Minutes of the
High Energy Physics Advisory Panel Meeting
February 14-15, 2008
Palomar Hotel, Washington, D.C.

HEPAP members present:

Jonathan A. Bagger, Vice Chair
Daniela Bortoletto
James E. Brau
Patricia Burchat
Robert N. Cahn
Priscilla Cushman (Thursday only)
Larry D. Gladney
Robert Kephart
William R. Molzon
Angela V. Olinto
Saul Perlmutter
Lisa Randall
Tor Raubenheimer
Kate Scholberg
Melvyn J. Shochet, Chair
Sally Seidel
Henry Sobel
Maury Tigner
William Trischuk
Herman White
Guy Wormser (Thursday only)

HEPAP members absent:

Hiroaki Aihara
Alice Bean
Sarah Eno
Joseph Lykken
Stephen L. Olsen

Also participating:

Charles Baltay, Department of Physics, Yale University
Barry Barish, Director, Global Design Effort, International Linear Collider
William Carithers, Physics Division, Lawrence Berkeley National Laboratory
Tony Chan, Assistant Director for Mathematics and Physical Sciences, National Science Foundation
Glen Crawford, Program Manager, Office of High Energy Physics, Office of Science, Department of Energy
Joseph Dehmer, Director, Division of Physics, National Science Foundation
Persis Drell, Director, Stanford Linear Accelerator Center
Thomas Ferbel, Department of Physics and Astronomy, University of Rochester
Marvin Goldberg, Program Director, Division of Physics, National Science Foundation
Paul Grannis, Department of Physics and Astronomy, State University of New York
Michael Harrison, Physics Department, Brookhaven National Laboratory
Abolhassan Jawahery, BaBar Collaboration Spokesman, Stanford Linear Accelerator Center
Steve Kahn, Director of Particle Physics and Astrophysics, Stanford Linear Accelerator Center
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
Usha Mallik, Department of Physics and Astronomy, University of Iowa

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
Raymond Orbach, Under Secretary for Science, U.S. Department of Energy
Moishe Pripstein, Program Director, National Science Foundation
James Reidy, Division of Physics, National Science Foundation
Robert Sugar, Department of Physics, University of California at Santa Barbara
Robert Svoboda, Department of Physics and Astronomy, Louisiana State University
Andreene Witt, Oak Ridge Institute for Science and Education

About 70 others were present in the course of the two-day meeting.

Thursday, February 14, 2008
Morning Session

Before the meeting, the members of the Advisory Committee were sworn in and advised of their rights and responsibilities by members of the DOE General Counsel's Office.

Chairman **Melvyn Shochet** called the meeting to order at 10:07 a.m. and introduced **Raymond Orbach** to present the news from DOE.

This is a major point in time for high-energy physics. The Omnibus Bill was a slap across the face for the long-term prospects of science. A three-peat would present a dismal outlook, as recognized publicly by Norman Augustine and Craig Barrett. The United States is going in the reverse direction from the other developed countries of the world. The P5 [Particle Physics Project Prioritization Panel] charge represents the future of high-energy physics in the United States. This year will be critical. The attack on high-energy physics in the Omnibus Bill ignored *EPP 2010*. One cannot fail more profoundly than did *EPP 2010*. The Omnibus Bill was a frontal attack on the unity of science itself. Two programs were supported more than the President's budget called for. Congress played favorites. The America Competes Initiative (ACI) speaks to the unity that science is. The Secretary of Energy and the Assistant Secretary are doing all they can to seek support for high-energy physics.

In the FY09 President's request, core experimental and theoretical research at universities and national laboratories is supported with $254.8 million to carry out world-class programs, to advance scientific discovery at the Fermilab Tevatron and the CERN [Conseil Européen pour la Recherche Nucléaire (now Organisation Européenne pour la Recherche Nucléaire)] Large Hadron Collider (LHC), and to introduce new initiatives in astrophysics and neutrino science. An opportunity has been lost at BaBar. The same should not be done at Fermilab. In Japan, superconductors are the basis of a new industry. Here they were cut by a factor of 4. The FY09 President's Request restores R&D for the International Linear Collider (ILC).

For the Office of High Energy Physics (HEP) as a whole, the President's Request to Congress adds $116 million above the FY08 enacted budget. The Office of Science (SC) has a 20% increase and will be a sitting duck for budget cuts. This administration is coming to an end with no guarantee that funding in the future will be any better. For HEP, the goal must be a world-class, vigorous, and productive program. Real changes are being made at the program level to keep the United States at the forefront. A robust, scientifically compelling plan for U.S. high-energy physics must be developed and be supported by the scientific community, the administration, Congress, and the public. Something needs to be developed between the FY08 budget and the FY09 projected budget. People must be convinced that exciting research can be done. It has to be world-class, productive, and exciting. What happened in FY08 *can* be repeated in FY09.

High-energy physics is at an extraordinary productive and exciting period. The FY08 Omnibus Bill funding is short $93 million from the FY08 President's Request, and $43 million less than the FY07 appropriation, leading to the loss of high-energy-physics scientific productivity and workforce and U.S. credibility as an interagency and international partner. *EPP 2010* priorities are challenged by the U.S. budgetary situation.

The President has offered a flat discretionary funding budget. SC could easily, again, become a donor program. It is unlikely that Congress will change its priorities. The case needs to be made that high-energy physics is the backbone of the competitiveness of our nation. The timing of the P5 report is critical. Congress has been told that that report will be available to guide deliberations on the FY09 budget.

In the State of the Union Address, the President inserted the statement, "To keep America competitive into the future, we must trust in the skill of our scientists and engineers and empower them to pursue the breakthroughs of tomorrow. … This funding is essential to keeping our scientific edge." The President has given the scientific community the opportunity to ensure that that funding is not shifted to short-term demonstration projects. Hard work must be put in to get this budget passed to allow this remarkable program to flourish.

Randall asked what areas got increased funding. Orbach replied that short-term research in high-end computing and biological and environmental research got increased funding. Computation is important to climate change and to the industrial base (for reducing costs and for getting to market quickly). Randall wanted to know whether that funding was distributed across the country or given to large, local projects. Orbach answered that both occurred.

Shochet asked whether there was a possibility of supplemental funding. Orbach did not know. There was talk about several supplemental actions. Such approaches are very tricky. It is a presidential decision. If one area is given supplemental assistance, it opens up the possibility for all areas that were slighted. It will become apparent in May or June if this path will be pursued. The International Thermonuclear Experimental Reactor (ITER) has been zeroed out; by shifting funds, the project office can be kept open through September, but there will probably not be an FY09 budget until March of 2009, a loss of 6 months.

Cahn stated that, in the FY08 budget, high-energy physics shared much less in the ACI effort than did other SC programs. Orbach said that Marburger wants to restore high-energy physics to full funding. Also, funding goes up and down with program stages. Cahn said that, even with this FY09 budget, high-energy physics would not be back to where it should be.

Bagger noted that high-energy physics has not been effective in improving its outcome and asked whom it should partner with. Orbach replied that he could not tell the Committee to lobby. P5 is terribly important. Congress should see it as important and, hopefully, will respond.

Wormser asked if there were any hope of increased discretionary funding in science. Orbach responded that that is not the way the U.S. budget was constructed. Congress picked and chose; it knew precisely what it was doing. One cannot take money from one program and give it to another. The members of Congress decided this budget.

Cahn said that it had been assumed that high-energy physics would be fully funded because the pertinent committees agreed on the FY08 budget; that outcome was changed by the Omnibus Bill. Orbach stated that, when Congress was forced to get down to the President's request for discretionary funding, decisions were made.

Randall asked, aside from P5, what else could be done to communicate this message. Orbach responded that all citizens have a congressman and two senators and can express their views to them. Individuals need to say that high-energy physics has laid out a program for the future of the country, and here it is.

Wormser noted that there are international linkages and asked what influence other countries could have on Congress. Orbach did not know. ITER is a very serious situation. The international science community questioned whether the United States is a reliable partner. International understandings must be arrived at to collaborate on large-scale programs.

White asked if anything new can be started before the FY09 budget is passed. Orbach answered, no.

Shochet had all the members introduce themselves. A break was declared at 10:52 a.m. The meeting was called back into session at 11:17 a.m. **Dennis Kovar** was asked to speak on the budgeting situation at the Office of High Energy Physics at DOE.

In the FY08 appropriation, SC's funding increased by 4.6%. But if one excludes earmarks, it is 2.5%. Funding was reduced for the ITER project. Except for ITER, HEP was the only organization that decreased from FY07. SC funding was reduced by $503 million (11%) from the FY08 President's Request. HEP funding was reduced by $93 million (12.5%) from the FY08 President's Request. That level of funding is a $63 million reduction (8.4%) from FY07. The operating funds for the B-Factory have been lost. The language of the Omnibus Bill specifies no funding for the NuMI Off-Axis ν_e Appearance experiment (NOvA) and a funding at about one-fourth of the requested levels for the ILC R&D and the superconducting radio frequency (SRF) infrastructure. A large fraction of this reduction supported people. Fermilab and the Stanford Linear Accelerator Center (SLAC) were impacted most severely. The size of the reductions and the fact that they occurred almost a quarter of the way through the fiscal year limited options. Layoffs alone could not meet the bottom line, and large non-salary costs had to be looked at. Each facility could run only less than one-half of the planned weeks. It came down to a choice of running Fermilab or the B-Factory, and the operation of the Tevatron in FY08 was judged more important.

The decision was to run the Tevatron for 42 weeks with a 200-person reduction in force and rolling furloughs at Fermilab. The B-Factory would run two months with a 225-person reduction in force at SLAC. With this decision, the activities of the remainder of the program are largely preserved.

The decision was not made easily. It is a loss of science and investments. It is a failure to live up to expectations of our collaborators and partners. The B-Factory's last run should be as productive as possible. Funding was provided for an additional two months for measurements at the 3S and 2S upsilon resonances. It will now have a four-month running schedule.

The abrupt reduction in funding was totally unexpected. HEP has tried to deal with the reductions in a way that minimizes the impacts, is focused on the scientific priorities, and positions the program for the future. Not running the Tevatron in FY08 would be the termination of the Tevatron operations. The decision also took into account U.S. international obligations and commitments. There is no dispute that the impacts of the Omnibus bills have undermined the credibility of the United States as a reliable collaborator in high-energy physics. The United States has performed well in many ventures; however, every once in a while there have been miserable failures. Generally, these failures have occurred when the community and program office get out of touch with what is happening in our country. The winds change. The P5 exercise is meant to get the community in touch with some realities. Based on this input, it is hoped that a strategic plan can be put together that is compatible with realities and will gain traction.

The FY09 SC budget request is $4.721 billion. It is a 21% increase over the FY08 appropriation and a 24% increase over the FY07 appropriation. The FY09 HEP budget request is $805 million. It is a 16.8% increase over the FY08 appropriation, which is just a cost-of-living increase. Proton-accelerator-based physics is increasing, electron-accelerator-based physics is decreasing, nonaccelerator physics is growing, theoretical physics is getting more than cost-of-living, and advanced technology R&D is growing.

There are a number of significant program shifts, some driven by the Omnibus Bill budget. The B-Factory run will be completed. The Tevatron is running full-out. U.S. researchers are playing leading roles at the LHC. Core advanced technology R&D is increasing 41% from FY07. LHC and GLAST [Gamma Ray Large Area Space Telescope] have been completed. NOvA has been slipped back a year. Advanced Accelerator R&D has two proposals on the table.

The strategic plan is to define and execute a balanced scientific program that includes a collider at the energy frontier. The ILC is widely viewed as that collider. In FY09, HEP will continue support for a U.S. role in the global ILC R&D effort, focused on areas where the United States is the acknowledged leader. It will also maintain a balanced scientific program. The overall strategy for accelerator technology R&D is balanced among short-term, mid-term, and long-term R&D.

The HEP program is at a pivot point. There is support for R&D, but there is debate about how much should go for short-, mid-, and long-term research. The administration is strongly supporting long-term basic research. For high-energy physics in the United States, it can go in a couple of directions. The U.S. community has to develop a compelling, realistic vision for a U.S. program and has to support that vision. This support is essential if the direction of the U.S. program that was implied in the Omnibus Bill is to be changed. It also has to be part of a coordinated international plan.

P5 is being asked to provide scientific recommendations under three budgetary scenarios: constant effort at the FY08 funding level, constant effort at the FY07 funding level, and a doubling of funding starting in FY07.

The HEP office is going to implement a new organizational structure. It will be organized according to scientific and technical campaigns. Those campaigns will be managed by program managers who are empowered and accountable. Those programs will include universities and national laboratories. The Office will implement a new review process for national laboratories that will include annual science and technology reviews of user facilities, reviews of all national laboratory research groups on a rotating basis, reviews of specific activities and initiatives annually, and institutional reviews on a rotating basis. The Office has obtained approval to fill 12 permanent federal positions in the new organization. The Office has operated for a number of years with Intergovernmental Personnel Act (IPA) personnel and detailees; it is envisioned that such appointments will be continued. These are exciting jobs because the officeholders get to shape the program.

In regard to the FY08 budget, most significant decisions were made in the February Financial Plan. Fermilab and SLAC reviews will be held this summer. Laboratory group reviews will also be held this summer. Decisions are going to be made about the Outstanding Junior Investigator, the Dark Energy solicitation, the Advanced Detector Research, etc. Project and targeted reviews will be held, as will the last university actions. In regard to the FY09 budget, congressional hearings will be held in March, a memorandum of understanding (MOU) is being worked on with the National Aeronautics and Space Administration (NASA), and the impacts of a continuing resolution need to be thought about. In regard to the FY10 budget process, laboratory managers' budget briefings were held in February, the P5 interim report will be due in mid-March, consensus will be reached on the strategic plan and priorities in March, the HEP budget will be submitted to SC in April, that budget will be submitted to DOE in May or June, and it will be submitted to OMB in August.

Trischuk asked if the long-term, mid-term, and short-term map onto the HEP plans and whether there is any high-energy physics in the short term. Kovar replied that it might be beneficial to change whom we talked to and what we say. The planned programs do not need to be changed. Congress's view of those programs needs to be understood.

Bagger asked how the United States' high-energy physics can be embedded in the international context. Kovar replied that the United States should be cost-efficient and not duplicate what is being done elsewhere. Bagger asked how the Funding Agencies for Large Colliders (FALC) fitted in. Kovar answered that it has the potential of being very helpful.

Molzon asked how universities will interact with DOE in the organization chart. Kovar answered that there will be an evolution over time. There will be no change for the rest of the year. Crawford added that, in practice, most university groups will have multiple program managers and those program managers will have to work in concert to fund each new university grant. Coordination will be needed and will result in a better overall effect.

Kahn (SLAC) noted that, in this transitional year, some universities and national laboratories are mixing pure and applied research. Kovar responded that that is why there are program managers.

A break for lunch was declared at 11:54 a.m.

Thursday, February 14, 2008
Afternoon Session

The meeting was called back into session at 1:30 p.m. **Tony Chan** was asked to review the situation at the NSF. The Directorate for Mathematical and Physical Sciences (MPS) has joint stewardship with DOE/HEP. NSF is the lead on the Deep Underground Science and Engineering Laboratory (DUSEL), and P5 is now looking at the discovery potential of DUSEL.

He referenced the President's statement on science in the State of the Union Address. The three main ingredients of the ACI are the tying of fundamental discoveries to marketable technologies, facilities and instrumentation, and a world-class science and engineering workforce. The MPS Directorate tries to respond to the ACI. The ACI drives many of the programmatic decisions at NSF.

The FY08 situation is not good news. As a result of the Omnibus Bill, NSF has a flat budget. Subsequently, it has deferred new Physics Frontier Center (PFC) awards to FY09, funded three facilities below the FY08 request levels, cut most core programs 5%, and made planned investments in new core programs (Physics of Living Systems and DUSEL R&D and design activities).

In the FY09 request, the increase is looking good for research and related activities (R&RA), and that is because FY08 was so bad. NSF did get a lot of money to relieve the understaffing problem. The FY09 budget increase is distributed across all the directorates, but physical science and engineering got a larger portion than most. The real question is: how real is this?

The Major Research Equipment and Facilities Construction (MREFC) account is outside MPS's control. ALMA [Atacama Large Millimeter Array], IceCube, and Advanced LIGO [Laser Interferometer Gravitational Wave Observatory] get MREFC appropriations. Advanced LIGO's request is before the National Science Board (NSB) for approval now. ALMA is in the thick of construction and is partially operating. IceCube is also under construction. MREFC covers *only* construction. R&D is funded separately. The Advanced Technology Solar Telescope is currently being designed.

MPS has five divisions, including Astronomy and Astrophysics. MPS is the largest of seven directorates and five offices, representing about 20% of the total NSF budget. It supports 7,500 university-based principal investigators (PIs), 2,300 postdocs, and 14,300 students. It has a broad portfolio, from individual PI grants to centers and institutes to more than 12 major facilities. It supports a spectrum of research from fundamental discoveries to marketable technologies. And it has strong international ties throughout its programs. (LIGO and ALMA are good examples.)

The MPS FY09 budget request represents a hefty increase over the FY08 Omnibus Bill appropriation. All of the MPS divisions are getting funding increases that are greater than that of the Foundation as a whole. These increments go to centers and institutes ($23.3 million), facilities ($21.0 million), and individual and group investigators ($191.1 million).

The MPS challenges for the 21st century include understanding and exploiting quantum nature, creating new molecules and materials, understanding the behavior of the living world, discovering connections between mathematics and the sciences, and charting the origin and evolution of the Universe.

Three NSF-wide investments in partnership with others are science and engineering beyond Moore's Law, cyber-enabled discovery and innovation, and adaptive-systems technology. Within MPS, the major partnered investments are the life science interface and quantum information sciences.

NSF uses centers and institutes to allocate funding. It wants to emphasize (1) chemistry and (2) physics frontier centers. There are now nine PFCs, and it is hoped to expand these to thirteen. These centers now have a track record. They leverage funding and have impacts outside the area of physics.

The major facilities include the Cornell High-Energy Synchrotron Source (CHESS), LIGO, Arecibo, IceCube, ALMA, etc. This is a large portfolio, and it continues to grow. The budget calls for ramping down the Cornell Electron Storage Ring (CESR), completing IceCube, operating LIGO, and operating the Large Hadron Collider (LHC) detectors. DUSEL is proceeding through the solicitation and decision phase. The Large Synoptic Survey Telescope (LSST) is in the final stages of design and development. GSMT is in the planning pipeline.

MPS supports workforce development throughout the educational spectrum. It encourages young investigators, undergraduate students, K-12 science educators, broadened participation, and ACI fellows. In the pilot ACI Fellows Program, each division is addressing a different aspect, such as junior-rank workforce development and outreach activities.

Shochet noted that, in difficult funding years, the PI grants up for renewal that year bear the brunt of cuts. He asked if that could be smoothed out. Dehmer replied that the NSF policy is that the commitment of funding is for 3 years. Once that commitment is made, the funding is not touched.

Bagger asked how the decision was made to make investments in DUSEL while cutting core-project support. Dehmer responded that NSF tries to make cuts across all sectors, but one cannot plan a very large project in a stop-and-go fashion.

Bortoletto said that it looks like the MPS budget is going down for FY09. Chan replied that that was an allusion of how the budget was presented.

Cahn asked how DUSEL and LSST fitted into MREFC. Chan replied that that is tricky. The Division has to come up with the operating funds. The division has already chosen DUSEL as a high-priority after Advanced LIGO. These construction funds may have to be spaced out.

Piermaria Oddone was asked about the budget's impact on Fermilab. Fermilab's ongoing program gives the greatest discovery potential before the LHC turns on. It has strong collaborations, has great operations at high luminosity, and dominates world physics.

The Main Injector Neutrino Oscillation Search (MINOS) utilizes a beam with large neutrino flux and a slight electron-neutrino contamination. MiniBooNE [a detector for the Booster Neutrino Experiment] is exploring the low-energy anomaly in neutrino interactions, SciBooNE [SciBar Booster Neutrino Experiment] is measuring neutrino cross-sections, and the Cryogenic Dark Matter Search (CDMS) is days from the best dark matter limits. The Sloan Digital Sky Survey (SDSS) is conducting a huge impact survey and studying baryon acoustic oscillation. Pierre Auger is explaining the GZK (Greisen, Zatsepin and Kuzmin) cutoff. And the Chicagoland Observatory for Underground Particle Physics (COUPP), a clever bubble chamber, is obtaining competitive results for spin-dependent weakly interacting massive particles (WIMPs).

The ongoing program has a powerful theory group and capabilities in computational science, detector instrumentation, accelerator design, control and operations, mechanical and electronic engineering, and magnet design. Fermilab does everything in the context of worldwide collaboration.

In the future, Fermilab will address the energy frontier, the intensity frontier, and non-accelerator-based programs.

Fermilab has a broad involvement in astrophysics: with participation in the Dark Energy Survey, CDMS, COUPP (which is scaling from 2 to 60 kg), and the SuperNova Acceleration Probe (SNAP).

At the high energy frontier, Fermilab is involved in the Compact Muon Spectrometer (CMS), the Remote Operations Center at Fermilab, and ILC technology.

On the intensity frontier, Fermilab has produced a major neutrino detector and upgrades to the present complex and planning for a facility for neutrinos and rare processes. This was done in a clever way, producing a very powerful beam that can be used for a variety of programs. Project X could provide more than 2 MW to the neutrino program.

In the past 3 years, there has been steady progress on the high-energy frontier, neutrino program, and particle astrophysics.

There have also been tight budgets, but great productivity. In the FY08 budget process, cuts were distributed when the President held the line on the budget total. From the expected budget of $372 million, only $320 million was received for FY08. Therefore expenditures needed to be reduced by $52 million. That meant an immediate stoppage of ILC, superconducting radio frequency (SCRF) R&D, and NOvA. Staff will move to other projects. For the future, the laboratory will be resized to absorb the reduction in the program. The size of the reduction in force (RIF) is about 200 full-time equivalents (FTEs). In addition, a "rolling furlough" of approximately two days per month will be implemented.. The Tevatron is not affected, but the whole Laboratory has to be reshaped. The Laboratory has not fully absorbed the entire impact.

Within all this disaster, we are trying to save the 2008 run of the Tevatron as well as the neutrino programs, maintain our commitment to and participation in the LHC, and support the smaller projects that add vitality to our program. There is also a broad influence on the community: ILC is a broad national and international collaboration; our U.S. high-energy-physics partners will suffer, and there could be a long-lasting impact on the United States' credibility as an international partner. For Fermilab, the burden falls largely on NOvA, ILC, and SCRF. Collateral damage included the early termination of the B-Factory. Good management was needed because every initiative is funded separately. We have a huge problem to handle because of this budget.

The recovery plan calls for working with DOE. We need to work with the community, P5, and HEPAP to make a compelling roadmap that DOE, the public and legislators will support in future years. A general rule is that, if the LHC discovers new particles, Fermilab will conduct precision experiments to tell about the physics behind those particles through rates and couplings to standard particles; if the LHC does not see new particles, the only avenue to probe higher energies will be precision experiments with negligible rates in the Standard Model (SM).

One approach is an expandable Project X, whose configuration exploits alignment with ILC. But it is expandable to three times the repeat rate, three times the pulse length, and three times the number of klystrons. Project X would position the program to be a multi-megawatt proton source for a variety of experiments. That would be the best source in the world, with a neutrino program at 120 GeV and, in addition, significant proton intensity at 8 GeV. Existing 8-GeV rings can be developed to deliver and tailor beams, allowing a full duty cycle for experiments with the correct time structure. High-rate 8-GeV experiments do not decrease the protons-on-target for the neutrino program at 120 GeV.

There are several strategies: (1) NOvA. It is the only experiment sensitive to the mass hierarchy; together with Tokai-to-Kamioka (T2K) and a reactor, it provides the best shot at determining neutrino oscillation parameters. (2) Replace MINOS by a 5-kton liquid-argon detector on axis; together with NOvA, this approach is by far the best reach into mixing angle, CP violation, and mass hierarchy. (3) Develop detectors for DUSEL with a new beamline from Project X, which would be the ultimate superbeam experiment. In addition, if a neutrino factory were needed, Project X would be the ideal source.

One could start with a booster beam. If a mu-to-electron conversion signal were found at 10^{-16} level, a dependence could be studied with higher beam levels. If a signal were not found, the search could be extended with higher beam levels. Further power levels could be obtained with Project X by increasing the 8-GeV power. It also helps one with the ILC because the Project X linac would develop U.S. capabilities toward an ILC, would position Fermilab as a potential host, would positions the United States to contribute to a major part of the ILC, and would allow concrete collaboration with potential partners.

Another evolutionary path is to use Project X to develop a 1.5- to 4-TeV muon collider.

In conclusion, a base program is needed that provides exciting physics, maintains many options for the future, is not dependent on huge jumps in funding, can be carried out incrementally in bite-sized pieces, and supports a path to gain a large machine at the energy frontier.

Cahn asked if there were money for Project X in the FY09 budget. Oddone replied that there is money for work that would contribute to Project X. He has argued to continue running the Tevatron in 2010. There are several areas in which the Tevatron information is complementary to that from other sources. If one does not prepare for a new project, one comes to the edge of a cliff.

Brau asked where the branch point was for making a decision between neutrinos and the ILC. Oddone responded that that is one reason why SuperNuMI (SNuMI) was being put on the back burner. The key decision has to be later than 2010.

Persis Drell was asked to outline the budget impact on SLAC. The impact of the FY08 appropriations budget is severe. SLAC anticipated \$120 million; it was told in December that it would be closer to \$95 million. Every program is taking a hit. The brunt was borne by the B-Factory and BaBar. BaBar was shifted to the 3S upsilon resonance and will then be moved for one month to the 2S upsilon resonance. The B-Factory will then be shut down. This is a serious loss to science and does damage to the entire physics community. The programs at SLAC funded by the Office of Basic Energy Sciences (BES) did much better, being fully funded and, at worst, flat funded. SLAC is resizing its workforce. 191 people have been laid off. A voluntary RIF program was initiated, and 72 volunteered, requiring 191 involuntary reductions in force during the week previous to the meeting. Additional empty positions will not be filled for a total reduction of 225.

The layoff decisions were made by looking at the future and its needs. Without a user facility onsite, the needs of remote users still need to be met. The core skills at the laboratory were retained. SLAC will support GLAST and will provide B-Factory data delivery. It will support many programs of the community. Planning and development for a lepton collider and the ILC will continue.

In a limited time, difficult choices were made. Particle physics at SLAC is vulnerable now. High-energy physics in general is facing a funding crisis. The major question is whether the United States will play a role in high-energy physics.

P5 should listen to what it is being told. Rebaselining was not a fluke. Particle physics has fared poorly because it was seen as not having a comprehensive plan for the future. There is no entitlement for science. The scientific community must be willing to face very difficult questions, such as whether an operating HEP accelerator is needed, whether more than one national laboratory HEP program based at Fermilab is needed, can one have a world-leading science program at the energy frontier in the United States, what the appropriate balance is between the accelerator-based program and the nonaccelerator-based program, and what the investment strategy for the areas where we are not in a world-leadership position could be.

The answers to these questions have to be based on what will be won: value, leadership, and the broad scientific community's benefit.

Particle physics needs a plan that starts with the baseline of current funding of $690 million and shows that one can produce leadership science with that. A world-class leadership program might entail only one project. Then leadership must be shown by gains in other areas with incremental resources. Why that leadership is important must be articulated. Resources must be justified. Institutions must change. One cannot argue to preserve the past; one must move on to the future.

Cahn observed that P5 has a great quandary with the FY08 budget of $688 million. Shochet said that the danger is saying that $688 million is inadequate and having it taken away.

Ferbel asked whose deliberations were involved. Drell replied that Congress believed that the scientific community was not paying attention and that this would get its attention.

Bagger said that these questions are incredibly important. However, P5 is already on an accelerated schedule. He asked if parallel discussions were being conducted. Cahn doubted that these questions would be addressed by P5.

Moishe Pripstein said that these questions should have been addressed a long time ago and answered in a rational timescale.

Wormser asked what the value of this world leadership was. Drell said that one must define leadership carefully. One cannot be a leader in all fields; choices have to be made.

Kephart asked to what degree the program was fungible. Drell countered: Why didn't the B-Factory operating funds remain in the field? Because the high-energy-physics community did not have a plan. Kovar noted that P5 is being charged to come up with a $655 million plan that DOE and NSF will try to implement.

Shochet asked what program is likely to be supported by Congress and the people in terms of where it is done and what discoveries are made. Drell suggested starting with science and trying to sell what is the most compelling case. Chan noted that there is a missing part of the equation: the agencies.

Cahn said that the community has for some time said that the ILC is the most compelling scientific opportunity. Was the sale missed? Drell said that that is what Orbach said in the morning session. Cahn asked how the ILC should be regarded from now on. Drell said that a lepton collider will not go away. There is funding hoped for in FY09. In the near term, there is excitement about ILC technology. It may be difficult to maintain that excitement. The R&D should be kept going at a reasonable level (e.g., $50 million).

Usha Mallik asked how the $655 million value was arrived at. Drell responded that that was a baseline. Other scenarios can be considered.

A break was declared at 3:28 p.m. The meeting was called back into session at 4:01 p.m. **Barry Barish** was asked to comment on how the ILC program was coping with the budget reductions.

In the United Kingdom, there are 40 FTEs at two new accelerator-physics centers. Those centers are attracting the intellectual leadership away from the United States. The cancellation of ILC work in the U.K. is a serious loss. It is hoped that intellectual contributions can continue under a generic R&D program.

In the United States, the ILC program was terminated. It is hoped that it is reinstated in FY09. Generic SCRF R&D was terminated.

In response to the charge to produce a global design, a baseline was established, and a reference design was developed. Those goals were reached, and the effort was documented. In terms of the science, nothing has changed. The keys to doing more are the technical, design, and cost issues that have to be resolved. Strong encouragement has been received from our collaborators to move forward.

The goals and strategy are to produce a detailed technical design, which would need R&D demonstrations, reliable costing, and a project plan. We need to be prepared when the LHC results indicate what needs to be done.

Central coordination is being used to eliminate duplicative efforts. The scope has been reduced. The timescale has been stretched out. The problem has been divided into two phases. All goals are to be reached by 2012. By 2010, all critical items should be in hand.

A close relationship is being developed with the X-Ray Free Electron Laser (XFEL). It is planned to take advantage of synergies with the U.S. SCRF program, Project X, etc. Some linear-collider efforts are being integrated with the Compact Linear Collider (CLIC).

The technical design phase R&D plan represents a balance among the R&D priorities identified during the Reference Design phase, the available funding and supporting infrastructure, and the interest and skills of a given institution. These three considerations are facilitated by the Reference Design Report and the associated value estimate; input from the Regional Directors, funding program, and institutional managers; and responses to a broadly distributed solicitation of expressions of interest.

The key features of the two phases in the next three years are

1. technical risk reduction (i.e., in the gradient and the electron-cloud effect),
2. cost-risk reductions (e.g., the water-cooling costs and the costs of the main linac), and

3. technical progress to allow plug-compatible parts.

A lot of R&D test facilities are available or being built.

A major goal is to achieve a cavity-gradient of 35 MV/m in a nine-cell cavity in vertical Dewar tests with sufficient yield. DESY's [Deutsches Elektronen-Synchrotron] cryomodule performance has been increasing.

Conventional-facility designs are where great savings can be made. One of the capabilities that was needed for this was a group at SLAC that has been eliminated in the budget cuts. Best-bet possibilities have been targeted.

On the 2012 timescale, an RF test unit should be hooked up with a beam at the High Energy Accelerator Research Organization (KEK). The completion of the technical design and the R&D needed for a project proposal are also needed. A project plan will be developed by consensus.

The cryomodule design breaks down into about five pieces on which design can be done in parallel.

The first goal is to achieve 31.5 MV/m at $Q_0 = 1 \times 10^{10}$.

What will not be done are detailed engineering design, a global cryomodule industrial plant construction, and other unresolved issues.

In conclusion, there is a recovery plan with two stages that resolves critical issues by 2010. Strong support from FALC is needed to go forward with this plan as is support from P5, ILCSC/ICFA [International Linear Collider Steering Committee/ International Committee of Future Accelerators], and HEPAP.

Bagger asked what cost was being aimed at by 2012. Barish replied that he was not yet confident of any cost.

Shochet noted that one can lose people by attrition because of lowered expectations. He asked whether any such attrition had been observed. Barish said that he had not seen any attrition but that the U.S. part is difficult to assess. This worry is of concern in detectors. The detector-machine interface needs to be understood, and the detector conditions are severe. Wormser said that he did not see a domino effect in Europe except in the United Kingdom. In fact, a bid is being made to the European Council to host the collider.

Bagger asked what was on the horizon in the United Kingdom. Barish said that the United Kingdom had really made a policy statement: they have a large financial problem and it cannot afford to do anything outside the CERN program.

Michael Harrison was asked to discuss the U.S. ILC program. The Omnibus Bill capped U.S. FY08 ILC funding at $15 million. Because we were 3 months into the fiscal year with a $60 million guidance, this was tantamount to a cease-work order for the balance of FY08. All spending was halted at the beginning of January, and a count of funds remaining at the laboratories indicated an unobligated balance of about $2.5 million under the cap. The FY08 priorities then became the Global Design Effort (GDE) common fund, GDE core support, CESR TA [Test Accelerator], and machine-detector interface.

The plan was to have 200 FTEs in 2008, and the program ended up with four. Even with a funding cap, there is a need for some functionality to maintain the ability to resume.

Priority 2 was the CESR TA, which is a comprehensive electron-cloud R&D program based on the very flexible machine complex at Cornell. This is a unique time, a critical opportunity. It is rated as the highest technical risk in the baseline design, which relies on successful mitigation of this risk. The funding cut also hit several other participating laboratories. CESR TA addresses a lot of the R&D priorities.

Priority 3 is the machine-detector interface that has highly complex physics/engineering issues and a totally integrated design between the machine and the detector. It is critically important for the detector design, and the United States is the GDE lead; however, FY08 funding is uncertain.

Moving on to FY09, since August of last year, the projected FY09 funding has fallen from $95 million to $60 million to $35 million. Together with the FY08 stop-work order, this uncertainty in funding makes detailed planning difficult. The recent President's budget shows the Americas Region Team (ART) at roughly 50% of the former budget. The program should be robust and thus easily defensible. Given the FY08 situation then, only top-down planning is possible for the near term. Therefore, there is no detailed ART multi-year program yet, but it is conceptually compatible with the new GDE plan. The strategic goals are to preserve the collaborative commitment to the GDE, provide contributions to the ILC R&D program that are unique to the United States, support the value-engineering effort in the medium term, and maintain the U.S. presence in ILC SRF R&D. There is a reduction in effort of the management and conceptual engineering. The end result was to reduce the electron-source program by 20%, eliminating the positron source, eliminating the damping-ring effort, eliminating the RF-system hardware deliverables, reducing the beam-delivery system by 10%, reducing the accelerator physics/global systems by 50%, and eliminating the bid to host the system and site categorization.

An attempt was made to preserve the U.S. presence in the international effort without industrialization and without system tests. The global card was played, cutting out of the U.S. program what is being done elsewhere. A minimal high-gradient program and cryomodule prototyping at Fermilab are being kept.

The cryomodules are complex and expensive. The U.S. program was parallel with what was being done elsewhere. Now the rest of the world will take off in 2009, and the United States will remain flat.

The expectations of a host are 50% of the cost and a wide-ranging knowledge of and involvement in the technology. Otherwise, one goes into a very topic-specific program. That means that decisions have to be made on mission needs, cost ranges, performance baselines, construction start, and start of operations.

An attempt was made to cost a U.S. machine for P5. Starting in FY08, one would need 15, 35, 60, 85, and 148 million dollars per year. A nonhost scenario is being looked at. A major question is if one could get back to a host scenario, which would require boosting superconducting-cavity production.

In summary, there are a funding cap for the balance of FY08 and a reduction of about 50% in FY09. The effort is becoming more focused. We have pulled back on SCRF technology to a point that is consistent with a non-host role at this funding level for the next couple of years. A little stability in the funding would help to get the most from the available resources.

Shochet asked if there is a problem in retaining people because of diminished opportunities. Harrison replied that the core personnel will be there in FY09.

Cahn asked what $35 million would support in FY09. Harrison replied that it would support coordination of the work done at SLAC and elsewhere.

Tigner stated that before throwing in the towel on hosting the ILC, the United States should examine more closely what it means and costs to be a host.

Cahn noted that, at the Fermilab P5 meeting, Harrison had shown costs. Harrison responded that he had not wanted to bore this august assembly with those details. The answer he had gotten was $14.9 billion.

The U.S. Double Chooz Collaboration had asked to make a presentation as part of the public comment. **Robert Svoboda** said that things are going on outside the United States that will affect the Panel's plans. One such effort is Double Chooz in France, which involves people from many countries.

θ_{13} is important, and the Neutrino Scientific Assessment Group (NuSAG) report recommended a program of R&D on both the detector technologies and the beam so that decisions can be made as soon as the size of $\sin^2 2\theta_{13}$ is known. NuSAG points to three regimes as possible values; each has a different implication for each potential facility being contemplated. Double Chooz is going to get to the critical level about a year after turning on the second detector in 2010. In 2006, HEPAP said that Double Chooz should get a high priority. The NSF provided a small amount of support, and a number of other countries have joined the collaboration and supplied funding.

The collaboration would like to have HEPAP reiterate its statement of support made in 2006.

Scholberg asked how much of the $1.3 million had been committed and how soon would Daya Bay have results. Svoboda said that Europe and Japan have committed $300,000. Daya Bay would start in 2011.

Burchat asked how HEPAP was to reiterate its support. Shochet suggested that it be done in the letter to the agencies summarizing this meeting.

Kovar noted that the only time a committee supplies advice is when an agency asks for it. Shochet pointed out that the language can distinguish between advice and a comment. The letter could say that it is just good science. Kovar noted that it has to pass the General Counsel's scrutiny. A committee can exchange information; it may not make unsolicited advice. The Committee must be careful to preserve these open discussions.

Shochet opened the floor to questions about the new organization of the Office of High Energy Physics.

Randall asked how these positions were selected. Kovar responded that managers were put in place to parallel the existing budget categories. Those managers will discuss what projects are needed, the importance of the science, resources that are needed, etc. They will depend on community advice (e.g., P5), peer reviews, national-laboratory reviews, etc. They will set a bottom line and whether it needs to grow and how to optimize funding. In high-energy physics, each national laboratory had a facility. When one has a facility, one needs to worry about the institutions. But the focus has to be on science. Disciplines need to be analyzed, and decisions need to be made on funding based on scientific opportunities. There is going to be a transition now. The PIs better be prepared to defend to the program manager the science they are doing.

Shochet asked how many reviews per year the national laboratories would have. Kovar responded, two apiece, based on the topics dealt with.

Bortoletto asked how big a change it was going to be for universities. Kovar answered that it would vary according to what the university was already doing.

Scholberg asked about flexibility because one did not always know what the future holds. Kovar responded that one had flexibility to make changes, but those changes had to be defended in annual reviews. Universities will be reviewed in 3-year cycles. All pertinent program managers will be involved in any given university-grant review. The national-laboratory reviews will compare a national laboratory's activities against the activities of all the other national laboratories. It turns out that universities are much cheaper, but there are things that national laboratories can do that universities cannot. There is a basic tension there. In addition, each program has different goals and different needs for resources.

Bagger asked if institutional stability would not be a major concern anymore. Kovar said that high-energy physics will have to compete with other fields, so it will need to be more efficient. At the same time, impacts on an institution will be factored in. The U.S. industrial sector is extremely productive now; that productivity should be seen in research activities, also.

Molzon asked how the impacts of the university reviews would show up in the national-laboratory topical reviews. Kovar responded that that is a problem that each program manager will have to come to grips with. These programs could end up as massive enterprises.

Perlmutter commented that they must have seen people vote with their feet and universities reprogram the funds. Kovar responded that that happens rarely. The university should pick up the phone and talk with the program manager. Resources need to be channeled to where science will be gotten out of those funds.

Raubenheimer asked if they had thought to group program managers by energy frontier, intensity frontier, and nonaccelerator high-energy physics. Kovar said that they are grouped by budget structure so everyone knows where he or she fits.

Randall asked if people are told what funds are available for their research. Kovar answered that, for FY09, that funding level is now set. For FY10, people can argue for increased funding. There are now very small reserves, and those reserves will probably go to "taxes" imposed by the Department. A very few reserve funds will be available for strategic investments at the end of the year.

Molzon asked if there were upper limits on projects. Kovar replied affirmatively; there are MIEs with limits on them.

Gladney asked whether there would be metrics with the increased efficiency and whether the researchers would get to see what they are. Kovar noted that, when the Office of Management and Budget (OMB) tried to impose metrics, they decided that peer review based on milestone accomplishment is the only defensible metric. There are easy metrics for projects and facility operations, but he did not know how to quantify R&D. An attempt should be made to do something about this issue.

The meeting was adjourned for the day at 6:03 p.m.

Friday, February 15, 2008
Morning Session

Chairman Shochet called the meeting to order at 8:31 a.m. **James Reidy** was asked to give an overview of the NSF budget preparation.

The NSF uses several sources of input:

- EPP [the NSF program on Elementary Particle Physics] on particle physics
- PNA [the NSF program in Particle and Nuclear Astrophysics] on astronomy and astrophysics
- Fred Cooper on theory
- John Kotcher on DUSEL

NSF asks the community to draw up a plan. The overall Physics Division strategy covers the short, intermediate, and long terms with various projects falling in one or the other categories. The core research is not allowed to go below 50% of the available funding. The rest is split between facilities and centers.

Proposers send in proposals, a peer-review panel convenes in Washington, and the panel interviews the proposers by telephone.

In FY08, EPP is down 5%, Theory is down 4%, and PNA is down 2%.

The portfolio includes the University Program, LHC experiments, DUSEL, CESR/CLEO-c (ending in February 2008), accelerator R&D, detector R&D, and partnerships and broader impacts.

The theory program is comprised of 13 university groups, 66 proposals from PIs, two centers for collaborative research, a possible LHC center, and the Theoretical Advanced Study Institute in Elementary Particle Physics (TASI) Boulder Summer School. The funding for theory is down a bit from FY07. The university part is about $11 million. The critical issues are the need to involve more young people in LHC-related physics, the need for new hires in phenomenology, and the need for more funding for students.

The EPP/PNA underlying themes are empowering university-based investigators and adding value through partnerships; broadened participation; and education, outreach, and broader impacts.

Partnerships with the Office of Cyberinfrastructure (OCI), DOE, Office of Multidisciplinary Activities (OMA), Directorate for Education and Human Resources (EHR), and Office of International Science and Engineering (OISE) include Tier 2c, UltraLight, Open Science Grid (OSG), QuarkNet, Center for High Energy Physics Research and Education Outreach (CHEPREO), Interactions in Understanding the Universe (I2U2), Mariachi, CyberBridges, Partnerships for International Research and Education (PIRE), and ILC Outreach.

From 2006 to 2007 in EPP, senior professionals went from 107 to 119, postdocs from 76 to 75, other professionals from 28 to 19, graduate students from 102 to 107, undergraduate students from 23 to 26, clerical from 7 to 10, and others from 7 to 5., which all comes out to $162,100 in grants per senior personnel.

There were 85 funding actions in FY07 with a mean of $237,000, based on 70 PI programs. Two actions were for more than $2 million, and 13 small awards were for conferences and workshops.

For PNA, there were 40 universities , 73 PIs, 12 under-represented PIs, 7 FTE research scientists, 40 FTE postdocs, 77 graduate students, 63 undergraduates, $13.4 million in support, and $307,939 per FTE PI.

Planning for FY09, NSF will continue to support university groups participating in a compelling experimental program at Fermilab; strengthen the University Experiment

Program and Theory; continue a successful history of partnerships with DOE/HEP on the LHC, Pierre Auger, QuarkNet, CESR-TA, and DUSEL; continue a successful history of partnerships with DOE/NP [Office of Nuclear Physics] on DUSEL and the Cryogenic Underground Observatory for Rare Events (CUORE); and advance possible future major facilities.

To do all this, a plan is needed, so NSF is asking for HEPAP's help.

Bagger asked what was happening with the growth in senior personnel. Reidy responded that this is real growth. The number of high-energy physics programs and professionals has grown. Goldberg noted that a lot of career awards had been made during the past few years, and some undergraduate students have been funded.

Bortoletto asked why CESR was shut down early and why the LHC is reviewed. Reidy responded that CESR was cut off a month early for budgetary reasons. To be good stewards, NSF wants to know what the LHC is doing and to make sure that the strong groups have the resources they need.

Molzon asked if there would be other new PFCs. Goldberg replied, no. The proposals are currently under review.

Charles Baltay was asked to review the P5 activities in progress.

P5 was given several budget guidances for 2007 through 2017. One of its issues is to show that the program funded at $688 million is very good but that a little more money would produce a great program. The panel is getting the community involved as much as possible.

The first meeting was held at Fermilab two weeks before the HEPAP meeting. Topical discussions and a town meeting were held. The next meeting will be held at SLAC the week after HEPAP meeting with a broad range of topical discussions and a town meeting that will include European participation. A meeting will be held at Brookhaven National Laboratory (BNL) in March, at which time institutions will present their perspectives.

The Panel met at Fermilab and discussed its organization, developed agendas for the SLAC and Brookhaven meetings, heard informative talks about the Fermilab plans and the ILC situation, and had a long discussion about what issues the Panel should focus on. No attempt was made at decision making at this stage.

A personal impression is that it is crucial for this Panel to articulate a vision for high-energy physics that will make people want to open their wallets. So the question arises, can one think of the field as having three Frontier Areas with similar high priority:

- The Energy Frontier: The Origin of Matter
- The Luminosity Frontier: Neutrinos and Leptonic CP Violation
- The Cosmic Frontier: Dark Matter and Dark Energy

Each of these three frontiers seeks answers to fundamental questions that one should be able to articulate and that everyone should be able to appreciate, even though they require different approaches and facilities to pursue. High-energy physics is richer in exciting intellectual questions than 15 years ago and is at the threshold of incredible discoveries.

What might follow from this? In the Energy Frontier, should the United States consider the LHC program as an integral, high-priority part of the U.S. high-energy physics program, and should the goal of regaining the Energy Frontier in the United States via future high-priority lepton colliders be supported? At the Luminosity Frontier, should our long-range vision include having a world-leading neutrino program in the

United States with a megadetector at the DUSEL site with the neutrino source at Fermilab and eventually advanced neutrino sources? If so, it is clear that one cannot get there in one step but needs a program with a series of steps. It might be important to realize that each step by itself may not be spectacular but is justified as a step necessary to get to the ultimate goal. Care should be taken that these steps not be detours or sidetracks but are the most direct and rapid steps that lead to the goal. And at the cosmic frontier, does the United States have a world-leading program in dark matter and dark energy, assuming that current plans are realized?

It will be important to develop a vision that is coherent with the international nature of high-energy physics. The energy-frontier facilities have to dovetail with what might be planned in Europe and Asia. One should consider scenarios with both onshore and offshore facilities. The luminosity-frontier plans have to be coordinated with Europe and especially Japan. And the dark matter, dark energy, and neutrino programs will also be international endeavors.

The question must be asked how important it is to have an onshore accelerator program in the United States to maintain accelerator expertise to train the next generation of accelerator physicists, to recapture the Energy Frontier, and to maintain a level of support for high-energy physics anywhere near what it is now? If there were no accelerator facilities in the United States, what would be the United States' fair share of the operating costs at CERN?

Despite being asked for a 10-year plan, the P5 crystal ball cannot see too far ahead. A 10-year roadmap will have to have some branch points 4 or 5 years from now as more information becomes available. What is found at the LHC will influence the nature of future lepton colliders. The value of θ_{13} will affect the nature of the optimum neutrino program as will whether DUSEL is approved or not. The Panel also has to be sensitive to canceling an ongoing program to pursue something that ultimately does not come to fruition. It is not clear how to balance programs within reach that might be slightly less exciting against more exciting science with less certainty of realization. The first 4 or 5 years will have to include an R&D program sufficiently well balanced to be able to follow the best forks in the road as rapidly as possible.

Cahn said that it is interesting to compare the scenarios looked at by the old and new P5s. The difference between the high and low in this P5's scenarios is greater than $2.5 billion over 10 years. The spread is extraordinary. The project landscape has changed, and the choices are going to be very difficult.

Bagger observed that it is important not to make it look as though the spoils are going to be divided among the three components of science. Also, one should not throw out EPP2010; they were a lot of important views put forward in that report. Shochet pointed out that the boundary levels have changed since EPP2010 was published. Baltay said that P5 would not give equal weight to the three "legs" of science. It will not ignore EPP2010, the previous P5 advice, or other inputs. The world is changing, though, and we need to change along with it. The perception is that a new strategy is needed. We may need to focus on a few areas in which we can be world leaders and may need to be important players in all areas.

Randall commented that it is important that all of these enterprises lead to a common goal and it is the pathway to that goal that needs to be chosen. Nothing should be scrapped just because it is not world-class. Training the next generation of physicists needs to be focused on, not just training accelerator physicists. What to do when the LHC starts producing data needs to be faced up to.

Grannis asked if there were enough time to fully consider and answer the questions and issues. Baltay responded that as much discussion time as possible was put in. There is never enough.

Dehmer said that DUSEL approval is not input to your deliberations as much as your deliberations are input to the DUSEL decision. Baltay responded that P5 has had that discussion and realizes that Fermilab's plans also bear on the DUSEL decision.

Burchat stated that P5 should consider the meaning of world leadership in a scientific enterprise. It may not be the major contributor. It may be intellectual leadership, but how does one maintain intellectual leadership? Shochet noted that the funding from European nations added to the CERN budget is three times the U.S. high-energy-physics expenditures.

Molzon asked how international these programs are in their funding. Kahn said that it is significant, at least 20%. One could argue that European investment in high-energy physics is great for the United States because of the amount of science it gets.

Kovar warned that P5 should make the perspective clear early in the report and should develop that theme soon because it may significantly influence the discussions.

Bagger asked how willing the Japanese were to coordinate their program with the U.S. program. Baltay said that Atsuto Suzuki, Director General of KEK, understands that his range of programs is beyond Japan's ability to fund and that partnerships will be needed. He is very realistic.

A break was declared at 9:55 a.m. The meeting was called back into session at 10:18 a.m., and **Abolhassan Jawahery** was asked to review the plan forward for BaBar and the PEP II Experiment.

The B-Factory has two rings that accelerate and store electrons and positrons and then collide them in an asymmetric manner to observe CP violations in the BaBar detector. The mission of the B-Factory was to investigate CP violation in B-meson decays, to test the CKM [Cabibbo-Kobayashi-Maskawa] paradigm, to search for new physics in rare decays, and to test quantum chromodynamics (QCD) predictions of B-meson-decay dynamics.

The machine has been running since 1999. It reached seven times the original design daily integrated luminosity; $\sin^2 2\theta$ was achieved within 5%; accuracy is within 1 femtosecond.

The collaboration is made up of 10 countries, 74 institutions, 459 physicists, 130 students, and 75 postdocs, most working on the analysis of current data and counting on future data. The status is: Run 6 was concluded on Sept. 3, 2007, and was to be followed by a 3-month downtime, which involved significant work to prepare for higher beam currents and the luminosity regime of 2×10^{34} cm^{-2} s^{-1}. The expectation for Run 7 was 250 fb^{-1}, a 50% increase in total data and nearly a tripling of the data with fully upgraded muon identification. With the budget news on Dec. 17, PEP II switched to running at the 3S upsilon resonance on Dec. 21. Extensions granted on the basis of the physics case will include a month running at the 2s upsilon resonance until April 6, 2008. The goal of this Run 7 is to produce 30 fb^{-1} at the 3S upsilon resonance and 20 fb^{-1} at the 2S.

There is sensitivity to new physics effects, such as the invisible width of the 1S upsilon resonance, light dark matter, or exotic light Higgs. Bottomonium spectroscopy could be done. This data set is comparable to the largest set on charmonium decays. The measurements are of significant interest to tests of lattice QCD (LQCD) and potential models. As-yet unseen new states and transitions, including singlet states, may be observed. This is a fairly strong program.

The whole of the BaBar data consists of about 0.5×10^9 B–anti-B events, 0.5×10^9 c–anti-c events, 0.5×10^9 τ–anti-τ events, and 1.5×10^9 electron–positron collisions leading to q–anti-q events.

The physics reach of the BaBar data includes CP studies with B and anti-B physics, the most important achievement. It also is good for charm physics, tau physics, continuum electron–positron interactions producing hadrons, and measuring the hadronic part of photon vacuum polarization.

The program has been successful in publishing: 330 papers so far. Its publishing rate is far above that of other programs.

It is aiding tests of the CKM paradigm. The B-factories are aiming at standard deviations of the CKM matrix element $|V_{ub}|$ of about 5%, of γ of about 5 to 10º, of α of about 8º, and sin 2β equal to 0.02. The current experimental values are 7 to 10%, about 20º, about 10 to 15º, and about 0.04, respectively. This program is far from complete. There is a core data set that needs to be completed; now about two-thirds of the core measurements have been performed with less than half of the full data set.

The task in hand is to complete more than 100 core-physics measurements; currently ~250 analyses are ongoing. That sets up our plan: Nearly all core-physics channels are covered with active analysts and will be updated with full data. The final BaBar reconstruction code has been developed after extensive studies during the past year; the plan is to reprocess the full 4S data by fall 2008. The post-data-taking phase has been planned out, defining the "core" physics and planning for the resources needed to complete it. A period of 2 to 3 years of intense analysis activity is expected following the end of the data taking.

The intense-analysis activity has already begun. The key element of the program is the continuing availability of the computing resources (hardware and manpower) at SLAC and at the five Tier-A centers. This strategy is consistent with the BaBar physics goals and the manpower realities of the experiment. The key players in the analyses effort are the current postdocs and graduate students, whose life span in the experiment is the next 2 to 3 years. The success of this program depends on keeping a coherent and well-coordinated effort with SLAC-centered computing resources being employed beyond 2010.

BaBar's computing Tier-A centers perform a fast-calibration pass at SLAC, send the data to Padova for reconstruction, and receive the reconstructed and returned data. Data skims are uniquely assigned to Tier-A centers. Disk space for the corresponding analysis working group is located at the same center.

In summary, there was tremendous disappointment at the early termination of Run 7. Even so, an enormous amount of physics is still to come from the analysis of the 4S data, the principal physics program of the experiment. The majority of the core physics measurements will be updated with the full data set in the next 2 or 3 years. The current data on narrow-upsilon resonances expands the physics reach of the program with unique opportunities in the quarkonium spectroscopy and searches for the effects of new physics. The collaboration is healthy with a strong base of students and postdocs. More than 130

Ph.D. theses are in the pipeline. The full exploitation of BaBar physics needs the continued support of the community and of the funding agencies through the intense-analysis period and beyond. Strong support has been received from DOE HEP and BaBar's International Finance Committee for the completion of the run and the intense-analysis phase of the program.

Trischuk asked where the students will come from to do the analyses. Jawahery replied that SLAC will need 20 to 30 new students to continue this effort. It will be difficult to find students to work on a project that is no longer running.

Bortoletto noted that the Tier-2 centers seem to overlap with the LHC centers. Jawahery replied that, after the 2 years of work on BaBar data, most computing will be done at SLAC, and those centers will probably shift to analyzing LHC data.

Usha Mallik was asked to give an update on the demographic survey. There is a critical need to know how the field of high-energy physics is faring in terms of trends (how many enter, how many leave, how many get permanent positions, and how many stay as untenured staff) and where such physicists go when they leave. Now the need is more urgent about the future of high-energy physics.

The Demographics Subpanel got jump-started with Mike Ronan taking over the previous existing database and re-doing the software in 2005. Bill Carithers took over at the end of 2006, and Mallik has been working on analysis with help from her group (now Matthew Charles).

There has been real improvement where error rates can be measured. Carithers has done a phenomenal job to keep things moving and presented results for 2007. Mallik and Charles analyzed the data, comparing it with data collected in previous years. During 2007, 58 people disappeared. A unique ID key has been incorporated in the database so that the career paths of individual physicists can be traced. While numbers in various categories are similar, they are not the same; however, the analysis points to certain systematic trends.

From 2003 to 2007, the number of participating institutions decreased from 156 to 153, and the number of people increased from 4222 to 4589. Retirees went from 187 to 208, tenured personnel from 1343 to 1355, untenured faculty from 228 to 284, untenured staff from 396 to 436, postdocs from 935 to 970, and graduate students from 1129 to 1335. Those working in theory increased from 1292 to 1414, in experiments from 2555 to 2783, and in accelerators from 487 to 517.

The data collected need improvement; old entries keep getting repeated. There is a general apathy to filling the survey out. It was decided to improve the census and make it more user friendly, to incorporate automatic checks, and to have a transparency in the database for easy analysis and readability.

The database is being completed. To improve data quality and to ascertain the quality, intensive and careful work is needed. Next, the transition rates will be compared in order to understand the details. The results will be reported soon.

Scholberg asked how one ensures that the census instrument gets to everyone it should. Carithers said that DOE and NSF give the Subpanel a list of all the institutions it supports, the Subpanel requests that those institutions supply information on all of their students, and it sends the surveys to those individuals.

Cahn asked what kinds of questions the survey will answer. Mallik responded that career-length trends should be able to be observed. Carithers added that the table of data is a snapshot of all the people. It seems stable from year to year, but it is actually quite dynamic because people move around in a great number of ways. Last year is the first time that this complex movement was analyzed.

Olinto asked whether transitions between fields were being included. Mallik responded that astrophysics is but nuclear physics is not.

Trischuk noted that this information might be helpful to P5 and asked if it would be completed in time to inform P5. Mallik said that some of the numbers will be ready, but some will definitely not.

Olinto asked if Wall Street were part of U.S. industry. Mallik responded that it was, but there were questions on how to include it. There also are data on people leaving the profession through retirement, but those data are not shown here. Carithers added that this is 2000 data, which was a down year, depressing the number of people entering the profession.

Robert Sugar was asked to review work on lattice quantum chromodynamics (QCD). In February 2004, the plans of the U.S. lattice gauge theory community to acquire dedicated computers for the study of QCD were presented to HEPAP. HEPAP's judgment that lattice QCD calculations could play a valuable role in high energy physics was instrumental in the DOE's decision to fund dedicated hardware. A great deal of progress has been made in lattice QCD during the past several years in no small part because of the availability of machines.

Lattice QCD calculations have reached the point where some quantities have been calculated to an accuracy that equals or exceeds that of the corresponding experiments, providing checks of the methods used. A limited number of predictions have been made, which were later confirmed by experiment. New algorithms, new formulations of QCD on the lattice, software developed under the DOE's Scientific Discovery Through Advanced Computing (SciDAC) program, and rapid increases in computing power will enable accurate determination of a wide range of important quantities in coming years. It is an exciting time for the field.

The ratio of various quantities calculated on the lattice to their experimental values in the quenched approximation and in full QCD with up, down, and strange sea quarks is very nearly one-to-one.

Predictions have been verified by experiment for f_D, f_{Ds}/f_D, m_{Bc}, and f_B.

And the semileptonic form factors of the D meson are very similar for experiment and calculations.

Areas of focus include the determination of fundamental parameters of the Standard Model and precision tests of the Standard Model; theories for physics beyond the Standard Model; QCD at nonzero temperature and density; and the spectrum, internal structure, and interactions of hadrons.

With a strong coupling constant, the average lattice value is $\alpha_s(m_Z) = 0.1170 \pm 0.0012$, and the world average of perturbative QCD determinations is $\alpha_s(m_Z) = 0.1185 \pm 0.0015$.

For quark masses m_u, m_d, m_s, m_c, and m_b, one can provide input to beyond the Standard Model physics. These values have been calculated to an accuracy of 6% to 10%, and errors are expected to be reduced to the 1% level in the next few years.

A major effort is the determination of weak-interaction matrix elements. Lattice determinations of weak-interaction matrix elements can lead to accurate determinations of CKM matrix elements, precise tests of the Standard Model, and constraints on the nature of new physics that are complementary to the direct searches of the LHC. Only recently full control of all sources of systematic errors has been obtained for some matrix elements, while such control is still to be obtained for others. As work progresses, the magnitude of the systematic errors decreases, and the reliability of the estimates of these errors increases. The work to date provides confidence that weak-matrix elements can be calculated accurately, but the era of precision testing of the CKM paradigm by lattice calculations is just beginning.

A number of amplitudes or determinations, such as those for CKM matrix elements, show low rates of error (1 to 10%) from nonlattice methods. Meson mixing provides important targets for us. The goal is to test the Standard Model to 1%. In the area of weak-matrix elements and fundamental parameters, the LQCD Computing Project Review Committee found that the USQCD is internationally competitive.

Experiments at the LHC are likely to focus interest on strongly coupled field theories that go beyond the Standard Model. Methods for studying such theories are not as well established as those for QCD, but exploratory studies are in progress. The parameter space to be studied is likely to be much larger than for the Standard Model, but the accuracy required will initially be much less stringent. If the Higgs is discovered at the LHC without other new particles, then lattice studies of the Higgs–Top system, could shed new light on the structure of the Standard Model and the energy scale at which new physics is to be expected.

If supersymmetry (SUSY) is discovered at the LHC, then lattice calculations could determine the SUSY breaking mechanism and the particle spectrum, thereby helping to distinguish among competing supersymmetric models. If new strong dynamics for electroweak symmetry breaking is discovered at the LHC, then lattice studies can help to distinguish among the wide range of gauge theories that have been proposed for this scenario. Exploratory work is in progress in each of these areas.

The USQCD Collaboration consists of nearly all of the high-energy and nuclear physicists in the United States involved in the numerical study of lattice QCD. Membership is open to all physicists based in the United States. USQCD was formed 9 years ago with the goal of developing the computational infrastructure needed for the study of lattice QCD and other strongly coupled lattice field theories of interest in high-energy and nuclear physics. USQCD software is publicly available, and its hardware is open to all of its members on a peer-reviewed basis. Members build infrastructure as a community, but do science in groups or as individuals.

Two grants have been received from SciDAC, allowing the writing of efficient code that is currently being optimized. It is used very widely in the United States and abroad. There are two USQCD hardware projects:

- A computer that was specially designed for lattice gauge theory by a group of physicists centered at Columbia University now sustains 4.2 teraflop/s.
- Clusters that sustain 6.2 teraflop/s are in production use at Fermilab and the Thomas Jefferson National Accelerator Facility (TJNAF).

A proposal is in to DOE called LQCD II. The DOE panel recently reviewed the proposal and expressed strong support.

Brau asked how much funding is being asked for LQCD II. Sugar replied, about $4.3 million per year for hardware and programming.

Molzon said that calculations are needed for g-2, and lattice QCD has been put forward as the only way to do those calculations. Sugar did not know of any other way of doing those calculations to the required precision. It *is* doable with lattice QCD.

Shochet initiated a discussion of the letter report to the agencies. He plans to discuss

- The difficult time high-energy physics is in.
- The Omnibus Bill budget has serious applications for all science.
- HEP funding decreased while SC funding increased.
- A compelling vision of high-energy physics needs to be developed.
- HEPAP sees advantages to the new organization of the Office of High Energy Physics and looks forward to seeing how effective it is a year hence.
- At NSF, the 5% decrease in core-research funding is a concern.
- Fermilab, despite layoffs and furloughs, is focusing on Project X, which is aligned with the ILC R&D and incorporates flexibility by being incremental.
- SLAC is shutting down BaBar and PEP II before the data can be collected to completely address essential science.
- Drell raised fundamental questions about the future of high-energy physics and stressed the importance of the P5 recommendations.
- Almost all ILC work in the United States has been stopped; future R&D will focus on work that can be done only in the United States.
- HEPAP has not changed its view of the appropriateness of pursuing the low-cost option for measuring $\sin^2 2\theta$ offered by Double Chooz.
- The Panel had many comments on the work of P5.
- The Panel was pleased that DOE found a way to keep BaBar running for even a short period to collect scientifically important data.
- It is important to understand the workforce dynamics in high-energy physics.
- Lattice QCD enhances the value of many experiments to a great degree.

Shochet opened the floor for comments. Kovar noted that the other pieces of information on high-energy-physics demographics need to be obtained. About half of the students come from outside the United States, and about half the postdocs come from non-U.S. institutions, and half of the faculty from non-U.S. countries. The question is why the United States is not recruiting great, competitive people from its own population. If foreign nationals see the opportunities are elsewhere, they may not come to the United States at all, and the United States would be in real trouble. The field may be in decline.
There being no further discussion, the meeting was adjourned at 12:13 p.m.

The minutes of the High Energy Physics Advisory Panel meeting held at the Palomar Hotel, Washington, D.C., on Feb. 14-15, 2008 are certified to be an accurate representation of what occurred.

Signed by Melvyn Shochet, Chair of the High Energy Physics Advisory Panel on April 15, 2008.

Melvyn J Shochet