

Minutes
Department of Energy and National Science Foundation
Nuclear Science Advisory Committee
Marriott Bethesda North Hotel & Conference Center, Bethesda, MD
February 26, 2010

Members Participating:

Susan Seestrom, Chair	Gail McLaughlin
Richard Furnstahl	Hendrik Schatz
Carl Gagliardi	Johanna Stachel
Christopher Lister	William Zajc
Allison Lung	

Members Absent:

Vince Cianciolo	Dmitri Kharzeev
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Others Participating:

Robert Atcher	Robert Janssens
Linda Blevins	Bradley Keister
William Brinkman	Michael Kreisler
Patricia Dehmer	Hugh Montgomery
Susan Gardner	Lee Schroeder
Konrad Gelbke	Edward Seidel
Timothy Hallman	Alan Tatum
Eugene Henry	Steven Vigdor
Peter Jacobs	Sherry Yennello

Presenters in Order of Appearance:

Edward Seidel	Robert Janssens
William Brinkman	Konrad Gelbke
Bradley Keister	Alan Tatum
Timothy Hallman	Sherry Yennello
Hugh Montgomery	Hugh Montgomery
Steven Vigdor	Steven Vigdor

About 30 others were in attendance during the course of the meeting.

Chair **Susan Seestrom** called the meeting to order at 8:46 a.m. She had all the members at the table introduce themselves. New members who had not yet been sworn in sat in the audience and introduced themselves, also.

Edward Seidel was asked to review the budget outlook of NSF's Directorate for Mathematical and Physical Sciences (MPS).

NSF fared well in the President's FY11 Budget Request to Congress. After a decade of strong growth, MPS is requesting nearly \$60 million in new funding, which would bring the total funding in the Directorate to more than \$1.41 billion, a 4.3% increase with

about a 6% increase in the discovery portfolio. All of the MPS Divisions receive an increase under this request. The primary themes of the MPS budget request are innovation in fundamental scientific research, support of young scientists (which is where many new ideas come from), and targeted investments in science that serves national priorities. Much of the MPS increase is in discovery, which includes the fundamental “core” programs. Overall, MPS Division’s discovery lines increased 6.7%, with Physics being the highest increase in discovery science at 11.4%.

From the ARRA funding in 2009, there was a \$490 million total investment in MPS Research and Related Activities (R&RA) and \$146 million in Major Research Equipment and Facilities Construction (MREFC) for the Advanced Technology Solar Telescope (ATST). Research and Education grants total \$402 million, including close to 400 new principal investigators (PIs) and 85 Early Career Development Program awards. Major investments are made in the Graduate Research Fellowship, Research Experience for Undergraduates, and post-doc programs. Facilities and Instrumentation support totals \$88 million, with \$2 million of that for the National Superconducting Cyclotron Laboratory (NSCL).

Core programs support research on the structure/evolution of the universe, behavior and control of molecules at the nanoscale, and new mathematical structures and theories. These disciplines are fundamental for advances in all science, medicine, industry, and technology.

Computing is important in nuclear physics, but it is not the only data-intensive discipline. Today, 1 Tb/min of data can be produced by a university laboratory with the new biological-revolution systems. NSF has a new concept in CF21, the Cyberinfrastructure Framework for 21st Century Science and Engineering. This initiative will develop high-end computation, data, and visualization for transformative science. These must be made sustainable while staying at the cutting edge. Its software, tools, science applications, and virtual organizations are critical to science, and they will be integrally connected to hardware. Ways have to be found for campuses to be fundamentally linked to support people. The most important thing in advanced computing is people. A comprehensive approach must be taken to workforce development for 21st century science and engineering. Specifically, there will be a new high-performance-computing program in the next few months. The basic concept is to develop long-term efforts sustainable for 4 to 5 years (supporting centers, teams, and PIs) for software development. All of the NSF directorates will be integrated into this long-term cyberinfrastructure program.

Science, Engineering, and Education for Sustainability (SEES) is a new priority investment in energy and climate research. In SEES, NSF is partnering with other NSF directorates to invest in research on energy, energy storage, and new battery materials. This is a priority area that will grow.

Funding priorities of MPS include the NSCL (for which the FY11 request is an increase of \$0.5 million over the FY10 appropriation) and the Deep Underground Science and Engineering Laboratory (DUSEL).

In DUSEL, the majority of Geotechnical Investigations are complete, and an Integrated Safety Management plan is being developed. Environmental impact statement (EIS) planning is under way as are the design and development of potential DUSEL experiments. Funding for preliminary design [through the Preliminary Design Report

(PDR)] has been awarded to University of California at Berkeley. An independent review of DUSEL by National Academy of Sciences has been initiated, and a report has been requested by February 2011 as input to the National Science Board (NSB) MREFC portfolio review. Collaboration is coordinated through the Joint Oversight Group (JOG). NSF will steward the DUSEL facility, and DOE's Office of High Energy Physics (HEP) will steward the Long Baseline Neutrino Experiment (LBNE). DOE's Office of Nuclear Physics (NP) will lead neutrinoless double-beta decay experiments, and NSF will lead dark matter and other science and engineering disciplines. Partnership models to inform planning have been agreed to. DOE "Critical Decision 0" (CD0, approve mission need) was granted to the LBNE by the DOE Deputy Secretary on January 8, 2010, and planning for CD1 (approve alternate selection and cost range) is in process. The Office of Science and Technology Policy (OSTP) is now engaged to help guide the NSF-DOE joint planning process. There have been a lot of DUSEL reviews. One a couple of weeks ago focused on the technical design basis and the plan for achieving a PDR in December 2010.

Zajc asked about the safety concerns with DUSEL? Seidel replied that safety issues are deeply integrated in the planning. There are serious issues, and they will be talked about in the Science and Technology Plan.

Montgomery asked if there were a model of management. Seidel answered, yes. NSF will steward the facility. Operational management will be determined in the PDR process. Montgomery asked if there were coordination with DOE on cyberinfrastructure issues. Seidel said that there was. He and Michael Strayer (Director of DOE's Office of Advanced Scientific Computing Research) meet regularly, often with industry leaders. There is also a consortium centered in Germany on exascale software development. A lot is being done.

Kreisler asked what the FY11 budget for DUSEL covered. Seidel replied, funding for the environmental impact study, activities beyond the PDR, and the final design review in FY12, but that there are serious challenges going forward

William Brinkman was introduced to speak on the budget outlook for DOE's Office of Science (SC).

The President is very interested in scientific advance. The SC FY11 budget request to Congress is for \$5.121 billion, an overall increase of 4% (actually 6.1% after earmarks are deducted) over the FY10 appropriation. The request for NP is \$562 million, a \$27 million or 5.0% increase. The request for Basic Energy Sciences (BES) goes up 12%; for Advanced Scientific Computing Research (ASCR), 8%; and for Biological and Environmental Research (BER), 4%. There are more modest increases for other offices.

SC supports 27,000 Ph.D.s, graduate students, undergraduates, engineers, and technicians and 26,000 users of world-leading, open-access facilities. It provides support to 300 leading academic institutions and all 17 DOE laboratories. The request emphasizes the three Energy Innovation Hubs; enhanced activities in climate science and modeling; individual-investigator, small-group, and Energy Frontier Research Center (EFRC) awards in areas complementing the initial suite of 46 EFRCs awarded in FY09; Leadership Computing Facilities' operations and preparation for the next generation of computer acquisitions for S&T modeling and simulation; and multiscale modeling of internal combustion and advanced engine systems.

In scientific user facilities, facility construction is fully funded, and projects are meeting baselines of schedule and cost. Several new projects and major items of equipment (MIEs) are initiated.

In education and workforce development, there are expansions of the SC Graduate Fellowship Program and the SC Early Career Research Program (ECRP) funded in all of the SC research programs. The first wave of awards in the ECRP has been made.

The Energy Innovation Hubs are modeled after the SC Bioenergy Research Centers. They will focus on critical energy technology challenges by building creative, highly integrated research teams that can accomplish more faster than researchers working separately. FY10 Hubs tackle three important energy challenges:

1. Production of fuels directly from sunlight (SC)
2. Energy-efficient building systems design [Office of Energy Efficiency and Renewable Energy (EERE)]
3. Modeling and simulation of advanced nuclear reactors [Office of Nuclear Energy (NE)]

Enhanced activities in climate research are being funded to improve the predictive capability of climate-change modeling. The current state of climate models is insufficient to predict with detail and accuracy the future interactions between climate change and energy policy.

SC leads the world in supercomputing capabilities at Oak Ridge National Laboratory (ORNL) and Argonne National Laboratory (ANL). Simulations are conducted by Scientific Discovery Through Advanced Computing (SciDAC) teams and others.

A new initiative is to develop the science base for computational design of advanced engines.

SC has three Bioenergy Research Centers (BRCs) to pioneer new approaches to accelerate biofuels research: The Joint BioEnergy Institute (JBEI) conducts research on model crops that can be transferred to bioenergy crops, lignin modification, and synthetic-biology approaches to fuels. The Great Lakes Bioenergy Research Center (GLBRC) conducts research on model plants and potential bioenergy plants, microbial biorefineries, and sustainability of biofuel production. The BioEnergy Science Center (BESC) conducts research to overcome “recalcitrance” (resistance of plant fiber, or lignocellulose, to break down into sugars); gene discovery for recalcitrance; and consolidated bioprocessing.

SC also supports the genomic revolution. The synchrotron radiation light sources have had a massive impact on structural biology. Sequencing the 3 billion base-pair human genome took 13 years. Today the DOE Joint Genome Institute sequences more than a trillion base pairs annually.

The emerging science of high-energy-density laboratory plasma (HEDLP) is enabling deeper understanding of extreme phenomena in a range of disciplines including fusion energy science, condensed matter physics, materials science, fluid dynamics, nuclear science, and astrophysics. This research will leverage world-class Fusion Energy Sciences (FES) and National Nuclear Security Administration (NNSA) facilities.

The United States is uniquely positioned for a world-leading program in neutrino physics. At the heart of the DOE HEP program is the NuMI [Neutrinos at the Main Injector] beamline at Fermilab, the world’s most intense neutrino source, which serves MINERvA [Main INjector ExpeRiment v-A] and MINOS [Main Injector Neutrino

Oscillation Search] and will support NOvA [NuMI Off-Axis ν_e Appearance] and the proposed LBNE.

The DOE Nuclear Physics Program is charting new directions at the frontiers of nuclear science. The United States is a leader in studying the compelling questions of nuclear science. The Relativistic Heavy Ion Collider (RHIC) is the only machine in the world devoted to colliding heavy ions at near light speed, as well as polarized high energy protons. The Continuous Electron Beam Accelerator Facility (CEBAF) is the world's most powerful probe for studying the nucleus of the atom. Investments in radioactive ion beam experiments and capabilities (such as the Facility for Rare Isotope Beams, FRIB) probe the properties of rare nuclear isotopes to better understand the origin of the elements and fundamental symmetries of nature.

New science follows the completion of the 12-GeV upgrade at the Thomas Jefferson National Accelerator Laboratory (JLab). With the completion of the 12-GeV upgrade, researchers will address the search for exotic mesons, physics beyond the Standard Model, the spin and flavor dependence of valence parton distributions, the structure of atomic nuclei, and nuclear tomography. A new capability at FRIB will sustain core competency in nuclear structure and astrophysics. It is funded with a DOE investment of up to \$550 million and a \$94.5 million cost share from Michigan State University (MSU).

\$16 million will be available in FY11 to fund about 60 additional ECRP awards at universities and DOE national laboratories. The purpose is to support individual research programs of outstanding scientists early in their careers and to stimulate research careers in the disciplines supported by SC. Applicants must be within 10 years of receiving a Ph.D., either untenured academic assistant professors on the tenure track or full-time DOE national laboratory employees. The SC ECRP started with \$100 million of American Recovery and Reinvestment Act (ARRA) funding; there are now 60 early career researchers.

There were about 3000 applicants for the SC Fellowship Program in FY10. The SC offices and programs themselves will fund this program in the future, and the number of researchers will increase to about 170. \$10 million will be available in FY11.

Seestrom expressed concern about the small number of users at fusion-energy facilities. Brinkman replied that there are not many facilities, and they are diverse in interests.

Montgomery stated that the Leadership Computing Facilities are very important, but it is also important to have another scale of computing available. Brinkman responded that computing must advance from description to prediction.

Henry asked where the hub for nuclear power will be. Brinkman answered, in DOE's Office of Nuclear Energy (NE).

Seidel noted that NSF sends fellows and interns to facilities for the summer or a semester, also, and the two agencies should try to coordinate their efforts.

Stachel noted that many facilities and programs are oversubscribed by an order of magnitude.

Seestrom asked if DOE had any goals for gender diversity in education. Patricia Dehmer responded affirmatively; a third of the early career awards went to women.

Seidel noted that two potential dark-matter particles had been discovered and asked about the details on that. Brinkman said that two observations had been made but it was too early to verify the significance of those observations.

Gagliardi asked where the nuclear energy hub would be located. Brinkman replied, in NE. Schroeder noted that the management of the NE hub is to be competed; ORNL and ANL are known to have put together competitive teams.

Bradley Keister was asked to review the nuclear physics outlook at the NSF.

Nuclear Physics at NSF includes experiments, theory, particle and nuclear astrophysics, Frontier Centers, and the NSCL. These are funded at a total of \$47 million.

The Physics Division programs have a budget guidance, which constitutes an increase over the FY09 appropriations. The Operating Plan awaits Office of Management and Budget (OMB) and congressional approval. The strategy is to smooth out the impact of the ARRA over three years. The doubling strategy would mitigate the bump in funding caused by the ARRA.

MPS is the largest directorate at NSF. Physics has a small increase in the FY2011 budget submission, but within the division budget breakdown, the investigator programs show a requested aggregate increase of about 11%. NSCL funding would go up according to a plan approved by the National Science Board.

Additional funding sources include Major Research Instrumentation (two solicitations are close to awards; the 2010 solicitation is out, with an April submission deadline); Cyber-Enabled Discovery and Innovation (CDI), a 5-year initiative begun in FY08 funded at a planned increase of \$50 million per year (the FY10 deadline has passed); Petascale Computing Resource Allocations (PRAC); and the Department of Homeland Security's Domestic Nuclear Detection Office initiative with NSF.

Science highlights include muonium (at NSCL); neutrino coherence on cosmological scales; ^{24}O , a magic nucleus; and local strong parity violation studies at RHIC.

Since the prior NSAC meeting, there was the first meeting of the JOG for DUSEL. It will help the user community coordinate present operations and future transitions and its information/plans.

The NSF Director will be leaving in June. New personnel are being sought for Nuclear Physics.

Gagliardi asked if this delay in allocating the NSF budget would pose any problems. Keister replied that the appropriation for research has to be allocated across divisions. This takes several months before an approved operating budget is set. In the meantime many proposal decisions can be made with the information at hand, and this is not different than the situation in other recent fiscal years.

Seestrom asked for his thoughts about the operations money from NSCL. Keister replied that facilities funding is handled by the division director. This process has undergone a transition since the phaseout of IUCF. As a present example, there is no operational support for the Cornell Electron Storage Ring (CESR) for FY10 but there is research funding. With CESR phaseout, some funds will be put into the Elementary Particle Physics Program for investigator grants, and the remainder will be kept by the division director for present and future facilities funding.

Timothy Hallman was asked to present an update on the Office of Nuclear Physics of DOE.

The nuclear physics facilities produced a number of science highlights. Research at JLab concerns how nucleons change their structure. It showed that the EMC [European Muon Collaboration] effect is related to nuclear density.

The ATLAS (Argonne Tandem Linac Accelerator System) program's thrusts are the nature of nucleonic matter, the origin of the elements, and tests of fundamental symmetries, all fundamental nuclear science.

At the Holifield Rare Isotope Beam Facility (HRIBF), a single-neutron transfer process (one neutron above a magic number) was observed at an excitation energy of 1363 keV in ^{133}Sn . It shows that ^{132}Sn is doubly magic.

Heavy-Ion research at RHIC observed an event-by-event preference for like-sign charges to emerge in the same direction with respect to the magnetic field produced by the colliding nuclei and for opposite-sign charges to emerge in the opposite direction.

A \$2 million grant through the NP Applications of Nuclear Science and Technology will support a collaborative effort between the ATLAS facility at Argonne National Laboratory and the Idaho National Laboratory which will use its irradiation facilities at the Advanced Test Reactor to irradiate actinides commonly found or produced in nuclear fuel prior to analysis by Accelerator Mass Spectroscopy (AMS) at ATLAS. The results of this research will reduce uncertainties in the cross sections for fission and neutron capture relevant to the production of actinide daughters in nuclear fuel. The ultimate goal is to address questions of waste minimization, fuel optimization, and nuclear non-proliferation in the design of advanced fuels for future nuclear reactors. A committee of visitors (COV) to NP was carried out on January 12-14, 2010. It is reported on later in this meeting.

The SC ECRP supports the development of individual research programs of outstanding scientists early in their careers in areas supported by SC. NP received 29 applications from university faculty and 26 from laboratory staff, spanning a broad portfolio. Five university awards and three national-laboratory awards were made. This program was started with ARRA funding, and an additional \$10 million will be added each year once the steady level is reached after five years.

There is a Graduate Research Fellowship Program in SC. It received 3000 applications for 150 awards.

A funding opportunity announcement was issued for topical theory collaborations, and three awards were announced on December 14, 2009.

In the Nuclear Physics isotopes program, work continues on restructuring the Isotope Business Office into the National Isotope Data Center (NIDC). The NIDC has now been established, and Robert Atcher is the Director. Additional production sites have been integrated into the DOE isotope program. NSAC made recommendations on the isotope program, two of which called for the construction and operation of facilities that will be needed in the future, an electromagnetic isotope separator facility for stable and long-lived radioactive isotopes and a variable-energy, high-current, multi-particle accelerator and supporting facilities that have the primary mission of isotope production.

In the FY10 appropriation, NP was about 11% of SC's funding. The recent history has been solid funding for NP. The SC FY11 congressional request for NP is \$562 million, again 11.0% of the SC budget. The total increase for NP is \$27 million. It covers the 12 GeV CEBAF Upgrade according to the planned construction profile, constant effort for research at national laboratories and universities, Majorana Demonstrator R&D, and FRIB engineering and design. The request also provides for some modest increase in the beam hours for NP National User Facilities.

Of the FY11 Congressional Request for NP, 54% of it is for facility operations, 35% is for research, 8% is for major projects, 2% is for MIEs, and 1% is for all other expenditures. Of the requested research funds, 50% goes to national-laboratory research, 42% goes to university research, 7% goes to national-laboratory MIEs, and 1% goes to accelerator R&D.

The NP long-range-plan recommendations are being implemented. New physics reach is going to be provided by the 12-GeV CEBAF upgrade, providing new capabilities for future calls for proposals. DOE selected MSU to establish FRIB; a Lehman minireview of preparations for CD1 will be held March 17, 2010; engineering design is to be started in FY11. Luminosity and detector upgrades are under way for RHIC. There are also investments in neutrons, neutrinos, and fundamental symmetries at the Cryogenic Underground Observatory for Rare Events (CUORE), at the Majorana Demonstrator, and in R&D for the Neutron Electric Dipole Moment (nEDM) experiment at the Spallation Neutron Source (SNS).

NP sponsors advances in technology for nucleus science and other disciplines through the Small Business Innovation Research (SBIR) and Small Technology Transfer Innovation Research (STTR) programs.

The FY11 Request allows for Nuclear Physics to continue what it does best, delivering discovery science and forefront advances in technology; providing opportunities and training to advance the next generation of scientists; meeting national needs for production and R&D on rare isotopes for research, medicine, and national security; and developing new research tools that will provide new capability and maintain U.S. leadership. In the out-years the field will face challenges. A unique strength of nuclear science has been the ability to work closely together to ensure compelling research and technical developments. That ability will continue to serve the community well.

Seestrom stated that it is good to see the support for theory topical collaborations as identified in the Long Range Plan.

Stachel asked about the status of funding for the new facility for isotope production. Hallman answered that options for addressing this need were being considered; presently the program is selling its inventory of stable isotopes from storage. It is a challenge that the Office is engaged on, to see how to fund that facility.

Jacobs asked what plans there were for the future of additional topical collaboration in theory. Hallman responded that the Office wants to be prudent in the stewardship of the program and will approach it carefully, especially until it is seen what the available resources will be.

Lister asked if the education funding were shifting to the facilities. Hallman replied that it is not a change in approach but an attempt to make it more apparent and to make available a lot of research experience that young scientists can learn from. The facilities can provide these opportunities.

Konrad Gelbke (MSU) noted that some faculty members were excluded from participation in the Early Career Award Program because they were not on a tenure track and asked if the application requirements could be redefined to allow the selection of non-tenure-track faculty. Linda Blevins replied that the program was open to a broad range of sciences. As a result, there were 1750 applications. Being designated as being on a tenure track was used as a criterion to narrow down the number of applications to be

considered in the selection for early career awards. SC is going through a lessons-learned process now.

A break was declared at 10:27 a.m. The meeting was called back into session at 10:47 a.m. **Hugh Montgomery** was asked to report on the budget effects on the 12 GeV CEBAF Upgrade to the CEBAF at JLab.

The budget effects are favorable. There is an increase of 16.6% over FY10. The scientific objectives are to run the three halls to the greatest extent and to support lattice quantum chromodynamics (QCD). Within some constraints, all of the tasks planned for the 6-GeV program will be completed. Looking forward, one or two experiments require large resources. In 2011, the facility will run 28 weeks. The other 6 months will be used for installation of the 12 GeV CEBAF Upgrade components. The runs in 2011 are in good shape.

Stachel asked whether, if money comes from other sources, those other programs suffer. Montgomery replied that it turns out that, by good management, the klystron burnup has been less than anticipated, so there is an excess of klystron-operation funding. That is the type of situation we find ourselves in.

Steven Vigdor was asked to speak on the budget impacts on RHIC operations. Since FY06, the RHIC budget has improved steadily and vigorously, although it is still running somewhat less than optimally. The run going on now will run 22 weeks. The next one will run 28 to 30 weeks (depending on personnel available for overtime). Run 10 is going very well, and the FY11 budget looks very good. It will have a new ion beam up and running in FY11.

From ARRA funds, RHIC got \$4.0 million for two horizontal stochastic cooling planes, \$4.0 million for two electron lens systems, \$2.25 million to complete MIE funding for PHENIX silicon vertex tracker (VTX) and forward silicon vertex (FVTX) upgrades, about \$1 million to fund radioisotope production R&D for ⁶⁷Cu and ⁸⁶Y, and Brookhaven National Laboratory (BNL) infrastructure maintenance funds.

Improvements are expected from the budget. That will help morale. 172 papers were published by the Solenoidal Tracker at RHIC (STAR) and PHENIX by July 2009. There are still more than 1000 active RHIC users.

Zajc asked if Vigdor could elaborate on new funding for infrastructure. Vigdor replied that DOE's science laboratories infrastructure (SLI) funding allows renovation of buildings. BNL is benefiting from that program, but it also has internal general plant project (GPP) funding.

With respect to the future acceleration of uranium beams, Stachel asked if there were a plan to reduce uncertainties associated with the uranium-uranium interaction volume. Vigdor replied that the Physics Advisory Committee (PAC) recommended that, in Run 11, the uranium beam be conditioned and characterized. Then other tacks will be pursued to investigate the nature of the interactive volume.

Furnstahl asked where the students are ending up. Vigdor answered that most end up in the United States. A way to track that is being set up.

Robert Janssens was asked to comment on the budget effects on the ATLAS facility.

The facility is oversubscribed by a factor of about 2. In FY09, it had 390 users. The HELical Orbit Spectrometer (HELIOS) spectrometer was brought online last year, and it has produced the first experimental results. An energy upgrade of ATLAS was implemented last year. A new cryomodule has been added, producing an increase of a

factor of 3. The Californium Rare Ion Breeder Upgrade (CARIBU) is being brought online this year. The shield cask is ready. One source is ready, and the other will be soon. The facility will be commissioned with one 3-mCi source and in full production by the end of the year. With ARRA funding, an order of magnitude increase in intensity has been produced for stable beams and in-flight rare-ion-breeder beams. The second phase of the upgrade will add a new electron cyclotron resonance (ECR) source and a new cryo region. With the FY11 budget, accelerator operation will increase 3.6%, experimental support 4.8%, and low-energy research 3.5%. Priority will be given to Phase I of the upgrade. Replacement upgrade of accelerator components and new detector initiatives will be delayed.

Konrad Gelbke was asked to review the budget impacts on the NSCL.

A joint NSF-DOE oversight group for NSCL has been formed. The NSCL science thrust is aligned with the Facility for Rare Isotope Beams (FRIB). The facility had a 92% availability in 2009 with more than 830 rare isotope beams being used in experiments. Demand exceeds available beam time by a factor of 2. The amount of beam time is limited by the NSB-approved budget to 4100 hours in FY10. An attempt is being made to leverage MSU and NSF to make re-accelerated beams available. A lot of new equipment is being built and installed. The plan calls for minimal perturbation of the experimental area in the transition from NSCL to FRIB. All MSU funding resources are leveraged to implement new gas stopping, stopped beams, the Reaccelerator 3 (ReA3), ReA3 beamlines, a new cryoplant, and accommodation of the first science campaign of GRETINA [Little GRETA, the Gamma-Ray Energy Tracking Array]. In summary, NSF and DOE are working in a partnering mode. There was a significant reorganization that separated FRIB and NSCL. MSU has made major investments in NSCL that will benefit users. An NSCL site review was conducted by NSF. The current cooperative agreement with NSF expires September 30, 2011. Renewal proposals will be written this year and will request funds for operating the ReA3.

Alan Tatum was asked to review the budget implications on HRIBF, which is funded by DOE NP.

The facility currently has 570 users in nuclear structure and astrophysics and operates 4500 research hours/year. Researchers are investigating such societal applications as wear studies on medical implants. The facility produces 175 radioactive species. It uses the Isotope Separator On-Line (ISOL) radioactive ion beam (RIB) process and conducts ISOL R&D.

FY06 to FY08 were lean years. The operations budget was flat even after that. It had to lay off staff and limit operation hours. The FY09 budget gave some needed relief, and those increases continue. The FY11 budget has an 8.9% increase. Staff are being reinstated, and the facility is moving to 7-day-a-week operation, and reliability is increasing. The facility is operating under an upgrade strategy. The first two phases of that strategy have been completed. These projects are (1) the High-Power Target Laboratory (HPTL), a venue for testing ISOL targets, ion sources, and beam production and purification techniques using high-power Oak Ridge Isochronous Cyclotron (ORIC) beams, and (2) the Injector for Radioactive Ion Species2 (IRIS2), a second RIB production station that is co-located with HPTL and that provides much-needed redundancy and the ability to rapidly switch between RIB campaigns. ORNL has funded utility infrastructure and cooling towers. It is hoped to replace the 50-year old ORIC with

a commercial accelerator (an IBA Cyclone 70). A user workshop was held to make the science case. The facility's base capital equipment funding is about \$1.5 million /year. The facility's base-accelerator-improvement project has been ramped up with NP funds.

Stachel asked how the oversubscription could be alleviated. Tatum replied that the facility has a backlog that will be addressed with a new platform, increasing the number of available hours.

Sherry Yennello was asked to present the NP COV report. The charge called for the Panel to 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. The COV looked at the facilities and research of the national laboratories, the university research program, the 12 GeV CEBAF Upgrade, FRIB, 14 smaller projects, SBIR/STTR, and the isotope program.

The COV congratulated the Office, which manages a broad portfolio, for doing an outstanding job of managing its program. This review opened the eyes of many of the COV members to the huge amount of work that the Office does and how hard-working, dedicated, and knowledgeable the individuals within the Office are.

The recommendations of the COV for improving this already-outstanding Office are:

1. NP should immediately establish a database that can be used to track relevant proposal and grant information, which is needed to assess timelines of proposal actions.
2. NP should develop a written policy to finalize the reports of the laboratory-research-group site reviews within 4 months of the review.
3. NP should prepare a written response to the COV recommendations within 3 months of receiving them from NSAC. This response should contain a plan of action to address the recommendations in the COV report. A "report card" that details the progress on the COV recommendations should be sent to NSAC at the time of charging the next COV.
4. A discussion of workforce development should be required in all proposals. This discussion should include descriptions of the gender and ethnic makeup of the current group and plans that might impact the diversity of the group all levels.
5. NP should improve feedback to PIs on reviews of proposals, including Outstanding Junior Investigator/Early Career Awards and theory topical reviews so PIs could improve future proposals.
6. NP should develop metrics to measure the performance of SBIR projects and proactively work to make the community aware of new technological developments.
7. NP should include ways for program managers to have face-to-face contact with university research groups at least once during a grant cycle.
8. NP should consider making the comparison of university grants across each program to establish, normalize, and monitor research-grant support and performance across program elements.
9. DOE Order 413.3A should be further tailored by NP in its application to smaller, low-risk projects. Prudent reduction in documentation and other requirement on small projects should reduce costs.
10. The AD should be involved in developing and approving the final handoff of a project to scientific operations (CD-4).

11. The regular review of facility operations should be strengthened and formalized at the four national user facilities of NP, expanding the scope of the facility operations element of the annual S&T review process to better address maintenance, budgetary efficiency, and long-term planning.
12. NP should continue to pay close attention to supporting new investigators and new scientific opportunities.
13. NP should establish a mechanism other than the individuals' research grants for funding travel expenses for all members of review panels and for site visits.

Recommendations on the COV process:

1. The COV review material should be made available electronically 2 weeks ahead of the visit, and the COV chair should help determine its contents.
2. The COV chair should solicit comments from the community regarding the operation of NP.

Seestrom thanked the COV and the Office for their hard work in conducting the review.

Gagliardi asked if, in putting diversity in the proposals and tracking that information, that information would become part of annual reports or annual workforce reports.

Henry responded that similar tracking was done for the ECRP and other programs.

Gagliardi asked if, in the face-to-face meetings between PIs and program managers, one program manager could represent all the Office's program managers? Yennello responded that that would vary from case to case. They travel a lot and could incorporate these contacts into their travel plans.

Lister said that he would like to see some additional emphasis on closing cycles, and the timescales presented are confusing. The feedback is beneficial, even 6 months later. Yennello responded that there are some outliers that are *very* delayed and need to be kept on track. The report has some general statements that dilute the important recommendations. The first three are really important and the last two are on the COV process itself. Seestrom asked if making the first three the recommendations and the others "suggestions" would be okay? Yennello said, no; suggestions are embedded in the text.

Zajc noted that sometimes a "formal" request (an e-mail) for feedback has been required and asked if there were some regulation to be followed here. Henry said that he did not know. Yennello replied that the thrust of the recommendation is that people be made aware that feedback is available, not the details of how that feedback is to be accomplished.

Seestrom called attention to the recommendations on closing the loop on scientific and technical reviews and asked if that included the implementation of the review. Yennello said that there was no discussion about the implementation of a review, just the formalization of the process.

A break for lunch was declared at 12:33 p.m. The meeting was called back into session at 1:36 p.m. Seestrom initiated a discussion of the COV report.

Stachel suggested calling the first three recommendations Major Recommendations and stated that the long list could stand some hierarchy. One does not want to jeopardize the good will of the community by requiring too much documentation. There were some things (like timelines for approval) that were done by the COV for the national laboratories that were not done for the universities. She would prefer to see more

parallelism in the treatment. Proposals submitted should be reviewed by a single panel. There is not a similar finding for universities. Stachel continued that some portions of the report should be given more emphasis by putting them up front. Seestrom noted that the major recommendations of the COV appear up front.

McLaughlin noted that there was a lot of discussion by the COV about single panels for university grants. However, there are so many (~200) university proposals, that would be impractical. The COV wanted to allow the Office some flexibility in handling this problem. Seestrom suggested that, if there were a single database, then management would have the information needed to deal with such a problem as this.

Gagliardi and Lister said the diversity information is very important and should be elevated in emphasis. That information should be an evaluative element of the award-selection process. Yennello said that the COV could consider making it a major recommendation. Also, the recommendations could be ordered and delineated by section of the report.

Zajc noted that diversity data have been required by NSF agency-wide. It would be strange to have such requirements to be unique to NP. He asked if some of these recommendations could be taken to a higher level, especially those about frequent reviews with little feedback. It should be noted that these recommendations might be effectively applied elsewhere as well as at NP. Seestrom suggested that that might be noted in a cover letter.

Montgomery asked to whom this was important. Hallman noted that the offices of SC had new instructions from DOE. NP has to respond to the COV report within 30 days and that response has to be reviewed by Pat Dehmer and posted on the web. SC is trying to improve and instill uniformity. Zajc said that he thought that a notation should be made in the cover letter about this issue being applicable to other offices in SC. Yennello replied that some data on the OJI success rate and grant size for regular awards did not raise any red flags about gender bias. The recommendations on timelines was driven by an isolated incident.

Lung noted that there was a specific statement in the text on there being a dedicated operation review vs. including that operational review in the S&T review, but this issue is not mentioned in the recommendations. Yennello replied that adding another burden in the form of an additional review was discussed by the COV, and it did not want to recommend another standalone review. Lung asked if the recommendation could be reworded (e.g., by deleting the second sentence or adding “one way to do this”). Lister called attention to the fact that there is already a large amount of operations review in the S&T review. Yennello stated that the facilities people on the COV wanted a more probing review of operations. Originally, the recommendation was stronger, but consideration of operations data in a specific review countermanded the need for such a strong recommendation. Lung pointed out that, for an S&T review, significant time is devoted to issues other than machine operations. Seestrom suggested inserting a sentence to clarify the nature of operations.

Jacobs noted that the COV has an opportunity to “solicit comments” from the community. The report does not address program management. There is wide variability in the degree of detail that a program manager brings to the job. He asked if there were broad office policies on proper management strategy. Seestrom asked if there were some data or finding on this issue. Yennello replied that there is a comment in the report on

this topic (on p. 13), but it was not raised to the level of a recommendation. Jacobs stated that this is an important issue that should be a recommendation. Seestrom did not believe that recommendations should be added at this point in the process.

The members were polled whether NSAC could support this report if a hierarchy were added to the recommendations, a mention of diversity were included, and the “operations” language were clarified in the transmittal letter.

Gagliardi said that he could live with this report with the mention of diversity in the cover letter.

Lister said that he would like to see diversity made a major recommendation and the major recommendations included in the Executive Summary. Otherwise, yes, the Committee should accept it.

Lung said that the 20 people on this COV had a lot more information than she did, and how they order this information would be fine with her. Her concurrence would depend on changes to the recommendations on operational reviews.

McLaughlin agreed with the report.

Schatz liked the report and believed it would be helpful to the Office.

Seestrom stated that, with the changes suggested, the Committee would accept the report. Yennello said that she would be happy to run those changes past the COV. The recommendation on collecting diversity information is in the new proposals but is not part of the scoring. Talent is needed for the future. Scoring is a way to influence the breadth of the talent pool.

Seestrom suggested letting Yennello run these suggestions past the COV, and one week from now a new version along with a draft of the cover letter would be sent to the Committee members, and an e-mail vote would be taken in the following week.

Seestrom said that she would like to review progress on two long-range plan areas in each NSAC meeting. As part of this process, **Hugh Montgomery** was asked to present an update on the JLab upgrade.

More than 1300 active international users are engaged in exploring quark-gluon structure of matter at JLab today. The superconducting electron accelerator provides 100% duty factor beams of unprecedented quality, with high polarization at energies up to 6 GeV. CEBAF delivers beams with unique properties to three experimental halls simultaneously. Each hall offers complementary capabilities.

The 12-GeV science program is to explore the physical origins of quark confinement (GlueX), provide new and revolutionary access to the spin and flavor structure of the proton and neutron, discover new aspects of the quark structure of nuclei, and probe potential new physics through high-precision tests of the Standard Model.

If one looks at the spectroscopy of hadrons, there are missing states. With the 12-GeV CEBAF, a linearly polarized photon beam, and the GlueX detector, JLab will be uniquely poised to discover these states, map out their spectrum, and measure their properties.

The effect of nucleons on the nucleus is still not understood. The 12 GeV CEBAF Upgrade provides substantially enhanced access to the deeply inelastic scattering regime with enough luminosity to reach the high- Q^2 , high-x region.

If one is to look at the properties of the nucleon, 12 GeV will access the regime ($x > 0.3$), where valence quarks dominate.

During the past 4 years, four reviews of the project have been held. Recently, JLab has been charged to review the proposals that will use the base equipment for the 12-GeV program and to review the proposals that will require major new apparatus. As a result of these reviews, 32 experiments were approved, and 13 were conditionally approved. In the future, the Program Advisory Committees will evaluate and rank the proposals in hand. The Laboratory has chosen to fund the hadron spectra as probes of QCD, the transverse structure of the hadrons, the longitudinal structure of the hadrons, the 3-D structure of the hadrons, hadrons and cold nuclear matter, and low-energy tests of the Standard Model and fundamental symmetries (dosimetry measurements). CEBAF currently has 42 cryomodules. The upgrade will add 10 more cryomodules; the energy will be doubled; a new hall, cryoplant, and counting house will be added; and an arc will be added. The upgrade entails packaging eight cavities into each cryomodule. As a result, the high performance of the 10 new cryomodules will quadruple the gradient. Each cavity has a dedicated microwave source; there are 338 microwave sources in CEBAF today, and the upgrade will add 80 new ones. The existing cryogenics plant will be duplicated.

In Hall A, exciting new experiments in parity violation will be conducted. The 4π detector in Hall B is being modified. In Hall C, the valence quark properties in nucleons and nuclei will be precision determined.

The upgrade will increase the number of halls from three to four. The number of passes through the accelerator to each existing hall will be unchanged. The number of passes through the accelerator to the new hall will be 5.5. The maximum energy to the existing halls will increase to about 11 GeV; the energy to the new hall will be 12 GeV. In Halls A and C, current will decrease from 180 to 85 μA at the higher energy. The central helium liquefier will increase from 4.5 to 9 kW. The number of cryomodules in the linacs will increase from 40 to 51 and the accelerator energy per pass will increase from 1.2 to 2.2 GeV.

CD-0 for this project was granted in March 2004. CD-1 was granted in February 2006. CD-2 was approved in November 2007. And CD-3 (start of construction) was in September 2008. The project is currently about 15 months into a 5.5-year construction period.

The total project cost is dominated by the total in equipment costs of \$287.5 million, or 93.1% of the total project cost. Of the construction costs, the civil construction consists of only 15.5%; the construction costs are dominated by the physics and accelerator systems costs. The ARRA advance funding of \$65 million allowed the acceleration of many procurements. The project is currently one month behind schedule, and costs are on track with 12 months of remaining float. Construction of Hall D and the accelerator are considerably advanced. Hall A will have a commissioning start in October 2013. Hall D will have a commissioning start in April 2014. Halls B and C will have a commissioning start in October 2014. The complete downtime is very limited. This approach has been well received.

The accelerator major procurements are in place for the cryomodule cavities, beam-transport magnets, and helium refrigerator. Accelerator installation has started in the radiofrequency zones, baseplates, stands, and alignment.

Major contracts have been awarded for three superconducting spectrometer magnets and the Hall D Barrel Calorimeter detector construction (at the University of Regina).

Major contracts are in progress for the Hall C horizontal bend spectrometer magnet (at MSU NSCL), for the Hall D central drift chamber (at Carnegie Mellon), the Hall D forward calorimeter (at Indiana University), and the Hall B drift chambers (at Old Dominion and Idaho State).

The physics equipment construction is progressing or in testing. The physics equipment has a strong university user involvement. There are two NSF major research instrumentation (MRI) grants and international contributions and collaborators.

The civil construction on the Hall D complex is progressing.

In summary, the 12-GeV upgrade is an exciting scientific opportunity that will allow exploring the physical origins of quark confinement, new access to the spin and flavor structure of the proton and neutron, discovering the quark structure of nuclei, and probing potential new physics through high-precision tests of the Standard Model. This is a cost-effective plan that re-uses most of an existing facility. There is strong user-community involvement through funding to universities for detector elements and strong international collaborations. Project performance is within DOE thresholds. Construction is well under way. Accelerator commissioning will start May 2013, hall commissioning starts Oct 2013 through Oct 2014, and the project will be complete by June 2015.

Seestrom noted that new cryomodules were being added and asked what was being done with the existing ones? Montgomery replied that there have been improvements made to them continuously. There will be additional upgrades to each of them. Both the gradient and Q value are improved by the upgrades.

Gardner asked him to expand on the dark matter program. Montgomery said that there was a JLab science plan that runs through 2012. There may be a workshop to see how all these projects fit together. If an opening appears in the schedule, it might be possible to slip in a dark-matter experiment. Whatever is approved must be a solid experiment.

Steven Vigdor was asked to give an update on the RHIC-II luminosity upgrade.

RHIC is a versatile collider that uses gold-gold, deuterium-gold, copper-copper, polarized protons, and other collisions. The luminosity has increased substantially in recent years, and exciting new results have emerged.

Some results included the hottest matter ever created in a laboratory, about 250,000 times hotter than the center of the Sun, which is hot enough to melt protons and neutrons, as needed to create a quark-gluon plasma (QGP). The results are consistent with other results, indicating liberated quarks and gluons as the perfect liquid's constituents. Suggestions have been observed that there are bubbles of broken symmetry in the quark soup. The data suggest the event-by-event electric dipole moment (EDM), which is predicted to arise from sphalerons near the QGP phase transition, leading to "bubbles" that locally violate parity (LPV) and charge conjugation-parity (CP). These results are analogous to the B-violating bubbles speculated to occur at the electroweak phase transition in the infant universe. These observations resulted in two press releases at the American Physical Society meeting held during the previous week that generated large worldwide interest.

In central deuteron-gold collisions, STAR sees strong suppression of away-side forward pi-pi correlations. PHENIX sees strong suppression of forward J/psi production. Both effects are predicted signatures of the color glass condensate.

In RHIC Run 9, both STAR and PHENIX see clear W-boson production signals above QCD background from the first 500-GeV p-p collisions. The preliminary cross-section and helicity asymmetry results are consistent with theory, demonstrating RHIC's ability to isolate W production cleanly. There is a lot coming out from all parts of this program.

With enhanced luminosity and detector upgrades, it is expected that rare probe studies of yield and flow of quarkonia (qq systems), sensitive to color screening and parton equilibration/coalescence in the quark-gluon plasma will be seen.

The goals are to:

- Facilitate rare- and multi-particle correlation measurements (i.e., γ + jet to quantify the energy loss transport coefficient, multihadron interactions to study a possible Mach cone, and extracting the speed of sound);
- Improve the experiment–theory comparison of particle-identified (especially heavy-quark) flow to quantify the shear viscosity; and
- Improve measurements at low collision energy to search for the QCD critical point and onset of deconfinement (e.g., the disappearance of jet quenching or of evidence for local parity-violating bubbles).

The Large Hadron Collider (LHC) and RHIC-II heavy-ion results should be complementary and mutually stimulating. A quantitative interpretation of both requires a coherent theory assault. The question is, does matter still behave as an ideal liquid, or does shear viscosity grow from that observed at RHIC?

At time of the Long-Range Plan (LRP), the RHIC-II realization was envisioned via electron cooling, at a cost of about \$95 million (in addition to about \$35 million of detector upgrades). The LRP timeline would have yielded upgraded luminosity by about 2017, hampering the achievement of the science goals. Technological advances at RHIC came to the rescue and changed the view of what RHIC-II is, allowing RHIC-II science without the RHIC-II Project. An R&D program improved the state of the art in low-noise multi-GHz pickups and kickers to achieve stochastic cooling of a high-energy bunched beam for the first time, providing a path to a luminosity upgrade at an order-of-magnitude less cost and about 5 years faster than the electron-cooling plan. Longitudinal stochastic cooling was demonstrated in a 2007 gold-gold run giving about a 15% improvement in the average luminosity. Transverse stochastic cooling was demonstrated in a 2010 gold-gold run. Stochastic cooling works to overcome intrabeam scattering and improve beam lifetime and emittance.

Based on the 2007 results, simulations predicted an order of magnitude improvement in useful collision luminosity. We will have longitudinal and transverse pickup. In this year's run, longitudinal and vertical pickups and kickers were installed in each ring for the 2010 run. Transverse cooling was successfully demonstrated. Vertical systems cool both of the transverse planes via betatron tune coupling. Commissioning issues so far complicate simultaneous operation of all four systems. Blue and yellow horizontal cooling currently under construction with ARRA funds for Run 12 will reduce the transverse cooling time. A 56-MHz superconducting radio frequency (SRF) system is anticipated for Run 13 leading to the full anticipated luminosity gain. Both beams must be cooled simultaneously for optimal luminosity improvement. That is for gold-gold collisions. A proton-proton luminosity limit from the beam-beam tune spread was encountered at 200 GeV in Run 9. A larger dynamic aperture and a less stringent limit at

500 GeV are expected. Electron lenses are being constructed with ARRA funds to compensate for the p-p beam-beam effect via interaction with an about-5-keV electron beam, leading to a factor of about 2 increase in L_{pp} in about 2013. That is a development project right now. At 250 GeV, polarization was limited by Snake resonances. They were mitigated via improved power-supply stability, permitting operation nearer the 2/3 resonance. Further improvements to the source polarization and Alternating Gradient Synchrotron (AGS) polarization loss are under way.

The electron-beam ion source is being upgraded. A new high-brightness high-charge-state pulsed-ion source, ideal for RHIC, is being built with NP and National Aeronautics and Space Administration (NASA) funding. It is on schedule for completion in the fourth quarter of FY10. It will provide uranium-uranium collisions to increase the energy density and to distinguish effects of elliptic flow from effects caused by the ion-ion magnetic field.

Several detector upgrades have been undertaken. PHENIX hadron blind detector is a windowless gas (CF₄) Cerenkov to identify/suppress Dalitz-pair backgrounds. The STAR time-of-flight detector extends particle identification as needed for critical-point searches.

FY09 ARRA funds ensure timely completion of the PHENIX VTX and FVTX upgrades. An updated plan with a sharpened physics focus is being awaited for the PHENIX FOCAL [forward calorimeter]. A successful muon trigger rescoping was completed in FY09.

A detailed 5-year run plan has been developed, and a decadal plan has been charged to PHENIX and STAR to identify needed upgrades to the machine or its detectors. It is expected that RHIC will evolve through the rest of the decade and become the first stage of an electron-ion collider (eRHIC). This would require a \$350 million R&D program to reach the first stage. The STAR Heavy Flavor Tracker received its CD-0 in FY09; CD-1 approval is anticipated soon. The STAR Forward GEM [gas electron multiplier] Tracker was launched as a capital equipment project for Run 12.

In summary, RHIC is on track for order-of-magnitude improvement in full-energy heavy-ion collisions by 2013, attaining intermediate improvements along the way. Independent approaches are being pursued to improve proton-proton collision luminosity and beam polarization on a similar time scale. Many detector upgrades proposed in the decadal plans (circa 2003) for STAR and PHENIX are now in place or under way. A new decadal charge was issued for 2010. Further RHIC detector and machine upgrades need to be integrated with plans for an electron-ion collider. The second-generation measurements at RHIC are yielding significant new physics results and surprises. Together with improved collider and detector performance, this upgrade path promises continuing RHIC vitality through next decade.

Seestrom asked what the significance was of the global parity violations. Vigdor replied that it is interpreted as a change in the vacuum of the gluon field with localized parity violations. It has not been observed directly. If this interpretation is correct, it would open a way to test it in the laboratory.

Gardner noted that not even in the central rapidity region does one have a measure of good charge-parity, so charge separation by itself is not a robust signature of charge-parity violation, and asked how one rules out all of the conventional mechanisms that could mimic this effect? Vigdor replied that the observable is a parity. A series of future

measurements is planned. If a parity-odd violation were observed, that would be more informative. There will be a theory workshop on this at BNL in April.

The floor was opened to public comment. There being none, the meeting was adjourned at 3:38 p.m.

These minutes of the Nuclear Science Advisory Committee held at the Marriott Bethesda North Hotel & Conference Center, Bethesda, Maryland, on February 26, 2010 are certified to be an accurate representation of what occurred.



Susan J. Seestrom
Chair, Nuclear Science Advisory Committee