Minutes
Department of Energy and National Science Foundation
Nuclear Science Advisory Committee
Holiday Inn National Airport Hotel, Arlington, Va.
December 8, 2010

Members Participating:

Susan Seestrom, Chair
Robert Atcher
Vince Cianciolo
Gail Dodge
Richard Furnstahl
Carl Gagliardi
Peter Jacobs
Silvia Jurisson
David Kaplan
Dmitri Kharzeev
Joshua Klein
Christopher Lister
Allison Lung
Gail McLaughlin
Curtis Meyer
Hendrik Schatz
William Zajc

Members Absent:

Susan Gardner
Johanna Stachel

Others Participating:

Joseph Dehmer
Jehanne Gillo
Geoffrey Greene
Timothy Hallman
Eugene Henry
Bradley Keister
Robert Redwine
Steven Vigdor

Presenters in Order of Appearance:

Joseph Dehmer
Timothy Hallman
Bradley Keister
Timothy Hallman
Thomas Glasmacher

About 15 others were in attendance during the course of the meeting.

Morning Session

The meeting was called to order by the Chair, **Susan Seestrom**, at 9:29 a.m. She asked **Joseph Dehmer** to present an update on the activities of the NSF's Mathematics and Physical Sciences Directorate (MSP).

The nuclear physics community has been a driver in the Deep Underground Science and Engineering Laboratory (DUSEL) program, especially the NSAC Long-Range Plan. The Office of Nuclear Physics (NP) was working on the Rare Isotope Accelerator (RIA), and the Office of High Energy Physics (HEP) was working on the International Linear Collider (ILC), and it was not known what would come to fruition. To date, NSF, DOE, the State of South Dakota, and private citizens have spent $300 million on planning and research. The preliminary design report (PDR) was to be finished this month, but it is delayed 2 to 4 months. The mine has been pumped out, improvements have been made, and early science has been conducted. About 90 employees are in place. The Particle Physics Project Prioritization Panel (P5) was asked for a long-term plan for HEP. P5 pointed out that there were the energy, intensity, and cosmic frontiers and recommended funding to be distributed across these frontiers. NSF, NP, and HEP have made up a partnership to steward

the DUSEL program to distribute costs and management responsibilities. There are about 1000 people involved in planning research activities. NSF recommended a bridge award to review the PDR, to design adjustments, etc. The week before this meeting, the National Science Board (NSB) disapproved the bridge award. The science program was of the highest quality, but the stewardship structure was not acceptable; it exposed NSF to too much risk. This failure to receive approval is not a good thing, but it is not the end of time or DUSEL. Both agencies are actively figuring out a path forward. The stakeholders were surprised. The early science program is of interest to NSF. The National Research Council (NRC) panel will review DUSEL starting the week after this meeting. That panel will weigh in on the multidisciplinary aspects of the program.

The NSF does not have an FY11 budget. The House and Senate markups would include a 7% increase, but a year-long continuing resolution is more likely than an omnibus funding bill. The agency needs to figure out how to get through FY11 with minimum damage.

Klein asked if NSAC should make a statement about the science. Dehmer replied that NSAC advises the agencies and that he does not advise NSAC.

Jacobs asked why this decision was made now. Dehmer answered that everyone expected an award of $19 million through FY11; this denial was a big surprise. The NSB acted when it was scheduled to act.

Seestrom asked if the details of the decision provided by the NSB were sufficient to develop a new stewardship plan. Dehmer responded that, for one to see how costs and risks are distributed, one has to look at a memorandum of understanding (MOU) that the NSB had not seen. The agencies could come back with a model that would satisfy the NSB, but DOE would have to take on all the risk.

Vigdor asked about the time pressures (e.g., the installation of the Majorana Demonstrator). Dehmer answered that there are a lot of stakeholders, and the timing is bad. South Dakota put the majority of money into the early science.

Meyer asked what the timeline would be if one went back to the NSB. Dehmer pointed out that the NSB meets once every six months, so going back to it would take that long, and the program would be irretrievable. Not enough is known at this point to be able to say anything about the path forward.

Timothy Hallman was asked to give an update on the NP program.

Several scientific advances have occurred in nuclear science:

- Lead–lead collisions at 2.76 TeV per nucleon pair have opened a new science horizon at the Large Hadron Collider (LHC).
- Two-particle correlations were observed in the Compact Muon Spectrometer (CMS) detector at the LHC, confirming results from the Relativistic Heavy Ion Collider (RHIC).
- A new element with atomic number 117 has been discovered. In addition, six new isotopes were discovered at LBNL with atomic numbers ranging from 104 to 114, zeroing in on a possible island of stability.
- The Holifield Radioactive Ion Beam Facility (HRIBF) discovered a new doubly magic nucleus, tin-132.
- Rubidium-82 is most widely used radionuclide for positron emission tomography (PET) assessment of the heart muscle, but because of its 1.26-minute half-life, it must be obtained locally by extraction from a strontium-82–rubidium-82 generator. The question of how much strontium-82 was needed to extract a given amount of rubidium-82 was determined by measuring the number of the 776.5-keV gamma rays arising from the beta decay of rubidium-82 to stable krypton-82 per 100 decays of strontium-82. Oak Ridge National Laboratory (ORNL) found that there were 14.93 gamma rays for every 100 decays of strontium-82 in the generator.

- Graphic processing units (GPUs) were successfully used as "afterburners" in lattice quantum chromodynamics (LQCD) calculations at Jefferson Lab.
- A linear correlation was found in quark distribution in dense nuclei, consistent with the local-density European Muon Collaboration (EMC) effect seen in light nuclei.
- The universal nuclear energy density functional has a new model of nuclear excitation and has calculated a 17-body quantum state in fluorine-17 that involves a proton halo.
- A new, state-of-the-art cryomodule for ATLAS [Argonne Tandem Linear Accelerator System] has several innovative features: a separate cavity vacuum, canceled beam steering effects, low-particulate cavities surfaces, and higher accelerating fields and cavity voltages.
- 100-MeV gamma rays have been produced at the High Intensity Gamma Ray Source.
- A new electron beam ion source has been completed on time and on schedule at RHIC.
- Excellent progress has been made on the 12-GeV CEBAF Upgrade construction at Jefferson Lab.
- CARIBU [Californium Rare Ion Breeder Upgrade] has been commissioned with a 100-mCi source.
- New research has been conducted on alpha-emitting radioisotopes.
- The Facility for Rare Isotope Beams (FRIB) attained Critical Decision 1 (CD1) in September 2010, and steady progress is being made toward CD2.

A funding opportunity announcement (FOA) for nuclear science and technology will be released this year. There was American Recovery and Reinvestment Act (ARRA) funding of $19.4 million in FY 09, but this additional funding is not available in FY 10, which limits the research that could be funded.

In the isotope program, all three isotope production/processing capabilities within the program have been peer-reviewed for performance. There will be a new solicitation for isotope R&D coming out in December. A solicitation for new isotope production at existing and new sites will be coming out in early CY11. The issuance of a new solicitation for letters of interest for commercial partnerships and a dedicated isotope facility is planned for early CY11. A joint NP– National Nuclear Security Administration (NNSA) review of re-establishing americium-241 production in the United States has been completed.

The FY11 congressional request has not changed; it calls for a 5% increase, which is influenced by construction. The House mark called for a reduction of $8 million in the NP request. The Senate mark called for a reduction of $23.4 million but contains language for the addition of the Office of Biological and Environmental Research (BER) medical imaging program. The Office of Science (SC) was not going to push back on this issue. There was now a continuing resolution until December 18 currently in place. It was not known what will come in terms of an appropriation. As a result of funding constraints, a number of rare isotope beam (RIB) science initiatives have been declined. The FY12 budget was in the hands of the Office of Management and Budget (OMB); passback was expected later during the week of this meeting. The Early Career Research Program applications closed November 9; there are about 1150 applications currently undergoing merit review by SC offices; notification of awards is anticipated in March 2011. The solicitation for FY11 graduate fellows was on hold pending budget outcomes, but a solicitation was anticipated soon; the FY10 size of the program was under consideration. SC is assessing recent news on DUSEL and what the various options may be. There is a great awareness of the time pressures from the Majorana Demonstrator and the Large Underground Xenon (LUX) detector.

The Office of Workforce Development has announced that the National Nuclear Science Week will be held January 24-28.

National user facilities have gone to biennial science and technology reviews. The review process is being streamlined Office-wide.

John Pantaleo has retired from the Office of Nuclear Physics. The Office expects to hire a deputy/program manager in 2011. The National Isotope Development Center has appointed a new lead for the isotope business office at ORNL. In NP, a new program manager for National User Facilities, a program manager for Isotope Facilities, and a program manager for Nuclear Data and Computing have been named. Detailee and Intergovernmental Personnel Act (IPA) positions are open.

Nuclear science continues to deliver discovery science and forefront advances in technology. The community has to articulate the value of nuclear science and the importance of fundamental research to the country.

Klein asked what happened to the money that used to fund the nuclear imaging activities. Hallman responded that it was carried over to NP.

Cianciolo asked how many Early Career Award applications were funded. Hallman answered that there were about 1150 applications. Henry added that about 15% of those submitted to NP were funded.

Zajc asked if the commercial isotope production part would be funded out of NP. Hallman replied that it would be a partnership administered out of NP. Zajc asked if there were other such partnerships. Henry replied that there may be at the research centers, but he could not think of any. Seestrom said that there may be some at the applied-technology offices.

Lister asked what had happened to take away the pushback from SC to the nuclear imaging transfer from the BER to NP. Hallman responded that this instruction had come from the Senate for 2 years running. There is a sense that this is a healthy step to take for all involved. Gagliardi noted that that was in the Senate mark to the FY11 budget but not in the House mark. Under the continuing resolution, that move would not be made. Hallman pointed out that, in Washington, anything can happen.

Klein asked what progress was being made in getting grants through the Chicago Office of DOE. Hallman answered that the Chicago Office has been clearing its backlog and there are no added ARRA funds this year. There is a good working relationship between NP and the Chicago Office. Henry added that the Chicago Office cleared all actions by the end of the fiscal year. This year, they are delayed by the uncertainty of the budget. All NP proposals were approved by early November, exhausting the first continuing-resolution appropriations. The next batch of proposals is smaller and the Office will continue to fall behind in processing the grants. The Office's grants are front loaded, exacerbating the problem. The Office will continue to fall behind as long as there are continuing resolutions.

Furnstahl asked if the FY11 Graduate Fellowship solicitation would be canceled. Hallman said that that is possible, but there is great support in SC for this program.

Jacobs asked what the significance of the House and Senate marks was for the radioactive ion beam research program. Hallman stated that construction will not be affected, but instrumentation may be affected. That program has a history: it was $50 billion and then reduced to $32 million. There is now a picture in which funding may not be prudent.

Redwine asked if there were anything new on molybdenum-99. Gillo replied that NNSA had a new solicitation this past summer for accelerator-based production. An industrial production method is to be set up by 2013. Through international cooperation, the supply is being maintained.

Bradley Keister was asked to update the Committee on the NSF Nuclear Physics Program outlook. Nuclear Physics funds nuclear physics experiment and theory, particle and nuclear astrophysics, the Physics Frontier Centers, and the National Superconducting Cyclotron Laboratory (NSCL).

FY10 is now closed; nuclear physics experiments got an increase of 4.3%, nuclear physics theory got an increase of 9.2%, and particle and nuclear astrophysics got an increase of 5%. Three-year awards made with ARRA funds will al expire in FY12.

The Physics Frontier Centers have a triennial solicitation; half of the existing centers have to re-compete this year. Cyber-Enabled Discovery and Innovation (CDI) is in its last year of solicitations. Major Research Instrumentation (MRI) had one award last year; a new solicitation's deadline is coming up in January.

A continuing resolution provides a prorated amount of money based on the previous year's funding. The House and Senate marks were close to the President's request. In the Physics Division, there is a 2.8% increase with an 11% increase for research [principal investigator (PI) grants].

There are two new pieces of information required by NSF to be included in proposals: a postdoctoral mentoring plan and a data-management plan, implementing the data-sharing policy, effective January 18. The data-management plan can be up to two pages in length. Both requirements will be evaluated in the merit-review process.

There is a new NSF director (Subra Suresh). Edward Seidel is now the Assistant Director of MPS.

Lister asked if there were any sense of what merit-review panels will be looking for in database-management plans and/or what the drivers were for such a requirement. Keister replied that one issue is in climate change: various agencies' data sets were not interoperable. Also, there should be transparency in taxpayer-funded research. For NSF, the key element is the use of merit review rather than agency prescriptions to evaluate data management plans. Many collaborations and some individuals already have relevant plans. For example, individual PIs should state how requests for data would be responded to.

A break was declared at 10:55 a.m. The meeting was called back into session at 11:06 a.m. Seestrom pointed out that, in considering charges, anyone with any potential conflict of interest should recuse himself or herself. She recused herself from the discussions of the forthcoming charge. Hallman announced that Jacobs would be the Acting Chair during the discussion of the new charge to the Committee.

Timothy Hallman was asked to present the new charge to the Committee from SC and NSF.

Both DOE and NSF have programs in fundamental physics with neutrons (about 2% of the NP budget). The two agencies contribute to the joint fabrication of apparatus for several ongoing and planned experiments. DOE- and NSF-supported researchers collaborate on experiments and plan for future experiments.

Neutron-decay correlation coefficients a and A provide the best measurement of g_A, one of the fundamental coupling constants of the Standard Model, and the neutron lifetime directly enters into the verification of Big Bang nucleosynthesis. Together, g_A and the neutron lifetime determine V_{ud}, which enters into verification of the unitarity of the Cabibbo-Kobayashi-Maskawa (CKM) matrix to test the Standard Model. Precision measurements of the hadronic parity-violating processes provide a window into strangeness-conserving interactions between quarks.

In the neutron electric dipole moment (nEDM), a tighter limit provides clues regarding charge-parity (CP) violation and the baryogenesis origin of the dominance of matter over antimatter. In addition, the nEDM constrains extensions of the Standard Model. The best limit to the nEDM has improved steadily over the years. The allowed region for baryogenesis determines the matter-antimatter asymmetry.

A charge was made to NSAC in 2003 to look at opportunities and priorities in neutron science, and NSAC studied the compelling and fundamental nature of the science. Interest was exhibited by the nuclear science community, and there were existing/developing capabilities at the Los Alamos Neutron Science Center (LANSCE) and the National Institute of Standards and Technology (NIST). It was desired that the United States have a strong presence in this important area of research. Experiments were in progress or being developed to measure the neutron lifetime, A, etc.; and the Spallation Neutron Source (SNS), which could provide unique (intense and pulsed) beams of neutrons, was under construction. The NSAC report said that the United States had an active neutron program, nEDM had the highest discovery potential, a cold-neutron beamline should be

constructed at the SNS as a capability for a broad neutron physics program, and the theory effort in this area should be increased.

These recommendations were taken seriously through

- Increased funding for fundamental neutron physics research in the United States;
- Continued measurements at the Ultra-Cold Neutron Asymmetry (UCNA) experiment at LANSCE, which have resulted in a new precision measurement of the asymmetry parameter A, moving closer to resolving a large discrepancy between previous measurements;
- Construction of the Fundamental Neutron Physics Beamline (FNPB) for research with cold and ultracold neutrons at the SNS; and
- Initiation of the n + p —> d + γ experiment for precise determination of A_g.

Investments were made in R&D for the next-generation neutron EDM experiment at FNPB and in collaborative research with neutrons that was jointly supported by NSF.

Measurement of the beta-asymmetry parameter has improved with time with UCNA at LANSCE now pegging it at -0.1175 ± 0.0011. The UCNA experiment is now poised to significantly improve its recent result during the present LANSCE run.

The low-energy parity-violating (PV) potential contains coupling constants for meson exchange. The weak interactions in strongly interacting systems are not well understood. The n + p —> d + γ experiment will show if the up/down gamma rates differ, violating parity; and this experiment will measure cleanly one of the seven weak PV coupling constants. This experiment was developed and commissioned at LANSCE. The experiment has moved to the SNS, and the main components have been installed on the cold neutron beamline at the Fundamental Neutron Physics Beamline.

An important program on the neutron's half-life is being conducted at NIST. It is looking at hadronic parity violation with neutron spin rotation in liquid helium, the radiative decay mode of the neutron, the neutron lifetime, the fundamental decay of the neutron, and the measurement of the a parameter. NIST will increase the footprint of the neutron science experimental area by a factor of 2.

The U.S. capabilities include the SNS/FNPB, NIST (upgrade in progress), and LANSCE; the major international capabilities are carried out at the Institut Laue-Langevin, Paul Scherrer Institut, and TRIUMF/JPARC [the TRI-University Meson Facility/ Japan Proton Accelerator Research Complex] (under development). The U.S. science program is focusing on neutron properties, parity-violating hadronic interactions, and neutron electric dipole moment. Precision experiments are high-risk, high-discovery-payoff efforts. There is complementarity of these methods and approaches. The best U.S. and international expected limits for nEDM are similar. Early phases of international nEDM experiments are operating or about to begin. The U.S. nEDM experiment uses a unique co-magnetometer technique to control systematic errors. The SNS uses a pulsed proton beam, with different experimental conditions than (quasi-) steady-state neutron sources.

Some very important questions that make a difference in our understanding of fundamental physics and that could be answered in this decade are to improve the precision of decay asymmetry parameters to better determine g_A and to test the Standard Model, trying to measure A to 0.5%, a to 0.1%, the neutron lifetime to <1 s, and n + p —> d + γ and to conduct follow-up measurements of hadronic parity-violation interaction parameters. The goal of the nEDM experiment is about 10^{-28} e-cm. The FNPB cold neutron beam project is under new management, and critical R&D is under way. A rigorous effort is being made to understand costs, and the impact on the rest of the neutron program is being investigated.

The Neutron Charge Letter asks NSAC to

- Review and evaluate the current and proposed research program, scientific capabilities, and opportunities for fundamental nuclear physics with neutrons and to make recommendations of priorities consistent with projected resources;

- Identify the most compelling scientific opportunities and the infrastructure and effort required to address them within the context of the scientific efforts and capabilities in the United States and elsewhere;
- Establish priorities within a constant-effort budget and recommend priorities for incremental investments beyond this level;
- Assess the current scientific and technical workforce committed to these activities and the incremental workforce needed for further investments;
- Provide guidance regarding the appropriate mix of facility operations, research, and investments in instrumentation to optimally exploit these opportunities; and
- Provide an interim report by June 1, 2011.

Keister pointed out that this was a joint charge. 10% of the PI programs are funded by NSF. There has been a growth in the community on the NSF side. There is a wealth of opportunities, all carrying high risk. The charge was developed in close cooperation between DOE and NSF.

Zajc asked what the NSAC participation would be in the Subcommittee. Hallman said that there would be some NSAC members and some nonmembers on the Subcommittee.

Lung asked what the timescale for the development of the recommendations would be (e.g., a 5-year outlook). Hallman replied, yes, 5 years.

Jacobs noted that the fourth recommendation of the 2003 report called for increases in theory funding and asked what had happened. Henry said that the increase has been modest. Several theory groups and one new theory PI have been supported. As experimental results come in at a measured pace, those results will interest theorists in working on the topic. Kaplan pointed out that DOE's Institute for Nuclear Theory (INT) also supports theory. Greene asked what the "current level of funding" referred to. Hallman replied that it refers to the current level of funding in neutron science.

Jacobs asked for additional comment on funding scenarios. The Subcommittee will want to understand the opportunities of the program and, if additional funding were available, what the priorities would be. He noted that the Subcommittee is being set up and input would be welcome.

A break for lunch was declared at 11:43 a.m.

Afternoon Session

The meeting was called back into session at 1:00 p.m. Seestrom underscored the importance of the advice and oversight provided by advisory committees like NSAC. Henry and Keister presented certificates of appreciation to the members of the Committee whose terms were coming to a close: Vince Cianciolo, Silvia Jurisson, Christopher Lister, Gail McLaughlin, Hendrik Schatz, William Zajc, and Johanna Stachel (not present). Hallman also recognized the value of the input from the Committee and the work put in by the Committee members.

Thomas Glasmacher was asked to update the Committee on the progress of the Facility for Rare Isotope Beams (FRIB) Project.

The 2007 Long-Range Plan recommended the construction of FRIB, a world-leading facility for the study of nuclear structure, reactions, and astrophysics. That Plan poses a number of fundamental questions that the field of nuclear science should address; FRIB is needed to answer all of those questions:

- What is the nature of the nuclear force that binds protons and neutrons? The goal of FRIB is to develop a predictive theory of atomic nuclei.
- What is the origin of simple patterns in complex nuclei? The answer to this question requires access to a broad range of the nuclear chart to produce key nuclides.

- What is the nature of neutron stars and dense nuclear matter? FRIB will allow the study of all proton and alpha capture reactions needed to model the surface regions and interpret X-ray-burst light curves and other astrophysical applications.
- What are the nuclear reactions that drive stars and stellar explosions? FRIB will allow the exploration of the weak-interaction rates needed to model pre-supernovae core evolution and type Ia explosions.

Another Long-Range Plan theme is the need for tests of nature's fundamental symmetries. Certain isotopes can be made at FRIB, and their electric dipole moments can be measured.

The National Research Council (NRC) report said that nuclear structure and nuclear astrophysics constitute a vital component of the nuclear science portfolio in the United States. That NRC committee recognized the value on a U.S. FRIB as one element of a much broader portfolio in the physical sciences.

The community has developed science drivers, key measures that need to be made.

Michigan State University (MSU) was chosen to construct and operate FRIB. It is a large institution with 11,000 employees, 46,000 students, 36 square miles of property, and $1.8 billion in annual revenue. Experimental nuclear physics has a long history at MSU from the 1950s, all funded by NSF until 2008 when DOE contributed funding for the FRIB. MSU is not a DOE facility. The government makes a large investment and gets a significant involvement in the programmatic interests. DOE management principles are followed, as are state, Nuclear Regulatory Commission, and Environmental Protection Agency regulations. Oversight is provided by DOE-SC-NP as well as by MSU.

FRIB will need to accelerate ions to ≥200 MeV/u with fast heavy-ion beams combined with gas stopping and reacceleration so scientists can do world-class scientific research at the start of operations. It will accommodate 100 users at a time, 400 to 500 per year.

CD-1 for the preferred alternative was approved on September 1, 2010. The total project cost is $614.5 million with $520 million from DOE and $94.5 million from MSU. CD-4 is expected in the second quarter of FY20 with an early finish goal in the fourth quarter of FY18. The design is the lowest-cost configuration that meets the FRIB key performance requirements; it is upgradable to 400 MeV, and one can add Isotope Separation On Line (ISOL), a light-ion driver, and multiuser capabilities. The CD-1 design maintains key performance requirements: driver beams with ≥200 MeV/u; rare isotope production; ready for world-class science program on Day 1; and upgradable for a doubling of the experimental areas, driver beam energy increase to ≥400 MeV/u, ISOL capability, and multiuser capability by addition of light ion injector.

The risks identified and mitigation developed include the current economic situation. There are plans proposed to reduce risks, expedite implementation, early acquisition of the cryofacility, and an acquisition strategy for cryomodules. R&D plans are proposed to reduce technical risks on accelerator systems and experimental systems.

Collaborations are being encouraged to develop early science opportunities with fast, stopped, and reaccelerated beams during commissioning. An experienced DOE-MSU FRIB Project Team has been assembled. It has external project and science advisory groups and external peer advisory groups for project management, accelerator systems, experimental systems, and ad hoc safety and civil construction topics/issues. Work for other agreements and MOUs are in place with Argonne National Laboratory, Brookhaven National Laboratory, Lawrence Berkeley National Laboratory, Oak Ridge National Laboratory, Jefferson Laboratory, Stanford National Accelerator Laboratory, Sandia National Laboratories, Soreq(Israel), RIKEN (Rikagaku Kenkyusho, Japan), GSI (Gesellschaft für Schwerionenforschung, Germany), GANIL (Grand Accélérateur National d'Ions Lourds, France), TRIUMF (Canada), and Laboratori Nazionali de Legnaro (Italy). CD1 is expected by 2010, CD2 by 2012, CD3 by 2015, and CD4 by 2020.

The cryogenic plant, earth retention systems, tunnel, and electron cyclotron resonance (ECR) building have to come together and form the critical path. The performance baseline is based on

performing civil construction early on, making implementation more manageable. However, that means that technical requirements have to be tied down. In FY11, the key activities that must be completed are technical R&D on the superconducting radio frequency (SRF) cryomodule assembly, prototype target, lithium-stripper, plasma stripper, and gas stopper.

There has been strong MSU support for the FRIB project with a $94.5 million cost share plus $212 million in contributions plus $6.3 million in FY10 for site preparation and $5.5 million in FY11 for the low-energy experimental area expansion.

The FRIB users are highly engaged with more than 800 registered users from 55 countries holding workshops and symposia.

In summary, the project is on track for CD-2 (possibly CD-2/3A) in 2012, and the FRIB team is highly energized and motivated for success. The integrated cost and funding profiles have been developed collaboratively with DOE-NP for a conceptual design total project cost of $614.5 million and project completion in 2020 and early completion in 2018. There are effective working relationships in place with DOE-NP, the federal project director, the project advisor, MSU senior administration, and MSU support organizations. The project is being managed to allow early completion.

Lung asked if the MOU were working well. Glasmacher replied, yes.

Jacobs asked what it meant to say that there were 100 users at one time. Glasmacher said that one has 30 users setting up, 30 running experiments, and 30 concluding their activities at any given time. It costs $15,000 per hour to run the facility. Because of economics, one needs to do as much as possible at one time. Each experiment averages about one week.

McLaughlin asked if there were any bridge arrangements being made for theory. Glasmacher replied that the theorists have written a long-range plan but that it would need to be funded by NSF or DOE.

Zajc asked how many weeks the facility will run. Glasmacher answered that it would run 5000 to 6000 hours per year.

Gagliardi asked what plans were being made by the agencies for a theory effort. Glasmacher replied that there needs to be a theory effort, but planning has not evolved to that point, yet. The managers are keeping their eyes on it. Keister added that every such facility needs a research theory group and a theory initiative that have their own lives. How one funds the latter is not known. The two agencies have not discussed it. It is a separate issue from the laboratory.

Lister asked if anyone had thought about the cost of an ISOL being built now. Glasmacher responded that the advisory committee said that one could not run the program and build the ISOL, too. Two buildings were seen to be the best path forward. An area is being left clear for an ISOL building. The target would be $40 to $50 million.

Lister asked what it would cost to put ReA12 back in the program. Glasmacher answered, about $6 million. MSU picks up the hall, and NSF and DOE put in $0.5 million and $2 million, respectively. Funding has been requested from NSF. They have been supportive. One needs to see what contingencies will come to pass.

Lister asked what plans there were for agency support for equipment. Jacobs said that detectors are about 10% of the facility cost, and that needs to be coordinated with the rest of the project and should be added as soon as possible. Seestrom said that there is a lot of equipment there at the NSCL that may be used by the FRIB. Glasmacher agreed that, for the fast beam, the equipment is there. For the re-accelerator and recoil beams, there may be a need in the project that will need to be planned for.

Kharzeev asked if any international partners would be interested in providing equipment. Glasmacher responded that requests had gone out but no solid offers have been made, as yet. Hallman said that the strategy is to use existing NSCL and GRETINA (Little GRETA, the Gamma-Ray Energy Tracking Array) equipment to begin with. Additional equipment may be seen to be needed and can be requested and added at a later date.

A break was declared at 2:07 p.m. The meeting was called back into session at 2:21 p.m. Jacobs, as Acting Chair, called the meeting to order to discuss the new charge. Klein asked about the scope of the discussion. Jacobs said that the Subcommittee will be formed; broad guidance on the terms of the charge could be sought, and clarification of the scope of the investigation could be asked for. There is one big project (nEDM) and a lot of small ones; evaluations and prioritization are needed.

Lung asked if follow-on discussions would be held on costing or whether the Subcommittee is supposed to do that. Jacobs could not see the Subcommittee doing the costing; rather, it should be looking at the science, risks, and general costs and schedules. The primary information would have to come from the projects, and the Subcommittee would have to have the expertise to evaluate that information.

Cianciolo asked about the timescale for the Subcommittee's activities. Jacob said that a Subcommittee chair is needed first and then a Subcommittee membership. The Subcommittee would probably need three meetings, meeting every 2 months, starting in late January or February. The reports should be submitted to NSAC for approval by June 1. There will be a summer NSAC meeting.

Zajc asked if it were normal to make reference to the Long-Range Plan in charges like this. Jacobs said that it simply states what the Long-Range Plan calls for. Zajc noted that there is a prioritization involved that improves the targeting of the Long-Range Plan. Jacobs did not see any conflict there.

There being no further discussion, Seestrom resumed the Chair. She called for other business.

Atcher said that the Council on Radioisotopes and Radiopharmaceuticals appreciated being able to participate in the review at Los Alamos Scientific Laboratory (LASL) on americium production. He asked

- If there will be any further activities by the Radioisotope Subcommittee and any follow-up of the NSAC radioisotope report;
- Why there was not a voting member of NSAC representing the radioisotope community; and
- Whether there could be another isotope utilization and production workshop in the near future.

Hallman said that the Radioisotope Subcommittee was a standing subcommittee that could be asked for more guidance in the future. A member from the radioisotope community on NSAC would be an interesting idea. Getting all the stakeholders together may be a good thing to do. He would look into it.

Klein asked if NSAC should make a statement on DUSEL. Seestrom said that NSAC usually responds to charges from the agencies. Anyone can share the relative priorities of the Long-Range Plan with the pertinent people. Several chairs of DOE advisory committees sent DOE a letter on the graduate fellowships. She pointed out that the next meeting NSAC is likely to be during the first two weeks of March.

The floor was opened to public comment. Vigdor stated that the future of DUSEL is a major interest to many communities. He asked how these multiple communities could be brought together. Hallman replied that, in SC, there has been some information sharing among the offices, but they are still trying to understand the options involved. Keister pointed out that there is a DUSEL joint operating group (JOG) meeting coming up, and that question may be addressed there. Hallman noted that, when important issues arise, private citizens have gotten together and submitted letters to agencies and Congress. Seestrom pointed out that, if budgets are tight, joint projects may become the rule.

Zajc asked what the best way was to address a concern to the agencies. A response to a charge is one way. How best to handle the DUSEL concern needs to be determined. Hallman said that the fine tuning of the Long-Range Plan with the neutron charge is different from the DUSEL issue; there, DOE and NSF were forging a new way of doing business with shared risks and responsibilities. The

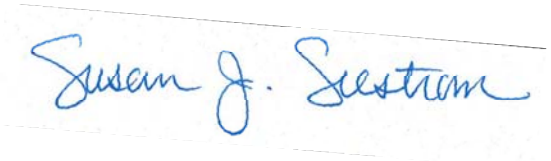
agencies thought that they were making good progress in that direction and hope that they can continue to make such progress.

Seestrom asked if there were other plans for improving the Long-Range Plan and how that work was going to be done. Hallman responded that the Office has not discussed or made plans for another charge in low energy. DUSEL and the neutron charge are two very different issues. Majorana has a backup plan: the Sudbury Neutrino Observatory. Majorana research will not be affected by a slowdown of DUSEL. Gillo commented that it would be a shame if the community got the wrong impression about how the agencies view the two programs. A lot of advances have been made since the Long-Range Plan was drawn up. The agencies will want to make sure that they are going in the right direction. The charge should not be looked at negatively. Jacobs agreed. The neutron-science community should look at this charge as a positive opportunity to look at future possibilities. Zajc noted that only those in the room at this meeting would be aware of the nuances of the discussions about the charge and about DUSEL; others will only see a charge issued for one topic and none for the other.

There being no further business, the meeting was adjourned at 3 p.m.

These minutes of the Nuclear Science Advisory Committee held at the Holiday Inn National Airport Hotel, Arlington, Virginia, on December 8, 2010, are certified to be an accurate representation of what occurred.

Respectfully submitted,



Susan J. Seestrom
Chair, Nuclear Science Advisory Committee