

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

**PUBLIC MEETING MINUTES**

**Hilton Washington DC/Rockville Hotel & Executive Meeting Center  
1750 Rockville Pike, Rockville, MD 20852**

**June 2, 2017**

**NUCLEAR SCIENCE ADVISORY COMMITTEE  
SUMMARY OF MEETING**

The U.S. Department of Energy (DOE) and National Science Foundation (NSF) Nuclear Science Advisory Committee (NSAC) was convened at 8:50 a.m. EDT on Friday, June 2, 2017, at the Hilton Washington DC/Rockville Hotel & Executive Meeting Center, Rockville, Maryland, by **Committee Chair David Hertzog**. The meeting was open to the public and conducted in accordance with Federal Advisory Committee Act (FACA) requirements. Attendees can visit <http://science.energy.gov> for more information about NSAC.

Committee Members Present

David Hertzog (Chair)	Kawtar Hafidi	Mark Pitt
Mei Bai	Silvia Jurisson	Sofia Quaglioni
Helen Caines	Cynthia Keppel	Krishna Rajagopal
George Fuller	Michael Lisa	Martin Savage
Geoffrey Greene	Zein-Eddine Meziani	

Committee Members Participating by video:

Yury Kolomensky

Committee members unable to attend:

Laetitia Helene Delmau, Frederic Fahey, Kate Jones, Jeffrey Nico, Daniel Phillips, Michael Thoennesen

NSAC Designated Federal Officer:

Timothy Hallman, U.S. Department of Energy, Office of Science (SC), Office of Nuclear Physics (NP), Associate Director

Others present for all or part of the meeting:

Cyrus Baktash, Retired, DOE	David Dean, Oak Ridge National Laboratory (ORNL)
Ethan Balkin, DOE	Patricia Dehmer, Retired, DOE
Kate Bannan, DOE, Office of Scientific and Technical Information (OSTI)	Jim Decker, Decker Garman Sullivan
Elizabeth Bartosz, DOE	James Dunlop, Brookhaven National Laboratory (BNL)
Ted Barnes, DOE	George Fai, DOE
Steve Binkley, DOE SC, Acting Director	Glenn Fox, Lawrence Livermore National Laboratory (LLNL)
Joseph Carlson, Los Alamos National Laboratory (LANL)	Edmundo Garcia, NSF
Art Champagne, University of North Carolina / Triangle Universities Nuclear Laboratory (TUNL)	Doon Gibbs, BNL
Tiffani R. Conner, Oak Ridge Institute for Science and Energy (ORISE)/ Oak Ridge Associated Universities (ORAU)	Jehanne Gillo, DOE
Zachary Conway, Argonne National Laboratory (ANL)	Thomas Glasmacher, Michigan State University
	James Hawkins, DOE
	Karsten Heeger, Yale University
	Mary Hockaday, LANL

Barbara Jacak, Lawrence Berkeley National  
Laboratory (LBNL)  
Bethany Johns, American Institute of  
Physics (AIP)  
Brian Knesel, DOE  
Krishna Kumar, Stony Brook University  
Lisa McDonald, AIP  
Robert McKeown, Thomas Jefferson  
National Laboratory (JLab)  
Gail McLaughlin, North Carolina State  
University  
Berndt Mueller, BNL  
Allena Opper, NSF  
Erich Ormand, LLNL  
Gulshan Rai, DOE

Robert Redwine, Massachusetts Institute of  
Technology (MIT)  
Don Rej, LANL  
Dariusz Seweryniak, ANL  
Bradley Sherrill, National Superconducting  
Cyclotron Laboratory  
Paul Sorensen, DOE  
Alan Stone, DOE, High Energy Physics  
James Symons, LBNL  
Bogdan Mihaila, NSF  
James Ulvestad, NSF  
Harry Weerts, ANL  
Boleslaw Wyslouch, MIT  
Sherry Yennello, Texas A&M University  
(TAMU)

**June 2, 2017**  
**Morning Session**

**WELCOME AND INTRODUCTIONS**

NSAC Committee Chair **David Hertzog** welcomed everyone and asked the NSAC members to introduce themselves and state their areas of expertise.

**PERSPECTIVES FROM THE DEPARTMENT OF ENERGY**

**Steve Binkley**, Acting Director, DOE, Office of Science indicated that Secretary of Energy, Rick Perry, has started visiting each national laboratory. The Senate Confirmation Hearing for Deputy Secretary of Energy, Dan Brouillette, was held one week ago. Notable changes within SC have been the departure of Cherry Murray (January 2017), the retirement of Patricia Dehmer (November 2016), and the appointment of Barbara Helland as the Associate Director for Advanced Scientific Computing Research (ASCR).

A significant feature of the President's Budget Request (PBR) for Fiscal Year (FY) 2018 is the reduction of the SC budget by 17% (~\$900M), reflecting the administrations priorities on defense and national security, and a shift towards earlier stage research and development (R&D). SC completed its budget appropriations briefings and is awaiting the House and Senate marks.

The 12 GeV Upgrade project in NP should be finished this year and the Facility for Rare Isotope Beams (FRIB) is continuing ahead with a \$20M reduction in the funding request for FY18, relative to their baselined profile. Both the Gamma Ray Energy Tracking Array (GRETA) and the Stable Isotope Production Facility (SIPF) Major Items of Equipment (MIE) are trying to maintain momentum.

Binkley reminded NSAC that given the FY18 PBR, the best thing to do is focus on the Long Range Plan (LRP) and bring the community together to speak with a unified voice. The long-range planning process makes a difference in appropriations discussions.

**Discussion**

**Martin Savage** asked about the role of universities going forward given the budget situation. **Binkley** said SC intends to continue supporting university research. The funding

opportunities for laboratories and universities will continue to be available through the Funding Opportunity Announcements (FOAs).

**Mark Pitt** inquired about the time lag for awardees to receive DOE grant funding.

**Binkley** said the incoming administration purposely wanted to evaluate all DOE funding actions. The process is in place and most SC funding actions and FOAs have cleared.

**Bethany Johns**, AIP, asked for an update regarding the workforce reduction memorandum from the Office of Management and Budget (OMB). **Binkley** clarified that the memorandum was directed at the federal workforce only, not grantees or national laboratories. The OMB memorandum is directed at SC's program management lines which consume 3-4% of the total SC budget. Examination of ways to streamline efficiencies has intensified and SC's plan will be delivered to OMB by the end of June.

## PERSPECTIVES FROM THE NATIONAL SCIENCE FOUNDATION

**James S. Ulvestad**, Acting Assistant Director for Mathematical and Physical Sciences (MPS), NSF shared the news that the Laser Interferometer Gravitational Wave Observatory (LIGO) has confirmed a third detection of gravitational waves. Organizational changes to NSF were shared along with information concerning the effect of the OMB Federal Agency Reform guidance in April 2017. While Ulvestad believes NSF will see little impact in terms of its workforce, he is concerned about the outgoing funding and user facilities. NSF is moving from Arlington, VA to Alexandria, VA during the July – September 2017 timeframe.

The American Innovation and Competitiveness Act (AICA) was passed in January 2017 and provides new requirements for NSF and the National Institute for Standards and Technologies (NIST). Appropriations for FY17 were passed by Congress in May 2017; NSF's budget is essentially flat with respect to FY16 enacted budget. NSF is currently preparing their plan for FY17, but the PHY budget will principally be flat. The NSF Director has testified before House appropriators about the FY18 PBR and NSF Assistant Directors are meeting with Congressional members and their staff to discuss the FY18 PBR. The NSF FY18 budget request is \$6.65B, an 11% decrease from previous years, and is consistent with the administration's priorities. NSF is continuing to invest in research infrastructure.

NSF priorities related to the FY18 budget request included funding all the science and engineering disciplines, supporting early career awardees, protecting the core (individual investigators and high-priority facilities), and rolling back accretions (graduate fellowships). MPS distributed a 10.3% cut uniformly across the divisions in the Directorate. Ulvestad echoed Binkley's statement concerning the FY18 PBR, for NSAC an important part of the process is a clear articulation of priorities from the community.

## Discussion

**George Fuller** asked about LIGO's budget with regard to the FY18 PBR. **Ulvestad** said LIGO's FY18 budget request is flat with respect to the FY17 request and FY16 actual at \$39.43M. **Fuller** said that being able to see neutron star mergers and to get the eventual sensitivity limit is important to the nuclear physics community. **Ulvestad** noted that LIGO is scheduled to continue current operations until late August and then work on commissioning bringing the sensitivity up to the ultimate limit that Advanced LIGO is supposed to reach. Opportunities to repair the small leaks in the vacuum lines at the LIGO Livingston Observatory during the shutdown are being examined; the LIGO Hanford Observatory may have the same issue.

**Michael Lisa** asked about de-emphasizing in terms of investigators' early and future career awards. **Ulvestad** said that MPS's Physics Division (PHY) funds most early career investigators through the regular physics grants program. PHY tries to protect those regular programs, then the program officers ensure there is a balance in their program between early, mid, and late career. The emphasis on career awards is answered, in part, in the budget request as well as NSF's internal guidance of ensuring a balance of career levels in proposal selections.

**Lisa** asked how the community could provide guidance on priorities and budget. **Ulvestad** said the LRP is the most important component of community guidance, but also suggested utilizing the mechanisms and tools within the sub-programs, such as the decadal survey.

**Helen Caines** referred to the roll back on accretions and asked for clarification on the changes relative to graduate fellowships. **Ulvestad** stated that 30,000 graduate students are funded by NSF in a given year through normal research grants. NSF has been funding 2,000 graduate students per year through graduate research fellowships. Rolling back the fellowships to 1,000 enables the individual investigator award programs to be more robust. Students working on research grants are working on their advisor's research, whereas a graduate research fellowship allows them to be more self-directed.

## DOE OFFICE OF NUCLEAR PHYSICS OVERVIEW

**Timothy J. Hallman**, Associate Director, DOE, Office of Nuclear Physics (NP) walked through the FY18 PBR and its potential impacts on NP. The FY18 PBR is a decrease of 19.2% (~\$119M) for NP with respect to the FY17 enacted budget. NP will focus on the most critical areas of nuclear science research, the Relativistic Heavy-Ion Collider (RHIC), the 12 Giga-electron Volts (12 GeV) Continuous Electron Beam Accelerator Facility (CEBAF), the Argonne Tandem Linac Accelerator System (ATLAS), and construction of FRIB and the Stable Isotope Production Facility (SIPF) MIE. All nuclear physics-supported operations at TUNL, TAMU, and the Lawrence Berkeley National Laboratory 88" cyclotron are paused. Targeted cuts to research in the NP FY18 budget request were in the RHIC Spin Program, Large Hadron Collider (LHC) Heavy Ion Program, MIT Research and Engineering Center, new Early Career Awards, and a general reduction of 24.5% across all research lines. Jehanne Gillo, DOE, provided a list of impacts of the FY18 PBR on other NP projects in medium energy, heavy ion program, nuclear structure and astrophysics and fundamental symmetries, theory, nuclear data and Scientific Discovery through Advanced Computing (SciDAC), and DOE Isotope Program, available at [https://science.energy.gov/~media/np/nsac/pdf/201706/Impacts\\_of\\_FY\\_2018\\_Presidents\\_Request.pdf](https://science.energy.gov/~media/np/nsac/pdf/201706/Impacts_of_FY_2018_Presidents_Request.pdf).

Hallman shared other news with NSAC as well. RHIC, the only polarized proton collider and dedicated heavy ion collider in the world, continues to set records for luminosity. JLab operates for 10 weeks in FY18. The 12 GeV CEBAF Upgrade is 99.9% complete. FRIB construction is 77% complete but there will be some delay and cost growth due to the reduced funding in FY18 of \$20M. The FY18 budget request for GRETA, a Major Item of Equipment (MIE), is \$0.2M and the total project and schedule will have to be reevaluated in the context of available funds. Construction of SIPF is a priority because the U.S. is dependent on other countries for stable isotopes.

The U.S. has unquestioned world leadership in experimental Quantum Chromodynamics (QCD) research. CEBAF and RHIC are both unique and at the "top of their game" with compelling "must-do" science in progress or about to start. Long term, the future of QCD

science is pointing to the need for an electron-ion collider. Near term, there is a wealth of science opportunity at ATLAS, and longer term FRIB will be world leading. NP is beginning to position the low energy experimental community to take full advantage of FRIB. The Theory Alliance (and support for theory in general) is also crucial. A very high priority for the NP community is U.S. leadership in the science of neutrino-less double beta decay. Research and production efforts to meet the Nation's need for isotopes in short supply are being strengthened; re-establishing U.S. capability for stable isotopes will be a major advance and will help address community concerns in this area documented in the 2009 and 2015 NSAC Strategic Plans.

## Discussion

**Sofia Quaglioni** asked if the vacant and acting positions within NP will be affected by the workforce reduction mandate. **Hallman** said SC does not yet know what the Federal Agency Reform will mean, but discussions are underway. SC is currently unable to fill vacant positions; instead SC is seeking interim individuals from the laboratories.

**Geoffrey Greene** requested that Hallman confirm that what was presented is the worst case. **Hallman** said what was presented encompasses the full range of anything provided for FY18.

**Mei Bai** asked how international collaborations may be impacted given the budget situation. **Hallman** said SC is very concerned about the impact on international relations from the proposed reductions in the RHIC Spin and LHC heavy ion programs. Japan's interest in RHIC has been mainly on Spin and their contribution over the years has been approximately \$150M. NP has provided the principals with some sense of what the FY18 PBR means. The LHC program has been enormously productive and has accelerated the pace of discovery in heavy ion physics; while not the major DOE participant in the overall LHC program, NP is still very concerned regarding relations on nuclear physics at the LHC. Hallman has spoken with the principals at LHC and will have more conversations with managers later to provide perspective on what the FY18 PBR means.

**Quaglioni** asked about the prioritization process in the event the FY18 PBR becomes the enacted budget. **Hallman** said that scenarios have not yet been optimized and all the program managers will have the ability to optimize within their bottom lines.

**Lisa** asked what drove the decisions to target certain areas. **Hallman** said while NP realized exiting the LHC would be painful, the focus had to be the flagship facility and program at RHIC.

**Hertzog** asked if there was a calendar for gathering information based on the House and Senate marks. **Hallman** said there was no specific timeframe and the need for information depends on the House and Senate marks. If Congress decides on a budget close to the FY18 PBR then a strategy on revising priorities would occur sometime in FY18. What NP submitted will allow work to continue for a time, but decisions that would become effective in FY18 would have to be made.

**Savage** asked about the long-term damage to U.S. competition in nuclear physics if junior scientists go elsewhere. **Hallman** thought the U.S. would lose leadership in some areas, but asked NSAC to keep in mind that the budget process is a process and that junior people interested in NP as a career choice need to be patient.

**Caines** asked if NP was preparing for another competitive review. **Hallman** said it is too early to say.

**Barbara Jacak**, University of California, Berkeley and LBNL, asked two questions 1) if there would be any change to funding existing early career awards, and 2) where scientists would go if both the LHC heavy ion program and RHIC go away. **Hallman** said that funding for existing early career awards would not change. Remaining flexible would allow NP to continue in the LHC program; NP's exit from the LHC program would not be so complete that there would not be a path back if needed.

**Bob Redwine**, MIT, asked about rescinding targeted cuts should the FY18 appropriations be similar to the FY17 appropriations. **Hallman** said SC has not discussed this yet, but he projected if the FY18 budget is similar to FY17 enacted budget the targeted cuts could be reinstated.

**Sherry Yennello**, TAMU, asked about communication with the community as the House and Senate marks come in. **Hallman** guessed SC would use the available instruments such as NSAC.

**Hertzog** adjourned NSAC for a break at 10:50 a.m. The meeting was reconvened at 11:20 a.m.

## NSF NUCLEAR PHYSICS OVERVIEW

**Allena Opper**, Program Officer, Nuclear Physics, NSF discussed the NSF budget process and funding opportunities. Because NSF's appropriation is at a high level with little detail, NSF must get Congressional approval for how the agency will allocate the appropriation within NSF directorates and divisions. To get that approval, NSF submits the NSF Budget Book to Congress through the OMB and Congress has 30 days to make comments. If there are no comments, the budget is approved. This process, which doesn't start until after an appropriation is made, means that appropriated funds are not available for making awards until about two months after the appropriation. NSF's FY18 budget request is \$6.6B, a decrease of 11.2% compared to FY16. The total PHY budget is down from the FY16 funding level by 8.5% and research for PHY will decrease by 12.7% in FY18.

Opper discussed funding opportunities in physics, Midscale Instrumentation, and CAREER programs. Currently PHY supports six midscale projects: ATLAS, LHC-beauty (LHCb), Compact Muon Solenoid (CMS), Super Cryogenic Dark Matter Search (SuperCDMS), Search for an electric dipole moment of the neutron (nEDM), and MUon proton Scattering (MUSE). Twenty-three Major Research Instrumentation (MRI) NSF 15-504 proposals were received; 10 of which were in experimental nuclear physics.

Principal Investigators at Alliances for Graduate Education and Professoriate (AGEP) schools or AGEP affiliated institutions, can apply for graduate research supplements. The Dear Colleague Letter (DCL) 16-125 contains more information on AGEP opportunities.

## Discussion

**Lisa** asked about the effect on the ATLAS and CMS upgrades if DOE pulls out of LHC. **Opper** said that PHY collaborates and coordinates closely with NP and there is currently no plan to change PHY funding for those activities.

**Hertzog** asked how NSF begins the budget process for FY19. **Opper** said Nuclear Physics meets with the Division Director regularly about the challenges and opportunities now and on the horizon. In terms of preparing the FY19 budget, the Division Director requests information from program officers and that information goes into preparing the budget.

**Ulvestad** added that the Division Directors may only share information on a need-to-know basis.

**Hallman** said that in DOE NP is similar; guidance comes from SC management to address specific scenarios but there has been no direction yet.

## **DISCUSSION OF MORNING PRESENTATIONS, NSAC**

**Hertzog** opened the discussion period for NSAC members to comment on anything discussed in the morning presentations.

**Meziani** sought clarification on proposals asking if the budget should be assumed flat over the three year period of performance. **Hallman** said DOE has not yet addressed this but SC is remaining flexible to address the whole range of possibilities. SC is not making decisions that have irreversible consequences and are trying to maintain a normal outlook. **Ulvestad** added that NSF does risk mitigation against future budgets. NSF also gives out two types of awards, standard and continuing. When the future is particularly uncertain NSF gives more standard awards with fewer out-year commitments.

**Hafidi** asked how budget priorities are set between MPS and NP. **Hallman** clarified the question and said the starting point was that everybody shared an equal percentage of the reduction, then there was an overlay of the Secretary of Energy's priorities, and some tuning according to SC priorities. **Hafidi** asked about push-back from the sub-programs. **Hallman** said all of the sub-programs in SC work as a team; the value of NP and the impacts of what can be lost are voiced.

**Lisa** asked how the FY18 PBR affects the full funding mandate. **Hallman** said that within DOE the full funding mandate is still in effect. When an award is made, all of that funding is obligated even though the allocation will be year-by-year.

**Hertzog** adjourned NSAC for lunch at 12:06 p.m.

### **Friday, June 2, 2017 Afternoon Session**

The NSAC meeting was reconvened at 1:33 p.m.

## **FURTHER DISCUSSION OF MORNING PRESENTATIONS, NSAC**

**Hertzog** read a question from **Kolomensky** who asked for advice on the strategy of dealing with potential cuts and risks in the various continuing resolution (CR) scenarios. **Hallman** said that the response depends on what happens, within DOE, SC always needs to operate at lowest of any proposed budget. If there are no marks from Congress by September 30, 2017, DOE may be obliged to operate at the level of the FY18 PBR. That could be particularly challenging at the laboratories because they are less flexible in terms of the time needed if they have to react. **Hallman** suggested being prudent where possible and retaining flexibility in the budget. DOE does not believe that making a big irreversible change in a program at this time is the best strategy. **Opper** added that planning should be based on the President's Budget Request. She reiterated that people should be frugal; if there is a CR, NSF would be funded at a prorated rate at the FY17 funding level.



## **INTRODUCTION TO AFTERNOON LRP “SNAPSHOT” PRESENTATIONS, David Hertzog, NSAC**

**Hertzog** reviewed the afternoon agenda which focused on science and physics. The presentations will provide a snapshot on the progress of the 2015 LRP; NSAC covered Recommendation 1 and Theory Initiatives.

## **CEBAF UPGRADE STATUS AND EARLY PHYSICS, Bob McKeown, JLab**

Realizing the science potential of 12 GeV CEBAF is the top priority in the 2015 Long Range Plan (LRP). McKeown shared the progress on projects and experiments at CEBAF. Full luminosity and multi-Hall beam delivery have been demonstrated. In Hall C, the super high momentum spectrometer was installed and commissioned with beam during March 2017. In Hall B, key performance parameters for CEBAF Large Acceptance Spectrometer 12 GeV (CLAS12) were demonstrated in February 2017. Future proposed projects include the MOLLER experiment which received Critical Decision (CD) CD-0 in December 2016 and the Solenoidal Large Intensity Device (SoLID) experiment which will have a pre-CD review this summer. The JLab Program Advisory Committee approved 76 experiments, four of which have been completed. Accelerator activities include the GlueX runs in 2017, deeply virtual Compton scattering experiment and high momentum transfer magnetic form factor of the proton experiment, and an experiment on the argon spectral function which will yield the nuclear physics needed to interpret future liquid argon neutrino data. The Heavy Photon Search (HPS) experiment, funded by High Energy Physics (HEP), has analyzed their engineering run. DOE funded GEM tracking detectors to implement the Proton radius experiment (PRad).

McKeown closed stating the 12 GeV Upgrade at JLab is a major investment. JLab's large and growing user community is anxious to realize the science program. JLab is ready to start the 12 GeV science program. It is important to remember that MOLLER, SoLID and other smaller projects are also essential to realizing the full potential of CEBAF at 12 GeV.

### **Discussion**

None.

## **FRIB CONSTRUCTION STATUS AND DAY 1 PHYSICS, Thomas Glasmacher, Michigan State University**

Glasmacher indicated that construction of FRIB is approximately 76% complete, with civil construction finished, technical construction at 70%, front-end accelerator ready to review in July 2017, and key performance parameter achievements demonstrated in FY17. Eight of the 49 cryomodules (~15%) have been tested in the tunnel; accelerated beam in cryomodules will be produced in 2018, and the cryoplant is on track to make liquid helium in winter 2017. FRIB will offer opportunities on day 1 of operation. FRIB is making 18 cold superconducting magnets together with the national laboratories and international partners. FRIB has 1,400 users organized into 19 working groups. The National Research Council of the National Academies Rare-Isotope Science Assessment Committee (RISAC) report indicates the science capabilities that FRIB needs to address; 17 representative programs constitute the scientific scope of effort. FRIB users developed plans for detectors and the day 1 science program. These plans are reviewed by the FRIB Science Advisory Committee.

The transition from an NSF-funded NSCL to DOE FRIB scientific user facility is well-organized between the agencies. The guiding principle is to retain the nation's leadership in rare

isotope science and minimize the impact on the scientific community. The Theory Alliance is now in its second funding cycle as part of FY17, and will initiate the bridge program for faculty and staff bridges.

### Discussion

**Meziani** asked which detectors are part of FRIB. **Glasmacher** said none of them are part of the FRIB project. Separator for Capture Reactions (SECAR) fabrication has started and is supported by DOE and NSF; GRETA had a pre-CD-1 review in May, High Resolution Spectrometer (HRS) is conducting pre-conceptual R&D, and Beta-decay is being discussed.

**Hafidi** asked Glasmacher which one of the detectors he would want to see ready for Day 1 science. **Glasmacher** responded that for day 1 and reaccelerated beams, SECAR is essential because there is no recoil separator for low-energy beams. GRETA is extremely important but is slightly less than essential because Gamma-Ray Energy Tracking In-beam Nuclear Array (GRETINA) already exists. HRS is also very important; the S800 Spectrometer exists but is limited to 4 Tm rigidity and it cannot make use of the full rigidity and thus the yield provided by FRIB. And the Beta-decay endstation is also important but could possibly be Day 2. **Hafidi** asked if Glasmacher would expect the same length of experiment, 100 hours. **Glasmacher** said in their experience most experiments do not exceed 10-days.

**Hertzog** asked if the experience at Paul Scherrer Institut (PSI) was relevant. **Glasmacher** said yes, one of the senior operators was trained at PSI.

### THEORY INITIATIVES, Gail McLaughlin, North Carolina State University

McLaughlin shared the 2015 LRP theory initiatives: 1) new investments in computational nuclear theory, 2) establish FRIB Theory Alliance, and 3) increase the number of topical collaborations. There is one endorsement to develop a plan to enhance the theory effort in neutrinos and fundamental symmetries. New investment in computational nuclear theory includes SciDAC, complementary efforts, and deployment of capacity computing. Complementary efforts focus on exascale computing and the Jet Energy-loss Tomography with a Statistically and Computationally Advanced Program Envelope (JETSCAPE). Two grants on exascale computing in NP have been funded, and JETSCAPE was awarded last year by NSF. The infrastructure for the FRIB Theory Alliance is being developed and a second project has been recommended by SC. Four new collaborations have been funded since 2015 LRP: Transverse Momentum Distributions (TMD), Beam Energy Scan Theory (BEST), Double Beta Decay (DBD) and fundamental symmetries, and Fission in the r-Process Elements (FIRE). Finally, the NSF theory hub (N3AS) in neutrinos and fundamental symmetries has been awarded.

### Discussion

**Hertzog** stated that almost everything in the theory initiatives was addressed and asked if there was anything still remaining. **McLaughlin** said no, nothing was forgotten.

**Meziani** asked about the collaborations' interactions with Lattice QCD. **Savage** said there have been preliminary calculations using Lattice QCD performed on intermediate meson-exchange contributions and direct two nucleon contributions and identification of additional operator structures that have not been seen before. **Meziani** added that both BEST and TMD are deeply involved in lattice calculations but not the other two collaborations.

**Hafidi** asked about the FRIB bridge positions, status with the current funding situation. **Glasmacher** noted the principal investigator (PI) has indicated the position will move forward. **Hafidi** clarified that this is the bridge position where the institutions will be chosen. **Glasmacher** said correct, one bridge position will move forward. **Mclaughlin** added that the institution has been chosen but not announced to the community.

**Hertzog** asked for clarification on the relationship of high performance computing to NP. **Mclaughlin** said that in the Exascale Computing Project (ECP), NP played a role in advocating for nuclear theorists. The ECP is not to do immediate science; it is meant to get coding ready so that it can be run on the architectures of exascale machines.

**Jurisson** stated that there is a large QCD component in the DBD collaboration and the bridge position at the University of North Carolina is held by a Lattice QCD researcher.

**Savage** commented that there has been no additional funding provided for capacity computing hardware for Lattice QCD and under the FY18 PBR, the HEP contribution will terminate in 2017 and the NP contribution will be paused.

**Berndt Mueller**, BNL, asked if Mclaughlin could say a few words about the Institute for Nuclear Theory (INT) and asked how the INT would be impacted in the FY18 PBR.

**Mclaughlin** said that INT's importance is well-known, not only in running programs, but also the postdoctoral program for training new people. Another important part of the NP program is the Base program. **Hallman** indicated that the reductions, handled in the individual subprograms, are not optimized yet. In principle, INT is subject to the same general reduction. **George Fai**, DOE, mentioned that the first thing INT would suffer is the number of programs, and there may be fewer postdoctoral appointments.

**Hertzog** adjourned for a break at 3:03 p.m. and reconvened at 3:22 p.m.

### **RHIC HEAVY ION AND SPIN PROGRAM STATUS, Berndt Mueller, Brookhaven National Laboratory**

Mueller stated that RHIC is the only polarized proton collider in the world. Luminosity continues to increase and has reached 44 times the design value. RHIC highlights included four experiments on collective flow, vorticity, and transverse spin in QCD. In 2018 RHIC plans to conduct a high statistics isobar system run, to complete the low-energy electron cooling upgrade, install the inner Time Projection Chamber (iTTPC) upgrade for Solenoidal Tracker At RHIC (STAR), and finish two runs with Au+Au at different energies to complete a second high statistics beam energy scan, install strongly interacting Pioneering High-Energy Nuclear Interaction eXperiment (sPHENIX), and carry out detailed runs in 2020 and beyond.

Two upgrades to RHIC Beam Energy Scan (BES-II) are the Solenoidal Tracker at RHIC (STAR) detector, to extend its coverage and rapidity, and the luminosity of the machine at the lowest energies. There are three campaigns of RHIC delivery: Campaign 1 (2014-2017) focused on heavy flavor, Campaign 2 (2018-2020) RHIC will focus on the chiral symmetry restoration and chiral magnetic effect and the second beam energy scan, and Campaign 3 (2020++) includes measurements using sPHENIX.

### **Discussion**

**Hertzog** asked about Lambda polarization. **Mueller** stated that the understanding of this is in the proton collision and is reflected in the initial spin momentum structure of the colliding nucleons. The original proposal was that if you form quark gluon plasma where the hyperons are

formed by coalescing of quarks, that correlation would be destroyed. Publications in the 1980s and 1990s indicated that the disappearance of Lambda polarization was a signal for the quark gluon plasma. The experiment here is very different because it does not look at the global polarization overall but with respect to the collision plane. The result here is fundamentally different. Analysts show that there is a small, but non-zero effect. Now we can look at the properties of the quark gluon plasma rather than its existence.

### **STATUS OF TARGETED OPPORTUNITIES IN FUNDAMENTAL SYMMETRIES AND NEUTRINOS, Krishna Kumar, Stony Brook University**

Kumar stated that fundamental symmetries and neutrinos address big questions about the origins of all matter in the universe and implications for the characteristics of the basic forces in nature. Three broad areas encompass the strategy of targeted initiatives: the nature of neutrinos, electric dipole moments, and the new standard model. A variety of experiments in this field are operating and yielding interesting results. Potentially profound, new discoveries and insights to the big questions exist.

#### **Discussion**

**Meziani** asked what is limiting the uncertainties in Muon  $g-2$ . **Hertzog** stated that the target is to balance the statistics and the systematic uncertainties. The two systematics are 70 parts per billion (ppb) and the statistics are 100 ppb. The whole total is 140 ppb, which is four times better than the BNL result. Theoretical 3<sup>rd</sup> order systematics are being found; while they are subtle, low, and tiny, they are no longer totally ignorable as they were at BNL.

#### **PUBLIC COMMENT**

None.

**Hertzog** thanked all presenters and shared his thoughts on the value of these sessions. We are a community, we need to continue to inform ourselves, and we need to all be ambassadors for the entire program. These talks allow each of us to become up-to-date with the work being done outside of our subfield. There has been a huge jump of progress, just being two years into the LRP. Despite the budget situation discussed this morning, we have such an incredibly compelling physics case story and so much momentum going on right now that we should be able to share that at the right moments and in the right venues. The right way to do it as a community on behalf of the strength of the field.

**Hertzog** adjourned the June 2017 NSAC meeting at 4:13 p.m.

The minutes of the U.S. Department of Energy and the National Science Foundation/Nuclear Science Advisory Committee meeting, held on June 2, 2017, at the Hilton Hotel, Rockville, Maryland, are certified to be an accurate representation of what occurred.



David Hertzog, Chair of the Nuclear Science Advisory Committee on