# NUCLEAR SCIENCE ADVISORY
to the
U.S. DEPARTMENT OF ENERGY AND NATIONAL SCIENCE FOUNDATION

## PUBLIC MEETING MINUTES

Hilton Washington DC/ Rockville Hotel
& Executive Meeting Center
Rockville, Maryland

June 30, 2014

**NUCLEAR SCIENCE ADVISORY COMMITTEE**
**SUMMARY OF MEETING**

The U.S. Department of Energy (DOE) and National Science Foundation (NSF) Nuclear Science Advisory Committee (NSAC) meeting was convened at 9:00 a.m. EDT on Monday, June 30, 2014, at the Hilton Hotel in Rockville, MD, by NSAC Chair, Donald Geesaman.

Members Present:

Donald Geesaman, Chair
Ani Aprahamian (2014 APS ex-Officio)
Robert Atcher (2012 SNM ex-Officio)
Abhay Deshpande
John Hardy
Karsten Heeger
Suzanne Lapi
Paul Mantica (2014 ACS ex-Officio)
Erich Ormand
Jorge Piekarewicz
Patrizia Rossi
Kate Scholberg
Jurgen Schukraft
Matthew Shepherd
Michael Wiescher

Members Absent:

Vincenzo Cirigliano
Jamie Nagle
Filomena Nunes
Allena Opper
Raju Venugopalan

NSAC Designated Federal Officer:

Timothy J. Hallman, DOE Office of Science (SC), Associate Director of Science for Nuclear Physics

Others present for all or part of the meeting:

Vince Cianciolo, Oak Ridge National Laboratory
Jolie Cizewski, Rutgers University
Patricia Crowley, DOE
Gail Dodge, Experimental Nuclear Physics, NSF
George Fai, DOE, SC, Office of Nuclear Physics
Manouchehr Farkhondeh, DOE, SC, Office of Nuclear Physics
Jehanne Gillo, DOE, SC, NP, Director Facilities and Project Management Division,
Kawtar Hafidi, DOE, SC, Office of Nuclear Physics
Andrew Hime, Pacific Northwest National Laboratory
Andrew Lankford, University of California, Irvine
Robert McKeown, Thomas Jefferson National Accelerator Facility
Hugh E. Montgomery, Thomas Jefferson National Accelerator Facility
Dennis Phillips, DOE, SC, Office of Nuclear Physics
Gulshan Rai, DOE, SC, Office of Nuclear Physics
David Robertson, University of Missouri
Lee Schroeder, LBNL, TechSource
Michelle Shinn, DOE, SC, Office of Nuclear Physics

James Sowinski, DOE, SC, Office of Nuclear Physics
Scott Wilburn, Los Alamos National Laboratory
Philip Wilk, DOE, SC, Office of Basic Energy Sciences
Sarah Wilk, Pacific Northwest National Laboratory/DTRA
Jeffrey Vanhoy, U.S. Naval Academy
Sherry Yennello, Texas A&M University

**JUNE 30, 2014**

## WELCOME AND INTRODUCTION

The DOE/ NSF Nuclear Science Advisory Committee Meeting convened at 9:01 a.m. EDT at the Hilton Hotel in Rockville, Maryland. NSAC Chair **Donald Geesaman** made logistics announcements and also added that the DOE/ SC High Energy Physics Advisory Committee (HEPAP) Chair **Andrew Lankford** was present to discuss the P5 (Particle Physics Project Prioritization Panel) report.

## NSF NUCLEAR PHYSICS UPDATE

**Gail Dodge**, Program Director at NSF, gave an update on news from NSF. Topics included budget, personnel changes, and the new physics grant solicitation. For 2014, the nuclear physics program budget ended up almost $1M higher than the year before, at $20.8M. However, the base was not increased. **Ken Hicks**, Dodge's replacement, will arrive at NSF at the end of August; Dodge departs in the beginning of August. The NSF physics division now accepts proposals through a solicitation rather than the general Grant and Proposal Guide. One key change is that the there is a deadline for applications, rather than a target date. In addition, PIs with other sources of support are required to articulate their commitments related to the other funded work and explain how the proposed work is distinct from other funded work. Proposals intended for the mid-scale fund, which must go through the program, may be required to undergo a separate cost, schedule, and management review.

**Robert Atcher** asked for more details on the Accelerator Science call for grant proposals with the February deadline.

**Dodge** said the next deadline is February 4, 2015. The solicitation is to award basic science research funding to encourage more university research in accelerator science.

**Michael Wiescher** asked who could apply. Dodge said applicants should be university faculty members. Funds are not intended to go to staff at the DOE national laboratories. NSF perceives a need to support university-based accelerator research.

**Ani Aprahamian** asked about the NSF mid-scale instrumentation fund.

**Dodge** clarified that the NSF Physics Division had established a mid-scale instrumentation fund. The intention is to fund projects above $4 million (the MRI limit). Funding is not available for "operations," so program funds will have to be used to run the experiment. NSF already has a good mechanism to support instrumentation proposals

for up to $4M. However, if scientists have a $10M proposal it can be submitted by the October 29, 2014, deadline, and it would be reviewed within the program and have an additional cost, schedule, and management review. Cost estimates would need to be good.

**Geesaman** asked about NSF program staffing for Brad Keister's replacement.

**Dodge** answered that phone interviews had been occurring; hopefully the physics division can make an announcement in the fall.

**Geesaman** then asked whether there were developments regarding the Michigan State University (MSU) National Superconducting Cyclotron Laboratory (NSCL) and the transition to the Facility for Rare Isotope Beams (FRIB).

**Dodge** replied that an agency joint oversight group existed to enable a smooth transition. The time scale for the transition from an NSF to a DOE facility is in the future. The DOE was trying to understand what the operating cost of FRIB should be. The effort to complete FRIB was taking longer than originally planned. She said there were no details yet for how the transition would occur.

## DOE OFFICE OF NUCLEAR PHYSICS OVERVIEW

**Timothy J. Hallman** reported that the Fiscal Year 2015 (FY15) President's request for the DOE Office of Science (SC) Office of Nuclear Physics (NP) was for $593M. The House of Representatives committee marked up funding legislation resulting in a total of $600M. No information was available for the Senate committee mark of its corresponding funding legislation.

**Hallman's** presentation, available online, covered NP subprograms, both in terms of funding and also major science and/ or facility highlights within the subprograms. He also discussed long-range plans, NP news and events, and relayed an optimistic outlook for the field.

**Geesaman** asked about staffing for the division director for research position. Hallman said there was no development, and that he needed to get that search going.

**Geesaman** then asked the status of the Majorana Demonstrator at Sanford Underground Research Laboratory (SURF). He said the physics community was counting on SURF for the Long-Baseline Neutrino Facility (LBNF). He asked what was the expectation for DOE support for that underground facility.

**Hallman** recommended that Jim Siegrist or someone from the DOE Office of High Energy Physics (HEP) give an update, adding that within SC, HEP is the steward of the resources needed to operate SURF. DOE NP views its role as supporting experimental efforts such as the Majorana Demonstrator.

**Geesaman** asked if there were infrastructure issues with the Majorana Demonstrator.

**Hallman** answered that the agency had been in discussion with the SURF facility management. If infrastructure for specific experiments were needed, NP would support that. But DOE OHEP would support general infrastructure investments.

**Jehanne Gillo** confirmed that there were infrastructure needs. They are supported partially by project funds, and partially by Sanford Laboratory. NP has close communication with DOE HEP, including bi-weekly calls with SURF. A concern on

everyone's mind was long-term plans for that facility. The HEP/ Sanford side has been good at ensuring that Majorana has obtained the infrastructure support that it needs.

**Jurgen Schukraft** asked for more information about the EXO neutrino experiment.

**Hallman** replied that was a HEP question. The experimental effort has been impacted by an accident at WIPP, although it is located at the other end of the facility from the radiation leak.

**Hugh Montgomery** of Jefferson Laboratory, in the audience, asked about the status of the Relativistic Heavy Ion Collider (RHIC) experiments.

**Hallman** clarified that the data projections for the two experiments indicate what they need to accomplish, scientifically, for the program this year. The excitement is that the machine has already exceeded both projections; the machine is performing very well.

## THE P5 (PARTICLE PHYSICS PROJECT PRIORITIZATION PANEL) REPORT

**Andrew Lankford,** chair of the DOE High Energy Physics Advisory Panel (HEPAP), gave a brief summary of the P5 Report. He explained the three budget planning scenarios and process for gathering scientific community inputs. He discussed key recommendations and the five science drivers, focusing on recommendations likely to be of greatest interest to the nuclear physics community: four neutrino-related recommendations (12-15); and accelerator R&D recommendations (23 and 26: HEPAP had formed a subcommittee to report in greater detail and align efforts with the science drivers). He said that the HEPAP accepted the report on May 22, 2014.

**Abhay Deshpande** commented that the report contained a relatively large number of recommendations (29). How would the agencies, DOE and NSF, determine how to allocate funds?

**Lankford** conceded it was true; people might think there were a lot of recommendations. The plan was done in the global context, in contrast with plans done by HEP. The P5 did not prioritize the science but did identify the five science drivers. Certain examples, such as double beta decay, were highlighted to illustrate that due to the high cost of conducting the experiments, they should be global undertakings. The P5 recommended "handling the research program with care," while robustly supporting facility support. As illustrated by the 25 specific project recommendations: the field is not totally facility-based. Recommendations had been grouped, and the HEPAP feels that the report is focused. The executive summary is concise.

**Ani Aprahamian** asked whether all Higgs boson research should be overseas, a/ the European Organization for Nuclear Research, a.k.a. CERN's Large Hadron Collider (LHC).

**Lankford** responded that the high luminosity LHC program was a top priority. The U.S. is the largest single contributor to that program; the LHC is a good example of an international collaboration with robust U.S. participation. The next logical step would be the lepton collider: a Japanese facility. Future efforts depend on science developments and also rely on accelerator technology advances. The U.S. should not be counted out, for long term hosting prospects. However, current fiscal support was constrained.

**Aprahamian** asked if there was a timeline corresponding to these priorities. Specifically, for LBNF: is there a development timeline?

**Lankford** showed a slide illustrating Figure 1 from the P5 report depicting a rough timeline. Blue bars indicated periods of construction, and green bars indicated periods in which construction projects should yield physics results. A new international collaboration was called for LBNF; funding agencies met in mid-June of 2014 in Paris to discuss it.

**Jorge Piekarewicz** asked what about the P5 planning process worked well and not well.

**Lankford** said he was generally satisfied with the process. It was intense because of the fiscal constraints. The Snowmass process, the first stage, provided a jump-start in providing program data. The subsequent deliberation phase was intense. Scheduling people for the discussions was challenging, but even the European members who had to travel far for meetings missed only two days. He added that **Kate Scholberg** had served on the P5.

**Scholberg** said that the panel had been productive, efficient, and had worked hard to gain consensus.

**Lankford** said **Steve Ritz** from U.C. Santa Cruz was a tireless, energetic, and organized chair.

**Schukraft** asked about LBNF. The project could go from one extreme, like for CERN, an international project; or, it could be another just-U.S. project. He asked about the reformulation discussions.

**Lankford** said the P5 discussed a feasible path forward for LBNF. Although the panel did not want to prescribe how the agencies and scientists should interact, the P5 recommended LBNF to be an internationally coordinated and funded collaboration, and Fermilab should be the host. The LHC experiments are an important model for the LBNF experiment. The international focus should define scope and capabilities. Proton Improvement Plan-II (PIP-II) upgrades are in a different category; they don't require the same complexity of international collaboration.

**Schukraft** asked how the panel had done its planning while considering the Congressional aspect. A second question was regarding the global context of the proposed International Linear Collider (ILC).

**Lankford** said there was no way, within budget scenarios, to contribute $1B or more to the ILC. The P5 had recommended exploiting the LHC/ neutrino program. It would be beyond the P5 to determine whether a major contribution to the ILC should go forward, but budget Scenario C tried to cover that. The panel's recommendations had focused heavy investments in transformative accelerator R&D. A second recommendation included participation in the ILC, as it furthers three of the five science drivers. Third, the panel had recommended expanding LBNF to incorporate a deep underground detector.

**Geesaman** asked how much money had been carved out for small projects.

**Lankford** said he couldn't answer that question.

**Geesaman** said that Scenarios A and B represented "flat-flat" funding levels, implying a $50M decrease in spending over three years. The panel recommended changes in muon accelerator R&D; what other efforts would be decreased or cut?

**Lankford** said to support construction, funding needed to come out of other aspects of the budget: the research or operations programs. Ending the Muon Accelerator Program (MAP) at Fermilab would save $12M.

**Geesaman** noted that the long-range planning charge for the NSAC was different from that to the HEPAP's P5, although the P5 did make recommendations on specific projects. The NSAC was charged to review scientific accomplishments of the field. The P5 effort started with Snowmass and was spread over two years. The NSAC time for planning is shorter. **Geesaman** said he thought that the P5 had articulated vision and priorities well.

Geesaman called a break at 10:55 a.m., and the committee reconvened at 11:14 a.m.

## STATUS OF PLANNING FOR THE NSAC LONG RANGE PLAN

**Geesaman** discussed the anticipated LRP schedule. Geesaman will chair the LRP and will make writing assignments in the summer of 2014. The last LRP was in 2007.

**Patrizia Rossi** asked about costing the double beta decay effort.

**Piekarewicz** expressed concern about the workload of the working group. How will all of them be coordinated?

**Geesaman** said they would have to be carefully coordinated, in memberships and meeting times. Their product would be the chapters of the report.

**Wiescher** asked about the town meeting white papers: they would be due in January of 2015. Would they be generated via the town meetings?

**Geesaman** indicated multiple collection efforts could inform the white papers. The committee would not ignore input at any stage of the process, but said he expected subcommittee members to attend the resolution meeting with information to produce the report.

**Heeger** asked should the white papers be science driven, not considering project size?

**Geesaman** advised the working group and the town meetings to "understand the realities." In the past, information from town meetings had evolved into a set of recommendations that were brought forward by the working group. Should the working group encounter a set of recommendations that would be difficult to fit into a constrained funding scenario, they could articulate as one of the budget scenarios a scenario that described resources that would be required to support the recommendations. **Geesaman** said the NSAC wouldn't ignore it, but one of the strengths of the process is taking budget guidance seriously. A strength of the P5 report is that the panel took budget guidance seriously.

**Deshpande** said he supported that costs should be articulated. The working group should get guidance from **Geesaman** on what sort of cost basis they should assume.

**Geesaman** said he had not yet thought through that, but he agreed.

**Atcher** noted that the American Chemical Society's Division of Chemistry held similar town hall meetings, and that they were good forums to let people know this planning was occurring.

**Paul Mantica** noted that the newsletter, in July, would broadcast planning activities. For the July ACS meeting, the schedule has been set since April; but the business portion of the meeting could include it.

**Atcher** asked whether it was too late to think about doing something in the March meeting.

**Mantica** answered maybe.

**Aprahamian** noted that an education and innovation town meeting was set for August 6-8, 2014, at Michigan State University.

**Mantica** added that the ACS meeting in San Francisco starts on August 10.

**Montgomery** from the audience asked whether there would there be a specific set of requests for the labs.

**Geesaman** answered that he had not intended to do that.

**Montgomery** recommended that the committee clearly ask for input from major facilities. Then he asked if the resolution meeting would occur in March of 2015, and the final report would be released in October of 2015. He noted that the P5 did not publicize its conclusion until it released its report at the spring HEPAP meeting.

**Geesaman** said in the past, NSAC had been asked for an interim report. This time, the committee had not. Since annual budget process will be in progress from April to October, major "changes in direction" recommendations may be awkward in the context of budget development.

## PRESENTATION OF THE REPORT ON WORKFORCE DEVELOPMENT

**Jolie Cizewski**, the subcommittee chair considering workforce development for the NSAC, presented the charge and tasks. The charge was only from DOE-SC, rather than jointly from DOE and NSF. Her presentation, available online, indicated the names of members of the subcommittee.

The percentage of early career awardees that earned their Ph.D.'s in the U.S. is shrinking. The percentage of NP physics faculty with a U.S. Ph.D. also appears to be decreasing (comparing senior to junior faculty statistics). Thus, the U.S. is having trouble attracting the best and brightest graduate students and early-career faculty. There are relatively few training grants available and few Ph.D. programs in the U.S. in the area of accelerator science. Many of the fields, such as DOE nuclear physics, need U.S. citizens for specific work.

**Cizewski** said the subcommittee recommended support of the Nuclear Chemistry and the U.S. Particle Accelerator Schools. She noted that the fields of high performance computing and simulations have similar challenges as accelerator science..

## NSAC DISCUSSION OF THE REPORT ON WORKFORCE DEVELOPMENT

**Heeger** asked how mentoring compares to HEP. **Cizewski** said NSF takes funding applications, breaks them into subgroups, and one third is promoted, one third is ranked, "maybe," and one third is rejected. Approximately half are eventually funded. Applications for NSF funding must demonstrate the potential for broad impact. DOE

must have a strong research program, and the timeline is such that students "age out" of it very quickly.

**Mantica** said one of his students received grant funding. For students who come into nuclear sciences, the issue is not a shortage of dollars. Principal investigators (PIs) are encouraged to apply to supplement their own funding. His students have an application in before they even walk in the door. Usually by the second application attempt, they are successful. He said the field should look beyond this funding model and support better mentoring.

**Cizewski** noted that there is a smaller percentage of Ph.D.'s in this country. If we take in foreign students, we can produce more Ph.D.'s. And DOE has 'national needs' training components, requiring trainees to spend time at a DOE national laboratory.

**Deshpande** raised the point regarding the shift in Ph.D.'s from the U.S. versus outside the U.S. He asked, what do we know about U.S. Ph.D.'s leaving academic professions and going to Wall Street and other places?

**Cizewski** answered that half the Ph.D.'s in our field do things other than basic research. Twenty-three percent leave academia for business and industry careers: that includes Wall Street, but fewer people are doing that because of current market forces. The other half is at universities and government agencies.

**Deshpande** said that companies like Google and Microsoft have hired some of them.

**Geesaman** said there has been a distribution between government and industry. The sum of those two has stayed about the same.

**Cizewski** added that in 2004 we were looking at less than five years past the Ph.D. The two timelines are very similar. We saw the same trend in 2000, for the 2004 report. The Wall Street component is missing from the 2013 numbers.

**Piekarewicz** said fundamental nuclear physics doesn't have the same challenges as other areas. In his research area, it seemed that we are doing very well.

**Cizewski** said that if one looks at the "Country of Ph.D." chart: it indicates who our future leaders are. One can see a growing proportion of foreign Ph.D. recipients as the field's leaders. Right now, less than 40 percent of our leaders got their P.D. in the U.S.

**Geesaman** suggested that the NSAC take a break for lunch at 12:20. Discussions reconvened at 1:30.

**Geesaman** read an internet question **Donna Lyason** (see paper notes).

**Schukraft** asked if the foreign trend holds for all Ph.D.'s or just for nuclear physics.

**Cizewski** said she had not seen the broader data. One difference could be that there is an increase in the number of postdocs that have been hired because they came to the U.S. as postdocs. She reviewed the NP postdocs report and could not see any trends. The doubling of National Institutes of Health (NIH) funding a decade ago meant a dramatic increase in number of postdocs that were hired.

**Schukraft** also asked about the three science areas specifically mentioned as focus areas. Regarding the scale: is this a big or small problem?

**Cizewski** said a large number of U.S.-trained accelerator physicists got their Ph.D. in basic NP, supported by NSF. These physicists later in their careers transitioned

back into accelerator sciences. For nuclear chemistry, the number of recent, U.S. Ph.D.'s is small – maybe five people.

**Cizewski** said multidisciplinary fields can help encourage growth in the field of nuclear chemistry.

**Schukraft** asked if a re-direction in nuclear physics was a plausible strategy.

**Cizewski** said the first recommendation was to increase funding opportunities for grad students in nuclear physics, and for nuclear science: to fill needs for the DOE labs. The support should not be offset from within DOE's NP budget. For NSF, if they grow that field, they would not be decreasing physics research funding. With funds going to US citizens, then the field could grow by 5 to 10 more Ph.D.'s.

**Deshpande** asked at what stage of education that awards with a practicum opportunity are given.

**Cizewski** said she was using the stewardship science and computational science graduate research fellowship (GRF) as a model. The fellowship funds work over a four-year period. Trainees need to spend three months at one of the weapons labs. Trainees typically do it closer to the penultimate year. Trainees are encouraged to work in a field not related to their area of accelerator science, but to learn something different.

**Deshpande** said that training in a different lab made sense.

**John Hardy** asked why **Cizewski** ignored the NSF Research Experiences for Undergraduates (REU) program.

**Cizewski** answered that only DOE SC programs – not NSF programs – were reviewed.

**Hardy** said it is "part of the picture," and should not be ignored.

**Cizewski** said if it was the sense of the committee to add a sentence regarding the REU program, that she could add it, but the charge was specific from the DOE perspective. **Hallman** supported that.

**Aprahamian** said REU is a general science program, not focused on nuclear physics.

**Hardy** countered that the committee was not discussing DOE in isolation. Many labs take REU students in the summer. Most have never seen nuclear physics before. He didn't know how many of them become grad students in nuclear physics. It is part of the picture.

**Cizewski** again said she had concerns about offering a recommendation about REU since it is not an SC program, but for tracking, it should be considered. The REU is a good model. We need to be sensitive to highlighting how the Science Undergraduate Laboratory Internships (SULI) Program really is different. It is not a university setting, for example. NSF's REU cannot give everything that DOE's SULI can give students.

**Rossi** asked about a new call.

**Aprahamian** mentioned the NRC decadal review. We were not able to get the statistics for the report. We need to know how many NSF and DOE awards that there were, as well as success rates.

**Cizewski** noted that there were 2,000 awards over that five-year period. They have really increased the number. NP numbers haven't changed that much. Why so few in nuclear physics? We looked at STEM versus physical science STEM, data from 1992-2003. The number of degrees in NP has been flat over that fifteen-year period, even as there have been huge increases in engineering and life sciences degrees and workforce.

The increase trend is also true for social and bio-behavioral sciences. Before, approximately 17 percent of science, technology, engineering, and math (STEM) degrees were for physical sciences. Now it is only 12 percent.

**Mantica** mentioned the CEU program – it could become more nuclear physics-focused. That could be mentioned in the report. Tracking is problematic. Mantica said that he was a previous holder of a summer school grant. It takes about ten years from graduate school to job market. One's grant period is five years. **Mantica** advocated for a central resource to do this tracking. What happened to interested students who applied for grants and were turned down? We should track them if we are going to try to grow the field. The effort should be broader than just the SULI tracking.

**Cizewski** said that the subcommittee had tried to find individuals 5 to 10 years past the Ph.D. It costs money to do detailed tracking work. She added that she participates in an undergraduate women-in-physics program. Most tracking is with universities that produce Ph.Ds. or is done by individuals like her who track their own students. If there is a sense that it should be broader than just the SULI students, the NSAC could recommend it.

**Hardy** asked where **Cizewski** got the statistic of there being 16 schools in the U.S. with accelerator programs and 75 in Europe.

**Cizewski** answered that the subcommittee had cited a report from a group called TIARA, and it is referenced in the report to the NSAC. In the U.S., it was 12 universities. In Europe it is 75 institutions. The accelerator labs themselves are running workforce development and continuing education programs. Someone who received their training in accelerator science 10 years ago would need ongoing technical training to help move the field forward in building new instruments. We should expand the particle accelerator school to include professional development for scientists.

**Suzanne Lapi** complimented the field. The few faculty members in the field of nuclear chemistry do mentor students. The DOE National Nuclear Security Administration (NNSA) has training grants in NP and nuclear chemistry.

**Cizewski**: said she was not sure the NNSA was making strong investments in those training grants.

**Erich Ormand** noted that if budgets are flat, it would be impossible to grow the field.

**Hallman** added, as a correction, that funding had not been flat since 2000. It had been flat since 2010.

**Atcher** said that when he cross-walked Tables 2 and 3, he had counted a few schools that were missing from the program.

**Cizewski** said that for Table 3, nuclear chemistry and technology data was taken from the ACS website. Other data was gathered by Sylvia Jurrison who went out and personally collected the data. Some of the people who get the funding are at medical schools and do not have Ph.D. students.

**Atcher** said he knew of programs in Kentucky, Maryland; and at Carnegie Mellon.

**Mantica** said he was the editor of that portion of the ACS website and could make the updates.

**Atcher** commented that if we expand training grants but don't have jobs for these people coming out: that's a challenge. Or students or post-docs may be interested in the

field, but they terminate because there are no employment opportunities after their training. The U.S. used to have a robust radiochemistry program. Aligning workforce development programs with post-development jobs is an important issue.

Los Alamos National Laboratory (LANL) and the University of New Mexico have submitted parallel proposals, but due to lack of synergy between review panels, there seems to be no structure to encourage lab-university collaborations. The subcommittee should call this out, specifically, in terms of the review process.

**Cizewski** said trying to comment on the review process was challenging.

**Cizewski** said she was amazed at how many of the labs list radiation science as an area of national need. Foreign nationals may have barriers to working in that area.

**Ormand** said it takes about seven years for a foreign national to get citizenship and a clearance. That is a long time.

**Cizewski** said there were discussions for an accelerated process for green cards for people with advanced degrees.

Hearing no further discussion, **Geesaman** invited NSAC members around the table to give final comments.

**Montgomery**, in the audience, said the nuclear chemistry summer school challenge is a result of the White House and Office of Science and Technology Policy (OSTP) proposal for STEM education. DOE is the singular agency with a mission involving nuclear science. It really is DOE's purview to develop the nuclear science workforce.

All were complimentary of the workforce development report.

**Rossi** commented on the order of findings and recommendations. The order should be: first we build our pool in nuclear physics, and then we recommend how to attract the best and brightest. The SULI program at Jefferson Lab is an effective program: students are challenged by activities of the lab. There are also some acronyms that are not spelled out. She agreed with Piekarewicz that a re-write was needed before the NSAC voted to accept the report.

**Scholberg** said it was a nice report. There is a delicate balance having the world's best scientists come to the U.S. and also grow the expertise from within. It is a good thing that people from other countries are being attracted to the U.S., but that doesn't diminish the need to develop scientists here at home.

**Schukraft** said more should be included about the size of the problem: data on how many students we have and want are missing. For a small funding increase in one area: does accelerator science have a greater need than other fields? The report is nicely laid out.

**Cizewski** said the charge was in April, and the report was due on June 30. She could add some quantitative data, as there are probably only five students per year in this area, but given the time constraints, she felt that gathering more data was beyond the scope of what the subcommittee could do.

**Matthew Shepherd** said there is a lot of pressure to specialize earlier and earlier in students' academic careers, so getting students to try NP early is good. NSF early career awards are critical to the field but won't grow the field like early career experiences will.

**Wiescher** commented that for universities, the challenge is to get money to send students to these schools. Early career experiences are very important and good for

students. We may lose some to international labs. Tracking is extremely challenging. We need a sociologist to do that. He added that, in general, he liked the report.

**Mantica** said he had already provided detailed comments and complimented the report.

**Lapi** had nothing additional and complimented the report.

**Heeger** thanked **Cizewski** for producing the report and said it was good to see statistics and numbers the committee didn't see that often. Research support is critical to workforce development (versus construction and operations). Emphasize in the recommendations that workforce development programs are key for DOE-SC and how they differ from those of NSF-NP.

**Cizewski** said that for almost all recommendations, the subcommittee stated, "We recommend that XYZ…" and specified which source and program would be targeted.

**Hardy** echoed the appreciation to **Cizewski** and the subcommittee. He thought the REU and CEU programs should be included. Regarding the graduate research fellowships: students typically don't matriculate the program with a declared specialty. Many take courses for a year before declaring an interest. Making a funding deadline by October of their second year should be reconsidered as too soon. An education program for the professors should be included, too, because I hadn't heard of some of these funding opportunities.

**Cizewski** said the funding deadlines were designed to get new grad students into the practice of grant writing.

**Deshpande** said he was happy to see the data and liked the report. Regarding the need to balance between homegrown and foreign Ph.D.'s – it would be useful to highlight that point in the report. The REU program should be called out as especially effective. Also, recommendations should specifically state which practicum at what lab yields a specific expertise.

**Cizewski** said she wanted to expand what that meant in the recommendation.

**Atcher** complimented **Cizewski** for putting together the report in so little time. He agreed that the report should address some of **Hardy's** concerns regarding other agencies. The National Academy of Sciences (NAS) report on nuclear chemistry covered the topic a little more globally. This subcommittee should limit the focus to SC.

**Aprahamian** asked whether she understood correctly that the context was whether SC was being redundant in funding workforce development programs. There have been several NRC reports pointing out the need for training in accelerator physics as an area of national need. It might not hurt to refer to all of them. Second, nuclear science is not just a basic science; its applications are important for country's economy and safety.

**Cizewski** asked **Aprahamian** if she could provide the NRC report references. Then she asked if everyone else recommended re-ordering the recommendations. **Geesaman** said to ask the subcommittee. He also asked NSAC members to email **Cizewski** their comments.

**Geesaman** said there was pressure from OMB and OSTP that DOE SC should not be doing workforce development. Workforce development needs to be a joint effort between DOE and NSF, applying best practices to specific agency missions and free of redundancy. He added that since there was a large number of suggestions for

improvements, the subcommittee should make changes for comments that make sense, or if didn't make changes, to explain why. NSAC members should send comments to **Cizewski** in 24 hours. Then, the subcommittee could submit the draft in a week or so; and the NSAC could approve the report by email after that.

**Atcher** said we have 300 cyclotrons around the U.S. developing isotopes for applications. Here is the case of the demand for people with knowledge to use those tools. The agencies need to address that demand and that market pull; the imperative doesn't seem to be reflected in nuclear science workforce development/ training activities.

**Geesaman** thanked and complimented **Cizewski**, saying it was hard to find this kind of quantitative information and coordinate remotely.

## OFFICE OF NUCLEAR PHYSICS ISOTOPE PROGRAM

**Geesaman** said the committee had received a separate long-range plan (LRP) charge in April for the isotope program. It's a small program, but it is "the little engine that could."

**Dr. Jehanne Gillo** gave a presentation describing the program. She said it is a DOE program but is managed within the NP program. The program's purpose is to produce isotopes not available commercially, or not in the quantities needed domestically. The program has undergone significant changes when it moved over from the Office of Nuclear Energy to DOE: its scope and personnel have both increased. The DOE National Isotope Development Center is located at Oak Ridge National Laboratory. **Gillo** presented the different sites, around the nation, where isotopes are produced. She discussed facility investments and tracked program capabilities of high commercial and national interest. She covered strategic planning areas and isotopes commercially available or that present challenges. The program is relatively small dollars but is highly visible, both to Congress, other agencies, and to industry.

## NSAC DISCUSSION OF THE ISOTOPE PROGRAM

**Heeger** asked what fraction of the annual budget goes into R&D.

**Gillo** said probably now about $5M (competitive). Another $2M goes to support a core base.

**Heeger** then asked about adding universities and generally about connections with them.

**Gillo** answered that the program has made investments in universities. Isotope production facilities at universities are not owned by the Isotope Program. University facilities could "take the money and walk," or they may not have the infrastructure for customer sales, so they let DOE manage the contractual/ sales part. Alternatively, these facilities could choose to sell the isotopes through their university. Some facilities, if going through the isotope program, want base funding. There are different ways the business can be done; it depends on the university.

**Schukraft** asked what was the ratio of different funds: earnings versus agency support.

**Gillo** replied that the earnings were greater than the appropriated amount.

**Deshpande** said it is a wonderful program. He asked how universities deal with defense-related or classified activities.

**Gillo** said the agency did support projects with export control restrictions, but only at national labs. In our funding opportunity announcements, proposals must be able to operate within regulations. That kind of work occurs at the national labs.

**Aprahamian** asked about the solicitation for Strontium-82.

**Gillo** answered that the funding opportunity announcement was made a couple of weeks ago and closes August 1. The announcement was for public-private partnerships in general, not just for Strontium-82.

**Aprahamian** asked for the status of discussions regarding the US domestic supply of stable isotopes.

**Gillo** said that regarding stable isotope production: we are in the process of producing a pilot plant. That is one of our big projects; it is at Oak Ridge should be operational in a couple of years. There are a couple of isotopes that do not fall within our purview. For Molybdenum-99: It is up to the NNSA to produce a stable domestic supply of Mo-99. We interface regularly with them.

## CLOSING REMARKS AND ADJOURNMENT

There were no additional comments by the committee or audience. NSAC Chair Geesaman adjourned the meeting at 5:00 p.m. EDT.

The minutes of the U.S. Department of Energy and National Science Foundation Nuclear Science Advisory Committee meeting held at the Hilton Hotel in Rockville, Maryland, on June 30, 2014, are certified to be an accurate representation of what occurred.

Donald Geesaman
Chair, Nuclear Science Advisory Committee