Minutes of the Meeting of the
Department of Energy and National Science Foundation
Nuclear Science Advisory Committee
Marriott Bethesda North Hotel, Rockville, Md.
March 2, 2009

**Members Participating:**

Robert Tribble, Chairman
Richard Casten (afternoon only)
Gail McLaughlin
Richard Milner
Hendrik Schatz
Johanna Stachel
Mark Stoyer
John Wilkerson
I-Yang Lee
Vince Cianciolo
Charlotte Elster
Richard Furnstahl
Carl Gagliardi
Xiangdong Ji
Dmitri Kharzeev

**Members Absent:**

Allison Lung
Susan Seestrom
Michael Ramsey-Musolf
Christopher Lister

**Others Participating:**

Lawrence Cardman
Michael Kreisler
Joseph Dehmer
Donald Geesaman
Eugene Henry
Clyde Jupiter
Bradley Keister
Hugh Montgomery
Jehanne Gillo

**Presenters in Order of Appearance:**

Joseph Dehmer
Eugene Henry
Bradley Keister
Ani Aprahamian
Donald Geesaman

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

Chairman **Robert Tribble** called the meeting to order at 9:10 a.m. Susan Seestrom, the incoming chair, was unable to attend the meeting because of a weather emergency. Tribble asked Henry to pass the NSAC gavel on to Seestrom at the next meeting.

**Joseph Dehmer** was asked to give an update on activities at the NSF.

In the American Recovery and Reinvestment Act (ARRA), NSF got $3 billion; of that, $0.5 billion will go for university research infrastructure and instrumentation. The solicitation for these funds will be out in a week or two with a 60-day turnaround. A second Major Research Instrument (MRI) competition will also be announced soon. Young people, success-rate improvement, and standard grants will be the focuses of stimulus funding. The agency's plans for using the stimulus funding are currently being approved. Standard grants will broaden participation without producing out-year

mortgages. The FY 09 budget has been approved by Congress and is awaiting the President's signature, so the agency's current budget should be known shortly. The FY 10 budget has NSF's funding increasing by about 15%. The top-line budget was rolled out last week; a more detailed budget request will be announced during the next month.

IceCube and Advanced LIGO [Laser Interferometer Gravitational Wave Observatory] are under construction. In IceCube, 59 strings are in place out of 70 to 80. Each string weighs 12 tons and goes down 2500 m. Advanced LIGO started in 2008, increasing detection ability by a factor of 10. It has reached its assigned value and is performing extremely well.

Upgrades for the Large Hadron Collider (LHC) detectors have been proposed.

The preliminary design phase of the Deep Underground Science and Engineering Laboratory (DUSEL) is under way. The annual review of DUSEL was held in Berkeley in late January with a diverse group of 24 world-class experts. They evaluated the project's status and progress to date. They said the planning money needs to be about $100 million. Solicitation 3 was awarded to the University of California at Berkeley. The Solicitation 4 proposal deadline was January 9, 2009, and 25 proposals were received. Results should be announced this summer. The timeline for DUSEL is

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| July 08: | Internal project review of the facility and infrastructure |
| January 09: | NSF Project Review #1. |
| January 10: | NSF Project Review #2 |
| December 10: | NSF Preliminary Design Review (PDR) of project readiness |
| Spring 11: | Presentation of DUSEL Major Research Equipment and Facilities Construction (MREFC) package to the National Science Board |
| FY 13: | Earliest construction funding (MREFC) start, if approved |

Every three years, there is a Committee of Visitors (COV) for the 10 programs of the NSF. The COV did a fantastic job. They reviewed plans, project jackets, portfolio balance, etc. This mechanism is the primary way that NSF is held accountable to the scientific community.

Since 2000, the Physics Division has added four new programs. There are now six traditional programs, four new (and small) programs, and one proposed program. Accelerator Physics and Physics Instrumentation (AP&PI) is waiting to become a program. About $30-$40 million is needed to support a new program. This might happen for AP&PI in FY 10.

The funding level of the Physics Division is not quite doubling in 10 years. The 10-year funding profile shows a 6.1% increase per annum. In the FY 09 request, the NSF is up 12.69%, the Directorate for Mathematical and Physical Sciences (MPS) is up 19.77%, and the Physics Division is up 18.3%. For FY 10, the Physics Division request reflected an 18% increase, but the NSF as a whole is getting 13% rather than the 16% that was requested.

The core or base research funding [principal investigator (PI) grants] is the most important investment NSF makes. The PI grants are kept at more than 50% of the overall NSF funding. The facilities are funded between 30 and 40% of the budget. Centers are funded at 10% or more (as recommended by the COV). An effort is being made to increase the participation by women and under-represented minorities. The number of awards going to female PIs or co-PIs has increased dramatically since 1999, and the

number of other minorities receiving awards has also increased. However, although the percentage of women receiving awards has increased (from 12 to 17%), the percentage of awards to minorities has increased only from 7 to 8%. Minority PIs or co-PIs have increased from 40 to 60. As a percentage of all awards, new awardees are steady at about 27% each year.

McLaughlin asked what the average funding was for men and women. Dehmer responded that there is not a big spread. The big difference is between theory and experiment.

Wilkerson asked how MRI would work. Dehmer answered that one call is for instrumentation and will be like the usual MRI. The other is for upgrading university infrastructure, not for construction. It will be for $200 million, a small amount of money, and it will go to those who are prepared. Wilkerson asked if the DUSEL review's call for increased planning funding would increase the overall cost. Dehmer said that it did not. It just made the planning funding a more realistic portion of the overall cost.

Milner asked how major a role the DOE will have going forward. Dehmer replied that DOE and NSF support the communities that will use DUSEL. Half of NSF's funding will go to infrastructure, and the other half will be shared costs with DOE for experiments. A commitment from NSF is needed to fund the plant.

Cardman asked if the potential drop-off of funding 3 years from now could be mitigated by further funding of current projects. Dehmer replied that there are many ways to avoid a funding drop-off in the future, and NSF is considering all of them. The 2005 cohort of research projects was unfairly underfunded in subsequent years.

Geesaman asked if NSF was able to encourage women and minority PIs to enter the field. Dehmer answered, yes; the bully pulpit is used to encourage PIs of large groups to include such co-PIs. Even with such encouragement, the growth is topping out.

Montgomery noted that there was an initial award for conceptual design in the DUSEL funding; then there is construction. He asked where the preliminary design funding will come from. Dehmer responded that that issue is being debated now. The funding will probably come from a number or sources.

**Eugene Henry** was asked to review the current situation at DOE. The Nuclear Physics Program supports 1000 PIs, 400 postdocs, and 500 graduate students. The Division will add two isotope-production facilities to its portfolio when the FY 09 budget is signed.

The DOE Office of Science (SC) Nuclear Physics (NP) program has a university/national laboratory research program, national user facilities, laboratory facilities/centers, centers of excellence, and experiments. The manpower study results show that graduate students have rebounded slightly but postdocs have not. Highlights of this past year's program include:

Argonne National Laboratory accelerated a charge-bred beam for the first time, producing a 1+ rubidium beam charge-bred to 13+ and then accelerated to 123 MeV. At Lawrence Berkeley National Laboratory, the first module of GRETINA [Little Gamma-Ray Energy Tracking Array] was produced with each encapsulated crystal segmented six ways longitudinally and six ways transversely to measure in 3 dimensions interaction points of individual gamma rays from a cesium-137 pencil beam. The Thomas Jefferson National Accelerator Facility (TJNAF) remains a world-leader in superconducting radio frequency (SRF) technology, cryogenics, and instrumentation.

Nuclear techniques and instrumentation are widely used in nuclear medicine, national security, environmental studies, and industrial applications. The field should build on this usefulness to society. The program studies accelerator physics in general and specifically ion sources, polarized electron sources, and superconducting RF accelerators. Nuclear Physics (NP) and Basic Energy Sciences (BES) will conduct R&D for uses in its programs, and High Energy Physics (HEP) will look far into the future and look at the long-term needs of accelerator science.

In implementing the recommendations of the Long Range Plan, the 12-GeV Continuous Electron Beam Accelerator Facility (CEBAF) upgrade project Critical Decision-3 (CD-3) was approved in September 2008. The Fundamental Neutron Physics Beamline project decisions CD-4A was approved September 2008. The Cryogenic Underground Observatory for Rare Events (CUORE) Double-Beta-Decay Neutrino Experiment major items of equipment (MIE) is preparing for CD-2. Michigan State University was just announced as the site and operating institution for the Facility for Rare Isotope Beams. The luminosity and detector upgrades for the Relativistic Heavy Ion Collider (RHIC) are continuing.

The DOE SC Nuclear Physics Strategic Plan addresses the scientific opportunities identified and priorities recommended by community; builds on existing strengths and infrastructure; exploits opportunities elsewhere in which the United States can play leadership roles; and positions the United States to deliver outstanding science, remain among the leaders, and maintain core competency. The major elements of the plan are to operate and upgrade RHIC and CEBAF to achieve their scientific goals, implement a plan to become a world leader in nuclear structure/astrophysics studies, address compelling high-impact scientific opportunities in neutrinos/fundamental symmetries, nurture a strong U.S. nuclear physics research community, and produce isotopes in short supply for basic research and applications. In the out-years, funding is needed to support implementation of this plan.

For FY08, NP requested $471.319 million and got 434.226, a 7.9% decrease. To fit this budget, the Office stretched out the Electron Beam Ion Source (EBIS) construction project, RHIC MIEs, GRETINA, Neutron Electric Dipole Moment (nEDM), accelerator improvement projects, and facility capital equipment projects. It was able to partially restore GRETINA funding later in FY08. NP research programs were nearly flat funded with FY07. Planned increases in research efforts that support ongoing initiatives, such as Fundamental Neutron Physics Beamline (FNPB) and LHC, were reduced, but still met LHC commitments. Generic R&D related to rare isotope beam capabilities was reduced; 16 out of 29 proposals were supported (about half). Operations at all four national user facilities were reduced. RHIC operated 19 weeks; CEBAF 24 weeks. All four facilities operated reliably. Increased support for the Advanced Fuel Cycle Initiative (AFCI) and theoretical topical collaboration were deferred. AFCI proposals were declined. Efforts were made throughout the year to mitigate reductions in force (RIFs) throughout the program.

There was some supplemental funding during the summer, with an allocation of $62,500,000 FY08 emergency supplemental funding to SC, which was $1,500,000 over a prior FY08 appropriation of $432,726,000, for a revised total of $434,226,000 to NP. Support was directed towards RHIC to mitigate the potential of any RIFs and to ensure a minimum 19-week run in FY09.

The SC FY09 Congressional Budget Request was for $510 million, which was $77.3 or 17.9% more than the FY08 appropriation. About this amount was accepted by the Joint Committee; the House has passed it; the Senate is expected to pass it very soon.

In the Nuclear Physics Program in FY09, the request for medium energy nuclear physics is up 8.1%, for heavy ion up 8.0%, for low energy up 15.5%, for nuclear theory up 16.1%, and for isotope production and applications up 100.0% (a new program). University and national laboratory research efforts are strengthened; user-facility operations are increased; important instrumentation projects are continued; the 12-GeV CEBAF upgrade project initiates construction; conceptual design and R&D for a facility for a facility for rare isotope beams is initiated in FY09; support is provided for advanced fuel cycle initiatives and theoretical topical collaborations; and the Isotope Production Program is transferred to NP. The continuing resolution has affected all of the above.

Some specific details include: $7 million was requested for Facility for Rare Isotope Beams (FRIB) R&D and conceptual design report (CDR). "Other" is up 65%, which includes an increase for the Isotope Program. The Scientific Discovery Through Advanced Computing (SciDAC) and Lattice Quantum Chromodynamics (LQCD) programs are up 14%. $6.6 million was requested for AFCI R&D. And capital equipment is up 27%.

Looking at the 10-year funding profiles of the various offices of SC, one can see that Advanced Scientific Computing Research (ASCR) is the most robust, Basic Energy Sciences (BES) has grown by virtue of the infrastructure it has put in place, and Fusion is declining and is only half of what the America Competes Initiative (ACI) called for. NP shows a significant increase (17.9%) from FY08 to FY09 after pretty much flat funding from FY96 to FY08.

The continuing resolution produced essentially flat funding from FY08. The Office mitigated the impacts of reductions-in-force. The operations of National User Facilities decreased. TJNAL received $1.5 million in additional funds to mitigate potential RIFs because of unanticipated power-rate increases. An attempt was made to optimize MIE funding within available funds. Throughout the program, there are hiring freezes, lack of promotions, restrictions on salary increases, and an inability to support new postdocs and graduate students. Researchers experience restrictions on travel, including travel to support experimental programs at user facilities. New research programs are on hold, including research relevant to the design of next-generation nuclear reactors, the establishment of theoretical topical centers that will target advances necessary to interpret experimental results, and the initiation of a program to develop and produce research isotopes. The Isotope Program will not transfer from NE to NP until the signing of the FY09 appropriations bill.

The 12-GeV CEBAF upgrade got a successful CD-2 and CD-3 in FY08.

The Funding Opportunity Announcement for the FRIB called for proposals by July 21, 2008. A peer review with a Merit Review Panel selected Michigan State University for the award in December 2008.

The FY09 President's Request proposes to transfer the Isotope Production Program from the Office of Nuclear Energy (NE) to NP. The program is renamed the Isotope Production and Applications Program and includes isotope production infrastructure and a new initiative entitled Research Isotope Development and Production. Priorities will be defined by NSAC and peer review. The NP program has the expertise and experience in

operating facilities and developing technologies that are relevant to the production of stable and radioactive isotopes. This transfer will allow the strengthening of synergy between the two communities and opportunities for new collaborations. NP is working closely with NE and isotope stakeholders in anticipation of the transfer. NP has played the lead in setting up a federal DOE–National Institutes of Health (NIH) working group to address issues of mutual concern and interest and conducted a workshop on The Nation's Needs for Isotopes. The transfer of the Isotope Program is an exciting opportunity to build synergy between basic research programs and isotope development and production and to define new and effective mechanisms of communication between the Program and stakeholders. Currently, the program is strained and underfunded and cannot meet growing demands. Facilities require investment for robust operations and staffing levels are inadequate. To meet the needs of the nation, resources will be needed that are not included in the FY10 budget request. The Isotope Program must be kept from negatively impacting the NP program.

The Joint Congressional Committee recommends $24,900,000 for the Isotope Production and Applications program. The Committee recommends $5,000,000 within the available funds for the Research Isotope Development and Production Subprogram to develop and implement a research and production strategy consistent with the National Academy of Science study entitled "State of the Science of Nuclear Medicine." The recommended level of support for the Isotope Program necessitates almost $3,000,000 of funding to be transferred from base NP program, resulting in a reduction of research initiatives by 30 to 45 full-time equivalents (FTEs). Mitigation by stimulus funding is a possibility. The recommended level of support for the research isotopes is $2,000,000 above President's Request (covered with an increase in the bottom line), and another $3,000,000 can be distributed within the Isotope Program.

Gillo noted that this analysis is all stimulus funding.

The Secretary's criteria for research and investment are that they have a significant impact on economic prosperity, greenhouse-gas emissions, and national security and that they produce meaningful science. The Department will be open to partnerships with other programs, industry, and/or international partners. Questions to be asked of proposed research are

- Is the proposed spending likely to have transformative impacts?
- How close are we to technology innovation, demonstration, and deployment?
- Are we making the appropriate risk/benefit analysis?

DOE's priorities are to invest in science to achieve transformational discoveries; change the landscape of energy demand and supply; create millions of green jobs and increase competitiveness; maintain nuclear deterrent and prevent proliferation; and position the United States to lead on climate change policy, technology, and science.

The categories of support for ARRA funding are

- Facility construction. Funds are to accelerate completion of a number of ongoing construction projects for major scientific user facilities, major items of equipment for those facilities, and laboratory infrastructure. General Plant Projects (GPP) update laboratory infrastructure and establish new laboratory research space, renovate existing laboratory space, demolish inadequate facilities, and improve utility systems across SC national laboratories.

- Facility operations/infrastructure. Funds are to increase operations, experimental support, and infrastructure improvements at scientific user facilities across SC.
- Research. Funds are to support selected research programs across SC and are chosen to minimize out-year mortgages; Energy Frontier Research Centers are included.
- Computing. Funds are to support advanced networking, mid-range distributed computing, and computation partnerships in areas important to DOE energy missions.
- Fellowships. A program to support graduate students and early career scientists was proposed by SC and is under discussion within DOE.

The Solenoidal Tracker at RHIC (STAR) Heavy Flavor/Integrated Tracker received its CD-0 in February 2009 and has a proposed start date in FY10. The Rare Isotope Beam (RIB) has a total of $50 million in the out-years for investments in research capabilities (accelerator, instrumentation, and research) at leading rare-isotope-beam facilities around the world. The neutrino-less double beta decay Majorana R&D is a U.S.-led effort that is located in a deep underground mine that uses an enriched-$^{76}$Ge detector; it is proposed to be initiated in FY10.

Program-management activities this year included NSAC's completing the Performance Measures Report; establishing the Subcommittee on Isotopes; starting the Decadal Study in FY 2010; completing the site selection for FRIB; conducting the Heavy Ion Laboratory Research Review; completing the annual Science and Technology (S&T) Reviews of the four NP user facilities; finishing a long list of project reviews; and participating in the Office of Science and Technology Policy (OSTP) working groups on Physics of the Universe and Large-Scale Science. The Organisation for Economic Cooperation and Development (OECD) is starting another working group on nuclear physics, and NP will participate. In addition, NP has organized working groups on nuclear medicine (with NIH), molybdenum-99, and helium-3 and organized federal stakeholders for an Exascale Computing Workshop.

In the Office, a physicist position for nuclear data and theory is being filled, another for facilities is being advertised, a financial advisor was recently added, and a physicist position for isotope facilities is awaiting funding.

A break was declared at 10:57 a.m. The meeting was called back into session at 11:10 a.m., and discussion of Henry's presentation was initiated.

Lee asked if the signing of the FY 09 budget would stop the effects of the continuing resolution. Henry replied that there will be $510 million for this year, so there will be the opportunity for relaxation of restraints.

Kharzeev asked if the $3 million transfer would happen under the ARRA. Henry answered that that is still being discussed.

Milner observed that, during the past years, the universities have been damaged, and the field has been degraded in the eyes of students. He suggested putting a high priority on bringing new students into the field. Gillo said that that comment resonates with the Office. It has been addressed in the President's Request for FY 09 in the base program. That was taken care of first. The stimulus package does not create mortgages. Elster commented that bringing new students into the field was called for in the Long-Range Plan. She asked if the data on this issue could be shown at the next meeting. Henry said, yes.

Casten asked what a "robust nuclear workforce" was. Henry replied that it is an initiative for researchers and science; it will provide funding resources for researchers in short supply. It will bring together researchers of diverse interests. It could be used for new grants or for small-institution multi-PI proposals.

Ji asked how much of the PI money will be available. Henry responded that that will be driven by the solicitations and proposals.

McLaughlin asked how many solicitations will be issued. Henry answered that that depends on the funding in the final appropriations bill. It would be one or two: workforce and isotope R&D.

Elster noted that most universities have halted hiring. Postdocs are going elsewhere. She suggested the ARRA money could be used to keep those postdocs on. Henry said that many grants have already been funded under the continuing resolution. The universities could come back under these new scenarios; also, one needs to see what happens to the Fellowship Program higher up in DOE.

Tribble asked if there was any progress on filling Henry's position of Acting Associate Director of the Office of Science for Nuclear Physics permanently. Henry replied that the position closed on February 20, 2009. He did not know anything beyond that.

**Bradley Keister** was asked to comment on the nuclear-physics programs of the NSF. That program includes nuclear-physics experiments, nuclear-physics theory, particles and nuclear astrophysics (PNA), frontier centers, and NSCL. The total funding was $45 million for FY 08. PNA now includes neutrinos and astrophysics.

The MRI Program has an annual average at about $1.6 million in awards to universities and user groups at national laboratories. Another initiative is the Cyberenabled Discovery and Innovation (CDI) program started in FY 08 and the addition of $50 million per year was planned. One award was made in FY 08. Petascale systems has no awards currently. Department of Homeland Security has two awards.

Every agency is subject to Government Performance Results Act. The NSF uses merit reviews of proposals, COVs, and highlights of accomplishments as GPRA measures. (There were 12 highlights this year.)

In FY 08, NSCL operations were flat; everything else was down 5%. Some program impacts were moved from FY 09 to FY 10. In the FY 09 budget, an attempt will be made to restore the trajectory of NSCL operations toward optimal operations, to absorb some of the impact from the FY08 budget on Nuclear Theory and Experiment and move forward, and to move forward with DOE on a partnered funding plan for nEDM.

At this point, the government is still under a continuing resolution. In FY 08, $5.594 billion was requested for research and related activities (R&RA); $4.827 billion was appropriated. The appropriation looks like it will be $5.13 billion in FY 09, a 7% increase over FY 08. The FY 10 request is $7 billion, a 16% increase over FY 09. The request is projected to increase to $9.7 billion in FY 14.

The Solicitation 4 DUSEL proposals are in and are under review.

The NSF Director (who serves a six-year term) will continue to be Arden Bement. There will be a new deputy director.

Gagliardi noted that NSF did better in the ARRA than DOE did and that the opposite is true for the FY 09 budget. He asked if this would be a problem in the out-years.

Keister said that NSF is trying to fund people. The new people will come in through competitions, without mortgages but with heightened expectations.

**Ani Aprahamian** was asked to address Charge 1 to the NSAC Isotopes Subcommittee (NSACI).

In 2008, issues in the supply of medical isotopes gained widespread attention. The administration responded, in part, by transferring isotope production from Nuclear Energy (NE) to NP in the FY 09 Appropriation. To inform and guide NP about carrying out this responsibility, NSACI was formed. It is (1) to address the priorities for research isotope production and (2) to develop a long range strategic plan. These two requests were transmitted in the charge letter that prompted the Subcommittee's establishment.

A workshop was held in August to find out

- Who uses isotopes and why?
- Who produces them and where?
- What are the needs today and in the future?
- What is the status of the supply/what is missing?
- What options are there for increasing the availability and overcoming the technical hurdles?

The information gleaned from the workshop was to inform the answers to both charges in the charge letter. The workshop found (inter alia) that

- NP does not have the resources to carry out such a program.
- A reliable program in isotope production at DOE is crucial for the long term health of developments in medicine, basic physical and biological sciences, national security and industry.
- Many of isotopes in domestic use are produced only by foreign suppliers
- Affordability is an important component.
- The production capability of the National Isotope Production and Applications (NIPA) Program relies on facilities that are operated by DOE for other primary missions.
- There is a pressing need for more training and education programs in nuclear science and radiochemistry to provide the highly skilled workforce for isotope application.

NSACI's first charge was to identify and prioritize the most compelling research opportunities; the stable and radioactive isotopes needed to pursue these opportunities, including estimated quality and purity; the technical options for producing each isotope; and the R&D efforts associated with the production of the isotope. The second part (which was discussed separately by Geesaman) is to develop a long-range plan for producing medical, industrial, and research isotopes.

The Subcommittee held three meetings to get community input. Additional meetings will be held to address Charge 2. The final report will be finished by the end of July. A working group has been established on this topic by DOE and NIH.

Federal agencies and trade groups were contacted for input. The first report will include a general introduction; the landscape of production; medical, pharmaceutical, and biological uses of isotopes; basic physical science/engineering research; security applications; and a summary and recommendations.

Isotope needs for biological, medical, and pharmaceutical opportunities (with their required isotopes) were ranked by the Subcommittee:

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| Alpha therapy | $^{225}$Ac, $^{211}$At, $^{212}$Pb |
| Diagnostic dosimetry | $^{64}$Cu, $^{86}$Y, $^{124}$I, $^{203}$Pb |
| Diagnostic tracers | $^{89}$Zr |
| Therapeutic procedures | $^{67}$Cu |

Isotope needs for scientific opportunities in the physical sciences along with application (with their required isotopes) were ranked by the Subcommittee:

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| Fission source for the Californium Rare Ion Breeder Upgrade (CARIBU) at ANL | $^{252}$Cf |
| Electric dipole moment experiment at ANL | $^{225}$Ra |
| Heavy elements for searches for super heavy element research and for heavy element chemistry | Various actinides |
| Avogadro project – worldwide weight standard based on pure $^{28}$Si crystal balls | $^{28}$Si |
| Isotope dilution mass spectrometers | $^{236}$Np, $^{236}$Pu, $^{244}$Pu, $^{243}$Am, $^{229}$Th |
| Double-beta decay experiment | $^{76}$Ge |
| Spikes for mass spectrometers | $^{202}$Pb, $^{203}$Pb, $^{205}$Pb, $^{206}$Bi, $^{210}$Po |
| Neutron detectors, EDM, etc | $^{3}$He |
| Radioisotope micropower sources | $^{147}$Pm |

And the Subcommittee made six recommendations:

1. Invest in new production approaches of alpha-emitters, (e.g., $^{225}$Ac). Extraction of the thorium parent from $^{233}$U is an interim solution that needs to be seriously considered until other production capacity can become available.
2. Invest in the coordination of production capabilities and supporting research to facilitate networking among existing accelerators.
3. Create a plan and invest in production to meet the research needs for heavy elements.
4. Conduct a focused study and R&D to address new or increased production of $^{3}$He.
5. Carry out R&D in a focused study to prepare for the re-establishment of a domestic source of stable research isotopes.
6. Invest robustly in the education and training of personnel with expertise to develop new methods in the production, purification, and use of stable and radioactive isotopes.

Stachel asked if the Subcommittee recommended any levels of funding. Aprahamian replied that the parameter was a total funding of $3 million per year. Some issues do not involve money. Gillo noted that the recommendations certainly exceed the $3 million funding. Aprahamian added that there are reinvestments that need to be made to restart the production of these isotopes in the United States.

Schatz asked how the Subcommittee ordered the list. Aprahamian replied that the production of immediate science was a strong consideration. Geesaman added that the different agencies listed their near-term and long-term priorities for NSACI.

A break for lunch was declared at 12:42 p.m. The meeting was called back into session at 1:35 p.m. Discussion about the NSACI subcommittee was resumed.

The need for $^{235}$Ac for alpha therapy was the reason for Recommendation 1. The need for comparative diagnostic-therapy isotopes was the reason for Recommendation 2. The SC request for $^{252}$Cf, $^{225}$Ra was the reason for Recommendation 3. The $^{3}$He recommendation (Recommendation 4) was to avert a shortage and likely large price

increase in the future. The need for stable isotopes drove Recommendation 5. Aprahamian asked if an estimate of the amount of required $^{233}U$ was needed. Simon-Gillo said that it might be helpful. However, SC does not want to become a steward of uranium stockpiles. Many things complicate the selection of isotopes to be produced. The number of patients to be treated enters into the calculus.

Furnstahl asked where the requests for Recommendation 6 came from. Aprahamian said that there has been a culture change. Chemistry departments do not relate to nuclear-chemistry programs any longer. Stachel observed that that is true. This recommendation comes too late. Aprahamian noted that every group that testified said that there were more jobs than people to fill them.

Gagliardi asked what is behind recommendations 5 and 6. Aprahamian replied that it is a problem of supply.

Wilkerson asked if the science justifies the recommendations. Aprahamian answered that it will be in the final report how the science justifies these recommendations. Wilkerson observed that Recommendation 3 makes general statements about transuranics. Aprahamian said that in Recommendation 5, there are many isotopes that will come out of one process. In Recommendation 3, there is a specificity. Perhaps processes will make a difference.

Gagliardi noted that some isotopes are in the gram range and others are in the ton scale; the recommendations do not reflect that difference of scales. Aprahamian replied that the point is to re-establish the capability of producing the isotopes in the United States.

Schatz asked whether, in Recommendation 2, the program would benefit from viewing the problem from an international context. Aprahamian responded that it is a good idea in general, but there are rules about shipping across borders.

Tribble noted that this charge was very specifically related to R&D activities. This issue is pertinent to the long-range plan.

Montgomery asked how big the industry was that would be needed by this R&D. Aprahamian replied that the money part of medical applications is huge. Montgomery asked if it was $10 million or $100 million. Aprahamian replied that they are only making things that are not available from private industry. Tribble asked about the market for therapeutics that might be discovered by this R&D. Aprahamian said that she was not qualified to answer that question

Gillo commented that this is a big challenge and difficult. The Subcommittee was to address several details, and it has the intent to answer all of these details. This initiative is addressing R&D isotopes (which is new) as well as medical isotopes that are in short supply. The Office needs to be able to use these recommendations to develop a portfolio. Some of the isotopes are not reflected in the recommendations. Aprahamian noted that the recommendations cover the highest-priority isotopes for the users. The others not reflected are needs but are more remote from producing science or medical advances. Gillo asked if the Subcommittee considered prioritizing the various isotopes for diagnostic dosimetry. Aprahamian replied that it did not. It believed that some R&D could possible.

Casten asked whether these items were prioritized temporally by what should be done first, second, etc. Aprahamian answered, no; they are prioritized by importance. Simon-

Gillo noted that the Office will attempt to do them in the order recommended. This is the guidance on how to proceed.

Wilkerson asked if the isotopes stated within the recommendations were listed in a prioritized order. Aprahamian answered that it is a challenge to prioritize the isotopes and that the subcommittee had prioritized research opportunities. The Subcommittee could be asked to prioritize the isotopes. Gillo said that the Subcommittee did the right thing, but there are more items to be prioritized. There is stimulus money to be allocated and long-term funding to be considered, so a full prioritization would be helpful. The final report might list one isotope for a given recommendation, and DOE would address that one and then go on to the next priority. Or, the Subcommittee might list several isotopes, and DOE would go down that list of isotopes in that order. Geesaman said that he was not sure that such an ordering of diagnostic dosimetry isotopes is possible. Gillo said that, in the report, the Subcommittee should be careful to articulate what the issue is.

Tribble asked how comfortable people were about how the work on the report was progressing. Committee members said that this draft is a good starting point, they were happy with the recommendations, they were comfortable with the progress, they were eager to see more, the concept of prioritization should be clarified, they would like to see a more specific prioritization, the content needs to be tightened up, and nuclear chemistry and radiochemistry were properly included in the education recommendations.

Tribble said the drafts would be circulated for comment to see if the details could be ironed out. If they could not, the report can be discussed at the next meeting.

Gillo commented that the base program is ongoing and has five subprograms. This activity will be part of one of these subprograms. This program can be beneficial to the NP base. This program *has* to be embraced as part of the NP program. There are many communities that support isotopes. They need to be welcomed into the NP program. This is an opportunity to demonstrate nuclear physics' value to society.

**Donald Geesaman** was asked to address Charge 2 to the NSACI, the portion dealing with a long-range plan.

Making domestically produced medical isotopes is a national priority. In addition, $^{99}$Mo is used in 70 to 80% of all nuclear-medicine procedures. The production of this isotope takes a one-megawatt reactor operating continuously. Currently all production takes place in reactors outside of the U.S. These reactors were shut down for one reason or another. Two commercial entities are interested in producing this isotope. The second charge in the charge letter was to develop a strategic plan. The FY 09 Omnibus Bill said "Within this amount, $24,000,000 is provided for the Research Isotope Production and Applications program, and within these funds $5,000,000 is provided for the Research Isotope Development and Production Subprogram to develop and implement a research strategy consistent with the National
Academy of Sciences study entitled *State of the Science of Nuclear Medicine*. Consistent with the cost-sharing requirements of Public Law 101-101, the Department is directed to develop a cost-recovery strategy to ensure the long-term viability of the isotope production program. The Department is directed to complete a study of the feasibility of using the University of Missouri Research Reactor to supply up to half the U.S. demand for feedstock medical imaging compounds in the form of molybdenum-99 and technicium-99."

A lot of reports say that the isotope program is not working as well as it should. Funding has gone down. Another part of the problem is the complexity of the mission and the diffuseness of the resources. There are now six production sites, all of which have various restrictions. If one large customer pulls out, that can cripple a program. Recouping costs can be very complicated. Furthermore, programs were started up and then cut. There are important national-security issues. Revenues have increased from 2003 to 2008. These revenues are used for operations and maintenance.

Some of the issues that need to be addressed are:

- Should the program support repeat customers with a regular supply or new applications?
- When can the government compete with commercial suppliers and foreign suppliers?
- Foreign suppliers are, in many cases, subsidized by governments or capitalizing on previous government stocks.

The message that was received from NP was, as DOE-NP considers managing the program, they want an emphasis on communications with all interested parties and a visible and open process.

In 2008, most sales (totaling $17.1 million) came from accelerator-based isotopes. The Atomic Energy Commission Act of 1954 specified that prices are to be based on an equitable basis to provide reasonable compensation to the government and not discourage the use of or the development of sources of supply independent of DOE but rather encourage research and development. The Department continues to adhere to the procedures and criteria expressed in the Federal Register, Tuesday, March 9, 1965, with respect to determinations involving its withdrawal and re-entry into commercial markets. Two public laws are important. They are currently interpreted as prices for commercial isotopes are to be based on full cost and prices for research isotopes are to be based on direct cost for the entire batch. Currently, the pricing policy for research isotopes is being reconsidered.

NP has been very proactive in managing this program. A workshop was held, a working group was set up with NIH, $^{252}$Cf production was restarted, and charges were issued to NSAC. Now, NSAC I is supposed to " recommend a long-term strategic plan that will provide a framework for a coordinated implementation of the NIPA Program over the next decade," articulating the scope, the current status, and impact; the scientific and technical challenges; the identity and priority of the most compelling opportunities; and the opportunities' impacts. Then it is to coordinate a national strategy for the use of existing and planned capabilities; the rationale and priority for new investments; and a constant-level-of-effort budget and an optimal budget. To be most helpful, the 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 into the out-years. Investments in new capabilities dedicated for commercial isotope production should be considered, identified, and prioritized; but they should be kept separate from the strategic exercises focused on the remainder of the NIPA Program. Then the Subcommittee is expected to consider the robustness of current isotope production operations within the NIPA program.

The Subcommittee had four meetings, one organizational meeting to publicized its charges and solicit community input, one for getting from government agencies and another for input from professional societies and about ideas for production research R&D. At the fourth meeting , plans for production capability were presented by national laboratories and private firms. The long-range plan group meeting will be March 25-27. A final report is expected by the end of July.

Some of the other general issues considered were

- The definition of research isotopes
- The definition of commercial isotopes
- Issues that are off the table (weapons issues; the National Nuclear Security Administration's lead for $^{99}$Mo)
- How to hand off to industry effectively
- Examples where early commercialization was not sustainable
- Mike Holland's exhortation to show that current resources are used efficiently and effectively before considering upgrades

An outline of the report has been produced. It will review opportunities and impacts. These topics have been parceled out to individual members of the Subcommittee to develop recommendations. The full Subcommittee will consider the recommendations and refine them for the final report, which should be ready for NSAC's review by mid-July.

A lot of people are looking over the shoulders of the Subcommittee members, including other research communities, commercial users, commercial suppliers, doctors and patients, other government users (including national security), and Congress. The Subcommittee needs to do its best to get it right. All suggestions are welcome.

Tribble said that the August workshop had been enlightening about the breadth of the program and about the possibility of developing a long-range plan to solve the problems.

Lee asked how long a period the plan would cover. Geesaman replied, 10 years. Facilities take a while to build, and the demand for these isotopes will increase.

Ji asked how the decision can be made about how much money will be sufficient. Geesaman answered that one starts with a constant level of funding and looks at what levels of production can be achieved. Then one tries to figure what a constant level of production would contribute. One can also look at the prices of off-the-shelf equipment.

Elster asked what was meant by the term "commercial isotope." Geesaman responded that it refers to those isotopes that have commercial applications but that are produced only by the government. However, a private supplier may not produce an isotope all the time, so the government can step in and schedule production to complement the production schedule of the private firm.

Milner noted that this effort is to be part of the base program and asked how one would integrate this program into the nuclear-physics community. One has to get buy-in and trust from that community. Geesaman noted that the previous Long-Range Plan did not mention the Nuclear Data Program. There can be complementary long-range plans.

Tribble said that he believed that there is, from the NP perspective, a lot of education that needs to be done.

Aprahamian said that the concern seems to be how decisions about other communities (customers of NIPA) are going to be made in the future, and that issue needs to be developed carefully.

Kreisler commented that the Subcommittee should also consider that some facilities may not be there 10 years in the future.

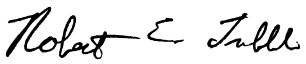
Tribble opened the floor to new issues and public comment.

Jupiter stated that ways of implementing the policy of DOE should be looked at. The cost should be less than the value of the product. It might be worthwhile looking at a public-private partnership. That might save money and time.

Henry and Keister congratulated Tribble for his yeoman's work for the nuclear-physics community. The Long-Range Plan he produced will serve well into the future. He is also serving as interim chairman until a new chair can be sworn in. An award of appreciation from DOE and NSF was presented to him. Tribble expressed his gratitude for the willingness of people to help in carrying out the work of the Committee.

The meeting was adjourned at 3:36 p.m.

These minutes of the Nuclear Science Advisory Committee meeting held at the Marriott Bethesda North Hotel & Conference Center, Bethesda, Maryland, March 2, 2009 are certified to be an accurate representation of what occurred.



Robert Tribble
Chairman
Nuclear Physics Advisory Committee