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

PUBLIC MEETING MINUTES

Bethesda North Marriott Hotel and Conference Center
5701 Marinelli Road, Bethesda, MD 20852

March 23, 2016

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 8:00 a.m. EST on Wednesday, March 23, 2016, at the Bethesda North Marriott Hotel and Conference Center, Bethesda, Maryland, by Committee Chair Donald Geesaman.

Committee members present:

Donald Geesaman, Chair	Karsten Heeger	Jamie Nagle
Paul Benny	David Hertzog	Jeffrey Nico
Helen Caines	Roy Holt	Filomena Nunes
Abhay Deshpande	Kate Jones	Daniel Phillips
Frederic Fahey	Suzanne Lapi	Jorge Piekarewicz
George Fuller	Michael Lisa	Krishna Rajagopal
		John Wilkerson

Committee members unable to attend:
John Hardy, Cynthia Keppel, Mark Pitt, Martin Savage, Raju Venugopalan, and Michael Wiescher.

NSAC Designated Federal Officer:
Timothy Hallman, U.S. Department of Energy (DOE), Office of Science (SC), Office of Nuclear Physics (ONP), Associate Director

Others present for all or part of the meeting:
Ethan Balkin, DOE SC
Angela Bracco, NUPECC
Fleming Crim, NSF
David Dean, Oak Ridge National Laboratory (ORNL)
Jens Dilling, TRIUMF
James Dunlap, Brookhaven National Laboratory (BNL)
George Fai, DOE SC
Glenn Fox, Lawrence Livermore National Laboratory (LLNL)
Marc Garland, DOE SC
Jehanne Gillo, DOE SC
Robert Janssens, ANL
Allison Lung, Jefferson National Laboratory (JLab)
Bob McKeown, JLab
Bogdan Mihaila, NSF
Hugh Montgomery, JLab
Cherry Murray, DOE SC
Allena Opper, NSF
Erich Ormand, LLNL
Robert Redwine, MIT
Lee Schroeder, Lawrence Berkeley National Laboratory (LBNL) / TechSource
Brad Sherrill, Michigan State University National Superconducting Laboratory (NSCL)
Michelle Shinn, DOE SC

Jim Sowinski, DOE SC
Alan Stone, DOE SC
James Symons LBNL
Alan Weinstein, California Institute of Technology (CalTech)
Scott Wilburn, LANL
Boleslaw Wyslouch, MIT

MARCH 23, 2016

NSAC YEARLY ETHICS BRIEFING

NSAC members were provided with the yearly ethics briefing.

OPENING REMARKS

The U.S. Department of Energy (DOE) and National Science Foundation (NSF) Nuclear Science Advisory Committee (NSAC) was convened at 8:30 a.m. EST on Wednesday, March 23, 2016, by **Committee Chair Donald Geesaman**. 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.

DOE OFFICE OF SCIENCE OVERVIEW

Cherry Murray, Director, DOE Office of Science (SC), described DOE's mission areas and devotion to nuclear safety and security, and environmental cleanup. DOE Offices fund science within their specific portfolios.

The fiscal year (FY) 2017 Congressional Budget Request is being marked up as SC works on the FY18 budget. The SC FY16 budget is $5.35B. The FY17 budget request is $5.67B, representing a 6.1 percent increase. Mission Innovation, funded at $1.8B in SC, is a highlight in the budget. It is a multi-nation initiative focused on clean energy development and strives to increase energy innovation technologies and associated R&D spending over the next five years..

Exascale computing is a focal point in SC Advanced Scientific Computing Research (ASCR). Within SC Basic Energy Sciences (BES), the BES Advisory Committee is charged to prioritize BES facility spending. The SC Biological and Environmental Research (BER) budget includes spending on Bioenergy Research Centers. SC contributes to DOE crosscuts. SC High Energy Physics (HEP) focuses on international collaborations. HEP is seeking to stage simultaneous upgrades on multiple facilities but this may not fit in the budget. SC Nuclear Physics (NP) activities include continuing construction on the Facility for Rare Isotope Beams (FRIB) and this is a priority for Murray.

The 2015 Long Range Plan for Nuclear Science enables communication of the Department's NP program to Congress.

The Relativistic Heavy Ion Collider (RHCI) is exceeding performance expectations; it is a high priority to continue operating the facility.

FRIB is on track and the Gamma-Ray Energy Tracking Array (GRETA) is proposed to be initiated in FY 17.

Balancing research with science for clean energy and crosscuts is a challenge for FY 17, as is balancing research funding with facility construction and operation. Exascale computing, international partnerships, and effective laboratory management are key issues.

Office of Management and Budget (OMB) scoring for Mission Innovation reflects 70 percent of applied energy funds and 30 percent in use-inspired science, out of $4.8B in FY 17 funds.

Murray considered the 28 FY 16 SC user facilities. Within facility funding, SC is investing less than 50 percent of its funds in research. Murray shared that construction is around 15 percent which is the right level. Funding for facility operations is putting pressure on research funding.

Moore's Law is expected to end with growing investment and interest in the Exascale Computation Grand Challenge. R&D will be done in collaboration with industry partners to bring about new hardware and software advances.

Murray reviewed the International Thermonuclear Experimental Reactor (ITER) investment, dating back to an agreement between President Reagan and Prime Minister Gorbachev. The costs for ITER have expanded. Some of the fusion community see ITER as a way to get to burning plasma while others see ITER as an opportunity lost. Congress is angry with the project and expects a report in May 2016 recommending that the U.S. remain a partner after October 2017 or terminate its participation. Remaining participation would constitute DOE's largest investment. Murray described the ITER management structure as complicated.

Investment in ITER impacts available funding for other activities. An example is the Long Baseline Neutrino Facility (LBNF) that engages European partners.

Murray described how DOE programs fund laboratories.

Discussion

George Fuller noted that the P5 Report described science related to a cosmology observation program. **Murray** shared that SC is building the camera for the Large Synoptic Survey Telescope. SC will lead exascale computation in a big data sense. SC will also take over the Dark Energy Spectroscopic Instrument (DESI) telescope to do dark energy research. As SC excavates the mine in the Western U.S., dark matter research will continue.

John Wilkerson noted the split between research, construction and operations. **Murray** explained that examining the upgrades for different instruments is one way to keep funding levels in balance. There is a charge to the BESAC and opportunity to spread out facility spending and examine new facility development parameters and costs. SC wants to build accelerators cheaper and faster, and noted research at Berkeley and the Stanford Linear Accelerator Center (SLAC). A fusion community proposal is underway to capitalize on 20 years of research from ITER to build something smaller and cheaper. SC needs to start thinking that way.

Murray told **David Hertzog** that SC has a continuum of investments that are small and large with Major Items of Equipment (MIE) in between. Anything over $100M is a big project and requires DOE approve it in a different way.

Filomena Nunes noted that NP's budget is lower despite the overall increase received by SC. **Murray** explained that the increase is from the Mission Innovation investment that may not happen. A flat budget is expected during this continuing resolution period.

Murray was not able to provide **Jeffrey Nico** with any speculation about what may happen with ITER in 2017. Management and project reviews will inform a decision to be made by an international committee meeting at the end of April 2016.

Murray commented that NP is going well and she encouraged thinking internationally.

DOE OFFICE OF SCIENCE NUCLEAR PHYSICS OVERVIEW

Timothy Hallman, Associate Director, DOE SC Nuclear Physics (NP), shared that DOE is the primary steward of U.S. nuclear science with specific goals and deliverables. NP supports nuclear science around the U.S. with three user facilities and FRIB under construction.

A report card on NP stewardship identified DOE effectiveness in meeting 2007 Long-Range Plan (LRP) recommendations. Facility developments and positioning of the field are working to fulfill the 2015 LRP vision. Additional R&D on Neutrinoless Double Beta Decay (NLDBD) is a step toward that vision. The ability to address critical R&D questions prior to making an informed decision about a tonne scale experiment for NLDBD is being discussed with NSF.

A National Academy of Science (NAS) study was initiated to inform movement toward an electron ion collider (EIC) facility. DOE approved the funding proposal. Progress is being made on a second NAS study on space radiation effects testing.

A Funding Opportunity Announcement (FOA) for accelerator R&D was published in March 2016 with proposals due on May 2nd. Beyond this FOA, there is a new direction planned for R&D for the EIC. Discussions with EIC stakeholders informed an approach that will enable future annual investments to be around $7M. Hallman reviewed how the proposal review panel will be established and operate.

Hallman reviewed progress on the Majorana Demonstrator experiment with a goal of demonstrating the very low backgrounds needed for a tonne scale NLDBD experiment.

The nEDM activity at the Spallation Neutron Source is advancing. The task of maintaining high voltage in liquid helium was overcome through research at Oak Ridge National Laboratory.

New results have emerged from the ^{225}Ra EDM Experiment at Argonne National Laboratory.

New activities include advances in measuring neutrino mass by observing electron cyclotron resonance radiation in tritium beta decay. Another experiment is advancing ways to look at a neutron lifetime.

NP is working to set up a dedicated portfolio on fundamental symmetries. Projects currently in other portfolios (principally low energy and medium energy) would be included in this new portfolio and formulating the new portfolio is ongoing homework for NP.

The SC NP conducted a Committee of Visitors (COV) on March 1-3, 2016. The report will be shared at a future NSAC meeting.

The FY17 NP budget request for research shows an increase of $10 M, including growth in isotope research. An increase of $12M for facility operations was also requested. Construction project funding would decrease in FY17 as the 12 GeV CEBAF Upgrade concludes, among other things.

Hallman thanked **Geesaman** for chairing NSAC since 2012. This is his last meeting as Chair.

The outlook for NP is compelling, with growing opportunities at ATLAS and NSCL, and longer term, at FRIB. CEBAF and RHIC have "must-do" science in progress or starting.

Discussion

Geesaman asked for the timescale for the NAS EIC study. **Hallman** shared that the study will likely start in April 2016.

Hallman noted that the NLDBD funding distribution for R&D is expected once DOE and NSF can jointly get the discussions of this FOA through their respective systems.

Karsten Heeger asked about a two to three-year R&D phase and then a downselect for NLDBD funding. **Hallman** believes that the FOA for NLDBD R&D will go out in 2016. R&D results could be seen around 2018 or 2019 with a downselect thereafter. Various projects at different stages of experimentation will inform decisions but the agencies may need to make a decision based on whatever is known at the time a decision is called for.

Hallman clarified for **Michael Lisa** that the joint study being done with the U.S. Air Force on radiation efforts was not connected in any way to the NAS study for the EIC and apologized for any confusion based on these appearing on the same slide.

Hallman shared with **Abhay Deshpande** that thinking about associated detector instrumentation for an EIC is not as advanced as thinking on accelerator R&D for the EIC. **Deshpande** suggested that discussions with international partners on detector R&D could be held to advance their work and get funding from their agencies.

Jorge Piekarewicz asked about the consistency of the timeline for NLDBD and other investments such as the EIC with the LRP. **Hallman** shared that for the moment, the FRIB needs to be completed with the hope that there will be flexibility to invest in beta-decay then the EIC.

Hallman told **Roy Holt** that money for detector funding activities is in the budget. This is demonstrated by funding for RHIC and Jefferson Laboratory. Those are part of the NP planning.

Wilkerson noted the steps for EIC accelerator R&D, and that NDLBD does not have a similar blueprint as the plan laid out at this meeting for EIC accelerator R&D which can frustrate international collaboration on plans and experiments which is important. **Hallman** shared that this comment is similar to previous community input that unlike RHIC and CEBAF, the fundamental symmetries community does not center around a national user facility, making it more challenging to develop similar levels of detailed plans. The need to be timely on Fundamental Symmetries experiments in a competitive world was acknowledged..

NATIONAL SCIENCE FOUNDATION MATHMATICAL AND PHYSICAL SCIENCES OVERVIEW

Fleming Crim, NSF, Assistant Director of Mathematical and Physical Sciences (MPS), shared a high level view of MPS and the FY17 budget request. NSF strategic goals include transforming the frontiers of science, and this is a goal shared with the community. Crim highlighted winners of the National Medal of Science and National Medal of Technology and Innovation being funded by MPS.

Around 29,000 graduate students and senior researchers will participate in MPS funded activities in 2017. Crim shared the dispersal of NSF funding among various academic fields, and how NSF funding has had only two periods of substantial, real growth since 1970.

The FY16 budget is $7.4B and the FY17 request is 6.7 percent higher at $7.9B. Research and Related Activities (R&RA) in the FY17 request is $6.4B. This increase of 6.5 percent is mostly due to mandatory funding designations. MPS funding for FY16 is estimated to be $1.3B with a 6.5 percent increase in the FY17 request bringing the total to $1.4B.

Mandatory funding of $81M would be spent on individual and early career investigators, unsolicited proposals, and computation and data efforts. Topics that would rise to the surface are quantum information science, optics and photonics, and clean energy. The first two are part of the National Strategic Computing Initiative (NSCI) and the latter is a Presidential priority.

MPS is investing in specific initiatives. These total nine percent of the MPS budget and are part of MPS' response to community input. Across MPS' five divisions, most of the MPS budget is going toward investigators. Astronomical Sciences is an exception with most of the funding invested in facilities. The funding dispersals differ based on the science to be done.

MPS and NSF do science at the scales of the universe. Quarks and elementary particles are at the smaller extreme. At the larger extreme are things like the solar system, Crab Nebula, and the observable universe.

Crim described specific science "hors d'oeuvres" to understand some of the specific things that scientists are doing. Discussing gravitational waves is an example of how leadership must address difficult questions around what is being funded and found. There is value in knowing the sensitivity of an instrument and knowing the limits of the instrument to provide content for communication with those outside of the field.

Discussion

Fuller noted that in MPS most of the funding goes to facilities and asked about expenditure breakdown data. **Crim** shared that specific funding levels can be shared. The ALMA project cost about $1B to construct. The rule of thumb for operations is about 10 percent and the annual cost is around $100M.

Piekarewicz shared that there is an overproduction of PhDs with no place to go after graduation. **Crim** responded that there is a lot of discussion of this issue and that postdoctoral support in MPS is about nine percent. The NSF Research Traineeship is replacing IGERT and will support people who are completing their PhDs. NSF would like to work with the community to understand how many people are being trained and how training leads them down the right paths. Crim shared that MPS serves the U.S. by producing education scientists but may not always be effective in providing career pathways.

NATIONAL SCIENCE FOUNDATION MATHMATICAL AND PHYSICAL SCIENCES OVERVIEW

Allena Opper, Program Director, Experimental Nuclear Physics (ENP), shared that 59 proposals were submitted to the Experimental Nuclear Physics Program at a total request of $13M and about $5M is expected to be available. There were six CAREER Program proposals and one was awarded.

While there has been an appropriation to NSF, there is no operating budget yet as approval from Congress is delayed. The PHY FY16 estimate for Research is $174M with an FY17 request of $190M.

Program elements with the Experimental Nuclear Physics program will be realigned to be more consistent with the LRP. For example, Nuclear Astrophysics will be combined with Nuclear Structure. Funding to the different program elements shifts based on funds requested in proposals each year. Opper pointed out that 25% of the NSF support for NSCL is for support of the MSU nuclear science research program. Thirty-four proposals were received for the Major Research Instrumentation (MRI) and 10 went to NP.

NSF and DOE joint collaboration on NLDBD R&E is continuing with optimism that an FOA will be produced shortly.

A "dear colleague" letter was sent to university presidents to announce the Inclusion across the Nation of Communities of Learners of Underrepresented Discoverers in Engineering and Science (INCLUDES) Initiative to strengthen U.S. leadership in STEM and engage groups

historically underrepresented in STEM. The initiative drives toward creating community alignment to ensure that innovative models, networks, partnerships, and research will enable the U.S. science and engineering workforce to thrive by ensuring that women, blacks, Hispanics, and people with disabilities are represented. Pilots for INCLUDES will be launched in 2016. Pre-proposals are requested by April 15, 2016, with funding levels up to $300K per funded proposal.

Discussion

Opper shared the INCLUDES Initiative can include partnerships with industry and others.

Daniel Phillips asked how funding for NSCL will unfold as FRIB comes online. **Opper** shared that as NSCL transitions to FRIB, the research portion of the NSCL support will be transferred to the ENP program and MSU faculty supported by the former will compete for those funds. The remaining NSCL support is for maintenance and operation of the lab and that will no longer be needed when FRIB becomes operational. The Division plans to direct those funds to the Mid-Scale Program. This is expected around 2020 or 2021, and is a time at which there may be new leadership.

Nunes asked about the difficulty around a new solicitation from the DOE and NSF partnership on NLDBD. **Opper** shared that the hope was to have the solicitation by this summer but it takes time to move this through the agencies. Both agencies are committed to this and there is no chance that this will fall through.

Heeger shared that the future NLDBD activity will rely on international collaboration and asked what the agency will need to engage in international dialogue over the next few years. **Opper** shared that every NLDBD experiment has some international collaboration and these are ongoing. There is large interest in beginning the R&D for the next generation and NSF is aware that international involvement will be needed, but R&D has to occur before that. **Hallman** added that there have been forums for communication between agencies and other countries, and noted that there is work to put agreements in place to define international collaboration.

Phillips asked about funding of theoretical physics. **Bogdan Mihaila** shared that the increases in other areas have not been seen on the theory side. This is based on the proposals that have been received.

Hertzog proposed that proposals for NLDBD look to the NSAC report as to guide. The idea with the LRP was that efforts be international and nimble, and advance the timescale. **Hallman** commented that there is a need to get the FOA out and there will be prescribed times when people need to produce things. He suspects that proposals are already being written.

Holt commented that funding trends and data on the Hadrons and Light Nuclei area show decreases and Theory has been decreasing. **Opper** shared that this trend is driven by the proposals that come in, review, and how they are funded. Money moves from one category to another based on the priorities of each review. **Mihaila** shared that some changes in Theory are due to the Recovery Act funds and investments in things such as theory hubs.

Opper confirmed for **Sherry Yennello** that proposals for the INCLUDES could be community-based a citing a proposal from the American Physical Society as an example. INCLUDES is looking for things that can be scaled up and tested. .

COMMENDATION TO DEPARTING NSAC MEMBERS

Hallman and **Opper** presented certificates of appreciation to departing NSAC members.

LASER INTERFEROMETER GRAVITATIONAL-WAVE OBSERVATORY OVERVIEW

Alan Weinstein, California Institute of Technology, described the recent observation of gravitational waves (GW) at the Laser Interferometer Gravitational-Wave Observatory (LIGO) and discussed the connections between gravitational wave sources and the nuclear equation of state, r-process nucleosynthesis and other aspects of nuclear astrophysics. Advanced LIGO construction ended in March 2015, leading to a period of commissioning that will take the instrument to design sensitivity. Once this period ends, Advanced LIGO will be 10 times more sensitive than its predecessor Initial LIGO. The two LIGO interferometers were built by the LIGO Laboratory and funded by NSF. The webcast and pdf file for this 50 minute talk can be downloaded from the NSAC webpage.

Discussion

Krishna Rajagopal noted that some frequencies are high for what LIGO measures. There is an ability to look at tidal information, and **Rajagopal** asked if that has been simulated. **Weinstein** shared that there is a big trade off in measuring BNS and NSBH mergers. LIGO can extrapolate and estimate the rate of interaction. LIGO hopes to detect the rate of BNS interactions. This is different for NSBH mergers and there are no data on these yet. The uncertainty rate is much worse for NSBH mergers and these are on the order of tens per year based on levels of sensitivity. The current state of the field is that there are no solid observations that can inform conclusions. Finding the mergers can be done through the inspiral phase without the need for templates. There are trade-offs when using and not using templates.

Piekarewicz brought up debate about accurately determining neutron star radii. **Weinstein** shared that there is no doubt that the first observations will constrain the radius of the system better than it has been before.

Fuller noted there is a key issue with getting objective data out of these events. Most of the emitted energy is in the form of neutrinos and there is no hope of detecting that information. Neutrinos can interact with material being ejected and this looks at lots of neutrino physics as well. **Weinstein** shared that there is a lot of uncertainty and debate in the field as this is nuclear physics at the frontiers. LIGO has to be lucky to get signals with enough signal-to-noise ratio above one or two kilohertz. This is the beginning of a new field.

STATUS OF THE CANADIAN LONG RANGE PLAN FOR SUBATOMIC PARTICLES

Jens Dilling, Department Head, Nuclear Physics, TRIUMF, described the subatomic particle research long range plan in Canada. The plan identifies venture and priorities, budgetary estimates for prioritized activities, and funding ranges or contribute to ventures. It covers a timeline from 2017 – 2021. The development of the plan was commissioned by the Natural Sciences and Engineering Research Council of Canada (NSERC).

The Canadian research community identifies compelling research topics and funding agencies govern what will be funded. The community has engaged in the developing the plan since early 2015 with completion scheduled for July 2016.

The main recommendation of the plan is to strongly support theoretical research in subatomic physics, and the community supports investments in experimental activities.

Scientific recommendations are to support facilities and experiments producing scientific results, smaller-scale efforts in which Canada is participating, activities in potential flagship

activities to position Canada's leadership role, and proposals for direct and generic accelerator and detector research. The last recommendation was generated via strong community support.

A primary policy recommendation is to strengthen diversity in the physics community. Information and statistics collection and analysis can help achieve this recommendation.

Growing scholarship funding for graduate student training, and forming more government representative and stakeholder relationships with CERN are among the policy recommendations. It is also recommended that the current envelope system used by NSERC be retained and carefully managed to support new project development, and grown over the next five years. It is also recommended that resources and funding be coordinated across agencies and laboratories. The plan recommends that the Canada Foundation for Innovation (CFI) consider applications for international projects not yet approved and provide awards contingent on project approval.

Discussion

Geesaman asked how the increased consultation between NSERC and other bodies such as CFI will occur. **Dilling** pointed out that NSERC and CFI interacted for the first time due to this plan development process. Proposals will also be communicated between bodies.

Lisa noted the recommendation to support efforts in which Canadian users could be involved and asked about the geographic range. **Dilling** confirmed that efforts include FRIB and other sites in the U.S. and activities in Europe and Japan.

Kate Jones suggested that the funding cycle of five years in the long range plan seems small. **Dilling** shared that Canada operates under five-year funding cycles. The plan looks 10 years ahead and provides funding scenarios for five years to make sure the funding actually works out.

Geesaman suggested an annual call with CFI to match timescales. The idea that unapproved proposals and competition-approved proposals could be considered could create a challenge. **Dilling** shared that some unspent funds were lost in the past. The CFI was set up by the Canadian government to keep the funds in the pot and maintain resources for these types of proposals.

Heeger asked about the number of people involved in physics. **Dilling** shared that the population and GDP of Canada is about 10 times less than the U.S. That also reflects the physics community. There is about $10B in national government funding for scientific research.

Phillips asked about the recommendation to maintain support for theoretical research and experimental activities. **Dilling** clarified that the recommendation is written to indicate that theory does receive strong support. There is an imbalance for nuclear physics experiments and underground neutrino physics but the need for more theoretical support. The committee can only give scientific recommendations in the long range plan to encourage the community. The plan will go to departments and university presidents, and seeks to give incentive to agencies to initiate activities. The committee itself was not commissioned to identify new initiatives.

Helen Caines pointed out the value of striving for diversity in particle physics and asked if the plan is leading the charge for diversity. **Dilling** shared that this is pointed out by the community in town hall meetings and briefs. The plan does not challenge someone to work on this but encourages this.

Nunes asked if NSERC is already compiling data on diversity and representation. **Dilling** shared that NSERC is doing this but does not represent the entire community.

Hertzog asked how a laboratory proceeds with hosting an experiment and what is provided. **Dilling** shared that with an example like SNOLAB, one would propose an experiment and get it

and space approved. A series of lifecycle gates equal to CD stages would be used to provide that the experiment is secure and able to proceed. Different pockets of money would be accessed through means such as foreign collaborators with funding. In the SNOLAB example, it would provide some support and research scientists, engineers, and technical support who could help with the operation.

Dilling shared that a recommendation to take on social initiatives is still on table and words for membership were carefully crafted. This is ongoing with strong support from community.

NUCLEAR PHYSICS EUROPEAN COLLABORATION COMMITTEE LONG RANGE PLAN

Angela Bracco, Nuclear Physics European Collaboration Committee (NuPECC) Chair, Universita di Milano, shared the long range plan for nuclear science in Europe. NuPECC involves 21 countries and consistently interacts with other nations and bodies to include NSAC.

Four long range plans have been developed over six to seven year intervals dating back to 1991. The 2010 long range plan recommended the construction of the FAIR and SPIRAL2 facilities, and upgrades to other facilities. The funding system in Europe is complex and economic challenges shifted the timeline for facility development. An updated plan was inspired by this and the need to update the recommendations.

The objectives for the updated plan are to review the status of the field, issue recommendations to advance science and applications, and develop a roadmap for new research infrastructures, facility upgrades, and collaboration on smaller scale facilities. European nuclear physics must also be considered in context, hence the need for international engagement.

The first portion of the plan will look at science and facilities, with completion by the end of 2016. Six detailed chapters will present current issues in nuclear physics and recommendations. NuPECC held a workshop in January 2016 to discuss the status of European facilities.

Facility examination was supported by the European Strategic Forum on Research Infrastructures (ESFRI). A report from ESFRI released on March 2016 commented on nuclear physics facilities. The list of facilities will be updated in 2018.

The Facility for Antiproton and Ion Research (FAIR) and the Superconducting Accelerator Complex at the Nuclotron-based Ion Collider Facility (NICA) are focal points for NuPECC and recommendations will be developed that address these facilities. Individual activities include CBM, APPA, PANDA and NUSTAR.

FAIR and NICA construction represents strong collaboration between the Joint Institute for Nuclear Research (JINR) in Russia and Germany.

NuPECC is also focused on hadron physics facilities.

Recommendations in the plan will address up to six ISOL beam facilities. Several facilities have been commissioned and are under construction with others awaiting phase upgrades. The facilities are thought of as a distributed facility initiative and will be laid out in a roadmap from 2018 through 2020 in the ESFRI facility update.

Future facilities for nuclear physics include the multi-purpose facilities ELI and ESS. These are organized in an integrated facility project. There are also multiple small-scale facilities with specific roles in education, R&D and applications.

Bracco outlined international collaborations and events being held in 2016. The NSAC was encouraged to attend the town hall meeting for the long range plan at GSI in January 2017.

Discussion

Jones asked when the nuclear component of MYRRHA will be active. **Bracco** shared that the activity is complex. This is an international collaboration hence it is difficult to generate funding from outside. The Belgian government has proposed funding. This will represent the first round and then development will produce a stable machine that can operate the reactor. There is private funding from others. There is the potential for other applications and it would be complementary to other facilities.

Bracco shared with **Deshpande,** when asked about interest in an electron–ion collider in Europe, that the recommendations will strive to be realistic. An electron-ion collider in Europe was mentioned in the 2010 plan but is unlikely at this time. European scientists interested in this physics will likely look to other countries. A FAIR upgrade mentioned in the previous plan is also on hold as the concentration is on completing the current project.

Jones asked about distributing facilities and if that means that EURISOL will be a new facility. **Bracco** shared that the concept of having a big ultimate facility is still there but at the moment the major upgrades need to be reinforced. There is a need for synergy to prepare R&D tools at a higher intensity. The idea of the distributed facility is a model to show some common operation such as common scientific community. The ELI facility is now finishing construction but the governance aspect is undecided. There could be more funding from Europe and the governmental bodies. This intermediate part will contain about 50 percent of what was planned.

Hertzog asked about neutron facilities. **Bracco** shared that there was a working group on fundamental physics. There is some nuclear physics planned. Europe follows some of the nuclear physics issues for which the main goal is not nuclear physics. This will appear somewhere in the recommendations. It is important to complete complementary and strong facilities.

Geesaman asked if NLDBD is part of the considerations. **Bracco** confirmed that Europe in general is not integrated into the activity but could recommend some experiments that would be useful in helping understand NLDBD or some theory support. There will not be any recommendations around the construction of new facilities.

Bracco shared with **Piekarewicz** that the integration of new people into the field depends on the country. There are some that do it better such as Italy, France, Germany and Belgium. Germany does this well because it has big facilities and can attract more people. Getting a new professorship is not easy. Europe on a local level is different from one country to the next.

OTHER BUSINESS

Geesaman provided a summary of the charge for the Committee of Visitors (COV). Scheduled for January 2016, the COV was postponed due to weather. The visit took place on March 1 – 3, 2016, with a report due in late April for consideration by NSAC in May 2016.

A charge to develop a report on Molybdenum-99 is expected at the next NSAC meeting.

PUBLIC COMMENTS

Geesaman was complimented for his service to NSAC and his leadership.

CLOSING REMARKS AND ADJOURNMENT

Geesaman adjourned the meeting at 3:00 p.m. EST.

The minutes of the U.S. Department of Energy and the National Science Foundation Nuclear Science Advisory Committee meeting, held at the Bethesda North Marriott Hotel and Conference Center on March 23, 2016, are certified to be an accurate representation of what occurred.

Donald Geesaman, Chair of the Nuclear Science Advisory Committee on May 24, 2016.