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

PUBLIC MEETING MINUTES

Hybrid Meeting
July 13, 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) hybrid meeting was convened at 9:00 a.m. Eastern Time on Wednesday, July 13, 2022, via Zoom® and at the Bethesdan Hotel (Bethesda, Maryland) 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

Gail Dodge (Chair)
Sonia Bacca (virtual)
Paulo Bedaque (virtual)
Lee Bernstein (virtual)
Romualdo deSouza
Evangeline Downie
Senta Victoria Greene
Oliver Kester (virtual)
Joshua Klein
Cecilia Lunardini
Rosi Reed
Nathalie Wall
Fred Wietfeldt

NSAC Members Absent

None

NSAC Designated Federal Officer

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

DOE Presenters

Asmeret Asefaw Berhe, DOE Office of Science Director (virtual)
Timothy Hallman, DOE, Office of Science, Office of Nuclear Physics, Associate Director

NSF Presenters

Sean Jones, NSF, Mathematical and Physical Sciences Directorate (MPS), Assistant Director (virtual)
Allena Opper, NSF, Nuclear Physics, Program Director (virtual)

Approximately 30 other individuals were present in person or on zoom for all or part of the hybrid meeting

Wednesday, July 13, 2022

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

Perspectives from the Department of Energy, Asmeret Asefaw Berhe, DOE SC Director

Berhe started her remarks by noting that sustained support for scientific research and innovation across the SC's portfolio, including for facilities and infrastructure, is key to realizing the SC's vision through the lens of inclusive excellence with the aim to promote economic growth. NP's investigation of how nuclear matter takes on natural forms across time and space support our nation's clean energy, commerce, medical, and security goals. Berhe said she is committed to supporting discovery science and expanding the SC's role in advancing emerging technologies like artificial intelligence (AI), quantum information sciences (QIS), and microelectronics that enable advances in all areas of research. She noted that NP is participating in SC crosscutting initiatives in these areas as well as Accelerator Science and Technology (AS&T).

Berhe reiterated that a continuing priority of particular importance is integration of belonging, accessibility, justice, equity, diversity, and inclusion (BAJEDI) principles into SC practices and policies. Science and technology must serve the needs of society, as must scientists supported by public resources. Initiatives like Justice40 ensure DOE is directing resources to communities most at risk. Berhe said she is pleased to see NP's proactive efforts in broadening training, and the next steps for the community are to design and implement initiatives to retain individuals in the Science, Technology, Engineering, and Math (STEM) workforce. She urged all to take meaningful steps in broadening science participation. Achieving such lofty goals likewise requires new strategies for effectively communicating SC's scientific successes with DOE, Congress, and the public.

Berhe emphasized the need to maintain a healthy SC infrastructure, including the national laboratories and user facilities, that is vital to meet current and future challenges as these laboratories and facilities expand their roles as regional hubs for economic opportunity and community partnerships with federal, state, and local agencies; universities; and the private sector. SC is proud to support four world-leading physics accelerators as scientific user facilities with complementary capacities. SC is pleased with the completion of the Facility for Rare Isotope Beams (FRIB) on budget and ahead of schedule thanks to cooperation among the DOE, Michigan State University (MSU), and NSF.

Partnerships of all scales are important for addressing the nation's and the world's challenges. Berhe gave as an example the National Virtual Biotechnology Laboratory coordinated efforts across all 17 national laboratories to make extraordinary advances in combating COVID-19. Concrete planning is currently ongoing to ensure future bio-preparedness and will utilize NP expertise. She noted that advancing partnerships with other agencies maximizes federal investments, illustrating the collaboration between the Thomas Jefferson National Accelerator Facility (TJNAF) and the National Institutes of Health (NIH) to translate nuclear physics science and technology to medicine. She advocated that the same collaborative approach must be brought to bear in addressing the climate crisis. SC's collaborations should extend beyond the nation's border in a responsible manner to advance the Administration's priorities through international partnerships while maximizing scientific access and ensuring research security. Meeting such ambitious goals requires everyone working together through community-driven strategic planning.

Looking to the future, Berhe expects NP to continue hosting 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. The FY23 President's Budget Request (PBR) includes significant funding for the EIC to progress towards critical decision 2 (CD-2). DOE also

appreciates progress on Neutrinoless Double Beta Decay (0νββ) experiment research and development (R&D).

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. Berhe looks forward to hearing how NP, partners, and the community will balance priorities within current budget constraints to continue progress. All of NSAC's contributions are appreciated.

Discussion

Dodge appreciated discussion of the LRP and requested advice. The community is well known for its prioritization work and unified support for each LRP, creating an exceptional partnership with funding agencies. NP's efforts add to scientific knowledge and the workforce. **Berhe** reiterated Dodge's remarks and appreciated the hard work the community puts into the LRP exercise. Work should also consider how to align scientific efforts with relevant Administration priorities, including opening doors for a very diverse next generation of scholars. This work offers rationale for continued public support for curiosity-driven and use-inspired science.

Bernstein observed nuclear physics supports many application areas, including carbon neutral energy production, nuclear security, and non-proliferation. In medicine, ongoing work, at the Joint European Torus (JET) lab applies to ion beam therapy. Are there considerations for how the Administration views these roles and how nuclear physics can support application areas? **Berhe** agreed many curiosity-driven nuclear physics questions have led to incredible applications as demonstrated by the new DOE Isotope Program (DOE-IP). Advancing science on its own behalf is important, but overarching implications also lead to societal benefits. Where there are opportunities, it is to the benefit of the community and those advocating on the community's behalf to align priorities with the Administration's goals. Working together will advance support as will identifying community priorities and opportunities to leverage resources. SC is here to provide support.

Klein drew parallels between astronomy's discovery-oriented research with a long horizon for returns and nuclear physics. Given nuclear physics' generally long horizon, how can alignments be made to Administration priorities. **Berhe** acknowledged this point and reiterated earlier comments. A case can be made for the importance of science for its own sake with research implications outlasting any administration. Nuclear physics is already working to align efforts to priorities; deciding how to articulate this balance is important.

Kester sought perspectives on future U.S. collaborations on international large-scale projects. **Berhe** is highly supportive of international projects. Scientific advances and training are made better by bringing everyone's talent together through international collaborations.

Bernstein recognized NP leadership for hosting the U.S. Nuclear Data Program (USNDP), which provides data to application areas. **Berhe** appreciated this comment.

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

Jones reviewed MPS leadership and staff changes, and emphasized NSF's interest in partnerships with DOE, NSAC, and the community, including in bio-related areas of nuclear physics.

In FY21, NSF issued ~11.3K competitive awards to ~318K individuals with ~$1.5B supplied for STEM education and >$180M to seed public-private partnerships.

The FY22 Enacted Budget of $8.8B represents a 4% increase over that of FY21. Funds from the American Rescue Plan (ARP) totaling $79M were used to support 260 awards. The Strategic Plan for 2022-2026 has established the new Directorate for Technology, Innovation, and Partnerships (TIP). TIP comprises three subdivisions: Technology Translation, Technology & Innovation Ecosystem, and Partnerships as a Foundation. TIP cuts across existing NSF directorates and engages other stakeholders in research, education, and innovation to strengthen and scale existing investments in use-inspired and translational research. Efforts include co-funding existing programs and launching new ones. TIP thus bridges fundamental research to applied public uses to bypass the translational research valley of death. There is already great synergy between TIP's vision and the MPS portfolio.

NSF's FY23 PBR of $10.5B is a 19% increase over the FY22 Current Plan. MPS's PBR of $1.75B is an ~10% increase over that of FY22. Plans focus on the Administration's priorities of climate change, clean energy, advancing equity in STEM, and emerging industries. Within the latter, ~$880M is allocated for TIP; ~$422M for advanced manufacturing; ~$169M for advanced wireless technologies; ~$734M for AI; ~$392M for biotechnology; ~$146M for microelectronics and semiconductors; and ~$261M for QIS. The PBR continues procurement and construction activities for research infrastructure. The FY23 budget is currently under consideration in the House and Senate, and internal agency planning for the FY24 budget has begun.

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 92-95% complete and has undergone a successful re-baseline. Operations are projected for 2024. The High-Luminosity Large Hadron Collider (HL-LHC) upgrade is >22% complete. All MPS facilities are open and operating under appropriate COVID-19 protocols with the exception of the Kitt Peak National Observatory which has been impacted by wildfires. Cleanup of the Arecibo Observatory is complete, and focus has shifted to future site uses. Four years of data taking will commence this summer at the Large Hadron Collider (LHC). The Laser Interferometer Gravitational-Wave Observatory (LIGO) is preparing for its fourth observation period projected for December 2022.

NSF's National Superconducting Cyclotron Laboratory (NSCL) made significant contributions to research and the training of PhD students in nuclear physics. NSCL assets successfully transitioned to the DOE-FRIB Laboratory in May with MSU management.

Mid-scale Research Infrastructure-1 and -2 (MsRI-1 and MsRI-2) awards support NSF-wide, shovel-ready projects with total requests between $6M-$20M and $20M-$100M, respectively. The next solicitation is scheduled for FY23. Importantly, funding can be leveraged to support data needs.

In FY22, MPS anticipates making five EArly-concept Grants for Exploratory Research (EAGERs) awards and one supplement award through the Advancing Discovery with AI-powered Tools (ADAPT) Dear Colleague Letter (DCL). NSF additionally anticipates issuing 31 MPS Ascending Postdoctoral Research Fellowship (MPS-ASCEND) awards; 57 Launching Early-Career Academic Pathways in MPS (MPS-LEAPS) awards; six Partnerships for Research and Education in Physics (PREP) awards; three Partnerships for Research and Education in Chemistry (PREC) awards; and 11 Partnerships in Astronomy and Astrophysics Research and Education (PAARE) awards. 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. The community is encouraged to continue applying for these programs with support also planned for FY23.

Discussion

Dodge raised TIP's Partnerships as a Foundation subdivision and asked about the Small Business Innovation Research/ Small Business Technology Transfer (SBIR/ STTR) programs. The community has not taken full advantage of funding opportunities outside usual programs; NSAC and others, especially those at universities, can play a bigger role in advertising. The valley of death presents an interesting challenge. **Jones** explained this TIP subdivision is meant to address global partnerships, with a focus on non-profit, industry, and agency opportunities to pull foundational research to the marketplace. The Department of Defense (DOD), for example, acts as a gateway for translational NSF work. SBBIR/ STTR was moved from the Directorate for Engineering to TIP to act as part of the new directorate's base. This program will continue, and new TIP programs will be added in FY23 and beyond with budget growth. NSF is open to any suggestions for how to effectively target and disseminate opportunities. As indicated by Dr. Berhe, if organized properly, the TIP Directorate will pull fundamental science across the valley of death. There are significant opportunities for MPS.

Bernstein commented DOE-IP has its own version of the valley of death. Any help that can be offered in their transition is important, and TIP's focus is appreciated. **Jones** acknowledged this remark.

Dodge invited thoughts on the LRP process. **Jones** called attention to Dr. Berhe's prior remarks. NSF does not want to be prescriptive beyond the charge, but encourages contemplation of the Administration's priorities, including racial equity and the concept that innovation can come from anywhere across the nation. This consideration will be well received for workforce development.

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.

DOE NP supports ~90% 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's missions. Indeed, >50% of PhDs in nuclear physics transition to other work sectors.

To investigate a vast range of time and physical scales, NP stewards a suite of facilities and instruments capable of various resolving powers. NP's budget consequently requires adequate facility operations and maintenance resources to support the complementary capabilities of its four national user facilities. Hallman presented a summary of NP projects. FRIB was completed in FY22 on budget and ahead of schedule. The EIC has achieved CD-1 with a total project cost (TPC) of $1.7B-$2.8B and completion projected for FY33. The EIC will leverage assets from the Relativistic Heavy Ion Collider (RHIC); a significant reprioritization of RHIC funds is anticipated to reduce the EIC's need for new funding to a value closer to $1B. The EIC will maintain U.S. leadership in collider AS&T for the next 20-30 years. In Major Items of Equipment (MIEs), the Super Pioneering High Energy Nuclear Interaction Experiment (sPHENIX) is nearing completion on time and on budget. The Gamma Ray Energy Tracking Array (GRETA) has advanced past CD-2/3 and has a TPC of ~$58M. Completion is projected for 2028. The Measurement of Lepton-Lepton Electroweak Reactions (MOLLER) project has

achieved CD-1 and has a TPC cost range of ~$46M-$57M. Completion is projected for FY27. The High Rigidity Spectrometer (HRS) has also received CD-1, with a TPC cost range of ~$85M-$111M. Completion is projected for FY29. The Ton-Scale 0vββ project is at CD-0 with an estimated TPC of $215M-$250M. Three proposed technologies for experiments present future research options within the ton-scale program. More than one 0vββ experiment would enable contemporaneous verification of results but would require contributions from other countries in addition to the United States.

Hallman highlighted FRIB's first scientific results from May 2022 produced isotopes that have never before been generated in sufficient quantities for research. FRIB's successful construction and early science is a testament to the sustained cooperation among MSU, DOE/SC, NSF, the Office of Budget Management, and Capitol Hill. Other recent impactful accomplishments include the discovery that ionizing radiation reduces coherence time for entangled quantum states; the first known observation of the Breit-Wheeler two-photon process at the RHIC; the discovery that heavy nuclei have a neutron skin at the Continuous Electron Beam Accelerator Facility (CEBAF); implementation of dynamical fermions and the real pion mass in Lattice Quantum Chromodynamics (QCD); and improving AI fault tolerance at CEBAF.

NP provides existing or updated nuclear data to numerous agencies and is reaching out to new nuclear data application customers in electronics protection (National Aeronautics and Space Administration [NASA], Missile Defense Agency, Federal Aviation Administration), human safety (NASA, NIH), and advanced reactors (Advanced Research Projects Agency-Energy, NASA). 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).

Hallman provided an update on the NP Traineeship Program. To date, the program has supported 36 proposals resulting in 110 traineeships using NP program funds. Award recipients include 18 Minority Serving Institutions (MSIs), ten other colleges and universities, and five DOE labs. Among award recipients, 40% identify as Hispanic, 40% as Black or African American, 10% as white, and 10% as other. Upcoming funding opportunity Announcements (FOAs) will aim to retain trainees in nuclear physics to sustain the NP community looking like America. The Inspire the next Generation of a Highly Trained Workforce (INSIGHT) Team will gather data for SC to assess program effectiveness, facilitate communication and coordination, and ascertain criteria related to trainee retention. FY23 Reaching a New Energy Sciences Workforce (RENEW) funds will focus on creating vehicles for retaining trainee talent and anchoring sustained investment at MSIs, including Historically Black Colleges and Universities (HBCUs).

Hallman reiterated his position that NP will not tolerate any unwanted or abusive behavior; his expectation is that the SC Statement of Commitment will be respected by the community.

Significant progress has been made on 2015 LRP priorities. Preparations for the next LRP exercise are underway. It is imperative the NP community remain united in realizing current and future goals, as division can set back the entire field.

Starting in FY21, DOE funding has not kept pace with the modest growth scenario outlined in the 2015 LRP. The FY23 PBR also falls short, though the FY23 House Mark of $780M is closer to the modest growth scenario..

Hallman provided additional details on the FY23 PR. NP's FY23 PBR of ~$739M is ~$11M greater than FY22's Enacted Budget. However, increases to FRIB operations (~$16M+),

GRETA (~$7M+), AI/ ML ($4M+), RENEW ($3M+), and the new Funding for Accelerated, Inclusive Research (FAIR, $2M+) and Accelerate Innovations in Emerging Technologies (ACCELERATE, $4M+) initiatives total ~$35M. Thus, as proposed, a portion of NP's base funding would be used to support these targeted increases. 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, Argonne Tandem Linac Accelerator System (ATLAS), and 88" Cyclotron operations, ~$68M to research, and ~$24M to projects. Theory receives ~$63M for research, and funding is flat at $20M for progress on the EIC.. In FY23 NP will continue participating in the QIS, artificial intelligence and machine learning (AI/ ML), microelectronics, and RENEW SC crosscutting initiatives, and will additionally contribute to ACCELERATE and FAIR. NP will also continue participation in Scientific Discovery through Advanced Computing (SCIDAC) and is cultivating a possible NIH collaboration to advance imaging useful to both NIH and SC/NP.

FY23 Request 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 CD-2 review; initiation of the sPHENIX science program 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.

Hallman stated that NP urgently needs assistance with peer review panels. Community members interested in reviewing proposals are encouraged to provide their contact information to NP.

Discussion

Klein sought guidance on the extent to which the next LRP might emphasize the importance of executing the Ton-Scale 0νββ experiment. Without being prescriptive, **Hallman** offered the general wisdom that decision makers recognize value in consistent priorities.

Greene raised concerns brought by high energy heavy ion researchers that once RHIC ceases operations, there will still be years worth of data to process. **Hallman** remarked the nation invests in producing science which entails both experiments and published findings. A continuing commitment was necessary for PHENIX, and the same will be true for sPHENIX and the Solenoid Tracker at RHIC (STAR).

Dodge dismissed the meeting for a break at 10:45 a.m. and reconvened at 11:00 a.m.

NSF Nuclear Physics Overview, Allena Opper, NSF Program Director

NSF responds to proposals that meet the agency's merit review criteria: intellectual merit and broader impacts. The NSF Nuclear Physics programs support research in the areas of nuclear and hadron QCD; nuclear astrophysics, reactions, and structure; and nuclear precision measurements of fundamental symmetries and constants. PHY also supports infrastructure at facilities and university laboratories as well as nuclear theory hubs. The division has noticed a trend in submitted proposals using atomic, molecular, and optical (AMO) physics techniques to examine signals beyond the standard model of physics. When appropriate, PHY seeks co-review and co-funding of proposals spanning broader NSF program areas.

NSF and DOE closely coordinate on nuclear physics experiments, with NSF funding specific aspects of project scope for MOLLER, the EIC R&D, and Next Generation 0νββ research. Importantly, since NSF responds to proposals, there is no guarantee of NSF participation in future mission-driven projects. Successful proposals present a clearly defined scope with high impact. In areas of research coordination, NSF will coordinate efforts with those of DOE.

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. Program managers, however, have successfully leveraged other program funding to increase support. Additionally, redirection of NSCL funds back to the community in FY20, FY21, and FY22 has increased the ENP research budget. The received number of ENP proposals in FY21 was lower than anticipated, likely due to COVID-19. Proposal numbers continue to be lower in 2022.

The FY22 PBR sought a 20% increase over the FY21 Estimated Budget, and the House and Senate marks were favorable. However, the final appropriation of $8.8B was a 4% increase to NSF's budget over the FY21 figure. 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.

The NSF Director's vision for FY23 continues emphasis of 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 through support for diversity, equity, inclusion, and accessibility (DEIA); and 3) Accelerating partnerships with other agencies, private industry, like-minded countries, and philanthropic organizations. The FY23 request includes $667M to fund focused efforts to broaden participation, with $528M available for NSF-wide and MPS-specific programs.

The NSF's observation of the NSAC's LRP process provides insights to the community's science challenges and opportunities. However, LRP identification of priorities and needs does not necessarily lead to direct NSF investments. NSF funds are appropriated at a high level, and there is no line item for PHY or other programs in the federal budget. In areas of agency overlap, NSF considers aspects of research distinctiveness and leadership. However, NSF's process for major facilities is similar to DOE's. Major facilities are projects with an NSF TPC >$100M. Such projects are funded through NSF's Major Research Equipment and Facilities Construction budget line and must be authorized by the National Science Board (NSB). FACA advisory input, decadal reports, and other studies are considered by the NSB. Since NSF's FY24 PBR is already under discussion, the timing of the LRP's delivery will determine whether prospective NP projects >$100M are considered in NSF's FY24 budget.

NSF programs supporting research infrastructure include MsRI-1 and MsRI-2; Major Research Instrumentation (MRI); and PHY Mid-Scale Instrumentation. The NSF-wide MRI program supports instrumentation with costs to NSF ranging from $100K to $1M for Track 1; and $1M to $4M for Track 2. The PHY Midscale Instrumentation program supports projects with a TPC ranging from $4M to $20M.

Opper encouraged parties with questions to contact MPS and PHY personnel. NSF also needs proposal reviewers, and interested individuals are invited to provide contact information.

Discussion

Dodge asked about the FY22 Enacted Budget. **Opper** said Congress makes a high-level appropriation of six budget lines. NSF then creates an allocation plan. Congress has approved this acting plan, now NSF's operating plan, and NSF is making awards as quickly as possible.

Presentation of the Long Range Plan Charge, Timothy Hallman, DOE-NP Associate Director

Hallman noted that on July 11, 2022, DOE and NSF jointly charged NSAC with developing the next LRP for coordinated advancement of the nation's nuclear science research program, both domestically and internationally, over the next decade (FY23-FY32). The new LRP will identify the scope of challenges and prioritize the most compelling opportunities in nuclear physics, detail progress made since the last LRP, and enumerate impacts of these accomplishments within and outside the field. The plan will articulate rationale for new investments and indicate what resources and funding levels would be required, including construction of facilities, mid-scale instrumentation and MIEs, to maintain a U.S. world-leadership position in nuclear physics. Coordination and collaboration with other countries and agencies, as well as crosscutting synergies with different scientific disciplines will be considered. The plan will also articulate how efforts to promote and sustain a diverse, equitable, and inclusive nuclear science workforce will be fully integrated into the field's future vision. The potential impacts and priorities under a constant level of effort budget, with two-percent growth per year using the FY22 enacted funding level as a reference, will be described. An initial report is requested by October 2023.

NSAC will coordinate with the American Physical Society's Division of Nuclear Physics (APS DNP) to develop the new LRP over the next 18 months or longer. The DNP will convene topical Town Meetings resulting in white papers. NSAC will subsequently form a panel comprising NSAC members and community experts for deliberating priorities and writing the LRP document, using the white papers as input. Final priorities will be determined through a Resolution Meeting. DOE and NSF will be informed throughout the process.

LRPs have supported a robust and healthy U.S. nuclear physics program for decades. Mutual respect, transparency, equitable access to providing input, and solidarity are some of the many important hallmarks of previous successful processes.

Discussion

Reed drew attention to inflation and growth scenarios. **Hallman** remarked the charge requires outlining the impact of a constant effort budget with two percent inflation growth per year. The LRP may examine other scenarios and might include a modest growth scenario comparable to that incorporated in the 2015 LRP to provide an upper as well as lower bound.

Wietfeldt inquired about the plan's technical writing level and audience. **Hallman** recommended the writing panel discuss this topic. A well-written plan should be understandable by SC and Capitol Hill decision-makers. Knowledgeable scientists, not necessarily field experts, and staffers should find the plan interesting.

Klein asked about discussion of the balance between research and projects in the report. **Hallman** advised the writing panel debate this point. It is important to articulate how core research is the foundation for initiatives. For example, the ability to visualize where cancer is in the body is the result of 100 years of R&D, let alone successful treatment with radioisotopes. Funding only for initiatives and not core research will not work.

Bernstein questioned the role of Nuclear Data charge reports in LRP formulation. Of note, NP facilities produce both medical imaging agents and radioisotopes. Personally, **Hallman**

believes the Nuclear Data charge reports, to the extent they are available, should provide input to the LRP discussion, similar to Town Meeting white papers. The LRP may illustrate all application areas where nuclear physics benefits society.

Abhay Deshpande (via chat) commented on Dr. Berhe's use of BAJEDI and the LRP Charge's lack of justice (J). **Hallman** clarified the LRP charge is high level and encompassing; the DOE's specific initiative in this area seeks to raise underserved communities.

Lunardini asked how the community is defined and inquired about involvement of postdoctoral scholars (postdocs) and graduate students in the LRP process. **Hallman** observed this exercise, if similar to the last, is meant to include everyone's input from professors to technical or lab staff to students. The DNP may make an announcement indicating all can have a role. **Dodge** said emails will be sent to invite input from the whole community in a number of different ways.

John Wilkerson sought LRP timeline clarification. **Hallman** explained an initial report is due in October 2023. This could be an oral report of LRP recommendations to Drs. Berhe and Jones. Writing of the final, polished report could still be ongoing at that time. Delivery of prior LRPs have historically taken ~18 months. **Dodge** added later discussion will address timelines.

deSouza expressed interest in how a balance for core research and supporting future workforce development might evolve. Building facilities no one uses is unproductive. Though the community will set priorities, **Hallman** predicted support for core research, which is being eroded, is likely to be an LRP priority. Simply asking for more money will likely be unproductive. Pointing to compelling opportunities that will lie fallow without additional workers is more likely to garner traction.

Downie asked if providing specific examples of industries with workforce needs would create stronger arguments for support. **Hallman** opined obtaining credible estimates of specific industry needs would be challenging but very valuable. One of NP's most important products is a trained workforce that meets both NP mission needs and those of other missions. About 80 PhDs are produced in the field each year, and this number has been consistent for several years. Expertise in nuclear physics and accelerator technology is becoming more relevant to other areas.

deSouza inquired about the number of PhDs produced in China, India, and other countries with growing nuclear power. Is this an argument for increasing U.S. PhD numbers? **Hallman** did not know exact numbers. China is building ~30 nuclear plants over the next 20 years and will require nuclear engineers and physicists. This is something to consider.

Greene raised concerns that increased facility funding and reduced research funding will leave data on the floor. Is this appropriate LRP content? **Hallman** encouraged LRP discussion of funding balance. Theoretically, the idea of 100% facilities operations resonates, but not if 50% of the research community must stand down.

Kester posed a question about accelerator driven systems (ADS) research and databases. ADS is a project in Belgium. To **Hallman's** knowledge, the U.S. is not enthusiastic about ADS Other countries like India and China are pursuing this research area. In the U.S., there is strong support for databases useful for applications within a certain envelope.

Hans Mumm (chat) questioned the absence of climate change in the charge. This is an application area where nuclear physics is important. **Hallman** recalled points made by Drs. Berhe and Jones encouraging the LRP, to the extent it makes sense to do so, to show how nuclear physics aligns with Administration priorities and can address problems to help society. Climate change and clean energy are among the highest Administration priorities.

Bernstein commented engineering modeling and simulation have advanced dramatically in the last decade, arriving at a point where nuclear physics inputs are becoming clear and a direct line can be connected to outputs in various applications. **Hallman** agreed. New, powerful computers have enabled calculations that previously would have relied on estimates. Electronics testing for space environments could benefit from additional modeling and simulation.

Lunardini inquired about document length and audience accessibility. **Hallman** said most LRP documents are ~100 pages. Some have three- or four-page executive summaries from which staffers can derive main points. Writing scientifically accurate documents that are also accessible to non-experts is an art form. **Dodge** observed it will be important to produce a document that is accessible for individuals who wish to read the entire report.

Greene provides relevant portions of the previous LRP to students being onboarded. **Hallman** remarked previous LRPs have included sidebars showing students in action; personal stories for the next research generation also resonate with decision makers. **Dodge** recollected Dr. Richmond's advice to incorporate DEIA throughout the report. Using sidebars is one way to do so. People learn through stories, and this form of communication should not be taken lightly.

Dodge dismissed the meeting for lunch at 12:30 p.m. and reconvened at 1:30 p.m.

Long Range Plan Discussion

Dodge broached the LRP timeline and logistics. Everyone on NSAC will be part of the writing team. Suggestions for additional experts, who will be identified over the next month and a half, are welcome. The committee needs members who can articulate science well, are passionate about the mission, and who take a broad view of nuclear physics priorities. Those rotating off NSAC next April will remain on the writing team. The committee will accept information in any form submitted, including DNP white papers, American Chemical Society feedback, and general emails. A kickoff meeting is proposed for October 26, 2022, the day before the DNP meeting starts. A proposed soft deadline for white papers is January or February, 2023. The Resolution Meeting is recommended to be held in person over five days. A week in the second half of April 2023 is being considered. Though some have teaching commitments in the spring, waiting until summer also offers challenges in terms of availability. Entering the Resolution Meeting, portions of the LRP may already be written. In principle, all the LRP recommendations will be known after this meeting, though writing will continue. It should be feasible to have an initial report by October 2023. There are many details to sort out. Subcommittees addressing the budget scenarios, applications, the workforce, and other areas need to be formed. Those with interests in particular areas are invited to send an email to Dodge. DNP Town Meetings may also help address particular topic areas. A webpage will be set up where all comments will be accepted and posted along with white papers and other materials.

Wietfeldt asked about meeting format. Holding the Resolution Meeting in April may be difficult for teaching schedules. **Dodge** presumed meetings will be in person without hybrid options. Faculty are usually able to take five consecutive days off, including a weekend, during the semester for academic conferences. People may have summer commitments that preclude participation. A convenient time is unlikely to be found for all. A two-week window will be provided to invited writing committee members. **Klein** noted faculty have many other semester commitments. It would be beneficial to avoid scheduling meetings during that time. **Lunardini** agreed. The second half of April is the most stressful time of the year. It is not just the week of

the meeting, but the time leading up to it where writing will need to take place. **Downie** added those with administrative duties have responsibilities related to graduation ceremonies.

Dodge considered the second half of May for the Resolution Meeting, after graduation ceremonies. NSAC members are requested to email schedule considerations. A time needs to be selected before inviting others. Regarding meeting format, the kickoff meeting may work in hybrid format, but the Resolution Meeting requires reaching consensus which is better done in person. Prior LRPs have held the kickoff meeting after the DNP. **Bernstein** and **Wietfeldt** agreed the Resolution Meeting should be in person. **Downie** advised the DNP Allies will need to be notified to leave training early if the kickoff meeting is held before the DNP conference. A hybrid option should be available for the kickoff meeting as there may be reluctance for some to travel to Louisiana as COVID-19 remains a concern. **Greene** supported holding the kickoff meeting before the DNP meeting. The business meeting will be turned over to discussion of the LRP.

Bedaque (chat) requested safety measures, such as testing, before holding in-person meetings. **Dodge** acknowledged COVID-19 will need to be considered, and the situation at the time will be taken into account.

Downie remarked other groups have posted white papers to arXiv, making them accessible to the community and citable with a digital object identifier. **Dodge** agreed some might wish to post to arXiv. The website being prepared for the LRP should link to all materials.

Dodge requested suggestions for how to gather workforce needs in application areas like the nuclear industry and others. **Bernstein** said one of the Nuclear Data charge subcommittees is polling the nuclear energy community in academia and industry about nuclear data topics using a distribution list from the American Nuclear Society. Workforce needs could be added to the poll. **Dodge** agreed any statements or statistics from those communities would be helpful.

Dodge reflected on acquiring community data related to DOE and NSF. **Klein** pointed to the annual workforce survey issued by DOE. **Downie** indicted American Institute of Physics (AIP) surveys graduate students in nuclear physics. AIP does not break majors down by nuclear physics, but AIP could be approached with an ask to generate a starting list of institutions. **Hallman** suggested contacting the individual who dealt with workforce issues during the last LRP process. **Greene** reasoned large collaborations may be a good information source as they typically track their PhDs. **Reed** added user groups may have statistics in terms of voting. Universities with large programs could be asked what their graduate students do to capture a cross section of stories of how nuclear physics feeds into other areas. **deSouza** suggested calling attention to subfields spawned by nuclear physics to demonstrate the field's impact.

Dodge asked about NP's presented pie chart. **Hallman** explained data came from an experimental study where participants were given $1K to provide information about where they went. There is also data for the field writ large.

Update on DNP Planning for Community Workshops, Vicki Greene, APS DNP Executive Committee Chair

Three DNP Town Meeting topics have been identified for 2022: 1) Hot and Cold QCD; 2) Nuclear Reactions, Structure, and Astrophysics; and 3) Fundamental Symmetries, Neutrinos, and Neutrons. Crosscutting issues related to Workforce Development (Education, Diversity) and Innovations/ Applications (Computing, Accelerator and Detector Science, Nuclear Data, and Isotope Science) will be threaded through each meeting's discussion. Following announcement of these topics to the community, a robust nomination response for topical conveners and

crosscutting conveners was received for each Town Meeting. Crosscutting conveners have both nuclear physics field expertise and expertise in crosscutting topics. Nine institutions have expressed interest in hosting Town Meetings, and selection of both conveners and venues is underway.

The draft timeline for DNP's contributions to the LRP process is aggressive. Town Meetings will be conducted in the September-November 2022 timeframe with white papers delivered in February 2023. In the interim, DNP is planning a special community update on the LRP process at the DNP October 2022 meeting. At the fall 2023 DNP meeting, a plenary session will be devoted to the LRP, pending DNP Chair approval.

The DNP expects and encourages other grassroots Town Meetings. For example, a newly proposed workshop will address Computational and Theoretical Efforts in Nuclear Physics, building on outcomes from a 2014 workshop supporting the previous LRP.

Discussion

Hallman was glad to see contemplation of other workshop topics. The 2015 process included either a quantum- or lattice-related workshop. Education and outreach typically convene a workshop. **Greene** pointed to the grassroots effort that has reached out. Such efforts are helpful, and the selected topics are intentionally broad. Topics like education were addressed in a separate town meeting for the last LRP, but the DNP made the deliberate decision to embed meetings with conveners with crosscutting expertise for the new LRP.

Klein advised the Snowmass process has been impacted by COVID-19 and by the fact many simply do not have time to write. The Community Summer Study is hybrid which may reduce attendance. The process has also resulted in a proliferation of papers: white papers, topical reports, executive report summaries, and ultimately the Snowmass Book. White papers are always important, and deliberately focusing LRP writing efforts in advance will maximize contributions. Less may be more. Some aspects of Snowmass organization have been opaque. DNP may consider community engagement in Town Meeting agenda and speaker formulation rather than dictating the process. **Greene** assured the DNP is envisioning a simpler process with three white papers. Other papers may be contributed by self-organized groups.

Downie recommended determining workshop dates before faculty write their syllabi. **Greene** agreed. Of note, it is too late to change DNP's Louisiana venue, and hybrid options will be provided for those who cannot safely travel. When choosing venues for Town Meetings, the DNP is taking ongoing state legislation activities into consideration.

deSouza and **Dodge** asked about conveners. **Greene** explained each Town Meeting will have two co-conveners and a committee of six individuals to ensure all topical and crosscutting areas are covered without team size becoming unwieldy. The DNP is developing a selection philosophy and will consider all diversity aspects in convener and committee selection.

Kester requested more information about submitting materials related to the technical development of electronics, detectors, and accelerators. Materials were recently submitted to the Canadian Subatomic Physics LRP. **Greene** reviewed incorporation of these topics as crosscutting areas for planned Town Meetings and welcomed more information about prior topical work. The fall DNP's business meeting will be spent on the LRP process. **Dodge** added specific topical contributions will be accepted from all individuals.

Hallman wondered about incorporation of AI, QIS, and isotope science in the meetings. **Greene** indicated AI and QIS are covered under the Computing cross cut area and may also be

addressed by self-organized groups. Future discussions with DOE-IP will ensure appropriate portions of isotope science are covered.

Downie weighed in on supplying conveners with specific requests up front to make compiling information for the LRP easier, especially for education and diversity. **Klein** advised generating a template for the LRP. **Greene** concurred. A white paper template would be very helpful. **Dodge** agreed. White papers should be succinct and cover desired charge aspects.

Downie remarked the prior LRP process was less transparent and suggested sharing the charge with the community and allowing Town Meetings to draft all input. **Greene** agreed. The process will be as transparent as possible, and Town Meeting conveners will not be charged with writing sections in advance. Conveners will guide community input to meet the charge. **Dodge** stated this is a time for all to share ideas.

Greene hoped grassroots meetings will address nuances not discussed in Town Meetings while providing relatively organized reports. **Dodge** expressed the invitation email to the community will need to be carefully phrased to be as inclusive and accepting of input as possible but also provide guidance on what kinds of input are most helpful.

Bernstein commented materials being prepared for the Nuclear Data Report may feed directly into the LRP. **Dodge** agreed.

Update on Nuclear Data Charge, Lee Bernstein, Nuclear Data Subcommittee Chair

On April 13, 2022, the NSF and DOE jointly charged NSAC to form a subcommittee to assess nuclear data stewardship with results to be delivered in 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, and domestic and international stakeholders.

An NSAC Nuclear Data (NSAC-ND) Charge Subcommittee was formed and workshop white papers, review articles, and external USNDP input were assembled to aid work. Following a kickoff meeting on June 15, 2022, the subcommittee sorted itself into topical subgroups: Energy Applications; Medical Applications; National Security; Nonproliferation; Basic Science; Databases; and Space Applications. Emergent common themes include the need for integral benchmarks; nuclear reaction networks containing 6000-8000 reactions; and reaction data pertaining to an energy regime $\leq$10 GeV$\cdot$A. A suite of suggestions from USNDP relate to inter-database consistency; publication rates; satellite sensors; ML evaluation tools; and an engineering study for streamlining the nuclear data pipeline process.

Bernstein reported that Topical subgroups will provide written input to the chair over the next three weeks. Together with USNDP input, information will be compiled into a draft report organized by both application area and crosscutting nuclear data type topics, such as decay data; structure beyond quasicontinuum structure; neutron-induced reactions with energy $\leq$ 20 MeV; and reactions with energy > 20 MeV. The resulting report will be distributed to the USNDP leadership for feedback and edited before the deadline. Efforts to address the second portion of the charge are ongoing.

Discussion

Dodge appreciated the committee's ongoing hard work that will support the LRP process.

Bernstein thanked the committee for their work and raised questions about report length. As a general rule, **Hallman** offered succinct reports are better. The 2010 Isotope Report was ~50 pages. More feedback will be provided.

Public Comment

Moshe Gai referred to the trend in reduced research funding and inquired about prospective support for single PIs at universities. **Hallman** replied decreases to NP's core research category, which funds both university PIs and national labs, constitute a concerning trend. NP budget formulation has been impacted by direction to optimize facility operations, as reflected in Congressional mark language. Going forward, there is recognition that core research must be prioritized, though current thrusts place emphasis on initiatives, which differ from core research. It will be important for the LRP to use effective language to push for change. Core research was increased by 7.5% in 2022, but is decreased a little in the FY23 PBR due to facility operation guidance. It takes constant work to keep core research's budget up.

Yury Kolomensky (chat) raised questions about Town Meeting organization and crosscutting topics. Voices of young researchers must be heard in the LRP process. **Dodge** agreed. Lots of thinking will need to go into how topics are included. There may be a separate chapter on applications, but DEI will be incorporated throughout the report. All suggestions are welcome.

Ani Aprahamian offered Notre Dame as a venue for Town Meetings. **Greene** and **Dodge** appreciated the invitation.

Alan Folmsbee (chat), posted a link to comments on a personal website (https://impuremath.wordpress.com/about/), a link to a book containing theoretical information detailing coordinates for every proton and neutron for all elements in the periodic table based on rules determined for iron (https://www.amazon.com/gp/product/B09CGDZ57W), and proposed future goals for this information. Criticisms and recommendations were offered for current research related to quarks, use of mixed units, radio and photons, photons and energy, and strong nuclear force. This information was requested to be shared with DOE, the Office of Nuclear Energy, and NSF. **Dodge** appreciated these remarks.

Dodge adjourned the meeting at 3:30 p.m.

The minutes of the U.S. Department of Energy and the National Science Foundation/Nuclear Science Advisory Committee meeting, held on July 13, 2022, via hybrid by zoom are certified to be an accurate representation of what occurred.

Gail E Dodge

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Gail Dodge
NSAC Chair
Date: 9/16/2022