# Minutes
# Department of Energy and National Science Foundation
# Nuclear Science Advisory Committee
# Crystal City Marriott Hotel, Arlington, Va.
# July 30, 2010

**Members Participating:**

Susan Seestrom, Chairman
Robert Atcher
Vince Cianciolo
Gail Dodge
Richard Furnstahl
Carl Gagliardi
Susan Gardner
Peter Jacobs
Sylvia Jurisson
David Kaplan
Dmitri Kharzeev
Joshua Klein
Christopher Lister
Gail McLaughlin
Curtis Meyer
William Zajc

**Members Absent:**

Allison Lung
Hendrik Schatz
Johanna Stachel

**Others Participating:**

Linda Blevins
William Brinkman
Joseph Dehmer
Ping Ge
Jehanne Gillo
Timothy Hallman
Eugene Henry
Bradley Keister
Steven Koonin
Kevin Lesko
Brian Plesser
Hugh Montgomery
Gisele Muller-Parker
Edward Seidel
Keith Tucker
Steven Vigdor

**Presenters in Order of Appearance:**

Steven Koonin
William Brinkman
Edward Seidel
Bradley Keister
Timothy Hallman
Linda Blevins
Keith Tucker
Gisele Muller-Parker
Ping Ge
Kevin Lesko

About 20 others were in attendance during the course of the meeting.

**Morning Session**

Before the meeting, the Committee was briefed on ethics issues by **Brian Plesser** of the Department of Energy (DOE) General Counsel’s Office.

The meeting was called to order at 9:00 am by Chair **Susan Seestrom**. She asked the members to introduce themselves. She then introduced **Steven Koonin** to give an overview from the perspective of the Under Secretary of Energy.

The advice of the Advisory Committees is very important. The Department is currently preparing the FY12 budget and is in the midst of a planning exercise. DOE has four missions: to sustain basic research, transform the national and global energy system, enhance nuclear security, and contribute to U.S. competitiveness and jobs. In basic research, the United States has been a global leader for 50 years, but now the rest of the world is investing a lot of money in science. It is unclear if the United States is still the leader in many fields. DOE needs to balance resources in basic research between fields that are close to versus distant from applications. Agencies must talk to the public and to Congress more effectively. Climate science must be improved; it has gone from an academic exercise 30 years ago to prominence today.

The drivers of energy transformation are energy security and reducing greenhouse-gas emissions. To enhance energy security, the target is to reduce crude-oil use by 3.5 million barrels per day. To check greenhouse gas emissions, a 17% reduction is sought by 2020 and an 83% reduction by 2050. Changes in energy supply occur at decadal scales; it takes a long time to make changes. One question is how to hook up science and technology with society and industry. Another is what the best research structures are. Coupling basic and applied research is on the Department's mind. The policy must be gotten right because industry can then do more.

Nuclear security is half the energy enterprise. DOE must maintain a technical base, it must keep its staff engaged even though it is not testing weapons anymore, it will begin a sustained-burn campaign in a couple of weeks at the national ignition facility, and it needs to exploit simulation capabilities.

In U.S. competitiveness, a deep understanding of the issues must be grasped. The rest of the world is growing and developing faster than the United States is. The long-term trends in domestic output and employment are not in the nation's favor. Scientists and science and technology must determine what roles they are to play; innovation is the key to competitiveness.

Simulations expand scientific and technical understanding. DOE is providing petascale machines to the scientific community to work on biology, turbulence, nuclear energy, fusion energy, biofuels, and quantum chromodynamics. If one can simulate energy systems with high fidelity, one can optimize designs, compress the design cycle, and facilitate a transition to scale. The rest of the world is working hard in this area.

In FY09, federal spending was largely for Social Security, Medicare, Medicaid and the State children's health insurance program, unemployment and welfare, interest on the national debt, and the Department of Defense. DOE is in the discretionary portion of the budget. This is unfortunate because the federal deficit is shaping the budget discussions.

Koonin thanked the Committee for its hard work and continued dedication to advising the government. He plans to continue calling on its expertise as the Department moves toward an overall strategic plan to optimize resources.

Furnstahl asked if there were an opportunity for cross-fertilization between nuclear science and climate in simulation. Koonin responded that there is not a close similarity in the form and coverage of the data, but the two disciplines use the same expertise. Climate-change workshops involving physicists have been held.

Gardner asked if he would term climate research basic or applied research and desire to improve that investment by balancing basic and applied research. Koonin replied that there are both basic and applied aspects of climate research (e.g., modeling, geoengineering, and treaty monitoring) with both predictive and policy uses.

Jacobs asked if basic research in accelerator facilities were moving offshore. Koonin answered that the work goes where the facilities are. The United States will not be able to build every forefront machine. It will support people to do the best research wherever they can. Brinkman added that these facilities cost so much money that one country cannot afford to build one. They have to be international exercises. Getting countries to cooperate is difficult. Laboratory-to-laboratory collaboration is working well. Koonin pointed out that, as one gets down the road to demonstration, commercial aspects of the research become more tangible, and issues of competitiveness arise and lead to fewer international actions.

Seestrom asked if accelerator science and technology were a core discipline for U.S. science that should be preserved in the approach to collaboration. Koonin said, yes. Brinkman added that an accelerator-technology workshop was held last year that was very enlightening. Koonin added that the country needs to look at and identify its core capabilities.

Lister asked where the United States was with nuclear energy. Koonin answered that the administration had said that nuclear energy must be an important part of the energy mix going forward. The administration has issued large loan guarantees for the construction of nuclear power plants; it is pushing hard for R&D supporting nuclear technology; it has started a hub on simulating nuclear power plant design; it has established the President's Blue Ribbon Commission on America's Nuclear Future; and it is considering R&D on the basic science needed to underpin the design and construction of small, modular reactors. The huge cost of reactors can be reduced by streamlining the licensing and siting processes. It should be recognized that there are a lot of other economic and societal factors that dominate the technology and deployment of nuclear power, such as the price of natural gas.

Zajc asked how a list of core competencies would be produced. Koonin said that he did not know. The National Academy of Sciences (NAS) or the Office of Science and Technology Policy (OSTP) might be the best one to perform that task.

Keister asked if there were plans to address electricity rate policy at a national level in a manner similar to California over the past few decades. Koonin replied, yes, but there are extenuating circumstances: the grid is very complex, and the federal government does not have as much clout as one might want.

Jurisson noted that few institutions train radio- and nuclear chemists. This decline has gone on since the 1980s. Europe, China, and India put much more effort into this field than does the United States. Seestrom added that the amount of effort in rare isotopes in Europe is staggering. Klein said that the United States will be dominant in neutrino physics in the next 10 years. Jacobs pointed out that the Relativistic Heavy-Ion Collider (RHIC) and other research institutes catalyze certain fields.

**William Brinkman** was asked to give an overview of activities in the DOE Office of Science (SC). President Obama wants the country to increase science funding and has been delivering on that promise.

SC's priorities are in scientific computing and climate science. Its requested budget for FY11 is $5.1 billion, a 6.1% increase. That request got a poor markup from the House, but the details are not known; the Senate was much kinder, leaving a 2.2%

increase. The nuclear medicine application program, currently within the Office of Biological and Environmental Research has been transferred from the Office of Nuclear Physics (NP), but no money was transferred in the Senate Markup. The Battery and Energy Storage Hub and the Fuels from Sunlight Hub were funded in the Senate markup. Funding for NP is down $8 million.

The SC Graduate Fellowship Program, which currently has 150 fellows, is not in the Congressional budget. It is hoped to get that corrected. The Early Career Program is embedded in the budgets of the SC offices and was untouched.

The ultimate goal for the Fuels from Sunlight Hub is to imitate photosynthesis with a factor-of-10 increase in productivity. The winning team was California Institute of Technology and Lawrence Berkeley National Laboratory (LBNL); it will be led by Nate Lewis, and will partner with six other institutions. The Battery and Energy Storage Hub will deal with the problems produced by intermittent energy sources (wind, solar, etc.).

The Office of Advanced Scientific Computing Research (ASCR) has an Exascale Initiative. The United States has the fastest machine in the world, the Jaguar at Oak Ridge National Laboratory (ORNL). The Chinese will take that lead in the fall, and the United States will reclaim the lead the following spring as the Jaguar is expanded and upgraded. A number of research questions require larger simulation capabilities than even the Jaguar offers. The major components of the Exascale Initiative include platform R&D on power, integration, and risk mitigation; critical technologies like memory, nonvoltaic storage, and optics; software and environments like the operating environment, systems software, system reliability, and programming models; co-design and integration with vendors on physics models, applied mathematics, performance models, simulators, and applications; and platforms that ensure component integration and usefulness and risk mitigation for vendors.

The Linac Coherent Light Source (LCLS) at SLAC produces an amplified X-ray beam and has already produced several science results, such as refracting nanocrystals in water.

The International Thermonuclear Experimental Reactor (ITER) in the past year has developed a real schedule, estimated a realistic cost (that translates to a $1.4 to $2.2 billion contribution from the United States during the construction phase), and installed a new director. The United States has a 9% share in this enterprise. It is located in Cadarache, France, and the site has been prepared.

The Inertial Fusion Energy project at the National Ignition Facility is nearing ignition.

In particle physics, SC is supporting work at the Large Hadron Collider (LHC) and at the Long-Baseline Neutrino Experiment (LBNE). There is a big push to keep the Tevatron running. The LHC is being slow in starting up. It is not clear how the ramp-up of the LHC is going to proceed. The Tevatron was to have been shut down in 2011, but areas of exclusion for the Higgs boson have been constantly expanded, leading to valuable prospective insights from its continued operation. But extending the operation of the Tevatron would have considerable cost. An advisory committee will consider the question of its continued operation later this summer.

NP now manages the isotope program, which was transferred in FY09. Several workshops have been held, and problems have been identified on the supply side, especially in helium-3 and molybdenum-99.

Four national user facilities [RHIC, the Holifield Radioactive Ion Beam Facility (HRIBF), Argonne Tandem Linac Accelerator System (ATLAS), and the Continuous Electron Beam Accelerator Facility (CEBAF)] are being operated and upgraded. Funding may be constrained in the future. The Facility for Rare Isotope Beams (FRIB)at Michigan State University (MSU) has its engineering design scheduled to start in FY11.

In accelerator technology, the questions are:

- Can accelerators be built with about 50 MW of power in the beam?
- Can associated targets be constructed?
- Can accelerators be built to burn actinides?

A workshop on this topic was held the previous week. A few such accelerators could destroy all the long-lived actinides produced by power reactors.

The Small Business Innovative Research (SBIR) program ($150 million to $200 million per year in DOE) is being moved up to report to the Deputy Director of SC. The Office is being enhanced to deal with SBIR better.

Dodge asked if the Office of Nuclear Physic's budget was actually down $23 million for FY11 in the Senate Markup. Brinkman replied, yes: $8 million down in the overall budget and $15 million down for the transfer of medical applications from BER, but that problem is being worked on to get the loss of funds reversed. Atcher said that the Society of Nuclear Medicine got a note from a congressional staffer the previous night that said that the medical applications funding has been moved to NP. Montgomery said that it is clear that there is a disagreement about whether or not the Department is doing a good job in medical applications. Brinkman replied that there is good work going on. The medical part is complicated by the biology part.

Zajc said that loss of funding for the SC Graduate Fellowship Program was a surprise. Brinkman agreed but said that the $5 million that is in the markup would support the current fellows but not allow any new awards.

**Ed Seidel** was asked for an update on the activities of the Mathematics and Physical Sciences (MPS) Directorate of the National Science Foundation (NSF). The impact of computing on all the directorates is great and will increase. MPS has five divisions: Physics, Materials Research, Astronomy, Chemistry, Mathematical Science. Energy and climate are very important to NSF.

Overall budget situation: Basic research is seen as being very important by the administration, but it is discretionary funding, which (cumulatively) is frozen. MPS is fundamental to the areas of priority (energy and climate). These areas have a fundamental science R&D effort.

The NSF overall budget request for FY11 is $7.4 billion, an 8.0% increase of $552 million. The request for the MPS directorate is $1.38 billion. The MPS request reflects investments in facilities, centers, workforce development, and core programs. The Senate and House markups are out, and both were close to the request for NSF.

There are new division directors in Astronomy, Chemistry, Materials Research, and Mathematical Science.

A number of working groups produced a series of white papers on organizational structure, science directions, broadening participation, computation, data-enabled science, and matter by design, life sciences, quantum information science, etc. to help MPS plan for the future. Discussions have been held on how to organize computational science across the foundation to have a longer-term, more stable program. Currently, community codes and other broad-based capabilities are fully supported. Campus links are being developed (e.g., through the open science grid). Training people in this area is very important, so computational science postdoctoral programs have been established. It is hoped that they will be expanded in time. NSF will also invest in software and institutes and is rethinking its top-level computing facilities.

The Science, Engineering, and Education for Sustainability (SEES) Program are a significant investment ($110.5 million) and it covers a large number of directorates. There is a lot of overlap with DOE programs. DOE and NSF representatives meet to coordinate and mutually support efforts.

MSP operates about 16 facilities and has requested $269.07 million for them for FY11.

The National Superconducting Cyclotron Laboratory (NSCL) at Michigan State has 700 users; facility construction follows NSAC priorities.

There is a current award to operate the NSCL, which ends in a year. That facility will see a transition to the Facility for Rare Isotope Beams (FRIB).

The NSF is confident of the plan for the decision process for the Deep Underground Scientific and Engineering Laboratory (DUSEL). An action item will be coming to the National Science Board (NSB) for bridge funding. An NAS study of DUSEL's prospects has been requested by DOE and NSF. A joint-stewardship model has been worked out. The laboratory will be overseen by NSF, and some of the experiments will be the responsibility of NSF and some of DOE. There has been a review of the scientific experiments that could be carried out at DUSEL to inform the design review in 2011.

Kharzeev asked if there were interdisciplinary collaborations in NSF. Seidel replied that there are tons of them. Condensed matter research, for example, connects many groups.

Jacobs pointed out that the Open Science Grid (OSG) is a national entity, not a truly integrated international grid. Seidel replied that there are a lot of discussions going on about joint efforts with the European Union.

Gardner asked what the Enriched Xenon Observatory's (EXO's) stewardship was. Dehmer replied that the steward is NP. Seidel added that DOE has the primary responsibility for double beta decay experiments, with NSF's cooperation. Dehmer pointed out that the steward is the managing partner. The managing partnerships have been distributed between NSF and DOE across the different scientific endeavors. It is a way of putting someone in the driver's seat. Seidel added that it carries a responsibility.

Montgomery asked about the advisory committee on DUSEL. Seidel said there is no advisory committee; it is an NAS study.

Vigdor asked to what extent a long continuing resolution would complicate things. Dehmer replied that there is a plan to manage such complications.

A break was declared at 10:56 AM. The meeting was called back into session at 11:13 AM.

**Bradley Keister** was asked to speak on nuclear physics at the NSF. On the NSF side, nuclear physics has several programs with complete budget-making decision capability and others for which the budget-making decisions are made elsewhere. Full budget programs are Nuclear Physics Experiment, Nuclear Physics Theory, Particle and Nuclear Astrophysics (PNA), and the frontier Center for Nuclear Astrophysics. The budget for all of these is about $47 million in FY2010.

In the FY10 appropriation, Nuclear Physics Experiment got an increase of 4.3%, (as did most experimental programs in the division). Theory got an increase of 9.2%, (part of a divisional effort to increase funding for theory), and Particle and Nuclear Astrophysics got an increase of 5%. Additional funding comes in for Major Research Instrumentation, in which awards are in process; Cyber-Enabled Discovery and Innovation, in which awards are in process; Department of Homeland Security (DHS) Domestic Nuclear Detection Office, in which awards are in process; Software Infrastructure for Sustained Innovation, for which awards are in process; and the Physics Frontier Centers for which the preproposal deadline is August 11, 2010.

The FY11 R&RA budget request asks for an 8% increase. The House and Senate marks are close to that. In physics, a 2.8% increase has been requested.

There is a nominee for NSF director, and there are new personnel in place: an NSF acting deputy director, an MPS assistant director, a physics division director, and Intergovernmental Personnel Act staff in Nuclear Physics.

Gagliardi asked if the joint appointment between NP and PNA were going to continue. Keister replied, yes; there will be no gaps.

**Timothy Hallman** was asked to summarize the activities of the Office of Nuclear Physics in DOE.

There have been several scientific highlights: A doubly magic nucleus has been captured at the Holifield Accelerator at ORNL, and element 117 was discovered in Russia using berkelium produced in the High-Flux Isotope Reactor at ORNL. The Thomas Jefferson National Accelerator Laboratory (JLab) showed conclusive evidence for the onset of color transparency with an increase in particle energy. RHIC has new evidence for a color glass condensate. At Argonne National Laboratory, HELIOS reconstructed the kinematics to probe the excited state $^{15}C(d,p)^{16}C$. Argonne National Laboratory (ANL) is gearing up for the Californium Rare Ion Breeder Upgrade (CARIBU).

The request from SC was $5.12 billion; for NP, the request was for $562 million. The House markup was $4.9 billion for SC. The Senate markup was $5.012 billion. The scope for NP was: "within the funds provided, $15.4 million is for nuclear medicine research with human application. All of the added funds must be awarded competitively in one or more solicitations that include all sources – universities, the private sector, and government laboratories – on an equal basis. Funding for nuclear medicine application research was previously within the biological and environmental research program." It is the current understanding that this scope came with no funding.

With the President's request, it is expected to achieve

- The 12-GeV upgrade at JLab
- Research at national laboratories and universities
- Majorana Demonstrator R&D
- Scientific user facilities at RHIC, CEBAF, HRIBF, and ATLAS
- FRIB engineering and design
- Etc.

At JLab, the roof is going up on Hall D, and great progress has been made on the 12-GeV upgrade. The lead-up to construction of the FRIB is progressing; a Lehman review was conducted from July 27 to July 29, 2010. The project will request CD-1 soon. Smaller investments are being made in accord with the long-range plan [e.g., in a Physics

Experiment (PHENIX), Solenoidal Tracker at RHIC (STAR), Cryogenic Underground Observatory for Rare Events (CUORE), the Majorana Demonstrator, and Neutron Electric Dipole Moment (nEDM)].

The Isotope Program was transferred from the Office of Nuclear Energy (NE) to NP in FY 2009. Research on isotope production has restarted. Several projects have been funded.

The NSAC Committee of Visitors (COV) was held in January, and a response has been delivered to the Deputy Director of SC. Implementation of some recommendations has already begun. A solicitation is out for the next round of early career research awards.

The outlook from the Office is:

- Nuclear science continues to deliver discovery science and forefront advances in technology.
- New opportunities for ground-breaking research are being addressed.
- Support for training and advancement of the next generation of scientists is increasing.
- National needs for production and R&D on rare isotopes for research, medicine, and national security are being addressed.
- New advanced research tools that will provide new capability and maintain U.S. leadership are being constructed.
- The United States continues to face a number of challenges.
- Actions that address national priorities directly affect SC and NP.
- It is essential to continue to articulate the relevance and value of nuclear science research to national priorities.
- As in the past, to ensure continued vitality and balance in the field, NP will work closely with the community to prioritize the most compelling research and technical developments.

Gardner asked if it were possible to fund the production of alpha-emitting nuclei through nuclear applications. Gillo responded that production is being supported elsewhere in the program. The earmarked funds in the Senate Markup were for purposes different from nuclear medicine isotopes. There is the possibility of reducing the R&D to fund the production.

Cianciolo asked whether the number of Early Career awards would be the same as last year. Henry responded that there would be three at the national laboratories and four at universities.

Kaplan asked if the increase in the Nuclear Physics Theory budget indicated wider funding in the coming year. Henry responded that the grants have been issued from the FY10 budget and subsequent funding will be flat. Gillo added that that increase is artificial; it just reflects a transfer from one program to another.

Montgomery asked about the SBIR program. Hallman replied that it may not be understood by Congress but is important in producing innovation. Jacobs asked if there were any tracking of SBIR awards that could demonstrate the efficacy of the program. Hallman replied that the office was thinking about how to produce metrics to do that: Is it money generated or utility to research programs or other benefit? Seestrom noted that there is a IUPAP [International Union of Pure and Applied Physics] publication on relevance coming out. There is dissonance about what the prime mission of the program is: Is it job creation or basic science?

**Linda Blevins** and **Keith Tucker** were asked for a briefing on the Portfolio Analysis and Management System (PAMS).

Last year, SC had about 150 federal programs, 3000 active grants, 1000 awards, 2500 new proposals, 10,000 reviews collected, and 1750 proposals for Early Career awards. The business process for universities is to issue a solicitation; receive pre-proposals; send encouragement/discouragement decisions; receive proposals; log and assign proposals to program managers; perform an administrative review; execute peer review; and make selections. If an award is accepted, the process continues to negotiate the scope and budget; receive a revised budget and scope; document the award decisions; place money in a monthly financial plan (STRIPES, the STRategic Integrated Procurement Enterprise System); create a requisition and obtain concurrence; approve the award recommendation; route the requisition to the Chicago Operations Office; negotiate the final award; issue the award; return reviews to the principal investigator; release the continuation or supplemental funding; receive and approve final technical reports; and close out the award. If the award is declined, the process continues to document the decision to decline; obtain approvals for the recommendation to decline; issue the declaration letter; return reviews; and close out the award. For the most part, the business process for national laboratories is much the same except that site offices rather than the Chicago Operations Office process the awards. This year, Chicago Operations is processing about 5000 awards, about 25% more than usual.

PAMS is web-based government off-the-shelf (GOTS) software in use at several federal agencies. It will automate currently manual portions of the grants management and national laboratory research project funding processes. It will support SC program offices, SBIR/STTR [Small Business Technology Transfer], and national laboratory research project funding. The system has a service-oriented design and has already been integrated with grants.gov and financial management systems at other federal agencies. The plan is to deploy this system iteratively, with initial operational capability in FY11.

The design philosophy behind PAMS is to support the complete research funding process. It will also consolidate or integrate with all the other existing information systems, improve data management, standardize data exchanges, and enable flexibility and process implementation. At the application level, PAMS will feed information back up into the management structure.

Klein noted that the money from Chicago Operations has been very slow in coming and asked if this situation will improve. Blevins responded that this past year there was a continuing resolution, the rollout of STRIPES, and the ARRA, each of which caused a lot of delays. The staff is working hard on both the program side and the process side to improve the system.

Atcher asked if there were a way to build in a return of reviews to the applicants. Blevins answered that management is very interested in doing that. It was done for the Early Career Award Program last year, and it was a huge effort. Everyone will not be the same. There will be some common processes and some that will be tailored to the community.

McLaughlin asked what demographic information will be able to be analyzed. Blevins replied that everything that goes in and out will be counted. Race, ethnicity, gender, etc. (personal data) must be protected. Seestrom noted that the COV was interested in what the success rates for women, minorities, etc. were. Tucker added that PAMS will process the declinations so it will enable demographic analysis.

Seestrom asked when the system was expected to be fully functional. Tucker replied that contractors will

- complete the requirements definition,
- identify gaps between base GOTS application and stated requirements, and
- plan a project to implement PAMS, iteration 1, sometime in FY11.

A break for lunch was declared at 12:23 PM.

## Afternoon Session

The meeting was called back into session at 1:35 PM. Gisele Muller-Parker was asked to review the NSF Graduate Research Fellowship Program, which was initiated in 1952. Many applicants are undergraduates. The program is designed to identify the nation's future science, technology, engineering, and mathematics (STEM) leaders. It focuses on the individual, promotes diversity in the STEM workforce, and adheres to the NSF merit review criteria.

The award of $121,500 can be used any time in a 5-year period. It provides 3 years of support (stipend plus educational allowance), international research opportunities, and supercomputer access. 2000 were just awarded. A lot of recipients come from smaller institutions but, once named, are recruited by universities. Currently, engineering and the life sciences constitute 60% of the awards. Physics and geology are underrepresented. There is the same success rate across all fields. Getting people to apply is important. The number of new fellows in nuclear physics between 1952 and 1970 ranged from 10 to 40. After 1970, there was a huge drop-off with only a few, if any, new fellows in nuclear physics each year. A similar but smaller drop-off occurred in all physics and astronomy. The numbers rebounded somewhat in 2010 when the number of fellowships was increased from 1000 to 2000. In FY13, it is hoped to award 3000 fellowships. There are 316 physics fellows right now, concentrated in a few schools and scattered throughout the physics disciplines.

There were 2002 awards this year and 2026 honorable mentions (which carried with them supercomputer allocations). The purpose is to encourage people to go to graduate school. There are 3600 fellows now enrolled in 200 institutions. Last year, the research directorate at the NSF got ARRA funding, artificially increasing the number of awards. With the increase in awards, there has been an increase in applications (12,000 this year with a 17% success rate).

Eligibility requires U.S. Citizenship (or permanent residency) for early-career students pursuing research-based graduate studies in NSF-supported fields at accredited institutions. Applicant resources include tips for applying, frequently asked questions, references to other funding opportunities, and panelist registration.

Klein asked to what extent the work the student is going to do would be taken into consideration during the application process. Muller-Parker replied that there are no research funds, so what work is to be done (and its funding from other sources) does not influence the consideration of the application one way or the other. One cannot receive another stipend, however.

Jacobs asked if students' careers were tracked after graduation. Muller-Parker answered that all programs have to be evaluated, and the contractor does that type of information gathering. The fellows are asked to tell what they are doing during each year of support. Fellows complete their degrees at a higher rate than do others.

Furnstahl asked what the undergraduate-to-graduate-student application ratio was. Muller-Parker said that the success rate is slightly higher for undergraduates. The panelists focus on promise of success. Undergraduate research experience is an important indicator.

Zajc asked if all the reviewers were volunteers. Muller-Parker replied that program managers are asked to solicit applications, and outreach is available to a couple of thousand volunteers from undergraduate institutions, national laboratories, industry, major graduate schools, women, and minorities. Zajc commented that the 1% nuclear physics representation is an issue that this community must address.

**Ping Ge** was asked to describe the DOE SC Graduate Fellowship Program. Before describing the program, she noted that the awards are to be made on the following week, so statistical data are not yet available.

The program is housed in the Office of Workforce Development for Teachers and Scientists (WDTS). Three of six research offices (Advanced Scientific Computing Research, Biological and Environmental Research, and Fusion Energy Sciences) already had graduate research fellowships. A coordinated and prestigious SC Graduate Fellowship Program was seen to be needed for all six research offices.

$12.5 million of ARRA funding provided a jump start for the program, allowing 80 fellowships. The WDTS FY10 budget allocation of $5 million provides continuity. The WDTS budget request of $15 million will cover a second year and a new cohort. Within SC there is a program management working group that identifies, recruits, and moderates reviewers with the help of the Oak Ridge Institute for Science and Education at Oak Ridge Associated Universities. That contractor lends logistic and software support in dealing with reviewers, applicants, and fellows.

The Fellowship is a 3-year award, totaling $50,500 per year and includes a living stipend, tuition and fees, and a research stipend. It also includes attendance at a Fellowship program research conference, which was to be held the following week at ANL, where fellows share their research with other fellows and invited researchers from Universities and national laboratories. Guest lectures, tours of the host laboratory, professional-development seminars, and workshops on how to access the DOE user facilities supplement an orientation for new fellows.

The eligibility requirements are U.S. citizenship, being an undergraduate senior or first- or second-year graduate student, and pursuing an advanced degree in areas of basic research important to SC. About 10% of the awardees are undergraduates, and 90% are graduate students. The application consists of an application form, transcripts, and three letters of recommendation.

The first merit review is of academic performance; the second is of the scientific and/or technical merit of the proposed plan of research; and the third is of scientific and technical contributions by the applicant outside the classroom. These reviews are carried out in (1) an eligibility and compliance review, (2) an online review with three external reviews, and (3) an on-site review of 400 to 500 finalists to select 150 awardees. For FY11, the program will be announced in August 2010, applications will be due in October 2010, the online review will be conducted in December 2010 and January 2011, the on-site review will be held in March 2011, and notification will occur in March or April 2011.

The program had a COV from the Basic Energy Sciences Advisory Committee (BESAC) in May 2010. From that COV, lessons were learned, the application was improved, and the review process was improved. Significant improvements are being made each year.

Kharzeev asked what fraction of fellowships was awarded in nuclear physics. Ge responded, close to 10%.

**Kevin Lesko** was asked to present an update on DUSEL.

The scientific community that is being dealt with numbers about 1000. The project has had a number of NAS and other reports published about it calling out the need for a deep underground laboratory. There is now a National Research Council (NRC) study of the science to be done there.

This is a multidisciplinary program, covering neutrinos, dark matter, dark life, the origin of the elements, symmetries and high-energy-scale physics, natural resources, excavation engineering, energy and carbon research, and education and outreach.

The DUSEL project is a major research equipment and facilities construction (MREFC) project of NSF with a suite of experiments. It has an expected start date in FY14 and will host the Long-Baseline Neutrino Experiment (LBNE), proton decay, neutrinoless double-beta decay, dark-matter, and other experiments. NSF advocates an early science program. Environmental, safety, and health capabilities have to be developed and validated.

The facility will have research campuses at the surface, 4850-foot level, 7400-foot level, and other levels and ramps.

It will be dual access to the research campuses, which require best-practices life-safety systems, need experimental staff, and allow for future expansion. The experiments will be transformational, diverse, and compelling. The surface campus will allow two simultaneous installations. A vertical shaft will host a vertical laboratory for carbon dioxide sequestration. At the 4850-foot level, there will be one large cavity, 425 physics experiments, and Earth-science experiments. At the 7400-foot level, there will be two physics experiments and Earth-science experiments. Other levels and ramps can accommodate biology, geology, and engineering (bio-geo-eng) experiments.

A multidisciplinary suite of experiments has been assembled. The facility that would be needed for these experiments has been designed. The next step is to iterate and value-engineer that facility design. The science is seen to need additional support. There was a $750 million funding target. The infrastructure took up $575 million of that. With $125 million committed for the LBNE, only $50 million was available for the rest of the science. Neutrinoless double-beta decay and dark matter would need more than that.

Currently, the project has about 55 employees working on design. The State of South Dakota also has employees working on the project. Much of the design has been outsourced to architectural and engineering firms. The geotechnical work is a major issue. The large cavity is the largest underground excavation in the world. The geotechnical news has been good. There has been a rigorous series of reviews. There is to be a presentation before the NSB in May 2011.

The stewardship model has NSF and DOE working closely together. There is a joint oversight group (JOG) with working groups on long-baseline neutrinos, neutrinoless double-beta decay, nuclear astrophysics, and dark-matter research. The JOG will negotiate and mediate major decisions. The stewardship involves management of the risk. The Senate appropriations committee report acknowledged the importance of the DOE–NSF collaboration.

Initial guidance (in late 2009) called for an FY14 construction start, an MREFC cost estimated at $750 million, including: a comprehensive deep facility; the four pillars of the physics program (long baseline neutrinos, proton decay, neutrinoless double-beta decay, and dark matter); plus additional well-motivated experiments in bio/geo/eng, nuclear astrophysics, and additional physics opportunities.

The schedule calls for an environmental impact statement in FY12, construction startup in FY14, access startup in FY16, and full DUSEL operations in FY19.

During the past few days, an independent assessment of the integration of the experiments and facility design was held. A safety program is under way and will continue through construction and operations. About 18 groups are currently using the facility operated by the State of South Dakota. Underground infrastructure is being upgraded and expanded.

The FY11 funding of DUSEL covers building the health and safety program and aggressively advancing the preliminary design and integrating activities. The project is on schedule for completing the Preliminary Design Report (PDR) in 2010.

Dodge asked how much of the tunnels and shafts already exist. Lesko responded that a lot of the tunnels are already there. Some are being expanded, and laboratory cavities are being excavated. Water has been brought down to the 5800-foot level. The deep-well pump will start next year and will run for a couple of years.

Gardner asked what physics tasks would be conducted at the 7400-foot level. Lesko replied, neutrinoless double-beta decay and dark matter experiments. Many other experiments would go there if they could, but they likely will not wait for the evacuation of the water. It takes years to build these experiments.

Jacobs commented that, to do the real program, $100 million to $150 million more is needed and asked if the 750-foot level were covered. Lesko responded that the NSB has to be told what the best science is that can be done for the money. What can be done at the 750-foot level is not compelling. In the LBNE, the costs are being negotiated. Dehmer commented that the planning is just being worked through at this point. The 750-foot level came with the engineering scope. Now the sweet spot in the design will be found for it. The process is evolving very nicely.

Lesko changed direction to describe neutrinoless double-beta decay. Certain isotopes can undergo two-neutrino double-beta decay, a very rare process. Neutrinoless double-beta decay would be even more rare and is only allowed if neutrinos are Majorana particles. Extremely good energy resolution is required to observe such neutrinoless double-beta events in such nuclear transitions as germanium-76 to selenium-76 and xenon-136 to barium-136. The neutrinoless double-beta-decay experiment is designed to reach down into the inverted hierarchy and also to cover the normal distribution of neutrinos. If neutrinoless decay were observed, that would mean that neutrinos are

Majorana particles, the lepton number is violated, the scale of neutrino masses is determined, and the hierarchy of neutrino masses may be determined.

The 1-ton germanium experiment will look for neutrinoless double-beta decay in approximately 1 ton of germanium enriched in germanium-76. Technologies are being explored by the Majorana Demonstrator and Germanium Detector Array (GERDA) collaborations. EXO will look for such decay in 1 to 10 tons of liquid or gaseous xenon. Technologies are being explored by the EXO-200 and EXO-Gas projects.

The 1-ton germanium experiment has two cryostats made of electroformed copper in conventional shielding. The Majorana Demonstrator will use up to 40 kg of germanium and will operate between 2011 and 2014.

Requirements for the experiments have been collected via phone calls and face-to-face meetings of the collaborators. DUSEL has defined a schedule for obtaining required deliverables that the experiments have followed.

Both the one-ton germanium and the EXO experiments have submitted documents requesting to be at the 7400-foot level. In both cases, the argument is made that the risk of fast-neutron backgrounds at the 4850-foot level is high. Ongoing R&D at smaller scales will help quantify the risks better.

How to build these experiments underground is being analyzed. Both experiments are in the process of vetting their proposed technologies. DUSEL is actively working with them to review and iterate on the information to refine the PDR. So far, both experiments are proposing layouts that require a slight increase in the 7400-foot-level laboratory module size.

The Dakota Ion Accelerators for Nuclear Astrophysics (DIANA) is an accelerator facility at the 4850-foot level that is an international collaboration. Gran Sasso has run out of space for this experiment. It would address the questions: What is the origin of the elements in the cosmos? What are the nuclear reactions that drive stars and stellar explosions? The underground facility is needed for shielding. This will be a long-term resident of DUSEL; it has decades of work to do. A design has been vetted, and the experiment would need only a small module. It would operate at a 50- to 400-keV platform with a well-focused beam. It would have a low-energy accelerator, a high-energy accelerator, and a target station. This is a unique facility with a design life of 30 to 50 years. Technical progress is on track, and the project will be ready to move in as soon as it can be accommodated.

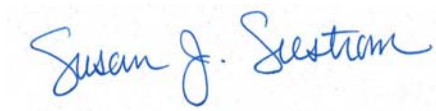
Dodge noted that the deep tunnels will not be ready soon. Lesko replied that the experiments can get started as soon as they can get a dry room. Dodge asked if one can drill and run other experiments at the same time. Lesko answered, yes, one can.

Montgomery asked how the MREFC and NSB processes interact with the DOE approval process for the LBNE. Lesko answered that the process would start with a CD-1 from DOE but would need to have a contingency plan. CD-2 could be occurring at the same time. Seestrom asked if everything would be delayed if the CD-1 were late. Lesko replied, no.

Seestrom announced that the next NSAC meeting is likely to be on December 7 or 8; the date will be finalized in the next couple of weeks.

The floor was opened to public comment. There being none, the meeting was adjourned at 3:26 PM.

These minutes of the Nuclear Science Advisory Committee held at the Crystal City Marriott, Arlington, Virginia, on July 30, 2010 are certifies to be an accurate representation of what occurred.



Susan J. Seestrom
Chair, Nuclear Science Advisory Committee