Draft Minutes
High Energy Physics Advisory Panel
March 12–13, 2012
Palomar Hotel, Washington DC

HEPAP members present:

Daniel Akerib
Edward Blucher
Karen Byrum
Andrew Cohen
Eric Colby
Mirjam Cvetic
Robin Erbacher
Bonnie Fleming
Murdoch Gilchriese
Douglas Glenzinski
Donald Hartill
John Hobbs
Andrew Lankford, Chair
Klaus Honscheid
Patricia McBride
Lia Merminga
Regina Rameika
Pierre Ramond
Leslie Rosenberg
Paul Steinhardt
Hitoshi Yamamoto

HEPAP members absent:

Ursula Bassler
Peter Fisher
Ian Shipsey

Also participating:

William Brinkman, Director, Office of Science, USDOE
Glen Crawford, Director, Research and Technology Division, Office of High Energy Physics, Office of Science, USDOE
Joseph Dehmer, Director, Division of Physics, National Science Foundation
Patricia Dehmer, Deputy Director, Office of Science, USDOE
Robert Diebold, Principal, Diebold Consulting
Marvin Goldberg, Program Director, Division of Physics, National Science Foundation
Wayne Gordon, Attorney-Adviser, Office of the General Counsel, USDOE
Michael Harrison, Physics Department, Brookhaven National Laboratory
JoAnne Hewett, SLAC National Accelerator Laboratory, Stanford University
Norbert Holtkamp, Associate Laboratory Director, SLAC National Accelerator Laboratory, Stanford University
Young-Kee Kim, Deputy Director, Fermi National Accelerator Laboratory
John Kogut, HEPAP Executive Secretary and Deputy HEPAP Designated Federal Officer, Office of High Energy Physics, Office of Science, USDOE
Jonathan Kotcher, Division of Physics, National Science Foundation
Kevin Lesko, Nuclear Science Division, Lawrence Berkeley National Laboratory
Joseph Lykken, Theoretical Physics Department. Fermi National Accelerator Laboratory
Marsha Marsden, Oak Ridge Institute for Science and Education
Piermaria Oddone, Director, Fermi National Accelerator Laboratory
Frederick O'Hara, HEPAP Recording Secretary, Oak Ridge Institute for Science and Education
Michael Procario, Director, Facilities Division, Office of High Energy Physics, Office of Science, USDOE
Natalie Roe, Physics Division, Lawrence Berkeley National Laboratory
Celeste Rohlfing, Head, Office of Multidisciplinary Activities, National Science Foundation

Michael Salamon, Research and Technology Division, Office of High Energy Physics, Office of Science, USDOE
Rita Sambruna, Astrophysics Science Division, Goddard Space Flight Center, National Aeronautics and Space Administration
Bob Scanoff [Panoff]???
James Siegrist, Associate Director, Office of High Energy Physics, Office of Science, USDOE
Vigdor Teplitz, Physicist, Goddard Space Flight Center, National Aeronautics and Space Administration
Michael Tuts, Department of Physics, Columbia University
Steven Vigdor, Associate Laboratory Director for Nuclear and Particle Physics, Brookhaven National Laboratory
Hendrik Weerts, Director, High-Energy Physics Division, Argonne National Laboratory
Andreene Witt, Oak Ridge Institute for Science and Education
Michael Zisman, Research and Technology Division, Office of High Energy Physics, Office of Science, USDOE

About 85 others were in attendance in the course of the two-day meeting.

Monday, March 12, 2012
Morning Session

Before the meeting started, new panel members were sworn in by a member of DOE's Office of the General Counsel, and an ethics briefing was conducted by **Wayne Gordon** of the DOE Office of the General Counsel.

The meeting was called to order by the chair, **Andrew Lankford**, at 10:00 a.m. He introduced **William Brinkman** to report on the activities of the DOE Office of Science (SC).

SC has, for a long time, been supporting research that has led to more than 100 Nobel prizes during the past six decades in a broad area of science. That list now includes Saul Perlmutter, who received the Nobel Prize in Physics this year for his work on dark energy. SC provides 45% of federal support of basic research in the physical and energy-related sciences. It supports more than 25,000 PhD scientists, graduate students, undergraduates, engineers, and support staff and provides the world's largest collection of scientific user facilities.

The President has been a strong supporter of science and technology, saying "innovation... demands basic research. ... Don't gut these investments in our budget. Don't let other countries win the race for the future. Support the same kind of research and innovation that led to the computer chip and the Internet, to new American jobs and new American industries."

Science is the basis of technology and underpins America's energy future. Today we are laying the foundations for the new technologies of the coming decades. In this enterprise, the federal government (and SC) plays a unique role. A highly trained workforce is required to invent the future.

SC has an arsenal of basic science capabilities (major scientific user facilities, national laboratories, and researchers) that we are using to break down the barriers to new energy technologies. Steven Chu has achieved a lot to mobilize technology in his three years at DOE. These advances have largely come through the bioenergy research centers, the energy frontier research centers, the Combustion Research Facility, the Joint Genome Institute, the five nanoscience centers, and the new energy innovation hubs.

Three classes of applications are the focus of SC research: materials and chemical processes by design (e.g., lighter cars from high-strength steel and the ability to survey the properties of thousands of materials), biosystems by design (e.g., decoding a chromosome sequence and modifying DNA and modifying *E. coli* to better make biofuels), and modeling and simulation.

SC has been underfunding the International Thermonuclear Experimental Reactor (ITER), so that funding is now being built up. The SC FY13 budget request to Congress clearly supports the three classes of research mentioned above; it includes $776.5 million for the Office of High Energy Physics (HEP), which is $14.3 million (or 1.8%) less than the FY12 budget. The total SC request is for $4.99 billion, which is $118.4 million (or 2.4%) more that the FY12 budget.

In the Office of Advanced Scientific Computing Research (ASCR), the FY13 request supports the operation of a 10-petaflop, low-power IBM blue Gene/Q at the Argonne Leadership Computing Facility and installation and early science access to a 10-petaflop, hybrid, multi-core computer at the Oak Ridge Leadership Computing Facility. In addition, code design centers will address critical challenges on the path to the exascale. ASCR's Innovative and Novel Computational Impact on Theory and Experiment (INCITE) computing program contributes to U.S. competitiveness and clean energy and gets the national laboratories more involved with U.S. industry. The nation needs to make investments for exascale computing.

In the Office of Basic Energy Sciences (BES), there was a big boost in the budget. The Linac Coherent Light Source (LCLS) has begun operations and has been performing spectacularly. The National Synchrotron Light Source II is in construction and early operations. An expansion of the LCLS and an upgrade to the Advanced Photon Source (APS) are needed. Forty-six energy frontier research centers were launched in 35 states in the fall of 2009; they have come up with some fascinating ideas about energy (e.g., light absorption and wire arrays that can absorb just as much sunlight as a conventional photovoltaic cell but with only 2% of the silicon). The Fuel from Sunlight Hub is just getting up and running. Another hub is being established on batteries; proposals are due soon; the hope is to be operating in late summer. Dozens of Fortune 500 companies use BES scientific facilities (e.g., Eli Lilly and Company uses a light source for protein-structure analysis).

In the Office of Biological and Environmental Research (BER), researchers are seeking to understand how genomic information can be translated with confidence to redesign microbes, plants, or ecosystems for improved carbon storage, contaminant remediation, and substantial biofuel production. There are three bioenergy research centers, and each has found something interesting. The Joint Genome Institute is informing studies of the effects of warming conditions on the Arctic. DOE provides end-to-end contributions for the International Panel on Climate Change (IPCC) Fifth Assessment Report (AR5) (e.g., providing information on the effects of aerosols on atmospheric processes).

In the Office of Fusion Energy Sciences (FES), the primary driver is ITER, where construction is well under way. The new leadership team, including U.S. participation at the highest levels, has streamlined operations, reduced costs, and maintained schedule. The United States has benefited from U.S. jobs, high-tech U.S. manufacturing, and industry funding from ITER overseas partners. At the Princeton Plasma Physics Laboratory, the National Spherical Torus Experiment upgrades provide world-leading capability. The goal is to assess the viability of this aggressive, compact tokamak geometry as a fusion neutron source for testing fusion materials and components.

In the Office of Nuclear Physics (NP), researchers are seeking to understand the existence and properties of nuclear matter under extreme conditions, including the conditions that existed at the beginning of the universe. The 12-GeV upgrade to the Continuous Electron Beam Accelerator Facility (CEBAF) will be used to study systems of quarks and gluons and the force that creates protons and neutrons. It is hoped to continue to move forward on this upgrade. The upgrade is 60%

complete and will support the search for exotic new quark–antiquark particles, evidence of new physics, and a detailed understanding of the internal structure of the proton. A major research result funded by this Office was the production of the heaviest anti-nucleus ever observed. It is helium's anti-matter twin and was created at Relativistic Heavy Ion Collider (RHIC). NP is preparing for the construction of the Facility for Rare Isotope Beams, which will increase the number of isotopes with known properties from about 2000 observed during the past century to about 5000 and will provide world-leading capabilities for research on nuclear structure, nuclear astrophysics, and fundamental symmetries. The grand-challenge question is whether the neutrino is its own anti-particle. The Majorana Demonstrator (MJD) technology demonstration is planned prior to a down-select between it and the competing germanium technology of the German Germanium Detector Array (GERDA) and a planned collaboration. MJD is on track with electroforming and with procurement and processing of enriched germanium. MJD plans to go underground with natural germanium in a prototype cryostat at the Sanford Laboratory in South Dakota in March 2012. The technology and the location of a future, international tonne-scale experiment is to be determined, based on the best value and the best capability. The SC-NNSA [National Nuclear Security Administration] Joint Workshop on Isotope Supply and Demand was held January 11–12, 2012. It identified key isotopes and radioisotopes and the companies that use them. This was a one step forward in ensuring the nation's access to essential isotopes.

In the Office of High Energy Physics, continued support is being provided for U.S. researchers at the Large Hadron Collider (LHC) and for starting neutrino experiments. Research is being funded in accelerator technologies, including superconducting radiofrequency and plasma wakefield acceleration. At the Tevatron, new results by the Collider Detector at Fermilab (CDF) and the Collider Detector at the D0 Interaction Region (D0) identify the mass of the W boson to within 0.02%. Additional experimental data in the search for the Higgs boson appear to be incompatible with the background and may be the beginning of a signal. At Daya Bay, the discovery of reactor electronic antineutrino disappearance at about 2 km leads to a conclusion that the neutrino mixing angle Θ_{13} is nonzero at 5.2 σ. At the Homestake Mine, the Liquid Underground Xenon (LUX) dark-matter experiment will begin operation in March 2012 in a cavern supplied by the State of South Dakota.

In summary, budget issues are very real; we will have to live with what Congress gives us.

Diebold asked what the status was of the Homestake Mine. Brinkman replied that there is money for two experiments; they will start construction in April.

Sambruna asked, in relation to dark energy, what the status was of the Large Synoptic Survey Telescope (LSST). Brinkman replied that that has a high priority and that James Siegrist would say more about it later in the meeting.

James Siegrist was asked to review the activities of the Office of High Energy Physics (HEP).

The Venn diagram of the energy, intensity, and cosmic frontiers has become world-famous and will continue to be the springboard of discussion about high-energy physics in the future. There is a lot of uncertainty in the intensity frontier.

The HEP domestic program is the world leader in the intensity frontier, and investments there need to be increased while keeping a balance with the other frontiers. The community is engaged on further developing the science case on all three frontiers. A healthy portfolio of construction ideas supported by compelling ideas is needed. The plan is for the program to deliver science now, in the near term, and in the long term on all three frontiers.

This year, HEP needs to

- Develop a mission-need statement for U.S. participation in the LHC detector upgrades,
- Make critical decisions on the Long-Baseline Neutrino Experiment (LBNE),

- Issue a solicitation for R&D leading to next-generation dark-matter experiments,
- Make selections among possible next-generation dark-matter experiments, and
- Develop strategic plans for the intensity-frontier and accelerator-R&D programs.

A lot of reports have come out of the LHC and the Tevatron, ruling out most of the interesting Higgs-mass range. The Tevatron run is completed, and final data analyses are under way. The LHC will run through 2012 and then shut down to achieve full energy (14 TeV). No new facilities are under construction at this time. In the plans are the LHC Upgrades Phase I (2017–2018) to cope with increased data rates and the LHC Upgrades Phase II (2021+) to provide a factor-of-10 increase in luminosity. The future evolution of lepton colliders will depend on results obtained during the next few years.

On the intensity frontier, the drive is to implement a comprehensive program to understand neutrino mixing and to deliver much improved measurements of charged-lepton mixing and hidden-sector phenomena. Daya Bay has discovered a third kind of neutrino mixing (and it is large). There are various hints of additional neutrino species and possibly anomalous interactions. New facilities under construction include the Neutrinos at the Main Injector (NuMI) upgrade and the commissioning of reactor experiments. How to proceed with the Muon-to-Electron Conversion Experiment (Mu2e) and LBNE needs to be figured out.

On the cosmic frontier, we need to figure out the particle(s) that make up dark matter and advance the understanding of dark energy. Recent results include some controversial evidence for dark matter from both direct and indirect searches and the demonstration and prototyping of several dark-energy measurements. Progress on facilities includes the commissioning of the Dark Energy Survey. Planned major projects include the LSST, which will make definitive ground-based dark-energy measurements using "weak lensing" and third-generation (ton-scale) dark-matter experiments to reach the ultimate background limits.

The leading HEP budget issues are:

- The International Linear Collider (ILC) R&D efforts are zeroed out. The 5-year R&D plan was successfully completed, but there is no project on the near horizon. The plan is to continue involvement with international planning at a very low-level, trying to minimize the damage to accelerator education etc.
- LBNE construction was not included in the requested budget because the revised project plan was not ready in time. The LBNE case must be developed with the administration. The Homestake dewatering effort will be maintained at a reduced scope. The lack of new facilities is a worry.
- To exert leadership, the United States needs not only to fully exploit current research infrastructure but also to develop new facilities and infrastructure. The current scientific landscape indicates the ripe opportunities are at the intensity and cosmic frontiers.

The actual budget request shows the zeroing out of the ILC R&D and it lacks growth in construction. The Office is trying to implement what was called for in the P5 [Particle Physics Project Prioritization Panel] plan. Funds are being shifted from Facility Operations and Technology R&D to (1) supporting planned funding profiles for projects (Mu2e) and new major items of equipment (MIEs) (the LSST camera and Belle-II), (2) conducting targeted R&D for future intensity- and cosmic-frontier projects, and (3) maintaining key research efforts needed for the future program. The Fermilab proton accelerator complex will run for 20 weeks to support the neutrino program. Operations funding would increase from $103 million in FY12 to $107 million in FY13. The accelerator upgrade components of NOvA [the NuMI Off-Axis ν_e Appearance experiment] would be installed and commissioned. Fermilab was hit more than any other laboratory: a large reduction in total HEP funding from $382 million in FY12 to $359 million in FY13.

Priorities of the Office include working with the collaborations and CERN [Conseil Européen pour la Recherche Nucléaire (now Organisation Européenne pour la Recherche Nucléaire)] to understand the impact of the CERN LHC upgrades on detectors.

In the Proton Accelerator Based Physics line item, $421.6 million was received in FY12. The FY13 request is for $411.5 million, a difference of –$10.1 million.

On LBNE, SC charged a review to examine cost-effective options to do underground science. The report was delivered in June 2011. The main findings relative to LBNE were:

- The cost estimates need more work.
- Making a technology choice should be done soon to reduce costs from developing two technologies.
- The project team was charged to develop a technology choice and to refine the cost estimates.

The project team has recommended a technology. Fermilab and DOE have concurred with that recommendation. A go/no go decision is to be made by the end of Q2 FY12. If the decision is to go, a technology decision for Critical Decision 1: Approve Alternative Selection and Cost Range (CD-1) is to be made by the end of Q3 FY12. If the decision is no-go, alternatives need to be explored to achieve a significant fraction of the science goals of LBNE in a different configuration with significantly reduced cost. How to determine charge-parity (CP) violation will also need to be figured out.

In the Electron Accelerator-Based Physics line item, $23.0 million was received in FY12. The FY13 request is for $29.1 million, a difference of $6.1 million. The Stanford Linear Accelerator Center (SLAC) B-factory analysis will be mostly completed in FY12 and will move into the archival phase in FY13. Decommissioning of the Babar detector is to be completed in FY13, and decommissioning and demolition of the Positron Electron Project (PEP-II) accelerator is to begin.

Dark energy is one of the high-priority science questions for HEP, and particle physicists want to lead that scientific effort and seek out partnerships. The Astro2010 decadal survey by the National Academies made recommendations relevant to HEP, the LSST being the highest-ranking ground-based initiative. The NSF Astronomy Division is pursuing LSST as a new project. The FY13 HEP request includes funding to begin fabrication of the LSST camera.

In August 2012, there will be a community workshop to get input on strategy for dark-matter research, particularly on coordination and complementarity of different methods.

In dark energy, the Office is pro-actively developing a balanced, robust dark-energy program. In computing, the questions are: What do Cosmic Frontier experiments actually need, and how well integrated are they with the emerging national computational cosmology collaboration? Something will be done about this in the summer.

In the Theoretical Physics line item, $66.9 million was received in FY12. The FY13 request is for $68.5 million, a difference of $1.7 million.

In the Advanced Technology R&D line item, $167.3 million was received in FY12. The FY13 request is for $149.9 million, a difference of –$17.4 million.

In accelerator R&D, the first production model of an advanced accelerator component at Argonne National Laboratory (ANL) worked "out of the box" and was much cheaper to produce than previous versions because delicate, labor-intensive modifications were not required. The reason this works is that the SLAC National Accelerator Laboratory has developed an advanced simulation code for these components that is then converted into code that runs the precision milling machines that make the parts. It is a major step forward in building cheaper accelerators and may have broad applications.

The FY12 Senate report charged DOE to submit a 10-year strategic plan on accelerator-technology R&D by June 12. HEP has charged a community task force to provide input on promising R&D areas, pros and cons of current technology transfer models, and potential challenges of implementation. This will be a significant effort to implement and is not without risk. Positive feedback is being received from other SC offices and other agencies. Industry has given many constructive suggestions.

Erbacher noted that, within the redirection, an effort is being made to maintain the spirit of the Venn diagram. Fermilab got hit mainly because of defunding of the ILC and LBNE. She asked whether that money has been redirected within Fermilab. Oddone replied that, basically, that money has been taken out of Fermilab. Erbacher asked if they had been handed a level of support from the Office of Management and Budget (OMB). Siegrist replied, yes; however, there is an opportunity to appeal. Kim added that Fermilab has nine accelerators running. It also has other programs that will be starting up. Erbacher asked whether the energy frontier and Advanced Technology had taken a big hit, then. Siegrist replied, yes. The ILC would have been under Advanced Technology. Erbacher asked whether what was left was just LHC support. Siegrist replied, yes; and even that did not go up as fast as was hoped. Oddone added that the research portion of the intensity frontier is larger than it appears because of the research facilities. Erbacher cautioned that one must think about maintaining the national laboratories. Siegrist replied that Fermilab has a critical global role. Oddone said that each laboratory needs to propose exciting science. The funding decisions have to be based on the science. Siegrist added that the science involved needs to be better defined and explained to Congress.

Honscheid asked if there were a reason for the increase in the budget of nonaccelerator physics. Siegrist replied that most of the increase was for liquid argon R&D.

Byrum stated that one wants to be back in the top three topics. Siegrist responded that those areas reflect the administration's priorities. One needs to better define the science and its impacts and to rally supporters.

Lankford asked what the relation was between ASCR and HEP. Siegrist answered that HEP has had a lot of interactions with ASCR and will have more: on increasing bandwidth by a factor of 10, on the exascale power problem, and on multicore computing. When the LHC computing grid was set up, NSF was highly involved, also.

Weerts asked how long the community would live by the Venn diagram. Siegrist answered that it is effective and that the three frontiers complement each other. At some point (before summer 2013), there will need to be a re-prioritization. At that point, there will be results from the LHC first run. Summer 2013 would be a good time to reassess the direction(s) of the field.

A break was declared at 11:20 AM. The meeting was called back into session at 11:41 AM.

Celeste Rohlfing was asked to report on the activities at the NSF Directorate for Mathematical and Physical Sciences (MPS).

The purpose of the NSF is to transform the frontiers, innovate for society, and perform as a model organization. It is based on advancing discovery, providing building blocks, establishing forefront facilities, and educating the next generation. The program includes Cyber-Enabled Materials Manufacturing and Smart Systems (CEMMSS), Cyber Infrastructure Framework for 21st Century Science and Engineering (CIF21), Expeditions in Education (E^2), Integrated NSF Support Promoting Interdisciplinary Research and Education (INSPIRE), Innovation Corps (I-Corps), Secure and Trustworthy Computing (SaTC), and Science Education and Engineering for Sustainability (SEES). It has supported a winner of the 2011 Nobel Prize in Physics and four of the seven winners of the 2011 National Medal of Science.

The building blocks are to catalyze advances in science, impacting innovation in medicine, industry, and technology; to develop sustainable chemistry; and to carry out the Materials Genome Initiative (which is tied to advanced manufacturing).

SEES is in its third year, and its focus is replacing rare and expensive materials. $27 million has been requested for SEES for the FY13 budget.

CIF21 seeks to transform research, innovation, and education. It involves all directorates and offices. It seeks to support computational and data-enabled science; to support core technologies, tools, and algorithms; and to respond to new, large data generators. Modeling science is producing huge amounts of data that need infrastructure to be interpreted and shared. This initiative also supports workforce development. $19.5 million has been requested for FY13.

CEMMSS is a partnership with the Engineering Directorate and the Computer and Information Science and Engineering Directorate (CISE) on advanced manufacturing and Designing Materials to Revolutionize and Engineer our Future (DMREF). It is to conduct fundamental research for discovering, making, modeling, optimizing, and manufacturing with new materials and material systems. In MPS, $50 million has been requested for FY13.

SaTC is a cross-Foundation partnership to build a cybersecure society. Its goal is to produce high-quality digital systems and a well-trained cybersecurity workforce. In MPS, $2 million has been requested.

E^2's goal is to transform science, technology, engineering, and mathematics (STEM) learning for the nation through cognitive research and frontier science and to provide cyber-learning and education about managing data. About $5 million has been requested for MPS, and more has been requested across the Foundation.

Cross-disciplinary efforts include those on

- Research at the interface of Biological, Mathematical, and Physical Sciences (BioMaPS) to provide insight into and inspiration from the living world; it received $5.5 million in MPS last year, and $11.6 million is requested this year.
- Enhancing Access to the Radio Spectrum (EARS]) is designed to improve electromagnetic-spectrum management. It seeks to ensure the effective use of the radio spectrum to benefit technology, the economy, social sciences, and public policy. It is responsive to the national broadband plan. $12 million has been requested for MPS in FY13.
- INSPIRE focuses on high-risk/high-reward research across disciplines, and the I-Corps has had its first NSF award on the use of solar radiation to dissolve oil contaminants in water. In MPS, $8.3 million has been requested for FY13 for these two programs.
- Science Across Virtual Institutes supports centers in multiple countries to produce a viable research effort. Two of NSF's first three awards in MPS were made to the Virtual Institute for Mathematical and Statistical Sciences (with India) and to the Physics of Living Systems Student Research Network (with Brazil, Israel, Singapore, and Europe). $8.3 million was requested in MPS for FY13.

Building the pipeline involves the Faculty Early Career Development (CAREER) Program, in which MPS accounts for 25% of NSF's awards to enhance our young-scientist pipeline. In addition, there are the MPS Alliances for Graduate Education (AGEP) graduate research supplements, which were the topic of a dear-colleague letter from MPS. For CAREER, $56.7 billion was requested for FY13.

MPS launch facilities in FY13 have done well in comparison with those at other agencies, but more still needs to be done. The Atacama Large Millimeter Array (ALMA) has large contributions from the NSF, Europe, and Asia; it has just put 16 (of 66) antennae into operation. The National Superconducting Cyclotron Laboratory (NSCL) got $21 million in the request. The Division of

Physics (PHY) held on to a 1% increase this year. In addition, $30.0 million has been requested in FY13 for the Office of Multidisciplinary Activities (OMA), an organization within the MPS directorate.

NSF has initiated its career-life balance program. Under this program, the Foundation is being generous on no-cost extensions, flexible start dates, supplements for additional personnel, and virtual participation in NSF activities to ease impacts on family life. A dear-colleague letter on the subject was sent out.

Sambruna asked for more information about the big data program. Rohlfing replied that NSF's physics and astronomy divisions will be the major players with solicitations coming out this summer. This is about a $20 million investment spread over five divisions.

Teplitz asked if NSF had a new program on collaboration with developing countries. Rohlfing responded, yes; that is run out of NSF's Office of International Science and Engineering.

Joseph Dehmer was asked to speak about the activities of the NSF Division of Physics (PHY). He welcomed the new Panel members and the new chair. He announced that Moise Pripstein and James Reidy had retired. There are three new members of PHY: Randy Ruchti, Jean Cottam Allen, and Saul Gonzalez. He pointed out that the Panel is advising two very different organizational entities: DOE/HEP and NSF/MSP. The Division has 11 programs.

The discovery potential in physics has never been greater. PHY funds a dozen areas with great promise (cold atoms, dark matter/dark energy, gravity waves, new fundamental particles and laws, neutrino physics and astrophysics, string theory, quark-gluon plasma and supernova dynamics, ultrafast and ultra-intense laser fields, cyber science and quantum-information science, biophysics of single molecules and cells, complexity and emergent behavior, and condensed-matter physics).

The investment goals that guide NSF funding are

- Major scientific advances that alter the course of physics and other fields
- Seeds of advances in the nation's health, wealth, and defense; it also takes cues from *The Gathering Storm*, the America Competes Initiative, American Competitiveness in the Twenty-First Century Act (ACA), and other studies and reports
- International leadership/cooperation across the intellectual frontiers of science
- Recruitment of exceptional talent into science (education, outreach, and early inspiration)
- Significantly increase diversity in science
- Production of highly trained professionals for the nation's workforce

Innovation involves the answers to two questions: "What is possible?" and "What is needed?" This is a nonlinear capability. It is best viewed as an innovation ecosystem with multiple keystone species (e.g., universities, industry, government, scientists, concepts, and techniques). PHY's role has three components: to advance intellectual frontiers, to develop the intellectual capital to activate the ecosystem, and to seize opportunities to apply new knowledge to practical needs. The ecosystem perspective matters because planning horizons shorten when funding is short, and this tends to emphasize incremental steps (as opposed to disruptively transformational events).

In facilities, the Laser Interferometer Gravitational Wave Observatory (LIGO) upgrade construction will be completed in FY15 and could shed light on the fourth source. LHC began operating at 7 TeV in FY10. IceCube was completed on time and began operations in FY11. The NSCL is to be succeeded by the Facility for Rare Isotope Beams (FRIB). The Deep Underground Science and Engineering Laboratory (DUSEL) was canceled in FY11. The Cornell Electron Storage Ring (CESR/CLEO) was phased out in FY09. A number of midscale projects are being supported, often in collaboration with DOE/HEP.

NSF spends about $7 billion per year, about $6 billion of that on research and related activities (R&RA) with a big investment in education. CISE got an 8.6% increase in the FY13 budget request.

Engineering got 6.1%. MSP got a 2.8% increase. But all the magnitudes are small, and the funding levels are essentially flat.

For 20 years, the support of principal investigators (PIs) has been more than half of the PHY budget, and facilities have been slightly less than 50%. Facilities are important because one needs tools to do research. PHY supports about 6000 people. The percentage of women among funded PIs is growing but is not, as yet, 50%. Women and minorities are not discriminated against in the grants process. There is a problem in the supply.

The PHY budget actions in FY 12 were:

- LHC, IceCube, and NSCL were flat; LIGO was up $100,000.
- All programs were initially cut 5%, with 2% restored when the budget was finalized.
- Investments were made in Biological, Mathematical, and Physical Sciences (BioMaPS), Cyberinfrastructure Framework for 21st Century Science and. Engineering (CIF21), and Science Across Virtual Institutes (SAVI).
- S4 [the fourth solicitation for DUSEL planning] funding was redirected to underground science.
- Midscale physics instrumentation is a priority for future budget cycles, and some funds are being applied to seed the activity.
- NSF is also discussing the possibility of accelerator physics research at universities as a possible investment.

The last two bullets express the Accelerator Physics and Physics Instrumentation (APPI) concept, and the last three bullets should benefit work at the three frontiers of particle physics.

The three-frontiers concept was a breakthrough by P5 and resulted in a more robust and interesting picture of the field. There have been recent results and opportunities in each of the three frontiers. Advisors should accept the budget reality for the next few years (at least). There is an important planning effort being carried out by the Division of Particles and Fields of the American Physics Society and others, which is leading to the Snowmass 2013 meeting. Advisors should think on two levels: What is doable this decade, and what is the grander vision? Make a plan or vision for the next decade that makes sense to those outside the field in that it is executable, delivers significant results at a regular pace, maintains a vigorous U.S. physics community, meshes with the global picture, and flows into the future in a plausible way.

Erbacher asked what the implication was of the cautionary caveat on accelerator R&D at universities. J. Dehmer replied that universities must be involved in the intellectual pursuit of accelerator science.

Sambruna asked J. Dehmer to comment on the Major Research Equipment and Facilities Construction (MREFC) funding line for the LSST. J. Dehmer responded that the agencies are working closely together to get to the next step. The LSST is a no-brainer. It has to be done. The putting down of DUSEL does not suggest that the LSST is going down.

Akerib noted that some things are ramping down and that DUSEL is going away. He asked what funds might find their way to the midscale. J. Dehmer answered that the DUSEL planning funding was re-allocated to the design of R&D in underground science on an annual basis. It would depend on the PIs what gets funded. A dear-colleague letter announced the solicitation for this funding activity. Akerib asked about the midscale program. J. Dehmer said that he did not expect a separate solicitation. The midscale funding will go out as part of the solicitations of other programs. In particular, the liquidity after FY12 is not big enough to address the LHC upgrade and almost a dozen other things. The Division will try to build up support of the midscale. These other programs are being seeded. The midscale did not make the cut in the FY13 request, but it needs to be done.

Rohlfing noted that the National Science Board (NSB) specifically recommended that the NSF not have a Foundation-wide midscale program.

Tuts asked about the funding spike in FY09. J. Dehmer replied that the projects that made up that spike were funded through the American Recovery and Reinvestment Act (ARRA) and will be cut back as their funding expires. However, the overall funding is flat.

A break for lunch was declared at 12:49 p.m. The meeting was called back into session at 2:03 p.m.

Monday, March 12, 2012
Afternoon Session

Norbert Holtkamp was asked to present the Interim Report to HEPAP of the HEP Accelerator Task Force.

In October 2009, DOE's HEP sponsored a symposium and workshop on Accelerators for America's Future. Its purpose was to elicit the views and opinions on a wide range of accelerator users on the challenges and opportunities for developing and deploying accelerators to meet national needs. It presented a range of ideas on how HEP could reach out. The report made recommendations, but it was not clear what should be done. Subsequently, the Senate Appropriations Committee noted that "powerful new accelerated technologies created for basic science and developed by industry will produce particle accelerators with the potential to address key economic and societal issues confronting our Nation. However, the Committee is concerned with the divide that exists in translating breakthroughs in accelerator science and technology into applications that benefit the marketplace and American competitiveness" and directed the Department to "submit a 10-year strategic plan by June 1, 2012, for accelerated technology research and development to advance accelerator applications in energy and the environment, medicine, industry, national security, and discovery science." This task force presentation is one step in gaining input for that strategic plan.

The Task Force argued quite a bit about whether the directive's order of topics was significant. It was a small group that had 3 to 4 months to complete its charge. An attempt was made to include the main players: DOE, NSF, universities, and industry.

The charge from HEP included a summary of costs and time scales for previous successful accelerator R&D efforts to help assess future funding profiles; an identification of those research opportunities that might have a strong potential for broad national benefits; a summary of the current scope of work, resources invested, and status of the key research and technology areas; and an identification of possible impediments. We stressed that HEP is the steward for long-lead R&D in this area and that it was reaching out to the community to ask how it can help that community. HEP does not do "old" accelerator science. It engaged BES, NP, FES, and ASCR; NSF, the National Institutes of Health, the National Cancer Institute, the Department of Defense, and the Office of Naval Research; and industry and it set up a blog. In 10 days there were 20 to 30 entries to the blog from the medical community alone. The goal is to engage with customers through the science delivered and to have the customers promote HEP's science because it adds value to them.

There have already been three panels on accelerator R&D with very good recommendations. There also was the Accelerators for America's Future workshop, which identified the needs and which disciplines had those needs. The needs were reliability, beam power/radio frequency (rf), beam transport and control, efficiency, gradient, reduced production costs, simulation, lasers, size, superconducting magnets, targetry, and particle sources. However, there were no recommendations on what to do about these issues. What came out of that workshop was not a science program. Instead, seven grand challenges were identified:

- Extend the energy reach of collider technology
- Extend the beam power and intensity reach of hadron accelerator technology
- Extend the capability and understanding of performance limits
- Break the rf barrier by developing scalable next-generation acceleration methods
- Develop tools and technologies for the manipulation of particle beam phase-space
- Develop concepts and technologies to extend the brightness, brilliance, and coherence of photon sources
- Develop accelerator systems to serve as compact sources of photons, neutrons, protons, and ions.

Seven science goals ("pushes") were identified for each DOE R&D program thrust; in addition, applications (pulls) were also identified, and feedback between the pull and push elements was established.

It is a given that detectors are relevant and driven by HEP and NP R&D.

The market is $5 to $10 billion per year and employs 10,000 people. Why is accelerator experimentation happening accidentally? The national laboratories have viewed industry as being remote, and industry has viewed the DOE laboratories as closed and restricted. There is no integrated view of what is out there. It takes 13 months to execute a Cooperative Research and Development Agreement (CRADA). Some mechanism is needed to direct the industrial market to the capabilities of the national laboratories.

There is no forum in which different agencies can discuss capabilities and progress. There needs to be communication. OHEP could lead an accelerator working group, an oversight panel, a steering group, or a board of stakeholders that would involve intra-agency and interagency program managers as well as industry representatives and technical advisors. There is a National User Facility Organization (NUFO) to develop simple user-friendly procedures to give customers access to national laboratory infrastructure and expertise and to allow proprietary research or at least research in access-controlled areas. Giving access is easy, and organizing it is easy, as well. Connecting to the potential users is the hard part.

SC and HEP can work to identify, understand, and resolve the concerns from industry and other agencies regarding protection of incoming and generated intellectual property or information. A template covering all aspects of a contractual arrangement that would be applicable to all user facilities and infrastructures would be useful. It takes from 2 months to 2 years to put a CRADA together.

Leveraging the Small Business Innovative Research/Small Business Technology Transfer Program (SBIR/STTR) funding with a specific focus on energy and environment, medicine, industry, and defense and security apart from discovery science could strengthen these parts of the program, directing money at once to the topic areas identified in the Accelerators for America's Future Workshop. Collaborative Accelerator Research Teams (CARTs) is a way of doing things more efficiently. Ask specific questions; pull a team together to answer those questions; and end the program after 5 or 10 years of funding.

SC would establish a program to bring industry, laboratories, and universities together to foster the application of a solar technology in energy and the environment, industry, medicine, defense and security, and discovery science. Such an effort would have to be set up as a program or thrust area with a funding stream.

Accelerator-science education is a must. Workforce development for particle accelerator R&D has traditionally been a major emphasis of SC. The PhD output for accelerators in the United States is declining; there are currently 80 graduate students in this field.

The medical community would benefit from hadron-beam medical facilities. SC could develop a stepwise implementation plan for providing beams and for developing beams and beam-delivery systems in a cost-efficient manner. This is a low-hanging fruit with a big impact; a lot of efforts could be carried out quickly. 10 years from now, electron-beam machines will all be made elsewhere.

SC could provide a home for laser R&D. Lasers have become an integral part of accelerators and provide tremendous potential for new methods of acceleration, for miniaturization of accelerators, and for desktop accelerator systems. These tools have been driven by NIH, industry, and the NNSA, all outside SC.

The Venn diagram of frontiers does not have an accelerator R&D component. At 20% of the total budget, shouldn't accelerator R&D have its own circle?

Congress is waiting for an answer on the six topics cited in its directive. It is hoped that the accelerator task force will be helpful. It needs advice on usability, appropriateness, and content of the preliminary report. Implementing some of the ideas would mean doing business a bit differently. The input of this task force will last a bit longer and go deeper than did some of the previous panels.

Michael Zisman was asked to report on the Accelerator R&D Strategic Plan from the perspective of HEP.

HEP wants to support world-leading research in the physics of particle beams and in accelerator-technology R&D. There are three types of R&D: near- to mid-term directed R&D; mid-term, facility-inspired R&D; and long-term, proposal-driven research. All SC programs participate in the first two categories; the last category is the purview of HEP.

In broad terms, the R&D goals are higher beam quality, higher beam intensity, and more compact size. If one generalizes the concept of "beam" to include not only charged particles but also neutral particles and photons, the overarching R&D goals are unchanged, but the potential customer base broadens considerably. Historically, HEP long-range accelerator R&D always implicitly assumed that HEP was its only "customer." Because HEP is a "high-end" consumer, resulting R&D efforts are often useful to a broader group.

Holtkamp already pointed out the eight core thrust areas: superconducting RF; accelerator, beam and computational physics; particle sources; RF sources; beam instrumentation and controls; normal conducting RF; new accelerator concepts; and superconducting magnets. 70% of activity occurs in three of these areas (superconducting RF; accelerator, beam, and computational physics; and new accelerator concepts). This work is done at seven DOE national laboratories and at 20 universities and other institutions. 90% of SC accelerator R&D is carried out at national laboratories. Expanded NSF involvement broadens university participation and supplies students for stewardship of workforce development.

There is a complementarity between the national laboratories and industry: large-scale efforts make use of national-laboratory infrastructure, engineering, and fabrication capabilities. Small-scale R&D is supported by university grants. In terms of workforce development, the national laboratory–university complementarity provides an excellent environment for training the next generation of accelerator physicists. About 75 graduate students are supported in accelerator R&D across SC.

The total HEP program contribution to accelerator R&D is $144 billion; the total SC program contribution to accelerator R&D is $164 million. These numbers do not include very-short-term R&D done on facility operations' budgets. The majority of SC's accelerator R&D effort is carried out by HEP.

HEP has programs of directed R&D aimed at specific goals that combine thrusts (i.e., the ILC, LHC accelerator research, and the muon accelerator). All of these are managed as multi-laboratory programs with clear milestones and deliverables. SC's accelerator R&D is distributed across seven national laboratories and universities, but all the programmatic efforts are distinct; there is no competition among the national laboratories; these are complementary projects.

In the long view, HEP and NP have always invested in longer-term accelerator R&D, and such R&D is a recognized part of the HEP portfolio.

There have been several past efforts to make accelerator technology more available (e.g., in the design, construction, and commissioning of the Loma Linda Medical Accelerator by Fermilab; other methods used include CRADAs and SBIR solicitations). HEP often partners with industry to deliver required components. These efforts have been successful in terms of technology transfer.

In a nutshell, accelerators are tools of discovery for medicine, the environment, etc. HEP is currently leading the development of a strategic plan for accelerator stewardship to respond to national needs. The plan will be coordinated by HEP in close consultation with other relevant SC program offices; the response to the Senate will be submitted at the SC level. The stewardship activities likely require partnerships with other programs because not all the right people will reside in HEP.

The Accelerator Task Force has provided input on how HEP might effectively broaden its long-range accelerator R&D portfolio to explicitly consider needs beyond HEP. A possible approach is to designate representatives from the various stakeholders to meet regularly and to advise and evaluate the accelerator stewardship program. Such representatives might be drawn from other SC programs, other agencies, the medical community, the national security community, and industrial users. Targeted community workshops could be used to assess progress and to solicit future needs. The decision-making process must be seen as transparent and fair.

Within HEP, the plan is to designate a program manager for the activity and to allocate a portion of long-range accelerator R&D funds for stewardship. Within SC, there could be regular briefings with cognizant programs and SC management. Beyond DOE, it could be regular meetings with a "board of stakeholders." That board could help evaluate and prioritize promising directions for the final decisions being made by the HEP director. Also, workforce development and training must be coordinated with NSF.

A successful program must address challenges identified at the Accelerators for America's Future Workshop: the difficulty of identifying cognizant federal "owners"; addressing the funding gap between bench-scale demonstrations and full deployment of new technologies; technology advances for increasing reliability and reducing construction and operating costs; and maintaining and improving core competency in accelerator design and construction. Additional challenges associated with collaboration between industry and national laboratories must also be handled. Over time, R&D program needs will modify the science goals and the program thrust areas.

The take-home messages are that

- SC programs already maintain a broad accelerator R&D program that leverages unique expertise and test facilities at different laboratories and universities.
- Near- and mid-term program-specific R&D is being carried out by various SC programs.
- HEP continues its historical support of long-term R&D in accelerator science and technology.
- HEP currently is leading the development of a strategic plan for accelerator stewardship.
- The goal is to have a world-leading program in accelerator R&D not only for SC applications but also for all of the nation's accelerator needs.

Yamamoto asked if there were any hope of meeting the challenge of identifying cognizant federal owners. Zisman replied that there has been nobody in whom authority resided. HEP is willing to act as a clearinghouse to connect proposers with programs across agencies. Gilchriese asked how this would impact the budget for accelerator R&D. Zisman answered that the Office was not changing what it was doing but how it was doing it. In the near term, it will do similar things with similar money by packaging it differently. The FY13 budget request is set; any changes will be re-allocations. An initiative will be put forward for FY14.

Kim asked whether 20 or 25 or graduate students were being talked about. Holtkamp responded that that increase will probably be a factor of three. Zisman said that an accelerator where students can learn from is a major asset and makes a big difference. Accelerator physics as an academic pursuit is not properly appreciated in the United States. There are few universities where there are personnel who do accelerator physics for a living. Merminga suggested that one thing that works is to have laboratory personnel teach accelerator physics at nearby universities.

Scanoff (???) asked what lessons could be drawn from isotope stewardship. Zisman replied that one has to be careful of heightening expectations. Things can be slower if management does not agree. A fan club needs to be developed in other agencies. Holtkamp added that the isotope program is a good example of inflated expectations. If one does not deliver, one can lose the program. Zisman said that NP is dealing with industries that are competing with each other, making it difficult to get access to competitive information. People are sensitive to turf but more sensitive to profits.

J. Dehmer noted that onsite accelerators allow students to do "hands-on research."

Byrum asked what the industries affected by the strategic plan would say about HEP. Zisman responded that the process is ongoing, and HEP continues to have interaction with these groups. The draft of the report will be widely circulated, and it is expected that they will see how this will help them. The program will succeed or fail on what R&D gets delivered. Holtkamp said that some of the efforts recommended will be long-term, some will be medium-term, and some will be short-term.

A break was declared at 3:33 PM. The meeting was called back into session at 3:53 PM.

JoAnne Hewett was asked to summarize the Intensity Frontier Workshop sponsored by HEP.

The charge to the Intensity Frontier Workshop was to document the physics and science opportunities at the intensity frontier, identify experiments and facilities needed for components of a program, demonstrate that the community is interested and wants to do intensity-frontier physics, and educate the community.

There is a good representation of high-energy physics: the high-energy-physics Venn diagram. It has the energy frontier overlapping with the intensity frontier and the cosmic frontier. It has proven to be very useful and effective in the United States in terms of funding and communicating the HEP program to the government. However, all three of the prongs are needed to probe particles and their interactions. The workshop struggled with the definition of the intensity frontier, and that struggle continues somewhat. The other frontiers are well-defined and are becoming more focused and defined. The energy frontier and the cosmic frontier are currently rather well-defined and will remain so for the foreseeable future.

The intensity frontier is a broad and diverse set of science opportunities. The intensity frontier is the exploration of fundamental physics with high-intensity beams and/or large sensitive detectors. It takes precision measurements that indirectly probe quantum effects to produce new physics. It addresses fundamental questions: Are there new sources of charge-parity violation? Is there charge-parity violation in the leptonic sector? Are neutrinos Majorana or Dirac? Do the forces unify? Is there a weakly coupled hidden sector linked to dark matter? Are apparent symmetries violated at high scales? What is the flavor sector of LHC discoveries? Can we expand the new-physics reach of the energy frontier?

The workshop leadership set up the following areas for study: heavy quarks (looking at the final states of s, c, and b quarks), hidden sectors [looking at dark photons, paraphotons, axions, and weakly interacting slim particles (WISPs)], nucleons in atoms (looking at properties of nucleons, nuclei, or atoms, including electric dipole moment), proton decay (looking at proton decay), neutrinos (looking at all experiments for properties of neutrinos), and charged leptons (looking at muons and taus). It also set up a working group on each of these topics and, during the months of October and November 2011, charged those working groups to identify any needed facilities at the intensity frontier.

Before the workshop, there were working group meetings, regular convener meetings, and solicited written contributions. The focus was on science rather than facilities. What came out of the workshop was a statement that the intensity frontier looked for, studied, and addressed

- Neutrino oscillations, lepton flavor number violation in neutrinos, and neutrinoless double-beta decay;
- Lepton flavor number violation with muons and taus, and g – 2;
- Charge-parity asymmetries, rare detainees, distributions, kaons, charm, and bosons;
- New particle searches;
- Electric dipole moments and parity violation; and
- Proton decay.

However, the intensity-frontier topics are a connected, overlapping set of science opportunities, but it is not *a priori* clear which is most important; they should all be done. All of these topics connect with each other, lending strength to this definition of the intensity frontier.

The report concludes that

- Heavy quarks are an essential component of a worldwide balanced physics program. A compelling physics case is not predicated on theoretical progress. Several experiments are under way abroad, and the United States should be involved. The United States has an opportunity to mount its own program in kaon decays.
- Charged leptons are easy to produce and detect, so precise measurements are possible. Hadronic uncertainties are insignificant or able to be controlled by data. The Standard Model rates are negligible in some cases, so new physics stands out. The couplings of new particles to leptons can be directly probed. A diverse set of independent measurements is needed.
- Neutrinoless double-beta decay tests the fundamental nature of the neutrino and the lepton-number violation. A large Θ_{13} allows for the measurement of fundamental neutrino properties, such as charge-parity violation, mass, and hierarchy.
- Proton-decay experiments test theories of unification and baryon number violation.
- Hidden-sector couplings to the Standard Model are small enough to have been missed so far but big enough to be found. Theories are motivated by cosmic-frontier signatures at the intensity and energy frontiers.
- Neutrons offer the most exciting possibilities. Electric dipole moments are excellent probes of new physics. There is a new area of nuclear beta decay: precise measurement of V_{ud} and the future measurement of the neutron's lifetime and decay correlations. A program in neutral currents looks at polarized electrons scattering from unpolarized targets and electrons for precision measurements of a weak mixing angle over a large Q^2.
- As the LHC results become more precise, it becomes more important to study the flavor gain.

More than 500 participants attended the workshop, and it was peppered with ideas and enthusiasm. There were more than 100 parallel session talks plus much discussion. It demonstrated that there is a large, young community that wants to do this science. The science case has been documented, and a strategy is being developed; the program to be expected comes later.

The intensity frontier is a broad set of precision measurements of properties of known particles. It is a multi-pronged, interconnected program with a global reach.

The first draft of the technical report was completed around the end of 2011. The working group report was reviewed by the community by the end of January 2012. The working group reports were completed by the end of February 2012. The report is being made available to HEPAP at this meeting for its comments, with a final report being made by the end of March 2012. The total report is about 200 pages. Everyone who contributes will be a coauthor. A website will be set up for people to sign up in support of the described science opportunities. There will also be a seven-page glossy brochure that will be ready by the end of March 2012.

This workshop is just a step in the process toward making this program a reality. A broad intensity frontier discussion must continue. It should be centered on science opportunities, communities should support each other, the community must be educated, and the working groups should continue in some form.

There will be a workshop in Snowmass on June 2–22, 2013, with a community planning meeting in October 2012 at Fermilab.

Glen Crawford was asked to review the intensity frontier strategic planning.

The community needs to take ownership of the science by placing the science first, speaking with one voice, and becoming well-informed. The Office is asking HEPAP for constructive engagement and informed opinions. It is asking the Division of Particles and Fields (DPF) of the American Physical Society to take the lead in the ongoing development of the science case.

Congress asked for a report describing the benefits of the research; a strategy for maintaining the U.S. lead; and the funding needs over the next 10 years, including construction activities, for implementing the proposed strategy. The Intensity Frontier Workshop report answers the first element of this charge.

DOE, with community input, will develop a high-level Intensity Frontier Strategic Plan based on the workshop report, budget projections, and programmatic and cross-cutting concerns. This is *not* to be a list of projects and priorities but instead a vision for the detailed scientific opportunities. One challenge is to turn this strategic vision of the workshop report into an executable plan. One main challenge will be to take a diverse but connected set of science topics and develop a simple coherent story. Matter-antimatter asymmetry is the big pole in the tent. However, there are important secondary messages:

- Developing a comprehensive understanding of the lepton sector
- Discovering the undiscovered laws of nature

The long-term science goal of the intensity frontier is to explain the matter-antimatter asymmetry of the universe. This will be done by understanding lepton flavor violation, deepening the understanding of the quarks, and asking whether there are important missing pieces. The program implementation would require experiments and facilities that are buildable in about the next decade to start addressing these questions. The path forward for LBNE is the key question right now.

The intensity-frontier landscape includes currently operating projects [Main Injector Neutrino Oscillation Search (MINOS), Main INjector ExpeRiment v-A (MINERvA), MiniBooNE at the Booster Neutrino Experiment, Tokai-to-Kamioka (T2K), the Enriched Xenon Observatory (EXO-200), and Daya Bay], projects that have been approved (NOvA, Mu2e, MicroBooNE, Belle-II, and LBNE), and possible future projects (proton linac upgrades, Muon g – 2, T2K upgrades, large double-beta-decay experiments, sterile-neutrino searches, ORKA, nucleon EDM, and next-generation hidden-sector searches).

The workshop report is not the end. Typically, developing, socializing, and implementing such a vision is a multiyear process. The vision will likely be fine-tuned as the physics and budget environments evolve. Implementation of the currently envisioned intensity-frontier program will be pressed for. HEP will continue to work with the community to develop future initiatives.

J. Dehmer asked, what if one changed project space into science space in the intensity-frontier landscape? Crawford replied that that would be what he would need in order to talk to someone on the Hill. It would be an excellent way to present this information. As it stands, the whole path forward hinges on what happens with the LBNE.

Vigdor asked what the plan was for coordinating with NP. Crawford replied that there is a working group and that HEP needs to have discussions with its colleagues in NP. They have questions about how neutron physics fits in. The report will be out soon, and HEPAP members will have a couple of weeks to comment on it. The draft will be reworked and sent to the Office.

Michael Salamon was asked to comment on the plans for the second-generation dark-matter program.

Each generation of dark-matter experiments produces an order-of-magnitude improvement in resolution. The first generation has supported R&D for several different weakly interacting massive particle (WIMP) detection media [liquid argon, liquid xenon, crystalline germanium, bubble chamber fluid (CF3I), CF4, and others] and has searched for axions in magnetized resonant cavities. It has also supported several small-scale experiments capable of reaching WIMP-nucleon interaction cross-sections of 10 to 45 cm^2 and one axion experiment. In the absence of detection, crucial information about backgrounds and other limitations are sought for each method and detector medium. These experiments were selected asynchronously.

The second-generation experiments are much larger, and a synchronous selection process is needed. It is desired to maintain leadership in this area. However, many technologies are not demonstrated and mature. A solicitation will be issued for 1 year of R&D with down-selection to two or three of the most promising techniques at the end of the year. At the same time, the first-generation experiments will be ongoing. Eventually, they will be a third-generation dark-matter experiment that will approach the background limits.

The second-generation funding opportunity announcement (FOA) just came out. It requests a letter of intent by early May. The proposals are due July 6. Selections will be made in September with funding commencing in FY 13. A CD-0 [critical decision zero: a statement of mission need] will be issued in the summer of 2012.

The FOA solicits proposals for experiments that will improve knowledge of a dark-matter physical parameter by at least 1 order of magnitude. The solicitation is for 1 year of research. It will not cover any fabrication or equipment acquisition. There will be a down-selection; only a few will be selected to carry forward into the project phase. Proposals for continuation support into the project phase will be submitted so a rapid selection can be made. These proposals will be jointly reviewed with NSF. The project phase will start with MIE funding in FY14. Critical Decision 4 (CD-4), the approval of the startup of operation, is to be reached by the end of FY16. Approximately $29 million will be available for FY14 to FY16.

Small experiments will be under the radar; they are not controlled by DOE orders and MIE restrictions. Down-selection will occur via the submission of a proposal to the DOE SC Continuation Solicitation (DE-FOA-0000411).

As the second-generation R&D activities occur in FY13, current first-generation experiments will continue fabrication and operations. Non-second-generation dark-matter experiments may always apply to the DOE SC Continuation Solicitation for support. This is a pathway for achieving competitiveness for the third-generation selection process in FY17 or later. These proposal reviews will be coordinated with NSF.

HEP will conduct an open workshop in late August or early September 2012 to assess the complementary roles played by direct- and indirect-detection experiments and by accelerator searches. The information obtained will be used to craft a strategic plan. This plan will be used to explain and advocate dark-matter research to governmental bodies and the community with an extensive technical document and a short "elevator" summary. This workshop will not provide advice or recommendations; only nonconsensual findings will be presented; it will not come under the Federal Advisory Committee Act (FACA). A dear-colleague letter will be issued for organizing-committee membership along with the workshop charge and goals.

Jonathan Kotcher was asked to present NSF's plans for underground physics.

The NSF is trying to respond to the defunding of DUSEL. Underground physics is overseen by the Particle Astrophysics Program director with much interaction with NSF and DOE program managers. In December 2010, the NSB voted to discontinue further DUSEL design funding. The NSF DUSEL facility design and cavities were zeroed out in the FY12 budget. Consideration of underground infrastructure and related activities at the Sanford Laboratory has shifted to DOE, with continuing support from the State of South Dakota. After the NSB decision, NSF agreed to provide $4 billion to continue dewatering and maintenance of security at the Sanford Laboratory to cover the remainder of FY11. Funds have been provided in the FY12 DOE HEP and NP budgets to maintain conditions in the Laboratory. The early science program is moving forward in the Large Underground Xenon (LUX) and MJD experiments with co-funding by the NSF and DOE. NSF assisted in the transition of the facility to DOE in FY 12; that transition was completed this past February. NSF is supporting the University of California at Berkeley team in that transition in any and all ways possible short of providing additional funds. The NSF/DOE Joint Oversight Group (JOG) continues to meet regularly.

Solicitation 4 call for proposals to develop designs and to pursue targeted R&D for potential DUSEL experiments in January 2009 resulted in 25 proposals from 300 senior researchers at 91 institutions. Nine proposals in physics were funded for a total of $21 million over 3 years. The total NSF DUSEL-related funding totaled $90 million.

As stated by the National Research Council (NRC) and other advisory panels, underground physics offers the opportunity for discoveries of seminal importance in the coming years. In light of this, and also in response to the recent shift in agency responsibilities, NSF PHY is redirecting its future-generation, facility-driven investments in underground research to the site-independent, nearer-term development of individual underground experiments and experimental techniques.

Such an approach is responsive to the stated NSF and NSB goals and directives as well as to the strong NRC and community endorsement of underground physics. It also optimally leverages investments in PHY and is consistent with its long-standing goal to support the best possible research. A dear-colleague letter announced this funding redirection in January 2012. The review and funding decisions are being coordinated with the Particle Astrophysics Program.

The dear-colleague letter [DCL] said that "PHY is redirecting its related investments from a primary focus on future generation experiments to one that emphasizes the greatest potential for scientific discovery that will evolve over the next decade. The scope of this ongoing program considers, in a site-independent and generation-independent way, the near- and mid-term development of detectors and related activities in underground physics." "The investment announced in this DCL is consistent with the ongoing practice in PHY to support world-class, transformational research at all three frontiers of particle physics, including those questions at the cosmic and intensity frontiers that can only be addressed by means of state-of-the-art detectors placed underground. It also continues the long-standing interagency partnership between PHY and DOE's Office of Science in this area of physics, as the agencies and the community adapt to the recent shift in responsibilities." "Subject matter for activities in this area may be interpreted broadly, but includes such topics as searches for dark matter, neutrino-less double beta decay, underground nuclear astrophysics, neutrino oscillations, proton decay, and other physics topics that require an underground environment. Proposals may request funds to support activities related to the development of underground physics experiments, including research and development, engineering and design, detector construction and deployment, operations and maintenance, and/or other activities on the critical path to significant scientific advances." "Proposals should be submitted to the Particle and Nuclear Astrophysics program and reference this DCL. The target date for submission is May 1, 2012. Applicants are requested to contact the cognizant Program Director in PHY prior to submission."

In the midscale, projects greater than $140 million are funded through the Major Research Equipment and Facilities Construction (MREFC) budget line. The Major Research Instrumentation (MRI) program supports the acquisition or development of instrumentation at universities costing from $100,000 to $4 million. A midscale instrumentation program is currently under development in PHY that would fill the gap between MRI and MREFC programs; it would support one-time capitalization, would be competed division-wide, and would be independent of the above-mentioned redirection of underground science funding.

In support of the next-generation dark-matter effort, the dark-matter community is, generally speaking, not ready to proceed with second-generation construction. NSF is supporting second-generation R&D, engineering, and design via the final spend out of solicitation-4 funding this year, as well as through the ongoing particle astrophysics program. Opportunities for future support for such development work exist via proposal submissions. Proposals to NSF should be submitted to the Particle Astrophysics Program in October 2013.

From all the advice received from the community, NSF is poised to probe a series of rich, fundamental questions, a number of which can be accessed only underground. PHY is adapting to a leaner, more focused future during this period of transition in U.S. underground research while the more global scientific and budgetary priorities are being assessed. Resources in the next few years will be stretched. A monthly, collaborative, consensus-driven community approach will be a major determinative factor in the quality of the scientific future that can be established. PHY looks forward to working with the community in defining this new path forward during this challenging time.

Akerib noted that there seems to be a mismatch between DOE's and NSF's approaches and timelines for the second generation of dark-matter experiments. Salamon replied that the timing works out well, and DOE's selection processes coincide with NSF's.

Rameika asked how many proposals were expected. Salamon replied, about ten with at least two remaining after down-selection; it is desired to do more than three. Rameika asked if they envisioned coordination with NSF to add their funding to DOE's. Kotcher responded that there will be coordination between the agencies but they may not fund the same experiments. Salamon added that this is a second-generation plan for the two agencies together. There may be *some* joint funding. Kotcher pointed out that they have no idea what money will be available. Funds will come from other sources, also; there will be flexibility.

Roe asked if the second-generation funding will be site independent. Kotcher answered that NSF is no longer authorized to move into a site-dependent experiment; it cannot build a facility. If someone wants to use a facility, NSF will consider funding forward. Salamon stated that the solicitation will be site independent. Experiments will be selected on the basis of the science and costs. Kotcher added that the proposals submitted will be independently reviewed by the two agencies with observers from the other agency. Selected projects will be reviewed cooperatively by both agencies. This model is not new; it has worked before.

Gilchriese asked if there will be other programs that will be conducted this way. Kotcher said that, at the moment, this is the only program that is being worked on.

Lesko noted that there are lots of rooms in the Sanford Laboratory that have been de-watered and that proposals for their use are welcome.

There being no further comments from the members or audience, the meeting was adjourned for the day at 5:33 PM.

Tuesday, March 13, 2012
Morning Session

The meeting was reconvened at 9:02 AM. Chairman Lankford reviewed the agenda and the protocol of drawing up the summary letter to the agencies.

Glen Crawford was introduced to describe the outcomes of the DOE comparative review process.

The goal of this effort is to improve the overall quality and efficacy of the HEP research program by identifying the best proposals. Program managers feel the need to directly compare groups working in the same area to optimize their programs, particularly in an era of tight research budgets. There are general concerns about fairness of funding distribution across the program. This process allows for better alignment of the research program with priorities. This change in process has been recommended by several DOE advisory committees, most recently the 2010 HEP Committee of Visitors.

This process is not just for existing DOE HEP groups. New grant applications are welcome. However, a proposal must be for scope not funded elsewhere. Of 232 PIs who were reviewed, 71 were not funded by DOE in FY11. There were hard page limits and other requirements. Proposals not respecting the page limits or other requirements were *not* reviewed; seven proposals were declined without review for this reason, and two were missing required budget sheets. One was outside scope of HEP, and two were withdrawn. PIs with proposals that were rejected for "technical" reasons could re-submit to the general DOE/SC solicitation.

All proposals were submitted to HEP by December, and a timely turnaround was performed on the mail reviews. The review panels were held Jan 19–27. In almost every case, more proposals were received than were expected. There were 104 distinct proposals, 15 of which had multiple research thrusts (requiring multiple reviews). HEP program managers met in February to assess reviews and decide funding. Fortunately, the FY12 budget had been resolved. New awards were issued to Chicago procurement by early March for a May 1 start date. Some projects are starting a bit later.

There were five panels with 4 to 16 panelists each; they met for one or two days to consider all the proposals submitted in a given topic area. Most reviews were "mail plus panel." Detector R&D was done by mail review only. Analysts considered the mail reviews and then discussed each proposal; other panelists were invited but not required to write a review. There was a full discussion of each proposal, the individual PIs, and the ranking. However, there was no consensus report. All panelists were asked to submit their individual rankings and commentary to DOE by e-mail. The key question was, "If it were your money, whom would you fund?"

It was generally very useful to have head-to-head reviews of PIs working in similar areas, particularly for large grants. There was lots of discussion of the relative strengths and weaknesses of individual proposals and PIs. In some cases, the metrics of success/impact are clear and agreed to (i.e., merit and relevance of proposed work; invited presentations, publications, citations, and h-index; mentoring and track record of students and postdocs). In other cases, there are other factors (i.e., contributions to operations and research infrastructure of experiments; synergy and collaboration within group; alignment with programmatic priorities). All of these factors weigh into final funding decisions.

Essentially, all proposals and PIs were rated good or above. This is understandable, but finer distinctions were needed. The reviewers were asked to rate each PI in quintiles relative to other active HEP researchers. This distribution was still skewed to the high end. Historically, about 30% of HEP proposals have multiple research thrusts ("umbrella" grants). Some were voluntarily (by PIs) broken into separate proposals for the purpose of this review. The remaining 15 "umbrellas" were broken (by hand) into their component pieces and reviewed by separate panels. Nonetheless, reviewers were also asked to evaluate the benefits of a larger group grant; in most cases, little tangible benefit was seen.

New academic faculty were encouraged to apply to the DOE Early Career (EC) program. This year's winners will be announced in April. However, the EC program is very competitive (about a 10% success rate), so most Junior faculty will need to apply for "regular" grant support. This year they were invited to do so through Comparative Review (even if their home institution's grant was not up for review). About 15 of these (typically 2nd or 3rd year faculty) were funded, typically for 1 or 2 years to "synch up" with the HEP group grant at the home institution. Also, some were funded through the HEP group grant.

The success rate (the percentage of those getting *some* funding) by topic was

- Energy: 78%
- Intensity: 83%
- Cosmic: 60%
- Theory: 61%
- Technology R&D: 68/75%
- Total: 70%

Most proposals are not fully funded at the requested level. About half of the proposals reviewed were from research groups that received DOE HEP funding in FY11.

By PI, the number of proposals received was

- Energy: 71
- Intensity: 37
- Cosmic: 21
- Theory: 78
- Technology R&D: 35 + 11
- Total: 253

and the success rate was about the same (63–81%) across topics (the total success rate for PIs was 70%). The success rate for new PIs was about 50% on average; the success rate for existing DOE PIs was about 75% on average. New proposals from PIs in their first year of academic appointment were not funded. Most (but not all) PIs who were funded were funded at the requested level of effort.

Fleming asked if it were policy not to fund first-year researchers. Crawford replied that, typically, they have funding from their institutions. It is desired to see some track record as a university researcher before committing DOE funding to them.

Erbacher asked if the unsuccessful Early Career Award (ECA) applications were considered. Crawford responded that DOE no longer does that. If they do not get Early Career Awards, DOE does not use the information from the ECA proposal.

Blucher asked what happened to those proposals from first-year people who could not be awarded. Crawford said that the proposal is sent back. It is clearly stated in the request for proposals that they are not eligible.

Akerib asked how the current success rate for current awardees compared with historical data. Crawford said that he did not have the historical data but expected it to be lower.

HEP Program Managers discussed various mechanisms for optimizing funding levels in response to the review outcomes. The following guidelines were sent to all PI's in the comparative review:

- Academic faculty summer salary support is limited to 2 months.
- Individual salary costs are limited (pro-rated as necessary).
- Support for some specific activities is ramped out.
- Research faculty/postdocs who are no longer supported effective with this action can be allowed phase-out funding. The duration of the phase-out period should be discussed with the grant monitor.

McBride asked if the availability of phase-out funds were widely known. Crawford responded that the information was sent to all funded PIs.

In December 2009, a dear-colleague letter was sent out that said, "We do not, in general, favor open-ended support for long-term research scientists on grants (as opposed to support for graduate students or post-docs), but we do consider each individual case on its merits. ... Support for academic research staff depends on the quality of their work, the overall quality of the proposal and its alignment with programmatic goals, and overall cost considerations. ... Proposals which do not review well will likely be supported at a level significantly below the budget request, if at all. This has serious impacts on research staff who derive some or all of their support from the grant.

As managers of the grant, PIs need to be cognizant of these realities and have contingency plans for supporting or transitioning research staff if their new or renewal proposal is not funded at a level sufficient to retain them. "

About 20 senior research scientists or research faculty were included in the 2012 comparative review research proposals, dominantly in the energy frontier. In general, they did not review well (11 of 20 were dropped). Many were regarded as not making unique or particularly compelling contributions commensurate with their positions (e.g., "doing work that could be done by a postdoc"). The breakdown by type of work was three on LHC experiments, five on CDF/D0 (planning to migrate to LHC but not done yet), one on detector R&D, and two eliminated because the PI was dropped.

There were lots of questions about the new proposal process, the review process, and the outcomes. The Office is working with PIs to minimize adverse impacts and avoid unintended outcomes and will work with LHC and Fermilab operations managers to better understand the impacts on people who have an operations focus. Groups that were "borderline" before did not necessarily get that message. All the proposers will get all of their reviewers' comments back.

Erbacher asked if any trend were seen in the different opinions that the reviewers held. Crawford replied that it was observed that those who do facility operations do not do as well when reviewed by those who do, say, data analysis. The challenge for operations-oriented proposers is to show that they make important contributions to research efforts.

Honscheid asked if this were another way to shift funding from university personnel to national-laboratory personnel. Crawford replied that national-laboratory people are reviewed separately, and the (largely university populated) panel will review their contributions to research. Erbacher noted that institutional memory is important. Expecting them to do a central role in analysis seems to not value institutional memory. Crawford said that that argument was not found compelling by the review panels.

Harrison asked if any data were collected on the minority success rate. Crawford said that the only data in hand is that one historically black college or university was a proposer and was funded.

This was a new process but ran relatively smoothly. The goal is a better-optimized, more efficient program. It is believed that, overall, better outcomes resulted. A large number of new (to DOE) PIs applied, and about half are being supported. Current PIs mostly reviewed well, but there is some turnover. The total number of funded PIs is about constant, but the demographics are changing. Several new junior faculty were supported. Some senior faculty are no longer supported. Several senior research faculty are no longer supported. It is expected that the total number of full-time equivalents (FTEs) supported will be down somewhat. The solicitation for the 2013 comparative reviews will out this summer.

Ramond asked if there were a transitional process if a senior scientist is working on a successful group and does not get funded. Crawford responded that six months additional funding was made available plus more for any postdoc affected.

McBride expressed concern about compromising the institutional memory with the defunding of senior researchers in operations. If funding were not shifted to operations, there could be a disconnect. Procario replied that there were more than 100 FTEs in that program, so nothing disruptive is being done. Those people are going to be moved into operational positions.

Gilchriese asked if they were a target level of funding. Crawford said that the program managers have budgets. There is some flexibility. An effort is being made to hold the research line at about the FY11 levels or about $120 to $130 million in university grants.

Cohen asked if there were anything new this year. Crawford said that they had explained the process better. The reviewers and the information they gave to DOE were what was expected and worked pretty well.

Lankford noted that letters had been received from the community. A letter from Chip Brock et al. said that some funding for senior researchers was being eliminated, affecting their universities and the experimental facilities that were constructed and operated by those universities (e.g., components for D0) and that the severity of those actions should be openly discussed. A second letter from Michael Tuts and other LHC program managers said that the success of the LHC relies on the core LHC funding and university funding, and the cuts to those who made critical contributions to facilities will affect operations. Therefore, those cuts should be reassessed. Substantial investments have been made in the LHC program, and those investments are being undercut. Copies of these letters are included in these minutes as Appendix A and Appendix B.

Crawford said that the Office agrees that the overall success of the program is important, but it has to live within its budget. This is a useful discussion to have. Universities feel that they have important infrastructure and personnel to contribute. It is an open question where the balance is to be found. The Office welcomes input on that decision.

Ramond said that the community was not aware of what was coming, even though it was specifically stated.

Weerts noted that the entire community relies on the review process. The reviewers were part of the community and knew what they were doing. People might not agree with the reviews, but they have to live with them. He asked what went wrong. Crawford replied that he did not think that anything went wrong. A good outcome was achieved. More work needs to be done with the community to mitigate unintended consequences. Siegrist noted that there is a separate process to review operations. The Office needs to figure out how to deal with people who reach across such distinctions.

Erbacher said there could be an issue with the review process; the D0 letter brings up a philosophical point about how to do research in this country. Taking away research staff removes the last way for universities to contribute to these projects. It seems like funding is being shifted away from the universities. Lankford interjected that he believed that he heard that DOE is interested in entering a discourse on this topic.

Honscheid said that only 75% of the prior awardees got re-awarded. He was concerned about those people who were not re-awarded. Crawford pointed out that they can reapply next year. The Office cannot reshuffle funds to cover those people except for some transitional funding.

Joseph Lykken was asked to discuss new HEP results that shape the future program.

A lot is new. At Daya Bay last week, the value of Θ_{13} was found to be nonzero and likely to have a fairly large value. It is being nailed it down to some reasonable error bars. This determination eliminates several theories that have predicted a small value. It is good news for NOvA's chances to resolve the neutrino mass hierarchy and to determine if Θ_{23} is maximal or not. It allows prediction of the fraction of CP violating phase for which the mass hierarchy can be determined, given a beam power, detector, and run time. A bigger value of Θ_{13} is also good news for LBNE's probability of finding neutrino CP violation.

Also in neutrinos, the OPERA problem is probably with the cables.

Reactor data seem to hint at sterile neutrinos. There are also cosmic hints that sterile neutrinos may exist. Measured values are larger than those predicted by models. Something should come out of Planck about the cosmic microwave background. The Fermi Short-Baseline Neutrino Focus Group was set up in January 2012. It is to consider new-generation detectors and/or new types of neutrino sources that would lead to a definitive resolution of the existing anomalies. Its report is due in May 2012.

LHCb is closing the window. A new measurement puts bounds on two rare decays. Models of new physics like supersymmetry (SUSY) can make large contributions. For a large tan β SUSY, one had better have a large M_A. It makes the lightest Higgs in SUSY more like the Standard Model Higgs.

From LHCb and CDF, there are indications of a CP asymmetry in the D^0 to kaons decay, producing a 4σ deviation from the estimates of what this should be in the Standard Model. It is a difficult Standard Model calculation, but one gets a large deviation. One can ask whether one can do a calculation in the Standard Model that is not wrong but gives a value 5 times bigger than expected. Yes, you can do such a calculation, and it shows that there is a lot of slop, and a better job needs to be done.

On the other hand, it could be new physics (i.e., supersymmetry) . It could be a chromomagnetic penguin from left-right squark mixing in SUSY. It is compatible with squark/gluino masses larger than a TeV, compatible with D-D mixing data, and borderline for electric dipole moments. An analysis at Fermilab has just shown that most other BSM explanations have more serious problems explaining this result.

Things are happening at the energy frontier. From searches for the Higgs at the LHC, it has been learned where the Higgs is not. We do not have a CMS/ATLAS exclusion. In the low-mass region, we are now excluding 110 to 117.5 GeV and 118 to 122.5 GeV. Then there is a 5-GeV gap and an exclusion from 127.5 to 600 GeV. At that point, the Higgs is getting so broad that the experiments do not know what they are supposed to do. Separate ATLAS/CMS 95% CLs exclusions for Standard Model Higgs have been found in mass ranges of 110 to 117.5 GeV, 118.5 to 122.5 GeV, and 127.5 to 600 GeV. There is a 99% CLs exclusion in the mass range from 129 to 525 GeV. This is a very convincing exclusion that is being obtained. In what is left over, there may be a Higgs.

In the golden mode, there is a bump that is exciting. However, the most sensitive channel does not show much of an increase, which should give one pause. But, obviously, neither the ATLAS nor CMF nor their combined measurements is conclusive, but it is interesting.

What is very new is the Tevatron. Four years ago, P5 [the Particle Physics Project Prioritization Panel] was interested in the scenario in which the Higgs decayed into $B\bar{B}$; also, it noted that the CDF and D0 sensitivity has improved faster than one would expect from the integrated luminosity. P5 pointed out that, if that improvement continued, these searches would be quite interesting. Indeed, there has been such an improvement in the sensitivity of these analyses; and on CDF, one sees a 2σ excess between 120 and 130 GeV in the $B\bar{B}$ channel. It is not trivial.

Another interesting Tevatron result is the W mass measurement with a very small error bar of 15 MeV that pushes down the bounds of the Higgs. The upper bound now goes down to 150 GeV. This makes it worse for the models living at the ragged edge.

What if the 125-GeV residence is real? That does not mean it is a Standard Model Higgs. Several questions have to be answered: Is it spin-0? Is it the CP-even? Does it come from a weak doublet? Are its couplings proportional to masses? Is it composite, or is it an elementary scalar? Are there other neutral or charged resonances? Do other things decay into it? Has all the possible associated production of it been looked at? If you are at 125 GeV, there are a lot of modes to play with.

But maybe it is not the Higgs. Maybe there are Higgs look-alikes that exist for other reasons.

One can see in the golden mode that the CMF plot shows *two* events in one bin where one would expect *one-third*. The data might be background, but if increased by a factor of 5 this year, they may be seen as a real discovery. In 2012, we could end up with something clean and convincing. One could have six relative degrees of freedom to work with for full-likelihood hypothesis testing. One could get into the game of figuring out what we are talking about with the Higgs relatively easily.

For SUSY, a 125-GEV Higgs is on the high end of a light Higgs. This is telling us that, in SUSY, you have to work to make the Higgs.

What if this residence is not confirmed and the Standard Model Higgs is ruled out completely? In that case, we probably have a non-Standard Model Higgs.

There could be a non-Standard Model Higgs with some combination of suppressed coupling to gg, being very light or very heavy, or decaying to exotics. There could be no Higgs at all, in which case unitarity requires other heavy resonances.

If there is not a Higgs, what else might there be? There could be heavy resonances that have very small production cross-sections. Then we would have to be very patient and wait.

What else is happening at the LHC? Where is SUSY? An mSUGRA with a 1-TeV gluino and 1.5-TeV squarks rules out some SUSY models. There are no excesses in these channels.

Were some lighter superpartners missed? Lighter charginos and second neutralinos would be expected. Naturalness would prefer lighter stops and perhaps sbottoms. Inclusive searches can capture some of this, but it is better to have targeted searches, too. Both ATLAS and CMS started to do this in the 2011 data, producing a limit (but not a generic limit). We are starting to get into a more relevant regime for these more-targeted searches.

The question arises, is SUSY hiding? A recent theory postulates that LSP is a nearly massless gravitino, NLSP is the lightest stop (only 15 GeV heavier than the top), and the missing transverse momentum in SUSY decays is suppressed. Already with the 2011 LHC data, novel analyses are aimed at light stops, so there will be something definitive to say about this model in 2012 one way or the other.

Other models will be more difficult to address. The SUSY search is a long-scale project. About 100 searches are going on for all sorts of exotic things besides SUSY. Either finding or not finding something will be very informative.

In dark matter, there is a new exclusion limit, and there are three experiments that are finding signals.. There will be a new CDMS look at the CoGeNT annual modulation signal. CoGeNT claims that they see such a signal. CDMS ought to see it, also; but CDMS does not confirm such a signal. Another CDMS-CoGeNT mismatch was in the energy spectrum until the problems with surface contamination events in CoGeNT were taken out. Then the energy spectra looked better.

DAMA has been claiming to see annual modulation for years. DAMA and CoGeNT are compatible, but to get CoGeNT and DAMA data to agree, one has to have a nonstandard halo distribution for the dark matter. These developments show the maturity of these dark-matter analyses. Still, a lot of uncertainty has to be factored into these experiments.

CMS is now making exclusion plots. They are saying that light WIMPs can be produced at colliders. This procedure assumes that the WIMP is a Dirac fermion and that the mediator is heavy. One can then use effective operator analysis to relate collider monojet and monophoton searches to direct dark-matter searches. This procedure already gives strong limits, which are certainly competitive.

In summary, the neutrino program has great prospects. Flavor keeps surprising us. We do not know if there is a Higgs, no Higgs, or Higgs look-alikes. We must keep beating the bushes to flush out SUSY or other BSM. And the dark-matter connections (direct vs direct, direct vs indirect, direct vs LHC) must be made.

Yamamoto asked what one would do if nothing were found. Lykken replied that one would need to probe higher energy fields. The Standard Model could survive, but then one would have to explain where dark matter came from. Fine-tuning is a big problem. There will always be a number or initial condition that cannot be explained by a theory. Some people say that that point has already been reached. He did not believe that.

Erbacher was surprised that the Tevatron results on the Higgs and on limits on dark matter from nanojet structures were not mentioned. Lykken agreed that the history of that is very important. Theorists at Fermilab thought it up, CDF went out and did it, and then the LHC did it. A lot of people should pat themselves on the back. The largest excess is at 120 GeV. People have often said that this was the most sensitive channel and therefore was very important, but he would have a more nuanced view: The gamma-gamma is nice in that it has a bump, but one is never going to have any more evidence. For the bump at 125 GeV, all one has to do is wait for more data.

A break was declared at 10:49 a.m. The meeting was called back into session at 11:13 a.m.

James Siegrist was asked to reflect on the current U.S. high-energy physics program vis-à-vis the 2008 P5 plan.

Fermilab is the HEP main laboratory. The Office's first priority is to increase the research capability investment at Fermilab to support its future intensity frontier program, while keeping all three frontiers in balance. Fermilab must concentrate efforts in this area, and the rest of the community needs to support that mission, where appropriate. The other national-laboratory groups, in addition to bringing their unique expertise to the program, need to serve as portals to other programs in SC. They must interact with and use material science, computing, nanoscale, etc. to enable new technologies for use by HEP. HEP expertise must be transferred to other fields in detector and accelerator technology, but national laboratories must keep alert for opportunities elsewhere. It must also continue their connections and collaboration with universities, as has historically been the case. Fermilab can do this directly on large projects, or collaborate with the other labs.

HEP's goal is to increase connections to other SC programs to help stabilize its budget as well as because it is an intellectually good thing to do.

HEP needs to continue to develop the science case and to plan a program on all three frontiers. It needs more projects in the pipeline than it has budget to be certain that the funding directed out of the program into construction will not be lost. If one does not have a line item for construction, one risks losing the money in the future.

The plan for Snowmass in summer 2013 is to assess HEP's program. Active participation of the community is needed in the development of the science case, with national-laboratory leadership in the background. DOE and NSF agree on this approach. This is an inversion of the traditional HEP modus operandi. The HEP community needs to own the science case and sell the science case.

On the intensity frontier, DOE/NSF plan to work with DPF to continue the development of the science case started at the December workshop. FNAL will lead work on research infrastructure improvements to support that science case.

On the energy frontier, DPF could do the same, or the LHC users organization could do it. It is less time-critical than the intensity frontier, but discoveries at the LHC could change this situation rapidly.

For the cosmic frontier, HEP is less clear on how to proceed. Solicitations for second-generation direct dark-matter detection are in place. Work is needed to further develop other parts of the program, especially in dark energy.

On the LHC, the Office is developing a CD-0 for near-term detector upgrades. U.S. participation in the large planned upgrades later in the decade is not a sure thing. Plans will need to be developed carefully, and an appropriate foundation will need to be laid to request participation in the intensity upgrade of the machine.

On the ILC, the Office will keep a *very* low-level Global Design Effort (GDE) involvement while it waits to see if another region will press forward with a project. The physics case for this potential Higgs factory will need to be developed and sold to the community. A participation decision is most likely above all our pay grades. The Muon Accelerator Program (MAP) is concentrated on a machine way off in the distance, and the Office is concentrating on near-term deliverables in all our communications. There will be a laboratory review this summer.

On the intensity frontier, a science case needs to be developed. Continued community engagement is a must. Theorists need to engage in development of the program. Generally, more protons on target are needed at FNAL to support the intensity frontier program. FNAL is looking at options here. International contributions to the U.S. intensity frontier efforts will help stabilize the program.

On the cosmic frontier, the HEP community needs to decide what physics it wants to do. Beyond the mantra of dark matter, dark energy, and everything else, what should this program look like? Once that has been figured out, the science plan needs to be taken to other communities and other agencies to look for a fit. HEP priorities and operating principles need to be maintained. Lower-cost and faster options are welcome.

The P5 framework is a solid foundation, but some of the recommendations have been overtaken by events. Budgets have generally been on the lower end of plans. However, one does not want to give up that foundation or "re-open" project prioritization at this time. Instead, one should evolve and strengthen the P5 plan from a better understanding of the science opportunities and with new and improved input data (including the current budget environment). DOE and NSF believe that this is crucial for a successful Snowmass meeting and the future U.S. HEP program. Community leadership in developing the science plan is more important than ever. The DPF would take the lead in developing this plan. There are several areas in which we need a greater diversity of ideas. Another P5 review is not envisioned at this time.

Fleming said that it seems that Snowmass should be held this summer. Siegrist replied that the community is not that well organized. McBride added that the community wanted more data from the LHC and on Θ_{13}.

Lankford asked what events had overtaken the P5 framework. Siegrist responded that DUSEL was not being built anymore. If LBNE costs too much, it may need to be rethought.

Patricia McBride was asked to review the European HEP strategy.

The process for planning the European strategy is a formal one. A mandate has been given to the European Strategy Group (ESG) to establish a proposal for an update of the medium- and long-term European Strategy for Particle Physics to be approved by the CERN Council.

The aim is to enhance existing European particle physics programs; increase collaboration among Europe's particle physics laboratories, institutes, and universities; promote a coordinated European participation in global projects and in regional projects outside Europe; and encourage knowledge transfer to other disciplines, industry, and society. The proposal is to include a review of the implementation of the 2006 Strategy as well as of the structures and procedures currently in place with regard to the Strategy.

The Strategy adopted by the Council in July 2006 consists of two general issues; eight scientific activities (LHC, accelerator R&D, ILC, neutrinos, astroparticles, flavor, nuclear physics, and theory); four organizational issues (CERN Council's role in coordinating European particle physics, globalization, nonmember state relations, and relations with the European Union); and three complementary issues (outreach, technology transfer network, and relation with industry). There is a glossy book that comes out, also. The update to the 2006 Strategy is under way. It is to outline priorities with special emphasis on future large infrastructures and projects, including preparatory steps for a next project at CERN after the LHC. It is also to consider possible future participation by CERN in experiments outside the Geneva laboratory as part of the Strategy implementation. The CERN Council updates the Strategy every 5 years by setting up a working group, the ESG, that is assisted by the European Strategy Preparatory Group (ESPG). The kickoff meeting for the Strategy update was held at a joint European Committee for Future Accelerators–European Physical Society (ECFA–EPS) session during the 2011 EPS meeting in Grenoble.

The European Strategy Group is to draft the Strategy statements. It is made up of the Scientific Secretary of the Strategy Session of the CERN Council; Tatsuya Nakada chairs the ESG and the Preparatory Group. The ESG will meet in January 2013 to prepare the Draft Strategy Statements during a week-long session. The next ESG meeting will be held on March 16, 2012. The ESG membership includes Melvyn Shochet from the United States.

The update process was opened for submissions on scientific issues on February 1, 2012. Submissions closed for the Open Symposium on July 31, 2012. All submissions will be made available to the speakers and the session chairs of the Open Symposium. The Open Symposium will be held at Cracow on September 10–12, 2012. Submissions closed for being included in the Briefing Book to the Strategy Group on October 15, 2012. The Strategy Group is meeting to draft the Update of Strategy on January 21–26, 2013. The Update of Strategy will be finalized by the CERN Council in March 2013. A special Council session will be held to adopt the Update of the European Strategy in Brussels in May/June 2013.

The ESPG collects and prepares the scientific and technical material for the Strategy Update. It compiles community input and discussions from the Open Symposium into briefing documents. It also plans the agenda and organizes the discussions for the Open Symposium. The ESPG meets once

per month to collect information and determine how to organize it. The topics for submissions are: accelerator physics,
astroparticle physics, gravitation and cosmology, flavor physics and symmetries, physics at the high-energy frontier, physics of neutrinos, strong-interaction physics, particle-physics theory, general infrastructure and facilities, and general comments. Input should be self-contained and be up to 15 pages in length.

Lankford asked what the different roles for the ESPG and the ESG were. McBride answered that the strategy group synthesizes all the information provided by the preparatory group. Langford asked what her role was as a representative from the Americas. McBride replied that her role was to communicate about the process and about what is done here. Langford asked if there were other regions asked to provide input. McBride responded, yes; they can submit 15-page summaries.

Merminga asked whether Europeans will be allowed to participate in U.S. research. McBride said that that will likely be discussed. The preparatory group will gather information about the U.S. efforts, and the strategy group will decide if it is to be included in the Strategy.

Pierre Ramond was asked to describe the plans for the Snowmass 2013 Conference.

The Snowmass process attempts to speak for the community, articulate its vision, and engage the community. It will hold two meetings: October 11–13, 2012, at Fermilab and June 2–22, 2013, at Snowmass, Colo. The first meeting is designed to provide input and structure to the second. The process will consider the cosmic frontier, energy frontier, facilities frontier, instrumentation frontier, and intensity frontier. This framework is very general. It needs to engage the younger members of the community, giving them the widest possible representation in the planning process, including junior faculty, postdocs, and students, and encompassing computing, education/outreach, and diversity. The coordinators also want to address interconnections between frontiers, with other APS divisions, and with the international community.

The process is patterned after the Intensity Frontier Workshop. There will be three conveners for each frontier: an experimentalist, a theorist, and an outside observer (to add perspective). Conveners will then organize subgroups along the same structure. Each subgroup should have at least one meeting before the Community Planning Meeting in October of 2012 (CPM-2012). A half day at CPM-2012 will be devoted to each frontier report and discussion.

From the CPM-2012, what is expected is no detailed writeup but a brief summary from each frontier to ensure success of the Snowmass planning exercise. These subgroups will hold focused meetings between CPM-2012 and Snowmass. From the Snowmass meeting will come a writeup of some 25 to 30 pages for each of the five frontiers. This process is community driven and is intended to produce an intellectual and practical roadmap for U.S. particle physics.

The meeting is being held now because of the emerging physics: dark-matter experiments are maturing and may be on the verge of discovery. There are evocative signals from the LHC and the Tevatron heralding the Higgs completion of the Standard Model. The LHC results may suggest the need for new accelerators. Large-area planar photodetectors are being developed and deployed. And neutrino mixing angles from Daya Bay suggest another important source of baryon asymmetry in the universe.

What is next? There will likely be a new generation of dark-matter experiments. A low-mass Higgs suggests a weakly coupled Standard Model at short distances, opening the way for supersymmetry and grand unification. LHC physics will suggest the need for new accelerators, neutrino beams, and an underground facility. Large-area photodetectors hold the promise for new observations. CP-violation in lepton mixing may be measured, and grand unification rekindles the search for proton decay.

The realities are that Fermilab's Tevatron is shut down. The energy frontier has moved to Europe with significant contributions from U.S. physicists. For the first time since the Second World War, there is no major particle physics project left on U.S. soil. There are recurring budgetary uncertainties. The good news is that U.S. programs continue to probe nature's inner secrets; witness the community enthusiasm at the Intensity Frontier Workshop.

The United States appears to be retreating from the basic sciences frontier. With the engagement of the particle physics community and with the support and encouragement of the DOE and NSF, the United States can be kept at the basic sciences frontier.

Kim pointed out that Fermilab's neutrino beam is a very powerful beam, and together with NOvA will be 725 kW and can provide the best science. Ramond replied that all these things will be highlighted in the right way. The HEP community sells ideas and discoveries. It has to say that to the public and funders.

Rameika noted that there is a lot of science out there, and stated that the HEP community's interests should be pushed without minimizing the other endeavors. Oddone said that one needs to speak to one topic and not confuse one's audience. The United States *does* have large and major facilities that are supported.

Roe said that the meeting should reflect accelerator and nonaccelerator facilities. Ramond replied that it is structured that way.

Glenzinski said that one cannot just say that one wants everything. There are budgetary limits. Ramond responded that a certain focus is desired. It is desirable to be practical. The community will have to make decisions. It is expected that the community will become engaged as the process goes along.

Lankford opened the floor to general discussion. Glenzinski said that he did not believe that one could get a practical roadmap in three weeks at Snowmass. McBride agreed. There has been no agreement about what will be the output of Snowmass. The process will last more than a year. Glenzinski said that the tough choices require people to step outside their own interests. Rameika stated that a bad outcome would be a big book of everybody's interests. The community needs to figure out how to speak with one voice. Hard decisions cannot be made without understanding the budgeting constraints. The community will need realistic costs to consider.

Meringa said that, in 2007, a Nuclear Science Advisory Committee (NSA)C) Long-Range Plan gave four prioritized recommendations that the community embraced through a series of town hall meetings synthesized by a committee. There was also a plan on how the recommendations would fit into budgetary envelopes. McBride responded that using such a small group to define such syntheses in funding limitations should be considered. Siegrist added that practical roadmaps are always useful, but community buy-in is primary. If the community could agree on what the science should be, DOE and NSF could prioritize after that. Compelling science can produce excitement and funding. He was worried about having budgeteers telling scientists what science to do.

Cvetic asked if there were a prioritization aspect. Salamon replied that it depends on how far the community is comfortable in going. McBride added that the community needs to decide whether it wants a vision or a roadmap. The conveners need to decide if there will be a prioritization step.

Erbacher asked how young researchers would get involved. McBride said that there had been a lot of discussion about that. The conveners need to get a more proactive. Many who were young investigators at the 2001 meeting are now established in the field.

Kim asked if this were to be a 10- or 20-year plan. McBride said that one has to do both. Kim noted that some of these projects have long construction times. The critical points are the commitments that have already been made.

Lankford opened the floor to discussions of topics for the summary letter to the agencies. A draft will be circulated by e-mail to panel members for comment.

Glenzinski said that the letter should mention the accelerator plan required by Congress. It is important for the agencies to act quickly on, say, a roundtable. Other stakeholders should see that plan for comment. Erbacher observed that it was presented as being HEP centric; however, the BES seems to have funded accelerator and light sources, too. She asked how future R&D will be split. Zisman said that HEP's strength is long-term accelerator R&D. HEP will not be Varian's R&D division. HEP should work on problems that will have economic benefits. Decisions will be made on a case-by-case basis. The primary goal is discovering science.

Fleming suggested underscoring how successful the Intensity Frontier Workshop was. McBride suggested adding how the success of the workshop is being continued. Collapsing the whole document into one physics problem may be overreaching. Crawford stated that there will be several themes to the report and brochure. The Office will get the draft report from Weerts and Hewett and will review its contents.

Rameika said that, if one reads the report, one does not know what the best bang is for the buck. All the projects cannot be put on an equal cost footing. Crawford said that there should be two parts: the science case and the Strategic Plan. Rameika asked how the Strategic Plan is to evolve. Crawford replied that the current plan will be taken to Congress in June, and then it will be decided what we would like to see in the next decade. The Strategic Plan would be expected to be sensitive to budgets and it will be a public document that people can comment on. Cvetic noted that a number of new ideas have been put forward and asked if they will get grafted into the plan. Crawford said that this will be a high-level, general plan, setting goals and some suggestions on how to get there. Byrum said that the main things are vision and buy-in. Salamon agreed. Steinhardt asked how the Panel members can help. Crawford said that, if one has better ways to phrase these topics, those suggestions would be welcome. Lankford said that there is a danger of telling too simple a story. The intensity frontier is very complicated; it is not a one-measurement frontier. Salamon pointed out that there is a gradation of science across the government. There are those who are conversant in the field. But they need to talk with many decision-makers who are not conversant. Therefore, one does not escape this issue.

Honscheid asked if there were enough facilities in the hopper. Siegrist replied that the Office needs to work on what the contribution in facilities might be.

Lankford asked if there were any comments on dark matter. Steinhardt said that there are many opportunities for exciting discoveries, but they are scattered among many areas like cosmic microwave background, black holes, and gravity waves. The planning process should allow for this diversity. The situation could be quite fluid. depending on what is found in the next few years. Lankford agreed that a better plan is needed for the cosmic frontier. Siegrist said that this topic needs to be thought through and what is needed needs to be figured out.

Rosenberg pointed out that the intensity frontier has a lot of overlap with the cosmic frontier. However, a narrower definition is needed. The cosmic frontier is not just dark matter, which itself is a very broad field. HEP needs to cooperate with other agencies and offices that are supporting dark-matter research. Siegrist said that that should be re-discussed. The HEP community needs to define what it wants to do so the Office can cooperate with other agencies.

Lankford asked about the dark-matter solicitation. Rosenberg said that the solicitation was very clear and specific. Langford asked about cooperation between agencies in this area. Rameika said that the DOE presentation was very good. The budget is quite small. There is a lot of overhead already; with NSF involvement, the overhead costs may become murky. Byrum said that NSF should be clearer in its funding. Glenzinski said that there was not a lot of room for additional ground unless DOE and NSF worked very closely together. The time scale is very aggressive, also. Lankford said that he was glad to see the high level of coordination in this matter between DOE and NSF. He asked if there were comments that should be made about the highly constrained agency budgets. Erbacher noted that BES funding went up in response to administration priorities. The accelerator mandate is unfunded. One might ask for more money or siphon off BES funding. The community needs to step up its communication with its political leaders. Rosenberg said that he did not see any unfunded mandate. Billions are going into accelerator R&D, and those will be repackaged. Zisman said that there is a potential for an unfunded mandate. HEP will not drop all that it is doing and build accelerators. If one builds a demonstration project, there has to be some mechanism for funding. Rosenberg said that any future large projects should be competed against other proposed large projects. Glenzinski asked whether this Panel had not said that HEP is the steward of accelerator research. Rosenberg said that a broader community could look at that issue.

Lankford noted that the comparative review issue had been heavily discussed. He asked if there were any changes that should be made before the next round. Fleming said that she was still unhappy that first-year researchers cannot apply. Crawford replied that there is no prohibition against people applying, but the chances of being funded are very small because first-year researchers have no established track record as university faculty. Proposals that are more documented rise to the top. Rameika said that, if a first-year faculty person does not have support, he or she does not have any way to produce a track record. Honscheid said that the amount of money they pay new hires is too high. Rosenberg said that no one is bringing in a new hire with no support. That is not a viable business plan. He did not understand the implications of the letters that were submitted. The costs of these senior people should be funded in a program that reflects their contributions. That seems to be what DOE is suggesting. Honscheid said that the Office needs a mechanism to pick up these people who are viewed as being in the wrong part of the program. Maybe these commenters should be part of the review. Erbacher said that part of the problem is that reviewers bring different perspectives, and a perspective can come and go with reviewers. The broader concern is that these researchers are not being valued anymore. Eleven out of twenty were eliminated; some are being valued and reviewed well. McBride said that there is a value to things that cannot be measured by a physical publication. The community has been led to panic. Crawford noted that the umbrella grants were broken into their components, and sometimes the added value was not recognized.

Lankford announced that the next meeting will be August 27–28, 2012. There being no further comments from the members or the public, the meeting was adjourned at 1:51 p.m.

Respectfully submitted,
Frederick M. O'Hara, Jr.
Recording Secretary
April 18, 2012

Andrew Lankford
3/11/13

Appendix A.

Appendix B.