Minutes

Department of Energy and National Science Foundation
Nuclear Science Advisory Committee
North Bethesda Marriott Hotel and Conference Center, Rockville, Md.
March 9, 2012

Members Participating:

Donald Geesaman, Chair
Robert Atcher
Jeffrey Binder
Jeffery Blackmon
Gail Dodge
Alexandra Gade
Susan Gardner
Peter Jacobs
David Kaplan
Joshua Klein
Zheng-Tian Lu
Curtis Meyer
Jamie Nagle
Allena Opper
Jorge Piekarewicz
Robert Tribble
Julia Velkovska
Raju Venugopalan

Members Absent:

Karlheinz Langanke
Kenneth Nash

Others Participating:

William F. Brinkman
Joseph Dehmer
Patricia Dehmer
Konrad Gelbke
Jehanne Gillo
Timothy Hallman
Norbert Holtkamp
Bradley Keister
Berndt Mueller
Hugh Montgomery
Brian Plesser
Susan Seestrom
Edward Seidel
James Symons
Steven Vigdor
Hendrik Weerts
Michael Wiescher

Presenters in Order of Appearance:

Edward Seidel
Bradley Keister
Timothy Hallman
Michael Wiescher
Hendrik Weerts
Norbert Holtkamp
William F. Brinkman
Donald Geesaman

About 45 others were in attendance during the course of the meeting.

Morning Session

Before the meeting, new members of the Committee were sworn in by a staff member of the DOE, Office of Science, Office of Human Resources and Administration.

The meeting was called to order at 9:03 a.m. by the Chairman, **Donald Geesaman**, who introduced **Timothy Hallman**. Hallman reviewed the agenda and introduced the new members of the Committee. Geesaman introduced himself and made administrative announcements. Hallman welcome all the new members; pointed out that, for the first time, this meeting was being webcast; and thanked Susan Seestrom for her services as the previous chair of this Committee.

Edward Seidel was asked to review the NSF FY13 budget request. The purpose of the NSF is to transform the frontiers, innovate for society, and perform as a model organization. The program includes Cyber-Enabled Materials Manufacturing and Smart Systems (CEMMSS), Cyber Infrastructure Framework for 21st Century Science and Engineering (CIF21), Expeditions in Education (E^2), Integrated NSF Support Promoting Interdisciplinary Research and Education (INSPIRE), Innovation Corps (I-Corps), Secure and Trustworthy Computing (SaTC), and Science Education and Engineering for Sustainability (SEES).

The mission of the Directorate for Mathematical and Physical Sciences (MPS) is to advance discovery, provide building blocks, establish forefront facilities, and educate the next generation.

The building blocks are to catalyze advances in science, impacting innovation in medicine, industry, and technology; examples include sustainable chemistry and the Materials Genome Initiative (which is tied to advanced manufacturing).

SEES informs the societal actions needed for environmental and economic sustainability and sustainable human well-being by addressing resilience to natural and technological disasters; coastal and arctic systems; sustainable chemistry, engineering and materials; and improvements in information technology's energy efficiency. $27 million has been requested for the FY13 budget for MPS.

CIF21 seeks to transform research, innovation, and education. It involves all directorates and offices. It seeks to support computational and data-enabled science; to support core technologies, tools, and algorithms; and to respond to new, large data generators. Modeling science is producing huge amounts of data that need infrastructure to be interpreted and shared. This initiative also supports workforce development. About $21 million has been requested for MPS for FY13.

CEMMSS is a partnership with the Engineering Directorate and the Directorate for Computer and Information Science and Engineering (CISE) on advanced manufacturing and Designing Materials to Revolutionize and Engineer our Future (DMREF). In MPS, $50 million has been requested for FY13.

SaTC has a small role for NSF; in MPS, $2 million has been requested.

E^2 is to reinvent how education and research in education are done. Science is done in new ways, and education should reflect this change. Its goal is to transform science, technology, engineering, and math (STEM) learning for the nation through cognitive research and frontier science and to provide cyber-learning and education about managing data. About $5 million has been requested for MPS, and more has been requested across the Foundation.

Cross-disciplinary efforts include those on

- The interface of Biological, Mathematical, and Physical Sciences (BioMaPS), which received $5.5 million in MPS last year and for which about $11 million is requested this year.
- Enhancing Access to the Radio Spectrum (EARS]) for electromagnetic-spectrum management seeks to ensure the effective use of the radio spectrum to benefit technology,

the economy, social sciences, and public policy. It is responsive to the national broadband plan. $11.6 million has been requested for MPS in FY13.

- INSPIRE focuses on high-risk/high-reward research across disciplines, and the I-Corps has had its first NSF award on the use of solar radiation to dissolve oil contaminants in water. In MPS, $8.3 million has been requested for FY13 for these two programs.
- Science Across Virtual Institutes supports centers in multiple countries to produce a viable research effort. Two of NSF's first three awards in MPS were made to the Virtual Institute for Mathematical and Statistical Sciences (with India) and to the Physics of Living Systems Student Research Network (with Brazil, Israel, Singapore, and Europe).

MPS accounts for 25% of NSF's Faculty Early Career Development (CAREER) Program awards to enhance our young-scientist pipeline.

MPS-launched facilities in FY13 have done well in comparison with those at other agencies, but more still needs to be done. The Atacama Large Millimeter Array (ALMA) has large contributions from the NSF, Europe, and Asia; it has just put 16 (of 66) antennae into operation. The National Superconducting Cyclotron Laboratory (NSCL) got $21 million in the request. The Division of Physics (PHY) held on to a 1% increase this year. In addition, $30.0 million has been requested in FY13 for the Office of Multidisciplinary Activities (OMA), an organization within the MPS directorate.

NSF sent a "Dear-colleague" letter on career-life balance. We are being generous on no-cost extensions, flexible start dates, supplements for additional personnel, and virtual participation in NSF activities to ease impacts on family life.

Blackmon asked if the requirement for a data management plan were changing. Seidel replied that the requirement is now flexible with not much guidance. The NSF will be more prescriptive in the future, requiring more sharing. Some NSF programs have particular cultures and requirements (e.g., to comply with international treaties). More openness and sharing is coming.

Jacobs asked what was meant by data-management infrastructure. Seidel replied that a national data infrastructure is needed, but it is not known what that means. Certainly, it includes centers with supercomputers that can share data. One way is seen in earth science, which had a charrette, sort of a workshop, that would drive a crowd of scientists in a direction they wanted to go. They found common interests and agreed to fund a number of these concepts. It was very successful, and there will be more going forward for light sources, large telescopes, etc. International cooperation is reflected in meetings with the European Union to ensure international cooperation and coordination.

Bradley Keister was asked to review nuclear physics at the NSF. Nuclear physics at NSF has specific programs covering experiments and theory (including nuclear astrophysics), and the Physics Division supports the Joint Institute for Nuclear Astrophysics (JINA), and the National Superconducting Cyclotron Laboratory (NSCL) a major facility that requires National Science Board (NSB) approval of its cooperative agreement. DOE is a key partner in much of the NSF's nuclear physics activities. The NSF is heavily involved in NSAC charges and subcommittee deliberations.

NSF investigator awards cover cold QCD (primarily at Jefferson Lab and the RHIC spin program), hot QCD (at RHIC and LHC), nuclear structure and nuclear astrophysics and precision tests of the standard model. A new accelerator at Notre Dame is the first new low-energy accelerator for basic research in nuclear physics in 30 years.

NSF-funded investigators participated in the Daya Bay Experiment (with major DOE funding), which has recently reported a result for θ_{13} of 8.8°, with a zero value excluded to about 5.2σ.

In the FY12 budget, Research and Related Activities (R&RA) was up 2.8%, nuclear physics and most other programs in the Physics Division were down 3.5% from FY11 (which was down 3% from FY10), and the NSCL was flat from its FY11 level. The program continues to manage the American Recovery and Reinvestment Act (ARRA) funding impact from FY09.

MPS's FY13 budget request is up 2.8% from the FY12 appropriation level; and within that, the Physics Division is up 1.0%. Within Physics, funding for the NSCL is flat, and research is up 1.3%.

Due to lack of funds, the joint solicitation between NSF and the Department of Homeland Security Domestic Nuclear Detection Office was canceled for FY12, but is hoped to be restarted next year; the Major Research Instrumentation (MRI) deadline has passed, and proposals are under review; the Petascale Computing Resource Allocations program (for testbed access for petascale code development) has been discontinued as the Blue Waters computing system is about to go online.

People at NSF: Subra Suresh (Director), Cora Marrett (Deputy Director), Ed Seidel (MPS Assistant Director), Joe Dehmer (Physics Division Director), Brad Keister (Nuclear Physics: experiment and theory), and Kyungseon Joo (Nuclear Physics: astrophysics and underground physics).

Klein asked about the Dear Colleague Letter on deep underground science. J. Dehmer replied that it takes the investment that the NSF was making in experimental design ($10 to $11 million) and devotes it to underground activities with a shorter-term focus because the Deep Underground Science and Engineering Laboratory (DUSEL) is out of the picture. The letter establishes a new target date (May 1) for this program. It is a new opportunity to apply for these funds.

Blackmon asked about the APPI (Accelerator Physics and Physics Instrumentation). J. Dehmer replied that midscale instrumentation has risen as a priority in the division, and this program would allow investigators to address important scientific questions with instrumentation that cannot be acquired or developed via the longstanding MRI or MREFC processes. The division has a few million dollars per year to devote to APPI, but plans to see this activity grow over time.

Timothy Hallman was asked to present an overview of DOE's Office of Nuclear Physics (NP). That Office addresses the existence and properties of nuclear matter under extreme conditions, the exotic and excited bound states of quarks and gluons, the ultimate limits of existence of bound systems of protons and neutrons, nuclear processes that power stars and supernovae and synthesize the elements, and the nature and fundamental properties of neutrinos and neutrons. It supports operations and research at three national nuclear science user facilities [the Relativistic Heavy Ion Collider (RHIC), the Continuous Electron Beam Accelerator Facility (CEBAF) at JLab, and the Argonne Tandem Linac Accelerator System (ATLAS)]; the 12 GeV CEBAF Upgrade; continued preparation for construction of the Facility for Rare Isotope Beams; and research, development, and production of stable and radioactive isotopes for science, medicine, industry, and national security. A new strategic planning activity will begin in FY12. The FY13 request contains funding for the continuation of all of these areas, but there are budget pressures; the impact will be spread across all research areas. The NP request is for $527 million, which is a decrease of 3.7%.

NP works in five subfields: medium energy, heavy ions, low energy, theory, and isotope production and applications. The budget impacts are approximately evenly distributed among the subfields.

The 12 GeV CEBAF Upgrade is progressing well and will enable world-leading research on the search for exotic new quark-antiquark particles to advance our understanding of the strong force, evidence of new physics from sensitive searches for violations of nature's fundamental symmetries, and a detailed understanding of the internal structure of the proton. The upgrade's performance index is 95% for the schedule and 96% for the cost. In FY12, the appropriated amount provided ($50 million) was below the planned funding of $66 million. That difference has not been made up in FY13, which will produce a one-year delay in startup and will decrease productivity. Total project cost has also been raised. To be cost effective, operational personnel were converted to construction personnel over the lifetime of the project.

The RHIC program has had high impact to the field. It has produced among the most highly cited research papers ever in NP. It is producing spectacular research results (such as the production of anti-helium-4). The funding for RHIC activities in FY13 is reduced by 5.8% in university and laboratory research. Reduced operations funding will support an estimated 1,360 hours of operations for the highest priority experiments. This is a decrease of 1,030 hours relative to FY12. Effective operation will be achieved by combining FY13 and FY14 operations, running into a single back-to-back run bridging the two fiscal years. Impacts of constrained FY12 funding, including a voluntary reduction in force at RHIC and one-time cuts to materials and supplies, are still being assessed and may further impact FY13 levels of operations. There will be a decrease in laboratory-wide General Purpose Equipment at Brookhaven National Laboratory (BNL).

Data taking at the LHC has begun. Heavy-ion collision data at the LHC indicate a new state of opaque, strongly interacting matter similar to that first discovered at RHIC.

At ATLAS, the facility has done extremely well with 92% operational reliability. The requests for beam time have been double what can be accommodated. Use of the Californium Rare Isotope Breeder Upgrade (CARIBU) beams will help meet this need. However, the closure of the Holifield Accelerator at Oak Ridge National Laboratory (ORNL) will exacerbate the situation. ATLAS beam operations are supported for 4000 hours of operations, 80% of the maximum 5000 hours possible with the scheduled installation of facility upgrades in FY13. The facility's operations funding in FY12 and the modest increase in FY13 do not keep pace with cost-of-living increases. The impacts on the workforce of constrained FY12 funding and the FY13 proposed level of funding are being assessed.

The construction of the Facility for Rare Isotope Beams (FRIB) will increase the number of isotopes with known properties from about 2000 observed over the last century to about 5000 and will provide world-leading capabilities for research on nuclear structure [the ultimate limits of existence for nuclei; nuclei that have neutron skins; the synthesis of super-heavy elements; nuclear astrophysics; the origin of the heavy elements and explosive nucleosynthesis; the composition of neutron star crusts; fundamental symmetries; and tests of fundamental symmetries, atomic electric dipole moments (EDMs), and weak charge]. This research will provide the basis for a model of nuclei and how they interact. The President's request supports this project. In April, there will be a DOE project review to assess readiness for construction. There is a good collaboration between the Michigan State University (MSU) team and experts at other DOE and NSF facilities.

An additional grand-challenge question being addressed is whether the neutrino is its own anti-particle. The Majorana Demonstrator (MJD) technology demonstration is planned prior to a down-select with the German Germanium Detector Array (GERDA) experiment between competing germanium technologies and a planned collaboration. MJD is on track with electroforming and with procurement and processing of enriched germanium. MJD plans to go underground with natural germanium in a prototype cryostat at the Sanford Laboratory in South Dakota in March 2012. The technology and the location of a future, international tonne-scale experiment is to be determined, based on the best value and the best capability.

In Nuclear Theory, Research is decreased 5.8%. Scientific Discovery Through Advanced Computing (SciDAC) is flat, and Nuclear Data decreased 5.8%.

An Office of Science–National Nuclear Security Administration (SC–NNSA) joint workshop on isotope supply and demand was held January 11–12, 2012, to develop a strategic plan to meet the isotopic needs of the federal government. Some key isotopes and radioisotopes were identified. NP's stewardship of this program is taken very seriously. Research is decreased 5.8%, operations is flat, and the total is decreased 2.0%.

The FY13 request continues support for the two highest priorities in the 2007 Long Range Plan for Nuclear Science: the 12 GeV CEBAF upgrade and the FRIB. The FY13 budget is a decrease of $20.4 million, or 3.7%, relative to the enacted FY12 appropriation. Funding for research across the program decreases by $9.9 million, or 5.8%, relative to FY12. NP national user facilities are funded for an estimated 5360 hours of beam time for research, 38% of optimal utilization for the operating facilities, and a decrease of about 6800 hours compared with the beam hours planned for FY12. This reduction in hours is a result of reduced RHIC and ATLAS operations and a planned shutdown period at CEBAF associated with the construction of the 12 GeV upgrade. Holifield Radioactive Ion Beam Facility (HRIBF) decommissioning and demolition planning activities are supported. Funding for the 12 GeV CEBAF Upgrade ramps down $6.9 million according to the original baseline plan; it does not restore the FY12 reduction of $16 million. Funding for FRIB is flat with the FY12 enacted level. Funding is provided for the Solenoidal Tracker at RHIC (STAR) Heavy Flavor Tracker Major Item of Equipment (MIE) per the project baseline.

Actual funding from FY10 to FY13 shows a decline in MIEs and Other Projects, Research, and Facility Operations despite a constant increase in requested funds.

In the FY13 request, Research represents 31%, Facility Operations represents 52%, and Major Projects represents 12%. A plot of operations of NP's national user facilities shows a research cycle that perpetually closes out certain efforts and opens up new opportunities for research. In FY13, NP will be providing a historically low number of running hours at its user facilities (about 38% of the optimum utilization).

The FY13 President's request for Nuclear Physics provides resources for:

- U.S. world leadership in discovery science, illuminating the properties of nuclear matter in all of its manifestations.
- Tools necessary for scientific and technical advances that will lead to new knowledge, new competencies, and groundbreaking innovation and applications.
- Strategic investments in tools and research to provide the United States with premier research capabilities.

NP continues, and will continue, to support a high-impact world-class research effort with world-leading facilities and research tools. Nuclear physics, similar to all federally supported programs, is potentially facing very challenging budgets. NP will work with the community to mitigate impacts and ensure continuation of the highest priority, highest impact nuclear science research. NP has a vibrant program. One hot-off-the-press example is the contribution to exciting new science from Daya Bay that Brad Keister also mentioned.

Binder said that, on the isotope front, the huge coalition of federal agencies that NP pulled together for the federal Isotope workshop is great. The list of critical isotopes appears similar to previous such lists. He asked how this group will proceed and identify infrastructure needs in the future. Hallman replied that this was a workshop focused on isotope supply and demand, but there is no coalition. SC supports the isotope program. There is a deliberate strategy to consider opportunities and needs of the program. NP is still supportive of a dedicated research facility in the future. Geesaman asked if there were progress in stable isotope separation capability. Gillo replied that the program has been making progress in research on that topic at ORNL aimed at establishing a capability to produce stable isotopes. The office hopes to fulfill the stable isotope recommendation of the committee.

Gardner asked for clarification on how the impacts of the numbers can be difficult to interpret. Hallman answered that an impact might be a realignment of an activity from one division to another. Funding for Early Career awards can also skew funding levels.

Dodge asked what the $13 million for Washington was. Hallman responded that that is the program-direction account. P. Dehmer added that it is money that comes to Headquarters for administration.

Lu asked if the open positions have been filled or if there are still a lot of vacancies. Hallman responded that the budget for that activity has been decreased, and hiring has been frozen. Some realignments in the staffing have been made. A program manager for stable isotopes and accountable materials has been allotted. Gene Henry will be replaced.

The floor was opened to the public. Mueller asked if anyone had looked at other metrics of user facilities and compared the numbers of different metrics. Hallman answered that it should be weighted by scientific opportunities, but that has not been done yet. That will show the impact on young scientists.

Gelbke said that it struck him that small university facilities are also being closed down. Hallman agreed that that is true; his analysis did not include that aspect. The most compelling scientific opportunities must be pursued. That slide should be made more accurate.

A break was declared a 10:53 a.m. The meeting was called back into session at 11:14 a.m.

Michael Wiescher was asked to report on the Nuclear Science Opportunities at the National Ignition Facility (NIF) Workshop and the white paper and recommendations that resulted from that workshop. The NIF concentrates the power of 192 laser beams in a football-stadium-sized facility into a target volume of a cubic millimeter to produce more than 10^8 K at a density of more than 10^3 g/cm^3. It also has extensive diagnostic instrumentation to measure what happens.

The question was raised if this were a facility for doing nuclear astrophysics research, so an international workshop was held March 13–14, 2011, in London to address that question and to identify potential projects. Four committees were established at the NIF–JINA [Joint Institute for Nuclear Astrophysics] workshop: nuclear physics, material in extremes and planetary physics, beam and plasma physics, and cross-cut/facility-user issues; each had 20 to 30 members. Another workshop was organized by the NNSA and held May 10–12, 2011, in Crystal City, Virginia.

Plasma nuclear physics is an important component of nuclear astrophysics. Nuclear physicists have made major advances in understanding the origin of the elements. However, even with new capabilities being planned, a full, experimentally validated picture of nucleosynthesis will be missing critical elements: interactions between the nuclear processes and the plasma environment in which they take place. Experiments at the NIF will certainly manifest these interactions.

Scientific opportunities present themselves in plasma coupling to nuclear excitation and decay processes, plasma-screening effects in low-energy charged-particle-capture reactions, thermal excitation of low-level states and the impact on neutron-capture reactions, and density dependence on electron-capture processes. The field of inquiry naturally addresses important questions in nuclear astrophysics and matches the overall goals/needs of the broadly interdisciplinary nuclear astrophysics community. However, new tools for diagnostics are needed to investigate star formation, which leads to stars, Type II supernovae, planetary nebulae, white dwarfs, red giants, novae, short X-ray beams, and Type Ia supernovae.

The NIF has nuclear-plasma diagnostics that provide reliable measurements of temperature, density, neutron flux, and gamma flux. These are measured with X-ray imaging, gamma radiation, a magnetic-recoil spectrometer, a neutron spectrometer, and neutron time-of-flight systems. While knowledge of shock environment and timescale is essential, new diagnostic tools for a science program are required.

In the gamma-flux environment, one gets a variety of materials: deuterium tritide, deuterium, carbon, gold, aluminum, and silicon inter alia. In the neutron-flux environment, one can get 10^{18} neutrons in milliseconds that can be used for neutron capture. The nuclear reaction ^{197}Au(n,γ)^{198}Au is used as a benchmark for mapping the thermal-neutron contribution. Future reactions may serve as benchmarks for reactions in thermally excited states. A lot of work has been done on the interactions of gold with neutrons and on gold's cross-section across a broad energy range.

Stellar energies are being reached and exceeded in classical accelerator experiments and at the NIF. It is not clear that three-body break-up is occurring with a strong final state interaction. Model calculations are being performed. In ^{3}He + ^{3}He plasma screening, low-energy experiments at plasma conditions are feasible; the NIF provides a unique opportunity to probe reaction-plasma interaction.

There are also NIF connections to other fields, such as

- Hydrodynamic studies of the evolution of convection and mixing or rapid Raleigh-Taylor instabilities from late stellar evolution to supernovae as shock-driven plasma events;

- Planet formation, condensation at high density, shock impact, and conditions and nature of exoplanets;
- Material evolution toward extreme densities as anticipated for neutron-star-crust and white-dwarf-core environments; and
- Astrobiology, such as the formation of organic molecules in dense ice materials under intense radiation exposure.

There are complementary activities in Europe at the Extreme Light Infrastructure (ELI) Beamlines Facility in the Czech Republic, the ELI Attosecond Facility in Hungary, the ELI Nuclear Physics Facility in Romania, and Orion in the United Kingdom.

Another U.S.–European workshop is planned. Its purpose will be to couple the U.S. and European nuclear, plasma, and high-density physics communities to formulate a list of scientific goals in astrophysics. It will be held at the Notre Dame London Centre at Trafalgar Square on October 14–15, 2012.

Geesaman noted that there are interesting physics experiments that could be conducted; whether one could extract quantitative information from them is an issue.

Klein asked if one can do anything besides D-D experiments. Wiescher responded, yes, one can mix in different things, or one can use the neutrons. Klein asked if this facility had been looked at as a neutrino source. Wiescher answered that no one seems to have looked at that.

Gardner asked how one goes from the NIF to the broader impact (e.g., if one could use NIF data to understand the mechanism of the Type Ia supernova with implications for studying dark energy). She also asked how one would employ NIF data without a large investment in theory. Wiescher said that SC had been approached by NIF researchers to establish a research program there. There would be full access to the data and to the codes involved. That possibility is being discussed. Currently, such studies operate on a piggyback basis. Proposals have to be approved by the security apparatus at the facility.

Blackmon asked how a science program at the NIF would be funded. Wiescher responded that there are a number of goals and there are small programs at universities and at Los Alamos National Laboratory that are funded by NNSA. DOE funding is possible. One cannot finance shots of more than $1 million. It has to be a mixed-funding structure.

A break for lunch was declared at 12:00 p.m. An ethics briefing for the nonfederal numbers of the Committee was conducted during the lunch break by **Brian Plesser** of DOE's Office of the General Counsel.

Afternoon Session

The meeting was called back into session at 1:07 p.m. **Hendrik (Harry) Weerts** was asked to report on the Intensity Frontier Workshop.

The charge to the Intensity Frontier Workshop was to document the physics and science opportunities at the intensity frontier, identify experiments and facilities needed for components of a program, demonstrate that the community is interested and wants to do intensity-frontier physics, and educate the community.

There is a good representation of high-energy physics: the high-energy-physics Venn diagram. It has the energy frontier overlapping with the intensity frontier and the cosmic frontier. This is a good representation as long as they *are* all together. The workshop struggled with the definition of the intensity frontier, and that struggle continues somewhat. The other frontiers are well-defined and are becoming more focused and defined. The energy frontier and the cosmic frontier are currently rather well-defined and will remain so for the foreseeable future.

What is the intensity frontier? It is the exploration of fundamental physics with high-intensity beams and/or large sensitive detectors. It takes precision measurements that indirectly probe quantum effects to produce new physics. One does this through research on direct production, precision measurements, rare and forbidden processes, and fundamental properties of particles.

The workshop leadership set up the following areas for study: heavy quarks, hidden sectors, nucleons and atoms, proton decay, neutrinos, and charged leptons. It also set up a working group on each of these topics and, during the months of October and November 2011, charged those working groups to identify any needed facilities at the intensity frontier.

The workshop charge was to summarize findings, get community input, and inform the community at the intensity frontier. What came out of the workshop was a statement that the intensity frontier is a broad and diverse set of science opportunities that looked for, studied, and addressed

- Neutrino oscillations, lepton flavor number violation in neutrinos, and neutrinoless double-beta decay;
- Lepton flavor number violation with muons and taus, and g-2;
- Charge-parity asymmetries, rare decays, distributions, kaons, charm, and bosons;
- New particle searches;
- Electric dipole moments and parity violation; and
- Proton decay.

All of these studies are covered by experiments that are planned, under construction, the subject of wishful thinking, etc.

However, the intensity frontier topics are a connected, overlapping set of science opportunities; but it is not, a priori, clear which is the most important. If possible all of them should be done.

The expectation was that the LHC would solve all of this with its new physics output, but new physics is not rolling out every week. The first surprise from the LHC was the discovery of direct charge-parity violation in charm decays.

There is no consensus on science priorities yet for the intensity frontier. A case for each will have to be made. Also, one has to fold in other constraints (e.g., budgetary limits).

More than 500 participants attended the workshop, and it was peppered with ideas and enthusiasm. There were more than 100 parallel session talks plus much discussion. It demonstrated that there is a large, young community that wants to do this science. The intensity frontier is a broad set of precision measurements of properties of known particles. It is a multi-pronged, interconnected program with a global reach. The science case has "only" been presented.

The first draft of the technical report was completed around the end of 2011. The working group report was reviewed by the community by the end of January 2012. The working group reports were completed by the end of February 2012. The report is being made available to

HEPAP at this meeting for its comments, with a final report being made by the end of March 2012. Everyone who contributes will be a coauthor. A website will be set up for people to sign up in support of the described science opportunities. There will also be a seven-page glossy brochure that will be ready by the end of March 2012. The total report is about 220 pages. A sample title page of a working-group report and sample summaries of the findings of the neutrino and the nucleons, nuclei, and atoms working groups were displayed.

In summary, the program is directed at new physics. There are six working groups. The science is broad and diverse but interconnected. The science reach of each area has been documented. The continuation of a broad-based science discussion of the intensity frontier is recommended. A description of the science should serve as input into strategic planning. Some observations about the workshop:

- The workshop was organized along science not funding sources.
- Neutrino working groups are aligned with both NP and HEP.
- Obviously, nuclear physics is part of the intensity frontier.
- The intensity frontier should continue to be science-based and not funding-based.
- Snowmass 2013 and other high-energy-physics meetings are coming up.
- The current layout on the glossy brochure is very HEP centric; some advice about this situation is needed.

The nuclear-physics community held a workshop in Wisconsin during the fall of 2011. Its findings are perfectly in synchrony with the Intensity Frontier Workshop findings. In parallel with a publication of the findings of the Wisconsin workshop, a website will be developed that is similar in spirit to that of the Large Electron-Positron Collider collaboration's Electroweak Working Group (LEP EWWG), where information can be rapidly shared.

In addition to the June Snowmass meeting, there will be a community planning meeting in October 2012 at Fermilab and a Project X physics workshop at Fermilab in the summer of 2012.

Geesaman pointed out a disappointing issue is how to proceed in QCD as it is in the nuclear physics portfolio but is important to the intensity frontier. Weerts said that this issue had been discussed, and it had been decided, for the workshop, to leave out QCD and to emphasize other areas. It is important to find ways to move forward together (with common facilities etc.).

Klein asked if there had been any discussion of U.S. competitiveness. Weerts replied that he was not aware of any such discussion. It was defined as a science-based workshop, and the workshop participants looked for what the United States could best do.

Gardner asked how the brochure could be made broader. Weerts stated that it is important that the brochure make a case for *science*; that would be beneficial for all involved.

Jacobs asked if there were consensus on facilities needed for progress. Weerts responded that there was no consensus, but the facilities that will be needed in the next 10 years are already under way. The workshop participants could not see beyond those 10 years.

Montgomery confirmed that the workshop separated out QCD.

Nagle pointed out that a lot of work beyond the Standard Model is supported by DOE and NSF. He asked how the brochure could be made more reflective of NP. Hallman replied that the workshop was jointly sponsored by NP and HEP, but HEP was more heavily involved. All references are to particle physics, not particle and nuclear physics.

Norbert Holtkamp was asked to present the interim report of the HEP Accelerator Task Force.

In October 2009, DOE's HEP sponsored a symposium and workshop on Accelerators for America's Future. Its purpose was to elicit the views and opinions of a wide range of accelerator users on the challenges and opportunities for developing and deploying accelerators to meet national needs. Its report presented a range of ideas and made recommendations, but it was not clear what should be done. Subsequently a congressional directive stated that DOE should submit a 10-year strategic plan by June 1, 2012, for R&D to advance accelerator applications in energy and the environment, medicine, industry, national security, and discovery science.

The charge from HEP to the Task Force included providing a summary of costs and time scales for previous successful accelerator R&D efforts to help assess future funding profiles. The Task Force stressed that HEP is the steward for long-lead R&D in this area and that it was reaching out to the community to ask how it can help that community. It engaged the offices of Basic Energy Sciences (BES), Nuclear Physics (NP), Fusion Energy Sciences (FES), and Advanced Scientific Computing Research (ASCR); NSF; National Institutes of Health (NIH); National Cancer Institute (NCI); Department of Defense (DoD); Office of Naval Research (ONR); and industry, and it set up a blog. In 10 days there were 20 to 30 entries to the blog from the medical community alone.

There have already been three panels on accelerator R&D with very good recommendations. There also was the workshop on Accelerators for America's Future, which identified the needs and which disciplines had those needs. The needs were reliability, beam power/RF, beam transport and control, efficiency, radiance, reduced production costs, simulation, lasers, size, superconducting magnets, targetry, and particle sources. However, there were no recommendations on what to do about these issues. What came out of that workshop was not a science program. Instead, seven grand challenges were identified:

- Extend the energy reach of collider technology
- Extend the beam power and intensity reach of hadron accelerator technology
- Extend the capability and understanding of performance limits of rf structures
- Break the rf barrier in developing scalable next-generation acceleration methods
- Develop tools and technologies for the manipulation of particle beam phase-space
- Develop concepts and technologies to extend the brightness, brilliance, and coherence of photon sources
- Develop accelerator systems to serve as compact sources of photons, neutrons, protons, and ions.

Seven science goals ("pushes") were identified for each DOE R&D program thrust; in addition, applications (pulls) were also identified, and feedback between the pull and push elements was established. A major finding was that detectors are relevant and driven by HEP and NP R&D.

The market is $5 to $10 billion per year and employs 10,000 people. Why is accelerator experimentation happening accidentally? The national laboratories have viewed industry as being remote, and industry has viewed the DOE laboratories as closed and restricted. There is no integrated view of what is out there. It takes 13 months to execute a Cooperative Research and Development Agreement (CRADA). Some mechanism is needed to direct the industrial market to the capabilities of the national laboratories.

There is no forum in which different agencies can discuss capabilities and progress. There needs to be communication. The Office of High Energy Physics (HEP) could lead an accelerator working group, an oversight panel, a steering group, or a board of stakeholders that would involve intra-agency and interagency program managers as well as industry representatives and technical advisors. There is a National User Facility Organization (NUFO) to develop simple user-friendly procedures to give customers access to national laboratory infrastructure and expertise and to allow proprietary research or at least research in access-controlled areas.

SC and HEP can work to identify, understand, and resolve the concerns from industry and other agencies regarding protection of incoming and generated intellectual property or information. A template covering all aspects of a contractual arrangement that would be applicable to all users of facilities and infrastructures would be useful.

Leveraging the Small Business Innovative Research/Small Business Technology Transfer Program (SBIR/STTR) funding with a specific focus on energy and environment, medicine, industry, and defense and security apart from discovery science could strengthen these parts of the program, directing money at once to the topic areas identified in the Accelerators for America's Future report. Collaborative Accelerator Research Teams (CARTs) is a way of doing things more efficiently. Ask specific questions; pull a team together to answer those questions; and end the program.

SC would establish a program to bring industry, laboratories, and universities together to foster the application of accelerator technology in energy and the environment, industry, medicine, defense and security, and discovery science. Such an effort would have to be set up as a program with a funding stream.

Accelerator-science education is a must. Workforce development for particle accelerator R&D has traditionally been a major emphasis of SC.

The medical community would benefit from hadron-beam facilities. SC could develop a stepwise implementation plan for providing beams and for developing beams and beam-delivery systems in a cost-efficient manner. This is a low-hanging fruit; a lot of efforts could be carried out quickly.

SC could provide a home for laser R&D. Lasers have become an integral part of accelerators and provide tremendous potential for new methods of acceleration, for miniaturization of accelerators, and for desktop accelerator systems. These tools have been driven by NIH, industry, and the NNSA, all outside SC.

Congress is waiting for an answer on the six topics cited in its directive. It is hoped that the Task Force will be helpful. It needs advice on usability, appropriateness, and content of the preliminary report. Implementing some of the ideas would mean to do business a bit differently. The input of this task force will last a bit longer and go deeper than did some of the previous panels.

Geesaman noted that HEP would not have the expertise to apply accelerator science to so many disciplines. He asked if accelerator science should be split among several SC offices. Holtkamp replied, no. There needs to be some type of roundtable to guide programs in the field. Geesaman agreed; however, this is a charge to HEP; accelerators at universities have not been able to be used for accelerator-science programs and training, and the United States has lost a great opportunity to benefit the workforce's development.

Gardner asked about accelerator options that fall between subfield cracks with no obvious user community or funding niche (e.g., wakefield accelerators for driving reactors and making possible a thorium option for energy production). She asked if that could be an example for another infrastructure proposal rather than a program in HEP. Holtkamp replied that the workshop pointed out that the United States and DOE are leading accelerator science (e.g., with the Spallation Neutron Source in Oak Ridge). The Office of Nuclear Energy (NE) is swamped by the research required to support the licensing process for new reactors. It is not interested in accelerator science for driving reactors. HEP could do that faster than anyone else.

Jacobs suggested that accelerator-science education should be placed in the Long-Range Plan. Holtkamp noted that the workshop report will have some suggestions on how to promote accelerator-science education. Keister noted that NSF has been involved in accelerator-science education through university-based facilities, including Indiana, Michigan State, and Cornell. It has lost some of that activity as facilities have phased out. APPI is a mechanism to keep some of these activities going through research and graduate education. Hallman added that, within DOE, the stewardship of generic accelerator R&D has lain with HEP. Education in accelerator-science R&D is not being supported. DOE does not want to overlap responsibilities with NSF.

Symons asked if there were a problem or not; whether a major redirection is needed, or whether the money is being spent well. Holtkamp said that there is no good answer to that question. The congressional staff wants to see impact. What is being suggested is probably good, but a connection needs to be drawn. Redirection is probably not needed. There is a problem in technology transfer.

Wiescher noted that the workforce is an important part of developing new accelerators for the different applications. The university facilities have a problem getting young technical staff. Something needs to be done.

A break was declared at 2:42 p.m. The meeting was called back into session at 3:06 p.m.

William F. Brinkman was introduced to review the FY13 budget request to Congress for SC.

The Office of Science (SC) has for a long time been supporting research that has led to more than 100 Nobel prizes during the past six decades in a broad area of science. That list now includes Saul Perlmutter, who received the Nobel Prize in physics this year for his work on dark energy. Science is the basis of technology and underpins America's energy future. Today we are laying the foundations for the new technologies of the coming decades. In this enterprise, the federal government (and SC) plays a unique role. A highly trained workforce is required to invent the future.

The President has said, "Don't let other countries win the race for the future. Support the same kind of research and innovation that led to the computer chip and the Internet, to new American jobs and new American industries."

SC has an arsenal of basic science capabilities (major scientific user facilities, national laboratories, and researchers) that we are using to break down the barriers to new energy technologies. We have focused these capabilities on critical national needs, such as through the bioenergy research centers, the energy frontier research centers, the Combustion Research Facility, the Joint Genome Institute, the five nanoscience centers, and the new energy innovation hubs.

Three classes of applications are the focus of SC research: materials and chemical processes by design, biosystems by design, and modeling and simulation.

The SC FY13 budget request to Congress includes $526.9 million for NP, which is $20.45 million (or 3.7%) less than the FY12 budget.

The total SC request is for $4.99 billion, which is $118.4 million (or 2.4%) more that the FY12 budget.

In FY13, Nuclear Physics operations and research will continue at three nuclear science user facilities (RHIC, CEBAF, and ATLAS). We hope to continue to move forward on the 12-GeV CEBAF upgrade. We will continue to prepare for the construction of the FRIB to study the limits of nuclear existence. We will conduct research, development, and production of stable and radioactive isotopes for science, medicine, industry, and national security.

A major research result has been the production of the heaviest anti-nucleus ever observed, helium's antimatter twin, being discovered at RHIC.

With the completion of the 12 GeV CEBAF upgrade, researchers will address the search for exotic new quark-antiquark particles to advance our understanding of the strong force; seek evidence of new physics from sensitive searches for violations of nature's fundamentals symmetries; and develop a detailed microscopic understanding of the internal structure of the proton, including the origin of its spin, and how this structure is modified when the proton is inside a nucleus.

A grand-challenge question is whether the neutrino is its own anti-particle. The MJD technology demonstration is planned prior to a down-select with the German GERDA experiment between competing germanium technologies and a planned collaboration. MJD is on track with electroforming and with procurement and processing of enriched germanium. MJD plans to go underground with natural germanium in a prototype cryostat at the Sanford Laboratory in South Dakota in March 2012. The technology and the location of a future, international tonne-scale experiment is to be determined, based on the best value and the best capability.

The SC–NNSA joint workshop on isotopes supply and demand was held January 11–12, 2012. It identified key isotopes needed by federal agencies over the next five years. This was a one step forward in ensuring the nation's access to essential isotopes.

He closed by saying that this is an interesting time; DOE is trying hard to maintain funding.

Geesaman said that the obvious question is what the charge will be to the nuclear-physics community. Brinkman replied that some important decisions will need to be made, and community input will be needed.

Klein noted that he had mentioned fundamental science, yet the current budget is turning away from fundamental science and toward short-term applications. Brinkman said that that is right; clean energy is a pressing problem. The United States is in a highly competitive situation. There are economic pressures to deal with; one cannot ignore them, especially climate change.

Blackmon called attention to the pride that NSAC takes in its planning process, and noted that any charge will not be done in time to be useful for future planning. The budget for FY13 is lower than expected. He asked what might be expected in FY14. Brinkman answered that there are lots of places where cuts are being made. The agencies have to take what they get.

Jacobs asked when the charge will request a report. Brinkman answered, as soon as he could get it out.

Donald Geesaman took the floor to discuss the charge that had not been received. The timescale for preparing the report is not known. Nuclear physics is an integral part of the history of the universe, starting with the quark–hadron phase transition. One does not know how the hadrons change as they form nuclei. Isotope research is needed. The nuclear physics community needs to craft its future actions to address these and other issues. There are incredibly important properties that need to be elucidated.

The 2007 Long Range Plan presented a number of recommendations: the upgrade of CEBAF, the construction of FRIB, experiments on neutrino properties and fundamental symmetries, and the upgrade of the RHIC.

NSAC has prepared a long-range plan approximately every six-seven years and responded to charges to define how to implement the long-range plan in a constrained budget after almost each one. In long-range plans, one wants to dream about where one will find the best science. Implementation plans consider the budget. One cannot do both of these things at the same time. The budget considerations may result in the closure of facilities; flat-flat budgets might result in there being only one major facility.

If asked for a long-range plan, NSAC will get as much community input as possible. If asked for an implementation plan for the 2007 Long-Range Plan, quick action will be needed. A chair will need to be selected soon. Discussions have been held with several potential candidates. Only one person has been identified who would have the broad trust of the entire community: Robert Tribble. [Applause.]

A balanced and diverse membership of the Report Subcommittee is essential. Someone from outside nuclear physics is needed to help convince the agencies and the world that this is a fair and thorough process. NSAC will prepare a charge letter to the Subcommittee to help focus its deliberations. Suggestions for this letter would be appreciated.

The goals of the selection process are

- To be viewed as fair and deliberate
- To base recommendations on science opportunities and the future of the field
- For the entire field to embrace the document and speak with one voice
- To eschew criticism and arguments about relative values of other DOE or NSF programs and political interests
- To communicate the value of the science and the wisdom of the planning
- To project confidence to coherently respond to the issues
- To respond to the charge

Gardner asked how many nonnuclear physicist members would be typical. Geesaman expected a level of 10%.

Jacobs noted that Brinkman had said that there are other elements to how decisions are made (e.g., economic pressures and educational impact); these issues were not considered in the previous reports. It might be more effective to include these issues in the next report.

The floor was opened to the public.

Vigdor asked if there were aspects that could be initiated no matter what type of report is requested. Geesaman replied that as soon as we receive a charge, some Subcommittee members could be named within a week; a timeline for the report-preparation process would be drawn up.

Montgomery asked if town meetings were anticipated. Tribble said that, if the timescale allowed, town meetings would be held. If not, an indirect method for community input will need to be found.

Velkovska asked how many Subcommittee members were envisioned. Geesaman responded, 23 or 24; everyone should read the 2007 Long-Range Plan.

The floor was opened for additional public comment. There being none, the meeting was adjourned at 4:10 p.m.

The minutes of the Nuclear Science Advisory Committee meeting held at the North Bethesda Marriott Hotel and Conference Center, Rockville, Md., March 9, 2012, are certified to be an accurate representation of what occurred.

Donald Geesaman,
Chair, Nuclear Science Advisory Committee