NUCLEAR SCIENCE ADVISORY COMMITTEE
to the
U.S. DEPARTMENT OF ENERGY and NATIONAL SCIENCE FOUNDATION

PUBLIC MEETING MINUTES

Virtual Meeting
April 28, 2022

NUCLEAR SCIENCE ADVISORY COMMITTEE
SUMMARY OF MEETING

The U.S. Department of Energy (DOE) and National Science Foundation (NSF) Nuclear Science Advisory Committee (NSAC) virtual meeting was convened at 10:00 a.m. Eastern Time on Thursday, April 28, 2022, via Zoom®, by **Committee Chair Gail Dodge**. The meeting was open to the public and conducted in accordance with Federal Advisory Committee Act (FACA) requirements. Visit http://science.energy.gov for more information about NSAC.

NSAC Members Present

Sonia Bacca
Paulo Bedaque
Lee Bernstein
Joseph Carlson
Gail Dodge (Chair)
Romualdo deSouza
Evangeline Downie
Renee Fatemi
Victoria Greene
Tanja Horn
Oliver Kester
Joshua Klein
Cecilia Lunardini
Thomas Schaefer
Rebecca Surman
Nathalie Wall
Fred Wietfeldt
Boleslaw Wyslouch
Sherry Yennello

NSAC Members Absent

Bonnie Fleming

NSAC Designated Federal Officer

Timothy Hallman, DOE, Office of Science (SC), Office of Nuclear Physics (NP), Associate Director

Presenters

Geraldine Richmond, DOE Undersecretary for Science and Innovation
Sean Jones, NSF, Mathematical and Physical Sciences Directorate (MPS), Assistant Director
Timothy Hallman, DOE NP, Associate Director
Allena Opper, NSF, Nuclear Physics, Program Director

Approximately 145 others were present for all or part of the meeting.

Thursday, April 28, 2022

Welcome and Introduction, Gail Dodge, NSAC Chair, welcomed attendees and asked committee members, NSF representatives, and DOE representatives to introduce themselves.

Perspectives from the Department of Energy, Geraldine Richmond, Under Secretary for Science and Innovation

NP's investigation of how nuclear matter takes on natural forms across time and space support our nation's clean energy, climate, commerce, medical, and security goals. To enable research across such a vast scientific enterprise, SC supports four world-leading nuclear physics accelerator microscopes. The newest of these, the $730M Facility for Rare Isotope Beams (FRIB), finished construction on budget and ahead of schedule. This huge accomplishment is the result of a cooperative agreement between DOE and MSU, showcasing what can be accomplished when Federal and State partners work together on important goals.

Collaborations are all the more vital for meeting the threats and challenges of climate change. Looking to the future, NP will continue to host world-class facilities and join global partnerships foundational to the worldwide nuclear physics enterprise. The community has identified construction of the Electron-Ion Collider (EIC) as the next highest construction priority following FRIB. With a global user group >1.3K scientists and engineers from 36 countries, the EIC promises a watershed of scientific discoveries and technical advances. DOE is committed to working with the Administration and Congress to see this project succeed. International cooperation also underpins large-scale experiments like Neutrinoless Double Beta Decay ($0\nu\beta\beta$) where discoveries will open new scientific horizons.

NP is actively participating in SC cross-cutting initiatives to advance quantum information science (QIS), artificial intelligence (AI), microelectronics, and accelerator science and technology (AST). At the same time, NP is working with Minority Serving Institutions (MSIs) to develop emerging technologies. The science workforce needs to reflect America, and DOE along with 90 other federal agencies released its first equity plan this month. Among other actions, DOE will invest up to $102M in MSIs, including Historically Black Colleges and Universities (HCBUs). The President's Budget for fiscal year 2022 (FY22) supports new programs to build research capacity, and NP is proactively working to diversify the community through traineeships. The next important community step is to move beyond recruitment to retention. Diversity, equity, and inclusion (DEI) are central to success. All are urged to take concrete steps to make sure workplaces are welcoming and inclusive to all, including at DOE facilities.

NP's next round of strategic planning is scheduled for this summer, and the resulting NP Long Range Plan (LRP), outlining the community's global vision for the following decade, is anticipated the following year. Richmond looks forward to seeing the plan and encourages integration of DEI throughout the body of the report. It is an exciting time to be working in this field, and all of NP's efforts and contributions are appreciated.

Discussion

Dodge asked about balancing basic and applied research. **Richmond** seeks to balance both areas. Climate change issues are currently prioritized by the Administration, and it is

Richmond's job to ensure that contributions from the nuclear physics community, which may seem tangential but are actually central to addressing climate change, are recognized.

Kester called attention to technology transfer and societal demand. In **Richmond's** opinion, it is a new DOE; discoveries must be integrated into communities and the public informed of the value of new technologies. The Bipartisan Infrastructure Law supports technology, and the DOE's scope encompasses fundamental research, to applied research, to deployment. There will be increased efforts to commercialize findings and bring them to the public's awareness.

Horn invited further comments on workforce retention. Though many do not remain in the field *per se*, nuclear physics contributes to societal talent in artificial intelligence and machine learning (AI/ ML) and other areas. **Dodge** added retention of women in faculty roles in the pandemic's (COVID-19) aftermath requires particular attention. **Richmond** defines retention as keeping scientifically literate individuals in the system. Academic culture often emphasizes careers in academia when such talent is also needed in policy and other societal areas. Statistics show that underrepresented groups, especially women of color, have lower undergraduate and graduate retention rates in Science, Technology, Engineering, and Math (STEM) fields. The reasons for this are clear, and all need to work harder to support the educational aspirations of these individuals. Recent research underscores the impact mentors, postdocs, and other graduate peers can have on retention of underrepresented individuals by making them feel that they are part of the game. Retention after COVID-19 is also a concern, including for employees at national laboratories. Addressing this issue is difficult, and offering flexibilities is key, especially for women. The field of nuclear physics is to be commended for all it has already done to increase diversity, but greater efforts are needed. Agreeing with remarks about diversity, **Hallman** articulated nuclear physics has historically retained slightly less than half of the individuals trained. Those that leave the field pursue work in other areas that benefit the nation, like commerce, industry, and medicine. **Amber Coles** (via chat) observed some national laboratories are no longer nonprofits. This disqualifies employees from public service loan forgiveness which is intended to encourage talent to take public jobs.

Downie pointed to the benefits of NSF COVID relief supplements provided to researchers during the pandemic from funds in the American Rescue Plan. At universities, however, faculty are seeking additional funding to aid in recovery in the pandemic's aftermath. Most universities are still suffering from lower enrollments due to COVID-19. Could national agencies play a role in offering financial booster opportunities? **Richmond** resonated with this suggestion and will mention it at a future meeting with NSF. COVID-19 is an ongoing issue, and it is important that it continue to be addressed. Though tangential, the SC issued a Dear Colleague Letter (DCL) to support Ukrainian scientists through U.S. or European collaborations. Other agencies will hopefully follow this example.

Klein acknowledged the importance of translating work to benefit broader society, but also emphasized the biggest historical breakthroughs have not come from focusing on an immediate problem, but from having a distant horizon reaching towards broader unknowns. **Richmond** appreciated these remarks.

Pallan asked about ITER. **Richmond** explained DOE remains hopeful about and supportive of the project, but COVID-related delays may require some re-baselining. International collaborations like this one are incredibly important.

Perspectives from the National Science Foundation, Sean L. Jones, MPS Deputy Assistant Director

Jones reviewed leadership and staff changes in the MPS Directorate.

In FY21, MPS awarded >$1.5B to ~2.4K competitive awards, supporting >29.6K individuals, ranging from undergraduate students to senior professors and other professionals at many of MPS's facilities and centers.

The FY22 Enacted Budget allocates $8.8B to the NSF, a 4% increase over that of FY21. Internal NSF allotments are still being determined in conjunction with the Office of Management and Budget (OMB). Designations will align with the NSF's new Strategic Plan for 2022-2026; establish the new Directorate for Technology, Innovation, and Partnerships (TIP); support research facilities; and advance the Administration's priorities of clean energy, climate change, racial equity, and emerging industries

TIP will cut across existing NSF directorates and engage other stakeholders in research, education and innovation to strengthen and scale existing investments in use-inspired and translational research, including co-funding existing programs and launching new ones. This new directorate comprises three subdivisions: Technology Translation, Technology & Innovation Ecosystem, and Partnerships as a Foundation. TIP envisions new Regional Innovation Accelerators or Regional Innovation Engines (RIAs/ RIEs) to address major scientific and technological goals while serving as research hubs in NSF's portfolio to incentivize partnerships and balance geographic activities. These centers will operate at the scale of individual communities and/ or regions to bring about broad societal benefits. There is already great synergy between TIP's vision and the MPS portfolio.

The FY23 President's Budget Request (PBR) of ~$10.5B and ~$1.8B, respectively, for NSF and MPS are 24% and 9.6% higher than enacted FY21 levels. Following the new Strategic Plan, the PBR seeks $1.5B to accelerate research and development in climate change and clean energy; $393M to advance equity in STEM, ~$880M for TIP; ~$422M for advanced manufacturing; ~$169M for advanced wireless; ~$734M for AI; ~$392M for biotechnology; ~$146M for microelectronics and semiconductors; and ~$261M for QIS. The PBR continues construction and procurement activities for research infrastructure and instrumentation.

All facilities are operational under COVID-19 protocols. The Daniel K. Inouye Solar Telescope (DKIST), the world's most powerful solar telescope, commenced operations in February 2022. Impacted significantly by COVID-19, the Rubin Observatory is 92% complete; the project's re-baseline is being finalized and operations are projected for 2024. The High-Luminosity Large Hadron Collider (HL-LHC) upgrade is ~22% complete. Cleanup of the Arecibo Observatory is complete, and focus has shifted to future site uses. The Large Hadron Collider (LHC) is back online, and four years of data taking will commence this summer. The Laser Interferometer Gravitational-Wave Observatory (LIGO) is preparing for its fourth observation period projected for December 2022.

Mid-scale Research Infrastructure-1 and -2 (MsRI-1 and MsRI-2) awards support shovel-ready projects with total requests between $6M-$20M and $20M-$100M, respectively. Solicitations are published in alternate years with the next publication scheduled for FY23.

NSF QIS flagship activities include foundries, research centers and the Quantum Leap Challenge Institute (QCLIs). The second QLCI competition issued two awards in FY21, conferring a total of $25M each over five years to the QCLI for Quantum Sensing in Biophysics and Engineering and the QCLI for Robust Quantum Simulation. The Quantum Interconnect Challenges for Transformational Advances in Quantum Systems (TAQS) program issued ten

awards totaling ~$25M. The new Expand Capacity in Quantum Information Science and Engineering (ExpandQISE) aims to broaden participation in higher education institutions contributing to QISE that have received ≤$5M in the last five calendar years from all federal funding sources for broad QISE research. Two application tracks are available: 1) Individual primary investigators (PIs) paired with an external co-PI; or 2) Small-to-medium teams paired with one or more external co-PIs. Those applying through the second track may access funds to build QIS research at their institute. Proposals are due May 6, 2022.

To advance AI-focused research, the community is encouraged to apply for EArly-concept Grants for Exploratory Research (EAGERs), Research Advanced by Interdisciplinary Science and Engineering (RAISEs), and supplements to existing awards through MPS's DCL for Advancing Discovery with AI-powered Tools (ADAPT). ADAPT prioritizes collaboration among MPS domains; collaboration between MPS and AI researchers; broadening participation; and collaborations between industry and academia.

The MPS Ascending Postdoctoral Research Fellowship (MPS-ASCEND) program supports post-doctoral researchers in MPS fields, increasing participation of members of those groups most underrepresented as leaders. The new MPS-ASCEND External Mentoring (MPS-ASCEND EM) program builds cohort experiences for fellows along with professional development, mentoring, and networking opportunities. Partnerships for Research and Education in Physics (PREP), Partnerships for Research and Education in Chemistry (PREC), and Partnerships in Astronomy and Astrophysics Research and Education (PAARE) aim to increase the recruitment, retention, and degree attainment by underrepresented groups while supporting excellent research and strengthening partnership ties with MSIs. The DCL for High School Student Research Assistantships Funding to Broaden Participation in the Mathematical and Physical Sciences (MPS-High Supplement) will provide supplemental funding to support research and mentoring opportunities for underrepresented high school students in STEM fields.

Held on January 28, 2022, ~1300 individuals attended the NSF Materials Research Science and Engineering Centers (MRSEC) Science Slam, with ~30 international attendees.

Discussion

Horn commented publishing AI/ ML work in nuclear sciences is challenging. NSF may consider working with the community to develop tools or platforms for disseminating research. Regarding TIP, how will longer-term projects fit into this Directorate's agile vision? Fundamental research does not necessarily conform to predetermined time schedules. **Jones** will share recommendations to build out the AI/ ML ecosystem through publications with the AI Working Group. TIP will augment the innovation ecosystem; the rest of NSF's discovery engine will still focus on fundamental, basic, and potentially long-term research. When there are translation opportunities, TIP will accelerate the process. NSF hopes to inspire new programs within TIP, and programs shared today will evolve. MPS will work with TIP to determine how its expertise in instrumentation development and facilities can maximize economic impacts. The spirit of fundamental science and research will remain at NSF's heart.

Fatemi expressed enthusiasm for MPS-High Supplements. NSF encourages training undergraduates; as a PI, it can be challenging to decide whether to fund undergraduates or promising high school students. This program will also help institutions that do not have Research Experiences for Undergraduates (REUs). Reaching students earlier in their education is a way to fix the leaky STEM workforce pipeline. **Jones** observed the DCL was recently published and is already attracting interest. NSF has successfully created a pathway for high

school students from a low economic area in Puerto Rico to attain PhDs through intentional mentoring and partnerships with Carnegie Research 1 (R1) institutes. The program has supported many Hispanic female PhDs.

Bernstein, highlighting nuclear energy, inquired how the Administration defines clean energy. **Jones** stated nuclear energy is part of the President's portfolio, and a recent announcement underscored the importance of nuclear energy.

DOE Office of Nuclear Physics Overview, Timothy Hallman, Associate Director

Hallman reviewed NP staff changes. Staff have returned to the office with modified in-person schedules. Federal travel has recommenced, though will likely be reduced based on lessons learned during the pandemic.

DOE NP supports ~95% of the nation's investments in nuclear physics basic research, and DOE NP delivers knowledge, leadership class facilities, new technology, and a highly-trained, diverse workforce capable of supporting DOE and other agency missions. Indeed, eight percent of PhDs in nuclear physics work in finance, 15% in government, 27% in research labs, 24% in industry, and 26% at universities.

The 2015 LRP prioritizes 1) Operating and producing science from the Relativistic Heavy Ion Collider (RHIC), Continuous Electron Beam Accelerator Facility (CEBAF), Argonne Tandem Linac Accelerator System (ATLAS), and FRIB; 2) Making progress on a U.S.-led 0νββ experiment; 3) Initiating EIC construction; and 4) Implementing smaller-scale instrumentation to leverage facility capabilities. Starting in FY21, NP funding levels fell below the 2015 LRP's modest growth scenario, with lower levels of available funding due to increases to the Isotope Program (IP) within NP and/ or in NP appropriations. Funding challenges in realizing the 2015 LRP's full vision continue with the FY23 PBR. It is imperative the NP community remain united in realizing goals as division can set back the entire field. Activities to initiate the next LRP planning process this summer are underway.

The FY22 Enacted Budget of $728M represents a $93M increase over the corresponding $685M FY21 budget which excludes IP funding. This $93M increase is distributed across the NP portfolio including: CEBAF's Performance Plan ($6M); increasing the number of CEBAF operating weeks ($19M); the EIC ($20M); core research (~$13M); FRIB operations ($27M); nuclear data (~$3M); Reaching a New Energy Sciences Workforce (RENEW, $3M); and other initiatives (~$3M). In FY22, Medium Energy's funds totaling ~$196M confer ~$143M to CEBAF operations and ~$53M to research. The Heavy Ion budget of ~$256M designates ~$184M to RHIC operations, ~$47M to research, and $25M to projects. Low Energy's support of ~$199M portions ~$108 to FRIB and ATLAS operations, ~$74M to research, and ~$17M to projects. Theory receives ~$57M for research and facilities retains $20M for EIC construction. In FY22, NP continues participation in the QIS, AI/ ML, and Scientific Discovery through Advanced Computing (SciDAC) cross-cutting SC initiatives and is additionally participating in the Microelectronics, Strategic AST, and RENEW initiatives. NP is also cultivating a possible collaboration with the National Institutes of Health (NIH) to advance imaging useful to both NIH and DOE.

Enacted FY22 construction highlights include FRIB completion and the upgrade to the super Pioneering High Energy Nuclear Interaction eXperiment (sPHENIX) detector on cost and ahead of or on schedule. FRIB's ribbon cutting is scheduled for May 2, 2022; the science program has already received 82 proposals from 130 institutions in 30 countries requesting ~10K hours of beam time. The EIC has a highly engaged international community. The concept design

selection process for the EIC Project Detector will be completed in FY22. In research, studies recorded the first known observation of the Breit-Wheeler two-photon process at RHIC; developed the first model of independent sub-electron-volt limit set on the neutrino mass by the KArlsruhe TRItium Neutrino mass (KATRIN) project; integrated AI technology at CEBAF to make accelerator operations fault tolerant; and developed the "Rodeo Algorithm" for quantum computing. In technology transfer, ANL and ATLAS successfully cultivated U.S. industry capabilities to hydroform cavities for superconducting radio frequency cryomodules.

NP's FY23 PBR of ~$739M is ~$11M greater than FY22's Enacted Budget. However, increases to FRIB operations (~$16M+), Gamma Ray Energy Tracking Array (GRETA, ~$7M+), AI/ ML ($4M+), RENEW ($3M+), Funding for Accelerated, Inclusive Research (FAIR) ($2M+), and the new Accelerate Innovations in Emerging Technologies (ACCELERATE) initiative ($4M+) totaling ~$35M mean a portion of NP's base funding will be used to support targeted growth. Medium Energy's ~$194M budget will support CEBAF operations at ~$143M and research at ~$50M. Heavy Ion's budget of $245M allocates ~$191M to RHIC operations, ~$43M to research, and $10M to projects. Low Energy's ~$217M funds designate ~$126M to FRIB and ATLAS operations, ~$68M to research, and ~$24M to projects. Theory receives ~$63M for research, and line item construction funding is flat at $20M for the EIC project. NP will continue participation in all previous initiatives except Strategic AST and will additionally contribute to FAIR and ACCELERATE.

FY23 highlights include FRIB's first full year of science research; operation of NP User Facilities (RHIC, CEBAF, ATLAS, and FRIB) at ≥90% utilization; final preparations for the EIC's Critical Decision 2 (CD-2) review; initiation of sPHENIX and Large Enriched Germanium Experiment for Neutrino-less double beta Decay-200 (LEGEND-200) research; increased or new investments to SC initiatives; and funding support for GRETA in accordance with the project's technically driven schedule.

At present, the EIC resides at CD-1 with a total project cost (TPC) range of $1.7B-$2.8B and completion projected for FY33. In Major Items of Equipment (MIEs), GRETA attained CD-2/3 in October 2020 and has a TPC of ~$58M. Completion is projected for 2028. Measurement of Lepton-Lepton Electroweak Reactions (MOLLER) attained CD-1 in December 2020 and has a TPC of ~$46M-$57M. Completion is projected for FY27. The High Rigidity Spectrometer (HRS) attained CD-1 in September 2020, has a TPC of ~$85M-$111M, and a projected completion date in FY29. The Ton-Scale 0νββ project is at CD-0 with an estimated TPC of $215M-$250M.

NP provides existing or updated data to numerous agencies, and addressing data gaps is critical to electronics protection, human safety, and development of advanced reactors. Nuclear data shortfalls impact projects in many federal agencies. The U.S. Nuclear Data Program (USNDP), managed by DOE NP, is exploring a mechanism to rapidly provide nuclear data in response to requests for urgent, high-impact needs. DOE NP also leads the Nuclear Data Interagency Working Group (NDIAWG) which has published four FOAs.

NP is preparing for a Congressional Briefing on the status of the NP Traineeships program. To date, traineeship award recipients include 18 MSIs, 10 other colleges or universities, and five DOE laboratories. Additional institutions are engaged as recruitment sites, collaborators, members of Inspire the next Generation of a Highly Trained Workforce (INSIGHT), and/ or as hosts.

Discussion

Bedaque inquired about replacement for a vacant NP position in Nuclear Theory. **Hallman** relayed the relevant portfolio is currently stewarded by a consortium and may be managed by an interim Intergovernmental Personnel Act (IPA) employee. Ultimately, a permanent federal employee is needed. This will likely be the next position hired by NP.

Lunardini inquired about the status of the 0νββ experiment. When will project funds ramp to the requisite hundreds of millions of dollars? Sustaining this experiment is important because of the potential long-term benefits. **Hallman** agreed 0νββ could reveal new, Nobel Prize-winning physics. Many hoped NP would be at a construction stage by now, but both the rate of determining which experiments to invest in and budget constraints have slowed progress. NP is currently working to provide program funds at the level of a few million dollars to sustain progress of the main experiments towards CD-1. Once achieved, CD-1 will release reserved program funds and continue experimental progress towards baseline. Though Congress could revise the FY23 budget, it is unlikely funds will reach the level of tens of millions of dollars until FY24. It is not possible to say when funds will ramp to higher levels. Also, some isotope suppliers are based in Russia; thus, the war in Ukraine may impact schedules.

Greene observed future facility funding appears robust. However, cuts to the research budget may mean there is not a strong community to use facilities. **Hallman** appreciated these remarks. NP has received direction that all facilities must function at ≥90% operation. Supporting facilities at this level detracts from other budget elements. Although research funding increases by eight percent in FY22, the FY23 PBR reduces funding. NP will do its best to improve the situation.

NSF Nuclear Physics Overview, Allena Opper, NSF Program Director

Opper presented staff changes in NSF's Division of Physics (PHY) and highlighted IPA opportunities. NSF staff have returned to the office with flexible telework options.

Proposal trends in Experimental Nuclear Physics (ENP) show PIs tend to request two-to-three times the amount of funding ENP is able to provide. However, the Nuclear Physics programs have been able to leverage other program funding. The anticipated number of ENP proposals in 2021 was much higher than the actual number received due to COVID-19. Proposal numbers continue to be lower in 2022. PIs unable to complete research have been able to apply for no-cost extensions.

The FY22 budgeting process has been tumultuous. The FY22 PBR sought a 20% increase over the FY21 Estimated Budget, and the House and Senate marks were favorable. However, the Omnibus Bill passed in March 2022 appropriated $8.8B, a 4% increase to NSF's budget over FY21 estimates. Since NSF funds are appropriated at a high level, NSF has 45 days to develop and submit a Current Plan delineating spending details to Congress following the bill's signing. Congress is required to provide feedback or approve the Current Plan within another 30 days. Congress has not yet returned the FY22 Current Plan. Thus, funding details across NSF Directorates and Programs are unavailable. NSF is unlikely to issue FY22 awards until the Current Plan is approved for transition to an Operating Plan.

The NSF Director's vision for FY22 emphasizes three primary opportunities: 1) Strengthening the established NSF which reaffirms NSF's focus on central research areas; 2) Bringing the "Missing Millions" into the STEM workforce; and 3) Accelerating partnerships with other agencies, private industry, like-minded countries, and philanthropic organizations.

The FY23 PBR of $10.6B is ~18% greater than the enacted FY22 NSF budget. The FY23 PBR seeks ~$1.7B for MPS and ~$317M for PHY representing ~10% and ~4% increases over the actual FY21 values, respectively. The FY23 PBR has been submitted to Congress.

A new solicitation for the Faculty Career Development Program (CAREER, NSF- 22-586) has been published and it supersedes the prior solicitation. Proposals are due July 27, 2022. Recipients of Presidential Early Career Awards for Scientists and Engineers (PECASE) are selected from among the most meritorious CAREER awardees, those progressing PECASE consideration must include a statement that reflects their commitment to DEI and accessibility. Pending availability of funds, the PHY DCL titled Growing a Strong, Diverse Workforce offers graduate student supplements with an emphasis on underrepresented groups in STEM. Likewise, REU supplements are available to support underrepresented groups; usually only one REU is provided per PI, but PHY may consider providing an additional REU supplement to PIs to support STEM diversity. The second MPS-ASCEND and Launching Early-Career Academic Pathways in MPS (MPS-LEAPS) competitions are under review.

All NSF review panels will be remote for the remainder of FY22. No guidance has been issued for FY23 panels.

FRIB will open exciting research possibilities and the whole nuclear science community is looking forward to those opportunities. The National Superconducting Cyclotron Laboratory (NSCL) received a no-cost extension to complete the PAC approved NSCL experiments and MSU is supplementing NSF funds to complete those experiments. This partnership is extremely beneficial to the community.

Discussion

None.

Dodge dismissed the meeting for lunch at 12:18 p.m. and reconvened at 1:15 p.m.

Recognition of Departing Members, Timothy Hallman, DOE NP Associate Director and Allena Opper, NSF Program Director

Hallman and Opper recognized Thomas Albrecht-Schoenzart, Joseph Carlson, Renee Fatemi, Bonnie Fleming, Tanja Horn, Rebecca Surman, Boleslaw Wyslouch, and Sherry Yennello for their service and program stewardship. **Dodge** voiced appreciation for the guidance and support supplied by these individuals.

Presentation of New Charge: Nuclear Data, Timothy Hallman, DOE NP Associate Director

On April 13, 2022, the NSF and DOE jointly charged NSAC to form a subcommittee to assess challenges, opportunities, and priorities for effective nuclear data stewardship. "Nuclear data" is derived from observed properties of nuclei, their decays and decay products, and the interactions of both nuclei and their decay products with other nuclei, subatomic particles, or in bulk matter. Data from theoretical models created for comparison with experimental nuclear data may also be considered for inclusion under this definition.

The USNDP, managed by DOE NP, aims to provide current, accurate, authoritative data for workers in pure and applied areas of nuclear science and engineering. This is accomplished primarily through the compilation, evaluation, dissemination, and archiving of extensive nuclear datasets. USNDP also addresses gaps in nuclear data through targeted experimental studies and the use of theoretical models. A keystone of USNDP stewardship is the activity of the National

Nuclear Data Center (NNDC) hosted by BNL. NSAC will develop a strategic plan with prioritized recommendations to guide federal investment in USNDP through two reports. The first report, due September 15, 2022, will document nuclear data achievements and impact; survey current and future federal and non-federal nuclear data needs; and assess the USNDP in an international context. The second report, due January 30, 2023, will identify future nuclear data stewardship challenges; describe ways the nuclear data community can train and retain a diverse, equitable, and inclusive workforce; and identify access needs for facilities and instrumentation, as well as crosscutting and/ or collaborative opportunities with other federal programs as well as domestic and international stakeholders. The subcommittee's timeline will likely operate in parallel with and inform the LRP exercise.

Nuclear Data Charge Discussion

Bernstein relayed the annual Workshop for Applied Nuclear Data Activities (WANDA) and other processes since 2015 have already initiated assessment of nuclear data needs and produced peer-reviewed publications. Does the charge's scope encompass polling federal and nonfederal users? Is it USNDP's role to continue management of nuclear informational oddities like stopping powers? **Hallman** affirmed a goal for USNDP is to understand which agencies, nongovernmental stakeholders, and other clients will benefit from improved data service. This is a broad swath, and not all can be interviewed. A scoping activity is called for. It is the subcommittee's responsibility to determine whether USNDP is the appropriate custodian for certain types of nuclear data or whether focus should be elsewhere. Some may be wondering why DOE is issuing a nuclear data charge when there are other opportunities related to FRIB, EIC, and 0νββ. One of the field's greatest outputs is curiosity-driven science that does not yet have clear applications. It is important to demonstrate the societal relevance of the field's work to this Administration. For example, a century's worth of basic science has led to successful application of alpha-emitting isotopes for cancer treatments and increased understanding of astronaut safety needs for space exploration. **Keith Jankowski**, DOE NP Program Manager for Nuclear Data, communicated many stakeholders have been part of the interagency WANDA working group, including the U.S. Department of Defense (DOD). Conversations are ongoing with other potentially interested parties, including the space community.

Dodge requested suggestions for additional stakeholders and names of individuals best qualified to serve on the subcommittee.

Surman inquired about the charge's role in addressing needs of basic science users. Current nuclear databases are not always friendly to those working in fundamental sciences like nuclear astrophysics. **Hallman** replied this scope is for the subcommittee to determine. Astrophysics modeling data is also important; cataloguing information would enable users to compare their results to those of simulations. Likewise, there are discussions about the NNDC's potential role in capturing the large amounts of data that FRIB will generate. **David Brown**, NND group leader and chair of the USNDP, (chat) observed there are strong overlaps in nuclear data needs for applications and basic science. Nuclear astrophysics is one of many important areas. **Bernstein** (chat) agreed there are tremendous overlaps in both curiosity- and application-motivated nuclear data needs in traditional areas of focus as well as other critical spaces such as nuclear masses, nuclear level densities, photon strength functions, and more.

Alejandro Sonzogni, prior chair of the USNDP and head of NNDC and Cross Section Evaluation Working Group (CSEWG), articulated 99.5% of USNDP data is published. Not having access to unpublished data is frustrating in part because it limits the ability to determine

realistic uncertainties if attempting to combine data sets. Data cross sections are sometimes obtained by reading plots, but this introduces uncertainty. Hopefully, future nuclear data collection will include unpublished data. NNDC's traditional NNDC library and the nuclear reactor safety library, contain about 5K-10K reports that have not yet been digitized and are unavailable elsewhere. Some reports only have digitized titles and authors, so content is not searchable. NNDC would like to recover this legacy information by digitizing it and assigning metadata.

Yennello inquired about interfacing with groups working with classified data. To encourage awareness, it is important the subcommittee contain one member from the classified space who can discuss generalities of needed data but not applications. **Hallman** stated classified materials will remain classified. The National Academies of Science (NAS) has previously produced reports with classified sections. NSAC may take a similar approach, though participants must have security clearances. There are some open discussions where those working in classified areas share information about types of experimental nuclear data that would be helpful to produce. **Jankowski** explained many programs working in the classified space also participate in open WANDA workshops. **Bernstein** commented many involved with USNDP have clearances and try to maintain relationships with those working in classified areas. These individuals also make key contributions outside of the national security arena. Both the defense and nuclear nonproliferation communities from the National Nuclear Security Agency (NNSA) have been important supporters of nuclear data, especially in reactions. Contributions from the nuclear energy and space exploration communities have been more modest of late, but they also need data access. Help from all has been important for nuclear data. Every WANDA meeting is preceded by a discussion regarding security and followed by a classified meeting. It is important USNDP is supportive of all partners' needs, including communities working in secure areas or those with intellectual property concerns. **Brown**, who is also chair of the Working Party on International Nuclear Data Evaluation Cooperation (WPEC), noted that WPEC supports European cooperation. He agreed with comments made by Jankowski and Bernstein. By construction, USNDP and NNDC connect between basic science and applications. The field of high energy physics also has many complementary nuclear data needs, and a collaboration engagement process has been initiated. **Ron Soltz**, Deputy Leader, Science and Technology Division at LLNL, emphasized earlier remarks by Yennello pertaining to open and classified nuclear data areas. Both LANL and LLNL receive high levels of funding, and there are many opportunities for cross fertilization. A large amount of the funding that supports nuclear data is channeled through the weapons programs. The subcommittee composition can impact communication. **Sofia Quaglioni**, Deputy Leader, Nuclear Theory and Data Group at LLNL, observed many at LLNL with a clearance work in both basic and applied areas; this superposition of roles offers a venue for communication.

Dodge posited the subcommittee may need to be large or split into additional groupings to cover all areas. **Hallman** reflected a scoping discussion may assist in determining subcommittee composition.

Yennello broached coordination between the LRP planning process and the charge. If timing aligns, those on the nuclear data subcommittee can develop a white paper for the American Physical Society's (APS's) Division of Nuclear Physics (DNP) LRP exercise. It is important both processes remain aware of each other's activities. Previous LRP white papers have not focused exclusively on nuclear data but have incorporated applications. **Dodge** concurred. Feeding the results of the nuclear data charge into the LRP will reduce the burden of

commitments for those wishing to participate in both activities. **Bernstein** agreed. Space is at a premium in the LRP, so it is important to consider whether nuclear data issues are incorporated throughout the report, included as a separate section, or both.

General NSAC Discussion

Downie asked about budget impacts to NSF awards and proposal resubmission. **Opper** stated there is a general delay in awards. Those with questions about resubmission can reach out for answers and for access to reviews to inform proposals revisions.

Dodge inquired about TIP funding. **Opper** stated Congress has directed NSF to form TIP, but has not provided funding to fully staff TIP. At present, most TIP activities encompass existing programs like Small Business Innovation Research (SBIR). There will be some new initiatives, but TIP will not be as dynamic as originally envisioned.

deSouza voiced concerns regarding the funding balance for facilities and research programs. More than a decade has passed since program managers stopped visiting PIs and students at local institutions. Loss of visits disadvantages single PIs in university settings and may lead to demise of strong single PI programs. The agency's ability to maximize this intellectual talent is a concern. Though there are distinctions in research and operations funding, those at laboratories experience intangible benefits from operations funding. **Alan Poon**, Deputy, Nuclear Science Division at LBNL, (chat) expressed support for site visits to smaller facilities; students are bolstered when program managers take an interest in their work. **Hallman** acknowledged the weight of these comments. Funding level is a concern. In prior years, it was possible to adjust funding of facilities operations to strike a balance with research funding. This adjustment is no longer available, and NP will be seeking to increase research funding since facilities without users are unproductive. A great deal is lost without site visits, and NP is working to begin these again. Leadership may encourage virtual site visits, but there is no substitute for in-person interactions with students, PIs, and laboratories. Though universities will be treated no differently than laboratories when making core cuts to the research funding program, there are collateral benefits to those at laboratories.

Dodge asked about adjustments to facilities funding. **Hallman** explained NP receives funding direction from other parts of the agency that must be prioritized when formulating the budget. For example, the FY23 request requires all facilities to operate at ≥90%. In principle, NP would like facilities to operate at 100%. However, absent additional increases to laboratory and university research, adjusting operations to 85%-88% would achieve a different research balance.

Wyslouch emphasized concerns about university programs. How is the federal government planning to handle inflation? Without adjustments, there will likely be a significant loss of postdocs and other young individuals in nuclear sciences next year. **Hallman** cannot offer comments on how the government will respond to ongoing inflation issues. Of note, escalation in government funding is typically lower than cost increases in the field, so it is important to be as cost-effective as possible. NP is very concerned about research and is seeking additional ways to provide funding. NP projects are also in serious funding straits, a concern generally shared across several parts of the government. The Undersecretary testified to the House Committee on Science, Space, and Technology about the need for additional funding for projects and research.

Long Range Plan Discussion

Dodge announced NSAC anticipates receiving an LRP charge from DOE and NSF at its next in-person meeting on July 13, 2022. Agenda suggestions are welcomed. Richmond's suggestion to incorporate DEI throughout the report is important. **Hallman** remarked NSF and DOE have a high level of confidence the charge will be delivered. The Undersecretary is aware of the LRP process and looks forward to its outcome.

Dodge invited details about DNP's preparation for the LRP planning process. **Greene** is DNP chair. Rather than each activity having its own mailing list, **Yennello** commented the DNP chair line is interested in polling the community at large and NSAC on whether APS Engage is a preferred communication platform. **Ramona Vogt,** DNP Secretary and Treasurer, remarked the community paid attention to Engage notices for the April meeting. Anyone who is a DNP member can post anything. Posts may need to be moderated. Subscribers receive daily digests.

Dodge asked about nonmember access to Engage. Those, for example, in the broader nuclear data community may not be members. **Yennello** remarked initial conversations indicate Engage would be willing to let nonmembers use the platform. **Vogt** explained many who work with nuclear data are DNP members. The membership issue will need to be revisited if the community decides to proceed with Engage. The community may provide a list of nonmember names and emails to Engage, and all could be notified in advance to opt in for emails. **Greene** noted if Engage is selected, there will need to be careful messaging to ramp up community use of the platform. **Downie** added Engage can set up a separate community that does not require all users to be DNP members; nonmember users can register for an APS account. Engage also provides a threaded, asynchronous conversation record. Slack offers these features too but charges a fee based on user number to retain >10K messages. Though APS Engage is not everyone's favorite platform, its selection will encourage the community to use the platform and will not cost extra money.

Hallman cautioned such a platform is good for ensuring all voices are heard but may make achieving convergence difficult. It is easier to negotiate convergence in person; a single prolific individual could take over a platform. **Dodge** clarified the communications platform will not be used for convergence but for organizing workshops.

Wilkerson inquired if APS Engage can host subpages for each town meeting, town meeting organizing committee, and the executive committee. Individuals may subscribe to more than one community discussion. It may be overwhelming to moderate all conversations. Having a conversation record is important as is access for nonmembers, such as international individuals or those from other communities. It may take time to initiate communications. **Vogt** appreciated these suggestions and will need to check with Engage about feasibility of public and private libraries depending on the subgroup as well as moderation options.

Dodge asked if town hall conveners will be appointed. **Greene** confirmed. **Yennello** said DNP has templates from the previous LRP and must decide on town meeting topics. There will be some differences between plans. For example, the LRP may not need a town meeting on nuclear data since there will be a parallel process, the NSAC charge on Nuclear Data. Education and diversity have sometimes had their own town meetings or been distributed throughout all meetings. If Engage is selected as a platform, DNP will either need to collect names and emails or devise a way for individuals to sign up for different areas.

Hallman asked about LRP meeting topical areas. There has been pressure for the process to advance, but leadership has waited for delivery of the FY22 budget in case there was a large funding contraction. NSF has drafted a preliminary charge and perhaps information can be shared to aid in DNP planning. **Yennello** explained the DNP chair line has been waiting for the

charge. Given the charge's expected delivery in July, topics are likely to be settled at the next chair line meeting. In addition to information about the charge, a timeline would aid in planning the DNP agenda. **Greene** added a different set of meeting topics may be appropriate. For example, the EIC community is growing.

Dodge inquired about the length of the LRP process. **Hallman** said the planning process is typically 18 months. The 2015 LRP was completed in a shorter timeframe. Submission of the LRP generally influences budget formulation two years out from the current fiscal year. For example, if LRP main ideas were identified by the July of FY23, it would impact budget formulation for FY25. This short timeline is unlikely. There is no deadline driving the timeline, but the sooner the information is received, the sooner it can be delivered to decision makers.

Bernstein flagged Nuclear Data Week as an opportunity for delivering materials for the second nuclear data charge report in January 2023. The timing of other relevant meetings offers the chance to poll individuals from nuclear energy and NNSA. CSWEG and the Nuclear Data Advisory Group (NDAG) will meet October 31-November 4, 2022 on reaction topics and USNDP will meet November 7-10, 2022 on structure topics. **Vogt** invited suggestions for any LRP topics that would be useful to discuss during the fall DNP meeting which immediately precedes Nuclear Data Week.

Dodge asked about the DNP meeting schedule and suggested including a community town hall devoted to questions about and comments on the LRP. Individual groups could meet through a workshop session. **Vogt** explained there is a skeleton schedule; the chair line will take recommendations into account.

Wilkerson recommended reviewing slides outlining the previous LRP process shared during the 2021 November NSAC meeting. Activities for the writing committee, town meetings, and community meetings are interconnected. The timing may be tight depending on what the chair line aims to accomplish at the next DNP meeting.

Dodge asked if the chair line can select workshop organizers before the writing committee is formed. **Greene** agreed, though it would be helpful if workshop organizers mapped to the writing committee. Alternative approaches are possible.

Public Comment

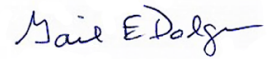
Giorgio Gratta highlighted recent 0νββ progress. DOE and NSF held a portfolio review, and DOE is spearheading an effort to build broader community support between North America and Europe leading to experimental contributions ranging from 25%-50% depending on the experiment. DOE initiated LEGEND and next Enriched Xenon Observatory (nEXO) funding in January 2022. It is important that the next LRP adequately support construction and science. **Dodge and Hallman** appreciated remarks. 0νββ updates were provided at the last NSAC meeting.

Adding to prior comments, **Steve Elliott** urged DOE NP to capitalize on the investments and leadership the U.S. currently has in this paradigm-changing area of science. Projects are shovel ready and only lack support to begin construction. Maintaining momentum is important; falling behind will risk the loss of committed international plans. The previous LRP's goal of initiating experiments have been met. Hopefully, the next LRP will include this integral portion of the NP program as its highest priority.

Alan Folmsbee shared a link to http://pyramidalcube.blogspot.com/ and requested NSAC send data to the Office of Nuclear Energy (NE). **Dodge** confirmed shared titles of books and theoretical nuclear structure data will be transmitted to NE.

Dodge adjourned the meeting at 2:51 p.m.

The minutes of the U.S. Department of Energy and the National Science Foundation/Nuclear Science Advisory Committee meeting, held on April 28, 2022, via virtual by zoom are certified to be an accurate representation of what occurred.



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Gail Dodge
NSAC Chair
Date: July 10, 2022