports a $7 billion fishing and $16 billion boating industry.

With Asian carp on the doorstep of devastating the Great Lakes region, in combination with Representative Bill Huizenga and 21 other Members of Congress, I have submitted specific report language to ensure that this project remains a priority:

Asian Carp

This agreement acknowledges that the Great Lakes and Mississippi River Interbasin Project, Brandon Road Lock and Dam, was authorized by Congress as part of the Water Resource Development Act of 2020 (Public Law 116-260). As the Corps prioritizes projects, it shall consider critical projects to prevent the spread of invasive species. The committee further acknowledges that the first year of Preconstruction, Engineering and Design for Brandon Road Lock and Dam was included in the Corps FY21 work plan. The Corps is reminded that this critical project is eligible to compete for additional funding within the Investigations account in order to move forward with the Planning, Engineering, and Design (PED). The Corps is directed to provide to the Committees on Appropriations of both Houses of Congress quarterly updates on the progress and status of efforts to prevent the further spread of Asian carp, including the Brandon Road Recommended Plan, the location and density of carp populations, the use of emergency procedures previously authorized by Congress, and the development, consideration, and implementation of new technological and structural countermeasures.

The Corps shall continue to collaborate at levels commensurate with previous years with the U.S. Coast Guard, the U.S. Fish and Wildlife Service, the State of Illinois, and members of the Asian Carp Regional Coordinating Committee, including identifying navigation protocols that would be beneficial or effective in reducing the risk of vessels inadvertently carrying aquatic invasive species, including Asian carp, through the Brandon Road Lock and Dam in Joliet, Illinois. Any findings of such an evaluation shall be included in the quarterly briefings to the Committees on Appropriations of both Houses of Congress. The Corps is further directed to implement navigation protocols shown to be effective at reducing the risk of entrainment without

jeopardizing the safety of vessels and crews. The Corps and other federal and state agencies are conducting ongoing research on potential solutions. The Corps shall brief the Committees on Appropriations of both Houses of Congress on such navigation protocols and potential solutions not later than 30 days after enactment of this Act.

This project is crucial to preventing a full scale, irreversible inundation of this highly destructive invasive species in the Great Lakes region.

3. **The Advanced Photon Source Upgrade**

The Advanced Photon Source (APS) has played a foundational role in the nation's response to the COVID-19 pandemic. Researchers from across the nation have used X-rays from the APS to determine the protein structure of viruses, which are then used to design techniques, drugs and vaccines that fight the virus more effectively. More than 150 protein structures for the virus that causes COVID-19 have been determined at the APS. The APS upgrade project will enhance these capabilities to ensure the U.S. remains at the forefront of X-Ray technology and is able to respond to future national emergencies.

The APS upgrade will use next-generation technology to make the APS hundreds of times brighter, opening up scientific frontiers at the nanoscale that are completely inaccessible today. It will provide industrial and university researchers with the advanced tools they need to continue to drive innovation in areas ranging from identifying causes of diseases and brain imaging, to advanced materials and next-generation electronics.

Thank you for your past support of the APS upgrade. The upgrade leverages the existing infrastructure, valued at $1.5 billion, while applying a new technology to create a world-leading facility at a substantially lower cost than a new facility. The project is more than 50 percent complete and continues to minimize delays across our supply chain due to the effects of the COVID-19 pandemic. The experienced leadership team remains in place and has a proven track record in major science construction projects.

With this upgrade, the APS will become the ultimate 3D microscope; without it, the United States will lose its global leadership in x-ray science to Europe, Japan, and China. This loss would not only affect our scientific leadership, but also our economy – many of the companies and researchers that use high-energy research facilities choose to locate nearby. This is why I, along with Representative Marie Newman, also from Illinois, and 10 other Members of Congress have submitted an Appropriations letter requesting that you to fund the project within the Basic Energy Sciences account at $101.2 million in the FY22 Energy and Water Appropriations bill.

4. **The Long-Baseline Neutrino Facility/Deep Underground Neutrino Experiment**

I would also like to take this opportunity to express my strong support for the Department of Energy's (DOE) Long-Baseline Neutrino Facility/Deep Underground Neutrino Experiment (LBNF/DUNE). This project is critical to maintaining U.S. leadership in High Energy Physics (HEP) and fundamental science. Specifically, Representatives Lauren Underwood and Dusty Johnson have led a letter, which I and several other Members joined, which requests $225 million to continue construction of LBNF/DUNE and $100 million for the associated Proton

Improvement Project-II (PIP-II) which will produce the world's most powerful beam of neutrinos. This level of funding will enable the United States to complete these projects on time and on budget and to fulfill our commitments to our international partners.

LBNF/DUNE is critical to understanding the most abundant and least understood matter particles in the universe: neutrinos. As the first major international world-class scientific facility to be hosted by the U.S., LBNF/DUNE would guarantee U.S. leadership in neutrino physics for decades, retain and attract the best scientific minds to the U.S., train the next generation of scientists and engineers, and push the boundaries of technology development. To study the properties of neutrinos, the Fermi National Accelerator Laboratory (Fermilab) in Illinois would produce an intense beam of neutrinos, which would travel 800 miles across the United States to a deep underground lab at the Sanford Underground Research Facility in South Dakota. Four massive detectors a mile underground will be used to study the properties of neutrinos.

LBNF/DUNE is the world's leading neutrino experiment with more than 1,200 scientists from more than 200 institutions and over 30 countries that have signed up to participate. Our international partners continue to make major investments in this project, such as the U.K, France, Brazil, and Poland, as well as CERN—which is investing in a country outside of Europe for the first time in its 60-year history. Fully one quarter of funding for LBNF/DUNE and PIP-II will come from international collaborators.

Despite the COVID-19 pandemic, over the last year, the project has continued to achieve major milestones:

- In October 2020, the contract for full underground cavern excavation in South Dakota was awarded, and work will begin in April 2021. This will start the process of removing 875,000 tons of rock to create the four large caverns that will house the massive DUNE detectors containing 70,000 tons of liquid argon.
- Cavern excavation can begin because the pre-excavation work in South Dakota—a $160 million effort—was completed on time and on budget. This involved restoring and refurbishing rock-crushing equipment, installing a 3,900-foot-long rock conveyor, and outfitting one of the mine shafts to carry loads of crushed rock.
- The project made significant progress in advancing international collaborations and partnerships. In January 2021, CERN and France both expressed strong interest in supplying a second cryostat and components for a second far detector, respectively, for LBNF/DUNE, and formal negotiations for a new agreement will begin in Summer 2021. Similarly, an agreement is currently being negotiated with Italy to provide major contributions for the second far detector and near detector at Fermilab, and the goal is to finalize that agreement by Summer 2021. To date, 27 legally binding agreements have been signed with international partners.
- In December 2020, DOE formally approved the scope, schedule, and cost of PIP-II (Critical Decision 2)—a major project management milestone.
- In July 2020, Fermilab began construction of the cryoplant building for PIP-II, which will house a $30 million cryogenic plant supplied by India.

Building on this momentum, FY 2022 will be a critical year for these major projects. For LBNF/DUNE, the requested funding level will support continued excavation of the underground caverns and tunnels as well as design and procurement activities for the major nitrogen cryogenics systems in South Dakota. In Illinois, design and preparation work for the neutrino beamline facility will continue. For PIP-II, the requested funding level would enable completion of the cryoplant building construction and testing of two superconducting accelerator cryomodules, as well as assembly of a third prototype cryomodule in partnership with the United Kingdom.

Despite this tremendous progress, Japan is moving forward with plans to invest more than $600 million to build one of the world's largest neutrino experiments, known as Hyper-K, to compete with LBNF/DUNE. The goal of the project is to use competing detector technology to make ground-breaking discoveries about the properties of neutrinos before LBNF/DUNE. To meet the challenge of this international competition, LBNF/DUNE and PIP-II require sufficient resources to meet project schedule milestones and signal to our international collaborators that the U.S. is a reliable partner and fully committed to the project. Although I recognize that meeting these ambitious goals may be particularly challenging at a time when the pandemic has imposed unprecedented demands on federal resources, I believe bold investments in America's scientific leadership are worthwhile.

5. **The Chicago Quantum Exchange**

The Chicago Quantum Exchange (CQE) is an intellectual hub and community of researchers with the common goal of advancing academic and industrial efforts in the science and engineering of quantum information across CQE members, partners, and our region. The hub aims to promote the exploration of quantum information technologies and the development of new applications. The CQE facilitates interactions between research groups of its member and partner institutions and provides an avenue for developing and fostering collaborations, joint projects, and information exchange.

Members of CQE are focused on developing new ways of understanding and exploiting the laws of quantum mechanics, the fundamental yet counterintuitive theory that governs nature at its smallest scales. The overarching aim is to apply research innovations to develop radically new types of devices, materials, and computing techniques.

The mission of the CQE is to accelerate discovery and innovation in the rapidly developing areas of quantum technology, and to attract talent, funding, and industry to the Chicago area to become the source for tomorrow's leading quantum engineers.

Based at the University of Chicago's Pritzker School of Molecular Engineering, CQE catalyzes research activity across disciplines and member institutions. It is anchored by the University of Chicago, Argonne National Laboratory, Fermi National Accelerator Laboratory, and the University of Illinois at Urbana-Champaign and includes the University of Wisconsin-Madison, Northwestern University, and industry partners.

The CQE brings together the institutions' intellectual talents, research capabilities and engineering capacities in a powerful collaborative effort to advance quantum science. Together, the universities and national laboratories have more than 100 researchers in various areas of quantum information technology—a set up that makes Chicago a unique destination for researchers and engineers to explore quantum information science in numerous ways.

Quantum information science - or QIS - is a revolutionary technology that will allow us to achieve groundbreaking advances in a variety of fields. I am proud to say that some of the country's foremost experts on quantum technology are in Illinois, as shown through the CQE.

The nation that leads in QIS will have a competitive advantage in areas such as artificial intelligence, cybersecurity, financial services, and medicine, which is why the National Quantum Initiative Act was such a critical achievement. I am proud that the National Quantum Initiative Act was passed into law, but our work is not done. We must continue to work diligently to make sure the initiative is implemented effectively.

As a scientist who worked at a DOE National Lab for more than 20 years, I have seen firsthand the incredible impact a commitment to research and development has on scientific discovery. By leveraging the expertise and resources of industry, academia, and government, this bipartisan effort and commitment to QIS research will help address fundamental gaps in our understanding of the power and limits of efficient algorithms. Work that organizations like Argonne and Fermi National Laboratories are doing with groups like CQE, will ensure that the United States remains a global leader in science and technology. I believe that work like this must remain a priority.

6. **<u>The Aurora Project at the Argonne Leadership Computing Facility</u>**

The Argonne Leadership Computing Facility (ALCF), a U.S. Department of Energy (DOE) Office of Science User Facility located at Argonne National Laboratory, enables breakthroughs in science and engineering by providing supercomputing resources and expertise to the research community. Supported by the DOE's Advanced Scientific Computing Research (ASCR) program, the ALCF and its partner organization, the Oak Ridge Leadership Computing Facility, operate leadership-class supercomputers that are orders of magnitude more powerful than the systems typically used for open science.

The ALCF and Argonne National Laboratory will be home to one of the nation's first exascale supercomputers when Aurora arrives in 2022. While people have been using supercomputers to solve big problems for years, the capabilities of the machines that will soon begin rolling out in national labs around the country will be brand new. Researchers will be able to run a greater diversity of workloads, including machine learning and data intensive tasks, in addition to traditional simulations. Providing the data science software "stack"—the high-level programming languages, frameworks, and I/O middleware that are conventional toolkits—at exascale, is a major effort in deploying Aurora.

The Aurora systems' exaFLOP of performance – equal to a "quintillion" floating point computations per second – combined with an ability to handle both traditional high performance computing (HPC) and artificial intelligence (AI) – will give researchers an unprecedented set of

tools to address scientific problems at exascale. These breakthrough research projects range from developing extreme-scale cosmological simulations, discovering new approaches for drug response prediction, and discovering materials for the creation of more efficient organic solar cells. The Aurora system will foster new scientific innovation and usher in new technological capabilities, furthering the United States' scientific leadership position globally.

Exascale computers like Aurora will more realistically simulate the processes involved in scientific discovery and national security such as precision medicine, regional climate, additive manufacturing, the conversion of plants to biofuels, the relationship between energy and water use, the unseen physics in materials discovery and design, and fundamental forces of the universe, and myriad others. Exascale computing researchers have recently shown work that uses exascale computing to model additive manufacturing processes such as 3D printing with metals, which could have major implications for the manufacturing sectors, as well as our economy. Our national laboratories, like Argonne National Lab, are national leaders in this field, and the work that they are doing is crucial for the United States to remain a global science leader. I urge you to continue to follow these programs and consider our national labs as you work through the appropriations process.

7. <u>Low-Enriched Uranium Naval Fuel Research and Development</u>

Finally, I respectfully request your continued support for low-enriched uranium (LEU) naval fuel research and development for pressurized water reactors for propulsion of aircraft carriers and submarines as you prepare the Energy and Water Appropriations bill.

As America confronts the threat of nuclear terrorism and rogue nuclear states, and as allies and enemies alike continue to enrich uranium for naval purposes, the imperative to reduce the use of Weapons-Grade, High-Enriched Uranium (HEU) for non-weapons purposes becomes increasingly urgent. HEU fuel is vulnerable to theft during manufacturing and transportation from civilian sites. The International Atomic Energy Agency (IAEA) also exempts inspections of HEU facilities when countries are developing HEU for naval propulsion, offering cover for rising adversaries to develop nuclear weapons.

Recognizing this threat, the U.S. has spent decades converting most research HEU reactors around the world into proliferation-resistant LEU reactors. The next step is to convert the reactors for naval propulsion. The U.S. Navy agrees. Admiral Richardson stated before the House Armed Services Committee's Subcommittee on Strategic Forces on March 24, 2015 "The potential exists that we could develop an advanced fuel system that might increase uranium loading and make low-enriched uranium possible while still meeting, you know, some very rigorous performance requirements for naval reactors on nuclear-powered warships."

The Navy must continue assessing the feasibility of using LEU in naval reactor fuel for pressurized water reactors that would meet military requirements for aircraft carriers and submarines. Using LEU in naval reactor fuel brings significant national security benefits related to nuclear nonproliferation. It has the potential to reduce security costs and supports naval reactor research and development at the cutting edge of nuclear science, attracting and retaining key personnel. Pursuing the development of LEU fuel offers the opportunity and rationale to achieve

transformational progress on fuel technology; the same imperatives do not apply to research and development for highly-enriched uranium (HEU) fuel improvements.

This work should not become a fiscal burden for the U.S. Navy; instead, it should be considered a core tenet of the Defense Nuclear Nonproliferation (DNN) mission and the resources for this effort should come from the DNN account.

The Navy must begin this LEU research now so that it can complete the research and incorporate the requirements for an LEU reactor into design plans for the next class of attack submarines. These design phases occur only every few decades, given the many years required to build a submarine and their decades of service-life. The design phase for the successor to the Virginia-class submarines will begin soon. The window for incorporating safer fuel will close shortly thereafter and will not reopen until the late 21st Century.

As such, I urge you to provide an additional $20 million for the Deputy Administrator for Defense Nuclear Nonproliferation of the National Nuclear Security Administration for the exclusive purpose of carrying out research on LEU fuel for pressurized water reactors for aircraft carriers and submarines.

Thank you for the opportunity to submit this written testimony; I look forward to working with the Subcommittee as the appropriations process for Fiscal Year 2022 continues.