Draft Minutes
High Energy Physics Advisory Panel
May 29-30, 2008
DoubleTree Hotel, Washington, D.C.

HEPAP members present:

Hiroaki Aihara
Jonathan A. Bagger, Vice Chair
Alice Bean
Daniela Bortoletto
James E. Brau
Robert N. Cahn
Priscilla Cushman
Sarah Eno
Larry D. Gladney
Robert Kephart
William R. Molzon
Angela V. Olinto
Tor Raubenheimer
Melvyn J. Shochet, Chair
Sally Seidel
Maury Tigner
William Trischuk
Herman White
Guy Wormser

HEPAP members absent:

Patricia Burchat
Joseph Lykken
Stephen L. Olsen
Saul Perlmutter
Lisa Randall
Kate Scholberg
Henry Sobel

Also participating:

Charles Baltay, Department of Physics, Yale University
Barry Barish, Director, Global Design Effort, International Linear Collider
Joseph Dehmer, Director, Division of Physics, National Science Foundation
Patricia Dehmer, Deputy Director for Science Programs, Office of Science, Department of Energy
Robert Diebold, Diebold Consulting
Thomas Ferbel, Office of High Energy Physics, Office of Science, Department of Energy
Marvin Goldberg, Program Director, Division of Physics, National Science Foundation
Michael Harrison, Physics Department, Brookhaven National Laboratory
Judith Jackson, Office of Communication, Fermi National Accelerator Laboratory
Chang Kee Jung, Department of Physics and Astronomy, Stony Brook University
Young-Kee Kim, Deputy Director, Fermi National Accelerator Laboratory
Jacobo Konigsberg, Department of Physics, University of Florida
John Kogut, HEPAP Executive Secretary, Office of High Energy Physics, Office of Science, Department of Energy
Dennis Kovar, Acting Associate Director, Office of High Energy Physics, Office of Science, Department of Energy
Joseph Kroll, Department of Physics and Astronomy, University of Pennsylvania
Andrew Lankford, Department of Physics and Astronomy, University of California at Irvine

Marsha Marsden, Office of High Energy Physics, Office of Science, Department of Energy
Piermaria Oddone, Director, Fermi National Accelerator Laboratory
Frederick M. O'Hara, Jr., HEPAP Recording Secretary, Oak Ridge Institute for Science and Education
Robert Tschirhart, Computing Division, Fermi National Accelerator Laboratory
Michael Tuts, Physics Department, Columbia University
Andreene Witt, Oak Ridge Institute for Science and Education
Philip K. Williams, Office of High Energy Physics, Office of Science, Department of Energy
Stanley Wojcicki, Department of Physics, Stanford University

About 60 others were present in the course of the meeting.

Thursday, May 29, 2008
Morning Session

The meeting was called to order at 8:59 a.m. Chairman **Melvyn Shochet** asked **Dennis Kovar** to give a status report from the DOE Office of High-Energy Physics (OHEP).

The FY08 program had a reduction from the request. It has been a productive program nonetheless. Tevatron is running well with the Collider Detector at Fermilab (CDF) and D0, the Main Injector Neutrino Oscillation Search (MINOS), and MiniBooNE. The B-Factory completed a successful 4-month run. The Large Hadron Collider (LHC) and the A Toroidal LHC ApparatuS (ATLAS) and Compact Muon Spectrometer (CMS) detectors are proceeding on schedule. The Gamma Ray Large Area Space Telescope (GLAST) is set to launch in June. And a number of projects are under way: Main Injector Experiment ν-A (MINERvA), Tokai-to-Kamioka (T2K), Daya Bay, the 200-kg Enriched Xenon Observatory (EXO-200), Dark Energy Survey (DES), and Second-Generation Cryogenic Dark Matter Search (CDMS-II). DOE and the National Aeronautics and Space Administration (NASA) are planning to proceed on the Joint Dark-Energy Mission (JDEM). An agreement has been reached with the National Science Foundation (NSF) on the LHC Phase I upgrade. Funds have been increased for Outstanding Junior Investigator awards. A dark-energy R&D solicitation has been issued.

Significant impacts of the budget include the curtailing of the B-Factory run; the reduction of staff at Fermilab; the stopping of the NuMI Off-Axis ν_e Appearance (NOvA) experiment; and reducing support for the International Linear Collider (ILC) and superconducting radiofrequency (rf) R&D to a minimal level.

An FY08 supplemental bill was passed by the Senate that gives an additional $45 million to HEP, but there has been no action by the House.

A U.S.-Japan annual review meeting will be held at Brookhaven National Laboratory (BNL). There will be a Fermilab review and an ILC review. A review of the Stanford Linear Accelerator Center (SLAC) will be held in July. National-laboratory theory and accelerator reviews will be held in July, also.

The FY09 budget request is $150 million over of the FY08 request. A 6-month continuing resolution (CR) is expected. Some projects will be delayed (e.g., the Advanced Plasma Accelerator Program). There will be reductions at the national laboratories. If the CR is too long in duration, the Department will not be able to go forward with NOvA. FY09 will be pivotal.

The FY10 budget request will be submitted to a new administration from whom guidance will be required.

Five new positions in the Office are being advertised. Five Intergovernmental Personnel Act staffers (IPAs) are coming in, and three are leaving.

A gift to Fermilab was announced a few days before this meeting. The rolling furloughs have been stopped.

Cahn asked when the funding opportunity announcement (FOA) for JDEM would come out. Kovar replied, in 2008.

Cushman asked if Panel members can call their House members about the supplemental funding. Shochet replied, yes.

Eno asked when the Particle Physics Project Prioritization Panel (P5) report would have an effect on the budget. Kovar responded that it will be looked at for the FY09 request. Bagger asked if it were needed now or a month from now. Kovar replied that the report that HEPAP is happy with should come out as soon as possible.

Joseph Dehmer was asked to comment on the status of the NSF Division of Physics. The P5 report is vital and urgent to adjust for developments during the past 18 months.

The Division went from an 18% to a 1% increase overnight. $3 million were taken out of the facilities. The Physics Frontier Center program was cut 5%. However, assistance to Deep Underground Science and Engineering Laboratory (DUSEL) has been maintained. The Advanced Laser Interferometer Gravitational Wave Observatory (Advanced LIGO) was approved; the project will start soon.

At the energy frontier, support for Tevatron experiments was cut, the Large Hadron Collider was not, and R&D for a future collider was funded at the Cornell Electron Storage Ring (CESR) Test Accelerator (TA). DUSEL has had a third solicitation and award, with a fourth solicitation nearing the end of its approval process.

At the cosmic frontier, U.S. efforts are providing global leadership through CDMS, Xenon, IceCube, Auger, Borexino, Advanced LIGO, Veritas, etc.

DOE and NSF are poised to respond coherently to advice from P5 and HEPAP.

Joseph Kroll asked to present information about the upcoming International Conference on High Energy Physics, July 30–August 5. 900 abstracts have been submitted for parallel sessions followed by three days of plenary sessions. Registration was urged. The final program will be available in a couple of weeks. Visas for foreign nationals may be a problem.

Charles Baltay was asked to present the report from P5. At the November meeting of HEPAP, the P5 committee was charged to develop a 10-year plan for U.S. particle physics under various DOE funding scenarios:

A Constant effort at the FY2008 level ($688 million)
B Constant effort at the FY2007 level ($752 million)
C Doubling of budget over 10 years starting with FY07
D Additional funding above the previous level, associated with specific activities needed to mount a leadership program.

The Subpanel was also briefed on the status of NSF fiscal planning. The plan described here assumes approval of the DUSEL Major Research Equipment and Facilities Construction (MREFC) proposal, and continued funding of the NSF University Program and LHC operations. Annual budgetary amounts were calculated for each scenario and year.

The Subpanel was broadly constituted. A webpage was set up for community participation. Meetings were held at Fermilab, SLAC, and BNL. The six laboratory directors were supportive of the P5 process.

The National Research Council's *Revealing the Hidden Nature of Space and Time* (the EPP2010 report) and earlier P5 reports have discussed the outlook for the field of particle physics in the United States. The scientific priorities have not changed since those reports appeared, but the context for the scientific opportunities they describe has.

Particle physics in the United States is in transition: Two of the three high-energy physics colliders in the United States have now permanently ceased operation. The third, Fermilab's Tevatron, will turn off in the next few years. The energy frontier, defined for decades by Fermilab's Tevatron, will move to Europe when Conseil Européen pour la Recherche Nucléaire's (CERN's) LHC begins operating. American high-energy physicists have played a leadership role in developing and building the LHC program, and they constitute a significant fraction of the LHC collaborations. About half of all U.S. particle physicists participate in LHC experiments.

The U.S. high-energy physics program faces serious fiscal challenges that are changing the particle-physics landscape even as this transition occurs. The large cost estimate for the ILC, a centerpiece of previous plans, has delayed plans for a possible construction start and has led the particle physics community to take a fresh look at the scientific opportunities in the decade ahead. The severe funding reduction in the Omnibus Bill of December 2007 stopped work on several projects and had damaging impacts for the entire field. The present P5 Subpanel has developed a strategic plan that takes these new realities into account.

There is a lot of excitement in particle physics. It has been very successful in creating a major synthesis, the Standard Model, that explains to a high accuracy almost all experimental observations so far. However recent results show that there is new physics beyond the Standard Model. Neutrino oscillations imply that neutrinos have mass and exhibit neutrino mixing. The accelerating universe implies dark energy, and the missing mass in the universe implies dark matter. In addition, Tevatron, Large Electron-Positron (LEP) Collider, and SLAC Large Detector (SLD) experiments strongly point to new physics at the terascale. These discoveries make particle physics richer and more exciting then ever before. During the past decade, the field has developed new, cutting-edge instruments to address these new physics questions. Fundamental new discoveries are expected in the coming decade.

Addressing the central questions of the field requires a broad program of research using a variety of tools and techniques that we broadly classify into three interrelated frontiers. The energy frontier uses high-energy colliders to discover new particles and directly probe the properties of nature. The intensity frontier uses intense beams to uncover the elusive properties of neutrinos and to observe rare processes that probe physics beyond the Standard Model. The cosmic frontier reveals the natures of dark matter and dark energy and uses high-energy particles from space to probe the architecture of the universe. These three frontiers form an interlocking framework that addresses fundamental questions about the laws of nature.

The Subpanel recommends that the United States maintain a leadership role in worldwide particle physics by deploying a strong, integrated research program for U.S. particle physics at the three frontiers.

The Tevatron at Fermilab is currently the highest-energy collider in the world. The Subpanel recommends continuing support for the Tevatron Collider program for the next 1 to 2 years, to exploit its potential for discoveries.

The LHC is an international project with significant U.S. investment and major U.S. involvement. Significant U.S. participation in the full exploitation of the LHC has the highest priority in the U.S. particle physics program. The Subpanel recommends support for the U.S. LHC program, including U.S. involvement in the planned detector and accelerator upgrades under any of the funding scenarios.

The international particle physics community has reached consensus that a full understanding of the physics of the terascale will require a lepton collider as well as the LHC. The Subpanel reiterates the importance of such a collider. In the next few years, results from the LHC will indicate the required energy for such a collider. If the optimum initial energy proves to be at or below approximately 500 GeV, then the ILC is the most mature option with a construction start possible in the next decade. The cost and scale of such a collider mean that it would be an international project, with the cost shared by many nations. International negotiations would determine the siting, and the host would be assured of scientific leadership at the energy frontier. A requirement for initial energy much higher than the ILC's 500 GeV would mean considering other collider technologies. Whatever the technology of a future lepton collider, and wherever it is located, the United States should plan to play a major role.

For the next few years, the United States should continue to participate in the international R&D program for the ILC to preserve the option of an important role for the United States should the ILC be the choice of the international community. The United States should also participate in coordinated R&D for the alternative accelerator technologies that a lepton collider of higher energy would require. The Subpanel recommends for the near future a broad accelerator and detector R&D program for lepton colliders that includes continued R&D on ILC at roughly the proposed FY09 level in support of the international effort. This will ensure a significant role for the United States even if the ILC is built overseas. The Subpanel recommends R&D for alternative accelerator technologies to permit an informed choice when the lepton collider energy is established. The Subpanel also recommends an R&D program for detector technologies to support a major U.S. role in preparing for physics at a lepton collider.

On the intensity frontier, measurements of the mass and other properties of neutrinos are fundamental to understanding physics beyond the Standard Model and have profound consequences for understanding the evolution of the universe. The United States can build on the unique capabilities and infrastructure at Fermilab, together with the proposed DUSEL, to develop a world-leading program in neutrino science. The Subpanel recommends a world-class neutrino program as a core component of the U.S. program, with the long-term vision of a large detector in the proposed DUSEL laboratory and a high-intensity neutrino source at Fermilab. The Subpanel recommends proceeding now with an R&D program to design a multi-megawatt proton source at Fermilab and a neutrino beamline to DUSEL and recommends carrying out R&D on the technology for a large detector at DUSEL. Construction of these facilities could start within the period considered by this report. A neutrino program with a multi-megawatt proton source would be a stepping stone toward a future neutrino source, such as a neutrino factory based on a muon storage ring, if the science eventually requires a more powerful neutrino source. This in turn could position the U.S. program to develop a muon collider as a long-term means to return to the energy frontier. The Subpanel further recommends that, under any of the scenarios, Fermilab proceed with the upgrade of the present proton source by about a factor of 2 to 700 kW to allow a timely start for the neutrino program in the Homestake Mine.

The value of the mixing angle θ_{13} is currently unknown. Around 2012, the results of θ_{13} measurements and the results of accelerator and detector R&D efforts should be used to optimize the design of the long-baseline neutrino physics program. At that point construction of the beamline and the first stage of a detector should proceed as rapidly as possible. If the decision is made to proceed with the multi-megawatt proton source, construction should start as soon as possible after the completion of the R&D program under all but the lowest funding scenarios. The lowest funding scenario would delay the construction start of a multi-megawatt proton source.

The Subpanel recommends support for R&D on large liquid-argon detectors and water Cerenkov detectors for DUSEL under any funding scenario. The Subpanel recommends designing the detector in a fashion that allows an evolving capability to measure neutrino oscillations and to search for proton decay and supernovae neutrinos.

For the international neutrino program, in all but the lowest funding scenario, the Subpanel recommends a rapid NOvA construction start; however, Fermilab should not proceed with the NOvA experiment under the lowest funding scenario.

The reactor experiments Double Chooz and Daya Bay are designed to carry out measurements of the mixing angle θ_{13}, an important physics parameter. The Subpanel recommends support for these experiments under any of the funding scenarios. Nonaccelerator experiments searching for neutrinoless double-beta decay have the potential to make discoveries of major importance about the fundamental nature of neutrinos. The Subpanel recommends support for these experiments, in coordination with other agencies, under any funding scenario.

The latest developments in accelerator and detector technology make possible promising new scientific opportunities through the measurement of rare processes. Incisive experiments, complementary to experiments at the LHC, would probe the terascale and possibly much higher energies. The Subpanel recommends pursuing the muon-to-electron conversion experiment, subject to approval by the Fermilab Physics Advisory Committee (PAC), under all budget scenarios considered by the Subpanel. The intermediate budget scenario would allow, in addition, pursuing significant participation in one overseas next-generation B factory. The more favorable Scenario C would allow for pursuing a program in rare-kaon-decay experiments at Fermilab, as well.

The physics program of DUSEL is of central importance to particle physics. Experiments at DUSEL would address many issues, including neutrino physics, proton decay, dark matter, and neutrinoless double-beta decay. DOE and NSF should define clearly the stewardship responsibilities for such an experimental program. The Subpanel endorses the importance of a deep underground laboratory to particle physics and urges NSF to make this facility a reality as rapidly as possible. Furthermore the Subpanel recommends that DOE and NSF work together to realize the experimental particle physics program at DUSEL.

At the cosmic frontier, although 95% of the universe appears to consist of dark matter and dark energy, we know little about them. The quest to elucidate the nature of dark matter and dark energy is at the heart of particle physics, and the field has identified compelling opportunities for dark-matter-search experiments and for both ground-based and space-based dark-energy investigations. The Subpanel recommends support for the study of dark matter and dark energy as an integral part of the U.S. particle physics program.

The Subpanel recommends that NSF and DOE jointly support direct dark-matter-detection experiments under any of the funding scenarios. The choice of which of these experiments to support in the longer term should be made after completion of the ongoing experiments and the R&D on the next generation of detectors.

The Dark Energy Survey is approved. The Subpanel recommends that DOE support JDEM, at an appropriate level negotiated with NASA, under all budget scenarios. The Subpanel recommends DOE support for the ground-based Large Synoptic Survey Telescope (LSST) program, in coordination with NSF, in all funding scenarios, at a level that depends on the overall program budget.

The Subpanel recommends limited R&D funding for the other particle-astrophysics projects under all budget scenarios, but support for any possible large construction projects should be considered only under funding scenarios C and D. The Subpanel recommends that the funding agencies establish a Particle Astrophysics Science Advisory Group to advise DOE and NSF on the relative merits of the various proposals anticipated in this area.

Advances in accelerator and detector R&D are critical for the United States to maintain leadership at the energy, intensity, and cosmic frontiers of particle physics; to allow the possibility of hosting a future energy-frontier accelerator in the United States; and to develop applications for the benefit of society. The Subpanel recommends a broad strategic program in accelerator R&D, including work on ILC technologies, superconducting rf, high-gradient normal-conducting accelerators, neutrino factories and muon colliders, plasma and laser acceleration, and other enabling technologies, along with support of basic accelerator science. The Subpanel recommends creation of a HEPAP subpanel to develop a strategic plan for accelerator R&D. This subpanel should be followed by an advisory group to monitor the progress and effectiveness of this program. The Subpanel recommends support for a program of detector R&D on technologies strategically chosen to enable future experiments to advance the field.

The Subpanel also recommends preserving the funding for the university program even under the lowest funding scenario and increasing it by close to 10%, as recommended by the HEPAP Subpanel on the University Program, in the more favorable funding scenarios.

A roadmap was developed for funding from FY07 to FY18 for the energy, intensity, and cosmic frontiers, indicating the effects of the funding of Scenario B. Similar charts were made up for the other scenarios, but were not effective means of explaning the scenario differences.

Budget Scenario A would significantly reduce the scientific opportunities at each of the three frontiers compared to Scenario B and would stretch out progress over a longer time scale. Scenario A would most profoundly limit studies at the intensity frontier, with a negative impact on both neutrino physics and high-sensitivity measurements. It would require cancellation of two neutrino experiments, NOvA and MINERvA, that are ready for construction, because of the lack of funds for construction of the experiments as well as the cost of operating the Fermilab accelerator complex. Consequently, a first look at the neutrino mass hierarchy would be unlikely during the next decade. Furthermore, this budget scenario would delay the construction of a high-intensity proton source at Fermilab by 3 to 5 years. This delay would in turn severely compromise the program of neutrino physics and of high-sensitivity searches for rare decays at the intensity frontier in the subsequent decade. It would also postpone the development of a foundation for a possible future muon collider. Under Scenario A, the United States could not contribute significantly to the next-generation overseas B factories that will carry out unprecedented studies of matter-antimatter asymmetry and searches for new processes in the quark sector. For dark-energy studies at the cosmic frontier, Scenario A would delay DOE funding for the ground-based LSST telescope. This budget scenario could not support the investment in new facilities for advanced-accelerator R&D. Scenario A would require an additional reduction of approximately 10% beyond the FY08 cuts in the number of scientists over the 10-year period. It would lead to a significant drop in the number of graduate students and postdoctoral fellows and would limit scientific opportunities in the subsequent decade. Overall, while this funding level could deliver significant science, there would be outstanding scientific opportunities that could not be pursued under this scenario. It would sharply diminish the U.S. capability in particle physics from its present leadership role.

Dehmer asked if the Subpanel had commented on DUSEL in Scenario A. Baltay stated that Scenario A would slow down that program but not eliminate it.

Budget Scenario C, at the energy frontier, would extend the discovery potential of the Fermilab Tevatron Collider by supporting operation in FY10. Should results from the LHC show that the ILC is the lepton collider of choice, funding in this scenario would support R&D and enable the start of construction of an ILC abroad. If another lepton collider technology is found to be preferable, its R&D would be advanced. Scenario C would significantly advance the exploration of physics at the intensity frontier. Construction of a new high-intensity proton source, which would support both neutrino physics and precision searches for rare decays, would be completed. Operation of the neutrino experiments would begin, using the beamline to DUSEL and a very sensitive neutrino detector, providing great sensitivity to matter-antimatter asymmetry in neutrinos. Scenario C would enable new rare K-decay experiments highly sensitive to new physics. At the cosmic frontier, Scenario C would advance the exploration of dark energy by enabling the timely completion of the two most sensitive detectors of dark energy, the JDEM space mission and the ground-based LSST telescope. Scenario C enables strategic, large-scale investments in exciting projects at the boundary between particle physics and astrophysics, the study of high-energy particles from space. This budget scenario would provide additional support for university groups and would obviate the need to cut the scientific work force at the national laboratories.

In Scenario D, major participation by the United States in constructing a lepton collider would require additional funding beyond that available in the previous funding scenarios. If the scale of JDEM requires significantly more funding than is currently being discussed, an increase in the budget beyond the previous funding scenarios would be justified.

A break was declared at 10:24 a.m. The meeting was called back into session at 10:58 a.m. Responses to HEPAP members who had suggested changes or raised interesting issues were addressed. Most of the suggested changes were made by the Subpanel. The report's order was changed to put the science up front, followed by the recommendations. Boxes were added on the Standard Model, Hadron Colliders, etc. There were many smaller changes.

Four issues raised by HEPAP members were

- the role of the ILC in the Ten-Year Plan,
- the need for more detail on the reach of neutrino experiments,
- the reasonability of reliance on DUSEL, and
- the need for more budget detail.

There was a wide spread of opinion on the role of the ILC both in the community and on the P5 Subpanel. After long and thoughtful discussions, the Subpanel arrived at a middle-of-the-road plan that balanced an overall particle-physics program and provided the best shot at a future lepton collider. Everyone believes that a lepton collider is needed. It makes sense to wait for the LHC results to determine the required energy. The ILC will be an *international* decision. The question will be, what role should the United States aspire to? It should be a major role. For the next few years, the United States should continue to participate in the international R&D program for the ILC to preserve the option of an important role for the United States should the ILC be the choice of the international community. The Subpanel recommends for the near future a broad accelerator and detector R&D program for lepton colliders that includes continued R&D on ILC at roughly the proposed FY09 level in support of the international effort. This program will ensure a significant role for the United States even if the ILC is built overseas. The Subpanel also recommends R&D for alternative accelerator technologies, to permit an informed choice when the lepton collider energy is established. The Subpanel spent four months arguing about this topic.

The Subpanel developed a vision for the long-range U.S. neutrino program that includes an intense neutrino beam from Fermilab that needs a multimegawatt proton source, a long baseline with a large detector at DUSEL, and a possible improved neutrino beam from a neutrino factory that uses a muon storage ring. Such an ambitious program needs to proceed in steps:

- NOvA with a 700-kW source
- Phase-1 detector in Homestake Mine with a 700-kW source
- Full-sized detector in Homestake Mine with a 2-MW source
- A beam from a neutrino factory, if needed.

This vision provides a good neutrino program that complements the Japanese program.

Figures show the reach for different beams and detectors. NOvA is the first step. An experiment in DUSEL with a 2-MW source at Fermilab would extend the sensitivity to θ_{13} by an order of magnitude. One could push it down by another order of magnitude with a neutrino-factory beam.

What is bothering some in the community is the reliance on DUSEL. It is important for the Particle Physics Program in many ways. The long baseline from Fermilab to Homestake enables the most sensitive neutrino experiments. DUSEL enables high-sensitivity searches for dark matter, proton decay, and neutrinoless double-beta decay. What if DUSEL is delayed? The Homestake Mine does exist and is being refurbished right now with substantial nonfederal funding as the Sanford Laboratory. It could host the program if the NSF DUSEL program could not. A strong endorsement by P5 will help DUSEL.

The Subpanel spent considerable time and effort collecting and digesting budgetary information. Estimates were provided by the agencies, the national laboratories, and proponents of projects. All of this information suffers from uncertainties to various degrees. The Subpanel did its best to draw on their experience and expertise to formulate plans, taking these uncertainties into its collective account.

A chart was shown for budget Scenario B (expressed in constant FY08 dollars) with expenditures distributed among the various projects for each of the 12 years from FY07 to FY18. The "major facility" on the chart could be ILC, a proton source, or something else, as determined by the scientific results produced by FY12. This budget has a fighting chance of shaking out this way. Providing these funds from the 12-year budget among the frontiers shows 11% going to the cosmic, 37% to the intensity, and 52% to the energy frontiers. Dividing it by category shows 15% going to accelerator and detector operations; 30% to physics research; 12% to advanced technology R&D; and 43% to Project R&D, construction, and maintenance and operations (M&O) at the LHC. Dividing it by project shows 29% going to the LHC, 10% to the lepton collider, 38% to neutrino physics, 3% to precision measurement, 4% to dark matter, 8% to dark energy, and 8% to other. The energy frontier divides its funds with 19% going to the Tevatron Collider, 38% to LHC operations, 22% to Super LHC upgrades, and 21% to lepton-collider R&D. The intensity frontier divides its funds with 26% going to near-term neutrino research, 23% to long-baseline neutrino research, 8% to nonaccelerator neutrino research, 8% to precision measurements, and 35% to the Fermilab Proton Source. And the cosmic frontier divides its funds with 31% going to dark matter, 66% to dark energy, and 3% to other astrophysics .

A break for lunch was declared at 11:39 a.m.

Thursday, May 29, 2008
Afternoon Session

The meeting was called back into session at 1:05 p.m. Shochet opened the floor to questions and comments on the P5 report. He reminded the Panel members of the DOE General Counsel's Office instructions on recusing oneself from discussions in cases of conflict of interest.

Issues about the energy frontier were discussed first. Eno wanted to know more about the LHC and budget requests. Baltay replied that about $63 million was projected for the LHC, and the Subpanel took the numbers for upgrades provided by the collaborations. Tuts added that the exchange rate was considered in these figures.

Gladney asked what the Subpanel assumed for a lepton collider if the requisite energy is greater than 500 GeV. Baltay replied that the amounts for LHC upgrades, dark energy, etc. were all laid out in developing the report. The choice of lepton-collider technology is beyond the capability of the Subpanel. If the energy required is greater than that of the ILC, construction would be beyond the timeframe of P5.

Cahn was struck by the strong statements about Higgs boson capability of the Tevatron but that it was also stated that the Tevatron would not operate beyond 2010. Bortoletto said that that was a compromise. Cahn asked if the trade-off was getting NOvA started. Bortoletto said that in Scenario C one can do both; in Scenario A, one can do neither; in Scenario B, it is either/or.

Molzon asked for the rationale for continuing with the ILC under the lower scenarios. Baltay replied that, in scenarios A and B, there is little money for ILC. In Scenario C, siting an ILC in the United States is beyond the budget. That decision will come 4 years from now. The United States needs to be involved in the R&D program. Shochet noted that budget scenarios do not live forever. However, if one cuts out R&D, future participation may not be possible.

Cahn stated that, in accelerator R&D, advances in magnet technology will be important for increasing the energy of the LHC. He believed that that was likely and wondered why it did not get more emphasis. Baltay replied that that was a judgment call.

Wormser asked why the report focuses on the initial energy of the ILC. Baltay commented that any lepton facility will likely be upgraded later. Shochet added that the Subpanel wanted to make clear where the science program starts. Wormser suggested pointing out a branch point for decisions. Baltay said that the report does that clearly: it is when the LHC results come in. And putting it on a chart shows more than one actually knows.

Wormser pointed out that the R&D funding shown is flat, but one would expect it to increase. Baltay responded that the Subpanel had about 16 budget scenarios, but only one is shown. Lepton and ILC R&D were combined, and the funding was kept constant at $35 million. Wormser asked if there would be enough people to meet these needs. Baltay admitted that it will not be easy. Cahn said that HEPAP had addressed that question some time ago, and the answer was yes.

Konigsberg asked if the 2010 Tevatron running were in competition with LHC upgrades. Baltay replied that it was not, but rather with NOvA construction.

Kephart asked why U.S. ILC R&D should focus on unique capabilities. Baltay responded that this will better benefit the international ILC effort. Harrison added that there were other criteria, like synergy with the national laboratories and the U.S. program.

Bagger suggested that references to the 500-GeV energy be consistent.

Wormser asked if one can be a long-term leader without being a leader in the energy frontier. Baltay responded that the language says “a” leader, not “the” leader in all frontiers. The Subpanel would like to see the United States host the ILC. It also mentions leadership in accelerator R&D and in other contexts. Bagger commented that the Subpanel did a nice job of portraying leadership as a multifaceted issue.

The discussion moved on to the intensity frontier. Cahn observed that this report contained no tables or figures, making it difficult to assess what choices P5 had made. Shochet explained that those were added in the presentations made at this meeting. Cahn added that the absence of references does not allow readers to access that information. All of this information should be pulled together in a separate document. People will prefer to have graphs rather than “take our word for it.” Baltay responded that the Subpanel had a first draft with lots of tables and graphs but the result was a document that would be unreadable to those making policy decisions. Cahn suggested that a few people from P5, Neutrino Scientific Assessment Group (NuSAG), and other groups should prepare a more thorough and informative analysis. Baltay said that all of those graphics are publicly available. Kovar explained that the agencies are asking for guidance on what the scientific opportunities are and their priorities. This exercise makes the community think about the U.S. program, its impacts, and its balance. One has to have a sustainable program. This report has to be credible. As soon as these graphs are published, they will be out of date in three months. The real question is credibility. Cahn said that he was not asking for financial numbers and did not want to hold up this report. He would like to see a coherent supplement that pulls together the information presented at the Subpanel meetings. Kovar agreed that that would probably be a good thing. Eno stated that this report makes a lot of detailed descriptions of science associated with very small amounts of money. It does not need to be a detailed budget, just enough financial data to put the investments in perspective. Cahn said that he did not know how much money is being talked about. Shochet suggested that there could be a bibliography linking to relevant Web documents. The other extreme is a full-blown discussion of the rationales behind the recommendations. Bortoletto said that the information is there. Shochet added that it could be put in the public P5 webpage.

Bagger stated that the interplay between the U.S. and Japanese neutrino programs was not well described. Baltay said that the long baseline is the most important aspect of the U.S. program. Lankford added that there are a lot of unknowns that make a direct comparison very hard.

Cushman asked what the relative importance was of the dark-matter research versus neutrino research. Baltay responded that he thought that the priorities were clearly stated. The recommendations protect the LHC and the ILC R&D. They also protect small programs like dark matter. In Scenario A, the brunt of the cuts is in the neutrino program.

Seidel said that some of the programs that are not protected (e.g., K and B physics) and their value could be better described. Shochet promised that links to those topics will be provided in the bibliography.

Molzon asked how the psychological effect of cancelling experiments was taken into account. Baltay said that it weighed very heavily, but in Scenario A the money just was not there. The Subpanel did not want to sugar-coat this report.

Bagger asked if the Subpanel had assumed a chosen scenario. Shochet replied that the Subpanel was charged to come up with excellent science for each scenario. It was not charged to select a scenario.

Bagger stated that the report suggests that the Fermilab proton driver should not be tied to the ILC and asked why. Baltay replied that one would get a proton driver cheaper that way. Shochet added that the synergy is in the R&D and that the construction decisions should be driven by how to get the best science out of the machine.

Kephart asked why Scenario C was not described more fully. Cahn noted that it has been more fully described in the latest version of the report.

Cushman observed that Scenario A chops the middle part out of the stepwise process of the neutrino program. That does not seem wise. What would happen if Scenario A obtained in one year, and Scenario B obtained for the next year?

Gladney asked whether there was discussion with the national laboratories on the interaction between current layoffs and the possible future neutrino program. That loss of expertise may hinder later efforts. Oddone offered the explanation that management looks at the future needs and structures the layoffs to minimize long-term effects.

Wormser asked if the workforce size were a problem. Baltay replied that the B-Factory's shutting down will decrease the workforce in the intensity frontier. However, people may flock to neutrino science if there were important new projects there.

Wormser asked how the muon-to-electron reach compares with the European project. Tschirhart responded that the European experiment is muon to electron-gamma. The muon-to-electron conversion experiment is much more sensitive.

Wormser was concerned about the lack of support for Double Chooz. Dehmer assured him that NSF is putting money into Double Chooz. Shochet added that all experiments with U.S. participation are reflected in the report.

Wormser suggested that there could be a better lead-in to the description of the lepton versus quark sides. Shochet replied that a new general description of the problem of flavor has addressed that issue.

Kovar clarified that in an FY09 continuing resolution, one would have to follow the guidance of FY08, which means no money could be put into NOvA. There may be a year-long continuing resolution, or it may be well into the year before the budget is approved.

Bagger asked how robust the statement about NOvA was and how time-sensitive NOvA was. Baltay responded that the physics reach is not a function of time. The sociology is a function of time.

Kim noted that Fermilab has a lot of documents that it is willing to share with P5. Cooperation with Japan will provide a strong neutrino program. International collaboration on kaon and other programs is also being discussed.

Kim asked why MINERvA is cancelled in Scenario A. Shochet pointed out that, without NOvA, the burden of operating the accelerators would be borne entirely by MINERvA, making that experiment's operational cost extremely high.

Bagger asked what the Subpanel learned about a long-baseline program in Japan. Baltay admitted that they had not gotten much information from Japan. Kim stated that Japan has found that including another country is tricky.

Kroll asked what defines the scale of an international project. Specifically, why is not a neutrino program an international project? The B-factories and the Tevatron produce a lot of papers, but the neutrino program will measure fewer entities. Baltay responded that the ILC is an order of magnitude greater than other programs financially. All projects in this field are international. Shochet added that some projects *must* be international because the cost clearly exceeds what one country can afford.

Trischuk noted that international collaboration is important for all projects. The ILC must be *planned* internationally. Oddone observed that, in DOE, there are many billion-dollar projects. The agency can tackle such a project. If one has many countries contributing to a project, that slows down the management of such a project. One does not undertake international planning and management lightly.

Dehmer pointed out that a long baseline has a beginning and an end. There will probably only be one megaton detector in the world, and it, therefore, must be international in nature.

Cahn asked if one could go ahead with the long-term program with only the Sanford Underground Science and Engineering Laboratory (SUSEL). Baltay said that SUSEL management pointed out that an experimental hall would cost $19 million, which is not prohibitively expensive.

Bortoletto pointed out that having a facility in the United States continues the tradition of reaching out to other nations.

Trischuk pointed out that the number of students who would want to come to a neutrino facility would be different from the number who would come to a B-factory. Gladney pointed out that the report does say that an important purpose of projects is to train the next generation.

Wojcicki commented that a large number of people from BaBar will be going into the cosmic frontier or to the LHC. Brau noted that the LHC and cosmic physics are going up, but that can change.

A break was declared at 2:55 p.m.; the meeting was called back into session at 3:26 p.m., when the discussion turned to the cosmic frontier.

Bean asked whether, on the astrophysics material, the Subpanel was trying to identify the HEP portion with the expectation that someone else will fund Auger and other projects not mentioned. Baltay replied that the cosmic frontier is at the front and center of HEP. Within that, dark energy, dark matter, and others are important. What the Subpanel looked for was what was important for particle physics. Also, other agencies *do* fund those other projects, but they should get support (e.g., in instrumentation R&D) as much as can be afforded.

Olinto noted that the intensity and cosmic frontiers overlap. Cosmic particles could be included in the Venn diagram in the overlap of the intensity and cosmic frontiers. Baltay said he would look at it. Olinto also asked what constitutes a large project. Baltay responded that Auger's $40 million cost makes it a large project. Bagger suggested that including cosmic particles in the Venn diagram would not hurt and could broaden support.

Bagger pointed out that the report says the decisions on future dark matter projects will occur after the completion of current experiments and asked what constituted completion. Baltay answered that it varies, but generally depends on the performance of the larger detectors and measured background rates.

Eno wanted to know why, in Scenario A, dark matter experiments would be delayed but not muon-to-electron. Baltay responded that, if money is tight, delaying dark matter a little would be better than killing the muon-conversion experiment.

Wormser asked if there were a recommendation about NSF's funding of the LSST and DUSEL. Baltay replied that the Subpanel did not compare LSST and DUSEL. Shochet pointed out that DUSEL is in the division of NSF that HEPAP advises; the LSST is not.

Bagger noted that little is said about Stage III dark energy experiments other than the Dark Energy Survey (DES). Baltay replied that there are nearby-supernova projects, but the report may have neglected other experiments because they are below P5's cost minimum.

Bagger asked if it were necessary to put MINERvA on the chopping block. Baltay replied that it was necessary because of the cost of operating the Fermilab accelerators.

White asked how agreements were made with NASA. Kovar responded that OHEP is in negotiations with NASA.

Gladney noted that only one project, JDEM, has a dollar amount listed in the report and asked why. Baltay answered that that section was added after comments were made on the draft. One respondent believed that the current projected funding for JDEM was too small. Kovar explained that DOE mentioned that it was interested in contributing $400 million of the cost. Talks with NASA considered cooperative stewardship. The science package was estimated to cost $400 billion, and NASA wanted to partner on that effort, so the prospective DOE cost dropped to $200 million. That is where the different funding numbers come from. DOE is working with NASA to put together a mission and to issue an FOA in 2008.

Shochet steered the topic of discussion to infrastructure and general, broad issues. Kephart wanted to know the rationale for giving DUSEL its own section. Baltay explained that DUSEL does not involve only a single frontier as do the other projects; plus, the Subpanel wanted to underscore its uniqueness. DUSEL is broadly very beneficial to the field.

Bagger stated that the budget pie charts integrated over 10 years are very beneficial and will build support in the community. He asked if they could be put in an appendix in the report. Baltay said that he would be sympathetic to doing that, plus including the 12-year table. Shochet also voiced support for that plan but wondered if they would tie the agencies' hands too much. Brau noted that there are also demographic charts. Baltay said that there are a lot of subtleties that can lead to discussions and arguments. Shochet pointed out that these charts will be available online for anyone to use. Baltay suggested that maybe that should be where they should stay. Cahn stated that there are no demographic data in the report and that the data in the presentation are from 2005.

Diebold asked if the support for the university programs would come from the national laboratories. Baltay said, yes. There will be less work being done there. Diebold noted that the theoretical efforts are not mentioned. Baltay responded that they are mentioned in several places.

Wormser commented that it would be useful to be able to compare all four of these scenarios. Baltay replied that, on the roadmap, the Subpanel looked at all four and decided that showing all four was not beneficial. For the budgets, the comparison might be helpful. He will try and see how it looks.

Shochet proposed voting on the acceptance of the report. Cushman suggested asking the public for comments. Jung stated that proton decay and the international context should be the next major part in the discussions of a very large detector. Super-Kamiokande will have 20 years of data before any U.S. detector is built. Shochet pointed out that that is mentioned explicitly in the report. Jung added that lifetime sensitivity of 10^{35} years is needed for $p \rightarrow e\pi^0$ and 10^{34} years for $p \rightarrow K\nu$. A detector that can do the job should be built, not just a small detector to get a foot in the door. Baltay pointed out that the Subpanel made no decision on what detector should be built; it says that R&D should be done on both technologies.

Wormser suggested that Scenario B is detailed because the Subpanel wants to get out of Scenario A; but a few months ago, the Subpanel said that Scenario C was the desirable one. He would prefer that the government agencies be able to see more about Scenario C. Baltay replied that the Subpanel started by comparing Scenario A to the others and felt this did not work. Scenario C is justified by the ILC, and that was seen as dangerous; so the Subpanel settled on focusing on Scenario B as the most effective one that could be presented in Washington.

Cahn asked if the Panel could approve the report contingent on a possible rewrite of the Scenario C description the next day. Baltay offered to include in the report any comments that were provided to the Subpanel by the next morning if they did not change the substance of the report. Shochet said that the Subpanel would have to consider the substantiveness of any changes and whether another pass through P5 might be needed. In addition, a strong cover letter should be drafted.

Wormser suggested that the comparison of scenarios could be done in the caption of the roadmap online. Baltay agreed that that might be possible.

Cushman noted that, on page 17, the economic benefits of particle physics are alluded to and asked if those benefits could be stated explicitly. Shochet replied that this report describes in general that impact; putting a dollar figure on it would be very powerful, but that a study has to be done to quantify it.

A vote was held to accept the P5 report as a HEPAP report. The Panel members voted unanimously in favor of accepting the report.

Shochet thanked P5 and Baltay for their hard work and he thanked Judy Jackson for her important contributions. Dehmer thanked Shochet for his leadership and thanked the community for this wrenching self-examination. Kovar thanked everyone and stated how much he learned from the exercise and from the exceptional panel. Kim pointed out that there will be a workshop the following week on how to present this report to the community.

The meeting was adjourned at 4:23 p.m.

Respectfully submitted,
Frederick M. O'Hara, Jr.
HEPAP Recording Secretary
June 11, 2008

Corrected – M.J. Shochet, 8/7/08

The minutes of the High Energy Physics Advisory Panel meeting held at the DoubleTree Hotel, Washington, D.C., on May 29-30, 2008 are certified to be an accurate representation of what occurred.

Signed by Melvyn Shochet, Chair of the High Energy Physics Advisory Panel on August 7, 2008.

Melvyn J Shochet