Minutes
Department of Energy and National Science Foundation
Nuclear Science Advisory Committee
Crystal City Marriott Hotel, Arlington, Va.
July 27, 2009

Members Participating:

Susan Seestrom, Chair
Lawrence Cardman
Vince Cianciolo
Charlotte Elster
Richard Furnstahl
Carl Gagliardi
Dmitri Kharzeev
I-Yang Lee
Christopher Lister
Allison Lung
Gail McLaughlin
Richard Milner
Michael Ramsey-Musolf
Hendrik Schatz
Mark Stoyer
John Wilkerson

Members Absent:

Johanna Stachel
Xiangdong Ji

Others Participating:

Joseph Dehmer
Donald Geesaman
Jehanne Gillo
Eugene Henry
Bradley Keister
Richard Kouzes
Thomas Ludlam
Leonard Mausner
John Pantaleo
Robert Redwine

Presenters in Order of Appearance:

William Brinkman
Joseph Dehmer
Eugene Henry
Bradley Keister
Donald Geesaman
Richard Milner

About 16 others were in attendance during the course of the meeting.

As the new Chair of the Committee, **Susan Seestrom** called the meeting to order at 8:41 a.m. She welcomed the members and had them introduce themselves. She introduced **William Brinkman**, the new Director of the Office of Science (SC), and asked him to present an update on the activities of the Office.

Three themes describe the work supported by SC: science for discovery unravels nature's deepest mysteries to change our view of the world and how we live in it; science for national need; and national scientific user facilities, the 21st century tools of science.

SC has a $5 billion budget, and that may double in the next 7 years. In SC, the Office of Basic Energy Sciences (BES) has the largest appropriation, and that for the Office of Advanced Scientific Computing (ASCR) is growing rapidly. SC places a lot of emphasis

on computing, with large facilities at Oak Ridge National Laboratory (ORNL), Argonne National Laboratory (ANL), and Lawrence Berkeley National Laboratory (LBNL). SC has four synchrotron light sources. The Stanford Linear Accelerator Center (SLAC) got its laser to lase on the very first day. There are many options for funding, including the Large Hadron Collider (LHC), which is funded by SC at $300 million per year. There is also the question about a U.S. particle physics facility, the International Linear Collider, which has a $27 billion price tag. There is the Deep Underground Scientific and Engineering Laboratory (DUSEL). And the question looms when to turn off the Tevatron.

SC has several fusion/plasma facilities, including the International Thermonuclear Experimental Reactor (ITER), which seeks to demonstrate a burning plasma and which is an experiment in international cooperation. Five Nanoscale Science Research Centers are operational and have lots of users. SC also has the Joint Genome Institute, which has sequenced several genomes. There are also the Environmental Molecular Science Laboratory and the atmospheric and environmental facilities to understand climate change, about which we *have* to do something.

The four light sources are cost-effective, serving about a third of the scientific users of SC facilities, of which there will be about 25,000 in FY10.

Nuclear beams are provided for the research community at the Relativistic Heavy-Ion Collider (RHIC) at Brookhaven National Laboratory (BNL), Continuous Electron Beam Accelerator Facility (CEBAF) at Jefferson Lab, Holifield Radioactive Ion Beam Facility (HRIBF) at ORNL, and Argonne Tandem Linac Accelerator System (ATLAS) at ANL.

SC has a robust budget for FY09 and is requesting an increased budget in FY10.

DOE has a more than 50-year history of training scientists, mathematicians, and engineers through research grants, the DOE national laboratories, and targeted education programs. In FY08, more than 300,000 K–12 students; 21,000 educators; 3,000 graduate students; and 4,200 undergraduate students participated in opportunities at the DOE laboratories, funded by DOE and other federal and nonfederal sources. SC has started a Graduate Student Research Fellowship Program to support approximately 400 graduate students and an Early Career Program. SC will provide support for more than 4400 graduate students and 2700 postdocs in FY09.

The House and Senate Appropriation Committees have acted on the FY10 Budget. For SC, DOE requested $4.942 billion. The House mark is $4.906 billion, and the Senate mark is $4.858 billion. DOE is pushing hard to increase the amounts being considered by the House and Senate.

The DOE Energy Innovation Hubs have been a challenge. Eight hubs were proposed at $50 million per year apiece. Congress cut that back, and there probably will be two or three such hubs in FY10. Congress is interested in nuclear power right now, and that might influence the topics of the selected hubs. The characterization of these hubs as being "largely under one roof" has been confusing to Congress and to the community, as well.

SC has initiated many Recovery Act projects with the goals to preserve and create jobs and promote economic recovery; and to provide investments needed to increase economic efficiency by spurring technological advances in science and health. SC's American Recovery and Reinvestment Act of 2009 (ARRA) projects were selected on the basis of their ability to enhance research infrastructure and support high-priority R&D

and their low risk (e.g., they had in-place or imminent CD-3s). Fifty-one projects were selected, totaling $1.6 billion, including the acceleration of ongoing line-item construction projects ($338.2 million), the acceleration of major items of equipment ($171.1 million), upgrades to SC user facilities ($391.0 million), laboratory general plant projects ($129.6 million), scientific research ($562.1 million), and management and oversight ($8.0 million). A number of these Recovery Act Projects are in the Office of Nuclear Physics (NP).

When broken down by major function, NP's support is mostly facility operations; research is about 40%; and facility construction and major items of equipment make up most of the rest.

A new charge is being presented to NSAC: to assemble a Committee of Visitors (COV) to review the management processes of the NP program. The COV should (1) provide an assessment of the processes used to solicit, review, recommend, and document proposal actions and monitor projects and programs for both DOE laboratory and university programs; (2) assess the operations of the Office's programs during FY07, FY08, and FY09; and (3) consider and provide evaluation of the efficacy and quality of the processes and the quality of the resulting portfolio (including its breadth and depth and its national and international standing). The COV should also comment on the observed strengths or deficiencies in any component or subcomponent of NP's portfolio and suggestions for improvement and on progress made towards addressing action items from any previous COV review. A report should be submitted to NSAC by February 28, 2010.

NP has a lot of things on the table in science for discovery and user facilities: to complete the 12 GeV CEBAF upgrade, construct the Facility for Rare Isotope Beams at Michigan State University, implement a luminosity upgrade at the RHIC, and continue a targeted program of experiments to investigate neutrino properties and fundamental symmetries.

Science has an opportunity now as never before to do something to affect the world and to alleviate the problem associated with increased carbon dioxide concentrations in the atmosphere.

Milner asked about the Graduate Student Research Fellowship Program. Brinkman answered that it is starting out with 100 students and that number is hoped to increase to 400.

Geesaman asked when the new leadership of NP would be named. Brinkman replied that there is a candidate, and it is hoped to put that candidate in place soon.

Seestrom noted that hard work had gone into integrating the isotope program into SC from Nuclear Energy (NE) and asked if there was any additional information. Brinkman said that the Office was trying to figure out what to do, especially on Mo-99/Tc-99. The High-Flux Isotope Reactor (HFIR) and the University of Missouri reactor could produce needed Mo-99. This issue is really critical. Another debate is where radiochemistry belongs; the Office does not have a clear sense of that. Redwine said that the House and Senate markups are of concern to the radiochemistry community. Brinkman said the Department is trying to straighten this out.

Joseph Dehmer was asked to present an update on NSF activities in nuclear physics.

The Physics Division had its triennial Committee of Visitors (COV) in January, and that COV was reported on at the spring NSAC meeting. The Physics Division mission also contributes to the missions of all other agencies. The division will continue to support nuclear physics and will continue its cooperation with NP.

The NSF FY10 budget request is for $7.045 billion, most of it ($5.733 billion) in research and related activities (R&RA).

Typically, the NSF does not know its budget until April or May. It did not get the increase that DOE/SC did. It got a satisfying increase of 7% per year in FY08 and FY09. The FY10 budget request is for a 10% increase. That would return NSF to the mean in its budget increases in recent years. The nation has a president who grasps the importance of basic research

The Directorate for Mathematical and Physical Sciences (MPS) got $490 million from the ARRA, nearly all of which went into the divisions to support research. These dollars were distributed fairly uniformly across programs. There will be a drop-off in 2012 when these ARRA funds run out. An effort is being made to mitigate that drop-off. An investment of ARRA funds was made in the design of DUSEL. The MPS major research equipment and facilities construction (MREFC) projects, of which there are four, will taper off as construction is completed.

In March, a lifecycle plan was presented for DUSEL. There was a Lehman-style review, chaired by Ed Temple, in January that called for more planning money and for the University of California at Berkeley (UCB) to step up and take ownership. Both of these recommendations have been acted upon.

DUSEL will support a set of potentially transformational physics experiments that require a deep underground location (free of cosmic rays) and the necessary infrastructure. The particle, nuclear, and astrophysics communities have selected DUSEL as central to their national programs. Although physics is the main cost driver, other communities remain actively engaged. Sleepers, like carbon sequestration research, have the opportunity to contribute to society at DUSEL.

The vetting of DUSEL shows the intensity of activity in developing the DUSEL concept and in considering nine other sites besides Homestake. It is hoped to have a preliminary design report (PDR) by December 2010. The solicitation process started in 2004 and included Solicitation 1 to define the site-independent science scope and infrastructure needs and to unify the community; Solicitation 2 to develop conceptual designs for one or more sites; Solicitation 3 to develop a facility design for an MREFC candidate; and Solicitation 4 to develop technical designs for candidates for the DUSEL initial suite of experiments. The results of Solicitation 4 are currently being announced.

In selecting the successful proposal in Solicitation 3, the panel unanimously voted by secret ballot to recommend the Homestake proposal to the NSF for funding. NSF concurred. A cooperative agreement was sent to UCB in September of 2007. The total award was $15 million over 3 years to start design work.

The Homestake site was deeded to the South Dakota Science and Technology Authority (SDSTA). They have agreed to take over the legacy issues as well as the shafts, buildings, and waterworks. There are 600 km of drifts between tunnels and two shafts 1 km apart. The upper layers are quartz; the lower layers are basalt, which is more amenable to excavation for laboratories. The 300-level laboratory has been eliminated.

Four consultants in deep mining will be on the advisory board that will certify the design of the deep laboratories. A 12-story building will comfortably fit in the chamber for the Long Baseline Neutrino Experiment..

The baseline from Fermilab to Homestake is 1300 km, which is long enough to do the needed physics

The DUSEL Physics Joint Oversight Group (JOG) was set up after the release of the P5 report. It has representation from NSF/PHY, DOE/Office of High Energy Physics (HEP), and DOE/NP. It builds on successful NSF and DOE collaboration on the LHC in high-energy physics. It will jointly coordinate and oversee the DUSEL experimental physics program. And it is meeting quarterly. Both agencies are closely collaborating in defining and realizing the DUSEL physics program.

The Sanford Laboratory operates under the SDSTA, which holds $124 million for development of the Sanford Laboratory. It will fund an education center, the partial refurbishment of the 4850-ft (depth) and 7400-ft levels, and the operation and management of the Sanford Laboratory activities. $60 million has been released and is in use. Key staffing continues, and approximately 80 people have been hired to date. SDSTA began mine re-entry late July 2007. Dewatering and treatment began April 21, 2008. The main campus level at the 4850-ft level is now dry.

Gran Sasso is full and not very deep (300 m). Cooperative experiments are planned between DUSEL and other underground laboratories around the world.

Hamish Robertson (U Wash) asked how the funding gap between Sanford and the NSF would be bridged. Dehmer replied that that is not known at this time. The NSF cannot start pumping before construction. It will probably fall on the state to continue pumping between the Sanford funding and NSF funding.

Eugene Henry was asked to provide an update on the activities of NP.

The early career awards have been made in the form of three Outstanding Junior Investigator (OJI) Awards and three Presidential Early Career Awards.

The groundbreaking for the 12 GeV CEBAF upgrade project occurred, and a cooperative agreement between DOE and Michigan State University for the Facility for Rare Isotope Beams (FRIB) was signed in early June.

In nuclear theory, topical collaboration has finally begun by the issuance of a solicitation for proposals on about 15 topics. The national laboratory theory group review will be held Sept. 16-18, 2009.

In FY08 NP received $424 million after a reduction is made for the SBIR/STTR program. Its original appropriation on FY09 was $512.08 million, which was supplemented by an additional appropriation of $154.80 million of ARRA funds. The FY10 request is $552 million, an increase of $39.92 million or 7% over the FY09 appropriation.

The FY09 appropriation percentage increases are respectable. The university and national laboratory research efforts have been strengthened, user facility operations have been increased, important instrumentation projects are continuing, construction of the CEBAF upgrade project was started, conceptual design and R&D for FRIB was initiated, support was requested for the advanced fuel cycle initiatives that transitioned into the broader Applications for Nuclear Science and Technology effort, theoretical topical collaborations are supported, and the Isotope Program was transferred to NP.

The list of ARRA projects includes advance funding for the 12 GeV CEBAF upgrade and the Fundamental Neutron Physics Beamline major items of equipment (MIE) at the Spallation Neutron Source (SNS), enhanced Accelerator Improvement Project (AIP) funding at user facilities, enhanced utilization of isotope facilities, Jefferson Lab infrastructure investments, the Nuclear Data Program Initiative, and lattice chromodynamics computing.

Funding opportunity announcements (FOAs) have been announced for the Nuclear Science Workforce ($19.440 million) and for R&D on alternative isotope production techniques ($4.617 million). About 200 applications were received for the workforce FOA, and about 55 for isotope production. The decisions on both FOAs were being finalized at the time of the meeting.

ARRA funds will also be used for SC's Early Career Research Program. The purpose of this program is to support the development of individual research programs of outstanding scientists early in their careers and to stimulate research careers in the areas supported by SC. All SC programs are involved, and solicitations are open to university and national laboratory researchers. The solicitations close on Sept. 1, 2009. Eligibility rules apply. University applicants may receive a minimum of $150,000 per year for 5 years; national laboratory applicants may receive a minimum of $500,000 per year for 5 years, depending on the availability of funding. In NP, the research areas cover medium-energy, heavy-ion, low-energy, theory, isotope program, and accelerator R&D. About five university awards and two to three national-laboratory awards are anticipated, depending on funding.

Elster asked why there is a big difference between universities and national laboratories in minimum funding. Henry replied that, at the national laboratories, DOE is paying for 12 months of a PI's time; at universities, it is paying about two months per PI.

Henry returned to the budget narrative. For FY10, NP is asking for an 8% increase. The FY10 budget request is designed to optimize scientific productivity of the program by balancing the research workforce, facility operations, and investments in advanced technology and capabilities. Research increased, including nuclear science applications and technology that is inherently relevant to a broad suite of applications. All facilities are supported at near-optimal levels of operation. Investments are made in programmatic infrastructure, facility equipment, and accelerator improvement projects that will increase reliability, cost-effectiveness, and productivity and will provide new capabilities to pursue discovery science. Under the requested budget, RHIC will operate 30 weeks, and CEBAF will operate 35 weeks. Funding for instrumentation increases according to planned profiles, and two new MIEs are initiated [(1) the Solenoidal Tracker at RHIC (STAR) with the Heavy Flavor Tracker (HFT) detector and (2) rare isotope beam (RIB) science]. Construction of the 12 GeV CEBAF upgrade will continue according to the planned schedule but procurements are accelerated by Recovery Act funding. R&D and the conceptual design of FRIB will be continued in accord with the cooperative agreement.

The FY10 budget distributes increases fairly uniformly among research, construction, operations, and stewardship. The research funds increase for universities by 4% and for national laboratories by 11% (because of MIEs).

Both the House and Senate appropriation committees have given their marks. The FY10 budget request for NP was $552 million. The House Appropriations Committee

report was for $536.455 million. The Senate Appropriations Committee report was for $540 million. The House committee recommends $111.816 million for low-energy nuclear physics, $5 million below the request; $12 million for FRIB, $3 million above the request; $12 million for the 12 GeV CEBAF upgrade, $10 million below the request (in light of reduced requirements for the project); and $29.2 million for Isotope Development and Production for Research and Applications Program (IDPRA), $10 million above the request. It also directs the Department to work with the academic community to most cost-effectively increase the availability of medical isotopes. The Senate committee report says that, within the funds provided, $17.5 million is for nuclear medicine research. All of the added funds must be awarded competitively in one or more solicitations that include all sources, universities, the private sector, and national laboratories.

Compared to the FY10 budget request, the House mark reduces the NP core program by $28.5 million, and the Senate mark reduces it by $29.5 million. This is not a trivial change; it could impact up to 400 personnel. The House and Senate marks would lead to significant reductions in force at universities and national laboratories; either of these marks would necessitate a redirection of the program.

There are new people in the Office: a theory program manager and a financial advisor. There are four openings, two of which are being advertised now. A new detailee is working on the isotope program.

Schatz asked if the increase in the request was related to isotopes. Henry replied that a program office is being moved from the Office of Biological and Environmental Research (BER) to NP.

Lee asked if the recommendations are mainly for increases. Henry answered that there are also recommendations for decreases for Jefferson Lab.

Gagliardi stated that the House and Senate seem to have targeted NP and asked why. Henry responded that he did not know.

Ramsey-Musolf stated that there is a short-term crisis for new graduates and asked if there was any strategy for keeping them in the system a while longer. Specifically, could university grants be bumped up to address this problem? Henry answered that the 4% increase for universities largely covers the increase in the cost of living; the 11% increase to national laboratories goes largely to MIEs. There is not a direct strategy for the issue raised. Some things will help young researchers, such as new research being funded, theory-center funding, and early-career awards that can support the graduate students and postdocs of a PI.

Milner stated that universities are flat funded and that more attention needs to be paid to funding graduate students. He asked about the Graduate Student Research Fellowships. Henry pointed out that those fellowships come out of SC Workforce Development, not any of the science program offices.

Bradley Keister was asked to present an update on Nuclear Physics at the NSF.

In the FY09 budget, Nuclear Physics received a +0.5% allocation for experimental proposals, +1.5% for theory, and +0.5% for particle and nuclear astrophysics. The National Superconducting Cyclotron Laboratory (NSCL) got a 5% increase to optimize operations.

The ARRA funding provided $13 million for nuclear-physics-related programs. At NSF, ARRA awards are multiyear grants with all funds provided up front. These funds

could not be used to make supplements to existing awards. However, ARRA funding also freed up FY2009 appropriation funds across nuclear-physics-related programs, and this enabled a small number of one-time supplements. By using ARRA funds to buy down future-year obligations, the ARRA "delta function" can be smoothed out.

Additional NSF-wide initiatives with potential benefit (and pending awards) to the NP community include Major Research Instrumentation (MRI), Cyber-Enabled Discovery and Innovation (CDI), petascale applications, in the joint solicitation with the Department of Homeland Security's (DHS) Domestic Nuclear Detection Office, and a second MRI solicitation. The latter will require cost sharing from the top 100 funded research universities. There will also be an Academic Research Initiative (ARI) for broad-based infrastructure improvements at universities.

The MPS Assistant Director (AD) Tony Chan leaves Sept. 1, 2009; the Interim AD will be H. E. Seidel, the current head of the Office of Cyberinfrastructure (OCI). In Nuclear Physics, Allena Opper will also be responsible for astrophysics and the underground laboratory.

A break was declared at 10:47 a.m. The meeting was called back into session at 11:03 a.m. Seestrom pointed out that NP's stewardship of the isotope program is very important and asked **Donald Geesaman** to present the report of the NSAC Isotope (NSACI) Subcommittee.

On July 18, a draft of the report was e-mailed to the Committee. Some typos and grammatical errors have since been changed. The name of the program has been changed to the Isotope Development and Production for Research and Applications Program. The program sells radioactive and stable isotopes, associated by-products, surplus materials, and related isotope services. It maintains the infrastructure required to supply isotope products and related services. It supports R&D for development and production. It had more than 190 customers and made more than 560 shipments in FY08. Ten of its customers provided more than 85% of its sales.

This program was transferred to NP from the Office of Nuclear Energy (NE). In preparation for this transfer, NSAC was requested to establish a standing subcommittee, the NSACI Subcommittee, to advise NP on specific questions concerning the National Isotope Production and Applications (NIPA) Program. NSACI will be constituted for a period of two years as a subcommittee of NSAC. It will report to the DOE through NSAC, which will consider its recommendations for approval and transmittal to the Department. The Subcommittee was asked to establish the priority of research isotope production and development and to recommend a long-term strategic plan for the NIPA Program. The program's name change became official with the Omnibus Bill, which provided $24.9 million for a Research Isotope Production and Applications Program and, within those funds, $5 million for a Research Isotope Development and Production Subprogram to develop and implement a research strategy consistent with the National Academy of Sciences (NAS) study, *State of the Science of Nuclear Medicine*.

The NSACI Subcommittee was formed with a broad, diverse array of members.

The isotope program is important, and a lot of people are on record saying that things are not working as they would like. The problems are shortages, shared facilities, and aging facilities whose planned lifetime ended 30 years ago. Production of isotopes is or has been conducted at Richland, Idaho [at the the Advanced Test Reactor (ATR)], BNL [at the Brookhaven Linac Isotope Producer (BLIP)], ORNL (at the HIFR and by the

Stable Isotope Inventory), Savannah River Site (at the tritium facility), LANL [at the Los Alamos Neutron Science Center/Isotope Production Facility (LANSCE/IPF)], and the University of Missouri Research Reactor.

The FY09 budget provided $24.9 million for the program. The base-program funding was decreasing and increased abruptly in FY09. The sales have increased steadily for the past 5 years.

The charges to NSAC were to identify compelling research opportunities using isotopes; to recommend a long-term strategic plan that will provide a framework for a coordinated implementation of the NIPA Program during the next decade; to identify, prioritize, and articulate the most compelling opportunities for the program to pursue during the next decade; and to develop a coordinated national strategy for the use of existing and planned capabilities, both domestic and international, and the rationale and priority for new investments under a constant-level-of-effort budget and an optimal budget. That plan should indicate what resources would be required, including construction of new facilities, to sustain a domestic supply of critical isotopes for the United States, and it should review the impacts and associated priorities if the funding available is at a constant level of effort (FY09 President's Request Budget) into the out-years (FY09 to FY18). The Subcommittee was to consider, identify, and prioritize commercial isotope production and to consider the robustness of current isotope-production operations. An interim report containing the essential components of NSACI's recommendations was to be submitted by April 1, 2009, and a final report by July 31, 2009.

For the workshop that preceded and informed the Subcommittee's deliberations, a large number of professional societies, industry trade groups, and federal agencies were solicited for input. The NSACI Subcommittee held an organizational meeting on Nov. 13-14, 2008; got input from government agencies on Dec. 15-16, 2008; got input from customers on Jan. 13-15, 2009; submitted the first-charge interim report to NSAC on Jan. 31, 2009; heard plans for facility and infrastructure improvements on Feb. 10-11 2009; met with NSAC to consider the report on the first charge on Mar. 2, 2009; decided on recommendations for a long-range plan on Mar. 25-27, 2009; submitted the interim report for the second charge to NSAC on Apr. 1, 2009; transmitted the report on the first charge to DOE on Apr. 1, 2009; and submitted the final report to NSAC on Apr. 23, 2009.

The Subcommittee's first report was accepted by NSAC in February. The long-range plan was outlined. Individual recommendations were introduced in the sections of the report and pulled together in a summary at the end.

Challenges in radiopharmaceuticals include

- An initial supply of a new isotope suitable for basic characterization must be produced.
- The National Institutes of Health (NIH) wants supply to be available before funding research.
- Quantities increase as clinical trials proceed; part of the research is to establish the correct dose.
- A consistent year-round availability is needed; in many cases, these materials cannot be stockpiled.
- If trials succeed, the quantity needed can increase dramatically, and new production techniques may be required, along with associated R&D.

- If trials fail, demand can shrink dramatically.

This level of risk is unattractive to commercial producers

One success story is Sr-82/Rb-82, which is used in clinical positron emission tomography for cardiac perfusion studies, which requires 70 MeV particle beams from accelerators to produce. Its production and use were pioneered by BNL and LANL. The limited running time at accelerators requires multiple producers for year-round availability. It is currently the isotope with the highest sales within the Isotopes Program.

The path to an effective program involves communication. The isotope program has to know what to produce. That knowledge requires forecasts from major customers and funding agencies. The NIH-DOE Working Group is an excellent example of such information gathering.

A list of isotopes that are in demand was drawn up, showing the half-lives, availability, and current production facilities. Coordination with outside partners to make use of potentially unused capacity and align production schedules can introduce major complications. R&D is needed to create more efficient processes that can be shared. Isotope shipments must be made more reliable. A skilled workforce is needed, and a new generation of isotope production workers must be ensured. Extant facilities must be made mission ready, and new investments must be made in needed production capacity, including a dedicated flexible accelerator with year-round availability for isotope production and a new separation facility.

NP has already started down this path. With the August isotope workshop, the NIH-DOE Working Group, the Interagency Working Group on He-3, the restart of Cf-252 production and sales, the search for a National Isotope Data Center (NIDC) director, the Virtual Isotope Center, significant ARRA investment in research, significant investment in FY09 in upgrading infrastructure, and significant ARRA funding of facilities. DOE understands the problems and is moving forward.

The draft recommendations for the present (base) program are:

1. Maintain a continuous dialogue with all interested federal agencies and commercial isotope customers to forecast and match realistic isotope demand and achievable production capabilities.
2. Devise processes for the isotope program to better communicate with users, researchers, customers, students, and the public and to seek advice from experts.
3. Encourage the use of isotopes for research through reliable availability at affordable prices.
4. Coordinate production capabilities and supporting research to facilitate networking among existing DOE, commercial, and academic facilities.
5. Support a sustained research program in the base budget to enhance the capabilities of the isotope program in the production and supply of isotopes.
6. Increase the robustness and agility of isotope transportation.

Major investments that need to be made to plug holes in the supply of isotopes are to

1. Construct and operate a roughly 30- to 40-MeV variable-energy, high-current, multi-particle cyclotron and supporting facilities that have the primary mission of isotope production.
2. Construct and operate an electromagnetic isotope separator facility for stable and long-lived radioactive isotopes. This facility should include several separators for a raw feedstock through-put of about 300 to 600 mA.

This facility needs to produce high-quality, low-energy beams. Excellent beam properties are needed from 15 to 40 MeV. Most commercial cyclotrons have alpha energies fixed at the maximum. At-211 production requires around 30 MeV. Higher energies produce too much At-210, which must be minimized because its decay product binds to bone marrow. 40 MeV beams allow target cooling on both sides. Shielding and activation requirements increase significantly for 70 MeV. Six isotopes require higher energy. If (1) a higher energy accelerator could have excellent beam properties at 15 to 20 MeV or (2) parasitic operation of the current IDPRA facilities should no longer be available, a higher-energy accelerator must be considered.

Only electromagnetic separation currently provides the range of stable isotopes and enables high purity. Scaled to capacity, four separators similar to calutrons would be needed: two for production; one in set-up, maintenance, or R&D; and one dedicated to radioactive material. This arrangement would provide capacity about equal to current sales. There may be new technology, possibly classified, that may make the capacity possible with fewer devices. There are security and export-control issues with operation of high-throughput separators. This situation may limit the choice of available sites. Plasma separation continues to look promising for large-quantity, moderate-purity applications. There are other R&D issues to be addressed, such as He-3 and lithium.

A highly trained workforce must be invested in with a multipronged approach that reaches out to students, post-doctoral fellows, and faculty through professional training, curriculum development, and meeting/workshop participation. The program requires some very specific skills. They can be provided through academic programs, training programs, workshops, and summer schools.

The general sense of the Subcommittee is that the most important need is the electromagnetic separator. A proposed optimum budget in FY09 dollars and a similar constant-effort budget were devised for the program and extended to 2018. A static, constant-effort budget will not plug the holes in production.

Mo-99/Tc-99 is a high-demand isotope system, but its production currently uses highly enriched uranium targets, a proliferation problem. The NAS has recommended the use of low-enriched uranium. The FY09 Omnibus Bill mandates the use of low-enriched uranium in Mo-99 production. This Subcommittee did not insert itself into this policy-development process. The National Nuclear Security Administration has the lead for establishing a domestic Mo-99 supply for the U.S.

In summary, this program is a major asset for the nation's competitiveness. It is an essential role for the federal government because of the need for unique capital investments, sensitive technology, considerable economic risk, and intellectual advances. The program should focus on development and production. It needs to replace lost capabilities (e.g., stable isotopes) and be able to provide radioactive isotopes for research year-round. Following the recent significant pulse of investment, the program could operate on a constant-effort budget for a few years. In the long term, this strategy will force the nation to rely heavily on uncertain foreign sources of isotopes.

Seestrom thanked the Subcommittee cochairs for the leadership of this Subcommittee. For purposes of transparency, she revealed that she was the steward of property upon which one of the facilities mentioned operates.

Lee asked how much production capacity the Russians had. Geesaman said that they were selling their stocks, which are finite. Wilkerson noted that the Russians are achieving substantial production of stable isotopes.

Kharzeev asked who was going to produce the isotopes that require the higher energy. Geesaman responded that BLIP, IPS, and NuView could. If some of this supply were lost, there would be a problem.

Ramsey-Musolf asked about the long-term replacement of aging reactors. Geesaman replied that DOE should start thinking about that need. HFIR will be available for 20 years.

Wilkerson asked what the role of the National Nuclear Security Administration (NNSA) was. Geesaman responded that there are isotopes related to weapons that the isotope program is not responsible for and therefore not responding to. The leadership responsibility to produce Mo-99 was given to NNSA. They have spent a lot of money in separation processes. Where one would get the neutrons is still up in the air. It could be useful to describe the policy debate in the report. If Mo-99 were ignored, everyone would think that the Subcommittee had not addressed a serious issue.

Lister asked if the calutrons were gone forever or whether there was a way back for them. Geesaman said that they were, indeed, gone forever.

A break for lunch was declared at 12:37 p.m. The meeting was reconvened at 1:33 p.m. **Richard Milner** was asked to review the results of the COV to the Physics Division of NSF, which has programs in Atomic Molecular and Optical Physics, Elementary Particle Physics, Nuclear Physics, Particle and Nuclear Astrophysics, Theoretical Physics, Education and Interdisciplinary Research, Gravitational Physics, Physics of Living Systems, Physics at the Information Frontier, and Physics Frontier Centers (PFCs).

The review process itself was found to be excellent. The summary reviews by program officers are outstanding. The success rate is decreasing; as a result, many excellent proposals are unfunded. The use of both written and panel reviews was strongly endorsed. In terms of program balance, NSF supports frontier research with investments at all scales. The present balance should be maintained. More than 50% of funding goes to individual investigators; the remainder goes to support large facilities and PFCs. As highlighted in previous COV reports, more funding and flexibility is needed to support instrumentation and equipment. There is a clear need for funding research in accelerator physics and instrumentation.

The COV commented that management over total life cycle (design, construction, operation) must be high quality. Total life cycle costs must be clearly and accurately established before construction is authorized. DUSEL will require a commitment from the Foundation as a whole. These will require partnership between NSF and other agencies, and other countries. Community engagement is essential for success; the Laser Interferometer Gravitational Wave Observatory (LIGO) offers an interesting model with its collaboration and its separate laboratories.

The COV read the 19 jackets identified by the Office as well as another 9 jackets. The National Superconducting Cyclotron Laboratory (NSCL) review was read. Sample proposals on the borderline during the past 3 years were reviewed carefully. The complete list of reviewers over the last three years was reviewed. The 2006 COV report was read and considered. The COV found that the quality of process is outstanding.

Merit-review criteria are addressed. The rationales for decisions are well documented. Consistently good judgment is applied to funding decisions. High-quality reviewers are used. The process is timely. Decisions are well aligned with the NSF strategic plan and national scientific priorities. The portfolio is well balanced and has broader impacts on education and training, diversity and outreach, strong intellectual connections to other fields, and substantial societal benefit.

Highlights of the activities of the Division were probing the limits of stability at NSCL, where the spin of the proton is, and the 10th anniversary of the Conference Experience for Undergraduates.

Elster asked if they had connected theory and experimental science. Milner said, no. The main focus was on process, management feedback, and alignment. Geesaman added that the same issue came up in 2006. The fact that decisions in NP and HEP are made by one person ensures that the agency does not go off in different directions.

Eugene Henry was asked to present to the Committee the new charge referred to by Brinkman earlier in the meeting.

The Office is expected to have a COV every 3 years, so a charge letter has been sent to the Committee to "assemble a Committee of Visitors (COV) to review the management processes of the Department of Energy (DOE) Office of Science's Office of Nuclear Physics program. The panel should provide an assessment of the processes used to solicit, review, recommend, and document proposal actions and monitor active projects and programs for both the DOE laboratory and university programs ... during the fiscal years 2007, 2008, and 2009." The COV should consider two major elements:

"(a) the efficacy and quality of the processes used to solicit, review, recommend, monitor, and document application, proposal, and award actions; and

(b) the quality of the resulting portfolio, including its breadth and depth, and its national and international standing."

It should also give "comments on observed strengths or deficiencies" ... "and suggestions for improvement ... ." One area requested not to be visited in depth is "the Isotope Development and Production for Research and Applications subprogram ... ." Because it "was transferred to the Office recently with the 2009 Appropriation, only management activities related to the transfer should be considered by this COV." The COV should assess "what progress has been made towards addressing action items from the previous COV review ... [and] the report should be submitted to NSAC by February 28, 2010." Any resources needed by the COV will be provided by NP.

Seestrom noted that this charge is very much like previous COV charges. Sherry Yennello has been asked to chair the COV. About 17 or 18 people from both inside and outside NSAC are being sought to staff this COV. It is hoped that the COV will be put together so it can meet in August and report at an NSAC meeting in December.

Jehanne Gillo was asked to comment on the Office's perspective on the NSAC Isotope Subcommittee report. She complimented the co-chairs' efforts to lead the Subcommittee to consensus. The FY09 budget and markups put an emphasis and money on this program. The level of detail and emphasis in the Subcommittee's report are important. Close attention must be paid to what is included in this report. The recommendations should allow enough flexibility for the program to conduct its business and make the right business choices.

Ramsey-Musolf noted Congress's eagerness for NP to embrace this project and asked how NP will balance this effort with the core research of the Office. Gillo replied that this report should look at the merits of the projects proposed without considering their impact on the overall program of the Office. The report should focus on priorities and things to do. To do the isotope program justice, its needs must be sought out and documented. Ramsey-Musolf asked about the long-term impact on the Office's programs. Gillo replied that that is why the Subcommittee is to look at two budgets: optimal and constant-effort. The results of those budget analyses will give the Office the ammunition to propose and defend initiatives.

Cardman stated that this is a well-constructed report. It could be softened by clarifying that the purpose of the report is to address the charge related to the isotope program. Putting such a caveat early in the document would be very helpful.

Milner said that an element left unaddressed is the next long-range plan and whether it will cover the isotope program. Gillo replied that it will be a challenge to have the isotope community understand the nuclear-physics community and vice versa. This situation makes it difficult to develop a long-range plan for isotope production coupled with the nuclear science long range plan. Seestrom said that she would expect that a boundary would be put around the funding of the isotope program if the two were combined into one long range planning process.

Wilkerson observed that the isotope program involves many professional societies, whereas the nuclear-physics program involves primarily one. How to deal with earmarks is a problem of society, not of this Committee. Ramsey-Musolf said that the Office of Nuclear Physics has to respond to the budget earmarks. NSAC could provide such a response. It really does not belong in the Subcommittee report. Gillo pointed out that there are vocal communities that respond to congressional actions. The response to earmarks should not be mixed up with this report.

Wilkerson asked how much the operations personnel would cost for the new separators. Geesaman replied that the Subcommittee assumed that most of the operating costs would be covered by sales, but that there would be residual costs in the first year. The Subcommittee tried to strike a reasonable balance between present and potential future costs and sales.

Ramsey-Musolf asked what the investment would be for ?. Geesaman responded that there are small cyclotrons that are used during the day and could be used to produce, say, Cu-67. That is unused capacity.

Schatz noted that the first report calls for new production capabilities in alpha emitters and asked how that was reflected in the second report. Geesaman said that it was reflected in continued R&D and a U-233 pilot plant. The most important thing is R&D. The Subcommittee put significant money in for R&D to conduct development to export the technology.

Gagliardi said that he did not see the germane words in the report. It seems like leaving out the highest priority of the first report is like the Washington Monument trick. Geesaman replied that R&D was recommended in the first report, and money was included in the second report but not tied to U-233 research.

Wilkerson asked if any facilities were producing research isotopes. Geesaman said that the Subcommittee could spend more time surveying the international community. Even the international facilities are not satisfying the U.S. needs for research isotopes.

The people that need the isotopes tried hard to get them from international sources but were not successful. Much of this information is proprietary. For medical research, the purification processes have to be certified in order for them to be used in the United States. The International Atomic Energy Agency (IAEA) is also trying to look into the reactor production of isotopes and trying to form regional consortia so that research isotope demand can be met and reactor operators can find a market for their products.

Gagliardi asked if the recommendations were in any order. Geesaman said that the Subcommittee did not set any priorities. He offered to go back and ask how to state the priorities.

Lung noted that Recommendation 2 has commercial implications. Geesaman replied that expert help could be beneficial. Lung asked if the user's group included for-profit companies. Geesaman responded, yes.

Lee noted that the report referred to "affordable prices," but the price is determined by the costs of production. Geesaman answered that there are means to bring down production costs. Pricing strategy could also be altered. The Subcommittee did not want to make any recommendations on that issue. Seestrom said that the Subcommittee's recommendation appears to be sufficiently vague and provides enough flexibility to do something sensible.

Wilkerson noted that there is nothing in the report on making these processes commercial. Geesaman replied that the Subcommittee meant to encourage commercialization. The medical community feels that it was burned by too-early commercialization that then dried up. Therefore, the Subcommittee did not want to overemphasize commercialization.

Ramsey-Musolf asked who decided what "affordable" means and whether the phrase really needed to be in there. Geesaman replied that research directions are sometimes determined by costs. Cardman suggested using "as low as reasonably achievable" (ALARA). Geesaman noted that, in its environmental applications, ALARA has been interpreted as zero. Pantaleo added that the words in the Atomic Energy Commission Act are vague, so why should this recommendation not be vague? There is also the charge to be reliable.

Wilkerson noted that the recommendation, as stated, opens it up to advocacy interests. Geesaman replied that it also has benefits to the research community. Gagliardi stated that, in such a situation, the program would not be sustainable and would need a gatekeeper. Geesaman noted that that discussion is in the report.

Wilkerson asked why the major-investment recommendations need to be so specific. Geesaman responded that all the Subcommittee needs to say is that this is the most cost-effective method and that these are roughly the energies needed. Seestrom said that she did not see any business cases justifying saying that this is the most cost-effective manner. Geesaman agreed that it could be made more general. The costs of a high-energy linac are known, so the "cost-effective" term is justified. Seestrom asked if this strategy is aimed at replacing the existing accelerators. Geesaman replied, no. However, if one can get higher-quality beams, one should consider them. Seestrom noted that it was not stated that this recommendation refers to isotopes not made today; that should be stated.

Ramsey-Musolf observed that the recommendations are ordered chronologically, not by importance. Geesaman said that that is correct. It probably should be stated that the most important recommendation is the second one.

Cardman stated that siting these facilities at a current NP research site would help educate new workers. Geesaman pointed out that building new hot cells would significantly add to the cost of the program. It needs to be a facility with the needed infrastructure and with good relations with an academic institution.

Wilkerson asked about the possibility of breakthroughs (e.g., laser separation). Geesaman said that the Subcommittee looked into that, and laser separation is not cost-effective. The Office is smart enough to jump on board any new technologies. All the experts say this is not a technology that is ready. The sustained R&D program covers some of these technologies. Seestrom said that there needs to be more justification why an electromagnetic isotope separation facility should be constructed.

Geesaman pointed out that, on the highly trained workforce recommendation, the specific skill set needed requires a special educational component to provide the necessary workforce. Elster commented that his explanation during his presentation was much better than the text in the report, which is too general. Geesaman agreed that it looks too open-ended and needs to be more specific to isotope development. Elster said that if this were taken out of context, it could be easily misunderstood and suggested inserting into the text what he had said. Geesaman asked if this topic/recommendation should be included in the first set of recommendations. Wilkinson suggested that one could make this the second set of recommendations and make the current second set the third presented. Gagliardi said that the workforce-education recommendation should not be integrated into the first section of recommendations. Putting it ahead of facilities would boost its impact.

Furnstahl said that it is not clear what would be lost with the constant-effort budget. In the constant-effort budget, the program can be effective in the short term, but other limitations will stop it in the long term. The last paragraph of the Executive Summary should be moved closer to the front. Seestrom said that a better ending to the Executive Summary is also needed.

Seestrom polled the Committee members on the acceptability of the report's recommendations. Many of the members were willing to accept the report and its recommendations as amended during these discussions. Most of the members wanted to review the amended recommendations before accepting the draft as a final Committee report. Several of the members suggested additional, specific improvements to the report, such as more context and more discussion of the budget in the Executive Summary.

Seestrom stated that there was no doubt that the meat of what is in the report will be accepted by the Committee. Geesaman said that the clarifications offered for the recommendations are very good. Seestrom pointed out that some of the detail provided has not been vetted and is not necessarily useful; an explicit statement about the isotopes that are needed would strengthen the case. Geesaman said that he found the sidebars to be important to understand such a broad document as this. Gagliardi offered that the three-page sidebar on constructing a reactor is attention-getting and the report might not need to go there. Geesaman stated that there are enough neutrons now; that cannot be

taken as a rationale for building a new reactor. Gagliardi noted that the statement that the recommendations cover a 20-year horizon does not come across in the text.

Ramsey-Musolf pointed out that the Executive Summary jumps quickly from the charge to the recommendation; a statement describing the isotope program should be included. Seestrom added that some statement should distinguish among the short range, when enough neutrons are available, and the long-range, when there might not be enough neutrons.

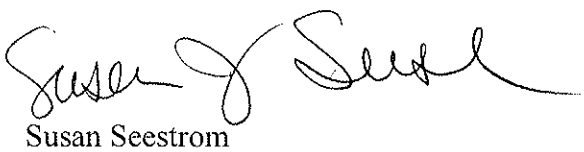
Kouzes stated that the map included in the report should refer to "Pacific Northwest National Laboratory" rather than to "Richland." Geesaman agreed. Kouzes asked if the broker role still applied to He-3. Also, he did not see any large-scale separation of certain materials considered in the second report. Geesaman responded that there is an interagency working group on He-3. The Subcommittee said that, if there were new ways to extract it, they should be considered. For isotopes to detect the emissions from double-beta decay, the Subcommittee did not come up with a solution.

Mausner noted that Type-3 casks are not used in transportation. Type-A casks are used and are inexpensive. The need for manpower in separations and chemistry is overwhelming and is not reflected in the report. The crux of workforce development is that chemistry departments are not replacing nuclear chemists on their faculties, and nuclear chemistry programs are declining in number. The 30- to 40-MeV cyclotron would be cheaper, but to produce volumes of isotopes would require multiple cyclotrons, driving up costs. Geesaman said that he would ask the Subcommittee again about transportation, but it had been adamant that an interlaboratory working group should be set up to develop the packaging for, say, higher-activity shipments.

Ludlam (BNL) pointed out that, in the FY10 budget process, the marks by the House and Senate are serious business. Responses need support from the community, and that community is largely unaware of these marks. Redwine responded that the American Physical Society (APS) Division of Nuclear Physics (DNP) will be meeting with the committee staff on the following week. It is aware of the situation and is acting on the marks.

There being no further public comments, the meeting was adjourned at 3:55 p.m.

These minutes of the Nuclear Science Advisory Committee meeting held at the Marriott Crystal City, Arlington, Virginia, on July 27, 2009 are certified to be an accurate representation of what occurred.



Susan Seestrom
Chair
Nuclear Science Advisory Committee